Yukon state of the environment
interim report 2021

A report on
environmental indicators

Yukon

Acknowledgements

Reviewers and contributors

Government of Yukon

Department of Environment: Nicole Goldring, Michal Wojcik, Kirsten Burrows, Katie Woodstock, Aletta Leitch, Maxine White, Elizabeth Barker, Marie Ducharme, Alexandre Mischler, Holly Goulding, Jonathan Kolot, Cameron Sinclair, Pascale Savage, Bruce Bennett, Lars Jessup, Peter Knamiller, Mark O'Donoghue, Thomas Jung, Charles Krebs, Alice Kenney, Scott Gilbert, Piia Kukka, Traci Morgan, Shawn Taylor, Tyler Kuhn, Amy Law and Jane Harms

Department of Energy, Mines and Resources: Robert Legare, Celine Theriault and Krysti Horton

Yukon Bureau of Statistics: Gary Brown

Others

City of Whitehorse: Sarah Preiksaitis

Fisheries and Oceans Canada: Oliver Barker

Research institutions: YukonU Research Centre, Yukon University

Yukon Land Use Planning Council: Nick Grzybowski

Photos

Published 2021

ISBN: 978-1-55362-881-1

On the cover: Grizzly Bears in Kluane National Park. Photo by Zachary Tng.

Table of contents

Highlights

Climate change

Trends in greenhouse gas levels

Yukon's greenhouse gas emissions increased 23.7 per cent between 2009 and 2019, with 783.2 kilotonnes of greenhouse gases emitted in 2019.

Arctic sea ice extent and volume

Approximately 280 km^3 of sea ice is lost every year. Remaining sea ice is becoming younger and thinner.

Long-term temperature variation

Precipitation in Yukon has increased by about six per cent over the past 50 years. Since 1948, annual temperatures in northern Canada have increased by 2.3°C, with temperature rising most rapidly in Yukon and the Northwest Territories.

Air

Levels of particulate matter

Overall, Yukoners enjoy good air quality with levels of fine particulate matter in Whitehorse remaining some of the lowest across urban areas in Canada.

Water

Water quality

Over the last several years, the Yukon River upstream of the Takhini River has consistently received the highest Water Quality Index (WQI) score in Yukon, which indicates the status of water quality and the suitability of streams to support aquatic life.

Yukon River ice breakup at Dawson City

In Dawson City, the Yukon River breakup occurred on May 3, 2020, around 5 p.m.

Land

Population of Yukon

From June 2019 to June 2020, the total Yukon population increased by 794 people, or 1.9 per cent.

Waste handled at the Whitehorse waste management facility

In 2019, Whitehorse residents sent an average of 570 kg of waste to the landfill. This is a decrease from 620 kg in 2018. Thirty-three per cent of waste was diverted from the Whitehorse landfill through recycling and composting in 2019.

Presence of alien and introduced species

As of November 2020, an estimated 228 alien species have been identified in Yukon, including vertebrates, invertebrates, plants and fungi.

Fish and wildlife

Density of Snowshoe Hares

Snowshoe Hare numbers have undergone a cyclical decline throughout Yukon from a peak in 2016-2018.

Number of spawning Chinook Salmon

In 2020, the spawning escapement goal for Yukon River Chinook Salmon was not met, with an estimate of just under 31,000 fish reaching their spawning grounds in Yukon. This is the second time the spawning escapement goal was not achieved since 2013.

Monitoring wild sheep and goat health

Mycoplasma ovipneumoniae was not detected in the 443 thinhorn sheep and 10 Mountain Goats tested between 2015 and 2020.

Introduction

Yukon state of the environment reporting gives an annual overview of the status of Yukon's environment and guides future planning through updates on several key indicators. The *Environment Act* requires release of a full report every three years, and an interim report in the years between. This interim report builds and comments on data presented in the ***Yukon state of the environment report 2020***.

The conclusions in this interim report are based on information available at the end of the 2020 calendar year, drawn from scientific experts, government agencies and non-government organizations. The base year for comparing trend data in this report is 2017. Collecting, analyzing and reporting data can take up to 36 months. Assessment of some indicators is still ongoing. For a more complete snapshot of all indicators, consult the previous full report.

Climate change

Trends in Yukon greenhouse gas levels

Significance

Greenhouse gases (GHGs) trap heat in the atmosphere, keeping the Earth's surface warmer than it would be in their absence. This process is essential for sustaining life on the planet, but burning fossil fuels has increased the amount of GHGs in the atmosphere, which enhances the warming effect and results in changes to the climate.

GHG emissions include carbon dioxide, methane and nitrous oxide, among others. Carbon dioxide is the principal contributor to human-caused increases of atmospheric levels of GHGs; therefore, it is used as a basis to compare all greenhouse gases. Carbon dioxide equivalent (CO_2e) is the measure most often used to compare emissions from various GHGs based on their potential to contribute to climate change.

Tracking Yukon's GHG emissions (in units of kilotonnes of CO_2e) enables us to identify the major sources of emissions and opportunities for reducing them, as well as quantifying Yukon's contributions to national and global emissions.
The observed and predicted rate and magnitude of temperature change in Yukon is among the highest in Canada.

The Government of Yukon is taking action to limit GHG emissions produced from its operations and those from key sectors. The Government of Yukon is also working on climate change adaptation in the short and long-term. These measures consider Yukon's unique challenges, including high demand for heat during cold winters, an isolated electricity grid and the long distances required to ship goods into the territory.

What is happening?

The Government of Yukon works with local and federal partners to prepare an emissions profile for Yukon each year. Knowledge of our greenhouse gas emissions is necessary to support effective policies and programs to reduce GHG emissions. Two data sets are available to support an understanding of Yukon's GHG emissions.

- Emissions estimates by Environment and Climate Change Canada for Yukon (Canada's Greenhouse Gas Inventory), found in the ***National Inventory Report 1990-2019: Greenhouse Gas Sources and Sinks in Canada.***
- Emissions estimates by the Yukon Bureau of Statistics.

The Government of Yukon is continuing its work with Environment and Climate Change Canada as well as Statistics Canada to improve accuracy in federal data collection and reporting. Currently the Government of Yukon uses a combination of data from Environment and Climate Change Canada and the Yukon Bureau of Statistics' fuel tax database in its greenhouse gas emissions reporting. This is to make use of the best available data from both sources.

Summary points from the 2019 Yukon GHG Inventory

- Emissions have increased by 23.7 per cent between 2009 and 2019.
- Including mining activity, Yukon's total GHG emissions for 2019 were 783.2 kilotonnes of carbon dioxide equivalent.

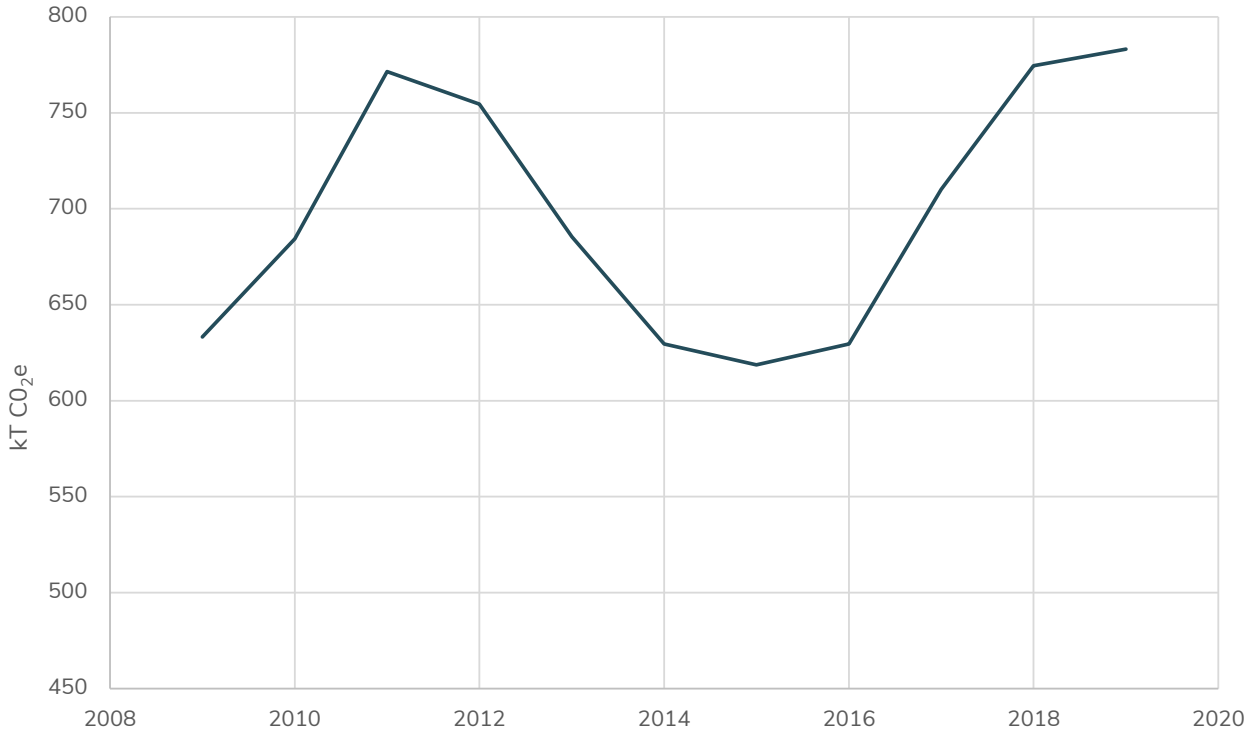


Figure 1: Total Yukon-wide emissions of carbon dioxide equivalent, 2009 to 2019.

- Transportation accounts for the largest share of greenhouse gas emissions in Yukon: 72 per cent of the total in 2019. Approximately half of these emissions come from passenger vehicles, with the other half from commercial and industrial transportation.
- After transportation, space heating from fuel oil and propane is the next highest source of GHG emissions in Yukon at 15 per cent. Electricity generation accounts for four per cent of Yukon's emissions.

National comparison

- Canada is ranked amongst the highest of all countries in the world in terms of per capita GHG emissions. Canadians produced 730,000 kilotonnes of $C0_2e$ in 2019, about 21 per cent above 1990 levels (Environment and Climate Change Canada 2021).
- Per capita emissions in Yukon in 2019 were 18.9 tonnes per person. Compared to the per capita emissions of the 12 other provinces and territories as reported in the National Inventory Report, Yukon's per capita emissions rank sixth out of 13.
- Yukon's total GHG emissions contributed 0.1 per cent towards the national total in 2019.

Taking action

The Government of Yukon released ***Our Clean Future: A Yukon strategy for climate change, energy and a green economy***, in September 2020 (Government of Yukon 2020). ***Our Clean Future*** was developed collaboratively with Yukon First Nations, transboundary Indigenous groups and Yukon municipalities. It sets out 131 actions the Government of Yukon will take to reduce greenhouse gas emissions, enhance energy security, adapt to the impacts of climate change and build a green economy. It also includes actions that Indigenous and municipal partners will undertake to work toward our collective goals and objectives.

Through ***Our Clean Future***, Yukon will reach several ambitious climate change and energy targets, including:

- a 45 per cent reduction in greenhouse gas emissions from transportation, heating, electricity generation and other areas by 2030;
- a 97 per cent renewable energy generation on Yukon's main electricity grid on average by 2030; and
- net zero greenhouse gas emissions across the entire economy by 2050.

Data quality

Until 2016, the GHG emissions indicator was based on data provided Environment and Climate Change Canada via the ***National Inventory Report*** (NIR). It presents GHG information annually for Yukon in kilotonnes of CO_2e by sector (energy, industrial processes and product use, agriculture and waste). All National Inventory Reports are accessible online (Environment and Climate Change Canada 2021).

Since 2016, the Government of Yukon draws from both the Yukon Bureau of Statistics' tax and finance data and the National Inventory Report in order to use the most accurate data available. The methods used to calculate Yukon's greenhouse gas emissions by both the Yukon Bureau of Statistics and Environment and Climate Change Canada are continuously improved as better information becomes available. This means that emissions reported in previous years may be revised upwards or downwards in subsequent years. Methodology improvements are applied to previous years to make sure that emissions reported for each year are directly comparable to one another. For example, Yukon's greenhouse gas emissions in 2018 were 1.8 per cent higher than previously reported, largely due to improvements in how Environment and Climate Change Canada calculates Yukon's emissions from waste sites such as landfills. More information on how greenhouse gas emissions are calculated can be found in the Government of Yukon's greenhouse gas emissions reports.

The Government of Yukon will continue to work with Environment and Climate Change Canada as well as Statistics Canada to improve data accuracy, and in the meantime, will assess and report Yukon data from both local and federal sources to inform our understanding of Yukon's GHG emissions.

References

Environment and Climate Change Canada. 2021. National Inventory Report 1990-2019: Greenhouse Gas Sources and Sinks in Canada. Environment and Climate Change Canada, Gatineau, Quebec, Canada. Available from: https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/inventory.html.

Government of Yukon. 2020. Our Clean Future: A Yukon strategy for climate change, energy and a green economy. Government of Yukon, Whitehorse, Yukon, Canada. Available from: https://yukon.ca/en/our-clean-future-yukon-strategy-climate-change-energy-and-green-economy.

Intergovernmental Panel on Climate Change (IPCC). 2014. Climate Change 2014 Synthesis Report. IPCC, Geneva, Switzerland. Available from: https://ar5-syr.ipcc.ch/.

Arctic sea ice extent and volume

Significance

Arctic sea ice is melting, as indicated by changes in the extent and volume of ice across Arctic and northern oceans. Less and less ice is remaining from one year to the next, and the ice that lasts more than one season is thinning significantly.

The net result, if this trend continues, is that summer sea ice will be nearly non-existent across the Arctic by the end of the century. This has wide-ranging implications for the Arctic and the globe, including increased coastal erosion, changes to atmospheric circulation in distant locations, damage to human infrastructure and negative impacts on species that depend on sea ice.

What is happening?

- Arctic sea ice is melting, reducing both the minimum annual sea ice area and its overall volume. Sea ice melt also appears to be accelerating, with most of the melt occurring in the past decade.
- **Figure 1** shows the annual extent (area) in September (in millions of square kilometres) of Arctic sea ice with at least 15 per cent ice concentration.
- **Figure 2** shows the annual Arctic September sea ice volume (in thousands of cubic kilometres).
- September sea ice loss in the circumpolar Arctic averages 83,700 km^2 per year, although there is significant variability from one year to the next, and more recent losses have exceeded earlier losses.
- Approximately 280 km^3 of sea ice volume is lost per year. Remaining sea ice is becoming younger and thinner.

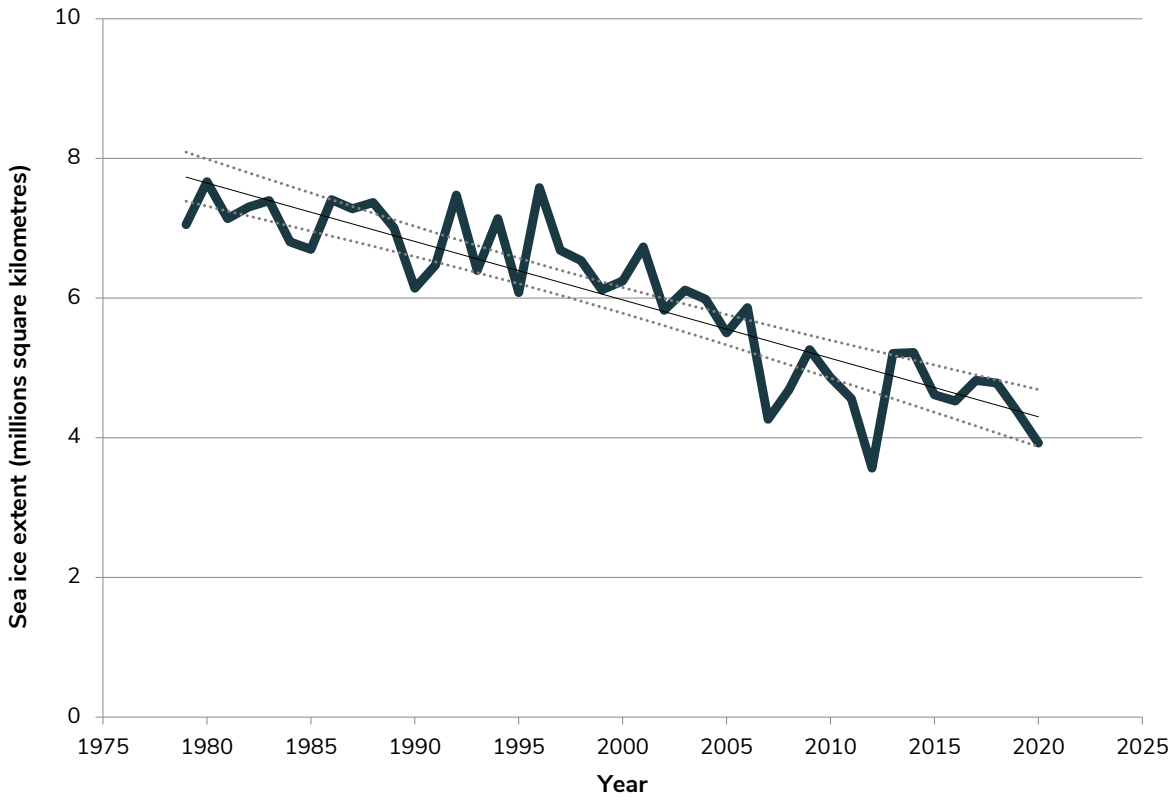


Figure 1: Arctic September sea ice area minimum 1979-2020 (measured in September).

Source: National Snow and Ice Data Centre, University of Colorado Boulder. Graph prepared by YukonU Research Centre, Yukon University.

Taking action

Actions to reduce greenhouse gas emissions in Yukon, as detailed in ***Our Clean Future: A Yukon strategy for climate change, energy and a green economy***, will contribute to global efforts to lessen the long-term negative impacts of the trends presented in this indicator (Government of Yukon 2020).

Data quality

- The National Snow and Ice Data Centre gather satellite data to make calculations for sea ice extent. You can find this data at: nsidc.org/data/g02135.
- For sea ice volume, the University of Washington Pan-Arctic Ice-Ocean Modeling and Assimilation System (PIOMAS) makes data available at: psc.apl.uw.edu/research/projects/arctic-sea-ice-volume-anomaly/data/.

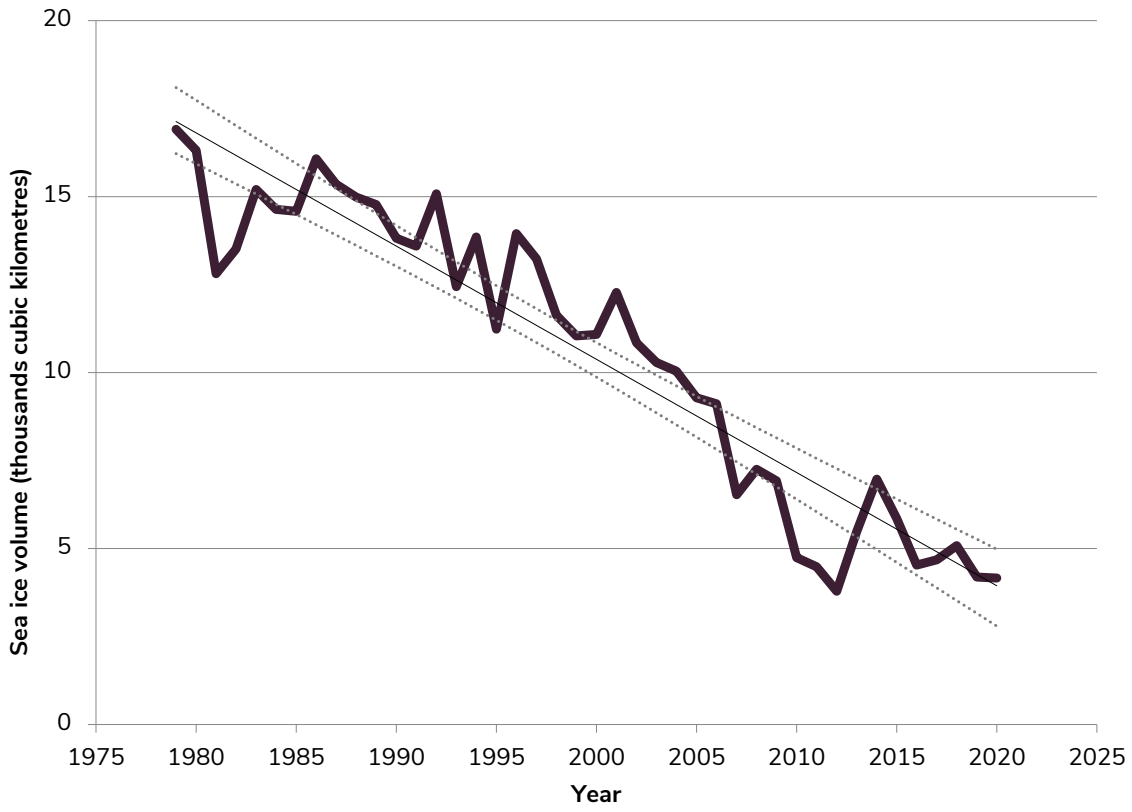


Figure 2: Arctic September sea ice volume minimum 1979-2020 (measured in September).

Source: Polar Science Center, University of Washington. Graph prepared by YukonU Research Centre, Yukon University, 2020.

References

Fetterer F., K. Knowles, W. N. Meier, M. Savoie and A. K. Windnagel. NSIDC: National Snow and Ice Data Center [cited 2020 Dec 14]. University of Colorado Boulder, Boulder, Colorado, USA. Available from: https://nsidc.org/.

Government of Yukon. 2020. *Our Clean Future: A Yukon strategy for climate change, energy and a green economy*. Government of Yukon, Whitehorse, Yukon, Canada. Available from: https://yukon.ca/en/our-clean-future-yukon-strategy-climate-change-energy-and-green-economy.

National Snow and Ice Data Center. Arctic Sea Ice News and Analysis - September 2020. [modified 2020 Oct 05, cited 2020 Nov 20]. University of Colorado Boulder, Boulder, Colorado, USA. Available from: https://nsidc.org/data/g02135.

Polar Science Center, Applied Physics Laboratory. 1979- 2019. PIOMAS Daily Ice Volume Data, 1979-present [cited 2020 Nov 18]. University of Washington, Seattle, Washington, USA. Available from: https://psc.apl.uw.edu/research/projects/arctic-sea-ice-volume-anomaly/data/.

Polar Science Center. PIOMAS Arctic Sea Ice Volume Reanalysis [cited 2020 Nov 26]. Available from: https://psc.apl.uw.edu/research/projects/arctic-sea-ice-volume-anomaly/.

Streicker J. 2016. Yukon Climate Change Indicators and Key Findings 2015. Northern Climate ExChange, Yukon Research Centre, Yukon College, Whitehorse, Yukon, Canada. Available from: https://yukonu.ca/sites/default/files/inline-files/Indicator_Report_Final_web.pdf.

Long-term precipitation and temperature variation

Significance

Changes in temperature and precipitation are two of the most commonly used variables to demonstrate changes in climate. Since 1948, rain and snowfall increased by six per cent in Yukon and has become more unpredictable. Tracking temperature and precipitation variation helps us see how rising global greenhouse gas emissions are impacting Yukon's climate. It also helps us to prepare and adapt to these impacts, as well as predict what impacts future changes in temperature may bring.

What is happening: Precipitation

Annual precipitation

- Precipitation variability is measured by the departure from a baseline which is presented as the 30-year average from 1961 to 1990. Precipitation departures are given as a percentage change from this average (Figure 1).
- Precipitation in Yukon has increased by about six per cent over the past 50 years.
- The largest increase in precipitation occurred in summers.
- There is variability in terms of where precipitation occurs in the territory, and what time of year it occurs.

