CHAPTER 1

To Melt Away

Abstractive Sensations in Ice

Cymene Howe

In recent years, ice has become a climatological signal: a substance that renders visible rising temperatures brought about by anthropogenic climate change. Ice can be measured, its retreats photographed, its depths plumbed and its duration—or lifespan—calculated. And it is melting: nowhere faster (and faster than expected) than in the Arctic region.[1] Melting ice is now understood as the key index that polar temperatures are increasing dramatically according to the Intergovernmental Panel on Climate Change (IPCC), taking glacial diminishment to be the "highest confidence temperature indicator in the climate system" (Houghton et al. 2001). Greenland's ice sheet, which is only one tenth the size of Antarctica, is currently contributing twice as much to overall sea levels[2] and scientists have concurred that the rate of melt in polar zones has been considerably underestimated.[3] The 2017 Arctic Monitoring and Assessment Programme report[4] details that global sea levels will rise much more quickly than previously thought with new estimates almost double the pace predicted by the IPCC in 2013. Ice's physical changes and the geohydrological implications associated with it have now become regular media features as news of catastrophic melt continues to mark our times. The mutations of the world's ice, and the implications of these cryohuman processes serve as powerful indicators of what we might call, not just an "Age of Asymmetry," (Morton 2013: 161) but an Age of Extreme Asymmetry.

Iceland is an important locus for understanding climate change because few places have had more glacial retreat or experienced melt more dramatically than Iceland. Ten percent of the country's surface is covered by glaciers, and it is home to the largest ice cap in Europe, Vatnajökull. Since settlement in 874, glaciers have played an important role in Iceland's history and culture, often as a dangerous presence threatening to displace villages with encroachment and massive outburst floods (Jóhannesson 2005).[5] Because of climate change, however, the cultural meaning of glaciers appears to be changing. Bodies of ice that were once threats are now vulnerable and in need of care. Iceland's more than four hundred glaciers now lose eleven billion tons of ice per year[6] and scientists have predicted that by the end of the twenty-first century all of Iceland's glaciers will be gone.

The Arctic Circle barely touches Iceland,[7] but the country has centered itself politically as an influential member of the Arctic Council states.[8] With the advance of climate change, the Arctic has also become a site for security concerns, a "new Cold War" zone in the once-frozen North (Heininen 2015). The region's future is increasingly cast in relation to the activities of two Cold War protagonists, China and Russia. A gold rush mentality has also come to occupy the region as new shipping routes are cleared by the loss of sea-ice and mineral stores become more accessible by the disappearance of ice on land and sea (Bertelsen and Graczyk 2016; Pincus and Ali 2015). The logistics hub for the Northern Sea Route[9] may be constructed in northern Iceland and within the coming decades several Arctic shipping passages are expected to be entirely free of sea ice year-round. As ice recedes on land and on the ocean's surface, hydrocarbon exploration and extraction will almost certainly increase, although little infrastructure is in place to treat oil spills or other accidents if 25 percent of the world's remaining carbon fuel reserves are unearthed in the Arctic region.

The Social Life of Ice

Social scientists have long explored how ice and human populations have interacted. Franz Boas, who is considered the "father" of American anthropology, created detailed studies of Inuit people's relationship to ice in the late nineteenth century (Boas 1888).[10] More recently, anthropologists and others (Grossman and Parker 2012) have begun chronicling Indigenous people's experiences with climate change in arctic zones and among those who live near glaciers and ice-covered

Figure 1.1. | *Glacial lagoon. Jökulsárlón, East Iceland, 2016.*
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peaks (Crate and Nuttall 2009; Cruikshank 2006; Marino 2015; Nuttall 2009; Rhoades, Zapata, and Aragundy 2008). These narratives reveal deep concerns about retreating ice among First Nations people and subsistence hunters who rely on seasonal freezing and ice pack for their livelihoods. Responses to melting cryospheres, however, are not singularly negative. Some Greenlanders have been embracing ice reduction because it will increase access to mineral and hydrocarbon resources (Nuttall 2009, 2015, 2016). Several Icelandic politicians have likewise celebrated the possible economic windfall of the great melting, arguing that warmer conditions represent a boon for northern nations because this will make agricultural and resource extraction more practical and economically viable. Given the rapidity of climate-induced melting and its resulting impacts, it is important that we understand the effects of cryospheric diminishment in the frozen places where ice has dominated landscapes, shaped lives, and conditioned encounters with land, resources, and livelihoods (Harwood et al. 2011).

