Yukon

state of the environment report

2023

A report on environmental indicators

Acknowledgements

Reviewers and contributors

Government of Yukon

Department of Environment:
Cindy-Anne Naylor, Julien Schroder, Elizabeth Barker, Alison Fung, Marie Ducharme, Alexandre Mischler, Anthony Bier, Jonathan Kolot, Anthony Bier, Holly Goulding, Ghislain de Laplante, Amélie Janin, Aaron Barker, Jean Langlois, Brian Johnston, Julia Fedoriak, Tyler Kuhn, Bruce Bennett, Randi Mulder, Amy Law, Kelsey Russell, Mike Suitor, Thomas S. Jung, Jane Harms, Maud Henaff, Cameron Sinclair, Brendan Mulligan, Cole Fischer, Patrick Huggins, Norbert Botca and Shannon Clohosey.

Department of Energy, Mines and Resources:
Jocylyn McDowell, Krysti Horton, Mike Ellis, Robert Legare

Yukon Bureau of Statistics: Rebecca Johnson

City of Whitehorse: Sara Thompson

Environment and Climate Change Canada: Hayley Hung, Cecilia Shin, Margaret Campbell

Fisheries and Oceans Canada: Adam O'Dell

Gamberg Consulting: Mary Gamberg

Yukon Environmental and Socio-economic Assessment Board: Heidi Rumscheidt

Published 2023
ISBN: 978-1-55362-911-5

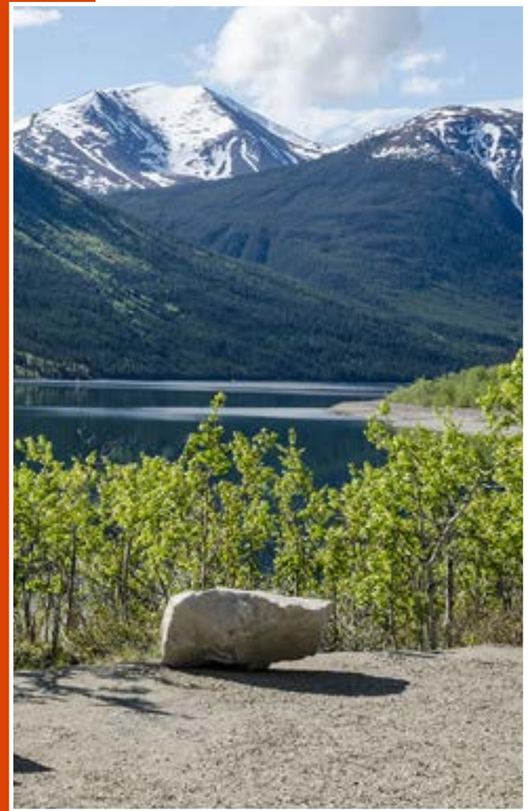
Table of contents

Introduction

The 2023 Yukon State of the Environment Report reflects on the status of the environment and presents information on climate change, air, water, land and fish, and wildlife indicators. This report tracks environmental indicators, used to monitor, describe and interpret change. While indicators cannot provide all the information on a particular topic, they do give information that shows how aspects of the environment are doing.

The indicators featured in this year's report are based on criteria including data availability, data reliability, usefulness and ease of understanding. Indicators are used to evaluate and demonstrate whether environmental conditions are improving, remaining stable or declining. The 2023 State of the Environment Report has three new indicators: Avian influenza, Biodiversity and Groundwater levels in the Yukon Observation Well Network. Monitoring wild sheep and goat health was removed and replaced with Monitoring respiratory pathogens in Yukon wildlife to encompass a broader range of hoofed mammals.

This report includes information available at the end of the 2022 calendar year. The base year for comparing trend data in this report is 2019. Several agencies require up to 36 months to complete the data collection, compilation, analysis and reporting to the Government of Yukon. This report represents information, data and advice from scientific experts, government agencies and non-governmental organizations.



Highlights

Climate change

Arctic sea ice extent and volume

Arctic sea ice extent and volume are decreasing significantly, with both measures having experienced a 50 per cent reduction in their respective values since 1980. These decreases highlight the impact of rising global temperatures on the Arctic environment and the people who live there.

Long-term precipitation and temperature variation

The Yukon's annual precipitation is projected to increase by 13 to 18 per cent in the next 30 years and by 14 to 38 per cent by 2100. Over the past 50 years, annual temperatures in the Yukon have increased by 2.2°C. Temperatures are expected to increase by 2.0 to 4.0°C in the next 30 years. By 2100 temperatures are estimated to increase by 3.0 to 8.0°C

Air

Levels of particulate matter

Overall, the Yukon maintains good air quality while occasionally experiencing elevated levels of particulate matter, primarily in the winter months.

Water

Snow accumulation

The Yukon saw its greatest ever-recorded snowpack in 2022. New historical records were set at 29 of 57 snow survey stations. Eight of eleven monitored basins recorded the highest snowpack estimate since recording began. When averaged across the 57 stations comprising the Yukon Snow Survey Network the trend in maximum Snow Water Equivalent (the amount of liquid water volume held within a snowpack that becomes available when melted) has increased by 4.0 per cent per decade, or 16.8 per cent since 1980.

Yukon River ice breakup at Dawson City

In Dawson City, the Yukon River (called Chu Kon' Dëk in Hän language, meaning "sparkling water river") breakup occurred on May 7, 2022, around eight p.m. The Yukon River ice breakup at Dawson City now occurs almost eight days earlier on average since data collection began in 1896.

Groundwater levels in the Yukon Observation Well Network

Annual maximum groundwater levels in most observation wells across the territory were the highest on record in 2022. High groundwater levels are likely the result of higher-than-average snowpack levels observed in much of the Yukon for the past three consecutive years.

Land

Population of the Yukon

The Yukon's population density remains one of the lowest in Canada, despite a 21 per cent growth in population over the past ten years. This growth distribution is uneven across the territory, with almost 90 per cent of the Yukon's population development in the Whitehorse area.

Status of parks and protected areas

The amount of land recognized in conservation areas in the Yukon increased from 98,695 km^2 to 99,788 km^2 in 2022. This increased the percentage of protected lands and waters in the Yukon from 19.1 per cent to 19.3 per cent.

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

The Yukon Environmental Socio-economic Assessment Board assesses over 125 projects per year. Four Executive Committee screenings (major projects) are currently in process, with three submitted in 2022, a precedent for the Yukon Environmental Socio-economic Assessment Board.

Recreational land use (campground visitation)

Territorial campgrounds are experiencing continued use and have almost returned to pre-pandemic levels. The number of people using campgrounds was up 55 per cent from 2021, only eight per cent below the 2019 peak season (before the pandemic reduced the number of visitors from outside the territory).

Whitehorse Waste Management Facility

In 2022, Whitehorse disposed of an average of 610 kilograms of waste per person. Recycling, composting, and reuse efforts managed to divert 33 per cent of this waste from the landfill, marking a one per cent increase from 2021.

Forest health

Yukon forests remain in relatively good health as determined by the Forest Management Branch's risk-based forest health monitoring program. In 2022, the Forest Management Branch conducted ongoing spruce bark beetle monitoring near Haines Junction and completed ground surveys and pheromone trapping to assess bark beetle risk near Deep Creek, Lake Laberge.

Wetlands

In 2022, the Government of Yukon released *A Policy for the Stewardship of Yukon's Wetlands*. Broad-scale wetland mapping has been completed for around 81,000 km^2 (less than 16 per cent of the Yukon).

Fish and wildlife

Species management plans

In 2022, the Wildlife Management Advisory Council (North Slope) and the Wildlife Management Advisory Council (Northwest Territories) completed and updated the *Inuvialuit Settlement Region Aklat/Akhaq (Grizzly Bear) Co-Management Plan*.

Sustainability of lake trout fisheries

In 2022, the Fish and Wildlife Branch began developing a 10-year strategic adaptive monitoring plan to assess lake trout populations across the Yukon. This plan, anticipated for release in 2023, will help build on long-term population trends. The plan will also address populations of concern, climate change, and the sustainability of our lake trout populations.

Number of spawning Chinook salmon

In 2022, an estimated 12,000 Chinook salmon reached their spawning grounds in the Yukon. This is the lowest recorded estimate and is well below the spawning escapement goal for Yukon River Chinook.

Avian influenza surveillance

A highly pathogenic strain of avian influenza virus called H5N1 emerged globally in 2022. Surveillance in Yukon wildlife found the virus in five bird species and in one species of mammal (a fox).

Monitoring respiratory pathogens in Yukon wildlife

Since 2015, over 1400 samples from Yukon wildlife have been tested for the presence of *Mycoplasma spp*. bacteria. In 2022, a sample from a healthy caribou was found to be positive for *Mycoplasma ovipneumoniae*. The remaining 279 samples from wildlife in 2022 were all negative for *Mycoplasma* spp.

Biodiversity

In the Yukon, there are 8,184 wild species, including 8,022 native species, 153 introduced species, and nine species with unknown origins. Vascular plants form the largest group, with 1,185 species, followed closely by beetles (1,167 species) and flies (1,123 species).

Climate change

1. Arctic sea ice extent and volume

Significance

- Ice, ocean and atmospheric systems converge at the Arctic Ocean. The loss of sea ice shows the impact of climate change on these interrelated systems. Sea ice melt can result in changes in ocean circulation and weather patterns, which have far-reaching effects beyond the Arctic Ocean.
- The melting of sea ice profoundly impacts the Arctic ecosystem. Wildlife, including species such as polar bears, walruses and seals rely on sea ice for habitat. The loss of sea ice also affects the Northern communities that depend on it for hunting and travel.
- Changes in sea ice are tracked by monitoring both sea ice extent (which reflects the area of the Arctic and Northern Oceans covered by ice) and sea ice volume (which accounts for the thickness of this ice).
- Both extent and volume indicators are used to build a more comprehensive understanding of the impact of climate change on the Arctic Ocean and its ecosystems.

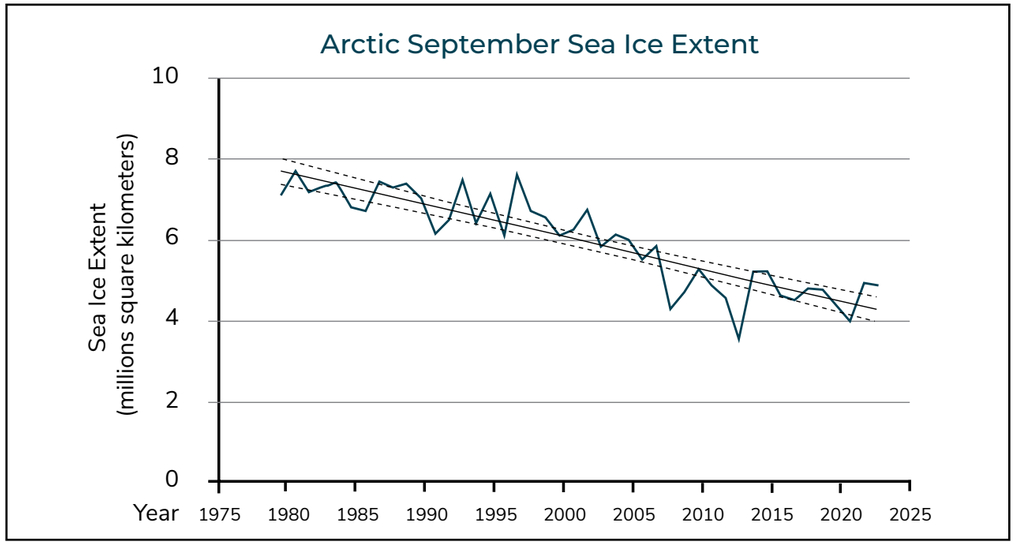


Figure 1: shows the monthly average area (in millions of square kilometres) of the Arctic Ocean and other Northern seas from 1979 to the present. It is measured in September when the minimum extent of the sea ice can be observed.

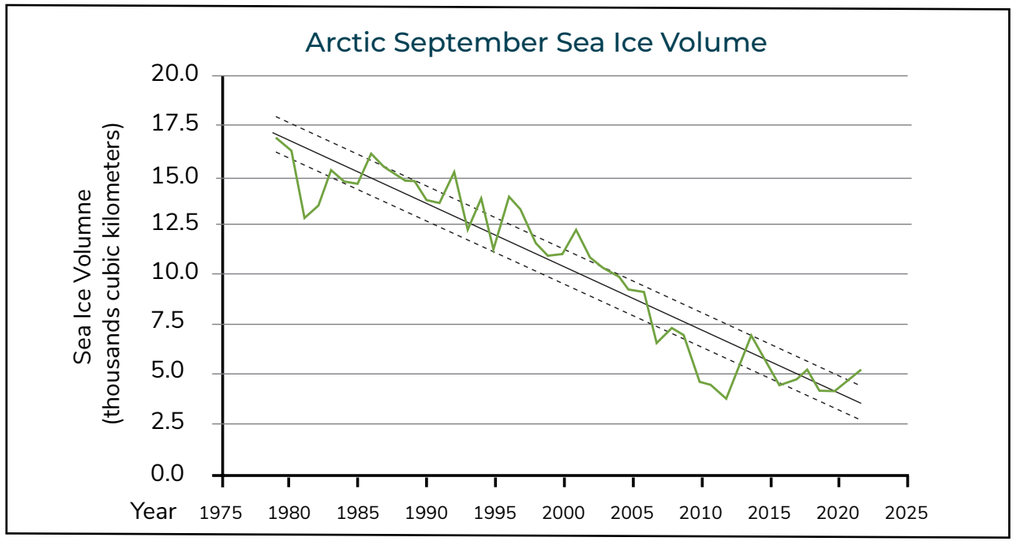


Figure 2: shows the monthly sea ice volume (in 1000 cubic kilometres) of the Arctic Ocean and other Northern seas from 1979 to the present. It is measured in September, when the minimum sea ice volume can be observed.

What is happening

- The declining trend in Arctic sea ice volume and its extent show that global climate change impacts ice coverage in the Arctic Ocean and Northern seas. Loss of sea ice has consequences for the Arctic wildlife populations that rely on it for habitat. This loss also impacts northern communities, such as the Inuvialuit, who depend on sea ice for hunting and travel. The downward trend in sea ice highlights the widespread effects of climate change on both the environment and human populations.

Taking action

The Government of Yukon is actively working to reduce the Yukon's greenhouse gas emissions through Our Clean Future.

Data quality

- The National Snow and Ice Data Center at the University of Colorado Boulder collects daily satellite images over the month and averages them to derive data for sea ice extent.
- Researchers use satellite data in combination with a Thickness and Total Energy Distribution Sea-Ice Model to derive data for sea ice volume.
- By combining these two sources of data, scientists can gain a more accurate and complete understanding of sea ice volume, which is crucial for monitoring the state of the polar ice caps and the effects of climate change.

References

Fetterer, F., K. Knowles, W.N. Meier, M. Savoie, and A.K. Windnagel. 2017, updated daily. Sea Ice Index, Version 3. Boulder, Colorado USA. Ice Extent. NSIDC: National Snow and Ice Data Center. Available from: https://doi.org/10.7265/N5K072F8. Accessed January 30, 2022.

Polar Science Center. 2021. PIOMAS Ice Volume Data, 1979-present. University of Washington. Available from: http://psc.apl.uw.edu/research/projects/arctic-sea-ice-volumeanomaly/data/. Accessed January 30, 2022.

Schweiger, A., R. Lindsay, J. Zhang, M. Steel, and H. Stern. 2011. Uncertainty in Modeled Arctic Sea Ice Volume. Journal of Geophysical Research: Oceans, Aug.

2. Long term precipitation & temperature variation

Significance

- Temperature is the most commonly monitored climate variable. The temperature anomaly shows how much the temperature has changed over time compared to a 30-year climate baseline (1961 to 1990) (Figure 1). For 2022, other datasets were used to estimate temperature variation because there was no official data.

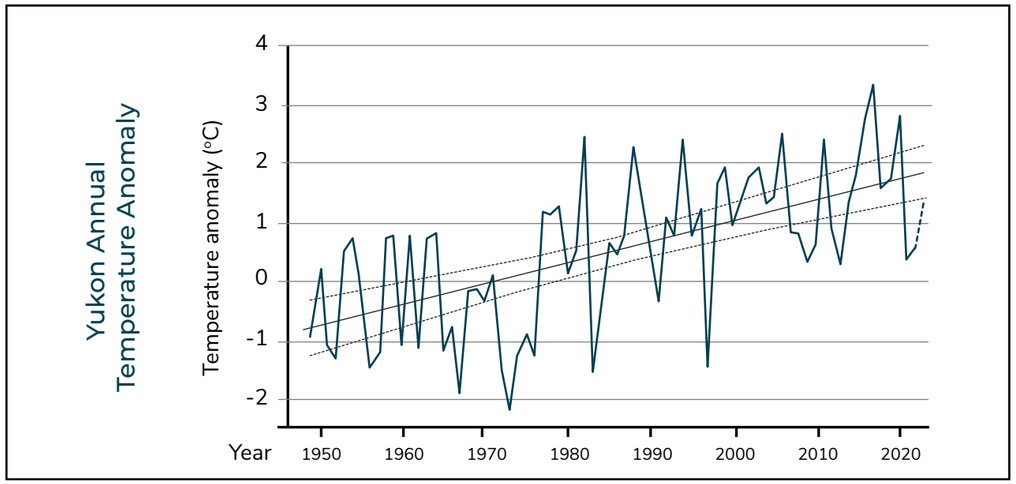


Figure 1: Yukon annual temperature anomaly, 1948 to present.

- The projected temperature anomaly shows us how the average annual temperature in the Yukon compared to the baseline (1961 to 1990). This is based on three scenarios and is projected until 2100 in Figure 2.

- Projections of Temperature and Precipitation values were produced using data created for the 6th International Panel on Climate Change's Assessment Report (AR6). These models are computed based on a set of scenarios representing potential future conditions which are called Shared Socio-economic Pathways (SSPs). Here is a quick overview of the scenarios used in Figures 2 and 4 (more details on SSPs can be found at Climate Data Canada's Understanding Shared Socio-economic Pathways).
  - SSP1-2.6: In this best-case scenario, global CO^2 emissions are cut severely, reaching net-zero after 2050, which would keep global warming at around 1.8°C above pre-industrial temperatures. It imagines societies switching to more sustainable practices, focusing on shifting from economic growth to overall well-being. Investments in education and health would go up, and inequality would fall.
  - SSP2-4.5: This is a "middle of the road" scenario. CO^2 emissions stay around current levels before starting to fall mid-century but do not reach net zero until 2100. Socio-economic factors follow their historical trends, with no notable shifts. Progress toward sustainability is slow, with development and income growing unevenly. In this scenario, temperatures will rise by 2.7°C by the end of the century.
  - SSP5-8.5: This is a future to avoid at all costs. Current CO^2 emissions levels roughly double by 2050. The global economy multiplies, but this growth is fueled by exploiting fossil fuels and energy-intensive lifestyles. By 2100, the average global temperature is a significant 4.4°C higher.

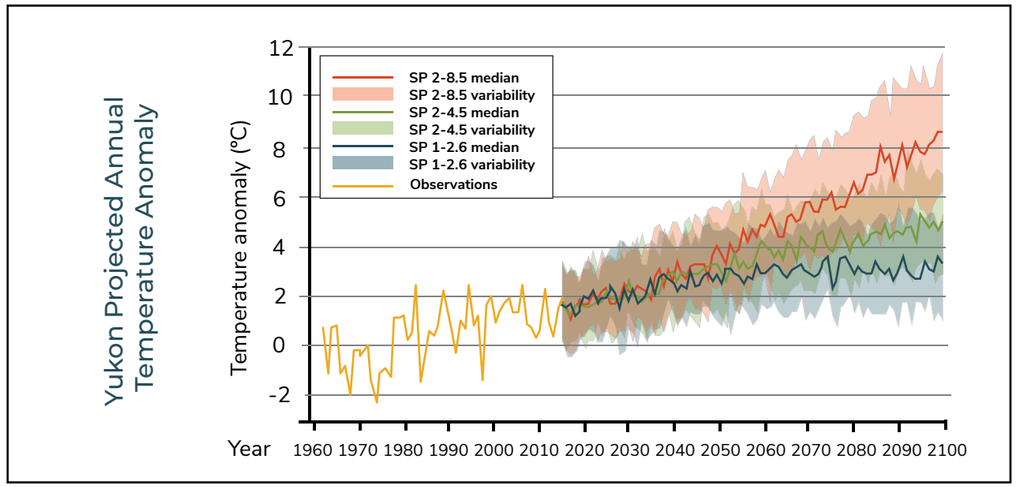


Figure 2: Yukon projected annual temperature anomaly, three scenarios.

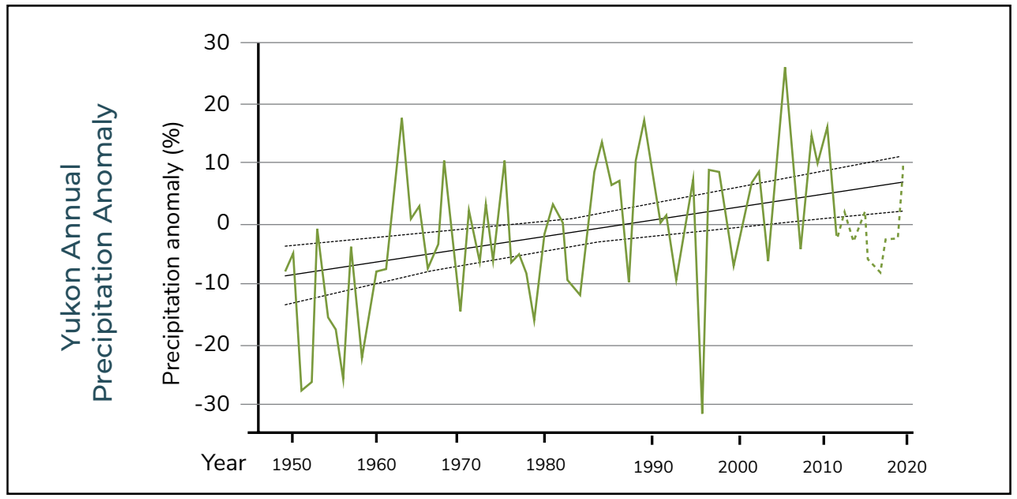


Figure 3: Yukon annual precipitation anomaly, 1948 to present.

- Precipitation is also a critical climate variable; however, it remains challenging to monitor across the Yukon. There is a gap in official data from 2015 to 2022, represented by the dashed line in Figure 3, so other datasets were analyzed to approximate the precipitation variation.
- The projected precipitation anomaly shows how much the annual precipitation is expected to change compared to the baseline of 1961 to 1990 and what is projected to 2100 in Figure 4.

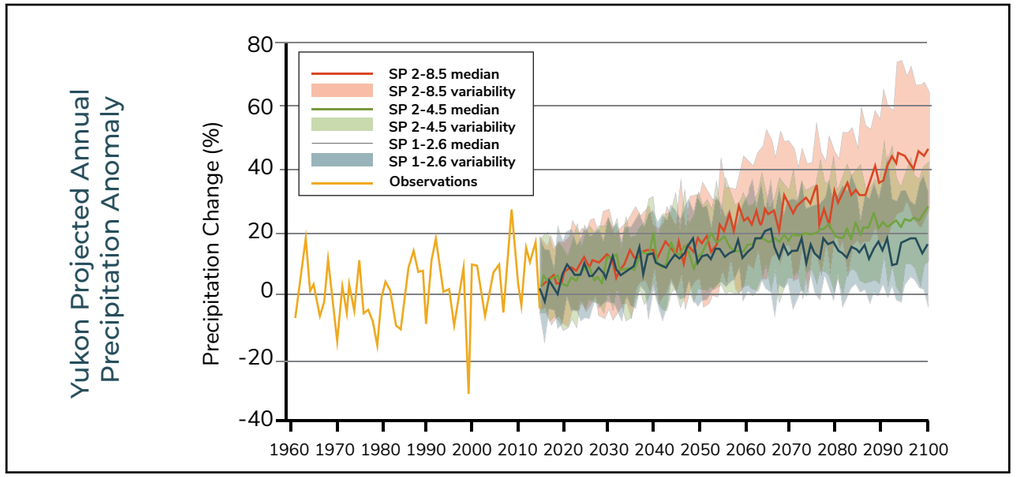


Figure 4: Yukon projected annual precipitation anomaly, three scenarios.

What is happening?

- Over the past 50 years, annual temperatures in the Yukon have increased by 2.2°C and are expected to increase by 2.0 to 4.0°C in the next 30 years and by 3.0 to 8.0°C by 2100.

Taking action

- The Government of Yukon is collaborating with Environment and Climate Change Canada to enhance indicators for the North by improving historical data quality, monitoring efforts, and developing guidance to ensure their confident utilization.
- As the Yukon faces direct impacts of climate change, including rising temperatures and increased precipitation, the Government of Yukon is taking proactive measures to respond to these effects.
    - Through Our Clean Future: A Yukon strategy for climate change, energy, and a green economy, the government is actively working to reduce the Yukon's greenhouse gas emissions and adapt to the challenges of climate change. For more information on this topic, including partners, targets, and actions, refer to the Our Clean Future 2021 Annual Report or visit the Our Clean Future Yukon.ca web page.

Data quality

- Environment and Climate Change Canada provide historical data. While this is one of the best datasets available, gridded datasets such as CanGRD are produced by interpolating temperatures and precipitations from climate stations. The low number of stations in the Yukon limits the ability to validate CanGRD. This reduces confidence in the data relative to parts of Canada with higher station density.
- Furthermore, there is insufficient monitoring of precipitation in the Yukon and across Canada. As a result, CanGRD is no longer updated for precipitation. The values presented as the dashed line in Figures 1 and 3 were estimated by using the median of an ensemble of reanalysis datasets which best align with the historical period of the official dataset.
- Projection data is provided by Pacific Climate Impacts Consortium through climatedata.ca and Pavics.ca. Projected values also suffer from a lack of climate stations in the Yukon. There are ways to increase confidence such as:
    - using an ensemble of models and scenarios,
    - using anomalies instead of single values, or
    - summarizing data over an extended period of time and large area.

References

Copernicus Climate Change Service (C3S) (2017): ERA5: Fifth generation of ECMWF atmospheric reanalyses of the global climate. Copernicus Climate Change Service Climate Data Store (CDS).
Available from: https://cds.climate.copernicus.eu/cdsapp#!/home.
Accessed on January 25, 2023.

Environment and Climate Change Canada. 2020.
Available from: https://www.canada.ca/en/environment-climate-change/services/climate-change/canadian-centre-climate-services/display-download/technical-documentation-historical-climate-data.html#toc8.
Accessed on January 21, 2023.

GISTEMP Team, 2023: GISS Surface Temperature Analysis (GISTEMP), version 4. NASA Goddard Institute for Space Studies. Dataset. Available from: https://data.giss.nasa.gov/gistemp/. Accessed January 20, 2023.

Harris I, Osborn TJ, Jones P and Lister D (2020) Version 4 of the CRU TS Monthly High-Resolution Gridded Multivariate Climate Dataset. Sci Data 7, 109 (2020).
Available from: https://doi.org/10.1038/s41597-020-0453-3.

Japan Meteorological Agency/Japan (2013): JRA-55: Japanese 55-year Reanalysis, Daily 3-Hourly and 6-Hourly Data. Research Data Archive at the National Center for Atmospheric Research, Computational and Information Systems Laboratory. Dataset.
Available from: https://doi.org/10.5065/D6HH6H41. Accessed on January 10, 2023.

Lenssen, N., G. Schmidt, J. Hansen, M. Menne, A. Persin, R. Ruedy, and D. Zyss, 2019:
Available from: Improvements in the GISTEMP uncertainty model. J. Geophys. Res. Atmos., 124, no. 12, 6307-6326, doi:10.1029/2018JD029522. Accessed on January 21, 2023.

Schneider, Udo; Becker, Andreas; Finger, Peter; Meyer-Christoffer, Anja; Rudolf, Bruno; Ziese, Markus (2011): GPCC Full Data Reanalysis Version 6.0 at 0.5°: Monthly Land-Surface Precipitation from Rain-Gauges built on GTS-based and Historic Data. DOI: 10.5676/DWD_GPCC/FD_M_V7_050. Accessed on January 21, 2023.

Understand how SSPs differ from RCP scenarios and learn about key considerations when using SSPs in climate risk assessments.
Available from: https://climatedata.ca/resource/understanding-shared-socio-economic-pathways-ssps/.
Accessed on January 21, 2023

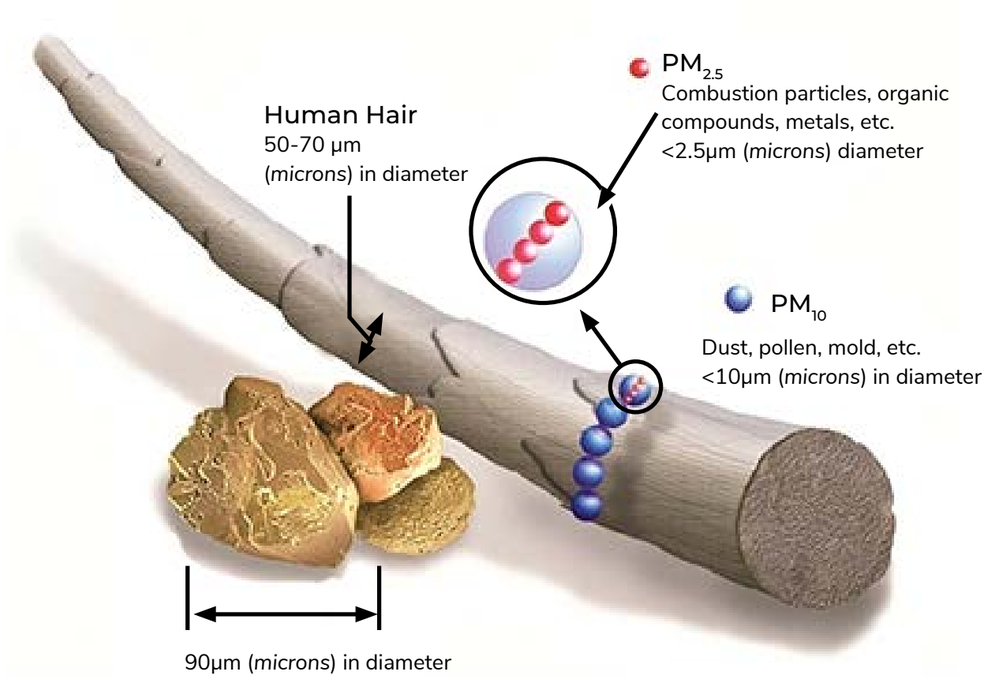


Figure 1: Size comparisons for PM Particles. Source: United States Environment Protection Agency (2016)

Air

3. Levels of particulate matter

Significance

When it comes to pollutants in the air, fine particulate matter ($PM_{2.5}$) is of particular concern. $PM_{2.5}$ is a mixture of solid particles and liquid droplets found in the air, measuring less than 2.5 micrometers in diameter, around 30 times smaller than a human hair. $PM_{2.5}$ comes from various natural and human sources, including windblown dust, wildfire smoke, residential wood burning, vehicle emissions and industrial operations.

A smouldering forest fire outside of Keno (Elizabeth Barker, 2019).

Due to the small size of $PM_{2.5}$ they are capable of penetrating deep into the lungs and bloodstream. Inside of the body they can cause an array of health issues including aggravated asthma, decreased lung function, heart disease and increased respiratory symptoms. (Environmental Protection Agency, 2022).

$PM_{2.5}$ can also impact the environment in numerous ways. Elevated levels of $PM_{2.5}$ can impair visibility, which may affect driving, aviation and outdoor sports or recreational activities like hiking or camping. When elevated levels of $PM_{2.5}$ settle on the ground, they can change the nutrient and acidity balance in the soil or water. Furthermore, black carbon, a component of $PM_{2.5}$, is a short-lived climate pollutant that can have a warming impact up to 1500x stronger than carbon dioxide according to the Climate & Clean Air Coalition.

