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THE CIRCLE

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PROTECTING THE LAST ICE AREA



The Circle 3.2026

PROTECTING THE LAST ICE AREA



COVER: Walrus.

Photo credit: Francesco Ungaro, Unsplash

THIS PAGE: A group of polar bears rush out to "defend" their ice floe against curious scientists. Photo taken in autumn 2017 in northeastern Greenland.

Photo credit: Andreas Preußer distributed via imaggeo.egu.eu. CC BY-ND 3.0

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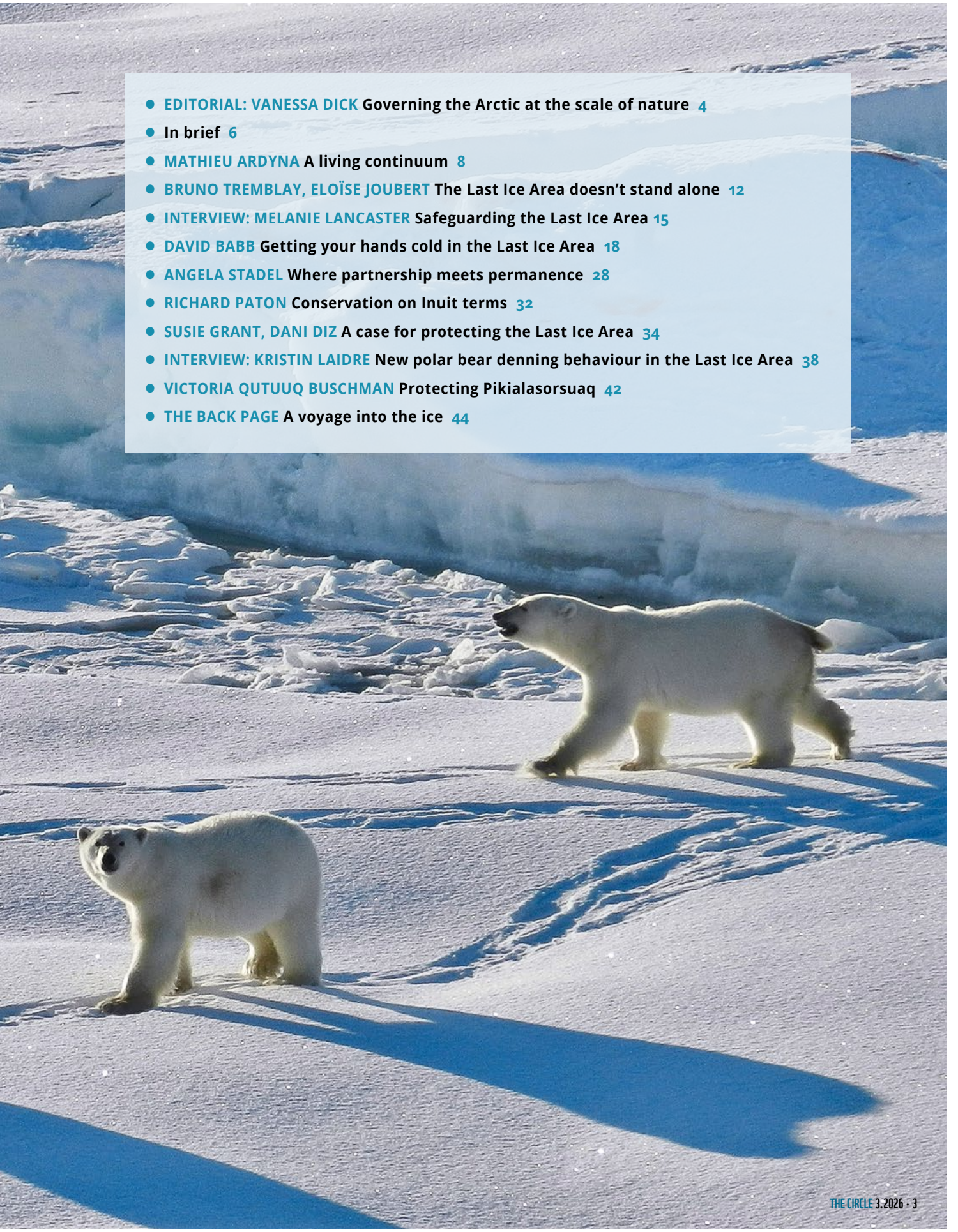
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EDITORIAL

Governing the Arctic at the scale of nature

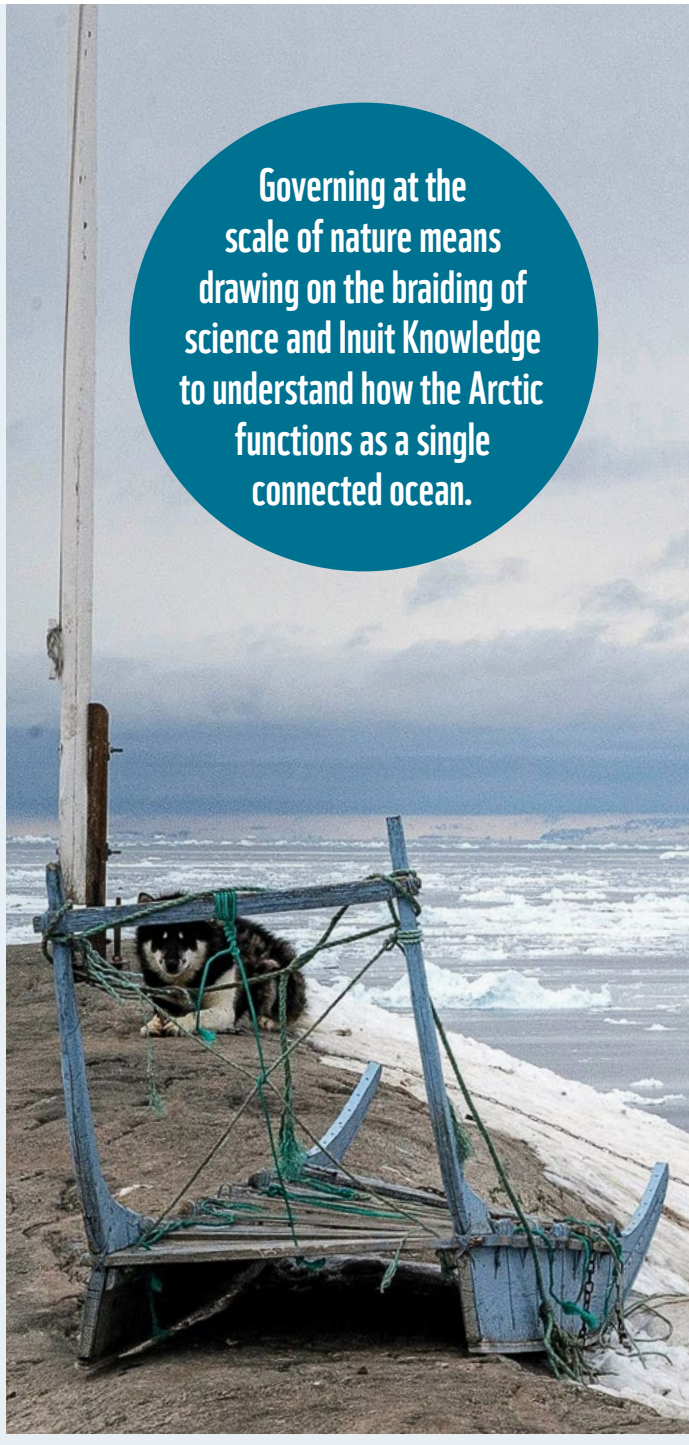
THE LAST ICE AREA is the Arctic's ecological anchor. Sweeping across the Arctic Ocean north of Canada and Greenland, this one million square kilometre region is the area most likely to retain multi-year sea ice in the decades ahead. As such, it will provide a refuge for ice-dependent species that Inuit communities rely on. But its future depends on what happens far beyond its own boundaries.

The Last Ice Area contains the thickest, oldest sea ice in the Arctic. While climate models project that summer sea ice across much of the Arctic Ocean will largely disappear in the coming decades, this region is expected to remain frozen the longest, offering species such as polar bears, seals and narwhals a place to persist when conditions change elsewhere. Inuit have lived in this region for millennia, building knowledge of its rhythms and abundance that science is only beginning to grasp.

Yet this refuge does not exist in isolation. It depends on an Arctic "ice shed"—a system in which sea ice forms thousands of kilometres away before winds and ocean currents carry it into the Last Ice Area, linking distant parts of the Arctic into a single living system.

Those connections are also what make the Last Ice Area vulnerable. As sea ice retreats, the Central Arctic Ocean is becoming more accessible to shipping, fishing and other forms of development. Decisions about these activities are often made one sector at a time or within national boundaries, even though their cumulative effects can spread across ecosystems that have no borders. Ice drifts freely, currents transport nutrients and organisms, and marine mammals travel vast distances between feeding and breeding grounds. A change in one part of the Arctic can alter conditions far away, including in the Last Ice Area and in the coastal communities whose food security, culture and livelihoods depend on healthy marine ecosystems.

This means that protecting the Last Ice Area requires governance at the scale of the system itself. An ecosystem-based approach recognizes that shipping, fisheries, conservation and other ocean uses do not occur in isolation—and neither do their impacts. Governing at the scale of nature means drawing on the braiding of science and Inuit Knowledge to understand how the Arctic functions as a single connected ocean.





VANESSA DICK is the senior governance lead for the WWF Global Arctic Programme, where she oversees the development, implementation and monitoring of strategies for effective Arctic governance.



The day's catch dries on a rack in Ilulissat, Greenland.

Photo credit: Erin Towns (PolarTREC 2022), Courtesy of ARCUS. CC BY-NC-SA 4.0

understand how the Arctic functions as a single connected ocean.

The people who know this region best—Inuit rights-holders, scientists, policymakers and those who manage Arctic waters—must help define what persistence truly requires for the Last Ice Area and the people and wildlife that depend on it. Together, they can identify where conservation measures are most effective, how Indigenous-led stewardship can guide future management, and how the institutions responsible for shipping, fisheries and marine protection can work in concert rather than separately.

This conversation belongs not only in Arctic institutions, but in the broader public as well, because lasting stewardship depends on everybody understanding what is at stake.

The Last Ice Area is often described as the Arctic's last refuge. But no refuge can endure if the systems that sustain it are left unprotected. The choices we make today about the Central Arctic Ocean will determine whether this extraordinary place continues to support wildlife, Inuit communities and future generations. Ultimately, protecting the Last Ice Area means thinking beyond its borders and acting before it's too late. ▯

MORE FOOD, LESS ICE

Will the Last Ice Area remain a refuge for marine predators?

RECENT RESEARCH HAS suggested that the Last Ice Area may lose multi-year ice even faster than previously thought. A new study goes a step further, unpacking what the area's future ice dynamics might mean for polar bears, seals, whales and other marine mammals.

An international team led by University of Washington researchers used computer modelling to examine how future sea ice loss and shifting nutrient conditions could alter plankton communities in the region. By running two high-resolution climate models under a high-emissions ("worst case") scenario, they projected steep declines in summer ice concentration and thickness through 2070. In one simulation, summer ice disappeared almost entirely by mid-century, and in the other, only thin, patchy ice remained.

In contrast to the projected summer ice loss, the models project that all parts of the Last Ice Area will remain ice-covered in spring, a critical breeding and feeding period for ringed seals and polar bears. Recent surveys recorded both species, as well as bearded seals, narwhals, walrus and beluga whales, across the region, suggesting that parts of it already provide suitable habitat.

Despite the projected ice loss through 2070, both simulations pointed to higher summer productivity, driven by longer open-water seasons and more light reaching the surface. The resulting boost in phytoplankton could increase food availability higher up the food web, and more open water could lead to new habitat for Arctic whales. But ice-dependent predators, such as polar bears, seals and walrus, will still need stable sea ice for hunting, resting and raising their young.

