Using remote sensing products to assess the acoustic habitat of bowhead whales in the Amundsen Gulf

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Wildlife Conservation Society

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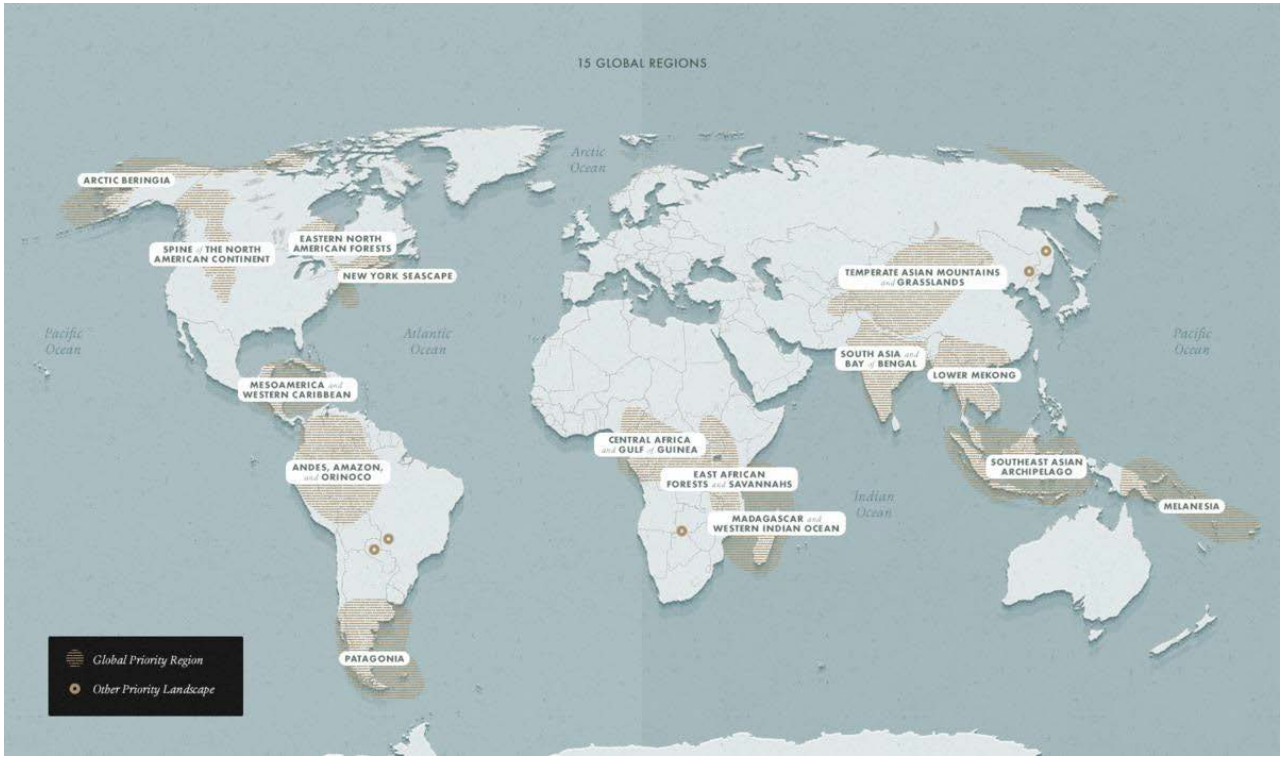
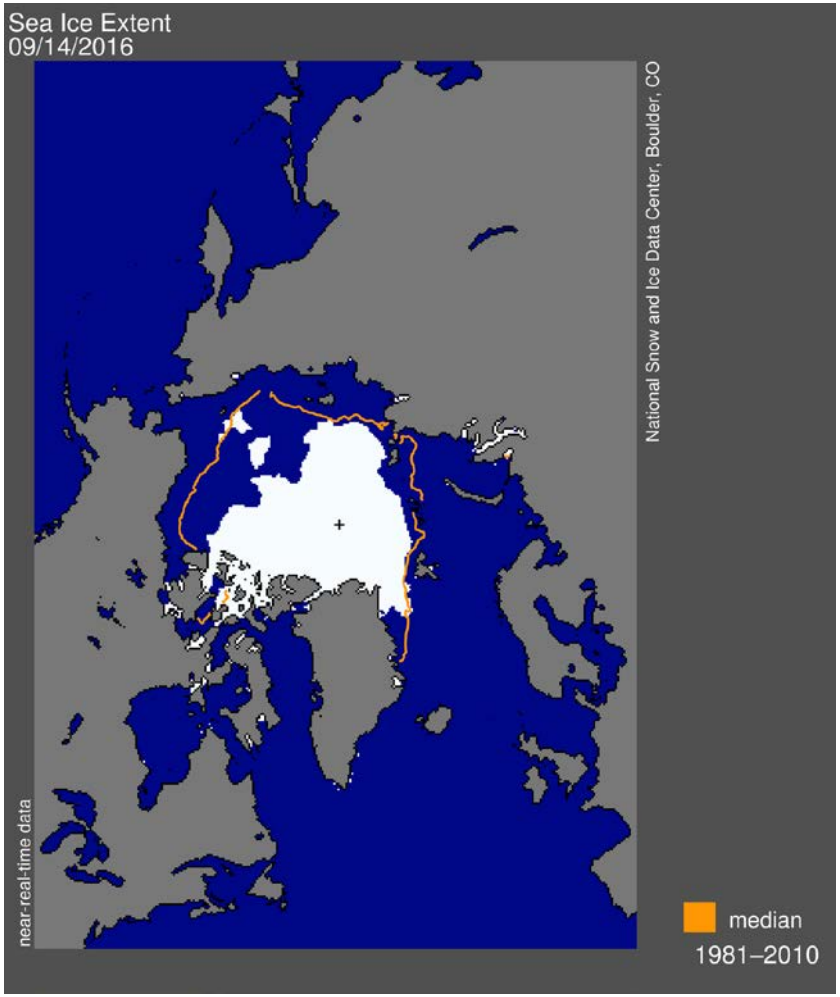


