# USGS Changing Arctic Ecosystems (CAE) Initiative

**Joshua Koch**

jkoch@usgs.gov

*Research Hydrologist, CAE – PI, USGS Alaska Science Center*

*ABoVE Co-I*

# Alaska Science Center

- ~ 150 Scientists
- 40 in Water, Ice, and Landscape Dynamic (WILD) Office
- 50 in Changing Arctic Ecosystems (CAE)

Contacts:

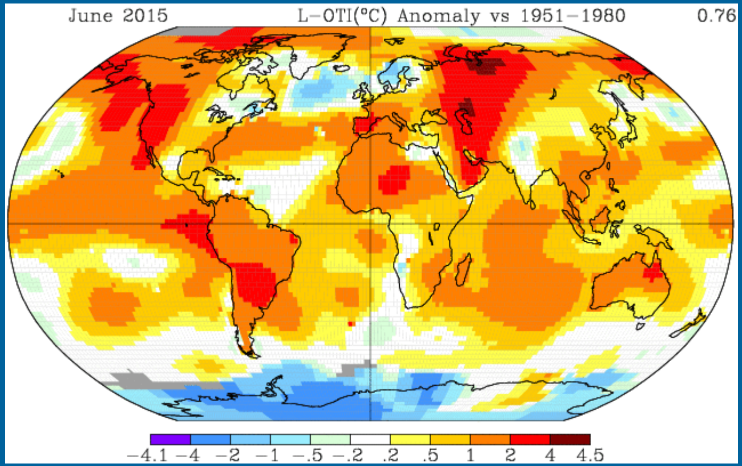
Mark Shasby - Director

John Pearce - CAE

# Talk outline

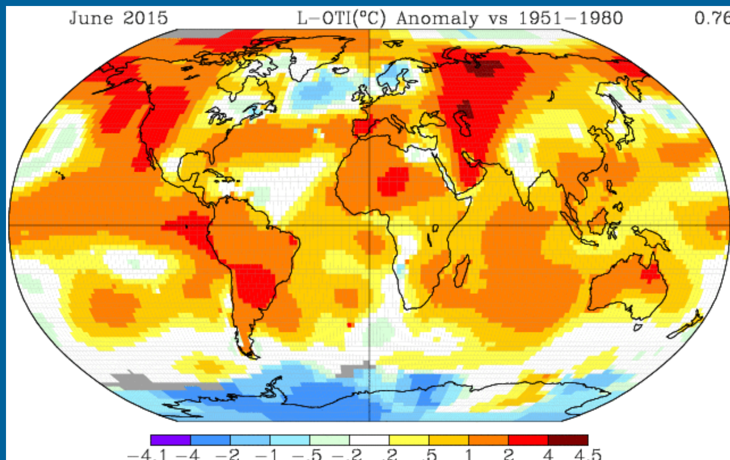
- Wildlife “Winners and Losers”
- CAE goals and approach
- Research framework and study examples
- Forecasting

# Temperature-driven changes: terrestrial






# Temperature-driven changes: marine





Melting sea ice


Changes in water temperature and productivity


Salt water inundation

USGS

# The current narrative for wildlife

NEWS | FEATURES

**BOOM & BUST**

**IN THE GREAT WHITE NORTH**

As the Arctic warms, retreating sea ice is revealing winners and losers in ecosystems under siege

*By* **Eli Kintisch** *in Ny-Ålesund, Norway*

*Science*

ENERGY/ENVIRONMENT

**Global warming: winners and losers in the Arctic's 'new normal'**

The Arctic Report Card study suggests that changes at the top of the world have led to unusual weather patterns, a greener Greenland, and lots of plankton. At least the whales are pleased.

*Christian Science Monitor*

**Study: Warmer Arctic means faster mosquito growth, spelling hazard for caribou**

Yereth Rosen | September 15, 2015

*Alaska Dispatch News*

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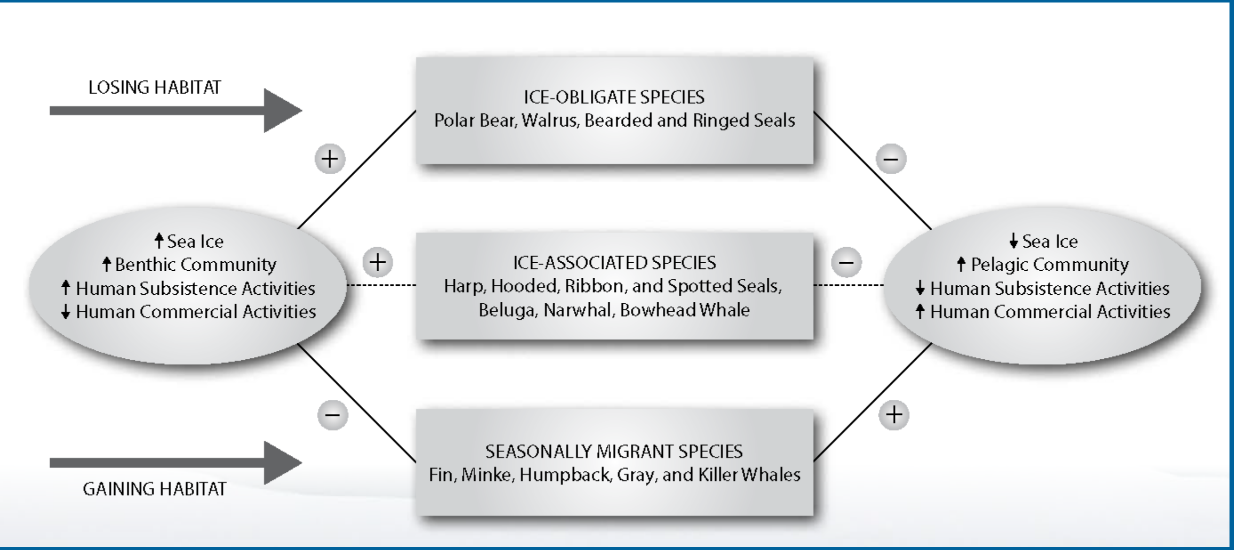
# Winners & losers

- Marine species
  - Ice-obligates lose
  - Seasonal migrants gain


Adapted from Moore and Huntington *Ecol Appl* 2008

# But is it so simple?

Arctic

## Polar bears to humans: Relax, we've got this

Annika Fredrikson | September 7, 2015

Young polar bears are chased away from whale meat in Kaktovik. September 7, 2012

Loren Holmes photo

*Alaska Dispatch News*

There are spatial and temporal variations in the magnitude and direction of change, and there are some apparent mixed signals.

