

Frontiers in Understanding Climate Change and Polar Ecosystems

Jacqueline M. Grebmeier (Co-chair), University of Maryland; John C. Priscu (Co-chair), Montana State University; Rosanne D'Arrigo, Lamont-Doherty Earth Observatory; Hugh W. Ducklow, Marine Biological Laboratory; Craig Fleener, Alaska Department of Fish and Game; Karen E. Frey, Clark University; and Cheryl Rosa, U.S. Arctic Research Commission
NRC Staff: Martha McConnell, Laurie Geller, and Lauren Brown

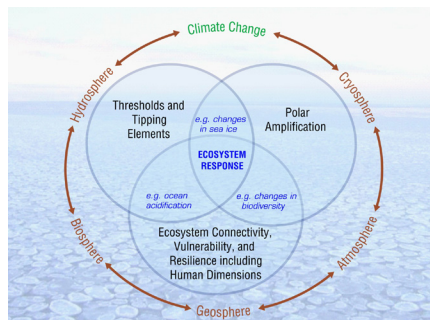
FRONTIERS IN UNDERSTANDING CLIMATE CHANGE AND POLAR ECOSYSTEMS

REPORT OF A WORKSHOP

Reference:
National Research Council, 2011. Frontiers in Understanding Climate Change and Polar Ecosystems. National Academies Press, Washington, D.C., 76 pp.

Acknowledgements:
National Science Foundation
National Aeronautics and Space Administration
National Oceanic and Atmospheric Administration

To investigate the steps needed to gain a better understanding of effects of climate change on polar ecosystems, the Polar Research Board of the National Research Council organized a workshop that brought together scientists with expertise in Arctic, Antarctic, marine, and terrestrial environments in August of 2010. This poster highlights a few of the key research questions identified in the subsequent report.



This figure illustrates the connectivity among earth system components and climate change in the context of three themes developed for the workshop (thresholds and tipping elements; polar amplification; and ecosystem connectivity, vulnerability, and resilience including human dimensions).

POLAR CASE STUDIES

Impacts of Climate Variability in the McMurdo Dry Valleys

From 1986 to 2000, summer temperatures in the McMurdo Dry Valleys cooled by about 0.7 degrees Celsius per decade. The cooler summer temperatures caused layers of permanent lake ice to thicken, reducing the amount of light available for the growth of photosynthetic plankton that serve as food for other species. In addition, cooler temperatures also reduced the flow of glacial melt streams, reducing water and nutrient input to the lakes.

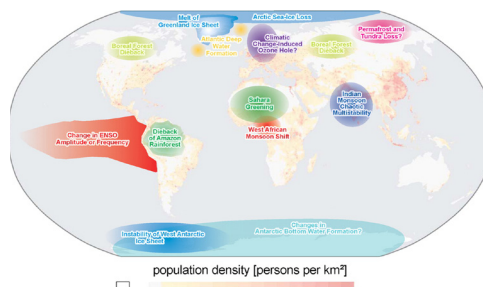


Arctic Sea Ice Retreat and Walrus Relocation

Because walrus must now travel further from land to reach prey fields, they are using more energy, leaving less energy available for growth. The evidence also suggests walrus will have a progressively harder time finding sea ice platforms, which is expected to have a negative impact on walrus populations.

Frontier Questions

1) Will a rapidly shrinking cryosphere tip polar ecosystems into new states? The loss of cryosphere is an important indicator of change in the polar regions and could have significant implications around the globe.



Potential policy-relevant tipping elements in the climate system. Subsystems indicated could exhibit threshold-type behavior in response to anthropogenic climate forcing. Source: Lenton et al. (2008).

2) What are the key polar ecosystem processes that will be the "first responders" to climate forcing? Understanding the linkages and interactions among components of polar ecosystems is crucial in the development of climate models that accurately predict future change. Perturbations to one part of the system can cause a cascade of impacts throughout the system.

3) What are the bi-directional gateways and feedbacks between the polar and the global climate system? Complex

connections and feedbacks in ecosystem processes require research and collaboration among many disciplines to improve understanding of "gateways" in the global system. Examples of gateways that need additional research include sea level rise, ocean circulation, the albedo effect, and biome shifts and migration patterns.

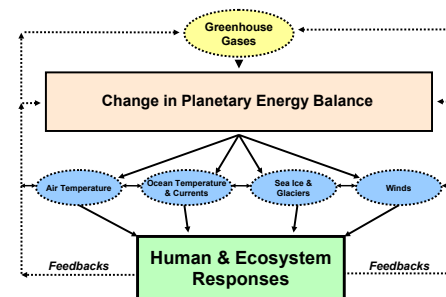
4) How is climate change altering biodiversity in polar regions and what will be the regional and global impacts?

Rapid changes in the polar regions associated with shifting climate patterns present serious complications for both marine and terrestrial organisms. Changes in productivity and migration could threaten biodiversity in ways that we do not yet understand.

5) How will increases in human activities intensify ecosystem impacts in the polar regions? Increased access to

the polar regions as a result of climate change will result in increased human activity (for example, fishing, tourism, and resource extraction). Human presence in these regions can mean additional risk in the form of oil spills, invasive species, and disturbances to wildlife.

Climate Change and Ecosystem Linkages



Methods and Technologies to Address the Frontier Questions

Emerging Technologies

- genomics, remote sensing, in situ instrumentation

Sustained Long-Term Observations

- in situ observations, monitoring impacts on people, biological sentinels/proxies, biotic community composition, marine LTER in the Arctic

Data Synthesis and Management

- international coordinated efforts, Polar Systems Institute

Science-to-Society Interface: Data Dissemination and Outreach

- increased communication of results for local and federal policymaker engagement



The Polar Research Board (PRB) is a unit within the National Academies and is responsible for studies related to the Arctic, Antarctic, and cold regions in general. More information about the PRB and other related activities can be found at <http://dels.nas.edu/prb/>. The report is available as a free PDF download at http://www.nap.edu/catalog.php?record_id=13132 and paper copies are available for purchase through the National Academies Press at (888) 624-8373.

**NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES**