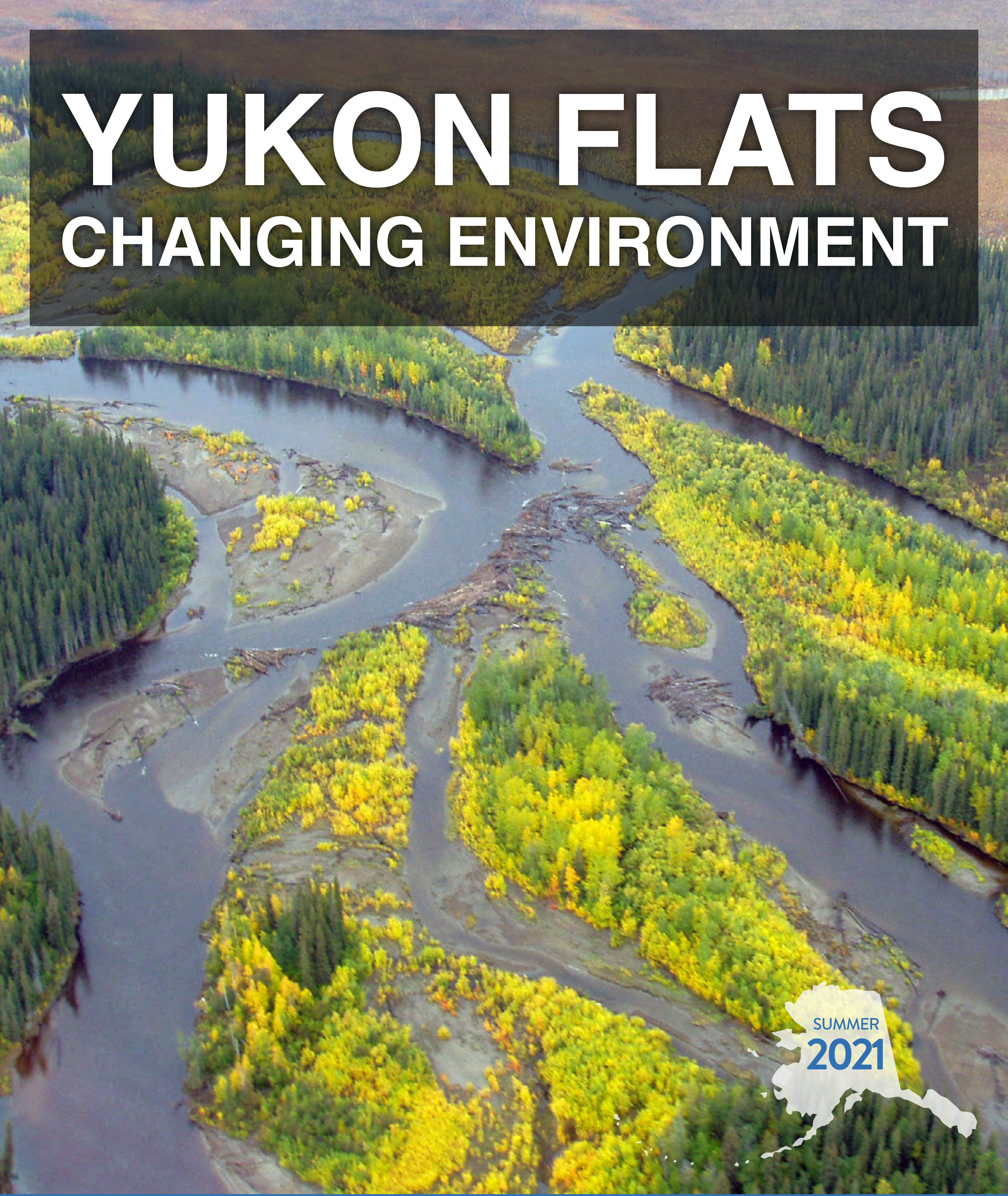
YUKON FLATS
CHANGING ENVIRONMENT



SUMMER
2021

Read it online at uaf-iarc.org/yukon-flats-changes

International Arctic Research Center
UNIVERSITY OF ALASKA FAIRBANKS

WELCOME

The skies were blue as Beaver Traditional Chief Paul Williams, Sr. and I loaded up the boat. We were beginning a long trip to visit fish camps across Yukon Flats. Our job was to see how fishing was going. It was July 2006. My notes remind me we heard needs weren't being met. For many, the Chinook harvest was below normal. There was worry about smaller fish. Some remarked about high water.

The trip symbolized for me change and concern for the future. Between 2003 and 2007, I worked as an assistant manager for the Yukon Flats National Wildlife Refuge (NWR) at the US Fish and Wildlife Service (US FWS). During that time, I listened to folks and spent time out on the land. I counted moose, boated and paddled hundreds of miles, cleaned up an old military drum site and helped study ducks. Right before I transferred to Arctic Refuge, I attended the first climate change workshop my agency held in Alaska. It was a sobering week. The take-home message: much was changing, and we had more to learn.

When I came back to work for Yukon Flats Refuge in 2019, only 12 years had gone by. But things are different. People in villages talk more often about changes they see on the land. They talk about changes in their way of life. New scientific research sheds light on causes.

This outreach booklet highlights some of those changes in and around the Yukon Flats Refuge. We hope to get more people talking about what the future holds for themselves and the land. If we're successful, you'll discuss these stories with others and share yours with us.

Mahsii choo' and ana bassee!

Jimmy Fox, Refuge Manager, Yukon Flats National Wildlife Refuge

Major themes

- Warmer temperatures, especially in winter
- Thawing permafrost and changing plants
- Lake drying and changing water conditions
- More frequent large wildfires
- Arrival of more southern wildlife species

WHO ARE WE?

This report was created by Yukon Flats National Wildlife Refuge and the University of Alaska Fairbanks International Arctic Research Center with help from the Council of Athabascan Tribal Governments.

The report is part of the Alaska's Changing Environment series.

CONTENTS

SUGGESTED CITATION

Fox, J., M. Bertram, N. Guldager, R. Thoman, H. Carroll, R. Brown, B. Lake, Z. Grabinski & D. Vargas Kretsinger. (2021). Yukon Flats changing environment [outreach booklet]. H. R. McFarland, editor. Yukon Flats National Wildlife Refuge & International Arctic Research Center.

CONTACT US

Ask a question or send in an observation by calling 1-800-531-0676 or emailing jimmy_fox@fws.gov.

Photo by Adam Grimm

The Yukon Flats National Wildlife Refuge is a 40-year old federal land designation on about 8.6 million acres in eastern interior Alaska. Yet for thousands of years, this area has been—and continues as—a homeland for Gwich'in and Koyukon Athabascan people. The Refuge Manager is grateful for generations of these people caring for the land and looks forward to continuing that legacy with the current generation.

LOCAL VOICES

Local observations play an important role in tracking changes on Yukon Flats and how they impact people on the land. One new program supports local residents as they share their knowledge and observations.

Local observers document changes

A new US FWS and Council of Athabascan Tribal Governments (CATG) program, Eyes in the Bush, hires local residents to document environmental change. Observers report information like snow depth, river break-up and freeze-up, migratory bird arrival, tree green-up, the presence of invasive plants, and track permafrost thaw, regrowth of vegetation after wildfires and outdoor air quality. They will also collect ticks and soil samples for the University of Alaska.

This effort gives village residents, Tribes, the US FWS and others important baseline information to understand how the environment is changing and plan for the future.

GWICHYAA GWICH'IN GINKHII

— The Yukon Flats People Speak

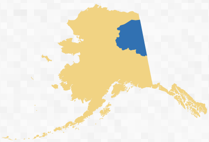
"Gwichyaa gwich'in ginkhii" in this report shares changes seen in recent years by local residents, hunters and Elders. These observations were gathered by Mimi Thomas (top photo) and Julie Mahler (bottom photo).

Mimi is originally from Fort Yukon and is now Yukon Flats NWR's Park Ranger. Julie is a Refuge Information Technician at the CATG and liaison between Yukon Flats NWR and villages.

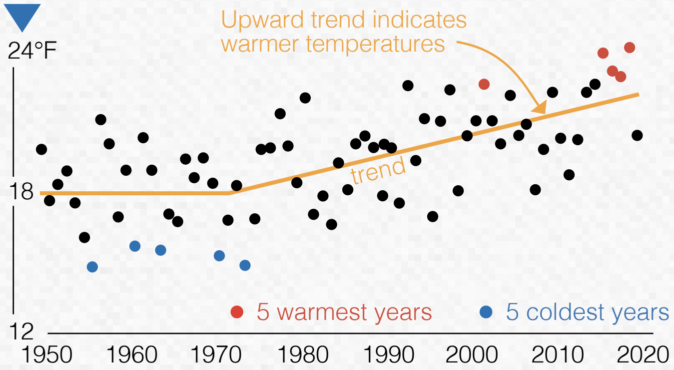
"I was born and raised in Fort Yukon ...Throughout the years living on the land, we've seen changes with the weather, water, animals and plants." ~ Julie Mahler, CATG & US FWS

CLIMATE

TEMPERATURE 1

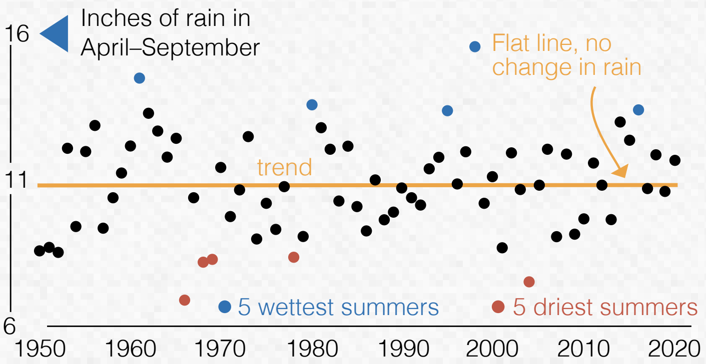


Annual average temperatures are widely used as a measure for long term changes. Temperatures in the Upper Yukon Valley (the blue area on map, which includes Yukon Flats and the surrounding higher mountains to the north and south) have been rising since the 1970s, with typical annual average temperatures now over 4°F warmer than in the 1950s. Recent years have been exceptionally warm, four out of the five warmest years all occurred since 2015.



