

Each spring, Iñupiat hunters route and build trails across the shorefast sea ice off Utqiagvik to access hunting sites along the lead edge as they pursue the bowhead whale during its spring migration to the Beaufort Sea. Since 2007, an ongoing collaboration between whalers, scientists, and local organizations have worked together to map and survey the community's spring whaling sea ice trails and measure the average thickness of the ice.



This book has been compiled by the Alaska Arctic Observatory & Knowledge Hub to serve as a compilation of the history of trail mapping research collaborations in Utqiagvik as well as to provide annual summaries of maps and activities surrounding spring whaling over nearly 20 years, 2008-2024. We hope this will be a celebration of our long term collaborations as well as a useful resource to look back on for the whaling community.



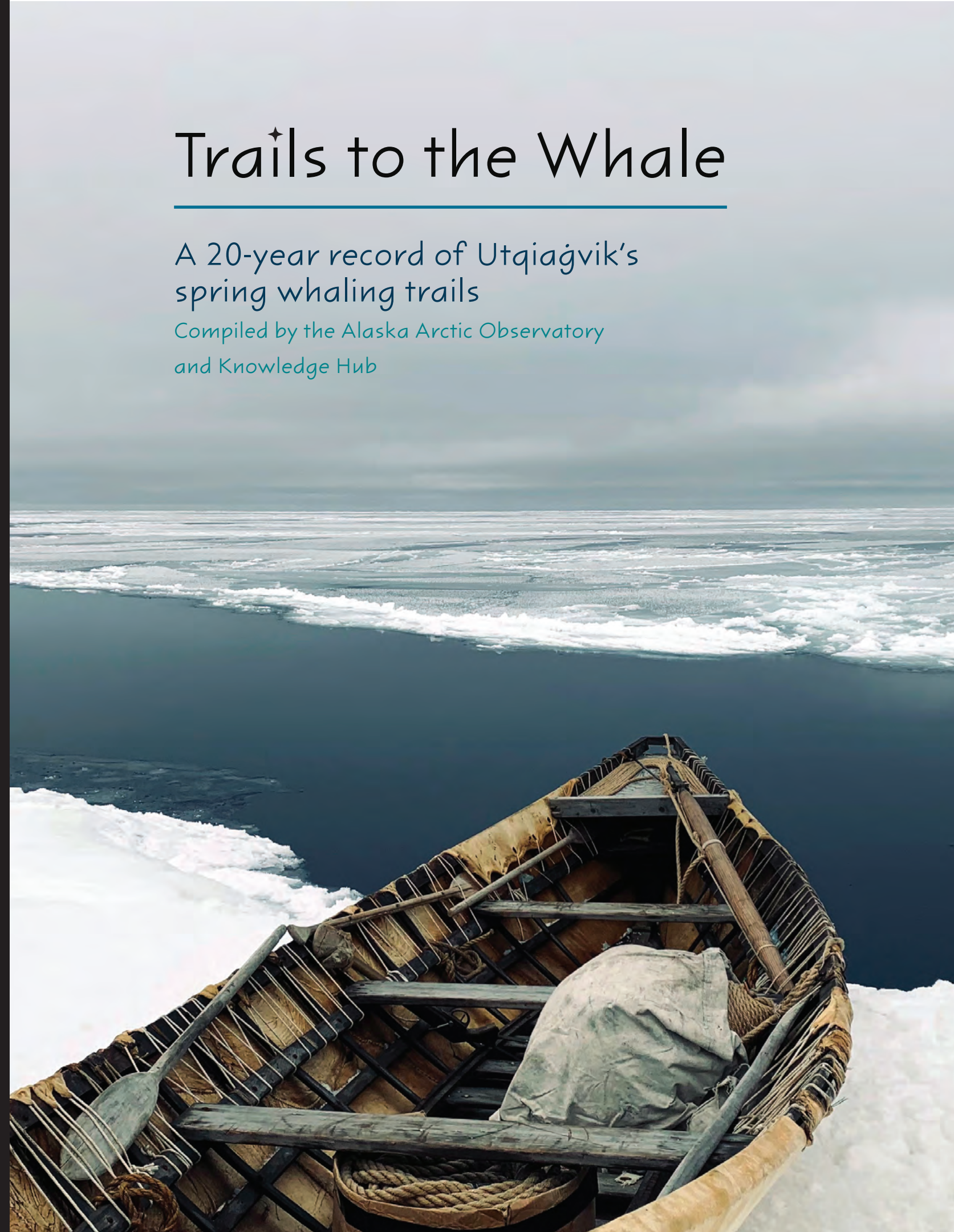
*The Barrow Search and Rescue Office, known as "Rescue Base," is homebase for volunteers who search for overdue North Slope community members.*  
Matthew Druckenmiller

Suggested citation: Alaska Arctic Observatory and Knowledge Hub (AAOKH). 2024. *Trails to the Whale: A 20-year record of Utqiagvik's spring whaling trails*. Edited and compiled by Matthew L. Druckenmiller, Joshua Jones, Roberta Tuurraq Glenn-Borade, Kimberly Kivvaq Pikok, and Donna D.W. Hauser. Report for the Barrow Whaling Captain's Association. Fairbanks, Alaska. DOI: 10.7265/3PZV-6906.

# Trails to the Whale

A 20-year record of Utqiagvik's spring whaling trails

Compiled by the Alaska Arctic Observatory and Knowledge Hub



# Trails to the Whale

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## A 20-year record of Utqiaġvik's spring whaling trails

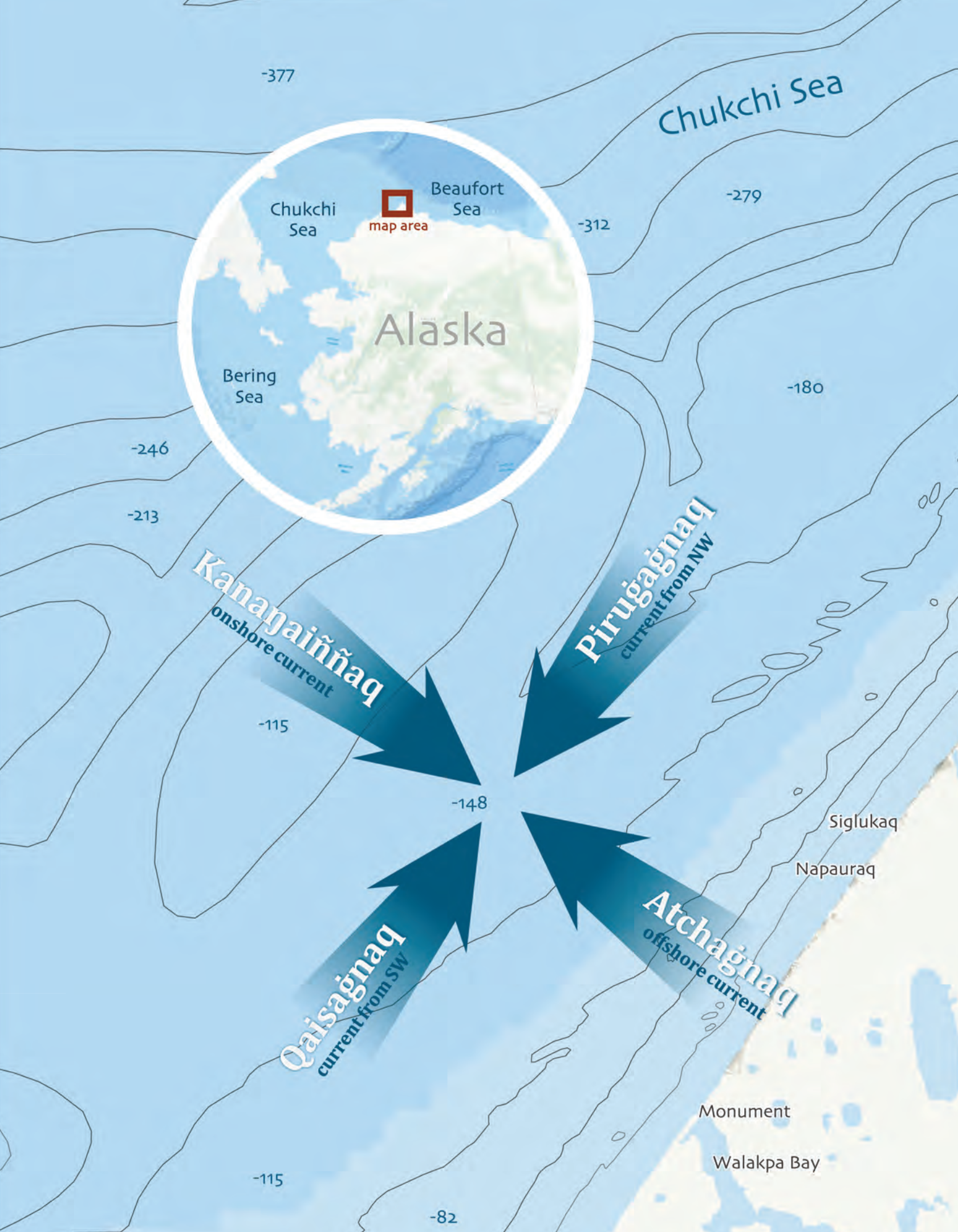
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✦ *Umiaq at the ice edge, April 23,  
2022 (cover photo).*

Matthew Druckenmiller

✦ *Photo of a mapping team member,  
Matthew Druckenmiller, towing the  
EM31 by one of the icebergs in 2022  
(left). Joshua Jones*



-49



Nuvuk

Niksiuraq

Plover Point

Pigniq

North Salt Lagoon

NARL Imikpuk Lagoon

Elson Lagoon

South Salt Lagoon

Browerville

Utqiagvik

Kanagnaq

Nunavaq

Uᅇalaq Atchiksuq

Ikagnaq

Uᅇalaq

Nigiqpaq

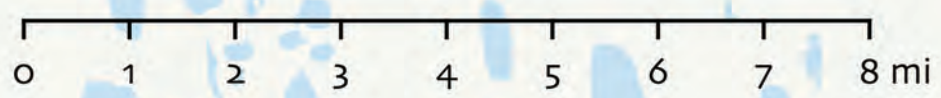


Uᅇalaq Qatchiksuq

Nigiq Qatchiksuq

Kiluagnaq

**Bathymetry is shown as feet below sea level.**





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✦ *Harry Brower Jr. standing next to his umiaq looking over lead.*

Joshua Jones



# Introduction

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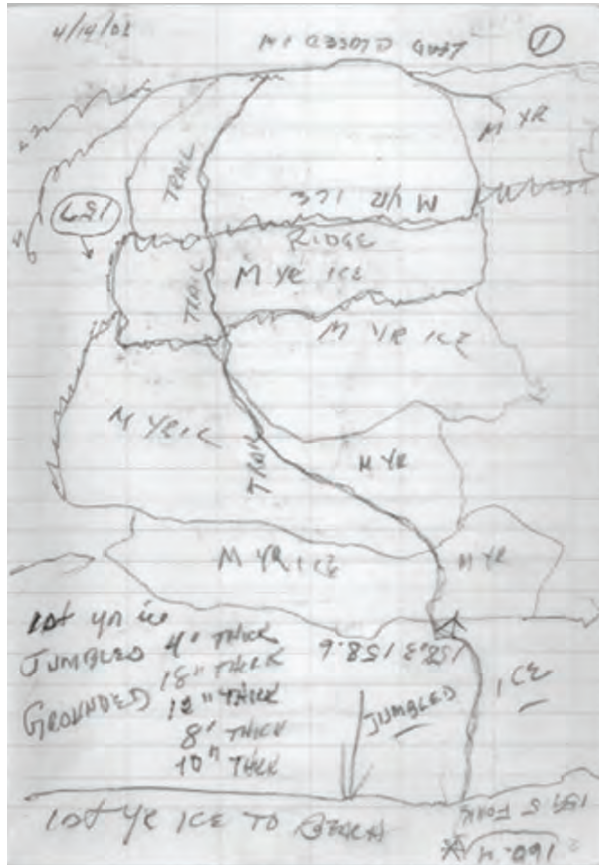


✦ *The late Utqiaġvik Elder Warren Matumeak who—along with Craig George—provided the inspiration for mapping whale trails.*

Shari Fox

Since 2007, an ongoing collaboration between the University of Alaska Fairbanks (UAF) and the Alaska Arctic Observatory and Knowledge Hub (AAOKH), National Snow and Ice Data Center, North Slope Borough Department of Wildlife Management (NSB-DWM), Ukpeaġvik Inupiat Corporation (UIC) Science, Barrow Whaling Captain's Association, and the Utqiaġvik whaling community has supported this project to map and survey the community's spring

† One of Warren Matumeak's early, hand-drawn maps of Utqiaġvik's spring trails on April 14, 2001. His trail drawings inspired the modern map project that began in 2007.



† AAOKH Observer Billy Adams provides an example of trail-building activities by Utqiaġvik hunters on February 27, 2022.

Bill y Adams



whaling sea ice trails. Each spring, Iñupiat hunters route and build trails across the shorefast sea ice off Utqiagvik to access hunting sites along the lead edge as they pursue the bowhead whale during its spring migration to the Beaufort Sea. This project was largely inspired by an initial effort by Utqiagvik Elder Warren Matumeak and NSB-DWM biologist Craig George to document the trails using GPS and hand-drawn maps in 2001. The first known maps of Utqiagvik's spring trails were hand-drawn by the late Warren Matumeak in 2001, and formed the basis for a collaborative effort to start digitally mapping trails in 2007 (Druckenmiller et al. 2013).

Trail locations are mapped using GPS, while ice thickness is surveyed continuously along the trails using a EM-31 electromagnetic conductivity meter (see the 'More Information' section for more details).

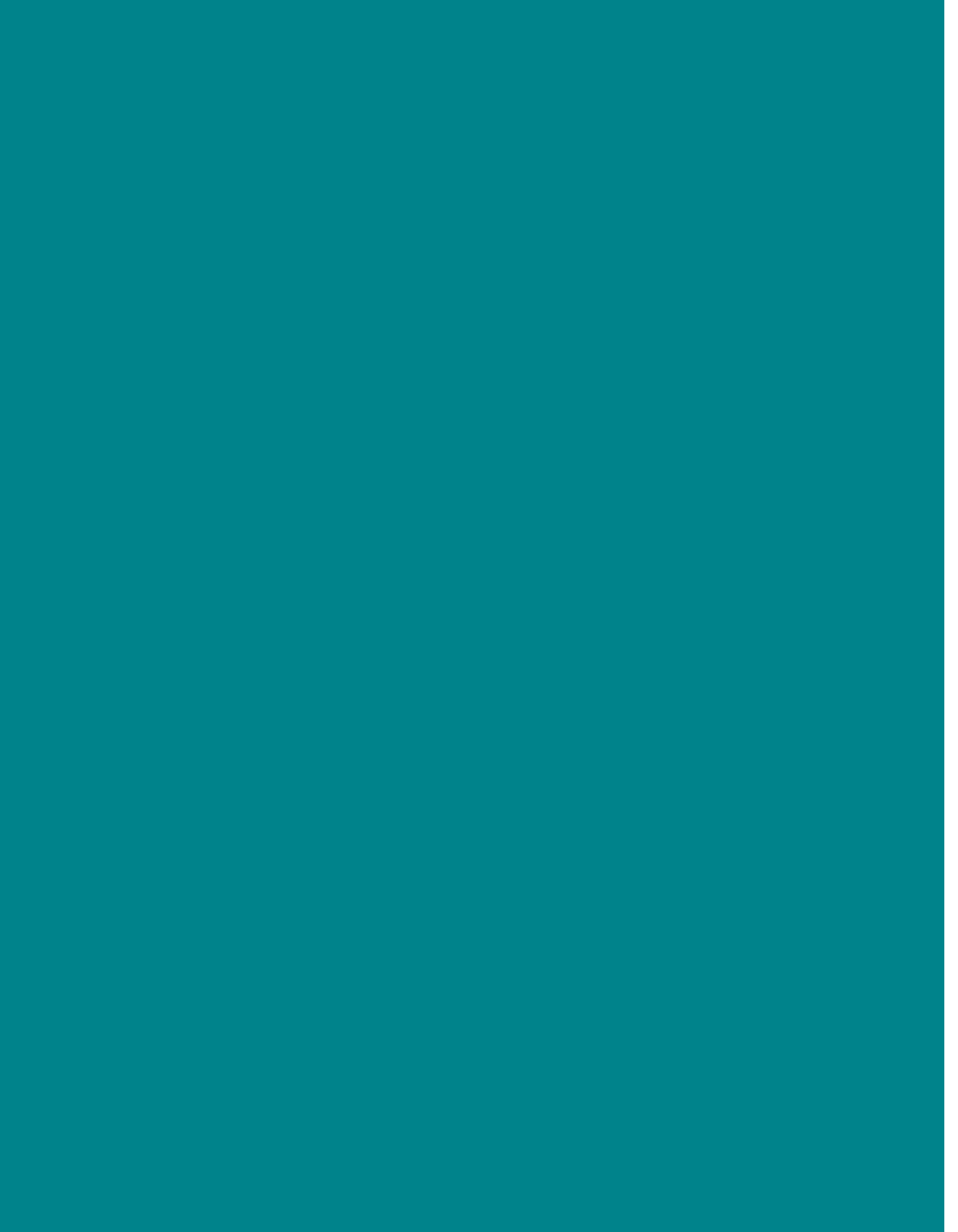
The ice trail thickness surveys not only provide information about ice along specific sections of trail, but also reveal bulk information about the local shorefast ice. Specifically, the surveys reveal the average thickness of level first-year shorefast ice, which is controlled by local freeze-up processes and timing, as well as weather, ocean, and ice conditions in the region throughout fall and winter.

Trail maps are provided to the community during the hunting season to inform the hunting crews on trail locations. Maps are both emailed throughout the community and made available in hardcopy form, typically in late April through early May.

In this book, our goal is to provide annual summaries of maps and activities surrounding spring whaling in Utqiagvik. We hope this will be a celebration of our long term collaborations as well as a useful resource to look back on for the whaling community. For context and to tell a deeper story, we include observations contributed by Joe Mello Leavitt and Billy Adams, as part of AAOKH, as well as a number of photographs by Lloyd Pikok, Jr. and our research team.

*The trail building for spring whaling has begun, it was 7°F, winds 10mph from the east, sunny, and visibility to 6 miles. Aaluk, Quuniq, Pamiilaq, and Anagi crew members. Saw a couple jellyfish on top of the ice. The currents were from the south.*

—Billy Adams



# Dr. John Craighead Umiŋmak George

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✦ *Craig George helping break trail during the 2019 census.*

Darr en Kayotuk

This project would not have been possible without the continued commitment, support, and encouragement of Dr. Craig George. Together with Warren Matumeak and Tommy Olemaun, Craig documented some of the first maps of Utqiaġvik's ice trails in the early 2000's, motivated by wanting to create something to give back to the community. It was then in 2006 that Craig, Richard Savik Glenn, and Dr. Hajo Eicken of the University of Alaska Fairbanks came together and formulated the initial idea for developing the mapping and surveying of the ice trails into a long term monitoring project. Craig served as a close advisor as I, then as a graduate student at the University of Alaska Fairbanks, implemented their vision into what has resulted in a nearly two decade long collaboration with the community.



✦ *The North Slope Borough Department of Wildlife Management’s “perch” where George’s drawing appears (top).*

Mat the w Dr uckenmiller

✦ *A drawing by Craig George on the blind of the “perch” used in the 2010 bowhead whale census (top right).*

Mat the w Dr uckenmiller



*Biology is easy, but working with people is hard. And, ultimately, in terms of conservation, and I think this is a beautiful example of the bowhead whale, the [North Slope Borough Wildlife] Management program is one of the great conservation success stories. Bowheads have done well. The hunters are happy. But it comes down to working collaboratively. And that’s forgotten. In so many of these clashes, I know they’re very complicated situations around the world. This one may have been more solvable in some ways, but gee, you know, got to work together. And that’s often missed. You know, biologists and user groups aren’t on the same page in many cases. Be curious, I guess. A lot of what I’ve done is driven by a really honest fascination with the natural world and cultures and working with people. And, uh, make it, you know, enjoy it.*

*. . . there’s this amazing Inupiaq sharing system of food. And it’s the same with knowledge. If you’re given some knowledge about whatever, you’re expected to give something back, to share what you know.*

— Craig George, interview with Kimberly and Lloyd Pikok, May 2023

Craig was enthralled by the beauty of sea ice. He saw the ridges as mountain ranges, reminiscent of his younger days climbing peaks in the Teton Range of Wyoming. More than anything, the sea ice was the ever-present backdrop for his love and fascination with bowhead whales.

Craig, like the many Elders who taught him, knew that understanding the ice required careful and consistent observation. Throughout spring, when not at a harvested whale with colleagues from the North Slope Borough Wildlife Department, Craig traveled the ice trails to help various whaling crews build their trails, to drop a hydrophone into the lead to listen for whales, or to simply “check on the ice.” He could also often be found traversing the ice on cross country skis or by dog team with his friend Geoff Carroll.

His knowledge of sea ice expanded throughout his years listening and working with Utqiaġvik’s whaling captains to better understand bowhead whale behavior, biology, and population numbers. His visceral understanding and relationship with the ice developed more fully during the many springs when Craig led the bowhead census and built ice perches at the lead edge for around-the-clock counting of migrating bowheads. For many years, the Wildlife Department maintained census camps at the ice edge throughout spring to capture an estimate of the bowhead population—an effort critically reliant on observing the ice. The DWM perch, located near the north end of the trail system, is often in the most dynamic ice environment, facing risks from its “front door” to the west, and “back door” to the east. Craig’s cautionary and caring mindset helped to keep the teams safe over the years, and instilled in him a deep appreciation for the power of nature. Craig was fond of saying that “you never really know the ice until you’ve slept on the ice.” Umiŋmak spent many nights on the **Tuvuk** under the spring sun.

Craig became the world’s foremost scientific expert on bowhead whales, and was a passionate supporter and ally to scientists of all kinds. No one had a better ability to balance curiosity, humility, and humor, while also challenging visiting researchers to think differently and more meaningfully about their work. Craig welcomed and collaborated with researchers from around the world, yet I like to think that sea ice scientists were among his favorite species.