POSITIVE NEWS

Arctic deep water protected from climate change

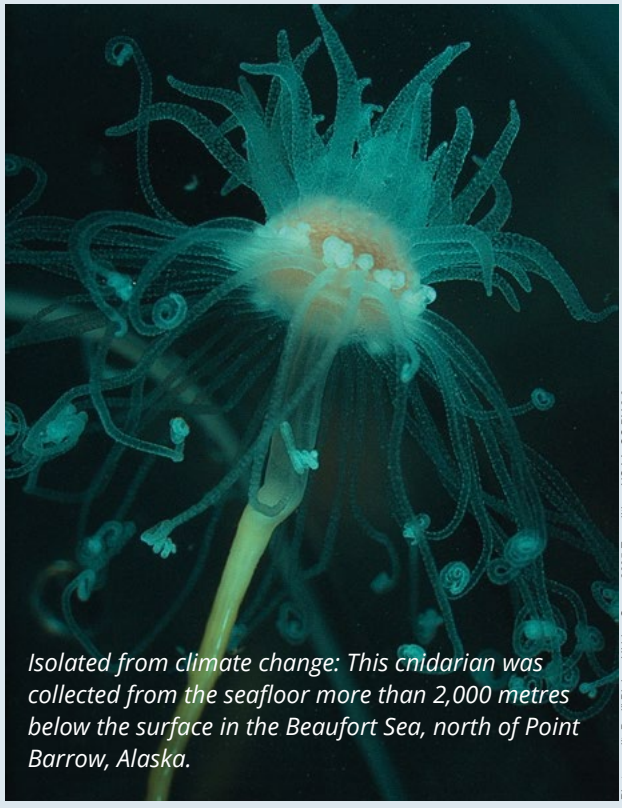
ALTHOUGH SEA ICE is melting rapidly on the surface of the Arctic Ocean, new research shows that the deep water that lies beneath remains relatively stable—for now.

A study led by researchers at Arizona State University and Columbia University in the United States found that a vast pool of deep Arctic water, sitting more than 1,500 metres below the surface, has remained largely isolated for roughly 450 years. The researchers found that only trace amounts of modern surface water have penetrated this layer, highlighting how slowly the deep Arctic Ocean circulates.

A cooler intermediate layer helps keep the warmer deep water from mixing upward toward the surface and the sea ice above. The new findings suggest that this layered structure remains largely intact, despite rapid warming and record-low levels of winter sea ice in recent years.

If continued warming weakens this separation and allows more mixing between the layers, warmer water from below could reach the surface and accelerate sea ice loss. Changes in deep-water circulation could also have far-reaching effects on global ocean circulation and potentially contribute to faster melting of Greenland's ice sheet.

For now, however, researchers have found no indication that deep-water circulation has begun to change—a rare piece of encouraging news about the rapidly changing Arctic.



Isolated from climate change: This cnidarian was collected from the seafloor more than 2,000 metres below the surface in the Beaufort Sea, north of Point Barrow, Alaska.

Photo credit: Bodil Bluhm. Hidden Ocean 2005 Expedition: NOAA. CC BY 2.0



Jakeman Glacier, Jones Sound, Nunavut, Canada, August 2024

SCIENCE EXPOSED

Retreating glaciers reshape Arctic marine ecosystems

AS MARINE-TERMINATING glaciers—glaciers that extend into the sea—retreat from the waters around Grise Fiord in Nunavut, Canada, they may be reshaping Arctic marine ecosystems in unexpected ways.

New research led by Patrick White, a PhD student at Dalhousie University in Canada, found that glaciers extending into the ocean help draw nutrient-rich deep water to the surface, supporting blooms of phytoplankton—the microscopic organisms that form the foundation of Arctic marine food webs and are an important food source for many zooplankton. But as glaciers retreat onto land, that natural nutrient pump weakens, shifting marine ecosystems toward smaller phytoplankton that are adapted to nutrient-poor waters. The result could be reduced productivity throughout the food web.

The research was conducted in collaboration with Inuit experts, whose local knowledge enabled researchers to safely navigate and sample near the glaciers.

White's fieldwork also produced *Small boats, big glaciers*, a photograph that won a jury prize in a 2025 photography competition organized by the Natural Sciences and Engineering Research Council of Canada. The image (shown here) captures one of the tidewater glaciers at the heart of the study and highlights how scientific research, local collaboration and photography can together reveal the changing Arctic.

Photo credit: Patrick White, Dalhousie University

UNDER THE ICE

Shrinking sea ice could reshape Arctic food webs

THE LOSS OF Arctic sea ice is changing more than the Arctic's physical environment. It could also alter the daily movements of the tiny marine animals that underpin the region's food web.

New research suggests that as thinning sea ice allows more light to penetrate the ocean, zooplankton may spend less time feeding beneath the ice during the twilight periods of autumn and spring. Using observations collected beneath Arctic sea ice during the international MOSAiC expedition (a year-long mission to study the Arctic climate system) and climate model projections, researchers estimate that by the middle of the century, zooplankton in some regions could spend up to a month less each year in this under-ice habitat.

Zooplankton are a vital food source for fish, seabirds and marine mammals, and their seasonal movements help transport carbon and nutrients through the ocean. The findings highlight how seemingly subtle changes in Arctic light conditions can ripple through entire ecosystems, with consequences that extend well beyond the ice itself.



The Last Ice Area is far more than just a frozen ocean—it is an integrated system where coastal habitats, the water column and the deep seafloor exchange energy and organic matter.

More than ice

A LIVING CONTINUUM

The Last Ice Area is expected to be the Arctic's final refuge for multi-year sea ice. But the region is so much more than ice. As **MATHIEU ARDYNA** writes, it is an ecological network that includes land, glaciers, sea ice, ocean and seafloor. Understanding how these are all connected is becoming urgent as this remarkable system transforms.

AT THE NORTHERN edge of Canada and Greenland lies one of the most extraordinary landscapes on Earth. Mountains and glaciers meet narrow fjords, sea ice stretches towards the horizon, and the ocean remains largely unexplored. Known as the Last Ice Area, this region is expected to retain Arctic sea ice longer than anywhere else in the world. But even there, change is already underway.



The bed of a stream draining the east side of Twin Glacier, at the head of a valley south of Alexandra Fjord on Ellesmere Island, Nunavut, Canada

Photo credit: Martin Brummell (distributed via imaggeo.egu.eu) CC BY 3.0

Thinking of the area as simply a frozen refuge misses much of what makes it exceptional. Freshwater and particles flow from land and melting glaciers into coastal waters (as shown in the photos at the right). Sea ice controls how much light reaches the ocean. Ocean currents redistribute heat and nutrients. All these processes influence where and when life can flourish.

But the linked landscapes of the Last Ice Area are transforming because the climate is warming. As multi-year ice declines, glaciers melt and ocean circulation changes, altering the movement of freshwater, nutrients and energy through the ecosystem. These changes do not stop at the edge of the ice or at the coastline—they spread through the entire ecosystem. That is why understanding and protecting the future of the Last Ice Area requires us to look beyond the sea ice itself.

A HIDDEN WORLD

Some of the most important parts of this ecosystem are the hardest to see. Microscopic algae grow within and beneath the sea ice. Phytoplankton can form blooms in the water column, sometimes unseen by satellites looking down from space. And because much of the Last Ice Area is relatively shallow, sunlight can reach the seafloor, where macroalgae and microscopic benthic algae may represent another important source of primary production.

Yet we still know remarkably little about how these different components interact or how much each contributes to the ecosystem.

During the 2024 REFUGE-ARCTIC expedition aboard the Canadian research icebreaker *CCGS Amundsen*, an unexpected observation brought these elusive relationships into sharper focus.

At the entrance to Archer Fjord, our remotely operated vehicle discovered large accumulations of detached kelp on the seafloor, hundreds of metres below the surface (as shown in the photos below). Finding marine macroalgae in one of the Arctic's iciest regions drives home the point that the Last Ice Area is far more than just a frozen ocean—it is an integrated system where coastal habitats, the water column and the deep seafloor exchange energy and organic matter. Understanding these links is one of the main goals of REFUGE-ARCTIC, an international research programme that is investigating the Last Ice Area as a single interconnected ecosystem.

Those connections matter because primary production is only the beginning of the story. The carbon captured by algae can follow different pathways. Some enters the food web, supporting zooplankton, fish and ultimately large Arctic mammals, such as seals, walruses and narwhals. Some sinks through the water column and reaches the organisms that live on or within sediment on the seafloor.

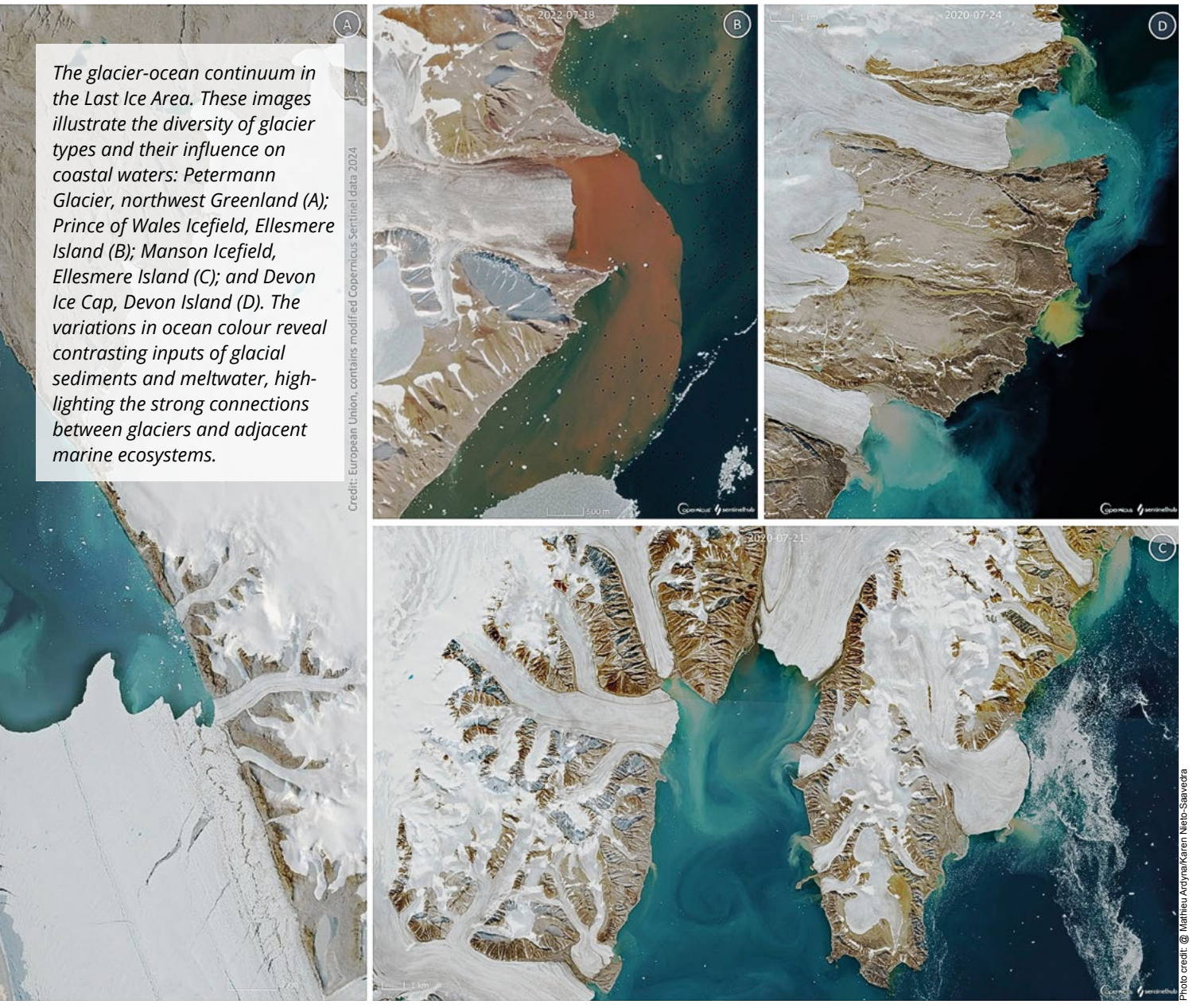
In Archer Fjord, our observations also revealed an intriguing paradox: the water column had relatively low biological productivity (production of new organic matter), yet the ecosystem




Photo credit: @Maxime Geoffroy/Philippe Archambault


Photo credit: @Maxime Geoffroy/Philippe Archambault

Detached kelp deposits rest on the seafloor at the entrance of Archer Fjord in the Last Ice Area. These illustrate an unexpected connection between productive coastal habitats and deep benthic ecosystems.



