

Marine Mammals as **Ecosystem Sentinels** and Guides to Holistic Adaptive Management

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Arctic Marine Resource Governance
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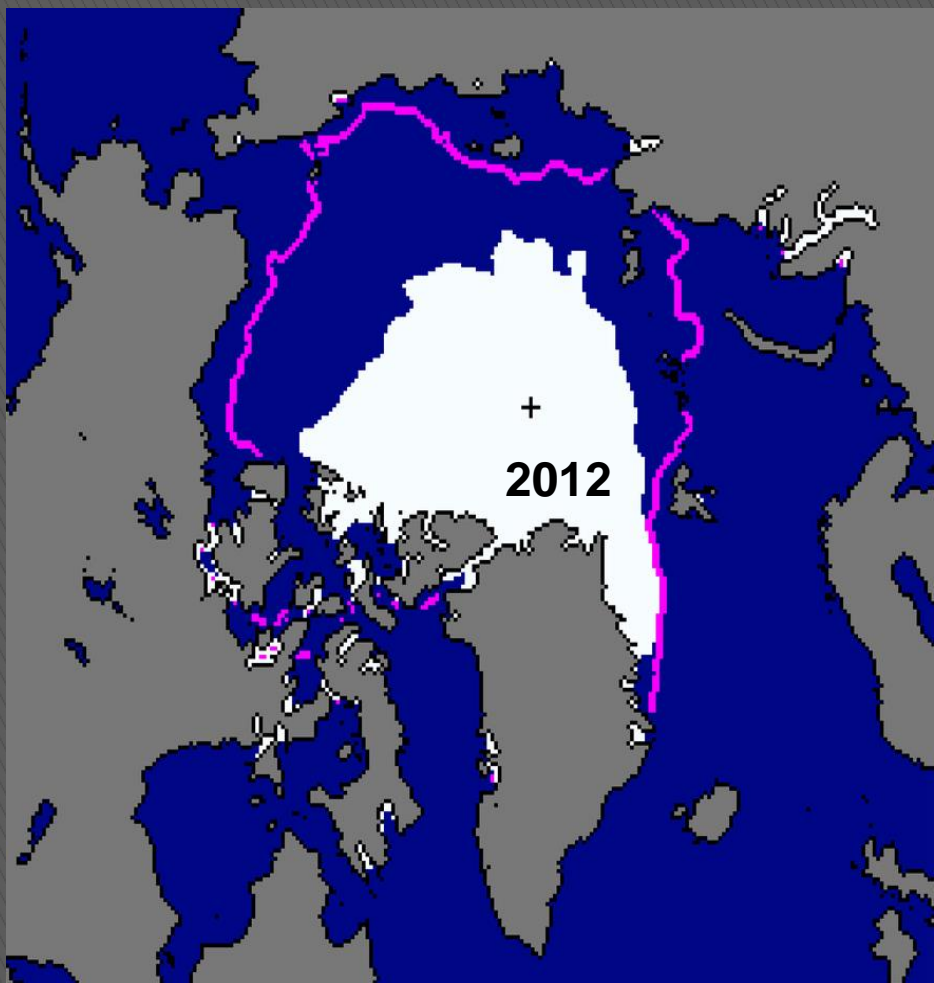
Outline



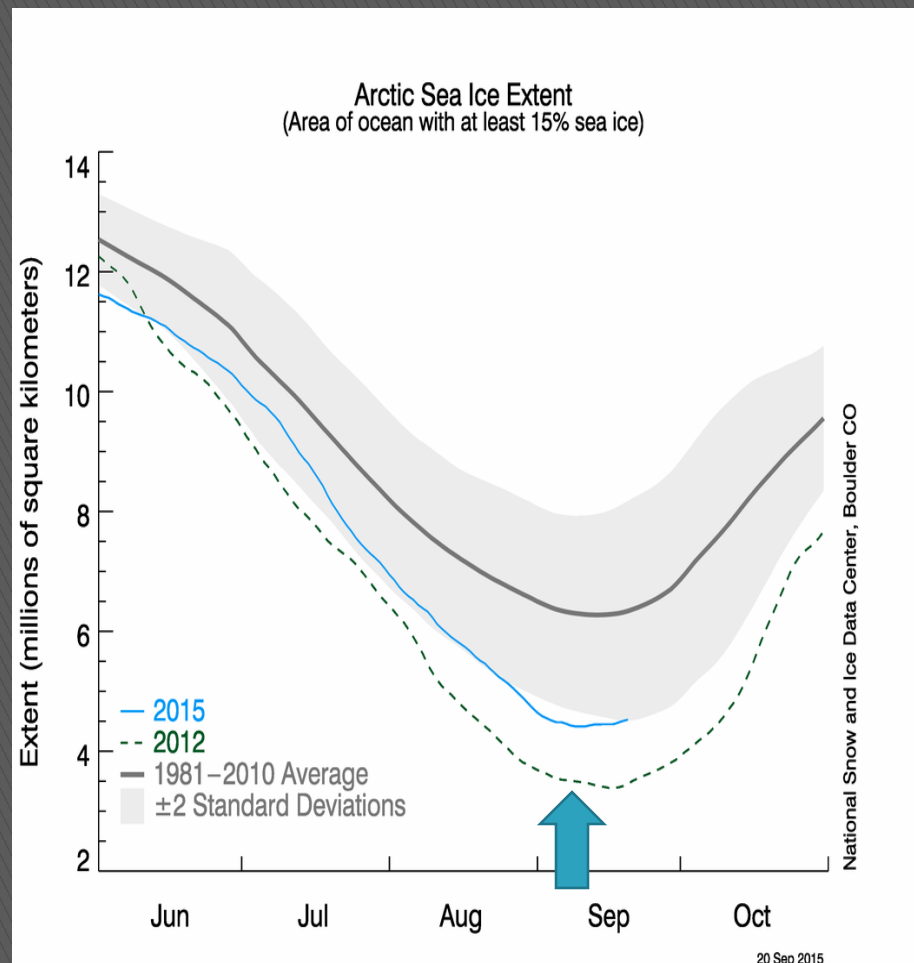
>100 year old bowhead whale
Photo: C. George

- The **‘New Normal’** Arctic Ocean
Sea Ice, Storms & Productivity
- Marine Mammals as Ecosystem Sentinels
Research ‘Partnerships’ – Bowhead example
Sampling Tools – Acoustics example
- Holistic Adaptive Management
the ‘Pacific Arctic Triad’ example
- Pan-Arctic Connections: Arctic Council
the IWC, NGOs and Industry