Craig loved his home community of Utqiaġvik, and his support for this project was one small part of how he gave back and supported the people and whalers of Utqiaġvik.

—Matthew Druckenmiller, January 2024



# Building Trails to the Whale

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Iñupiat whalers in Utqiagvik break trails through the shorefast ice (**tuvaq**) to reach open leads (**uiñiq**) for spring whaling. These trails, starting from the coast, navigate various ice features such as ridges (**ivuniq**), rubbles, and cracks, and terminate at the ice edge where whaling camps are set. Safety is critical, and navigation requires careful observation of ice conditions throughout the year, from freeze-up to the whaling season in spring. Whalers and hunters use a combination of personal experience, local and Indigenous Knowledge, and continuous monitoring of weather, ocean and sea ice conditions to assess ice stability and risks. Trail locations are based on several factors: safety and stability, effort required for scouting and breaking trail, ease of navigation and evacuation, proximity to other crews, expected late spring conditions, whale migration patterns, and local knowledge from Elders and whaling captains. The process of trail construction and placement is deeply rooted in Iñupiat traditional knowledge and experience. Hunters start by meticulously monitoring the ice throughout the winter, assessing its stability and the interplay of ice movement, temperature, and ocean and atmospheric processes. This monitoring includes noting the formation of flat ice zones (**igniñaq**), grounded pressure ridges (**kisitchat**), and the areas where these features are most stable and safe. Trails are typically built to traverse ice that is well-grounded or securely attached to stable ice. Early season trail conditions are monitored by initial assessments from winter seal hunters who provide detailed insights into the ice conditions. Construction effort is another consideration; trails



✦ *Whalers breaking trail (top). March 2023. Lloyd Pikok, Jr .*

✦ *Umiaq ready to launch at the ice edge, though young ice is covering the lead (right). Joshua Jones*

through flatter ice are easier to establish, whereas those through rough, ridged areas require more time and effort but are often more stable. The ice edge conditions are crucial for a successful hunt. Whalers look for thick, heavy ice near the lead where they can set up camp, build boat launches, and haul up whales. Trails are also placed based on predictions of late spring conditions; those built on thicker, more stable ice often last longer into the season compared to those on thinner ice, which deteriorate as temperatures rise and snowmachine traffic erodes the trails. This strategic trail placement ensures successful and safe whaling practices while adapting to seasonal and short-term changes in ice conditions as well as longer term climate changes.





# Recent Ice History

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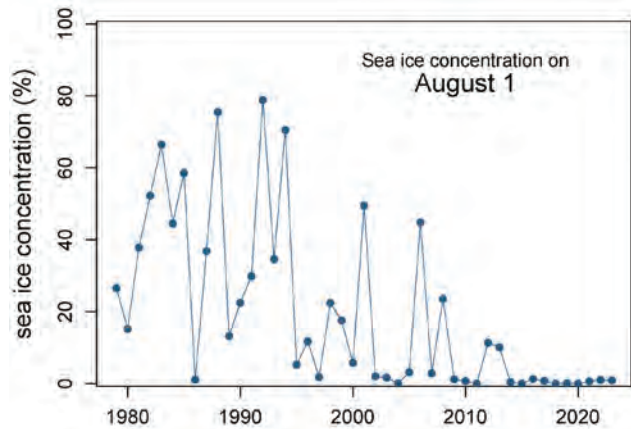
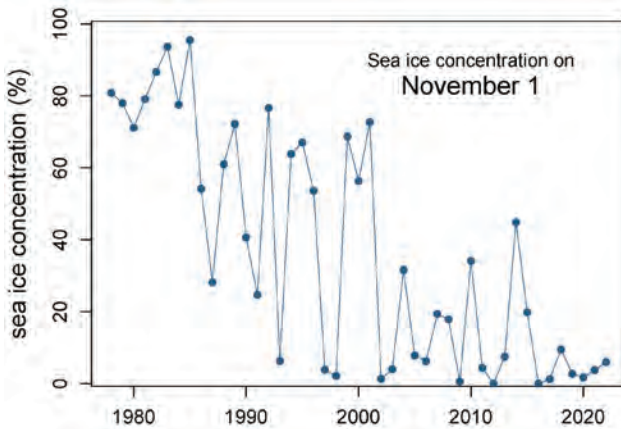
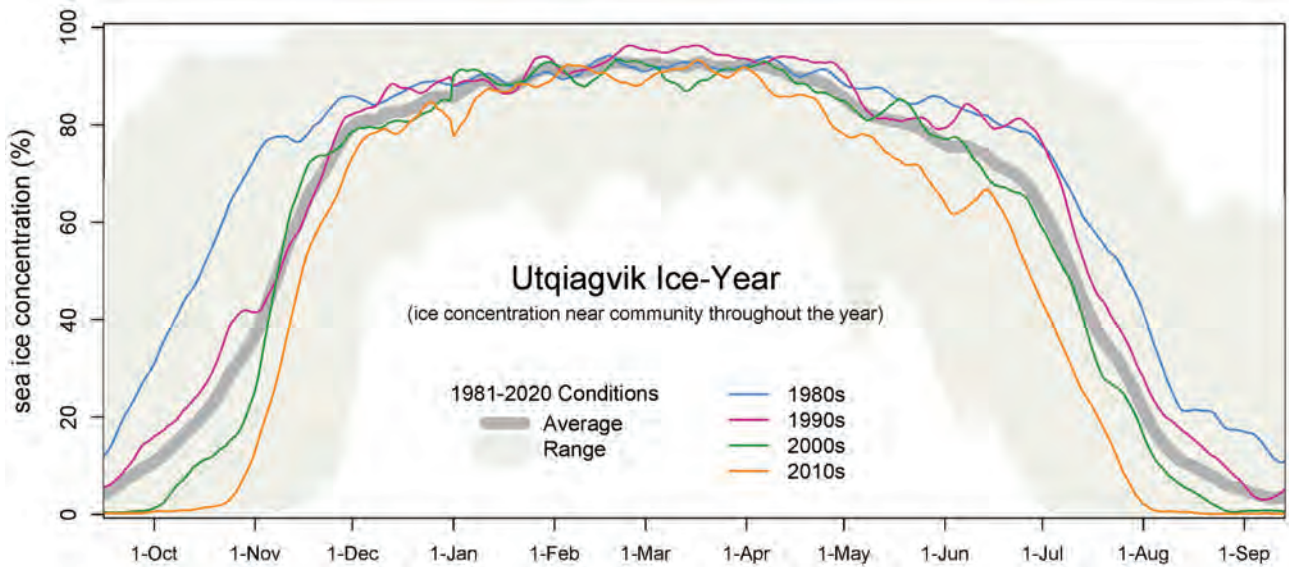
## HOW HAS SEA ICE CONCENTRATION CHANGED NEAR UTQIAGVIK DURING THE SATELLITE RECORD?

Sea ice concentration has been observed by satellite since 1979 as the percentage of ice covering a particular region. It is a measure of coverage but does not observe how thick the ice is.

Sea ice concentration near Utqiagvik has decreased throughout recent decades, but most of the change has been during the fall and late spring or summer. Ice concentration has also changed during the spring whaling months of April and May, but not as much.



✦ *Matthew Druckenmiller standing on one of the icebergs from Milne Ice Shelf that grounded near Utqiagvik in 2022. Joshua Jones*



The plot above (top) shows the "ice-year" off Utqiagvik for the climate baseline period of 1981-2020 and individually for the last four decades. This shows how the ice-year has shrunk when comparing across decades.

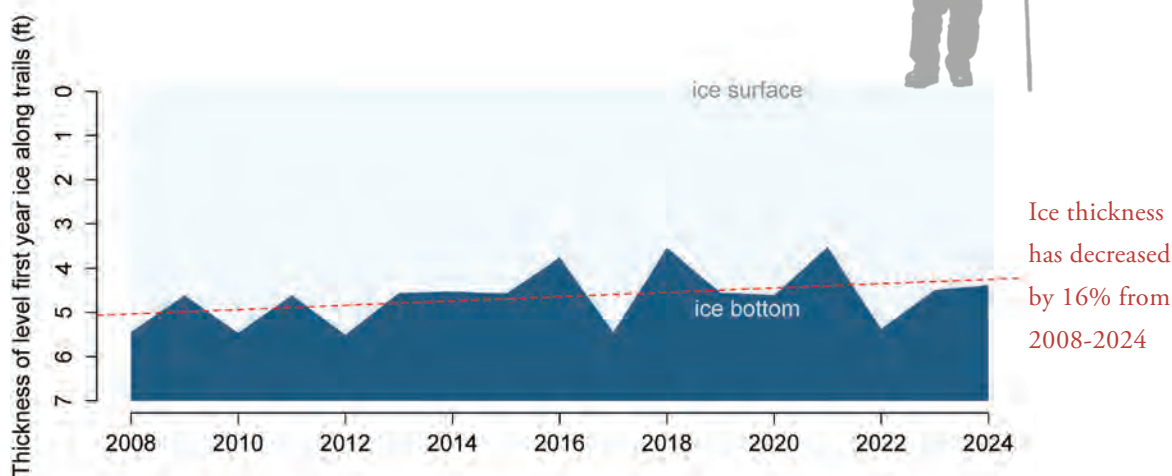
The two plots in the middle show how significantly ice concentration has changed during 1979-2023 on November 1 (near the start of the ice-year) and on August 1 (near the end of the ice-year).

## HOW HAS SEA ICE THICKNESS CHANGED DURING THE YEARS OF ICE TRAIL MAPPING AT UTQIAGVIK?

A later freeze-up of sea ice in fall, together with warming temperatures throughout winter, have led to thinner sea ice during spring. The ice trail surveys, in part, record the thickness of level first year ice each year. Throughout the years of ice surveys, 2008-2024, the thickness of the level first year ice has decreased by 16%. The thickest ice was observed in 2010 (5 1/2 feet) and the thinnest ice was seen in 2021 (3 1/2 feet). These measurements of level first year ice thickness, however, do not indicate the thickness of rubble or ridged ice that ice trails encounter each year.

Alongside decreases in ice thickness, ice types and ice ages have also changed. One of the most striking changes over the last two decades has been the substantial loss of multi-year ice (**piqaluyak**) that gets incorporated within the shorefast ice each spring. Across the Arctic as a whole, multi-year sea ice rapidly began to decrease in the early 2000's, and since 2012 ice older than 4 years has been almost entirely absent from the Arctic.

This loss of old ice is apparent at Utqiaġvik. During the earliest years of this project, it was common to see large sections of multi-year ice scattered throughout the shorefast ice, either as large pans or as small fragments. In the latter years, there has been a recognized absence of ice. With this loss of multi-year ice, the overall thickness of the shorefast ice is decreased. Thick multi-year ice floes have also helped to stabilize the shorefast ice cover, and to serve as source of drinking water for crews camped on the ice.



✦ *Hunters watching for whales at a ridge north of Nuvuk (Point Barrow)*  
on April 30, 2015. Mat the w Dr uckenmiller







# Trail Maps

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✦ *The end of a trail, looking over a 'bay' in the ice edge.* Joshua Jones



# 2008

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## WHALES LANDED

9 Bowhead whales  
landed in spring



## APRIL TEMPERATURE

-14 °C / 8 °F average



## PREVAILING WINDS

April: E 12 mph  
May: E 12 mph



## ICE

First observed shorefast ice: Dec. 14  
Average thickness  
during whaling: 8 feet  
Thickness occurs most often: 5.4 feet

**sikuliaq** – young ice formed around  
edge of old solid ice on open lead

**naniaqtuġvik** – safe place on shorefast  
ice where hunters store whaling  
equipment and camp when waiting for  
good conditions

**katak** – a sudden drop in sea level;  
means “to fall”; may cause floating ice  
near grounded ridges to crack

**tuvaġruaq** – shore-fast ice; to come in  
to shore (of ice); (Ti) shore ice

## SEASONAL SUMMARY

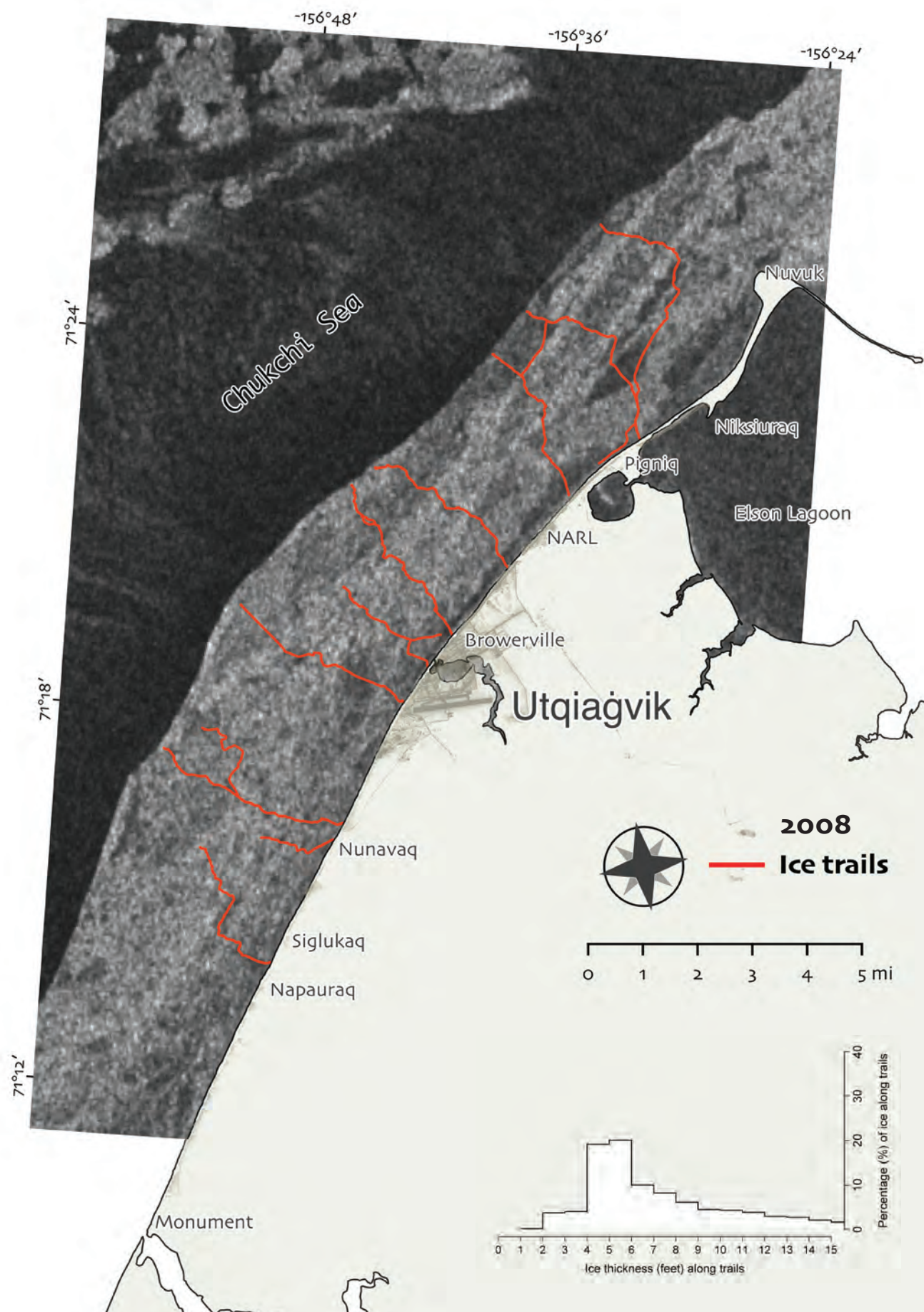
The shorefast ice was rough and stable due to stormy conditions during freeze-up and repeated ridge building events throughout winter, with ridges often near the beach and some ice blown onto the shore at Nunavaq. The ice was exceptionally rough off NARL (that is, the Naval Arctic Research Laboratory, owned by UIC)

East winds dominated, keeping the lead open for most of the whaling season, which allowed Utqiagvik to catch many whales, starting with Aalaak Crew’s first whale on April 26. Many crews camped on the **sikuliaq** at the end of Jacob Adams’s trail off Gravel Pit, noting whales swimming beneath the flat ice and surfacing at the edge.

Crews frequently retreated to their **naniaqtuġvik** when west winds brought in pack ice or when strong east winds threatened the floating ice from the grounded ridges (**katak**).

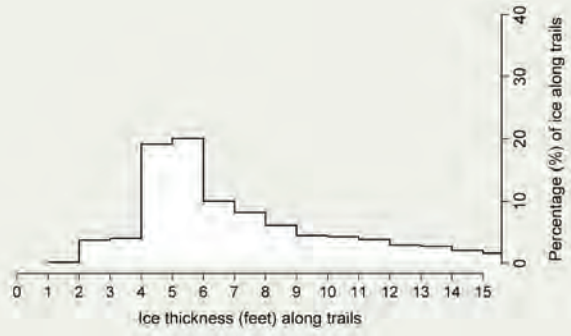
On April 25, significant portions of the **sikuliaq** broke off due to pack ice impact, yet the ice remained safe for camping through early May. Adams landed a 30 ft whale on May 7, just before the remainder of the **sikuliaq** broke out. However, this ice was only suitable for pulling up whales up to 40 ft, not 50 ft.

Tom Brower III reported that early April snowfall created hazardous conditions by insulating the ice, causing rapid bottom melt and eroding ice at the surface due to snowmachine traffic, leading to dangerous conditions south of town. Brower had to abandon their trail off Napauraq in early May after only a few days of heavy use. Crews that were unable to land whales earlier in the season concentrated at the safer trails north of Browerville later in the season where they found older, thicker, and more stable flat ice (**tuvaġruaq**) near the edge, which remained in place into late May, beyond the end of the whaling season.



-156°48'                      -156°36'                      -156°24'

71°24'  
 71°18'  
 71°12'



# 2009

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## WHALES LANDED

3 Bowhead whales  
landed in spring; 1 lost



## APRIL TEMPERATURE

-17 °C / 2 °F average



## PREVAILING WINDS

April: E 11 mph  
May: W 10 mph



## ICE

First observed shorefast ice: Nov. 6  
Average thickness  
during whaling: 7.7 feet  
Thickness occurs most often: 4.6 feet

**nuvuḡaqpuk** – large promontory of ice extending out from the ice edge

**muḡaliq** – slush ice. Snow and thin ice on water at freeze-up, slushy ice on shore at the first freeze

**tuuq** – when pack ice impacts shorefast ice; means “to chisel”

**iiguat** – ice that weakly attaches to the outer edge of the shorefast ice

**maktak** – whale skin with blubber

**injutuq** – young female bowhead

## SEASONAL SUMMARY

At the start of the whaling season, the shorefast ice off Utqiaḡvik was very stable up to the last major row of ridges nearly 2 miles offshore. Off NARL and Browerville, the ice was heavily ridged with few areas of level ice, but scattered pieces of **piqaluyak** provided drinking water. South of town, off Gravel Pit and Hollywood, the ice was flat and thin, with crews being cautious of drift ice due to the lack of anchored ice. A large promontory of shorefast ice (**nuvuḡaqpuk**) extended 11 km offshore of Monument and remained throughout the season.

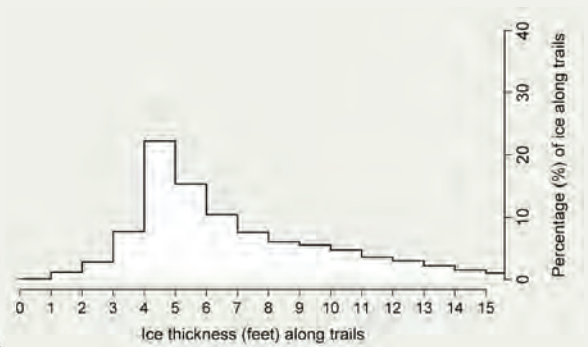
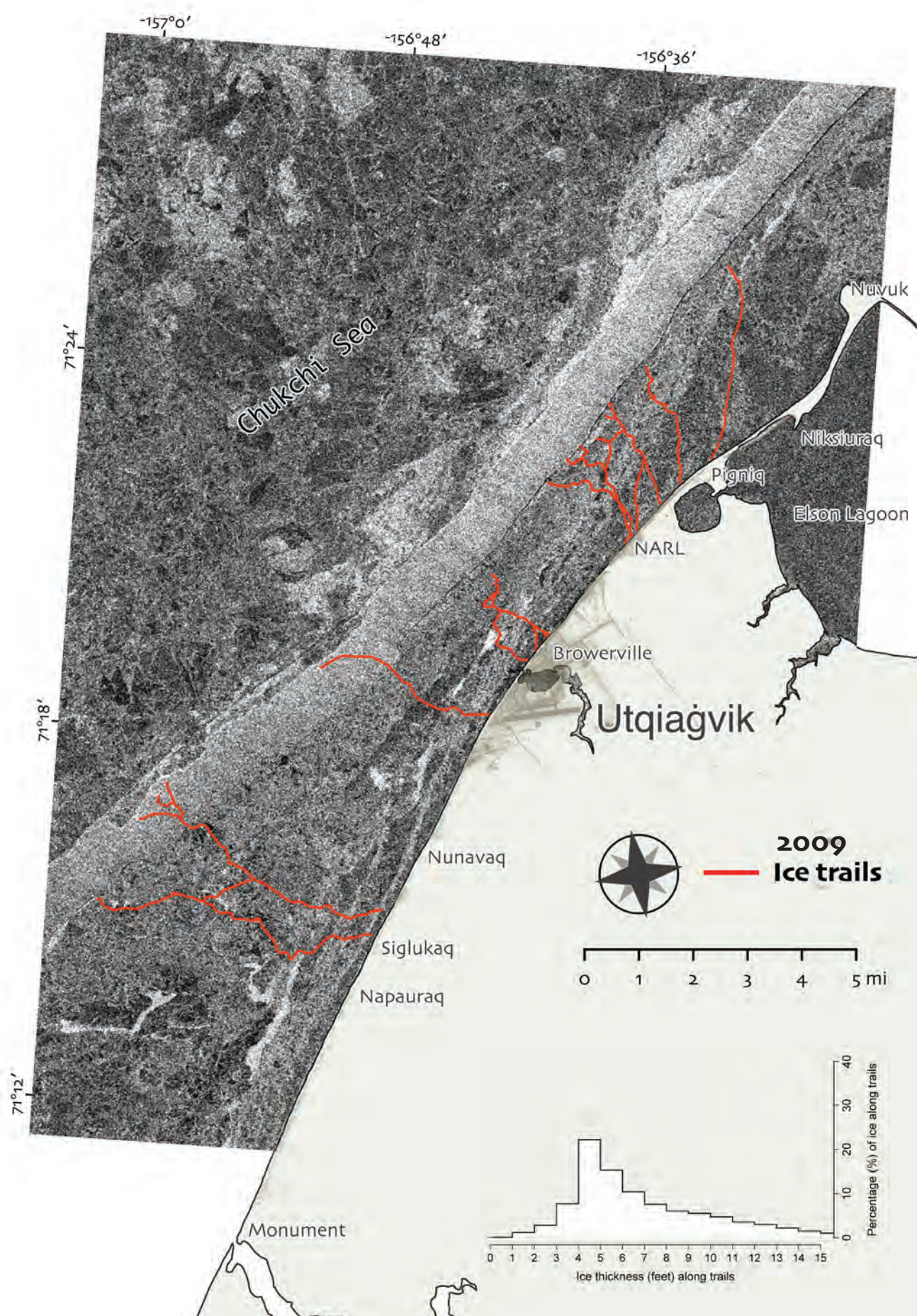
Despite stable conditions, the pack ice, winds, and currents never made the ice edge suitable for whaling. From April 20, west winds dominated, creating **iiguat** and occasionally a moving wall of slush ice (**muḡaliq**) along the edge, which never froze solid. Warm weather and water quickly deteriorated trails, leading some crews to pull off the ice by May 12.