The glacier-ocean continuum in the Last Ice Area. These images illustrate the diversity of glacier types and their influence on coastal waters: Petermann Glacier, northwest Greenland (A); Prince of Wales Icefield, Ellesmere Island (B); Manson Icefield, Ellesmere Island (C); and Devon Ice Cap, Devon Island (D). The variations in ocean colour reveal contrasting inputs of glacial sediments and meltwater, highlighting the strong connections between glaciers and adjacent marine ecosystems.

Credit: European Union, contains modified Copernicus Sentinel data 2024

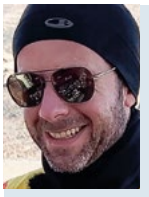
Photo credit: @ Mathieu Ardyna/Karen Nieto-Saavedra

was capable of supporting rich benthic life (organisms living on, in or near the bottom of the ocean) and marine mammals. But where does the energy that sustains this ecosystem come from? Following carbon from sea ice, phytoplankton and benthic producers through the ecosystem may help answer that question.

PREPARING FOR A CHANGING ECOSYSTEM

This is also why establishing a baseline now is so important. The Last Ice Area of the future will not simply contain less ice. The relationships linking glaciers, sea ice, ocean productivity, the seafloor and animals may also be reorganized. Some productive habitats could expand as more light becomes available, while others that depend on persistent sea ice could shrink. Changes in the timing or location of primary production could alter when and where food is available to the rest of the ecosystem.

For conservation, understanding these processes is crucial. Protecting the Last Ice Area does not mean protecting sea ice alone. We need to understand how the entire ecosystem functions, including the parts that remain largely invisible. Scientific observations can help identify which habitats are particularly productive, how they work together, and which may be most vulnerable as environmental conditions change.



MATHIEU ARDYNA is a biological oceanographer with IRL Takuvik, an international research project jointly run by Laval University in Canada, Sorbonne University in France, and France's Centre national de la recherche scientifique (CNRS) that is studying how climate change is transforming marine ecosystems across the Arctic Ocean.



A pressure ridge in the late afternoon light, photographed from the icebreaker Oden *during the Arctic Ocean 2016 expedition. The ridge measured about five metres across and two metres high.*

Sea ice dynamics

THE LAST ICE AREA DOESN'T STAND ALONE

The Last Ice Area is widely considered the Arctic's final refuge for ice-dependent species. But as **BRUNO TREMBLAY** and **ELOÏSE JOUBERT** write, its existence depends on sea ice formed thousands of kilometres away. What happens elsewhere in the Arctic will determine whether the area can continue to provide sanctuary for the species that depend on it.

Credit: Grace Shephard (distributed via imaggeo.egu.eu) CC BY-NC 3.0



The Last Ice Area is not an isolated sanctuary. It is the downstream end of a dynamic Arctic-wide system.

MANY PEOPLE PICTURE Arctic sea ice as a vast, frozen landscape, fixed in time and place. But in reality, it is constantly on the move, forming along Arctic coasts, drifting across the ocean for years or even decades, and eventually melting.

The duration of this journey depends not only on winds and ocean currents, but on one key property: thickness. Thinner ice has a shorter lifespan in the Arctic, while the "quality" of the ice that reaches the Last Ice Area depends greatly on its birthplace.

Large-scale atmospheric circulation drives two dominant pathways for Arctic sea ice: the clockwise Beaufort Gyre in the western Arctic, and the Transpolar Drift Stream, which carries ice from the Eurasian coast across the pole, through Fram Strait, and out of the Arctic (see map, next page). Near the boundary between these systems, drifting ice converges along the Canadian coast, where it fractures and piles up into thick ridges—typically five or six metres thick, although 25 metres or more is possible in areas of intense compression.

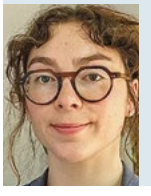
Some of this thick ice is recirculated by the Beaufort Gyre, while some enters the Canadian Arctic Archipelago, where it effectively becomes trapped among hundreds of islands. This combination of transport, thickening and retention explains why the archipelago and the region to its north have historically supported one of the Arctic's largest reservoirs of perennial sea ice—the region we now call the Last Ice Area.

A CHANGING ICE SUPPLY

But as the Arctic warms, sea ice in the area is becoming thinner and more ➤



BRUNO TREMBLAY is a professor in the Department of Atmospheric and Oceanic Sciences at McGill University in Canada.



ELOÏSE JOUBERT is a master's student in the Department of Atmospheric and Oceanic sciences at McGill University.

The Last Ice Area and the mean ice drift across the Arctic Ocean

Arctic sea ice is constantly on the move. This map shows the two dominant circulation patterns—the Beaufort Gyre and Transpolar Drift Stream—that transport ice across the Arctic and help supply the Last Ice Area.



prone to breaking apart. Faced with the same winds, thinner ice moves more easily and spends less time in the Arctic Ocean, limiting its ability to thicken and allowing more ice to drift away.

Equally important is the warming of North Pacific waters that enter through the Bering Strait in spring and summer and short-circuit the recycling of thick multi-year ice in the Beaufort Gyre. Instead, thinner first-year ice (ice that has formed during a single winter) enters these circulation patterns and is carried forward. Climate models project that the Last Ice Area will be the last remaining refuge for species that depend on sea ice.

While the existence of the Last Ice Area depends mainly on atmospheric circulation and Arctic geography, the thickness and resilience of the ice within it depend on the ice that feeds it. This upstream source region—the Last Ice Area's "ice shed," so to speak—extends from parts of the Eurasian Arctic to the Alaskan and Yukon coasts, where ice forms before entering the Beaufort Gyre and Transpolar Drift Stream.

Much like a watershed that supplies water to a lake or river system, the ice shed supplies the raw material that sustains the Last Ice Area. As a result, environmental changes and human activities in these distant regions—including shipping, tourism, mining and resource extraction—can influence the quantity

and quality of the ice that eventually reaches the Last Ice Area, with consequences for the ecosystem it supports.

In short, the Last Ice Area depends on the quality of the sea ice that forms far beyond its own boundaries.

WHEN THE RESERVOIR BEGINS TO DRAIN

Recent high-resolution climate models simulating the movement of sea ice through the narrow channels of the Canadian Arctic Archipelago show that the thick ice north of the archipelago could be drained through these pathways in as little as 15 years. As the Last Ice Area allows more ice to escape, it may no longer act as a reservoir that retains thick multi-year ice. Instead, this ice may increasingly drift southward into warmer waters, where it will melt.

The ecological consequences could be profound. Sea ice supports a rich web of Arctic life, from ice algae and plankton to iconic marine mammals. As sunlight penetrates the ice in spring, the algae that grow beneath the ice provide food for zooplankton, fish and species higher in the food web. Ringed seals, polar bears and other ice-dependent species rely on stable sea ice to rest, breed, hunt and raise their young. As sea ice declines, habitats shrink and food webs are disrupted, forcing these Arctic specialists to adapt.

Within Canadian waters, protected areas such as Tuvaijuittuq (an Inuktitut word meaning "the place where the ice never melts") and Tallurutiup Imanga constitute important conservation measures.

Internationally, areas of the Central Arctic Ocean proposed for protection under the High Seas Treaty could help safeguard part of the ice shed that feeds the Last Ice Area. These actions can help preserve this unique ecosystem. But ultimately, the future of the Last Ice Area depends on limiting global warming and maintaining the supply of thick, resilient sea ice on which the area depends.

The Last Ice Area is not an isolated sanctuary. It is the downstream end of a dynamic Arctic-wide system. Protecting it requires conserving not only the area itself, but the larger Arctic system—and climate—that creates and replenishes it. ▯

The ice shed

SAFEGUARDING THE LAST ICE AREA

Summer sea ice underpins Arctic marine ecosystems, supports Inuit communities, and helps regulate the global climate. Yet its extent is shrinking rapidly. As the ice thins, retreats and becomes increasingly unstable, scientific projections show that the northernmost reaches of Canada and Greenland will be a final stronghold for multi-year ice—a last refuge for species that depend on it.

Known in Inuktitut as Similijuaq ("place of the big ice"), this region is one of the most critical climate refuges in the circumpolar world. WWF was the first to call it the Last Ice Area, a term that underscores both its global significance and the urgency of safeguarding it. Today, Indigenous Peoples, scientists and conservation organizations like WWF are reassessing what must be done to ensure this stronghold endures.

MELANIE LANCASTER, a senior specialist in Arctic species conservation with WWF's Global Arctic Programme, spoke with *The Circle* about why the Last Ice Area's multi-year ice matters and what governments must consider to protect this unique ecosystem.

What do we know about how the ice in the Last Ice Area forms and moves?

We have good science showing that much of the ice that ends up in the Last Ice Area is formed elsewhere—in the Central Arctic Ocean and surrounding seas, especially the Laptev and East Siberian seas in Russia. Wind and ocean currents circulate the ice around the Central Arctic Ocean until it ends up at the northern coastlines of Greenland and Canada. The source of ice for the Last Ice Area—called the "ice shed" by scientists—is dynamic. It is projected to change in size and location over time as climate heating continues.


Melanie Lancaster

Knowing where the ice in the Last Ice Area originates tells us that the area is not isolated. What happens in these other places could affect the integrity of the ice that ends its journey in the Last Ice Area and creates that lasting habitat for the species and ecosystems that need it. ➤

Why does the age of the ice matter? What makes multi-year ice so important?

Multi-year ice is ice that has survived a summer. That means it goes through summer without melting and continues to build up the following winter. As the ice survives multiple summers, it gets thicker and fresher (meaning less salty, because salt is gradually flushed out of the ice). It also collides with other ice pieces, forcing them to pile up into ridges—a process known as pressure ridging—and creating complex 3D icescapes above and below the surface.

When ice is first formed, it has a very flat undersurface. That's one reason why young ice can act like a sounding board—underwater noise from ships bounces off it. But older ice has ridges that act like sound baffles, muffling underwater noise. The shape and freshness of multi-year ice also make it a crucial building block for the Arctic marine food web by providing habitat for algae and other microscopic organisms that form the foundation of the Arctic Ocean's unique sea ice ecosystem. Ringed and bearded seals and polar bears also use multi-year ice.

Finally, while annual sea ice melts in summer and exposes a dark, open ocean, multi-year ice blankets the ocean's surface with thick, bright white ice, reflecting much more sunlight back to the atmosphere. This helps keep the planet cool.

The Last Ice Area—and everything that lives around it—will essentially be a safe haven because conditions will not get quite so hard there. Life will be safest there.

