



A polar bear is shown in profile, walking across a thin, translucent layer of ice. The bear's fur is white and appears slightly matted. The ice is a pale blue color, and the background shows a vast, open expanse of water and more ice under a cloudy sky. The overall tone is somber and evocative of a changing environment.

ICE BEAR *in* TROUBLE

Essay and Photographs by
JENNY E. ROSS

Pummelled by relentless wind and rain, the Chukchi Sea was churning with huge waves. After exploring Wrangel Island in the Russian High Arctic, I was in my cabin on the Heritage Expeditions ship, Professor Khromov, as we headed south toward the Siberian mainland. Suddenly, the voice of an excited Russian crew member blared on the ship's intercom, "Polar bear! Swimming! Near ship! Port side!" I grabbed my camera and ran out on to the deck. Scanning the sea, I searched for a furry white head among the waves; I found nothing.

As the ship continued to plough through the turbulent ocean, I pondered the situation. We were hundreds of kilometres south of the nearest arctic sea ice, which had melted and receded far north towards the central polar basin. It was August 12, about one month before the sea ice would reach its annual minimum extent after the summer melt, but a vast expanse of open ocean already separated Wrangel Island from the pack ice. Historically, sea ice remained near Wrangel for most of the year. But climate warming has recently caused the ice to shrink dramatically, and now it's absent in prime polar bear habitat throughout the Chukchi Sea for several months from mid-summer through late fall. Polar bears need sea ice for all essential aspects of their lives; so why was this bear swimming here?

Polar bears travel mostly on sea ice as they traverse their frozen habitat hunting for seals - their primary prey. They are excellent swimmers with impressive endurance and they readily paddle in frigid waters. Nonetheless, they cannot swim

receded hundreds of kilometres to the north. The scientists surmised that two-dozen other bears, seen swimming before the storm, also probably perished. In 2008, researchers documented an astonishing 9-day non-stop swim of 687 kilometres by a radio-collared bear who departed from Alaska's coast and headed north across open ocean to reach the shrinking sea ice. She survived the journey but lost 22% of her body weight and her yearling cub.

While I considered these issues, a small animate form took shape in the violent swells beyond the bow. I could hardly believe what I saw: another polar bear swimming in the open ocean. Leaning precariously over the railing with my camera, I pressed the shutter as the animal crested a wave rolling toward the ship. A moment later, the bear was alongside the vessel; then she quickly receded behind us as we continued southward. I was preoccupied with questions: Where did she come from? Where was she headed? Would she survive a very long swim, or would she succumb to fatigue and drown before reaching her destination?

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POLAR BEARS WILL VANISH

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indefinitely and will encounter difficulties in stormy seas. Swimming from floe-to-floe in areas of broken ice is easy for them, but attempting to swim very far in rough waters can be disastrous. In 2004, researchers saw four drowned polar bears floating in Alaska's Beaufort Sea following a storm. Those bears died while attempting to find sea ice, which had

WHILE TRAVELING ON MELTING SUMMER SEA ICE this polar bear carefully pressed his paws on a stretch of ice to determine if it would hold his weight. He decided it would. As he attempted to cross, he fell through it. Polar bears prefer areas of ocean where there is substantial ice cover. When sea ice is widely scattered or very thin, the bears expend excessive energy dealing with the challenges of trying to move from one location to another as they hunt for seals.

(front page)

A polar bear is seen swimming in the middle of a stormy sea. The water is dark and turbulent, with white foam from the waves. The bear's head and ears are visible above the surface, looking directly at the camera. The overall scene is one of a wild, dangerous environment.

**DURING A STORM IN
RUSSIA'S CHUKCHI SEA,
an adult female polar
bear struggled to keep
her head above the
waves. Swimming in
rough seas far from land,
and even farther from
the nearest sea ice, she
faced an uncertain fate.**



TWO MALES CONFRONT EACH OTHER AT A SEAL KILL. Polar bears typically avoid physical conflicts. However, as sea ice shrinks and opportunities for hunting decrease, there will be greater potential for disputes between bears over access to limited food resources.