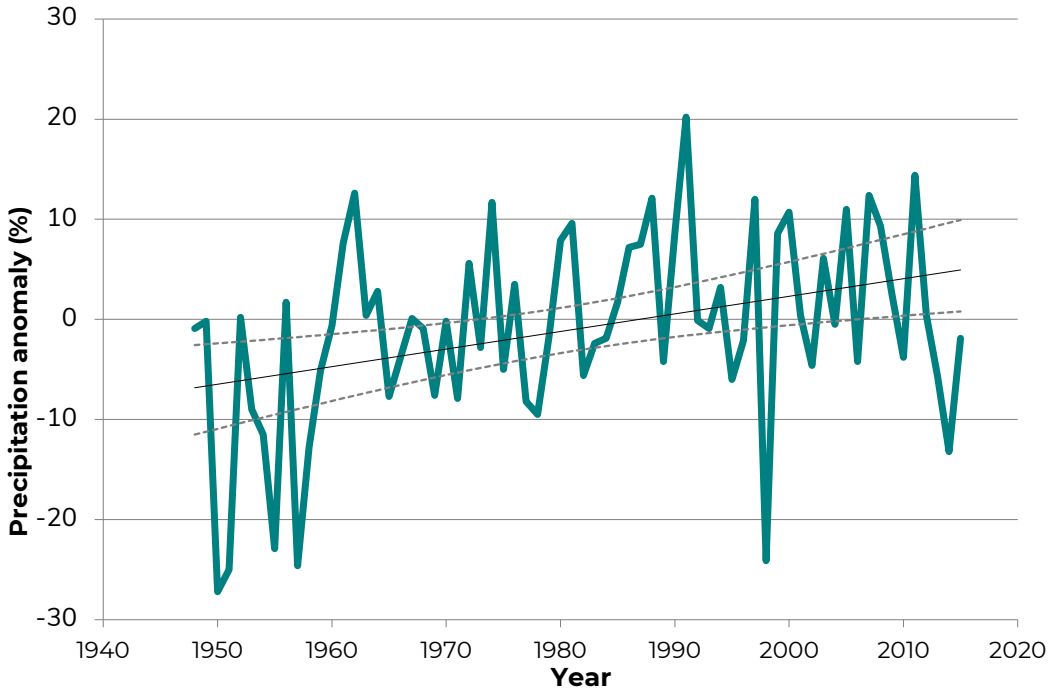


Figure 1: Yukon annual precipitation variability, 1950-2016.

Source: Environment and Climate Change Canada, Climate Research Branch (2016) Climate Trends and Variations Bulletins.

Projected precipitation

- Global studies, including the 2014 Intergovernmental Panel on Climate Change Fifth Assessment Report, show that climate scenarios project a significant increase in precipitation over the next 50 years (Figure 2).
- The three different lines in Figure 2 represent three potential precipitation futures based on emissions scenarios developed by the Intergovernmental Panel on Climate Change.
- All scenarios show an increase in precipitation and its variability.

What is happening: Temperature

Annual temperature

Monitoring the temperature departures from the average over the past 30 years helps us to understand the rate and extent of changes occurring in Yukon.

Temperature variability is measured by the departure from a baseline which is represented as the 30-year average from 1961 to 1990. Temperature departures are given as a change in °C from this average (Figure 3).

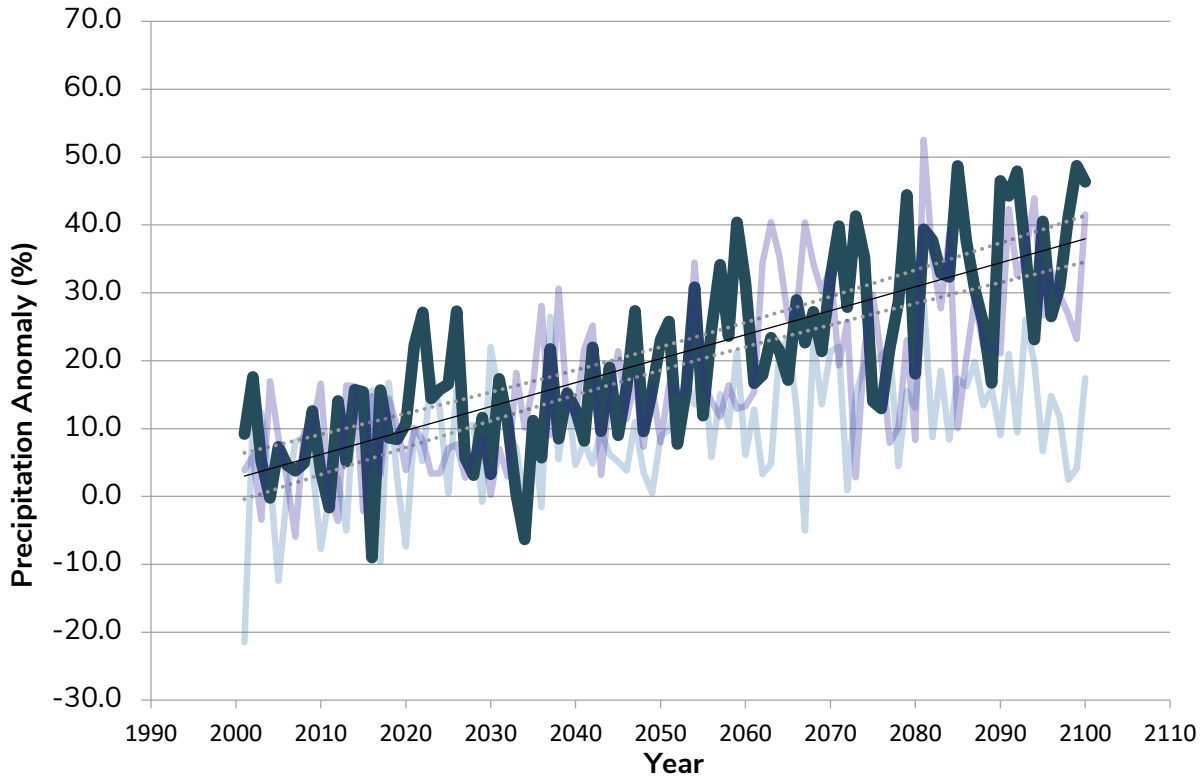


Figure 2: Yukon projected annual precipitation anomalies (A2, A1B, B1)*.

Source: Environment and Climate Change Canada, Climate Research Branch (2016), Climate Trends and Variations Bulletins.

*A2, A1B and B1 are different future emission scenarios that have been developed by the Intergovernmental Panel on Climate Change. Further detail on those scenarios can be found at: ipcc.ch/site/assets/uploads/2018/02/ar4-wg1-chapter8-supp-material-1.pdf.

Since 1948:

- Temperatures in northern Canada have already increased by 2.3 degrees Celsius, with temperature rise being most rapid in Yukon and the Northwest Territories. This is close to three times the rate at which global temperatures are rising.
- Winter temperatures have increased by approximately 5°C.

Projected temperature

- Global studies, including the 2014 Intergovernmental Panel on Climate Change Fifth Assessment Report, show that climate scenarios project a significant increase of more than 2°C in temperature globally over the next 50 years (Figure 4).
- Winters are projected to warm faster than other seasons.

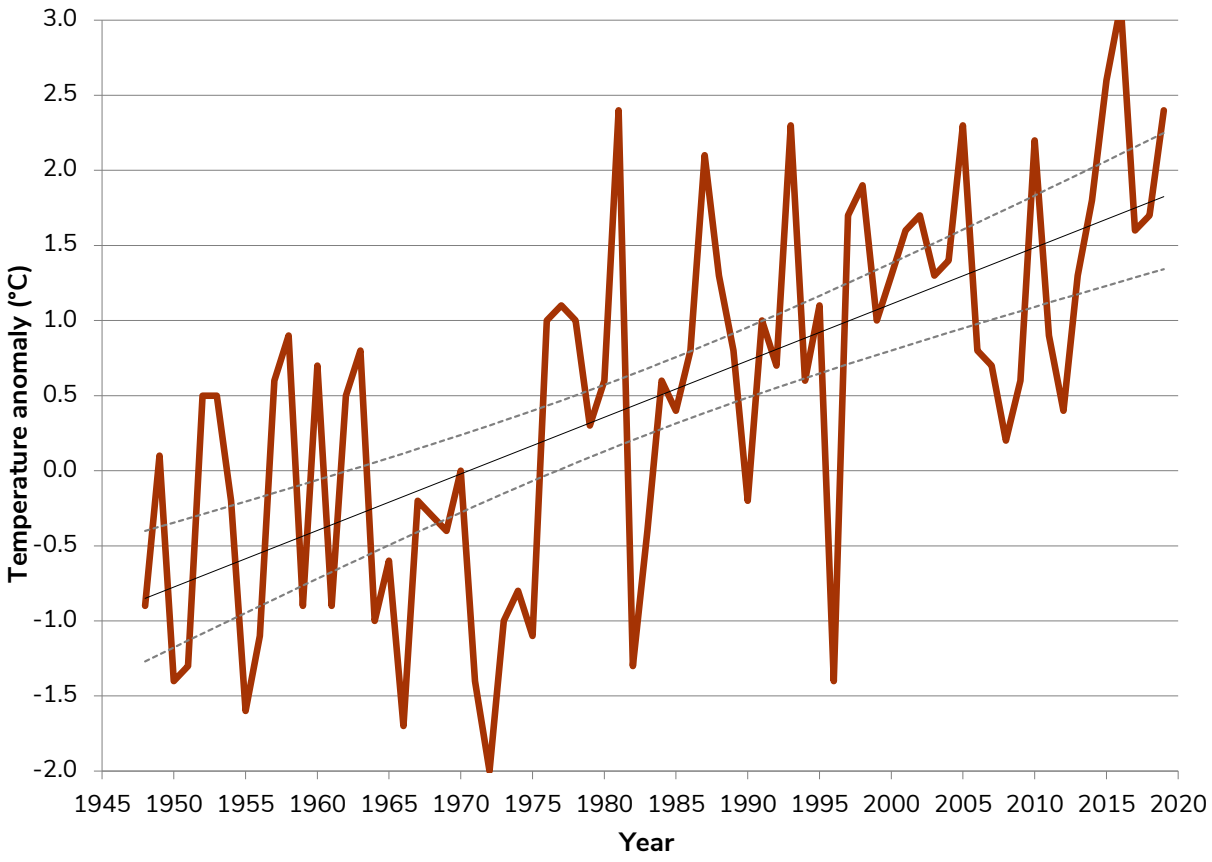


Figure 3: Yukon annual temperature anomaly 1945-2019.

Source: Environment and Climate Change Canada. Graph prepared by YukonU Research Centre, Yukon University.

Taking action

Reducing greenhouse gas emissions in Yukon will contribute to global efforts to lessen the long-term negative impacts of the trends in precipitation and temperature variation.

Our Clean Future: A Yukon strategy for climate change, energy and a green economy sets out a target to "make sure that Yukon is highly resilient to the impacts of climate change by 2030." To reach this goal, we will increase Yukon's resiliency to climate change by taking action to reduce our exposure to climate hazards like wildfires and flooding, decrease how sensitive we are to those hazards, and increase our capacity to adapt. Our actions will be informed by Indigenous, local and scientific knowledge and ways of knowing, doing and being. Our efforts will touch on infrastructure, housing, land use planning, emergency preparedness, ecosystem health, food security, and health and wellbeing in recognition of how broadly climate change can affect our lives.

Through the monitoring of indicators such as precipitation and temperature, we are able to make informed, forward-looking decisions to minimize the negative impacts that climate change may have on our health, well-being, ways of life and livelihoods.

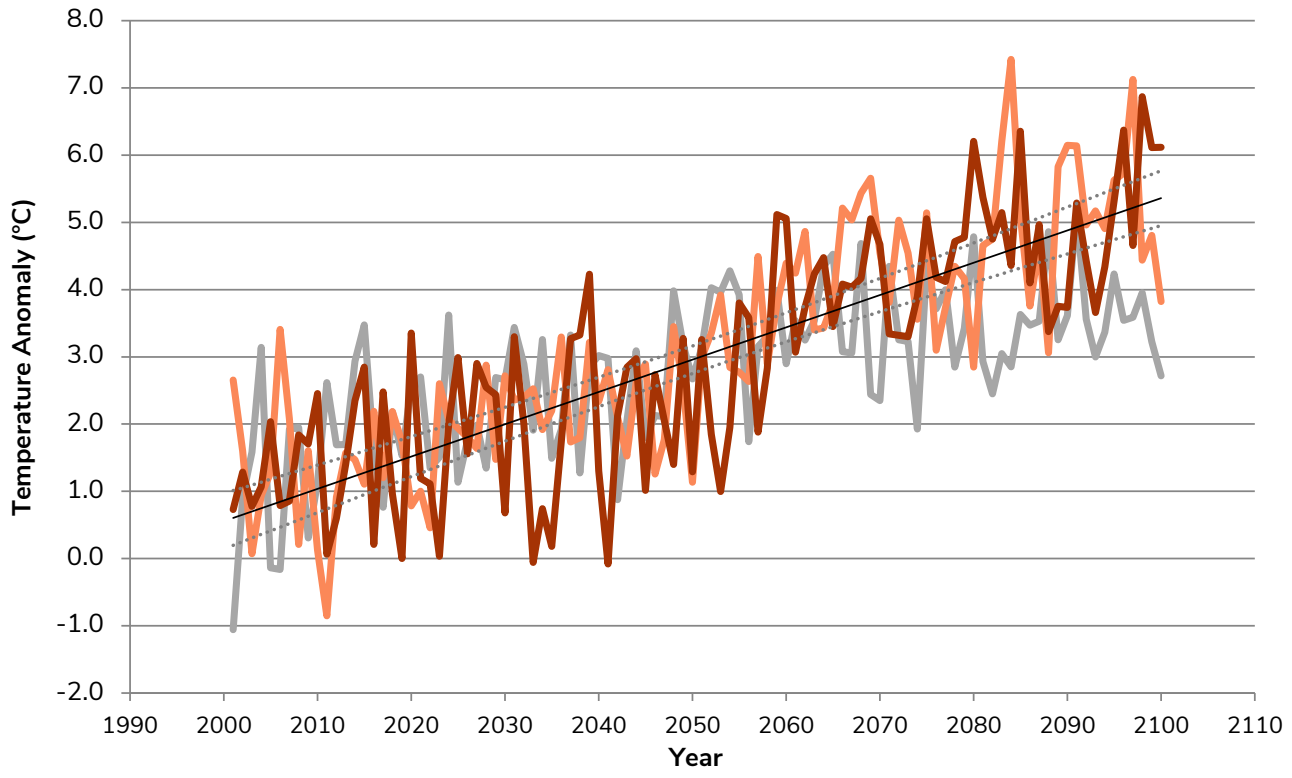


Figure 4: Yukon projected annual temperature anomalies (A2, A1B, B1)*.

Source: Environment and Climate Change Canada, Climate Research Branch (2016) Climate Trends and Variations Bulletins.

* A2, A1B and B1 are different future emission scenarios that have been developed by the Intergovernmental Panel on Climate Change. Further detail on those scenarios can be found at: ipcc.ch/report/emissions-scenarios/.

Data quality

The data are exclusively from Environment and Climate Change Canada's Climate Trends and Variations Bulletins.

The data spans from 1948 to present and are complete. Northern British Columbia is included in Environment and Climate Change Canada data. Canada regionally separates data, meaning results could be skewed towards southern Yukon.

There is uncertainty in the identified trends for precipitation because data are collected over a large area with uneven coverage (particularly for winter precipitation), and because of differences in instrument methodology over time.

Data is currently only available to 2016 because of changes to precipitation monitoring within Environment and Climate Change Canada. The update and reporting of historical adjusted precipitation trends and variations is currently on hold pending extensive data reconciliation.

However, these data findings are supported by local Yukon and Northern-specific research and data that can be found in the ***Yukon Climate Change Indicators and Key Findings 2015*** report.

The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of global climate change. The 2014 Intergovernmental Panel on Climate Change Fifth Assessment Report is a reputable synthesis of current climate change knowledge captured from 9,200 peer-reviewed scientific publications.

References

Bush E. and D.S. Lemmen, editors. 2019. Canada's Changing Climate Report. Government of Canada, Ottawa, Ontario, Canada.

Environment and Climate Change Canada, Climate Research Branch. 2014-2015. Climate Trends and Variations Bulletins [modified 2018 Dec 10, cited 2021 Jan 9]. Available from: https://www.canada.ca/en/environment-climate-change/services/climate-change/science-research-data/climate-trends-variability/trends-variations.html.

Environment and Climate Change Canada, Climate Research Branch. 2020. Climate Trends and Variations Bulletin 2019 [modified 2020 Feb 17, cited 2020 Nov 25]. Available from: https://www.canada.ca/en/environment-climate-change/services/climate-change/science-research-data/climate-trends-variability/trends-variations/annual-2019-bulletin.html.

Government of Yukon. 2020. Our Clean Future: A Yukon strategy for climate change, energy and a green economy. Government of Yukon, Whitehorse, Yukon, Canada. Available from: https://www.yukon.ca/en/our-clean-future-yukon-strategy-climate-change-energy-and-green-economy.

Intergovernmental Panel on Climate Change (IPCC). 2000. Special Report on Emissions Scenarios. Cambridge University Press, Cambridge, UK. Available from: https://www.ipcc.ch/report/emissions-scenarios/.

Intergovernmental Panel on Climate Change (IPCC). 2014. Climate Change 2014 Synthesis Report. IPCC, Geneva, Switzerland. Available from: https://ar5-syr.ipcc.ch/.

Scenarios Network for Alaska Planning (SNAP). 2011. Climate Projections for Yukon. Unpublished data produced for the Northern Climate ExChange, Yukon College, Whitehorse, Yukon.

Streicker J. 2016. Yukon Climate Change Indicators and Key Findings 2015. Northern Climate ExChange, Yukon Research Centre, Yukon College, Whitehorse, Yukon, Canada. Available from: https://www.yukonu.ca/sites/default/files/inline-files/Indicator_Report_Final_web.pdf.

Air

Levels of particulate matter

Significance

Poor air quality can affect public health and the environment. When it comes to pollutants in the air, fine particulate matter ($PM_{2.5}$) is of particular concern. $PM_{2.5}$ consists of airborne solid or liquid particles that are smaller than 2.5 micrometres in diameter. $PM_{2.5}$ comes from various natural and human activities, including wildfires, windblown soil and dust, pollen, burning of fossil fuels, residential woodstoves and industrial activity (McKendry 2006).

Exposure to $PM_{2.5}$ has been linked to a variety of serious health issues including asthma attacks, chronic bronchitis and heart attacks (Environment and Climate Change Canada 2020). The elderly, children and people with chronic respiratory illnesses are most at risk, but even healthy people can experience temporary symptoms. Both short-term (24-hour) and long-term (a year or more) exposure can have negative effects on human health.

$PM_{2.5}$ may also affect the environment in various ways. High levels of $PM_{2.5}$ can impair visibility, which may affect driving, aviation and outdoor sports or recreational activities like fishing, hiking or camping. High levels of $PM_{2.5}$ can change the nutrient and/or acidity balance in soil or water when $PM_{2.5}$ carried by the wind, settles on the ground. Furthermore, black carbon, a component of $PM_{2.5}$, is considered a short-lived climate pollutant.

Air quality monitor unit in Dawson City.

These pollutants have a relatively short lifetime in the atmosphere, a few days to a few decades, and are generally more potent than carbon dioxide in terms of their climate warming potential.

Air quality monitor unit in Whitehorse.

What is happening?

Under the federal Air Quality Management System, each province and territory in Canada is responsible for reporting $PM_{2.5}$ levels. $PM_{2.5}$ levels are calculated using two statistical forms called the annual $PM_{2.5}$ metric and the 24-hour $PM_{2.5}$ metric. Once calculated, these metrics are compared to the Canadian Ambient Air Quality Standards (CAAQS) to determine if the standards are achieved.

The CAAQS for $PM_{2.5}$ are achieved when the annual metric is 10.0 micrograms per cubic metre (µg/m^3), or lower, and when the 24-hour metric is 28 µg/m^3, or lower.

For this reporting period, the 2019 annual metric in Whitehorse for $PM_{2.5}$ was 3.8 µg/m^3 and the 2019 24-hour metric for $PM_{2.5}$ was 21 µg/m^3. When measured against the CAAQS for $PM_{2.5}$ the metrics achieved were well within the standards. A summary of the $PM_{2.5}$ metric values and their corresponding achievement status can be found in Table 1 below.

Table 1: Yukon $PM_{2.5}$ metric values (2014-2019).

Pollutant	Averaging Time	2019	2018	2017	2016	2015	2014
$PM_{2.5}$	24-Hour	21.0	16.8	-	-	-	18.9
	Annual	3.8*1	3.7	-	-	-	5.9
CAAQS Achievement Status		Achieved	Achieved	n/a	n/a	n/a	Achieved

- metric value not calculated due to data incompleteness.

*1 metric values based on only two of the required three years of data.

As shown in Table 1, data sets from previous years are incomplete, therefore it is not possible to compare annual and 24-hour $PM_{2.5}$ metrics through the years. As more data becomes available, historic and current metrics will be compared to identify trends.

Although the CAAQS for $PM_{2.5}$ were achieved in 2019, higher levels of $PM_{2.5}$ were observed in the summer and winter months.

Higher levels of $PM_{2.5}$ in the summer of 2019 likely came from smoke from wildfires burning inside and outside Yukon. Wildfire smoke is a natural source of $PM_{2.5}$.

Higher levels of $PM_{2.5}$ in the winter of 2019 is more likely a result of human-caused, local sources. Residential wood burning for heating purposes is estimated to be the largest source of $PM_{2.5}$ in the Whitehorse area during cold winter months. Vehicle emissions can also contribute to higher levels of $PM_{2.5}$ in the winter.

Another factor contributing to higher levels of $PM_{2.5}$ in winter are atmospheric phenomena known as temperature inversions.

Temperature inversions occur when air higher in the atmosphere is warmer than air closer to the ground. Inversions act like a cap on the atmosphere, preventing the dispersion of $PM_{2.5}$ away from valley bottoms, essentially trapping the $PM_{2.5}$. In Yukon, the two most populated communities, Whitehorse and Dawson City, are located in valleys and are often subjected to temperature inversions.

Although Yukon occasionally experiences elevated levels of $PM_{2.5}$ as a result of natural and human caused activities, the territory maintains the lowest average concentration of $PM_{2.5}$ across Canadian urban areas (Environment and Climate Change Canada 2016).

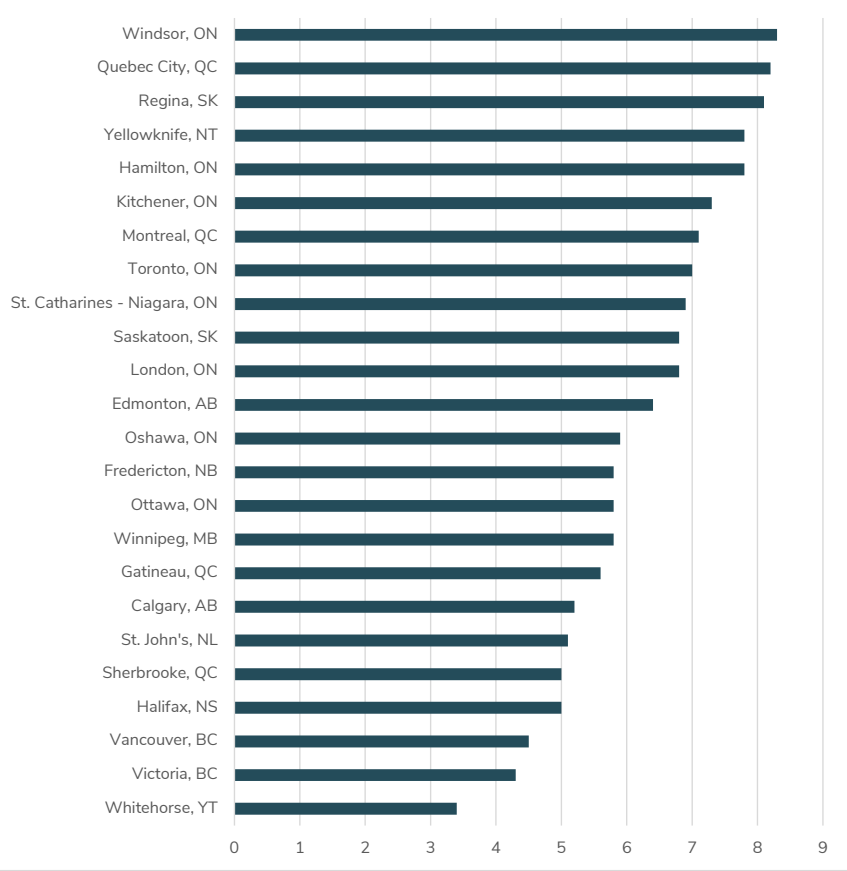


Figure 1: Average $PM_{2.5}$ Concentrations, selected Canadian urban areas, 2016 (annual ambient concentration in $\mu g/m^3$).