SEPTEMBER 2012 = New Sea Ice Minimum 50 % Reduction in Surface Area



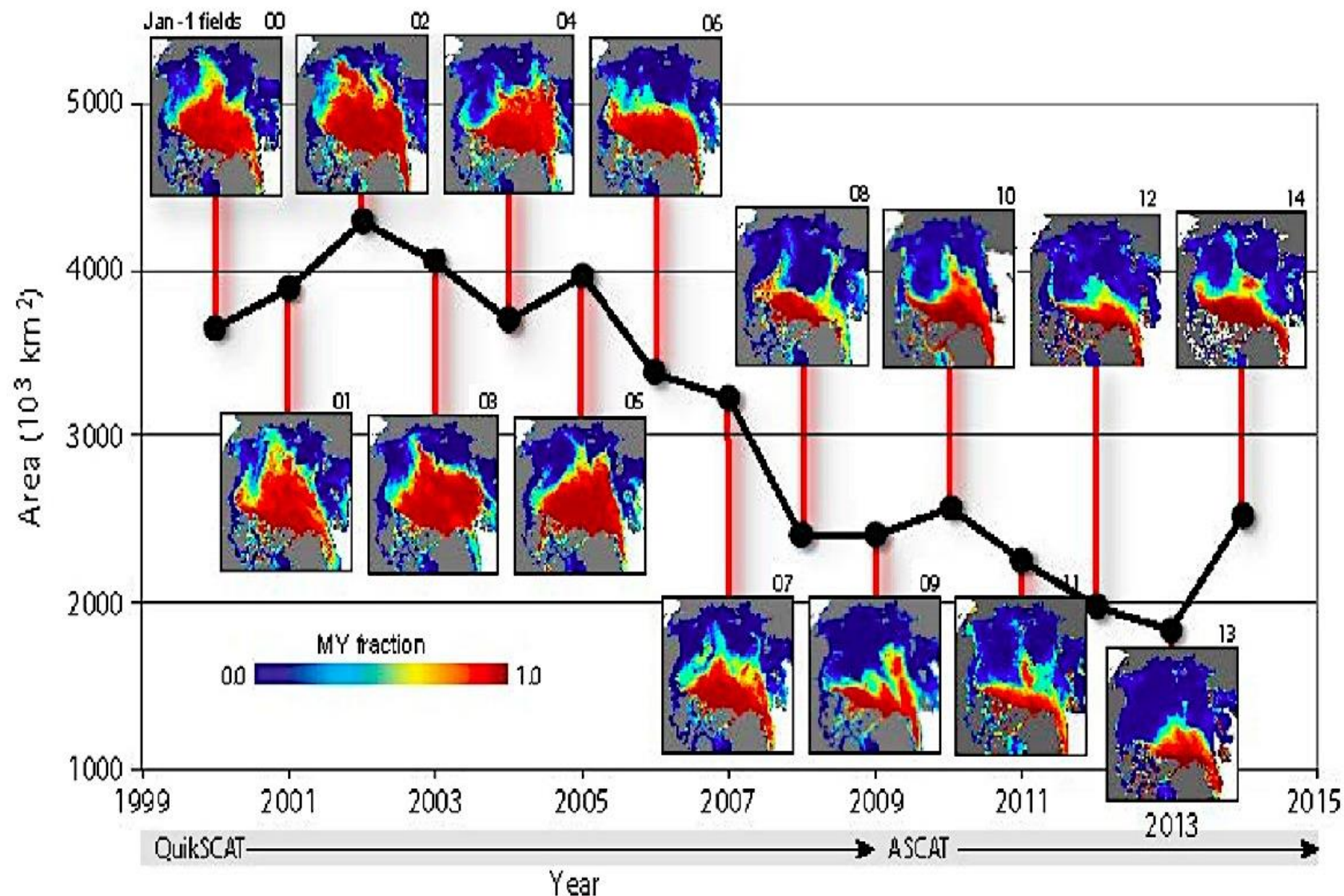
September median extent: 1981-2010



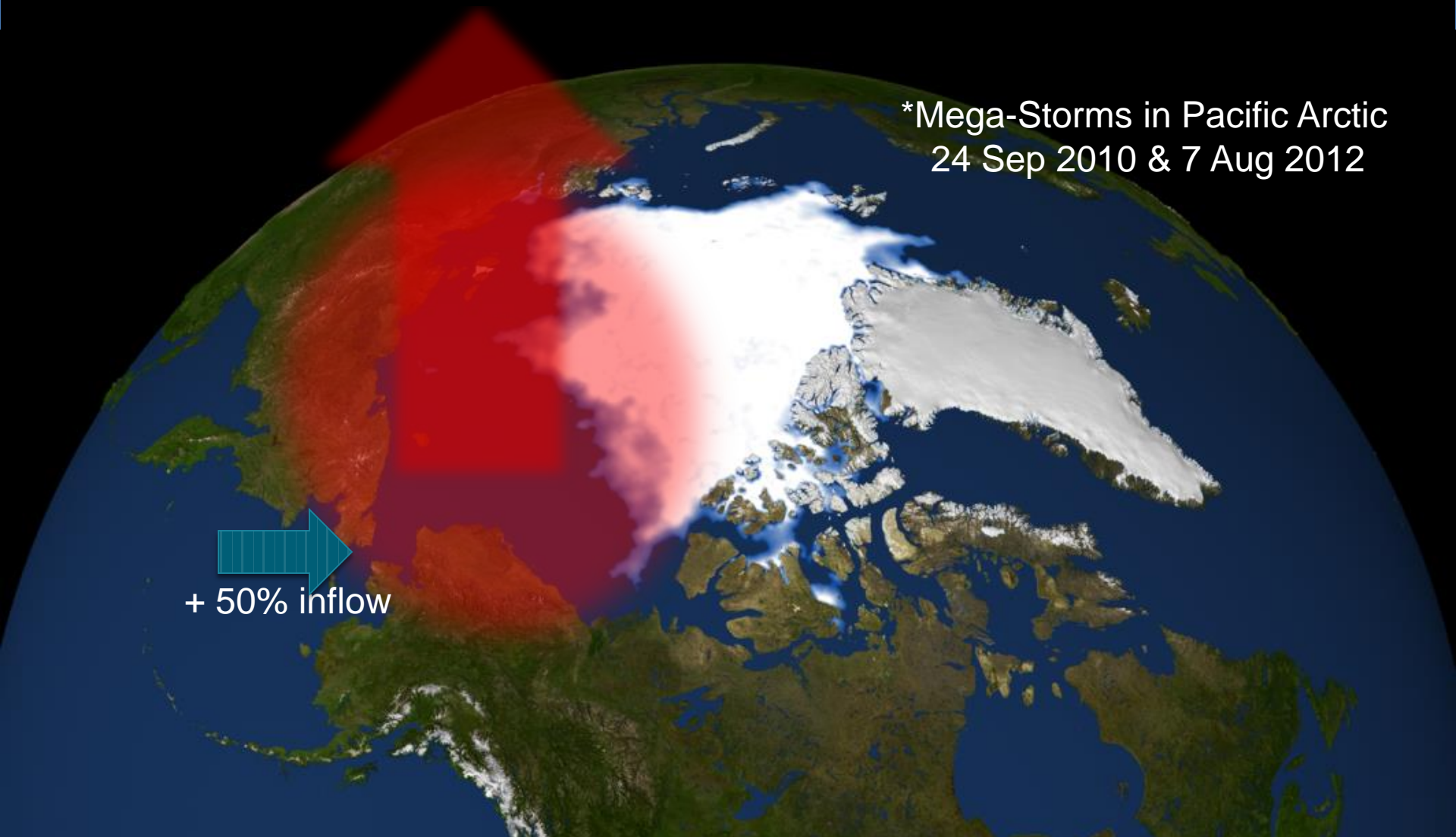
September 2015: 4th lowest sea ice extent
4.41 million square km

[Data products: <http://nsidc.org>]

Loss of Sea Ice Volume ~75%



Added Ocean Heat Storage and Heat Flux from New Sea Ice Free Areas = More Storms



‘New Normal’ Bio–Physics Headlines

SEA ICE

- Record Seasonal Retreats in 2007 & 2012
- Sea Ice Loss –50% by area; **75% by volume**
- Strong regional differences in seasonal Ice-free areas

HEAT & STORMS

- **Big Storms** in High Arctic – deep mixing & upwelling
- + 50% Bering Strait Inflow & Mackenzie Plume = **warm** & **fresh** Chukchi and Beaufort seas

PRIMARY PRODUCTION

- **Primary Production** up by an average 20%, to 135% regionally
- Massive under-ice phytoplankton blooms
- Ice algal deposition to central Arctic basins

but, what about marine fishes, birds and mammals (UTL species)....

