



Assessing Arctic Change

Revisiting an Earlier Exhibit with New Data and Contemporary Perspectives



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Challenges Facing Reindeer Herders

Warmer air temperatures have resulted in an increased number of rain-on-snow (ROS) events, a dangerous trend for reindeer herders.¹ An ROS event is when rain falls on snow during a warm spell in winter and can form a layer of thick ice on the surface of the ground, preventing reindeer from accessing lichens and sometimes resulting in mass starvation.² The Saami and Nenets of northern Europe cope with icy pasture by utilizing TEK to make informed decisions about when and where to move their herds. However, the increasing unreliability of formerly predictable seasonal changes and the significant growth of infrastructure restrict their ability to cope.³

Rain-on-snow events have grown in extent and frequency since 2006, as has economic interest in the North, creating unforeseen challenges to the adaptive strategy of indigenous reindeer herders.



Saami reindeer herder in Sweden. Photo © Mats Andersson.

¹ Ye H et al. 2008 Winter rain on snow and its association with air temperature in northern Eurasia. *Hydrological Processes* 22: 2728–2736. (doi: 10.1002/hyp.7094)
² Forbes BC et al. 2009 High resilience in the Yamal-Nenets social-ecological system, West Siberian Arctic, Russia. *Proceedings of the National Academy of Sciences* 106(52): 22041–22048. (doi: 10.1073/pnas.0908286106)
³ Turunen M et al. 2016 Coping with difficult weather and snow conditions: Reindeer herders' views on climate change impacts and coping strategies. *Climate Risk Management* 11: 15–36. (doi: 10.1016/j.crm.2016.01.002)