Many hunters described 2009 as a “waiting game,” with the pack ice never performing **tuuq** to fix the ice edge, especially off NARL where **iiguat** persisted. On May 16, a southeast wind briefly opened the lead, and ABC Crew landed an 8-m **injutuq** on May 17 using a pan of **tuvaḡruaq** for butchering. Three other crews caught whales before May 23 but struggled with **muḡaliq** at the edge, hauling whales long distances to find suitable butchering spots.

The final three harvested whales required crews to cut off the heads and anchor them to the ice edge, limiting meat retrieval to mainly **maktak**. Joe Leavitt noted that heavier ice conditions would have eased butchering challenges in 2009.

*NE@10-15 Ice has cracked up, about 2 mi out of Spenard is our camp Crews need east wind to open up lead, current is weak going to the Ene need to change to or strong east wind to open up Crews near Hollywood are waiting for young ice to be taken out their trails are rotten and some Places go all way through the ice.*

*—Joe Mello Leavitt, May 2, 2009*



# 2010

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## WHALES LANDED

14 Bowhead whales  
landed in spring



## APRIL TEMPERATURE

-13 °C / 8 °F average



## PREVAILING WINDS

April: E 12 mph  
May: E 13 mph



## ICE

First observed shorefast ice: Nov. 19  
Average thickness  
during whaling: 6.5 feet  
Thickness occurs most often: 5.5 feet

## SEASONAL SUMMARY

Through late March, the shorefast ice near Utqiaġvik maintained a narrow extent of half to two miles. On March 26, several large floes of multi-year ice (**piqaluyak**), averaging 9.5 feet thick, attached to the shorefast ice almost 2 miles off NARL.

In early April, three trails were established across these smooth floes to access the lead. The narrow extent of ice to the south led to many short trails early in the season.

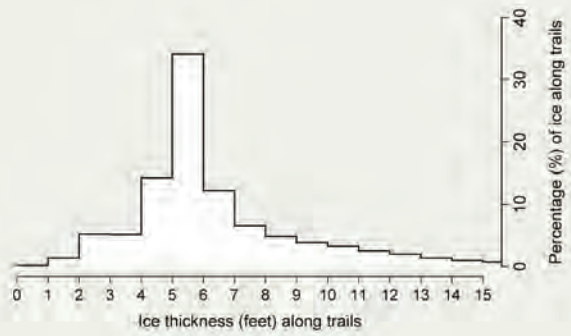
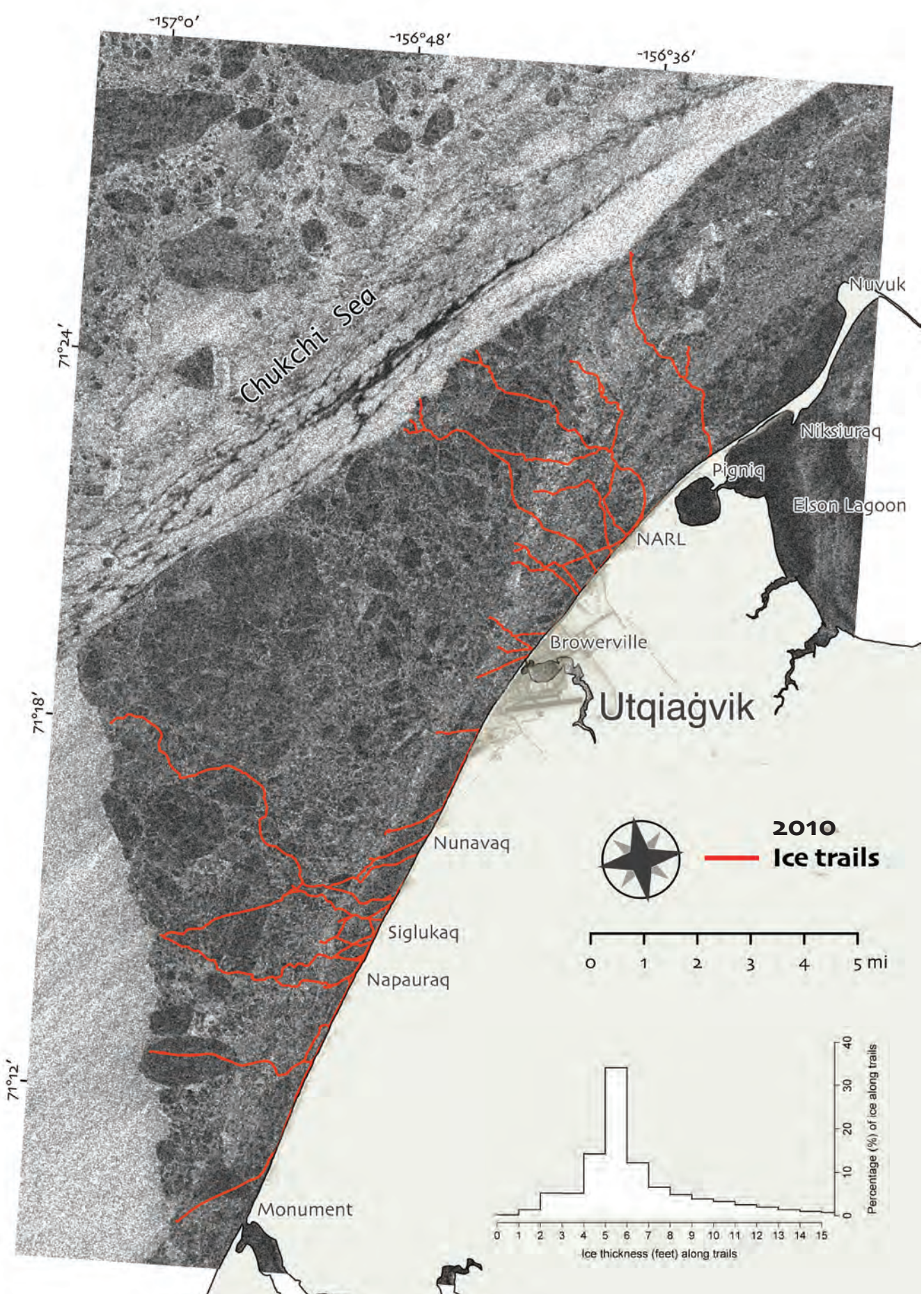
By mid-April, pack ice had attached, creating a large promontory of shorefast ice (**nuvuġaqquk**) extending over 7 miles offshore by April 28. Crews quickly extended trails to the western edge of this promontory, with some traveling as far as Monument for closer open water.

In early May, 14 whales were taken from the southern trails on the promontory, while none were taken from the northern trails. Joe Leavitt, whose crew landed Utqiaġvik's second whale on May 2, explained that the smooth, flat ice provided many places to haul up whales and clear views of approaching whales. The large promontory guided whales away from northern camps, and the thin ice allowed whales to dive beneath.

Despite rough water caused by a persistent east wind, which kept the lead open, some whales were lost as crews struggled to track floes attached to struck whales. Joe Leavitt described 2010 as “a good year for spring whaling,” despite these challenges.

**nuvuġaqquk** – large promontory of ice extending out from the ice edge

**piqaluyak** – large chunk of freshwater ice from river, good for drinking water; multiyear sea ice that has become fresh due to multiyear thawing



# 2011

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## WHALES LANDED

7 Bowhead whales  
landed in spring



## APRIL TEMPERATURE

-18 °C / -1 °F average



## PREVAILING WINDS

April: NE 10 mph  
May: E 10 mph



## ICE

First observed shorefast ice: Nov. 11  
Average thickness  
during whaling: 8.4 feet  
Thickness occurs most often: 4.6 feet

## SEASONAL SUMMARY

On February 17, a localized ice shove driven by strong southwest winds caused sections of shorefast ice off Barrow to become unanchored and rotate up the coast, creating 30-foot-high ridges on the beach and in shallow waters.

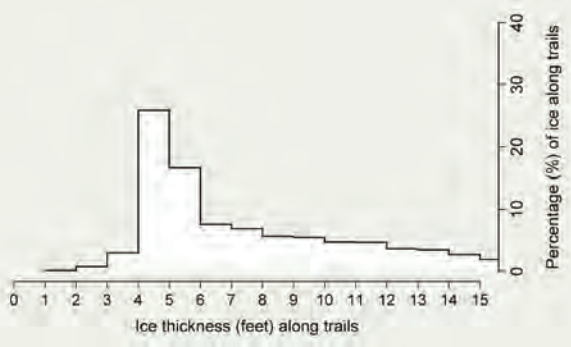
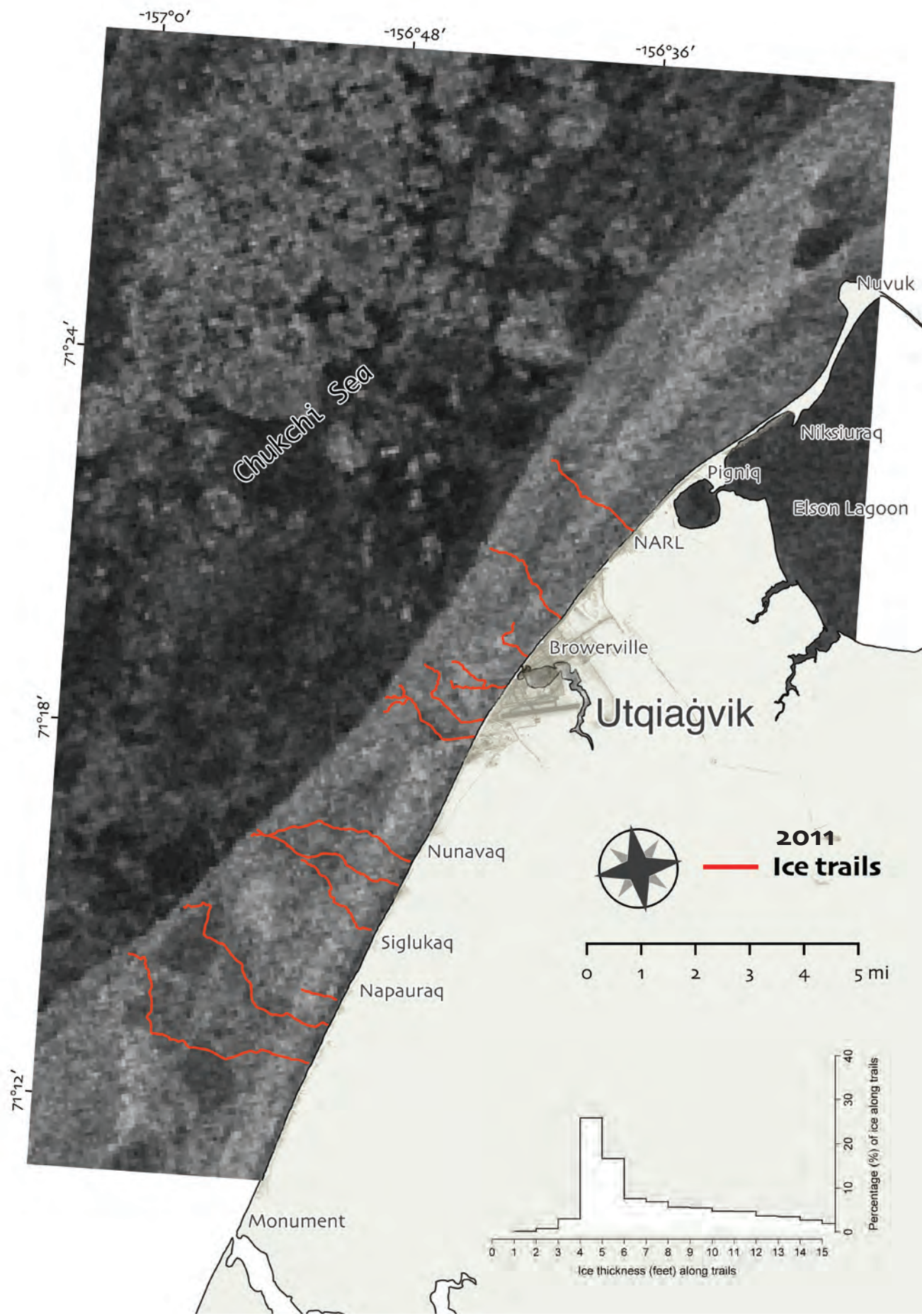
The primary challenge for whalers at the start of the season was not the rough ice, but a prominent shear ridge (**agiuppak**) at the ice edge, which persisted as a smooth, polished wall until rough water revealed its lack of structural integrity in mid-April. This ridge, made of ice and slush referred to as **muǵaliq**, remained throughout the season, complicating camp and butchering site placement.

By mid-April, eight main trails extended to or near the open water, but whalers faced difficulties due to the ridge. Most crews concentrated on the southernmost trail, where a narrow band of ice attached to the ridge provided a platform for camps and butchering.

Utqiaǵvik landed six whales during the season—two in early May and four on May 21 and 22. Heavy snowmobile traffic and warmer late May temperatures created dangerous holes along the trails. The persistent shear ridge may have been linked to the stable shorefast ice along the Chukchi coast between Point Franklin and Utqiaǵvik, which served as a deflection point for pack ice, creating a wide shorefast ice cover across Peard Bay to Nunavaq.

**agiuppak** – wall of sheared ice along the edge of the open lead that has been formed by the grinding action of the free ice against the shore-locked ice

**muǵaliq** – slush ice, waterlogged snow (on ocean) (foam-like in appearance), snow and thin ice on water when freeze-up begins, slushy ice which forms on shore at the first freeze



# 2012

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## WHALES LANDED

14 Bowhead whales  
landed in spring



## APRIL TEMPERATURE

-15 °C / 5 °F average



## PREVAILING WINDS

April: E 10 mph  
May: E 10 mph



## ICE

First observed shorefast ice: Nov. 15  
Average thickness  
during whaling: 5.8 feet  
Thickness occurs most often: 5.5 feet

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## SEASONAL SUMMARY

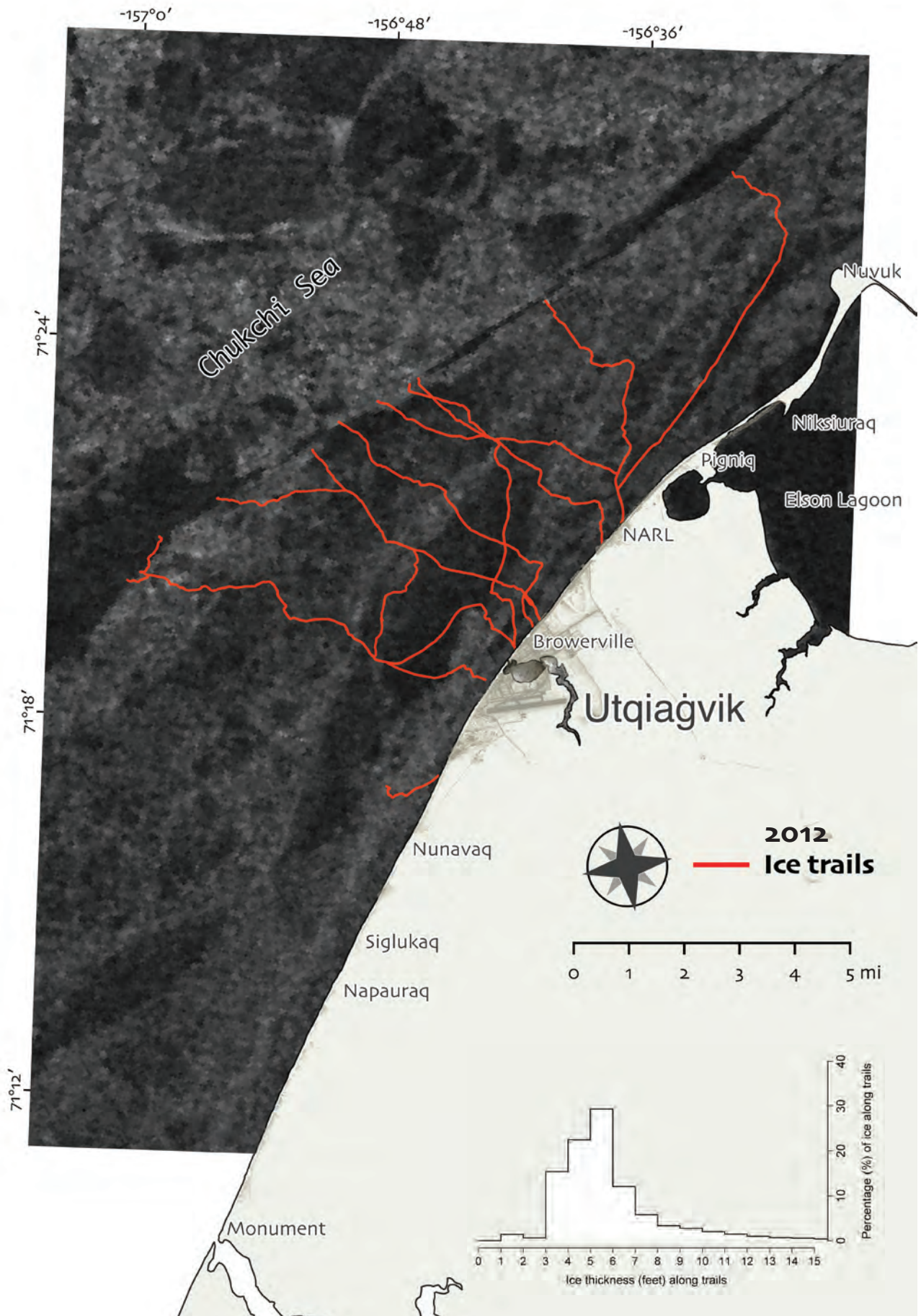
Large multiyear ice (**piqaluyak**) chunks were observed frozen in shorefast ice. Whaling activities commenced in late April, with the first whale landed on April 27th. However, northeast currents forced crews to pull back at the end of April, and three whales were lost. Remarkably, two lost whales were found under the ice at the beginning of May and harvested.

Mid-May brought reports of cracks ending at pressure ridges, prompting crews to exercise caution, as some found themselves on the wrong side of the cracks. Whaling slowed down due to the presence of cracks on the trails. Seeking more favorable conditions, crews moved southwest. By the end of May, the ice became thin with holes.