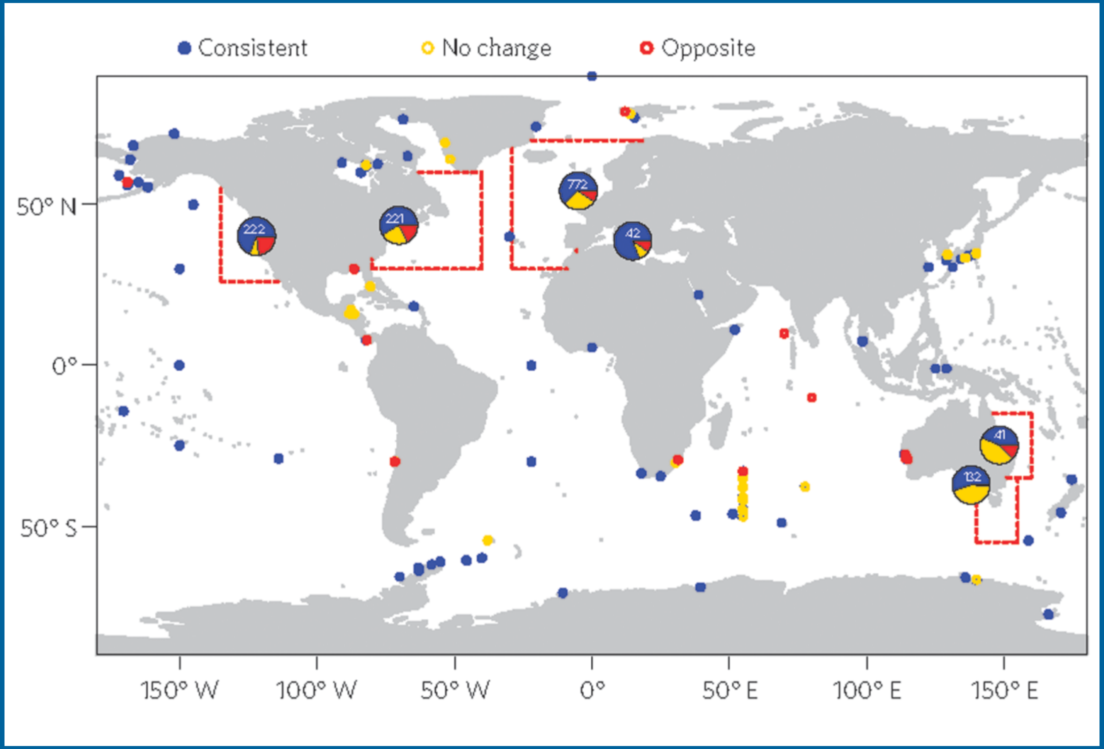
*Arctic Report Card*

“It’s not all like a gloom and doom story for the caribou and a positive story for the mosquitoes…”

*Alaska Dispatch News*

# At a global scale: marine environment

- 37% of species showed no change or opposite response
- Attributed to limited resolution, multiple drivers, evolutionary adaptation
- Need to understand mechanisms and drivers for better forecasting




Poloczanska et al. 2013 *Nature Climate Change*

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# Goals and approach of USGS Changing Arctic Ecosystems Initiative (CAE)

- Identify the role of physical drivers on changes in the Arctic
- Quantify wildlife and habitat response to these drivers
- Forecast likely outcomes of the responses
- Provide advanced warning of Arctic ecosystem change to decision-makers

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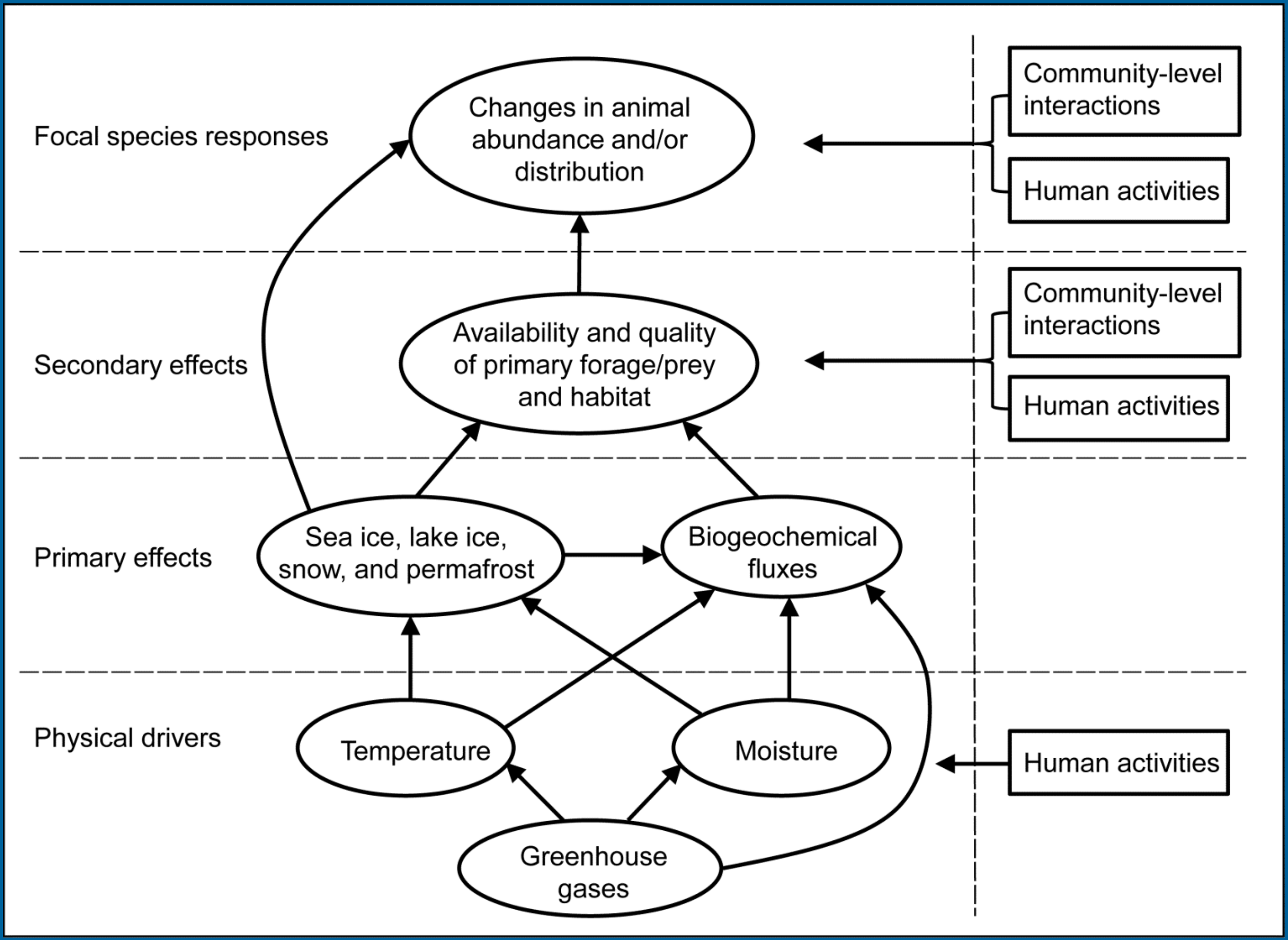
# CAE research framework and examples



