The Timing of Arctic Sea-Ice Advance and Retreat as an Indicator of Ice-Dependent Marine Mammal Habitat

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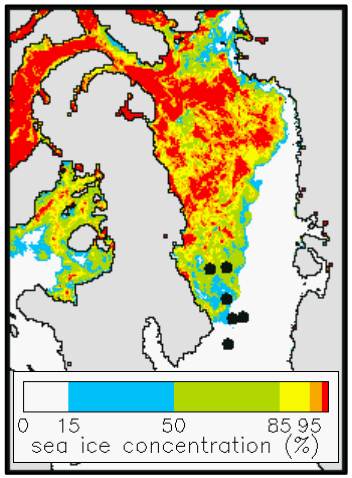
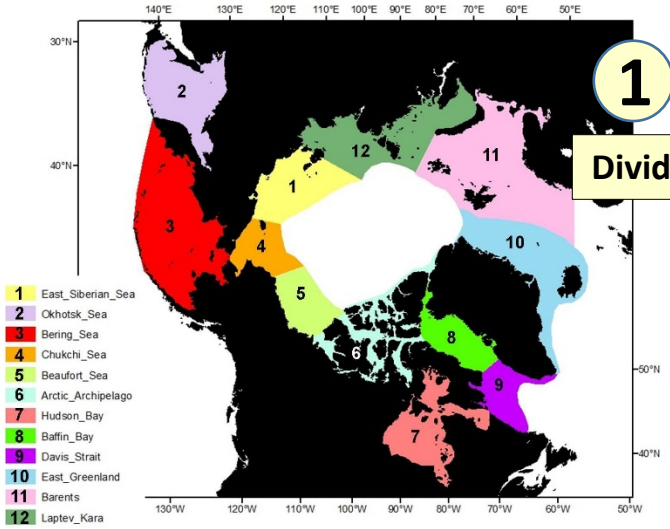


Arctic marine mammals such as polar bears, seals, walruses, belugas, narwhals, and bowhead whales depend on the sea-ice cover as an integral part of their existence.

The dates of spring sea-ice retreat and fall sea-ice advance are key indicators of climate change for ice-dependent marine mammals.

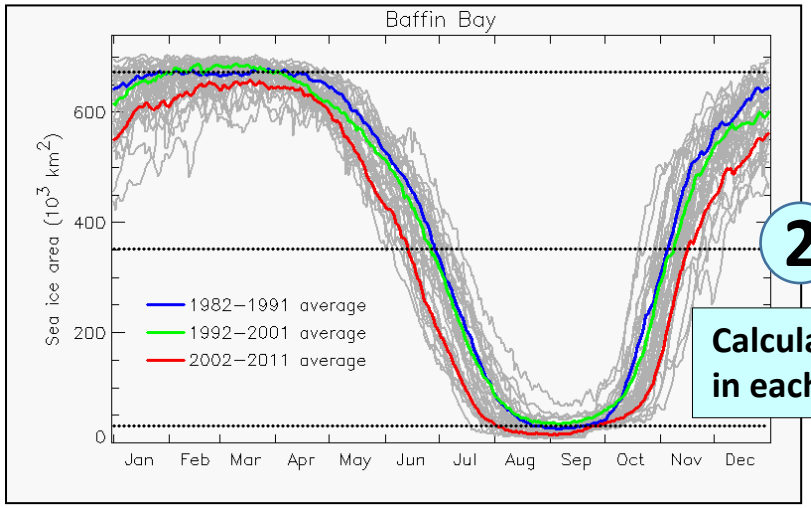
Method to Determine the Timing of Sea-Ice Advance and Retreat