This chapter is based on my anthropological research over the last several years, where I have been trying to understand how ice's material form is changing, moving, and presencing differently among Icelanders and within the ecosystems they inhabit. I began with the proposition that ice is conditioned by both ecological and economic inputs and that melting cryospheres will be experienced differently by differently positioned subjects, over time and space. My thinking about what I now call "cryohuman" relationships has drawn inspiration from several intersecting debates in the social sciences concerning climate change, environmental conditions, and adaptation responses to the Anthropocene (Barnes et al. 2013; Chakrabarty 2009). Some scholars have been interested in how industry (Linnenluecke and Griffiths 2015), security (Heininen 2015), and markets must now attend to unprecedented shifts in our earth system (Zolli and Healy 2013), especially as the number of climate refugees and the frequency of migrations increase at home and abroad. Infrastructural responses to ecological changes (Strauss and Orlove 2003; Watson and Adams 2010) have also shown that initial responses may not be sustainable as climate and weather phenomena become more virulent in the future (Edwards 2010; Hulme 2011).

Climate change is not limited to its political and economic impacts, or its effects upon (only) human populations. For this reason, I take a cue from Donna Haraway (2015) who calls us to attend to multiple kinds of "response-ability": the affective capacity to recognize the interfolding of human lives among a multiplicity of beings and inanimate forms. She is interested in our ability to "respond" to the intimate relationships between ourselves and other-than-human entities including glaciers, ice sheets, and sea ice. The capacity to sense dramatic environmental changes has been central to understanding the relationship between humans and our living contexts, particularly in times of technological and industrial accelerations (Parr 2010). As Kathleen Stewart (2007) has shown, subtle permutations in a known place—the scent of trees and blossoms or the smell of gasoline and rancid meat—can result in a powerful affective reaction among those who have inhabited locations for long periods of time and are attuned to quotidian changes in their atmospheres. In this chapter, I draw together a range of responses to melt by centering attention on how humans, and nonhuman others, experience abstractive moments of sensory engagement through a melting cryosphere. The term "abstractive," as this volume illustrates, serves as a conceptual frame to "render embodied knowledge explicit" by redistributing empirical capacities from humans to technical systems and, I would add, other-than-human actors (Mason 2016). Melt, I will argue, offers an assemblage of abstractive encounters that make climate change explicit, demonstrating the multiple ways that climatic conditions are sensed, experienced, and known by human populations but not limited to them.

On Extinctions, One Animal at a Time

This chapter began with the proposition that ice has become a signal for rapidly transforming environmental systems, or a "climatological canary in the coalmine." But before receding glaciers or melting ice sheets came to occupy much of the popular imagination around climate change, there was another charismatic figure of demise: the polar bear.

Dead bears are one way of abstracting melt.

Egill Bjarnason was the first to spot the bear just outside the northwestern Icelandic town of Sauðárkrókur in the summer of 2016. He was in no doubt that it needed to be killed immediately, as it was close to a farm where children had been playing. This was the first polar bear to have come ashore in Iceland since 2010. The bears are not native to the island, but they drift over on sea ice or swim from Greenland as their own cryoscapes elapse. After the bear's carcass was dissected it was clear that the female bear had been both swimming for many miles as well as floating on drift ice. The shortest distance between Greenland and Iceland is three hundred kilometers. But the distance between Greenland and the shore where this polar bear was first seen is considerably longer, about six hundred kilometers. The bear was also a mother who was still lactating, so it couldn't have been long since she was accompanied by her cubs.

Throughout recorded history there have only been a few hundred recorded sightings of polar bears in Iceland. The oldest of these was in 890, sixteen years after the first settlers arrived on the island. During the Middle Ages, polar bears were frequently tamed; but since that time, no bear has been captured alive in Iceland. For several decades, it has been national policy in Iceland to kill polar bears on sight as they are inevitably hungry after their sea voyage and therefore considered a danger to residents and livestock.