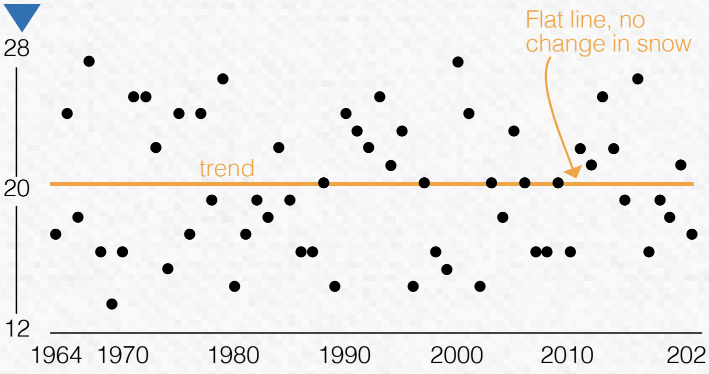
PRECIPITATION 1

While Yukon Flats is clearly warming, there has been no clear trend in precipitation in winter or summer since the 1950s, according to the best available computer model reconstructions. Precipitation for the Upper Yukon Valley varies significantly from year to year.



Snow at Fort Yukon 2

Spring snow has been measured at Fort Yukon almost every year since the mid-1960s. Unlike other parts of Interior Alaska, April 1st snow depths are not usually deep and do not vary greatly. The Yukon-Tanana uplands south and southwest of Fort Yukon, largely protect Yukon Flats from Bering Sea storms that occasionally bring large snowfalls to areas south and west of Yukon Flats.



WHAT DO THE NUMBERS MEAN?

Use the numbers in the blue circles # to find the associated contact and information source on page 16.

WILDLIFE

Photo by NPS / Zak Richter

DALL'S SHEEP

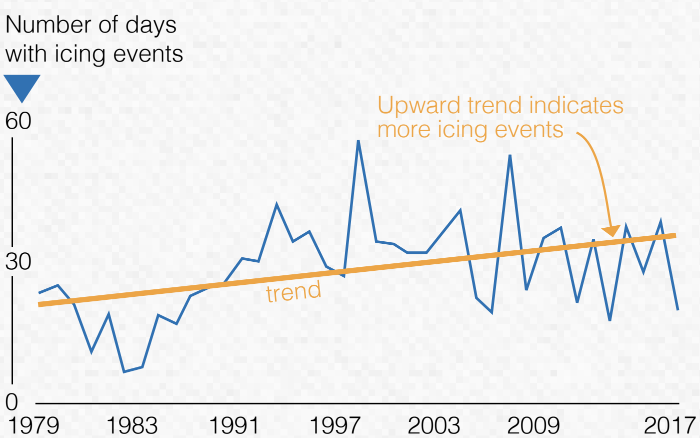
A small, isolated Dall's sheep herd lives in the White Mountains of the southern Yukon Flats. The herd usually contains about 400 animals, but reached a maximum of 717 sheep in 1999. Recent studies found that winter icing and summer vegetation growth affect the White Mountains sheep survival.

Icing events impact sheep survival

Winter icing events can coat vegetation and block wildlife, like sheep, from their food source. It can also make travel challenging for sheep, while simultaneously improving conditions for predators. On Yukon Flats, icing events are most common in October and April, but can take place any time throughout the winter. Biologists observed that sheep survival drops the year following a winter with significant icing events.

MORE ICING EVENTS 3

There are now about 15 more icing events in the White Mountains each winter (September–April) than there were in the late 1970s. In this graph, the blue line is the number of days with icing events each winter, while the orange line shows the trend.

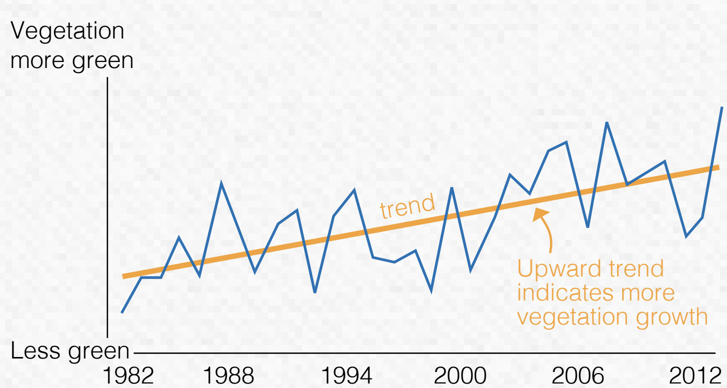


Vegetation "greenness" impacts lamb survival

Sheep use alpine areas year-round, relying on lichen, grasses and other low-lying plants for their food. Biologists monitor the density of these plants using satellite pictures. The satellites measure the light reflected off vegetation in summer. An increase in reflected light is referred to as "greening" and means there is more vegetation growth, while a decrease is referred to as "browning." This satellite tool can be used to assess and map sheep habitats. Biologists have observed that lamb survival increases in years when greenness levels are high.

INCREASED VEGETATION GROWTH 3

Summer (May–August) vegetation growth (greenness) in the White Mountains has been increasing annually since 1982. In this graph, the blue line is the vegetation greenness measured by satellites, while the orange line shows the trend.



What to expect in the future?

The trend toward more icing events in the White Mountains may continue to limit access to food. However, this may be offset by increased vegetation growth in summer. Better food allows female sheep to be healthier and increases lamb survival.

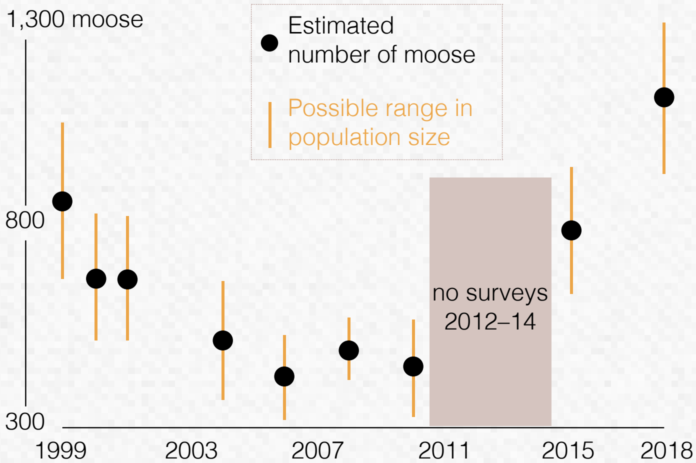
WILDLIFE MOOSE

According to surveys, moose numbers in the western Yukon Flats more than doubled from 2010 to 2018. More moose were also observed west of Yukon Flats around Bettles and Allakaket, and eastward near Eagle and Circle. The increase could be related to several mild winters with low snow and/or warmer than normal temperatures.

Photo of a Lower 48 moose by Dan Bergeron, N.H. Fish and Game Department

MOOSE NUMBERS INCREASE 4

The estimated number of moose in the western Yukon Flats during fall has increased in recent years. In this graph, blue dots show the estimated population size, while the orange line shows the range of possible sizes for a given year.



Counting moose

Although recent conditions may have benefited moose survival, low or no snow makes it difficult to count them. From 2012 to 2014, Yukon Flats moose surveys were canceled because there was not enough snow.

Biologists survey moose in November and early December after trees have dropped their leaves and the ground is blanketed in snow. From an airplane, the dark moose stand out better against the white background. By counting all the moose in small units, biologists can estimate the population size across the larger area.

Moose, mule deer and ticks

Warmer winters may boost moose populations, but they also allow more southern species to expand their ranges into habitats once too cold for them. For example, mule deer are now well established in western Yukon, Canada. In the past few years, several were spotted in Alaska between Fairbanks and the Canadian border, near Nenana and the Fort Knox gold mine.

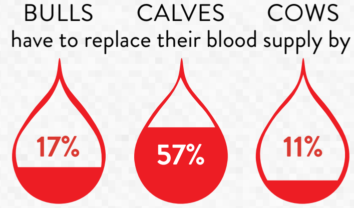
Mule deer can carry winter ticks, which are causing major moose population declines in the northeastern United States. One study found that almost half of mule deer surveyed in Yukon, Canada carried winter ticks. Although winter ticks have not been documented on moose in Alaska, wildlife veterinarians, biologists and hunters are concerned that mule deer may bring winter ticks to Alaska.

Winter ticks cause blood loss

In the Lower 48, winter ticks spread easily when moose densities are high. Thousands of ticks can attach to a single moose for the winter months. In spring, ticks often drop off and find a new host. Winter ticks don't spread disease, but they do cause significant blood loss, hair loss (visible in the picture above) and behavior changes that impact survival.

BLOOD LOSS 5

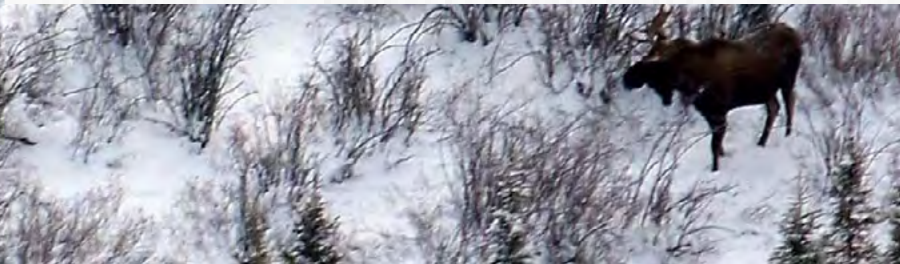
Moose calves are most harmed by winter ticks. Calves have little body fat and are slower to replace the blood sucked by ticks. This graphic compares how much blood the average tick infested bull, calf and cow moose must replace.