Over many tens of thousands of years, polar bears evolved to be uniquely well-adapted for a very narrow ecological niche. Their physical features provide superb protection from the cold: they have extremely dense fur and almost no exposed skin, their thick layer of fat provides excellent insulation, and their low surface-area-to-volume ratio helps retain heat. In addition, they are well-designed to walk on ice and snow, and swim in frigid waters. Huge feet function like snowshoes and make good paddles for swimming; bumpy foot pads provide traction on slippery surfaces; short, curved, sharp claws grab the ice effectively; and a blubber-wrapped body has excellent buoyancy.

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Evolution has honed polar bear physique, dentition, and metabolism for maximum exploitation of a completely carnivorous, high-fat, marine-mammal diet. A narrow skull, long muscular neck and flesh-grabbing teeth all facilitate plunging head-first deep into a seal's breathing hole or birth lair to grab prey. Clutching a captured seal in its powerful jaws, a polar bear then uses its incredible strength to drag prey upward and out onto a sea-ice platform where the quarry can be devoured. Polar bears are able to satisfy their enormous energy needs and thrive in the Arctic because they are able to digest and assimilate 84% of the protein and 97% of the fat from their blubbery prey.

Ice-dependent ringed seals are the main food of polar bears in all regions. To a lesser extent, some also eat other rotund arctic marine mammals, including bearded seals and walrus. Polar bears use various hunting techniques to catch their quick-swimming food, but all methods depend on the existence of sea ice. With extraordinarily rare exceptions, polar bears cannot seize their agile prey in the water.

As they travel huge distances in their icy habitat searching for food, polar bears use their remarkably keen sense of smell to detect prey. “Their eyesight is about the same as a human’s, but they rely on their prodigious sense of smell for information,” explains Ian Stirling, a retired Canadian Wildlife Service scientist, now affiliated with the University of Alberta, who has studied polar bears for over 40 years. Particularly impressive, says Stirling, is the polar bear’s ability to find an opening in the ice that is being used by a seal as a breathing hole, simply by sniffing the ice. “Seals have strong fishy breath which likely leaves a trace on the snow or ice, and it appears that a bear can tell by smell that a seal breathed there recently.” The bear may then commence ‘still-hunting’ – waiting motionless for an opportunity to grab an unwary seal as it surfaces for air. In addition, from over a kilometre away,

fractures and multiple large channels in the ice, and a seal is hauled out on a small distant floe. After spotting the seal, the polar bear will carefully slip into the water without making a splash and swim concealed among the floes toward its quarry. If the bear manages to reach the floe where the seal is resting without being detected, it will then explode from the water, catapult toward its prey and attempt to grab the seal before it dives into the sea.

Beyond requiring a sea-ice platform for travelling, hunting and feeding, polar bears need the ice for breeding. Males rely on their superb sense of smell to locate potential mates on the sea ice by determining whether polar bear footprints are those of a female and if so, whether she is in oestrus. Stirling has observed males select a single set of icy tracks from

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a polar bear can use its amazing sense of smell to detect a seal pup inside an icy birth lair beneath a thick layer of snow. The bear will then break into the lair by pounding on the snow with its powerful limbs, and attempt to catch the pup before it slides into the water.

For a polar bear to stalk a basking seal successfully on the sea-ice surface, the prey must be hauled out on a large expanse of intact ice. The bear will begin its surreptitious approach from far away, using raised features on the ice for camouflage. Then, once the predator has gotten reasonably close to its target, it will sprint forward and try to grab the seal before it escapes into the ocean. Still-hunting also requires a stretch of intact sea ice, preferably broken only in a location being used by a seal as a breathing hole or haul-out spot; the greater the number of alternative openings in the ice, the less likely the seal will surface where the polar bear is waiting to pounce.