What is happening?

Under the federal Air Quality Management System, each province and territory in Canada is responsible for reporting $PM_{2.5}$ levels. The annual $PM_{2.5}$ and 24-hour $PM_{2.5}$ metrics are two statistical forms used to calculate $PM_{2.5}$ levels. Once the annual and 24-hour $PM_{2.5}$ metrics are calculated, they are compared to the Canadian Ambient Air Quality Standards to determine Yukon's air quality.

Achievement of the Canadian Ambient Air Quality Standards for $PM_{2.5}$ occurs when the annual metric is 8.8 micrograms per cubic metre (ug/m3) or lower and when the 24-hour metric is 27 ug/m3 or lower. For this reporting period, the 2021 annual metric in Whitehorse for $PM_{2.5}$ was 6.1 ug/m3, and the 2021 24-hour metric for $PM_{2.5}$ was 26.2 ug/m3. When measured against the Canadian Ambient Air Quality Standards (CAAQS) for $PM_{2.5}$, the metrics achieved were below the standards. These metrics demonstrate Whitehorse's excellent air quality or low health risk air quality.

Views into Kluane National Park on a clear day (Elizabeth Barker, 2021).

Table 1 below shows a summary of the $PM_{2.5}$ metric values and their corresponding achievement status.

Pollutant	Averaging Time	2021	2020	2019	2018	2017
$PM_{2.5}$	24-Hour	26.2*2	21.5*2	21.1*2	16.8	18.8
	Annual	6.1*1	4.4*1	3.8*1	3.6	3.9
CAAQS Achievement Status		Achieved	Achieved	Achieved	Achieved	Achieved

*1 metric value based on only two of the required three years of data
*2 metric value based on incomplete data

Table 1: Yukon $PM_{2.5}$ Metric Values (2017-2021)

As shown in Figure 1, there appears to be an increasing trend in levels of particulate matter over the last few years, with 2021 measuring the highest level since 2017. Additional years of data will be required to make further trend analysis.

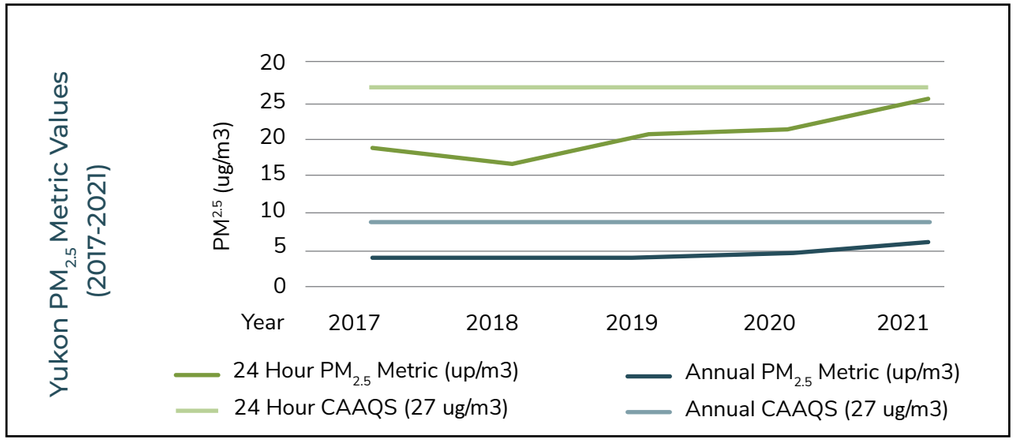


Figure 1: $PM_{2.5}$ Metric Values and Canadian Ambient Air Quality Standards

Although achievement of Canadian Ambient Air Quality Standards for $PM_{2.5}$ occurred in 2021, the highest levels of $PM_{2.5}$ were in the winter months. Figure 2 below shows the relationship between $PM_{2.5}$ levels and ambient temperature.

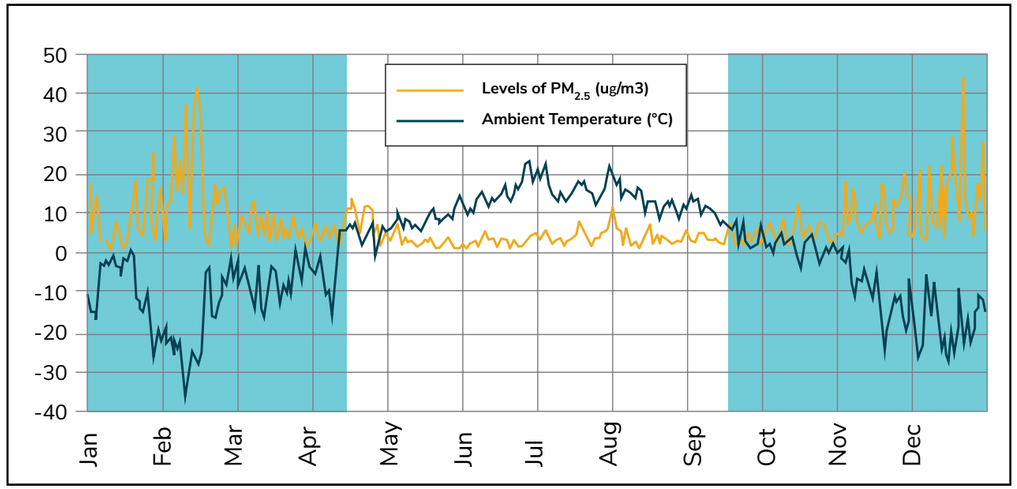


Figure 2: Relationship between Particulate Matter and Temperature.

Emissions from downtown Whitehorse on a winter day (Elizabeth Barker, 2021).

Naps Station Instrumentation (Elizabeth Barker, 2021)

As temperature drops in the winter months, specifically January through April and October through December, levels of $PM_{2.5}$ rise. This inverse relationship is most likely due to human activities such as burning fuel for heat and emissions from idling vehicles.

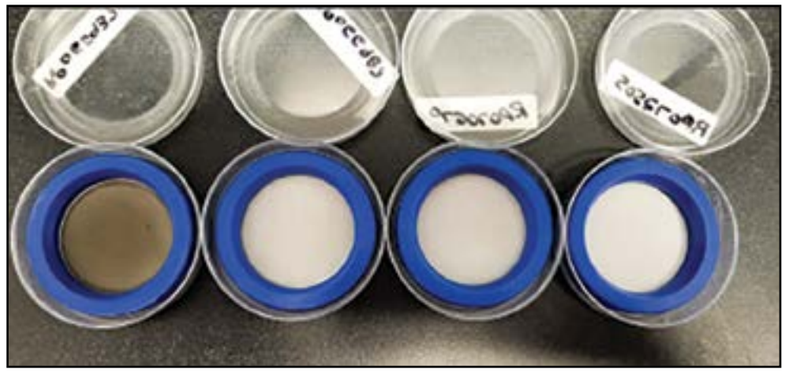
Temperature inversions, and natural atmospheric phenomena, also contribute to higher levels of $PM_{2.5}$ in the winter months. Temperature inversions occur when air higher in the atmosphere is warmer than air closer to the ground. Inversions act like a cap on the atmosphere, preventing the dispersion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

Taking action

The Government of Yukon, in partnership with Environment and Climate Change Canada, maintains a long-term air quality monitoring station to measure levels of $PM_{2.5}$ in Whitehorse. The station is part of the National Air Pollution Surveillance (NAPS) network. 24/7 monitoring of $PM_{2.5}$ provides a point of comparison of the Yukon air quality to national results and allows the Yukon to analyze long-term data trends.

To expand $PM_{2.5}$ monitoring beyond Whitehorse and into the communities, the Government of Yukon has implemented a Purple Air monitoring program. This program uses Purple Air sensors, small, portable $PM_{2.5}$ sensors that report air quality data to a publicly available on-line map. This program aims to install at least one sensor in each Yukon community. So far, Whitehorse, Dawson City, Carmacks, Faro, Haines Junction, Keno City, Mayo, Old Crow, Pelly Crossing, Ross River, Teslin and Watson Lake have installed sensors in their communities.

In addition to National Air Pollution Surveillance and Purple Air monitoring, the Government of Yukon, in collaboration with Health Canada, completed the second phase of the Whitehorse Air Quality Monitoring Study in the fall of 2021. This study, which began in 2015, collected data from eight monitoring stations in Whitehorse and one in Dawson City to determine levels and spatial variability of $PM_{2.5}$ pollution in various neighbourhoods. Researchers expect the results of the study within the next few years.



Filters from a $PM_{2.5}$ sampling instrument at the Whitehorse NAPS station; the darker filter was collected during a December 2022 cold snap (Elizabeth Barker, 2022).

Whitehorse NAPS station (Elizabeth Barker, 2021).

Data quality

The Whitehorse National Air Pollution Surveillance station provided the data to calculate the annual and 24-hour $PM_{2.5}$ metrics. Validation and review of the data occurred in accordance with the procedures outlined in the 2019 Canadian Council of Ministers of the Environment Ambient Air Quality Monitoring and Quality Assurance/Control Guidelines.

More about the $PM_{2.5}$ metrics:

- Calculations of the $PM_{2.5}$ metrics follow procedures outlined in the 2012 Canadian Council of Ministers of the Environment Guidance Document on Achievement Determination for Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone.
- The statistical form of the $PM_{2.5}$ annual metric is a three-year average of annual concentrations of $PM_{2.5}$. The three-year averages are calculated using data from 2019, 2020 and 2021.
- Replacement of the Whitehorse National Air Pollution Surveillance station occurred in the fall of 2019. As a result, the fourth Quarter of 2019 did not meet the Canadian Council of Ministers of the Environment completeness criteria. Consequently, there is no 2019 data from the $PM_{2.5}$ annual metric calculation. The basis for the 2021 $PM_{2.5}$ annual metric is air quality data from only two of the required three years (2020 and 2021).
- The 2019 data is included in the 24-hour metric calculation and flagged as being based on incomplete data per Canadian Council of Ministers of the Environment guidelines.

National Air Pollution Surveillance station instrumentation (Elizabeth Barker, 2021).

Profile

Data collected from the Whitehorse National Air Pollution Surveillance station feeds into a Canada-wide air quality database, which generates a real-time air quality health index (AQHI). The AQHI is a health protection tool designed to help members of the public make decisions to protect their health by limiting short-term exposure to air pollution.

Whitehorse: Air Quality Health Index

Observed Conditions

Calculated at: 12:00 PM PST Wednesday 15 February 2023

2

1 2 3 4 5 6 7 8 9 10 +

Low Risk (1-3) | Moderate Risk (4-6) | High Risk (7-10) | Very High Risk

At-Risk Population:
- Enjoy your usual outdoor activities
- Find out if you are at risk

General Population
- Ideal air quality for outdoor activities.

Forcast Maximums

Issued at: 600 AM MST Wednesday 15 February 2023

Wednesday	3 - Low Risk
Wednesday night	3 - Low Risk
Thursday	3 - Low Risk
Thursday night	3 - Low Risk

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.

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.

Climate & Clean Air Coalition, n.d. Black carbon.
Available from: Black carbon | Climate & Clean Air Coalition (ccacoalition.org).

Environmental Protection Agency, 2022. Health and Environment Effects of Particulate Matter.
Available from: Health and Environmental Effects of Particulate Matter (PM) | US EPA.
Canadian Environmental Protection Act (CEPA). 2022. Available from: Canadian Environmental Protection Act: general information – Canada.ca.

4. Organic pollutants

Significance

Organic pollutants, such as flame retardants and pesticides, are human-made chemicals that may contaminate ecosystems. Wind and water can carry these chemicals away from their sources to reach places like the Arctic, where they have never been used before. They tend to settle in colder climates once deposited and can enter Arctic ecosystems. Many of these contaminants are toxic and can accumulate in the food chain, affecting the health of wildlife and humans.

Measuring how much organic pollutants are present in Arctic air over time will provide us with information on:

- whether their concentrations are decreasing, increasing or not changing;
- where these chemicals have come from;
- how much of each chemical comes from each region; and
- what climate conditions influence their movement to the Arctic.

This information can inform policies that limit emissions and may reduce what comes into the Arctic. Results about how organic pollutant concentrations change in air can be used to negotiate and evaluate the effectiveness of domestic and international control agreements and to assess the risks of new contaminants. The results are also used to test numerical forecasting programs that explain contaminant movement from sources in the south to the Arctic.

What is happening

Samples were not collected during the pandemic at Little Fox Lake. Samples are now being collected and processed again and new data will be available in next year's report.

Little Fox Lake organic pollutants sampling tower (Cecilia Shin, 2022).

A HIVOL is a device that samples a large volume of air. A large pump draws air through a filter or trap. The target pollutants are captured by the sampling trap and then sent to Environment and Climate Change Canada's laboratory for analysis (Cecilia Shin, 2022).

Teslin Marina signs during the 2022 flooding (Anthony Bier, 2022).

Water

5. Snow accumulation

Significance

Snow throughout the Yukon is determined by measuring the snow depth and snow water equivalent (SWE) across a network of manual and automated snow survey stations. The SWE is a measurement of the liquid water volume held within a snowpack that becomes available when melted. The SWE accumulated throughout the winter has an influence on several hydrological and related processes:

- SWE can influence the timing and severity of river ice breakup.
- SWE directly influences groundwater levels because some of the melted snowpack infiltrates and recharges groundwater reservoirs.
- The peak snowpack volume is the largest factor controlling spring flows and provides an indication of seasonal flood risk
- A low SWE can increase the likelihood of wildfires at the beginning of summer.
- A deep snowpack can provide greater insulation to the ground surface from cold air, which may promote increased rates of permafrost thaw.
- Larger snowpacks can increase the likelihood of overflow on lakes and rivers due to the added weight.
- In addition, the increased insulation can diminish ice growth, resulting in thinner ice on average. One practical implication is a higher transportation risk or more difficult winter travel on lakes and rivers.

Hyland North meteorological station in near record snow conditions (Thomas Ulmer, 2022).

What is happening?

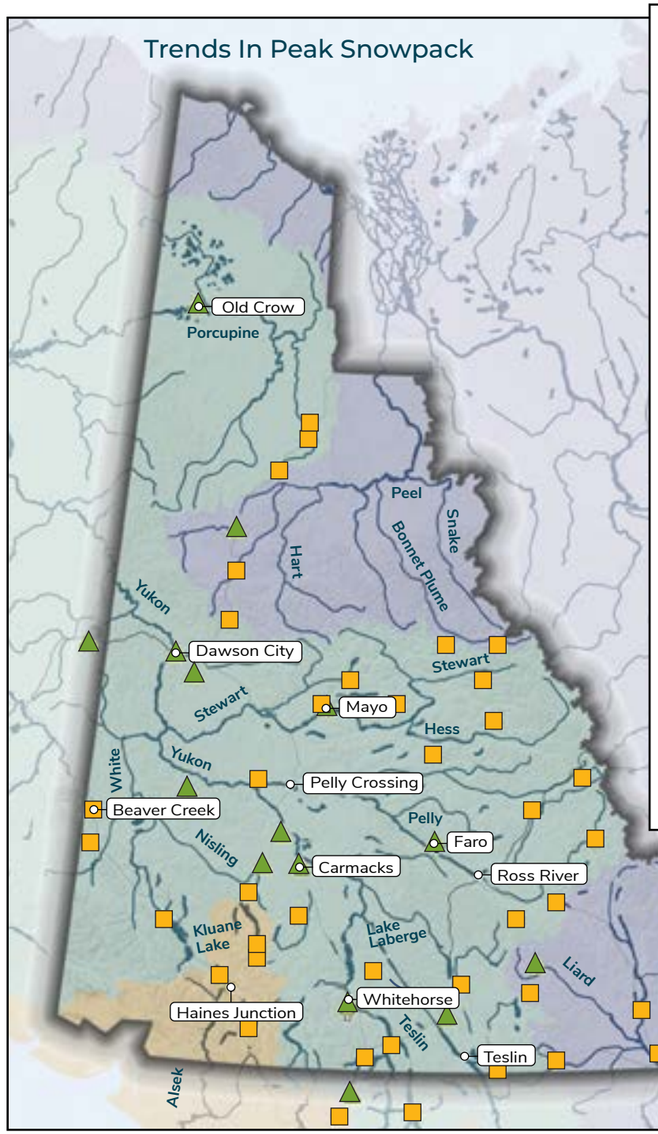
The first manual snow courses within the Yukon's drainage basins were established in 1958. The current network of reported snow courses consists of 52 snow courses within the Yukon and 5 snow courses in BC and Alaska, the majority of which were established by 1980.

Of the sites showing statistically significant change, the greatest increase observed in snow water equivalent was at Log Cabin (B.C.) in the headwaters of the Southern Lakes at a rate of 22 mm (7.2 per cent) per decade, or 140 mm since the start of the record in 1958. The greatest observable change was at Mount Berdoe, near Carmacks, at 15 per cent, per decade, with records beginning in 1975. Ten locations reported an increase in the snowpack. These locations are scattered throughout the territory, and no locations report statistically significant snowpack decreases. All snow survey data is available at Yukon Snow Survey Network.

Taking action

The Government of Yukon's Water Resources Branch compiles and quality controls all snow accumulation data.

In early 2022, Parks Canada's Inuvik office adopted Water Resources' snow sampling methodology for the six sites it operates within Ivvavik National Park on the Yukon's North Slope. In time, the data from these sites will be included in the Government of Yukon's snowpack trend analyses and the Snow Survey Bulletin and Water Supply Forecast.



Record Duration for Stations with Statistically Significant Trends

ID	Location Name	Start	End
1	Old Crow *	1977	2022
2	Ogilvie River	1976	2022
3	Boundary (Alaska)*	1968	2022
4	Midnight Dome	1975	2022
5	King Solomon Dome	1975	2022
6	Mayo Airport A	1968	2022
7	Casino Creek	1977	2022
8	Williams Creek	1995	2022
9	Mount Nasen	1975	2022
10	Mount Berdoe	1975	2022
11	Rose Creek *	1975	2022
12	Mt McIntyre B	1960	2022
13	Log Cabin (B.C.)	1960	2022
14	Meadow Creek	1976	2022
15	Tintina Airstrip	1977	2022
16	Hyland River B	1976	2022

Figure 1: Trends in Peak Snow-pack

Average Annual Change in Snow Water Equivalent

No Significant Trend Significant Increasing Trend

*** Station has some gap year(s):** Boundary (Alaska). Missing Year: 1998, Rose Creek. Missing Year: 1996-2004 , Old Crow. Missing Years: 1978 to 1980

Arctic
Pacific
Yukon River

Hydrology Technologist, Alexandre Mischler weighing a snow sample at Mt. McIntyre snow course (Jonathan Kolot, 2022).

Natural Resource Officer, John Minder reading the snow depth at Twin Creeks snow course (Alex Mischler, 2022).

Data quality

There are currently 52 snow survey sites across the Yukon and 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. The timing and methodology employed by the Government of Yukon in collecting snow survey data adheres to protocols used by government agencies throughout the circumpolar north. There are now snow monitoring stations in all of the Yukon's main watersheds; however, stations located on the Yukon North Slope are too new to consider for trends.

The Trends in Peak Snowpack map (Figure 1) was developed using all years with available data for individual locations. In contrast, the territory-averaged trend was developed using data from 1980 to 2022 to maintain a consistent set of snow survey locations.

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

Profile

The Yukon saw its greatest ever-recorded snowpack in 2022. New historical records were set at 29 of 57 snow survey stations and eight of eleven monitored basins recorded the highest snowpack estimate since records began. This exceptionally snowy winter was the third such winter in a row, with 2020 and 2021 also having high snowpack in many regions of the territory. This trend was in part responsible for some of the highest recorded groundwater levels across the territory as well as higher-than-normal flows observed in many Yukon rivers in 2022.

References

BC Hydro Manual Snow Surveying SOP 6.02 January 9, 2023.
Available from: Snow Survey Data – Province of British Columbia (gov.bc.ca)

BC Ministry of Environment Snow Survey Sampling Guide (n.d.)
Available from: Snow Survey Data – Province of British Columbia (gov.bc.ca)

6. Extreme high and low water in lakes and rivers

Significance

- River flows and lake levels in the Yukon are susceptible to changes from various processes.
- Changes to the timing of snowmelt, the amount and phase of precipitation (rain or snow), melting glaciers, shifts in vegetation, and permafrost thaw and resultant thickening of the active layer of permafrost are some of the processes that alter extreme high and low river flows and lake levels.
- Higher river flows can cause increased sedimentation and contaminant movement in river systems, which affects fish habitat, human health, drinking water and ecosystems. Increased peak flows and more intense river-ice breakup conditions increase flood potential. In populated areas, this can cause infrastructure loss or damage and result in significant economic costs and risk to Yukoners.
- 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 also 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 is generally a low flow time of year, are one of many confirmed climate change-driven hydrological trends. This trend is expected to continue with future warming.

What is happening?

River flows

An analysis of observed river flows at monitoring locations across the Yukon was conducted to determine the annual minimum and maximum flow trends. After filtering to ensure the capture of actual minimums and maximums and retaining sites with more than ten years of valid data, analysis was conducted at 51 locations for minimum flow trend and 53 for maximum flow trend. Most of these locations are monitoring hydrological conditions on large rivers (rivers that have drainage areas greater than 1,000 km^2) in the following basins:

- Tàgé Cho / Tágà Shäw (Yukon River) basin
- Alsek River basin
- Liard River basin
- Teetł'it Gwinjik[1] (Peel River) basin
- Ch'ōdèǹjik (Porcupine River) basin

Significant increases in annual minimum flows have been observed at 39 locations, with no significant decreases recorded at any location (Figure 1), indicating a considerable rise in water volume across most analyzed areas.

For this indicator, we have used place names as outlined in the Gazetteer of Yukon, however, we are aware that more place names exist. For example, the Yukon River basin spreads across a number of language groups and as such it has many Indigenous names beyond the two provided here. Tàgé Cho in Northern Tutchone, and Tágà Shäw in Southern Tutchone, translate to "Great River".

[1] Teetł'it Gwinjik, the Gwitch'in name for the Peel River translate into Teetl'it – headwaters region; Gwinjik – along the course of river, while Ch'ōdèǹjik (Porcupine River) translates into "porcupine quills river."

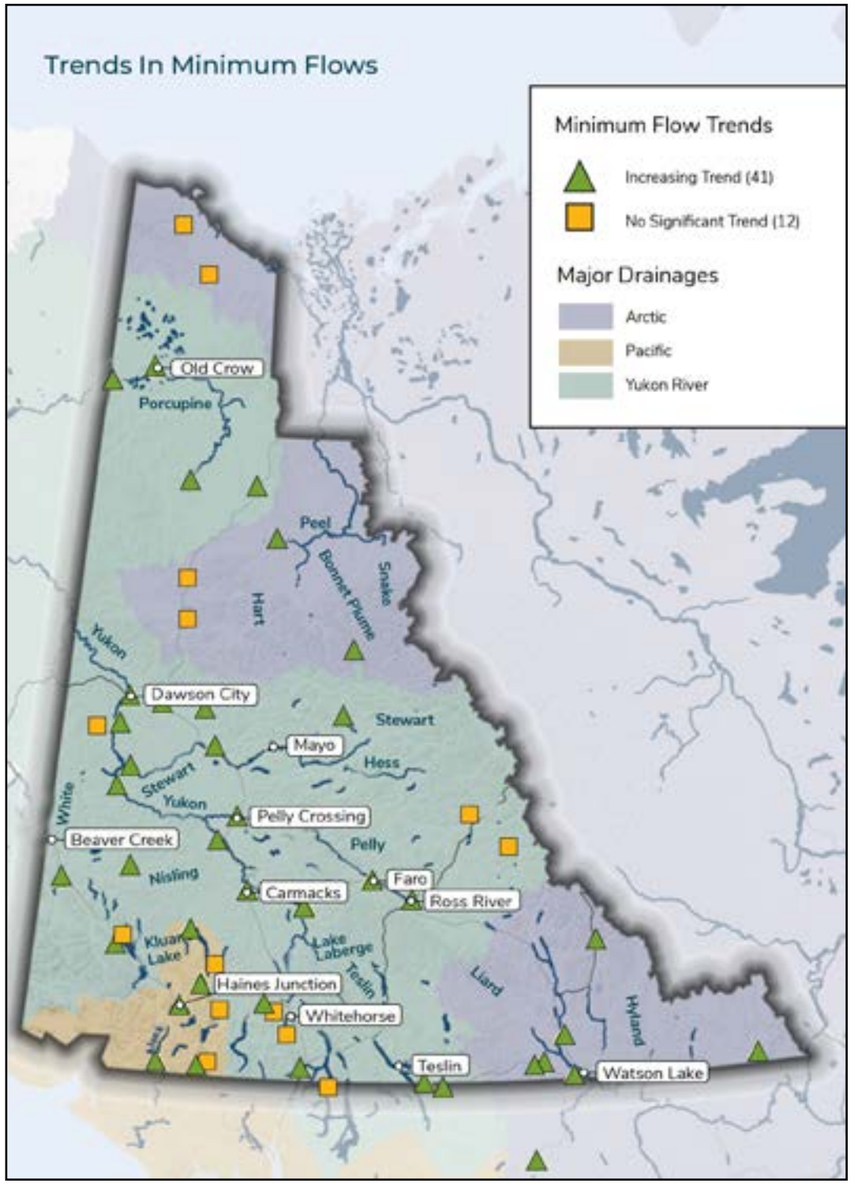


Figure 1: Trends in annual minimum river flow.

Annual maximum flows have increased significantly at the Alsek River above Bates River and the West Aishihik River near the mouth, within the Alsek River drainage. Only the Firth River near the mouth showed a significant decrease in maximum flows (Figure 2). There is no observable trend in annual peak flows across the territory.

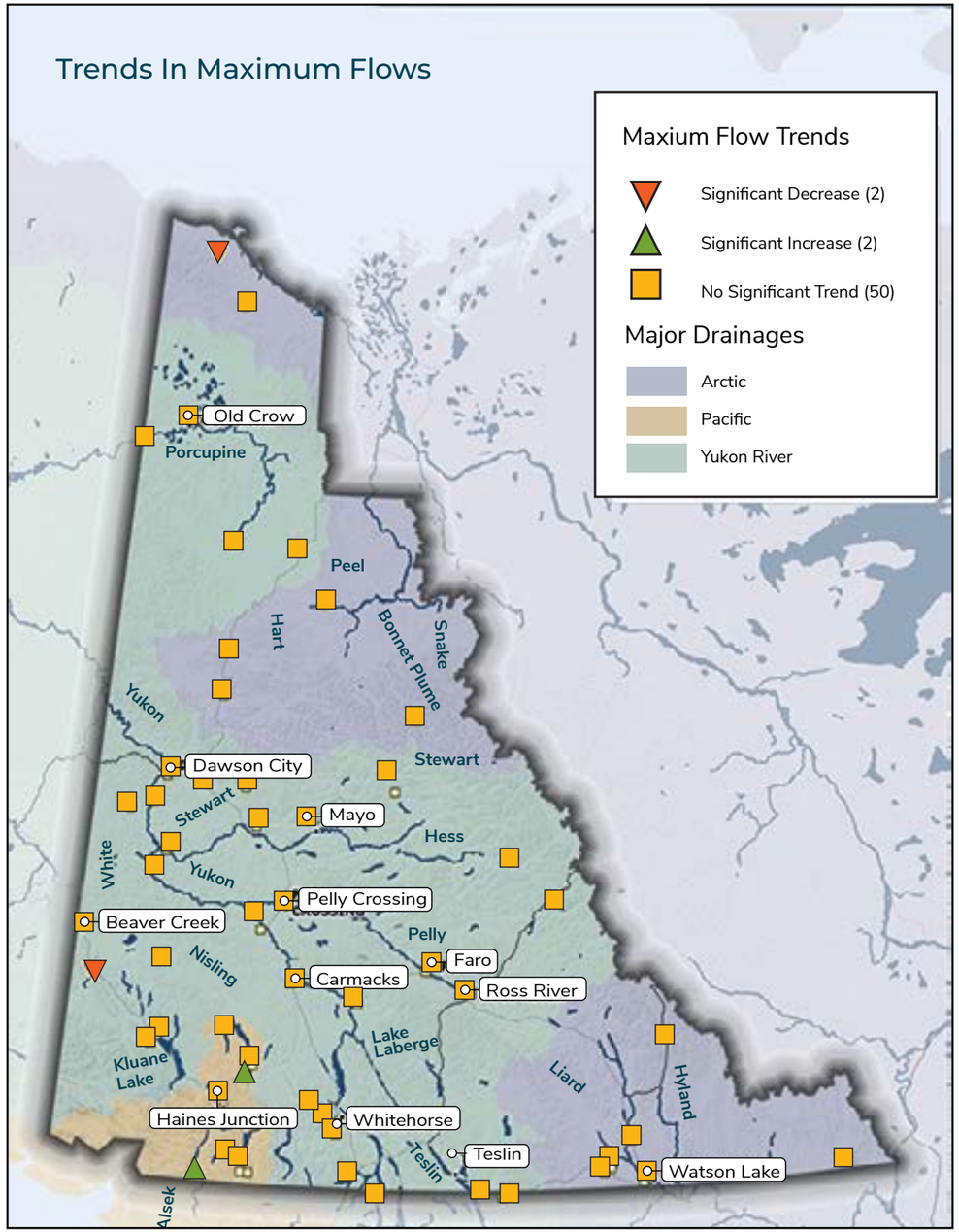


Figure 2: Trends in annual maximum river flow.

A Tiger Dam[3] set up on River Drive in Carmacks, Yukon (Anthony Bier, 2022)

Annual Water Levels

Annual minimum and maximum water level trends were analyzed for four Yukon lakes and Atlin Lake in British Columbia. The Yukon lakes were Bennet Lake, Łù'àn Mǟn (Kluane Lake), Tthecha ̀l Mǟn (Sekulmun Lake), and Teslin Lake.

Bennett Lake and Łù'àn Mǟn (Kluane Lake) show significant declines in minimum winter levels, while Tthecha ̀l Mǟn's[2](Sekulmun Lake's) minimum level has slightly increased. In addition, Teslin Lake showed a slight increase in minimum levels.

A decrease in maximum water levels is only evident on Łù'àn Mǟn (Kluane Lake), and this change is directly linked to the diversion of meltwaters from the Kaskawulsh glacier to the Alsek River drainage in 2016 owing to glacial retreat (Shugar et al. 2017). This event dramatically reduced flow into the Ä'äy Chù (Slims River), which was once the largest single contributor of flows into Łù'àn Mǟn. A recent study suggests that water levels will remain low in Łù'àn Mǟn and Kluane River for the foreseeable future (Loukili and Pomeroy 2018).

[2] Tthecha ̀l Mǟn means "stone scraper lake" in Southern Tutchone, while Łù'àn Mǟn means "big whitefish lake". Ä'äy Chù means, "it stands [alone by itself]".

[3] The dam is built using custom-made water-filled tubes around one metre high that combine to create a water barrier. Sandbags are stacked alongside, and the system is anchored to the ground.

Looking out from the Teslin Marina (Anthony Bier, 2022).

Data quality

The Water Survey of Canada conducts long-term measurements of large rivers and lakes, while the Water Resources Branch monitors smaller streams and rivers. The current analysis considers stations with at least ten years of data and excludes those affected by hydroelectric generation facilities.

Trends in peak or minimum flows do not necessarily indicate a trend in monthly, seasonal, or annual flows. Extreme flows in rivers are often the most difficult to interpret due to changing hydraulic conditions during extreme high-flow events and the challenges of measuring low flows under the ice. This means that these measurements are typically associated with a higher degree of uncertainty, which may be similar to the changes in long-term trends. Therefore, it is important not to give too much value to any single site but rather to look at the larger picture.

