The end of the Arctic as we know it

Less oxygen and ice, more acid and heat. Jonathan Watts joins an expedition studying what this means for the planet

Fri 7 Jun 2019 15.00 BST
Last modified on Fri 7 Jun 2019 18.17 BST

Stunning drone footage captures scale of Arctic ice melting - video

The demise of an entire ocean is almost too enormous to grasp, but as the expedition sails deeper into the Arctic, the colossal processes of breakdown are increasingly evident.

The first fragment of ice appears off the starboard bow a few miles before the 79th parallel in the Fram strait, which lies between Greenland and the Norwegian archipelago of Svalbard. The solitary floe is soon followed by another, then another, then clusters, then swarms, then entire fields of white crazy paving that stretch to the horizon.

From deck level it is a stunning sight. But from high above, drones and helicopters capture the bigger, more alarming picture: a slow-motion blast pattern of frozen shrapnel radiating from the high Arctic southwards through this strait, which is the interchange of 80% of the water between the ice cap and the world's oceans.

This is where ice floes come to die, and the cemetery is filling faster each year, according to the leader of this scientific expedition, Till Wagner, of the University of North Carolina Wilmington (UNCW). One of the objectives of the expedition is to investigate why the collapse of Arctic ice is happening faster than climate computer models predict and to understand what this augurs for the rest of the planet.

The melt is not simply a seasonal process. The natural thaw that starts with spring's warm weather is being amplified by manmade global heating. The Arctic has heated up by 2C above pre-industrial levels, twice the global average. Some hotspots, including parts of the Fram strait, have warmed by 4C. There are variations from year to year, but the trend is clear and accelerating. Sea ice is melting earlier in the spring and freezing later in the autumn. Each summer it thins more and recedes further, leaving greater expanses of the ocean exposed to 24-hour sunlight. This is driving back the frontiers of ice and fragmenting one of the planet's most important climate regulators. It is also creating a series of feedbacks that are accelerating the Arctic melt. Several are only partially understood.

Greenpeace's MV Arctic Sunrise anchored next to Dahlbreen glacier in Svalbard. Photograph: Denis Sinyakov/Greenpeace

The team and crew set out on the Greenpeace ships Arctic Sunrise and Esperanza from Svalbard's port at Longyearbyen in May, less than a month after the sea ice reached yet another record low. At the start of the melt season, this is a fast-changing body of water. The Greenpeace crew say high winds and strong currents have pushed the ice front southwards by 50 miles in the last four days. The floes appear on the radar screen as a thickening swarm of yellow flies. When the bands of ice cannot be evaded, they are nosed aside by the prow, scraping the hull as we pass. Occasionally, they are smashed through with a clanging jolt.

The combinations of shade and shape are endlessly varied: here an opal gorge, there an emerald grotto, some floes so perfectly rectangular they could have been cut with a guillotine, others as jagged as a Cornish coastline. Many surfaces are topped with snowy peaks or crenellations; others look as flat as a tennis court. Depending on the sea motion when it was formed, the ice can be frazilled into loose white ice crystals, pancaked into bluish layers, or dense, hard nilas so transparent that they appear to be black.

But all the floes have one thing in common: they are steadily diminishing as they head south. On the surface you can see the outliers, tiny translucent chunks that are destined to shrink to the size of an ice cube before they finally melt into the Atlantic.

Floating ice floes along one edge of Fram Strait. Photograph: Denis Sinyakov/Greenpeace

Since the start of the satellite era in 1979, the summer Arctic has lost 40% of its extent and up to 70% of its volume, says Wagner. Other scientists calculate the rate of decline at 10,000 tonnes a second. Much of the multiyear ice is now gone. Most of what is left is the younger, thinner layer from the previous winter, which is easier for the sun to melt and the wind to push around. Wagner expects ice-free summers in 20 to 40 years, which would allow ships to cruise all the way to the north pole.

Ice-free summers are 10 times more likely if the world warms by 2C rather than 1.5C, according to the United Nations Intergovernmental Panel on Climate Change. The body of top international scientists said last year that the Arctic and coral reef systems were the ecosystems at greatest risk.