Graphic adapted from Maine Department of Inland Fisheries & Wildlife.

Monitoring winter ticks

Like mule deer, winter ticks benefit from a milder climate. A longer snow-free period in early winter provides more time to infect their hosts. Monitoring is important to assess future risk of winter ticks in Alaska, especially as winters warm. The Council of Athabascan Tribal Governments will be collecting ticks found on dogs (and checks for presence on harvested moose) and sending them in for identification and testing.



BIRDS

Photo by US FWS

LESSER SCAUP IDENTIFICATION

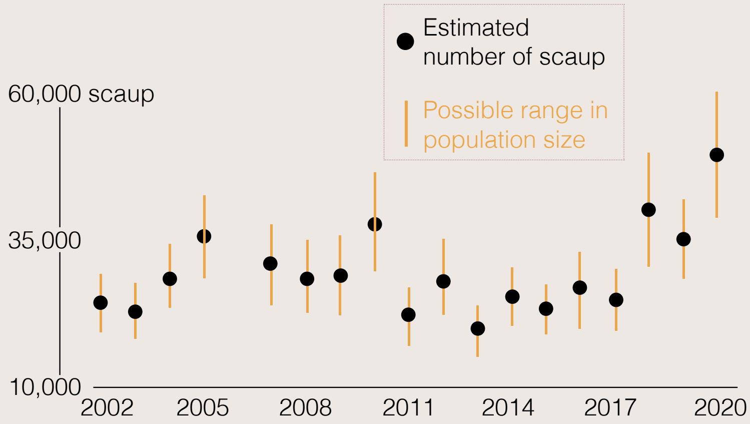
Lesser scaup are a medium-sized duck, with a peaked head and a yellow eye. Males have a black head, front and tail, but white to gray sides.

LESSER SCAUP

Lesser scaup are found nesting across Yukon Flats. Although they are declining in other parts of their breeding range in Alaska, Canada and the Lower 48 states, their numbers have been stable or increasing on Yukon Flats since the early 2000s.

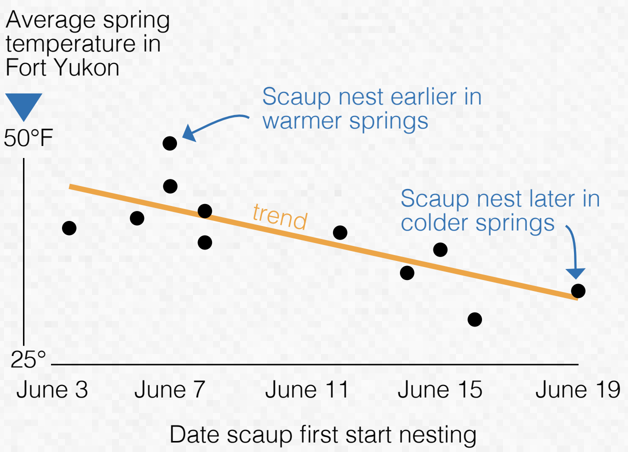
STABLE SCAUP NUMBERS 6

This graph shows the estimated scaup population size on Yukon Flats. Scaup are counted from aerial surveys of over 6,000 square miles of wetland habitat between Stevens Village, Chalkyitsik, Birch Creek and Venetie.



Yukon Flats scaup nest earlier when it's warmer 6

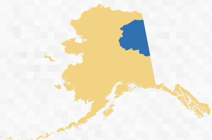
Nesting data from 2001–2013 on Yukon Flats shows that scaup can adjust their breeding with changing spring conditions. This graph compares the average temperature in Fort Yukon from May 1–15 to the date when scaup begin nesting. It shows that scaup nest earlier in years when temperatures are warmer, and later in years when temperatures are colder.

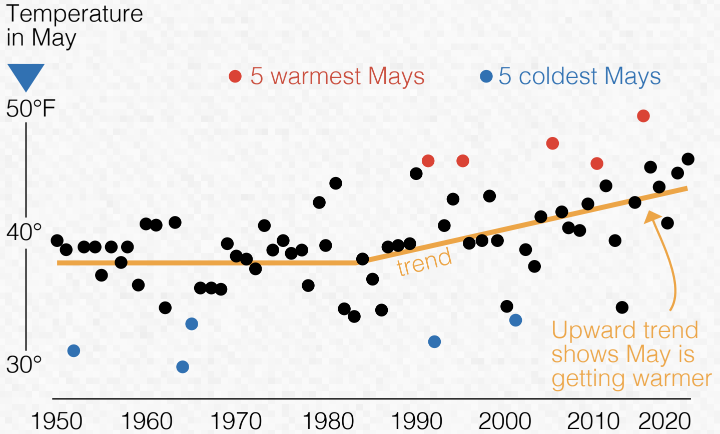


Warmer spring means stronger ducklings 1

May temperatures—when scaup arrive on Yukon Flats—have been warming since the 1980s. This graph shows the average May temperature since 1950 in the Upper Yukon Valley (blue area on the map). The five warmest Mays (red dots) all occurred in the past 30 years.

In warm years, early bird arrival followed by early nesting gives ducklings more time to grow fat and strong before migrating south. The longer growing season also allows birds to re-nest if their first attempt fails.





BIRDS

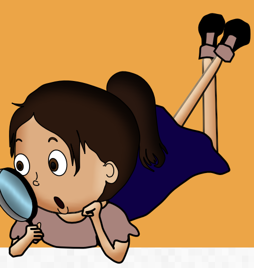
RUDDY DUCK 7

A species of duck uncommon in the interior of Alaska is now nesting on Yukon Flats. In 2017 and 2018, a brood of ruddy ducks was observed in July during annual brood surveys. Biologists assume the species is moving northward as spring comes earlier. Average Yukon River break-up at Fort Yukon starts about a week earlier than it did in the early 1900s. Lakes and ponds on Yukon Flats are now ice-free earlier and likely give species like the ruddy duck more time to nest and raise ducklings.

Photo by Adam Grimm

KIDS CORNER

Fun facts about the ruddy duck (scientific name Oxyura jamaicensis)



1. Ruddy ducks are excellent divers and swimmers! They forage for food on the bottoms of lakes and ponds.
2. They use their shovel-shaped bills to "scoop" food.
3. In Yukon Flats, ruddy ducks like to eat aquatic insects, larvae and seeds.
4. Males blow bubbles with their bills to attract females! The males inflate their necks and rapidly hit their chests with their bills. This makes the water bubble.
5. Ruddy ducks are sometimes nicknamed "bubblers" for the bubbles they make in this courtship display.
6. Female ruddy ducks lay the biggest eggs of any North American duck!

COLOR BY NUMBERS 8

1 — sky blue
2 — light blue
3 — black
4 — gray
5 — dark gray
6 — red brown
7 — dark brown
8 — light brown
9 — white
10 — orange
11 — Dark orange
12 — blue
13 — dark blue

PERMAFROST

Permafrost on Yukon Flats and across Alaska is changing. Warmer temperatures and increasing wildfires can thaw permafrost. This triggers a cascade of changes from shifting plant communities to new wetland dynamics. On Yukon Flats, the Council of Athabaskan Tribal Governments is helping measure permafrost thaw to better understand future changes.

Permafrost thaw can drain or create lakes

Frozen ground traps water near the surface keeping soils from easily draining. As permafrost under wetlands thaws, the water can drain, turning lakes and bogs into meadows. On Yukon Flats, thawing permafrost causes some lakes to rapidly drain, while others slowly shrink. When ice-rich permafrost thaws, it can leave behind new lakes, or cause existing lakes to expand.

Active layer above permafrost

The soil above permafrost that thaws every summer is called the active layer. The temperature of the active layer is usually kept low by the frozen ground below. The cool soils slow plant growth and limit the types of plants that grow. As permafrost thaws and moves farther from the surface, the soil above warms more easily and different types of plants can grow.

Permafrost stores carbon

Permafrost contains a lot of carbon from dead plants and animals. In frozen soil, these dead organisms decay slowly and over thousands of years the amount of carbon has built up. As permafrost thaws, the speed of decay increases which releases the stored carbon into the atmosphere as a greenhouse gas. Greenhouse gases contribute to global climate warming.

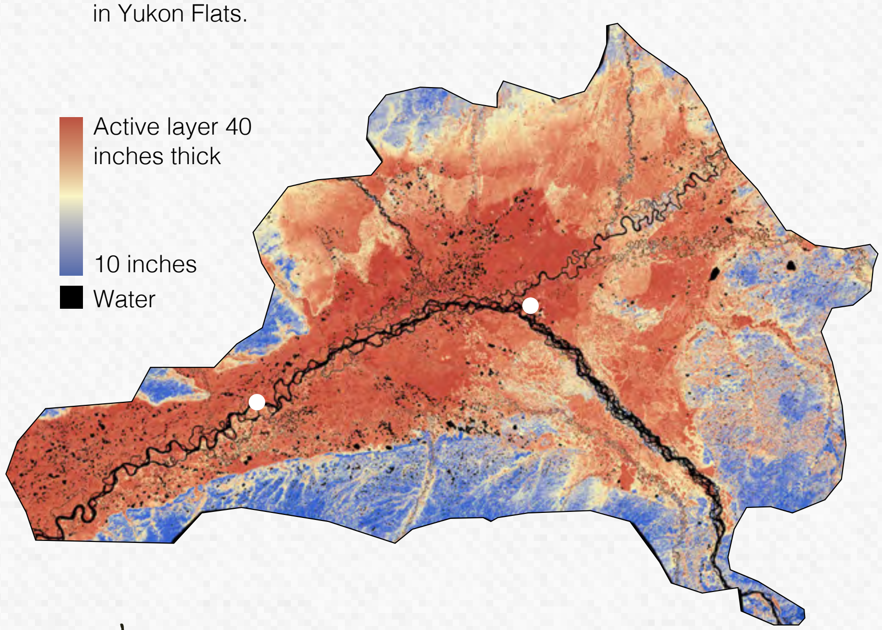
ICE WEDGE

Permafrost on Yukon Flats is ice rich, especially the Yedoma discussed on page 9. This photo shows an ice wedge with a thick soil active layer above that protects the frozen permafrost from thaw.

