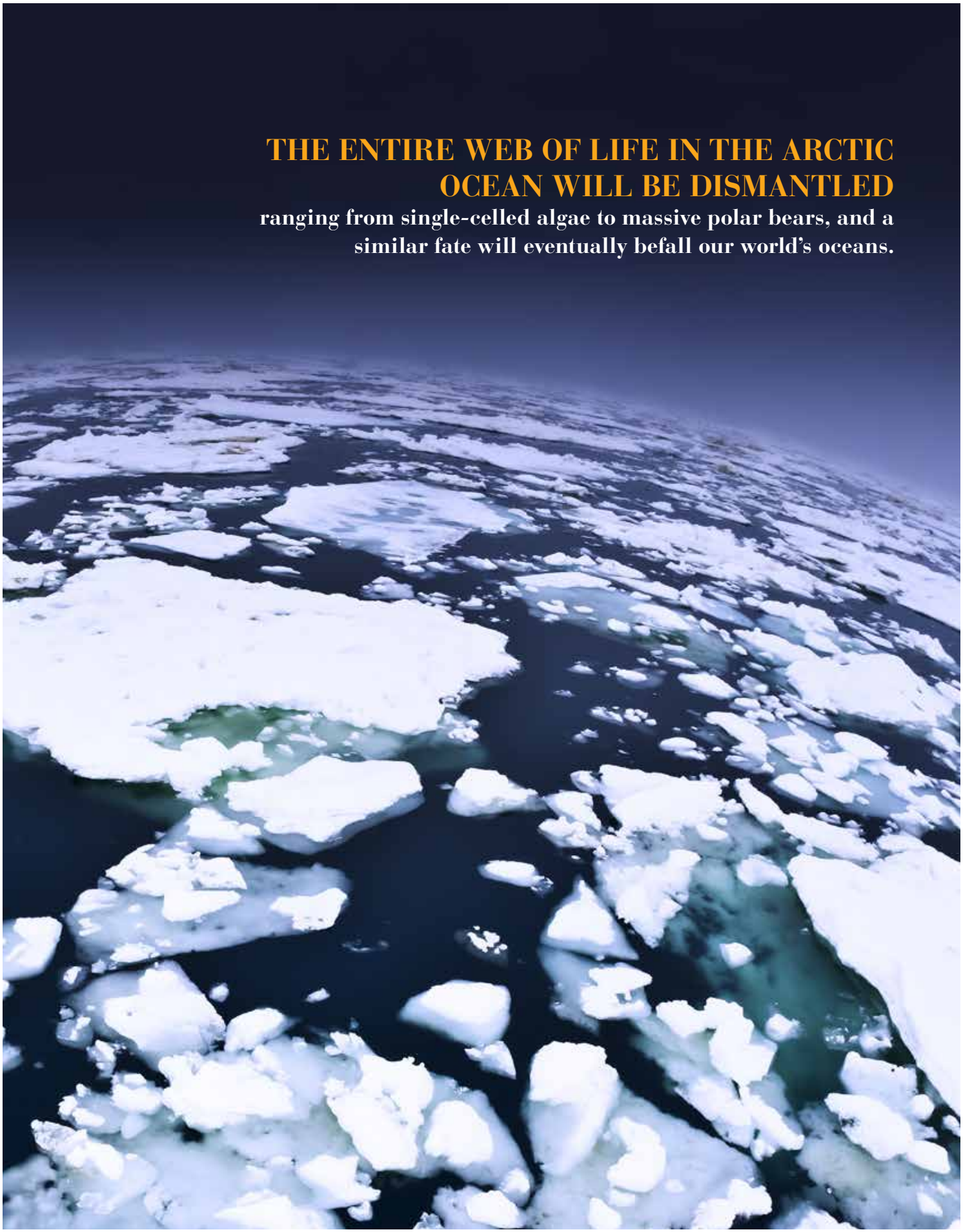
The BiG MELTDOWN

Essay by ***Alex Rose*** | *Photos by* ***Mark Goyen***



THE ENTIRE WEB OF LIFE IN THE ARCTIC OCEAN WILL BE DISMANTLED

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Arctic sea ice will melt, triggering an enormous rise in sea level, intensifying ocean acidification, and FUELLING SEVERE CYCLONES.

What do you think the future world of 2100 will be like? We all have different views of about how different our world will be almost 100 years from now, but advancements in the fields of science and technology, faster and more efficient ways of travel, a deeper understanding of space, and the prospect of longer lives tend to be pervasive ideas in most of our conceptualizations.