Taking action

Yukon Ambient Air Quality Standards have been developed under the ***Environment Act*** to protect human health and the environment. In 2019, Yukon's 24-hour average standard for $PM_{2.5}$ changed from 28 to 27 µg/m^3 and the annual average standard from 10 to 8.8 µg/m^3. These changes were made to align Yukon standards with the national CAAQS.

The Government of Yukon maintains a long-term air quality station to monitor levels of $PM_{2.5}$ in Whitehorse. This station is part of the National Air Pollution Surveillance (NAPS) network. Continuous, 24/7-monitoring of $PM_{2.5}$ provides an indication of the state of, and trends in, local air quality. Additionally, continuous monitoring provides a point of comparison of Yukon air quality to national results.

In addition to NAPS monitoring, the Government of Yukon in partnership with Health Canada, is continuing to monitor $PM_{2.5}$ in Whitehorse through the Whitehorse Air Quality Monitoring Study. This study, which originally began in 2015, is continuing to collect data from eight monitoring stations in Whitehorse and one in Dawson City (installed in 2018). Data from these stations will be used to determine the levels and spatial variability of $PM_{2.5}$ pollution in the various neighbourhoods, and subsequently enable partners to make decisions on actions that need to be taken in high-pollutant neighbourhoods. These actions could range from continued air quality monitoring to the development of woodstove or firewood incentive programs. This study was planned for completion in the spring of 2020, however due to COVID-19 and subsequent travel restrictions for out of territory partners, the study has been extended and is anticipated to end in 2021.

Roof of NAPS station showing sampling equipment.

Interface of the $PM_{2.5}$ monitor at the NAPS station.

Data quality

2019 data used to calculate the annual $PM_{2.5}$ metric and the 24-hour $PM_{2.5}$ metric was obtained from the downtown Whitehorse NAPS station. Before being used to calculate the $PM_{2.5}$ metrics, the data was reviewed and validated in accordance with the procedures outlined in the 2019 Canadian Council of Ministers of the Environment (CCME) ***Ambient Air Quality Monitoring and Quality Assurance/Control Guidelines***.

More about the $PM_{2.5}$ metrics:

- The $PM_{2.5}$ metrics are calculated following procedures outlined in the 2012 CCME ***Guidance Document on Achievement Determination Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone***.
- The statistical form of the $PM_{2.5}$ annual metric is the three-year average of the annual concentrations of $PM_{2.5}$. The statistical form of the $PM_{2.5}$ 24-hour metric is the three-year average of the annual 98th percentile of the daily average concentrations of $PM_{2.5}$.
- The downtown Whitehorse NAPS Station was replaced in the fall of 2019 and as a result, Quarter 4 of 2019 did not meet the CCME prescribed data completeness criteria. Consequently, all data from the year 2019 has been omitted from the $PM_{2.5}$ annual metric calculation. The 2019 $PM_{2.5}$ annual metric is based on air quality data from only two of the required three years of data (2017 and 2018).

Profile

$PM_{2.5}$ small sensor pilot project

Currently, most of Yukon's air quality monitoring data is based on monitoring results collected from Whitehorse. In an effort to expand Yukon's air quality monitoring network beyond Whitehorse, the Government of Yukon has partnered with Environment and Climate Change Canada and researchers at the University of Northern British Columbia to implement a $PM_{2.5}$ small sensor pilot project.

This pilot project is in the early stages and is currently testing the reliability of the $PM_{2.5}$ sensors in a Northern climate.

Currently, $PM_{2.5}$ sensors have been installed in Dawson City, Pelly Crossing, Carmacks, Ross River, Faro, Teslin, Haines Junction, Watson Lake and Whitehorse, and there are plans to have one installed in Burwash Landing. The Government of Yukon is striving to have a $PM_{2.5}$ sensor installed in each community across the territory by the end of 2021.

An online, publicly accessible map showing real time results of the $PM_{2.5}$ sensors can be found online by searching for "UNBC AQ Map."

$PM_{2.5}$ small sensor (small white item on building) installed in Faro.

References

Canadian Council of Ministers of the Environment (CCME). 2012. Guidance Document on Achievement Determination Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone. PN 1483, ISBN 978-1-896997-91-9 PDF. CCME, Winnipeg, Manitoba, Canada. Available from: https://ccme.ca/en/res/gdadforozonecaaqsen.pdf.

Canadian Council of Ministers of the Environment (CCME). 2019. Ambient Air Monitoring and Quality Assurance/Quality Control Guidelines: National Air Pollution Surveillance Program. PN 1599, ISBN 978-1-77202-056-4 PDF. CCME, Winnipeg, Manitoba, Canada.

Environment and Climate Change Canada. 2018. Canadian environmental indicators: Air quality [Cited 2020 Nov 23]. Available from: https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/air-quality.html.

Environment and Climate Change Canada. 2020. Canadian environmental indicators: Population exposure to outdoor air pollutants [Cited 2020 Nov 23]. Available from: https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/population-exposure-outdoor-air-pollutants.html.

McKendry I.G. 2006. Background Concentrations of $PM_{2.5}$ and Ozone in British Columbia, Canada. British Columbia Ministry of Environment, Victoria, British Columbia, Canada.

University of Northern British Columbia. UNBC AQ map [Cited 2020 Nov 3]. Available from: https://cyclone.unbc.ca/aqmap/v2/index.html?zoom=6&lat=61.858&lng=-135.011.

Organic pollutants

No new data was available this year. Refer to ***Yukon state of the environment report 2020*** for the latest reporting information.

Water

Snow accumulation

Significance

The amount of snow on the ground across Yukon is determined by measuring the snow water equivalent (SWE) at a number of snow survey sites. The SWE is a measurement of the liquid water volume held within a snowpack that can become available when melted. The SWE accumulated throughout the winter has an influence on a number of hydrological and related processes.

- SWE is a major component of spring freshet and therefore influences flood forecasting.
- The SWE can influence the timing and severity of river ice breakup.
- A larger-than-average SWE increases the likelihood of high spring flows.
- A high SWE (i.e., a dense snowpack) acts to insulate the ground surface from cold winter air temperatures and promotes permafrost thaw during the following summer.
- A low SWE can increase the likelihood of wildfires at the beginning of summer.
- In the long term, changing SWE can generate shifts in vegetation.
- The duration of the snow season has a significant impact on transportation.

What is happening?

Overall, on average the snow water equivalent (SWE) is increasing by three per cent per decade. There has been a significant increase in the SWE at only one of the 13 long-term snow survey sites analyzed; Log Cabin recorded a +7 per cent increase per decade. Only one of the monitored sites showed a significant decreasing trend: Atlin Lake, with a decrease of +4 per cent per decade.

The limited number of sites with increasing trends in SWE is unlike results seen in previous years. Below-average snow throughout much of the territory between 2016 and 2019 contributed to the current results, and despite higher-than-average snowpack in many regions in 2020, most locations that previously indicated significant increasing trends no longer have significant trends. However, the influence of recent years does not change the overall interpretation of the data, which generally suggest an increasing maximum snowpack over time, resulting from an increase in winter precipitation despite winters becoming shorter in duration.

Taking action

The Government of Yukon's Water Resources Branch continue to collect data, as do their partners in Yukon's remote areas. This includes staff and private contractors from the Government of Yukon, Vuntut Gwitchin First Nation, Parks Canada and the Yukon Energy Corporation. The Government of Yukon compiles and quality controls all snow accumulation data.

Data quality

There are currently 53 snow survey sites located across Yukon, with an additional five stations in adjacent areas of Alaska and British Columbia. These stations provide the data used by the Government of Yukon to produce the Yukon Snow Survey Bulletin and Water Supply Forecast, issued in March, April and May each year. Most areas of Yukon have good spatial coverage (Figure 1). There are snow monitoring stations in five out of Yukon's six main watersheds.

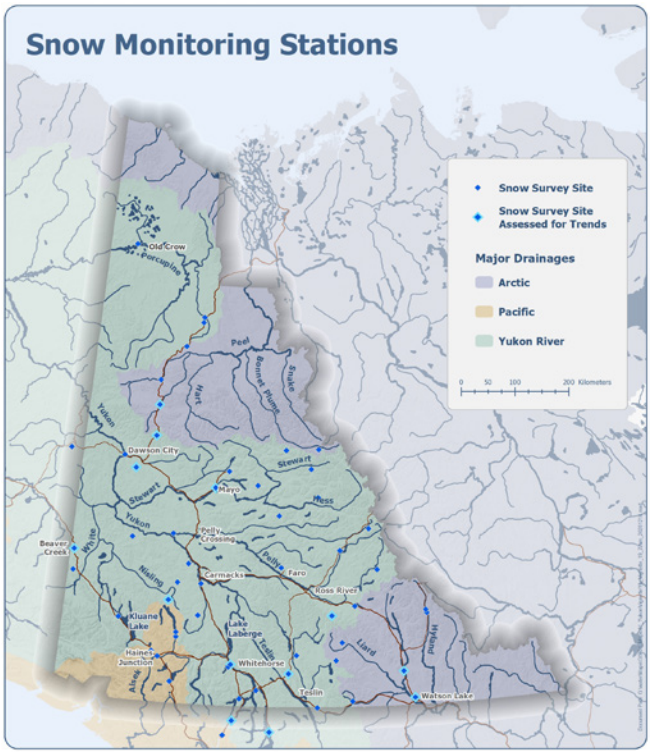


Figure 1: Locations of snow monitoring stations.

This indicator only examines trends in the maximum amount of snow; however, a shift in the timing of snowmelt has also been reported in various studies. The data collected by the Government of Yukon is not adequate for detecting changes in the timing of snowmelt at this time.

Twin Creek (*left*) and Hyland (*right*) Meteorological Station and Gauge House.

Extreme high and low water in lakes and rivers

Significance

High and low river flows and lake levels in Yukon are susceptible to change from a range of processes, which can result in different responses in different regions of the territory.

Changes to the timing of snowmelt, the amount and phase (rain or snow) of precipitation, permafrost thaw and active layer thickening, shifts in vegetation, and melting glaciers are some of the processes that are expected to alter extreme high and low river flows and lake levels.

Higher river flows can cause increased sedimentation and contaminant movement in river systems, affecting human health, drinking water and ecosystems. Increased peak flows and more intense river ice breakup conditions can increase flooding potential in populated areas, which can impact the security of people, and result in infrastructure loss and economic costs.

In contrast, low flows can result in increased concentrations of ions, such as dissolved metals, which can negatively affect aquatic ecosystems. Changes in river flows can affect resource development, such as hydropower production, mining practices or agriculture.

Changes in surface and groundwater availability and quality can affect the accessibility of water for communities and local needs. Increased flows in winter, which normally correspond to a low flow time of year, are one of many confirmed climate change-driven hydrological trends. Increases in winter flows result from warming air temperatures, a shorter cold season, degrading permafrost, and in some locations, increased precipitation. This trend is expected to continue with future warming.

What is happening?

River flows

Twenty-nine stations across Yukon were assessed for trends in annual minimum and maximum river flows. The majority of stations examined are monitoring hydrological conditions on large rivers (rivers that have drainage areas greater than 1,000 km^2). These stations are located in the following basins.

- Yukon River: 17 stations;
- Alsek River: 6 stations;
- Liard River: 2 stations;
- Peel River: 2 stations; and
- Porcupine River: 2 stations.

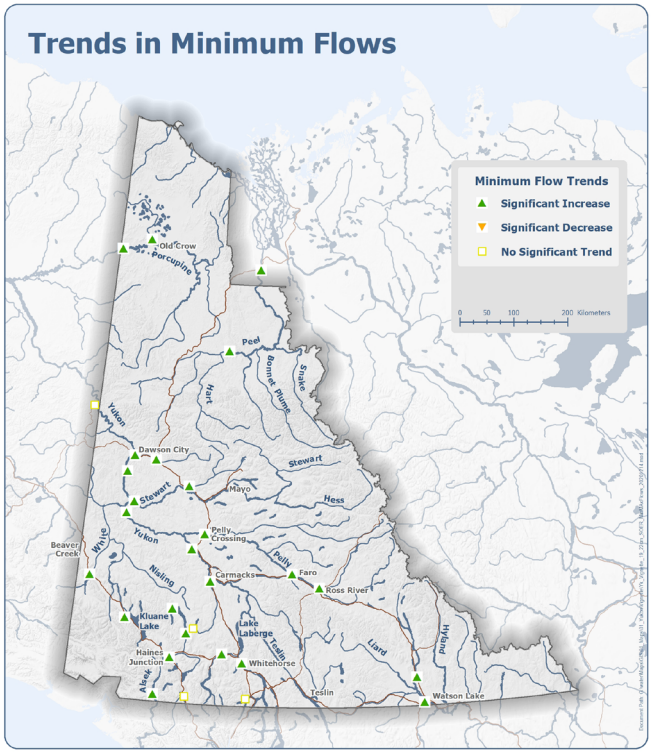


Figure 1: Trends in annual **minimum** river flow.

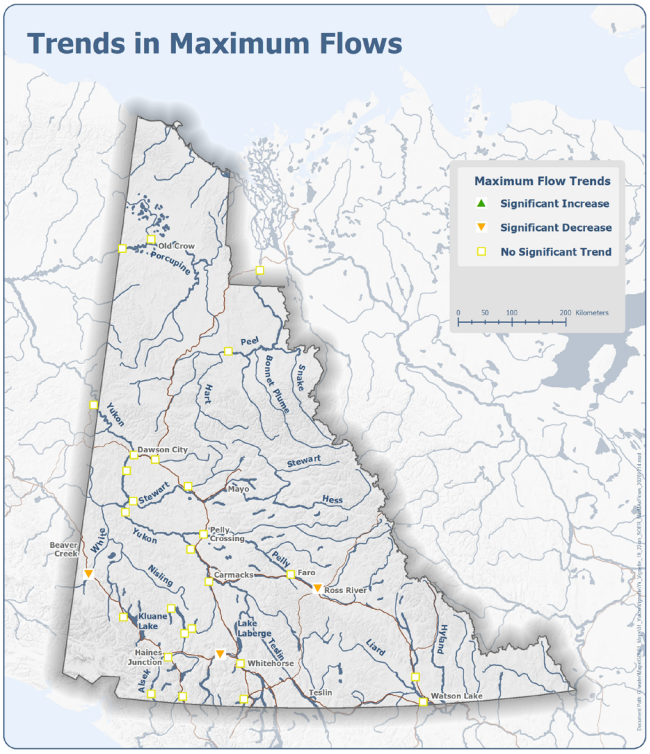


Figure 2: Trends in annual **maximum** river flow.

Annual minimum flows have increased at 25 of 29 long-term river stations; no stations had a trend of decreasing minimum flows (Figure 1).

Three long-term river stations, Ross River in the Village of Ross River, Takhini River near Whitehorse and White River at Kilometre 1881.6, show significant decreasing trends in annual maximum flow. The other 26 stations do not show trends in annual maximum river flow (Figure 2).

Annual lake levels

Annual minimum and maximum water levels are monitored for three Yukon lakes:

- Bennett Lake (as part of the Bennett – Tagish – Marsh Lake system);
- Lhù'àän Mân (Kluane Lake); and
- Teslin Lake.

High flow measurement at Ross River Bridge #1 hydrometric station with Acoustic Doppler Current Profiler (ADCP) instrument.

Bennett and Lhù'ààn Mân both show significant declines in minimum water levels over time, while Teslin Lake shows significant increases in minimum water levels. Neither Bennett nor Teslin Lake show significant change in annual maximum water levels over time; however, maximum Lhù'ààn Mân water levels have dramatically decreased since 2016 due to the movement of headwater glaciers diverting water away from the Slims River, once a major contributor to the lake. A recent study suggests that water levels will remain low in Lhù'ààn Mân and Kluane River from now on (Loukili and Pomeroy 2018).

Taking action

The water level drop in Lhù'ààn Mân has implications for the keystone Chum salmon species, who migrate from the Bering Sea to spawn in Kluane River and Lhù'ààn Mân.

From 2017 to 2020, the Kluane First Nation, Environment and Climate Change Canada, Fisheries and Oceans Canada, Parks Canada and the Government of Yukon partnered on the Kluane Watershed Salmon Climate Change Adaption Project. The project used thermal imaging of Lhù'ààn Mân and Kluane River to create maps of groundwater discharge areas (Fisheries and Oceans Canada 2018). Since Chum Salmon only spawn in groundwater discharge areas, the project investigated how well Chum Salmon are adapting to changes in their spawning environment.

Overview of Coal Lake outlet hydrometric station (Wolf Creek watershed).

Data quality

The Water Survey of Canada (WSC) conducts long-term measurements of large rivers and lakes. The WSC provides summaries of annual peak high and low flows based on daily mean flow and water levels. Data from the WSC (wateroffice.ec.gc.ca) is typically re-analyzed and released two years after data collection; currently data is approved to 2018. The current analysis considers stations that have 30 years of data available to 2017.

The trend in peak flows does not necessarily indicate a trend in monthly, seasonal or annual flows. Therefore, these trends should be used with caution when looking at the total amount of water in a system. Such a trend would require an assessment of the mean annual flows.

Extreme flows in rivers, particularly high flows, are often the most difficult to interpret due to the changing hydraulic conditions during high water. This means that these flows are typically associated with a higher degree of uncertainty, which may be of similar magnitude to the changes in long term trends. It is therefore important to not give too much value to any single site, but rather to look at the larger picture.

The period of record for the majority of hydrometric systems in Yukon is short relative to the dynamics of a changing climate system. Natural climate oscillations such as the Pacific Decadal Oscillation (PDO) can influence river systems and complicate the interpretation of trends.

High flow at Blind Creek hydrometric station.

Profile

Chance of flooding

As many Yukoners witnessed, flows were higher than average in many river systems during the summer of 2020. This was a result of heavier winter snowpack in many regions and greater summer precipitation. The Pelly River basin in central Yukon and the lower Yukon River basin in the Dawson area had the highest recorded snowpack since 1980. Subsequently, Dawson and Mayo had the third wettest June on record since 1901 and 1925, respectively, while southern Yukon had precipitation that was 130-180 per cent of the normal (1981-2010 period) over the 2020 summer period. Despite the high volume of water in river systems this year, flooding impacts were limited.

River ice breakup and snowmelt-driven high flows are the dominant drivers of flooding in Yukon communities. In spite of the above average snowpack in spring 2020, cool weather in May helped to slow melting and run-off, combined with dry conditions, reducing the likelihood of flooding during the spring freshet period. Two minor flooding events did occur over the 2020 summer in response to intense rain events: heavy rainfall in mid-June in the Dawson area resulted in minor flooding in Dawson's Rock Creek neighborhood from rising Klondike River flows; while heavy rainfall in mid-August in the Lhù'ààn Mân area resulted in a mudslide that temporarily closed the Alaska Highway between Haines Junction and Destruction Bay.

References

Environment and Climate Change Canada. n.d. Water Survey of Canada Historical Hydrometric Data. Available from: https://wateroffice.ec.gc.ca/.

Fisheries and Oceans Canada. 2018. Impacts to Kluane Fall Chum Salmon Stock from a Major Hydrological Change, CRE-145-17N Final Report. Fisheries and Oceans Canada, Yukon/Transboundary Rivers Area, Whitehorse, Yukon, Canada.

Loukili, Y. and J.W. Pomeroy. 2018. The Changing Hydrology of Lhù'ààn Mān— Kluane Lake — under Past and Future Climates and Glacial Retreat. Centre for Hydrology Report No. 15. Prepared for Government of Yukon, Yukon Community Services, Infrastructure Branch, Whitehorse, Yukon, Canada. Available from: https://research-groups.usask.ca/hydrology/documents/reports/chrpt15_kluane-lake_jan19.pdf.

Water quality

Significance

The Water Quality Index (WQI), developed by the Canadian Council of Ministers of the Environment, indicates status of water quality and the suitability of streams to support aquatic life. It can reflect the overall and ongoing condition of the water and track changes over time.

Specifically, the WQI measures the frequency and extent to which selected parameters exceed water quality objectives at individual monitoring sites. Using three factors (scope, frequency and amplitude), it creates a numerical ranking for the suitability of water for use by aquatic life. Guideline values are meant to protect all forms of aquatic life and all stages of an aquatic life cycle. A site will have a lower WQI rating when water quality objectives for the site are not met (CCME 2014).

What is happening?

Water quality samples are collected every month in 13 rivers across the territory by Government of Yukon staff and partners. First Nation partners include the Deylu Dena Council as well as Tr'ondëk Hwëch'in and Vuntut Gwitchin First Nation. The data from these samples are compiled on the Canadian Open Data portal. Additional analysis of the data by Environment and Climate Change Canada enables calculation of the WQI.

The most recent WQI scores are available for the period 2017 to 2019.

Water quality rating	Excellent (95-100)	Good (80-94)	Fair (65-79)	Marginal (45-64)	Poor (0-44)

Location	2005-2007	2006-2008	2007-2009	2008-2010	2009-2011	2010-2012	2011-2013	2012-2014	2013-2015	2014-2016	2015-2017	2016-2018	2017-2019
Klondike River upstream of Bonanza Creek	66.8	66.4	67.4	74.2	74.2	74.2	74	73.8	73.7	73.7	86.6	80.1	80.4
Liard River at Upper Crossing	87.2	93.6	93.6	87.2	85.5	80.6	80.6	n/a	80.6	80.6	80.5	80.6	80.6
South McQuesten River downstream of Flat Creek	64.4	64.3	64	70	69.5	70.1	70.4	70.6	70	63.8	63.7	63.5	64.1
Yukon River upstream of Takhini River	100	100	100	93.6	93.6	93.6	93.6	93.6	93.6	100	100	93.6	93.6
Ogilvie River above Engineer Creek	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	72.9
Alsek River above Bates River in Kluane National Park	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	87.3
Porcupine River above Old Crow River	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	70.4

Excellent (95-100)	Aquatic life is not threatened or impaired. Measurements never or very rarely exceed water quality guidelines.
Good (80-94)	Aquatic life is protected with only a minor degree of threat or impairment. Measurements rarely exceed water quality guidelines and, usually, by a narrow margin
Fair (65-79)	Aquatic life is protected, but at times may be threatened or impaired. Measurements sometimes exceed water quality guidelines and, possibly, by a wide margin.
Marginal (45-64)	Aquatic life frequently may be threatened or impaired. Measurements often exceed water quality guidelines by a considerable margin.
Poor (0-44)	Aquatic life is threatened, impaired or even lost. Measurements usually exceed water quality guidelines by a considerable margin.

Figure 1: WQI scores for Yukon monitoring stations calculated as three-year rolling averages.

All four watercourses monitored over the last decade (Klondike, Liard, South McQuesten and Yukon rivers) have water quality scores that have remained relatively constant over the last 10 years. Scores for the 2017 to 2019 period are consistent with previous years. The South McQuesten River downstream of Flat Creek has the lowest WQI score.

WQI scores are now being calculated for three additional stations (Ogilvie, Alsek and Porcupine rivers). The water quality scores at these stations for the 2017 to 2019 period are fair, good and fair, respectively. Water quality scores for these stations will allow us to track changes in water quality over the coming years.

Water quality sampling, Yukon River at Marsh Lake Bridge.

Taking action

As guided by the ***Yukon Water Strategy and Action Plan (2014 – 2019)*** and the recently released ***Our Clean Future*** strategy, the index is now calculated for three additional monitoring locations: Porcupine River upstream from Old Crow, and at the Eagle and Ogilvie rivers along the Dempster Highway. Additionally, an evaluation of the Yukon water quality monitoring network is underway to ensure that the network is effective in monitoring long-term water quality in Yukon.

Data quality

The WQI scores are calculated by Environment and Climate Change Canada. They are calculated as an average over successive three-year periods. Averaging over multiple years provides additional confidence in ratings.

Water quality samples are obtained by Government of Yukon staff and local partners following standardized protocols, and analyzed in Environment and Climate Change Canada laboratories, which are accredited by the Canadian Association for Laboratory Accreditation. Environment and Climate Change Canada performs further quality assurance/quality control to ensure datasets meet minimum data requirements for the analysis and that calculation standards are respected.