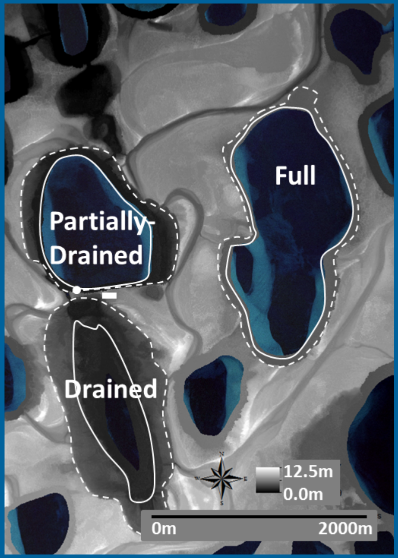

Van Hemert et al. 2015. BioScience

# Primary effects

- **Permafrost** presence and thaw
- **Hydrology** of streams, ponds and lakes
- **Biogeochemical cycling**
- **Vegetation**

Manipulations

Observation and Simulation

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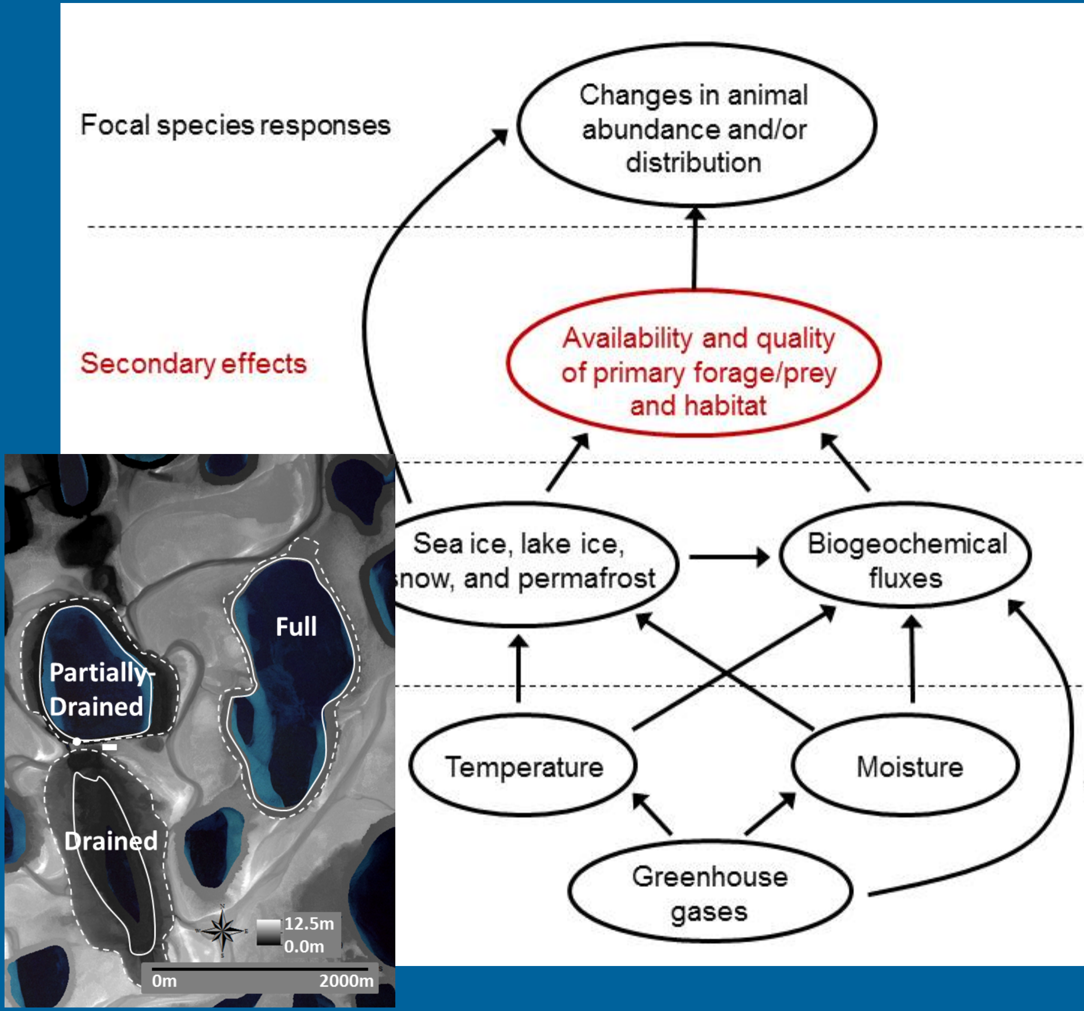
# Research actions: secondary effects

Secondary effects

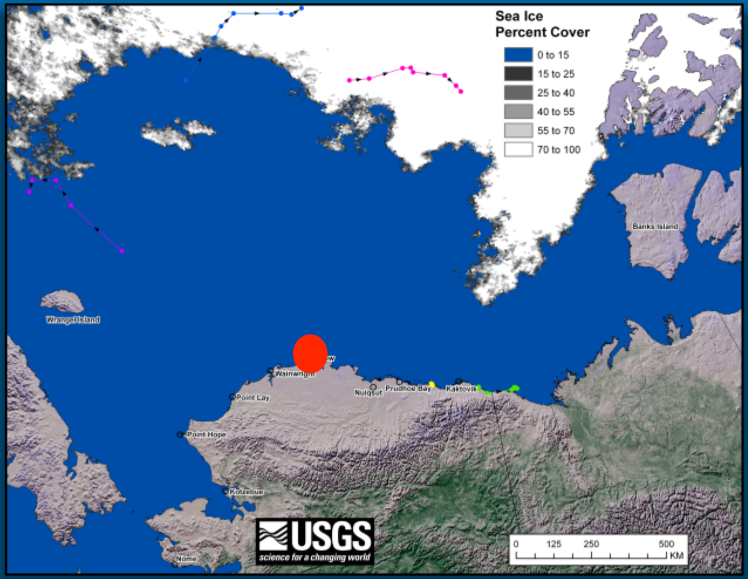
- Food
  - Quality
  - Quantity/availability
  - Timing (mismatch?)
- Habitat
  - Marine (sea ice vs. land)
  - Terrestrial (quality and quantity)



# Secondary effects: marine

Land?

Sea?