The shooting of the mother bear induced a rather vivid outpouring of affect across the country in the days that followed, seen especially on social media sites like Facebook. Reactions were divided along two general lines: either Icelanders must protect themselves and their livestock and, being that the bears come ashore hungry in remote parts of the island, it is up to local farmers or marksmen to ensure the safety of local residents; or, Icelanders ought to revisit this policy and put into place more humane responses to bear landings given that they will likely increase with the continuation of climate-induced melting on and around neighboring Greenland. Jon Gnarr, the former mayor of Reykjavík, who had run (partly facetiously) on a platform that included hosting a polar bear at the Reykjavík zoo, saw future bear migrations as a potential boon for the country. "Why not make a tourist attraction of a polar bear haven?" he asked. Jon Gunnar Ottosson, head of the Icelandic Institute of Natural History, along with many others, also decried the shooting of the bear, saying that it could have been shot with a tranquillizer rather than killed. (Officials contended that it would have taken an hour by plane to get the tranquilizers to the site and that it would have been impossible to keep track and control over the animal for that long). A spokesman for PolarWorld, a German group dedicated to the preservation of the polar regions and the creatures that inhabit it, called the bear's death "an avoidable tragedy," adding, in full irony, "this is another great day for mankind."

The circulation of the polar bear's story in both conventional and social media, and the international response to it, is indicative of a hypermediated communicational context where responses—affective and discursive—are able to spread quickly and with great reach. A platform such as Facebook, which is extremely popular in Iceland (and used by approximately three quarters of the population) allows for a particularly public affective response; it serves to promote structures of feeling across both a national and an international imaginary. In its digitized retelling, and in the collective human warnings and mourning that the bear's story evoked, there is evidence of further abstractions.[11] These are the abstractions of sentiment that channel one animal's plight in one or another political direction: indicating either the failure of "mankind" to preserve ecosystemic integrity, or the prioritization of human lives over all others. In both cases, the "meme-ification" of the bear's tale performs its own kind of abstraction, including as a signal of atmospheric and cryospheric transformations. The bear's death provoked emotive responses from many humans that were touched by it, but more than this, it drew attention to the diminishing cryosphere that was the cause of her journey and ultimately, her demise. Dead bears are one way of recognizing lost ice.

The Lost Sound of Sea Ice

Helga Edmundsdóttir remembers the sea ice when she was a girl growing up in a little village in the northwest of Iceland. It terrified her at night. Ghostly moans were emitted as floating mountains of ice rubbed up against each other, aching out a frictional chorus. That is heard much, much less now. "These days," Helga explained, "I hardly ever hear that screeching sound of ice at sea. Or the sounds of it hitting up against the ships in the harbor. And while it scared me then, I do miss it now." Lacking the eerie sound of sea ice, the Icelandic coasts are quieter than before. Silence then, can be taken as further confirmation of a melting north. This sonic disintegration is a sign too of wider, darker seas and coastlines more sparsely dotted with drifts of fresh water. Since sea ice also serves as bulwark and barrier to storm waves and the erosive powers of the world's oceans upon glaciers and ice sheets, the silencing of sea ice is also a signal of more disintegrations to come.

Sea ice, which forms and melts each year, has declined more than 30 percent in the past twenty-five years. In November of 2016, ice levels hit a record low, causing Artic climate experts to declare that "we are now in 'uncharted territory.'"[12] "The trend has been clear for years," explained one, "but the speed at which it is happening is faster than anyone thought." Unlike on the Antarctic continent, melting sea ice in the Arctic exposes dark, open ocean beneath, absorbing more sunlight and thus warming faster. Dark waters absorb heat and the reflective "albedo" effect, in which sunlight is reflected off the surface of white ice sheets and glaciers, is also reduced with each phase of melt. This, in addition to weather patterning, is why the Arctic is heating up much faster than the rest of the planet, about twice as fast as in the temperate latitudes, or by some estimates, as much as four times as much. Melting sea ice as well as land-based ice is affecting weather systems all over the world, especially as ocean currents and conveyors are modified by both hotter water and the influx of fresh meltwater into saltwater oceanic systems.

Glacial Response

Guðfinna Aðelgeirsdóttir has just returned from Sólheimajökull, a glacial tongue about two hours southeast of Reykjavík. Guðfinna teaches a glaciology class for exchange students in addition to her regular research and teaching as a professor at the University of Iceland. Each year she takes a group of students to Sólheim glacier where they use a steam drill, which she describes as acting like a pressure cooker—a mechanism that bores through the glacial ice like a hot knife through butter. The deep hole that is formed becomes a passage, a wire line that dips several meters into the glacier itself. As the ice on the surface melts away, the line will slowly be revealed. More line means less glacier because lost ice is now rarely replenished with an equivalent amount of new snow and ice in the ensuing winter.

