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RESILIENCE IN THE ARCTIC:
FACING THE FUTURE

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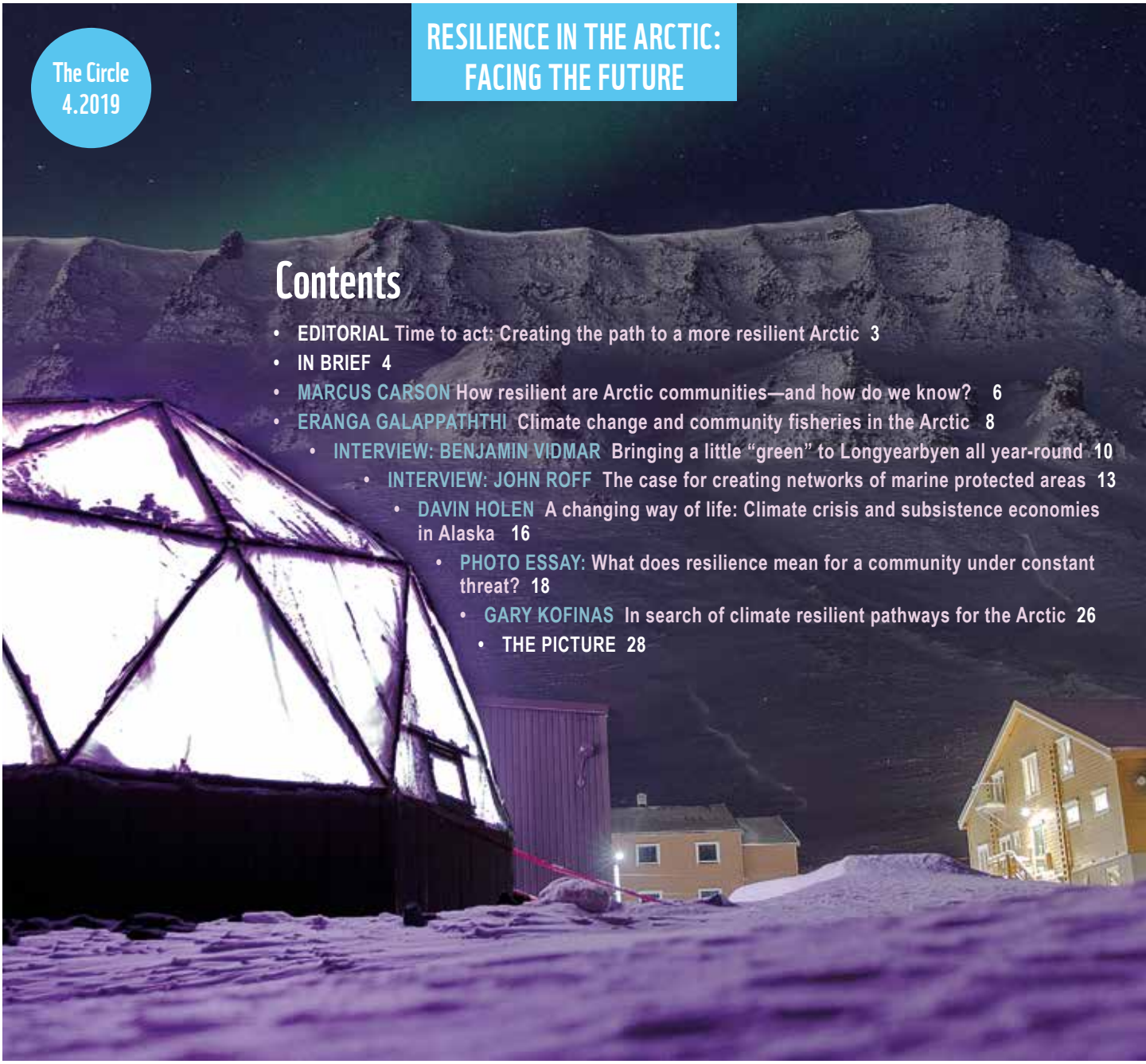

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COVER: Eben W. Hopson walks along a pile of sand bags meant to stop shoreline erosion in Utqiaġvik, Alaska, United States.

Photo: © Chris Linder/WWF-US

ABOVE: Greenhouse in Longyearbyen, Svalbard, Norway.

Photo: Francisco Mattos

EDITORIAL

Time to act: Creating the path to a more resilient Arctic

THIS FALL, the United Nations Intergovernmental Panel on Climate Change (IPCC) released its Special Report on the Ocean and Cryosphere in a Changing Climate. The IPCC is the most authoritative global organisation for assessing climate change science. Its report paints an extremely concerning picture of the status and future of our oceans and cryosphere and of the impacts of the climate crisis for ecosystems and people. Impacts are already evident, and will worsen under all possible emission scenarios, with some projected to be irreversible on the time-scale of centuries in a high-emissions future.

Considering that the ocean and cryosphere (comprising ice sheets, glaciers, sea ice, freshwater ice, snow and permanently frozen ground) together cover more than 90 per cent of the Earth's surface, this assessment has huge global significance, and reaches a sobering conclusion: "All people on Earth depend directly or indirectly on the ocean and cryosphere." Highlighting to people around the world the need for urgency in choosing the future we want, the report concludes: "This assessment reveals the benefits of ambitious mitigation and effective adaptation for sustainable development and, conversely, the escalating costs and risks of delayed action. The potential to chart Climate Resilient Development Pathways [...] depends on transformative change."

Only if we limit the global temperature increase to 2°C or less will substantial portions of the Arctic as we know it remain by the end of this century.

But how do we "chart Climate Resilient Development Pathways" for the Arctic?

One thing is clear: Arctic resilience depends heavily on urgent and ambitious reductions in greenhouse gas emissions. The report makes it crystal clear that only if we limit the global temperature increase to 2°C or less will substantial portions of the Arctic as we know it remain by the end of this century. (Ice, snow, permafrost and the ecosystems and cultures shaped by them may still exist, though at much smaller scales.)

While some Arctic countries are beginning to act on their "common but differentiated responsibilities" under the 1992 United Nations Framework Convention on Climate Change, overall, current commitments to the Paris Agreement are dangerously insufficient to ensure the survival and resilience of Arctic ecosystems and peoples.

