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WINTER 2014

Melting Point

Researcher Christian Haas is looking for clues to our vanishing Arctic

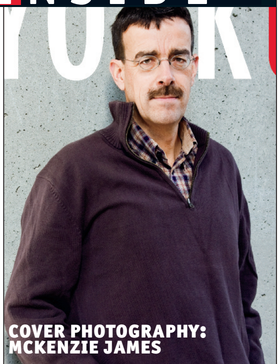
PLUS

Helping Hands

Clothes Call

"Fatshionistas"

INSIDE



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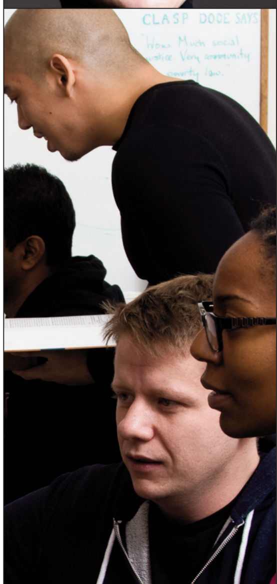

CORRECTIONS

The Fall 2013 and October 2008 issues of *YorkU* magazine incorrectly refer to Roger Pulwarty (BSc '86) as a Nobel laureate. Pulwarty was a lead author of the report that earned the Intergovernmental Panel on Climate Change a 2007 Nobel Peace Prize.

The Fall 2013 issue of *YorkU* contains an ad that incorrectly refers to Michael Tulloch (BA '86, LLB '89) as the first black judge to be appointed to an appellate court in Canada. Rather, Tulloch was the first black judge to be appointed to an appellate court in Ontario.

We have corrected these errors in the digital edition of *YorkU*'s Fall 2013 issue, available online at digital.yorku.ca

WINTER 2014

Eye Witnesses to a Melting World

York researchers are documenting disappearing sea ice, thinner polar bears, thawing permafrost and drier wetlands

BY MARTHA TANCOCK ● PHOTOGRAPHY BY MCKENZIE JAMES

CHRISTIAN HAAS IS A GEOPHYSICIST who has been measuring polar ice thickness since 1991. When he started his career, the sea ice over the North Pole was 2.5 metres thick. By 2007, a catastrophic year for Arctic melt, the ice was less than one metre thick – 90 centimetres to be precise. With ice thinning at this dramatic rate, will the long inhospitable North soon open for business? When can shipping companies start using the Northwest Passage? When can oil and gas companies start drilling? "Not any time soon," predicts Haas.

Haas started monitoring polar sea ice 22 years ago as a doctoral student in environmental geophysics in Germany. Now he is the Canada Research Chair in Arctic Sea Ice Geophysics at York and a world expert on sea ice. He is just one of many York researchers who has been documenting the impact of global warming on the Arctic. They are all frontline witnesses to major and likely irreversible trends – retreating sea ice, disappearing snow packs, drying-up wetlands, starving polar bears, thawing permafrost and rising levels of greenhouse gases.

SEA ICE DISAPPEARING

HAAS IS TRYING TO UNDERSTAND the reasons for the recent rapid retreat of Arctic sea ice and its short- and long-term consequences for the climate, ecosystem and the people of the North. It's a complex undertaking that requires extensive data collection on a massive scale.

When he started climate research in the early 1990s, he would do field work for two to three months every year on ice breakers at both poles. Every spring for the past 10 years, he's been flying out of Alert, Nunavut, on Ellesmere Island, making observations from planes and helicopters.

Now, he has narrowed his research focus to the area between Ellesmere Island and the North Pole where sea ice is quickly moving east from Russia to Canada at up to seven kilometres a day. Buffeted by strong winds and currents, the frozen ice pans here bump into and pile up along this part of Canada's northerly coast, making it the thickest ice in the Arctic. "This is only a tiny little piece of the puzzle, but we need to fully understand these conditions in order to make better predictions," says Haas. Accurate ice data is essential to generate accurate climate modelling that can serve as a benchmark for safe and responsible shipping and offshore exploration, he says.

Haas is constantly monitoring, adapting and refining a myriad of airborne and ground-based instruments that measure sea ice thickness and the factors that affect it – winds, atmospheric radiation, ocean salinity, atmospheric and ocean temperatures – in both the Arctic and Antarctic.

For ground-based measurements, he starts with the conventional electromagnetic (EM) ice meter to measure sea ice thickness. The 3.5-metre tube is equipped with sonic and laser sensors that are highly versatile because the sensors don't need to touch the ground to take readings. As a result, Haas has adapted it for a variety of moving platforms and has also designed a shorter, portable version. His EM "bird" is shaped like a torpedo and can be handheld or dangled from low-flying helicopters and planes. It is now manufactured and used by geophysicists all over the world.