Guðfinna explains that glaciers are anything but static. In fact, she says, they are best understood as operating like a conveyor belt. They move, and they move material. Snow and ice accumulate in the higher altitudes of the glacier and are depleted in the lower reaches. There is a circulation of material from high to low and from solid to liquid. Guðfinna describes glaciers in economic terms in much the same way that Helgi Björnsson, her senior colleague, does. "They are like a bank account," she explains. In the winter, positive accumulation fills up the bank. Deposits are made at higher elevations, while at lower ones, withdrawals occur. And just as you would your accounts, Guðfinna adds, "you want to keep it in a healthy balance." But we know that balance is not being achieved of late and that deposits have not kept up with expenditures.

Icelandic glaciers are especially well documented compared to many others in the world. Since the Middle Ages, and arguably over the last twelve hundred years—since the first-known human settlement of the island—Icelanders have been aware of the glaciers that occupy their homeland. Historically, the country's ice cover has varied. For Sólheim glacier, Guðfinna explains that they have excellent records going back to the 1930s. In the 1930s, temperatures had warmed and glaciers retreated. In the 1960s and 70s it became cooler and they grew. Since the mid-1990s however, they have only gone in one direction, and that is toward "ablation."

Ablation is the technical term for ice loss. In English the word denotes, in the first instance, "the surgical removal of body tissue." Coincidentally, the first person to thoroughly document Icelandic glaciers systematically was, by trade, a surgeon. In the second definition, ablation denotes the melting or evaporation of snow and ice. About half of ablation events occur through calving (cracking off of ice forms) and the other half through melting. While there have always been advances and retreats of glaciers in Iceland, Guðfinna notes that the country's glaciers have now withdrawn further than in the warm 1930s. She describes that in the West Fjords, on the

Northwestern peninsula, they are finding vegetation growth indicating newly exposed surfaces that have been ice covered for at least two to three thousand years. This is effectively "new land" now uncovered by melt.

Guðfinna and I talk for some time about what she terms "glacial response." She notes that Earth systems have accumulated only about 150 years of intensive fossil fuel use. "The atmosphere and the glaciers," she says "haven't managed to respond to it yet. Not fully. It is a slow system." And it is a very "stochastic" system—having a random probability or pattern that may be analyzed statistically but that will not be predicted precisely. "If you push it that way, you can expect a dramatic effect." But, she says,

> The climate models are not really managing to consider *all* of the physics. We have weather forecast models that are similar and they simulate the physics six or seven days into the future. This is a model that can tell you that about short-term weather, but not how the weather will be months from now. And with climate models we are really asking them to tell us what the weather will be in 100 years' time (Guðfinna pers. communication).

It is telling that Guðfinna turns to weather prediction as she speaks of glacial response. For her, and for several other glaciologists with whom I spoke, their role as scientists, they felt, was changing. Historically, glaciologists have been trained as geologists who might then specialize in cryoforms and their interactions. Glaciology, as Helgi Björnsson put it, "has always been closer to geology: observing what is happening, the forces and movements and cracks." Helgi himself began his studies and career in the "slow science" of geology. In the present, both Helgi and Guðfinna are convinced glaciology has become an exercise in understanding how ice and melt respond to larger systemic changes, including atmospheric conditions and weather. Glaciological expertise, like the cryoforms of glaciers themselves, is changing—becoming more like meteorology and attentive to the patterning of weather. If it began as a slow science, glaciology would now appear to be accelerating and observing new inputs of unprecedented weather events.

Before the Fourth Assessment Report of the IPCC, Guðfinna explained, glaciers and ice sheets often appeared in diagnostic modeling as "white mountains." Greenland and Antarctica, for example, would be represented as white, slightly protruding outlines in some past models (and in some now). But of course, ice sheets and glaciers are not inert, whitewashed, and static, but instead dynamic and contributing to sea-level rise and changing weather. Reflecting on how glaciology was itself moving in more meteorological directions and aware that models have been insufficient, Guðfinna quite plainly stated her estimation of the present: "This is the largest uncontrolled experiment that we have ever done."