1

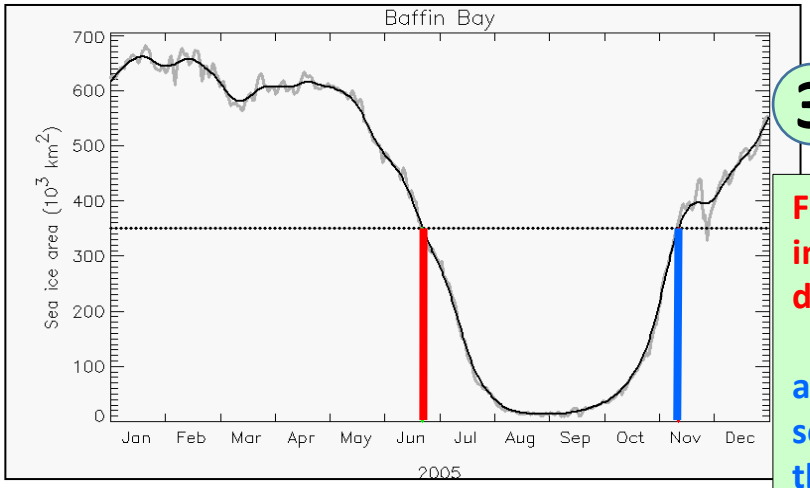
Divide the Arctic into regions

Data: Gridded daily sea-ice concentration (nominal cell size 25 x 25 km) from the National Snow and Ice Data Center, Boulder



2

Calculate the daily sea-ice area in each region, 1979-present



3

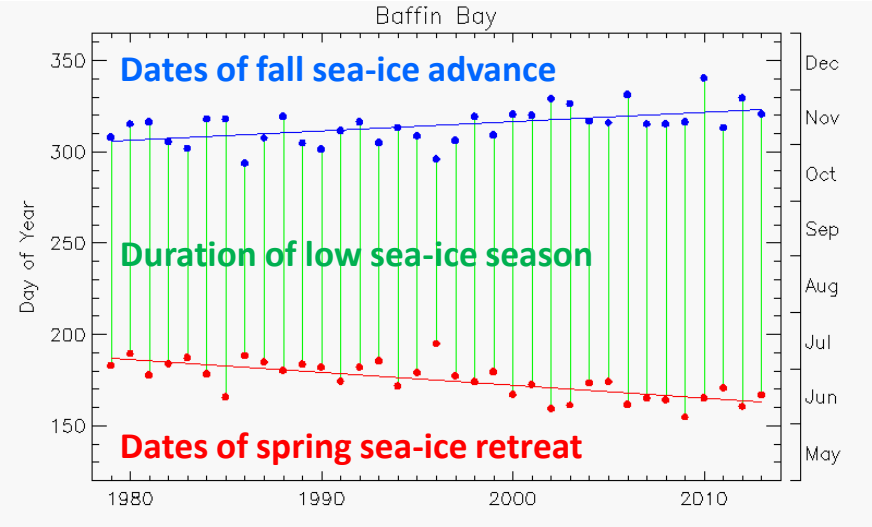
For each year, find the day in spring when sea-ice area drops below a threshold,

and the day in fall when sea-ice area rises above the threshold

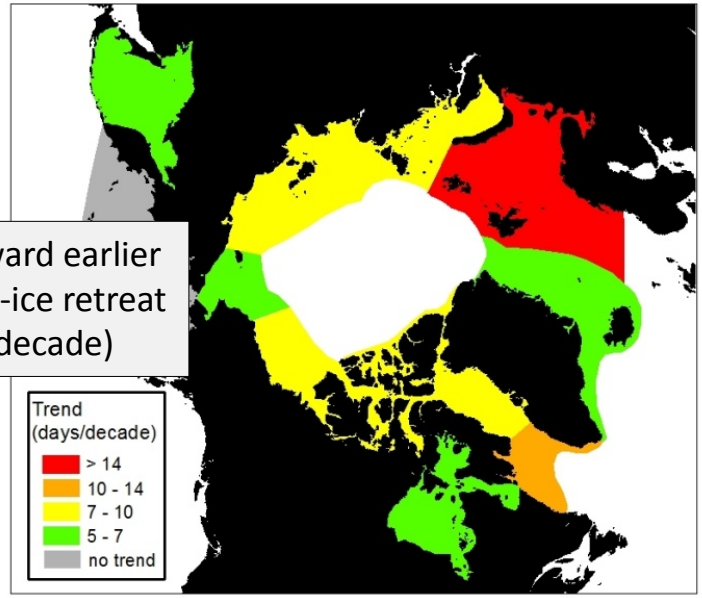
Results for Arctic Biodiversity Assessment (ABA) Regions