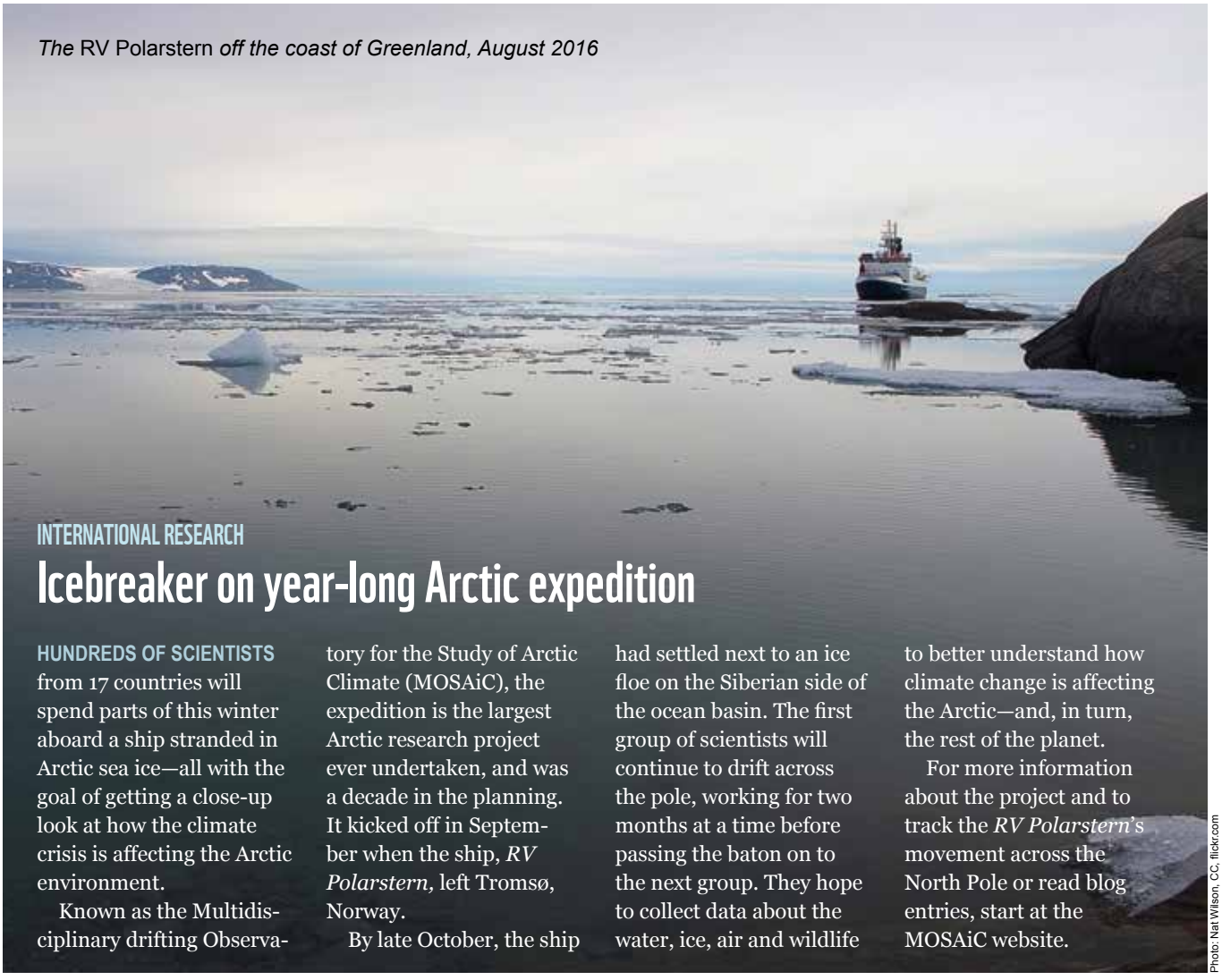
Aside from this global agreement, there is no single navigator at the helm charting resilient pathways for the Arctic. The report finds that instead, Arctic resilience can and must be strengthened—urgently—by fortifying the many ecosystems and societies (and their interactions) that make up the living Arctic. As a result, tools and practices that embrace and act upon such a systems approach—and that support ecosystems and biodiversity, sustain ecosystem services, strengthen cooperation and empower participation—are at the heart of resilience strategies.

While we are beginning to understand where and how to engage to strengthen resilience, bringing forward such an agenda is not a straightforward exercise. Our institutions are not equipped to consider all available knowledge or govern in the integrated fashion and at the speed needed to respond to rapid, pervasive change. We need information about the status, trends and futures of physical, ecological and social systems to support decisions that balance short-term risks and long-term resilience—but this information is often not available. Tools and practices that broaden participation and allow informed decisions are available, but are rarely linked to policy processes. Dedicated funding and capacity, including at the local scale, are needed but lacking.

MARTIN SOMMERKORN is Head of Conservation for the WWF Arctic Programme.

As the impacts of climate change mount in the Arctic, the urgency to respond and build resilience cannot be overstated. Governments must act urgently to prioritise, initiate and fund an agenda focused on strengthening resilience, and must coordinate and implement or incentivise it across institutions throughout the region.

Such a comprehensive, integrated approach would bring about the opportunities linked to Climate Resilient Development Pathways in the Arctic while addressing climate change risks. This issue of *The Circle* presents a collection of views on how to move the agenda forward. The time to act is now. ○



The RV Polarstern *off the coast of Greenland, August 2016*

Photo: Nat Wilson, CC, flickr.com

INTERNATIONAL RESEARCH

Icebreaker on year-long Arctic expedition

HUNDREDS OF SCIENTISTS from 17 countries will spend parts of this winter aboard a ship stranded in Arctic sea ice—all with the goal of getting a close-up look at how the climate crisis is affecting the Arctic environment.

Known as the Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC), the expedition is the largest Arctic research project ever undertaken, and was a decade in the planning. It kicked off in September when the ship, *RV Polarstern,* left Tromsø, Norway.

By late October, the ship had settled next to an ice floe on the Siberian side of the ocean basin. The first group of scientists will continue to drift across the pole, working for two months at a time before passing the baton on to the next group. They hope to collect data about the water, ice, air and wildlife to better understand how climate change is affecting the Arctic—and, in turn, the rest of the planet.

For more information about the project and to track the *RV Polarstern*'s movement across the North Pole or read blog entries, start at the MOSAiC website.

GREENLAND

Extreme snowfalls caused ecosystem collapse, report finds

MANY ARCTIC ECOSYSTEMS are able to bounce back from substantial annual fluctuations in temperature, snow cover and other climate variables. But as researchers at the Zackenberg Research Station in northeastern Greenland discovered in summer 2018, even the most resilient ecosystems have limits.

According to a study published in October 2019 in *PLOS Biology*, an ecosystem-wide reproductive collapse seems to have occurred in the area in 2018 after an unusually heavy winter left snow covering the ground well into summer. As a result, most plants and animals could not reproduce.

One bad year does not necessarily mean the end of plant and animal life for an area. However, if conditions swing between extremes—the summer of 2019 in Zackenberg was earlier, hotter and drier than usual—bad breeding years could follow in succession and push many Arctic species beyond their limits.

WHALES

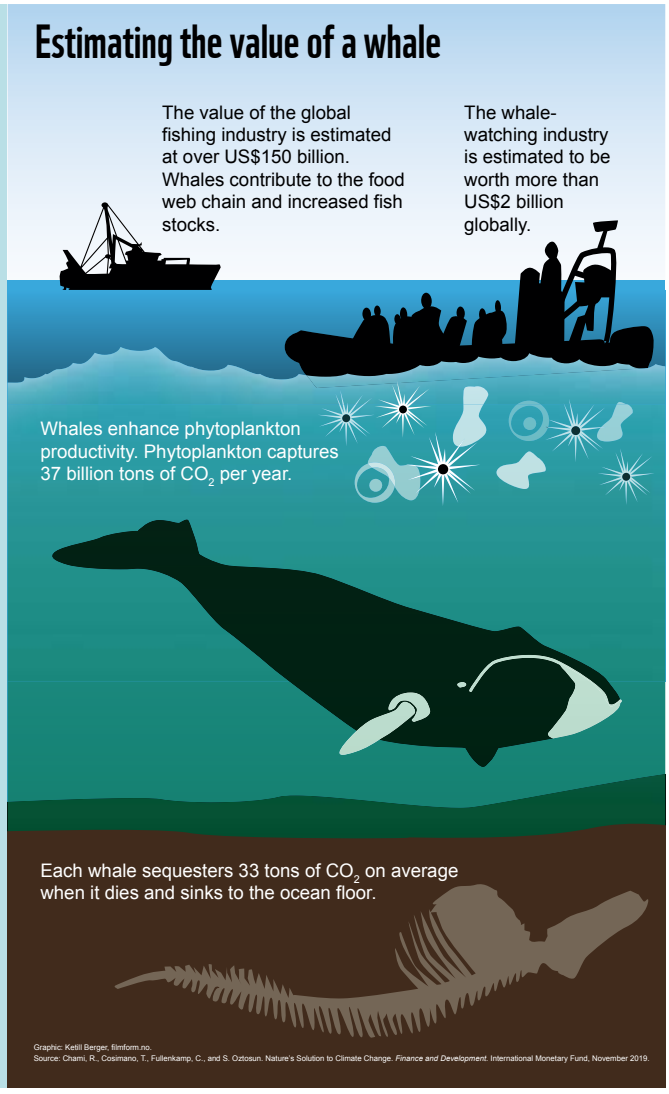
Protecting the Earth by protecting whales

INTERNATIONAL Monetary Fund (IMF) researchers estimate that whales are worth US$2 million each to the planet because of their tremendous ability to sequester carbon.

In the December issue of the IMF's magazine, *Finance & Development*, a group of researchers report that whales' bodies can sequester 33 tons of CO_2 on average over their lifetimes—and every time a whale dies and sinks to the ocean floor, that carbon is removed from the atmosphere for centuries. In comparison, a tree absorbs about 48 pounds of CO_2 per year. The authors argue that restoring the world's whale populations to pre-industrial levels would be akin to planting four Amazon forests' worth of trees, or about 1.7 trillion.

Researchers arrived at the US$2 million figure—which they call conservative—by calculating the value of the carbon sequestered by a great whale over its lifetime (based on estimates of the amount whales contribute to carbon sequestration and the market price of CO_2), then factoring in today's value of whales' other economic contributions, such as fishery enhancement and ecotourism, over their lifetimes.

The catch: for this low-tech climate solution to work, whales need protection—and there is a cost to that. The researchers argue that coordinating the economics of whale protection should be the top of the world's climate agenda.



RUSSIA

Melting glaciers reveal five undiscovered islands

IN OCTOBER 2019, the Russian navy reported finding five previously unknown islands in the remote Arctic archipelago of Novaya Zemlya. They had been uncovered by melting glaciers.

The newly discovered islands range in size from 900 to 54,500 square metres. The expedition head, Vice Admiral Alexander Moiseyev, said before the melt, it was assumed they were part of the area's main glacier, known as Nansen.

Although the discovery was announced in 2019, it dates to 2016, when a student engineer noticed unknown land masses in satellite imagery while working on a research paper. The 2019 expedition surveyed the topography of the new islands for the first time.

Receding glaciers are known to destabilise the land beneath them, so it's not clear whether the new land masses will last. However, according to a report on Sciencealert.com, life forms are already colonising them, including algae, plant life and birds. There is also evidence of larger land animals, such as bears and seals.

Resilience indicators

How resilient are Arctic communities—and how do we know?

It's been said that the future isn't what it used to be. No one knows for sure who coined that pithy phrase—but as MARCUS CARSON explains, one thing is certain: it's an apt description of the Arctic's situation today.

SEASONAL VARIATIONS in the Arctic that were large even under once-normal climate conditions are now amplified by new highs, new lows and occasional shocks. But what's even more unpredictable is how people respond to the environmental changes caused by human activities—especially since so many of these changes originate from activities that take place outside of the Arctic.

Under the circumstances, it should come as no surprise that developing and agreeing on effective responses can be challenging—not least because under conditions of disruptive social and environmental transformation, the very capacity to navigate change is itself often strained. But the ability to deal with change is key to community resilience, so it's a challenge we must embrace.

MARCUS CARSON is a Senior Research Fellow at the Stockholm Environment Institute and led its Arctic Resilience Assessment.

WHAT IS RESILIENCE?

Resilience speaks to the capacity to navigate change. It is often defined in terms of a system's ability to absorb disturbances while maintaining its original structure and function. But when we add people to the picture, defining resilience gets more complex.

From that starting point, our definition of resilience emphasises three social elements: a community's ability to act; its capacity to acquire and integrate different kinds of knowledge; and the indivisibility of social systems from ecological ones. In short, resilience describes a community's capacity to navigate social and ecosystem change effectively. This capacity has always been needed in the Arctic, but never more urgently than now.

> The ability to deal with change is key to community resilience, so it's a challenge we must embrace.

Traditionally, human activities in the Arctic have been intertwined with ecosystems. In fact, the Indigenous cultures of the Arctic conceptualise nature as a dynamic and evolving interaction between the biological and the physical worlds, with humans playing an integral part. Recognising this, it's clear that to define resilience indicators and measure resilience, we need to consider communities and ecosystems as parts of a larger whole.

MEASURING RESILIENCE

Developing a framework of indicators that can describe the capacity to navigate change is a challenging task, but it's important if we want to know whether efforts to strengthen resilience are having a positive effect. Recent Arctic Council reports* on the key ingredients of social-ecological resilience have emphasised social factors as the basis for developing indicators because societal choices will powerfully influence the fate of the Arctic—and the people who call it home. These factors include:

- **Capacity for self-organisation.** This should be understood in terms of a community's ability to steer itself in a chosen direction, both in its social context and in relation to the ecosystems it depends on. It includes the ability to identify the nature and cause(s) of challenges, and to agree on and implement suitable responses. Outside factors can influence this capacity. For example, legal rights or norms may dictate how efforts can be organised, or may define ownership or authority over resources or activities.
- **Knowledge integration and capacity to learn.** Integrating and adding to existing knowledge is the best way to steer community choices to foster greater resilience. Research on the capacity to adapt and respond to climate and other change recognises that knowledge is both a determinant and an indicator.
- **Diversity.** Diversity broadens the range of possible paths for responding

* These reports include the Arctic Resilience Report (Arctic Council 2016); resilience chapters in Adaptation Actions for a Changing Arctic (AMAP 2017); and the Arctic Resilience Action Framework (SDWG 2018).

Photo: Staffan Widstrand

Ice fishing for Arctic char, Baffin Island, Nunavut, Canada

to change. It can be seen as a form of insurance: when disturbance or changing conditions cause one type of response to fail, other mechanisms are there to carry out essential functions. In the social context, diversity of knowledge or skills can provide the foundations for creative problem-solving by maintaining a stock of elements that can be combined in novel ways to respond to change.

■ **Assuming change.** This means accepting uncertainty and surprise as reality—in other words, acknowledging that change is the norm. Communities can approach change, including abrupt and disruptive change, as an opportunity to pursue developmental goals in cases where it may not be optimal, desirable or even viable to maintain current conditions.

When it comes to developing resilience indicators, it's important to involve members of a community in the decision-making processes. Such participatory processes involve communities working together to describe how elements like the four indicators above are manifesting themselves locally. In fact, the very work of defining the indicators can contribute to learning and greater capacity for analysis.

When communities are interested in measuring resilience, we recommend that they begin by developing qualitative indicators, because these tend to be more accessible to the layperson than quantitative indicators, and more likely to invite further discussion. And in a world where the future isn't what it used to be, discussion aimed at fostering resilience is an essential first step. ○

Turbot fishery

Arctic char fishery

Photos: Eranga Galappaththi

Following the fish

Climate change and community fisheries in the Arctic

Against the backdrop of the mounting climate crisis, coastal fishery systems in the Arctic are undergoing rapid change. During four years of PhD field work, ERANGA GALAPPATHTHI had the opportunity to interview Inuit fishers and accompany them on fishing trips. As he found out, some communities in the Canadian Arctic are finding ways to adapt to their shifting environments.

WORLDWIDE, coastal Indigenous Peoples consume about 15 times as much seafood as non-Indigenous people. This includes the Arctic Inuit, who are coping with the environmental impacts of the climate crisis by increasingly turning to the ocean for food. The series of reports issued recently by the Intergovernmental Panel on Climate Change turned an urgent spotlight on coastal aquatic systems, which will be threatened even if we succeed in limiting the global temperature increase to 1.5°C. The impacts of the climate crisis are already causing drastic changes in coastal resources—and directly affecting the people who rely on them.

ADAPTING TO SURVIVE

But some Inuit communities are refusing to give up. Instead, they are using their accumulated knowledge and long habit of continuous learning to help build resilience to the effects of climate change. This emphasis on climate resilience among Inuit fishing communities may broaden and deepen their ability to adapt to climate change.

While completing my PhD, I was fortunate to do some field work in Pangnirtung, a beautiful coastal Inuit community on Baffin Island in the Canadian territory of Nunavut. This small, isolated community with a population of just over 1,400 is accessible only by aircraft for much of the year, and by boat during the summers. Travel in and out is extremely expensive. Residents must cope with other challenges as well, including housing shortages, high rates of food insecurity, and low rates of high school graduation. Many small Nunavut settlements face similar challenges, but in remote Pangnirtung, they are magnified.

A HOTSPOT FOR CLIMATE CHANGE IMPACTS

The community is also facing a deluge of climate change impacts, including changes in sea-ice conditions, severe weather conditions, permafrost thaw, emerging landscape hazards, and

Inuit country food

The migration of caribou toward western Canada has left Pangnirtung residents relying more on the sea for food.

stresses to wildlife population dynamics. Caribou, seals and Arctic char have traditionally been the most important food sources. In fact, Pangnirtung, also known as Pangniqtuuq, means "place of the bull caribou"—the area was once known to have plenty. However, the migration of caribou toward western Canada has left residents relying more on the sea for food in recent years. Fortunately, Arctic char and turbot fisheries in Pangnirtung are helping people adjust.

Arctic char is the staple food in the community, and is a popular subsistence fish, as in many parts of the North. But Pangnirtung also runs an Arctic char commercial fishery during the summer. Only a few commercial char licences are issued yearly (there were 15 in 2017), awarded through a lottery system managed by the community's Hunters and Trappers Association. In the summer, when the Pangnirtung fjord is clear of ice, fishers start boating into Cumberland Sound where they use gill nets to catch the char. In winter and spring, once the thick sea ice has formed, fishers travel by snowmobile to surrounding lakes to fish using short sticks and baited lines—known as jigging.

The commercial turbot fishery also brings a relatively large amount of money into the community each year—over CAD$1 million (US$756,000). This fishery runs in the winter and spring. Strong, thick sea ice is needed before winter turbot fishing can start, since fishers must travel to the Cumberland Sound sea ice and spend long hours or even days on the ice.

COMBATTING DANGEROUS CONDITIONS WITH KNOWLEDGE

Turbot fishers will use anywhere from one to three different ice holes on the frozen ocean. This is high-risk work due to conditions that include continuous darkness and extreme temperatures that can reach –40°C with wind chill—not to mention the fact that turbot longlines can snag Greenland sharks as bycatch. While not aggressive, they are among the largest sharks on the planet, have sharp teeth, and may be dead or alive when found on longlines.

To manage these risks, the Inuit combine their local and traditional knowledge of the environment, fish species and weather with scientific knowledge obtained through a fisheries co-management process. The Pangnirtung Inuit learned turbot fishing techniques from the Greenland Inuit in the mid-1980s, and now possess an accumulated body of knowledge that is transferable to neighbouring communities, such as Pond Inlet and Qikiqtarjuaq.

The Inuit-owned community fish plant processes Arctic char in both summer and winter, and the turbot catch has been increasing over the years. Today, these co-existing fisheries support many of Pangnirtung's residents, allowing them to earn money to buy other foods as well as hunting and fishing equipment. Fishers in the area have adopted relatively advanced technologies, such as GPS systems, VHF radios and advanced rifles for fishing and hunting activities.

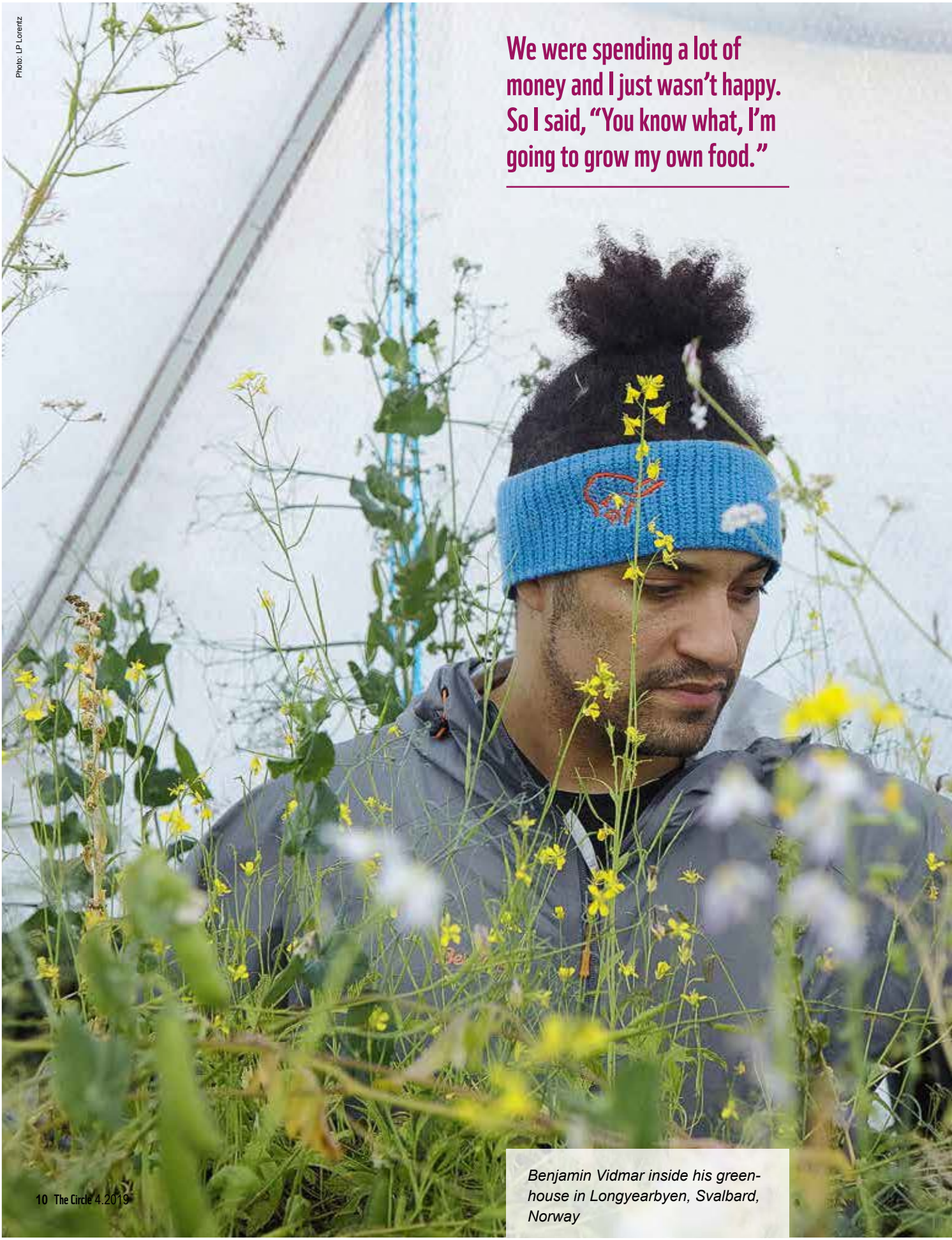
The rapid environmental changes unfolding in the Arctic have the potential to increase the risk of food insecurity for the Inuit significantly. Building resilience in Inuit communities and adapting to climate change are the keys to coping successfully. In that context, sustainable fisheries are a necessary pathway to building resilience.

By following in the footsteps of the Pangnirtung Inuit—experimenting with and continuously learning about new fishing opportunities and techniques—other communities have the potential to build their resilience as well. ○

ERANGA GALAPPATHTHI has been studying changing human-environment systems for more than 10 years. He is currently finishing his PhD at McGill University, Canada.

Photo: LP Lorentz

We were spending a lot of money and I just wasn't happy. So I said, "You know what, I'm going to grow my own food."



Benjamin Vidmar inside his greenhouse in Longyearbyen, Svalbard, Norway

Growing fresh food

Bringing a little "green" to Longyearbyen all year-round

Longyearbyen, Svalbard is the world's northernmost town. Although it's part of Norway, all 46 nations that have signed the Svalbard treaty have rights there (see sidebar, next page). But Longyearbyen is unique for other reasons. For three months of the year, it has sunshine 24 hours a day—followed by another three months of total darkness in winter, when it is a desolate landscape of fjords, snow and ice. Even when the snow melts, it's just tundra, without a tree in sight—an Arctic desert and, as BENJAMIN VIDMAR knows, a difficult place to grow food.

VIDMAR IS ONE of 2,300 people who call this Arctic town home. The chef has lived there for the past 12 years with his wife and four children. The lack of fresh produce inspired him to create the Polar Permaculture initiative. As he tells *The Circle*, he's on a mission to make fresh produce accessible to the community year-round.

What do the landscape and lack of sun mean for growing things in Longyearbyen?

Well, it's quite easy to grow things in the summer when you have a lot of sun, but it's quite challenging in the winter, unless you're using LED lights or something like that. You really have to create a protected environment.

There are a lot of people here who grow vegetables in their houses, just as a hobby. They grow different greens and some cucumbers and tomatoes. But there's no one really doing anything at a commercial level, selling to the hotels and restaurants or to the supermarket. So, that's where we've been trying to find our place. We want to do this for the town, not just for ourselves. ➤

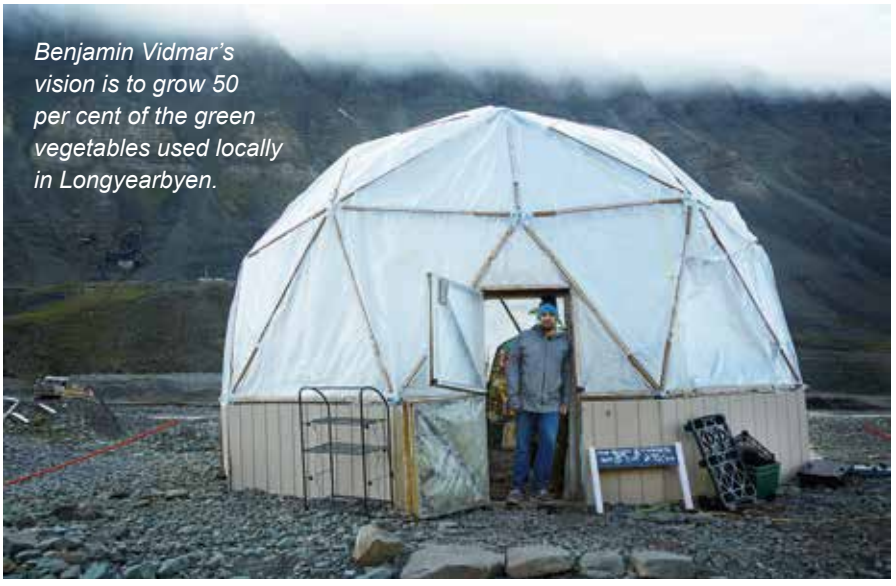


Photo: LP Lorentz

Benjamin Vidmar's vision is to grow 50 per cent of the green vegetables used locally in Longyearbyen.

Where were residents of Longyearbyen getting their fresh produce before you came along?

Everything was imported. Not only that, but we need to ship all the waste back to the mainland. All materials, whatever is not used, are shipped to Norway. We have a very long supply line and a very high CO_2 carbon footprint. So, it's quite challenging to be here.

As a chef, what are the main challenges created by the lack of fresh food?

It makes it very expensive to do business here. It also makes it very difficult to have good-quality food, because a lot of food doesn't survive the journey over. We have to throw away a lot of produce as soon as it arrives.

For me, the whole idea behind Polar Permaculture was to have the freshest food possible. I was really getting frustrated. I was the head chef at a restaurant here in Longyearbyen, and I wasn't satisfied with the quality of the food. We were spending a lot of money and I just wasn't happy. So I said, "You know what, I'm going to grow my own food."

What have you been growing since you started the Polar Permaculture initiative in 2013?

We've been trying to grow as much locally produced food as possible, using soil in the summer and hydroponics indoors in the winter. We've also been trying to find a way to compost the waste that's produced from that food. Because not only can't we produce much food, but all our organic waste, sewage and wastewater get dumped into the sea. There's no treatment, no filtering...Whatever comes out of the sewer pipe goes into the sea.

We deliver the produce we've grown to hotels and restaurants. We then collect what they don't use, compost that, and use it in our dome during the summer. We're trying to create some type of zero-waste circular system—trying not to dump as much into the sea and to reuse things as many times as possible.

What are you able to grow?

So far, we've grown lettuce greens and different leafy greens as well as herbs and micro greens. The main thing we grow is microgreens, because along with leafy greens and herbs, they have to be flown in and they don't transport very well. The hotels and restaurants really like microgreens and use them as garnishes. Right now, we deliver about 15 trays of microgreens per week. What they don't use during the week, we collect. We have composting worms, so we feed this returned organic waste to them. The worms produce castings, and we use the castings in the dome in the summer to grow things like kale, for example.

What's your vision for the future of this project?

My vision is to produce 50 per cent of the green vegetables that we use here in town locally and to compost much of the resulting organic waste instead of dumping it into the sea. I also want to create a green space where people can come and eat dinner—where they can come and visit and see how we're growing food here. I want to make a space that changes the way we do business here. We want to show that there's a different way to do it. We can't just keep doing the same thing and expect different results. ○

Celebrating 100 years of unique history in Svalbard

The Svalbard archipelago off the northern cape of Norway boasts a unique history and an even more unique status under international law. Although the nine islands are technically under Norwegian sovereignty, 46 nations have rights in the area—thanks to the **Svalbard Treaty**.

The Svalbard Treaty (formerly the Spitsbergen Treaty) was signed in 1920 as part of the Versailles negotiations at the end of World War I. Although all signatory nations have equal access to Svalbard, and their citizens have the right to live and work there, no nation can permanently station military personnel or equipment there. The treaty also makes Norway responsible for preserving the natural environment of Svalbard.

For almost 100 years, the treaty has ensured relative peace and stability in the region, but Svalbard now faces several challenges. The thawing Arctic offers immense potential for oil and natural gas production, and competition for these natural resources could fuel conflict in the region. As the treaty prepares to mark its centennial next year, many fear that if challenged, the area and its surrounding waters could look very different in the future.

Conserving Arctic waters

The case for creating networks of marine protected areas

There is no question that human activity is having a major impact on our oceans. Pollution, shipping, overfishing and increased boat traffic due to tourism, combined with ocean warming and acidification, are all contributing to the deterioration of marine ecosystems. But networks of marine protected areas (MPAs) offer a means of protecting species, habitats and ecosystems throughout the Arctic.

JOHN ROFF has been looking at the idea of establishing MPAs for more than 25 years. Currently the lead scientist with the Marine Ecological Conservation for the Canadian Eastern Arctic Project (MECCEA)—a WWF-Canada initiative to identify a network of priority areas for marine conservation in Canada's eastern Arctic—he is also a retired professor of marine conservation and former editor of the *Canadian Journal of Fisheries and Aquatic Sciences*. Roff says creating a network of MPAs in the Arctic needs to happen now—before it is too late.

Why are marine protected areas so important?

They're the only effective means we have of protecting the marine environment. Fisheries quotas were the original method, but they've proved ineffective. Basically, there are two ways in which you can try to protect the oceans. One is by restricting fishing activity, or by fisheries' quotas. The other is by closing off areas. It's been shown over and over again that closing selected areas of the oceans is a very effective means of protecting not only biodiversity as a whole, but fish stocks too. It protects the fisheries as well as the areas where fishery recruitment (young fish entering a population) is important, resulting in what we call spill-over effects. If you protect a particular area where fish are abundant and localised, that will enhance the populations in those areas and they will actually act as seed areas for surrounding regions.

It's been shown over and over again that closing selected areas of the oceans is a very effective means of protecting not only biodiversity as a whole, but fish stocks too.

What about the Arctic context? How successful have marine protected areas been in the Arctic?

I don't think we've really evaluated that yet. There's a great deal of difference between just establishing a protected area and monitoring it to find out whether the protection has been successful. Monitoring of protected areas in the Arctic is pretty much in its infancy. Although there are protected areas in the North—Tuvaijuittuq off the northwest coast of Ellesmere Island in the Arctic Ocean is a significant one—I ➤

John Roff, lead scientist with MECCEA

In most areas of the world, we're trying to protect marine environments that are already degraded in hopes that that they will re-establish themselves and become seed populations and biodiversity sources for other regions. But in the Arctic, we have the chance to protect something before it has become massively degraded.

would say that the most important biological area in the eastern Arctic right now is Lancaster Sound. That area is hugely important for marine mammals and bird populations.

The idea of establishing protected areas in the Arctic is quite recent. In Canada, we have three areas that have been closed to fisheries, but that was done so recently that they haven't been evaluated yet. Yet evaluation is precisely what is needed now—and that means having effective monitoring programmes in place.

Why are marine protected areas particularly important in the Arctic?

In most areas of the world, we're trying to protect marine environments that are already degraded in hopes that they will re-establish themselves and become seed populations and biodiversity sources for other regions. But in the Arctic, we have the chance to protect something before it has become massively degraded. Instead of trying to play catch-up, we have the chance to protect something that is in nearly pristine condition, which is unusual. There are estimates that only something like 12 per cent of the world's oceans are in an untouched or pristine condition—and most are in the Arctic.

There have been some recent initiatives in the Arctic to protect areas. In fact, the Canadian government has really done quite well. But while some MPAs, such as Tuvaijuittuq, have been protected from development through legislation under the *Oceans Act*, *Canada Wildlife Act* or *National Marine Conservation Act*, others have been "protected" very quickly by simply closing fisheries (under the *Fisheries Act*). Closures protect species by creating marine refuges, but unlike MPAs, refuges don't restrict activities like oil and gas extraction. In addition, there's no pattern of connectivity among the areas, so while some are now protected (or closed), it wasn't done in accordance with any overall strategy.

Why is it important to have networks that connect protected areas?

An individual protected area is not sustainable by itself. People have talked in the past about "ecological integrity." But there is really no such thing as ecological integrity when we're talking about an isolated, protected area, because the organisms that enter it come from other places. Likewise, the organisms that live within it can move from the protected area to other areas, whether by actively migrating or by means of ocean currents. So a protected area is not just an isolated lake. There's no such thing as an isolated lake in the oceans. These

A new approach

WWF's Arctic Programme is partnering with researchers and experts to create a **pan-Arctic network of marine protection** to reduce the loss of biodiversity and cultural identity in this vulnerable and rapidly changing part of the world.

This work prioritizes the needs of marine life, cultural values and the important functions of all the region's unique ecosystems. By identifying critical areas for marine life that need protection and connection, we can help ensure their long-term survival and build resilience to climate change.

Pan-Arctic priority areas for conservation have now been identified and the results will be shared publicly in 2020. For more information or to become involved, go to https://arcticwwf.org/work/ocean/protection/.

A pod of narwhals

Dr. Kristin Laidre, Polar Science Center, UW NOAA/OAR/OER [Public domain]

areas have organisms coming in and out and moving through them.

Connectivity is important because it protects the natural processes of recruitment. What we are trying to do in our modelling studies, as part of the MEC-CEA project, is to identify those natural processes of recruitment—whether it is larger organisms migrating into the areas, such as marine mammals or birds, or smaller organisms like larvae or propagules that come from the benthic animals moving around various areas.

How critical is timing, since we're seeing the Arctic Ocean open up more and more to shipping as sea ice disappears?

Changes are happening in the Arctic much more quickly than anybody ever expected. There will be increased pressure for shipping. And although a lot of fisheries are on hold in the high Arctic, as areas open up, there will be more and more pressure to move in and exploit resources. Tourism in the Arctic has also grown massively in the last few years, and will certainly increase. These changes are already affecting local communities, so I think there's an urgent need to do something very quickly. ○

How do marine protected area networks help build resilience?

Evidence suggests a number of reasons why connected MPAs likely contribute to resilience:

1) Establishing MPA networks is critical to maintaining climate change resilience and rebuilding ecological and social resilience.

2) Networks of MPAs, while not impervious to all climate change impacts, provide areas of reduced man-made pressures, improving the ability of marine organisms to adapt to climate change.

3) Well-designed MPA networks can increase species survival by allowing them to move around and escape ecosystem changes and pressures.

4) Effective networks protect examples of ecosystems or habitat types in a region, as well as special or unique areas.

5) MPA networks can greatly enhance individual MPAs' effectiveness through shared or complementary biological or oceanographic features.

A changing way of life: Climate crisis and subsistence economies in Alaska

Hunting and gathering have been central to the way of life of Native people in Alaska for thousands and thousands of years. But what does climate change mean for this traditional way of life? Anthropologist DAVIN HOLEN has interviewed hunters and fishers across Alaska who live a traditional subsistence lifestyle—and he's discovered that climate-induced changes are disrupting their ability to pass these traditions on to their children.

DAVIN HOLEN is currently the Coastal Community Resilience Specialist for Alaska Sea Grant at the College of Fisheries and Ocean Sciences, University of Alaska Fairbanks. He has been conducting social science research on subsistence economies in Alaska for the past 20 years.

IN THE EARLY 2000S, I conducted interviews in the traditional central Yup'ik community of Newhalen in Alaska's Bristol Bay region, on the easternmost arm of the Bering Sea. Perched on the Newhalen River near Iliamna Lake, the community is close to the calving grounds of the Mulchatna caribou herd, which was one of the largest herds in Alaska at the time.

I asked a young hunter and new father about his first caribou hunt. Among the Yup'ik, as with many Indigenous communities in Alaska, a boy would go through a coming-of-age rite that proved his ability to provide for a family and his community. This included harvesting his first large animal. The bounty was then distributed to the entire community while the young hunter took none. This act of sharing demonstrated and symbolised the reciprocity the hunter shared with his community—and with the caribou that had given itself so that he might feed his family and community. This rite bonded the hunter with the spirit of the caribou in a relationship of mutual respect—a bond that would strengthen over a lifetime. The young hunter told me how important this first hunt was to him and how he looked forward to passing the ritual on to his children. He described how the people of Newhalen had relied on caribou for as long as the Yup'ik had occupied the area.

A WAY OF LIFE COMES TO AN END

All of that was almost 20 years ago. If I interviewed the hunter's children today, they would no doubt have a different story to tell me. That is because the caribou have all but disappeared.

Caribou herd sizes are highly variable and influenced by their environments. A herd can multiply quickly as the animals expand their territory, then crash as they overgraze the available lichen, which grows slowly in the Arctic. A herd near Newhalen that once numbered more than 100,000 has dwindled to just 12,000 after most members migrated hundreds of kilometres north to the Kuskokwim River, driven by climate-induced changes to the region. Flying over the area today, you can see tundra punctuated by rivers with willow and other deciduous trees and shrubs growing along their banks—ideal food for the moose that inhabit these boreal forests, but less so for the caribou. As the climate changes and the permafrost thaws, these deciduous forests are slowly expanding across the landscape, pushing the caribou further north.

> If I interviewed the hunter's children today, they would no doubt have a different story to tell me. That is because the caribou have all but disappeared.

Because of this creeping change, the traditional caribou hunts have ended. They are now just stories that adults and elders tell their children. Changes like these are happening swiftly across the Arctic. In fact, in less than a generation, the caribou have almost disappeared from southwest Alaska.