The WQI index is based on a set number of measured variables that are deemed to be most important. It is possible for an unusual or unexpected source of contamination to not be captured by the index and require that the chosen variables be reassessed.

References

Canadian Council of Ministers of the Environment (CCME). 2014. Canadian Environmental Quality Guidelines [Cited 2020 Dec 2]. Available from: http://ceqg-rcqe.ccme.ca/en/index.html.

Environment and Climate Change Canada. 2019. National Long term Water Quality Monitoring Data [Cited 2020 Dec 2]. Available from: http://data.ec.gc.ca/data/substances/monitor/national-long-term-water-quality-monitoring-data/.

Water quality sampling, Ogilvie River.

Yukon River ice breakup at Dawson City

Significance

Over the past century, breakup has been occurring earlier in the spring. This is a strong indicator of a changing climate. Even if warmer winter temperatures reduce ice cover thickness and resistance, the effect of larger snowpacks and increased air temperature variability will impact ice jam frequency and intensity in ways not yet confirmed.

River ice conditions affect winter roads and wildlife corridors. The reduced river ice season is already having an impact on Yukoners. In recent years, changing freeze-up patterns have resulted in challenges to certify an ice bridge between West Dawson and Dawson.

The timing of river ice breakup influences breakup severity, which may result in the following impacts:

- An early rise in river discharge results in the mobilization of a very resistant ice cover, which can translate into damaging ice jams.
- A delayed snowmelt period may generate a sudden and significant runoff and a large-scale mobilization of river ice, which can also lead to ice jam floods.

Both conditions can have detrimental impacts on communities and infrastructure.

What is happening?

In Dawson City, the Yukon River breakup occurred on May 3, 2020, around 5 p.m. Ice breakup on the Yukon River at Dawson City now occurs more than seven days earlier on average since data collection began in 1896 (Figure 1). This trend towards earlier breakup dates is statistically significant. Nine of the 11 earliest recorded breakup events at Dawson City have occurred in the past 30 years. The two earliest recorded breakups occurred in the past five years (2016 and 2019, both on April 23).

Yukon River in Dawson City shortly after breakup, May 3, 2020 at 6:30 p.m. Photo: Sabastian Jones.

Taking action

As part of the National Disaster Mitigation Program, the Government of Yukon's Water Resources Branch created a new breakup model for the Yukon River at Dawson City. The model is helpful in forecasting the timing of breakup and its potential severity. Forecasting allows for effective decision-making and mobilization of resources, if ice jam flooding was to occur.

Data quality

Records documenting the timing of breakup on the Yukon River at Dawson City began in 1896 and the date of breakup has since been continuously recorded as part of the Yukon River breakup contest. In recent years, the timing of breakup has been recorded with a tripod placed on the ice that is connected to a timer. When the tripod moves downstream with the first movement of the ice, the clock stops and records the official breakup time.

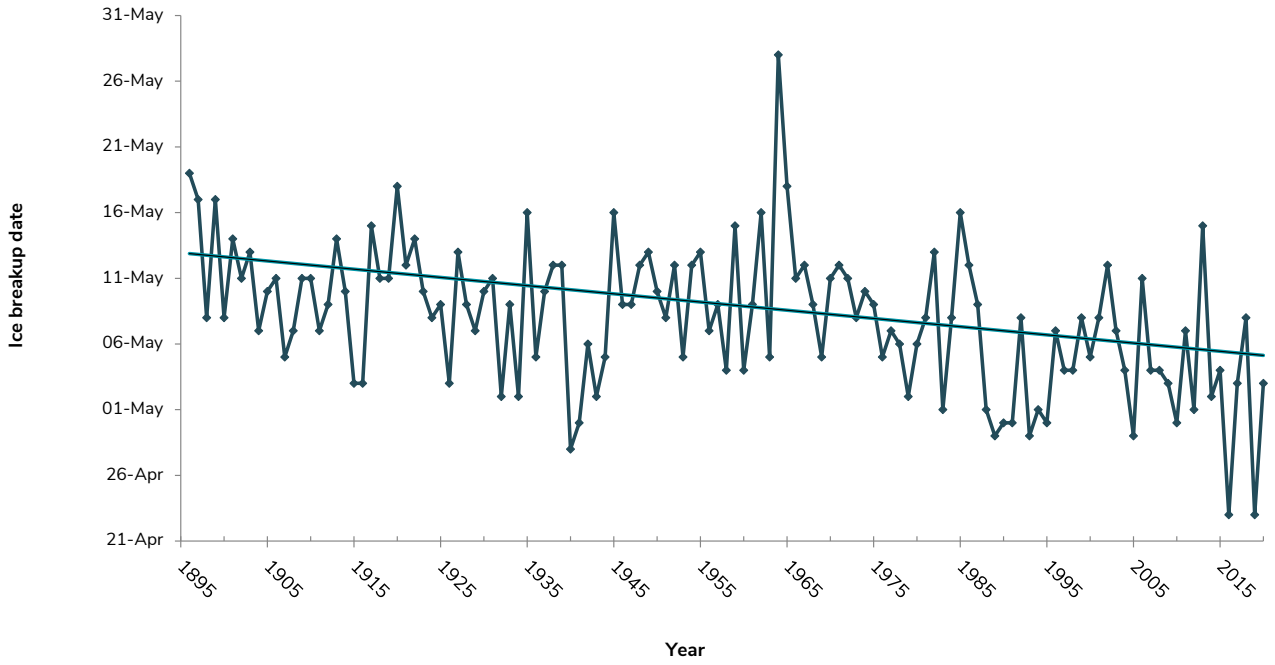


Figure 1: Yukon River at Dawson breakup date by year, 1896 to 2020.

Land

Population of Yukon

Significance

Human population can have an impact on the state of the environment based on:

- how many people there are (population growth);
- where those people live (population distribution); and
- how close in proximity they live (population density).

Keeping track of these three population indicators can help in analyzing and predicting the impact that human activities can have on the environment.

What is happening?

Yukon has a very low population density overall. In the 2016 census, there were 0.1 people for every square kilometre in Yukon.

Table 1: 2020 population, growth and density of Yukon communities.

Area	**2020 Population**	**Population growth from 2019** (per cent change)	**2016 population density** (people per km^2)
Beaver Creek	**124**	**1.6%**	**3.4**
Burwash Landing	**105**	**-6.3%**	**2.4**
Carcross	**477**	**6.2%**	**18.7**
Carmacks	**578**	**3.3%**	**13.3**
Dawson City	**2,277**	**0.0%**	**42.4**
Destruction Bay	**59**	**-10.6%**	**4.1**
Faro	**436**	**6.9%**	**1.7**
Haines Junction	**989**	**1.1%**	**17.8**
Mayo	**471**	**1.3%**	**188.7**
Old Crow	**265**	**0.8%**	**15.6**
Pelly Crossing	**396**	**3.4%**	**10.9**
Ross River	**407**	**0.0%**	**14.2**
Tagish	**359**	**0.8%**	**5.5**
Teslin	**473**	**0.4%**	**64.6**
Watson Lake	**1,493**	**-0.3%**	**129.4**
Whitehorse / Marsh Lake	**33,033**	**2.1%**	**3.3**
Unofficial Communities / Other	**268**	**n/a**	**n/a**
Yukon (total)	**42,230**	**1.9%**	**0.1**

Yukon's population is not distributed evenly. Many more people reside in southern Yukon, with approximately 78 per cent living in the Whitehorse/Marsh Lake area. The population density of this area, however, is still low at 3.3 people per square kilometre, because the population total incorporates Whitehorse and all surrounding areas (e.g., Ibex Valley, McPherson/Grizzly Valley, Marsh Lake and Mount Lorne).

Key comparisons

- From September 30, 2010 to September 30, 2020, Yukon's population increased by 7,246 people, or 20.7 per cent.
- From June 2019 to June 2020, the total Yukon population increased by 794 people, or 1.9 per cent.
- The greatest increases in population growth occurred in Faro, Carcross, Pelly Crossing and Carmacks.
- Population density is only 1 person per 10 square kilometres.

Yukon's community populations have been fairly stable since 1990 except Faro. Population in Faro was tied to the operation of the Faro mine that closed in April 1993, reopened in August 1995 and then closed permanently in January 1998.

For more information on Yukon community socio-economics, visit the Government of Yukon Socio-Economic Web Portal (sewp.gov.yk.ca).

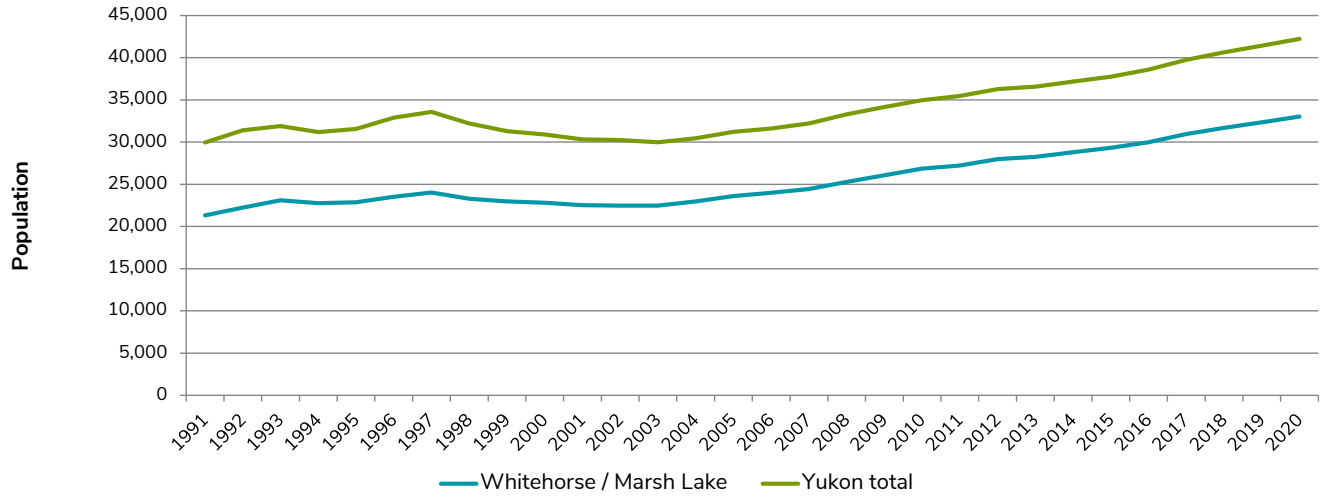


Figure 1: Population of Whitehorse compared to total population in Yukon.

* Due to a change in methodology in 2018, revised figures for the period from April 2011 onward are not strictly comparable to figures prior to that period..

Data quality

Population density is calculated during the Statistics Canada census; therefore, the most current data is from 2016. For the census, Statistics Canada divides data into 37 geographic census subdivisions that are different from the community divisions that Yukon Bureau of Statistics uses for population estimates. For this reason, use population density information with care.

In the June 2020 population estimates, two unofficial communities were added: Mendenhall (130 people) and Johnsons Crossing (54 people). An "Other" category (84 people) was also introduced. This category includes Braeburn, Champagne, Swift River, Keno and surrounding area, and Stewart Crossing and surrounding area.

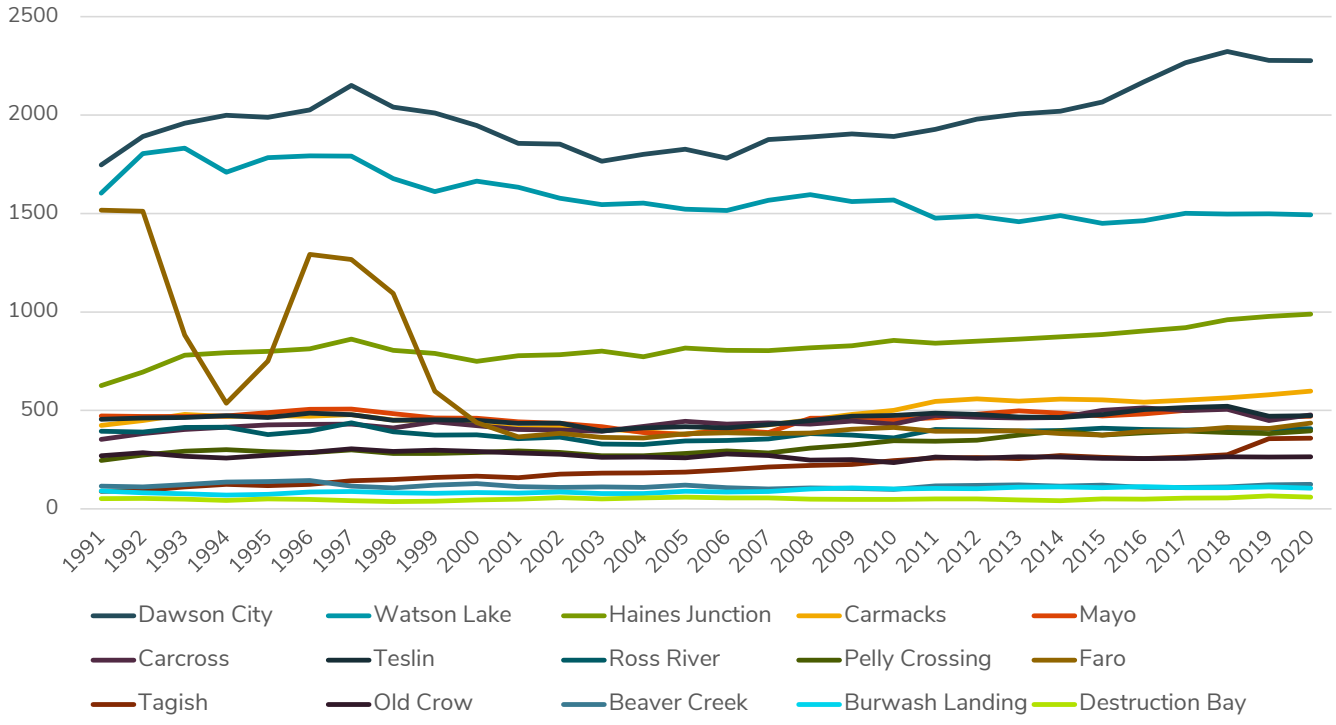


Figure 2: Yukon community populations, 1990-2020.

* Due to a change in methodology in 2018, revised figures for the period from April 2011 onward are not strictly comparable to figures prior to that period.

Regional land use plans

Significance

Developing long-term land use plans through public processes helps governments recognize and balance competing views about how lands and natural resources should be used.

Plans support effective land and resource management and are important obligations arising from Yukon First Nation Final Agreements. Chapter 11 of the Yukon First Nation Final Agreements established the regional land use planning process and represents a commitment by the governments to conduct regional land use planning in Yukon. Through land use planning, a regional commission, appointed by Yukon and First Nation governments, prepares a regional land use plan in consultation with First Nations, stakeholders and residents. The plans are approved by Yukon and First Nation governments and guide the future use and sustainable development of land in the planning region.

Regional planning is intended to reflect the traditional knowledge, experience and recommendations of residents, as well as incorporate science and broad socio-economic and environmental interests.

What is happening?

The Yukon Land Use Planning Council has proposed seven planning regions in Yukon.

Regional land use plans

Dawson

Status: Current

The Dawson Planning Commission has been established and is beginning work on visioning.

The Vuntut Gwitchin First Nation and Tr'ondek Hwech'in have approved an overlap agreement for a new boundary for the planning region which excludes Vuntut Gwitchin.

North Yukon

Status: Current 2009

In 2009, the Vuntut Gwitchin First Nation and the Government of Yukon approved the North Yukon Regional Land Use Plan. It provides a sustainable development framework for land management, while addressing the key issues of oil and gas development in Porcupine caribou herd habitat and development impacts in wetlands. The plan also recommends protected area status for the Whitefish Wetlands and the Summit Lake-Bell River area. It identifies important traditional use and wildlife areas that were mapped from local and traditional knowledge.

Peel Watershed
Status: Current 2019

Land use planning began for the Peel watershed in 2004 and the planning commission produced a recommended land use plan in 2011. The process was on hold while awaiting the outcome of a Supreme Court hearing on the plan.

Following the Supreme Court decision, the planning process was relaunched. In late 2018, final consultation occurred with affected communities, public, and stakeholders on the Final Recommended Plan. The plan was approved by all parties in August 2019.

Teslin
Status: On hold

A previous planning process for the Teslin region was suspended in 2004 before a Draft Plan was produced. In September 2011, the Yukon Land Use Planning Council recommended the Teslin Region as a priority planning region. Talks are ongoing with the Teslin Tlingit Council to re-start the process.

Northern Tutchone
Status: Not started

Planning in this region has not been initiated.

Kluane
Status: On hold

In September 2011, the Yukon Land Use Planning Council recommended the Kluane Region as a priority planning region.

Whitehorse
Status: Not started

Planning in this region has not been initiated.

White River
Status: n/a

Regional planning as envisioned under the Umbrella Final Agreement does not apply to White River as White River First Nation does not have a Final Agreement.

North Slope
Status: n/a

The Yukon North Slope is part of the Inuvialuit Settlement Region. As such, the provisions set out in the *Inuvialuit Final Agreement* speak to how land use planning processes are to be undertaken. The Final Agreement provides for the Inuvialuit to be effectively involved in all bodies, functions and decisions pertaining to land and wildlife management in the Inuvialuit Settlement Region.

Kaska
Status: n/a

Regional planning as envisioned under the Umbrella Final Agreement does not apply to asserted Kaska traditional territory, as Kaska nations do not have a Final Agreement.

Community and local area planning

No new data was available this year. Refer to the ***Yukon state of the environment report 2020*** for the latest reporting information.

Status of parks and protected areas

No new data was available this year. Refer to the ***Yukon state of the environment report 2020*** for the latest reporting information.

Number, type and location of environmental and socio-economic assessments

Significance

Environmental and socio-economic assessment is a process that identifies the potential environmental and socio-economic effects of proposed project activities required to be assessed under the ***Yukon Environmental and Socio-economic Assessment Act*** before they are authorized and carried out. The Yukon Environmental and Socio-economic Assessment Board (YESAB) conducts assessments in Yukon.

When a potential adverse effect is identified and determined to be significant and adverse, YESAB assessors recommend mitigations to reduce, control or eliminate the effect. If the significant adverse effects cannot be mitigated, YESAB assessors must recommend that the proposed project not proceed. YESAB directs its recommendations to decision bodies, which are federal, territorial or First Nations governments or agencies, who make the final decisions.

The number, type, complexity and location of projects assessed by YESAB can indicate development pressures on environmental and socio-economic values; such as:

- impacts on wildlife and their habitat;
- impacts on air and water quality;
- impacts on fish and fish habitat, and
- permanent land conversion.

What is happening?

In 2019, 212 project proposals were submitted to YESAB for assessment. The Kudz-Ze-Kayah Mine, Coffee Gold Mine and Faro Mine Remediation proposals submitted for screening at the Executive Committee level are still in progress.

Four common sectors that submit project proposals for assessment are placer mining, land development, quartz mining, and transportation (Figure 1).

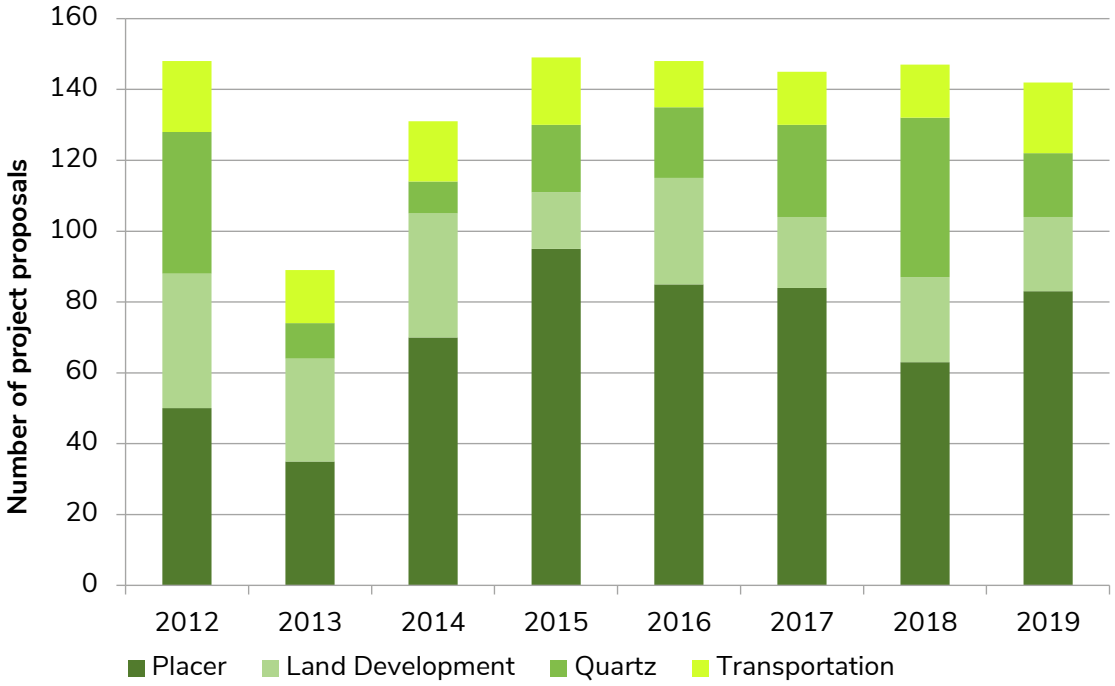


Figure 1: Number of project proposals for the four common sectors.

Source: YESAB 2019.

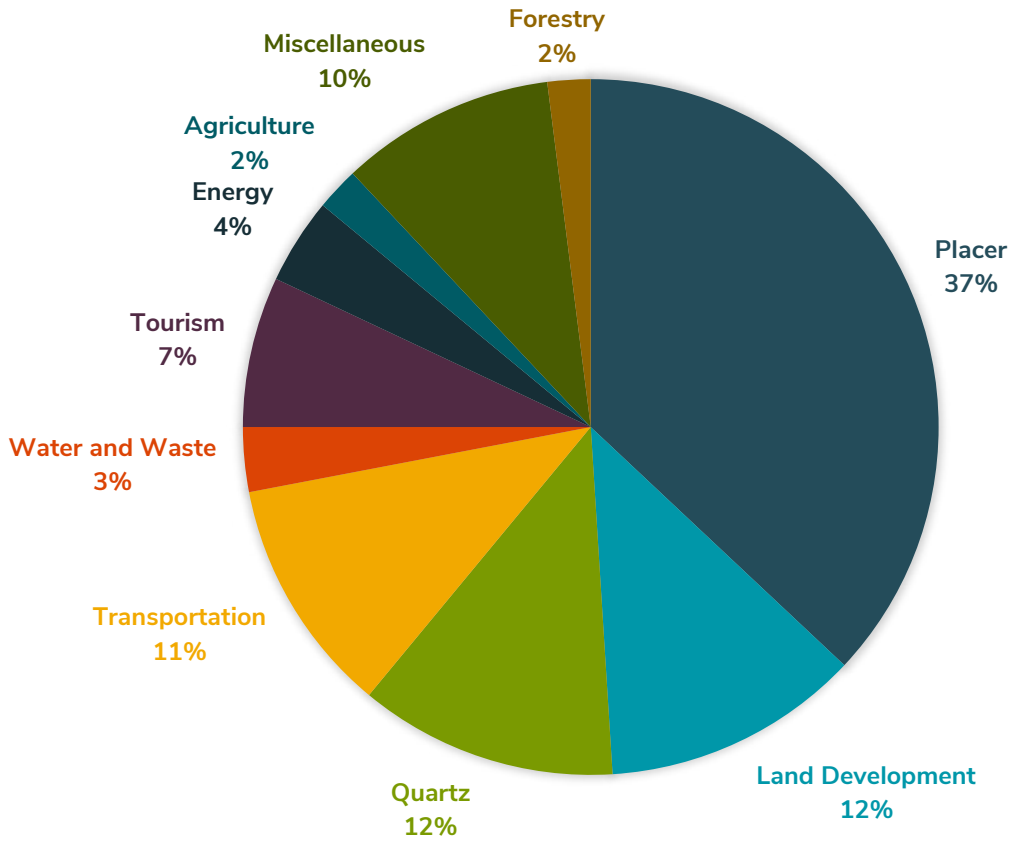


Figure 2: YESAB percentage of projects assessed by sector, 2019.