Outline

- Rational: Why study the acoustic environment of bowhead whales?
- Bowhead whale habitat
- Noise sources
- Research goals
- Study area
- Remote sensing products used to assess the acoustic habitat of bowhead whales
- Discussion/Conclusion
- Future work
- Challenges

Rational

1. *"As Arctic sea ice disappears, the projected increase in shipping threatens the region's outstanding marine mammal aggregations and migrations"* - Carly Vynne, Mongabay
2. *We need a baseline assessment of the acoustic environment before there is a significant increase in shipping*



Environment › Climate Change

Arctic could become ice-free for first time in more than 100,000 years, claims leading scientist

Professor Peter Wadhams of Cambridge University predicts we could see 'an area of less than one million square kilometres for September of this year'

Ian Johnston Science Correspondent | Saturday 4 June 2016 | 273 comments

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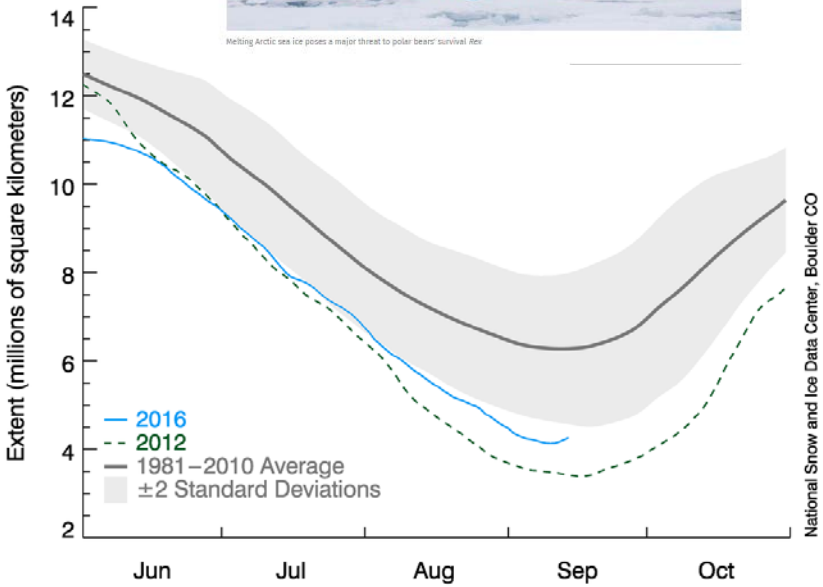
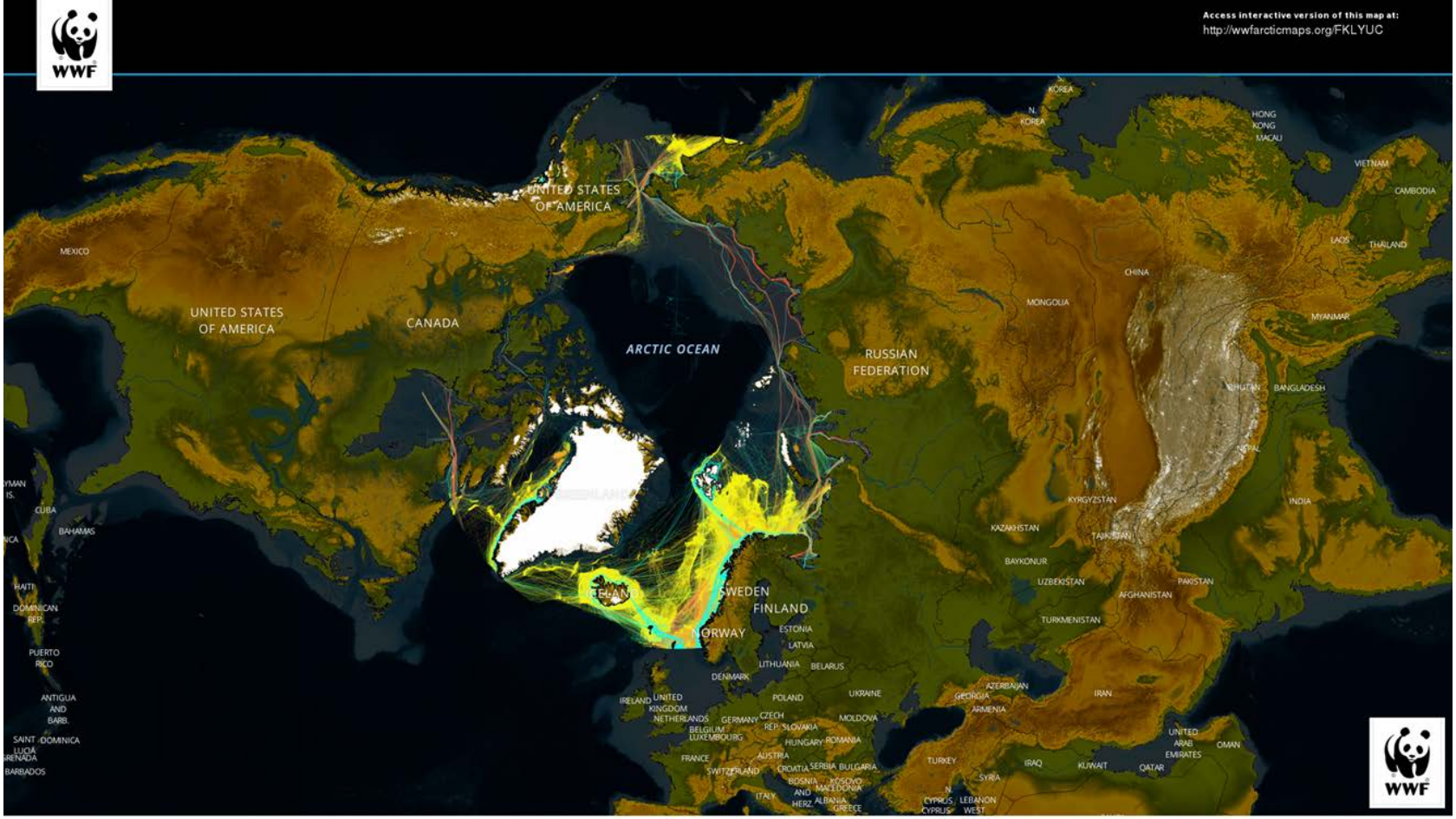
Melting Arctic sea ice poses a major threat to polar bears' survival Rex