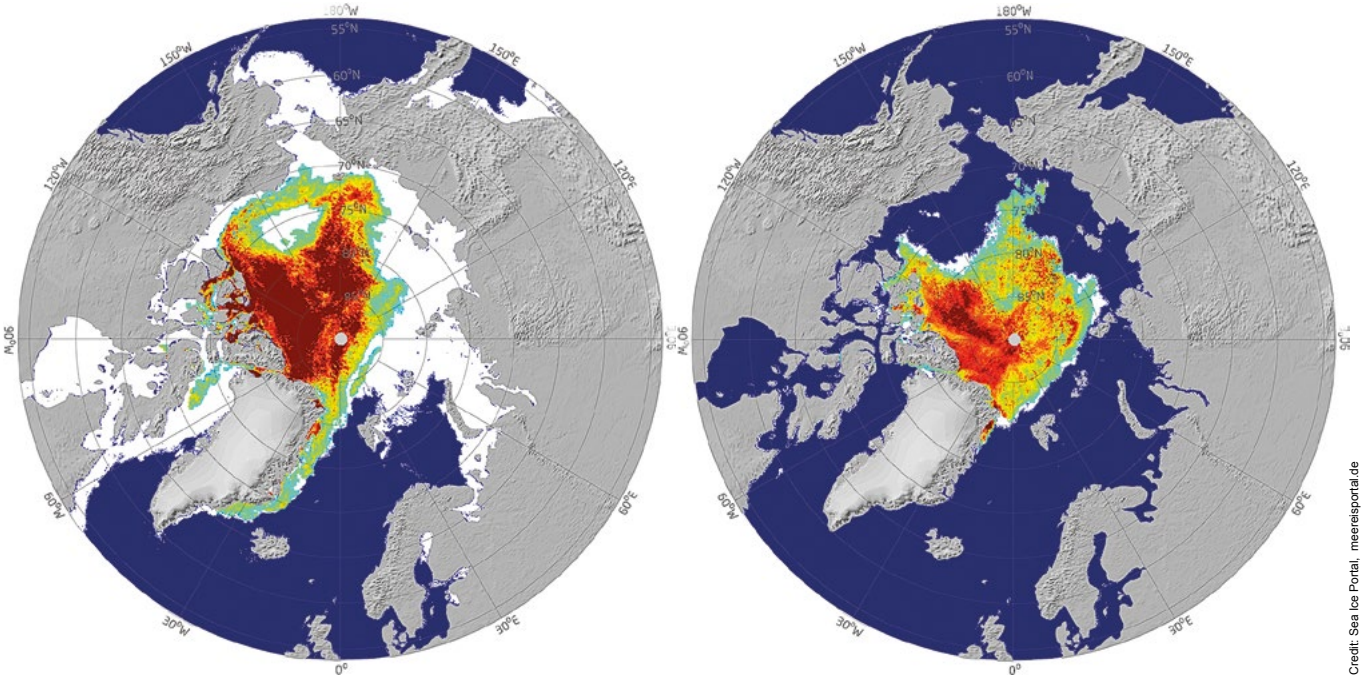
Why is it important to protect the Last Ice Area?

The Last Ice Area has been identified as a climate refuge because it is predicted to retain summer sea ice longer than anywhere else in the Arctic. When we talk about ice-dependent species, we generally think of polar bears, walrus, seals, fish, microscopic invertebrates and algae—species that have evolved with sea ice and still need it. Conditions will become very challenging for a lot of those species as the Arctic Ocean loses more sea ice.

But the Last Ice Area—and everything that lives around it—will essentially be a safe haven because conditions will not get quite so hard there. Life will be safest there.

Given that the Last Ice Area spans Canada and Greenland, and is fed by the Central Arctic Ocean, what challenges are involved in protecting it?

Huge challenges. Protecting the Last Ice Area is a truly multilateral and international effort that will require courage and innovation from all responsible parties. The area sits within the exclusive economic zones of Canada and Greenland—the waters where each has rights over natural resources. But as our understanding of the region has



Credit: Sea Ice Portal, meereisportal.de

Multi-year sea ice distribution in the Arctic Ocean in March 2026 (left), near the end of the winter ice-growth season, and in September 2025 (right), near the end of the summer melt season. Colours indicate sea ice age, progressing from younger ice in light blue to the oldest ice in red. The oldest ice is concentrated in the Last Ice Area and Central Arctic Ocean.

Source: Grosfeld, K.; Treffeisen, R.; Asseng, J.; Bartsch, A.; Bräuer, B.; Fritzsch, B. et al. (2016). Online sea-ice knowledge and data platform <www.meereisportal.de>, Polarforschung, Bremerhaven, Alfred Wegener Institute for Polar and Marine Research & German Society of Polar Research, 85 (2), 143-155, doi:10.2312/polfor.2016.011 (PDF).



Melanie Lancaster searches for bear prints in Svalbard.

Credit: © Micaela Hellström / WWF

increased, we've realized that measures will also likely need to be taken in the Central Arctic Ocean.

Because the Last Ice Area is so connected to the rest of the Arctic Ocean (through the transport of sea ice), we need to consider industrial activities across the ocean, including within the exclusive economic zones of the different Arctic coastal states, to really grasp the risks for this climate refuge. Sea ice that feeds the Last Ice Area should remain intact and free of pollutants—including oil from offshore exploration and extraction projects happening elsewhere in the Arctic, which is easily transported in sea ice and practically impossible to clean up.

Given that much of the Last Ice Area lies in Canadian and Greenlandic waters, how much responsibility do these two nations have to protect it?

Emerging international mechanisms, including the new Biodiversity Beyond National Jurisdiction Agreement (or High Seas Treaty), could help protect the ice shed. Canada, Greenland and Denmark could be leaders in proposing protections in the Central Arctic Ocean ice shed. Strong action from all Arctic governments remains essential.

Greenland and Denmark have yet to put specific protections in place for the portion of the Last Ice Area that sits within Greenland's waters. But in 2019, in partnership with the Qikiqtani Inuit Association, the Government of Canada designated Tuvaijuittuq—meaning "the place where the ice never melts"—as an interim marine protected area in the Canadian portion of the Last Ice Area. This interim status was renewed in 2024 for another five years.

If we can slow that warming so ice continues to form, we can hope for a time in the future when sea ice recovers.

Considering the loss of sea ice that we are witnessing, what questions are WWF and others asking about the future of this refuge?

We are working on questions like: What do we need to consider to make sure the Last Ice Area persists for as long as possible as a climate refuge, for the benefit of nature and people? What geographic and time scales do we need to consider? Which features should we focus on to maintain ecological function and cultural continuity? What conservation measures are needed, and to manage what, and how can we implement these? And finally, how can this be done successfully in a rapidly changing place that will look different in 10 years?

We still have the chance globally to act on climate change. If we can slow that warming so ice continues to form, we can hope for a time in the future when sea ice recovers. In the meantime, if we want to give nature the best chance, there is also much to be done in the Arctic itself. ▯

A year of fieldwork

GETTING YOUR HANDS COLD IN THE LAST ICE AREA

The Last Ice Area is one of the most isolated and inhospitable places on Earth—yet it is stunningly beautiful and provides a tangible goal for action to support our changing climate. **DAVID BABB** writes about the challenges and rewards of doing fieldwork in this remote area.



DAVID BABB is a research associate with the Centre for Earth Observation Science at the University of Manitoba in Canada.



AS A SEA ice scientist, a big part of my job is understanding the conditions in the Last Ice Area and filling in the knowledge gaps that exist. Some of our questions may seem basic, but answering them can be surprisingly challenging because of the demands of working here.

They include: How thick and how old is the ice? How much does it melt during summer and grow during winter? What lives in and around it? How are these characteristics changing? And perhaps most importantly, what will it be like in the future? Will the ice survive?

My colleagues and I at the University of Manitoba work with national and international collaborators to answer these questions. I have been fortunate to visit the Last Ice Area several times, taking in splendid views of fjords and glaciers that few others have witnessed.

We have camped on remote glaciers during whiteout blizzards, travelled over thin sea ice during polar nights, and confronted thick sea ice while navigating narrow, uncharted waters.

Why go through all of this? Partly for the adventure, and partly for the challenge of problem-solving in these conditions. But most importantly, we are motivated by the unending quest to better understand this critical environment.

Satellites can offer insight into the current status of the Last Ice Area, and models can provide a view of what it may look like in the future. But nothing replaces being there to appreciate the complexity of the environment. As my former supervisor, Dr. David Barber, always said, "You need to get your hands cold."

➤

View from the Müller Ice Core camp on Axel Heiberg Island, Nunavut

Photo credit: David Babb

Eureka Sound, Nunavut, in the Canadian High Arctic



Photo credit: David Babb



Photo credit: David Babb

The CCGS Des Groseilliers *at Eureka on Ellesmere Island, Nunavut*

AUGUST 2024: SHIPBOARD SAMPLING

We are aboard the CCGS *Des Groseilliers*, which is making the annual resupply run to the Eureka Weather Station on Ellesmere Island in the Canadian territory of Nunavut. There is a brief window in late August and early September when the ice pack breaks up enough for ships to resupply Eureka with fuel and other materials for the next year. If it's not on this boat, it has to come in by airplane, which is expensive.

Two of us are sampling the salinity, temperature and other properties of the waters along the route. This is the first time in more than 50 years that water samples have been taken in this northernmost passage through the Canadian Arctic. The observations reveal an increase in the presence of Pacific water, which is fresher (less saline) than Atlantic water, reflecting an overall freshening of the Arctic Ocean as a result of climate change.

The highlight of the cruise is making it to the edge of Nansen Sound, facing out into the Arctic Ocean—an area that until recently was covered by a semi-permanent landfast ice feature called the Nansen ice plug.

The plug prevented polar explorers from venturing into this area in the early 20th century. But because of climate warming and declining ice conditions, it is less stable now and collapses more often, affecting how sea ice moves within the Last Ice Area. ➤



Eureka Weather Station

Photo credit: David Babb



Deploying equipment in Eureka Sound

NOVEMBER 2024: THE POLAR NIGHT

Later this fall, we're back at Eureka, but this time the sun never rises. It's polar night. The ice in Eureka Sound—the narrow waterway between Ellesmere and Axel Heiberg islands—formed only three weeks ago, but is already thick enough to travel on safely. We will travel 20 kilometres by snowmobile through the darkness to the middle of Eureka Sound, stopping every 500 metres to ensure the ice is still thick enough.

We dodge icebergs that appear only once they are in range of our headlights. The lights of Eureka shimmer behind us, but Eureka Sound is dark, cold and windy. Finally, we are standing on ice that is just 35 centimetres thick in the middle of nowhere—yet there is an otherworldly calmness. Very few people have ever travelled to Eureka Sound at this time of year. These are the moments that stay with me.

Pretty soon, the mooring is in the water and the ice mass balance buoy is deployed in the ice. Together, these pieces of equipment will monitor the evolution of the ocean and growth of the ice throughout winter, providing us with unique insights into the growth and melt of sea ice in the Last Ice Area. My colleagues will return in May to recover the equipment, but I'll be on a different adventure by then. ➤



A close-up of David Babb during field work in Eureka Sound

Photo credit: David Babb

Finally, we are standing on ice that is just 35 centimetres thick in the middle of nowhere—yet there is an otherworldly calmness. These are the moments that stay with me.

Photo credit: David Babb

Frozen at the Müller Ice Core camp



Photo credit: David Babb

MARCH 2025: A TWO-MONTH ICE CAMP

By the following spring, I'm back in Eureka, and it's brutally cold: minus 40°C. Believe it or not, we're about to go camping for two months.

Two hundred kilometres west of Eureka on Axel Heiberg Island is the Müller ice cap, which is thought to have survived since the last glacial period more than 10,000 years ago. We are an international team that will live on the ice cap for two months as we drill an ice core that we hope will provide a record of the climate and sea ice conditions in the Last Ice Area.

A Twin Otter plane equipped with skis drops three of us. We have three days to set up camp and groom a ski-way for the larger planes that will deliver the 20 tonnes of gear we will need.

The emergency beacons and satellite phones are all working, so we give the pilots a thumbs-up. They fire up the engines and take off, leaving us alone on top of the ice cap.

On the first night, I cannot sleep. I'm cold despite wearing several warm layers and being inside a very thick sleeping bag with an extra parka and sheepskin layered on top, and I cannot shake the chill. Eventually, I abandon the idea of sleep. Up here, movement is the only way to stay warm.