These hopeful speculations are encouraging and have the potential to be actualized several decades from now, but none of these can be known for sure. There is only one undeniable truth: that our planet will have undergone some drastic changes primarily brought about by exponential human population growth.

By the end of this century, anthropogenic climate change will have caused average global temperatures to rise between 1.5°C—3°C above 19th century pre-industrial temperatures. Arctic sea ice and part of the Greenland Ice Sheet will melt, triggering an enormous rise in sea level, intensifying ocean acidification, and fuelling severe arctic cyclones. The entire web of life in the Arctic Ocean (from single-cell algae to massive polar bears) will be dismantled, and a similar fate will eventually befall our world's oceans.

Every day that we recklessly burn fossil fuels in the name of progress is another lost opportunity to protect OUR PRECIOUS BLUE MARBLE

Polar bears are but one of the many arctic mammals completely reliant on sea ice for food, reproduction and raising their young.

SHRINKING SEA ICE IS A MAJOR PROBLEM FOR ARCTIC MAMMALS

as these animals are fundamentally reliant on sea ice for essential aspects of their lives - hunting, reproducing, and raising their young.

This prediction may sound overly pessimistic, but it is based on a solid foundation of research and data that points toward the ever-increasing release of greenhouse gases as the culprit. While we cannot reverse the damage already done, we still have the capacity to reduce and mitigate further impacts on our planet by curbing our release of harmful greenhouse gases through the burning of fossil fuels, deforestation, and unsustainable agricultural practices.

There are quite a few complex issues associated with our changing world, but the melting of arctic sea ice is of primary concern because of the particularly delicate nature of the Arctic ecosystem and how much more severely this area is affected due to the phenomenon of arctic amplification. My goal is to cover each of the major problems connected to the loss of Arctic sea ice in order to better illustrate what our future looks like if we do not start controlling our insatiable appetite for dirty energy. It is not too late to change the outcome of our environmental fate, but we are rapidly approaching the tipping point of a complete Arctic meltdown from which there is no return.

Arctic sea ice is melting so fast that scientists are having a difficult time keeping pace with its disappearance. We must understand the specific processes that are causing this rapid loss of sea ice so that we can better predict the environmental changes that will occur and the ramifications of these changes not just for the Arctic, but for the rest of our planet as well. What we do know without a doubt is that the massive floating ice sheet of the Arctic Ocean is being lost at an increasingly rapid pace as a result of anthropogenic climate change.

There is a natural expansion and contraction of Arctic sea ice due to seasonal changes, but with an ever warming climate, sea ice has been steadily declining in both surface extent and thickness on an annual basis. According to the National Snow and Ice Data Center (NSIDC), 2012 saw the smallest and thinnest ice cover ever reported in the Arctic Ocean, a mere 51% of the average sea ice extent and only 20% of the average volume from 1979. The disappearance of this much ice is particularly disturbing because of the prominent role Arctic sea ice has in regulating Earth's climate. Arctic sea ice is highly reflective so most of the solar energy that hits its surface is reflected back into space, preventing this energy from affecting our climate.

ARCTIC SEA ICE IS HIGHLY REFLECTIVE

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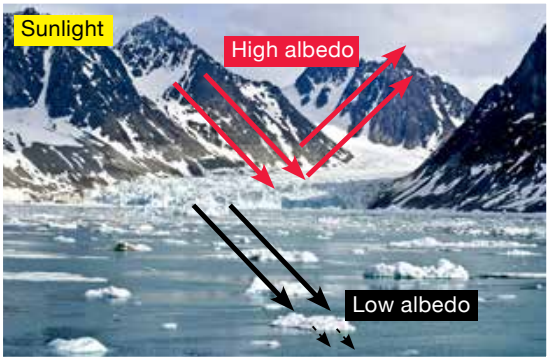


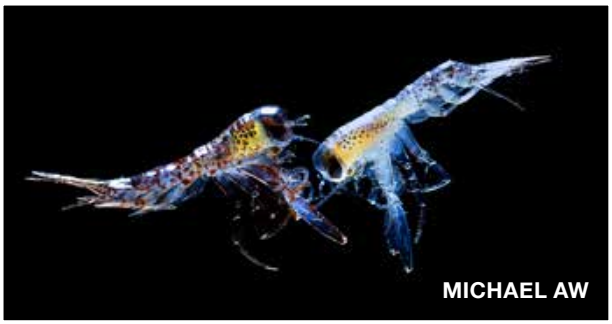
High and low albedo

High reflectivity, also referred to as high albedo, is an important characteristic of ice; conversely, dark ocean water is highly absorptive and has low albedo. As ice cover recedes and more dark water is exposed, less solar energy is reflected back into space and is instead absorbed, contributing to the further rise of ocean temperatures and subsequent loss of Arctic sea ice. This is known as the ice-albedo feedback mechanism and is a process known to contribute to the accelerated disappearance of this crucial sea ice.