Depressurizing

While much climate change discourse focuses on "small island nations" that appear to be sinking because of climate-induced sea level rise, Iceland is actually experiencing the inverse. It is rising out of the sea, at a rate of about 1 1/2 inches per year. As billions of tons of glacial ice melt[13] and fail to refreeze across the surface of Iceland, the earth beneath it is being depressurized and rising from its prior earthly coordinates. This is called "isostatic rebounding." Less ice on the island results in less weight creating pressure on its surface. And in a place with much geologic volatility this results in more impactful subsurface movement of magma, steam, and other pressures (Spada, Bamber, and Hurkmans 2013). An increase in volcanic eruptions, perhaps thirty times as many,[14] is expected to occur in Iceland and eruptions appear to have multiplied over the last twenty years.[15]

Compared to Antarctica and Greenland, Icelandic glaciers are more porous and have more air and water pockets. And, being located on the tectonic plate boundary of the mid-Atlantic ridge, Iceland has more glaciers atop volcanoes than anywhere else. Vatnajökull, the largest ice mass in Europe, is covering at least four active volcanoes. Because many of the country's large glaciers lie over active volcanoes[16] Iceland has installed a system of highly attuned seismometers[17] to quickly sense and respond to potential eruptions and their ensuing floods.

For Fear of Ice

Gudni Gunnarsson and his wife Hulda Magnúsdóttir have lived their entire lives near the village of Höfn in southeast Iceland. They are sheep farmers, with a home at the foot of a glacial tongue at Fláajökull. They have an old dog and grown children and Hulda is quick to bring cakes and coffee. She has never left Höfn, literally, has never traveled further than the next two villages over. Neither Hulda nor Gudni speak English and so I rely on Hugudur, a young woman from the research center at Neimar, to translate questions and responses.

Figure 1.2. | *Gudni Gunnarsson pointing to Fláajökull, a glacier that borders his farm, 2016.*
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Gudni is very clear that he has always found glaciers to do more harm than good. He explained in detail their dangers, the way they can crawl over land and destroy it in their wake. Glaciers could become monstrous, toppling structures and uprooting homes. More than the groaning and growing ice however, were the threats of *jökulhlaups* (glacial flooding), when melt water would pool and seep beneath the surface, causing instability at the juncture between water and ice. For a time, an ice dam might hold but it could just as easily burst without warning, sending crashing floods to all below it. This is why, Gudni explained, houses are placed higher up on the hillsides to avoid being whisked away and floated out to sea. Gudni had long understood the glacier in his backyard as an imminent threat; it was hard to live with, but you had to learn how to live with it.

Gudni had to think for a while to come up with anything positive to say about the glacier nested in the mountain near his home. Proximity is not easy. He conceded that they used to utilize the glacier for ice in the 1930s and 40s. Prior to refrigeration the glacier could provide adequate ice to keep freshly caught fish cold. Perhaps it was doing some good in retaining water over the year for what would later become waterfalls. He remembered too teams of scientists coming to the glacier in the 1940s, but he was unclear what precisely they were looking for.

What Gudni returned to several times is that the glacier is in fact a part of the mountain, not distinct from it. It seemed that speaking about the glacier in the singular was awkward. Perhaps even illogical. Glaciers are folded into the world. After we had eaten through several dishes of cakes washed down with dark coffee Gudni did agree that he finds his glacier beautiful, but only at times.

Glaciers may have sublime beauty. But they have also been menacing, threatening life with their mass and watery outbursts. So how do we understand this ice? As ominous threat or thing of wondrous beauty? As that to be avoided, or that to which we should direct our care and concern (Latour 2004)? In contemporary discourse and media portrayals, melting cryospheres are taken as objects of apprehension and distress: a measurable, visual, mobile indicator of a climate transforming more rapidly than had been expected. But if the affective response to melting glaciers is now tilted toward alarm (and rightly so), it has not always been the case. Recognizing this ambivalence should not lead us away from the material omens that are embodied in melting ice. Rather, these prognostications of an increasingly iceless future indicate the range of possible abstractions that humans, and perhaps more importantly, the more-than-human world, can offer to climatologically troubled times (Howe 2019; Howe and Boyer 2016).

Conclusion

In an epoch that has been dubbed the Anthropocene, human impact becomes literally set in stone, felt in the bodies of every earthly creature, and diffused through the cryosphere, hydrosphere, and atmosphere. The great melting at the top of the world, and the bottom as well, may have us wondering about what is being washed away and what future is to come.