Another dramatic hunting method, labelled “the aquatic stalk” by Stirling, is the best choice when there are widespread

among dozens of overlapping possibilities, and follow those tracks persistently in pursuit of a mate. He marvels, “I have tracked individual adult males as they plodded relentlessly in a more-or-less straight line across the frozen pack ice for 100 kilometres or more, non-stop, in search of a possibly receptive female.”

Due to their compulsory connections with sea ice for every crucial facet of life, polar bears are exceedingly vulnerable to the effects of climate warming. Human emissions of greenhouse gases are causing arctic temperatures to rise, and vast areas of sea ice that polar bears depend on are melting rapidly. The arctic sea ice extent in September 2011 was more than 2.43 million square kilometres below the average documented from 1979 through 2000. The ice has also decreased dramatically in thickness, making it more vulnerable to further melting. In September 2011, the total arctic sea ice volume estimated by scientists was the lowest ever – 66% lower than the average volume from 1979 through 2010. Mark Serreze, Director of the U.S. National Snow & Ice Data Center, describes the situation bluntly: “The Arctic



STANDING MOTIONLESS AT THE EDGE OF THE SEA ICE, this polar bear stares intently into the tranquil water. He is “still-hunting” – waiting for an opportunity to seize an unsuspecting seal as it surfaces to breathe.

summer sea ice is in a death spiral.” Unquestionably, this situation poses a dire threat to polar bears.

Over 30 years ago, Ian Stirling initiated long-term research on Canada’s Western Hudson Bay (WHB) population of polar bears to gain a detailed understanding of their biology and ecology. Since then, the decades-long work of Stirling and others has proven climate change is imperilling the bears.

From late fall through early summer, the WHB polar bears are on frozen Hudson Bay, hunting seals. By early July, the ice breaks up and the bears must go ashore. For several months, they are marooned on land and food-deprived because they cannot hunt seals until the bay freezes again in winter. Pregnant polar bears in this population must endure even longer periods of food-deprivation. After mating in spring, they attempt to build up huge fat reserves by gorging on seals until the ice breaks up in July; then they must move onto land. Once ashore, they’re obliged to subsist only on their stored fat while travelling to their denning area, giving birth, nursing tiny cubs through the winter, and waiting until their offspring are strong enough to travel to the sea ice

the WHB bears have much less time on the ice to hunt seals and accumulate the fat necessary to survive the ice-free period. Furthermore, explains Stirling, in addition to coming ashore with meagre quantities of stored fat, “the bears are now being forced to fast for even longer periods because freeze-up is coming progressively later in the fall as well.” The WHB polar bear population is declining from nutritional stress. Weights of adults are decreasing, litters are smaller, fewer young bears are surviving, and the overall population size is shrinking. The earlier break-up is particularly problematic for pregnant bears, because maximizing intake of seal blubber in the spring is crucial for successful reproduction. If current climate trends persist and the ice-free period continues to lengthen, Stirling says, “In a few more decades, not many adult females will be capable of reproducing in western Hudson Bay and any cubs that might be born will have difficulty surviving.”

Polar bears in the Beaufort and Chukchi Seas of Alaska and Russia are also struggling to cope as the ice disappears. Steven C. Amstrup, who has studied polar bears in Alaska for 30 years, and is now Chief Scientist for Polar Bears

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the following spring. By the time mother bears are able to resume hunting on the ice in mid-March, they have not eaten anything for at least eight months. That is an astonishing biological feat, and one which pushes the limits of what can be endured.

Research by Stirling and colleagues has established that during the past few decades, due to climate warming, the sea ice on Hudson Bay has been breaking up progressively earlier in the summer. Break-up now occurs at least four weeks earlier than it did a few decades ago. Consequently,

International, says that historically the sea ice remained over the biologically-productive waters of the shallow continental shelf all year round, and the bears could hunt seals even in summer. But now the ice recedes hundreds of kilometres away each summer, forcing the bears either to swim ashore and fast until the ice returns in winter, or remain with the ice as it shrinks toward the central polar basin where food is scarce. Polar bear size and survival rates are already declining in the Beaufort Sea region, Amstrup explains, due to reduced feeding opportunities as the result of ice retreat.