*E@8, Made it to the water today whales going by, ice is 1st year ice and lots of thin areas but a high piece of Multiyear ice is on our trail near the lead about 7 crews on the ice now waiting for better conditions, pack ice going by the shorefast in big pans.*

— Joe Mello Leavitt, April 19, 2012

**piqaluyak** – large chunk of freshwater ice from river, good for drinking water; multiyear sea ice that has become fresh due to multiyear thawing



# 2013

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## WHALES LANDED

2 Bowhead whales  
landed in spring



## APRIL TEMPERATURE

-17 °C / 1 °F average



## PREVAILING WINDS

April: N 11 mph  
May: S 11 mph



## ICE

First observed shorefast ice: Nov. 14  
Average thickness  
during whaling: 5.2 feet  
Thickness occurs most often: 4.6 feet



✦ *The shorefast ice extending off of Utqiaġvik on April 10, 2013.*

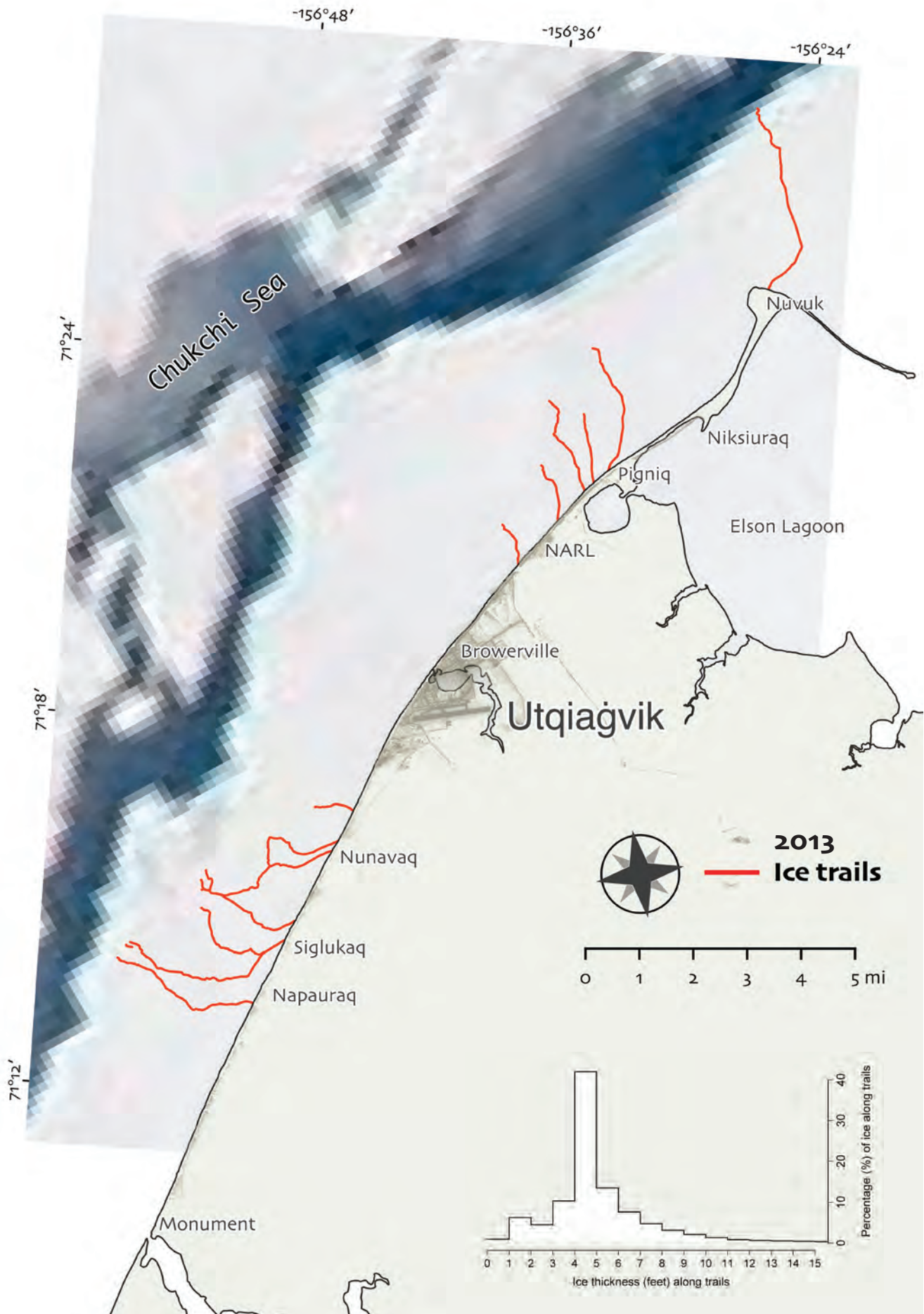
Stef an Hendricks

## SEASONAL SUMMARY

In early April, pressure ridges (**ivuniq**) formed along the open lead on the shorefast ice. No significant open water was observed for most of April and May, with frequent cracks in the ice hindering crew movements and keeping them away from the open lead.

Despite the lack of favorable conditions, crews persisted, hoping for a breakthrough. Finally, on April 29, the water opened up, prompting all crews to venture out, only to pull back shortly after due to incoming pack ice. In early May, although the lead opened again, fresh cracks continued to impede crew progress, prolonging the challenging conditions.

**ivuniq** – ice pressure ridge



# 2014

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## WHALES LANDED

7 Bowhead whales  
landed in spring



## APRIL TEMPERATURE

-16 °C / 4 °F average



## PREVAILING WINDS

April: E 9 mph  
May: S 14 mph



## ICE

First observed shorefast ice: Dec. 2  
Average thickness  
during whaling: 5.9 feet  
Thickness occurs most often: 4.5 feet

## SEASONAL SUMMARY

For most of April, there was no open water, and when it finally appeared, strong winds kept whalers from venturing out. Throughout April, whaling crews worked to prepare trails amidst numerous pressure ridges and a one-foot crack that extended along the shorefast ice. Some fragments of multi-year ice were spotted near Nunavaq. On April 29, high winds led to a major breakout of the shorefast ice, stranding some crews, but they were safely rescued.

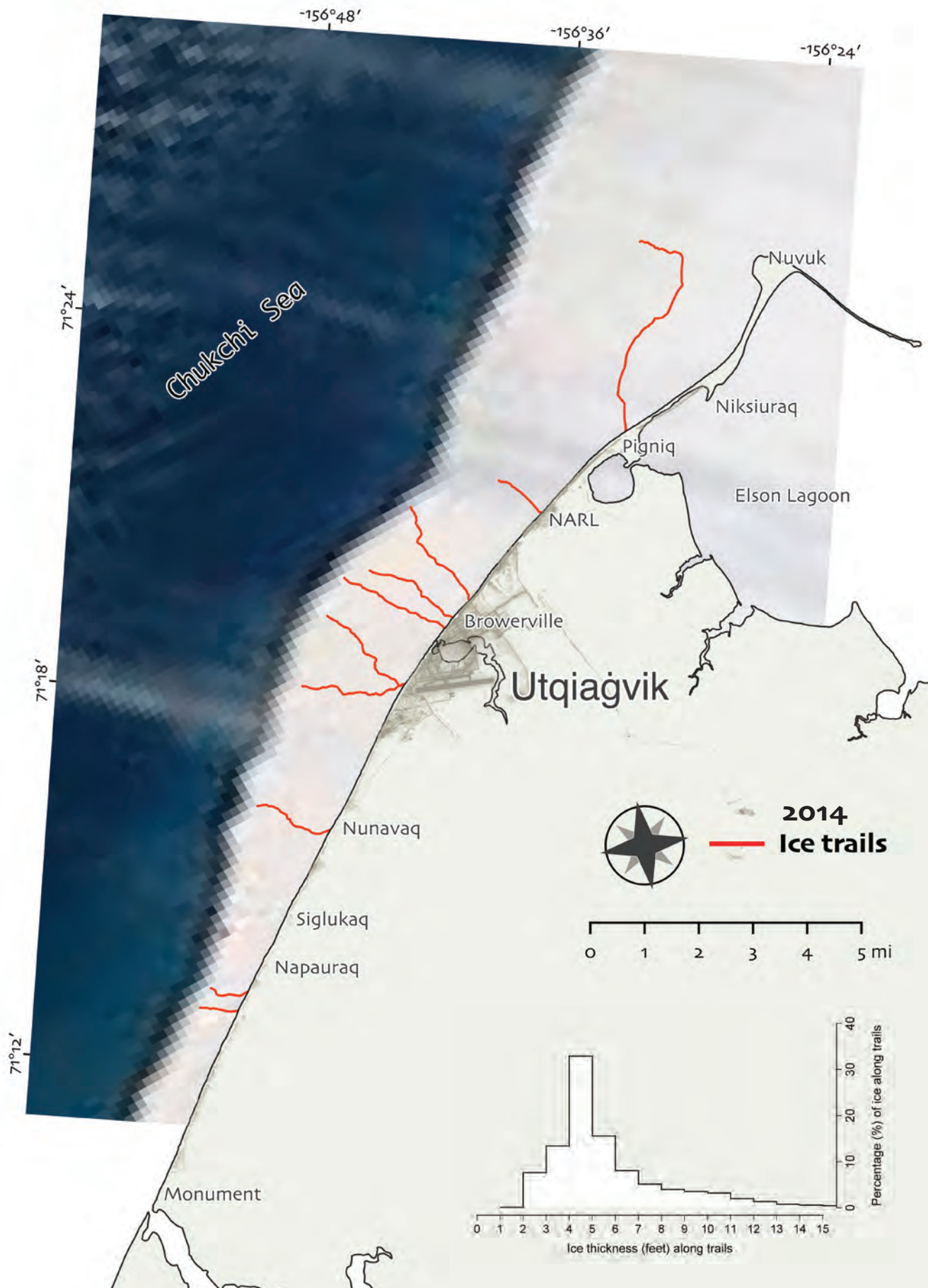
Early May saw brief openings in the lead, but fresh cracks and unstable ice conditions kept crews off the ice. An **iiguaq** that attached in mid-May did not budge despite sustained east winds up to 30+ mph. According to Craig George, a 'concrete-like' mix of **mugaliq**, first year ice, and **sikuliaq** was very thick at the lead edge, which helped to create a platform for easily supporting a huge 56 foot whale landed in May. Whaling efforts extended into June, with crews actively whaling during Nalukataq. Additionally, a whale struck in Wainwright was harvested in Utqiagvik.

*NE@15, 34°, Crews have made a new trail in front of NAPA. Two crews have served **mikigaq** at the beach ending their whaling season. Few boats still plan to go whaling.*

*—Joe Mello Leavitt, June 8, 2014*

**mikigaq** – mixture of fermented whale meat, whale tongue, and maktak

**sikuliaq** – young ice formed around edge of old solid ice on open lead



# 2015

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## WHALES LANDED

9 Bowhead whales  
landed in spring



## APRIL TEMPERATURE

-14 °C / 7 °F average



## PREVAILING WINDS

April: NE 12 mph  
May: E 12 mph



## ICE

First observed shorefast ice: Nov. 25  
Average thickness  
during whaling: 6.8 feet  
Thickness occurs most often: 4.6 feet

**piqaluyak** – large chunk of freshwater ice from river, good for drinking water; multiyear sea ice that has become fresh due to multiyear thawing

**tuuqniq** – west winds and south currents bring in heavy ice and rams the fast ice



✦ *A prominent crack opens in the ice on April 23, 2015. Bill y Adams*

## SEASONAL SUMMARY

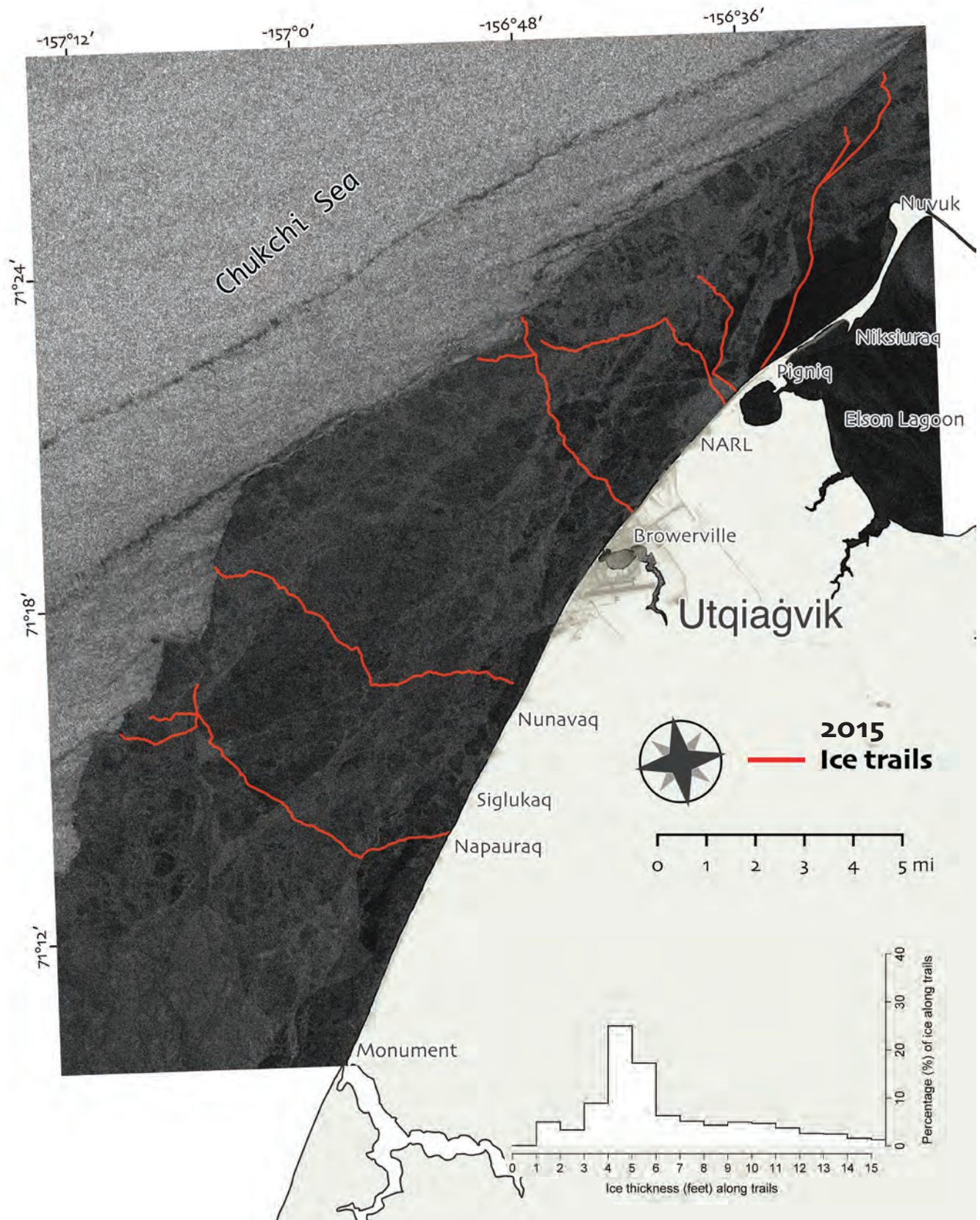
Currents from the south bring in animals, and multi year ice (**piqaluyak**). **Tuuqniq**, winds and currents bring in pack ice, ramming the edge of shorefast ice.

*Location is on our trail down by Naqilguq, south winds at 10 mph, sunny temperature is about 20f above very warm, visibility is 10 miles or far as you want to see very beautiful! The melting on the ice is not as bad as I thought it would be.... Small whales going by as well as belugas, bearded and ringed seals in the area. The currents are strong from the south at about 2-3 mph rubbing some multi year ice which looks very tempting to get ice from for making coffee or just to drink it! A crack was discovered 4.5 miles from the beach as shown in the picture. Pictures can tell you most of the reports that I give.*

*Email from Craig George: Thanks for this interesting report. We were able to get some piqaluyaaq drinking water for the ARF from Savik's trail where the pack ice slammed in. I heard there is a major crack in the southern trail where I think your crew is, is that correct?*

*Response from Billy: It is a tuuqniq we call where the west winds and south currents bring in heavy ice and rams the fast ice. It happens on first contact like a blunt blow but it cracks towards the beach and ends before it hits the beach. Those are not so much of a concern.*

—Billy Adams April 23, 2015



-157°12'

-157°0'

-156°48'

-156°36'

71°24'

71°18'

71°12'

Chukchi Sea

Nuvuk

Niksiuraq

Elson Lagoon

NARL

Browerville

Utqiagvik

Nunavaq

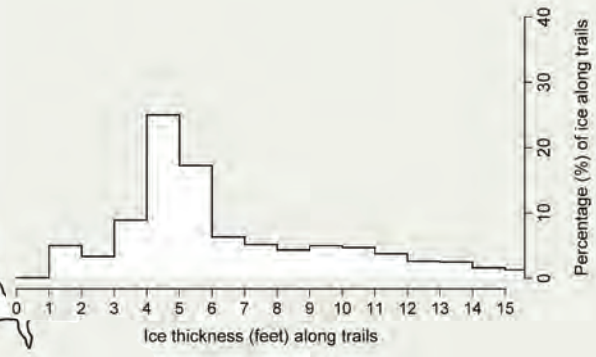
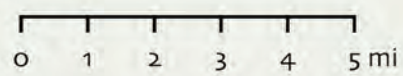
Siglukaq

Napauraq

Monument



**2015**  
**Ice trails**



# 2016

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## WHALES LANDED

12 Bowhead whales  
landed in spring



## APRIL TEMPERATURE

-12 °C / 10 °F average



## PREVAILING WINDS

April: E 18 mph  
May: E 12 mph



## ICE

First observed shorefast ice: Nov. 13  
Average thickness  
during whaling: 4.5 feet  
Thickness occurs most often: 3.8 feet



✦ *Whalers prepare a landing site on May 3, 2016.* Bill y Adams

## SEASONAL SUMMARY

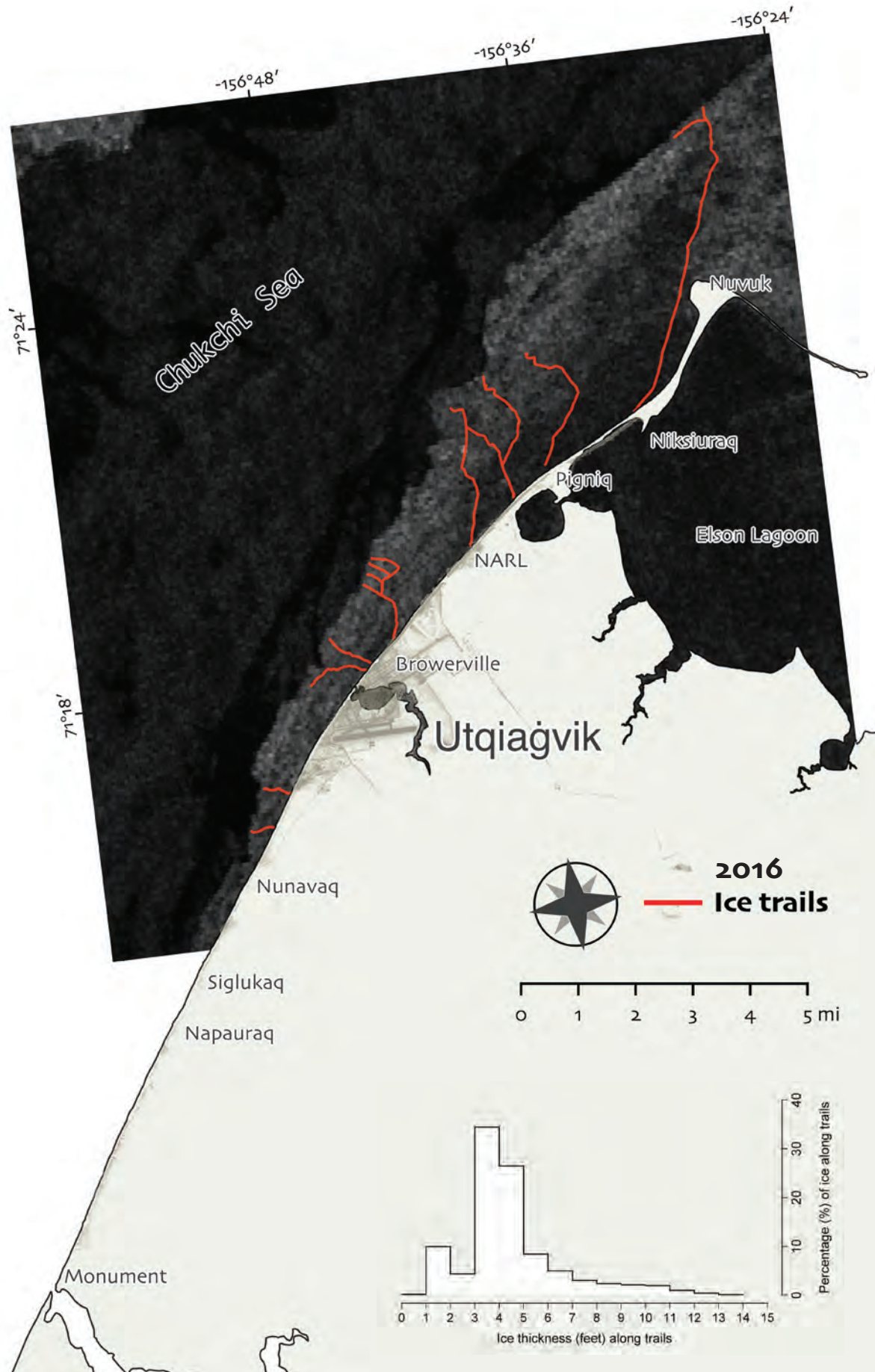
This year's ice season was marked by unusually thin ice and persistent strong winds. Early winter's warm temperatures and strong winds had blown out existing ice and prevented new ice from forming, resulting in thinner ice than in previous years. By April 13, the lead was just one mile from town, and sections of shorefast ice began breaking off throughout April. The first whale was taken on April 23. One crew lost a boat to the pack ice near the end of April. In May, whaling continued, with crews often pulling back due to fresh cracks and strong currents bringing in pack ice. By the end of May, the newly attached ice (**iiguaq**) extended the shorefast ice 5-6 miles from town.

*Hajo: What we are finding from our ice thickness sensors is that the ice is much thinner than in any other year since we started measurements in 2000. It's not clear whether this is all just because of a warmer winter or whether there's warmer water preventing the ice from growing thicker. If there is warmer water then that would eat away at the thin ice stretches along the edge of the shore fast ice as well.*

*Billy: The reason why it is not thick is that the whole ice blew away from the shore when we had a big blow from the east early this winter. And the winds blew very hard across the slope and kept the ice from forming throughout the winter. You are right too it has been very warm too.*

— *Hajo Eicken and Billy Adams, April 12, 2016*

**iiguaq** – ice that weakly attaches to the outer edge of the shorefast ice



# 2017

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## WHALES LANDED

8 Bowhead whales  
landed in spring



## APRIL TEMPERATURE

-14 °C / 7 °F average



## PREVAILING WINDS

April: E 13 mph  
May: E 12 mph



## ICE

First observed shorefast ice: Nov. 25  
Average thickness  
during whaling: 10.2 feet  
Thickness occurs most often: 5.4 feet



✦ Billy Adams north of Nuvuk  
where most whales were hauled  
out of the water.

Joshua Jones

## SEASONAL SUMMARY

Calm winds at the beginning of April allowed crews to make trails, but a shear wall (**agiuppak**) was observed on April 3, complicating travel. Fresh cracks were observed and kept crews from reaching the lead in April.

The first whale was taken on April 13, but strong winds and bad ice conditions prevented proper butchering as the ice kept breaking beneath the whale. Ice and lead conditions remained poor in front of Barrow all spring.

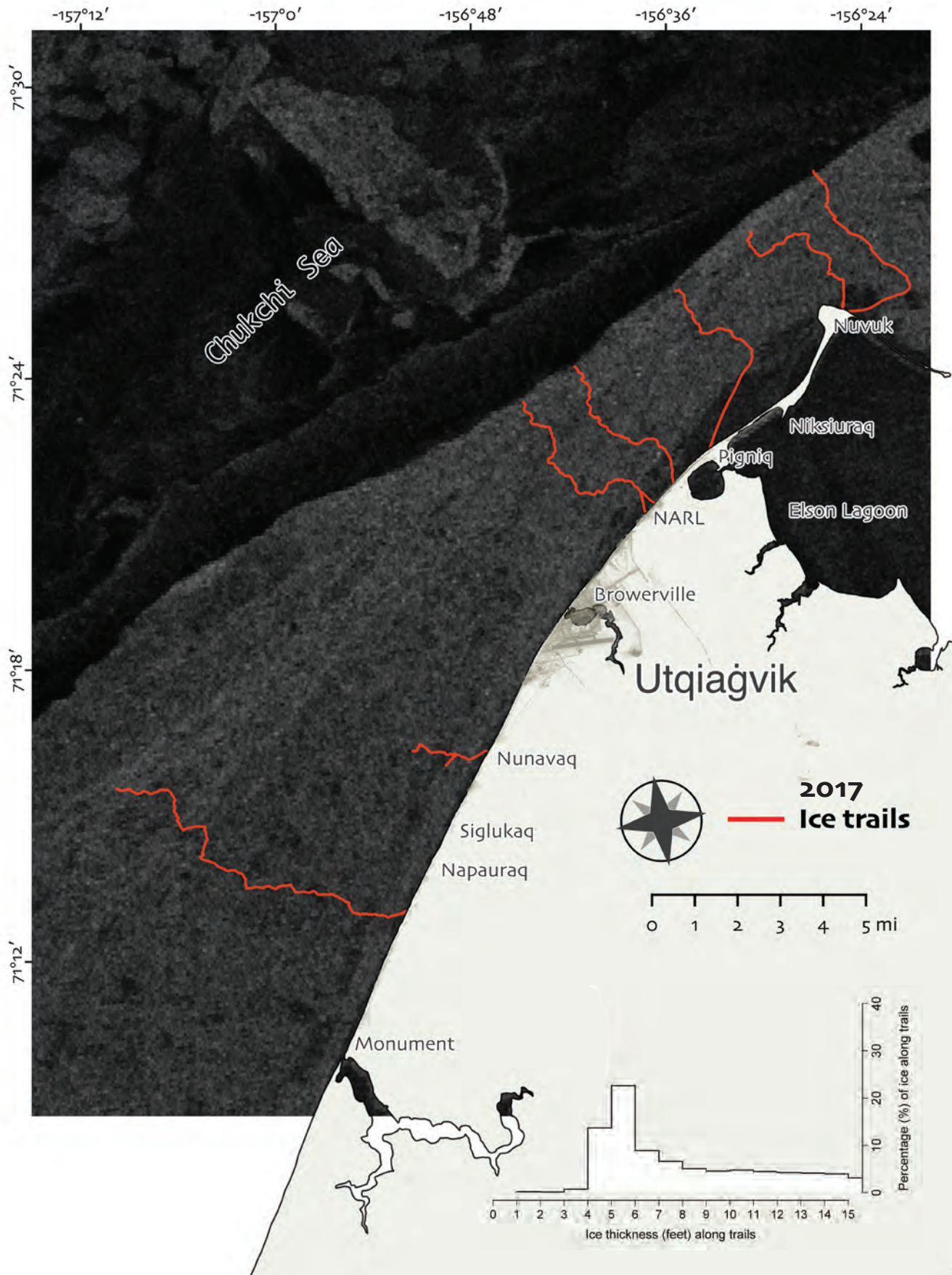
Throughout May, weak currents failed to break off the large ice attachment added in late March, and fresh cracks made travel risky, leading crews to be cautious. Three whales were successfully caught northeast of the point in April. In May, the difficulties continued with strong winds often keeping whalers off the lead. By the end of May, some trails had rotted out and open water was finally visible from land, signaling the transition to geese and duck hunting.

*East wind not strong enough to open lead. Current probably holding ice pack in. Some crews towards NARL have reached old lead edge but have come to a wall of ice on edge (**agiuppak**) where ice pack has rubbed shorefast parallel and created a wall.*  
—Joe Mello Leavitt, April 3, 2017

*Location Gravel Pit, clear skies partly cloudy, temperature -5°F, east winds 10-15 mph, and visibility to 8 miles or more. There is a big lead way out there but we can't make it out as there are reports from people who have seen the lead from an aircraft seen many cracks on it. Location Napaaraq we are making the trail a hair bit smoother but not by much hahahahaa!!!!*

—Billy Adams April 4, 2017

**agiuppak** – wall of sheared ice along the edge of the open lead that has been formed by the grinding action of the free ice against the shore-locked ice



# 2018

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## WHALES LANDED

8 Bowhead whales  
landed in spring



## APRIL TEMPERATURE

-14 °C / 6 °F average



## PREVAILING WINDS

April: E 14 mph  
May: E 14 mph



## ICE

First observed shorefast ice: Dec. 25  
Average thickness  
during whaling: 5.5 feet  
Thickness occurs most often: 3.5 feet



★ *The lead ice edge on March 27, 2018.* Bill y Adams

## SEASONAL SUMMARY

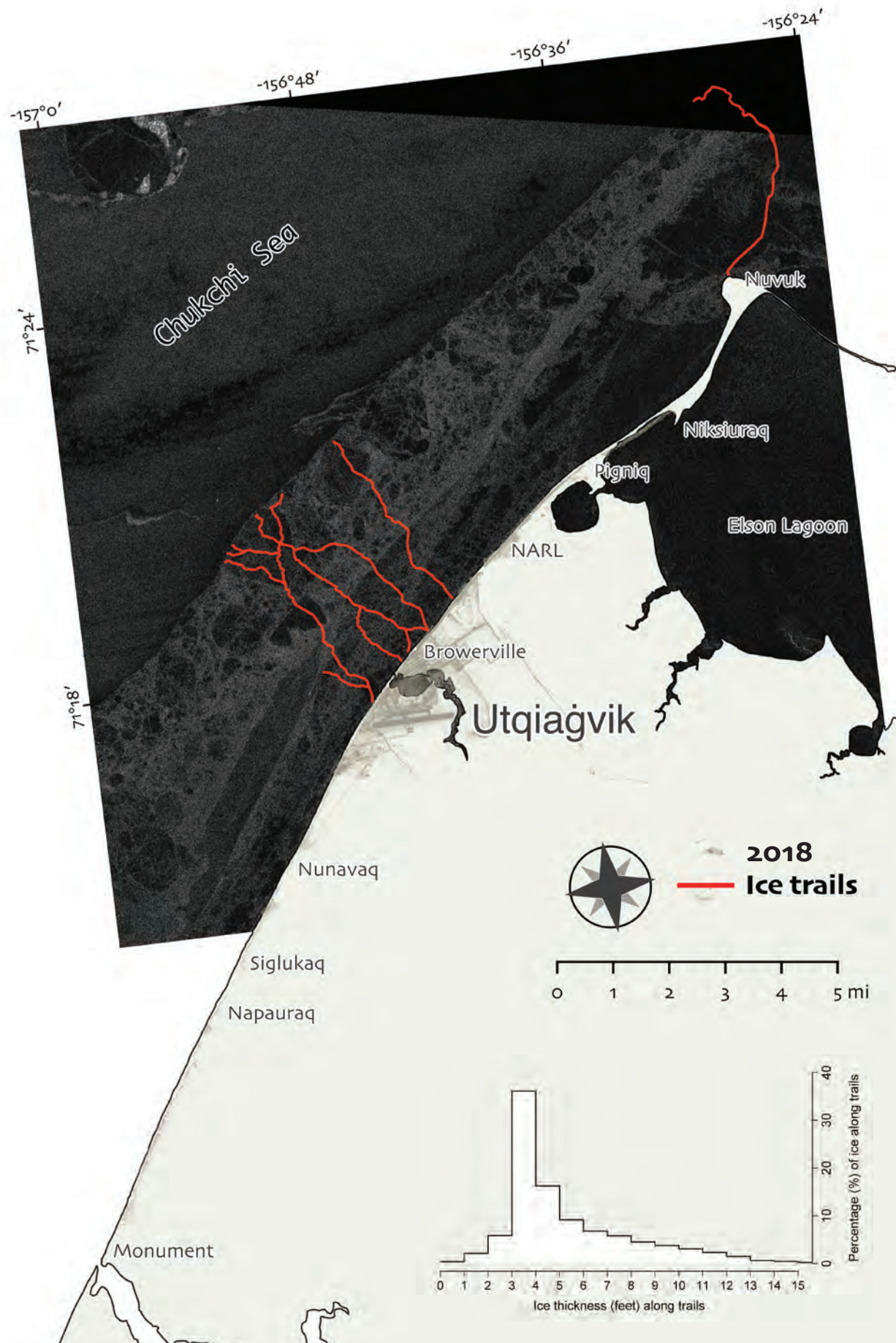
Early April saw the addition of flat young ice, with slush forming at the lead edge, creating a shear wall. Calm winds allowed for trail-making towards the old lead edge, but the ice closed up again by April 3, with a reported crack four miles out. Sightings of bowheads and belugas were sporadic.

By mid-April, open water was seen 8-11 miles out, but shifting winds and ice kept whalers out of the lead. In May, weather continued to affect whaling. By the end of May, the shorefast ice remained three miles out, with meltwater accumulating on top, particularly in front of town. Most whalers had come off the ice, but the weather remained cool.

*Total of 5 whales taken this week and 2 losses. There was hardly any current this week. Ice pans moving mostly to the SW, one **piqaluyak** was seen floating by—that is a glacial ice pan. Whales have been seen going by. Ice pack came in a couple of times and all crews had to get off the ice. Winds keeping whalers off the ice. NE. Still windy, outboard season starts tomorrow. Early this year because ice is so thin—all first-year ice, crews are whaling in front of Browerville all the way to the point.*

—Joe Mello Leavitt. April 22, 2018

**piqaluyak** – large chunk of freshwater ice from river, good for drinking water; multiyear sea ice that has become fresh due to multiyear thawing



# 2019

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## WHALES LANDED

9 Bowhead whales  
landed in spring



## APRIL TEMPERATURE

-14 °C / 7 °F average



## PREVAILING WINDS

April: NE 13 mph  
May: E 14 mph



## ICE

First observed shorefast ice: Nov. 17  
Average thickness  
during whaling: 7.8 feet  
Thickness occurs most often: 4.5 feet



✦ *Joshua Jones prepping the EM31 for measuring ice thickness on the way back to shore on April 2, 2019. Mat the w Dr uckenmiller*

## SEASONAL SUMMARY

Dynamic sea ice conditions were observed following a significant drop in sea level on March 22-23. This event caused many cracks along the NSB Wildlife trail to the Census Perch, with water surfacing near the shore and the landfast ice breaking out towards Peard Bay. However, the **tuvaq** off Utqiagvik remained intact.

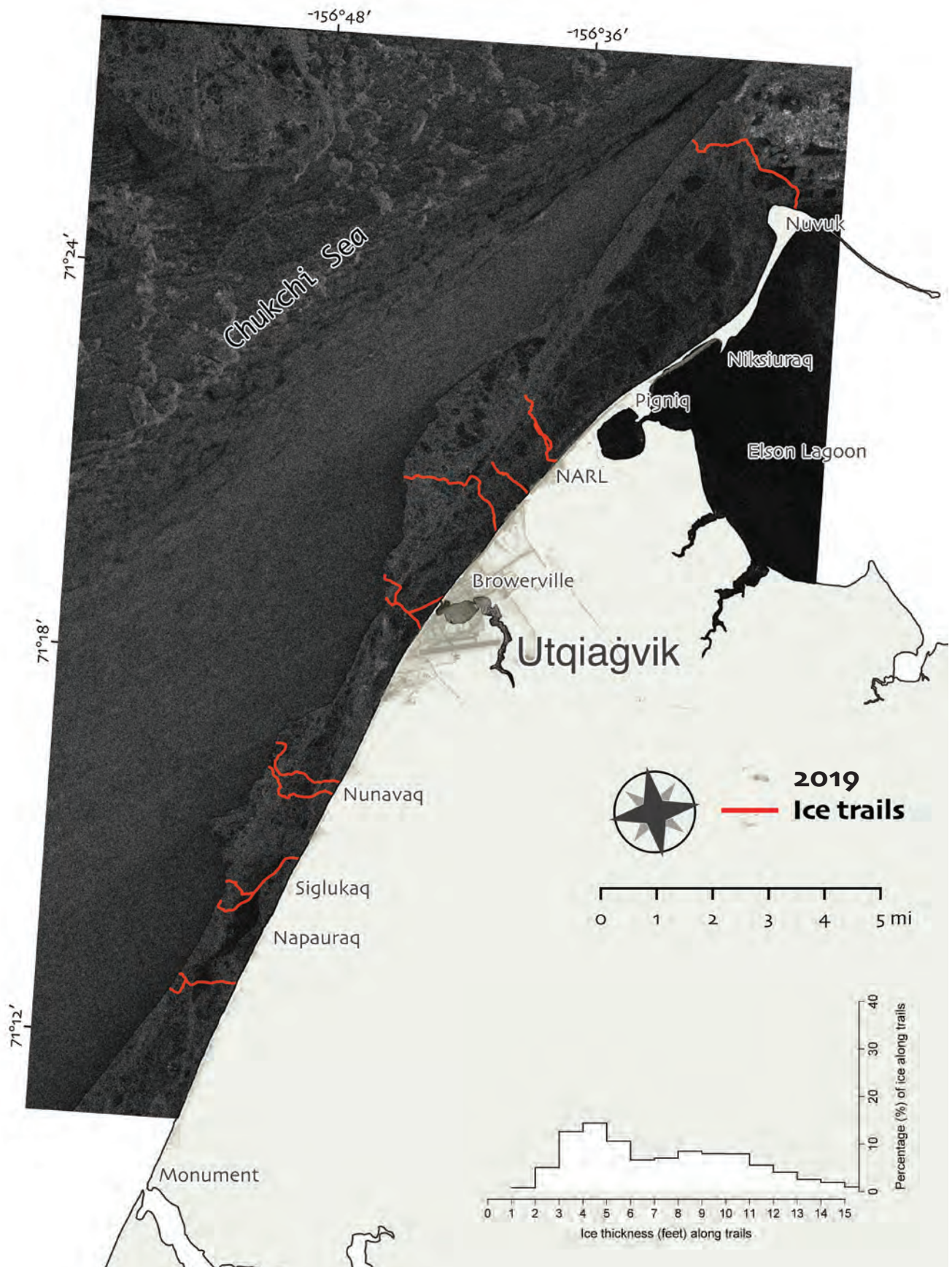
Throughout April, crews waited for the lead to open, which finally did around April 10, with the open lead 1.5-2 miles from town. East winds and weak currents initially prevented substantial ice movement. By mid-April, trails to the lead were completed, but conditions remained challenging with young ice and icebergs breaking off. The first whale was taken on April 19. Southwest currents kept pack ice in the lead and eroded shorefast ice.

Throughout May, thin shorefast ice and meltwater posed additional difficulties, but some crews continued to search for whales. By the end of May, shorefast ice had receded to  $\frac{3}{4}$  of a mile out, with significant meltwater on top and persistent open water in the ocean.

*Location Gravel Pit, temperature 3f, east winds 15 mph, blowing snow, overcast, and visibility to 2 miles. Here is a crack on our would be trail, not safe in this area so we have abandoned it for now.*

*—Billy Adams. April 10 2019*

**tuvaq** – shore-fast ice; to come in to shore (of ice); (Ti) shore ice



# 2020

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## WHALES LANDED

13 Bowhead whales  
landed in spring



## APRIL TEMPERATURE

-13 °C / 8 °F average



## PREVAILING WINDS

April: SW 11 mph  
May: E 12 mph



## ICE

First observed shorefast ice: Dec. 22  
Average thickness  
during whaling: 12.5 feet  
Thickness occurs most often: 4.6 feet



✦ *Jumbled ice at the lead edge, April 24, 2020. Bill y Adams*

## SEASONAL SUMMARY

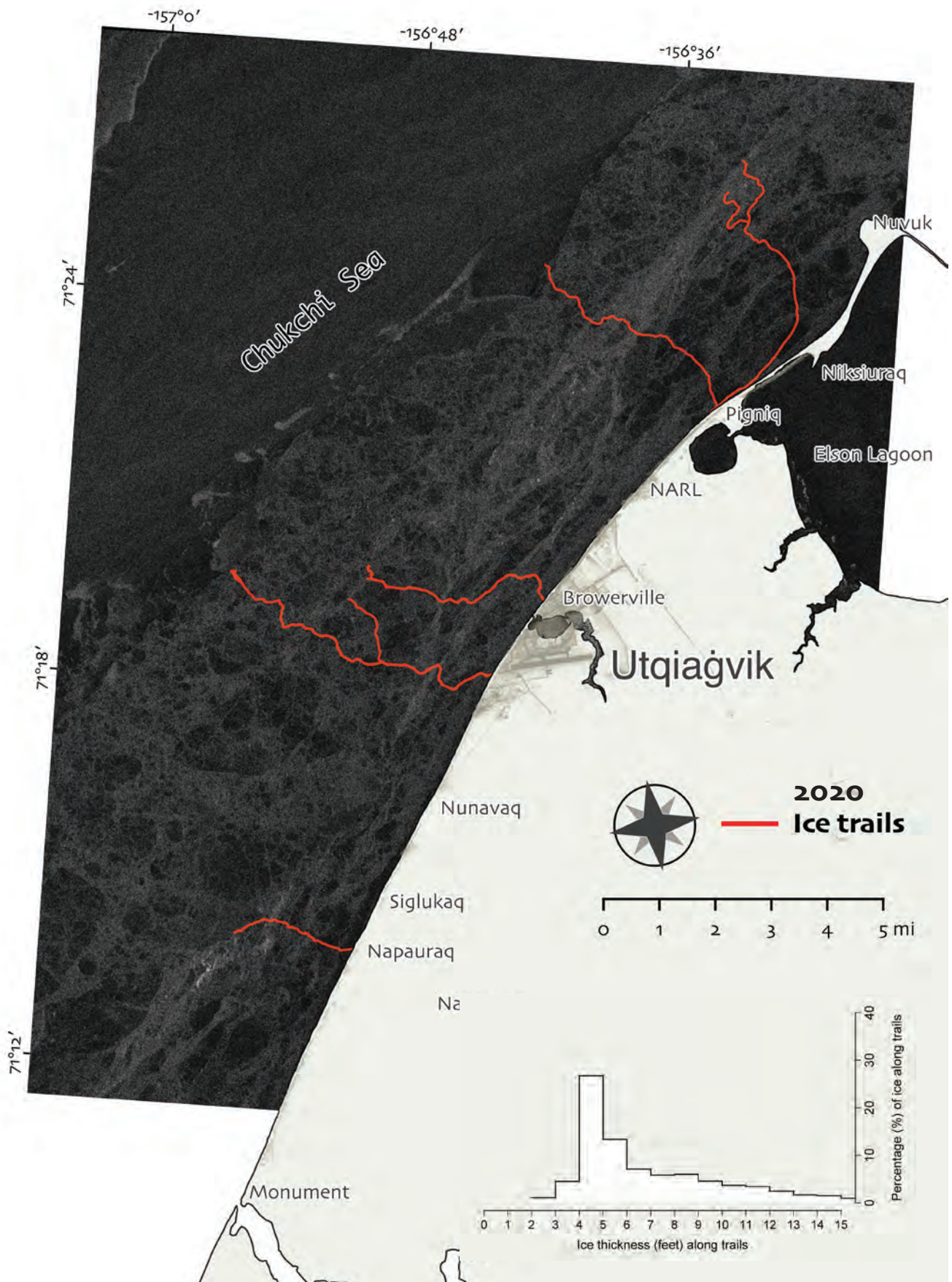
Due to COVID-19 travel restrictions, the trail mapping team couldn't travel to Utqiaġvik, but with the help of Craig George and local volunteers, trail mapping continued.

The ocean remained ice-covered with no open water until April 21. Crews focused on building trails to cracks in the shorefast ice, waiting for favorable winds to open the leads. Record low temperatures were recorded on April 29. The sea ice was particularly thick, reaching up to 5 feet in some spots, making trail-breaking arduous for the whalers. Strong winds created large ridges in the ice.

Despite these challenges, whalers managed to take three whales by April 30, launching from Duck Camp (Pigniq) and the Point (Nuvuk). Early May saw open water to the southwest, but shifting winds and heavy ice continued to pose difficulties. Shorefast ice remained, extending 5-7 miles out, with frequent sightings of whales and ducks. By the end of May, melting accelerated, and shorefast ice broke off, leaving open water 2.5-3 miles from the beach.