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

Profile

2022 Flooding on Teslin Lake and Tàgé Cho / Tágà Shäw (Yukon River) at Carmacks

On April 1, 2022, there was higher than average snowpack in many Yukon watersheds, including the Teslin River Basin and the Upper and Central Yukon River Basins, suggesting high flood potential for Teslin and Carmacks. April brought colder temperatures, resulting in more snow accumulation, pushing the snowpack higher in most of the territory when it usually would be starting to melt. By May 1, 2022, the Teslin River Basin's snowpack estimation was 204 per cent of normal while the Central Yukon River Basin was over 400 per cent, setting records for the highest snowpack since 1980.

Teslin Lake is unique from the other Southern Lakes because its water levels typically peak in mid to late June with the cessation of the snowmelt period. In 2022, there was more snow than seen in over 40 years, and the melt happened over a shorter period than usual owing to the late onset of the snowmelt period (freshet).

Teslin Lake peaked on June 23, 2022, at the second-highest water level on record, 15 cm below the record set in 1962. The village carried out active flood mitigation to manage the high water. Downstream in Carmacks, the water rose rapidly and peaked approximately 10 cm below estimated water levels associated with record flow events in 1962 and 1964. Active flood mitigation efforts were required to protect infrastructure and homes.

While the Yukon did not carry out snow surveys in the early 1960s, the hydrological data suggest that snowpacks were high for multiple years in that time period. This compares to recent back-to-back high-water events in the Upper Yukon River Basin, in Teslin and Carmacks in 2021 and 2022. The territory is becoming wetter and experiencing more frequent extreme events due to climate change. However, this pattern also supports the idea that climate oscillations, or cycles in weather patterns that occur on scales of decades or more, are also a factor in the occurrence of these extreme events.

References

Environment and Climate Change Canada. Water Survey of Canada Historical Hydrometric Data. Available from: Water Level and Flow – Environment Canada (ec.gc.ca)

Loukili, Y. and J.W. Pomeroy, 2018. The Changing Hydrology of Lhù'àän Mãn- 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.

Shugar, D., Clague, J., Best, J. et al., 2017. River piracy and drainage basin reorganization led by climate-driven glacier retreat. Nature Geosci 10, 370–375. Available from: River piracy and drainage basin reorganization led by climate-driven glacier retreat | Nature Geoscience

Yukon Geographical Names Program. 2022. Gazetteer of Yukon. Available from: LinguistCustom (yukon.ca)

7. Yukon River ice breakup at Dawson City

Significance

Over the past century, breakup has occurred earlier in the spring, a strong indicator of a changing climate. Even if warmer winter temperatures contribute to reducing the ice cover thickness and, therefore its resistance, the combined effect of larger snowpacks and increased air temperature variability will likely impact ice jam frequency and intensity.

The reduced river ice season is already impacting the Yukon because river ice conditions affect transportation routes, for both winter roads and wildlife corridors. In recent years, changing freeze-up patterns made certifying an ice bridge to connect West Dawson and Dawson City challenging.

Yukon River in winter downstream of Dawson City

The timing of river ice breakup is one-factor influencing breakup severity and associated negative impacts, due to:

- A rise in river discharge early in the season results in the mobilization of a very resistant ice cover, which can cause 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?

The Yukon River ice breakup at Dawson City now occurs almost eight days earlier on average since data collection began in 1896 (Figure 1). Breakup events in late April have increased in frequency, with nine such events since 1989, compared to only two breakup events in April between 1896 and 1988. The two earliest recorded breakups occurred in the past seven years (2016 and 2019, both on April 23rd).

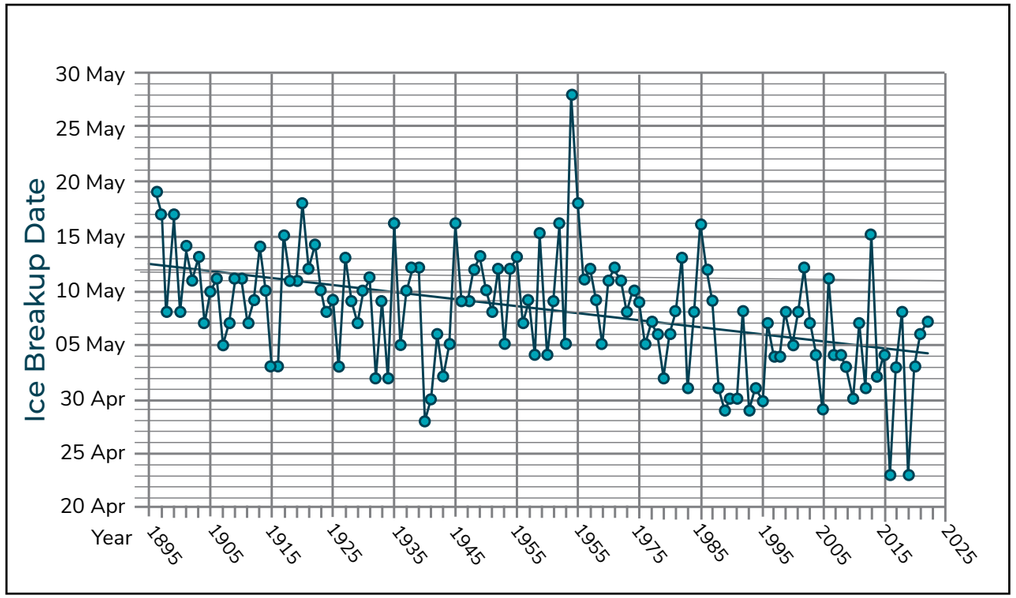


Figure 1: Yukon River at Dawson City breakup date by year, 1896 to 2022.

Yukon River, Dawson City, six hours before breakup May 7, 2022, at 14:22 (Sebastien Weisser).

Taking action

The Government of Yukon uses a network of monitoring stations and models to forecast the timing and potential severity of breakup on the Yukon River at Dawson City, in support of community flood preparedness. River ice processes are evolving with climate change, affecting both the timing and intensity of breakup and the severity of ice jams. To better understand these changes and improve forecasting tools, the Government of Yukon is working with researchers from Yukon University to develop and strengthen breakup models for several communities, including the Yukon River at Dawson City.

Data quality

Records documenting the timing of the breakup on the Yukon River at Dawson City and the continuous recording of the date of the breakup began in 1896 as part of the Yukon River breakup contest. IODE Dawson Chapter 4 organizes the lottery under the name “Dawson City Ice Pool” found at: IODE Dawson or Yukon River Ice Pool – Dawson City Yukon.

Profile

River break-up is a fascinating natural occurrence characterized by the melting of ice and the subsequent movement of ice masses within a river. This phenomenon has significant implications, including reopening river crossings by ferry and allowing communities access to goods and services by boat or barge. It can also lead to flooding ranging from minor impacts to inundating entire communities. From a scientific perspective, river breakup signifies the moment when ice begins to shift and relocate, marking the transition into the warmer season. To many people, it symbolizes the onset of spring.

From a hydrologist’s perspective, the focus is on flood forecasting and actively contributing to the understanding and prediction of these events. In some communities, the most significant floods on record were the result of ice jamming during a breakup. To effectively assess risk, parameters such as snow, ice, water levels, and weather patterns are all examined. The Water Resource Branch uses these data and monitors the progress of river breakup as it approaches critical communities. When conditions indicate an increased risk of flood, they contact emergency response officials in order to increase vigilance and preparation of additional mitigation measures.

To hear more about The Yukon River Break-up click **here**. You can also find the full audio recording of this podcast at the following website:
Nature & Environment – North of Ordinary Media. Yukon

North of Ordinary magazine did a podcast titled “The (river) breakup season” on February 27, 2022. The host, Editor Karen McColl interviewed Holly Goulding, Senior Scientist in Hydrology from the Water Resources Branch with the Department of Environment, Government of Yukon.

References

Dawson City Yukon River ice pool. Available from: https://dawsoncity.ca/yukon-river-ice-pool/.

Government of Yukon, Outdoor, Recreation and Wildlife, Yukon River Campground. Dawson City River Ice Break-up. Available from: https://yukon.ca/en/outdoor-recreation-and-wildlife/camping/site/yukon-river-campground

IODE Dawson Chapter. Dawson City River ice breakup. Available from: https://www.iodedawson.com/

Photo was taken by Water Resources Branch staff when collecting water quality samples from the Liard River.

8. Water Quality

Significance

The Water Quality Index developed by the Canadian Council of Ministers of the Environment indicates the status of water quality and the suitability of streams and rivers to support aquatic life. The Water Quality Index reflects the overall and ongoing condition of the water for tracking changes over time.

Specifically, the Water Quality Index measures the frequency and extent to which selected parameters exceed water quality guidelines 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. The guideline values consider all aquatic life forms and stages of an aquatic life cycle. A site will have a lower Water Quality Index rating when some water quality guidelines are exceeded.

What is happening?

Water quality samples are collected monthly from 13 rivers across the territory by Government of Yukon staff and partners. Yukon First Nations and transboundary Indigenous governments and group partners include the Daylu Dena Council, Tr'ondëk Hwëch'in, Vuntut Gwitchin First Nation and the First Nation of Na-cho Nyäk Dun. The data from these samples are compiled and available on the federal portal: Site Selection – Freshwater Quality Monitoring and Surveillance – Environment Canada. Analysis of the data by Environment and Climate Change Canada enables the calculation of the Water Quality Index using three consecutive years of data. However, the most recent Water Quality Indexes were calculated using only two years of data (2019 and 2021), as too few samples were collected in 2020 due to the COVID pandemic.

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

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

Location	Year 2005 - 07	Year 2005 - 08	Year 2007 - 09	Year 2008 - 10	Year 2009 - 11	Year 2010 - 12	Year 2011 - 13	Year 2012-14	Year 2013 - 15	Year 2014 - 16	Year 2015 - 17	Year 2016 - 18	Year 2017 - 19	Year 2018 - 19
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	80.2
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	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	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	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	73.2
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	87.6
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	70.3

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.

All four watercourses monitored over the last decade (Klondike, Liard, South McQuesten and Yukon rivers) have water quality scores that have remained relatively constant. Scores for the 2019-2021 period are consistent with previous years, except for the Liard River, which dropped slightly into the "Fair" category for the first time. The Liard River water quality trend analysis is underway and will be available in 2023. The South McQuesten River downstream of Flat Creek has the lowest water quality index in the Yukon. The Government of Yukon conducted and published an assessment of water quality trends and developed water quality objectives for the South McQuesten River. This information is available the at South McQuesten River – Et'o Nyäk Tagé cumulative impacts study.

Taking action

The Water Quality Index is specifically designed to monitor river health. The Government of Yukon has also been focusing on the health of Yukon lakes. During 2019, in partnership with the Lake Pulse program, supported by the Natural Sciences and Engineering Research Council of Canada (nserc-crsng.gc.ca) and managed by the University of Sherbrooke, 24 Yukon lakes were sampled, and several metrics were analyzed to assess lake health (aquatic ecosystem status, contamination, temporal changes and physical water properties). Following the sampling in 2022, the Government of Yukon and Lake Pulse researchers developed summary reports for each lake which will be published on Yukon.ca in 2023. The detection of a few contaminants occurred during this program.

Lake Pulse Sampling of an unnamed lake in Tombstone Territorial Park

Data quality

Environment and Climate Change Canada calculates the Water Quality Index scores. Calculating the scores as an average over several successive years provides additional confidence in ratings. Usually, the index is calculated over three years. However, the pandemic limited the data available in 2020, so the latest index is the average of two years of data (2019 & 2021).

The Government of Yukon staff and local partners follow standardized protocols and obtain and analyze water quality samples in the Environment and Climate Change Canada accredited laboratories. Environment and Climate Change Canada performs further quality assurance and quality control to ensure datasets meet minimum data requirements for the analysis.

A selection of measured variables deemed most representative forms the basis of the Water Quality Index. The set of variables is specific to each location and varies from site to site.

Yukon First Nations and Indigenous ways of Knowing, Doing and Being

The Water Resources Branch collaborates with many partners including Yukon First Nations and transboundary Indigenous governments and groups to gain a better understanding of the water that sustains us all. Over the last few years, the Water Resources Branch made strides to incorporate Yukon First Nations and Indigenous Ways of Knowing, Doing and Being. One example of this is recent collaborative work to center Yukon First Nations and Indigenous knowledge in our transboundary water agreements. In 2022, the Water Resources Branch collaborated with Yukon First Nations and transboundary Indigenous governments and groups in the Liard River basin of British Columbia and the Northwest Territories to develop a new process for learning about the Liard River based on both Yukon First Nations and Indigenous knowledge and western science. The process will follow the Land and People Relationship Model developed by Indigenous Land Planner, Joe Copper Jack (respectcareshare.ca). The development of the Learning Plan is starting in 2023 with an Elders circle for sharing Indigenous water knowledge. The Elders circle and other collaborative planning workshops will help to inform future collaborative monitoring and stewardship in the basin. The Water Resources Branch looks forward to continued collaborations with Yukon First Nations and transboundary Indigenous governments, groups and advisors to support water stewardship in our territory.

Profile

Water Resources Branch began sampling for microplastics in 2021 and, during this first year, explored analytical and sampling methodologies that would allow for sampling through ice during winter months. Microplastics are everywhere on our planet, and it is difficult to sample microplastics without any outside plastic contamination during sampling, transport or even in 'clean' laboratory water. Also of note, blank samples[6] that should not have microplastics, showed counts of microplastics. This makes differentiating background samples from our regular samples difficult, so we consulted Coregeo Science to help refine our methods to address this challenge.

Microplastics research is an emerging field of study with limited knowledge on the topic making interpretation more difficult. In 2022, the Water Resources Branch continued to collect samples along the Yukon River in Whitehorse, Carmacks, Dawson City and along the Tagish River and attempted to address the issues surrounding quality control of the analytical results. Our consultant, Coregeo Science, performed a statistical analysis of the results over two years and confirmed the presence of microplastics in the Yukon River at specific locations. However, the methods must be refined to meet consistent quality and control assurance thresholds. Testing of a new sampling methodology will begin in 2023 to address the analytical challenges.

[6] A blank sample is a quality assurance/quality control sample. It is a bottle filled with deionized water from the lab. This sample should theoretically have zero microplastics in it.

Microplastic Sampling of the Takhini River

References

National Long term Water Quality Monitoring Data. Available from: http://data.ec.gc.ca/data/substances/monitor/national-long-term-water-quality-monitoring-data/.

NSERC Canadian LakePulse.ca Network. Available from: https://lakepulse.ca/test-homepage-layout/web-atlas/.

9. Groundwater levels in the Yukon Observation Well Network

Significance

- Groundwater is the most abundant form of water in the Yukon and is a critical resource. Approximately 97 per cent of Yukoners rely on groundwater for potable water. Ecosystems similarly depend on groundwater, which maintains water levels, regulates temperatures, and delivers nutrients to surface water bodies (lakes, ponds, streams, rivers, etc.).
- The Yukon Observation Well Network is a groundwater-monitoring program operated by the Water Resources Branch to monitor groundwater levels and quality across the territory.
- Groundwater level monitoring strengthens understanding of local and regional hydrogeological processes across the Yukon, including:
  - recharge and discharge mechanisms, rates, and timings,
  - interactions between groundwater and surface water, including water table responses to high surface water events, and
  - responses to the effects of climate change, including permafrost degradation.
- Groundwater and surface water levels and quality are intimately interconnected.
- Groundwater levels are significantly influenced by snow accumulation because a portion of melted snow infiltrates and recharges groundwater. Winter flows in rivers and streams are controlled by groundwater discharge rates and tend to be higher when groundwater levels are high. The Government of Yukon's flood forecasting team considers groundwater conditions when assessing flood risk.

What is happening?

- 28 of 74 active wells in the Yukon Observation Well Network currently have sufficient data quantity and quality for analysis. Of these 28 wells, 75 per cent showed higher maximum groundwater levels in 2022 than at any time in their record (the start of record for each well varies from 2001 to 2020). The observed groundwater table rise appears to be a regional phenomenon, not limited to one part of the territory. Certain wells, particularly those with longer periods of record (beginning earlier than 2016), showed 2022 groundwater levels approaching but not exceeding their historical max, which occurred in 2016. High groundwater levels likely result from the higher-than-average snowpack observed in much of the Yukon for the past three consecutive years. There has been a significant increase in the peak snow water equivalent at several snow survey sites monitored throughout the Yukon and neighbouring jurisdictions.
- Between 2021 and 2022, both years with above-average snowpack, most wells saw an increase in maximum groundwater level. However, two wells showed a decrease in maximum water level, the cause of which is not yet known.

Taking action

- The Government of Yukon's Water Resources Branch staff continue to operate and expand the Yukon Observation Well Network. In 2022, Water Resources Branch:
  - commissioned the installation of twelve new observation wells (six at Army Beach and three each in Teslin and Watson Lake) to improve understanding of how groundwater levels respond to peak lake levels,
  - adopted into the network eight existing wells at Erik Nielsen Whitehorse International Airport to improve understanding of how groundwater levels may contribute to slope failures along the Whitehorse Escarpment,
  - commenced sharing The Yukon Observation Well Network data on-line via the Yukon Water Data Catalogue, and
  - piloted near real-time groundwater level monitoring.
- The Water Resources Branch also has aquifer mapping projects underway in some Yukon communities, which provide regional context for future groundwater-related work.

Real-time data broadcasting from a well at Army Beach (Cole Fischer, 2023)

Water Resources Branch staff preparing to download water level data and collect a water quality sample (Cole Fischer, 2022).

Data quality

- The Government of Yukon's Water Resources Branch staff conduct groundwater level monitoring. All wells in the Yukon Observation Well Network are instrumented with loggers that record groundwater levels hourly. Staff visit the wells twice annually in the spring and fall. Staff compensate and correct raw groundwater level data following standardized methods described in the annual Yukon Observation Well Network Narrative Report. Grading criteria are applied to all groundwater level data and published with the data via the Yukon Water Data Catalogue.
- A screening process applied to groundwater level data resulted in several wells being excluded from analyses in the 2022 fall field season due to short periods of record, data gaps caused by equipment failure and inconsistent data quality due to instrument drift and field errors.

Yukon First Nations and Indigenous Ways of Knowing, Doing and Being

The Water Resources Branch is working to enhance partnerships with Yukon First Nations and transboundary Indigenous governments and groups and to incorporating Yukon First Nations and Indigenous ways of knowing, doing and being to the groundwater program. The Water Resources Branch reaches out to Yukon First Nations in, whose Traditional Territory wells are located to foster relationship building and knowledge-sharing. Every year, Yukon First Nations and Indigenous stewards and land guardians accompany Water Resources Branch staff on field trips to participate in data collection and to recommend locations for new observation wells.

An example of how we are conducting our work in a new way is planning on the land groundwater knowledge-sharing events with Yukon First Nations. In 2022, Water Resources Branch staff collaborated with Tr'ondëk Hwëch'in, Little Salmon/Carmacks First Nation, McGill University, and the University of Waterloo to organize and implement an event called "Under the Land: Going on the Land to Learn about Groundwater." Together we visited groundwater springs, streams and places of cultural importance; discussed potential sources of contamination at landfills and other sites; learned about the impacts of climate change on permafrost; and heard community concerns for their groundwater.

In Carmacks, the event also involved government leadership (through a meeting with the Chief and Council), children and youth (through a camp co-organized by Little Salmon/Carmacks First Nation and Yukon University), and Elders and other citizens (through a community lunch, sponsored by the Water Resources Branch). Other activities included visiting the Water Resources Branch's observation wells on the Traditional Territories of Tr'ondëk Hwëch'in and Little Salmon/Carmacks First Nation. The outcomes of the event included new and strengthened relationships; a better understanding of how to tailor research to meet the needs of Yukon First Nations, and enhanced feelings of connection to land and water.

Profile

Al Foster, Annie Lake Road resident and former federal Water Resources' staff member, via email:

"I have lived in Mt. Lorne on Annie Lake Road next to the Watson River for the past 47 years. The Yukon Observation Well Network data definitely coincides with my own observations of what has been happening in this area; with the very rapid rise of the groundwater table in this area through the 2010s.

When we first moved here, we used to get our water from the Watson River. In the winters through the 1970s and 1980s getting water through the ice was a hit-or-miss experience as the winter base flow of the river was very low. By the 1990s I started to notice the base flow of the river slowly increasing and then a substantial increase by the late 2000s. In the spring all the low-lying areas in the Watson River drainage would have water in them but would dry up by June. Now all those areas have water in them all year long with some having 4ft or more. We finally put in a well in 1992 (jetted a sand point in) and hit water at 20 ft. We are on an old riverbed largely made up of sand. Our water level has also been rising over the years.

However, the most astonishing increase in groundwater levels is at the McConnell Lake area, which shows no signs of decreasing; even seeing areas of this lake showing upwelling of water in the winter keeping ice off certain areas on the lake. The excess water is now flowing down an old drainage channel to Cowley Lake."

References

Government of Yukon. Yukon Water Data Catalogue. Available from: Water data catalogue (arcgis.com)

Land

10. Population

Significance

The 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 analyze and predict human activities' impact on the environment.

The distribution and density of the Yukon's population may impact where land use activities occur; however, land use is also determined by opportunities for development. For information on the Yukon's economy, visit https://yukon.ca/bureau-of-statistics. Land use activities in the Yukon are managed through environmental assessments, permitting and land use planning.

What is happening?

The Yukon has seen a steady growth in population for the last three decades. This growth distribution is uneven across the territory, with almost 90 per cent of the Yukon's population development in the Whitehorse area.

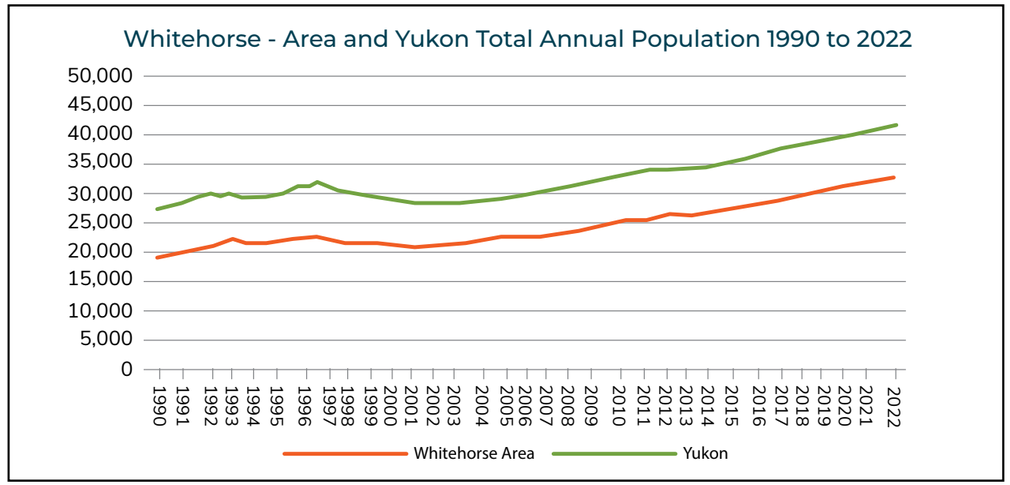


Figure 1: Whitehorse[7] and Yukon Total annual population from 1990 to 2022

[7] Whitehorse includes Ibex Valley, Marsh Lake, Mt Lorne, and Macpherson/Grizzly Valley.

All Yukon communities outside Whitehorse, except Old Crow and Watson Lake, have grown in population over the past 20 years. The most significant have taken place in Dawson City, Haines Junction, Tagish and Carmacks.

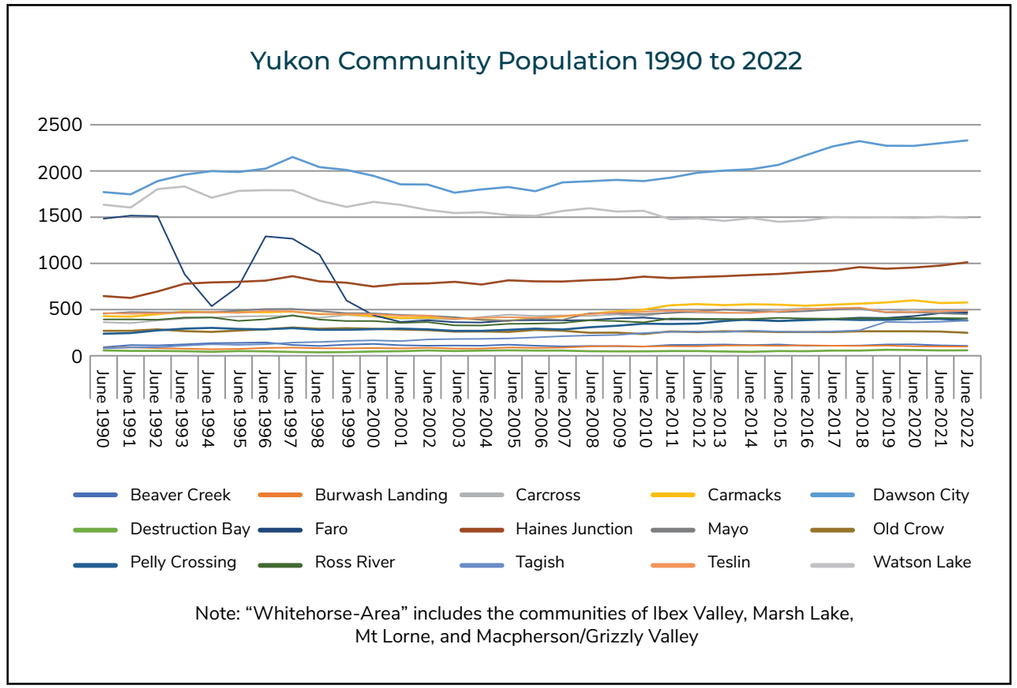


Figure 2: Yukon community population from 1990 to 2022.

Data quality

The Yukon Bureau of Statistics population estimates come from the Government of Yukon administrative data files. They produce forecasts on a quarterly basis.

References

Yukon population report.
Available from: https://yukon.ca/sites/yukon.ca/files/ybs/fin-population-report-q2-2022.pdf

11. Regional Land Use Planning

Significance

Land use planning supports effective land and resource management, and it is an important obligation arising from Chapter 11 of the *Yukon First Nation Final Agreements*.

A regional plan commission, appointed by the Government of Yukon and affected Yukon First Nations, prepares a regional land use plan in consultation with Yukon First Nations and Indigenous stakeholders and residents. These plans guide the future management of land in the planning region.

The development of long-term land use plans through public processes helps governments recognize and balance competing views about using Yukon's lands and natural resources.

What is happening?

- The Recommended Dawson Regional Land Use Plan was presented to the Parties in June 2022 and then was put up for public consultation in Fall 2022. The Parties are now determining whether the Recommended Plan will be accepted, rejected or modified, after which a Final Recommended Plan may be developed.
- The Parties to the 2019 Peel Watershed Regional Land Use Plan developed an implementation plan in 2020.
- The approved 2009 North Yukon and 2019 Peel Watershed Plans are proceeding according to their implementation plans.
- Government of Yukon is working closely with Yukon First Nations and transboundary Indigenous governments and groups to get the next regional planning process underway.

Taking action

- Government of Yukon and Tr'ondëk Hwëch'in consulted with the public in 2022 on the Recommended Dawson Regional Land Use Plan.
- Following public engagement, the Parties are considering all input received and are now deciding whether to accept, reject or modify the Recommended Plan.
- The Government of Yukon is working closely with the First Nation of Na-Cho Nyäk Dun, Carcross Tagish First Nation, Teslin Tlingit Council, and other First Nations to ensure the next regional processes can be underway.
- Implementation of the *Peel Watershed Regional Land Use Plan* has included work to ensure the relinquishment of over 5000 mineral claims in the region. Work is also underway to regulate off-road vehicle use throughout the Conservation Areas in the region.
- The Parties to the Peel Plan are now planning for Special Management Areas within the region. The Implementation Committee has developed guidance for those responsible for assessing and regulating proposed projects in the Peel region.

Government of Yukon, Yukon Land Use Planning Council and Teslin Tlingit Council meeting on regional planning (Jocylyn McDowell, 2022).

Yukon First Nations and Indigenous Ways of Knowing, Doing and Being

Regional planning's objectives in Chapter 11 of the Umbrella Final Agreement include recognizing and promoting the cultural values of Yukon First Nation people.

The regional planning process strives to reflect Yukon First Nations and Indigenous ways of knowing, doing and being, recommendations of residents, as well as incorporating science and broad socio-economic and environmental interests.

Chapter 11 Objectives

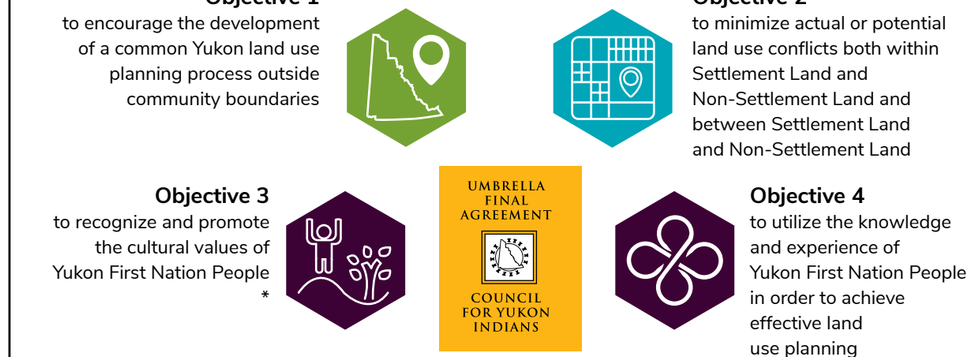


Figure 1: Chapter 11 Objectives diagram on the Yukon Land Use Planning Council Page

References

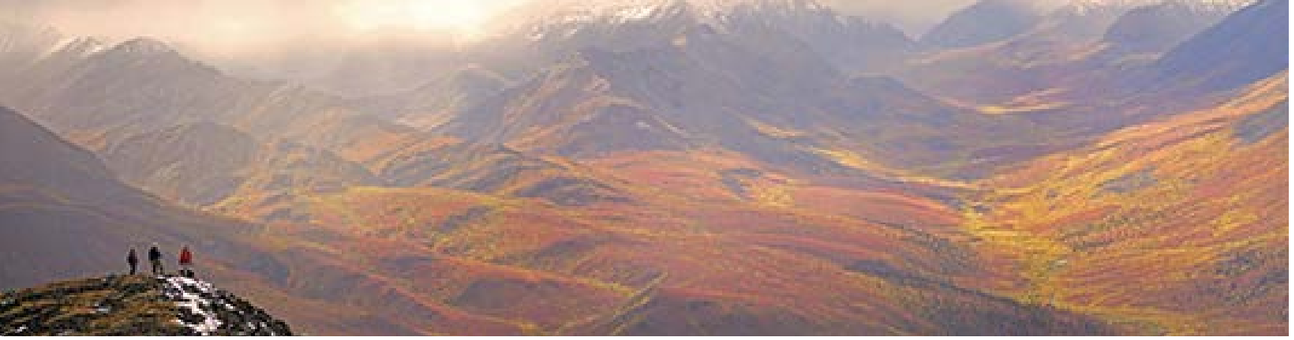
Dawson Regional Planning Commission. 2021. Dawson Regional Planning Commission Recommended Plan – June 2022. Dawson Regional Planning Commission, Whitehorse, Yukon, Canada.
Available from: https://yukon.ca/sites/yukon.ca/files/emr/emr-peel-watershed-regional-landuse-plan_0.pdf

Peel Plan Implementation Committee: 2019. *Peel Watershed Regional Land Use Plan.*
Available from: Yukon Land Use Planning Council | (planyukon.ca)

Peel Plan Implementation Committee: 2020. Peel Watershed Regional Land Use Plan – Implementation Plan.
Available from: Yukon Land Use Planning Council | (planyukon.ca)

Peel Plan Implementation Committee: 2022. *Peel Watershed Regional Land Use Plan* – Standard Terms and Conditions
Available from: Standard Terms Conditions in Peel Region March 24 – EH comments (00057941.DOCX;2) (planyukon.ca)

Review of the Presence/Use of Traditional Knowledge in Regional Land Use Planning. Prepared for the Yukon Land Use Planning Council, Whitehorse, Yukon, Canada.
Available from: https://planyukon.ca/~documents/yukon-land-use-planning-council-documents/discussion-papers/tk-rlup-2021/?layout=default tk-rlup-2021/?layout=default



View of Tombstone Park from the Dempster Highway

12. Community and Local Area Planning

Significance

- Local area plans guide development and land use in unincorporated Yukon communities. All modern local area plans are done collaboratively with Yukon First Nations and transboundary Indigenous governments and groups.
- Any unincorporated area experiencing high development pressure requires local area plans. A plan ensures that future development and growth occurs in an orderly manner by providing policies and land use designations to help minimize development conflict.
- Local Area Plans also help define a community's vision for the future and allow residents to influence decisions about land use.
- After the adoption of Local Area Plans, the next step is implementation. The main tool for implementation is the creation of zoning or land use regulations under the *Area Development Act*.
- Zoning regulations set out specific development areas, within which land use zones set out what development (i.e., typically the construction of buildings) is or is not allowed, along with limits on this development (e.g., maximum building height).