Methods

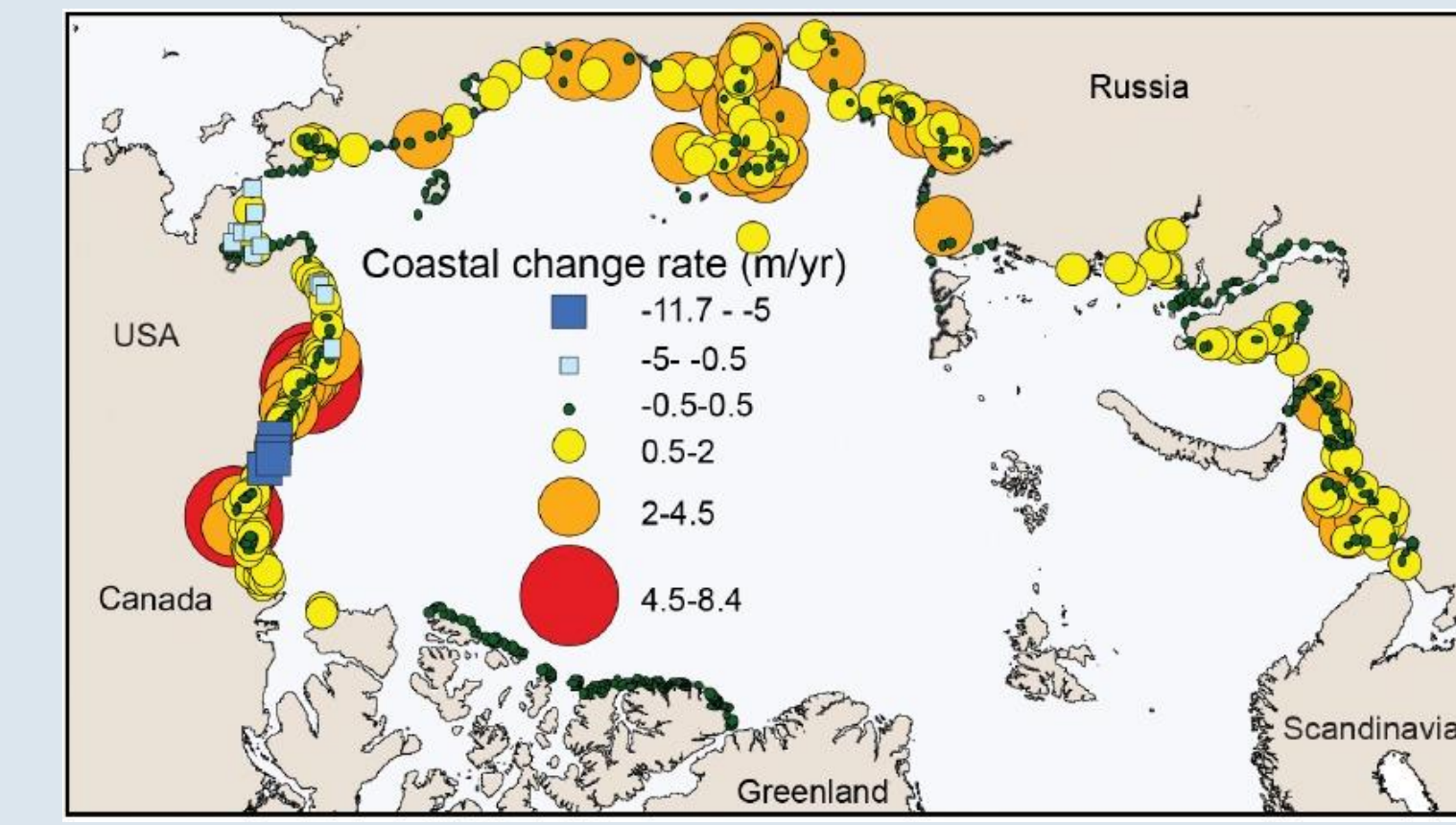
This project explored the developments in Arctic climate change research after 2006, the date of a Smithsonian exhibition called “Arctic: A Friend Asking Strangely.” Using the original themes (“stories”) of the exhibit, I explored the literature on each theme and identified topics in which major advances had occurred. The topics I chose included: sea ice loss, increased coastal erosion, challenges to Arctic reindeer herding, risks facing the boreal forest, and thawing permafrost. Following my topic selections, I surveyed the literature on each issue, eventually creating a synthesis of changes in each field over the past 10-15 years. I selected those stories which seemed most compelling, both in 2006 and 2017, and offered insight into the ways in which indigenous communities in the Arctic have observed, been affected by, and adapted to changes.



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Coastal Erosion

Coastal erosion rates are intricately linked with the amount of sea ice nearby: a larger fetch increases water levels and results in stronger eroding waves, particularly during the now ice-free fall time.¹ However, coastal communities have shown great resilience in spite of the advancing sea. The Alaskan village of Shishmaref, featured in the 2006 exhibit, remains in its original location. Shishmaref is one of the 183 coastal Native Alaskan communities that are impacted regularly by coastal erosion and flooding.² High costs and close ties to the land prevent communities from acting on calls for relocation, despite facing new challenges, including salt-water intrusion of freshwater sources and the loss of many cultural sites.³