WALRUS HUNTERS FACE DANGEROUS CONDITIONS

Meanwhile, nearly 1,000 kilometres north of Bristol Bay, in Alaska's Bering Strait, hunters rely on walrus to feed their families—another traditional cultural activity. Unlike caribou hunting, walrus hunting requires group participation for success. It also depends

In Alaska's Bering Strait, hunters rely on walrus to feed their families.

Photo: Christopher Michel, CC, flickr.com

on access to small boats, the ability to navigate the ice pack effectively, and deep knowledge of the territory and its hazards. Walrus hunting in the Arctic is a dangerous activity. Over many years, elders teach youth how to "read" the ice, and pass along other tips for hunting walrus safely and effectively.

But here too, climate change is making a traditional lifestyle difficult to pursue. Walrus rely on the icepack, but the icepack moves further north each winter, leaving behind open water that is tricky for hunters to access during winter storms.

Hunters have told me how they used to be able to plan their walrus hunts each year. Now they must watch the weather and wait for the pack ice to form. In many cases, they can no longer plan a hunt even one week in advance because of the uncertainty of climate conditions in the region: they must be ready as soon as the conditions are right.

Walrus rely on the icepack, but the icepack moves further north each winter, leaving behind open water that is tricky for hunters to access during winter storms.

FACING AN UNCERTAIN FUTURE

The climate crisis is disrupting the traditional subsistence lifestyles practiced by many people across the Arctic. These changes may bring opportunities as new fish stocks move further north. But the major impacts are uncertainty about the future, and the mounting dangers and difficulties associated with trying to continue age-old cultural practices.

The climate has affected traditional practices before. Alaska's Native people are resilient and have overcome these challenges. But the recent effects of climate change are more dramatic, and may prove more difficult to cope with. That said, when it comes to passing on knowledge and practices to future generations, the most important element is the connection to place and landscape—and that hasn't changed. Hunting and fishing practices may evolve in response to new realities—in fact, new techniques and traditions are already establishing themselves in Alaska's coastal communities—but the continuity of culture will prevail. ○

A town on the edge

What does resilience mean for a community under constant threat?

Photo: © Chris Linder/WWF-US

Signs near the Utqiaġvik airport remind visitors how far the town is from major world landmarks. ➤

Photo: © Chris Linder/WWF-US

Utqiaġvik is located at the edge of an eroding coastline, and sandbags are struggling to contain the damage from storms.

THE ALASKAN TOWN of Utqiaġvik is perched precariously on the wild coastline between the Beaufort and Chukchi seas. It's also on the frontlines of the climate crisis, continuously fending off the existential threat of coastal erosion.

Sea ice could once be relied upon to absorb the impact of fierce waves and storms, protecting the nearby settlement and its coastline. But the summer sea ice is disappearing, allowing storms to ravage the town and risking damage to its roads, drinking water and a decommissioned military landfill near the beach.

The community is no stranger to weather extremes. Generations of residents have responded successfully to sudden shifts in the past. However, the accelerating pace of change is starting

Photo: © Chris Linder/WWF-US

Utqiaġvik's temporary wall of sandbags is proving to be an inadequate defense against unrelenting coastal erosion caused by the loss of sea ice.

to outstrip the community's ability to cope, causing many to wonder just how resilient they can be.

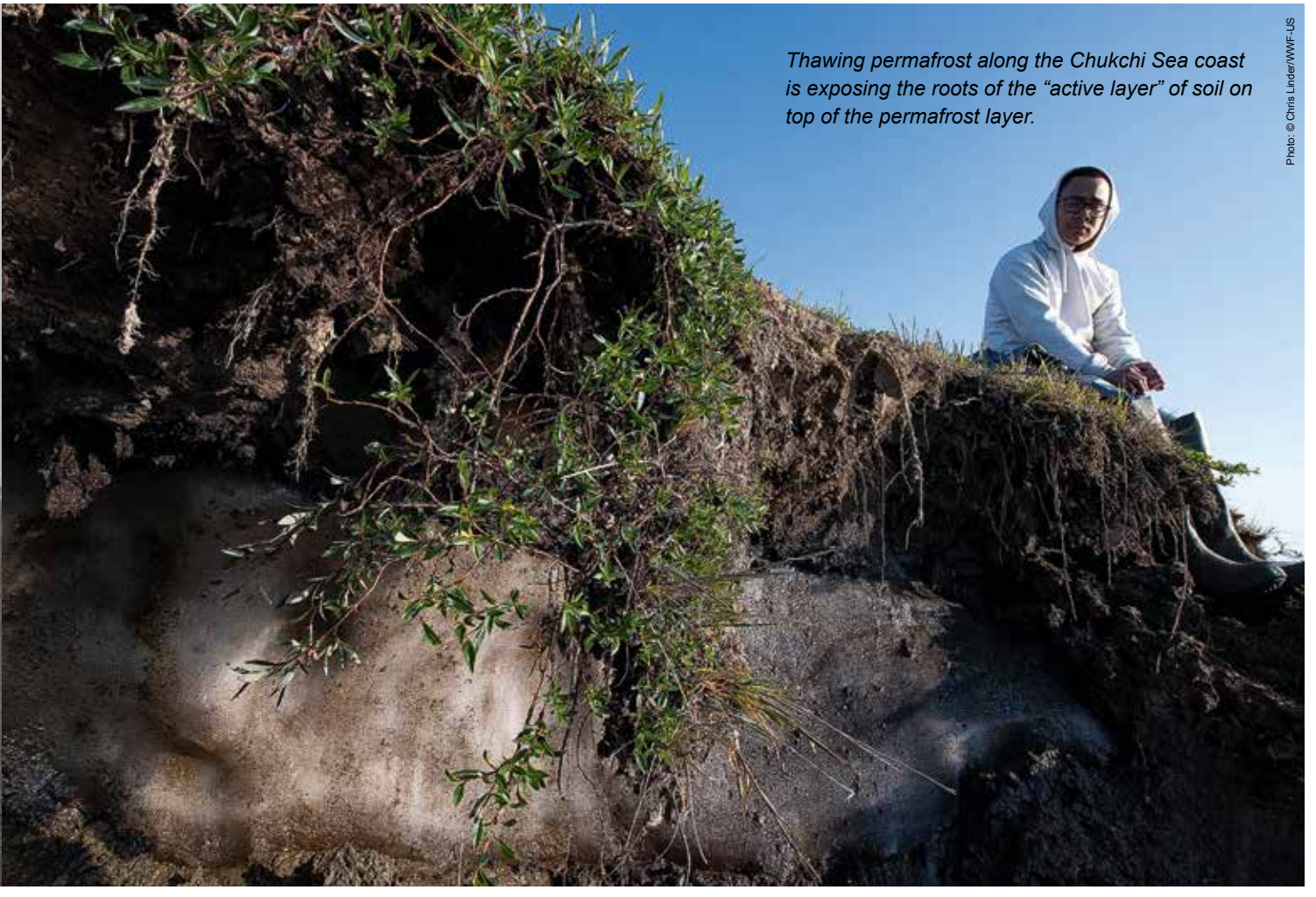
Building a seawall out of sandbags seemed like a good place to start, but it hasn't been enough to halt the shoreline erosion. A more permanent, effective structure would cost in the vicinity of US$380 million.

On top of that, Utqiaġvik is threatened by permafrost thaw. Much of its infrastructure is built on a foundation that is turning to mud, affecting homes, businesses and schools.

Some towns in similar predicaments have adapted by moving inland. But the cost to relocate all 4,400 or so Utqiaġvik residents would be in the hundreds of millions of dollars—and it might create as many problems as it solves. ➤

Photo: © Chris Linder/WWF-US

Thawed permafrost collects at the base of a snow ridge in Utqiaġvik. Permafrost is made of dirt, gravel and sand bound by ice, and turns to unstable mud as it thaws. Research indicates that it is thawing some 70 years earlier than expected.