Photo by Ben Jones

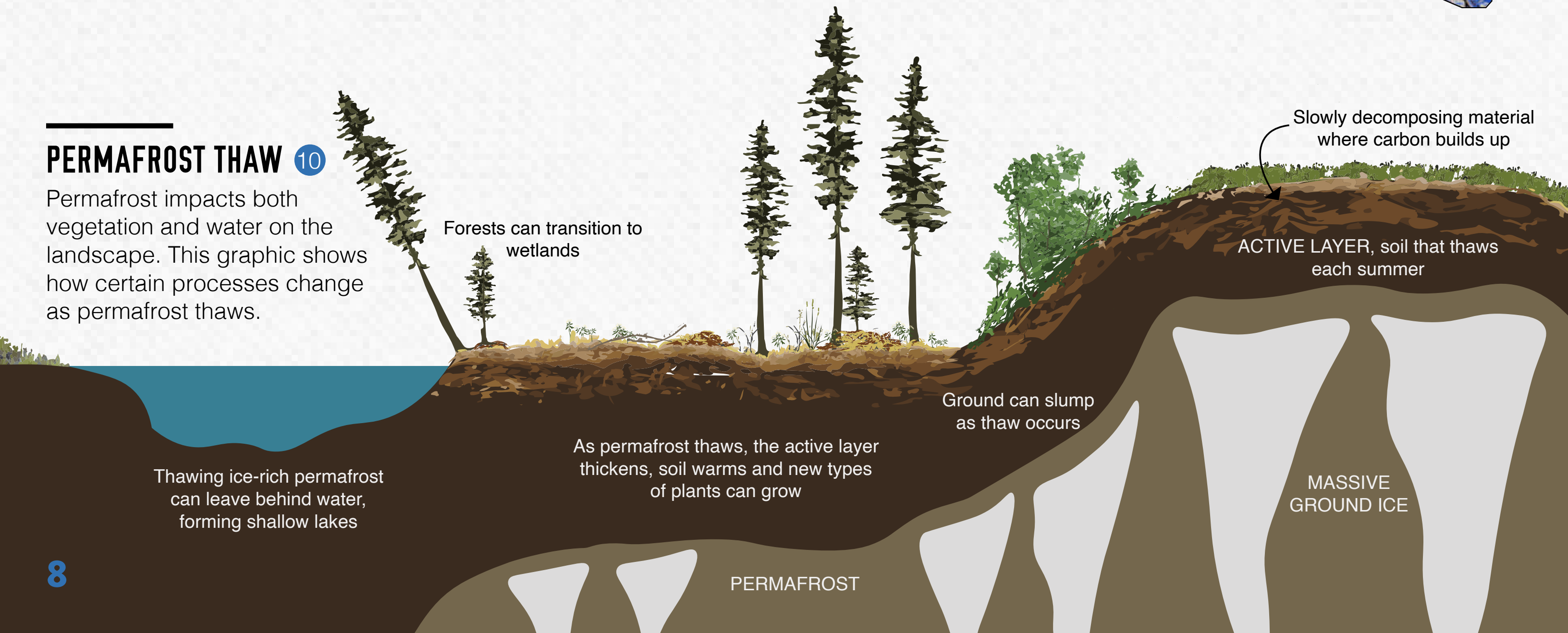
SUMMER THAW DEPTH 9

This map shows the active layer thickness in summers 2009 and 2010. As Yukon Flats warms, permafrost thaws and the depth of the active layer will likely increase. This data will allow for future comparisons of permafrost thaw in Yukon Flats.



PERMAFROST THAW 10

Permafrost impacts both vegetation and water on the landscape. This graphic shows how certain processes change as permafrost thaws.



YEDOMA

The foothills of Yukon Flats have a specific type of permafrost called Yedoma. Yedoma is very old, ice-rich permafrost that formed during the ice ages. As glaciers formed over the southern Brooks Range they ground rock into fine silt. Wind carried this silt, depositing it in the foothills of Yukon Flats. The silt settled and froze rapidly, preserving plant and animal material before it had time to decay, creating huge stores of carbon. In places, Yedoma on Yukon Flats can be 150 feet deep.

Yedoma thaws more quickly

Yedoma has two characteristics that make it particularly susceptible to rapid thaw. First, Yedoma contains lots of ice. When the massive sections of ice melt, it can bring heat deep into Yedoma. This speeds up thaw and can cause the ground to sink, forming deep lakes. Secondly, Yedoma has fine silty soil. Water can quickly erode the soil, which also speeds up thaw.

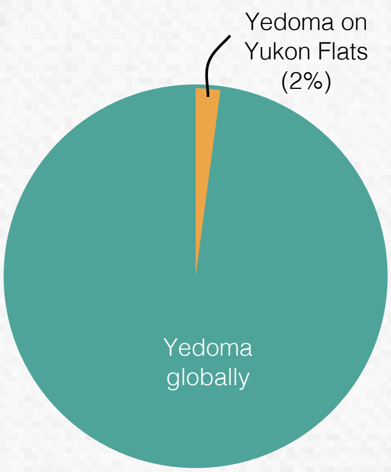
Beyond these local changes, thawing Yedoma releases carbon as a greenhouse gas which contributes to global climate warming.

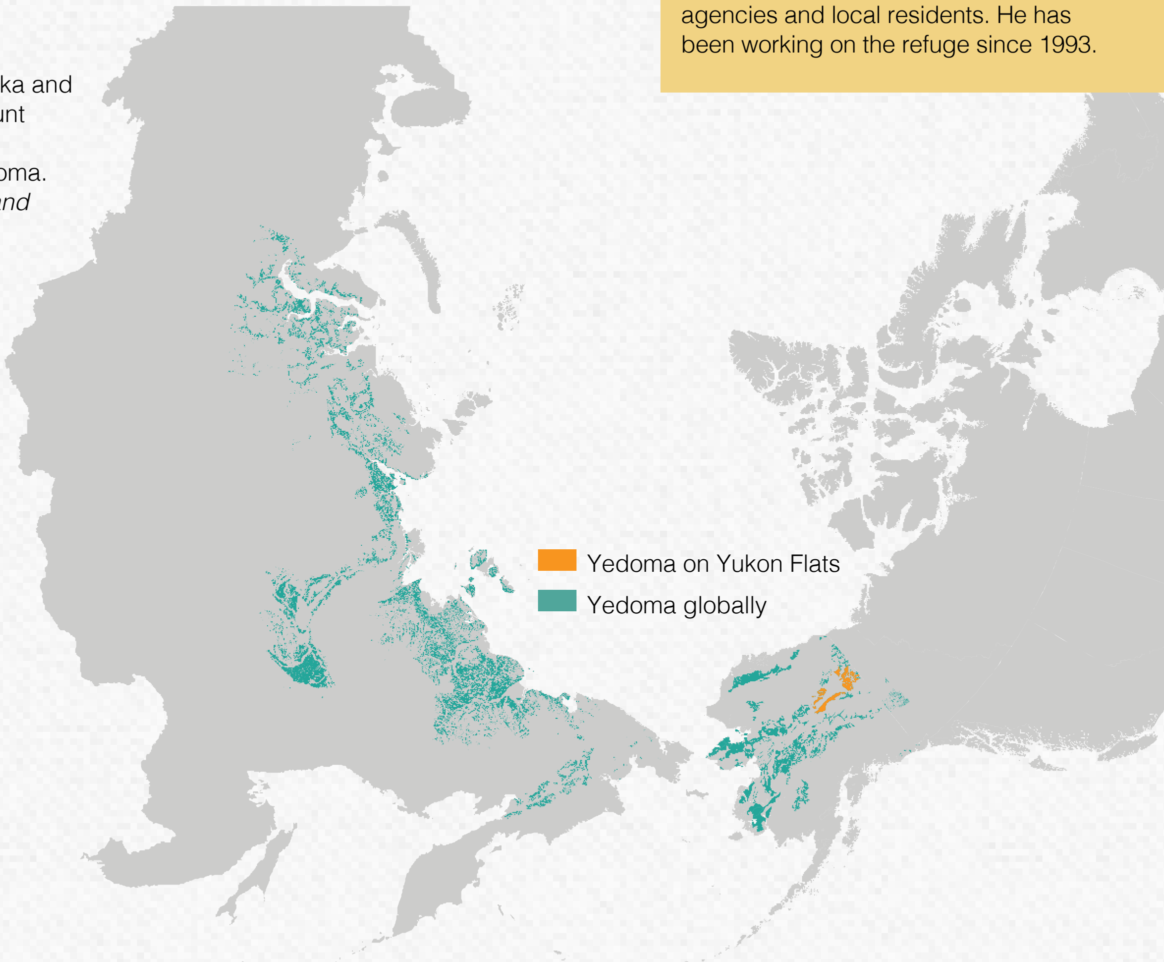
MARK BERTRAM — *Yukon Flats Staff*

Mark is the Supervisory Wildlife Biologist at Yukon Flats. Mark coordinates the plant and animal surveys and other research on the refuge conducted by staff, other agencies and local residents. He has been working on the refuge since 1993.