For Sheila Jasanoff, a scholar of science and technology, “abstraction,” is the key tool by which modern science cements its validity and universality. The scientific method has the capacity to abstract the phenomena it engages by lifting them out of a specific setting in order to demonstrate how fragments, elements, and pieces can be meaningfully independent of the whole out of which they come. This is how, Jasanoff notes, science is able to achieve its epistemic value: by creating abstracted entities like the periodic table of chemical elements, the nitrogen cycle, the metric system, biodiversity, or climate change. Abstraction represents no particular person's unmediated experience (or observation) of the world and yet abstractions are often recognized and accepted as real (Jasanoff 2010: 234). In contrast to the abstraction of the scientific method outlined by Jasanoff, in this chapter I have taken a turn toward the "abstrac*tive*," as a way to allow for other renderings of phenomena as "knowable" and real. If the abstraction exercised within science produces knowable fragments, taking parts from wholes and rearranging them otherwise, the practice of abstractive knowing is its opposite: a way of sensing the massive and enigmatic conditions and processes known as "climate change" in ways that are experienced at a human scale, but not necessarily felt by humans alone (Descola 2015).

The dead polar bear in Sauðárkrókur is not necessarily a sign of extinction. One killed bear does not end a species. However, the shooting of the bear and the debate surrounding her fate generated affective responses as well as critiques of existing policy. This, I would argue, is the abstractive work of the slaughtered bear: manifesting melt empirically so that it is felt. A dead bear makes climate change vividly "real" for those affected. The shot polar bear is more than a single death because it is an indicator of impending species extinctions as climate change advances and disappearing ice results in the disappearance of Arctic animals who rely on it.[18] The rebounding of Iceland itself can also be taken as an abstractive encounter, where the loss of ice across the island's surface creates the conditions for more rapid geologic upheaval. Less ice means less weight and in turn, more geological motion. Melting ice performs a reciprocal response to the activity of geos beneath it. In each of these instances, abstractive acts occur through other-than-human entities: bears and stone in response to bodies of ice. For Guðfinna, wires dropped deep into the ice indicate how layers of compacted ice are sloughed away, becoming liquid. The "mass balance" that keeps a glacier healthy, moving, and in equilibrium is no longer balanced, but tipping into deficit. For Gudni, the glacier that is slowly disappearing from behind his home may come as a relief from a natural world that in the past threatened to oust human settlement. Now, it leads to ambivalence, maybe nostalgia, and a certain unsettling. In melt, we find multiple points where abstractive encounters are assembled. Climatic conditions become known and sensed in their multiplicity. Between the abstractive sensing that occurs with dead bears and wary farmers, and the abstractions of glaciological science, we are positioned to engage the kind of response-ability that Haraway has called for. Slipping between abstractive sensing and abstractive sciences, as melting ice would have us do, we are led to new engagements with a cryosphere disassembling, retreating, and becoming differently in its dissolve.

Cymene Howe is Professor of Anthropology at Rice University. She is the author of *Intimate Activism* (2013) and *Ecologics: Wind and Power in the Anthropocene* (2019) and coeditor of *The Johns Hopkins Guide to Critical and Cultural Theory* and *Anthropocene Unseen: A Lexicon* (2020). Her research focuses on climatological precarity and her work has been funded by the US National Science Foundation, the Fulbright Commission, and the Andrew W. Mellon Foundation. She was also awarded The Berlin Prize for transatlantic dialogue in the arts, humanities, and public policy from the American Academy in Berlin.

Notes

1. www.climatecentral.org/news/arctic-ice-melting-faster-18967.
2. See: www.dw.com/en/polar-ice-sheets-melting-faster-than-ever/a-16432199.
3. www.theguardian.com/environment/climate-consensus-97-per-cent/2013/nov/13/global-warming-underestimated-by-half.
4. http://www.independent.co.uk/environment/arctic-warming-twice-rate-rest-of-planet-global-warming-snow-water-ice-permafrost-arctic-monitoring-a7710701.html#http://www.independent.co.uk/environment/arctic-warming-twice-rate-rest-of-planet-global-wa.
5. By definition, glaciers are formed where winter snowfall amounts exceed that of summer melting, causing snow to accumulate on the surface and transform to ice. Critical thickness for glacier formation is approximately 30 meters with a density of 0.85 g/cm^3 and when these conditions are achieved, the existing ice deforms and moves downslope to become a glacier (Debarbieux 2008: 4).
6. See Katz 2013. Nearly half of the world's terrestrial glaciers are located in the Arctic region. The global total of glacialized land is 680,000 km^2, with 315,000 km^2 of that total located in the Arctic. Iceland's glaciers are considered to be especially well-documented historically (United Nations Environment Programme 2009: 52)
7. The Arctic Circle passes through Iceland's offshore island, Grímsey.
8. The Arctic Council is comprised of the following member states: Canada, Denmark/Greenland, Finland, Iceland, Norway, Russia, Sweden, and the United States, with several other countries serving as observers (China, France, Germany, India, Italy, Japan, the Netherlands, Poland, Singapore, South Korea, Spain, and the United Kingdom). Six Indigenous nations' groups—represent-