POLAR BEAR CUBS ARE BORN INSIDE A SNOW DEN, and are tiny and helpless at birth. They remain sealed in the den with their mother for about three months, nursing and growing until they are strong enough to venture outside and accompany their mother when she resumes travelling and hunting on the sea ice.



MAROONED ON LAND DUE TO LACK OF SEA ICE, this bear forages for food at a garbage dump. Although trash can temporarily fill an empty belly, it cannot provide nourishing long-term sustenance. As rising temperatures trap fasting bears on land for longer periods, they are increasingly searching for food in close proximity to people, and that poses risks to both humans and bears.

Pregnant bears are facing especially serious challenges in the Beaufort and Chukchi Seas as the summer sea ice recedes far from maternity denning areas on land. When the ice withdraws northward in summer, a pregnant bear must decide when to go ashore. If she chooses to remain on the retreating ice temporarily, she can continue hunting seals longer. That will help her maximize the fat reserves she'll need to survive a lengthy period of food-deprivation while she's denning. However, remaining longer on the receding ice could mean a pregnant bear will then have to swim much farther to reach her terrestrial denning area, which could be so energy-intensive and difficult that she might lose her pregnancy or even drown in rough seas.

Alternatively, a pregnant bear might choose to head toward land promptly upon breakup of near-shore ice rather than ride the pack farther out to sea. In that situation, she would not expend as much energy swimming, but she would have less hunting time on the ice and therefore a smaller reserve of fat for sustenance during denning. A third option is for a pregnant bear to remain hunting on the shrinking ice as long as possible, and then den on the ice itself rather than on land. But as temperatures rise and sea ice weakens, this option has become increasingly risky. If a sea-ice den disintegrates and must be abandoned, or collapses into the ocean while the mother bear and her offspring are inside, the result will be almost certain death for the cubs. Eventually, this no-win situation will result in fewer successful pregnancies, fewer surviving cubs, and decreasing populations of polar bears in the Beaufort and Chukchi Seas. Scientists believe sea-ice retreat will soon have the same effects on bears in other populations as well, for similar reasons.

To make matters worse, deteriorating sea-ice conditions may also affect polar bears' reproductive rates by directly impairing their ability to locate one another for breeding. Canadian bear biologist Andrew Derocher of the University of Alberta, a former

Today, there are approximately 20,000 polar bears living in 19 relatively discrete populations. The IUCN Polar Bear Specialist Group – the world's foremost scientific authority on polar bears – has determined that eight of those 19 populations are already declining due to rising temperatures. Moreover, the scientists emphasize that all polar bears throughout the Arctic will ultimately be endangered by loss of their sea-ice habitat if temperature rise continues unabated.

Some have suggested that polar bears will adapt to an ice-free Arctic by consuming land-based foods such as bird eggs, rodents, berries and vegetation, as well as fish – essentially shifting to the diet of omnivorous brown bears. But Derocher, who has studied both polar bears and brown bears for nearly 30 years, says that theory is completely misguided. “Anyone who suggests that polar bears can survive by consuming terrestrial foods simply does not understand polar bear physiology,” he says. Unlike brown bears, polar bears are functionally obligate carnivores and they are physiologically dependent on consuming the blubbery bodies of marine mammals. Other foods simply cannot meet their tremendous energy needs over the long run. Furthermore, Derocher explains, it took tens of thousands of years for polar bears

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Chair of the Polar Bear Specialist Group in the International Union for Conservation of Nature (IUCN), has studied this issue. His research indicates that when increasingly warm spring temperatures cause sea ice to be fractured extensively, with many small mobile floes constantly moving in expanses of churning water, it may be difficult or even impossible for males to find females for breeding by following the scent of their tracks. “The males are trying to follow a broken path – whirling ice floes are like the pieces of a jigsaw puzzle – if it gets bad enough, there are so many pieces missing that the puzzle doesn't make any sense,” he explains. This issue will likely contribute to precipitous population declines as arctic temperatures continue to climb.

to evolve into the uniquely well-adapted, completely ice-dependent arctic predators they are today; it is just not possible for them to evolve into land-based omnivores within a few decades.