Source: YESAB 2019.

In 2019, the majority of project proposals were received in the Dawson City, Haines Junction and Whitehorse districts (Figure 3). Whitehorse, given its population density, generates a large number of project submissions for residential and commercial activities, such as access roads, subdivisions, road upgrades and lot enlargements. Dawson City is a well-known mining district with a long history of placer mining. Haines Junction saw a range of project submissions including quartz, placer, tourism and energy.

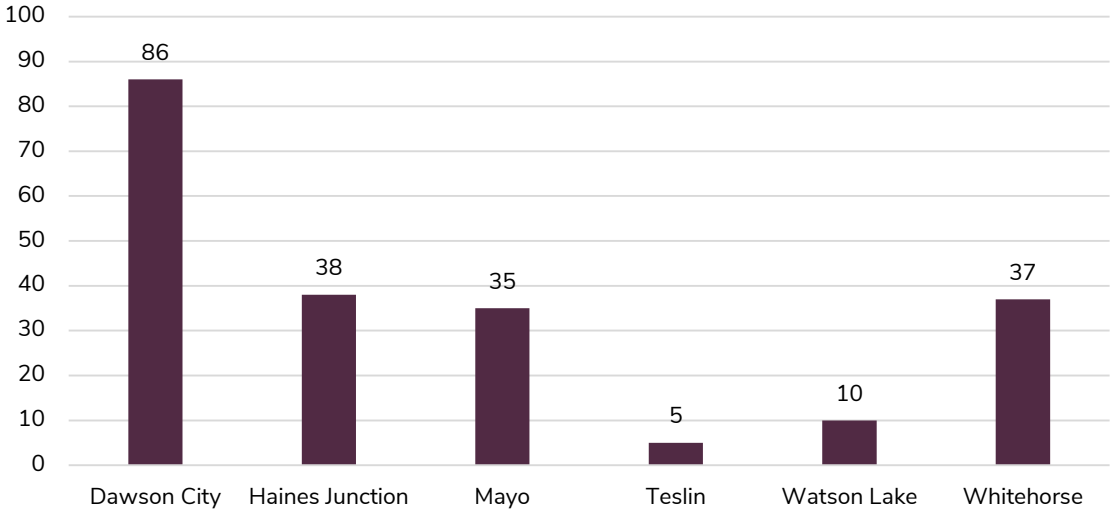


Figure 3: YESAB, project proposal submissions by Designated Office, 2019.

Source: YESAB 2019.

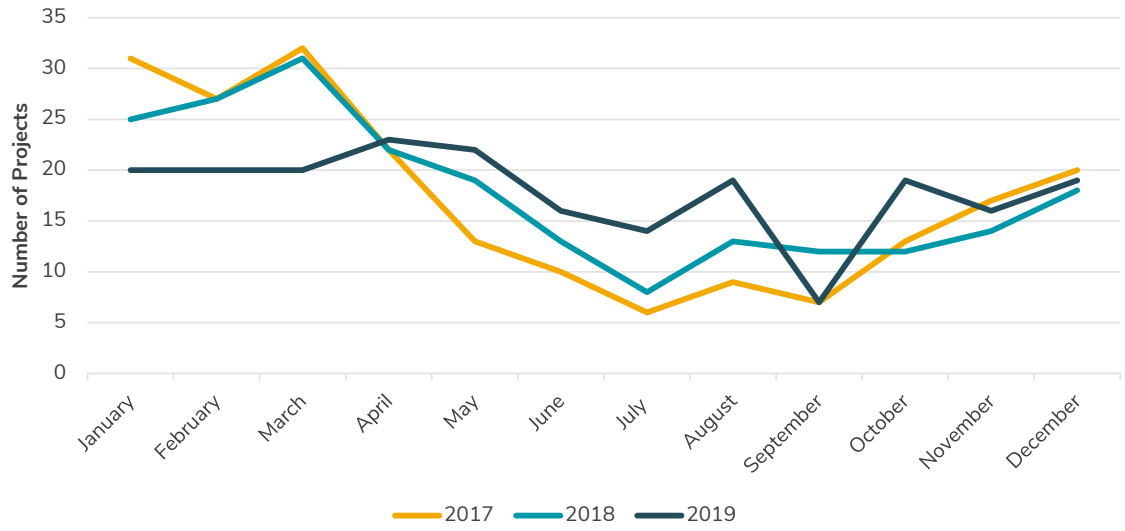


Figure 4: Designated office project submissions by month and year.

Source: YESAB 2019.

Additional YESAB assessment statistics are available on YESAB's website at yesab.ca/about-yesab/assessment-statistics. Information regarding individual projects can be found on the YESAB On-line Registry (yesabregistry.ca).

Recreational land use

Significance

The Government of Yukon operates and maintains 42 roadside campgrounds. These provide access to outdoor recreation opportunities such as fishing, hiking, boating and wildlife viewing. Recreational land use may have a negative impact on the environment "when the level of visitor use is greater than the local environment's ability to cope with this use within the acceptable limits of change" (UNEP n.d.).

For statistical purposes, the Government of Yukon tracks the number of people using its campsites.

What is happening?

- In 2020, the Government of Yukon's territorial parks included:
  - 42 recreation parks (campgrounds);
  - 9 wilderness parks; and
  - 11 day-use recreation sites.
- In most years, there are over twice as many non-resident campers as Yukon resident campers camping in territorial campgrounds (Figure 1). However, residents spend twice as much time in the campgrounds, so the person nights of residents and non-residents are roughly equal.
- From 2012 to 2017, there had been a steady increased use of campgrounds by both resident and non-residents. In 2018, visitation by non-residents continued to increase while resident visitation declined. Total visitation stabilized between 2017 and 2018.
- In 2019, there were approximately 90,000 visitors to Yukon territorial campgrounds.
- In 2020, campground occupancy rates decreased by a third compared to 2019 levels.
- Total visitation dropped dramatically in 2020 (an 87 per cent reduction among non-residents), due to COVID-19 campground closures, a delayed opening and a territorial closure to non-residents other than those from the northern territories or British Columbia.
- The 2020 camping season was a record-breaking year for residents, where the number of campsite nights increased by 37.5 per cent from 2019 (or up 24 per cent from the previous record in 2017).

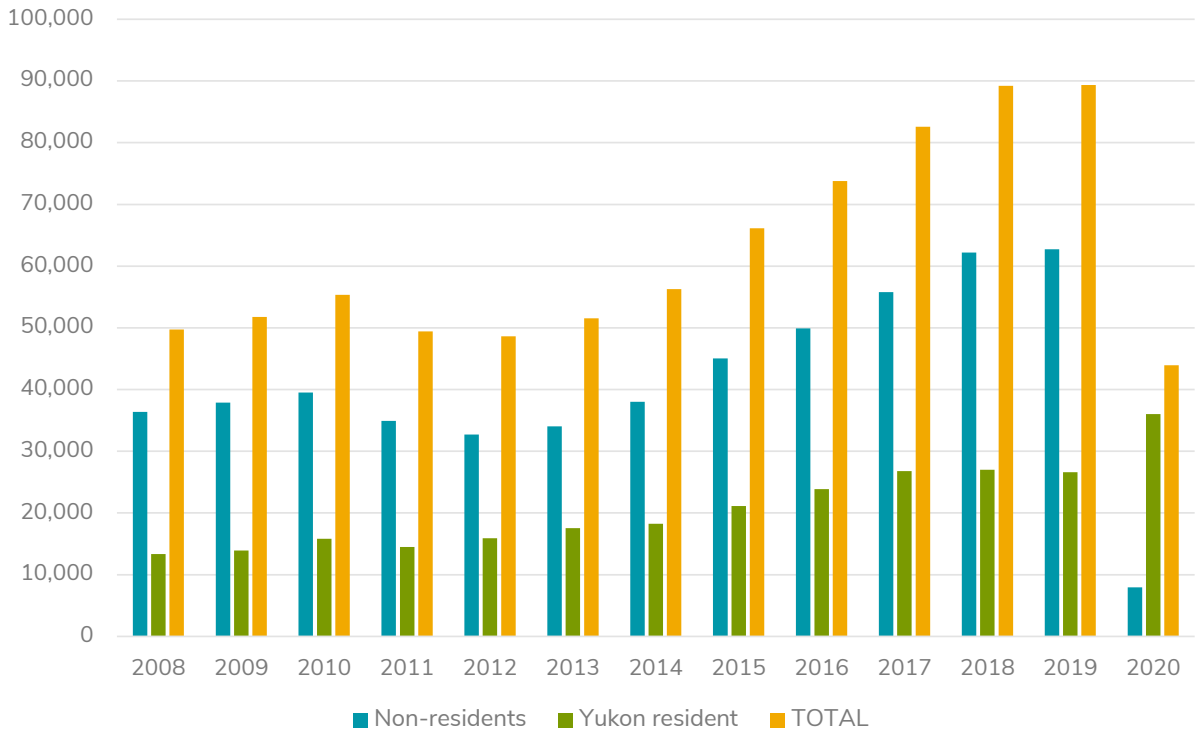


Figure 1: Number of people camping in territorial campgrounds each year.

Taking action

The Government of Yukon has worked to increase the number of campsites available to visitors and residents. In 2019, additional campsites were added to Little Salmon (seven sites) and Twin Lakes (five sites) campgrounds.

In 2020, a new pedestrian bridge was installed between Marsh Lake Campground and the adjacent recreation site. New playgrounds were also installed at several campgrounds in the territory.

In 2020, the ***Yukon Parks Strategy*** was released. The strategy provides strategic guidance on how to sustainably deliver the environmental, economic, social and health benefits of Yukon's network of parks and campgrounds from 2020 to 2030, while helping ensure healthy land, healthy people and a healthy economy.

Major actions in the strategy include:

- extending the serviced campground season to five months, from May 1 to September 30;
- building a new campground near Whitehorse with up to 150 campsites;
- developing new trails in territorial parks;
- increasing accessible wilderness experiences at boat-in and hike-in campsites;
- an online reservation system pilot project for some campsites; and
- expanding park infrastructure and adding additional campsites at existing campgrounds.

Other actions include developing a parks system plan to guide the development of existing and emerging parks and the establishment of future parks. Other initiatives include developing a collaborative park management framework jointly with interested First Nations and Inuvialuit, partnering with Indigenous guardians, and engaging in discussions with Indigenous partners to explore how the idea of Indigenous Protected and Conserved Areas may apply in Yukon.

Data quality

- The Government of Yukon's Parks Branch tracks overnight visitation through campground registrations.
- Registered visitors are calculated by person nights divided by average number of nights. This number includes repeat visitors.
- There are other campsites operated throughout the territory, including the Government of Canada-operated Kathleen Lake Campground in Kluane National Park and Reserve, First Nation owned and managed campgrounds, and several private RV campgrounds. Data from these sites are not included in this summary.

References

Government of Yukon. 2020. Yukon Parks Strategy. Yukon Parks Branch, Whitehorse, Yukon, Canada. Available from: https://yukon.ca/en/yukon-parks-strategy.

United Nations Environmental Programme (UNEP). n.d. Tourism's Three Main Impact Areas [cited 2020 Jan 2]. Available from: https://gdrc.org/uem/eco-tour/envi/one.html.

Waste handled at the Whitehorse Waste Management Facility

Significance

Solid waste disposal in landfills can pose environmental and health risks as well as land use planning challenges. Waste is costly to manage, whether it is sent to landfills, diverted through recycling and composting, or shipped outside the territory for treatment.

Landfill closure liability is a standard Public Sector Accounting Board principle that requires owners of landfills to account for the full costs of the closure and post-closure of a landfill. While this puts financial pressure on municipalities in Yukon, it also incentivizes waste diversion to lengthen the life of a landfill.

What is happening?

The City of Whitehorse routinely monitors the amount of waste handled by the waste management facility. This includes waste that enters the landfill and waste that is diverted away from the landfill through composting or recycling (Figure 1).

Waste that enters the landfill come from three major sources:

- domestic or household waste and the industrial, commercial, and institutional sector;
- construction and demolition; and
- waste from outside city limits. Since 2006, the City of Whitehorse has accepted waste from outlying communities on a fee-for-service basis in order to lessen the landfill burden on those communities.

Fast Facts

- **570 kilograms:** the total average, annual amount of waste per person landfilled in Whitehorse in 2019. This is an eight per cent decrease from 2018 (620 kg per person).
- **33 per cent:** the percentage of waste diverted from the Whitehorse landfill through recycling, composting, and re-use efforts. This is a three per cent increase from 2018.
- In November 2018, the Canadian Council of Ministers of the Environment endorsed a Canada-wide aspirational waste reduction goal meant to encourage and highlight waste reduction progress in Canada. The Canada-wide goal is to reduce this to 490 kg per person (a 30 per cent reduction) by 2030, and to 350 kg per person (a 50 per cent reduction) by 2040.
- The City of Whitehorse's 2013 ***Solid Waste Action Plan*** has influenced increases in the diversion rate. Programs and policies which targeted diversion of cardboard and organics from the commercial sector have been planned and realized throughout 2015-2020.
- The plan focused on the diversion of cardboard and organics from the commercial sector.

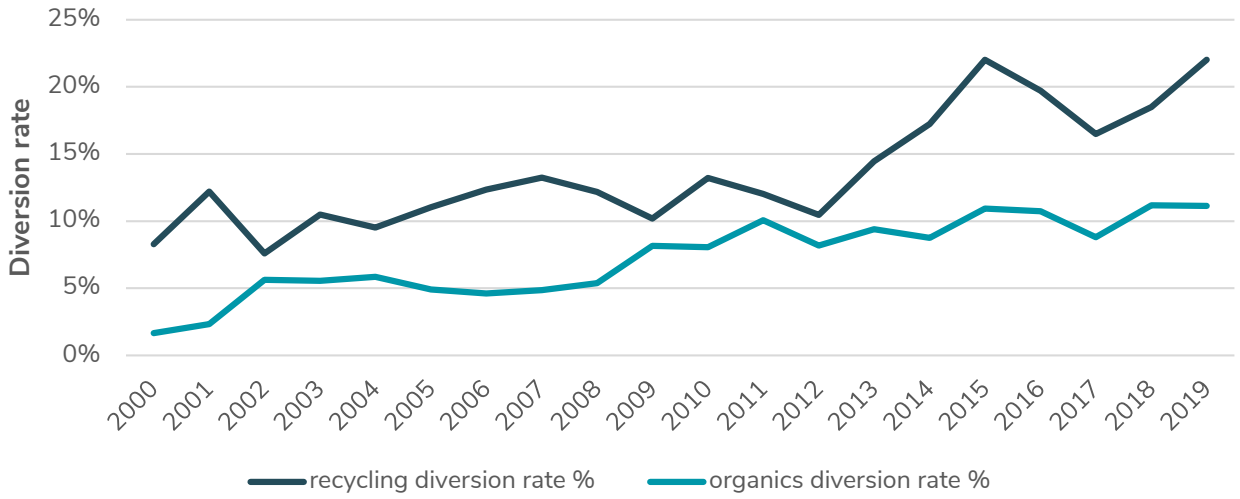


Figure 1: Diversion rate of organic and recycling materials from the City of Whitehorse Waste Management Facility.

Taking action

- In October 2018, many electronic devices became banned waste under the City of Whitehorse Waste Management Bylaw. This change was part of a coordinated effort with the Government of Yukon. E-waste is now diverted for recycling through an e-waste collection depot established by the Government of Yukon.
- The City of Whitehorse compost is an Organics Materials Review Institute-listed product. This means the quality of the compost is very high and can be used in organic gardens. In 2019 and 2020, demand for compost nearly exceeded available supplies.
- The compost facility is in the process of being upgraded to accommodate the growth of the program. The upgrade includes a concrete pad for processing that will increase processing capacity and reduce environmental impact of composting by capturing process water for re-use. The upgrade has funding support from the Government of Canada and Government of Yukon. The $4.4 million upgrade began in 2019 and is expected to be complete in 2021.

Data quality

- The Whitehorse population estimates are based on total Whitehorse area, excluding Marsh Lake but including people residing outside city limits, and were obtained from the Yukon Bureau of Statistics. However, in the ***Yukon state of the environment report 2020***, the City of Whitehorse collected waste management statistics that included population estimates for Marsh Lake, resulting in a slightly lower waste landfilled per person in the data.
- While material that enters the Waste Management Facility is tracked and recorded, other data, such as e-waste and recycling, is obtained from external organizations such as Raven Recycling.

References

Canadian Council of Ministers of the Environment. n.d. Aspirational Canada-wide Waste Reduction Goal [cited 2021 Feb 5]. Available from: https://ccme.ca/en/current-activities/waste.

City of Whitehorse. 2013. Solid Waste Action Plan [cited 2021 Feb 5]. Available from: https://www.whitehorse.ca/departments/environmental-sustainability/waste-diversion/additional-information/solid-waste-action-plan-swap.

Statistics Canada. 2015a. Table 17- 10-0009-01 (formerly CANSIM 051-0005) - Population estimates, quarterly [modified 2021 Feb 1, cited 2021 Feb 5]. Available from: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1710000901.

Statistics Canada. 2015b. Table 38-10-0032-01 (formerly CANSIM 153-0041) - Disposal of waste, by source, Canada, provinces and territories, every 2 years (tonnes) [modified 2020 Feb 13, cited 2021 Feb 5]. Available from: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3810003201

Forest health

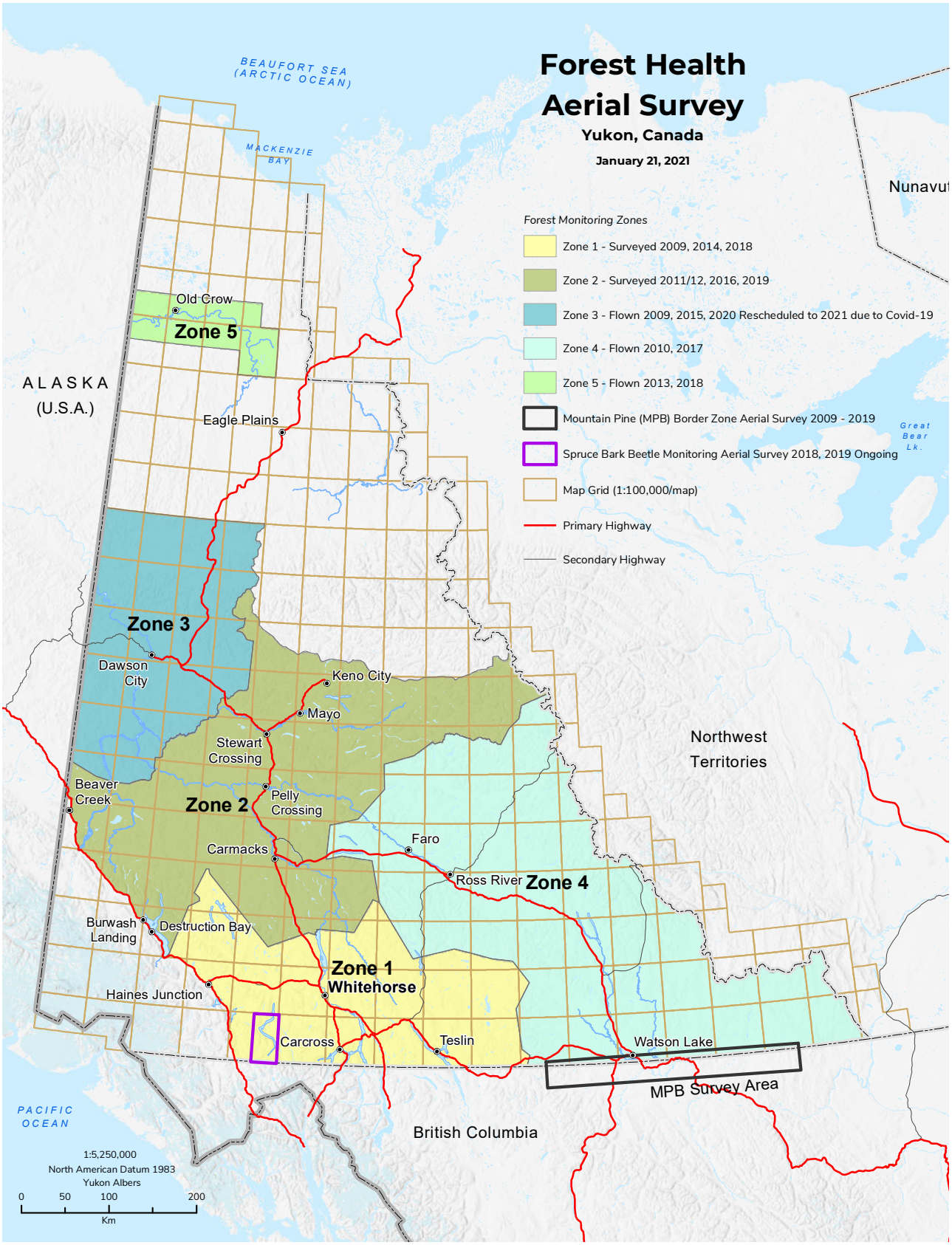
Significance

Native forest insects pose little concern at population levels that don't cause damage. Insects become an issue when their populations grow too large or when alien or native species show invasive behaviour. Active management interventions may be considered when an insect or disease outbreak has a measurable impact on ecology or the economy (Natural Resources Canada 2020).

The Government of Yukon's Forest Management Branch implemented a risk-based approach to monitoring forest health that is in line with the ***National Forest Pest Strategy*** in 2009 (Canadian Council of Forest Ministers 2021 and Government of Canada 2020).

The objectives of the approach are:

- to provide a Yukon-wide overview of forest health issues;
- to focus monitoring activities on high-risk forest health agents in high value forest regions; and
- to contribute to the ***National Forest Pest Strategy*** goals, one of which is developing early detection and reporting capacity of forest health pests.



Map 1: Forest Health Zone map shows areas flown from 2009 to 2019 and planned surveys for 2021.

What is happening?

- Typically, the Forest Management Branch's risk-based forest health monitoring program consists of:
  - aerial overview surveys;
  - monitoring of the Yukon/BC border zone for Mountain Pine Beetle;
  - Mountain Pine Beetle pheromone bait deployment; and
  - spruce beetle pheromone trapping.
- Due to COVID-19, only the Mountain Pine Beetle pheromone bait deployment and spruce beetle pheromone trapping were conducted in 2020, along with pest incidence reports from the general public.

Forest health disturbances

The Forest Management Branch maps two types of disturbances.

- **Biotic disturbances** are living disturbances, and include native and invasive insects and diseases.
- **Abiotic disturbances** are non-living disturbances caused by weather or wildfires.

Declines and pest complexes are generally a combinations of biotic and abiotic factors.

In 2009 the Forest Management Branch determined the top 10 concerns that pose the greatest risk to Yukon forests. Of these:

- eight are insects;
- one is a pathogen; and
- one is an environmental effect called drought stress.

Aerial surveys are an effective way to monitor these concerns because their damage to trees is very visible.

The following is a rationale (based on Ott 2008) for the identification of major forest health concerns that pose the greatest risks to Yukon forests.

1. Spruce Bark Beetle *(Dendroctonus rufipennis)*

This bark beetle is the most damaging forest pest of mature spruce (*Picea spp.*) forests in Yukon. A Spruce Bark Beetle outbreak in southwest Yukon that began around 1990 has killed more than half of the mature spruce forest (primarily White Spruce (*P. glauca*)) over approximately 400,000 hectares.

1a: Stand level damage - grey trees, Spruce Bark Beetle, Haines Junction, Yukon.

1b: Adult Spruce Bark Beetle.

2a: Single tree attack, Northern Spruce Engraver. Bark beetle, Haines Junction, Yukon.