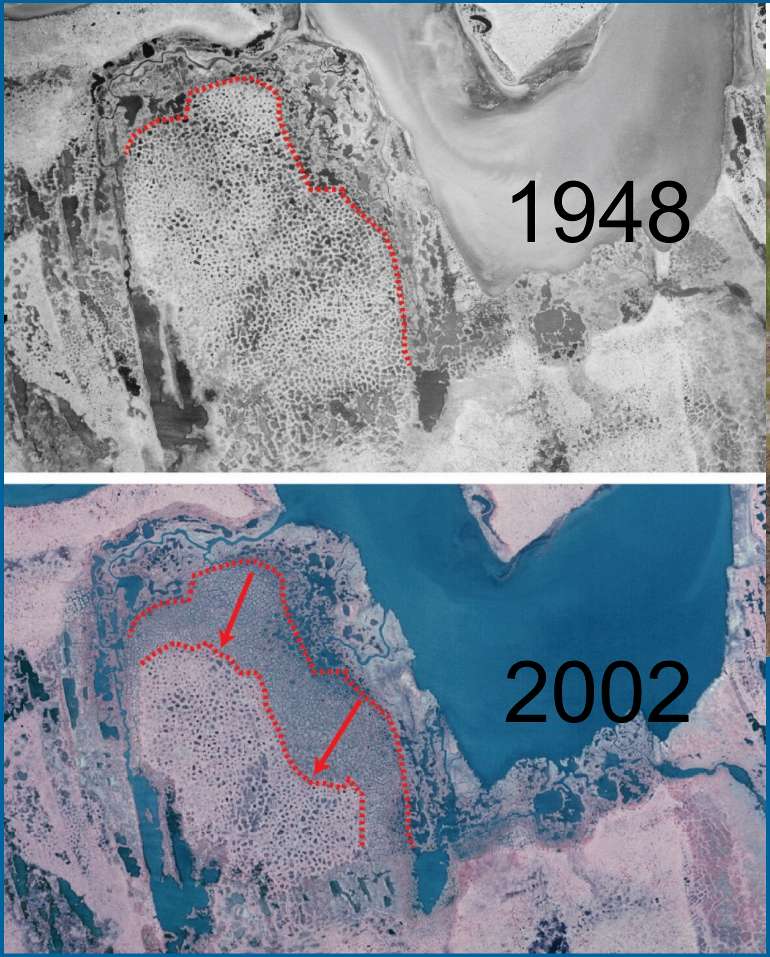

But are there seals out there?


**HABITAT ⟷ FOOD**

Novel Interactions

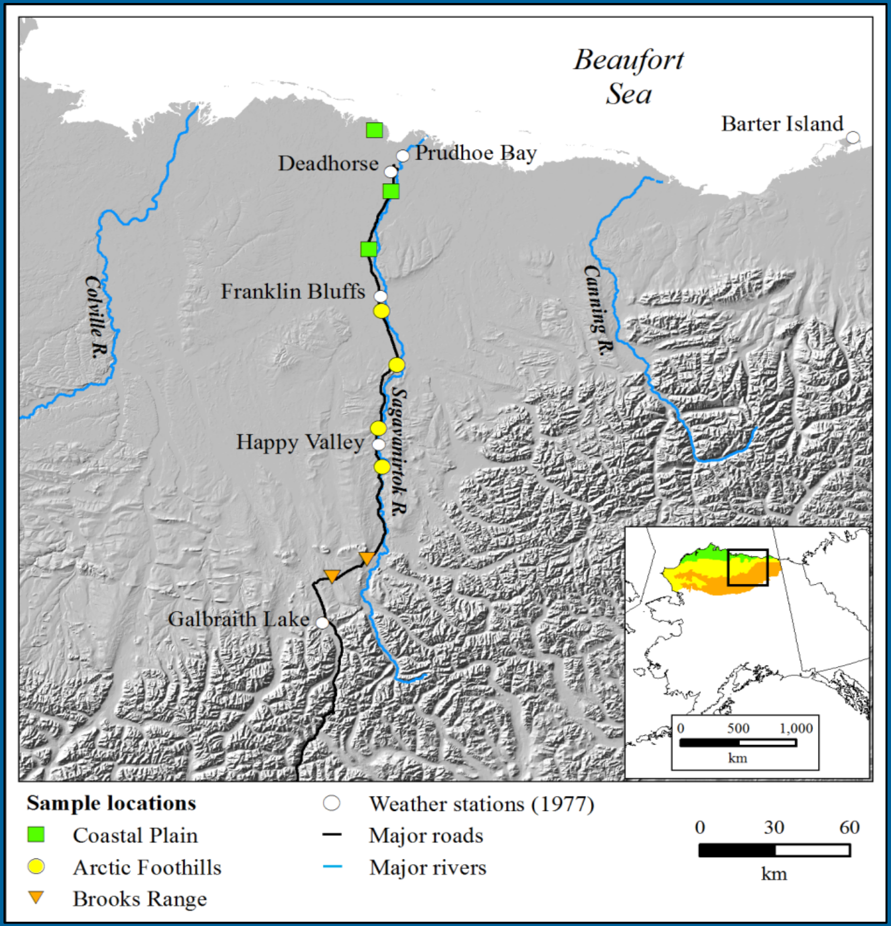
Long distance swims

# Secondary effects: terrestrial




- High quality goose food = good habitat, more geese
- Will it last?