Łu Zil Män (Fish Lake) (Government of Yukon, n.d.).

What is happening?

Development area	Local area plan (date of approval)	Zoning regulation (date of approval or last comprehensive update)
Carcross	2014	1976 new regulations underway
West Dawson/Sunnydale	2013	1990 new regulations underway
Golden Horn	2004	2011
Watsíx Eetí	2014, part of Golden Horn Local Area Plan	2011
Hotsprings Road	2002	2005
Deep Creek	2001	2011
Hamlet of Ibex Valley	2001	2010
Hamlet of Mount Lorne	1995	2006
Klondike Valley	1988	1992
March Lake	underway	to follow Plan approval
McClintock Place	part of Marsh Lake Local Area Plan	1996, to be updated following Plan approval
Fox Lake	underway	to follow Plan approval
Tagish	underway	to follow Plan approval
Alaska Highway West	underway	to follow Plan approval
Łu Zil Män (Fish Lake)	underway	to follow Plan approval
Lone Tree		underway
Shallow Bay		underway
Silver Trail		2018
Dutch Harbour		2016
Remote Recreational Lots (Lake Bennett and Tagish Lake)		2014
Mayo Road		2013
Little Teslin Lake		2010
Jackfish Bay		2000
Grizzly Valley		1996
Mendenhall		1990
Pine Lake		1990
Bear Creek		1983

Destruction Bay		1980
Dempster Highway		1979
Ross River		1978
Whitehorse Periphery		1978

- Approval of eight Local Area Plans has occurred. Four others are underway. This is the same as reported in 2020. Note the name change for Fish Lake Local Area Plan. The new name is the Łu Zil Män (Fish Lake).
- There are 23 zoning regulations still in effect.
- There are zoning regulations for two new areas currently under development. Shallow Bay is listed in the 2020 State of the Environment Report and Lone Tree (not listed, new since 2020).
- Carcross and West Dawson/Sunnydale are updating zoning regulations (listed as such in 2020).

Łu Zil Män overhead (John Meikle, 2018)

Łu Zil Män Aerial (John Meikle, 2020)

Taking action

- Work is ongoing to create new Local Area Plans and zoning regulations where necessary and requested by Yukon First Nations and transboundary Indigenous governments and groups.
- All new Local Area Plans are collaborations with Yukon First Nations and transboundary Indigenous governments and groups and are shared guidance documents.
- Several Local Area Plans face delays, and discussions are ongoing to determine solutions. Typically, planners prioritize regional planning, which involves planning at a broader scale than local area planning. All delayed Local Area Planning processes occur in areas without Regional Plans.
- Discussions are ongoing to consider updates to numerous zoning regulations.
- Individual zoning amendments occur at a rate of 10 to 20 per year. Individuals apply to the Government of Yukon to alter the permitted uses of their private property. In this way, the modernization of zoning regulations occurs.

References

2020 State of the Environment Report.
Available from: Yukon state of the environment report 2020 | Government of Yukon.

Peel watershed Bonnet Plume River (Government of Yukon, 2018)

13. Status of Parks and Protected Areas

Significance

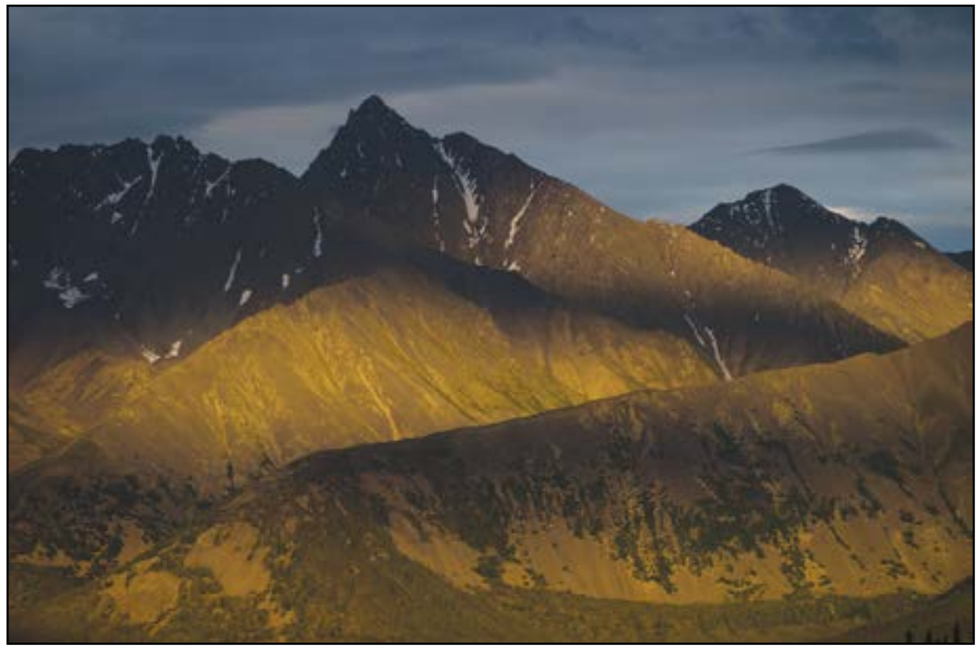
The amount of land protected indicates the Government of Yukon's commitment to conserving biodiversity.

The Government of Yukon reports protected area numbers nationally to support Canada's national targets and international commitments.

What is happening?

In 2021 portions of the special management areas identified in the *Peel Watershed Regional Land Use Plan* area were included in the Government of Yukon's protected area numbers as interim protected areas as agreed to by the parties of that plan. As the Yukon only reported the areas of the special management areas not under mineral disposition, this number is slightly smaller than the actual total area of the special management areas.

Throughout 2022, the Government of Yukon collaborated with the individuals and companies holding the mineral dispositions with the Peel special management areas. Most of the mineral dispositions have now been relinquished (1093 km^2 of land). These lands within the special management areas now meet the interim protected area criterion and are part of the Yukon's total protected areas.



Peel watershed Bonnet Plume River area (Government of Yukon, 2018)

Taking action

- Ongoing implementation of the Peel plan will determine the specific legal designations for those protected areas.
- Establishment of new protected areas is anticipated because of the Dawson regional land use planning process and other processes identified under the *Bilateral Nature Agreement* between the governments of Canada and the Yukon.

Data quality

- Numbers are based upon calculated areas of Peel special management area polygons[1], with the removal of the areas within the special management areas that are under mineral disposition as of November 25, 2022. All parties agreed to this method of calculation.
- The Yukon Land Use Planning Council provided peel special management area polygons.

[1] Calculated land sectors or boundaries.

Peel watershed Bonnet Plume Midnight light (Government of Yukon, 2016)

Yukon First Nations and Indigenous Ways of Knowing, Doing and Being

Planning and establishment of new protected areas is in partnership with Yukon First Nations and transboundary Indigenous governments and groups.

Peel watershed Bonnet Plume Midnight sun (Government of Yukon, 2017)

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

Significance

Environmental and socio-economic assessment identifies the potential effects of proposed project activities that are required to be assessed under the Yukon Environmental and Socioeconomic Assessment Act before they are authorized and carried out.

In the Yukon, the Yukon Environmental and Socio-economic Assessment Board is responsible for conducting assessments. If an adverse effect is found to be significant, assessors recommend mitigation measures to reduce, control, or eliminate the effect. In situations where significant adverse effects cannot be mitigated, assessors recommend that the proposed project not proceed. The Yukon Environmental and Socio-economic Assessment Board directs its recommendations to decision bodies, which are federal, territorial or Yukon First Nations governments or agencies, who make the final decisions.

The number, type, complexity and location of projects assessed by the Yukon Environmental and Socio-economic Assessment Board 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 2022, 201 project proposals were submitted to the Yukon Environmental and Socioeconomic Assessment Board for assessment. Three proposals were submitted for screening at the executive committee level in 2022 and are in progress – the Eagle Gold Mine Extension, the Brewery Creek Mine and the Mount Nansen Remediation proposal. The screening of the Faro Mine Remediation proposal is still in progress.

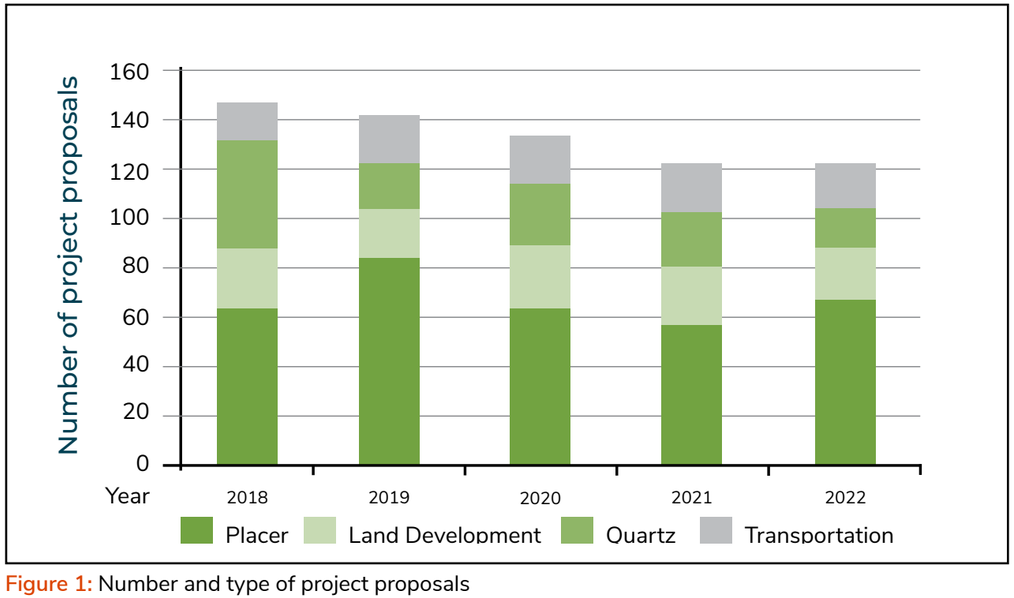


Figure 1: Number and type of project proposals

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

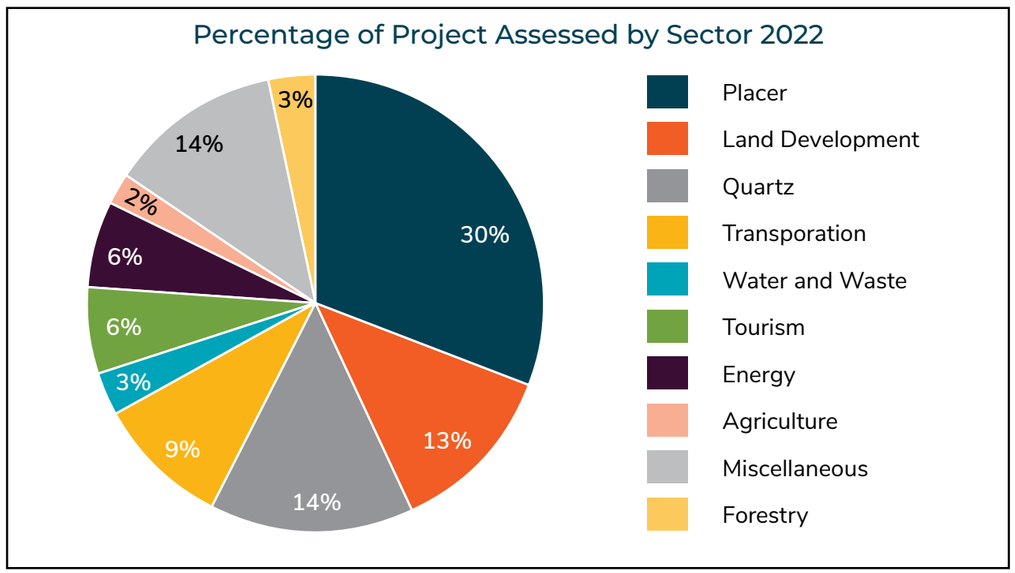


Figure 2: Percentage of projects assessed by sector in 2022

In 2022, the majority of project proposals were received in the Dawson City, Mayo and Whitehorse districts (Figure 3). Whitehorse, given its population density, generates a large number of project submissions for residential and commercial activities. Examples include access roads, subdivisions, energy, road upgrades and lot enlargements. Dawson City and Mayo are well-known mining districts with a long history of placer and quartz mining.

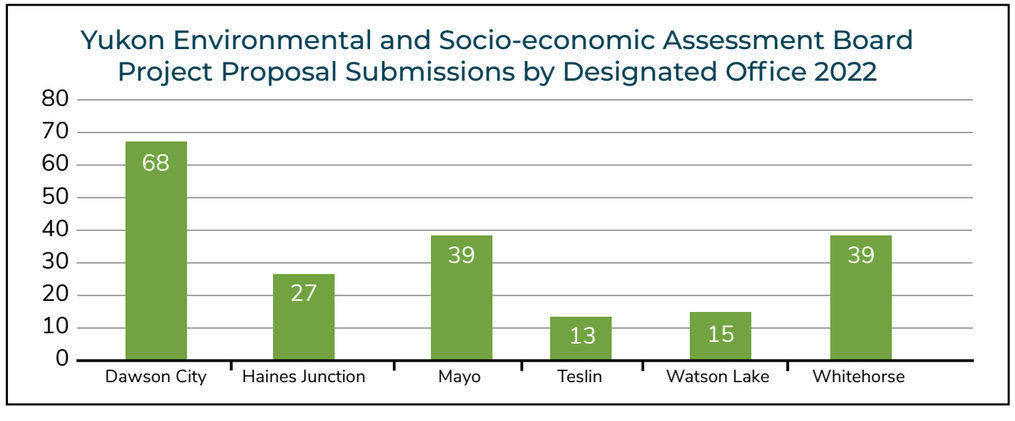


Figure 3: Yukon Environmental and Socio-economic Assessment Board project proposals by designated office in 2022

Information regarding individual projects is located on the Yukon Environmental and Socioeconomic Assessment Board On-line Registry.

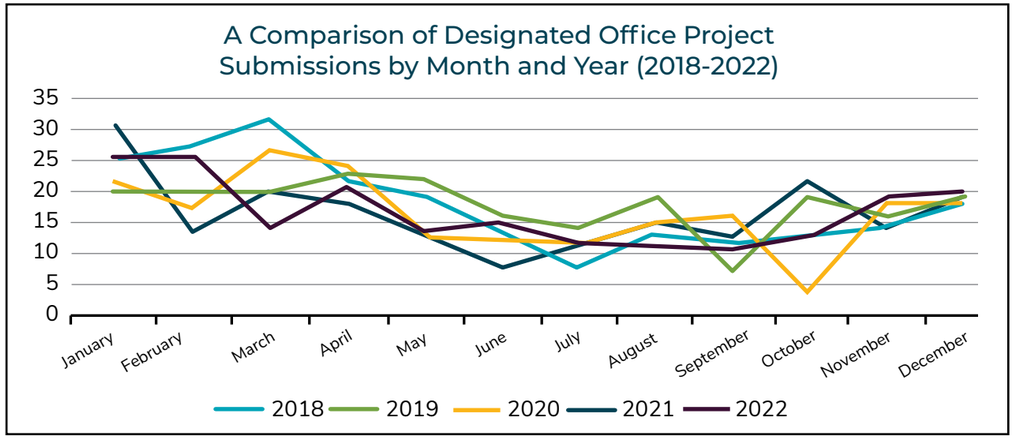


Figure 4: A comparison of designated office project submissions by month and year from 2018 to 2022.

Bonnet Plume River (Government of Yukon, n.d.)

Fox lake dock and campground (Government of Yukon, Yukon Parks, 2015)

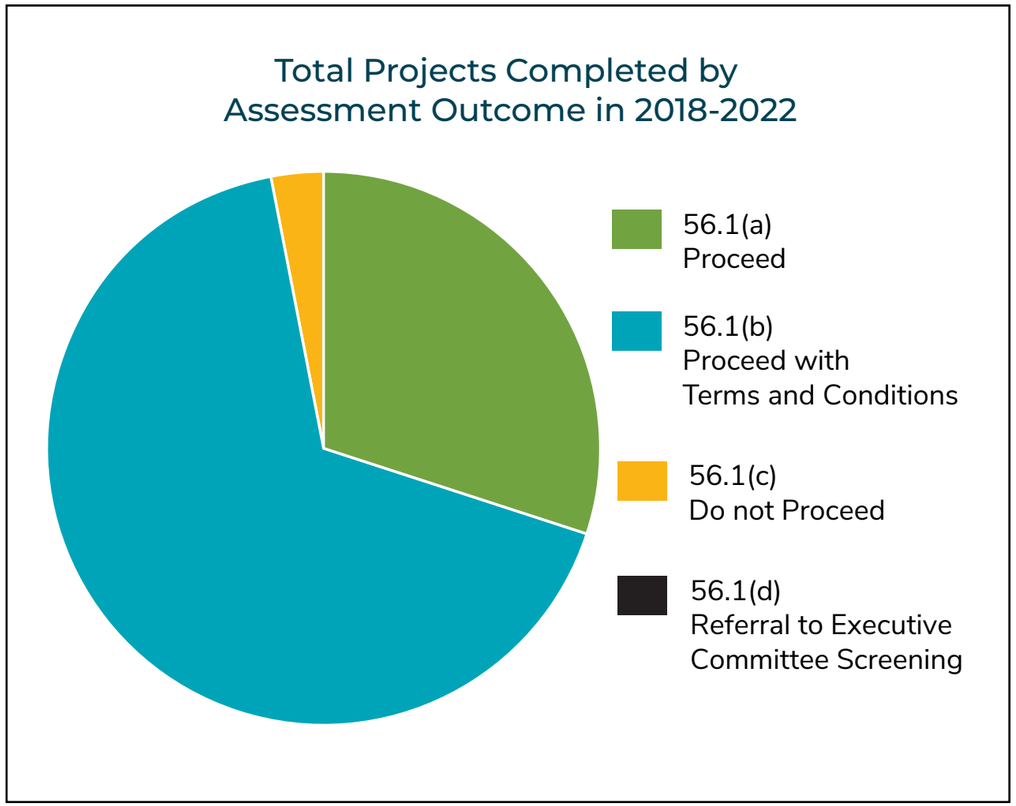


Figure 5: Total projects completed by assessment outcome from 2018 to 2022.

15. Recreational Land Use (Campground Visitation)

Significance

The Government of Yukon manages 42 road-accessible campgrounds that offer opportunities for outdoor activities such as fishing, hiking, boating, and wildlife observation. Territorial Park camping is a significant outdoor recreational service provided by the Government of Yukon to locals and tourists.

Every year, the Parks Branch of the Government of Yukon gathers information on campground visitation and their activities in territorial parks. By analyzing these patterns, we can decide how to allocate resources such as funding, personnel and infrastructure, and anticipate future needs. Additionally, examining the data can help us understand the impact of regulations and policies on user behaviour, for instance, implementing a 24-hour limit on campground site reservations.

Tent set up at Wolf Creek (Government of Yukon, Yukon Parks, 2018)

What is happening?

2022 Campground visitation highlights:

- The 2022 season showed an increase in visitors from the previous two seasons and was the second busiest season on record.
- We hosted 79,620 visitors for 57,886 campsite-nights at our road-accessible campgrounds.
- The number of people in the campgrounds was up 55 per cent from 2021 and only eight per cent below the 2019 peak season (before the COVID pandemic reduced the number of visitors from outside the territory).
- The number of campsite nights (occupancy of the campgrounds) was 18 per cent higher than last season, and only four per cent below the 2019 season.
- The 2022 season also witnessed a welcome return of tourists to the Yukon. During 2020 and 2021, Yukoners filled the gap and visited Yukon campgrounds in record numbers. In 2022, with the return of tourists to the territory, the majority (69 per cent) of campground visitors were non-resident, similar to the proportion prior to the pandemic.

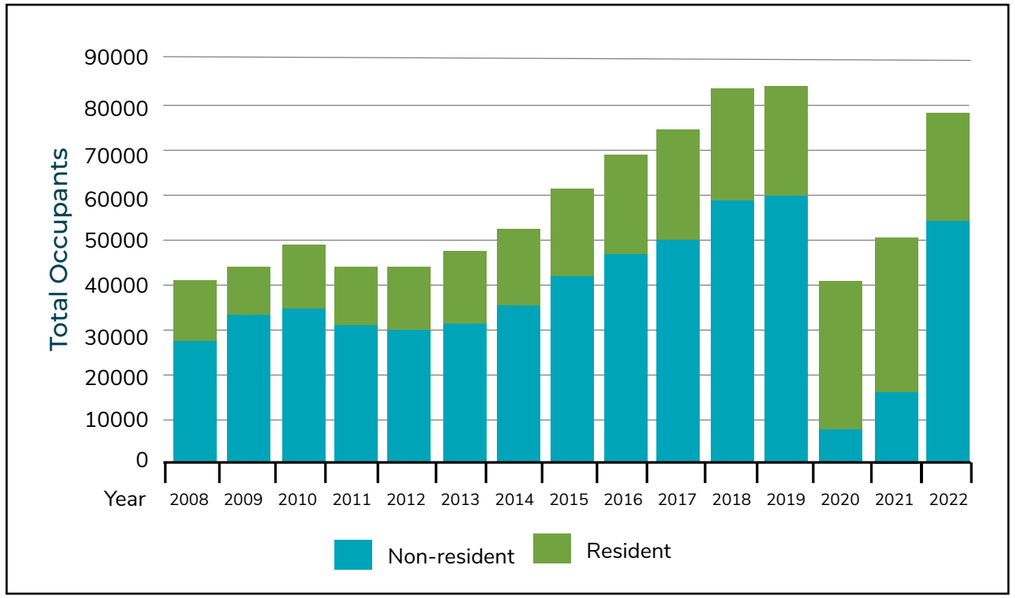


Figure 1: Number of occupants of Territorial Campgrounds

Campsite at Conrad (Government of Yukon, Yukon Parks, 2016)

Taking action

Through the *Yukon Parks Strategy*, we are working to make it easier to get a campsite in three ways:

- Building a large campground near Whitehorse
- Adding campsites to some existing campgrounds
- Testing a system for campground reservations

Data quality

The Government of Yukon's Parks Branch tracks overnight visitation through campground registrations.

The total number of occupants or registered visitors includes the total number of people that were camping during the year including repeat occupants or visitors.

There are other campgrounds operating throughout the territory, including Parks Canada's Kathleen Lake Campground in Kluane National Park and Reserve, Yukon First Nations managed campgrounds, and several private RV campgrounds. Data from these sites are not included in this summary.

16. Whitehorse Waste Management facility

Significance

- Disposing of solid waste in landfills can present environmental and health risks, in addition to land use planning difficulties. The management of waste is costly, regardless of whether it is sent to landfills, recycled, composted, or transported outside the territory for treatment.
- Tracking the type and source of material coming into and diverting from the landfill is a valuable step in managing the cost of solid waste disposal and coordinating solid waste policies and programs.
- 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.
- In the Yukon, this has put financial pressure on municipalities and the Government of Yukon to incorporate the liability into the financial costs of managing waste. However, it has also provided an incentive for waste diversion as a way 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.

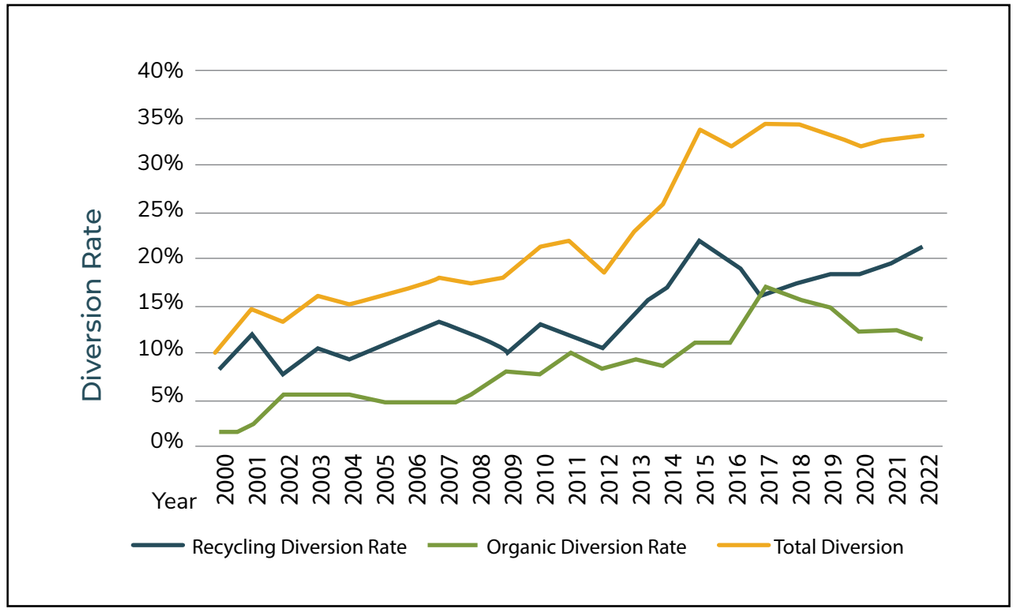


Figure 1: Diversion rate of recycling and organic materials from the City of Whitehorse Waste Management Facility.

Waste that enters the landfill comes from four major sources:

- Institutional, commercial and industrial,
- Construction and demolition,
- Residential, which includes domestic and household waste, and
- Outside city limits – waste from outlying communities taken on a fee-for-service basis to lessen the landfill burden on those communities.

City of Whitehorse Organic Waste Collection 2022

Taking action

- The City of Whitehorse is updating its *Solid Waste Action Plan*. Public engagement occurred throughout the summer and fall of 2022. This updated *Solid Waste Action Plan* will address current issues including increasing overall diversion rates, updating relevant City bylaws including the Waste Management Bylaw, working with the construction and demolition sector and institutional, commercial and industrial sectors to increase diversion, seeking feedback from stakeholders and implementing new education and outreach initiatives. The plan is projected to be finalized in 2023.
- A capital project for transfer station upgrades has begun at the Whitehorse Waste Management Facility, including a new weigh scale, safety upgrades and plans for reorganization of the public drop-off area. These upgrades will be ongoing from 2022-2024.
- City of Whitehorse and Government of Yukon co-hosted a recycling summit in November 2022 to demonstrate both governments' commitment to recycling in the territory.
- The Government of Yukon began public engagement near the end of 2022 for the *Extended Producer Responsibility policy*, which is anticipated to be in effect by 2025. This policy will help address current materials of concern including packaging and printed-paper, automotive waste fluids and household hazardous waste products.
- In 2022, the City of Whitehorse continues to expand the Commercial Organics Collection program to food service businesses, and multi-family residential buildings, with over 300 addresses signed on.

Quiet Lake south (Government of Yukon, n.d.)

Data quality

- The Whitehorse population estimates are based on the total Whitehorse area obtained from the Yukon Bureau of Statistics, which includes people residing outside city limits (but excludes Marsh Lake and Mount Lorne).
- Previously, clean wood and screened compost residuals were calculated together for landfill usage calculations.
- In 2022, tonnages for clean wood and screened compost residuals were accounted for separately.
- This change increases accuracy and enables better management of landfill resources.

References

Yukon Bureau of Statistics. 2022. Population Report, Second Quarter, 2022 [modified 2022 Nov 22, cited 2023 Jan 31]. Available from: https://yukon.ca/sites/yukon.ca/files/ybs/fin-population-report-q2-2022.pdf.

Statistics Canada. 2017. Table 38-10-0032 – Disposal of waste, by source, Canada, provinces and territories, every 2 years (tonnes) [modified 2020 July 9, cited 2023 Feb 2]. Available from: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3810003201.

Statistics Canada. 2022. Table 17-10-0009-01 – Population estimates, quarterly, Canada, provinces and territories [modified 2022 December 21, cited 2023 Feb 2]. Available from: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1710000901.

17. Forest health

Significance

Native forest insects pose little concern at population levels that do not 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.

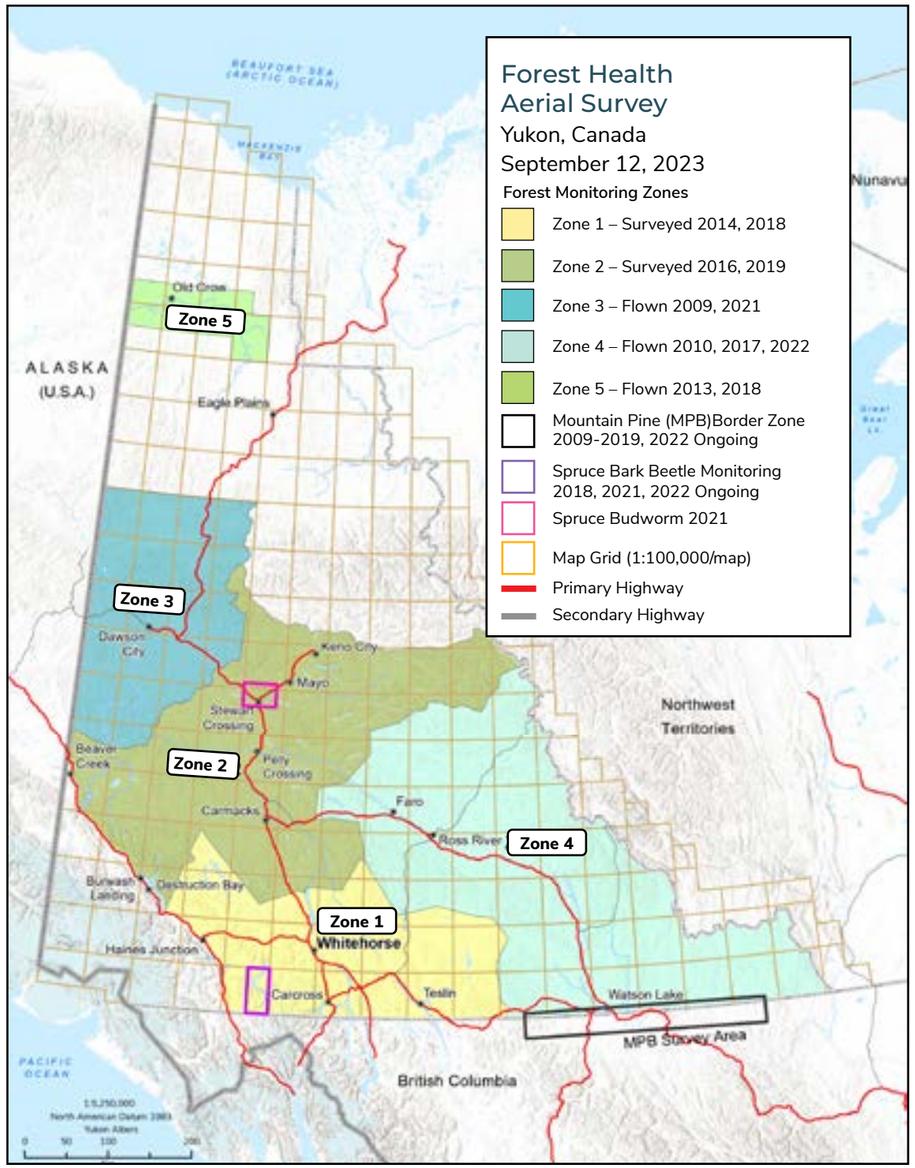
The Government of Yukon's Forest Management Branch implemented a risk-based approach to monitoring forest health in line with the *National Forest Pest Strategy* in 2009.