2. Northern Spruce Engraver *(Ips perturbatus)*

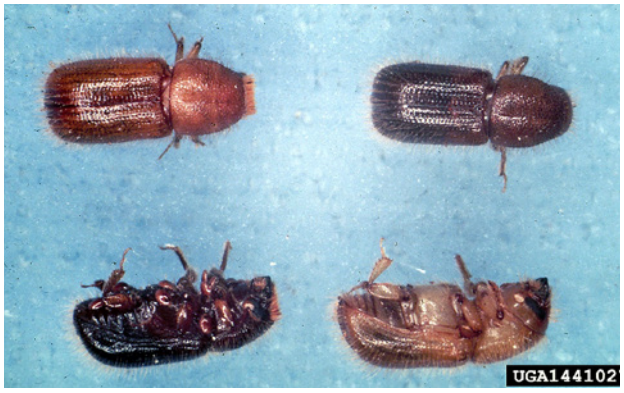
The Northern Spruce Engraver acts as both a secondary bark beetle that attacks trees infested with Spruce Bark Beetle, as well as a primary pest that attacks and kills stressed spruce trees (primarily White Spruce). The population of the Northern Spruce Engraver beetle has increased in Yukon as a result of the increased availability of host trees associated with the Spruce Bark Beetle outbreak in southwest Yukon. In 2008, infestations by the Northern Spruce Engraver were at their greatest level since the beginning of forest health recording in Yukon. Spruce engraver beetle infestation was mapped in southwest Yukon at over 3,000 hectares (Garbutt 2013).

2b: Young adults and larva, Northern Spruce Engraver.

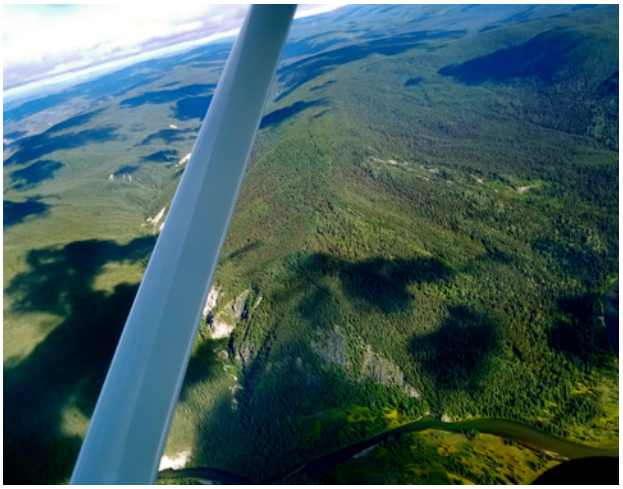
3. Western Balsam Bark Beetle *(Dryocoetes confusus)*

This beetle attacks subalpine fir (*Abies lasiocarpa*). Western Balsam Bark Beetle has moved north from BC in the late 1980s and has become an active disturbance agent in mature Subalpine Fir stands in southern Yukon.

3a: New (bright red), and old attack (dull red and grey), Western Balsam Bark Beetle.



3b: Adults, Western Balsam Bark Beetle.



4a: Eastern Spruce Budworm defoliation, west of Beaver River, 2017.

4b: Late instar spruce budworm larva.

5: Larch Sawfly larva; note gregarious feeding habit.

4. Budworms *(Choristoneura spp.)*

The budworm guild, comprising Eastern Spruce Budworm, Fir-Spruce Budworm, Two-Year Cycle Budworm and Western Black-Headed Budworm, cause similar defoliation damage to Spruce, Subalpine Fir and Larch (*Larix laricina*) forests in Yukon. In 2008, Eastern Spruce Budworm damage was mapped across 1,000 ha in Yukon, primarily near Stewart Crossing. Historically, Eastern Spruce Budworm damage has been mapped in the extreme southeast portion of Yukon (Garbutt 2013).

5. Larch Sawfly *(Pristiphora erichsonii)*

This defoliator is the most damaging agent of Larch in North America. In the mid- and late 1990s, mature Larch stands in southeast Yukon were heavily defoliated and experienced some mortality.

6a: Stand level defoliation by Large Aspen Tortix, Haines Junction, Yukon.

7a: Stand level damage, Aspen Serpentine Leafminer, southern Yukon.

6b: Large Aspen Tortix larva.

7b: Silvery leaf mining of Aspen Serpentine Leafminer.

6. Large Aspen Tortix *(Choristoneura conflictana)*

This defoliator of Trembling Aspen (*Populus tremuloides*) periodically erupts into outbreaks that result in severe defoliation, branch dieback and, at times, extensive tree mortality. Outbreaks of Large Aspen Tortix have occurred in several places throughout Yukon, including Teslin Lake, Braeburn, Haines Junction, Pelly Crossing and Champagne.

7. Aspen Serpentine Leafminer *(Phyllocnistis populiella)*

This insect pest occurs throughout the Yukon range of Trembling Aspen and also defoliates Balsam Poplar (*Populus balsamifera*). Starting in the early 1990s, a massive outbreak of Aspen Serpentine Leafminer extended from Alaska through Yukon, and into BC.

8a: Stand level damage, from Pine Needle Cast, Minto, Yukon.

8b: Damage to needles of young pine by Pine Needle Cast.

8. Pine Needle Cast *(Lophodermella concolor)*

This pathogen is the most common cause of premature needle loss of Lodgepole Pine (*Pinus contorta*) in Yukon (Garbutt 2009). Pine stands in southeast Yukon are chronically infected and the disease is becoming increasingly common in central Yukon. In 2008, Pine Needle Cast occurred from the BC border to the Continental Divide, Yukon. The most northern observation of needle cast was observed in young pine stands in the Minto Flats-McCabe Creek area in the Yukon interior (Ott 2008). The most severe damage in these pine stands covered 477 ha (Garbutt 2014).

9. Mountain Pine Beetle *(Dendroctonus ponderosae)*

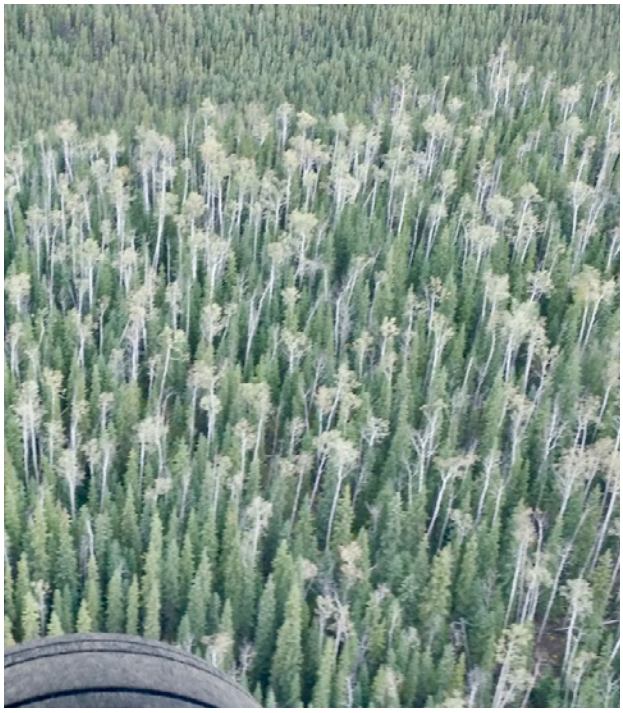
Though endemic to North America, this bark beetle is not present in Yukon. Most western pines in North America are suitable hosts, but Lodgepole Pine and Ponderosa Pine (*P. ponderosa*) are the most important host species (Logan and Powell 2001). In western Canada, Lodgepole Pine is the primary host of this beetle (Campbell et al. 2007, Li et al. 2005).

Mountain Pine Beetle (MPB) is currently the most important forest health concern in western Canada. The current outbreak in BC is responsible for killing over 13 million ha of pine forests (Safranyik et al. 2007). Cold-induced mortality is considered the most important factor controlling MPB dynamics (Régnière and Bentz 2007). A warming climate is expected to allow MPB to expand its range

9a: Mountain Pine Beetle, old and new attack, Rocky Mountain Trench, BC, 2012.

9b: Surviving larva at base of Lodgepole Pine Rocky Mountain Trench, BC. 2012.

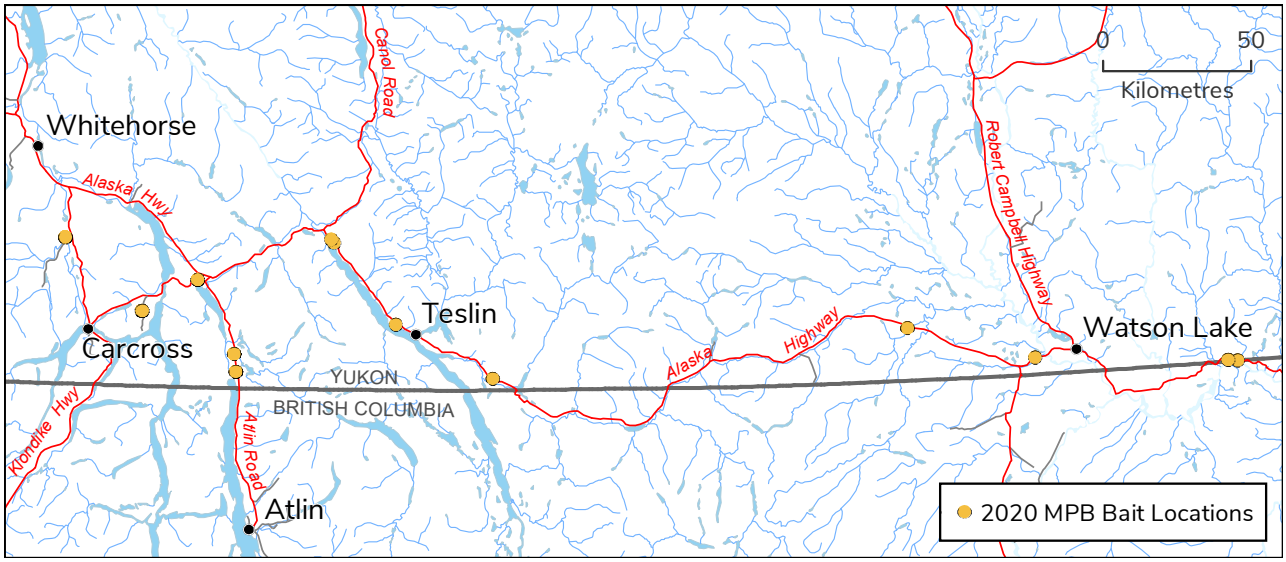
into higher elevations, eastward, and northward (Carroll et al. 2003, Régnière and Bentz 2007), potentially as far north as Yukon. Monitoring for MPB is a high priority because of its severe impact on pine forests during outbreaks and because of its confirmed proximity (80 km) to the Yukon border in 2011.



10: Tree dieback and aspen stand decline due to drought stress.

10. Tree dieback due to drought stress

Trembling Aspen tends to occupy the driest sites in Yukon. Because of this, dry site aspen stands are expected to be the first to exhibit dieback due to drought stress in a warming climate. In 2008, aspen stands exhibiting dieback were scattered along the North Klondike Highway between Whitehorse and Stewart Crossing. Most of these stands were on dry, rocky slopes and bluffs with south and west aspects, although some were located on level ground with well-drained gravel soil. Aspen stands experiencing dieback tended to be in an open canopy and were often stunted. Those on the rocky slopes and bluffs typically were adjacent to treeless steppe plant communities which are found on sites too dry for trees to grow (Ott 2008).



Map 2: Location of pheromone baiting sites in southern Yukon.

Taking action

Mountain Pine Beetle

Since 2009, the Forest Management Branch has been setting up and monitoring 15 pheromone bait tree stations in southern Yukon and northern BC to detect the presence of MPB (Map 2, Photo 11). These pheromone baits do not attract MPB over long distances but will draw them to the baits if they are already in the area. They also do not attract other species of bark beetles. No presence of MPB was found in 2020.

Pheromone placed on the north side of Lodgepole Pine tree.

Spruce Bark Beetle

In 2018 a spruce beetle monitoring program was established in the Haines Junction area, and has continued through to 2020. The objective of the program is threefold:

1. to track the presence or absence of spruce beetle in the Haines Junction Timber Harvesting Plan areas;
2. to better understand the timing of the spruce beetle flight period in the Haines Junction area; and
3. to determine if spruce beetle populations are higher in some areas than others.

Overall, a small number of spruce beetles (82) were collected for all traps over the spring and summer. Trap catchment was slightly lower than 2019, and considerably lower than 2018.

Lindgren funnel trap at Pine Canyon, 2020.

Pest incidence reporting

Northern Spruce Engraver Beetle

This bark beetle was found along Freegold Road near Carmacks on roadside spruce trees which had been harvested for firewood. This is typical behaviour for this bark beetle, which can act as both a primary and secondary pest by attacking stressed spruce trees.

Abiotic/environmental

Mature White Spruce on a residential property at Marsh Lake were showing signs of decline: reddish and discolored needles. As there was no evidence of insect activity, (i.e., boring dust, entrance or exit holes), the most probable cause is abiotic damage due to winter drying and possibly root compaction.

Pest of Trembling Aspen

Aspen leafminers

Aspen Serpentine Leafminer, *Phyllocnistis populiella*, and Aspen Blotchminer, *Phyllonoricter populiella*, were both noted near Dezadeash Lake, Mush Lake Road area. While the former is ubiquitous throughout the Trembling Aspen host range in Yukon, the latter has been less commonly observed. These two leafminers can be differentiated in both their color and behaviour; while one meanders and is serpentine in colour the other produces a single brown blotch on the underside of the leaf.

Stem cankers and wood borers

A number of stem cankers affect Trembling Aspen in Yukon, many of which can lead to stem deformity and eventual tree mortality. In 2020 a stem canker, likely rough bark disease, was found near Dezadeash Lake, Mush Lake road area. A wood borer, likely *Saperda calcarata*, was also found attacking the aspen at the location of the canker.

Pests of conifers

Pine needle cast

Pine needle cast, *Lophodermella concolor*, is a fungal disease of two-needle pines. In Yukon, it occurs throughout the range of the host species, Lodgepole Pine. The disease is prevalent in the southeast and is increasingly common in central Yukon. Outbreaks of pine needle cast tend to be more severe following successive wet summers when conditions have been optimal for spore production, dispersal

and infection. Successive years of severe infection results in only the current years needles remaining on the tree. This phenomena is commonly referred to as "lion's tailing".

In 2020 this needle cast was reported in Whitehorse and Annie Lake areas. It is also suspected that given the higher than normal rainfall experienced in Burwash Landing, Atlin and Teslin areas (Government of Yukon 2019) in 2019 that pine needle cast was prevalent in these areas as well.

Spruce needle rust

Small-spored Spruce Labrador Tea Rust (*Chrysomyxa ledi*) and Large-spored Spruce Labrador Tea Rust (*Chyrsomyxa ledicola*) are fungal diseases affecting the current year's needles of White Spruce. The range of spruce needle rust coincides with the ranges of the aecial (primary) host, White Spruce and the telial (secondary) hosts, Labrador Tea (*Ledum palustre* and *L. groenlandiculum*) and leatherleaf (*Chamaedaphne calyculata*). These complex rust fungi are heteroecious, meaning that they require the presence of both spruce and Labrador Tea to complete the disease cycle. In general, wet and cool weather is conducive for spore formation and spore dispersal from Labrador tea, as well as infection of new spruce needles. These conditions existed in the Burwash Landing, Whitehorse, Atlin and Teslin areas in 2019, hence it is suspected that this foliar rust may have been present in these areas.

Pests of native shrubs

In August 2020, black curled leaves and dieback of leaves of Highbush Cranberry shrubs were noted by local berry pickers in Mayo area. While the specific causal factor is unknown, it is suspected that the wet year contributed to its incidence and severity.

Data quality

The Canadian Forest Service (CFS) conducted the Forest Insects and Disease Survey (FIDS) from 1950 to 1995. The CFS and the Forest Management Branch conducted aerial surveys monitoring Spruce Bark Beetle near Haines Junction from 1995. The Forest Management Branch adopted the aerial overview survey program using National Forest Pest Strategy funding and has been conducting annual aerial surveys since 2009. The Forest Management Branch has conducted forest health aerial surveys at a landscape level since 2009 to identify both biotic and abiotic disturbances.

Aerial overview surveys are the primary tool for monitoring forest health in Yukon. Aerial overview surveys and ground field checks are a relatively simple and low-cost method for effectively monitoring forest health over large areas (Ciesla 2000, Mitton and Grant 1980). Aerial overview surveys are also adequate for regional and provincial summaries and to meet national requirements for the Forest Health Network (BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development and Canadian Forest Service 2000).

The forest health aerial overview survey standards used by the BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development are also used in Yukon, which ensures continuity across shared boundaries. Field checks are important for validating the data collected from the aerial surveys. Researchers check a portion of surveyed areas to confirm the identity and severity of the pest or disease disturbance.

As of 2013, all five forest health zones in Yukon were monitored by aerial overview survey. Baseline data has been collected from each forest health zone. From 2014 on, mapping resolution moved from 8 kilometre gridlines to 14 kilometre gridlines. During the monitoring of the forest health zones, researchers may select disturbances for further monitoring in the same year. If necessary, these disturbances are identified as ongoing monitoring areas to be included along with the forest health zones scheduled for aerial surveys during the current year.

The Forest Management Branch's Forest Health Program contains ground survey protocols to predict insect population trends, as well as evaluate the potential risk from various insect pests.

Further information

Forest management information: Yukon.ca/en/science-and-natural-resources/forests.

The Forest Management Branch produces an annual forest health report which presents the biotic and abiotic disturbance(s) detected by the annual forest health survey. The survey is performed in a different area (Forest Health Management Zone) each year.

Forest health reports: Yukon.ca/en/science-and-natural-resources/forests/learn-about-forest-health

References

BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development and Canadian Forest Service. 2000. Forest health aerial overview survey standards for British Columbia. Prepared for the Resources Inventory Committee.

Bentz B.J., J. Régnière, C.J. Fettig, M. Hansen, J.L. Hayes, J.A. Hicke, R.G. Kelsey, J.F. Negrón and S.J. Seybold. 2010. Climate change and bark beetles of the Western United States and Canada: Direct and indirect effects. Bioscience 60(8): 602-613. Available from: https://doi.org/10.1525/bio.2010.60.8.6.

Campbell E.M., R.I. Alfaro and B. Hawkes. 2007. Spatial distribution of mountain pine beetle outbreaks in relation to climate and stand characteristics: A dendroecological analysis. Journal of Integrative Plant Biology 49: 168-178.

Canadian Council of Forest Ministers. 2021. Forest Pest Working Group [cited 2020 Dec 13]. Available from: https://www.ccfm.org/english/coreproducts-forestpests.asp.

Carroll A., S.W. Taylor, J. Regniere and L. Safranyik. 2003. Effect of climate change on range expansion by the mountain pine beetle in British Columbia [cited 2020 Dec 13]. In The Bark Beetles, Fuels, and Fire Bibliography. Available from: https://digitalcommons.usu.edu/barkbeetles/195.

Ciesla W.M. 2000. Remote sensing in forest health protection. USDA Forest Service, Forest Health Technology Enterprise Team, FHTET Report No. 00-03. 266.

Garbutt R. 2013. Yukon Forest Health Report. 2013. Yukon Forest Management Branch, Whitehorse, Yukon, Canada.

Government of Canada, Natural Resources Canada. n.d National forest pest strategy [Revised 2020 July 7]. Available from: https://www.nrcan.gc.ca/our-natural-resources/forests-forestry/wildland-fires-insects-disturban/forest-pest-management/national-forest-pest-strategy/13409.

Government of Canada, Natural Resources Canada. n.d. Forest Pest Management. [Revised 2020 August 10]. Available from: https://www.nrcan.gc.ca/our-natural-resources/forests-forestry/wildland-fires-insects-disturban/forest-pest-management/13361.

Government of Yukon. Yukon Forest Health Report. 2019. Yukon Forest Management Branch, Whitehorse, Yukon, Canada.

Li C., H.J. Barclay, B.C. Hawkes and S.W. Taylor. 2005. Lodgepole pine forest age class dynamics and susceptibility to mountain pine beetle attack. Ecological Complexity Vol. 2 (3): 232-239.

Logan J.A. and J.A. Powell. 2001. Ghost forests, global warming and the mountain pine beetle (Coleoptera: Scolytidae). American Entomologist: 160-172.

Mitton J.B. and M.C. Grant. 1980. Observations on the ecology and evolution of quaking aspen, Populus tremuloides, in the Colorado Front Range. American Journal of Botany 67(2): 202-209.

Ott R.A. 2008. RAO Ecological Consulting Services trip report for the 2008 Yukon forest health survey. RAO Ecological Consulting Services, Bennington, Vermont, USA. Government of Yukon Contract Number GN08533048-55495.

Régnière J. and B.J. Bentz. 2007. Modeling cold tolerance in the mountain pine beetle, *Dendroctonus ponderosae*. Insect Physiol. 53: 559–572.

Safranyik L. and A.L. Carroll. 2007. Biology and epidemiology of the mountain pine beetle in lodgepole pine forests. The Mountain Pine Beetle: a Synthesis of Biology, Management and Impacts on Lodgepole Pine 1: 3-66.

Wetlands

Significance

Wetlands can be essential for maintaining water flows, flood protection, purifying water, recharging/discharging groundwater, and providing habitat for fish and wildlife. Some wetlands support traditional subsistence and cultural activities and provide for recreation. Wetlands also provide a number of additional valuable functions, including:

- slowing the flow of water, thereby reducing erosion;
- providing habitat for plants that help stabilize stream banks and shorelines;
- creating and fertilizing floodplains;
- supporting the food chain;
- enhancing aesthetics; and
- serving as a rich arena for education.

The Government of Yukon recognizes five classes of wetlands, as defined in the Canadian Wetlands Classification System (1997): bogs, fens, swamps, marshes and shallow open water. These classes are determined by soil, vegetation, water and other ecological characteristics.

The largest concentrations of wetlands in Yukon are located in areas underlain by continuous permafrost, in particular in northern Yukon (for example, the Old Crow Flats). However, wetlands and wetland complexes are present throughout the territory.

Wetlands are important for a disproportionally high number of species compared to many other habitats, which is reflected in the number of protected areas in Yukon that include wetlands.

What is happening?

The Government of Yukon is furthering wetlands management through development of policies, decisions and guidance at a broad territory-wide, regional and local watershed level.

There are a number of important wetlands identified as “significant” in the Government of Yukon’s Wildlife Key Area database held within the online Lands Viewer map tool (Government of Yukon n.d.).

Many of our existing and proposed protected areas include important wetland habitat.

As needed, wetland inventory is conducted to support various governments and non-government projects and planning processes.

There are bird monitoring programs in place in a number of wetland complexes recognised for their value to migratory birds which can provide an indication of wetland ecological health (i.e., waterfowl monitoring).

Taking action

The Government of Yukon remains committed to developing a wetlands policy for Yukon. We invited other governments and external organizations with an interest in wetlands to be partners in developing the policy. Throughout the development of the territory-wide wetlands policy, we have been working collaboratively with our First Nation partners to ensure their knowledge and cultural values are considered during policy development. Roundtable meetings occurred throughout 2018 and continued in 2019. In 2020, we have continued to develop this policy, completing a review and discussion of a draft policy with our partners. Find more about the results from past roundtables at: Yukon.ca/en/engagements/yukon-wetlands.

The Land Planning Branch of Energy, Mines and Resources is responsible for undertaking local area planning in unincorporated communities and supporting the development of regional and sub-regional land use plans. Land use plans are intended to reduce land use conflicts and promote the orderly development of land for the economic, social and environmental well-being of Yukoners. This includes consideration and protection of ecological values, including those of wetlands.

The Government of Yukon has established an interim approach to managing impacts of placer mining on wetlands in the Indian River area (Government of Yukon 2020a). Under this interim approach, specific requirements for protection of certain classes of wetlands are defined, as well as commitments to progressive reclamation for placer mining in the area. The interim approach has also committed us to working with Tr'ondëk Hwëch'in to develop reclamation guidelines and conduct further study on wetlands in the area.

While comprehensive wetland mapping has not been carried out in Yukon, wetlands have been mapped as part of ecosystem mapping done to support regional land use planning, and detailed local mapping has now been completed in several regions with high development interests. Recent local wetland inventory has been completed in the Indian River area (Government of Yukon 2020b) and within the Beaver River watershed (report in preparation).

We are currently undertaking a series of projects to explore the impacts of development activities on wetlands. In 2017, we initiated a multi-year project to develop a tool for determining the health of shallow open water wetlands. For this work, we have sampled more than 100 wetlands throughout the territory to determine what the natural ("reference") state of wetlands is. Future work will involve sampling and comparing impacted wetlands with the reference. In 2020, we also initiated a wetland health assessment project related to a proposed road development in central Yukon.