WHERE IS THE YEDOMA (11)

Yedoma occurs predominantly in Alaska and Russia, although there is a small amount in Yukon, Canada. Yedoma on Yukon Flats makes up 2% of the world's Yedoma. **Estimate is based on percent cover and does not account for Yedoma depth.*

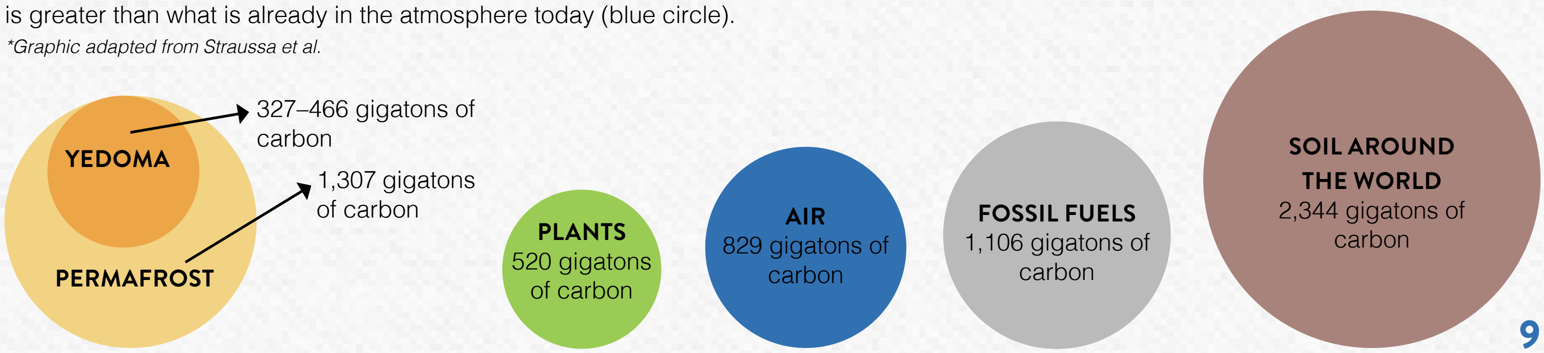




HOW MUCH CARBON? (12)

The circles below compare the amount of carbon stored in different sources. 25–35% of the carbon stored in permafrost (light orange) is in Yedoma (dark orange). These circles also show that the amount of carbon stored in permafrost is greater than what is already in the atmosphere today (blue circle).

**Graphic adapted from Straussa et al.*



LAKES

LAKE DRYING

The tan areas in this satellite photo show where wetlands and lakes have dried in the southern Yukon Flats.

WETLANDS

Yukon Flats is known for its highly productive brackish wetlands that contain a mix of salty and fresh water surrounded by meadow shorelines. These wetlands are due to soils naturally high in alkali salts and a warm, dry climate where evaporation periodically exceeds the inflow of water. During spring thaw and summer rainfall events, freshwater runs through these salty lowlands, creating brackish wetlands that become enriched with nutrients. These wetlands have the highest diversity and density of plants, insects and waterbirds on Yukon Flats.

Brackish wetlands and climate change

When more water evaporates from brackish wetlands than flows into them, the salt concentration increases to the point where soils can become too rich for existing plants and insects to tolerate. This makes brackish wetlands vulnerable to climate change. Increased warming can tip the balance of these productive wetlands, causing them to become too enriched or dry out entirely. Changes in hydrology, permafrost, precipitation and temperature have already caused many wetlands on Yukon Flats to dry up since the 1980s. Breeding waterbirds that fed on the previously abundant plants and insects can be negatively impacted.

Some Yukon Flats wetlands are expanding

In addition to brackish wetlands, Yukon Flats also has numerous freshwater bogs and marshes with forested shorelines. While brackish wetlands are drying, some freshwater bogs are expanding as ice-rich permafrost thaws and from flooding. However, these areas tend to be less productive with lower aquatic plant diversity.

NIKKI GULDAGER — *Yukon Flats Staff*

Nikki is a wildlife biologist and pilot at Yukon Flats. She flies aerial wildlife surveys and supports remote field camps. She is interested in habitat and has biology projects focused on everything from wetlands to mammals.

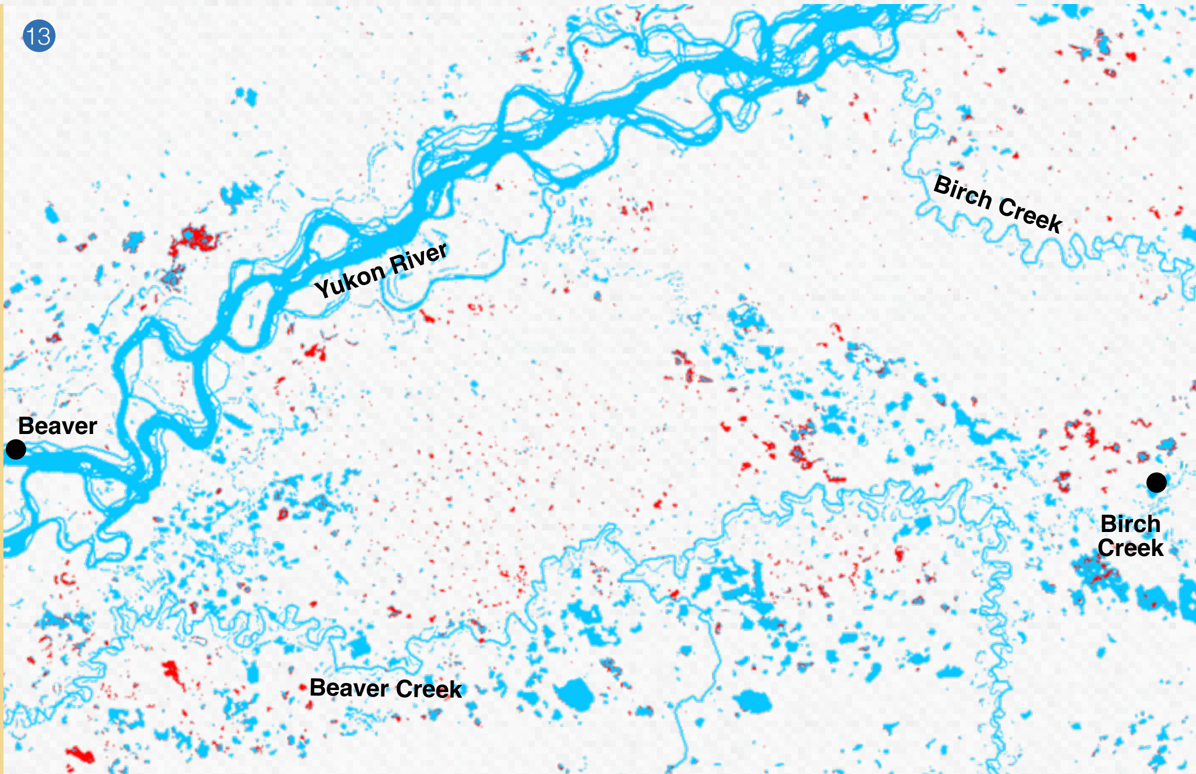
GWICHYAA GWICH'IN GINKHII

— The Yukon Flats People Speak

"Drying wetlands can affect migratory bird patterns and cause access problems as we hunt ducks and geese. I notice brush growing around the drying lakes. I notice alders growing where there used to be willows. The weather now is more unpredictable. Sometimes it'll be warm and then cold for a bit. It affects hunting and gathering and the collection of traditional foods."

~Randy Mayo, Stevens Village Tribe

RIGHT: Map shows lakes, rivers and streams on Yukon Flats that had water in them in 2019 (blue). The red areas show the lakes that shrank or dried up since 1984.



FISH

WHITEFISH

Whitefish are an important food for people living in the Yukon River drainage. In spring, several species of whitefish migrate into shallow flatland lakes on Yukon Flats to feed on the aquatic invertebrates that thrive in these environments. Most of the lakes are too shallow for whitefish to overwinter in, so they return to larger, deeper rivers in late summer or fall.

Whitefish lose access to feeding habitat

Warmer temperatures in recent decades and the subsequent thawing of permafrost has resulted in numerous lakes drying out in the southern Yukon Flats. When this happens, the streams connecting the shallow lakes to rivers are lost. Fish can no longer access these productive lakes in summer to feed. The impact of lake drying on the whitefish populations in Yukon Flats remains to be seen.

LAKE CONNECTIONS 14

These photos show how lake drying can cut off fish access to feeding areas. The left photo shows a series of lakes with streams connecting them to the Christian River in the northern Yukon Flats. The right photo shows a drying lake in the southern Yukon Flats that is no longer connected to other lakes or rivers.

BRYCE LAKE — *Yukon Flats Staff*

Bryce is a wildlife biologist at Yukon Flats. His work focuses on aerial and ground surveys of birds and mammals, plus banding waterfowl. In the photo, Bryce holds a female northern pintail and green-winged teal after banding them.

HOLLY CARROLL — *US FWS Staff*

Holly is the Yukon River Subsistence Fishery Manager for the Fish and Wildlife Service. She specializes in salmon.

RANDY BROWN — *US FWS Staff*

Randy is a fisheries biologist at the Fish and Wildlife Service. He spent many years living along the Yukon River and now specializes in species that live in the river like sheefish, cisco and whitefish.

FISH

CHINOOK SALMON [15]

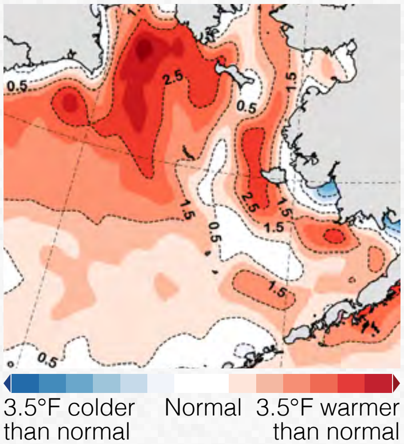
Yukon River fishermen have said for decades that Chinook (king) salmon are getting smaller. Recent scientific studies show that this is a problem for salmon across Alaska and the Pacific Northwest.