Laidre, K., H. Stern, et al (2014). A Circumpolar Assessment of the Status of Arctic Marine Mammals, Sea Ice Loss, and Conservation Challenges in the 21st Century, in revision for *Polar Biology*.

Time Series



Trend Map



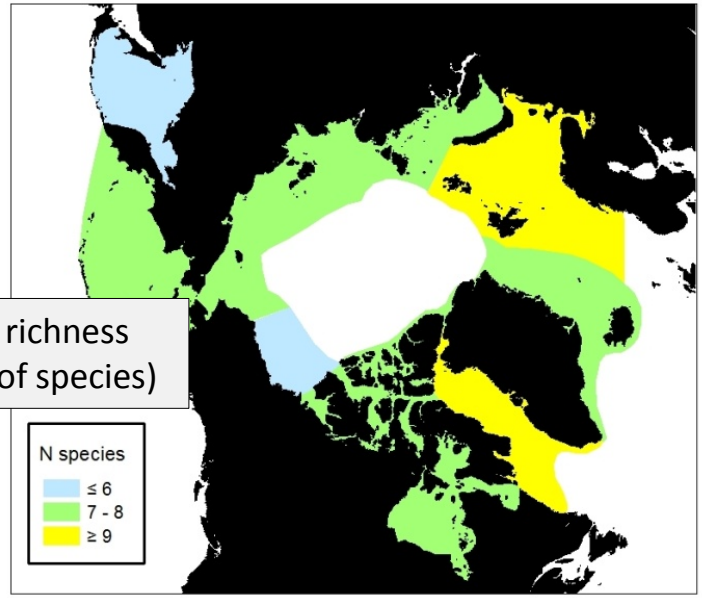


Table of Trends

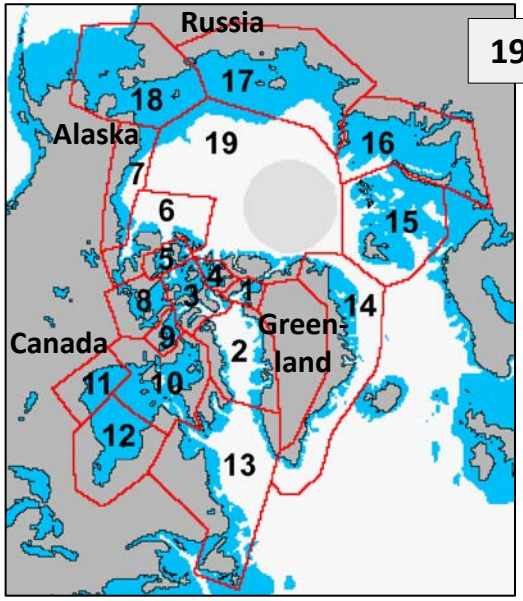
		Spring	Fall	Interval
1	East Siberian Sea	−6.8 ± 2.7 *	+8.6 ± 1.5 **	+15.4 ± 3.9 **
2	Sea of Okhotsk	−4.6 ± 1.6 **	+5.1 ± 2.2 *	+9.7 ± 3.1 **
3	Bering Sea	+1.8 ± 1.7	+0.9 ± 2.2	−0.9 ± 3.0
4	Chukchi Sea	−5.9 ± 1.5 **	+7.0 ± 2.2 **	+12.9 ± 3.3 **
5	Beaufort Sea	−7.3 ± 3.3 *	+7.8 ± 1.9 **	+15.2 ± 4.5 **
6	Canadian Archipelago	−7.3 ± 2.2 **	+6.3 ± 1.2 **	+13.7 ± 3.1 **
7	Hudson Bay	−5.0 ± 1.0 **	+4.8 ± 1.2 **	+9.8 ± 1.9 **
8	Baffin Bay	−7.0 ± 1.2 **	+5.2 ± 1.4 **	+12.2 ± 2.3 **
9	Labrador Sea	−9.7 ± 3.1 **	+10.7 ± 2.5 **	+20.4 ± 4.5 **
10	Greenland Sea	−6.1 ± 1.7 **	+6.2 ± 2.7 *	+12.3 ± 3.7 **
11	Barents Sea	−17.2 ± 2.8 **	+25.1 ± 5.4 **	+41.8 ± 7.1 **
12	Laptev and Kara Seas	−9.4 ± 1.6 **	+7.0 ± 1.5 **	+16.4 ± 2.8 **