Data quality

The wetland map of the Indian River valley reflects the best interpretation of available data gathered at specific times. The final dataset includes remotely sensed and manually interpreted polygons, which utilize different methodologies. Mapped polygons are expected to change over time due to the constantly changing landscape of the mapped area. At a mapping scale of 1:10,000, inclusions of non-wetland landscapes may be within wetland polygons and vice versa due to the inherent landscape heterogeneity.

You can find a further description of the data limitations in the accompanying report (Government of Yukon, 2020b).

References

Government of Yukon. n.d. Wildlife Key Area layers [cited 2020 Dec 10]. Available from: https://mapservices.gov.yk.ca/geoyukon/?&LayerTheme=Wildlife.

Government of Yukon. 2020a. Information sheet: placer mining in the Indian River area. Yukon Mineral Resources Branch, Whitehorse, Yukon, Canada. Available from: https://yukon.ca/en/information-sheet-placer-mining-indian-river-area.

Governmen t of Yukon. 2020b. Mapping and classifying wetlands in the Indian River valley, Yukon Final Report. Government of Yukon, Whitehorse, Yukon, Canada. Available from: https://yukon.maps.arcgis.com/home/item.html?id=aec017fcaac541f4a22017a356b83740.

National Wetlands Working Group. 1997. The Canadian Wetlands Classification System, 2nd edition. Wetland Research Centre, University of Waterloo, Waterloo, Ontario, Canada.

Presence of alien and introduced species

Significance

Introduced alien (or exotic) species are plants, animals and microorganisms introduced outside their normal range by humans. Not all alien species harm an ecosystem. Some are introduced on purpose for conservation, in gardens, to increase hunting or fishing opportunities, and other reasons.

Invasive species are alien species whose introduction has an environmental, economic or social cost (CBD Secretariat n.d.). Invasive species can cause loss of biodiversity, reduce property value or reduce the quality and abundance of resources to humans, including the loss of plants traditionally used by First Nations.

Besides the impact on native biodiversity, invasive species come at a cost. Costs can be:

- financial, such as the cost of highway maintenance, and competition and control in agriculture;
- social, such as the loss of a wilderness experience; and
- environmental, such as increasing wildlife attractants to roadsides or reclaimed mine sites.

Climate change is reducing the resiliency of native ecosystems to be resistant to the spread of exotic species. With increasing globalization, there are more opportunities for introduction of alien species. With warmer winters and wetter summers, established species are spreading more rapidly.

What is happening

Yukon is second only to Nunavut as a jurisdiction in North America with the lowest percentage of exotic species (NatureServe 2020). Just under three per cent of the nearly 8,000 species known to be wild in Yukon are considered introduced, or have introduced populations.

- As of November 2020, an estimated 228 exotic species have been identified in Yukon. Of these, 150 are currently believed to be present (Yukon Conservation Data Centre 2020; Figure 1), 34 are believed to be absent, and the presence of 44 additional species is unknown.

- Twenty-seven species have a high to medium invasiveness rank in Yukon (Government of Yukon 2020). All but two of these species are plants. Chytrid Fungus, which harms Yukon amphibians (Government of Yukon 2013) and Seven Spotted Lady Beetle, which is believe to be replacing Yukon's Transverse Lady Beetle (COSEWIC 2016, CABI 2020) are also considered to be invasive in Yukon.
- Nine species of vertebrates are considered introduced and found in the wild. These include three mammals (Elk, Feral Horse, House Mouse), three birds (Eurasian Collared-Dove, European Starling, House Sparrow) and three fishes (Arctic Char, Rainbow Trout, Three-spine Stickleback). The Rock Pigeon and Goldfish that were once found in the wild in Yukon are now considered extirpated. Three species of fishes (Bull Trout, Dolly Varden, Kokanee) have native populations, but also have populations that have been introduced into pothole lakes and are not considered wild.
- Toadflax Seed Weevil (*Rhinusa antirrhini*) was introduced in British Columbia to control the spread of invasive species of Toadflax (*Linaria spp.*). The species was found through a photograph by Ryan Sealy on the invasive plant Butter-and-eggs (*Linaria vulgaris*). It is unknown how this species has spread from southern British Columbia to Yukon.

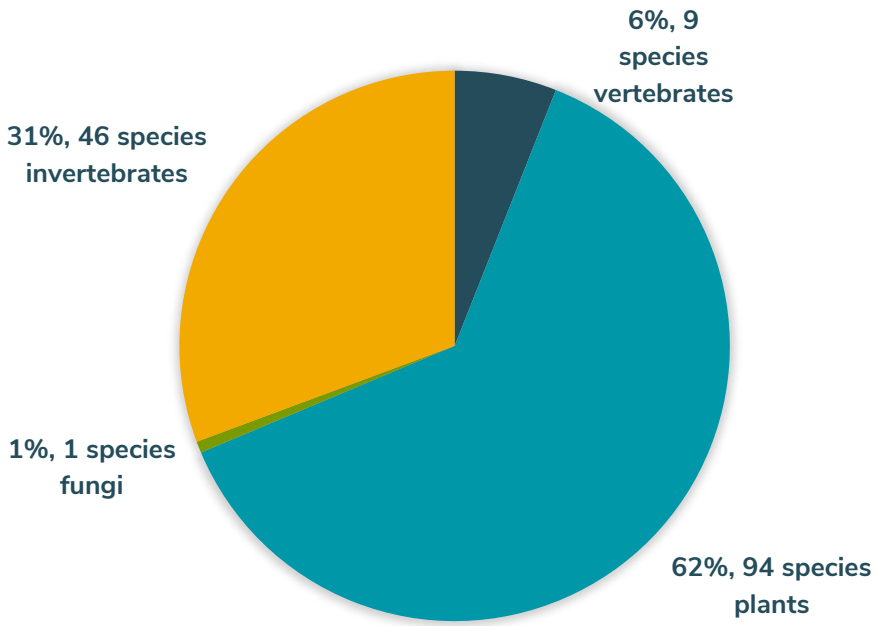


Figure 1: Exotic species present in Yukon.

Source: Government of Yukon, Yukon Conservation Data Centre (2020) species database.

Taking action

The Government of Yukon supports to Yukon Invasive Species Council to provide information on species introduced to Yukon. Find them at: yukoninvasives.com.

The Yukon Conservation Data Centre uses reports, collections and photographs through the platform iNaturalist.ca to help gather information on the distribution of species introduced to Yukon. The Yukon Conservation Data Centre makes data publicly available to anyone wishing to access information on species or ecosystems of conservation concern. This includes lists of species, range maps and identification guides.

The Government of Yukon provides additional information about Yukon's aquatic invasive species at: Yukon.ca/aquatic-invasive-species.

Data quality

The Yukon Conservation Data Centre gathers information on nearly 10,000 wild species of plants, animals and fungi. This includes information on which are naturally occurring and which are known or are likely to become invasive.

References

BC Ministry of Forests and Range, Forest Practices Branch. 2008. Operational Field Guide to the propagation and establishment of the biocontrol agent *Rhinusa antirrhini* (Toadflax Seed-feeder). Unpublished report. Victoria, British Columbia, Canada.

Centre for Agriculture and Bioscience International (CABI). 2020. *Coccinella septempunctata* (seven-spot ladybird). In: Invasive Species Compendium [cited 2020 Dec 12]. CABI, Wallingford, UK. Available from: www.cabi.org/isc.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2016. COSEWIC assessment and status report on the Transverse Lady Beetle *Coccinella transversoguttata* in Canada. COSEWIC, Ottawa, Ontario, Canada. Available from: http://www.registrelep-sararegistry.gc.ca/default.asp?lang=en&n=24F7211B-1.

Convention on Biological Diversity (CBD) Secretariat. n.d. Invasive species [cited 15 December 2020]. Available from: www.cbd.int/invasive.

Government of Yukon. 2013. Management Plan for Yukon Amphibians. Yukon Fish and Wildlife Branch, Whitehorse, Yukon, Canada. Available from: https://yukon.ca/en/management-plan-yukon-amphibians.

Government of Yukon. 2020. Species database. Yukon Conservation Data Centre, Whitehorse, Yukon, Canada.

NatureServe. 2020. NatureServe Explorer [cited 2020 Dec 15]. NatureServe, Arlington, Virginia, USA. Available from: https://explorer.natureserve.org/.

Fish and wildlife

Species management plans

Significance

Species management plans address conservation and population management concerns for fish or wildlife populations. They are used to help to develop or revise approaches to managing a population and regulating human interaction with these species.

Management plans are developed in response to local or territorial population management needs or as required through the federal species at risk legislation. Tracking the implementation of management plans helps to demonstrate commitment to continued action on managing species.

What is happening?

The Government of Yukon has the following species management plans in place or in progress.

Management Plan for Elk in Yukon

Approved: 2016
Status: Current

This plan provides an adaptive framework to guide the management of the Takhini and Braeburn Elk herds.

Management Plan for Yukon Amphibians

Approved: 2013
Status: Current

This plan provides a broad framework guiding the management of amphibians in Yukon. The Western Toad is listed as a Species of Special Concern under the federal ***Species at Risk Act***.

Management Plan for the Aishihik Wood Bison Herd in Southwestern Yukon

Approved: 2012
Status: Renewal underway

This plan provides a broad framework guiding the management of the herd in a manner consistent with recovery of a species at risk, while addressing local concerns and interests.

Yukon Wolf Conservation and Management Plan

Approved: 2012
Status: Implementation review complete

This plan guides wolf conservation and management throughout Yukon, ensuring that the roles of wolves and their prey species are respected.

A Conservation Plan for Grizzly Bears in Yukon

Approved: 2012
Status: Implementation review complete

The Government of Yukon and the Yukon Fish and Wildlife Management Board worked in partnership to develop this plan to address local management issues and to meet federal and international obligations. The Grizzly Bear is listed under the federal ***Species at Risk Act*** as a Species of Special Concern.

Management Plan for the Chisana Caribou Herd

Approved: 2011
Status: Renewal underway

This plan guides the management and conservation of the Chisana caribou herd, a small international herd shared with Alaska. The herd experienced population declines and a successful recovery effort in the past. The management plan provides guidance to maintain a healthy herd.

Taking action

View the species management plans for specific action items on species at: Yukon.ca/wildlife-habitat-planning.

Profile

Southern Lakes wolf study

Why are we doing this?

- Wolf population information needs to be updated;
- locals are concerned about the impact of wolf predation on recovering caribou;
- we want to learn about wolves, caribou and moose to help inform conservation and species management; and
- we want to build a community-based monitoring program working with First Nations game guardians and local trappers.

What has been done so far?

The Government of Yukon has:

- held workshops with program participants;
- carried out tracking and trapping efforts with Carcross/Tagish First Nation, Kwanlin Dün First Nation, Taku River Tlingit First Nation, Teslin Tlingit Council, Carcross/Tagish Renewable Resources Council and local trappers;
- trapped and collared eight wolves from five different wolf packs; and
- collected wolf scat for diet analysis.

What's next?

The Government of Yukon will:

- analyze and report on ground-tracking survey results;
- identify den sites and look at reproductive rates and pup survival;
- visit kill sites to determine composition of prey species; and
- deploy remaining eight wolf collars.

For more information about the Southern Lakes Wolf study, please contact:

- Lars Jessup, Southern Lakes regional biologist by phone at 867-667-5767 or email lars.jessup@yukon.ca.
- Peter Knamiller, wolf program coordinator, project lead, by phone at 867-332-5469 or email peter.knamiller@yukon.ca.

Caribou population and distribution

Significance

Caribou are important ecologically and culturally. Many people in Yukon rely on caribou for subsistence and spiritual well-being. Conserving and protecting key caribou habitat – rutting areas, migration corridors and winter range – is important for herd health and abundance.

Caribou herds that cross jurisdictional boundaries require a coordinated approach to their management. For example, the Porcupine caribou herd has a range that covers Yukon, Alaska, and the Northwest Territories.

What is happening?

There are two subspecies of caribou in Yukon, *Rangifer tarandus granti* which are the large migratory herds (e.g., Porcupine, Fortymile and Nelchina) and *Rangifer tarandus caribou*, which are more sedentary woodland herds (e.g., Northern Mountain and boreal).

- In 2016, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed all "barren-ground" caribou in Canada as a Threatened Species. Yukon's Porcupine caribou herd is included in this assessment.
- The Fortymile and Nelchina herds are not considered "barren-ground" caribou under COSEWIC's barren-ground caribou assessment and their status has not been assessed.
- The Porcupine caribou herd has increased in population size to 218,000 (2017) from 197,000 caribou in 2013 and 169,000 in 2010. All monitoring indicators and population models indicate a high probability that the herd is either stable or increasing in 2020.
- All monitoring indicates that the Fortymile caribou herd has experienced a natural decline in population size starting in 2018 following a recent population high of 84,000 in 2017. Nelchina caribou are thought to be relatively stable at this time.
- All large migratory caribou herds continue to make use of the important seasonal habitats available to them in Yukon although annual distribution can vary considerably.

Taking action

- The Government of Yukon monitors several caribou herds each year to assess overall status and trends.
- Recovery plans for woodland caribou populations have been developed under the federal ***Species at Risk Act***.
- Harvest management plans have been developed for the Porcupine (2010) and Fortymile (2020) caribou herds in collaboration with co-management partners. A new Yukon resident hunt was initiated for Fortymile caribou in 2020.
- An international, multi-jurisdictional management plan for the Chisana herd has been developed.

- Yukon is working together with our partners to identify required habitats and industrial guidance to ensure long term conservation of large migratory caribou herds. For example, we worked with the governments of Canada and the Northwest Territories, Inuvialuit Game Council, Gwich'in Tribal Council, Vuntut Gwitchin First Nation, Tr'ondëk Hwëch'in, and the First Nation of Na-Cho Nyäk Dun to advocate for the protection of the Porcupine caribou's calving grounds in the Alaska coastal plain.

Data quality

- Caribou herd population status (size and trend) is typically determined through aerial surveys, which estimate both herd size and the number of calves produced each year. The Government of Yukon has modified its approach over the past few years to use aerial surveys in combination with radio-collared animals to monitor Northern Mountain woodland caribou herds. This approach has increased the precision of population estimates as well as provided additional information on seasonal ranges and habitat use.
- The sizes of large migratory herds are estimated using aerial photo census techniques. The Government of Yukon partners with the Government of Alaska, which leads these surveys.
- Annual monitoring of large migratory herds is ongoing with our partners in Yukon, Alaska and Northwest Territories. Measures include calf production and survival, herd composition and health, and adult survival rates.
- Approximately 100 individuals in each of the Porcupine and Fortymile caribou herds carry satellite GPS collars, which provide location information every 2.5 to 25 hours, depending on the sex and age of the animal carrying it and the time of year. This information is generating a wealth of knowledge on habitat use and migration patterns including the response of caribou to climate change and industrial developments.
- Specialized camera collars have been deployed on both Fortymile and Porcupine caribou herds over the past several years and are helping researchers understand the complex interaction between diet, insect harassment, forage availability, and climate change.

Caribou mercury levels

No new data was available this year. Refer to the ***Yukon state of the environment report 2020*** for the latest reporting information.

Density of Snowshoe Hares

Significance

Snowshoe Hares are a “keystone” species in the boreal forest vertebrate food web. Their populations cycle in abundance, with peaks occurring about every 10 years throughout northern North America. These cycles have occurred for as long as we have records, which go back nearly two centuries from fur harvest data. Highs and lows occur at about the same time over large areas of the continent. At cyclical highs, hares may be 30 to 50 times as abundant as at low points in the cycle.

Cycles in hare numbers affect the abundance of the many predators that eat them as well as the plant species that hares eat. These in turn affect the numbers and survival of other species that are alternative prey for these predators, so the hare cycle has widespread effects in the boreal forest. Because of their importance, we monitor the density of snowshoe hares to look for changes that may be related to our warming climate or evolving patterns and intensities of human activity.

What is happening?

We monitor the abundance of snowshoe hares and other key indicators of change in the boreal forest in five different areas as a part of the Community Ecological Monitoring Project. These areas are Kluane Lake, Whitehorse, Watson Lake, Faro and Mayo. The data series go back to the 1970s at Kluane Lake, but monitoring began more recently, from 2004 through 2008, in the other communities. Figure 1 shows the Kluane Lake data, which are the latest results in the context of patterns observed over more than 40 years. Snowshoe Hare numbers at Kluane Lake have been undergoing their cyclical decline during the past three years and we are now at the low phase of the cycle. The pattern is very similar at the other four communities monitored. Cyclical lows typically last three to four years before populations of hares start increasing again.

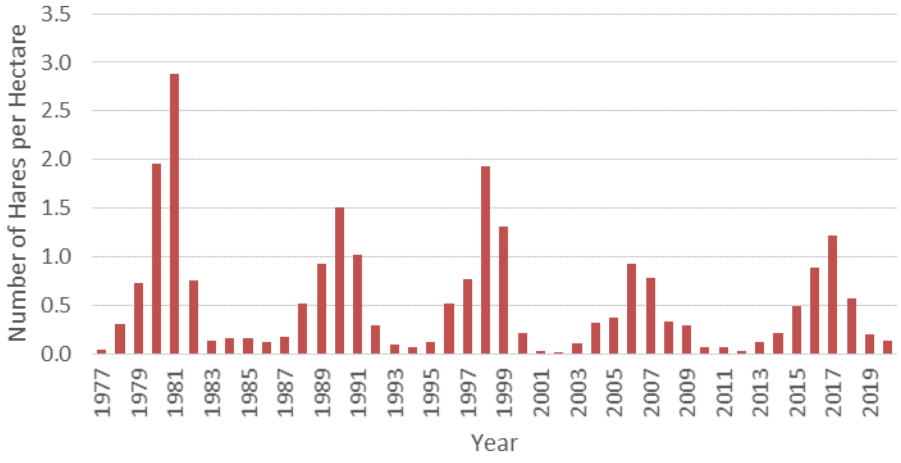


Figure 1: Spring densities of Snowshoe Hares at Kluane Lake.

Taking action

We are continuing to monitor the abundance of Snowshoe Hares and their predators, as well as key plants, in the boreal forest in the five areas in the southern and central Yukon as part of the Community Ecological Monitoring Project. Establishing the natural range of variation in abundance of these plants and animals and monitoring changes annually gives us the opportunity to detect the effects of influences like climate change on the boreal forest ecosystem.

Data quality

The Community Ecological Monitoring Program is a partnership between biologists at the Government of Yukon, Yukon University and the Outpost Research Station at Kluane Lake. Each year, teams of researchers, students and local residents head out into the field to our long term monitoring sites around these five communities and collect the data to add another year to the time series. Data are collated, error-checked, entered into a common database and summarised in annual reports.

Profile

Traditional and local knowledge of Snowshoe Hare populations

The data we collect on our long-term monitoring sites is one important source of information on the annual changes we are observing in the environment. Traditional and local knowledge provides us with a valuable second source that has a longer time frame, a wider geographical area and more local details than our technical data. In the Mayo area, we work with local students to annually interview local First Nation and non-First Nation people who spend lots of time on the land to record their observations.

Local people have observed the cycles in numbers of Snowshoe Hares for many decades and have observed a very similar pattern to that shown by the data from our monitoring sites. Figure 2 shows interview results from the Mayo area. These, along with detailed comments from the people interviewed, show numbers of Snowshoe Hares declining from a peak in 2017-2018, but still abundant in some pockets.

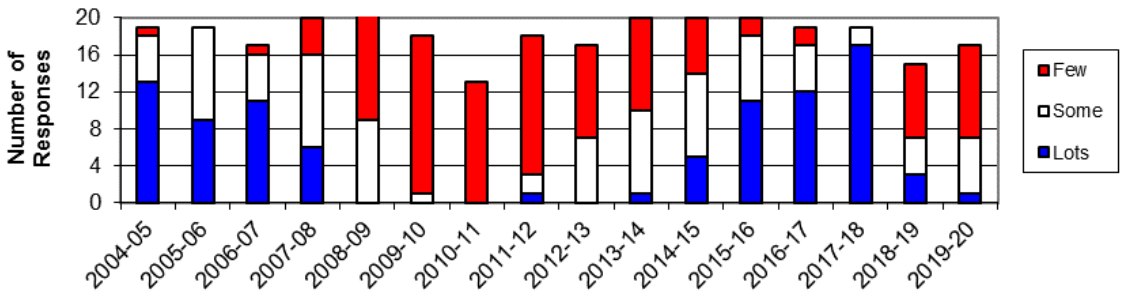


Figure 2: Snowshoe Hare numbers in Mayo based on interviews with local residents.

Winter Tick surveillance

Significance

Winter Ticks (*Dermacentor albipictus*) are parasites commonly found on cervids such as elk, mule deer, caribou and moose in Yukon. These parasites can harm the health of the host when present in large numbers. Moose are especially vulnerable. In some parts of Canada Winter Ticks cause severe disease and mortality in Moose.

To date, Winter Ticks are not a major disease concern for Yukon cervids. They also rarely carry diseases of concern to humans or wildlife, have no impact on the meat of harvested animals, and rarely feed on people or domestic animals.

The Government of Yukon is studying the distribution and occurrence of Winter Ticks in Yukon to monitor how these parasites may affect Yukon's wild cervid populations and how their geographical distribution may change over time.

Climate change may be an important factor in how Winter Ticks interact with cervids. Warmer summer temperatures and milder, wetter winters and springs may support larger populations of cervids that carry ticks, and allow larval ticks to survive longer. Seasonal changes may also influence vegetation patterns and cervid host habitat use, influencing the distribution and presence of wildlife parasites.

What is happening?

Winter Ticks affect different species in different ways.

- In early autumn, Elk and deer groom off most of the larval ticks in early autumn. This reduces tick numbers and minimizes negative health impacts.
- Moose only begin to groom off ticks in late winter, when adult ticks are present. This can lead to high numbers of ticks on individual moose.
- Heavy tick burdens can lead to severe disease associated with blood and hair loss in moose.

Table 1: Cervid hides examined for Winter Ticks between 2011 and 2020.

Species	Number of hides sampled*	Per cent hides found with Winter Ticks (actual number)
Mule Deer	88	60% (53)
Moose	65	7.7% (5)
Elk	95	68% (65)
Caribou	23	4.3% (1)

*An additional 60 hide samples from 2020 are pending processing.

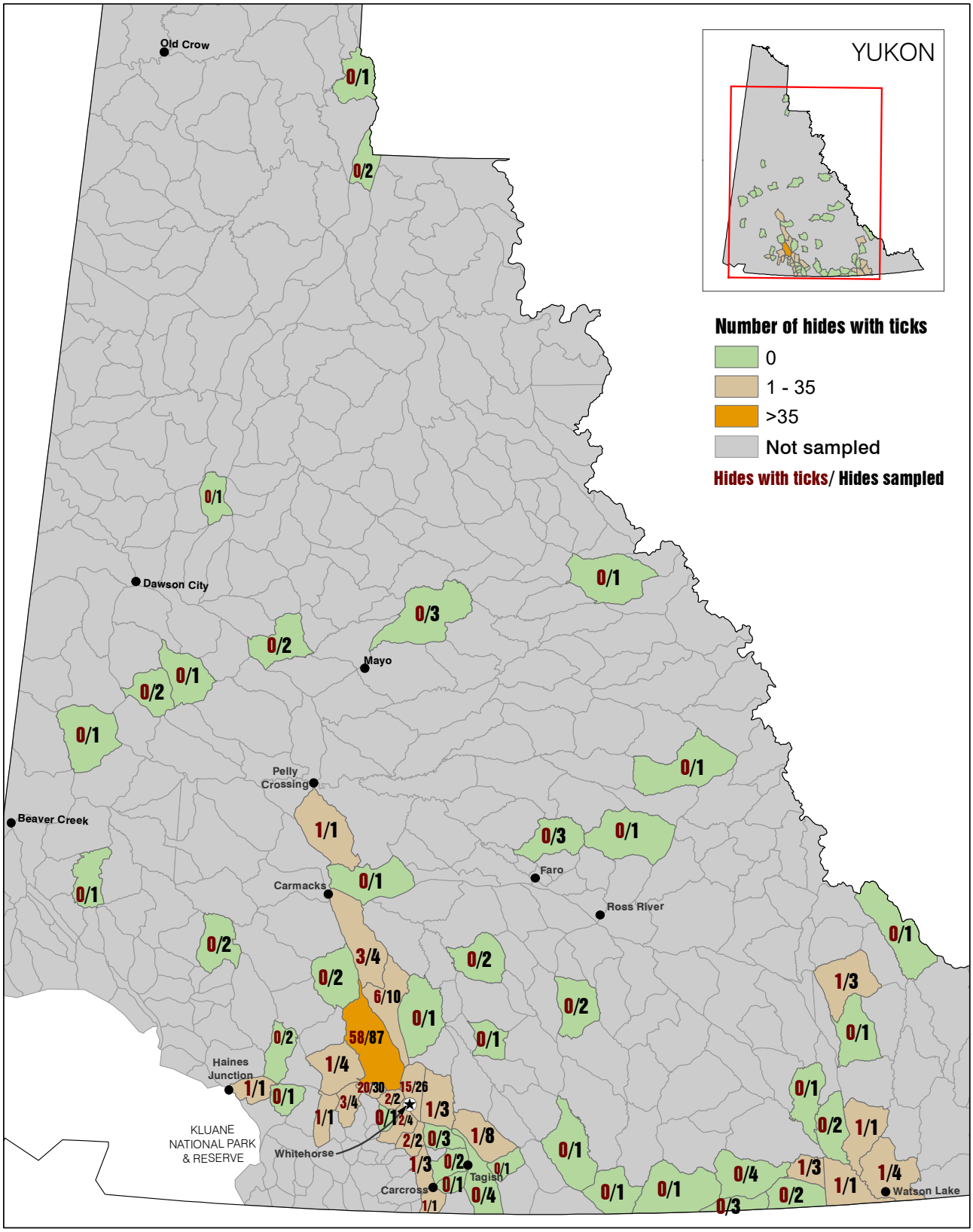


Figure 1: The known distribution of Winter Ticks based on hides examined to date (collected between 2011 and 2020).*

*An additional 60 hides samples from 2020 are still pending processing.