The Fram strait is one of the few places in the Arctic where the ice extent has not declined, but that is probably not good news. One of the theories being tested on this trip is whether this is because more ice is being flushed through this channel. The pace of change is mindblowing, Wagner says. “What we are looking at is whether this exit is accelerating.”

The team is also examining other processes to help gauge the health of the ocean and how it is changing. To get a baseline, they conduct tests at intervals along the 79th parallel. First, they identify a suitably sized floe, then an armed polar bear guard ensures there are no predators and checks the solidity of the ice. After the all-clear, a dozen or so scientists and volunteers pull up on motor dinghies to drill, measure, take water samples and extract cores. Every five metres a square trench is shovelled out of the surface snow down to the hard surface of the ice below. All the while, the floe drifts with the current and bobs gently in the swell. On the ship, crew members test the water at different depths for acidity, temperature, turbidity, dissolved oxygen and acidification.

Dr Till Wagner (right) drills an ice floe in the Fram Strait. Photograph: Denis Sinyakov/Greenpeace

In the past, the data would have been related only to physics and chemistry, but there is a growing awareness of the crucial climate role played by marine organisms, so biologists are also part of this interdisciplinary team. They scan the horizon for whales, seals and walruses and use tightly meshed zooplankton nets to capture teeming masses of minute shrimp- and wormlike creatures.

Far more than polar bears, these tiny creatures and the algae on which they graze play an essential role in not just the local ecosystem, but the global climate and food chain,

according to a growing body of research. The largest synchronised movement of biomass on the planet is the vertical migration of zooplankton, which happens daily as the tiny creatures move from the depths to surface feeding waters. The area under the ice floes is such a rich source of nutrients that it has been described as an all-you-can-eat buffet for zooplankton.

Researchers are discovering that the floes are home to an extraordinary variety and abundance of life, even during the four-month darkness of Arctic winter. Depending on how the ice is formed, it can be permeable and elastic, with space inside that can be colonised by bacteria, fungal spores and the tiny creatures that feed on them such as the transparent jellyfish *Sympagohydra tuuli*, which squeezes inside the cracks in the ice to hunt for food. The green and yellow shades at the base of floes indicate the presence of phytoplankton – algae that use sunlight to convert carbon dioxide and water into oxygen and energy. These are the pastures on which the zooplankton graze. Most important among them are copepods, a fat-filled staple in the diet of whales and fish.

A microscope image of zooplankton collected in the Fram Strait. Photograph: Denis Sinyakov/Greenpeace

Together, millions of these species form an oceanic pump, says Mattias Cape, a biological oceanographer with the University of Washington. Phytoplankton help the oceans produce more oxygen than all the world's forests. They also sequester carbon dioxide more effectively because copepods and the bigger creatures that eat them take the gas down to the depths, where it can be stored for hundreds of years. Nowhere is this pump more effective than near the poles – the zooplankton here are bigger, so they sink deeper.

But this is changing. When Cape observes the zooplankton through a microscope in the hold of the ship, he can see that the chubby Arctic copepods have competition from their slimmer and shorter Atlantic counterparts. This invasion has been recorded in other parts of the ocean. "We see a shift from big to small, which is a concern, because it will make this pump action weaker," he says. The study may help to explain why the Arctic is losing oxygen faster than almost anywhere on Earth. Another factor is that cold water absorbs more carbon dioxide, which gives it high levels of acidity. "We talk about the ocean being hot, sour and out of breath," Cape says.