ing Aleut, Athabaskan, Gwich'in, Inuit, Saami, and Russian Indigenous Peoples—have Permanent Participant status on the Council.

9. Formerly called the Northeast Passage, the Northern Sea Route traverses the eastern Arctic seas and connects the Atlantic and Pacific oceans. The seasonal variation in the Artic is considered to be more extreme than anywhere else on earth, moving from ice-cover to lush conditions in annual cycles. The Arctic Ocean, surrounded as it is by land, is more subject to terrestrial influence than any other ocean on the planet; its hydrology is singular, on the one hand encircled by land and on the other, fed by some of the world's largest rivers (Committee on Emerging Research Questions in the Arctic, Polar Research Board 2014: vii).
10. Franz Boas's legacy is complex, including the question of how to interpret the capacity of Inuit and Yupik languages to express numerous terms for snow and ice that Boas's research documented. However, it is worth noting that the loss of Indigenous cultures in the far North, which were associated with salvage anthropology of the late nineteenth and early twentieth centuries, can be taken as the first signs of cultural "loss" due to the effects of colonial encroachment and exposure to capitalist extraction. These kinds of disappearances would continue to accelerate over time with industrial pollutants now rendering polar bears, ice, and others increasingly imperiled.
11. I thank Arthur Mason and Marcel LaFlamme for this insight on the abstractive capacity of social media.
12. https://www.theguardian.com/environment/2016/dec/19/arctic-ice-melt-already-affecting-weather-patterns-where-you-live-right-now.
13. Greenland lost a trillion tons of ice between 2011–14, resulting in twice the sea level rise compared to the prior two decades, about one centimeter each year. Antarctic and Greenland ice sheets represent 99 percent of freshwater ice on earth. By definition, an ice sheet must be at least a total of twenty thousand square miles and situated on land. If the Greenland Ice Sheet (which is about three times the size of Texas) were to melt, scientists estimate that sea levels would rise about six meters (or twenty feet). If the Antarctic Ice Sheet (which is 5.4 million square miles) were to melt entirely, sea levels would rise by about sixty meters (or two hundred feet) (Ehrlich 2015).
14. This assessment is based on the last deglaciation period beginning 12,000 years ago. Reduced pressure on rocks beneath lost ice creates more volatile molten conditions and more eruptive potential.
15. In comparison, Scandinavia was covered by an ice sheet approximately twenty thousand years ago and it continues to rebound from that time. Iceland has a thinner crust than in Scandinavia and is positioned on the plate boundary meaning there are significant differences in the rate and speed of rebounding in the two regions. One glaciologist explained rebounding movement this way: "Iceland is like a rubber band while Scandinavia is like honey."
16. When a volcano erupts, magma at temperatures as high as 2,200°F meets ice and water, which casts plumes of steam and rock particles rocketing skyward. Matthew J. Roberts, a glaciologist with the Icelandic Meteorological Office, compares the ensuing smoke and particles to a mushroom cloud.

17. http://www.nytimes.com/2006/01/17/health/science/with-glaciers-atop-volcanoes-iceland-zooms-in-on-signs-of.html.
18. While I am not making the claim that polar bears are indicator species, I am intending to evoke the idea of species and other forms (such as ice) as indicators signaling anthropogenic harm. Indicator species are unique exemplars of significant ecosystemic change, and they are an integral component of conservation biology and scientific analyses of transformed environments (and the biotic life occupying them). However, while certain biological organisms may signal ecosystemic breakdown (or recovery), they can also become contested objects of political discourses surrounding preservation measures. See for example Blaser (2016).

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