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, including developing early detection and reporting capacity of forest health pests.

The Forest Management Branch also produces an annual forest health report, which presents the biotic and abiotic disturbances detected by the annual forest health survey. They perform an annual forest health survey each year in a different Forest Health Zone.

For a full assessment of Yukon forest health issues, see the Yukon Forest Health Reports, available at: Learn about forest health.



Map 1: Yukon Forest Health Zones map shows areas flown from 2009-2022.

Photo1: Multiple generations of spruce beetle near Kusawa Lake in Forest Health Zone 1; yellow-orange trees are 2021 attack; reddish and gray trees are older attack.

What's happening?

As a part of the Forest Management Branch's risk-based forest health monitoring program, aerial overview surveys, mountain pine beetle pheromone bait deployment, and spruce beetle monitoring were conducted in 2022.

Aerial overview surveys were conducted in Forest Health Zone 4 (FHZ 4, Map 1). In 2022, the Forest Management Branch also responded to various public reports, conducted ongoing bark beetle monitoring near Haines Junction, and completed ground surveys and pheromone trapping to assess bark beetle risk near Deep Creek, Lake Laberge.

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 combination of biotic and abiotic factors.
Unless otherwise stated the following summarizes disturbances mapped in Forest Health Zone 4.

Biotic Disturbances

Spruce Bark Beetle (*Dendroctonus rufipennis*)

In 2022, aerial surveys covering 344 hectares were conducted in the southern portion of Forest Health Zone 4. The spruce beetle infestation at Kusawa Lake grew by 283 hectares (to 1,677 hectares) from 2021.

Aspen Serpentine Leafminer (*Phyllocnistis populiella*)

This leafminer has been present in trembling aspen stands for the past three decades, with varying levels of severity and extent each year. In one of the longest outbreaks, in Forest Health Zone 4, the area infested decreased by almost half, from 94,390 hectares in 2017 to 52,246 hectares in 2022. The outbreak's longevity appears to be contributing to aspen decline, with over half of infested stands showing signs of deterioration.

Photo 2: Characteristic silvery leaves caused by aspen serpentine leaf miner in Forest Health Zone 4.

Northern Spruce Engraver Beetle (*Ips perturbatus)*

The northern spruce engraver beetle caused white spruce mortality in seven separate mapped areas across the Yukon in 2022. This is an increase compared to 2017 and 2010 when no mortality was recorded. Some affected areas were associated with high water levels or flooding.

Photo 3: Pinkish hue of defoliated trees characteristic of large aspen tortrix damage, near Champagne Forest Health Zone 1.

Western Balsam Bark Beetle (*Dryocoetes confusus*)

In 2022, a significant decrease in infested areas occurred; from 10,265 hectares representing 98 locations in 2017 to 1,145 hectares at over 73 locations, most of which were in the southern portion of Forest Health Zone 4. The vast majority were spot infestations.

Photo 5: Spot infestation of western balsam bark beetle in Forest Health Zone 4.

Photo 4: Suspected northern spruce engraver beetle mortality in association with high water levels or flooding in Forest Health Zone 4.

Willow Blotch Leaf Miner (*Micrurapteryz salicifoliella*)

This common leaf miner was first recorded in the Yukon in 2007 next to the Stewart River at Stewart Crossing. Depending upon the year, this leafminer can be quite widespread, causing extensive damage to foliage. In 2022, populations were down slightly to 323 hectares from 442 hectares in 2017.

Abiotic disturbances
Winter Wind Desiccation

Winter Wind Desiccation, also known as winter drying, typically affects one side of trees. In 2022, black spruce affected by winter wind desiccation appeared in one mapped area near the southern border.

Flooding

In 2022, flooding was recorded in Forest Health Zone 4 in 29 locations, totaling 401 hectares. The largest affected area was a 147-hectare white spruce stand near Coal Creek, east of Watson Lake. In Forest Health Zone 1, flooding occurred in three areas covering 127 hectares.

Site-related

Two trembling aspen stands exhibiting signs of chlorosis, also called yellowing, were mapped west of Francis Lake, totaling under one hectare. No ground assessments were conducted, although it is suspected that the chlorosis is due to a nutrient deficiency.

Photo 6: Yellowing, chlorosis, of a trembling aspen clone west of Francis Lake.

Bear

Trace damage suspected to be caused by bears was noted in a seven-hectare young lodgepole pine stand northwest of Watson Lake, near the headwaters of Contact Creek.

PEST COMPLEXES

Aspen Decline

Aspen Decline refers to mortality or damage in aspen forests caused by a combination of biotic and abiotic factors. In Forest Health Zone 4, the affected area increased significantly to 7,463 hectares in 2022, compared to 62 hectares in 2017 and 11 hectares in 2010. This increase is likely due to consecutive years of aspen serpentine leaf miner populations combined with above-normal summer temperatures and low precipitation since 2017. In Forest Health Zone 1, 6,601 hectares of trembling aspen infested with aspen serpentine leaf miner were also affected by aspen decline.

Photo 7: Single scattered yellow (dying) lodgepole pine characteristic of bear damage on lower bole, in a stand near the headwaters of Contact Creek, northwest of Watson Lake.

Photo 8: Scattered severe aspen decline in mixed conifer stands along the Liard River, southwest of Simpson Lake in Forest Health Zone 4.

Porcupine and Bark Beetles

Symptoms resembling those of the porcupine/bark beetle complex were observed over 7,747 hectares in Forest Health Zone 4.

Windthrow[10] and Pine Engraver Beetle *Ips pini*

A 150-hectare pocket of windthrow lodgepole pine was recorded near Mount Vanier in Forest Health Zone 1. Ground assessments conducted nearby in 2021 indicated that the pine engraver beetle is likely attacking susceptible downed and standing trees.

[10] Windthrow refers to trees uprooted by wind.

Table 1. Summary and history of mapped hectares affected by forest health disturbances recorded in Forest Health Zone 4 in 2010/2017/2022, and a small portion of Forest Health Zone 1 where special surveys were conducted.

	FHZ 1			FHZ 4		
Disturbance Type	**2019**	**2021**	**2022**	**2010**	**2017**	**2022**
Biotic						
Aspen Serpentine Leafminer		4,705	2,066	53,085	94,390	46,076
Aspen Serpentine Leafminer/Large Aspen Tortrix			13,242			
Large Aspen Tortrix		1,760	760		7,106	335
Large Aspen Tortrix/Aspen Serpentine Leafminer						344
Spruce beetle	709 (old)	1,394 (old with <1% current attack)	1,677 (<1 % current attack)			344
Northern spruce engraver beetle			0.25			3,097
Western balsam bark beetle				607	10,625	1,145
Cottonwood leaf rust					187	
Willow Blotch Miner					442	323
Willow leaf rust					1,075	
Abiotic						
Winter wind desiccation				873		200
Slide				278		
Flooding				506	238	274
Site-related						0.5
Windthrow		914 (old and new)		51	661	
Lighting				1		
Bear					46	7

	FHZ 1			FHZ 4		
Disturbance Type	**2019**	**2021**	**2022**	**2009**	**2015**	**2021**
Pest Complexes						
Aspen decline				11	62	479
Aspen serpentine leaf miner/ aspen decline			6,601			6,109
Large aspen tortrix/aspen decline						875
Porcupine/pine engraver beetle		0.5	1.5	1	18	1,406
Windthrow/pine engraver beetle		118	150 (old)			

Taking action

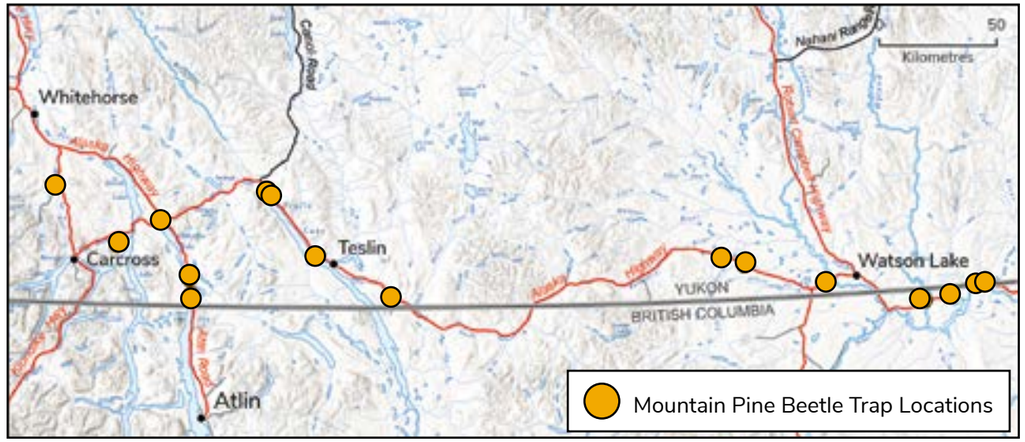
In addition to the annual aerial survey monitoring of the forest health zones, the Government of Yukon Forest Management Branch undertakes special projects. One example is the proactive management of mountain pine beetle, which is expanding northward from British Columbia.

The Government of Yukon has developed a risk analysis and monitoring strategy to track the northern movement of this bark beetle. In 2009, Yukon and British Columbia began greater monitoring of mountain pine beetle. In 2013, a mountain pine beetle monitoring plan and strategy was developed and implemented.

Analysis had indicated that the Mountain Pine Beetle was likely to reach the Yukon by 2020; however by 2022, this had not happened. In the future, favorable weather conditions could lead to univoltine (single brood per year) populations, which may be short-lived and decrease with average climatic conditions.

Climate and host models suggest that the cycle of endemic or incipient-to-brief-eruptive behavior is expected to persist until 2070, possibly becoming a defining characteristic of the beetle in the Yukon. New models could help guide efforts to suppress outbreaks.

In the short term, the impact on sociocultural values is anticipated to be low. However, in the long term, environmental and economic values are likely to be moderately to highly affected. To proactively manage the situation, annual aerial surveys of potential entry corridors and susceptible forest types are recommended as the highest priority monitoring activity, followed by ground assessments.

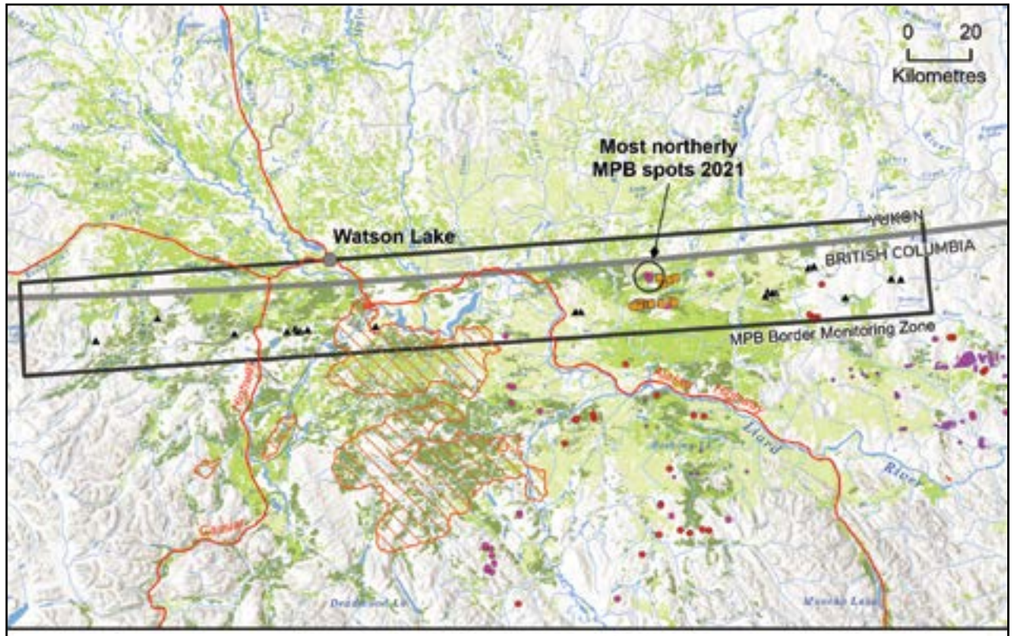


Map 2: Location of mountain pine beetle pheromone baiting sites in southern Yukon.

Next steps

In response to the mountain pine beetle risk, the Yukon Forest Management Branch has been proactively conducting pheromone bait tree stations since 2009 to detect the presence of the beetle. These stations have not detected the beetle in 2022. Additionally, aerial surveys have been used to monitor the border zone with British Columbia, and in 2022, 16 single and small groups of fading lodgepole pine suspected to be affected by the mountain pine beetle were observed near the spots identified by British Columbia in 2021. Further surveys are planned in 2023 to verify the presence and extent of the beetle in the border zone. As part of a proactive management approach the Yukon Forest Management Branch will conduct surveys in early summer 2023 to verify the presence and extent of Mountain Pine Beetle in the border zone. The Yukon Forest Management Branch will determine further steps based upon the outcome of the surveys but could include developing a Mountain Pine Beetle management strategy.

Photo 10: Suspected Mountain Pine Beetle in the border monitoring zone, within 15 km of the Yukon border.



Map 3: Location of porcupine complex and suspect mountain pine beetle spots as mapped by the Yukon Forest Management Branch in 2022 in the border zone, and history of observations by British Columbia from 2018-2021, including the three spots mapped in 2021.

A monitoring program has been in place since 2018 using Lindgren funnel traps to monitor populations of both spruce bark beetles (*Dendroctonus rufipennis)* and northern spruce engraver beetles in Haines Junction (Map 3). Trap catches in 2022 were low, suggesting populations have returned to endemic levels. In Deep Creek, near Lake Laberge, a pest risk analysis was conducted in 2020 following a windthrow event. In 2022, pheromone trapping, and ground assessments indicated the presence of all three beetle species but with minimal risk of development due to the downed material being too dry. Survey efforts will be modified in 2023 accordingly.

Map 4: Location of bark beetle pheromone monitoring traps near Haines Junction.

Map 5: Windthrow severity and location of pheromone monitoring traps in relation to leading species near Deep Creek.

The data collected through aerial surveys and ground assessments have been used to effectively monitor forest health in the Yukon. Aerial overview surveys are the primary tool for this purpose, and ground checks are conducted to validate the collected data. The forest health program includes ground survey protocols to predict insect population trends and assess potential risks from various pests.

Photo 11: Lindgren© Funnel Trap at trap location #2.

Overall, proactive management and monitoring strategies are in place to address the risks posed by the Mountain Pine Beetle and other bark beetles in the Yukon lodgepole pine forests.

Data quality

Since 2009, the Forest Management Branch in the Yukon has used an annual aerial overview survey program, funded by the National Forest Pest Strategy, to monitor forest health and detect biotic (insects and pests) and abiotic (non-living) disturbances. These surveys, along with ground field checks, are cost-effective methods for monitoring large areas and meeting national requirements for the Forest Health Network. They adhere to standardized forest health aerial overview survey guidelines used in British Columbia for consistency. Baseline data has been collected from all five forest health zones in the Yukon as of 2013. Ongoing monitoring areas may be selected during the monitoring process for further investigation. The forest health program also includes ground survey protocols for predicting insect population trends and assessing potential risks from insect pests, contributing to improved data quality and understanding of forest health in the region.

Photo 12: Spruce bark beetle frass-packed gallery on a windthrow spruce and some woodborer activity.

Further Information

Forest management information: Forests | Government of Yukon
The Forest Management Branch produces an annual forest health report presenting the biotic and abiotic disturbance(s) detected by the annual forest health survey. The survey is performed in a different forest health management zone each year.

Annual Forest Health reports: Learn about forest health | Government of Yukon

Forest Health Brochures featuring main pests and pathogens of Yukon: Learn about forest pests and diseases | Government of Yukon

References

Canadian Council of Forest Ministers [Internet]. 2022. Forest Pest Working Group.
Available from: https://www.ccfm.org/

Garbutt, R. 2013. Yukon Forest Health Report. 2013. Yukon Energy Mines and Resources. Forest Management Branch.
Available from: Learn about forest health | Government of Yukon

Government of Canada, Natural Resources Canada [Internet]. National forest pest strategy [Revised 2020 July 07].
Available from:
https://www.ccfm.org/releases/national-forest-pest-strategy-pest-risk-analysis-framework-users-guide-2/.

British Columbia Ministry of Forests, Lands and Mines and Canadian Forest Service. 2000.
Available from: Ministry of Forests – Province of British Columbia (gov.bc.ca)

Wetlands and permafrost drive landforms of the Yukon North Slope (Government of Yukon, n.d.).

18. Wetlands

Significance

Wetlands play a vital role in preserving water flows, mitigating the effects of floods, purifying water, regulating water, recharging and discharging groundwater, and providing a habitat for various fish and wildlife species. Additionally, wetlands support traditional ways of life, subsistence activities and recreation opportunities. Wetlands can also provide several additional and 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,
- storing large quantities of soil carbon,
- enhancing aesthetics, and
- serving as a rich arena for education.

Marsh and open water wetland complex

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 the Yukon are in areas underlain by continuous permafrost, particularly 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 the Yukon that include wetlands.

What is happening?

The Government of Yukon is furthering wetlands management through the implementation of its territory-wide *Wetland Stewardship Policy* and the Indian River Interim Approach for wetland protection in the Indian River area, as well as through decisions and guidance at territory-wide, regional, and project-specific levels.

Through implementing the Yukon wetland stewardship policy, the Government of Yukon will be introducing a suite of new wetland indicators, which will appear in the 2024 State of the Environment report.

Currently, we have completed wetland mapping for:

- Broad scale: 81,026.1km^2
- Local wetland mapping: 1,649km^2
- Vegetation Inventory: 28,557km^2

(Forestry vegetation inventory includes wetland identification to class level).

The Government of Yukon continues to advance foundational knowledge of the distribution and abundance of wetlands in the territory. This includes recently completing broad-scale wetland mapping in the Peel Watershed (a commitment within the *Peel Watershed Regional Land Use Plan*), the Beaver River watershed (to support ongoing land planning in this region), and within the Mayo and McQuesten watersheds. This information will be available on GeoYukon.

Taking action

In 2022, the Government of Yukon announced the completion of a territory-wide Wetland Stewardship Policy. This policy will help guide the management and conservation of wetlands throughout the territory.

The Dawson Regional Land Use Planning Commission released their recommended land use plan in 2022. Wetlands are a key ecological value within this land use plan, and the Commission, along with the Parties to the plan continue to work to define a wetlands stewardship regime that will provide effective conservation and opportunities for industrial activity within the Dawson planning region.

Aerial view of wetland complex in the Aishihik Lake region (Government of Yukon, n.d.).

Government of Yukon biologist collecting baseline wetland information in the Beaver River watershed (Government of Yukon, n.d.).

At a local level, the Government of Yukon has established an interim approach (Information sheet: placer mining in the Indian River area) to managing impacts of placer mining on wetlands in the Indian River area. This interim approach defines specific requirements for protecting certain classes of wetlands, 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.

In addition, the Government of Yukon undertakes sub-regional and local area planning 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, which can consist of wetlands.

The Department of Environment is 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 the natural ("reference") state of wetlands. The scheduled release of the final report on this pilot project is in 2023.

Distinctive polygonal permafrost landforms found in wetlands on the Yukon North Slope (Government of Yukon, n.d.).

Data quality

Throughout 2023, we will develop our wetland indicators and the required reporting processes.

Yukon First Nations and Indigenous Ways of Knowing, Doing and Being

Yukon First Nations and transboundary Indigenous governments and groups continue to share relevant Indigenous ways of knowing, doing and being relating to wetlands through a variety of mechanisms, including engagement on the wetland stewardship policy, contributions on the Dawson Regional Land Use Plan, and project assessment and regulatory reviews.

Within these processes, Yukon First Nations and transboundary Indigenous governments and groups have consistently raised the importance of wetlands in their ability to undertake incorporating their Yukon First Nations and Indigenous knowledge. To ensure their right to undertake these traditional cultural practices, along with their established rights to access water in its natural state, they have consistently advocated for the protection or conservation of the Yukon's wetlands. Recent project level environmental assessment comments in central Yukon, as well as the completed North Yukon and Peel Watershed regional land use plans, and the ongoing efforts to complete a Dawson regional land use plan, reflect the prominence of the consideration of wetlands.

A wetland adjacent to the historic grave markers in Herschel Island Qikiqtaruk Territory (Government of Yukon, n.d.).

Kluane Lake (Government of Yukon, 2006)

References

Government of Yukon. 2022. ***A policy for the stewardship of Yukon's wetlands***. Whitehorse, Yukon.
Available from: https://yukon.ca/en/policy-stewardship-yukons-wetlands

Environment and Climate Change Canada. 2022.
Available from: Environment and Climate Change Canada – Canada.ca.

Fish and wildlife

19. Presence of alien and introduced species

Significance

The Convention on Biological Diversity Secretariat defines invasive species as alien species that cause environmental, economic, or social impacts when introduced. Many alien species post a threat to ecosystems, causing declines in populations of native species and many other ecological concerns.

Humans may introduce alien species of plants, animals, and microorganisms outside their typical habitat. While many species have been introduced accidentally, others have been intentionally introduced for various reasons such as conservation, gardening, hunting or fishing enhancement. These species can cause a decline in biodiversity, property value and limit the quantity and quality of resources available to humans. Additionally, invasive species can impact cultural resources, such as competing with local berry plants.

Besides the impact on native biodiversity, invasive species come at a cost, which may be:

- financial, such as highway maintenance, and reduction in agriculture productivity,
- social, such as the loss of a wilderness experience; and
- environmental, such as losing native species through competition, predation or disease.

Climate change provides increased opportunities for species to expand beyond their historical geographic distributions and to establish and spread in new areas (Walther et al. 2009). Invasive species may influence the magnitude, rate, and impacts of climate change by altering ecosystem structure and function (Pyke et al. 2008). The interactive effects of climate change and invasive species threaten biodiversity, ecosystems, and human well-being worldwide (Smith et al. 2012).

Rock pigeon (allaboutbirds.org, 2023)

What is happening?

The Yukon is second only to Nunavut as the jurisdiction in North America with the lowest percentage of alien species (NatureServe 2022). Just under two per cent (150) of the 8,025 known wild species in the territory are introduced populations or considered introduced.

As of December 2022, 243 alien species were known to have occurred in the Yukon. Of these, 153 are currently believed to be present (Government of Yukon 2022; Figure 1), 35 are believed to be absent, and the presence of 55 additional species is unknown.

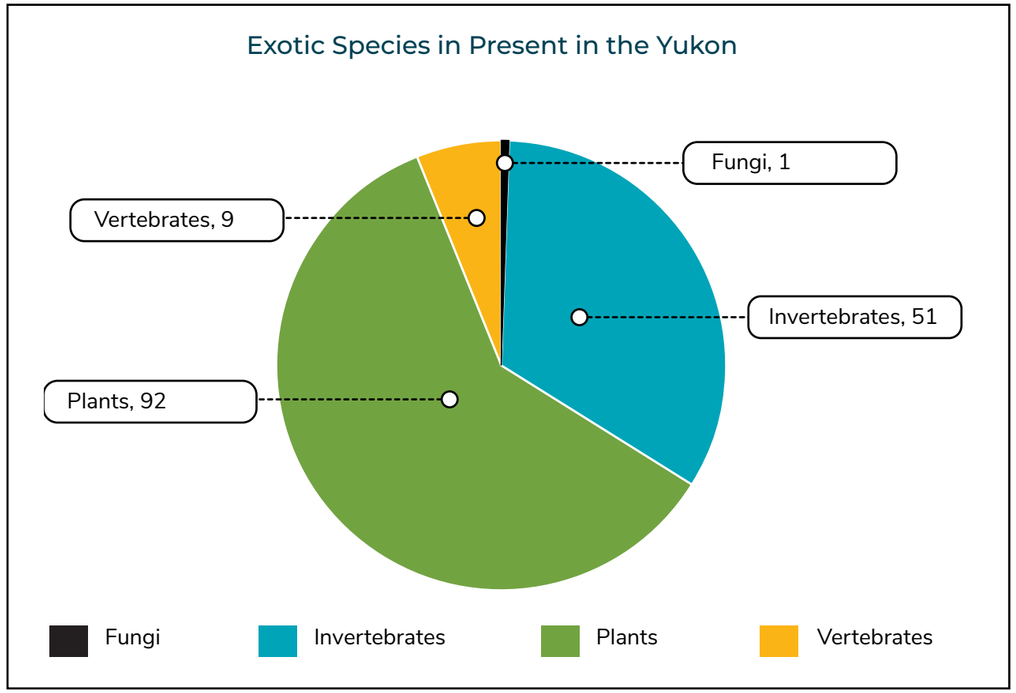


Figure 1: This shows a breakdown of exotic species currently known to be present in the Yukon, by taxonomic group.

Thirty-three species are considered to be present and to have a high to medium invasiveness rank in the Yukon (Government of Yukon 2022). All but three of these species are plants. Chytrid fungus, which harms Yukon amphibians (Government of Yukon 2013), and seven spotted lady beetle, which are considered to be replacing Yukon's transverse lady beetle (COSEWIC 2016, CABI 2020), are also considered invasive in the Yukon. It is believed that the octagonal-tail worm is becoming widespread in the Yukon.

Nine species of vertebrates are considered introduced and found in the wild. These include three mammals (elk, feral horse, and house mouse), three birds (eurasian collared-dove, european starling, and house sparrow) and three fishes (rainbow trout, three-spine stickleback, and arctic char). The rock pigeon and goldfish, once found in the wild in the Yukon, are now considered extirpated[1].

Three species of fish (bull trout, dolly varden, and kokanee) have native populations, but also have introduced strains which also exist in some pothole lakes and around the tributaries in the Whitehorse area.

Taking action

The Government of Yukon supports the Yukon Invasive Species Council by providing information and raising awareness about species introduced to the Yukon.

The Yukon Conservation Data Centre uses reports, collections, and photographs through the platform iNaturalist to help gather information on the distribution of species introduced to the 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.

Data quality

The Yukon Conservation Data Centre gathers information on over 9,000 wild species of plants, animals, slime moulds, and fungi. This includes information on those that are naturally occurring and those that are likely to become invasive.

Knowledge of the Yukon's wild species is improving. Some plants and animals once thought to be exotic are now known to be native. Wild species' ranges are changing more rapidly with the impacts of climate change.

[1] Extirpation (also known as 'local extinction') describes the situation in which a species or population no longer exists within a certain geographical location. Unlike extinction, whereby a species no longer exists anywhere, extirpation means that at least one other population of the species persists in other areas. Most species of plants and animals have a number of different breeding populations, which exist either globally or within a defined region or habitat. This means that when a population ceases to exist in a certain area, the other populations remain to keep the species extant (still in existence). Since the entire species is not extinct, it is possible for populations to recolonize after extirpation. However, this can sometimes lead to a reduction in genetic diversity.

Narcissus Bulb Fly (Merodon equestris) (Syd Cannings, n.d.).

Profile

In 2022, researchers collected a new exotic fly, the narcissus bulb fly, near the White River during the Beaver Creek Bioblitz[2] (Government of Yukon 2022). The narcissus bulb fly inhabits and consumes many garden plants that grow from bulbs including amaryllis, daffodil, galtonia, hyacinth, iris, lily, leucojum, narcissus, scilla, tulip, and vallota (Kaur 2023). The species is a common garden pest in southern British Columbia (Ministry of Agriculture and Lands 2019). It is likely that the narcissus bulb fly was inadvertently brought to the Yukon in commercial garden bulbs.

More Information

In 2022, a roadside survey of invasive plant species along Yukon highways was completed.
You can access information at Yukon Conservation Data Centre: data request | Government of Yukon, Yukon species at risk | Government of Yukon, and Aquatic invasive species | Government of Yukon.

[2] The BioBlitz is a biological treasure hunt – an event where scientists and amateur naturalists scour a region of the Yukon to get a scientific snapshot of the biological diversity of a region (Yukon BioBlitz).

References

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: CABI Compendium Invasive Species | CABI Digital Library

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: Species at risk public registry – Canada.ca

Convention on Biological Diversity Decision VI/23. No date. Available from: COP Decision (cbd.int)

Dictionary of Biology. Available from: Extirpation – Definition and Examples | Biology Dictionary

Government of Yukon. 2013. Management Plan for Yukon Amphibians. Yukon Fish and Wildlife Branch, Whitehorse, Yukon, Canada. Available from: Management plan for Yukon amphibians | Government of Yukon

Government of Yukon. 2022. Species database. Yukon Conservation Data Centre, Whitehorse, Yukon, Canada.

Kaur, N., editor. 2022. Pacific Northwest Insect Management Handbook [online].
Corvallis, OR: Oregon State University. Available from:
Insect Management Handbook | Pacific Northwest Pest Management Handbooks (pnwhandbooks.org)

Ministry of Agriculture and Lands. 2019. Home and Garden Pest Management Guide. King's Printer, Victoria, British Columbia. 472 pp.

NatureServe. 2022. NatureServe Explorer. NatureServe, Arlington, Virginia, USA. Available from: NatureServe Explorer

Pyke, C.R., Thomas, R., Porter, R.D., Hellmann, J.J., Dukes, J.S., Lodge, D.M., and Chavarria, G. 2008. Current practices and future opportunities for policy on climate change and invasive species. Conserv. Biol. 22(3): 585–592. Doi:10.1111/j.1523-1739.2008. 00956.x. PMID:18577088.

Smith, A.L., Hewitt, N., Klenk, N., Bazely, D.R., Yan, N., Wood, S., Henriques, I., MacLellan, J.I., Lipsig-Mummé, C., 2012. Effects of climate change on the distribution of invasive alien species in Canada: a knowledge synthesis of range change projections in a warming world. Environ. Rev. 20, 1–16.
Available from: Effects of climate change on the distribution of invasive alien species in Canada: a knowledge synthesis of range change projections in a warming world (cdnsciencepub.com)

Walther, G.-R., Roques, A., Hulme, P.E., Sykes, M.T., Pyšek, P., Kühn, I., Zobel, M., Bacher, S., Botta-Dukát, Z., Bugmann, H.,Czúcz, B., Dauber, J., Hickler, T., Jarošik, B., Kenis, M., Klotz, S.,Minchin, D., Moora, M., Nentwig, W., Ott, J., Panov, V.E.,Reineking, B., Robinet, C., Semenchenko, V., Solarz, W., Thuiller, W., Vilà, M., Vohland, K., and Settele, J. 2009. Alien species in a warmer world: risks and opportunities. Trends Ecol. Evol. 24(12): 686–693. Doi:10.1016/j. tree.2009.06.008. PMID:19712994.

Yukon Invasive Species Council (YISC). 2022. Yukon Invasive Species Council.
Available from: Yukon Invasive Species Council – Home.

20. Species Management Plans

Significance

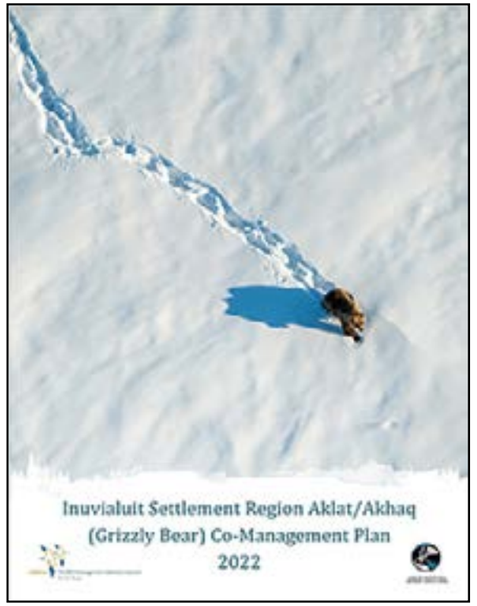
Species management plans are in place for six species. They are the Aishihik wood bison (2012), Chisana caribou (2012), elk (2016), wolf (2012), amphibians (2013) and grizzly bear, which are managed jointly by the *Inuvialuit Settlement Region Aklat/Akhaq (Grizzly Bear) Co-Management Plan*, and the *Yukon Government's 2019 conservation plan for grizzly bears in Yukon*.