# Secondary effects: terrestrial



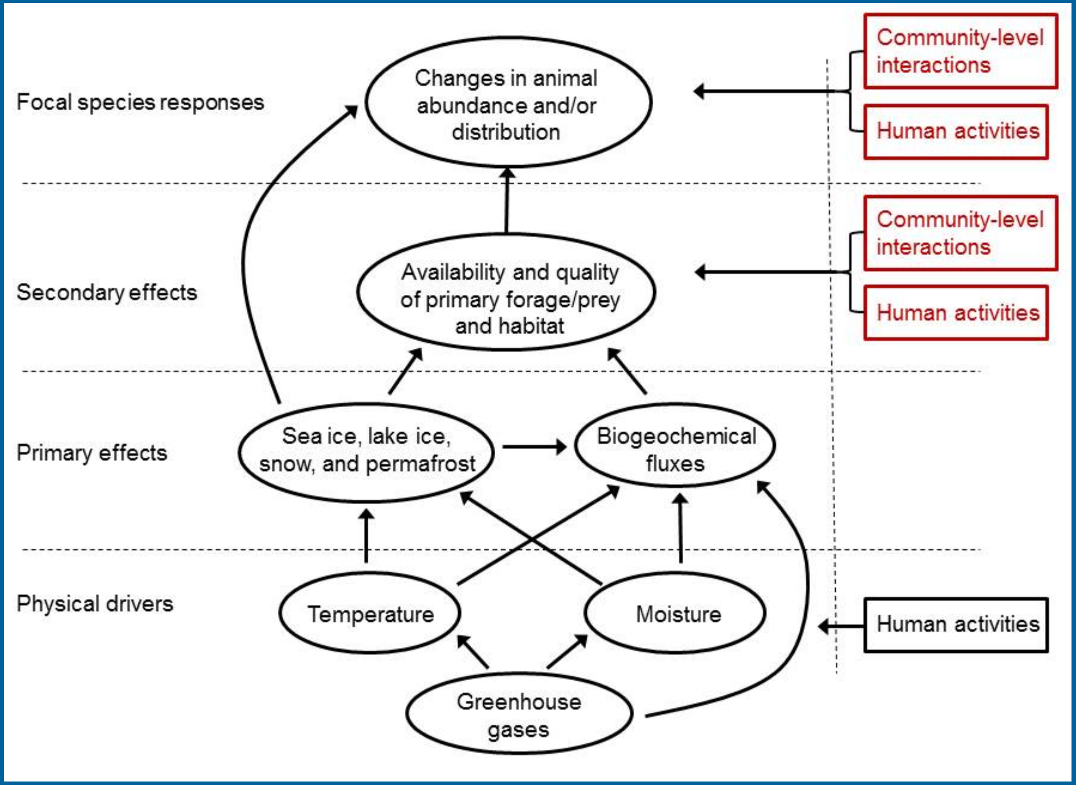

Gustine et al. in review

Earlier thaw date and longer growing season but no observed trophic mismatch

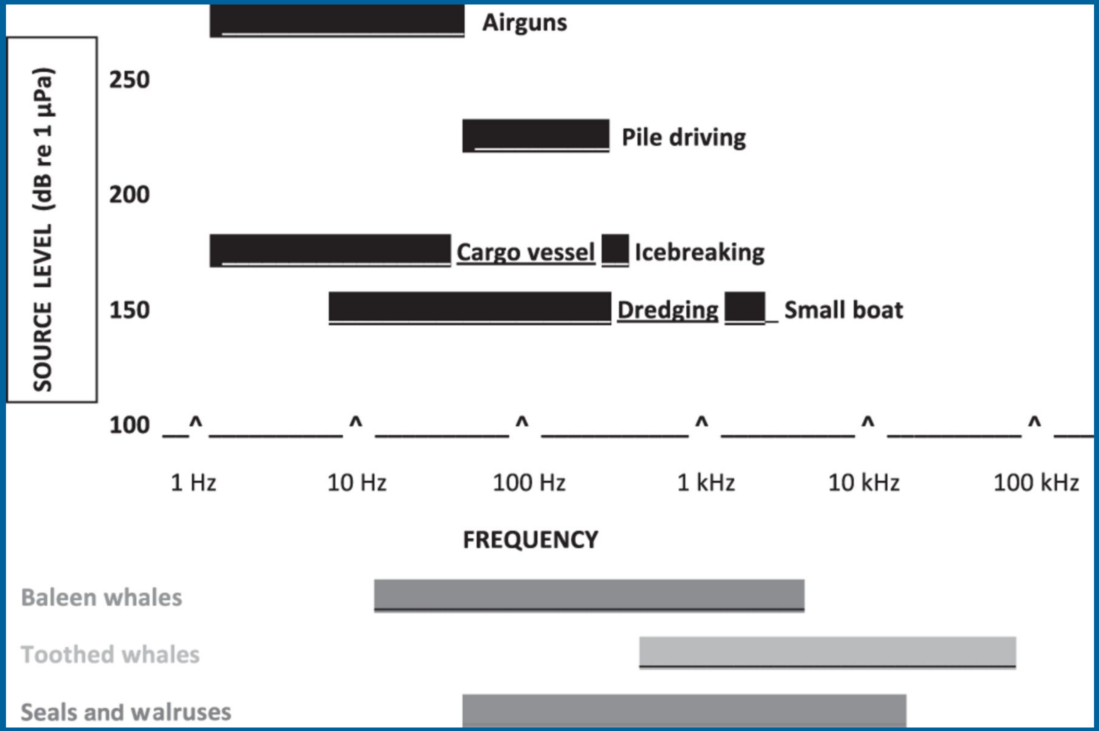
# Research actions: community-level

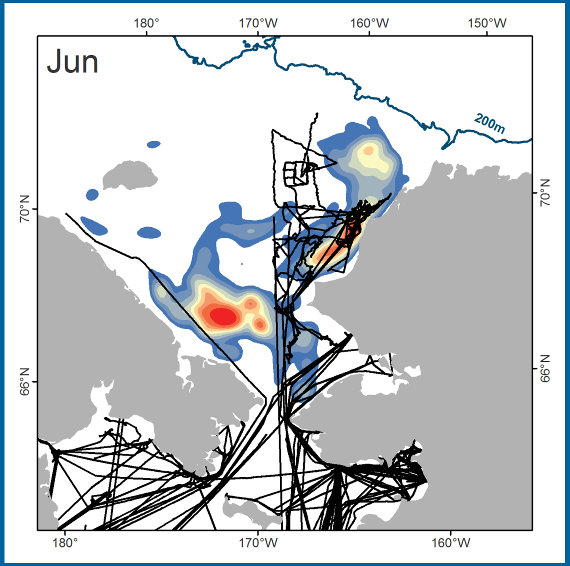
## Community-level and anthropogenic factors

- Disturbance
- Interspecific interactions
- Wildlife disease



# Community-level: disturbance




Frequency bands and source levels for offshore activities in the Arctic relative to frequencies used by whales, seals, and walruses.

Moore et al. *BioScience* 2012

# Community-level: interspecific interactions

Photo: J Simerson

Rode et al. 2015

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rspb.royalsocietypublishing.org

Research

## Longer ice-free seasons increase the risk of nest depredation by polar bears for colonial breeding birds in the Canadian Arctic

Samuel A. Iverson[1], H. Grant Gilchrist[2], Paul A. Smith[2], Anthony J. Gaston[2] and Mark R. Forbes[1]

[1]Department of Biology, Carleton University, Ottawa, Ontario, Canada
[2]Environment Canada-National Wildlife Research Centre, Ottawa, Ontario, Canada