After several hard days, the camp grows to 11 people and more than 25 tents, only one of which—the kitchen tent—has heat.

We begin drilling in two shifts for more than 16 hours a day during a period of 24-hour daylight. The team is fantastic, the cook keeps us well fed, and Starlink keeps us connected to the rest of the world.

After two months, we reach bedrock at 613 metres, making this the deepest ice core ever drilled in the Americas. We pack up the camp. Soon, other than a small hole, there is no trace that we were ever there.

The ice core is precious. There is only one, and it must be preserved as it makes its way south to the Canadian Ice Core Lab at the University of Alberta. Once there, the core will be sampled, and more than 10,000 years of data on air temperatures, sea ice conditions, contaminants, volcanic eruptions and many other environmental factors will be revealed. ➤

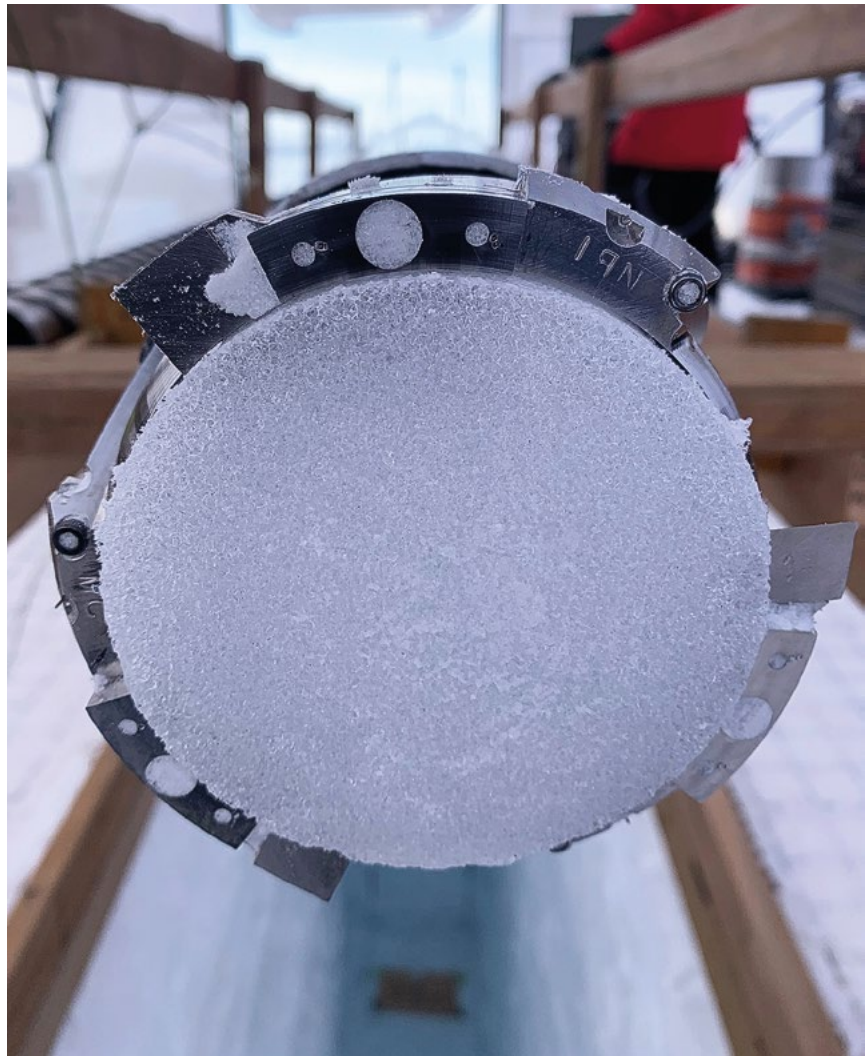


Photo credit: David Babb

Part of the Müller ice core in the core barrell



David Babb (left) and Dorthe Dahl-Jensen (right) with a section of the Müller ice core

SEPTEMBER 2025: THE *AMUNDSEN* EXPEDITION

It's late summer, and once again, I'm sailing north through Eureka Sound. But this time, instead of just two scientists, there are 40 scientists (and 40 crew) aboard Canada's research icebreaker, the CCGS *Amundsen*. The plan is to conduct a complete oceanographic survey of the Queen Elizabeth Islands.

The *Amundsen* is equipped to sample everything from the seafloor to the atmosphere and the surrounding sea ice, glaciers, rivers and land. But it has never operated in these waters before—in fact, we're venturing into areas where ships have never been. The ship runs 24 hours a day, often with multiple operations underway simultaneously, involving the foredeck, the helicopter, zodiac and other systems.

The work quickly moves from collecting sediment cores that provide a record of past conditions to sending teams out to sample waters near glacier termini (the outer edges of glaciers where they meet the water). Other teams tow nets to see which zooplankton, phytoplankton and fish form the base of the food web in these waters.

Eventually, it's time for a day on the sea ice. After poring over satellite imagery, we choose a floe and park beside it. We disembark and spend the day drilling, coring and scanning the ice. We sample everything from new ice—just 10 centimetres thick, covered in frost flowers—up to multi-year sea ice more than seven metres thick. Working on sea ice in summer means dealing with bad weather, fussy equipment, and the constant battle of everything getting wet. Still, we're able to characterize the ice, collect a wide range of samples for analysis, and deploy autonomous instruments that will continue to monitor the growth and movement of the ice as it freezes during winter.

In 28 days, we travelled more than 5,000 nautical miles (9,200 kilometres), conducted more than 300 scientific operations, and completed the first oceanographic survey of the Queen Elizabeth Islands.



Photo credit: Nick Decker

A polar bear checks out the CCGS Amundsen *in Penny Strait*



HOPE FOR THE FUTURE

Together, research programmes like these provide a record of past conditions and a baseline we can use to guide future projections of the Last Ice Area. Our work to date has largely focused on one portion of the Last Ice Area, but there are others to explore.



Photo credit: Amundsen Science

CCGS Amundsen *crew*

Fieldwork is challenging. Our hands are constantly cold, and we spend many weeks away from friends and families—but it scratches the itch of adventure and contributes to the protection of a critical Arctic ecosystem. After all, what happens in the Arctic doesn't stay in the Arctic.

As a scientist, I hope we can preserve the Last Ice Area—and as a father, I hope we can avoid the worst projections of an increasingly inhospitable planet for future generations.

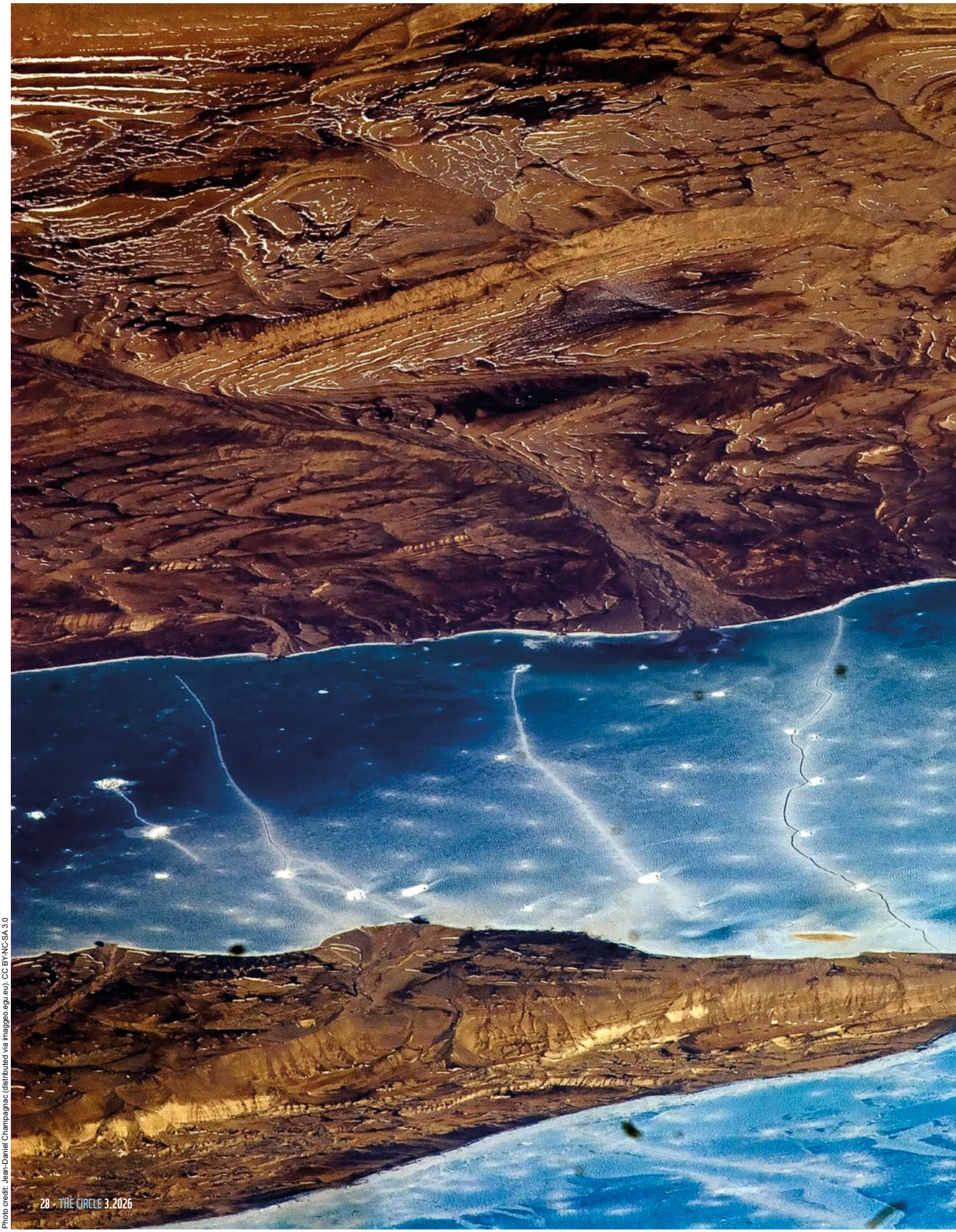


Photo credit: Jean-Daniel Champagnac (distributed via imaggeo.egu.eu), CC BY-NC-SA 3.0



Ellesmere Island, part of the vast marine and coastal environment of Nunavut's Qikiqtani region

SINAA

WHERE PARTNERSHIP MEETS PERMANENCE

SINAA, which means "floe edge" in Inuktitut—the edge where sea ice meets open water—represents the power of partnerships to protect Arctic ecosystems, including parts of the Last Ice Area, while strengthening the Qikiqtani Region's conservation economy. As **ANGELA STADEL** writes, through Inuit leadership and collaboration, SINAA is shaping the future of marine conservation and contributing significantly to Canada's goal of "30 × 30": preserving up to 30 per cent of its oceans by 2030.

SURROUNDED BY THE vivid fall colours of the tundra, we gathered in Iqaluit, Canada, in September 2023 with teams from the Qikiqtani Inuit Association (QIA) and The Pew Charitable Trusts to begin shaping what would become the SINAA Agreement.

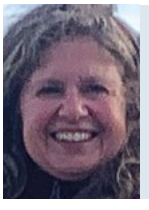
Looking back today, I find myself reflecting on what it took to reach this remarkable milestone—an agreement that will guide the establishment and management of marine protected and conserved areas and support Inuit governance, stewardship and employment for years to come.

For me and my Government of Canada colleagues, it was a profound learning journey. The Project Finance for Permanence (PFP) initiative was new to all of us. Bringing it to life required us to develop a deep understanding of the Qikiqtani Inuit vision, the priorities of the philanthropic donors led by The Pew Charitable Trusts, and the Canadian government's commitments to conservation and reconciliation. Over 18 months of difficult conversations, shared laughter and steady progress, we reached the SINAA Agreement in February 2025.