And if, in addition to being endangered by global warming and vanishing sea ice, polar bears are also subjected to increasing human disturbance, killed by hunters and poachers, and exposed to dangerous contamination in their shrinking habitat, they will decline into oblivion even faster. Of particular concern is the active push for oil exploration, production and shipping in many crucial regions of polar bear habitat as the Arctic Ocean becomes increasingly ice-free. “It is obvious that

an oil spill would be devastating to polar bears,” says Stirling. “The contamination will almost certainly kill them.” Polar bears have no natural aversion to oil and, in fact, may be dangerously attracted to it. Whether by swimming in oil-covered seas or travelling on oil-soaked ice, they would become contaminated in the event of a spill, and the consequences would be deadly. Once polar bear fur is fouled with oil, Stirling explains, it loses its insulating properties. Shivering bears will then attempt to groom their fur by licking themselves clean, and will ingest the toxic oil. Kidney failure and death will almost invariably follow. Because resources to contain an arctic oil spill are not currently available, and no proven technology exists to clean up oil in icy arctic seas, the danger to polar bears from oil drilling and transport in their habitat is indisputable and significant.

If humans continue to burn fossil fuels and pump ever-increasing amounts of heat-trapping gases into the air, arctic temperatures will inevitably continue to rise, and sea ice

are quickly and significantly reduced, and atmospheric concentrations of heat-trapping pollutants are stabilized within the next decade. Based on that hypothetical scenario, the scientists determined that the decline of arctic sea ice is not unstoppable, and some sea-ice habitat sufficient to support some polar bears can be preserved. “There’s a widely held perception that nothing can be done to help polar bears and the arctic ecosystem,” says Amstrup. “Our new findings show this isn’t true. Saving polar bears is all about temperature and sea ice. By minimizing greenhouse-gas emissions and therefore temperature rise, we will retain more sea ice. The more sea-ice habitat we retain, the more polar bears will survive.”

But is it feasible to reduce global greenhouse-gas emissions rapidly enough and drastically enough to avert an arctic melt-down and the demise of polar bears? Joseph Romm, a Senior Fellow at the Center for American Progress, says the necessary technological capabilities do indeed exist, but he

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will surely continue to shrivel. Will any polar bears survive anywhere in the wild by the end of this century if we simply carry on with business-as-usual? It appears extremely unlikely. “As the sea ice goes, so goes the polar bear,” says Amstrup. Research by Amstrup and colleagues has shown that if current trends persist, at least two-thirds of the world’s polar bears will vanish within the next 40 years, and the rest are likely to disappear by 2100.

However, in a recent study published in the December 2010 issue of the journal *Nature*, Amstrup and his collaborators concluded there is still hope for polar bears. Their research used mathematical modelling to test the effects of a scenario in which global greenhouse-gas emissions

stresses that lack of political will is the overriding problem. Romm, a physicist and climate expert, was the Assistant Secretary of Energy for Energy Efficiency and Renewable Energy in U.S. President Bill Clinton’s administration and is the editor of the respected blog *Climate Progress*. He explains that to stabilize atmospheric greenhouse-gas concentrations at 2020 levels within a decade, which is the hopeful scenario in the study by Amstrup’s group, the industrialized world would have to cut greenhouse-gas emissions about 60% to 70% almost immediately, and then continue cutting even further. Achieving that goal would be tremendously challenging yet technologically feasible, says Romm. But the stark reality, he notes, is that currently the world appears unwilling to do what is necessary.



AFTER KILLING A YEARLING CUB FOR FOOD IN THE NORWEGIAN ARCTIC, an adult male drags the young bear's body across the ice before stopping to eat it. As temperatures continue to rise and arctic sea ice continues to disappear, it will be increasingly difficult for polar bears to hunt seals. Scientists believe such tragic instances of polar bear cannibalism may become more common as a consequence.