*Location 1/4 mile out from Gravel Pit, temperature -15f, light winds, clear and visibility to 8 miles. Whaling crews are building trails. The big storms have made pressure ridges and crushed up most of the large pans that were in the area. It is much rougher now.*

—Billy Adams, April 21, 2020



# 2021

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## WHALES LANDED

9 Bowhead whales  
landed in spring



## APRIL TEMPERATURE

-15 °C / 5 °F average



## PREVAILING WINDS

April: SW 9 mph  
May: NE 11 mph



## ICE

First observed shorefast ice: Dec. 5  
Average thickness  
during whaling: 5.4 feet  
Thickness occurs most often: 3.5 feet



✦ *Harry Brower's crew sitting at the ice edge waiting for whales on April 26, 2021.*  
Joshua Jones

## SEASONAL SUMMARY

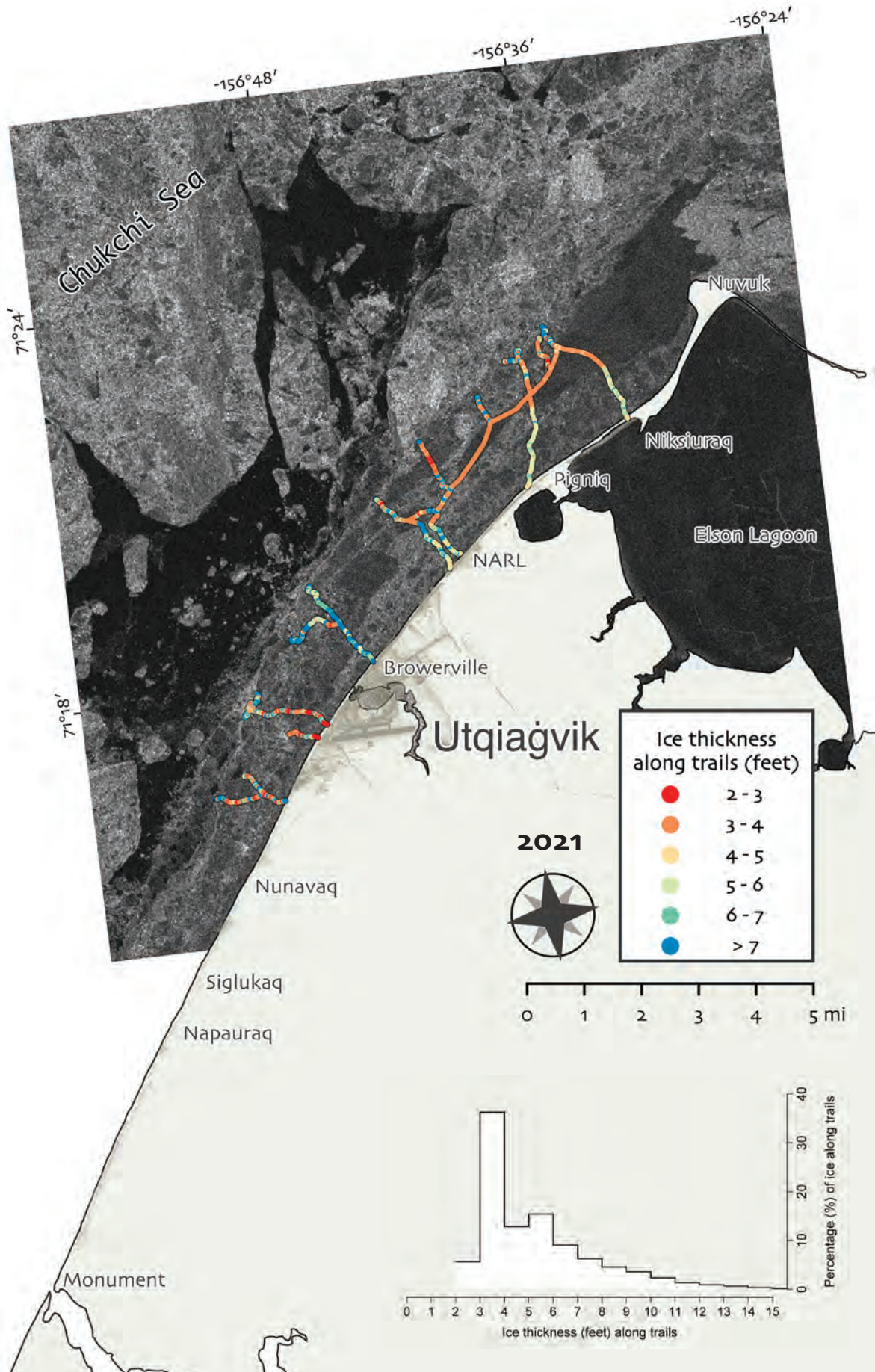
The landfast ice was mildly rubbled to the first big ridges; very navigable. Beyond the ridges there were quite a few large flat pans that allowed access all the way to the ice in many places.

There was a very large, very flat area of ice going from offshore of Pigniq to north of Nuvuk, a distance of about seven miles, that was referred to as the “Polar Highway.” There were also icebergs from the Milne ice sheet on Ellesmere Island incorporated into the landfast ice along the Polar Highway north of Pigniq and near Nuvuk (see iceberg photo on page 21). Newly added on ice (**iiguaq**) moved crews from Pigniq south towards Gravel Pits in April.

*3 miles out from Pigniq, 8°F, south east winds at 5 mph, mostly cloudy, and visibility to 7 miles. UAF ice experts Roberta Glenn and Josh Jones along with NSB Wildlife Biologist Kayla Scheimreif map a trail and listen for animals with a hydrophone. It was quiet as we did not spot any whales.*

—Billy Adams, April 16, 2021

**iiguaq** – ice that weakly attaches to the outer edge of the shorefast ice



# 2022

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## WHALES LANDED

16 Bowhead whales  
landed in spring



## APRIL TEMPERATURE

-17 °C / 2 °F average



## PREVAILING WINDS

April: NE 12 mph  
May: E 12 mph



## ICE

First observed shorefast ice: Nov. 30  
Average thickness  
during whaling: 7.8 feet  
Thickness occurs most often: 5.4 feet



✦ *One of the many bowhead whales spotted offshore on April 19, 2022.*

Bill y Adams

## SEASONAL SUMMARY

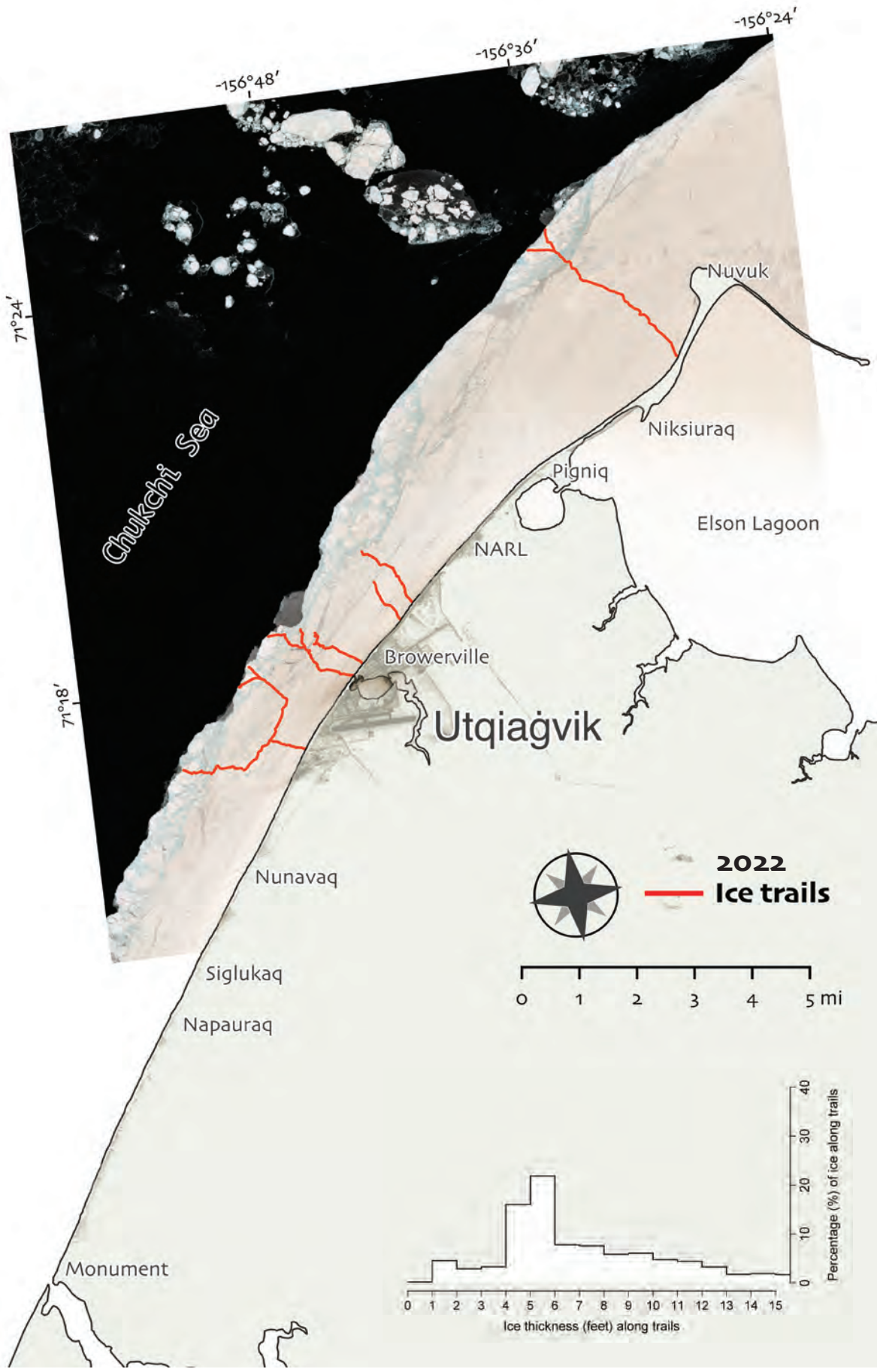
New ice was added onto the shorefast ice in early March (**iiguat**). The added on ice was broken off in late April, taking some shares (**ninjq**) with it.

*This years whaling is going good, 16 strikes have been taken with 9 to go. Lead is over a mile out with broken up ice in front of BRW. I have trails have young ice so some are in need of re-pair. One whale or part of shares were lost when the ice broke off. A crack was not noticed cause of snow cover.*

—*Billy Adams, April 30, 2022*

**iiguat** – ice that weakly attaches to the outer edge of the shorefast ice

**ninjq** – in Utqiagvik harvested bow-head whales are divided into different sections; the **ninjq** is the front section, from the head, and is put aside for whaling crews that actively participate in butchering the harvest



# 2023

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## WHALES LANDED

12 Bowhead whales  
landed in spring



## APRIL TEMPERATURE

-19 °C / -2 °F average



## PREVAILING WINDS

April: NE 11 mph  
May: E 11 mph



## ICE

First observed shorefast ice: Dec. 9  
Average thickness  
during whaling: 6.1 feet  
Thickness occurs most often: 4.5 feet



✦ *The trail mapping crew (Roberta Glenn, Matthew Druckenmiller, Joshua Jones, and Donna Hauser, left-right) takes a photo break. Roberta Glenn*

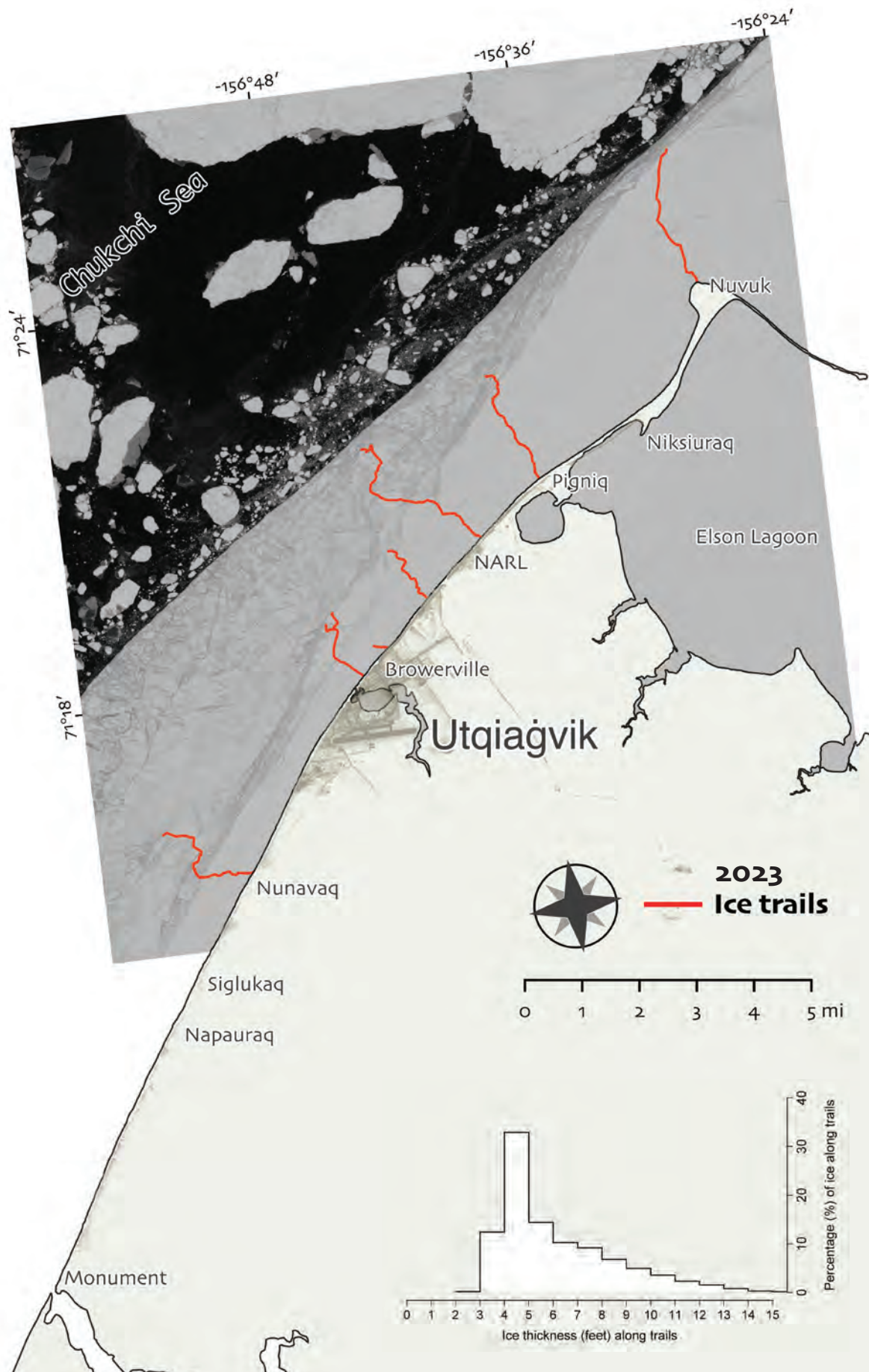
## SEASONAL SUMMARY

There were sustained west winds from January to March, keeping the ice closed. Crews were waiting for east winds to open the lead in April. The trail mapping effort in 2023 was hindered somewhat as the lead was closed the entire time the AAOKH team was in Utqiagvik. None of the trails had reached the water by the time the team left.

The shorefast ice was somewhat rough out to the first big ridges, with large ridges north and west of Nuvuk. Eventually the lead opened, and the whaling season was successful.

*The westerly winds have been consistent since late January, this has brought in the pack ice up against the shorefast ice. The east side of Pt. Barrow has been the area of open water making it a productive area for animals.*

—Billy Adams, March 11, 2023



# 2024

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## WHALES LANDED

11 Bowhead whales  
landed in spring



## APRIL TEMPERATURE

-3.5 °C / 25.7 °F average



## PREVAILING WINDS

April: E 14 mph  
May: E 11 mph



## ICE

First observed shorefast ice: Nov. 17  
Average thickness  
during whaling: 5.4 feet  
Thickness occurs most often: 4.4 feet

**agiuppak** – wall of sheared ice along the edge of the open lead that has been formed by the grinding action of the free ice against the shore-locked ice

**aggiupagruaq** – tallest walls of **agiuppak**, typically 20 ft tall or more



✦ *“Bears have been going north and stopping by to have lunch with us. There have been many mothers with cubs this winter and are looking very healthy.”*

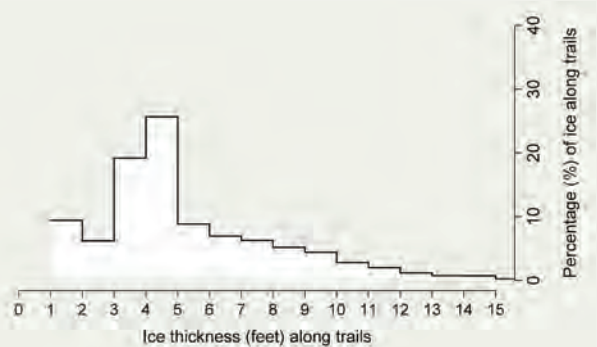
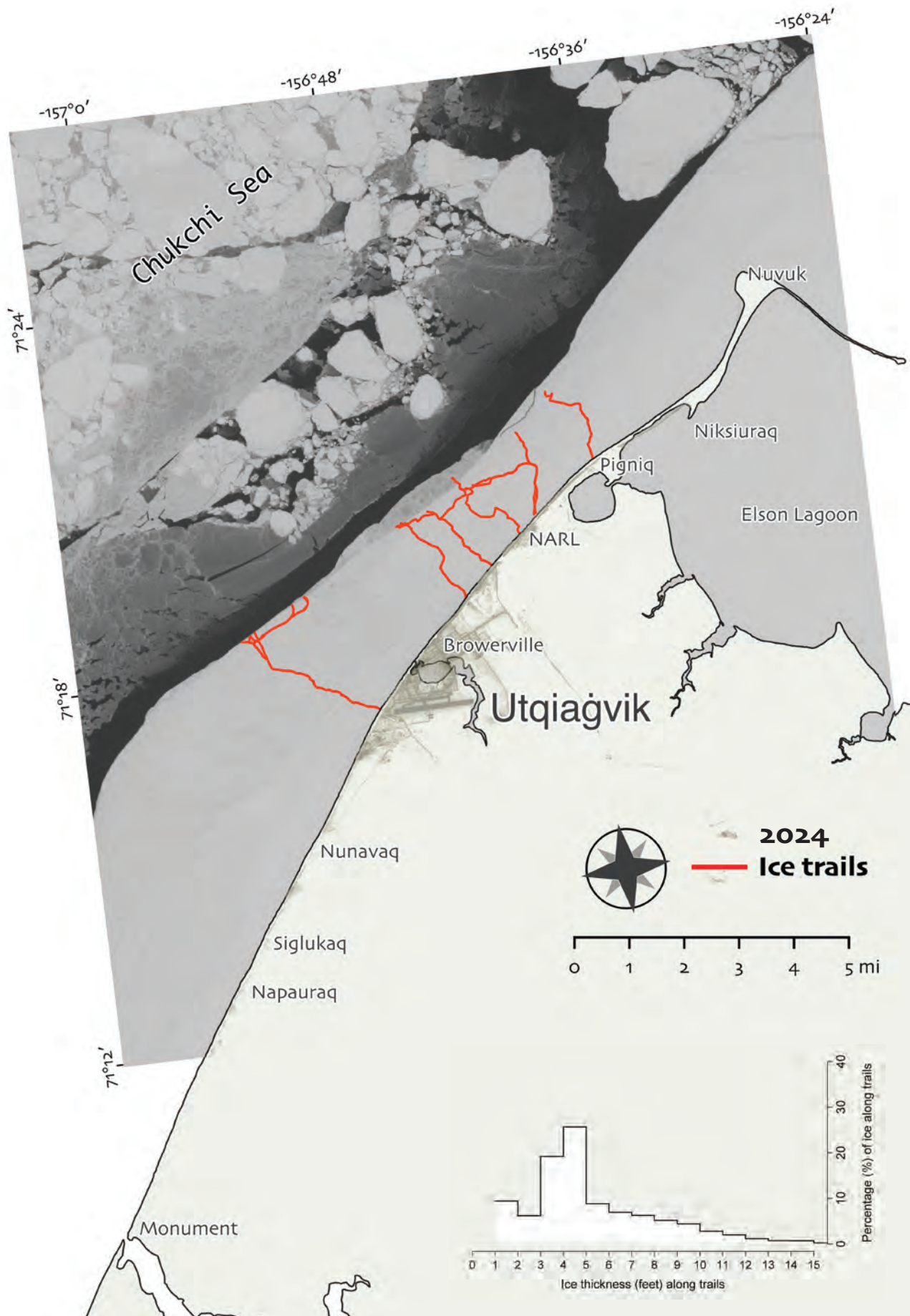
Bill y Adams, Mar ch 5, 2024

## SEASONAL SUMMARY

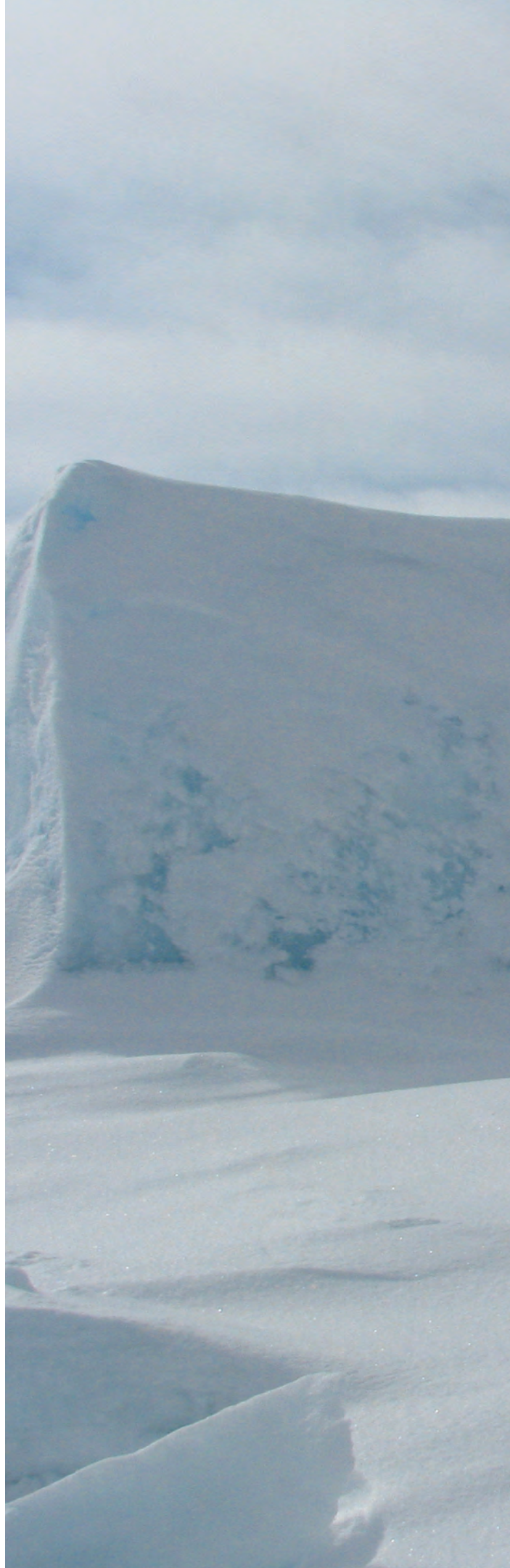
Beginning in early January, sustained easterly winds kept water levels low and whalers off the ice, with potential lifting expected once winds subside. By March, healthy mother bears with cubs were being seen frequently by whalers breaking trail. In April, Utqiagvik celebrated its first whale of the season. **Aggiupak** (a shear wall of ice) was observed and shifted whaling and trail building activities. Throughout early May, unusual northward currents and heavy ice delayed whaling. By the end of May, tide cracks were exposed as the south winds brought in warmer winds and higher water levels, speeding up the thinning of the ice.