A NEW MODEL FOR CONSERVATION

Every PFP initiative begins with a shared vision for lasting conservation. For SINAA, that vision came from the QIA, whose leaders recognized that the long-term health of the Arctic's marine and coastal environment is inseparable from Inuit language, culture, governance, livelihoods and economy.

When SINAA negotiations began, the Government of Canada and QIA already had a strong foundation of collaboration, having established the Tallurutiup Imanga National Marine Conservation Area and the Tuvaijuittuq Marine Protected Area in 2019. Together, these areas cover more than 420,000 square kilometres, representing nearly a quarter of the progress needed for Canada to protect 30 per cent of its oceans by 2030. Building on that foundation, the PFP initiative launched in 2022 created an opportunity to take a region-wide ➤



ANGELA STADEL was the federal lead negotiator for the SINAA and Great Bear Sea Project Finance for Permanence initiatives.

approach to conservation while securing long-term support for Inuit-led stewardship and governance. The result was SINAA.

SINAA combines all the key elements needed to make conservation last: a plan to establish new protected and conserved areas, long-term financing, a regional Inuit stewardship council to guide implementation, expansion of the Nauttiqsuqtiit Inuit stewards (local environmental guardians in Nunavut), and the construction of new community conservation centres.

The Aajuraq Conservation Trust Society was established to support this work over the long term and will manage the investments of $200 million from the Government of Canada and $70 million from philanthropists.

Building SINAA required more than funding and planning. It required partners to learn from one another and work through difficult issues together. The negotiations reinforced the importance of understanding the history of government decisions and their lasting impacts on Inuit. As part of the process, the federal government and philanthropic teams read the report and recommendations of the Qikiqtani Truth Commission and worked with QIA to build these into SINAA and our way of working together.

We also learned the importance of maintaining momentum. When any part of the agreement required more time, partners continued to work on other elements. We built mutual understanding to get through the challenges. Dedicated teams, supported by specialized expertise where needed, also helped move the work forward. The Pew Charitable Trusts contributed experience from other PFPs around the world. We also benefited from the experiences of the Great Bear Rainforest agreement and the Great Bear Sea PFP, which concluded in 2024.

SINAA combines all the key elements needed to make conservation last: a plan to establish new protected and conserved areas, long-term financing, a regional Inuit stewardship council to guide implementation, expansion of the Nauttiqsuqtiit Inuit stewards (local environmental guardians in Nunavut), and the construction of new community conservation centres.

A LASTING LEGACY

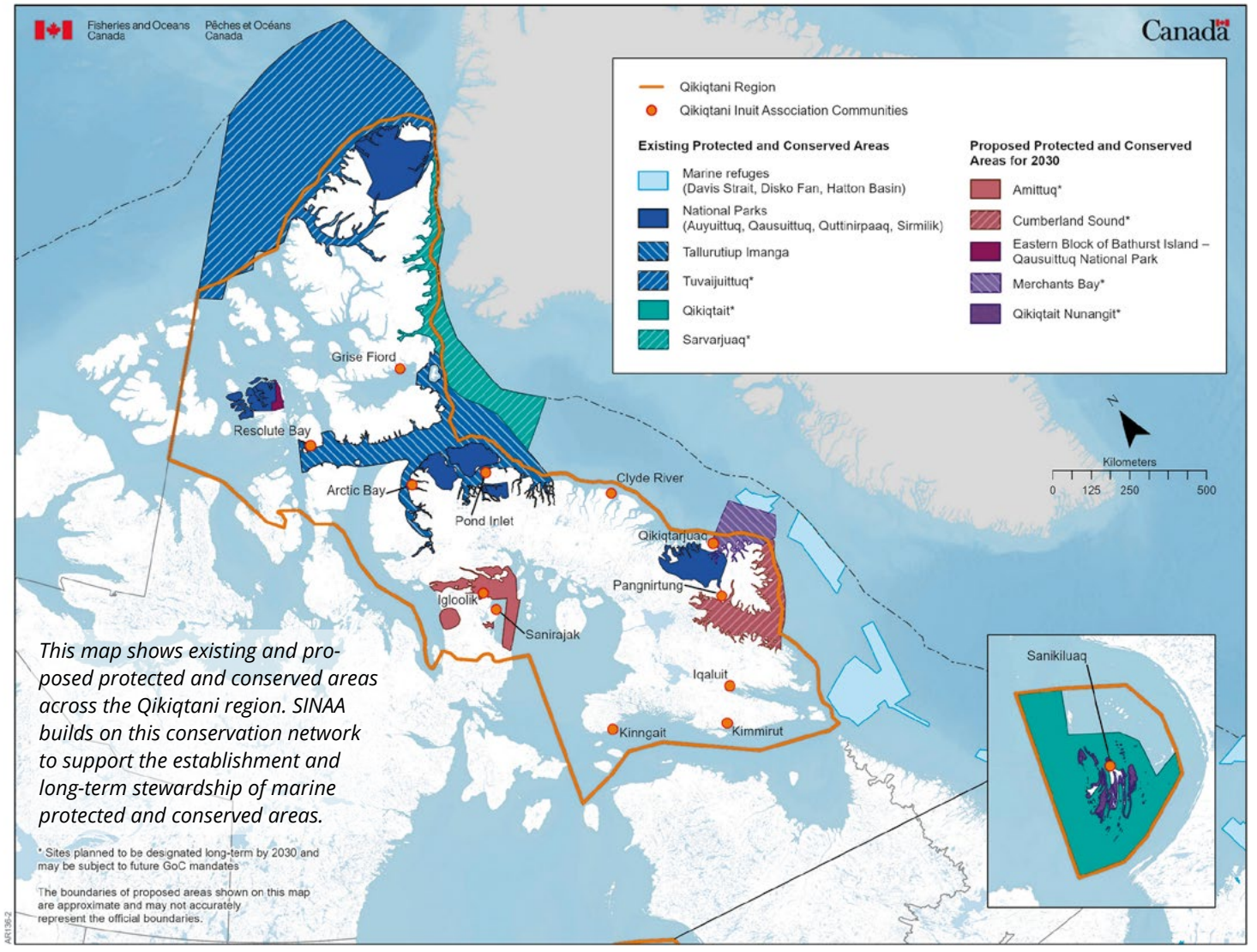
Less than a year after SINAA launched, we are already seeing its impacts.

In March 2026, the Qikiqtait and Sarvarjuaq Marine Protected Areas were established. Qikiqtait protects recurring polynyas—areas of open water surrounded by sea ice—that provide key habitat for polar bears, seabirds, seals, belugas, Atlantic walrus and Arctic char while supporting food security for the Inuit of Sanikiluaq. The QIA also designated the Qikiqtait Nunangit Inuit Protected and Conserved Area on the Belcher Islands. Farther north,



Photo credit: Mark Goldner (PolarTREC 2011). Courtesy of ARCUS

A bearded seal. The Qikiqtait Marine Protected Area provides important habitat for seals, polar bears, seabirds and belugas.



This map shows existing and proposed protected and conserved areas across the Qikiqtani region. SINAA builds on this conservation network to support the establishment and long-term stewardship of marine protected and conserved areas.

the Sarvarjuaq Marine Protected Area protects parts of Pikialasorsuaq (the North Water Polynya), a globally significant marine ecosystem shared with Greenland.

Together, these areas contribute an additional two percentage points to Canada's marine conservation targets. The Nauttiqsuqtiit programmes will create employment opportunities across the Qikiqtani region and strengthen stewardship, research, monitoring and Qaujimajatuqangit (Inuit Knowledge).

Conservation succeeds when Indigenous leadership, governments and philanthropic organizations commit for the long term. Like the floe edge itself, the future of conservation lies in the dynamic space where partnership, innovation and vision come together. I look forward to watching SINAA's story unfold for decades to come. ▯

SINAA: Key milestones

- **2019:** Canada and the Qikiqtani Inuit Association establish the Tallurutiup Imanga National Marine Conservation Area and the Tuvaijuittuq Marine Protected Area, laying the foundation for future collaboration.
- **2022:** Canada launches the Project Finance for Permanence initiative, creating an opportunity for a region-wide approach to marine conservation and long-term financing.
- **SEPTEMBER 2023:** Representatives of the Qikiqtani Inuit Association, the Canadian government and philanthropic partners start negotiating the SINAA agreement.
- **FEBRUARY 2025:** The partners sign the SINAA agreement, securing long-term funding and governance for Inuit-led marine conservation across the Qikiqtani region.
- **NOVEMBER 2025:** SINAA implementation launches, with a celebration in Iqaluit.
- **MARCH 2026:** The Qikiqtait and Sarvarjuaq Marine Protected Areas are established, marking the first major conservation outcomes under SINAA.
- **BEYOND 2026:** SINAA will continue to support Inuit stewardship, conservation centres, research and the establishment of additional protected and conserved areas.



Photo credit: Nina Qillaq

Tuvaijuittuq

CONSERVATION ON INUIT TERMS

Long used by Inuit for travel and harvesting, Tuvaijuittuq means "the place where the ice never melts" in Inuktitut. This culturally and historically significant marine area is globally, nationally and regionally unique due to the presence of multi-year pack ice—and as **RICHARD PATON** writes, all 319,000 square kilometres of it are now managed through the lens of Inuit protection and conservation.

TUVAIJUITTUQ IS ONE of the world's most remote regions and has the oldest and thickest sea ice in the Arctic Ocean. As sea ice continues to decline in the Arctic due to climate change, the ice here is expected to last longer than ice anywhere else in the Canadian Arctic. (Tuvaijuittuq is shown on the map on page 31.)

This means it will be an important summer habitat for ice-dependent species in the future, including walrus, seals and polar bears—species that Inuit depend on for our way of life.

We Inuit are the original researchers in our homeland. We have always observed, monitored and researched the area. We have gathered information, formed and shared knowledge, asked questions, assessed and analyzed. We know the Sila (the living environment and cosmos around us) and the Nuna (the sustaining physical land beneath us). More than that, we are part of them, and they are part of us.

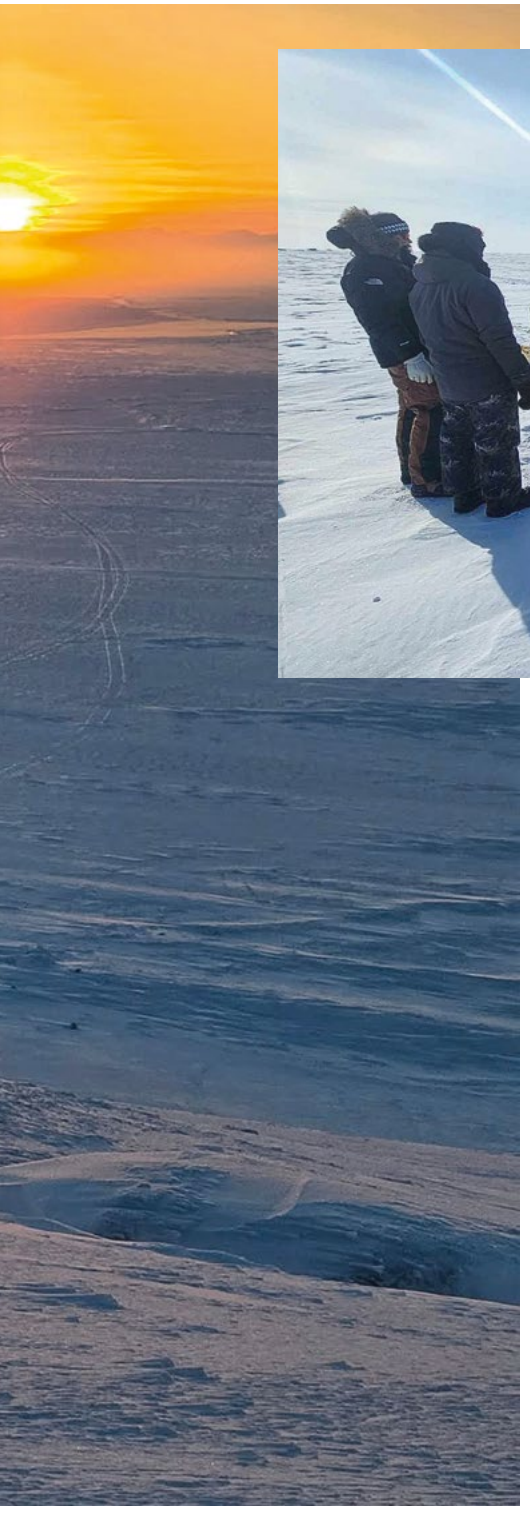




Photo credit: Jessie Olayuk

Top: Nauttiqsuqtiit (local Inuit Guardians) heading out to harvest, April 2025
Left: Nauttiqsuqtiit checking the floe edge, June 2025

For most of the year, Inuit travel over ice. In an ever-changing world, ice is at the heart of our efforts to protect and conserve Tuvaijuittuq.

KNOWLEDGE ROOTED IN THE LAND

As the eyes and ears on the ground, the Nauttiqsuqtiit (local Inuit Guardians of the land and sea) bring deep knowledge of and experience in Tuvaijuittuq. They are ideally positioned to lead local- and regional-scale research and monitoring to advance and support conservation outcomes that will sustain our culture and advance Canada's commitment to protecting 30 per cent of its oceans by 2030.

Words cannot fully convey how Inuit know and understand this land. The Nauttiqsuqtiit draw on their knowledge and skills, technical approaches and Inuit Qaujimajatuqangit (Traditional Knowledge). They employ lived experience, multiple ways of knowing, and many technologies every day—tools that are not separate but complementary.

Their extensive knowledge equips them to choose the methods and approaches that best suit their needs and communities. Everything is rooted in deep relationships with the land. Inuit knowledge, language, skills and values ground the Nauttiqsuqtiit in their work.

Inuit in the Canadian Arctic are protecting an area equivalent to almost 40 per cent of what Canada needs to conserve to meet its goal of protecting up to 30 per cent of its oceans by 2030.

Ninety per cent of Qikiqtani waters are recognized as ecologically or biologically significant. The Qikiqtani Region is a globally significant, climate-vulnerable ecosystem that supports many critical marine mammals, birds and fish. Yet our lands and freshwater and marine areas are under immense pressure from a variety of factors, including climate change, global pollution, shipping and resource extraction. Tuvaijuittuq is unique in that it has not yet had to face most of these pressures. But climate change is the ➤



RICHARD PATON is the assistant executive director of marine and wildlife conservation with the Qikiqtani Inuit Association.

most significant of all, and it is impossible to avoid.

Inuit are working diligently to advance conservation outcomes that will mitigate these pressures. These efforts are embedded in the SINAA Agreement—our regional conservation approach. At its northern end, Tuvaijuittuq serves as an anchor for almost one million square kilometres of Inuit-led protected and conserved marine areas. (SINAA means "floe edge" in Inuktitut—the place where landfast ice meets open water. It represents abundance, resilience and life at the boundary between sea and ice.)

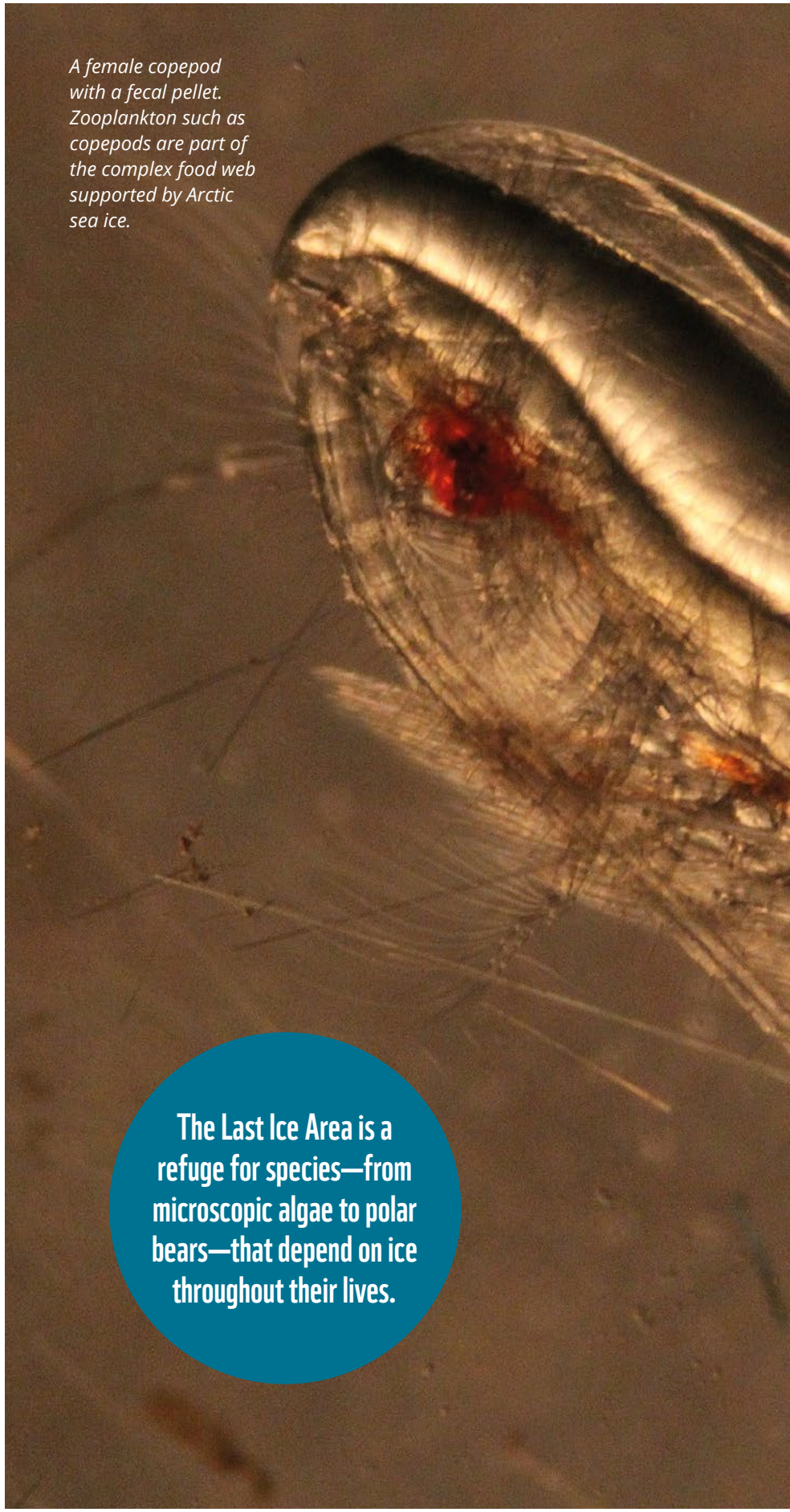
Inuit are not defined by the term "conservationist." But co-existence with nature is embedded in our way of life. By extension, protection for Tuvaijuittuq represents an economic opportunity linked to Inuit self-determination.

CONSERVATION AT A REGIONAL SCALE

SINAA links 13 communities, each with their own conservation priorities, in a plan to advance Inuit-led protection and conservation across 989,000 square kilometres of land and water. Stretching from Tuvaijuittuq in the Arctic Basin to Qikiqtait—the waters surrounding the Belcher Islands in Hudson Bay—this vast area is now one of the largest Indigenous protected and conserved areas in the world. And it is stewarded by Inuit who make up a tiny fraction of Canada's population.

SINAA creates jobs for Inuit (as Nauttiqsuqtiit) and space for Inuit decisions and governance around conservation. It also provides infrastructure that contributes to food distribution, supporting greater food sovereignty and security.

Embedded within the SINAA Agreement, Inuit in the Canadian Arctic—as guardians of the lands and waters for millennia—are protecting an area equivalent to almost 40 per cent of what Canada needs to conserve to meet its goal of protecting up to 30 per cent of its oceans by 2030. That's no small measure for the small population of 16,000 Inuit who live here. And it is a responsibility that Inuit are uniquely positioned to lead. ▯



A female copepod with a fecal pellet. Zooplankton such as copepods are part of the complex food web supported by Arctic sea ice.

The Last Ice Area is a refuge for species—from microscopic algae to polar bears—that depend on ice throughout their lives.



The High Seas Treaty

A CASE FOR PROTECTING THE LAST ICE AREA

As climate change rapidly transforms the Arctic, the Last Ice Area is expected to hold onto year-round sea ice longer than anywhere else in the Arctic. A new study finds that this unique ecosystem in the Arctic Ocean meets most of the criteria needed to obtain international protection from industrial pressures under the Biodiversity Beyond National Jurisdiction (BBNJ) Agreement. As **SUSIE GRANT** and **DANI DIZ** write, this means the area is a strong candidate for future marine area–based conservation measures. ➤

Photo credit: Celia Gelfman. Courtesy of Chantelle Rose (PolarTREC 2011). Courtesy of ARCUS

THE ARCTIC IS warming faster than any other place on Earth, and its sea ice is shrinking in both extent and thickness. Yet to the far north of Canada and Greenland lies an area that scientists believe will be one of the last places where multi-year sea ice can continue to survive.

The Last Ice Area is a refuge for species—from microscopic algae to polar bears—that depend on ice throughout their lives. As the rest of the Arctic becomes increasingly ice-free during summers, the ecological importance of this icy stronghold will grow.

THE ARCTIC'S ICE CONVEYOR

The Last Ice Area is part of a dynamic and interconnected sea ice system whose resilience depends in part on ice that is formed in the Central Arctic Ocean and transported into the region by wind and ocean currents. Together, these source and transport areas are termed the "ice shed." The ice becomes thicker and older as it drifts across the ocean to accumulate in the Last Ice Area.

Arctic multi-year ice supports biodiversity, including complex communities of algae, microorganisms, zooplankton and invertebrates. These organisms form the foundation of Arctic food webs, supporting fish such as polar cod as well as seabirds, seals, whales and polar bears. Multi-year ice also serves as a critical habitat throughout many species' life stages, providing feeding, breeding, resting and migration areas.

But in recent decades, sea ice throughout the Arctic has become thinner, younger and less extensive, reducing the amount of habitat available for ice-dependent species.

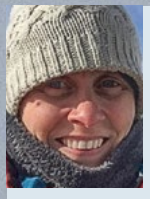
CONSERVATION BEYOND NATIONAL BORDERS

The BBNJ Agreement, or more simply the High Seas Treaty, entered into force on January 17, 2026. It is a landmark international treaty that creates the first global framework to protect marine ecosystems in areas that lie beyond national jurisdiction, including the high seas—the vast ocean areas outside any country's national borders.



A preliminary evaluation of whether the Last Ice Area could be eligible for protection under the BBNJ Agreement found that the area clearly satisfies at least 18 of the treaty's 22 indicative criteria for area-based management tools, including marine protected areas. These criteria include uniqueness, rarity, ecological connectivity, biological diversity, vulnerability, naturalness, importance for threatened species, and the occurrence of important ecological processes.

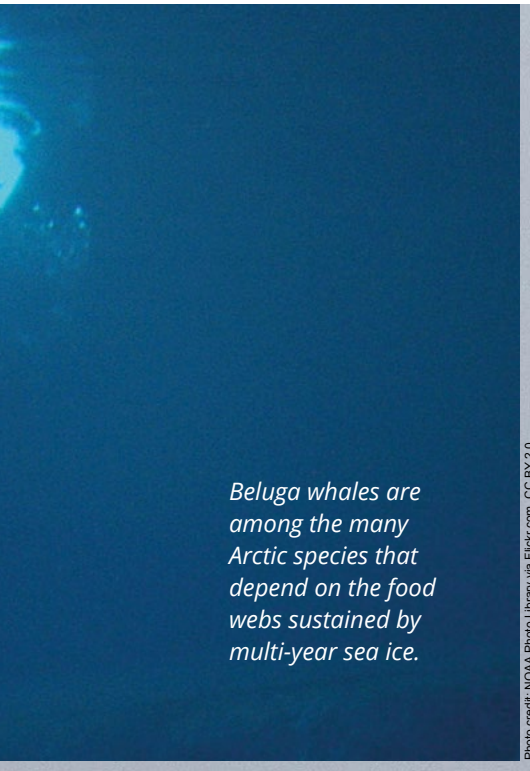
Four of the 22 criteria were not



SUSIE GRANT is a marine biogeographer working on spatial management and protected areas in the polar regions with the British Antarctic Survey.



DANI DIZ is an associate professor of international ocean governance with a focus on marine biodiversity conservation and sustainability policy and law with the Lyell Centre at Heriot-Watt University in Scotland.



Beluga whales are among the many Arctic species that depend on the food webs sustained by multi-year sea ice.

Photo credit: NOAA Photo Library via Flickr.com. CC BY 2.0.

assessed during the preliminary evaluation. These require further analysis and the involvement of a wide range of experts, including traditional knowledge holders.

A WINDOW OF OPPORTUNITY

Unregulated commercial fishing is prohibited under the Central Arctic Ocean Fisheries Agreement until at least 2037—and meanwhile, shipping, tourism and research are naturally constrained by the harsh environmental conditions. This means that for now, human activities in the region are limited. But as sea ice diminishes, the area will become more accessible and could be vulnerable to greater pressures from shipping, resource development and other industrial activities. Establishing conservation measures before these pressures intensify could help safeguard the region's ecological integrity.

Scientifically, the Last Ice Area is well qualified for future action under the BBNJ Agreement. A significant portion of the Last Ice Area ice shed lies in international waters beyond national jurisdiction, and the agreement is the first legal tool that could enable cross-sectoral coordination for the international protection of these waters.

A significant portion of the Last Ice Area ice shed lies in international waters beyond national jurisdiction, and the agreement is the first legal tool that could enable cross-sectoral coordination for the international protection of these waters.

But the Last Ice Area is far more than a remnant of a disappearing ecosystem. It may be the planet's final stronghold for multi-year Arctic sea ice and the life it supports. Protecting it now could help secure one of the Earth's most unique and vulnerable marine environments before climate change and human activities reshape it forever. ▯



An ivory gull flies over Arctic sea ice.

Photo credit: Linking Tourism & Conservationvia Flickr.com. CC BY 2.0



Photo credit: Peter Hegelund



Kristin Laidre with two polar bear cubs during a research trip

Northeast Greenland

NEW POLAR BEAR DENNING BEHAVIOUR IN THE LAST ICE AREA

Northeast Greenland is one of Earth's most remote, least studied regions—a landscape of multiyear sea ice, annual fast ice and drifting annual pack ice, with hundreds of icebergs that are grounded on the seafloor or become frozen into the ice for years at a time. Its coastline forms part of the northern gateway to the Last Ice Area.

In 2019, researcher **KRISTIN LAIDRE** and her late colleague Ian Stirling noticed something unusual: there were polar bear maternity dens among the region's icebergs along the northeastern and northern coasts. Laidre, a scientist with the Polar Science Center at the University of Washington, has worked in Greenland for some 25 years and studied polar bears since 2009. She spoke to *The Circle* about the discovery and what it reveals about how polar bears use this extreme environment.

How did you discover that polar bears were establishing dens in icebergs?

Accidentally. We had started an assessment of the East Greenland subpopulation. We had been working on that programme for eight years, and we spent one of our final years in northern and northeastern Greenland, extending into the Last Ice Area.

I was there to get a handle on the number of polar bears in the area, collect genetic samples, capture family groups, and fit adult female bears with satellite tracking collars to study their movements. We would use the information we collected to design a survey of the East Greenland polar bear subpopulation.

> As we lose sea ice in the Last Ice Area, bears are probably going to have to transition away from iceberg denning and onto land. But will there be suitable snowdrifts on land? I don't know.

What did you find while preparing for the survey?

We were searching for polar bears out on the sea ice. Every observation counts, especially in an area like northern Greenland, where historically, very little scientific effort has been expended.

This area of Greenland has many icebergs on the coast that can get frozen into the multiyear ice and become fixed in place for one or more years. Snow blows across the sea ice and hits these icebergs, forming drifts up against them. This creates good habitat for maternity denning. ➤



If you look closely, you can see a polar bear in a den (left) and a seal kill on top of the iceberg (right).

Photo credit: Kristin Laidre

We noticed what looked like a maternity den. You could see tracks from a family group—including really small cubs' footprints in the snow. We landed the helicopter on the ice, investigated the footprints, and walked up to the den in the iceberg. You could see that bears had been using these iceberg structures that are fixed in the sea ice as a framework for digging their dens. We continued to find similar dens all over the area.

How unusual is this behaviour compared to what female polar bears usually do?

To our knowledge, it was the first time that polar bears had been recorded denning in offshore, drifted snowbanks around icebergs. Most bears move onto coastal areas where there's a lot of geographical complexity, with hills or mountains that create similar snow drifts. Historically, bears would make dens on multiyear sea ice. But Greenland is special because there's so much freshwater ice in the form of icebergs. The icebergs were creating the habitat.

What does this discovery tell us about the connection between polar bears and the Last Ice Area?

I think it tells us about how polar bears are using this unique area. In addition, the longterm geographic predictability of maternity denning habitat is probably somewhat connected to the Greenland ice sheet and these icebergs. The Last Ice Area is arid. There's not a lot of precipitation, so there's not a lot of snow. You need suitable drifts for bears to be able to create maternity dens, and the icebergs sort of facilitate that.

As we transition from multiyear ice to annual ice in the Last Ice Area—and as that annual ice becomes less stable—I would expect this maternity denning habitat (made up of these icebergs and the multiyear ice) to decline. With warming, the icebergs will likely melt faster, the ice will break up earlier, there won't be multiyear ice to fix them in place, and they'll probably be more mobile. Over the long term, I think



It was the first time that polar bears had been recorded denning in offshore, drifted snowbanks around icebergs.

that's what might happen.

I also think this indicates that bears in the Last Ice Area are using a novel maternity denning habitat that gives them what they need to reproduce successfully. As we lose sea ice in the Last Ice Area, bears are probably going to have to transition away from iceberg denning and onto land. But will there be suitable snowdrifts on land? I don't know. We haven't studied that.

What challenges does this kind of denning create for monitoring and conservation efforts?

It's really hard to monitor this area. Most of the work we do on polar bears relies on helicopters or airplanes. Even just accessing the Last Ice Area and working up there is really logistically challenging. If we want to invest in understanding the Last Ice Area and have good data from the area to predict what's going to happen in the future, we need support for research. It's neither cheap nor easy to monitor this remote area.

But I think it gives us an indication that polar bears, depending on their habitat and what's accessible to them, can be pretty creative. Bears in the Southeast Greenland subpopulation are using the ice sheet as supplemental summer habitat—though not directly. They use glacial mélange, a mixture of calved freshwater ice chunks and sea ice.

It also tells us there's still a lot to learn. These are just observations from a couple of days spent flying in the areas we could access. I suspect that if we put effort into a bigger research programme, we would probably learn a lot.

What could you do with this research in the future?

I'd be very interested in getting back up there and doing more intensive sampling. With several years of repeat sampling, you'd learn a lot about how bears are using the region. You could collar some bears and look at how they are using the coastal areas of the Last Ice Area or the offshore region. You could also get a sense of whether bears use the same regions of the Last Ice Area year after year or are more transient. You would also be able to see to what extent they are using the Arctic Basin and get an idea of local abundance.

And if we were to capture bears, we would obtain a huge suite of health information. We could also look at genetics and subpopulation origin. There are definitely bears from the Kane Basin subpopulation that move into the Last Ice Area—we have tracked several that came from the western coast of Greenland. We also know the area is used by bears from the East Greenland subpopulation. But is it also used by bears from elsewhere?

There are many, many questions you could answer if it were possible to engage in a multiyear research effort in the region. ▯

The observations described here are published in more detail in the journal Polar Biology.

Inuit knowledge and leadership

PROTECTING PIKIALASORSUAQ

Inuit have thrived in the Arctic since time immemorial, developing holistic, intimate knowledge of our lands, waters, ice, animals and ecosystems over generations. Living across national borders, Inuit have identified Pikialasorsuaq—in the southern reaches of the Last Ice Area—as an important region that deserves special care. As **VICTORIA QUTUUQ BUSCHMAN** writes, recent community workshops show why Inuit knowledge, rights and leadership must remain at the heart of decisions about Pikialasorsuaq and the broader Last Ice Area.



VICTORIA QUTUUQ BUSCHMAN is a marine management advisor with the Inuit Circumpolar Council in Greenland.

THE INUIT CIRCUMPOLAR Council (ICC) first began organizing and leading discussions with Inuit hunters, fishers and other knowledge holders on shared concerns and aspirations for Pikialasorsuaq (called Sarvarjuaq by Inuit in Nunavut and known as the North Water Polynya in English) back in 2013. The focus has always been on safeguarding it for Inuit interests and future generations.

The Pikialasorsuaq Commission was eventually established, and its work has produced three primary recommendations: to establish a management regime and authority led by Inuit; to identify a protected area and management zone that reflects the connections between communities, their natural resources and the polynya; and to establish a free travel zone across national borders for Inuit.

INUIT VOICES AT THE HEART

From 2024 to 2025, ICC Kalaallit Nunaat (Greenland) hosted a series of co-developed workshops with Inuit hunters and fishers in five communities connected to Pikialasorsuaq. These five workshops—which took place in the northern Greenland communities of Qaanaaq, Hiorapaluk (Siorapaluk), Haviggivik (Savissivik), Upernavik and Kullorsuaq—responded to continued interest among community members



Map design: Ketill Berger, ketill.berger@filmform.no. © WWF Global Arctic Programme

in ensuring that Inuit voices are at the heart of the area's design, establishment and development.

Working with 42 hunters and fishers from these communities, we learned about how they use marine areas as well as about their individual and community-wide economies and the ecosystems and biodiversity that are found between Kalaallit Nunaat (Greenland) and Nunavut (Canada). Participants emphasized the recent effects of climate change, governance and globalization on marine mammals, birds and fish as well as changes in how Inuit use these species and sustain their livelihoods.

PROTECTION FOR INUIT RIGHTS

The workshops yielded insights into five main topics: marine ecology, wildlife management, traditional economies, marine governance, and research governance as it relates to decision-making for Pikialasorsuaq, with possible implications throughout the Last Ice Area.

These key messages included a resounding call for the protection of Inuit rights, including the right to self-determination. They also highlighted the need to keep a close watch on changing climatic conditions, ecosystem function, changes in species populations across space and time, and interspecies relationships. Ultimately, the workshops underlined the innate value and role of Pikialasorsuaq in sustaining and nourishing these communities physically, mentally, emotionally, spiritually and culturally.

As we begin to think more about the broader Last Ice Area and the Central Arctic Ocean, Inuit have much to share in terms of knowledge, cultural practices, management strategies and resource use. This knowledge should continue to shape debates around advancing Arctic biodiversity and conservation. As we consider future ways forward, one message is crystal clear: Inuit homelands must remain in the hands of Inuit.

For more details about the outcomes of the workshops, please refer to the full report.

Upernavik, Greenland, is one of the communities that use the marine areas in Pikialasorsuaq.



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Credit: Public Domain

A voyage into the ice

HMS *Alert* sits amid heavy pack ice during the British Arctic Expedition of 1875–76. After pushing further north than any wooden ship had gone before, the ship was beset by ice off Floeberg Beach on northern Ellesmere Island and spent the winter there. Nearly 150 years later, the waters north of Ellesmere form part of the Last Ice Area—the region where Arctic summer sea ice is expected to persist longest.

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