p < 0.05

p < 0.01

Results for Polar Bear Specialist Group (PBSG) Regions

Stern, H., and K. Laidre (2013). The Timing of Arctic Sea-Ice Advance and Retreat as an Indicator of Ice-Dependent Marine Mammal Habitat, poster IN11C-1538, AGU Fall Meeting, San Francisco, December 2013.



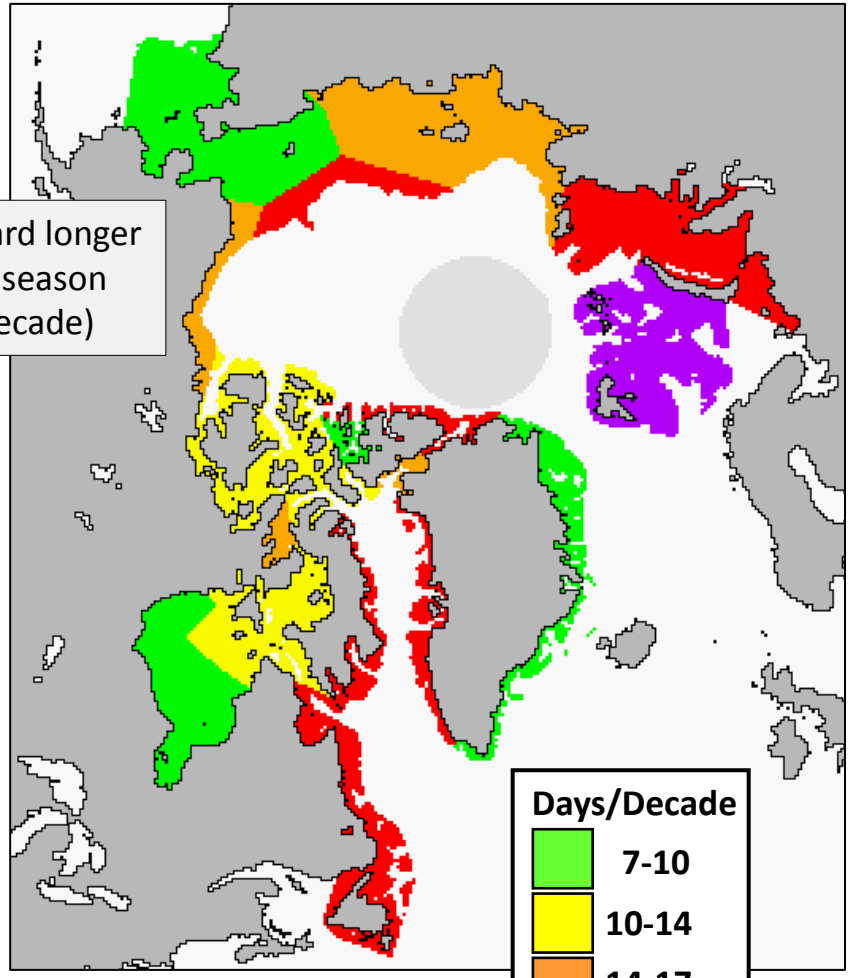
19 PBSG Regions

depth < 300 m

depth > 300 m

Trend Map

Trend toward longer summer season (days/decade)