Thawing permafrost along the Chukchi Sea coast is exposing the roots of the "active layer" of soil on top of the permafrost layer.

Photo: © Chris Linder/WWF-US

Utqiaġvik is a modern town in many ways, but the majority of its residents still rely on traditional activities, such as hunting and fishing, to feed their families.

Photo: © Chris Linder/WWF-US

A polar bear skin hangs to dry in the yard of a local hunter in Utqiaġvik. Many residents still count on activities like hunting and fishing to feed their families, but the melting sea ice is making these practices more challenging every year.

Photo: © Chris Linder/WWF-US

More than 60 per cent of the town's residents are Iñupiat Eskimo—and while Utqiaġvik is a modern town, many people still rely on traditional activities like hunting, fishing and whaling for their livelihoods. These activities depend to a large extent on the presence of sea ice. As well, the town is situated in a region that produces natural gas and oil—industries that rely on infrastructure that would be impossible to move.

In the past, Utqiaġvik's coastline was edged with ice almost year-round. But the ice-free periods are getting longer and longer, forcing some residents to alter not only how they hunt, but even how they conceptualise their relation- ➤

From atop a pile of sandbags, Eben Hopson gazes out across the Chukchi Sea. Hopson says climate change is affecting life in Utqiaġvik on a daily basis.

Generations of residents have responded successfully to sudden shifts in the past. However, the accelerating pace of change is starting to outstrip the community's ability to cope, causing many to wonder just how resilient they can be.

Photo: © Chris Linder/WWF-US

ships with the environment and animals.

"[T]he Inuit people are connected by the animals we respect, the animals we hunt, the animals we subsist off," says Eben Hopson, an Utqiaġvik resident and Alaska Geographic Arctic Youth Ambassador.

"By the land, our ancestors walked thousands of years before these westernised settlements were made that we now call home and our villages. By the ocean, we have paddled to get the biggest bowhead whale to the smallest sea bird."

Hopson says one of the most significant issues preying on his mind these days is climate change. To him, the term means "loss of culture, loss of the land and loss of the people that have called the Arctic home for the past thousands of years." ○

Puffins in Svalbard, Norway

Finding a way forward

In search of climate resilient pathways

For the two years leading up to the fall release of the Special Report on the Ocean and Cryosphere in a Changing Climate, GARY KOFINAS served as one of 104 lead authors, reviewing the state of knowledge on human responses to climate change in polar regions. As he explains, the report paints some frightening possible futures—but also offers room for hope if the world acts quickly enough.

THE KEY MESSAGE of the IPCC report is sobering: a 2°C increase in the global mean temperature is likely to cause significant melting of the Antarctic and Greenland ice sheets as well as the world's glaciers. As a result, rising sea levels may negatively impact almost 700 million people, or 10% of the world's population, requiring many to relocate. Ocean acidification is affecting marine shell species; ocean warming will harm many fish species; thawing permafrost will have an impact on Arctic vegetation, wildlife and human infrastructure; and Arctic residents, particularly Indigenous Peoples, will experience major disruptions to their livelihoods and health.

CAUSE FOR DESPAIR—AND CAUTIOUS OPTIMISM

The report notes that without action to mitigate the causes of climate change, the consequences for ecosystems and society will be dire. But if we act immediately, we may be able to limit these impacts through adaptive and transformative change.

My experience as a lead author has left me extremely frightened about the future of the Arctic and the Earth. However, the report offers signs of hope and recommendations for a way forward. A key take-home message is: While there is no way to know if—or to what extent—our global community will respond, there are steps we can take now to create climate resilient pathways.

Without action to mitigate the causes of climate change, the consequences for ecosystems and society will be dire. But if we act immediately, we may be able to limit these impacts through adaptive and transformative change.

Institutional change: Internationally, the Arctic Council and several key international agreements are among the most important tools for facilitating cooperation. At the national to local levels, some regions have established cross-scale institutions, such as co-management arrangements, where local communities have a voice and all stakeholders can plan ahead. But other regions have serious institutional deficiencies that require transformational change in governance. Regulations to address the risks of the increase in Arctic shipping are lacking. The rising costs of adaptation—for example, to relocate communities or maintain public infrastructure—will require major budget allocations. Finally—well before we find ourselves in crisis situations—we need to ensure that Arctic governance for all sectors is more responsive to climate changes and better supports adaptation.

Photo: Christopher Michel, CC, flickr.com

for the Arctic

Knowledge co-production: Climate change requires us to look to multiple sources of evidence and diverse disciplinary and cultural perspectives to better understand ecological systems, human systems and their interactions. Without a holistic approach, government policies are likely to result in unintended consequences. But the Arctic's rich cultural diversity and its people's close relationships with land and animals position it well to draw on multiple knowledge systems to observe, understand and respond to climate change. Community-based monitoring systems that include Indigenous knowledge are being developed in several areas, with promising results so far. Some researchers are building databases to track and understand abrupt and fundamental changes in social-ecological systems. Others are identifying and monitoring indicators that reflect human well-being and the adaptive capacity of communities.

Linking knowledge with policy-making: Connecting best available knowledge with policy is problematic in all regions. This means that addressing climate change requires a shift in research culture toward resolving real-world problems. Areas of the North are making progress using innovative practices like scenario analysis with high stakeholder participation, self-assessments of community resilience, climate adaptation planning, and structured decision-making (using computer simulation models and visualisation tools).

Resilience-based ecosystem stewardship: Rapid climate change will require us to rethink the goal of sustaining ecosystems in states of equilibrium. To that end, several resilience-oriented stewardship initiatives have been implemented in the Arctic, such as networks of marine protected areas. Adaptive management—a forward-looking process of monitoring and regularly evaluating past decisions—is now used for fisheries in some regions. As well, regulatory agencies increasingly recognise the importance of accounting for people's livelihoods when creating resource policy.

Reflecting on my own experience with this IPCC report, I am simultaneously hopeful that opportunities for resilience-building exist and petrified by the consequences of our not responding decisively.

These strategies are only a few of the many pathways we can follow to build resilience in an uncertain future. While they all show promise, they also need further development.

Reflecting on my own experience with this IPCC report, I am simultaneously hopeful that opportunities for resilience-building exist and petrified by the consequences of our not responding decisively. As a global society, we can only achieve climate resilient pathways by acting immediately. This will require each of us to step off the sidelines as bystanders and actively work to explore, formulate, test and implement solutions. Your engagement and participation are required. ○

GARY KOFINAS is Professor Emeritus of Resource Policy and Management at University of Alaska Fairbanks. His research has focused on the resilience and adaptation of northern communities to climate and land use change.

THE PICTURE

Signing of the Svalbard Treaty

Photos: From the archive of the Governor of Svalbard

Norwegian diplomat and negotiator Fritz Wedel Jarlsberg signing the Svalbard Treaty in Paris in 1920. The treaty was signed as part of the Versailles negotiations at the end of World War I. All signatory nations have equal access to Svalbard, and their citizens have the right to live and work there. The treaty also makes Norway responsible for preserving the natural environment of Svalbard.

The present Treaty will come into force, in so far as the stipulations of Article 8 are concerned, from the date of its ratification by all the signatory Powers, and in all other respects as to the same date as the mining regulations provided for in that Article.

Third Powers will be invited by the Government of the French Republic to adhere to the present Treaty duly ratified. This adhesion shall be effected by a communication addressed to the French Government, which will undertake to notify the other Contracting Parties.

In witness whereof the above-named Plenipotentiaries have signed the present Treaty.

Done at Paris, the ninth day of February, 1920, in duplicate, one copy to be transmitted to the Government of His Majesty the King of Norway, and one deposited in the archives of the French Republic; authenticated copies will be transmitted to the other Signatory Powers.