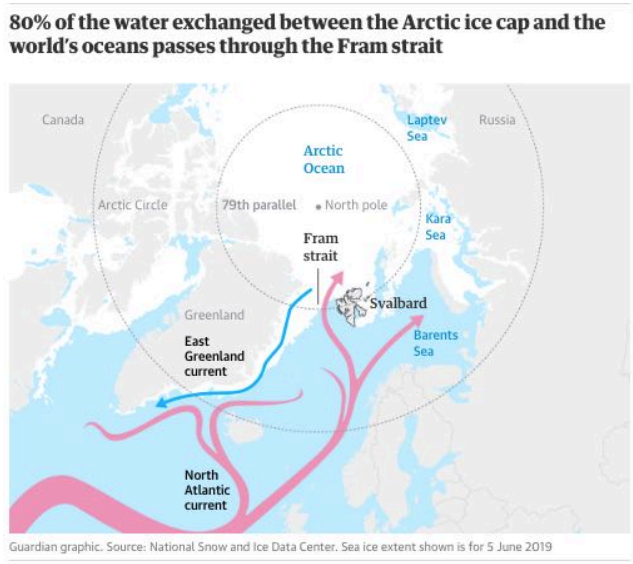
If the Arctic were a patient, doctors would be alarmed by its vital signs. As well as hot flushes, asthma and contamination (the researchers are following up on studies that suggest the Fram strait has one of the highest levels of microplastics in the world), the ocean has also been diagnosed with a weakening of its immune system. For centuries, the Arctic's distinctive character has been shaped by a layer of cold, relatively fresh water just below the surface, produced by melting ice and glaciers. This has insulated the sea ice from the warmer, denser, saltier waters of the Atlantic currents that flow in the depth. But this stratification is collapsing as temperatures rise.

The Arctic is losing oxygen faster than almost anywhere on Earth. Photograph: Denis Sinyakov/Greenpeace

The oceanic shift was outlined in a landmark study published last year in Science, which found that the water density and temperature of the Fram strait and Barents Sea were increasingly like those of the Atlantic, while further east, Russia's Laptev sea was starting to resemble what the Barents used to be. "The polar front is shifting," the lead author, Dr Sigrid Lind, of the Institute of Marine Science and the University of Bergen, told the Guardian this year. "The Arctic as we know it is about to become history. It will go when stratification breaks down completely and the Atlantic takes over the whole region."

This has not happened for more than 12,000 years, but the shift is well under way. First to succumb, according to Lind, will be the Barents Sea, which will have no fresh water by 2040, then the Kara sea. The consequences will be far-reaching. The food chain is already affected. Atlantic species of cod, herring and mackerel are moving

northwards. For the next 20 to 30 years this could boost fishing catches, but forecasts by Norway suggest boom will turn to bust later as the waters grow too warm for fish larvae.



There are signs elsewhere in the Arctic that the arrival of smaller Atlantic copepods may be associated with a decline in the whale populations that rely on them. This is not yet certain. It may be possible for whales simply to eat more. But Heather Koopman, a marine physiological ecologist at UNCW, says she is concerned that the speed of change is outstripping some species' ability to evolve.

"The bowhead whale, for example, can live for 200 years, so some are having to adapt to a modern climate with faculties developed in the Georgian age," Koopman says. "Things are moving far too rapidly for them to keep up. Perhaps small invertebrates can cope with year to year because their breeding cycles come round more quickly. But for a 200-year-old whale, how can they change that fast? Things are so accelerated."

The Dahlbreen glacier at nighttime. Photograph: Denis Sinyakov/Greenpeace

For humanity, the biggest impact is on the weather. The area between the cold pole and the warm equator is a ramp that propels weather fronts across continents. Its incline has always varied from season to season as the icecap expands in winter and shrinks in summer, providing a global pulse that pumps sea and air currents around the world. But that frozen heartbeat is warming and weakening as the Arctic becomes more like the Atlantic. Lind speculates that ocean destratification is the key driver for ice loss, which in turn affects the jet stream, weakens the polar vortex and can lead to heatwaves in the southern US and cold weather extremes in Asia. "The rules of the game are changing. We seem to be seeing large-scale weather pattern changes connected to the shrinking Arctic. As the Arctic becomes history, we need to understand how it affects the globe."

Such concerns are part of the motive for a new wave of international research. From September a German research vessel, Polar Stern, will drift across the north pole and be frozen into the ice over the winter so that 600 scientists can conduct tests billed as the biggest ever study of the Arctic. Norway has just launched a new icebreaker, the Nansen Legacy, which will embark on a series of trips over the next six years in conjunction with Birmingham University to examine ocean acidification and food chain contamination. "This area has been ice-covered and will change once the trawlers move in," says Marit Reigstad, of the Arctic University of Norway. "We need to know more before we do anything. We need to develop new laws and regulations for the area."

Greenpeace is calling for the central Arctic to be declared a protected marine area. On World Oceans Day on Saturday, campaigners will rally outside parliaments in several countries to demand a new global treaty to end the overexploitation of the high seas.