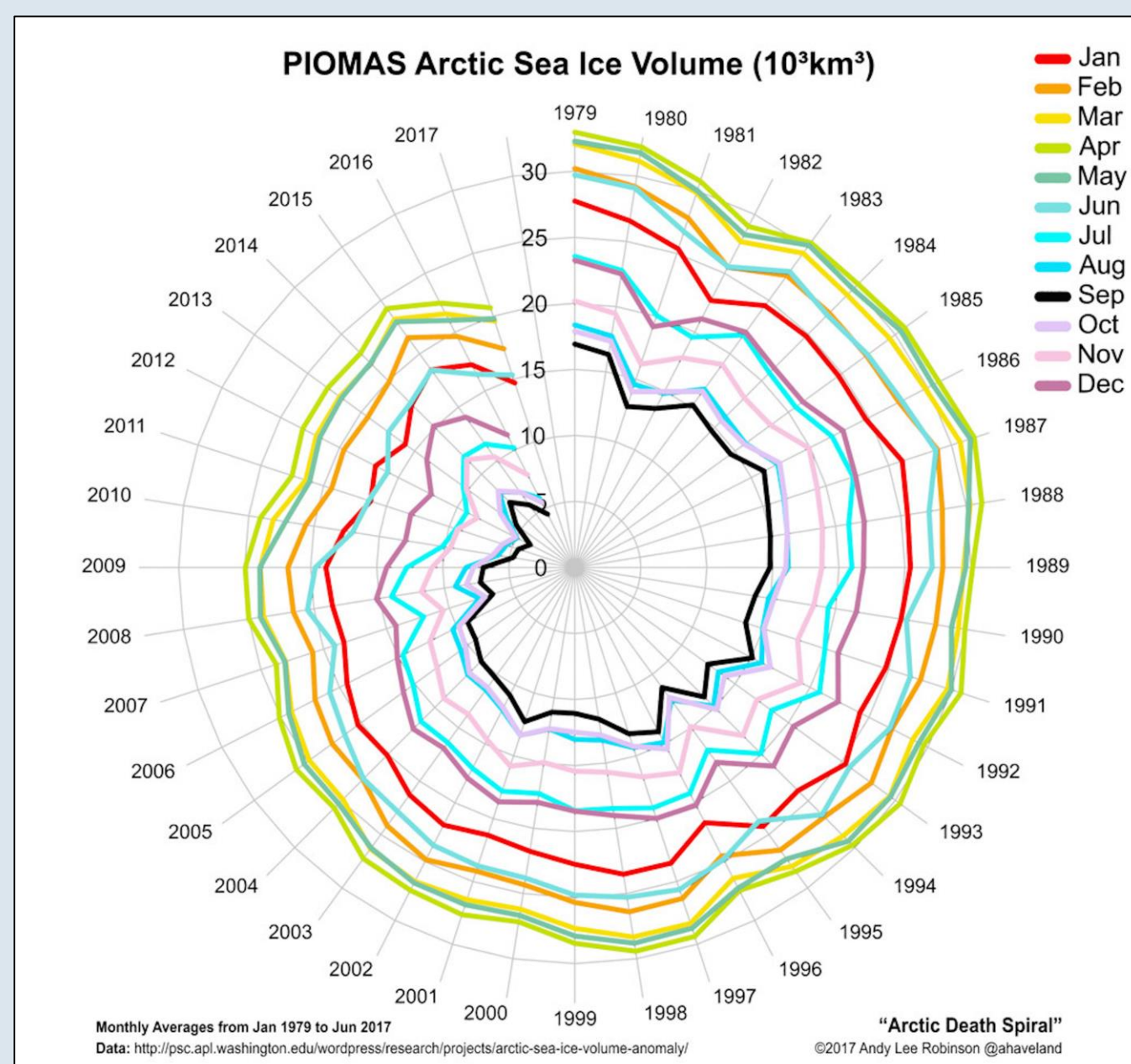
Coastal erosion and deposition rates per year along the Arctic coast. Reprinted from “The effect of changing sea ice on the physical vulnerability of Arctic coasts,” by KR Barnhart, 2014, *The Cryosphere* 8(1), 1785. Copyright 2014 by KR Barnhart.

Decreasing sea ice and a permafrost ridden coast mean that the Arctic coast is eroding at high rates – exactly as predicted in 2006. However, coastal communities have shown greater resilience than anticipated in 2006.

¹ Barnhart KR et al. 2014 The effect of changing sea ice on the physical vulnerability of Arctic coasts. *The Cryosphere* 8: 1777–1799. (doi: 10.5194/tc-8-1777-2014, 2014)
² Clement JP et al. 2013 Managing for the future in a rapidly changing Arctic: A report to the President. Interagency Working Group on Coordination of Domestic Energy Development and Permitting in Alaska (D. J. Hayes, Chair), Washington, D.C., 59 p.
³ Frederick JM et al. 2016 The Arctic Coastal Erosion Problem. Report by Sandia National Laboratories, Albuquerque, NM, 122 p.