The Government of Yukon is currently working with other governments and partners on updating three of those plans; 1) the grizzly bear management plan in the Inuvialuit Settlement Region, 2) Management plan for the Chisana caribou herd and 3) A conservation and action plan for the Aishihik bison population.

What is happening?

Grizzly bear management in the Inuvialuit Settlement Region

- In 2022, the Wildlife Management Advisory Council (North Slope) and the Wildlife Management Advisory Council (Northwest Territories) completed and updated the Inuvialuit Settlement Region Aklat/Akhaq (Grizzly Bear) Co-Management Plan.
- This updated plan is rooted in the community's knowledge and values, and it acknowledges existing and evolving relationships between the aklat/akhaq (grizzly bear) and the Inuvialuit.
- The updated plan also reflects changes in the environment experienced in the north due to a changing climate.



The Inuvialuit Settlement Region Aklat/Akhaq (Grizzly Bear) Co-Management Plan.

Chisana caribou (Ryan Drummond, 2017).

Management plan for the Chisana caribou herd

- The Chisana caribou herd is a small international herd that ranges between the Yukon and Alaska. The Government of Yukon, Kluane First Nation, White River First Nation, Environment and Climate Change Canada and the Yukon Fish and Wildlife Management Board are working with United States partners – Alaska Department of Fish and Game, United States Fish and Wildlife Service, and the National Park Service – to update the Management Plan for the Chisana Caribou Herd 2010-2015.
- The Yukon and Alaskan partners collaborate on Chisana caribou management and monitoring, including annual fall composition surveys that evaluate age and sex ratios, radio and satellite collar tracking to monitor distribution, movement, and survival, and population surveys to estimate the herd size.
- The latest population survey occurred in October 2022.
- The partners commit to collaboratively managing the herd sustainably and updating the management plan with current information.

A conservation and action plan for the Aishihik bison (Bison bison athabascae) population

- Since bison were re-established in the Yukon in the 1970's, the herd has grown and human relationships with bison have evolved[3].
- The Aishihik Bison Technical Team, which includes all governments and organizations with a role in bison management, have collaboratively drafted a new management plan for the Aishihik wood bison herd in southwestern Yukon.

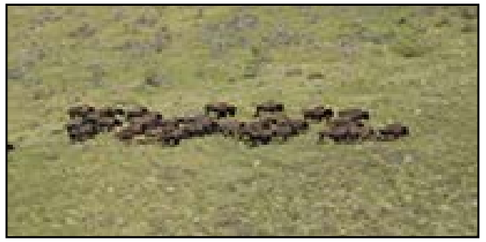
[3] BIson were extirpated (made locally extinct) from the Yukon 13,000 years ago, but were reintroduced in the 1970s

Bison Workshop

- This draft plan, once approved, will be the fourth management plan for the Aishihik bison population in southwestern Yukon. Previous plans came into effect in 1980, 1998, and 2012, each replacing the former as overall management direction for the population.
- The draft plan will modernize the management goals for the Aishihik bison population by ensuring that the associated outcomes reflect the aspirations of Yukoners. It will also align local management with national and international bison conservation efforts.

Data quality

- The process of developing a management plan includes seeking views from the public, and all completed plans are publicly available.
- Local and Yukon First Nations and Indigenous knowledge are included in the management plans. In most cases Yukon First Nation or Indigenous governments are partners in the development of the plans.
- Alaska and Yukon biologists collaborate to collect Chisana caribou data. The Government of Yukon publishes technical reports for the herd here: Woodland Caribou | Government of Yukon.
- The Government of Yukon publishes data about the Aishihik bison herd in technical reports here: Wood Bison | Government of Yukon.



Bison in the Aishihik Lake area region

Yukon First Nations and Indigenous Ways of Knowing, Doing and Being

The Inuvialuit Settlement Region Aklat/Akhaq (Grizzly Bear) Co-Management Plan is rooted in community knowledge and values. It acknowledges existing and evolving relationships between the aklat/akhaq (grizzly bear) and the Inuvialuit.

All species plans have provisions to include and uphold Yukon First Nations and Indigenous ways of knowing, doing and being alongside science-based understanding, data and knowledge. People involved in creating these plans are constantly learning better ways to express this intention and to demonstrate it through practice. First Nation governments have drafted the management plans for Chisana caribou and Aishihik bison.

Additional information

View the species management plans for specific action items on species here.
Wildlife and habitat planning | Government of Yukon.

References

Chisana Caribou Herd Working Group. 2012. Management Plan for the Chisana Caribou Herd: 2010-2015. Government of Yukon, Whitehorse, Yukon, Canada.
Available from: https://yukon.ca/en/management-plan-chisana-caribou-herd

Akłaq (Grizzly Bear) – Wildlife Management Advisory Council (North Slope).
Available from: Akłaq (Grizzly Bear) – Wildlife Management Advisory Council (North Slope) (wmacns.ca)

Grizzly bears (Government of Yukon, 2007)

Caribou herd in the summer.

21. Caribou Population and Distribution

Significance

- Caribou are important ecologically and culturally. Many people in the Yukon rely on caribou for subsistence and spiritual well-being. Conserving and protecting key caribou habitats (i.e., rutting areas, migration corridors and winter range) are important for herd health and abundance.
- Caribou herds that transect different jurisdictional boundaries require a coordinated approach to their management. For example, the Porcupine caribou herd has a range that covers the Yukon, Alaska, and the Northwest Territories.
- Porcupine caribou range widely across the northern half of the Yukon and rely on specific habitat requirements through all seasons. Alterations in habitat due to climate change are likely affecting many aspects of their ecology.

What is happening?

Migratory Caribou – Porcupine herd

- Detailed monitoring for the porcupine caribou herd is completed by the Government of Yukon and partners and is reported through the Porcupine Caribou Management Board, including detailed reporting at their Annual Harvest Meeting.
- Recent community reports indicate that the condition of cow caribou in late fall during and post-rut is poor, possibly explaining the low pregnancy rates observed on the calving grounds. However, those same reports indicate cow caribou increasing their condition over winter, which may help explain why calves that are born appear to be in good condition and survive the first month at high rates.
- Adult survival continues to be strong, accounting for positive trends in the population abundance reported above.
- Herd movements have changed considerably over the last decade, and these changes continue to be documented in 2022. Changes in movement may result from altered habitats due to climate change (e.g., increasing shrubs, loss of lichen forage to fire), changes to forage caused by herd size and grazing/trampling pressures, or a combination of both.

Recovering a drop-off video camera collar from the Yukon North Slope (Government of Yukon, 2022).

Taking action

General

- The Government of Yukon monitors several caribou herds yearly to assess overall status and trends. In 2022, the Government of Yukon conducted and collaborated on seven population surveys (Boreal caribou density estimate, Fortymile photo census, Finlayson late winter population survey, and fall mark re-sight surveys for the Chisana, Coal River, Little Rancheria, and Wolf Lake herds).
- Monitoring also occurred on demographic trends for adult sex ratios and calf recruitment in a number of herds without a formal population survey, including the Aishihik, Ethel Lake, Hart River, and Tatchun herds.
- The Government of Yukon also deploys GPS satellite collars on several herds to monitor habitat use, movement, survival, calving timing and location, etc. Herds with active collar monitoring programs include Aishihik, Boreal, Carcross, Chisana, Coal River, Fortymile, Hart River, Ibex, Laberge, Little Rancheria, Porcupine, Tay River, and Wolf Lake. Data owned by Alaskan partners on shared herds (e.g., Chisana, Fortymile, Nelchina, and Porcupine) are also shared with the Yukon.
- Assessing and managing cumulative effects on caribou, caused by the combined effects of historical, current, and potential future anthropogenic activities and natural processes on the land base, are crucial to support informed decision-making in natural resource management in the Yukon.
- In 2022, the Government of Yukon began a multi-year project to develop a tool to assess and inform the management of cumulative effects across the Yukon for Northern Mountain caribou.

Migratory Caribou – Porcupine herd

Porcupine caribou gather in the foothills of the Arctic National Wildlife Refuge to avoid insect harassment (Government of Yukon and United States Geological Survey Photo, 2021).

- The Government of Yukon leads or supports several research and monitoring initiatives and continues to participate in managing the herd in collaboration with the Parties of the Porcupine Caribou Management Agreement.
- The collaboration is the Porcupine Caribou Knowledge Hub and focuses on incorporating Yukon First Nations and Indigenous ways of knowing, doing and being and scientific knowledge to understand these changes.
- Efforts continue to ensure critical habitats such as the calving and post-calving grounds of the herd remain protected from oil and gas activities in the Arctic National Wildlife Refuge. Recent published science by researchers, including the Government of Yukon staff, reveals that climate change will increase the reliance of the herd on the Arctic National Wildlife Refuge.

Migratory Caribou – Fortymile and Nelchina herd

- The Government of Yukon is currently completing analyses with several universities and partners in Alaska to better understand habitat requirements and linkages to the Fortymile caribou herd's population size.
- Significant monitoring is also occurring to better understand trends and potential causes of changes in the herd's population, including caribou survival, calves born, and population size. A new population estimate of approximately 38,000 caribou was obtained recently based on photos taken of the herd in the Yukon in July 2022. This is a dramatic decline from the recent population high of 83,000 obtained in 2017.
- Although the Nelchina herd's time in the Yukon is limited to sporadic wintering, the Government of Yukon assists with monitoring the distribution and survival of the herd in partnership with Alaska. Alaska estimated this herd had declined to below 20,000 caribou in July 2022, less than half the population just five years prior.

Caribou crossing the Dempster Highway (Government of Yukon)

Data quality

General

- Caribou herd population status (size and trend) is typically determined through aerial surveys, which estimate herd size and composition (i.e., adult sex ratios and the number of calves produced each year).
- The Government of Yukon has introduced a mark re-sight approach over the past few years using aerial surveys in combination with satellite-collared animals to monitor Northern Mountain caribou herds. This approach has increased the precision of population estimates and provide additional information on seasonal ranges and habitat use.
- The Government of Yukon regularly deploys satellite collars on caribou throughout the Yukon. Satellite collar technology continues to improve, allowing for lighter collars with timed drop-off mechanisms to ensure animal welfare and providing more caribou locations to better evaluate movement, survival, fine-scale interactions with habitat and disturbance features, and more.

Migratory Caribou – Porcupine herd

- The Government of Yukon maintains an active satellite GPS collar program on the Porcupine Caribou Herd to collect most of the scientific data and continues to be the lead on this initiative.
- Several partners in the Yukon, Alaska, and the Northwest Territories collect data, including information provided by community members.
- The Porcupine Caribou Technical Committee summarizes the monitoring data and reports on it annually.
- Some data is collected annually, when possible (e.g., survival and calving data) while other data is collected when conditions allow (e.g., population estimate), or on a relatively regular but multi-year schedule (e.g., lichen cover).

Yukon First Nations and Indigenous Ways of Knowing, Doing and Being.

Migratory Caribou – Porcupine herd

- The Porcupine Caribou Management Board includes membership from active harvesters and community members who are Knowledge Keepers. The Board also invites knowledge submissions and actively collaborates with communities to bring their knowledge to the forefront of their work, which helps to direct the work of the Government of Yukon. Currently, the Board is working with several Yukon First Nations and transboundary Indigenous governments and groups on an Indigenous knowledge study to bring this wisdom to the forefront of its developing Conservation Plan and to assist in the ongoing stewardship of the herd.

The Southern Lakes Caribou Coordinating Committee

- **The Southern Lakes Caribou Coordinating Committee**, which comprises nine governments[4], is working together to develop a Relationship Plan for Southern Lakes caribou. This plan incorporates Yukon First Nations and Indigenous ways of knowing, doing and being, and Western science approaches to determine conservation and management priorities for the Southern Lakes Caribou Relationship Plan.

[4] Carcross/Tagish First Nation, Kwanlin Dün First Nation, Ta'an Kwäch'än Council, Teslin Tlingit Council, Champagne and Aishihik First Nations, Taku River Tlingit First Nation, Government of Yukon, Government of British Columbia, and Government of Canada

Figure 1: Southern Lakes Caribou Relationship Plan Seasonal Round (Southern Lakes Caribou Steering Committee, 2022).

The plan's framework is seasonal round, reflecting how our relationship with caribou changes with the seasons. There are five circles: 1) spirit and caribou; 2) share, care and respect; 3) the caribou story; 4) our responsibilities to the caribou; and 5) our human actions.

Finlayson caribou during the March 2022 population survey (Ryan Benson, 2022)

Profile

The Porcupine Caribou Knowledge Hub is actively working to understand the ecology and implications of a changing climate in northern Yukon on the porcupine caribou herd, its habitat and the people that depend on it. Research is bringing together science and Yukon First Nations and Indigenous ways of knowing, doing and being to understand changes in vegetation/habitat, impacts of invading boreal species like moose, the resulting changes in established species like wolves, and how these impact the herd. The Hub is relatively new, and work has gotten underway in the past year.

"*Ensuring appropriate strategies are available to adapt subsistence activities in the face of potentially dramatic changes to this landscape is critical in ensuring the long-term well-being of communities in the region. The direct integration of communities, agencies, academia, and co-management organizations will help ensure that local monitoring and observation plays a key role in the hub during this project and moving forward.*" Quoted from the Hub's Focus and Goals.

References

Porcupine Caribou Technical Committee. 2022. Porcupine Caribou Annual Summary Report 2021-2022. Available from: the Porcupine Caribou Management Board

Severson, J.P., H.E. Johnson, S.M. Arthur, W.B. Leacock, M.J. Suitor. 2021. Spring phenology drives range shifts in a migratory Arctic ungulate with key implications for the future. Global Change Biology, 27:4546-4563. Available from: Spring phenology drives range shifts in a migratory Arctic ungulate with key implications for the future – Severson – 2021 – Global Change Biology – Wiley Online Library.

Porcupine Caribou Knowledge Hub. 2023. Available from: https://www.canadianmountainnetwork.ca/research/knowledge-hubs/ecological-change-andlivelihoods- in-the-porcupine-caribou-summer-range

The Porcupine Caribou Technical Committee. 2023. Available from: Canada-United States agreement on porcupine caribou herd conservation – Canada.ca

22. Mercury in Porcupine Caribou

Significance

- Contaminants such as heavy metals can persist in the environment and have serious health implications for wildlife and people, especially those who depend on traditional foods.
- In Canada, mercury is a risk to ecosystems and human health (Environment and Climate Change Canada 2016).
- Wind and water transport many contaminants to the North, where they settle in colder climates without ever being used in the region.
- Contaminants persist in northern ecosystems despite being banned or restricted for many years.
- Caribou feed on lichens that can directly absorb airborne contaminants such as mercury.
- The annual changes in mercury on the Porcupine caribou likely reflect differences in atmospheric mercury levels as well as changes in the environment (e.g., temperature, precipitation and wind) that affect how mercury moves from the air to caribou.

What is happening?

Samples were collected from 20 Porcupine caribou in 2022. Mercury concentrations in the liver are generally lower than in the kidneys, averaging 0.35 µg/g dry weight in the liver as compared with 1.61 µg/g dry weight in the kidneys. Mercury does not tend to accumulate in muscle tissue (the average is 0.04 µg/g dry weight in muscle tissue). While mercury levels fluctuate over time in caribou organs, over the long term, they have remained stable in the Porcupine caribou herd.

Yukon Health Advisories

Meat (muscle) from Yukon caribou is a healthy food choice, as heavy metals are present in extremely low concentrations. Consumption of kidney and liver meat from Yukon caribou should be restricted depending on the herd (e.g., a maximum of 25 kidneys or 12 livers from the Porcupine herd per person per year).

Porcupine caribou hunting in Old Crow (Peter Mather, 2016)

Taking action

Mercury has been measured in the Porcupine caribou since 1990 and continues to be monitored under the Northern Contaminant Program's Contaminants in Arctic Caribou Project. This project aims to determine if these populations remain healthy (in terms of contaminant loads) and whether they remain a safe and nutritious food choice for northerners.

The Arctic Monitoring and Assessment Program Report 'Mercury in the Arctic' (2021) is an assessment of mercury contamination in the Arctic. Mercury remains an environmental and human health issue due to the continued risk of elevated exposure in wildlife and in humans. The assessment addresses the Arctic mercury cycle, including its transport, biogeochemical processing, bioaccumulation in food webs, and effects on wildlife and humans, with relevant implications for policymakers as well as current trends in the Arctic environment.

Data quality

Hunters in Old Crow usually collect samples in the fall, which are analyzed under the Contaminants in Arctic Caribou Project. The sex of the animal, as well as the season of collection, can affect mercury concentrations. Annual variation in mercury concentrations is common.

Yukon First Nations and Indigenous Ways of Knowing, Doing and Being.

Robert Bruce, Vuntut Gwitchin First Nation Elder, remembered his elders telling him that in the future, the world would warm up and the caribou would not thrive; they would be sick. He thought that maybe that could have something to do with contaminants like mercury. He said that with climate change, the winds change and that the caribou always move into the wind. If the wind changes, he said it could alter their migration patterns and that it might affect their exposure to contaminants. (Interview completed on February 1, 2023).

Porcupine caribou cow and calf (Peter Mather, 2016).

Profile

The data on mercury in Porcupine caribou were part of a dataset submitted by the Northern Contaminants Program to the United Nations Environmental Programme. The data supports the Minamata Convention, a global treaty to protect human health and the environment from the adverse effects of mercury. Signatories to the Convention work towards controlling the amount of mercury released into the environment. The Convention came into force on August 16, 2017, and, as of April 2023, has been ratified by 128 countries, including Canada. For information on their work, go to: mercuryconvention.org.

References

AMAP, 2021. AMAP Assessment 2021: Mercury in the Arctic. Arctic Monitoring and Assessment Programme (AMAP), Tromsø, Norway. pp 324. Available from: AMAP Assessment 2021: Mercury in the Arctic | AMAP

Environment and Climate Change Canada. 2016. Canadian Mercury Science Assessment [modified 2017 June 12, cited 2019 Nov 29]. Available from: Canadian mercury science assessment: summary of key results – Canada.ca

United Nations Environmental Programme (UNEP). 2021. Minamata Convention on Mercury [cited 2023 Feb 1]. Available from: Homepage | Minamata Convention on Mercury (mercuryconvention.org)

St. Elias Glaciers (Government of Yukon, 2011)

23. Density of Snowshoe Hare

Significance

Snowshoe hare (*Lepus americanus*) is a keystone species in the boreal forest, meaning that their abundance drives the abundance of a host of predators that eat them, especially Canada lynx (*Lynx canadensis*) but also other furbearers and birds of prey (Figure 1). Snowshoe hare are also an important small game species used as food by Yukon First Nations and licensed hunters.

Changes in the abundance of snowshoe hare affect predation pressure and population dynamics of other prey species in the food web, with species affected as diverse as red squirrels (*Tamiasciurus hudsonicus*) and thinhorn sheep (*ovis dalli*). Snowshoe hare are the fuel that drives the boreal forest food web.

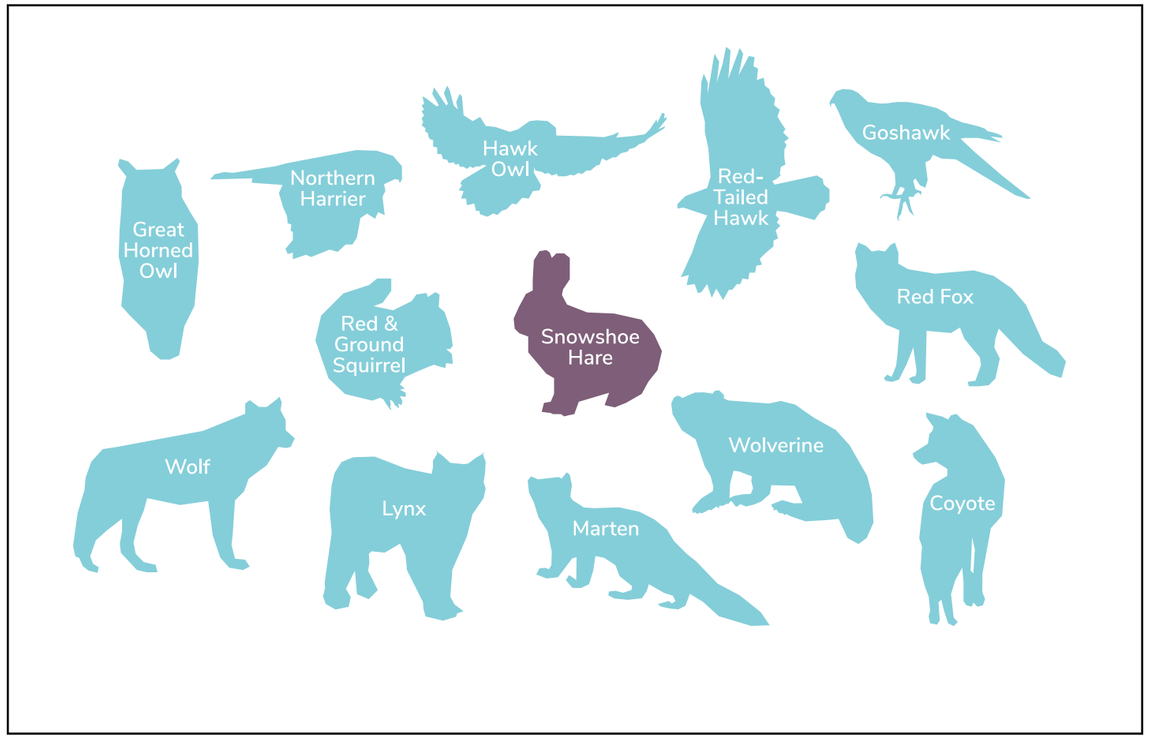


Figure 1: Some predators of snowshoe hare, including red and ground squirrels who can prey on snowshoe hare leverets.

Photo 1: Snowshoe hare summer coat colour

Because their coat changes colour from brown to white and back again with the seasons (Photos 1 and 2), changes in the duration of snow resulting from climate change may directly impact the survival of individual hares because they lose their camouflage from predators. As such, snowshoe hare are a key indicator of climate change impacts on the boreal forest food web. New predators to the Yukon's boreal forest, such as coyotes (*Canis latrans*), may place additional pressure on snowshoe hare populations.

Photo 2: Snowshoe Hare winter coat colour (jooinn.com, 2023).

What is happening?

The Yukon's boreal forest is changing because of climate change and other stressors. Changes in the duration and depth of snow, increases in shrubs, and more frequent and severe fires affect wildlife habitat and abundance. These changes are affecting both snowshoe hares and their cycles. Long-term monitoring data indicate that hare cycles in the Yukon do not oscillate as much as they did in the 1970s and 1980s; the highs are no longer as high as they once were. The reasons for this change are unknown. Monitoring results show that snowshoe hare cycles are synchronous across the Yukon, meaning that population highs and lows occur simultaneously, which has impacts for the boreal food web by affecting both predator and prey species. These impacts may affect food security and rural livelihoods, such as trapping of furbearers.

Densities of snowshoe hare in the Yukon last peaked in 2017, and the population is now starting its recovery from a cyclic low (Figure 2). This means that hare, their predators and other species in the food web, will become more plentiful in the next few years. It is expected that the peak will occur in 2026, but how high hare densities will get is unknown.

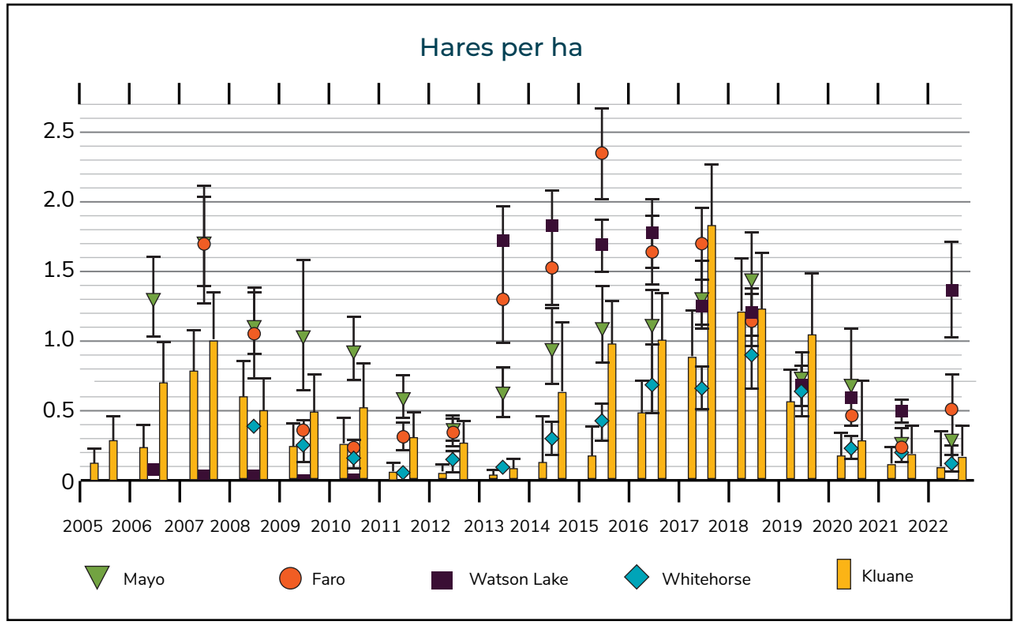


Figure 2: Density of snowshoe hare at five Community Ecological Monitoring Program monitoring sites.

Taking action

The Community Ecological Monitoring Program has been observing snowshoe hare density at sites in different regions of the Yukon, including near Haines Junction, Whitehorse, Mayo, Faro and Watson Lake, since 2005. Monitoring hare numbers is important as it provides a continuous record of changes in their abundance over time. Long-term data on their abundance can provide information on the fluctuations in abundance of their primary predators. Moreover, long-term monitoring efforts can inform how climate change affects this keystone species and, consequently, how those changes may affect people and ecosystems. The Community Ecological Monitoring Program is conducted by a partnership of the Yukon government biologists and biologists from several Canadian universities.

The Community Ecological Monitoring Program also monitors other components of the boreal food web, including berries, mushrooms, spruce cones, small mammals (mice and voles) and hare predators. The Community Ecological Monitoring Program aims to monitor the key ecological constituents of the boreal food web. For instance, lynx are the main predator of snowshoe hare, and their numbers have been in decline since 2018, as their populations appear inextricably linked to the hare population. In the absence of hare, movements of lynx increase as they search for food. Monitoring of lynx abundance occurs through winter track counts.

The Community Ecological Monitoring Program produces an annual report on the trends in snowshoe hare density and other monitored components. Furthermore, scientists publish peer-reviewed scientific articles each year that detail new findings aiding in the interpretation of Community Ecological Monitoring Program data.

Data quality

A strength of the Community Ecological Monitoring Program is that the data collection protocols are both simple and standardized so that they are repeatable over years and locations. While simple, protocols for estimating the density of snowshoe hare in the Yukon have been rigorously assessed and peer-reviewed. In the Kluane region, the Community Ecological Monitoring Program estimates the density of Snowshoe Hares by live trapping, marking and releasing individuals. These data extend from 1973 to the present, representing one of the world's longest continuous time series of wildlife monitoring data.

Data from the other Community Ecological Monitoring Program sites in the Yukon are available from 2005 onwards (Figure 2). At these sites, hare are not live trapped; rather, fecal pellets are counted yearly and used to mathematically derive an estimate of hare density. Standardized data from both live trapping and pellet counts done by the Community Ecological Monitoring Program allow for comparisons in the density of hare across the Yukon and with those in the Northwest Territories, Alaska and elsewhere.

Primrose Lake

Profile

Remotely tracking the boreal food web

Climate change is altering the boreal food web and the methods by which we monitor it. Decreases in snowfall events in the last decade have made counting tracks in the snow difficult in some years. In partnership with Dän Keyi Renewable Resource Council and Kluane First Nation, Community Ecological Monitoring Program partners have been conducting trials using camera traps to monitor much of the boreal food web at Kluane Lake as means of reducing the need to use snow tracking and some other traditional monitoring methods. Seven years of camera trapping data have been collected and analyzed, amounting to over 900,000 photos.

Additionally, over the past three years, Community Ecological Monitoring Program partners have also been using acoustic recording units to track populations of snowshoe hare predators such as great horned owls (*Bubo virginianus*) and goshawks (*Accipiter gentilis*) and some birds, including alternate prey species such as spruce grouse (*Falcipennis canadensis*).

References

Gobin, J., T.J. Hossie, R.E. Derbyshire, S. Sonnega, T.W. Cambridge, L. Scholl, N.D. Kloch, A. Scully, K. Thalen, G. Smith, C. Scott, F. Quinby, J. Reynolds, H.A. Miller, H. Faithfull, O. Lucas, C. Dennison, J. McDonald, S. Boutin, M. O'Donoghue, C.J. Krebs, R. Boonstra and D.L. Murray. 2022. Functional responses shape node and network level properties of a simplified boreal food web. Frontiers in Ecology and Evolution 10:898805. doi:10.3389/fevo.2022.898805
Available from: https://www.frontiersin.org/articles/10.3389/fevo.2022.898805/full

Jung, T.S., P.M. Kukka, R.F. Florkiewicz. 2021. Results of a Yukon small game hunter effort survey. Yukon Fish and Wildlife Branch Report SR-21-01, Whitehorse, Yukon, Canada Available from: https://open.yukon.ca/information/publications/plans-and-reportshunting/ resource/7f71652f-14dd-4c3e-9b49-ef53b49e4c80

Kennah J.L., M.J.L. Peers, E Vander Wal, Y.N. Majchrzak, A.K. Menzies, E.K. Studd, R. Boonstra, M. Humphries, T.S. Jung, A.J. Kenney, C.J. Krebs, D.L. Murray, and S. Boutin. 2023. Coat colour mismatch improves survival of a keystone boreal herbivore: energetic advantages exceed lost camouflage. Ecology 104:e3882.
Available from: https://doi.org/10.1002/ecy.388

Krebs, C.J., T.S. Jung, M. O'Donoghue, S. Gilbert, S. Taylor, R. Drummond, T. Morgan, A. Beatty, P. Kukka, R. Boonstra, S. Boutin, and A.J. Kenney. 2023. The community ecological monitoring program annual data report 2022. Unpublished report available at: https://www.zoology.ubc.ca/~krebs/downloads/2022_cemp_annual_report.pdf

Majchrzak, Y.N, M.J.L. Peers, E.K. Studd, A.K. Menzies, P. Walker, S. Shiratsuru, L. McCaw, R. Boonstra, M. Humphries, T.S. Jung, A.J. Kenney, C.J. Krebs, D.L. Murray, and S. Boutin. 2022. Balancing food acquisition and predation risk drives demographic changes during hare population cycle. Ecology Letters 25:981-991.
Available from: https://doi.org/10.1111/ele.13975

O'Donoghue, M., B.G. Slough, K. Poole, S. Boutin, E.J. Hofer, G. Mowat, D. Murray and C.J. Krebs. 2022. Snow track counts for density estimation of mammalian predators in the boreal forest. Wildlife Research 50 (in press): doi: 10.1071/WR221159 Oli, M.K., A.J. Kenney, R. Boonstra, S. Boutin, D.L. Murray, M.J.L. Peers, B.S. Gilbert, T.S. Jung, V. Chaudhary, J.E. Hines and C.J. Krebs. 2022. Does coat colour influence survival? A test in cyclic populations of snowshoe hares. Proceedings of the Royal Society B 290:20221421.
Available from: https://doi.org/10.1098/rspb.2022.1421

Peers, M.J.L., Majchrzak, Y.N., Menzies, A.K., Studd, E.K., G. Bastille-Rousseau, R. Boonstra, M. Humphries, T. S. Jung, A, J. Kenney, C. J. Krebs, D.L. Murray and S. Boutin. 2020. Climate change increases predation risk for a keystone species. Nature Climate Change 10:1149-1153. Available from: https://doi.org/10.1038/s41558-020-00908-4

Winter Snowshoe Hare search for free downloads Available from: https://jooinn.com/images/snowshoe-hare-4.jpg

24. Winter tick surveillance

Significance

Winter ticks (*Dermacentor albipictus*) are one-host external parasites that can be found on cervids such as elk, mule deer and moose in the Yukon. These parasites can negatively affect host health when present in large numbers. Moose are especially vulnerable because they do not groom off larval stages of ticks. In some regions of Canada, winter ticks can be responsible for severe disease and mortality in moose.