NICK LUNN AND GREG THIEMANN evaluate the health of a tranquilized mother polar bear and her young triplet cubs near the shore of Western Hudson Bay. This research, started by Ian Stirling decades ago, has established that polar bears are declining in physical condition and numbers due to climate warming and loss of sea-ice habitat. (left)

A POLAR BEAR WANDERS ALONG THE ICE-FREE SHORELINE OF WRANGEL ISLAND

in the Russian High Arctic in early August, subsisting on his fat reserves and waiting for sea ice to form again. Although in the past the ice remained near the island all year round, enabling bears to hunt for seals even in late summer, now the ice recedes far away toward the central polar basin for several months during the melt season. Wrangel was once called a “polar bear maternity ward” because several hundred mother bears denned and raised their cubs on the remote island annually. But Nikita Ovsyanikov, a Russian scientist who has been observing the bears for many years, notes that use of Wrangel for maternity denning is declining, apparently as the result of climate change. His data indicate that a maximum of only 60 to 70 females give birth to cubs on the island now, whereas in the early 1990s there were approximately 350 to 400 maternity dens in active use there each year.



Due to human emissions, carbon dioxide in Earth's atmosphere has already increased to a concentration that has not existed for at least 15 million years, and the rapid rate at which we continue to pump out tens of millions of tons of heat-trapping pollutants every day is unprecedented. If our carbon dioxide emissions continue to persist unabated through the end of this century, "the human species and global ecosystems will be placed in a climate state never

hot to support human life. Ocean warming, acidification and anoxia would destroy marine ecosystems and extirpate innumerable ocean species, many of which humans depend upon for food. Extreme drought, insect infestations, diseases, wildfires, violent storms and epic floods would predominate across the globe. Those conditions would decimate forests, grasslands, wetlands, and agricultural regions. Shortages of freshwater and food would become severe and widespread.

“AS THE SEA ICE GOES, SO GOES THE POLAR BEAR.”

before experienced in human history,” says Jeffrey Kiehl, head of the Climate Science Research Section of the U.S. National Center for Atmospheric Research. A paper by Kiehl published in the January 2011 edition of the journal *Science* makes clear that if our emissions continue on their current trajectory, by the year 2100 carbon dioxide will reach a concentration in the atmosphere that has not occurred on Earth since about 35 million years ago, when temperatures in the polar regions were 15 to 20 degrees Celsius hotter than they are currently, and global temperatures averaged about 16 degrees Celsius higher than they are now. During that time there was no permanent sea ice in the Arctic Ocean and little, if any, ice on Greenland and Antarctica, and sea level was about 70 meters higher than it is today.

What would our planet be like if unmitigated anthropogenic climate change causes those conditions to occur again? Vast regions where more than half the world's human population is currently living would be either submerged beneath rising seas or transformed into desiccated deserts too blisteringly

Permafrost beneath the tundra and on the arctic seafloor would thaw, releasing gargantuan additional quantities of planet-heating gases into the atmosphere. Countless species of flora and fauna would go extinct. Human misery would, no doubt, reach pandemic proportions.

Fundamentally, if current warming trends continue to the point that the Arctic can no longer support polar bears, the related climate impacts across the globe will be so severe and devastating that Earth will become a very different and far more hostile planet from the one on which humans evolved and the one on which human civilization depends.

As I stood on the deck of the Professor Khromov in the Chukchi Sea and strained to see the lone swimming polar bear buffeted by waves as she disappeared into the distance, the uncertainty of her fate weighed heavily on me. But the uncertain future of her entire species, and indeed the uncertain future facing all life on Earth, weighed on me even more. ○



About the Author

Jenny E. Ross is an award-winning photographer and writer whose primary focus is wildlife natural history and conservation. Much of her work concerns the Arctic, the world's bears, and the effects of climate change on wildlife and ecosystems. She was also a Principal Photographer for *Ocean Geographic's* Elysium Epic Antarctic expedition, and her work on that project will be featured in the Elysium Epic book, film and exhibition in 2013.