Declining Sea Ice

Perhaps the most dramatic and publicly recognizable change in the Arctic is an increasing decline in the extent and thickness of sea ice. Warming air temperatures lengthen and intensify the summer melt season, allowing the dark open sea to absorb more heat which then delays fall-freeze up.^{1,2} Indigenous people using rich terminologies are able to easily identify change in the type and quality of sea ice, expanding evidence for sea ice loss available through scientific data. Loss of sea ice has negatively impacted indigenous ways of life, as the ice that communities used to rely on in search of food is unsafe and no longer arrives on time, if at all.³



Graph showing the decline in sea-ice volume from 1979 to present, also called the “Arctic Death Spiral.” Reprinted from Haveland-Robinson Associates, by A. L. Robinson, 2017, Retrieved from haveland.com. Copyright 2017 by Andy Lee Robinson.

Arctic Sea ice is disappearing faster than the already alarming rate predicted in 2006. Since then, the negative effects of decreasing sea ice, both social and ecological, have become massive, more visible, and undisputable.

¹ Polyak L et al. 2010 History of sea ice in the Arctic. *Quaternary Science Reviews* 29: 1757–1778. (doi: 10.1016/j.quascirev.2010.02.010)
² IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.
³ Krupnik I et al. (2010). *SIKU: Knowing Our Ice*. Retrieved from www.springer.com

“Big Picture” Synthesis

There are a few scales at which one could address the concept of climate change. At the planetary scale, one can think about the rising concentration of greenhouse gases, the associated temperature warming, or about the projected sea level rise.¹ Focusing in more closely on a particular area, such as the Arctic, one could rely on additional sources of data, namely, the traditional ecological knowledge (TEK) and observational skills of Arctic indigenous peoples.

Of note when talking about climate change at a regional scale is the observed phenomenon of Arctic amplification, or that the Arctic is warming at 1.9 times the rate of the rest of the world.^{1,2} Therefore, data from the polar regions could provide a proxy for the impacts of global processes on people and environments of our planet.

¹ IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.
² Serreze MC et al. 2000 Processes and impacts of Arctic amplification: A research synthesis. *Global and Planetary Change* 77: 85–96. (doi: 10.1016/j.gloplacha.2011.03.004)