*Barrow has landed their first whale of the 2024 season by Aaluk crew. Beautiful ice formation like a wall which is constructed by currents from the south when the pack ice continually rubs the shorefast ice we call this type of ice **agiuppak** [wall of ice created by moving pack ice rubbing shorefast ice parallel to the ice edge] and they can be higher ones that can be 20 feet or higher we call **aggiupagruaq**.*

—April 25, 2024



✦ *Whaler Roy Ahmaogak standing in front of a piece of **Pikaluyak** (multi-year sea ice). Mat the w Dr uckenmiller*







# Why Wind is Important

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## SHOREFAST ICE IS SHAPED BY CURRENTS AND WINDS

The shorefast ice off Utqiagvik forms in fall through a combination of ice freezing in-place and the attachment of drift ice brought in-shore by wind and currents. Over the course of winter and spring, the shorefast ice thickens while continuously being added to, broken-up, or deformed under the forces of the wind, currents, sea-level, and drifting pack-ice. The shape of the coastline and local bathymetry (water depth) also control how these forces act on the ice. As a result, the shorefast ice off Utqiagvik is always a complex mix of different ice types and ice ages. No two years are ever the same.

The dominant current at Utqiagvik is from the northeast (**Pirugaḡnaq**) during most of the year. However, in mid-to-late May, there is typically a shift in the major current direction to that from the southwest (**Qaisagnaq**) and also an increase in current speed. **Qaisagnaq** brings warmer water that accelerates the melt and break-up of shorefast ice. **Qaisagnaq** is also known as the current that brings the animals.

Winds also play a major role in the drift of pack ice and in determining whether or not the lead along the shorefast ice is open. Onshore winds from the north to southwest may bring in pack ice to close the lead, while offshore winds from the northeast to south may open the lead. When an offshore wind is strong enough, it can drop local sea level (**katak**) by developing an offshore current, which can cause certain areas of the shorefast ice to detach (**uisauniq**) when cracks form around grounded ridges.



✦ *A dense, highly deformed rubble field making it difficult to get to the ice edge in 2023 (right).*

Joshua Jones

✦ *Matthew Druckenmiller looking over the lead with young thin ice. Frost flowers on the new ice (below).*

Joshua Jones

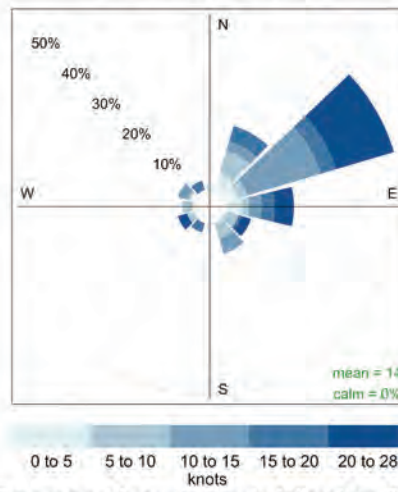
Currents and winds are particularly dangerous during spring whaling on any trails that are north of Nuvuk. Currents and ice dynamics in this area often lead to the formation of massive pressure ridges (**ivuniq**) in this area. These same forces present a risk to boating in any open leads north of the Nuvuk. Traveling during an east wind is particularly risky.



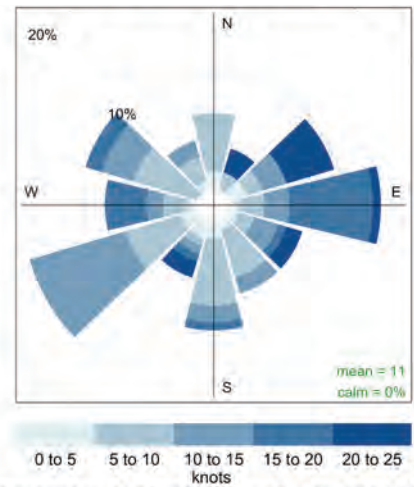


Direction and speed of winds from April 1 through May 15 during each trail mapping year.

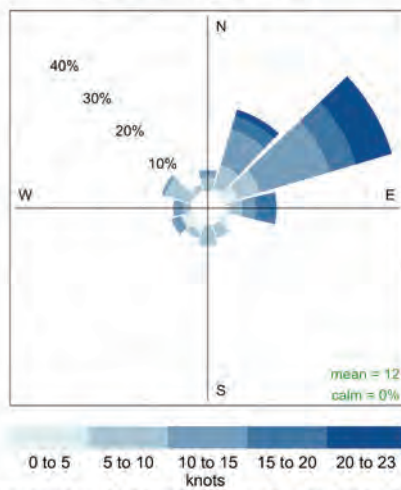
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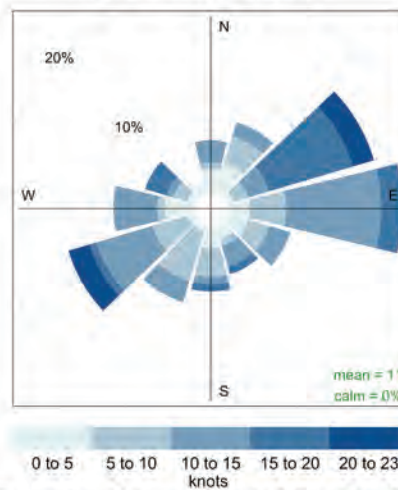
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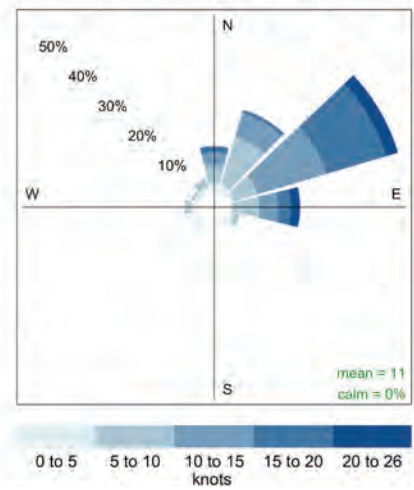
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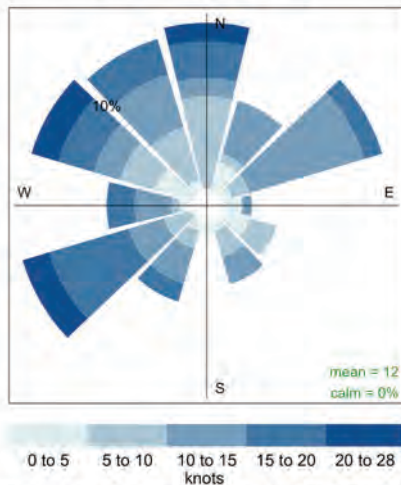
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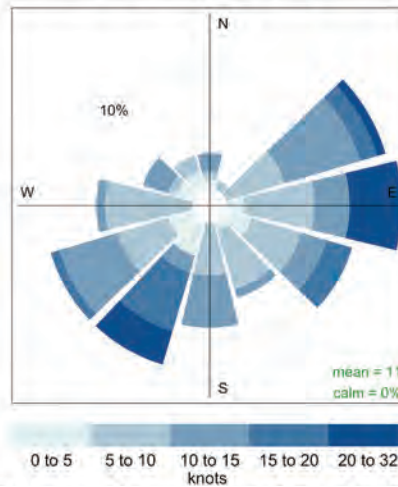
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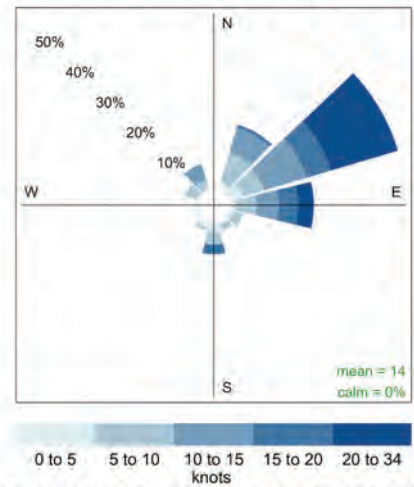
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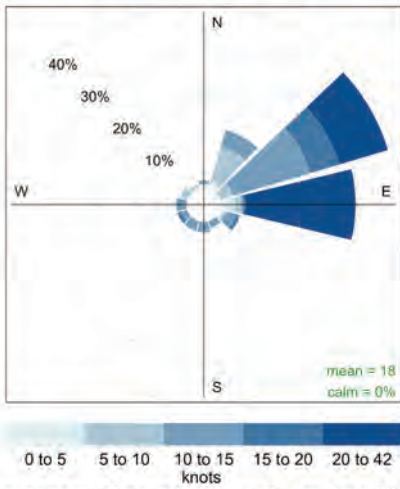
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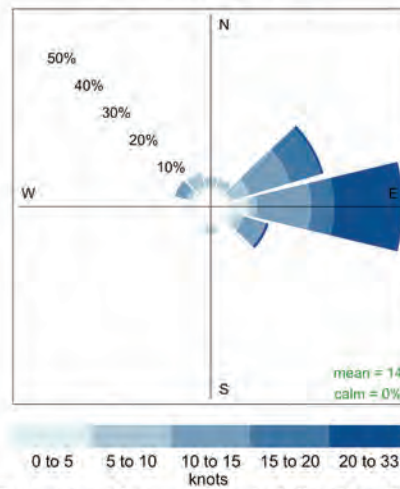
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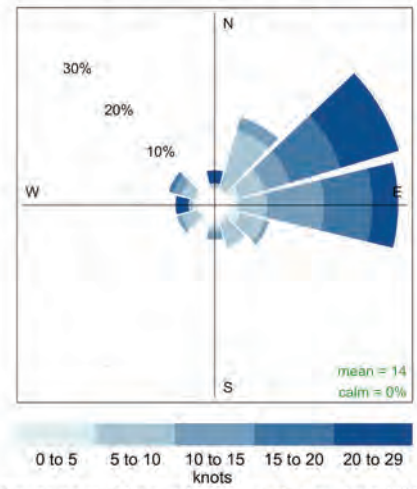
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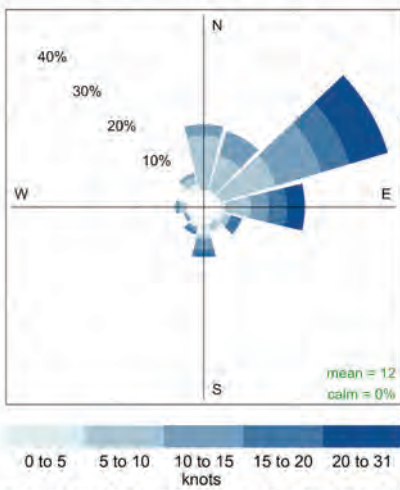
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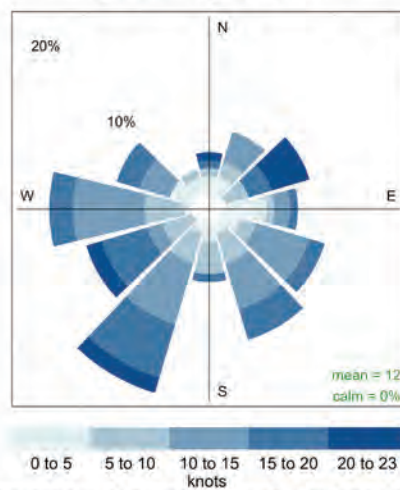
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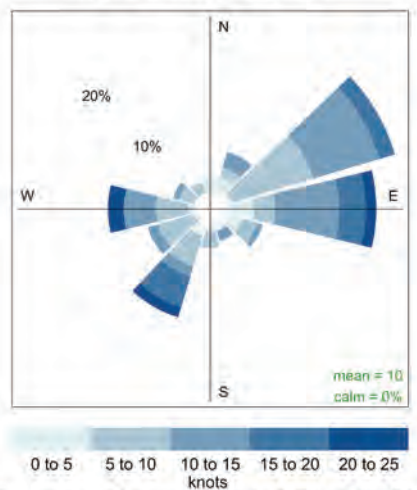
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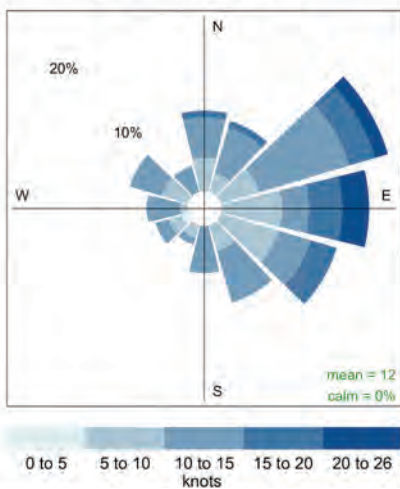
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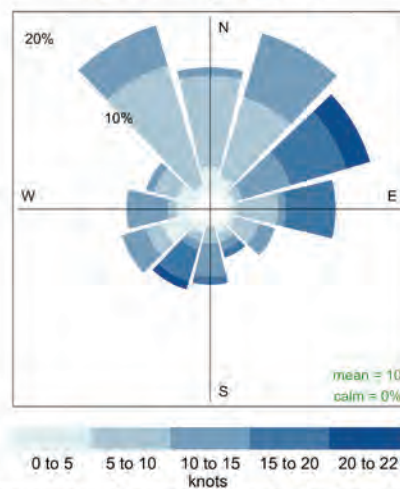
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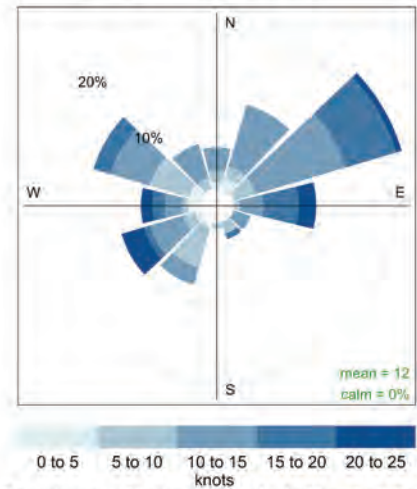
2022



2023



2024





# Sea Ice and Other Iñupiat Terms

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DEFINITIONS FROM MACLEAN (2012) AND  
HARCHAREK (2002) UNLESS NOTED

65 terms for ice are in this list

16 of which are based on the term siku “ice”

**agiukpak** or (Ti) **agiuppak** – wall of sheared ice along the edge of the open lead that has been formed by the grinding action of the free ice against the shore-locked ice

**alliviñiq** – ice under another piece of ice which may surface due to ocean currents or wake of boat

**apuqtinniq** – ice which has been pushed onto shore

**arguqtañiq** or **arguqtinniq** – newly formed thin ice on the down-wind side of a polynya or lead

**asitaq** – cracked ice made by force of moving ice when it attaches to free floating ice

**ataitchuaq** – shore ice not anchored to ocean floor

**atignigaaq** – new ice which forms along pre-existing ice

**aulaniq** – moving lead ice

Maclean, Edna. 2012.

Iñupiatun Uqaluit Taniktun  
Sivunniugutiñit North Slope  
Iñupiaq to English Dictionary.  
Alaska Native Languages Archives,  
University of Alaska Fairbanks.  
Compiled by Edna Ahgeak  
MacLean.

Har char ek, Jana Pausaura q. 2002.  
Aġviqsiuġnikun. Whaling Standards,  
Barrow and Wainwright. North Slope  
Borough School District, Barrow,  
Alaska.

Terms No t F rom Maclean 's  
\* Alaska Shorefast Ice: Interfacing  
Geophysics With Local Sea Ice  
Knowledge and Use by Matthew  
Druckenmiller, 2011.

\*\* inupiaqonline.com

\*\*\* Ronald Brower's  
Barrow Sea Ice Terms



✦ *Frost flowers growing on young ice covering the lead in 2022. Joshu a Jones*

**aunniq** or **aupkaḡniq** – rotten ice

**augniqsraq** – patch of ground from which the snow has melted while the surrounding area still has snow; area where sea ice has become dangerous due to melting

**avarraullaktuaq** – large ice floe which breaks off from the land-locked ice and begins to move in a circular motion

**ayaaqtinniq** – ice trapped in a narrow part of a river or lead

**ayiupaq** – ice chipped off by ocean waves

**ayuksraq** – piece of ice that does not freeze to shore-fast ice and goes out with ocean current

**iḡnigluq** – crushed, thin, young ice found in ice cracks

**igniqnaq** – stretch of smooth ice parallel to shore between pressure ice ridges and beach

**iiguaq** – ice that weakly attaches to the outer edge of the shorefast ice\*\*

**ikuḡaaḡniq** – ice adhering to ice that has been added to shore ice

**ikuḡaaq(-)** – depression on ice full of water; to become full of depressions full of water (of ice on ocean)

**illagauraq** – ice which has begun to melt and although solid is spongy and dangerous

**imiḡniq** – mound of earth or ice that makes an echoing sound when stamped on

**imuniq** – young ice which has been crushed by moving ice

**iḡutuq** – young female bowhead whale (choice eating); young whale\*

**irriqutit** – diamond dust or ice crystals in the air (indicating that a cold spell is imminent)

**isaamaniq** – narrow piece of ice that juts out from the main piece of ice

**ivuniġauraq** – small ice pressure ridge

**ivuniq** – ice pressure ridge

**ivuniqpaaluk** or **ivuniqpait** – big ice pile, pressure ridge

**kanġilaq** or (Nu) **kanġutailaq** – smooth ice with no frost on top

**kaniqtaq** – ice formed by frost; fragile, refrozen ice

**kanjıłuk** – bay, inlet; indentation in sea ice where whales often surface

**katak** – a sudden drop in sea level; means “to fall”; may cause floating ice near grounded ridges to crack\*



✦ *Divvying up a harvested whale in 2022.* Joshua Jones

**kiapku** – solid pancake ice

**kisisaq1** or **kisitchaq** – grounded ice pile (which keeps landlocked ice from floating away); grounded iceberg

**kuklugaq** – chunk of ice in house placed over water bucket to melt, drip, providing drinking water

**maktak** – whale skin with blubber attached\*\*

**mauraġaq(-)** – small ice floe used as stepping stone

**mayuqtinniq** – ice on the beach

**mayuqtitaq(-)** – slush ice pushed onto to shore

**miġaliq(-)** (Ti) – slush ice; slush and small chunks of new sea ice which wash up on shore in fall; to be covered by small chunks of sea ice in fall (of beach)

**mikigaq** – mixture of fermented whale meat, whale tongue, and maktak\*\*

**mitik1** (Nu) – slush ice (in a fishing hole)

**mitu(-)** (Nu) – first chunks of ice which form in ocean in the fall (clings to nets)

**muġalliq** or (Ti) **miġaliq** or **muġaliq** – slush ice, waterlogged snow (on ocean) (foam-like in appearance), snow and thin ice on water when freeze-up begins, slushy ice which forms on shore at the first freeze

**muġrak** – slush ice

**nanjaqtuġvik** – safe place on shorefast ice where hunters store their whaling equipment and camp when waiting for the lead to open or for other favorable conditions to develop\*

**napaayuq** – upright ice cake

**nilak** – layer of granular snow found under another layer (can be melted for potable water); moist crushed ice

**nutagun** – fresh snow on ice-free water; refrozen crack less than ten feet wide

**nutaqliq** – smooth ice covered by snow with moisture between the ice and the snow

**nuvugaqpuk** – large promontory of ice extending out from the ice edge\*

**paaġiiq** – ice propelled by the wind and ocean current simultaneously in opposite directions, making it appear to move\*\*\*

**pauk(-)** – ice that serves as an anchor to shore-fast ice

**pinu(-)** – isolated ice mound; knoll, dome; isolated hill; pimple, swelling on skin; swell (crestless wave or succession of waves); (i) to develop a pimple; to swell (of ocean)

✦ *Polar bear feeding off of whale carcass at Nuvuk. June 2023. Lloyd Pikok, Jr.*





✦ *A frost flower growing on young, thin ice.* Joshua Jones

**piqaluyak** – large chunk of freshwater ice from river, good for drinking water; multiyear sea ice that has become fresh due to multiyear thawing

**piquniq** – mound formed by pressure from below; place where river ice over deep water is pushed up so that it cracks and water flows through

**Pirugagnaq** – ocean current from the northeast\*

**pituuqqiq** – flat, secure ice at edge of ocean lead (where whaling camp can be set up at the end of the trail that's been made)

**puḡrak** (Ti) – slush ice

**puktaaḡ** – floating mass of ice; iceberg, large piece of ice

**puktaaḡat** – ice floe attached to another ice floe

**qaatchiñiq** (Ti) – depression on ice filled with water

**qaiḡilu** – ice with irregular surface features, partly rough and partly smooth

**qaiḡilḡuq** (Nu) – ripple on ice

**qaimḡuq** – first shore ice in fall

**qaimḡuq** – white frozen edge of water; frozen foam on beach; (Ti) smooth ice parallel to shore, a cake of ice smoothed by spray

**qaiqsuaqtat** – smooth ice between areas of rough ice

**qaisagnaq** – current from the Southwest; current that brings the animals in spring\*

**qaivaḡniq** – flat round cakes of ice frozen together

**qanaññaqtuaq** – pack ice moving directly toward shore fast ice

**qanḡatchiniq** (Ti) – ice with hollow space beneath it (easy to fall through)

**qan̄attaq** – ice or snow which has one edge partly off the ground; hollow area (as from erosion); hollow area between the ice and the water

**qimaktinniq** – shore fast ice left behind when the ice is carried away by an ocean current

**qinu(-)** – layer of slush ice which forms on ocean at freeze up and clings to shore; to form a thin layer of slush ice (of ocean at freeze-up)

**quasa** or **quasiraq(-)** or **quasiraaq(-)** – bare, smooth ice on lake or pond which one can slide on; (i) to slide along swiftly on a slippery surface; to skate

**qukhiaq** (Nu) – small cracks which fan out through ice or glass

**sagrat** – assembled pieces of ice traveling with the current in ocean

**sarri** or (Ti) **sarrik** – floating ice pack away from shore-fast ice

**sīgm̄iq** or (Ti) **sīgm̄iq(-)** – substance that hardens and can be used for patching; patch for sled runners of water and snow to improve their sliding; (Ti) ice which forms on boat or sled; (t) for it=boat or sled to get covered with ice; glacier