REVIEWS REVIEWS REVIEWS

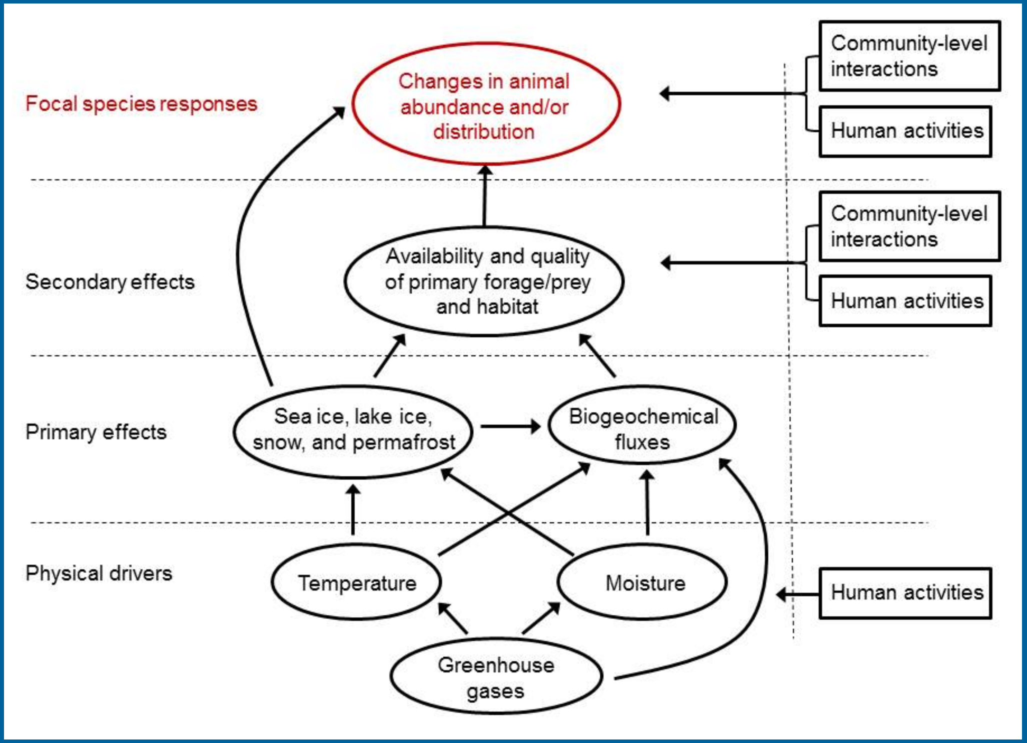
## Can polar bears use terrestrial foods to offset lost ice-based hunting opportunities?

Karyn D Rode[1*], Charles T Robbins[2], Lynne Nelson[3], and Steven C Amstrup[4]