Chinook lifecycle

Chinook salmon in the Yukon River typically spend a winter as eggs incubating in the gravel. After hatching, young fish spend another year growing in the river before migrating downstream into the Bering Sea. They feed and grow for 2–5 years in the ocean before returning to their natal rivers as mature fish between 4 and 7 years of age. The largest and oldest fish in the population, those age-6 and 7, have declined in length since 2000. Additionally, these older fish now make up a smaller component of the run than they used to.

Chinook grow faster in a warm ocean

One reason there are fewer age-6 and 7 Chinook salmon is warmer temperatures in the Bering Sea. In warming waters young fish can grow faster and mature earlier than they normally would in a colder ocean. Older fish are generally larger than younger fish and larger females produce more eggs than smaller females. As Chinook salmon decline in size, or spawn at younger ages, they deposit fewer eggs in the gravel and produce fewer offspring.



OCEAN TEMPERATURE [16]

Though Bering Sea ocean temperatures were not as warm in 2020 as in 2018 or 2019, they were still several degrees warmer than normal in most areas. This map compares water temperatures in October–December, 2020 to the longterm average.

Other reasons for smaller Chinook

Decades of fishermen targeting the biggest salmon can remove their genes from the river system. More work is needed to find out how this and other factors contribute to smaller salmon in the Yukon River. Conservation-minded fishermen in the Yukon continue to be important partners as we work to conserve Chinook, especially the oldest and largest fish, so that they can reach the spawning grounds. For Chinook, this means using 6-inch or smaller mesh gill nets rather than the largest legal gear, which is 7.5-inch mesh.

GWICHYAA GWICH'IN GINKHII

— The Yukon Flats People Speak

"Fishing this past year was poor for myself and family, but also for everyone else in our community. The numbers were low, the fish were poor, and just all around not as good ... Water levels were high and we had to deal with a lot of debris making fishing difficult. This with [fewer] fish available to harvest accounted for less in my freezer and [fewer] available to share."

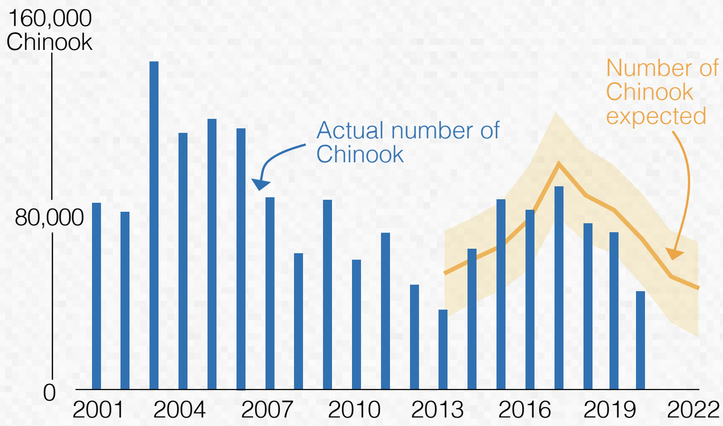
~Julie Mahler, Fort Yukon

Chinook outlooks are low

Along with smaller fish, Chinook salmon run sizes across Alaska have been below average to poor since 2008. The Yukon River Chinook salmon that pass through Yukon Flats are part of the Canadian-origin stock that makes up about 42% of the overall Chinook run. In summer 2021, fisheries managers expect there to be 57,000 Chinook salmon in the Canadian-origin run. A run of this size may not be large enough to meet escapement goals or provide much harvest opportunity.

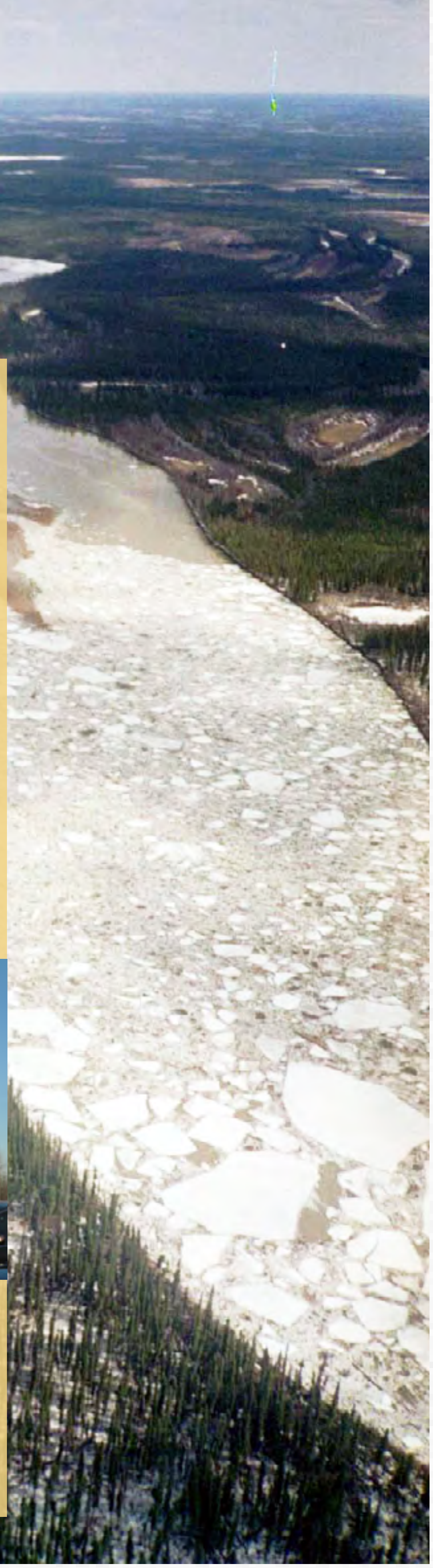
FEWER CHINOOK PASS THROUGH YUKON FLATS [17]

This graph shows the number of fish in the Chinook salmon run that passes through Yukon Flats. The run has been low in recent years because there are fewer juvenile Chinook in the northern Bering Sea since 2017. Based on this, Yukon River run sizes are expected to continue declining in 2021 and 2022.



CHUM SALMON

Fisheries managers expect there to be 1.2 million summer Chum salmon and 652,000 fall Chum salmon in the Yukon River during 2021. These runs should be large enough to meet escapement goals, provide subsistence and other harvest uses. Even so, a cautious early season approach to management is warranted based off last year's poor return of age-4 Chum salmon across the state.



RIVERS

GWICHYAA GWICH'IN GINKHII

— The Yukon Flats People Speak

Break-up is calmer now than it was in the past, "now there is less water and flooding in Chalkyitsik." It used to flood every year, "the river would rise two to three feet," and there were more ice jams. People had to move their belongings up to higher ground every spring because they knew the flood would be coming. "But there were lots of muskrats and ducks in the spring," so they would have a potlatch and enjoy living and connecting together.

~ Beaver Traditional Chief Paul Williams, Sr. (pictured below)

"River takes longer to freeze..break-up varies on how much rain and snow."

~Peter Druck, Chalkyitsik.

BACKGROUND PHOTO: shows the Yukon River breaking up on May 3, 2005 above Beaver.

BREAK/FREEZE-UP

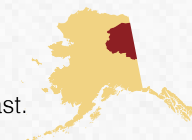
Of all the environmental changes projected for Yukon Flats, the most significant impacts are related to water. Beyond permafrost thaw (page 8) and wetland drying (page 10), scientists also expect increased water flow, flooding and more woody debris. These changes affect wildlife, subsistence activities as well as the timing and severity of break-up and freeze-up.

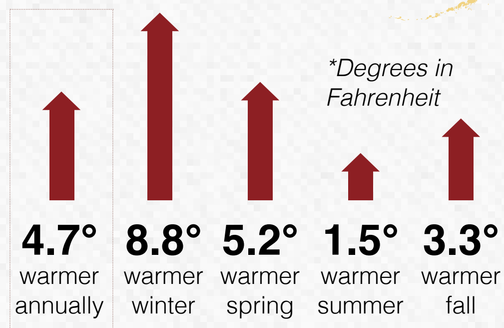
Warmer temperatures control ice

Break-up across Alaska now occurs on average about two days earlier and freeze-up about two days later than it did 30 years ago. Fort Yukon break-up records support this trend. Warmer air temperatures are partially responsible. The Upper Yukon Valley is 4.7°F warmer on average than it was in 1950.

EVERY SEASON IS WARMER [1]

Every season has warmed in the Upper Yukon Valley (red area on the map) since 1950. The relative size of each arrow shows that winter warmed the most, while summer changed the least.



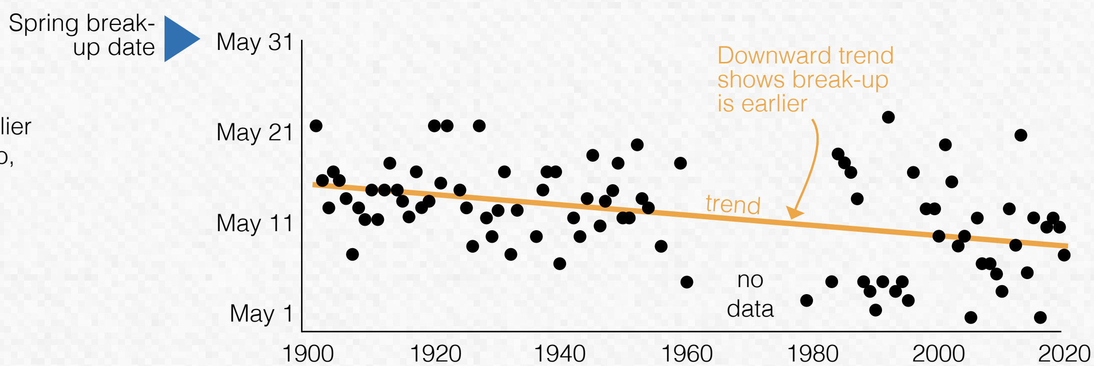


Break-up and freeze-up timing impact travel and access to subsistence resources

Today break-up and freeze-up are less predictable. Break-up is earlier, often less violent with fewer ice jams and flooding. Freeze-up is now later with a longer slush season, thinner more dangerous ice, and open water in mid-winter is common. These changes limit access to subsistence resources and have led to the loss of human life.