Days/Decade

7-10

10-14

14-17

17-21

> 21

p < 0.05

p < 0.01

Table of Trends

		Spring	Fall	Interval	Corr.
1	Kane Basin	−9.1 ± 3.2 **	+5.7 ± 2.1 **	+14.9 ± 4.1 **	−0.19
2	Baffin Bay	−8.8 ± 1.4 **	+11.0 ± 2.9 **	+19.8 ± 3.8 **	−0.53 **
3	Lancaster Sound	−7.7 ± 2.1 **	+5.6 ± 1.2 **	+13.4 ± 2.6 **	−0.18
4	Norwegian Bay	−2.6 ± 1.3 *	+5.9 ± 2.2 **	+8.5 ± 2.8 **	−0.20
5	Viscount Melville	−6.5 ± 2.3 **	+6.6 ± 4.4	+13.1 ± 4.8 **	+0.05
6	Northern Beaufort	−7.3 ± 3.1 *	+3.2 ± 1.2 **	+10.5 ± 4.0 **	−0.64 **
7	Southern Beaufort	−8.0 ± 2.3 **	+8.3 ± 1.8 **	+16.3 ± 3.7 **	−0.56 **
8	M'Clintock Channel	−4.0 ± 1.7 *	+6.3 ± 1.5 **	+10.3 ± 3.0 **	−0.74 **
9	Gulf of Boothia	−7.0 ± 1.9 **	+9.0 ± 1.7 **	+16.0 ± 3.3 **	−0.68 **
10	Foxe Basin	−5.9 ± 1.1 **	+6.7 ± 1.2 **	+12.6 ± 2.0 **	−0.53 **
11	Western Hudson Bay	−5.4 ± 1.7 **	+4.2 ± 1.3 **	+9.6 ± 2.3 **	−0.24
12	Southern Hudson Bay	−3.1 ± 1.6	+4.5 ± 1.5 **	+7.6 ± 2.6 **	−0.38 *
13	Davis Strait	−8.1 ± 2.4 **	+9.7 ± 1.8 **	+17.8 ± 3.2 **	−0.16
14	East Greenland	−4.0 ± 1.4 **	+3.9 ± 1.9 *	+7.9 ± 2.7 **	−0.27
15	Barents Sea	−16.6 ± 3.4 **	+26.1 ± 6.2 **	+42.7 ± 8.1 **	−0.39 *
16	Kara Sea	−9.9 ± 1.9 **	+9.5 ± 2.4 **	+19.4 ± 3.7 **	−0.48 **
17	Laptev Sea	−7.8 ± 2.5 **	+6.5 ± 1.3 **	+14.3 ± 3.5 **	−0.72 **
18	Chukchi Sea	−3.4 ± 1.3 *	+3.7 ± 1.5 *	+7.1 ± 2.3 **	−0.25
19	Arctic Basin	−6.1 ± 1.5 **	+14.7 ± 2.7 **	+20.8 ± 3.2 **	−0.08

User Communities

January 2014

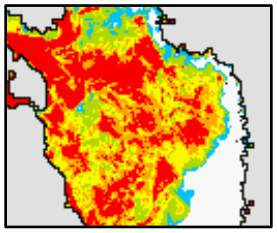
Scientific Working Group of the Canada-Greenland Joint Commission for Management of Polar Bears

June 2014

International Union for the Conservation of Nature (IUCN) Polar Bear Specialist Group (PBSG)

Next Steps

Compute sea-ice indicators for ***future*** sea-ice conditions predicted by IPCC CMIP5 models



Analyze migration timing of beluga whales and sea-ice indicators