We are also seeing vast reductions in the amount of multi-year ice – the incredibly thick ice that persists and builds on itself from one year to the next, as it is replaced by fragile first-year ice which forms in winter and melts in summer. The NSIDC reported in 2013 that multi-year ice used to cover 60% of the Arctic Ocean and now covers only 30%. Not only does first-year ice disintegrate more easily compared to multi-year ice, but it also reflects only about half as much solar radiation, meaning that it contributes less to global cooling because this energy is being absorbed/transferred as heat into the underlying ocean.

The ice-albedo feedback effect also helps to explain the Arctic amplification of climate change, a phenomenon where surface air temperatures in the Arctic are increasing two to three times faster than anywhere else on the planet. As temperatures in the Arctic increase with the loss of sea ice, snow cover on land decreases, exposing the dark ground with low albedo or low reflectivity so more solar energy is absorbed, warming the area even further. The most important factor regulating circumpolar temperature is the amount of Arctic sea ice present.

As Arctic sea ice gets thinner and scarcer, the multitude of creatures that depend upon its existence and stability for their well-being are facing increasing peril. The food web of the Arctic is delicate and comprised of multiple trophic levels, all of which are heavily impacted by sea ice loss. Primary producers make up the lowest trophic level and are the base of the food chain upon which all higher levels depend, and as such are a logical place to start exploring the complexities of the Arctic food web. Primary producers use photosynthesis to convert light into usable energy in the form of proteins, carbohydrates, and fats, and are then consumed by herbivorous zooplankton such as amphipods and copepods, which are in turn eaten by larger zooplankton, fish, seabirds, and even some marine mammals. The highest level of consumers at the top of the food chain includes animals such as whales, pinnipeds, polar bears, and humans.



ZOOPLANKTON: the foundation of the arctic food web

Over 1000 species of ice algae living in direct association with Arctic sea ice require its presence for survival. Ice algae, along with some species of sub-ice phytoplankton, are essential food sources for many other animals and their survival and proliferation are paramount to a healthy food web. Copepods, amphipods, and other lipid-rich herbivorous zooplankton are uniquely adapted to eat these primary producers and are poorly suited to life in open water. All of these co-dependent species will be adversely affected by the loss of sea ice.

Many species of animals including seabirds, whales, and arctic fishes will have trouble keeping themselves fed without a proliferation of these fatty crustaceans and will suffer as populations of ice-associated zooplankton diminish along with the sea ice. These creatures will all have to travel farther to find less food and will consequently work harder and expend more indispensable energy to feed themselves and their offspring, ultimately burning more calories than they can consume, leading to the demise of many Arctic species.

MORE THAN 1000 SPECIES OF ICE ALGAE

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Baby harp seal pup are on ice of the Russian Arctic – White Sea.

VLADIMIR MELNIK

It is projected that we will

LOSE TWO-THIRDS OF THE WORLD'S POLAR BEARS BY 2050.

IT IS NOT TOO LATE TO REIMAGINE OUR FUTURE,

but our window of opportunity to incite these critical changes is closing rapidly.

Numerous fish populations will head north as the ice shrinks in order to find food and appropriate shelter. Unfortunately, these needs will be increasingly difficult to meet as they travel away from the shallower and more biologically productive regions associated with the continental shelf. Some temperate fish species will expand their ranges into warming Arctic waters where they will compete with native Arctic species for food and spawning habitat, further stressing these already threatened populations of Arctic fish.

Shrinking sea ice is a major problem for Arctic marine mammals not just because their sources of food will diminish, but because these animals are fundamentally reliant on sea ice for many essential aspects of their lives including hunting, reproducing, and raising their young. The best known mammal suffering from the loss of A rctic sea ice is the polar bear. Their primary prey items are ice-dependent seals and with the ice thinning and being absent for more of the year, the polar bears' hunting season has been cut short. This results in thinner bears, declining reproductive rates, and climbing cub mortality rates. It is projected that we will lose two-thirds of the world's polar bears by 2050.

Bowhead whales, belugas and narwhals will face problems including, but not limited to, food shortages due to ice loss, entrapment in shifting ice and increased predation by orcas expanding their hunting range into the warming Arctic waters. Arctic pinnipeds, the seals and walruses, are already suffering from the troubling effects of habitat loss. Stable sea ice is a crucial component of successful reproduction and pup survival in all Arctic seal species. The ice must be solid enough for mothers to haul out on and nurse their young, and for some species such as the ringed seal (*Pusa hispida*), sufficient snow cover is equally important. Some species build a birth lair by digging a cave into the snow cover on top of the sea ice for thermal insulation and pup protection, and without a proper lair, seal pups will likely die of hypothermia.