Since 2011, the Government of Yukon Animal Health Unit has examined cervid hides to monitor Winter Tick presence in different cervid species (Table 1) and geographical presence over time (Figure 1).

- The range of Winter Ticks have expanded and can be found on Elk in Yukon.
- Winter Ticks have been found on cervids in 22 out of the 60 Game Management Subzones where hides have been examined.
- The Animal Health Unit also monitors the severity of Winter Tick burdens on the hides that are sampled. While most hides have light burdens, a few have heavier burdens. So far, the heaviest tick burden detected in Yukon was on a Moose.

Taking action

Detecting Winter Ticks on cervid hides

- The Government of Yukon's Animal Health Unit monitors Winter Ticks through assessment of cervid hides. These include Elk and deer hides, which hunters must submit, and caribou and moose hides that are submitted voluntarily.
- The majority of hides examined have been from southern Yukon (see Figure 1). More hides from other areas are needed. We encourage hunters to contact the Department of Environment to submit cervid hides for examination.
- We examine hides for Winter Ticks by visually counting nymphs and adults. Larvae are difficult to detect with the naked eye. Since 2018, we have used a new method of vacuuming hides to collect larvae.

Detecting Winter Ticks in the field

Preliminary data collected over winter 2019-2020 showed many detections of potential Winter Tick hosts (575 detections from 70 cameras). Elk were the most frequently photographed of the hosts and the only species to show Winter Tick hair loss, which was visible from late March onwards. Notable ticks, hair loss and damage were generally mild to moderate, suggesting relatively low tick numbers on these animals. However, initial estimates suggest greater than 30 per cent of the Elk herd showed apparent Winter Tick infestation over this period.

References

Chenery E.S., N.J. Harms, N.E Mandrak and P. K. Molnar. 2020. First records of Dermacentor albipictus larvae collected by flagging in Yukon, Canada. Parasites and Vectors 13: 565.

Leo S., W. Samuel, M. Pybus and F. Sperling. 2014. Origin of *Dermacentor albipictus* (*Acari: Ixodidae*) on Elk in the Yukon, Canada. Journal of Wildlife Diseases 50(3):544-551.

Government of Yukon staff conducting a Lake Trout population assessment at Dezadeash Lake.

Photo: Cameron Sinclair.

Sustainability of Lake Trout fisheries

Significance

Lake Trout (*Salvelinus namaycush*) are a top predator and a highly valued freshwater species for Yukon recreational and subsistence fisheries. Monitoring Lake Trout population levels, health and changes to habitat provides valuable information that reflects the state of our freshwater lakes. This is in part due to requirements of the Lake Trout's life cycle and unique ecology, including:

- its need for cold, well oxygenated and clean habitat;
- availability of prey fish; and
- its slow growth and long lifespan as a species.

These aspects and requirements make Lake Trout a valuable species to monitor overall lake health, ecosystem health and the effects of climate change on freshwater populations. As such, this species is monitored throughout Yukon to detect changes over time, maintain sustainable recreational levels and enable sustainable fisheries for future Yukoners.

What is happening?

Lake Trout population assessments are conducted on targeted lakes across Yukon on a yearly basis. In addition to these population assessments, we monitor recreational harvest pressure across Yukon to help determine sustainable harvest limits.

In 2020:

- We conducted lake trout population assessments on Dezadeash Lake, Pine Lake and Frenchman Lake.
- We monitored recreational harvest pressure Fish Lake, Little Atlin Lake and the Lubbock River.

In addition to these sampling events, the Government of Yukon published the ***Lake Trout Monitoring Program: 2019 Program Update***, encompassing assessment results from 2010 thorough 2019 (Sinclair and Savage 2020).

Current data suggests that the majority of the recreational Lake Trout harvest was sustainable across Yukon, maintaining high-quality angling opportunities. Lakes with stocks at-risk are managed through size, catch and possession regulations.

Taking action

The Government of Yukon is working to develop Lake Trout recovery plans for known depleted stocks in Pine Lake, Snafu Lake and Tarfu Lake.

A multi-year Lake Trout movement study within the Southern Lakes system has completed data collection and is undergoing analysis. This study will aid in determining movement patterns and genetic relationships among Lake Trout populations in the Southern Lakes system.

In 2021, the Government of Yukon will assess Lake Trout growth rates in several lakes, including assessment and analysis of known small-bodied populations.

Data quality

Lake Trout population estimates in individual lakes are derived from conducting Summer Profundal Index Netting over the course of several days. These methods have been used by the Lake Trout Monitoring Program since 2010. These estimates are combined with recreational harvest pressure monitoring, through conducting angler interviews, to determine sustainable yields.

References

Sinclair C.L. and P. Savage. 2020. Lake Trout Monitoring Program: 2019 Program Update. Yukon Fish and Wildlife Branch Report SR-20-02, Whitehorse, Yukon, Canada. Available from: https://open.yukon.ca/data/sites/default/files/SR-20-02%2520Lake.Trout.Monitoring.Program.2019.pdf

Number of spawning Chinook Salmon

Significance

Yukon Chinook Salmon:

- are among the longest running migrating salmon in the world;
- are an important resource for many species;
- release marine-derived nutrients from their ocean feeding ground to freshwater and terrestrial ecosystems when they die;
- are an integral component of First Nations history, diet and culture; and
- are an important source of livelihood in many Yukon communities.

Annual Chinook Salmon returns vary considerably due to a number of factors including:

- juvenile survival through incubation, emergence and outmigration to the Bering Sea;
- survival and growth in marine feeding grounds to adult stages;
- predation;
- disease;
- environmental variables including water level, temperature, and climatic events such as the Pacific Decadal Oscillation and El Niño; and
- marine and in-river harvest.

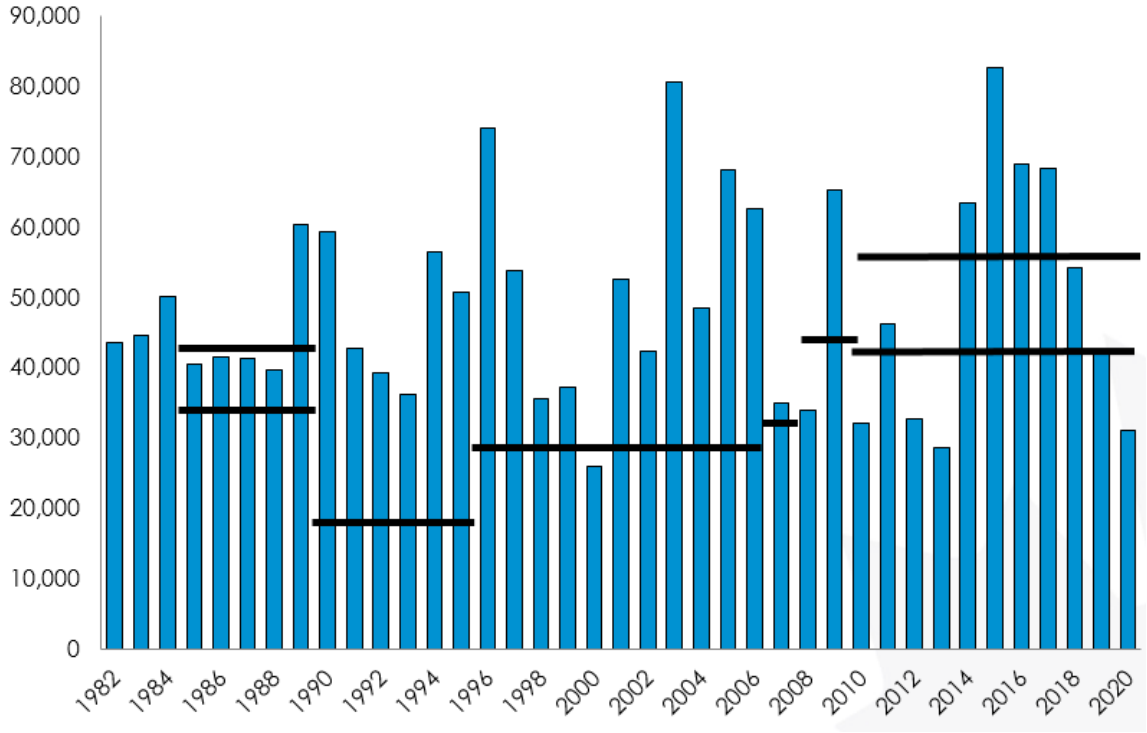


Figure 1: Number of Chinook salmon spawning in the Canadian portion of the Yukon River, excluding the Porcupine River drainage. Blue bars represent yearly spawning escapement estimates and black lines represent spawning escapement goals.

The international Yukon River Salmon Agreement has formally been in place since 2002 to help rebuild and conserve Canadian-origin salmon stocks and to define harvest allocations to Canadian and US fisheries. The Yukon River Panel established an interim spawning escapement goal that identifies the number of Chinook Salmon that should be allowed to return and spawn in the Canadian portion of the Yukon River.

The goal is to allow 42,500 to 55,000 Chinook Salmon to return to the Canadian portion of the Yukon River to spawn. Each year the federal government, through Fisheries and Oceans Canada, monitors if this target has been achieved, mainly through a border assessment project located in Eagle, Alaska that is operated in partnership with the Alaska Department of Fish and Game.

What is happening?

- In 2020, the spawning escapement goal for Yukon River Chinook Salmon was not met, with an estimate of just under 31,000 fish reaching their spawning grounds in Yukon (Figure 1).
- This is the second time the spawning escapement goal was not achieved since 2013.
- The 2020 drainage-wide run size (i.e., the number of Chinook Salmon estimated to enter the lower river which includes both US and Canadian salmon stocks) indicated a larger Canadian-origin Chinook Salmon run size than what was estimated at the border. Potential mechanisms that may have contributed to this discrepancy include measurement error at the river mouth and for US harvest, and non-harvest mortality of migrating Chinook between the river mouth and the border.

Taking action

To maintain a healthy number of spawning salmon in times of low productivity, fisheries managers in Yukon and Alaska have undertaken a range of actions including:

- full or partial closures of commercial, domestic and recreational fisheries;
- decreasing gill net mesh sizes to focus effort on smaller and younger fish; and
- consideration of environmental conditions, in particular extreme events, to inform management measures.

In addition, Yukon First Nations have placed voluntary restrictions or avoided subsistence harvesting activities in years of low returns.

The Yukon River Panel, established by the Yukon River Salmon Agreement, recommends spawning goals, reviews management strategies and conservation objectives, and funds restoration and enhancement projects focusing on Canadian-origin salmon stocks.

Data quality

Estimates of the total number of salmon that return to their spawning grounds in Yukon are based on:

- sonar passage estimates based in Eagle, Alaska; and
- harvest estimates from fisheries upstream of the sonar in both Alaska and Yukon.

In addition, a number of assessment projects in the upper Yukon River watershed are used to monitor the number of adult salmon returning to specific spawning tributaries. These projects also monitor the ratio of females to males, and the size and age composition of adult salmon returning to spawn.

References

Joint Technical Committee of the Yukon River US/Canada Panel (JTC). 2020. Yukon River salmon 2019 season summary and 2020 season outlook. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A20-01, Anchorage, Alaska, USA. Available from: https://www.yukonriverpanel.com/publications/yukon-river-joint-technical-committee-reports/.

Yukon River Panel. 2017. Salmon [cited 2021 Feb 1]. Available from: http://yukonriverpanel.com/.

Trumpeter Swan population monitoring

No new data was available this year. Refer to the ***Yukon state of the environment report 2020*** for the latest reporting information.

Monitoring breeding waterfowl

No new data was available this year. Refer to the ***Yukon state of the environment report 2020*** for the latest reporting information.

Monitoring wild sheep and goat health

Significance

- ***Mycoplasma ovipneumoniae*** is a bacterium that has contributed to pneumonia outbreaks in bighorn sheep across western North America.
- Domestic sheep and goats carrying ***M. ovipneumoniae*** can appear healthy, but can result in severe respiratory disease in wild sheep and goats.
- No pneumonia outbreaks have been detected in Yukon to date. In 2018 ***M. ovipneumoniae*** was detected in Alaska but no outbreak of pneumonia have been associated with these results.
- The Government of Yukon's Animal Health Unit has been testing nasal swabs collected from thinhorn sheep and Mountain Goats for ***M. ovipneumoniae*** since 2015. The Animal Health Unit has tested nasal swab samples from Caribou, Moose, Elk Muskox and Mule Deer in Yukon since 2018.
- On January 1, 2020, an order under the *Animal Health Act* came into effect for Yukon that requires anyone who owns domestic sheep or goats to test their animals for ***M. ovipneumoniae***. Animals that test positive are destroyed and the owners compensated. Owners must also have approved containment for domestic sheep and goats to reduce the risk of contact with Dall's Sheep and Mountain Goats.

What is happening?

- ***M. ovipneumoniae*** was not detected in the 443 thinhorn sheep and 10 Mountain Goats tested between 2015 and 2020.
- ***M. ovipneumoniae*** was not detected in the 12 Moose, 28 Elk, 8 Muskox and 14 Mule Deer tested between 2018 and 2020. Since 2018, samples from 137 Mountain Caribou from four herds, 11 caribou samples from unknown herds, and 111 Porcupine caribou samples have been tested. All samples have been negative.

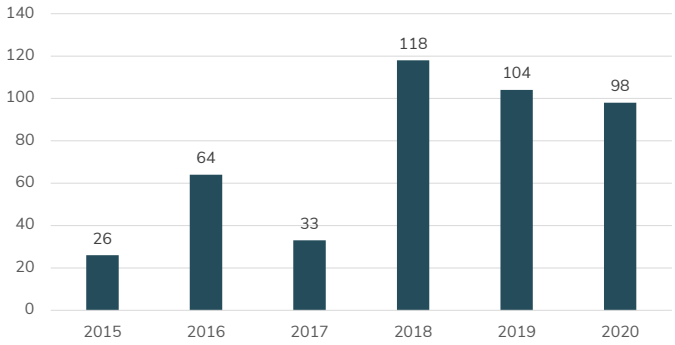


Figure 1: Number of thinhorn sheep tested annually for *M. ovipneumopniae*.

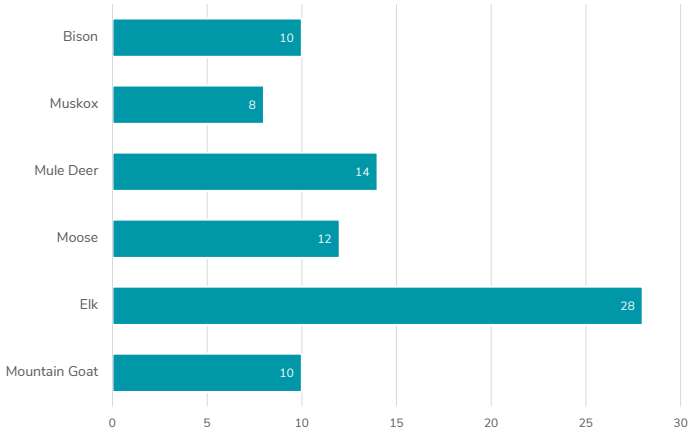


Figure 2: Number of wildlife samples from Yukon ungulates tested for ***M. ovipneumoniae*** between 2018 and 2020 (excluding caribou).

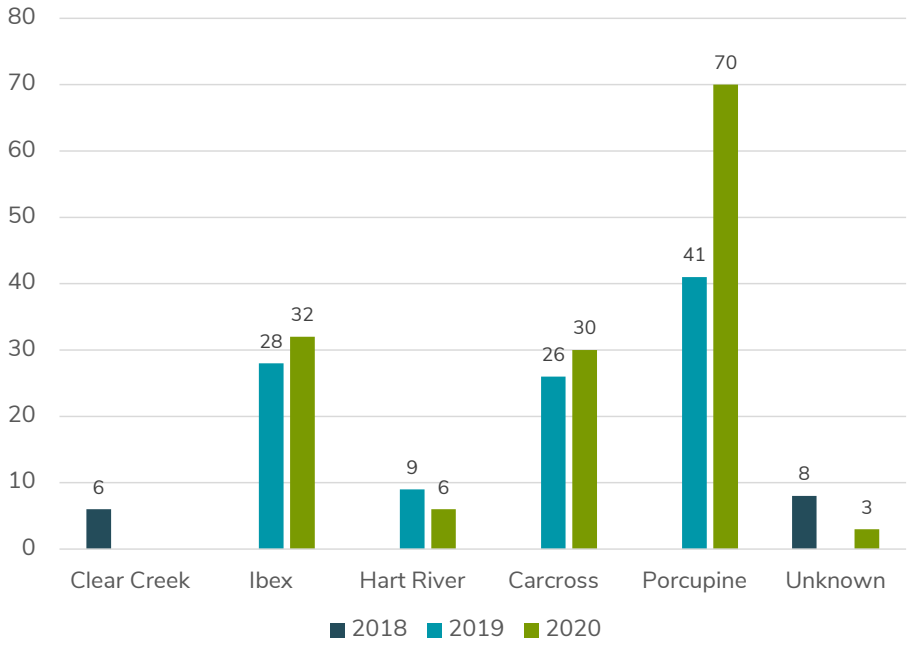


Figure 3: Number of Yukon caribou samples by herd and year tested for ***M. ovipneumoniae*** between 2018 and 2020.

Taking action

- The Government of Yukon's Animal Health Unit is responsible for health monitoring and diagnosis of disease in both wild and domestic animals.
- By monitoring for the presence of respiratory pathogens in wild sheep, goats and other wildlife, the Animal Health Unit will be better informed on the health status of these species across their range in Yukon, and will be better positioned to mitigate occurrences of declining health.
- Most sheep and goat owners in Yukon are now in compliance with the Control Order, which came into effect on January 1, 2020. The Animal Health Unit and the Agriculture Branch (Department of Energy, Mines and Resources) continue to work closely with Yukoners who wish to import or raise sheep and goats to reduce the risk of respiratory pathogens, such as ***M. ovipneumoniae***, being spread to wildlife.

Nasal swab collection and analysis

- Nasal swabs are collected by sheep hunters in the field or by Department of Environment staff from heads of harvested sheep that are brought into government offices for mandatory verification of age.
- Nasal swabs are submitted to a diagnostic laboratory to determine if ***M. ovipneumoniae*** genetic material (DNA) is present. In 2018, the Animal Health Unit collected nasal swab samples in duplicate using two different preservation techniques to better ensure that ***M. ovipneumoniae*** DNA can be detected. Both techniques yielded identical results. Nasal swabs for both domestic and wild species are collected using the same collection method and preservation techniques.

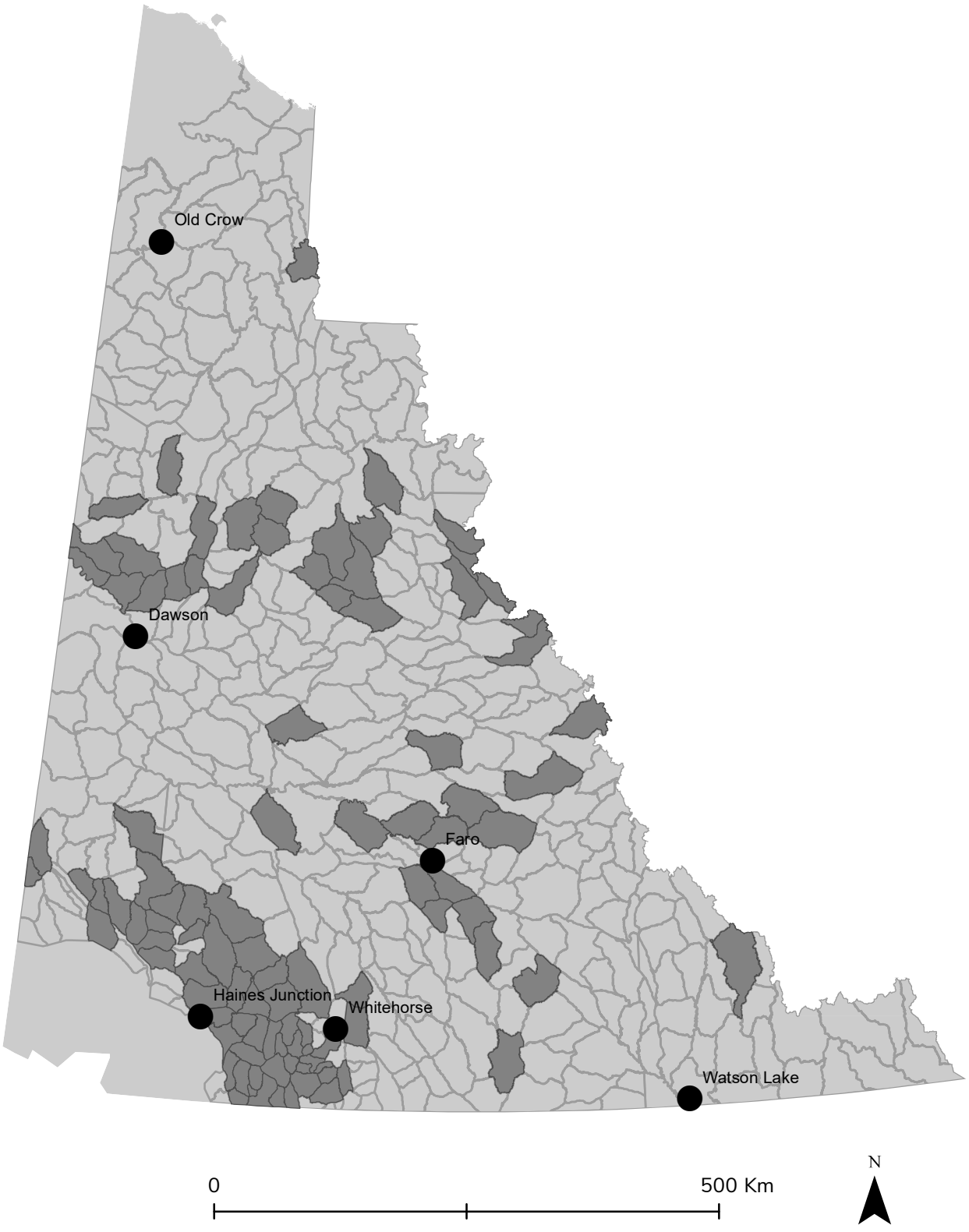


Figure 4: Map of Yukon showing game subzones (in dark grey) where samples from thinhorn sheep have been collected for ***M. ovipneumoniae*** testing between 2015 and 2020.

Yukon.ca