**siiqsinniq** – water flowing through crack in ice; underground springs, water flowing out of the ground; frozen overflow on top of river ice; glaciated stream (melts in summer)

**siku(-)1** – ice; to freeze over; to become icy

**sikuaq(-)** – thin ice on body of water; (Ti) ice on boat or sled; to become covered with thin ice (of water); (Ti) to ice over (of boat or sled)

**sikuatchiaq(-)** – newly formed thin ice

**sikuayaaq(-)** – new ice, young ice on water; to have new ice, young ice (of water)

**sikūgaq** (Nu) – small chunk of floating ice



✦ *The magnified tip of a frost flower.*

Joshua Jones

**sikuḡlak(-)** or **sikuḡlalaq** – frozen rain and snow on ground; hailstone; (Ti) icicle; (Ti) old packed snow good for drinking water; to freeze over ground or snow (of rain); to start forming (of ice); to hail; (Ti) (i) to form (of icicle); to get packed hard so that it is good for drinking water (of snow)

**sikuḡliñiq** – ice formed from water spilled on something

**sikulḡauraq** (Nu) – new thin ice

**sikuliḡruaq** – ice which is about one and a half feet thick

**sikuliaq** – young ice formed around edge of old solid ice on open lead

**sikuliuraq** – newly formed ice

**sikulluataq** – freshwater ice

**sikunaq(-)** – ice fog; ice crystals which settle out of the air; for there to be ice fog, ice crystals in the air

**sikuqqaq** (Ti) – block of ice

**sikuqqat** – small icefloes

**sikutchiaq** – new ice

**suḡaiñḡruaq** – very large mass of pack ice

**tuvaq(-)** or (Ti) **tugaq** or **tuvaḡruaq** – shore-fast ice; to come in to shore (of ice); (Ti) shore ice

**tuvaqtaq** – shore fast ice covering only a portion of the beach

**tuunig** – cracked ice made by force of main pack ice

**tuuq** – when pack ice impacts shorefast ice and acts as a chisel; means “to chisel”\*

**tuuqniq** – west winds and south currents bring in heavy ice and rams the fast ice\*\*

**uiñiq** – open lead\*\*

**uisauniq** – a shorefast ice separation or break-out event resulting in people adrift amongst the pack ice

**utuqqaviñiq** – piece of old shore-fast ice which has broken off; chunk of thick shore ice<sup>4</sup>. This spelling was provided by Ronald Brower, Sr., however it differs significantly from that provided by George et al. 2004, who published the term as Sarri.

this end creates  
electromagnetic  
field

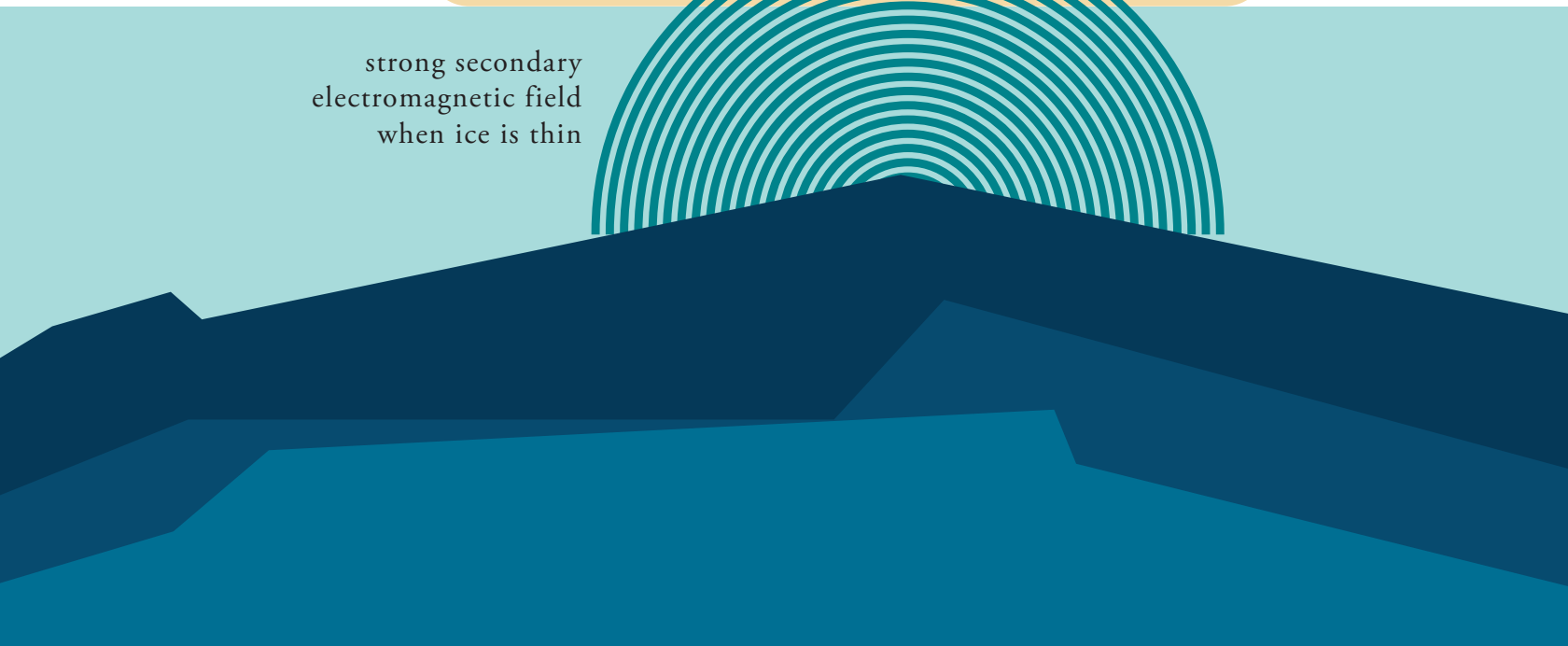


electromagnetic conductivity  
(EM) meter in a snowmachine  
sled is pulled across the ice

this end senses  
the secondary  
electromagnetic  
field



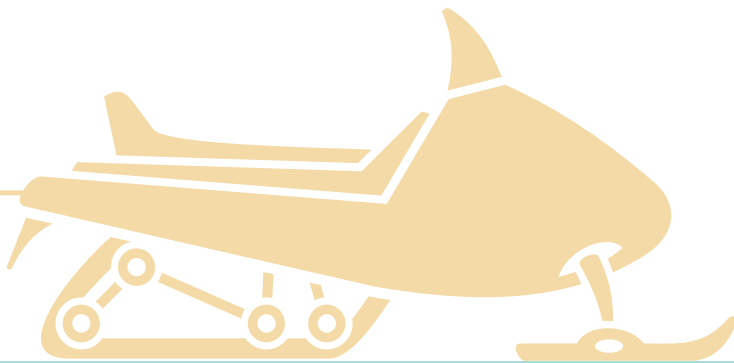
strong secondary  
electromagnetic field  
when ice is thin



# Measuring Ice Thickness

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Trail locations are mapped using GPS, while ice thickness is surveyed continuously along the trails using a 9.8 kHz Geonics EM-31 electromagnetic conductivity meter, which is mounted in a 14-foot plastic sled that is hauled behind a snowmachine. The EM-31 measures the strength of an induced electromagnetic field in the conductive seawater beneath the ice, which is converted into an indirect measure of ice thickness. This method allows ice thickness to be surveyed across large distances and the many ice types that make up Utqiagvik's shorefast ice each spring, without the highly laborious and time-intensive task of drilling holes in the ice.

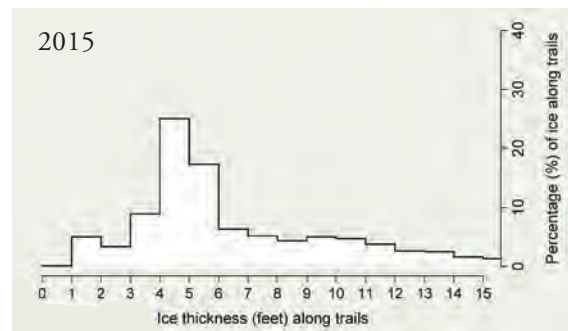
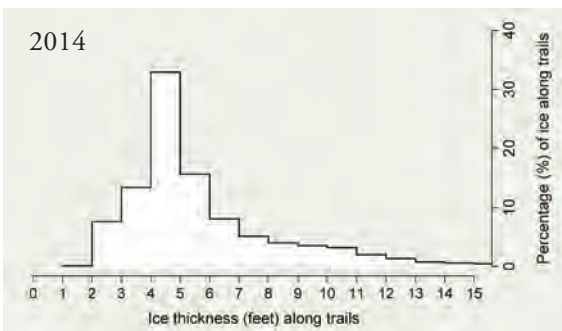
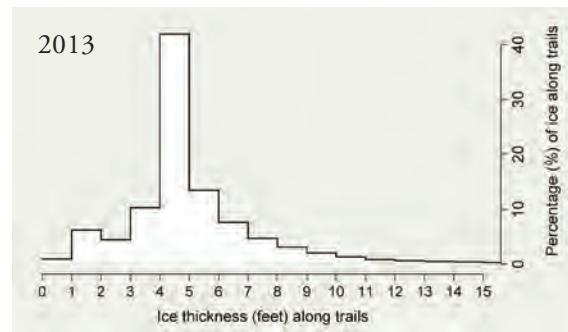
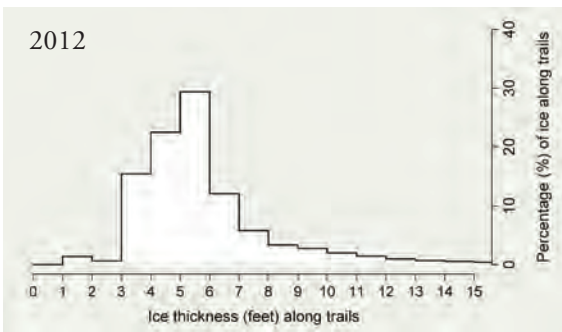
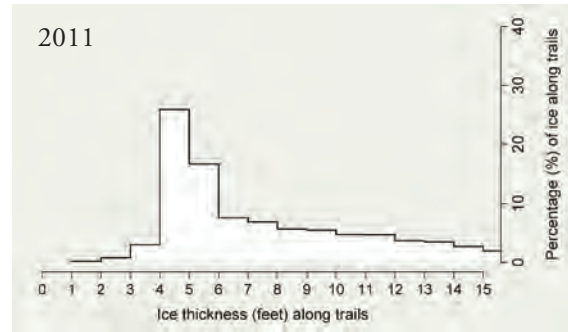
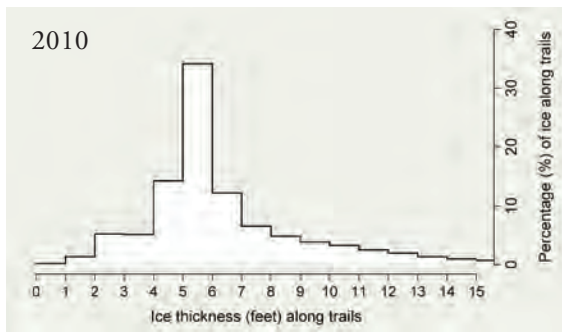
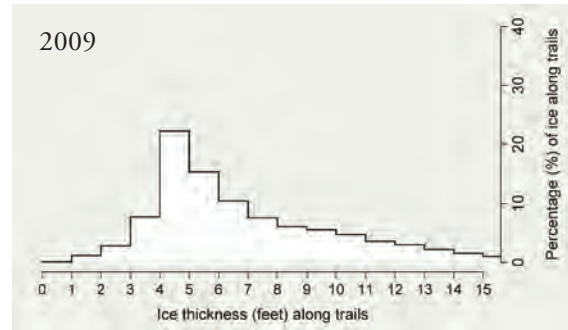
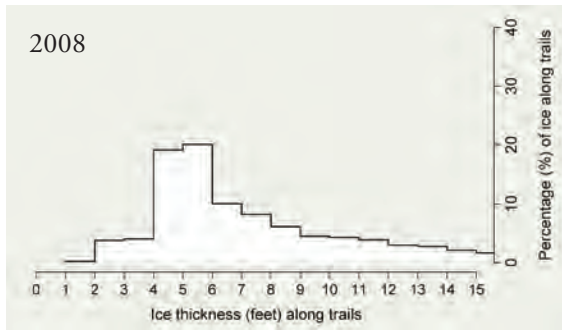


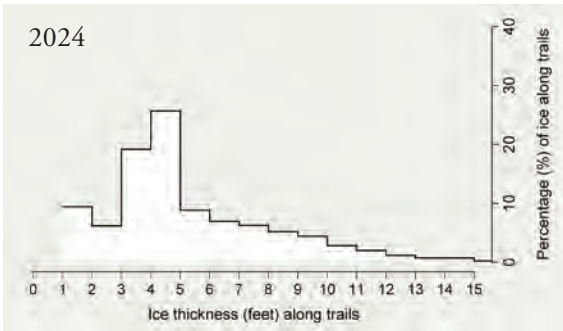
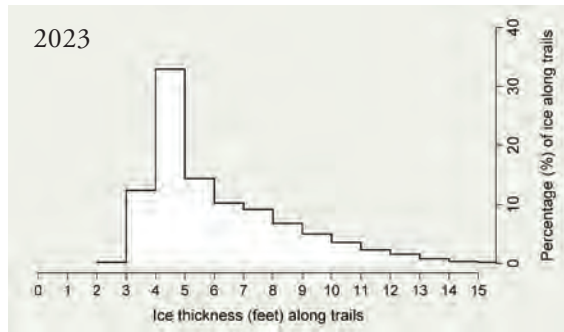
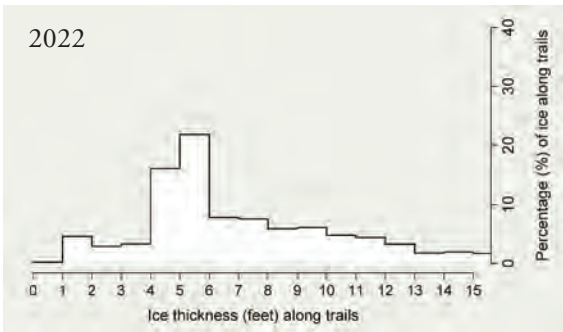
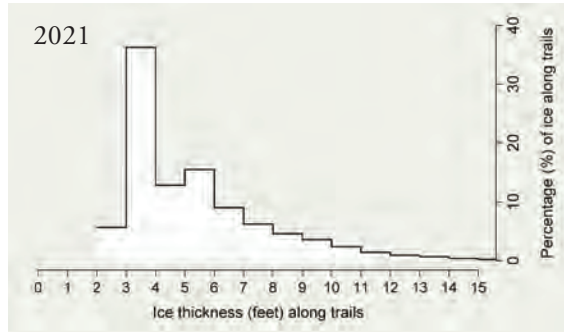
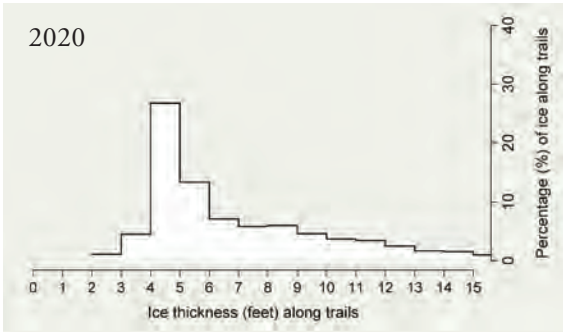
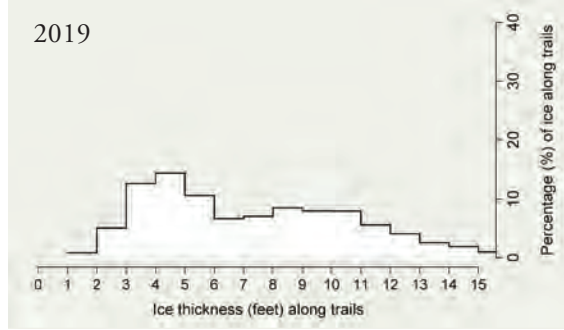
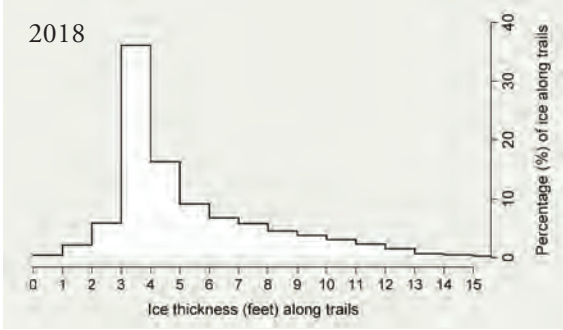
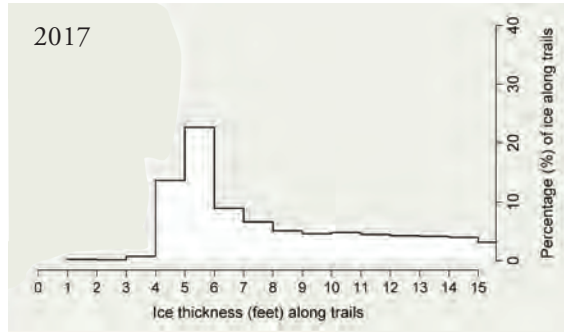
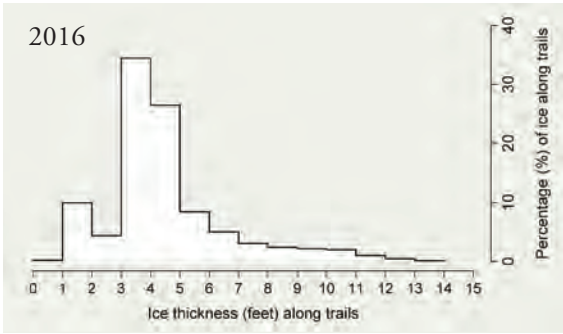
✦ *How scientists measure ice thickness using an electromagnetic conductivity (EM) meter.*

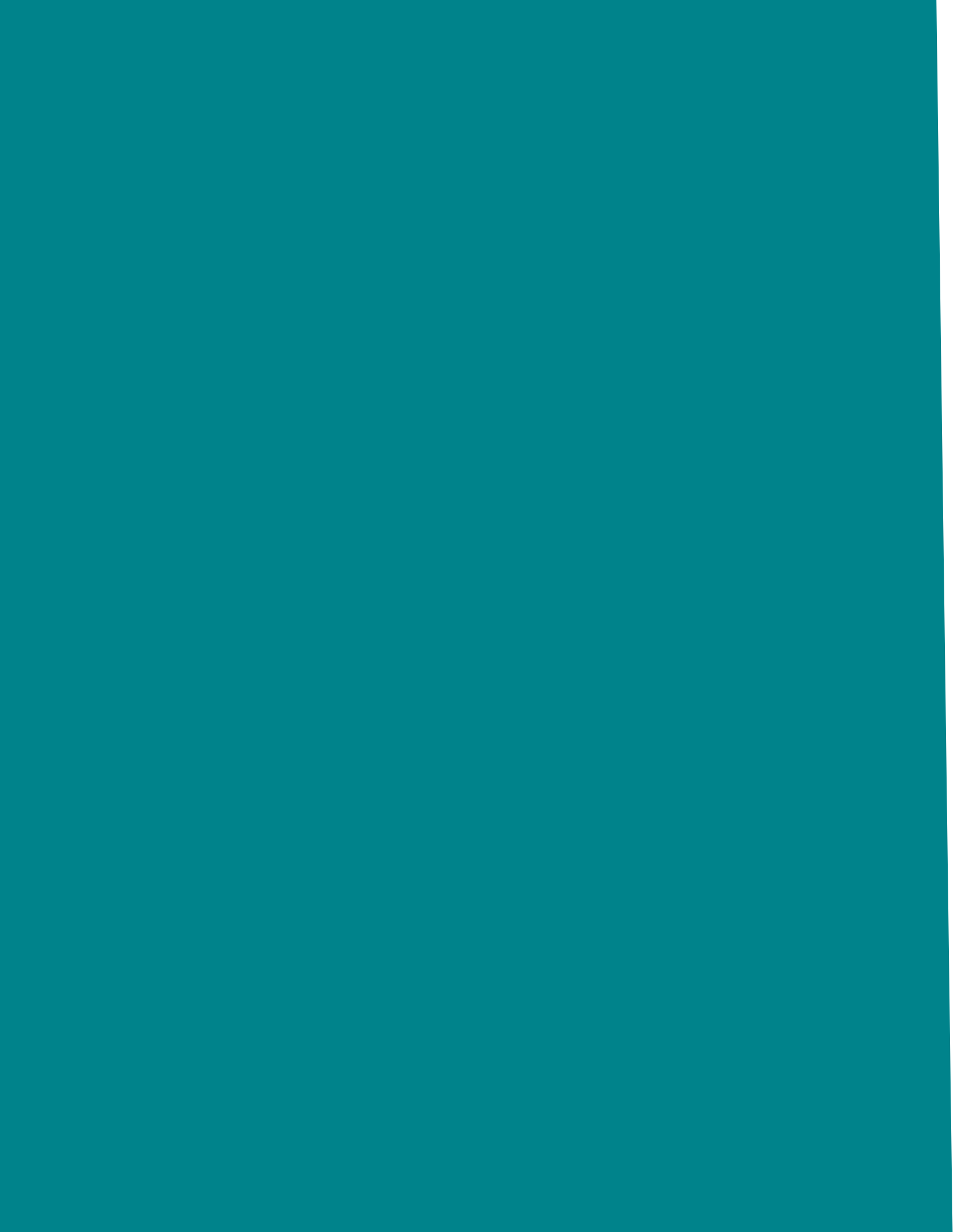
Krista West



Ice thickness along trails during each trail mapping year during the spring whaling season.







# Acknowledgments

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✦ *Spring whaling camp and umiaq  
at ice edge. April 15, 2019.*

Bill y Adams

✦ *Sunset in Utqiagvik, August 9,  
2010. Mat the w Dr uckenmiller*