The Arctic is so vast and aircraft so expensive to rent – you pay by the minute – that Haas enlists everyone he can to help gather data. He asks local Inuit hunters, Canadian Rangers and North Pole adventurers to tow his ice meters behind their snowmobiles and sleds. He even hooks them onto hovercrafts

Christian Haas: Looking for clues

Gregory Thiemann: Polar bear specialist

used for polar research in Scandinavia. A couple of years ago, he persuaded French geophysicist Eric Brossier, who was wintering on his polar yacht Vagabond in Grise Fiord on Ellesmere Island, to drag an ice meter over frozen pans every three days.

Recently, he has been collaborating with York University atmospheric scientists – including the world-renowned Tom McElroy a.k.a. "Mr. Ozone" – and space engineers like Jim Whiteway to improve instruments that can measure sea ice thickness from satellites. While satellites can identify ice types over large areas, their ability to measure the thickness of the ice from space has been less reliable. Haas is currently working on validating satellite observations with ground observations for the European Space Agency.

POLAR BEARS CHANGING DIET

Biologist Gregory Thiemann is just as concerned about melting sea ice, but for different reasons. As the sea ice disappears, so too does the traditional habitat of polar bears and their main food source, seals. Forced to swim longer distances in increasingly open water to hunt, they are using up the body fat that helps them endure long periods without food, thus threatening their capacity to reproduce.

Thiemann studies Arctic food webs – what eats what from top to bottom of the food chain. He is particularly interested in how carnivores at the top of the food chain "make a living".

Suzanne Tank: Monitoring CO_2

Every fall, he and his students fly up to Hudson Bay and James Bay for about two weeks to collect fat samples from the rumps of polar bears they locate and then sedate from helicopters. He also works with Inuit hunters across Nunavut to sample fat from polar bears taken in annual subsistence harvests.

Thiemann can tell from fatty acid signature analysis what species of seal the bears have eaten and the bears' general health. During the past two years, he and his research partners at the Ontario Ministry of Natural Resources have also fitted bears with global positioning system collars to track their movements.

"By understanding where, when and how predators hunt for food, we can better predict how wildlife populations will respond to ongoing environmental change in the North so we can act to protect them and their ecosystems," he explains.

A polar bear's ability to survive varies by individual, sex, age and region, says Thiemann. Adult male bears are most robust because, at twice the size of adult females, they have the strength to subdue and kill the largest seals. Cubs, pregnant females and subadults are more vulnerable. Food sources and sea ice conditions vary across the Arctic, so what happens to polar bear populations will differ depending on their geographical location.

"Evidence is fairly clear that the primary conservation threat to polar bears is habitat loss – sea ice – associated with climate change," says Thiemann. "I want to see the populations I've

Kathy Young: Studying snow cover

worked with continue to be viable," he adds. "They're a critical part of the northern marine food webs and essential to people who have lived with them for millennia."

PERMAFROST THAWING

As the sea ice melts at an ever quickening rate, so does the permafrost. Permafrost is permanently frozen soil and sediment that blankets most of the Arctic. It can be hundreds of metres thick and centuries old. It occurs in two layers – organic above inorganic. Until recently, the ground covering the permafrost – the "active layer" – thaws to consistent depths every summer. But warmer temperatures are driving the annual thaw deeper into the organic layer of permafrost with potentially dire consequences. When frozen organic matter melts, bacteria consumes carbon once locked in ice and unleashes carbon dioxide. Adding more of this greenhouse gas to an atmosphere already overloaded will only amplify global warming. Scientists are calling it a ticking carbon bomb.

York geography professors have been monitoring the carbon cycle – how carbon dioxide in the atmosphere cycles into plant matter, into ground water and into the ocean – in the Arctic for decades. "We seek to understand these processes because they are adding more carbon dioxide to the atmosphere," explains Arctic researcher Suzanne Tank. "And that has a direct bearing on climate change and global warming."

CARBON SINKING

Tank casts her research net wide over Canada's northern aquatic ecosystems. As head of the aquatic ecology and biogeochemistry lab in the North, this York newcomer and her graduate students are doing field research in the Mackenzie River watershed. Their aim is to understand the processes that connect land, freshwater systems and ocean. Their context is climate change.

The scope of Tank's lab research is wide and deep, reflecting her own multidisciplinary credentials in ecology, environmental biology and aquatic biogeochemistry. Students are monitoring permafrost thaw on land and under water, carbon cycling, greenhouse gases flux, nutrient dynamics and the biogeochemistry of northern rivers.

Tank has collaborated with researchers around the world. Between graduate degrees, she was a sustainable fisheries analyst for the David Suzuki Foundation. She has co-authored papers on the effect of ultraviolet radiation on Rocky Mountain lakes with David Schindler, the celebrated limnologist whose research on acid rain led to the ban on phosphates and a reduction in acid rain. She has participated in international research on the biogeochemistry of six Arctic rivers and remains involved with the Great Rivers Observatory, as well as pan-Arctic working groups on permafrost.

These days, Tank is excited about a surprising link she has discovered in her research on permafrost degradation.

When permafrost thaws, carbon dioxide is released from the rotting organic matter into the atmosphere. Most research is focused on this upward carbon flux, but Tank is examining how thawing permafrost can also trap carbon dioxide. In a process called chemical weathering, carbon dioxide mixes with water to form carbonic acid, which reacts with the minerals in the inorganic layer further down to form bicarbonate.