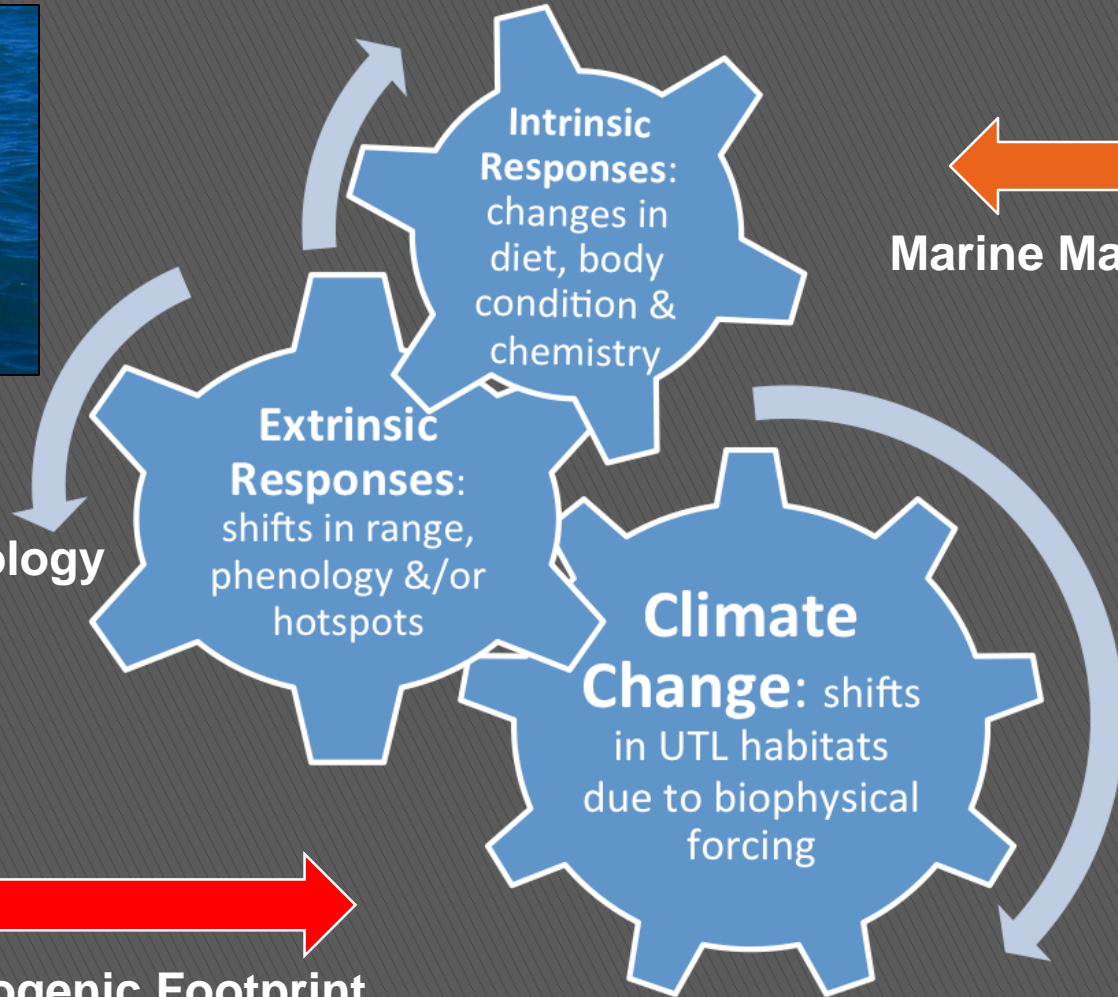
Marine Mammals as Ecosystem Sentinels



Marine Mammal Ecology



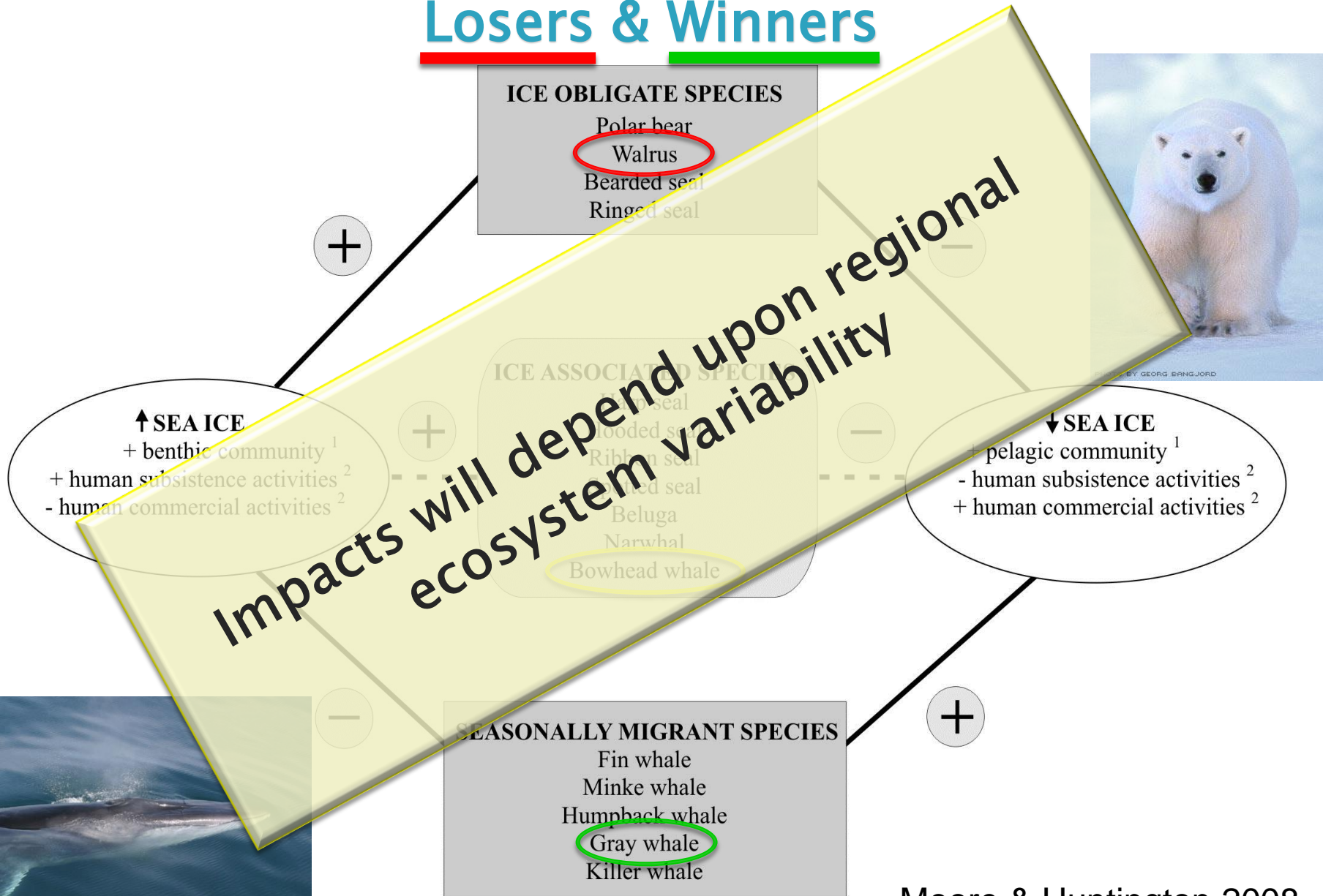
Anthropogenic Footprint



Marine Mammal Health

Marine Mammal Ecology & Sea Ice

Losers & Winners



Marine Mammals in the 'New Normal'



Walruses, Ice
Seals & Polar
Bears **no longer**
have sea ice
platform for
resting and
hunting...



...while Whales may be finding new feeding opportunities, which in some cases can be assessed based on 30y+ research partnerships

★ Research 'Partnerships': The Bowhead Example

Local Ecosystem Observers & Samplers



photo by Sue Moore

Bowhead whaling = nutritional & cultural 'keystone'

Ad-hoc* Partnership formed *via* Bowhead Whale Co-Management

~1980: AEWC forms
Alaska Eskimo Whaling
Commission

<http://aewc-alaska.com/>

AEWC-NOAA-IWC forms basis
for ~30year research partnership

Document population growth,
habitat use, diet, body condition,
response to underwater noise

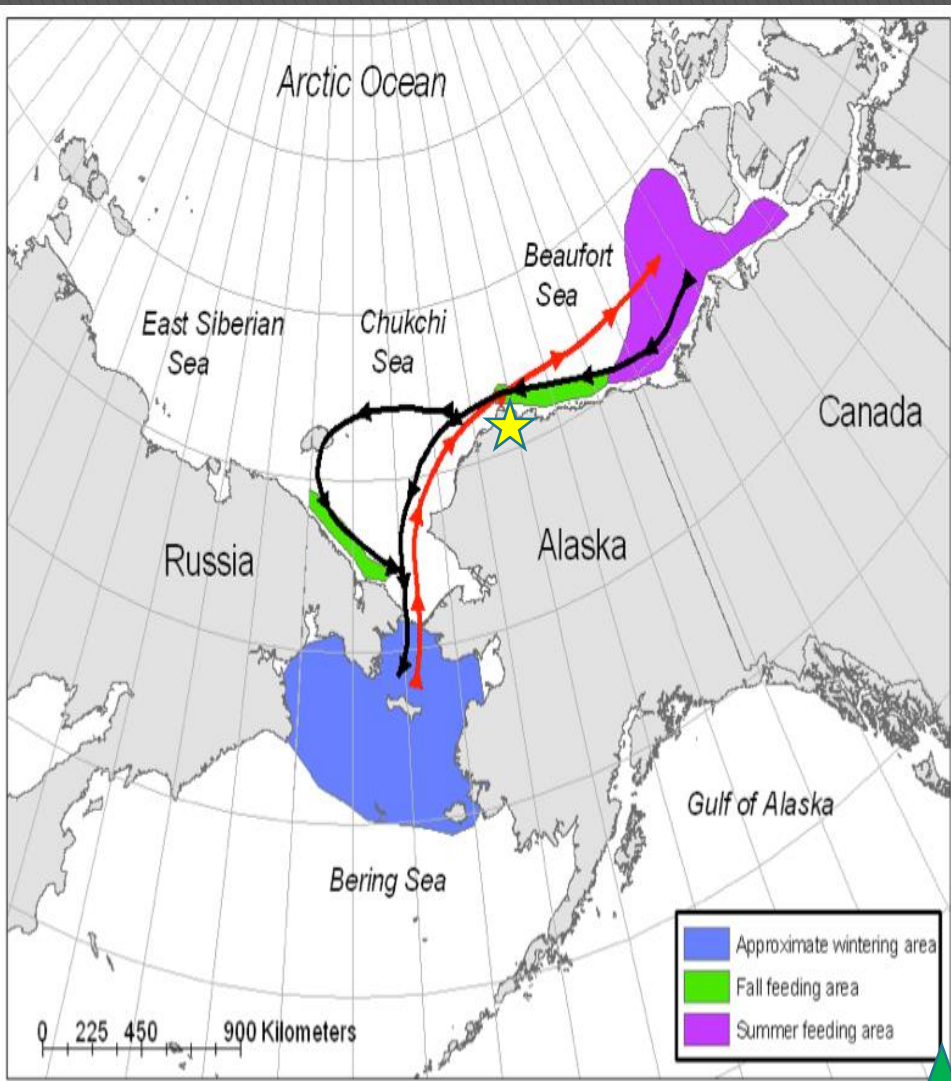


NSB Ice-based Census, in support of AEWC quota

*Government-government
consultation becoming more formal

<http://eli-ocean.org/arctic/consultation/>

Bowhead Whale Ecology in Pacific Arctic



Moore and Laidre 2006

★ NSF – SNACS Program



copepod



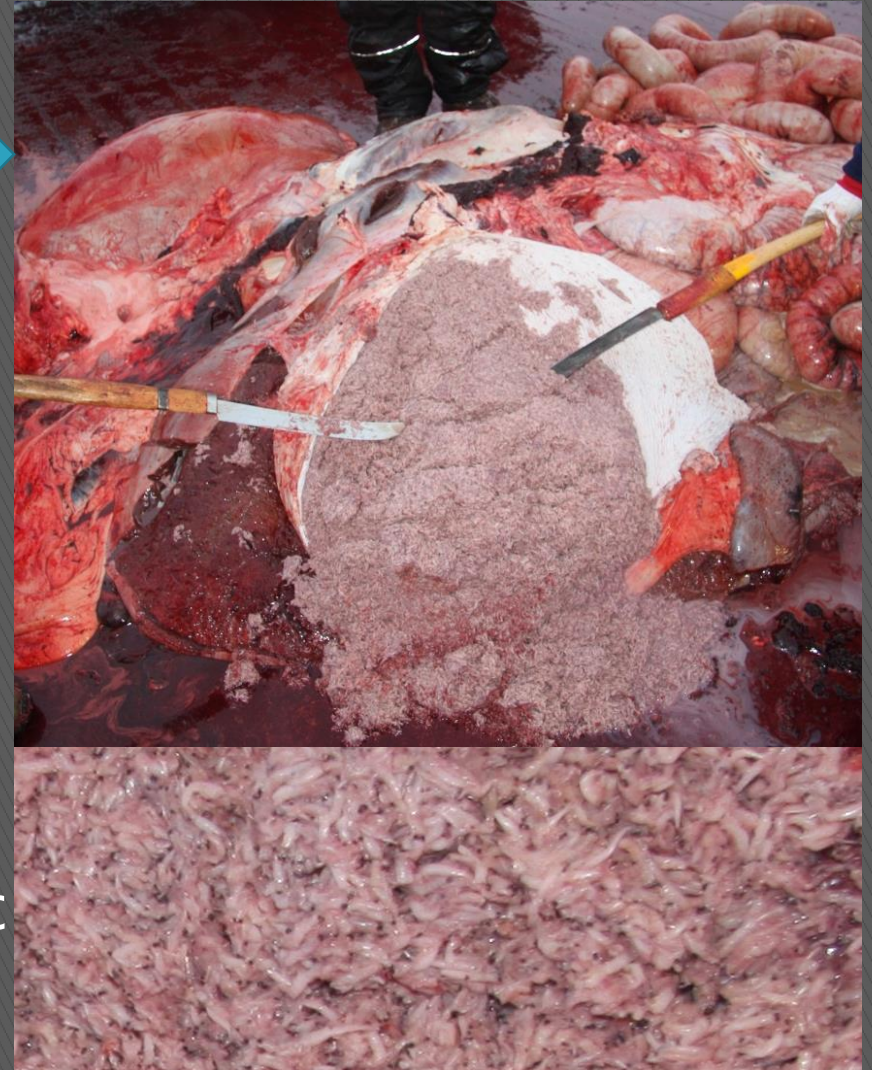
krill



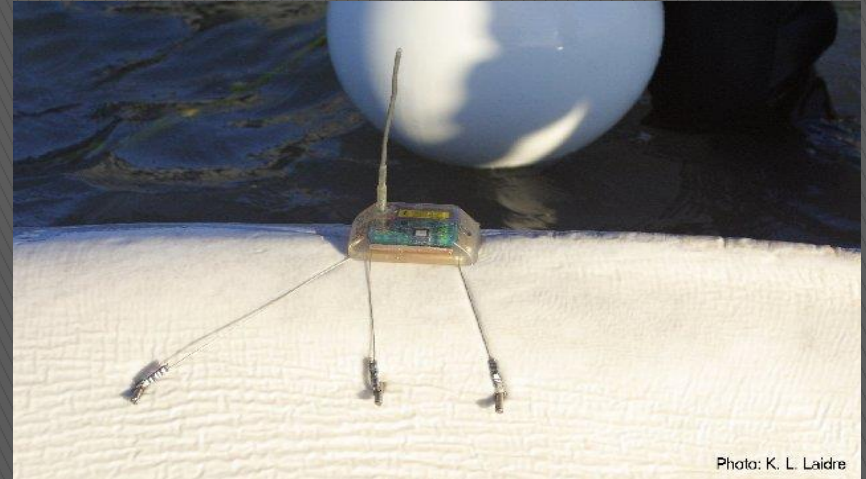
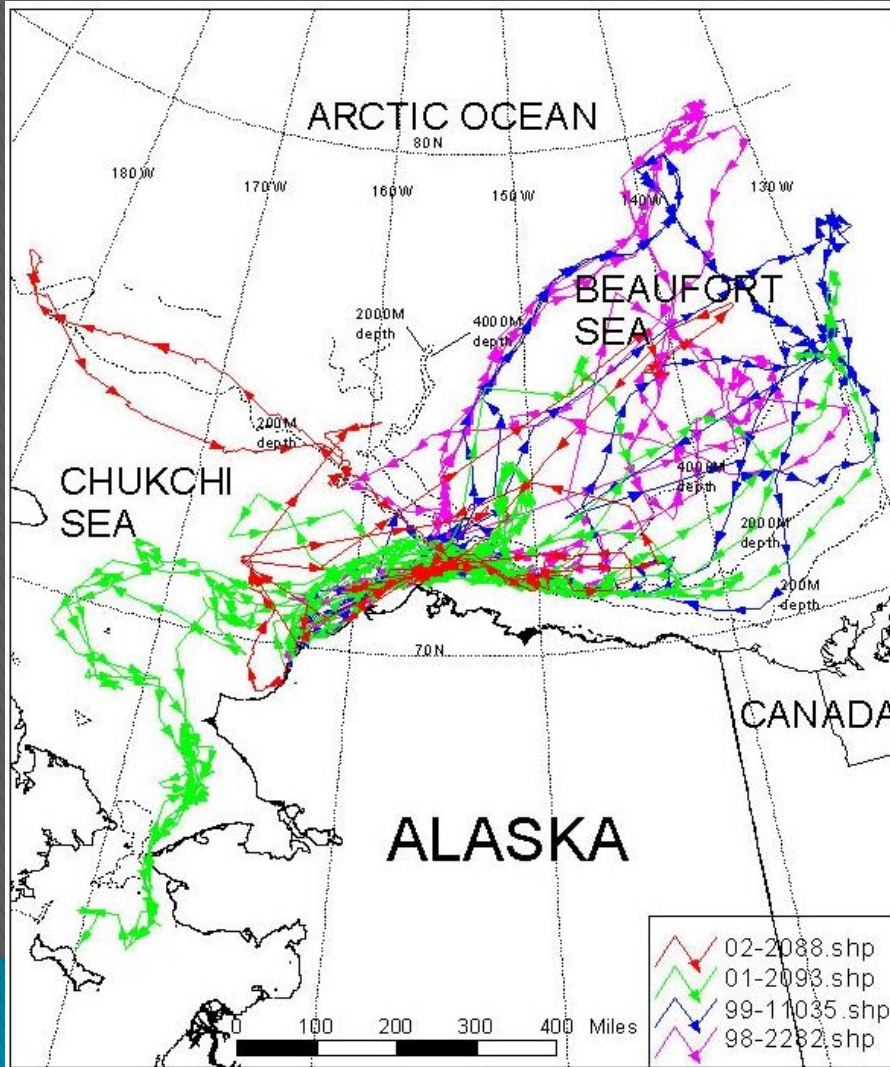
★ BOEM+NOAA – Aerial Survey Program
Vicki Beaver
NOAA APSC Permit # 14245

Bowheads are not supposed to eat krill, but they do....a 'discovery'* via 'Partnership'

- ▶ Euphausiids (krill) in whale stomachs, *since 1980s →
- ▶ Copepods are common prey too
- ▶ Copepods = local prey, expected in Pacific Arctic
- ▶ Krill = advected prey and *unexpected* in Pacific Arctic



Sampling Tools – Acoustics, Tagging, UAVs Bio-Chemistry (lipids & toxins), DNA



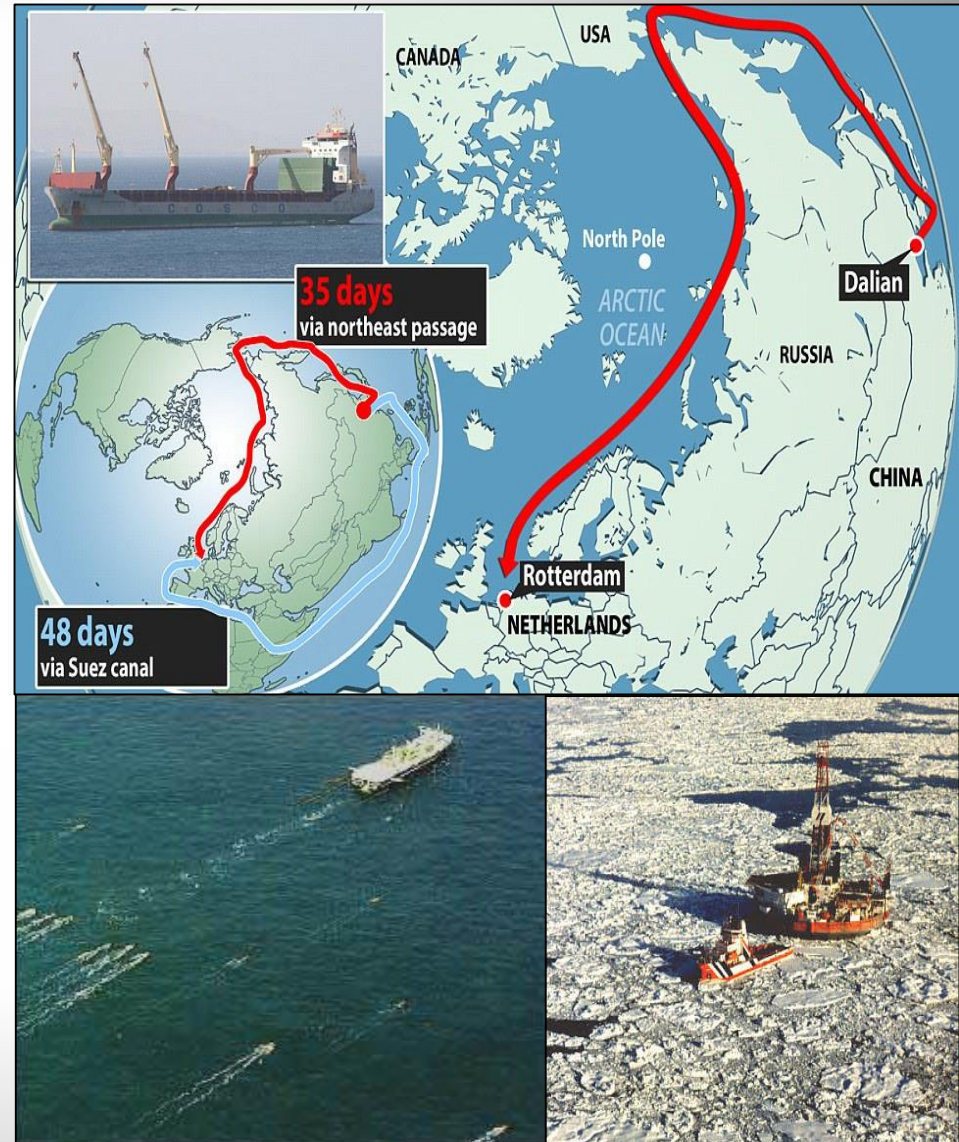
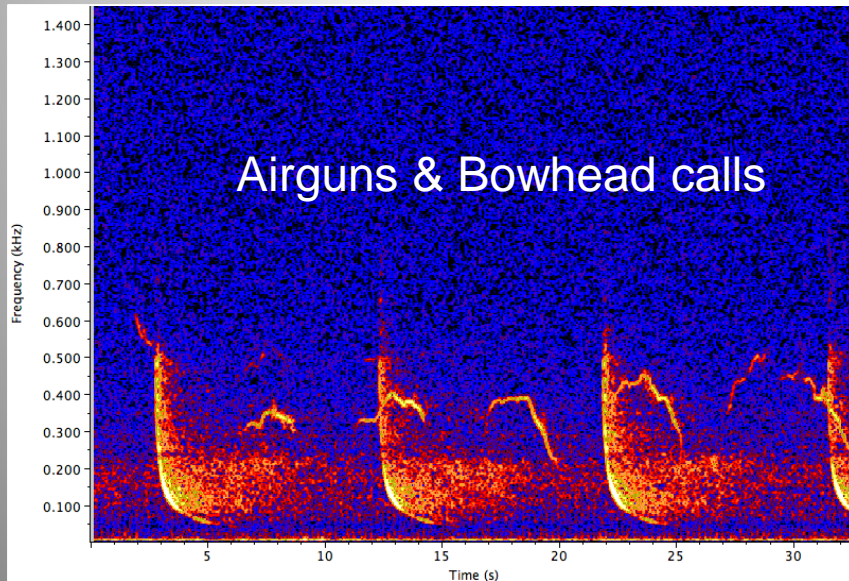
Tracks of beluga tagged @ Pt. Lay, courtesy R. Suydam & ABWC



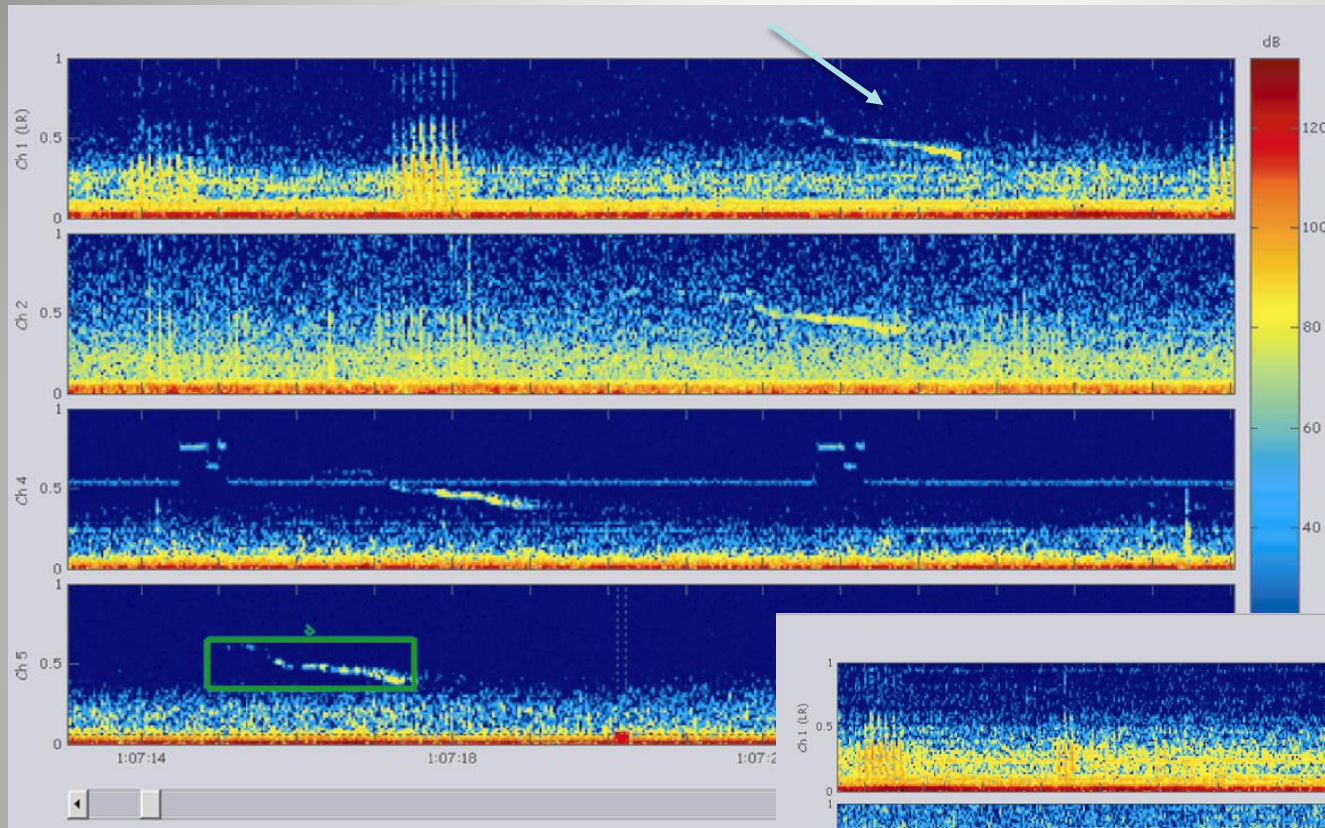
Anthropogenic Footprint

Shipping, Tourism, Fishing O&G Development

- > Ship Strikes
- > Increased Underwater Noise
- > Exposure to Contaminants
- > New Vectors for Disease

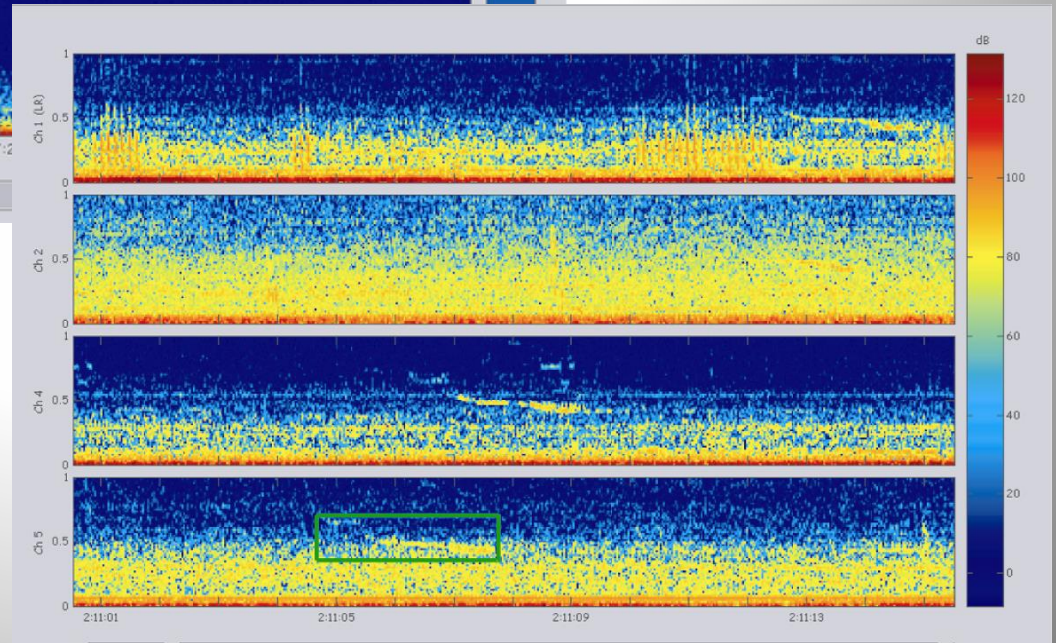


Sound Pollution – Fin whale call masking



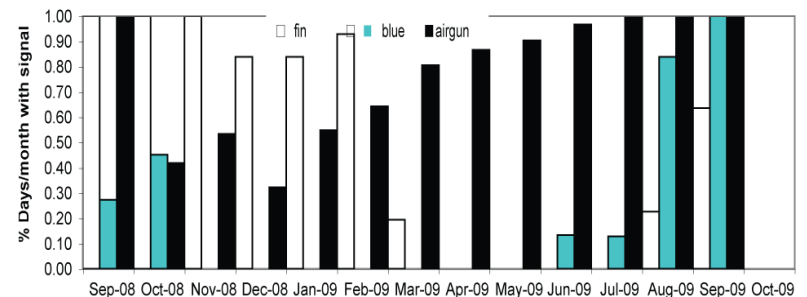
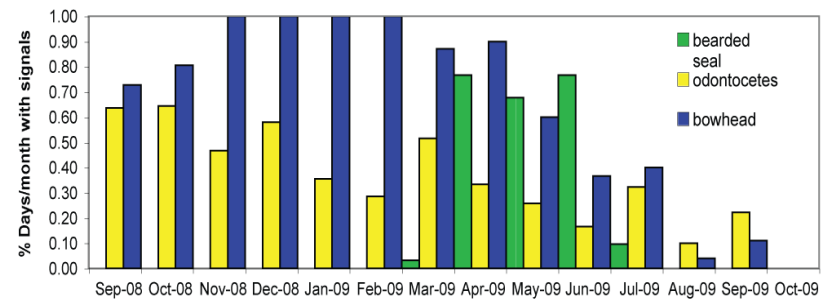
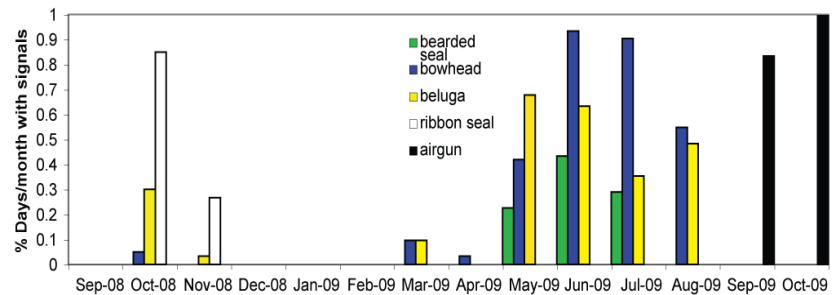
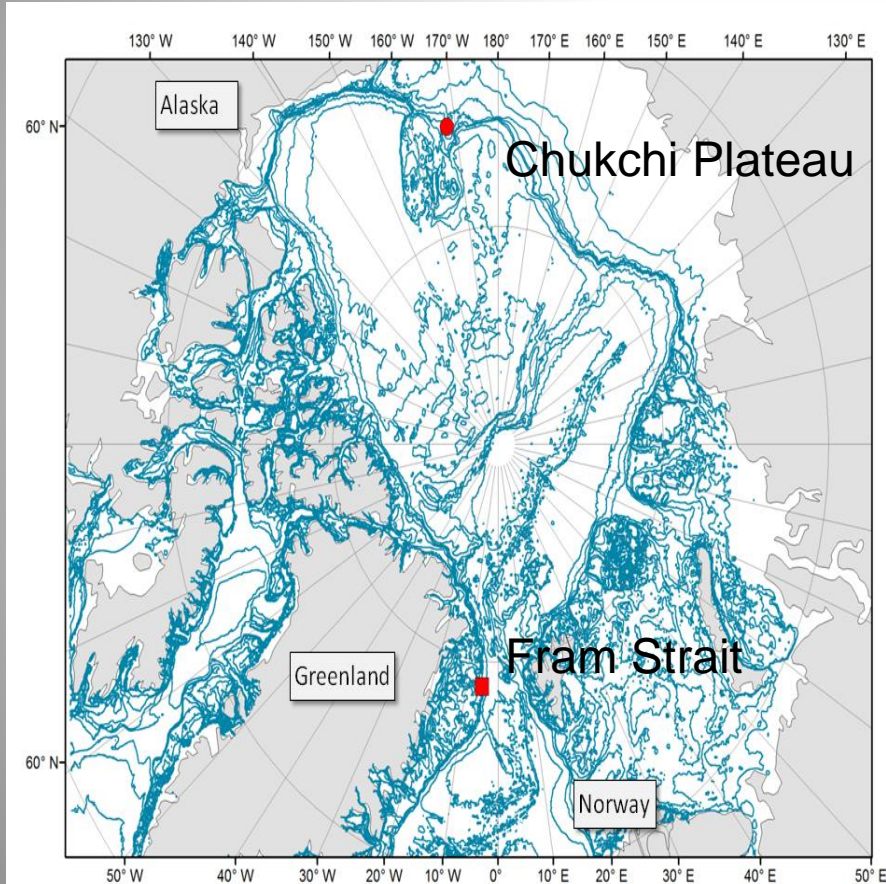
Bay of Fundy
Quiet – no ship

Bay of Fundy
Ship-passage

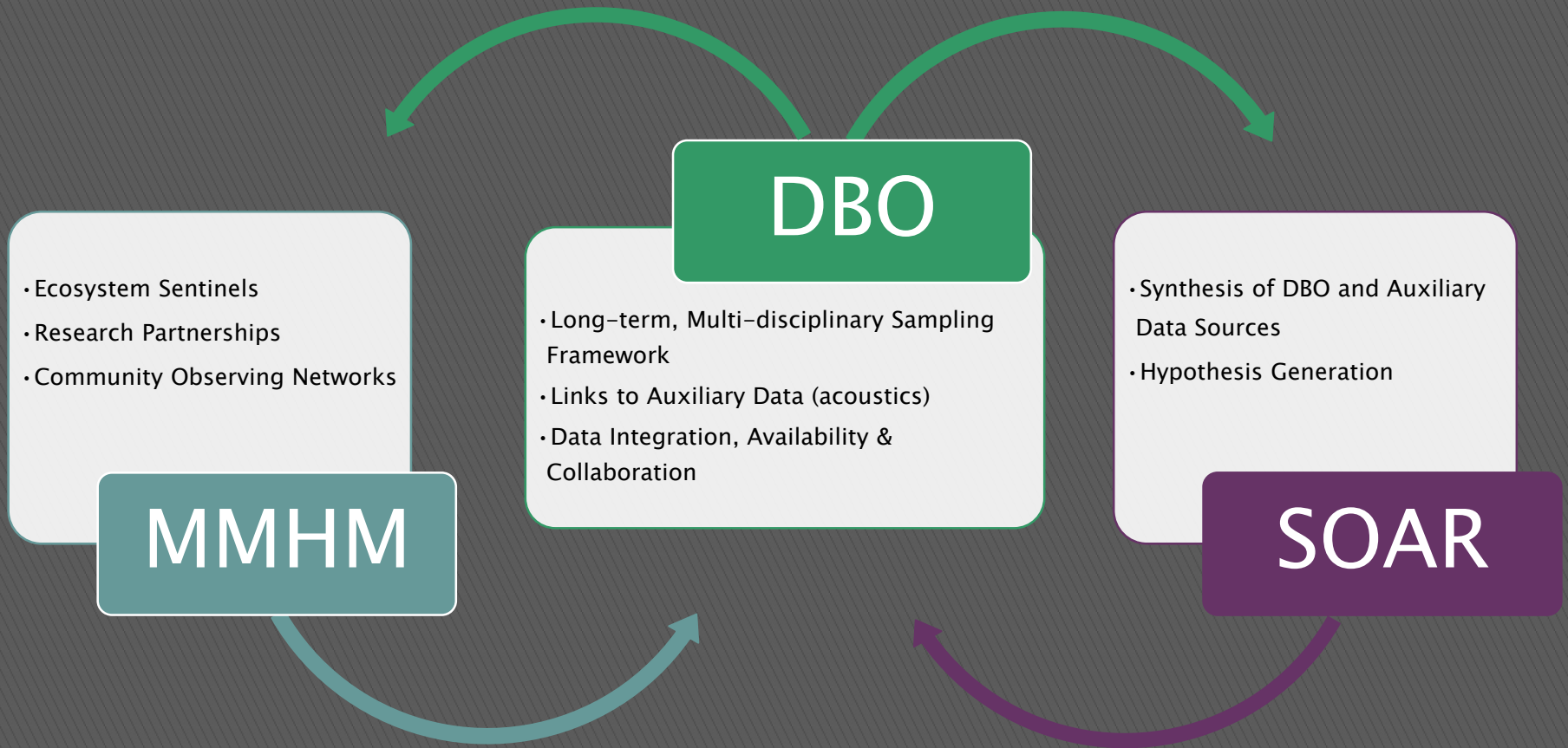




Marine Mammal and Airgun Sounds in the High Arctic



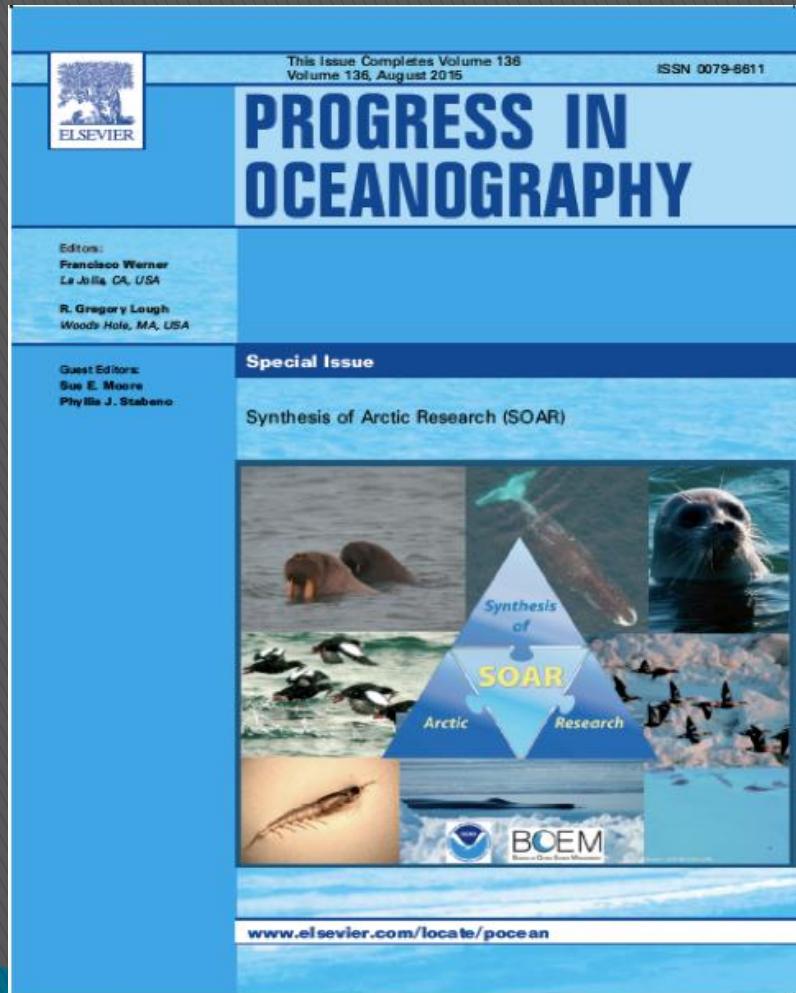
Holistic Adaptive Management the 'Pacific Arctic Triad' example



...”effective adaptive policy requires new ways of learning about and governing human interactions with marine mammals”...(Meek et al. 2011 Marine Policy)

SOAR: Synthesis of Arctic Research

Includes results from *Research Partnerships*



- ▶ **Bio-physical Responses to the 'New Normal'**
Arrigo, Frey, Mathis, Wood, Wang

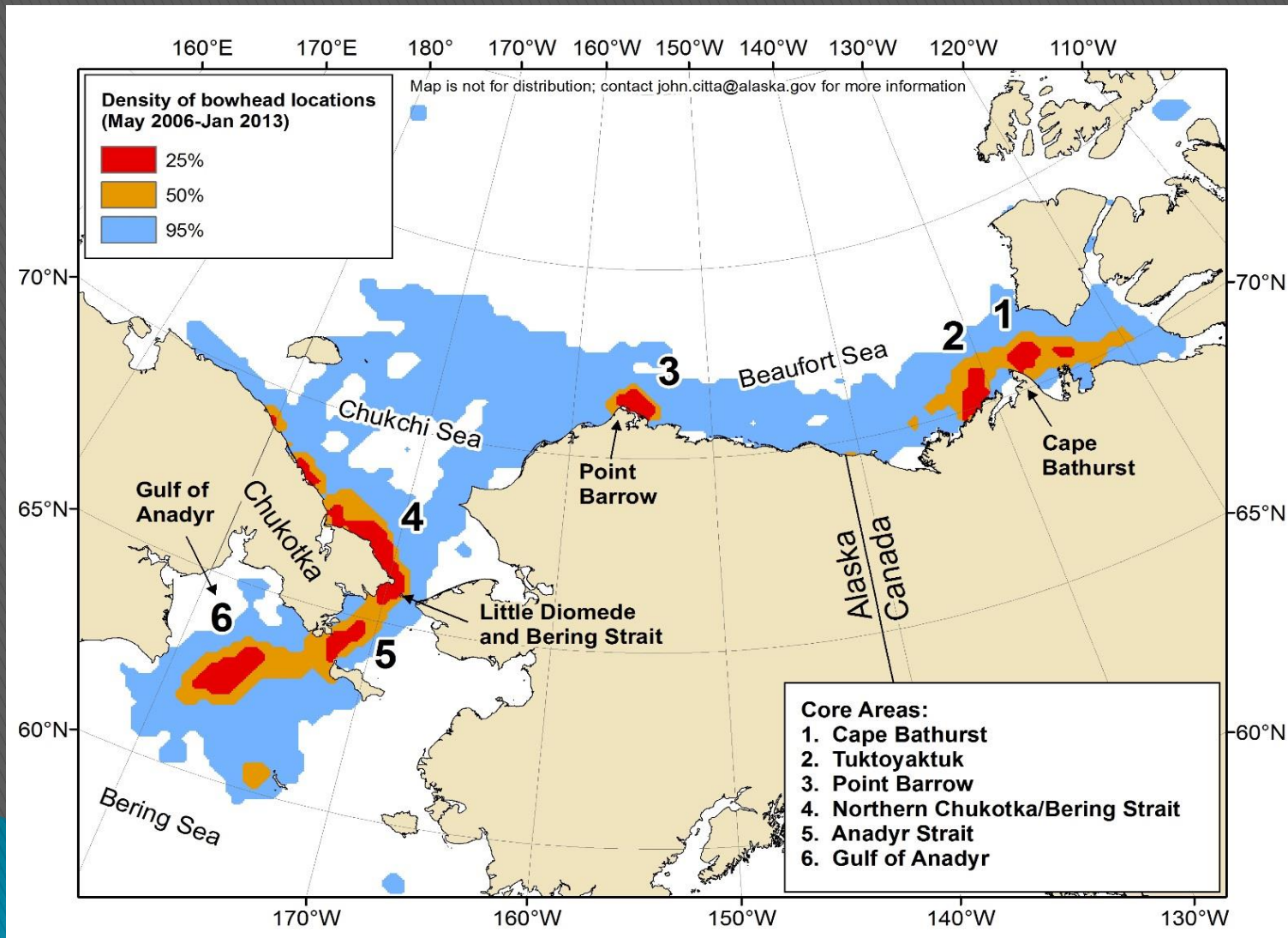
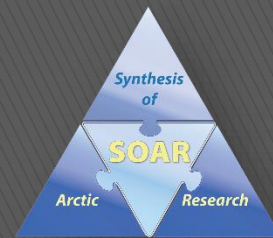
- ▶ **Marine Bird & Mammal Prey Responses**
Grebmeier, Logerwell, Crawford, Divoky, Lovvorn

- ▶ **Marine Bird & Mammal Responses**
*Citta, Clark, George, Harwood, Kuletz, MacIntyre

<http://arctic.noaa.gov/soar/>

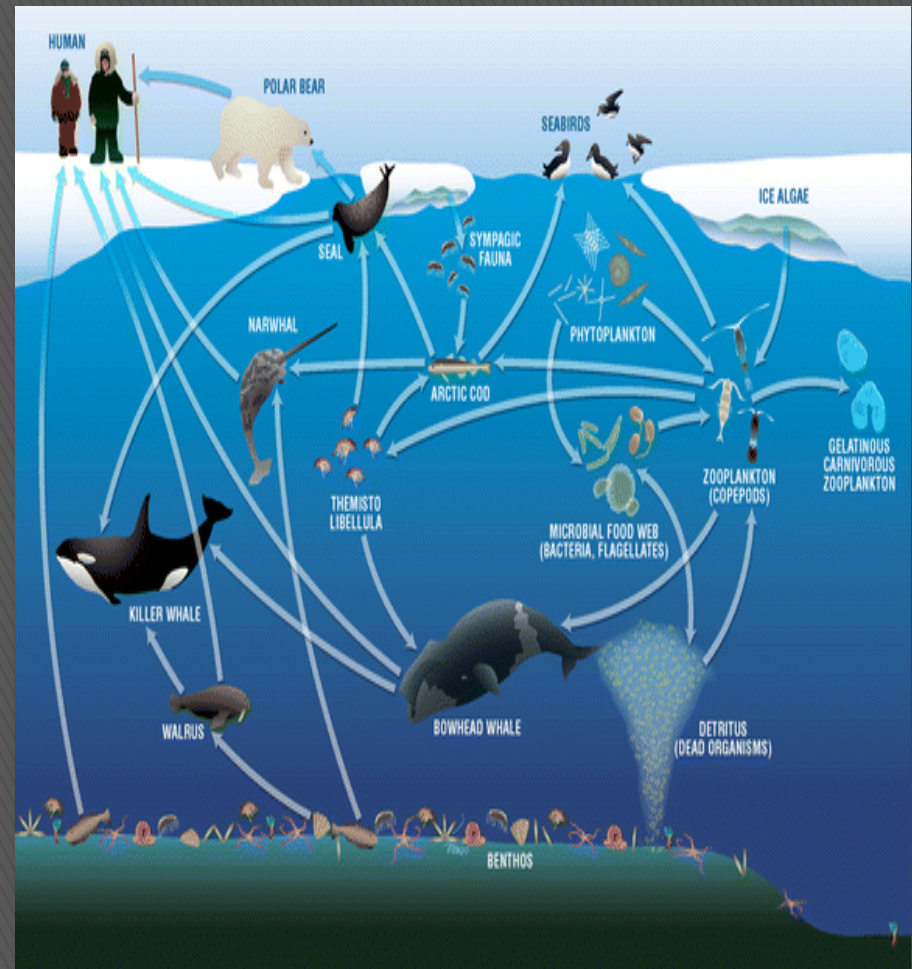
*Bowhead Whale Core–Use Areas

54 tagged whales 2006–12 (Citta et al. 2015)



For marine mammals to be effective **Ecosystem Sentinels**, we need to keep in mind

- ▶ Sampling Scale is based on species' ecology
- ▶ Integration of Bio-Chemo-Physical sampling is essential
- ▶ Routine Inclusion of marine mammals in ecosystem models and management plans is the goal

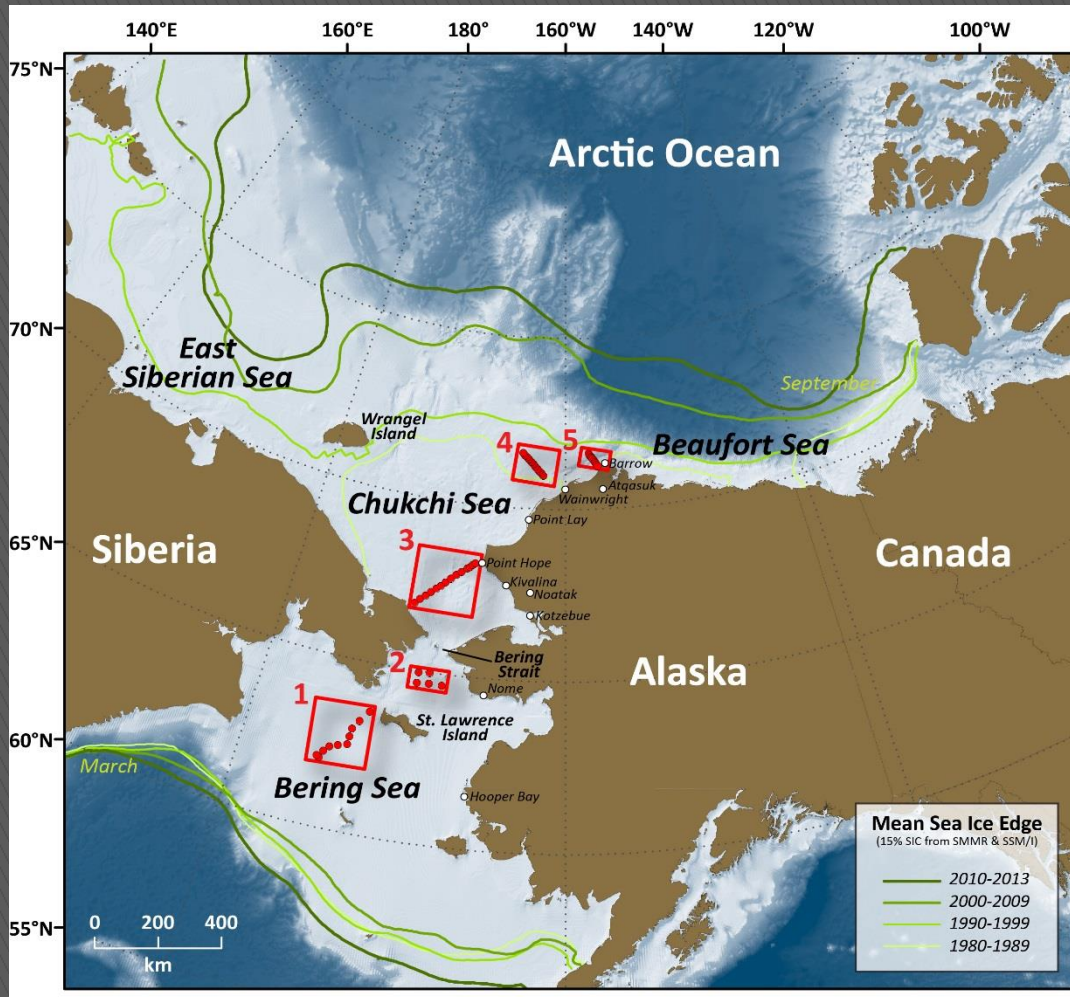


In the Pacific Arctic we have started the **DBO**

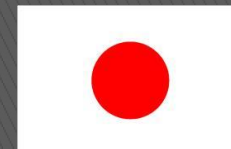


Distributed Biological Observatory (DBO)

<http://www.arctic.noaa.gov/dbo>



- DBO regions are centered on “hotspots” located along a latitudinal gradient
- The DBO serves as a *change detection array*, via consistent sampling of biophysical processes
- Successful International sampling, 2010-2015
- Need better links to Marine Mammal Health *via* Community Observations

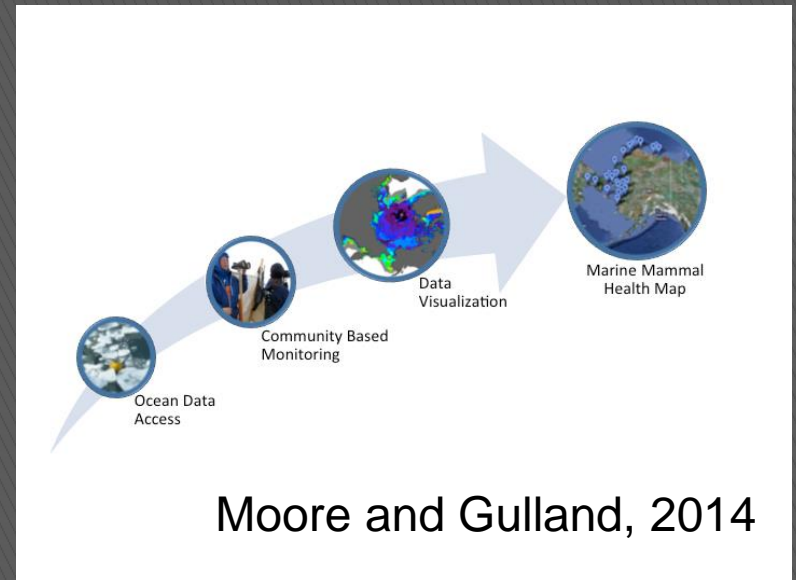


Linking Marine Mammal Health & Oceanography in the 'New Normal' Arctic



Seal and Walrus Unusual Mortality Event (UME), 2011-13

- ▶ Build Marine Mammal Health Maps (MMHM), *via*
- ▶ Links to Ecosystem & Oceanographic Research
- ▶ Display *via* regional Ocean Observation Systems



Pan-Arctic Connections

• CAFF

CBMP – Circumpolar
Biodiversity Monitoring Program
(CBMP-Marine)

-Expert Networks: Sea Ice,
Plankton, Benthos, Marine Fish,
Seabirds and **Marine Mammals**

-Linkage among existing
ecosystem-based Arctic research
& monitoring programs

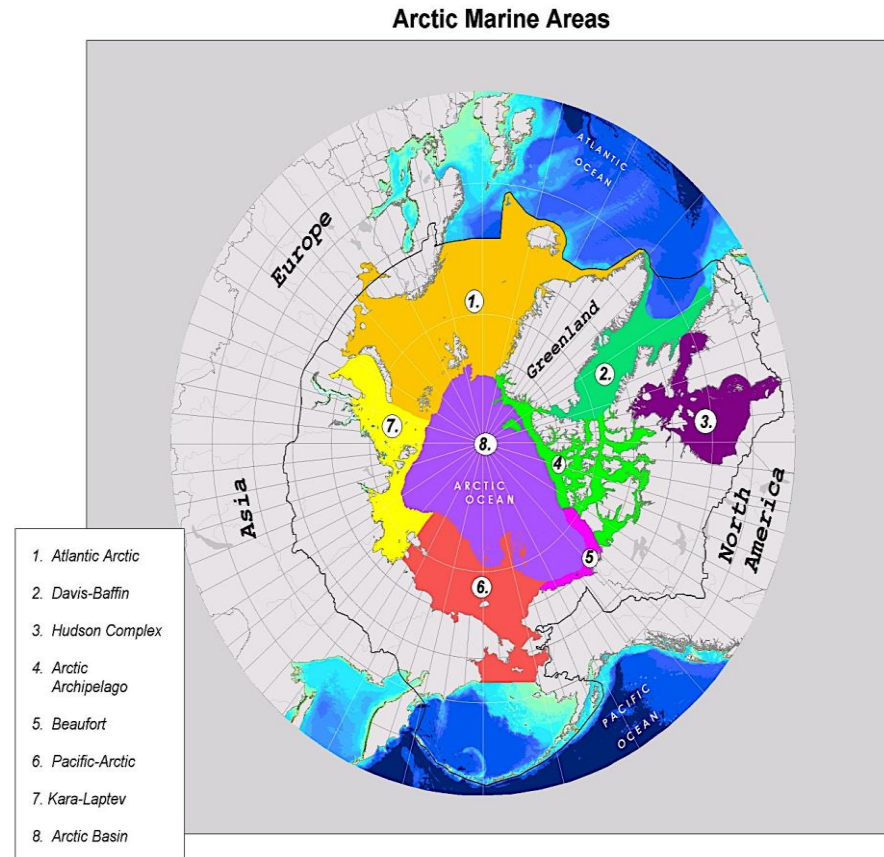
-DBO Stations = US CBMP
sampling in Region 6

<http://www.caff.is/marine>



Arctic Council

Conservation of Arctic Flora & Fauna (CAFF)
CBMP



CAFF/Arctic Biological Assessment

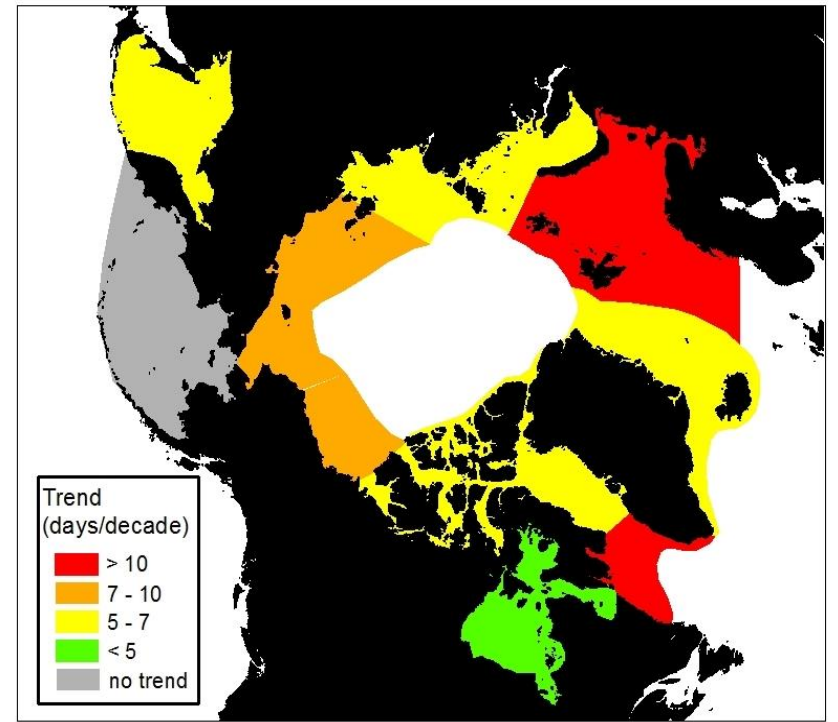
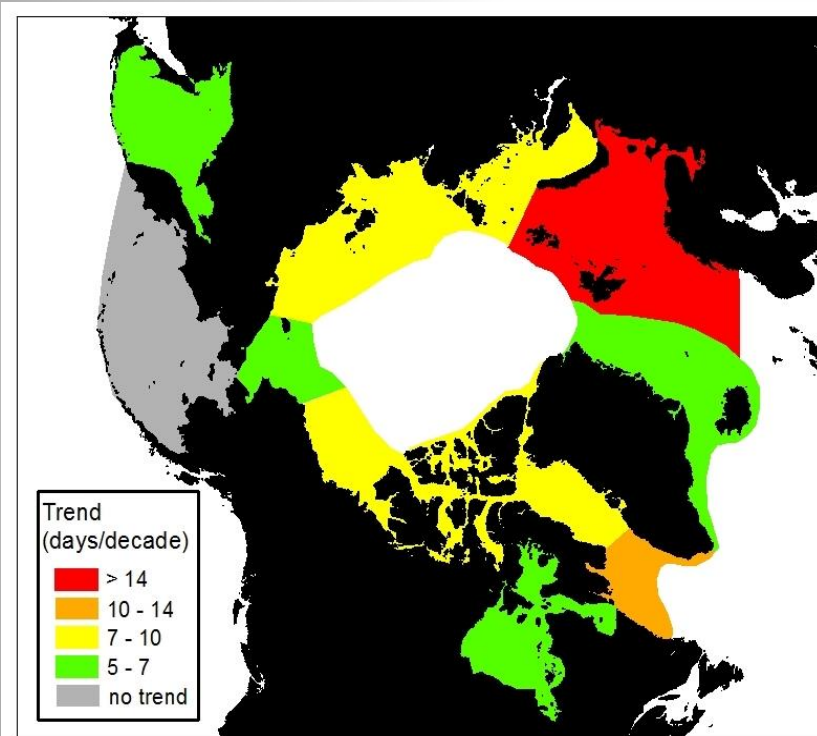
Regional Trends in Open Water

1979-2013



Spring

Autumn



ABA Mammal Chapter – led to peer-reviewed paper:

Laidre et al. 2015. Arctic marine mammal population status, sea ice habitat loss and conservation recommendations for the 21st century. *Conservation Biology*

Arctic Council – PAME

Protection of the Arctic Marine Environment

Four of eight projects:

- Arctic Marine Shipping

Arctic Marine Shipping Assessment

- Ecosystem Approach

Large Marine Ecosystems (LMEs)

Integrated Ecosystem Assessments (IEA)

- Arctic Offshore O&G Mgt, Regulation & Enforcement
- Marine Protected Areas

AMSA Theme II: A-H

- Indigenous Marine Use Survey
- Community Engagement
- Areas of Ecological & Cultural Sig.
- Specially Designated Areas
- Protection from Invasive Species
- Oil Spill Prevention
- **Impacts on Marine Mammals**
- Reducing Emissions

International Whaling Commission (IWC)

<https://iwc.int/home>



- **Scientific Committee**

- Aboriginal Subsistence Whaling**

- Environmental Concerns WG**

- AMSA Theme II-G**

- Ship Strikes (& Quieting)**

- <https://iwc.int/ship-strikes>

- **Anthropogenic Impacts to Cetaceans in the Arctic - Stakeholder Workshop**

- Overarching Goal:**

- Improved international coordination of research & management of cetaceans in the Arctic



Non-Governmental Organizations (NGOs) and Industry Organizations – examples

▶ Arctic NGO Forum

<http://arcticngoforum.org/>

- 16 members; e.g. WWF, Oceana,

“Promoting cooperation and influencing policy-making”

▶ PEW Trust – Arctic Ocean Program

<http://www.pewtrusts.org/en/projects/protecting-life-in-the-arctic>

▶ International Maritime Organization, MEPC

UN Specialized Agency

- Polar Code
- Ship Strikes & Quieting
- PSSAs (Hillmer-Pegram 2015)

▶ Oil & Gas Companies



ConocoPhillips



Summary

- As top predators, marine mammals reflect shifts in ocean ecosystems and thereby act as **sentinels** of environmental change.
- Marine mammals are nutritional and cultural **keystones** for people living in the Arctic – thus, can act as a ‘nexus’ for science partnerships.
- Policies guiding Arctic marine resource governance must be science-based and include (i) **local observations**, (ii) a **research framework** and (iii) **synthesis of results in peer-reviewed journals**.
- Resources available through Arctic Council, the IWC, Non-Governmental Organizations and Industry could be pooled to support more effective science and conservation programs in the Arctic, **but coordinating mechanisms are currently lacking**.
- Steps to Adaptive Management of Arctic Marine Resources are achievable now by “*building cross-scale (local to international) understanding.....based upon rules that are ecologically robust*”

Meek et al. (2011) *Marine Policy*

Marine Mammals Connect People to the Arctic Ocean Ecosystem...



Photo © Bill Hess

That connection can strengthen Arctic Marine Resources Governance