# Community-level: disease

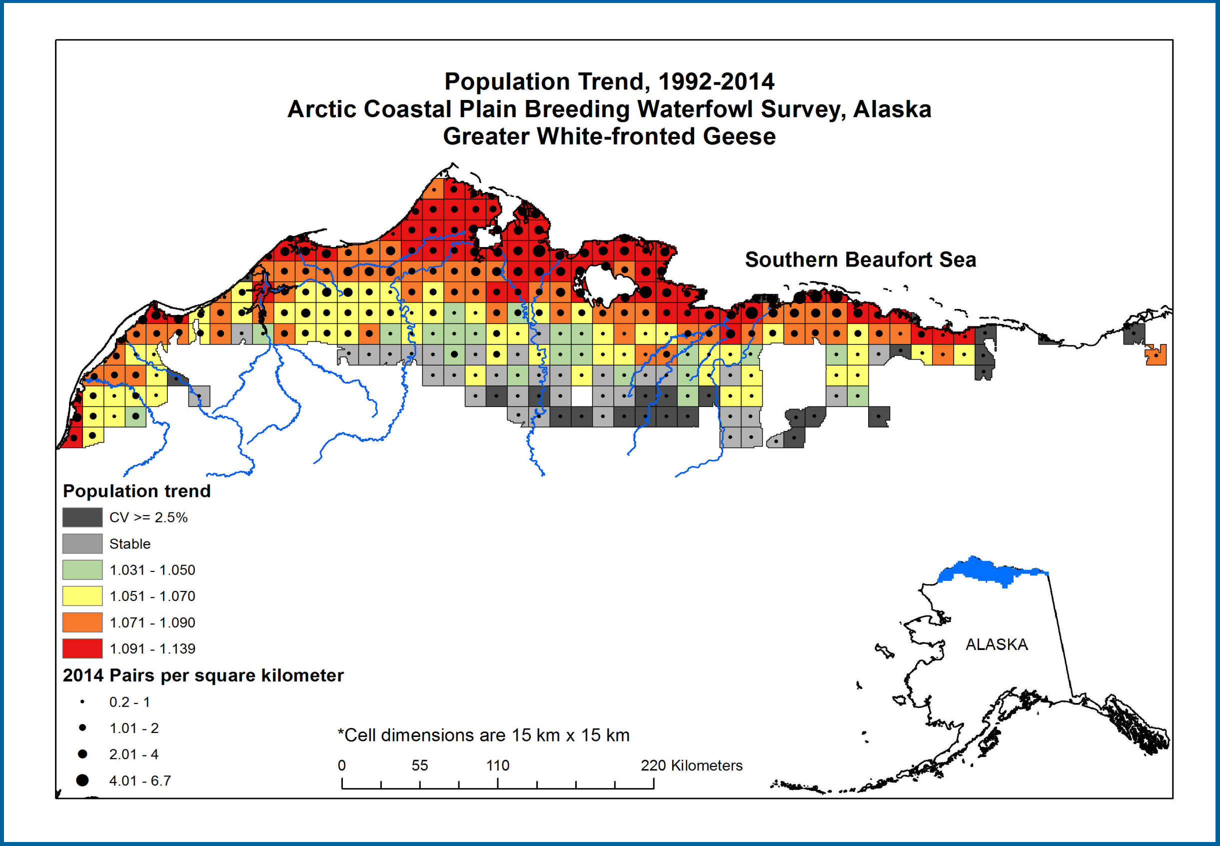
# Research actions: species response

- Predict future changes: forecasting
- Indicators of underlying change



# From detecting responses to forecasting outcomes

- ***Distribution maps:*** USFWS Arctic Coastal Plain waterbird data

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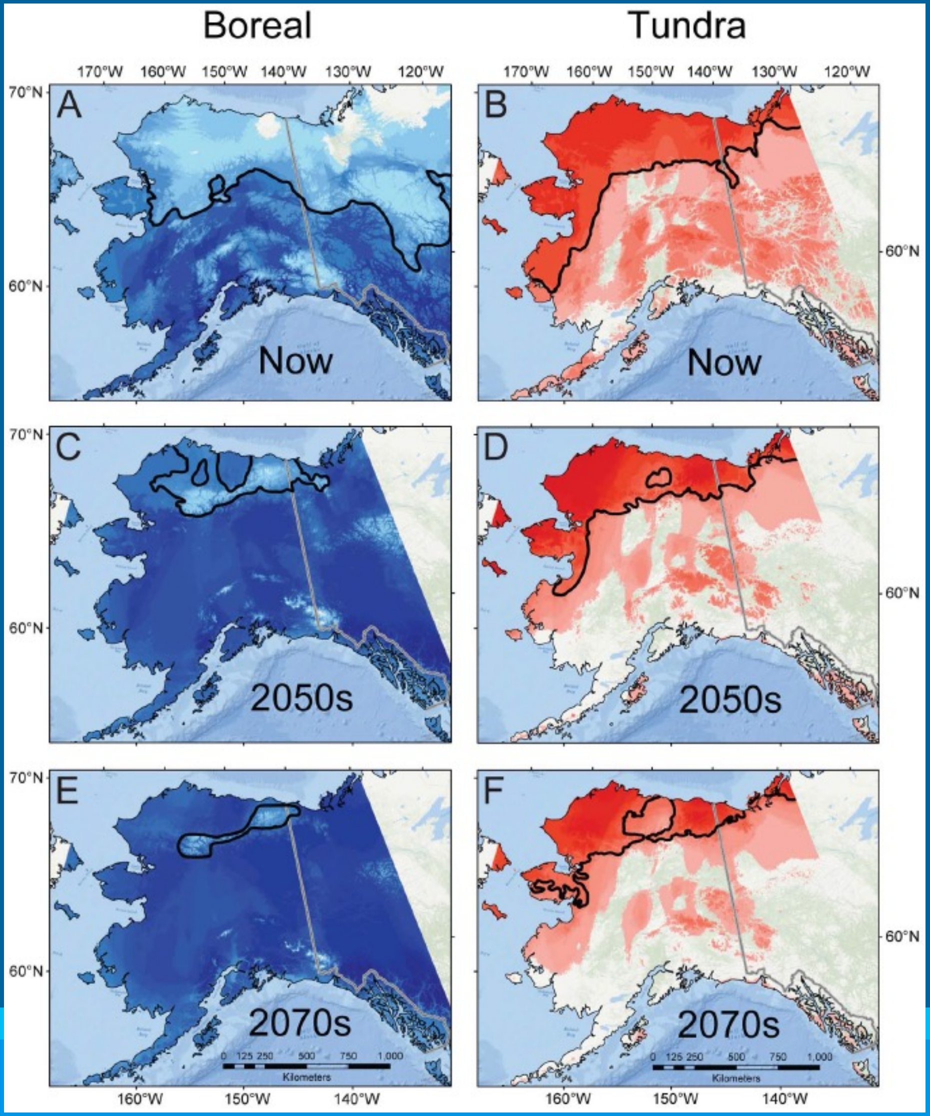
# From detecting responses to forecasting outcomes

- ***Distribution maps:*** small mammals




Hope et al. 2015

# USGS CAE updates for 2015

- 17 papers published
- 2 new fact sheets

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science for a changing world

Changing Arctic Ecosystems

## What Is Causing the Rapid Increase of Snow Geese in Northern Alaska?

Snow Goose. Photograph by Ryan Askren, U.S. Geological Survey.

### Warming Temperatures and Geese in the Arctic

Through the Changing Arctic Ecosystems (CAE) initiative, the U.S. Geological Survey (USGS) informs key resource management decisions for Arctic Alaska by providing scientific information on current and future ecosystem response to a warming climate. The Arctic Coastal Plain (ACP) of northern Alaska is a key study area within the USGS CAE initiative. This region has experienced a warming trend over the past decades, leading to decreased sea ice, permafrost thaw, and an advancement of spring phenology. The number of birds on the ACP also is changing, marked by increased populations of the four species of geese that nest in the region. The Snow Goose (*Chen caerulescens*) is the most rapidly increasing of these species. USGS CAE research is quantifying these changes and their implications for management agencies.

### Changes in Snow Goose Populations in the Arctic

Snow Goose populations in North America have greatly increased over the past six decades, resulting in considerable damage to vegetation on nesting areas and negative effects to other bird species, especially in Arctic Canada where the increase has mainly occurred. Although once common in northern Alaska, Snow Geese were largely extirpated by humans by the early 20th century. Only a small remnant population of less than 1,000 birds nested on the ACP through the latter half of the 20th century. Surveys conducted by the U.S. Fish and Wildlife Service (USFWS) Migratory Bird Management indicate that although the Alaskan population of Snow Geese remains relatively small (about 35,000 individuals) compared to the millions of birds that nest in Arctic Canada, it is increasing rapidly.

### USGS Research on the Changing Demography of Geese

Since 2011, the USGS has studied how Snow Geese on the Colville River Delta in northern Alaska are responding to a rapidly warming Arctic and how their increase may affect other bird species. USGS examined the migration chronology of Snow Geese and 15 other species that commonly nest on the ACP and determined that Snow Geese have advanced their arrival to the Colville River Delta more than most other species over the past 30 years. Snow Geese start their nests earlier in spring and hatch young 4–7 days before other goose species, such as Black Brant (*Branta bernicla nigricans*) and White-fronted Geese (*Anser albifrons*) (fig. 1). Early hatch confers an advantage to young goslings as it gives them access to higher quality forage. This allows goslings to grow larger, which in turn benefits their autumn and winter survival, future recruitment into the breeding population, and reproductive performance as adults. USGS research determined that in most years Snow Geese on the Colville River Delta have higher nest survival and produce as much as 25 percent more goslings than neighboring Black Brant or White-fronted Geese. Return rates to the Arctic also were higher for female Snow Geese than for female Black Brant. Thus, high reproductive success and adult survival are likely contributing to the rapid increase of Snow Geese on the ACP. Immigration of Snow Geese from the large populations in the Canadian Arctic also may be adding birds to the Alaskan population. Based on hunter recoveries of banded birds, USGS estimates that less than 3 percent of adult Snow Geese nesting in Alaska are harvested by hunters in North America, indicating that hunting likely has little effect on the population.

USGS captures and bands Snow Geese in late summer when they are flightless. Recoveries and recaptures of banded geese enable estimation of adult and juvenile survival, and hunter harvest. Late summer captures also provide an opportunity to measure juvenile growth; an indicator of habitat quality. Photograph by Jerry Hupp, U.S. Geological Survey.

U.S. Department of the Interior
U.S. Geological Survey

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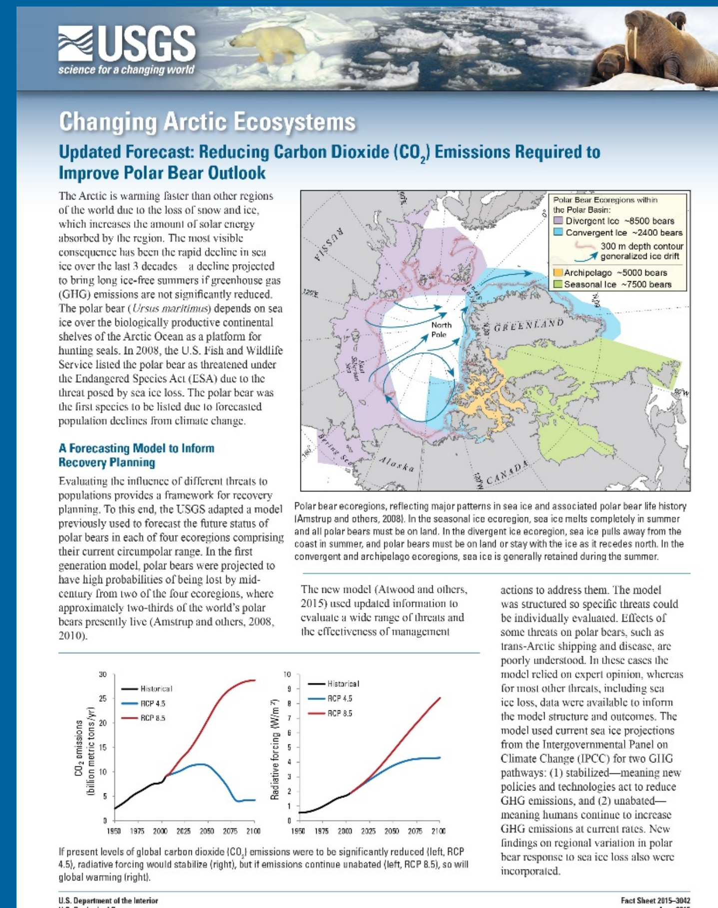
Fact Sheet 2015–3062
September 2015