To date, data suggests that winter ticks are not a major disease concern for Yukon cervids. By studying the distribution and occurrence of winter ticks in the Yukon, the Government of Yukon is monitoring how these parasites may affect the Yukon's wild cervid populations and how their geographical distribution may change over time. This is especially important for species such as moose, which are a key harvest species in Yukon. Winter ticks do not carry diseases of concern to humans or wildlife, nor do they negatively affect the meat of harvested animals. Winter ticks rarely feed on people or domestic animals.

A changing climate may be an important factor in the tick-cervid relationship. Warmer temperatures in summer and milder, wetter winters and springs may support larger populations of cervids that carry ticks and allow larval ticks to survive longer in the environment. Seasonal changes may also influence vegetation patterns and cervid host habitat use, thereby influencing the distribution and presence of wildlife parasites like winter ticks.

What is happening?

Winter ticks affect different species in different ways.

- In early autumn, elk and deer groom off larval ticks, which reduces tick numbers and minimizes negative health impacts.
- Moose only begin to groom off ticks once adult ticks are present (late winter), which can lead to high numbers of ticks on individual moose.
- Moose can experience severe disease associated with blood and hair loss from heavy tick burdens.
- Since 2011, the Animal Health Unit has examined cervid hides to monitor winter tick geographical presence over time and presence in different cervid species.
- Winter ticks are established on elk in Yukon. Winter ticks likely originated in Yukon from translocation of elk from central Alberta, and/or by range expansion of cervids from northern BC and Alberta (Leo et al. 2014).
- Winter ticks have been found on cervids in 17 out of the 37 Game Management Zones 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 continues to monitor for winter ticks through assessment of cervid hides. Elk and deer hides are a mandatory harvest submission, while caribou and moose hides are submitted voluntarily.

To date, most of the hides examined have been from the Southern Yukon, which has provided baseline data on winter ticks in this region. Hunters from all over the Yukon are encouraged to contact the Department of Environment to submit cervid hides for examination.

Hides are examined for the presence of winter ticks by visually counting nymphs and adults. Larvae are very small and difficult to detect with the naked eye.

In 2018 and 2019, a new method of vacuuming hides was also used to collect larvae. This method is more effective for detecting larvae on hides, which provides information on the timing of larval presence on host species.

Detecting winter ticks in the field

Since 2017, the Government of Yukon's Animal Health Unit has collaborated with the University of Toronto to better understand the geographical distribution of winter ticks in the Yukon. Using a combination of field work and mathematical modeling, the objectives of this project were to:

1. determine the current winter tick distribution in the Yukon and predict potential changes;
2. better understand the survival of winter ticks in changing environmental conditions; and
3. understand the current and ongoing risks winter ticks may pose to the health of Yukon cervids.

During the first field season, larval winter ticks were found on vegetation for the first time in the Yukon. Throughout consecutive field seasons, larval ticks were repeatedly detected near high-use game trails on south-facing slopes within the Takhini and Braeburn elk herd ranges. (Chenery et al. 2020)

To better understand when larvae are active in the environment, field technicians search for larval ticks during the summer season and into late fall and early winter. Larvae were found throughout the fall season and remained active even when the ambient temperatures were below freezing. To monitor host animal movements and assess winter tick induced hair loss, a set of wildlife cameras were installed at known sites of larval tick activity and in other areas frequently used by cervids.

References

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.

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.

25. Sustainability of Lake Trout fisheries

Significance

- Lake trout (*Salvelinus namaycush*) are one of the Yukon's top freshwater predators and a highly valued species for Yukon's subsistence and recreational fisheries.
- Monitoring the status of lake trout populations is significant to understanding the overall health of the Yukon's freshwater systems.
- This is in part due to requirements of the lake trout's life cycle and unique ecology, including:
  - its need for a cold, well-oxygenated and clean habitat,
  - availability of prey fish,
  - its slow growth rate, and its long lifespan.
- Changes observed in the status of a lake trout population may indicate the Yukon's freshwater systems are susceptible to over-harvest or are undergoing changes related to climate or habitat.

What is happening?

- During the summer of 2022, the Fish and Wildlife Branch assessed the status of lake trout populations at four lakes.
- The Fish and Wildlife Branch assessed Little Fox Lakes and Lewes Lake to gather more information on the status of the Yukon's small-bodied lake trout populations. The Branch assessed Twin Lakes to monitor its recovering population, and Ethel Lake to detect any change in the population within this popular angling lake.
- In addition to these sampling events, the Fish and Wildlife Branch continued to update and publish the yearly Lake Trout Monitoring Program Update, encompassing assessment results from 2010 thorough 2021 (Government of Yukon, 2023).

Kwanlin Dün First Nation Land Steward Officer Bruce Wilson, assisting Fish and Wildlife staff with a lake trout population assessment on Little Fox Lake (Cameron Sinclair, 2022).

Taking action

In 2022, the Fish and Wildlife Branch developed a ten-year strategic adaptive monitoring plan to assess lake trout populations across the Yukon (Sinclair and Savage, 2023). This plan helps build on long-term population trends, while addressing populations of concern, climate change, and the sustainability of our lake trout populations.

Haines Junction community members assisting with a spring lake trout capture event, to aid in providing data for this population's recovery plan (Cameron Sinclair, 2022).

The Fish and Wildlife Branch continues to work with Renewable Resource Councils and Yukon First Nations in the development of long-term lake trout recovery plans for Pine Lake, Snafu Lake, Tarfu Lake, Twin Lakes and Frenchman Lake. These plans include developing interpretive signage, monitoring and on-the-land education.

Data quality

- The Fish and Wildlife Branch collects the data sets from multi-day Spring Profundal Index Netting programs[5] and interviews with recreational anglers, who have indicated support for this program.
- The Fish and Wildlife Branch has employed these methods since 2010, allowing direct comparison of methods and status, as we build long term trends regarding both population status and recreational angling pressure.

Lake trout mark-recapture study using spaghetti tags also known as Floy tags

Yukon First Nations and Indigenous Ways of Knowing, Doing and Being.

The Fish and Wildlife Branch, Yukon First Nations, and transboundary Indigenous governments and groups work closely when assessing lake trout populations. Incorporating Yukon First Nations and Indigenous ways of knowing, doing and being is a key component when trying to understand current Yukon assessments of traditional population patterns.

[5] An adaptable methodology used to assess small and large bodied lake trout population in a wide range of lake sizes.

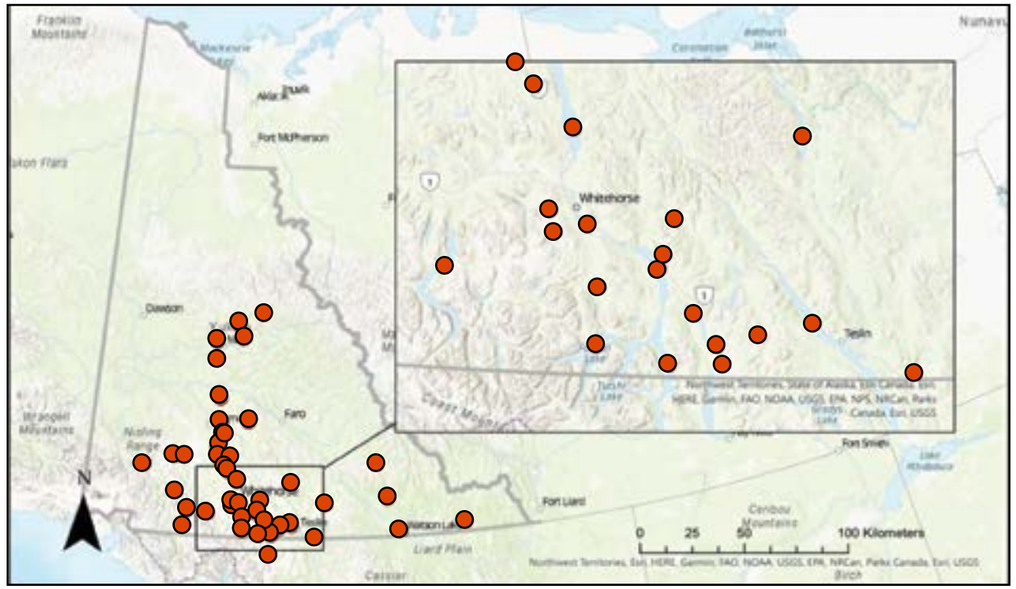


Figure 1: Locations of all lake trout population assessments conducted by the Fish and Wildlife Branch, since 2010 (Fish and Wildlife Branch, 2023).

Profile

Pine Lake Recovery

The lake trout population within Pine Lake is currently in a state of recovery. Assessments previously noted that this population was near collapse, which led to the 2015 regulation prohibiting recreational harvest. Recovering a lake trout population takes time. This slow-growing, long-lived freshwater fish only reaches age-at-maturity between eight and 13 years. Before removing restrictions, a recovering population needs several successful and protected spawning periods. A small population needs time for the next generation to grow and spawn.

Recently the Fish and Wildlife Branch has been collaborating with the Alsek Renewable Resource Council and the community of Haines Junction to help collect more information on the status of Pine Lake's recovering population. This information, combined with population surveys, will help better understand this population's status and determine when it has recovered enough to support a sustainable recreational fishery.

References

Government of Yukon. 2023. Lake Trout Monitoring Program: 2021 Update. Yukon Fish and Wildlife Branch Report SR-23-01, Whitehorse, Yukon, Canada. Sinclair, C.L., and P. Savage. 2023. Lake Trout Monitoring Program: 10-year adaptive monitoring strategy (2023-2032), MR-23-01. Government of Yukon, Whitehorse, Yukon, Canada, Destruction

Destruction Bay Kluane Lake

26. Number of spawning Chinook salmon

Significance

Yukon Chinook salmon:

- are among the longest running migrating salmon in the world,
- are a valuable 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 and Indigenous 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.

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 U.S. 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 achievement of this target occurs, mainly through a border assessment project located in Eagle, Alaska that is operated in partnership with the Alaska Department of Fish and Game.

Measuring pre-spawn female chum salmon from Porcupine River just downstream from Old Crow (Madeleine Czechowski, Department of Fisheries and Oceans, September 2022).

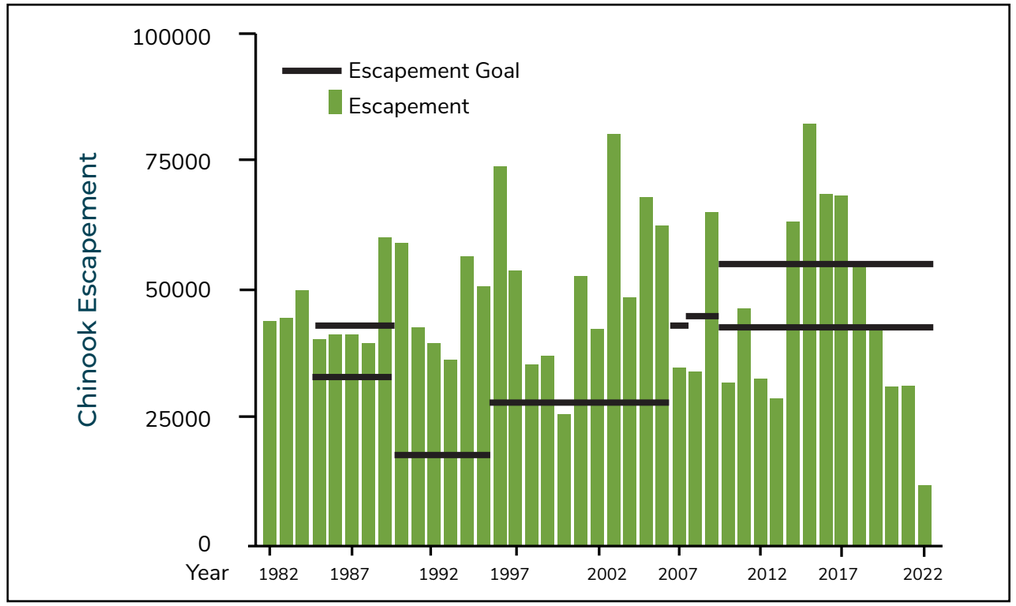


Figure 1: Number of Chinook salmon spawning in the Canadian portion of the Yukon River, excluding the Porcupine River drainage, from 1982-2022.

What is happening?

- In 2022, an estimated 12,000 Chinook salmon reached their spawning grounds in the Yukon. This is the lowest recorded estimate and well below the spawning escapement goal for Yukon River Chinook (Figure 1).
- In 2022, as with the previous three years, 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 observed at the border. The leading hypothesis for this discrepancy is non-harvest mortality of migrating Chinook salmon between the river mouth and the border.
- In 2022, Alaska Department of Fish and Game initiated a program that looks into the impacts of Ichthyophonus on migrating Chinook salmon. Ichthyophonus is a naturally occurring parasite that can lead to increased stress and/or mortality in various species of fish, including Pacific salmon. Sampling of Chinook salmon occurred at three locations along the Alaskan Yukon River, with detection, prevalence and severity of infection assessed. Results are presently not available, but insight into the impacts of this parasite can shed light on pre-spawn Chinook salmon mortality and provide more accurate in-season estimates on the number of Canadian origin Chinook expected to reach the border. There are plans to continue assessment of Ichthyophonus infection in Chinook salmon in 2023.
- The Alaska Department of Fish and Game and Fisheries and Oceans Canada are further evaluating Yukon River Chinook salmon enroute mortality through the application of a radio telemetry study. Radio tags will be inserted in up to 500 adult Chinook salmon near the mouth of the Yukon River, with an array of receivers erected throughout the Yukon River drainage, monitoring fish detection as tags pass. Outcomes of the program include better understanding of in-stream mortality of migrating Yukon River Chinook salmon.

Chum salmon from the Porcupine River (Madeleine Czechowski, Department of Fisheries and Oceans, September 2022).

Mature Chinook salmon at the fish ladder

Taking action

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

- full closures of commercial, domestic and recreational fisheries,
- decreasing gill net mesh sizes when targeting smaller salmon or freshwater species, 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 the Yukon are based on:

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

Natural on route (pre-spawn) mortality of migrating Chinook salmon has not been accounted for when estimating spawning escapement. With increasing in-river stressors, such as higher water temperature and pathogens, it is important to better understand these dynamics and their impacts on spawning escapement. The aim of the 2023 radio tagging study on Chinook salmon is to estimate in-stream mortality, therefore, improving our ability to accurately estimate Chinook salmon spawning escapement and manage for escapement goals.

References

Joint Technical Committee of the Yukon River US/Canada Panel (JTC). 2022. Yukon River salmon 2022 season summary and 2023 season outlook. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A20-01, Anchorage, Alaska, USA.
Available from: Yukon River Joint Technical Committee Reports | Yukon River Panel.

Trumpeter swans at the Celebration of Swans Marsh Lake Swan Haven

27. Trumpeter Swan

Significance

Trumpeter swans are a conservation success story. The Committee on the Status of Endangered Wildlife in Canada down-graded trumpeter swans from endangered to a species of special concern in April 1978. Their status was re-examined, and they are no longer designated a species at risk as of April 1996, based on surveys of trumpeter swan breeding grounds in northern Canada and Alaska (COSEWIC 2011). Trumpeter Swan populations have rebounded in Canada and are now above North American Waterfowl Management Plan population objectives (NAWMP 2018).

What is happening?

- Trumpeter swans are a familiar site in the southern Yukon in the spring, especially around the outlets of Marsh, Tagish and Teslin lakes. These areas are critical spring migration staging site for trumpeter swans and other waterfowl to refuel on their trip north to their breeding areas. M'Clintock Bay on Marsh Lake has been identified as a Key Biodiversity Area and can support 1.55 per cent of the global population of trumpeter swans during their spring migration.
- The Yukon has two breeding swan populations, the Rocky Mountain Population and the Pacific Coast Population. The Pacific Coast Population breeds mainly in Alaska, but also in the Yukon and northwestern British Columbia. The Rocky Mountain Population breeds mainly in Alberta, western Saskatchewan, southern Yukon, and the Northwest Territories. (Figure 1)

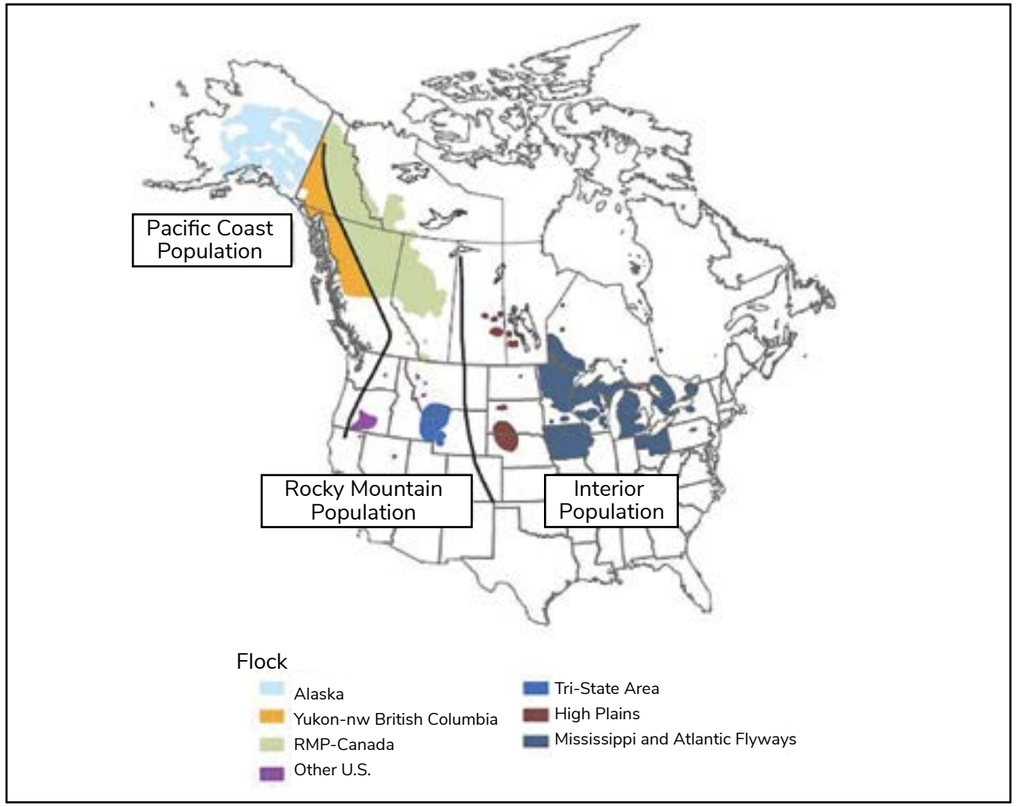


Figure 1: Breeding distribution of Trumpeter Swan Populations in North America (Groves 2017).

Migrating Trumpeter Swan Data

- Migrating trumpeter swans and all other waterfowl using M'Clintock Bay are counted from the Swan Haven Interpretive Center. Daily counts are recorded and used to generate information about how and when swans are using the stopover site.
- In 2022 the maximum number of swans counted in a single day at Swan Haven was 1,368 which is above the long-term average of 863 swans for April 14th (Figure 2).

Monitoring the Trumpeter swan population at M'Clintock Bay Marsh Lake

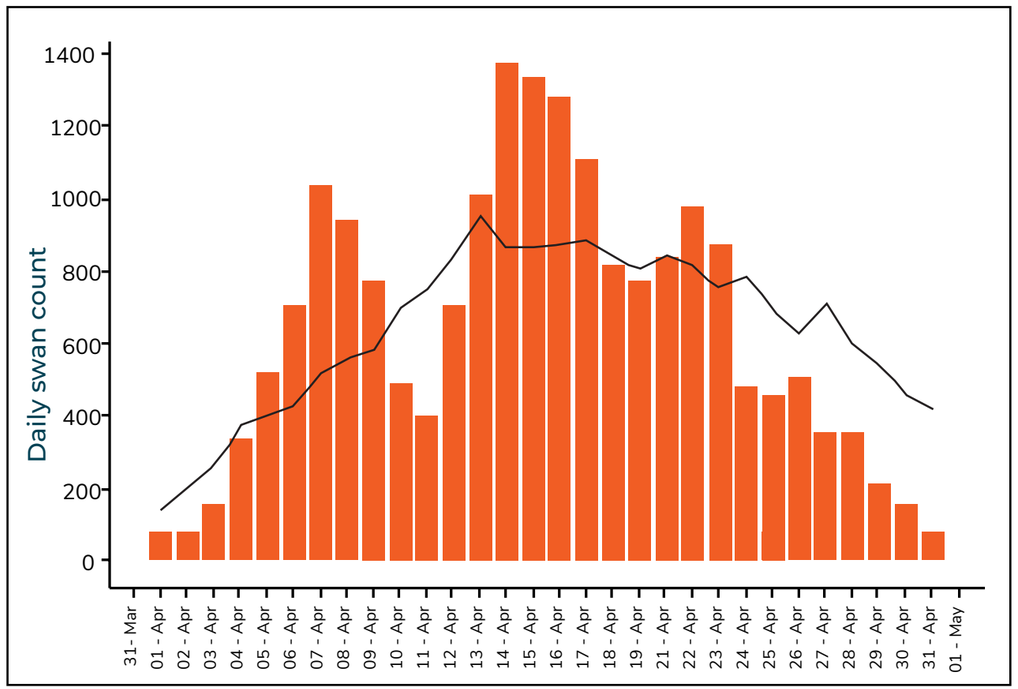


Figure 2: Daily swan count at Swan Haven, M'Clintock Bay, Yukon in April 2022, bars show daily counts, black line is the average daily count for all years (2000 – 2021).

Trumpeter Swans at Marsh Lake

- The peak of swan migration was earlier in 2022 on April 14th compared to the 22-year average date of April 18th (Figure 3). Swan migration is highly variable and the number and timing of birds stopping at M'Clintock Bay depends on ice and weather conditions.

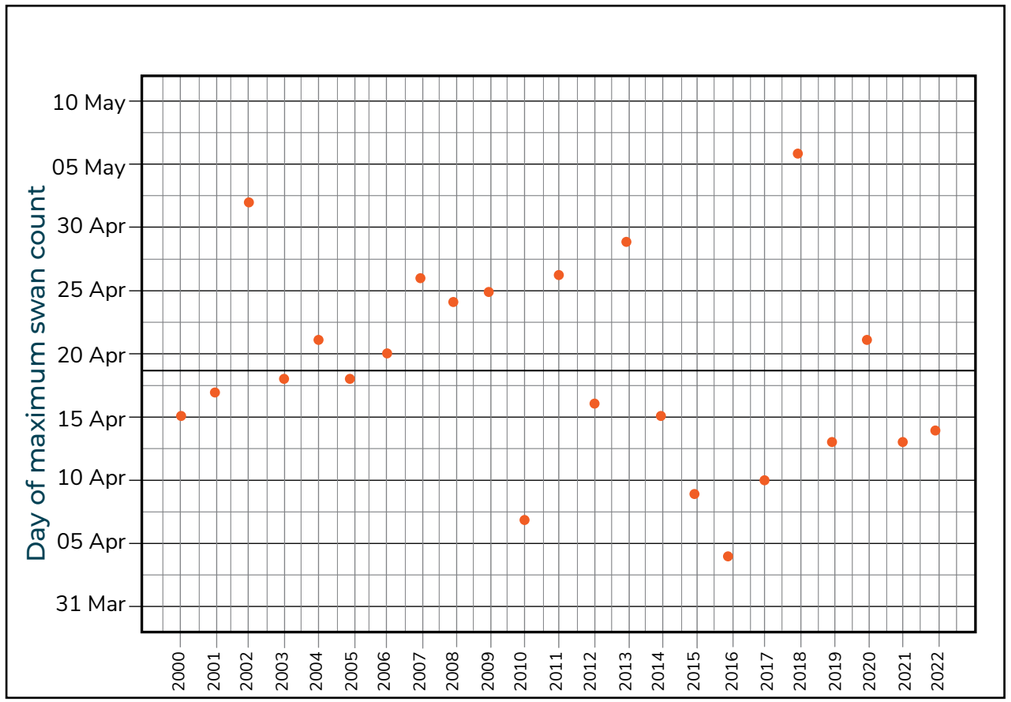


Figure 3: Day of maximum swan count at Swan Haven, M'Clintock Bay, Yukon for all years (2000 – 2022). The black line is the average date of peak swan use over all years, April 18th, years with earlier dates of peak swan-use fall below the line and years with later peak use are above the line.

Trumpeter swans on M'Clintock Bay

Taking action

Until 2015 monitoring of the trumpeter swans occurred on their breeding grounds every five years by the North American Trumpeter Swan Survey (Groves 2017). The survey ended after 2015 because continued growth of the swan populations makes the birds detectable on other waterfowl surveys.

Since 2000, trumpeter and tundra swans have been monitored at several important migration stopover sites in the southern Yukon as part of a collaborative project by the Canadian Wildlife Service and the Yukon's Environment Wildlife Viewing Unit. In the spring, these wetlands, located at the outlets of large lakes, become ice-free very early; the shallow water and exposed mudflats provide food and rest for migrating swans and other waterfowl.

The Government of Yukon operates the Swan Haven Interpretive Centre, where visitors can view and learn about M'Clintock Bay on Marsh Lake, an important staging area for migrating swans, waterfowl, gulls and shorebirds.

Trumpeter swans flying

Trumpeter swans at Tagish Lake

Trumpeter swans at the Wildlife Viewing Swan Haven Interpretive Centre

Data quality

Counting of migrating trumpeter swans and other waterfowl occurs daily at M'Clintock Bay and several days a week at the Tagish River and outlet of Teslin Lake. These annual counts begin in April and continue until mid-May. The same observer has been collecting the data using the same methods since 2000, and it can be found at ebird.org.

The North American Trumpeter Swan Survey was discontinued after the 2015 survey in Canada (Groves 2017). The Waterfowl Breeding Population and Habitat Survey includes swans in the data collected (United States Fish and Wildlife Service 2022).

References

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2011. Canadian Wildlife Species at Risk. Environment Canada, Gatineau, Quebec, Canada.

KBA Canada. 2022. Site Profile: M'Clintock Bay to Lewes River Marsh.
Available from: https://kbacanada.org/site/?SiteCode=YK016. Accessed: 2023-02-01.

Groves, D.J., compiler. 2017. The 2015 North American Trumpeter Swan Survey. U.S. Fish and Widlife Service, Juneau, Alaska, U.S.A.
Available from:
https://www.trumpeterswansociety.org/file_download/inline/16524876-ce39-48cd-ae86-cb0b82756773

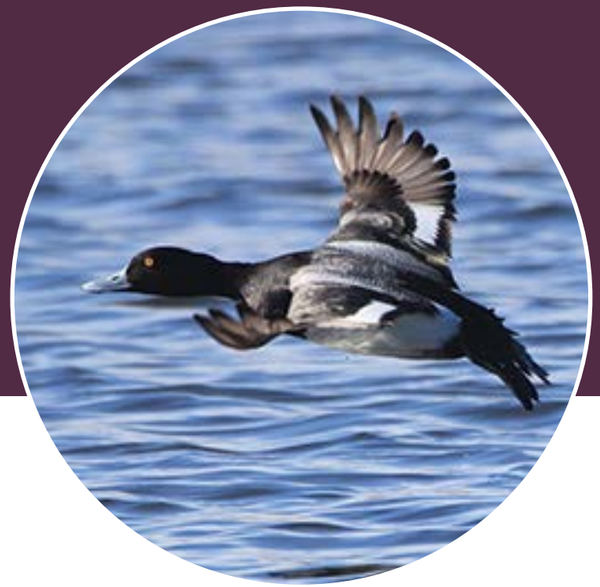
28. Monitoring Breeding Waterfowl

Significance

- In the summer, the Yukon is home to more than 30 species of breeding waterfowl, and it provides critical staging areas for birds migrating in the spring and fall.
- This indicator provides information about waterfowl using an example of a diving duck (lesser/greater scaup[16]) and a dabbling duck (mallard[17]) from a long-term waterfowl population monitoring survey flown in Old Crow Flats, Yukon.
- Old Crow Flats is Yukon's largest wetland and important habitat for waterfowl. It is a globally significant Ramsar wetland. This 12,122-km^2 area is almost free of development. It is an important hunting, trapping and cultural area for the Vuntut Gwitchin First Nation.
- Monitoring waterfowl presence and abundance gives a good indication of the ecological health of an area, as waterfowl depend on wetland areas for food, nesting areas, and cover from predators.
- Specific threats to Yukon waterfowl include:
- Removal of standing dead wood (i.e., snags, standing dead trees) from areas along lake and river margins by commercial or small-scale timber harvesters removes potential nesting cavities and sheltering areas for waterfowl.
- Changes in water regimes due to climate change or human activities (e.g., hydroelectric projects) may change the timing of ice formation and/or spring break-up. This has the potential to alter migration stopover sites for waterfowl either by preventing access (no open water in springtime) or by changing the accessibility of food (if water is too deep, waterfowl may not be able to reach submerged vegetation).
- Disturbance of waterfowl due to increased human recreational activity (e.g., dogs running loose, boating, etc.) has detrimental effects on foraging efficiency and body fat acquisition. It is especially important during spring migration when there is often less time and less space (due to ice cover) for birds to acquire the resources they need to ensure successful reproduction.

[16] The Lesser Scaup (Aythya affinis) and Greater Scaup (A. marila) are two closely related North American diving duck species in the Aythya genus.

[17] Mallard ducks are the most common and recognizable wild ducks in the Northern Hemisphere (Anas platyrhynchos).



Male lesser scaup airborne after its running-on water takeoff (Krista Lundgren, 2017).

What is happening?

- Waterfowl populations have been monitored using fixed-wing aircraft since 1955 as part of the North America Waterfowl Breeding Population and Habitat Survey.
- The United States Fish and Wildlife Service completes these surveys annually in Old Crow Flats, Yukon.
- Overall, waterfowl populations in Old Crow Flats are stable but there is annual variation in populations among species.

Diving Ducks – Lesser and Greater Scaup

- Their habit of diving for food is what gives diving ducks their name. They generally nest close to the water's edges. The presence and abundance of diving ducks are indicators of water health.
- Lesser and greater scaup are two diving duck species that are grouped for the purpose of this monitoring analysis since they are almost impossible to distinguish during aerial surveys.
- Scaup are in decline across North America; the combined estimate for scaup in the traditional survey area (western North America) was 3.6 million similar to the 2019 estimate and 28 per cent lower than the long-term average of 5.0 million (USFWS 2022).
- At Old Crow Flats (strata 12 Waterfowl Breeding Population and Habitat Survey) the 2022 combined lesser and greater scaup population estimate was 36250 19 per cent less than the estimate from the last survey in 2019. This is also 97 per cent less than the long-term average (1957-2022) but the long-term trend is stable at Old Crow Flats (Figure 1).

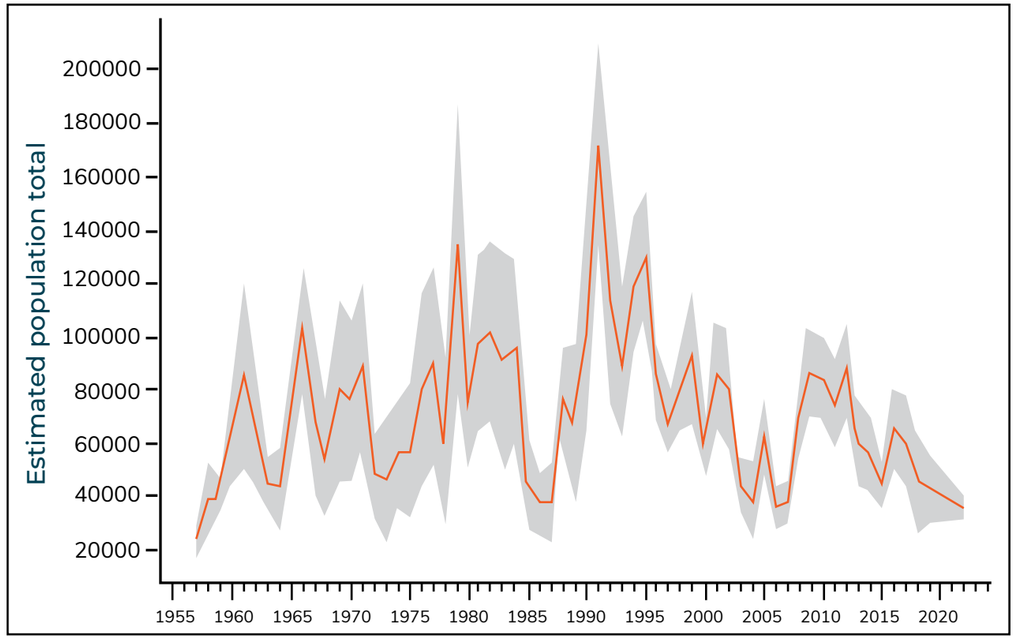


Figure 1: Population estimates with standard errors for combined Greater and Lesser Scaup at Old Crow Flats

Dabbling Ducks – Mallard

- Dabbling ducks walk well on land and can nest far from the water's edge. They feed on grass and seeds on land, as well as algae, plants and insects in the water. The presence and abundance of dabbling ducks are indicators of the health of a wetland area.
- The mallard is a common dabbling duck that is also extensively hunted in Canada; therefore, their populations are monitored. Across North America, mallard populations are 26 per cent above the North American Waterfowl Management Plan target.
- Estimated mallard abundance was 7.2 million, which was 23 per cent below the 2019 estimate of 9.4 million and 9 per cent below the long-term average of 7.9 million for the entire traditional survey area. (United States Fish and Wildlife Service 2022)
- At Old Crow Flats (strata 12 Waterfowl Breeding Population and Habitat Survey) the 2022 mallard population estimate was 2427, 139 per cent less than the estimate from the last survey in 2019. This is also 297 per cent less than the long-term average (1958-2022) but the long-term trend is increasing at Old Crow Flats (Figure 2).

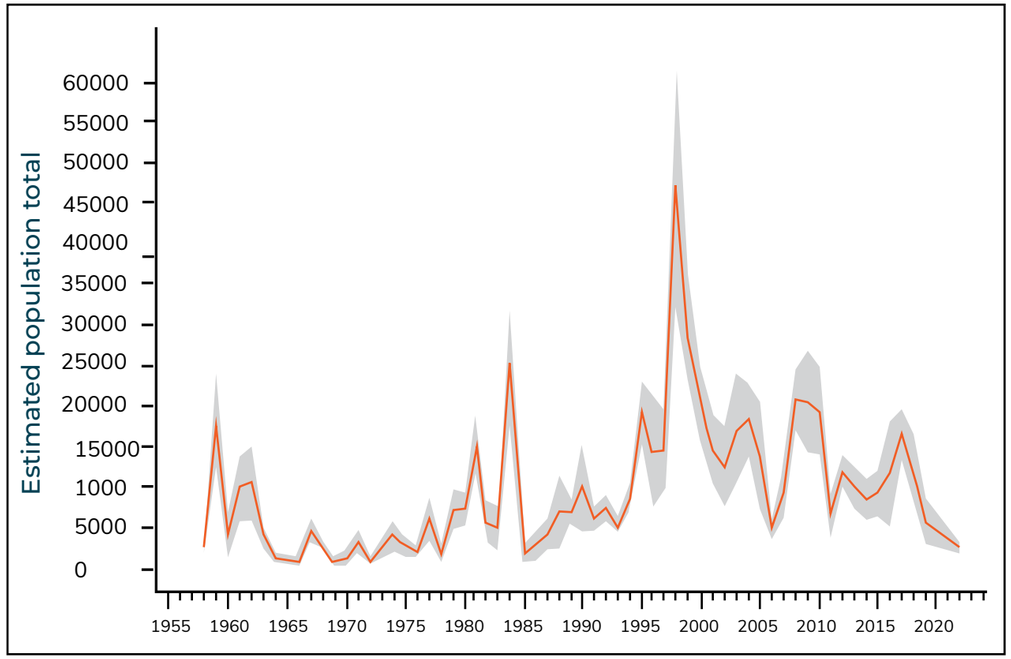


Figure 2: Population estimates with standard errors for Mallard at Old Crow Flats.

Mallard ducks swimming (USFWS, 2017).

Taking action

The North American Waterfowl Management Plan sets conservation goals for waterfowl across the continent; Yukon surveys contribute to information for continent-wide population monitoring and harvest management in Canada.

Data quality

- The Waterfowl Breeding Population and Habitat Survey is a continent-wide survey conducted by Canadian Wildlife Service and the U.S. Fish and Wildlife Service. The survey consists of annual fixed-wing aerial transects. In western North America data collection began in 1955.
- Old Crow Flats is the only part of the Yukon included in the survey; data has been collected since 1955 by the United States Fish and Wildlife Service.
- The annual aerial surveys are carried out on one day. Count results may be influenced by weather conditions.
- Due to COVID-19 restrictions most survey operations, including the Waterfowl Breeding Population and Habitat Survey, were suspended in 2020 and 2021. As a result, data annual estimates of change are not available; instead, the 2022 data is compared to 2019 to describe short-term population changes and to the entire data set for long-term changes.

References

Canadian Wildlife Service Waterfowl Committee. 2022. Population Status of Migratory Game Birds in Canada – 2021. CWS Migratory Birds Regulatory Report Number 55.
Available from: https://www.canada.ca/en/environment-climate-change/services/migratory-game-bird-hunting/consultation-process-regulations/report-series/population-status-2021.html

U.S. Fish and Wildlife Service. 2022. Waterfowl population status, 2022. U.S. Department of the Interior, Washington, D.C. USA. Available from: https://www.fws.gov/media/waterfowl-population-status-2022

North American Wetlands Conservation Council (Canada). 2018. North American Waterfowl Management Plan. Available from: https://nawmp.wetlandnetwork.ca/.

29. Avian influenza surveillance

Significance

- Several different strains of avian influenza viruses exist, and wild birds commonly carry some of them.
- First detected in late 2021, a strain of the virus known as highly pathogenic avian influenza is currently spreading in domestic and wild birds in North America and elsewhere. This strain (called H5N1) can spread easily and quickly among susceptible birds and causes severe illness and a high death rate in infected birds.
- Although very uncommon, human infection with the H5N1 strain of avian influenza can occur.
- In the current outbreak, infection with avian influenza virus is resulting in significant mortality in domestic poultry, as well as causing small and large-scale die-offs in a wide range of wild bird species.
- Interestingly, the strain of avian influenza virus causing this outbreak has also been found to infect different species of wildlife, including red foxes, black and grizzly bears, skunks, and harbour seals. The implication that avian influenza viruses can infect, and possibly spread between non-avian species is concerning, and is being studied further.

Bald eagle scavenging a swan carcass on a Yukon Lake in spring of 2022 (Cameron Eckert).

What is happening?

- In spring 2022, a collaborative monitoring program was initiated to test wild birds in the Yukon for avian influenza virus.
- The Animal Health Unit collected oral and cloacal swab samples from sick or dead wild birds and submitted them for testing.
- In total, 82 samples were tested in 2022, encompassing 35 avian species and one species of mammal (red fox) (Figure 1).
- Most samples were collected from the Southern Lakes region, but a few samples were collected near other communities (Figure 2).
- There were five confirmed avian influenza virus positive cases and three preliminarily positive cases detected in birds, including in one trumpeter swan, two Canada geese, three bald eagles, one snow goose, and one raven.
- Preliminarily positive cases are those where the sample has tested positive for avian influenza virus, and we are awaiting confirmation that the sample is the H5N1 strain of the virus.

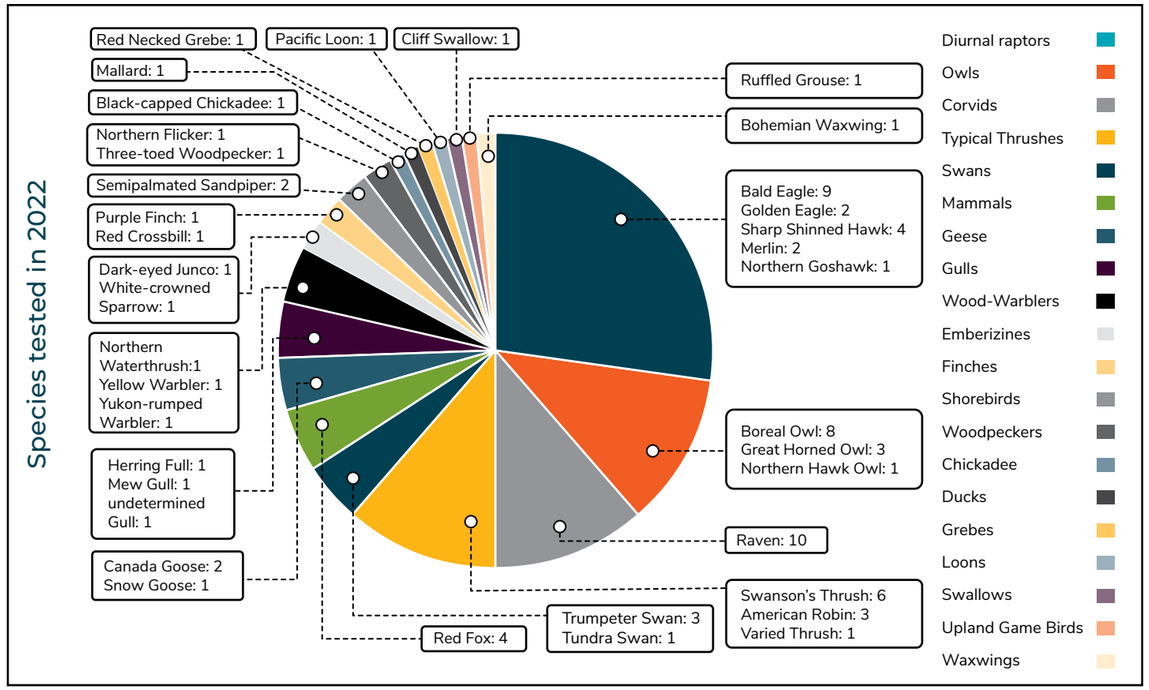


Figure 1: The number and species of wild birds and wildlife in the Yukon tested for avian influenza virus in 2022.

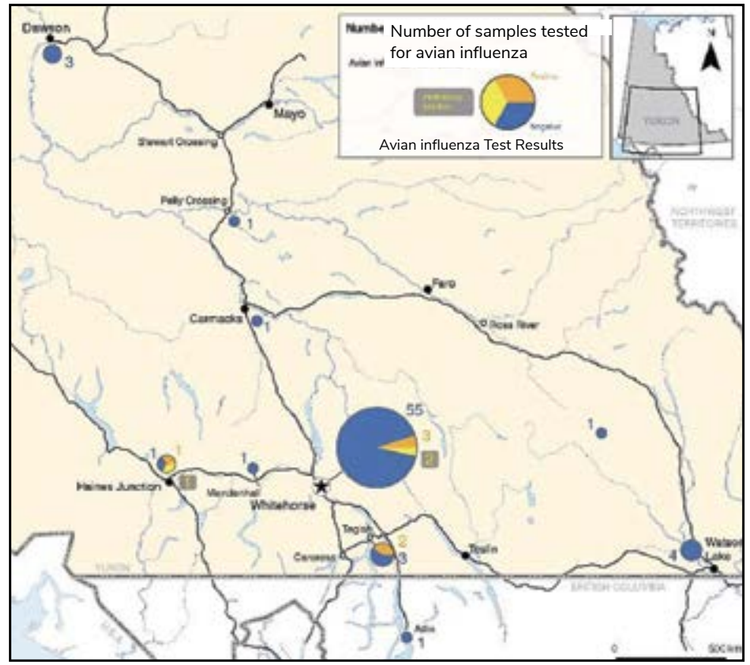


Figure 2. Map showing the distribution of samples collected for avian influenza virus testing in the Yukon in 2022. The discs represent approximate locations. Preliminary positive samples are samples that have not yet received confirmation as the H5N1 strain.

- So far, detection of avian influenza virus occurred in one red fox, making it the only Yukon mammal to test positive for this virus.
- Detection of most avian influenza virus positive cases occurred in the spring, but one avian influenza virus positive bald eagle occurred in the fall (Figure 3).

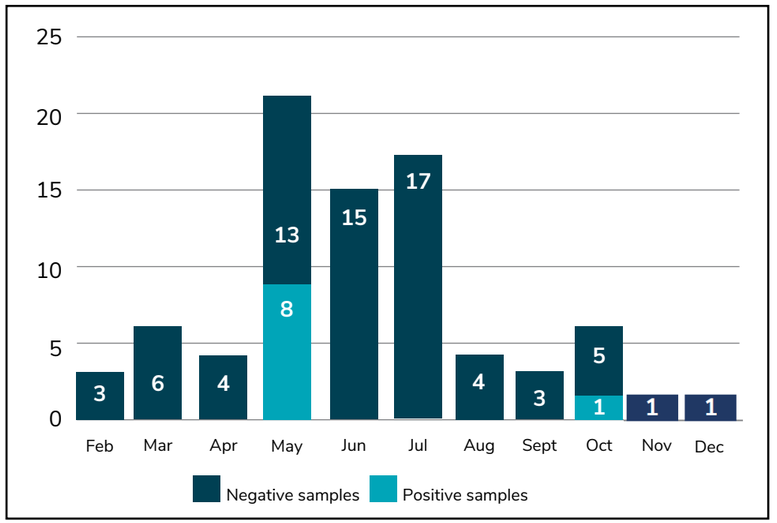


Figure 3: The number of samples tested per month for presence of avian influenza virus from Yukon wild birds and wildlife in 2022. Number of preliminary and confirmed positive samples combined are shown in light blue.

- Most of the birds and animals sampled were sent to a pathology lab for a complete necropsy to determine if infection with avian influenza virus was the cause of death.

Taking action

- Given the ongoing avian influenza outbreak in Canada and around the world, it is important to continue to monitor the health of wild birds and wildlife.
- Information about the presence and distribution of avian influenza virus in wildlife and birds is necessary to understand the potential risks of this disease to domestic poultry flocks, and even to people in the Yukon.
- The Animal Health Unit is working with a graduate student who is studying the best ways to conduct surveillance for avian influenza virus in wildlife and is supporting small-flock poultry owners to improve biosecurity and maintain healthy flocks in the face of the ongoing outbreak.

To date, infection with avian influenza virus has only been detected in one red fox in the Yukon.

Data quality

- Staff from the Animal Health Unit collaborated with the Canadian Wildlife Service, the Canadian Wildlife Health Cooperative, and the British Columbia Center for Disease Control laboratory to develop a method to collect samples from wildlife and birds in the Yukon, ship samples to the laboratory and to collect results and share data.
- Animal Health Unit staff collected samples from the birds and animals and sent them to British Columbia Center for Disease Control. Animal Health Unit staff sent dead wildlife and birds to pathologists at Canadian Wildlife Health Cooperative, who determined the cause of death/ illness in each case.
- Canadian Wildlife Service provided funding for shipping of samples and carcasses, and, along with the Animal Health Unit, used the resulting data to understand the impacts of avian influenza on wild birds and to shape the ongoing surveillance program.

References

Government of Canada [Internet] Canada.ca [modified 2023-01-20; cited 2023-01-26]
Available from: Avian influenza in wild birds – Canada.ca

Animal and Plant Health Inspection Service [Internet] USDA.gov [modified 2023-01-24; cited 2023-01-26]
Available from: USDA APHIS | 2022-2023 Detections of Highly Pathogenic Avian Influenza

30. Monitoring respiratory pathogens in Yukon wildlife

Significance

- The bacteria *Mycoplasma ovipneumoniae* (*M. ovi*) is a concern for wildlife health, as it has been implicated in fatal outbreaks of pneumonia in wild sheep and mountain goats in other parts of North America.
- In 2015, the Government of Yukon began testing thinhorn sheep and mountain goats in the Yukon for *M. ovi*. Samples from these species continued to be collected and assessed (Figure 1).
- In 2018, Alaska reported that *M. ovi* had been detected in wild ungulates in that state. Because of this finding, the Yukon's surveillance was expanded to include other wild ungulates.

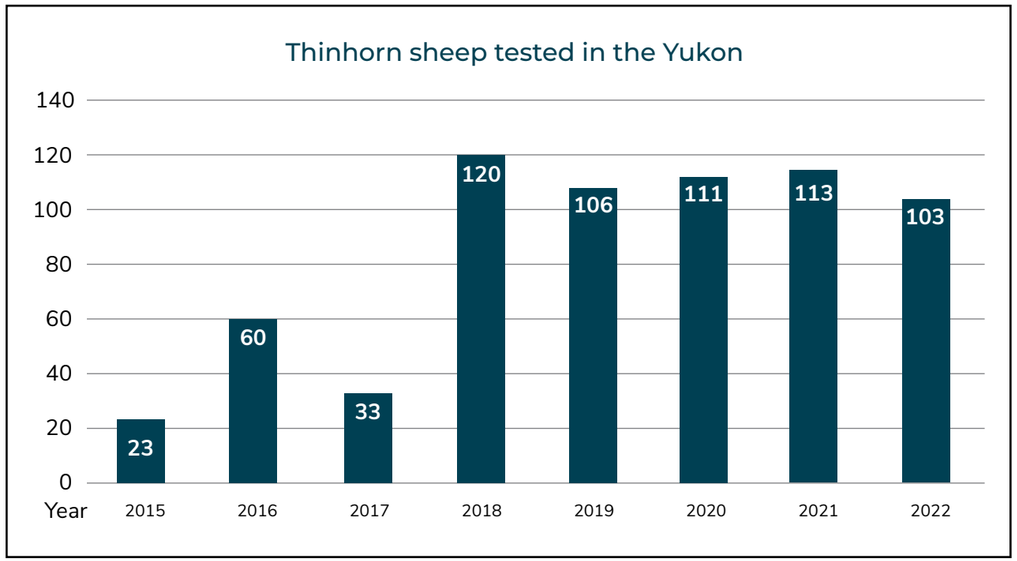


Figure 1: The number of individual thinhorn sheep tested in the Yukon per year since 2015.

Thinhorn sheep in the Faro area

What is happening?

- Since 2015 testing has been completed on samples from over 1400 wild ungulates (Figure 2).
- Samples are sent to the Animal Health Centre laboratory in British Columbia and Prairie Diagnostic Services laboratory in Saskatoon. Both laboratories use the same test for *M. ovi*, so results are comparable.

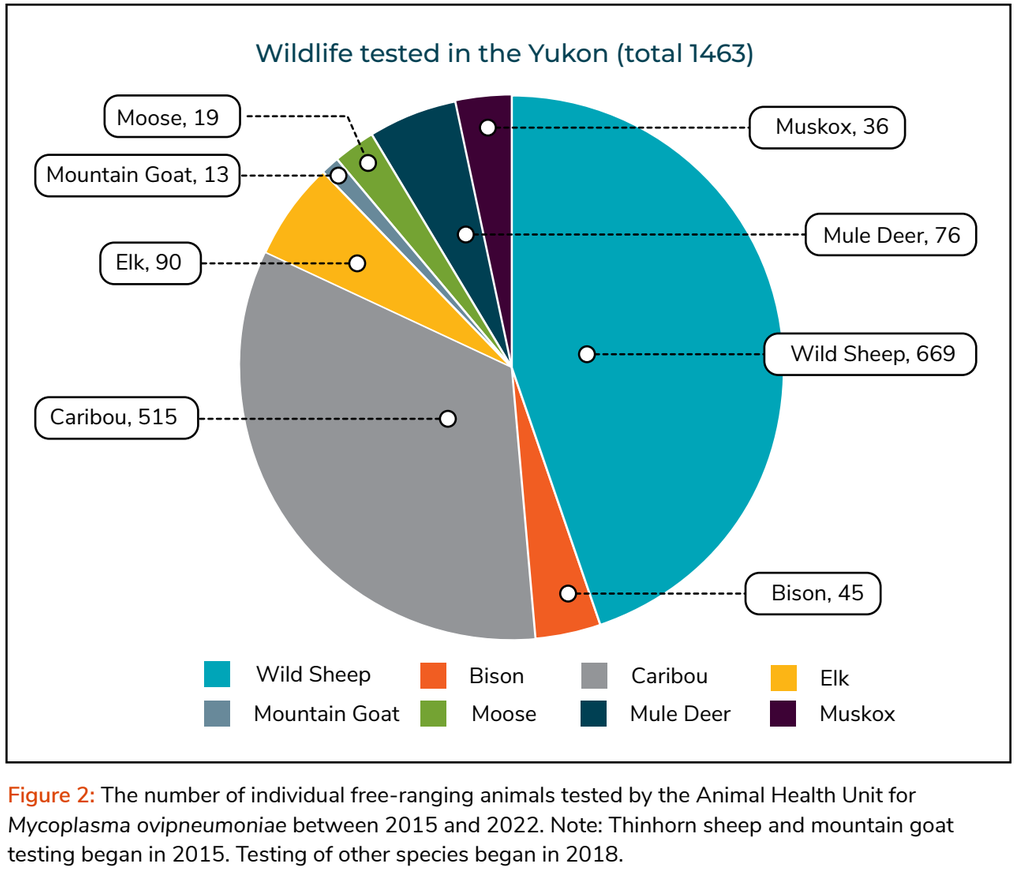


Figure 2: The number of individual free-ranging animals tested by the Animal Health Unit for *Mycoplasma ovipneumoniae* between 2015 and 2022. Note: Thinhorn sheep and mountain goat testing began in 2015. Testing of other species began in 2018.

- Between 2015 and 2021 all tests were negative for *Mycoplasma* spp. except for:
  - One caribou from the Forty Mile herd captured near the Alaska border in 2018. Approximately 10 per cent of the samples from the Forty Mile herd tested by Alaska have been positive for *M. ovi*, therefore this was not an unexpected finding. To date, no pneumonia outbreaks in wildlife have been associated with the positive samples in Alaska.
  - Four caribou from the Porcupine herd – one harvested in 2020, and three captured in 2021. Confirmatory genetic sequencing of these positive samples determined that the *Mycoplasma* detected was not *M. ovi*, but likely a closely related bacterium. *Mycoplasmas* can adapt to specific host species and not cause disease in those species, so it is not surprising to find a distinct strain of *Mycoplasma* in healthy caribou.

- Surveillance of *M. ovi* in wildlife is ongoing. Nasal samples are collected by thinhorn sheep hunters in the field, by laboratory technicians during compulsory and voluntary submissions from the regulated hunt, and from wildlife found dead. When possible, biologists and veterinarians collect nasal swab samples in the field during collaring of wild ungulates. The Yukon Wild Sheep Foundation been a key partner in supporting respiratory pathogen surveillance in Yukon wildlife since 2018.
- In 2022: 280 individual animals were tested, the majority being thinhorn sheep (103) and caribou (128).
  - Of the 128 caribou samples tested in 2022, one sample from the Porcupine herd tested positive for *Mycoplasma ovipneumoniae*. This animal was captured in Alaska in 2022. Although this is the first positive sample detected in this herd, we expect that, similar to the Forty Mile herd, there is a low level of *M. ovi* or similar *Mycoplasma* spp. present in Porcupine caribou. Further testing showed that the strain of *M. ovi* detected is very similar to the strain of *M. ovi* detected in other wildlife in Alaska. To date, the caribou that tested positive appears healthy and no outbreaks of pneumonia have been detected in Porcupine caribou or in any other wildlife in the Yukon.
  - The 103 thinhorn sheep and 176 other ungulates tested in 2022 were negative.

Taking action

- Surveillance of *M. ovi* in wildlife is ongoing. Nasal samples are collected by thinhorn sheep hunters in the field, by laboratory technicians during compulsory and voluntary submissions from the regulated hunt, and from wildlife found dead. When possible, biologists and veterinarians collect nasal swab samples in the field during collaring of wild ungulates.
- Sample kits for thinhorn sheep and mountain goat hunters are available for pick up at Department of Environment offices.
- Two swabs per animal are collected to enable further analysis of any *Mycoplasmas* found in wildlife.
- By monitoring wildlife for the specific respiratory pathogens, the Animal Health Unit is better able to manage wildlife health issues.

Related

- *M. ovi* can be carried by domestic sheep and goats. A control order under Yukon's Animal Health Act is in effect to reduce the chance of transmission of disease from these domestic animals to wildlife. The order requires sheep and goat owners to only keep animals that test negative for M. ovi and to comply with fencing requirements. Import permits are required for any movement of sheep and goats into the territory.

Muir's Fleabane (Erigeron muirii) is a showy, hairy daisy is known from Alaska and northern Yukon, historically from Canada and was last seen on Herschel Island in 1979 (Bruce Bennett).

31. Biodiversity

Significance

- To prevent species in Canada from becoming extinct, intervention at early stages is fundamental.
- This indicator records the number of species that regularly occur in the Yukon and how our knowledge has changed.
- In 1996, the wildlife ministers in Canada signed the Accord for the Protection of Species at Risk, making the commitment to "monitor, assess and report regularly on the status of all wild species".

What is happening?

- The Yukon is home to 8,184 species known to be wild. Of these 8,022 are native, 153 are introduced, and the origin of nine species is currently unknown (Government of Yukon 2022a).
- The largest group of species is vascular plants with 1,185 wild species, closely followed by beetles (1,167 species), and flies (1,123).
- One third (33 per cent or 2,702) of the Yukon species are considered secure or apparently secure and 1,107 species (13.5 per cent) are potentially at risk of disappearing from the Yukon.
- Of the 76 Yukon species assessed by the Committee on the Status of Endangered Wildlife in Canada, 43 have been assessed as at risk, and 33 have been federally listed (Government of Yukon 2022b).
- Of the 8,184 Yukon species, 3,667 (45 per cent) are data deficient. These species have been recorded in the Yukon, but there is not enough information to provide a conservation rank.

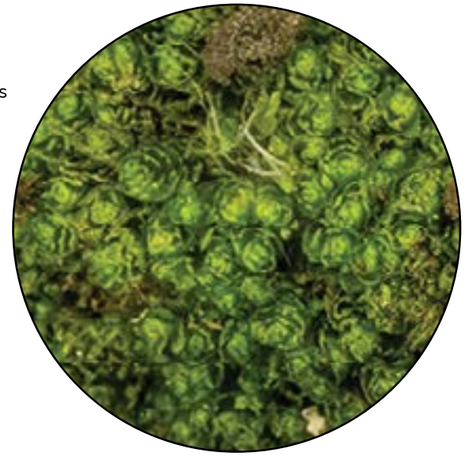
Yukon goldenweed (*Nestotus macleanii*) is one of 43 species found only in Yukon (endemic). British Columbia, Alberta, Quebec, and the Yukon have the most nationally endemic[18] species in Canada.

- Of the 8,184 species, 538 (6.5 per cent) are unranked. No effort has been made to assess their status in the Yukon.
- Ninety-six Yukon species are historical. They have not been seen in over 40 years despite targeted survey efforts.
- In 2022, 513 species had their ranks reviewed, 407 were changed and 106 stayed the same.
- In 2022, 315 species were added to the Yukon list of species known to occur in the territory.
- The Yukon Conservation Data Centre maps the distribution of 301 of the species at greatest risk and gathers information on an additional 508.

Moths and butterflies are the fourth largest group of wild species found in the Yukon. The Artichoke plume moth (*Platyptilia carduidactylus*) is one of over 30 moth species newly discovered in the Yukon (Carle Belanger, 2022).

[18] Endemic species are plants and animals that exist only in one region.

Bryophytes are the collective term for mosses and liverworts. The Yukon is home to more than 440 species of mosses, and 115 species of liverworts. The liverwort *Schistochilopsis incisa* ssp. opacifolia was discovered in the Yukon during the 2022 Beaver Creek Bioblitz (Mike Ryan).



Taking action

- The Government of Yukon provides data through the Yukon Conservation Data Centre in support of Wild Species Canada (2022).
- The Government of Yukon is actively involved in the assessment of species at risk in Canada through participation on the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2022).

Data quality

- The Yukon Conservation Data Centre uses reports, collections, and photographs through the platform iNaturalist to help gather information on the distribution of species found in the 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 Yukon Conservation Data Centre is part of the NatureServe network and follows their established methodologies. NatureServe data is widely recognized as a standard for conservation science and biodiversity assessment in North America. NatureServe uses standardized ways of collecting field data, mapping biological features, assessing the condition of those mapped species, and managing the information.

Profile

The Yukon has 96 species that are listed as Historical. These are species that have been confirmed in the Yukon, but with no reports in over 40 years despite efforts to rediscover them. Most of these are mosses (40) or lichens (29) and vascular plants (16).

Lichen in Tombstone Territorial Park

Lichens in Tombstone Territorial Park

References

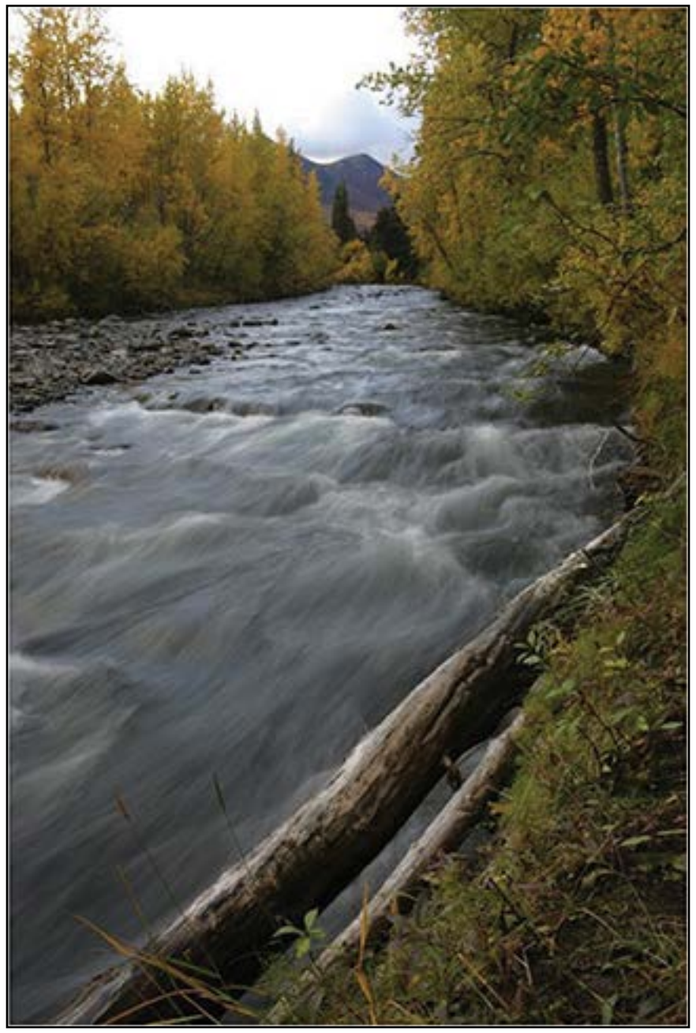
Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2022. Available from: Cosewic / Cosepac – Home

Government of Yukon. 2022a. Species database. Yukon Conservation Data Centre, Whitehorse, Yukon, Canada. Available from: https://yukon.ca/biodiversity

Government of Yukon. 2022b. Yukon species at risk. Available from: https://yukon.ca/en/species-risk

NatureServe. 2022. NatureServe Explorer. NatureServe, Arlington, Virginia, USA. Available from: NatureServe Explorer

Wild Species Canada (2022). Wild Species: The General Status of Species in Canada. Available from: Home – Wild Species: The General Status of Species in Canada



Tombstone Valley


Yukon