BREAK-UP IS EARLIER [18]

The right graph shows that at Fort Yukon spring break-up of the Yukon River is happening about a week earlier than it did in the early 1900s. Even so, break-up date is extremely variable and in some years does not happen until the third week of May.



EROSION

Near Beaver, Fort Yukon and Stevens Village, the amount of water (called the flow) coming down the Yukon River in winter and spring has been increasing since 1977. This increased flow is caused by warming temperatures and is responsible for higher erosion rates. As warming continues into the future, the high water season may be longer each spring causing more erosion.

In addition to threatening buildings near the river's edge, erosion can block or obstruct boating corridors. Since the Yukon River is essential for travel to communities and the fishing spots residents depend on, these changes can have negative impacts on locals. Increased debris from eroding banks can damage fishing equipment and reduce safety. For example, residents of Nulato described how trees floating downstream of eroding banks damaged fish wheels and disrupted harvest activities. [19]

GWICHYAA GWICH'IN GINKHII

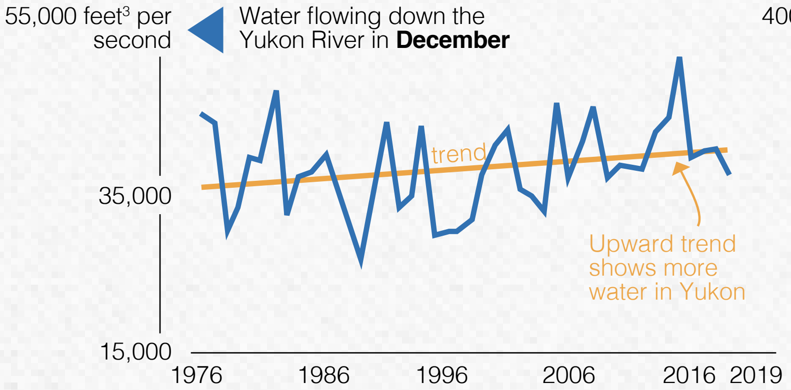
— The Yukon Flats People Speak

"Rivers are eroding- getting wider and shallow."

~Chief Eddie Frank, Venetie

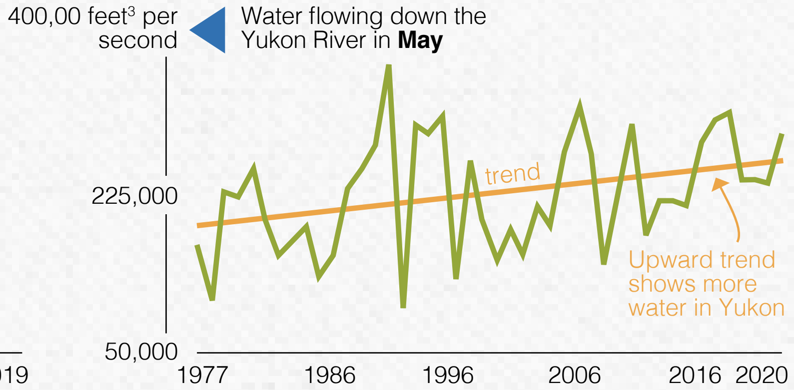
MORE WATER IN DECEMBER [20]

This graph shows how much water flows down the Yukon River past Stevens Village in December. More water comes down the river now than in the 1970s.



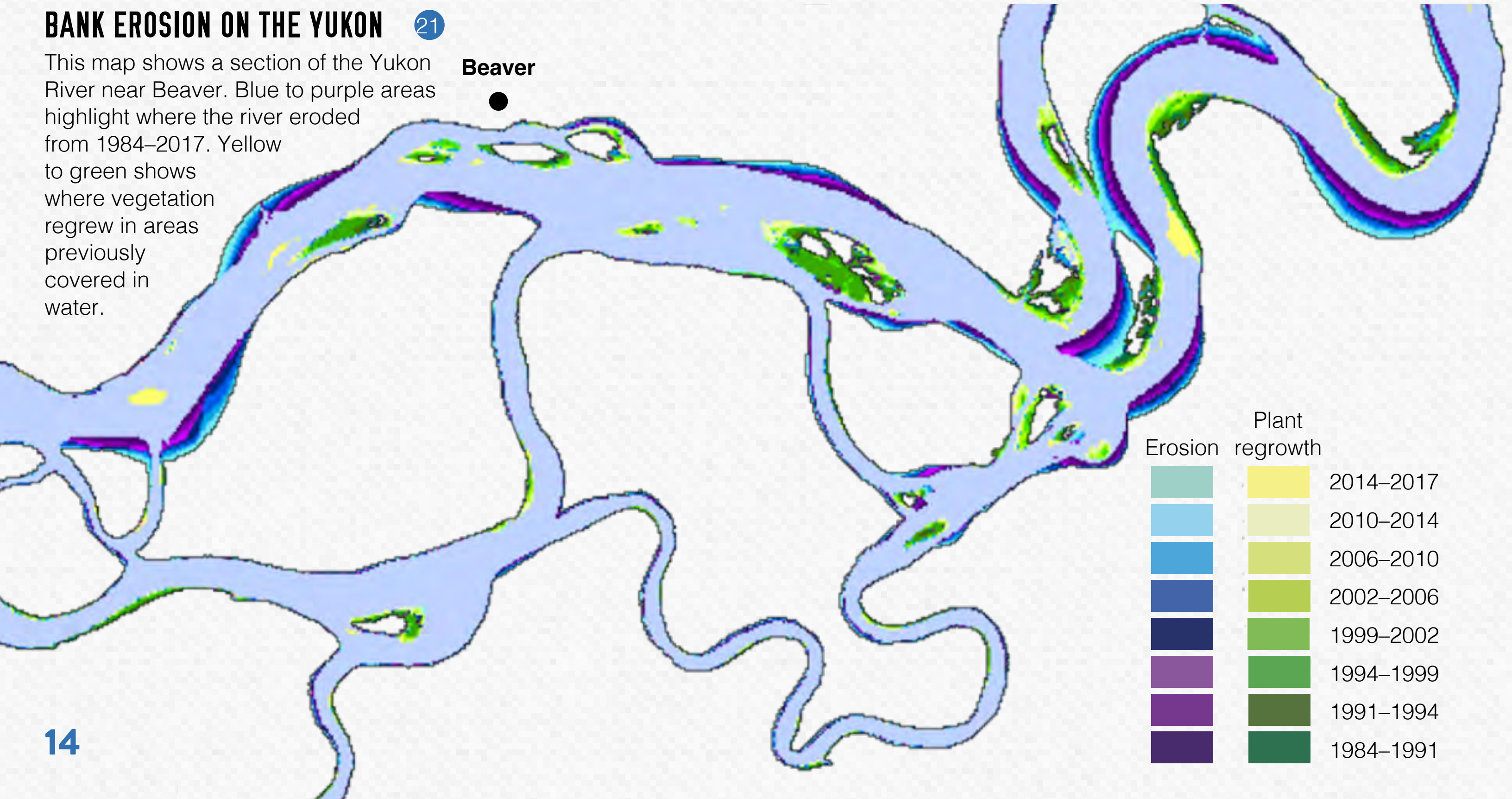
MORE WATER IN MAY [20]

This graph shows how much water flows down the Yukon River in May. Like in December, considerably more water comes down the river now than in the 1970s.



BANK EROSION ON THE YUKON [21]

This map shows a section of the Yukon River near Beaver. Blue to purple areas highlight where the river eroded from 1984–2017. Yellow to green shows where vegetation regrew in areas previously covered in water.



WILDFIRE

Although wildfire varies hugely from season to season, several trends are emerging in Yukon Flats and Alaska. More acres are burning, fires are more frequent, and more fires reburn the same location or smolder underground, surviving winter and reigniting the next spring. Since 1988, the frequency of years that burned over 250,000 acres on Yukon Flats quadrupled.

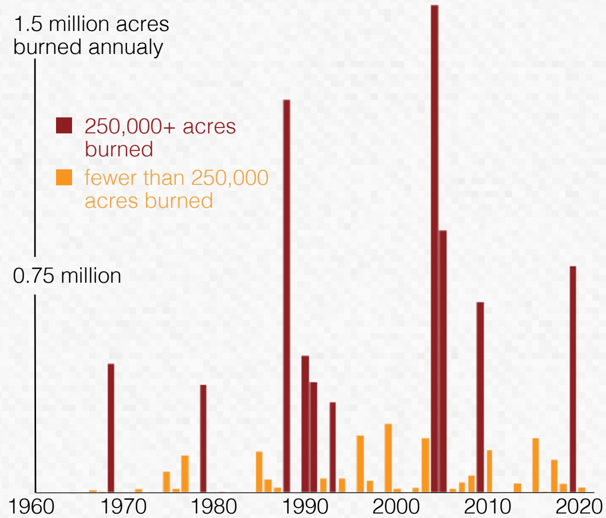
In 2010, researchers collected sediment cores from over a dozen lakes in Yukon Flats. These long, cylindrical samples provided a snapshot of the past 10,000 years. A careful look at charcoal deposits in the samples showed that the highest fire frequency and the most burning happened in recent decades.

Impacts to human health

Wildfires impact human health and reduce visibility. Smoke is especially harmful to older people and children as well as the unborn, because small smoke particles can enter the bloodstream and damage the brain, lungs and liver. When it is smoky, people can reduce their risk by closing windows and doors, wearing N95 respirator masks and cleaning indoor air with portable air filters.

INCREASED ACRES BURNED [22]

Area burned by wildfire varies tremendously from year to year. Factors such as temperature, drought, and earlier snow melt contribute to this variation. Over the past 30 years, Yukon Flats experienced a clear shift toward more frequent large fire seasons with hundreds of thousands of acres burned, although years with relatively few burned acres are still common.