Arctic Sunrise anchored next to the Dahlbreen glacier. Photograph: Denis Sinyakov/Greenpeace

The US, China, Russia, Canada and Korea are more focused on the commercial and strategic opportunities that are emerging as the Arctic melts and opens. Fishing, mining, tourism and cargo shipping could profit, but any gains will be far outweighed by the costs of a diminished Arctic. A recent study found melting permafrost alone would cause $70tn of damage, 10 times the expected revenue from resource extraction and new trade routes.

Adding further to that enormous, existential reckoning could be other feedback loops that are now being investigated. Among them is the possible loss of the Arctic's soothing influence on the northern seas. Bands of ice buffer the waves. Inside the floes, the ship's passage is far smoother. Wagner speculates that when this calming barrier melts away, the swells will churn the ocean and bring warm water to the surface, which could further accelerate the fragmentation of the polar cap. It is yet another potentially grim area of study, but he views it – like other signs of the Arctic's demise – with professional composure.

"Emotionally, I detach myself," he says. "The Arctic is an object of study. It's like a doctor observing a patient to see how sick they are." He is reluctant to offer a prognosis without a longer-term study, but he says the physics make a recovery extremely unlikely.

"I have to hurry up or my science will become archaeology," the 34-year-old jokes. "There will still be sea ice during the winter, but in the summer it will probably disappear. It won't be the death of the Arctic, but will be the end of the Arctic as we know it."

Walruses on sea ice near the Arctic Sunrise. Photograph: Denis Sinyakov/Greenpeace

Arctic melt: Threat beneath the ice

We know the Arctic is experiencing a vast melting of sea ice. But deep in the ocean, something is happening that scientists are still trying to fully understand

By **Arwa Damon**; video and photos, Brice Laine, CNN

Updated 1750 GMT (0150 HKT) June 8, 2019

Fram Strait, Arctic Circle (CNN) It's spring in the Arctic, and nature in the far north is just waking up, warmed by 24 daily hours of sunlight.

Here, in the waters of the Fram Strait, between Svaalbard and Greenland, is where ice comes to die.

Map: Natural Earth via Getty Images
Graphic: Gabrielle Smith, CNN

The Arctic is heating up twice as fast as the global average, causing massive melting of sea ice. But while we know climate change is warming the Arctic air, there is a lot more happening under the ice that we don't fully understand.

A team of interdisciplinary scientists is here on a study facilitated by Greenpeace, at the start of the environmental group's nearly year-long pole-to-pole expedition. The scientists want to learn more about this threat beneath the ice, which could potentially destroy the cycle of life that starts here, and threaten the lives of people all over the planet.

The Fram Strait is the main gateway through which sea ice leaves the Arctic Ocean.

A mosaic of fractured ice

The inflatable boats carrying the scientists maneuver slowly through a sea of fractured ice, a mosaic of pieces that once were part of the Arctic ice sheet, pushed south by winds and currents into the Fram Strait.
Here, the scientists spend days working on top of the precarious ice floes, keeping a watchful eye out for polar bears while drilling into the ice to measure its thickness.

"It has definitely thinned in this area, it has thinned everywhere" says team leader, polar physicist Till Wagner, of the University of North Carolina Wilmington.

Since 1990 the thickness of sea ice here has decreased by a third, from about 3 meters to 2 meters, according to the Fram Strait Arctic Observatory.

The Fram Strait is where warm waters originating in Mexico are brought up by the Gulf Stream, flowing thousands of miles through the Atlantic to meet the Arctic ice edge. 80% of the ice movement in and out of the Arctic Ocean happens through here.

Polar physicist Till Wagner.

"For the longest time the story of sea ice loss has been one of the higher air temperatures melting the ice from above," Wagner explains.
But that story may be changing.

"This warm water is at the surface as it comes up [from the south] and then it drops under the ice as it goes into the Arctic Ocean," says Wagner. "The layer that is under the ice has been coming up closer to the surface and melting the ice from underneath."
The researchers are trying to better understand exactly why this is happening.

A forest of microscopic life

What the sea ice melt does to the ecosystem, and to us, is at the heart of this study.