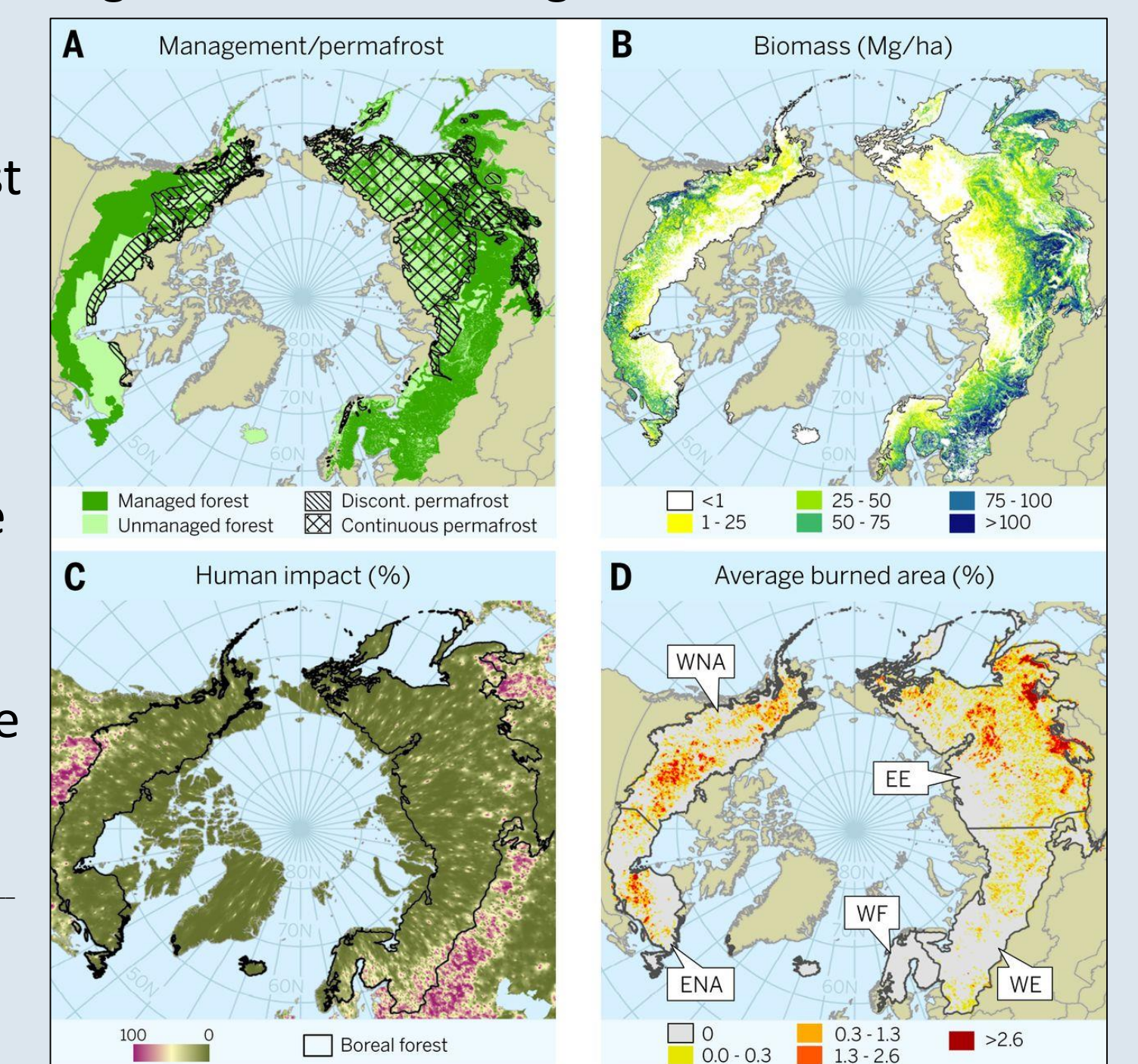
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Challenges to Boreal Forests

Wildfires in boreal forests are increasing in severity and frequency, resulting in deleterious effects for local communities. This issue was not covered in the 2006 exhibit. A longer fire season and a rising number of lightning strikes are thought to be the main causes.¹ Fires lower the quality of local ecosystems for traditional food economies, as well as threaten homes. The immobility of many settled communities means that adjusting residence or hunting locations following a wildfire is more difficult.²

Also, the boreal forest is a large carbon sink with 33% of Earth's forest cover. Carbon release during and following a burn has global implications as a source of greenhouse gases.³ Another issue, which is still seen as emergent, is the northward shift of the taiga-tundra ecotone as growing season length increases in the Arctic, which became more pronounced in the past decade.¹



¹ Veraverbeke S et al. 2017 Lightning as a major driver of recent large fire years in North American boreal forests. *Nature Climate Change* 7: 529–534. (doi: 10.1038/nclimate3329)
² Chapin FS et al. 2008 Increasing Wildfire in Alaska's Boreal Forest: Pathways to Potential Solutions of a Wicked Problem. *BioScience* 58(6): 531–540. (doi: 10.1641/B580609)
³ Ruckstuhl K et al. 2008 Introduction. The boreal forest and global change. *Philosophical Transactions of the Royal Society B: Biological Sciences* 363(1501): 2245–2249. (doi: 10.1098/rstb.2007.2196)

Interacting attributes of the boreal forest, mapped. From Gauthier S et al. 2015 Boreal forest health and global change. *Science* 349(6250): 819–822. Reprinted with permission from AAAS.