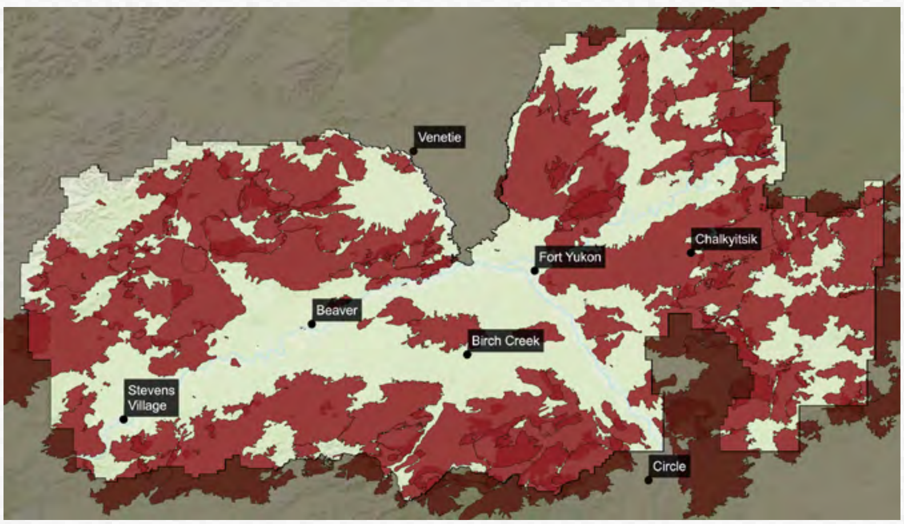


A positive note about carbon and wildfire [23]

Fires that burn deep into the soils can remove enough organic material to create a suitable seedbed for deciduous trees, like birch and aspen, to thrive. These severe burns can replace slow growing black spruce with fast growing birch and aspen, like in the forests around Chalkyitsik. Birch and aspen are less flammable, and fire burns them more slowly, less severely and less frequently. By storing most of their carbon above ground in the trunk and branches, they can store up to five times more carbon than spruce. New research suggests that in a deciduous dominated landscape fire activity may become less frequent, and there may be less carbon in the atmosphere.

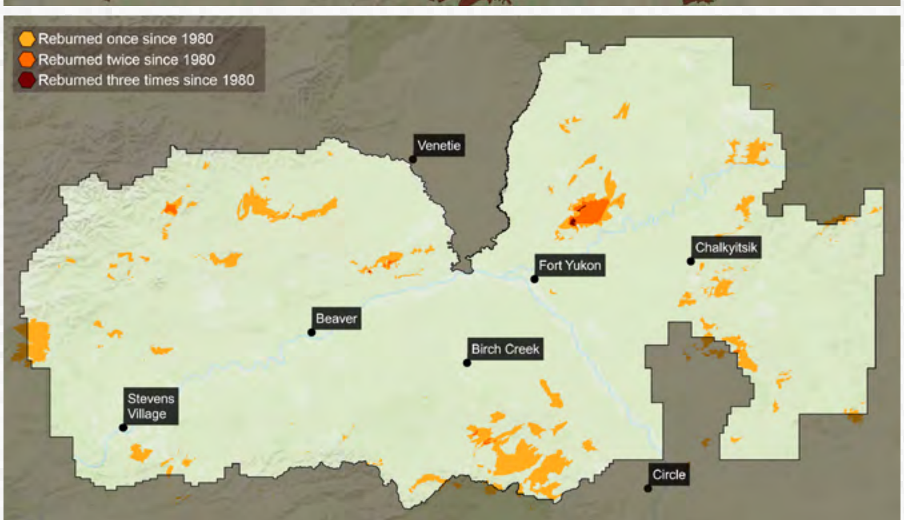
FIRE PERIMETERS [22]

This map shows the fire perimeters from 1960–2020 on Yukon Flats. In the past 60 years, wildfire burned over 8 million acres and touched 64% of the refuge at least once. Wetlands along the Yukon River are least affected by fire.



BURNING AGAIN [22]

A reburn occurs when fire impacts the exact same spot previously burned. Since 1980, 29 fires burned in areas of Yukon Flats that had already burned during the previous 20 years. Some areas reburned up to three times (shown in red on map). Reburn fires in Alaska are happening more frequently. Land managers are concerned about this trend because fire suppression personnel may no longer be able to rely on recently burned areas as effective barriers to new fire growth.



GWICHYAA GWICH'IN GINKHII

— The Yukon Flats People Speak

"Too many fires. There are some areas [that are] unrecognizable."

~ Linda Wells, Fort Yukon

ACKNOWLEDGMENTS

This summary of Yukon Flats environmental changes would not have been possible without the contributions of many individuals and organizations. At right we list the local residents who provided observations. Below are sources for data and information. Each number is associated with the blue circles found throughout the publication. We provide the name the individual who compiled the information and the data source, report or scientific publication it came from.

We thank each contributor for their generosity and dedication to understanding changes on Yukon Flats.

GWICHYAA GWICH'IN GINKHII

— The Yukon Flats People Speak

Pages 3, 12—Julie Mahler, Fort Yukon, CATG & US FWS Refuge Information Technician

Page 10—Randy Mayo, Stevens Village Tribal member

Page 13—Pete Druck, Chalkyitsik

Page 13— Beaver Traditional Chief Paul Williams, Sr., CATG & US FWS Refuge Information Technician

Page 14— Chief Eddie Frank, Venetie

Page 15—Linda Wells, Fort Yukon

DATA SOURCES

1 • Rick Thoman, Alaska Center for Climate Assessment and Policy (data source: ERA5 courtesy of ECMWF/Copernicus)

2 • Rick Thoman, Alaska Center for Climate Assessment and Policy (data source: National Resources Conservation Service, actual date last week of March to first week of April)

3 • Mark Bertram, Yukon Flats National Wildlife Refuge (from: Van de Kerk et al. 2020. Environmental Influences on Dall's Sheep Survival. The Journal of Wildlife Management; DOI: 10.1002/jwmg.21873)

4 • Bryce Lake, Yukon Flats National Wildlife Refuge (from: Lake, B. et al. 2018. Moose population survey of the western Yukon Flats – November/December 2018. Yukon Flats National Wildlife Refuge Report)

5 • Maine Department of Inland Fisheries & Wildlife (from: https://bit.ly/3b89IMn)

6 • Nikki Guldager, Yukon Flats National Wildlife Refuge (data source: US Fish and Wildlife Service)

7 • Bryce Lake, Yukon Flats National Wildlife Refuge (from: Lake, B. 2019. Northwest limit of the breeding range of the Ruddy Duck. Western Birds. https://bit.ly/3nzr49R)

8 • Sara Wolman

9 • Mark Bertram, Yukon Flats National Wildlife Refuge (from: Rey, D. M. et al. 2019. Investigating lake-area dynamics across a permafrost-thaw spectrum using airborne electromagnetic surveys and remote sensing time-series data in Yukon Flats, Alaska. Environmental Research Letters; https://bit.ly/2QG3Dzq)

10 • Adapted by Heather McFarland, International Arctic Research Center (from: Jin, X. Y., Iwahana, G., et. al. (2020). Impacts of climate-induced permafrost degradation on vegetation: A review. Advances in Climate Change Research; https://bit.ly/3oCva1r)

11 • Nikki Guldager, Yukon Flats National Wildlife Refuge (data source: Arctic Permafrost Geospatial Centre, https://bit.ly/3w3wNYv)

12 • Nikki Guldager, Yukon Flats National Wildlife Refuge (from: Strauss, J. et al. 2017. Deep Yedoma permafrost: A synthesis of depositional characteristics and carbon vulnerability. Earth-Science Reviews.; https://bit.ly/330WjB3)

13 • Nikki Guldager, Yukon Flats National Wildlife Refuge (from: Pekel, J. et al. 2016. High-resolution mapping of global surface water and its long-term changes. Nature; nature.com/articles/nature20584)

14 • Randy Brown, US Fish and Wildlife Service (data source: US Fish and Wildlife Service)

15 • Holly Carroll, US Fish and Wildlife Service (data source: US Fish and Wildlife Service)

16 • Rick Thoman, Alaska Center for Climate Assessment and Policy (data source: NOAA/PSL/ESRL)

17 • Sabrina Garcia, Alaska Department of Fish & Game (from: Murphy et al. 2021. Northern Bering Sea surface trawl survey, 2019. AKSSF Final Report, Project #51002. https://bit.ly/3nRU90m)

18 • Rick Thoman, Alaska Center for Climate Assessment and Policy (data source: NWS/Alaska-Pacific River Forecast Center)

19 • Todd Brinkman, University of Alaska Fairbanks (from: Cold, H. S. et al. 2020. Assessing vulnerability of subsistence travel to effects of environmental change in Interior Alaska. Ecology and Society 25(1):20. https://doi.org/10.5751/ES-11426-250120)

20 • Nikki Guldager, Yukon Flats National Wildlife Refuge (data source: USGS National Water Information System; nwis.waterdata.usgs.gov/ak/nwis/ at Stevens Village)

21 • Nikki Guldager, Yukon Flats National Wildlife Refuge (from: Brown, D. R. et al. 2020. Implications of climate variability and changing seasonal hydrology for subarctic riverbank erosion. Climatic Change; https://bit.ly/3eGBGjd)

22 • Zav Grabinski, Alaska Fire Science Consortium (data source: Alaska Interagency Coordination Center)

23 • From: Mack, M. C. et al. 2021. Carbon loss from boreal forest wildfires offset by increased dominance of deciduous trees. Science; sciencemag.org/content/372/6539/280

Photo by Lisa Hupp

Share your observations of changes on Yukon Flats! Call us at 1-800-531-0676 or share it on Facebook www.facebook.com/YukonFlatsNationalWildlifeRefuge.

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