Measuring the thickness and density of a recently extracted ice core.
The scientists extract ice cores from the floes, which hold clues that are invisible to the naked eye.

"Oh wow, that's beautiful," exclaims biological oceanographer Mattias Cape, examining a meter-long cylinder of ice. "Inside this piece of ice is this microscopic forest; all these little bubbles, these little channels are home for these microscopic organisms."

Greenpeace's Arctic Sunrise has been converted into a floating lab and on board, ice core samples are distilled and examined. Under the microscope the frozen clues within come to life -- a kaleidoscope of sea ice algae and phytoplankton, microscopic organisms that use sunlight for energy.

Cape explains that these organisms play a vital role in reducing climate change by pulling planet-warming carbon dioxide from the atmosphere and storing it as a long-term "carbon sink."
"They photosynthesize and take in CO2 and expel oxygen as part of the process -- which is the oxygen we breathe," he says.
They will be further tested later on land, helping us understand how sea ice loss is potentially impacting their ability to take in and sequester CO2.

Web of life

These waters might look barren, but they are hugely productive when it comes to the building blocks of ocean life.
Read: Arctic permafrost is melting so fast it's damaging scientists' equipment
The underbelly of the ice teems with zooplankton -- tiny crustaceans that feed on the phytoplankton. In turn krill and smaller fish feed on the zooplankton, big fish feed on the smaller fish and so it goes on up a food chain that includes whales, seals, sea birds, and even polar bears.
As the sea ice melts, ice algae and phytoplankton are released into the sea. In the short term, this creates something of a nutrient injection that jump starts the cycle of life in the ocean.

But this April saw a record loss of sea ice across the Arctic. Less ice ultimately puts that entire cycle at risk, with a smaller nutrient injection meaning less food further up the chain.

The team's study confirmed their expectation.

Biological oceanographer Mattias Cape.

"In the top layer [of the ocean] you see there is a ton of biomass between 10 meters and 30 meters" Wagner says.

"And then right below there is this warm water, that is almost 3.5 degrees and this is the warm Atlantic water" Cape adds.

In this warmer water, away from the ice, they found significantly less phytoplankton.

Freshly melted ice not only injects life into the water -- it creates a layer of cold water that protects sea ice above from more melting.

"It isolates the ice from the hot devil water sitting at the bottom waiting to come up" Wagner explains.

Less sea ice means there will be less of that protective cold layer, leading to even more melting.

Protecting our oceans

Greenpeace is traveling from the Arctic to the Antarctic to highlight the threats facing our oceans and part of its campaign for ocean sanctuaries.

With climate change and melting ice putting more pressure on Arctic sea life, the group wants more of our oceans to be set aside as protected reserves, free from commercial exploitation.

Negotiations towards a Global Ocean Treaty at the UN are under way and Greenpeace is part of a broader coalition that is campaigning for legislation that would see 30% of our oceans protected by 2030.

"We can put a deal in place that the status quo goes on or we can put a deal in place that has teeth, that will allow us to designate areas in the high seas for fully protected marine reserves," says Sune Scheller, Greenpeace's expedition leader. "And the risk of not doing that is pushing the marine ecosystem over the edge. In the end it's the political will that needs to be there."

But it may prove to be challenging, with some powerhouse nations, including Russia and the US, looking at short term economic gains at the expense of the planet's future.

The US has not signed on to the Law of the Sea treaty, the UN guidelines on how countries use our oceans, and Secretary of State Mike Pompeo recently hailed the economic opportunities presented by shrinking levels of sea ice opening up shipping lanes and a wealth of natural resources.

"It's tragic to hear something like that and I think this is an extreme case of cherry picking because obviously you can find small individual good things about climate change but in the broad perspective the negative downside of this to us as humans, the environment, the ocean, will outweigh the small potential benefits substantially," says Scheller.

Traces of a polar bear kill.

As the ship heads further south, we come across red streaks of blood across the ice, the bloody aftermath of a polar bear kill.

The absence of sea ice doesn't just threaten the top of the food chain, or the beluga whales we watch gently dipping along the ice edge, their deep breaths echoing across the silence of this remote region. Sea ice loss will impact us all, in ways that science is racing to understand.