It is common knowledge that bicarbonate travels from land to river to ocean bottom, where it is buried and forms a huge carbon sink. Tank is one of a few researchers starting to link permafrost degradation with carbon sequestration through chemical weathering. In other words, thawing permafrost is not only releasing carbon dioxide into the atmosphere as a greenhouse gas, it is converting carbon dioxide to bicarbonate, which is a carbon dioxide sink.

Does one help to offset the other? Could the "carbon bomb" be mitigated by this carbon sink? "I want to understand how these effects counter balance each other," says Tank. "We don't understand the magnitude of this process but this research will help us."

GREENHOUSE GASES GROWING

Rick Bello, a climatologist at York, has also been monitoring greenhouse gas emissions in the Arctic. He has been studying the spongy wet peatland of the Hudson Bay Lowlands for more than 30 years. The lowlands are the second largest expanse of frozen peatland – semi-decomposed vegetation – in the world after the Central Siberian Plateau. These boundless tracts of carbon-rich vegetation have been locked in ice for 4,000 years. Until recently, only the top 40 centimetres were affected by seasonal thaws. Now the thaw is going deeper. "It's like we're taking carbon out of freezer and putting it on the counter," says Bello.

In summer, the lowlands turn into a watery landscape dotted with millions of ponds. That's when Bello and his students set up base at the Churchill Northern Studies Centre in Churchill, Man., then head out to measure evaporation, nutrients and water flow, and, most importantly, carbon dioxide and methane emissions. Thawing peat produces carbon dioxide when it is exposed to air. It produces methane when it thaws under water. Methane is 22 times more dangerous as a greenhouse gas than carbon dioxide, says Bello, so understanding the hydrology – how water moves – is important, too.

Bello is also observing changes in wind patterns due to climate change. His students have tabulated 30 years' worth of data from hundreds of weather stations around Hudson Bay and discovered a correlation between diminishing ice cover and higher wind speeds. Using the same data source – the North American Re-analysis Dataset – they are correlating wind and wave data to predict the impact of stronger winds and higher waves on shoreline erosion and marine conditions, which could have implications for shipping, fishing and emergency response missions in the Arctic.

WETLANDS DRYING UP

KATHY YOUNG IS A HYDROLOGIST who has been studying snow cover in the High Arctic wetlands for about 20 years. One of her specialties is late-lying snow beds, ridges of snow so massive they sometimes endure for decades.

Most of the High Arctic is polar desert, but there are a few oases. In recent years, Young has focused on one – Polar Bear Pass on Bathurst Island, Nunavut. In summer, the pass blooms with cotton grass, sedges and dwarf shrubs, and abounds with wildlife, from migratory birds to lemmings and fox to caribou. After the main snowmelt in the spring, these late-lying snow beds keep wetlands like Polar Bear Pass hydrated for most of the dry summer.

Young was always aware that these giant snow beds were shrinking. But even after the record-high temperatures of 2007, she was shocked to discover some had disappeared altogether. Record warm Arctic summers in 2011 and 2012 have only accelerated their deterioration.

Without this reliable water source, aquatic and plant life can't thrive as well in these High Arctic wetlands. And from aerial surveys, Young and her graduate students have observed that tundra ponds and small patchy wetlands are drying up. As temperatures rise due to climate change, Young says what is happening at Polar Bear Pass could happen in other fragile Arctic wetlands.

Lately, Young has turned her attention to Iceland. When the Icelandic Volcano *Eyjafjallajökull* erupted in 2010, it spewed volcanic ash so thick it stopped air traffic over northern Europe and dusted the entire country in a fine powder. Young is looking at the impact of that cloak of ash and other dust events on snowpacks, snowmelt and streamflows, as well as on permafrost hydrology and geothermal activity.

ADAPT, THE LAST WORD

HAAS ANTICIPATES IT COULD BE FIVE or 10 years before the sea ice disappears long enough for seasonal shipping and to allow for oil and gas exploration. "Look at this," he says, pointing at an aerial image of a patch of frozen Beaufort Sea on his laptop. Barely detectable in the endless white expanse is a lone icebreaker. It was dispatched expressly to test how easily icebreakers could create open water. But it turned out that just as fast as the boat smashed through the ice, the freshly exposed water froze in its wake – like a zipper opening and closing.

Eventually, though, sea ice won't refreeze and when it's gone everything will warm up. Open water will bring shipping and oil and gas extraction to the North. It will also bring faster winds, bigger waves and dramatic storms. "Climate change is going to be with us for several generations," predicts Bello, "even if we could turn off the plug now on fossil fuel emissions."

"There's going to be a day when we start talking about North-South in Canada instead of East-West," says Bello.

The most important issue, according to Bello and his colleagues, is how we adapt to these changes.

For now, says Tank, "our role is to convey what we're seeing." **Y**

Rick Bello: Studying spongy wet peatland