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Changing Arctic Ecosystems

## Updated Forecast: Reducing Carbon Dioxide ($CO_2$) Emissions Required to Improve Polar Bear Outlook

The Arctic is warming faster than other regions of the world due to the loss of snow and ice, which increases the amount of solar energy absorbed by the region. The most visible consequence has been the rapid decline in sea ice over the last 3 decades—a decline projected to bring long ice-free summers if greenhouse gas (GHG) emissions are not significantly reduced. The polar bear (*Ursus maritimus*) depends on sea ice over the biologically productive continental shelves of the Arctic Ocean as a platform for hunting seals. In 2008, the U.S. Fish and Wildlife Service listed the polar bear as threatened under the Endangered Species Act (ESA) due to the threat posed by sea ice loss. The polar bear was the first species to be listed due to forecasted population declines from climate change.



Polar bear ecoregions, reflecting major patterns in sea ice and associated polar bear life history (Amstrup and others, 2008). In the seasonal ice ecoregion, sea ice melts completely in summer and all polar bears must be on land. In the divergent ice ecoregion, sea ice pulls away from the coast in summer, and polar bears must be on land or stay with the ice as it recedes north. In the convergent and archipelago ecoregions, sea ice is generally retained during the summer.

### A Forecasting Model to Inform Recovery Planning

Evaluating the influence of different threats to populations provides a framework for recovery planning. To this end, the USGS adapted a model previously used to forecast the future status of polar bears in each of four ecoregions comprising their current circumpolar range. In the first generation model, polar bears were projected to have high probabilities of being lost by mid-century from two of the four ecoregions, where approximately two-thirds of the world's polar bears presently live (Amstrup and others, 2008, 2010).

The new model (Atwood and others, 2015) used updated information to evaluate a wide range of threats and the effectiveness of management actions to address them. The model was structured so specific threats could be individually evaluated. Effects of some threats on polar bears, such as trans-Arctic shipping and disease, are poorly understood. In these cases the model relied on expert opinion, whereas for most other threats, including sea ice loss, data were available to inform the model structure and outcomes. The model used current sea ice projections from the Intergovernmental Panel on Climate Change (IPCC) for two GHG pathways: (1) stabilized—meaning new policies and technologies act to reduce GHG emissions, and (2) unabated—meaning humans continue to increase GHG emissions at current rates. New findings on regional variation in polar bear response to sea ice loss also were incorporated.

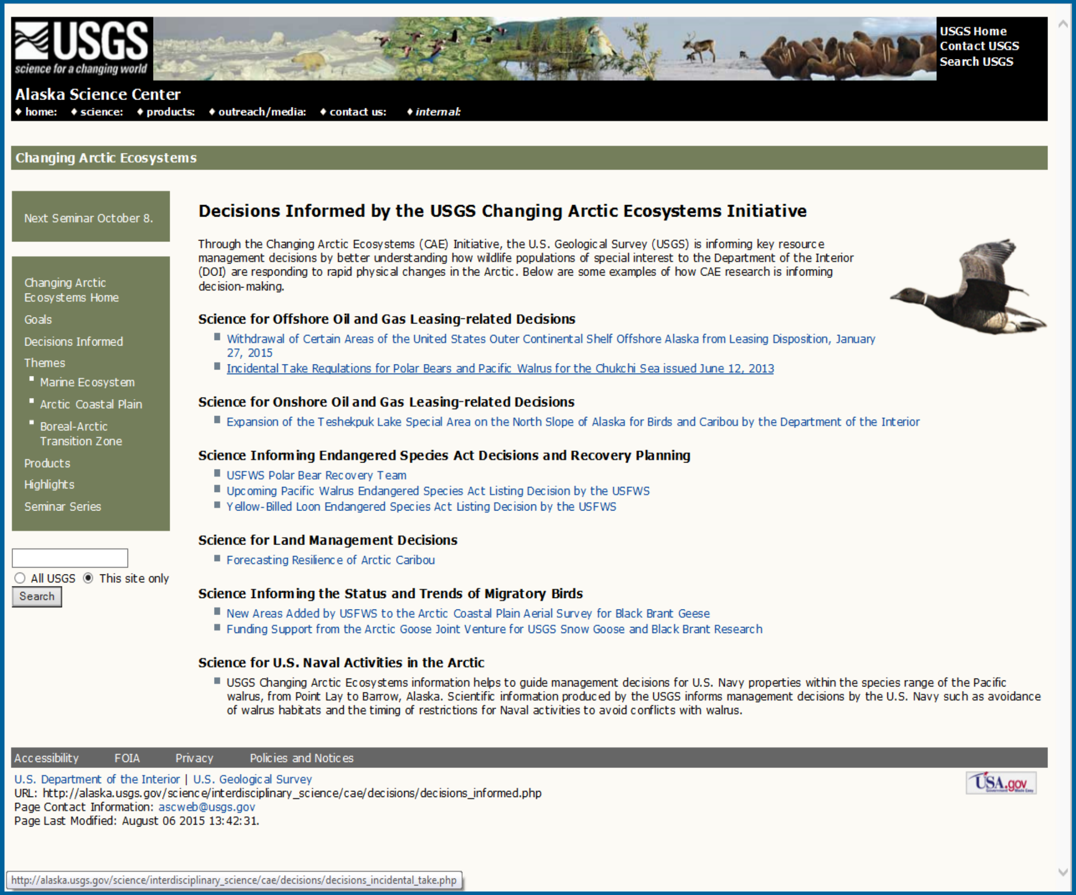


If present levels of global carbon dioxide ($CO_2$) emissions were to be significantly reduced (left, RCP 4.5), radiative forcing would stabilize (right), but if emissions continue unabated (left, RCP 8.5), so will global warming (right).

U.S. Department of the Interior
U.S. Geological Survey

Fact Sheet 2015–3042
June 2015

# Providing information for decision-makers




http://alaska.usgs.gov/science/interdisciplinary_science/cae/index.php

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# USGS Changing Arctic Ecosystems (CAE) Initiative

Questions?

USGS Changing Arctic Ecosystems Initiative
www.alaska.usgs.gov

Supported by the Wildlife Program of the USGS Ecosystems Mission Area