WALRUSES ALSO NEED A RELIABLE SEA ICE HABITAT

where they can birth and nurse their calves.

Walruses also need a reliable sea ice habitat where they can birth and nurse their calves, as well as moult. Walruses are bottom feeders and can spend up to 17 hours at a time, scouring the seafloor of the continental shelf for invertebrates such as clams, crabs and shrimp and then haul out onto the ice for a day or two to rest. With shrinking or non-existent sea ice, walruses have to travel much farther and expend more energy to feed and are also experiencing severe over-crowding because of the limited space now available to rest on land, resulting in increased aggression and higher pup mortality.

The fragile Arctic food web is intrinsically tied to fluctuations in sea ice extent and volume and is consequently extremely vulnerable to collapse because of warming Arctic temperatures caused by anthropogenic climate change. Indigenous humans are at the very top of this food web and are at risk of having to abandon their cultural identities and dissolve their local communities as subsistence living becomes unsustainable because wildlife populations are increasingly impacted by the disappearance of sea ice.

The melting of Arctic sea ice has other ramifications that must also be taken into account. The Arctic Ocean is particularly vulnerable to acidification – the process by which carbon dioxide is absorbed by the ocean and combines with water to form carbonic acid. The ability of the ocean to function as a carbon sink is a desirable trait at first glance, but the constant uptake of excess carbon dioxide has caused ocean surface waters to become 30% more acidic since the start of the Industrial Revolution.

As Arctic sea ice gets thinner and scarcer, the multitude of creatures that depend upon its existence and stability for their wellbeing

ARE FACING INCREASING PERIL.

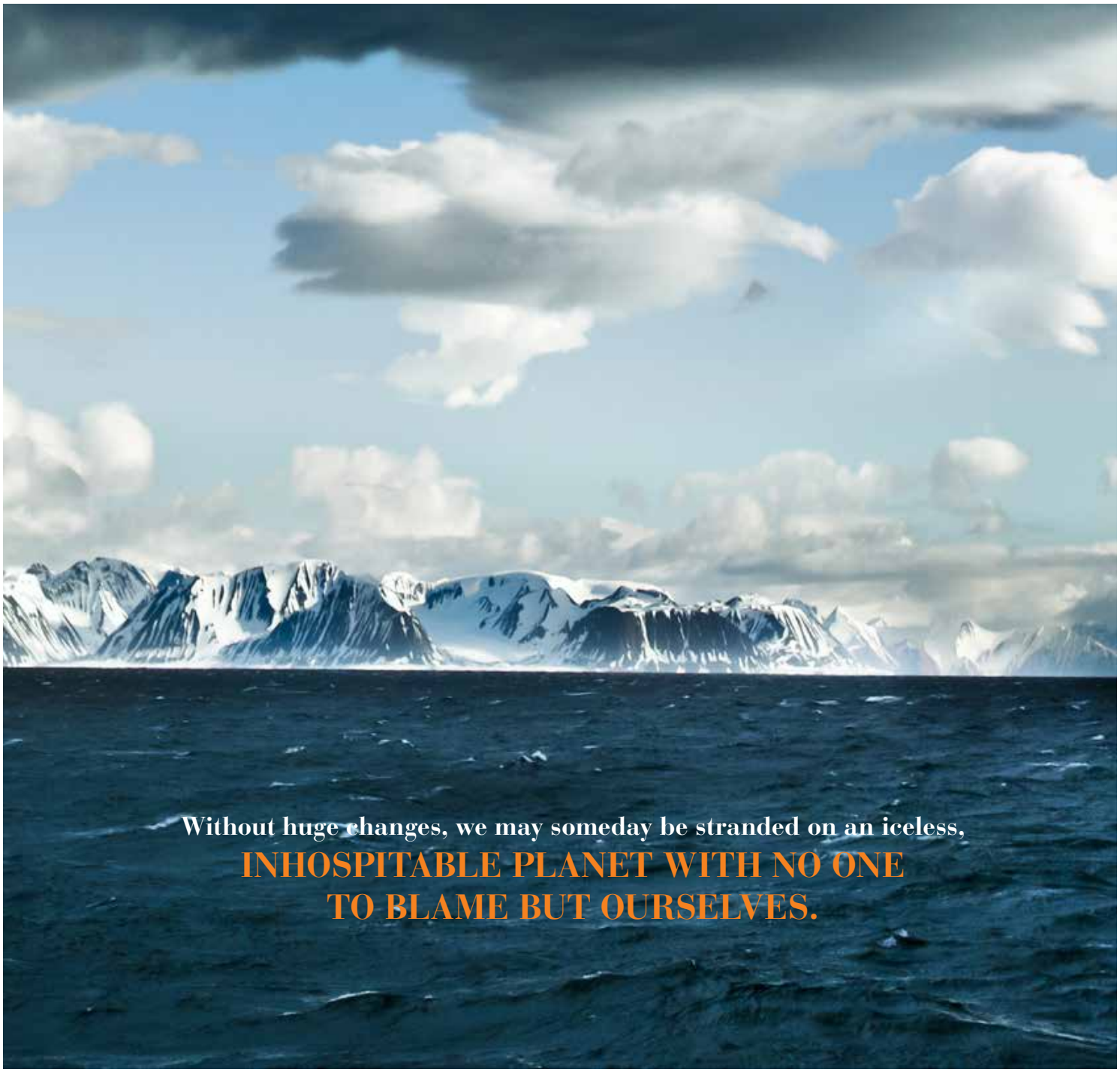
The Arctic Ocean is being more rapidly acidified for several reasons. First, low temperatures accelerate acidification. Secondly, lower salinity water is less effective at neutralizing acid formation. Lastly, increased surface area of exposed ocean water from sea ice loss allows more carbon dioxide to be absorbed and further drives acid formation. An acidic ocean will prevent calcifying organisms from forming properly and will cause harmful sensory and behavioural impairments in a variety of marine species.

Changing weather patterns are also the result of Arctic sea ice recession. As temperatures go up in the Arctic, the air becomes capable of holding more moisture, factors that are known to strongly contribute to storm development. Arctic cyclones are predicted to increase in frequency and severity as this warming trend continues, threatening communities, ecosystems and infrastructure, in addition to further degrading what sea ice is left. The loss of sea ice influences weather in North America, Europe, and Eurasia as well. The changing climate of the Far North is a crucial factor in shaping the speed and route of the jet stream, the exact forces that drove the superstorm Hurricane Sandy to pummel the East coast of the United States last year.

The Greenland Ice Sheet (GIS) is also seeing unprecedented losses along with Arctic sea ice. 80% of Greenland is covered by this massive body of ice, which contains a total of about 2.85 million cubic kilometers of ice. The average annual ice loss from the GIS increased by 600%, from 34 gigatonnes to 215 gigatonnes, from 2002 through 2011 and these losses are already having a measurable impact on sea level rise. The altered jet stream patterns caused by a warming Arctic have major implications in melting the Greenland Ice Sheet. If the GIS were to completely melt, sea level would rise by 20 meters; by the end of this century alone it can be expected to cause a 1.5-meter rise in sea level.

THE ARCTIC WOLF (*Canis lupus arctos*)

Thawing permafrost, or permanently frozen ground, is another major predicament. Permafrost can reach depths of over 700 meters in some areas, and when it thaws the ice in the soil melts and the ground collapses. This can result in immense infrastructure damage and more importantly, can release vast amounts of sequestered carbon in the forms of carbon dioxide and methane into the atmosphere, further contributing to the warming of the Arctic, a process called Arctic "greening". This "greening" can transform terrestrial ecosystems and cause species decline and even extinction. Near-surface permafrost soils are estimated to contain about 1700 gigatonnes of carbon, which is twice the amount currently in our atmosphere; 81% of this frozen ground is likely to be thawed by the year 2100 releasing 300 gigatonnes of carbon pollution into an atmosphere already saturated with greenhouse gases.



An Arctic Ocean that is ice-free during the summer months is a likely reality within the next few decades. Vanishing sea ice is just the beginning of an imminent climate crisis and is an indication that we need to act now in order to prevent further irreparable damage to our planet. Every day that we recklessly burn fossil fuels in the name of progress, is another lost opportunity to protect our precious blue marble. Each new coal-fired power plant represents another unique species lost to the immeasurable greed of humans. Without huge changes, we may someday be stranded on an iceless, inhospitable planet with no one to blame but ourselves. ○

Ocean Geographic has commenced planning a major expedition to the Arctic in 2015. The ***Elysium Artists for the Arctic*** expedition is about documenting the splendour of the region to reveal what we will lose with a warming global climate. The chief scientist; the visionary scientist for this expedition of the century shall be Dr Sylvie Earle. If you are keen to participate, see **www.ogsociety.org/expeditions**