Containers in 2012

Containers

Ro-Ro cargo in 2012

Ro-Ro cargo

Reefers in 2012

Reefers

Bulkships in 2012

Bulkships

General cargo in 2012

General cargo

Chemical product tankers in 2012

Chemical product tankers

Data source: Automatic System (AIS) data, provided by The Norwegian Coastal Administration/www.havbase.no (2013) and further processed by DNV and WWF

Gas tankers in 2012

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Oil tankers in 2012

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Fishing vessels in 2012

Fishing vessels tracks

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Passenger ships in 2012

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Offshore supply vessels in 2012

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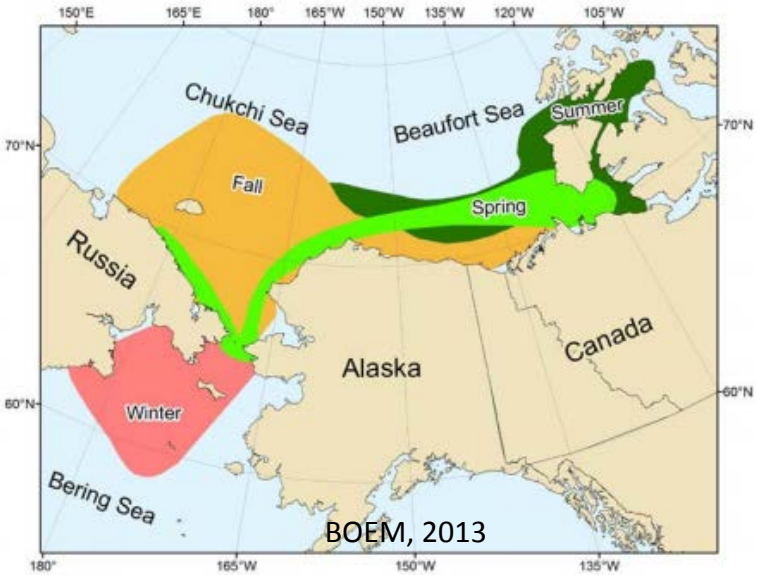
Bowhead whale habitat

Habitat characteristics:

- Ice rich
- Long winters
- Short summers
- Low ship traffic

- Low ambient noise levels



- Potential benefit: “Heat from the sun causes a surge in phytoplankton blooms, a food source for the crustaceans that are key to whales' diets. The melt thins sea-ice density, which eases movement for whales and their prey, and it revs up sea storms and wind, which helps nutrients reach the surface”.

- No mention of underwater acoustic changes or increase in shipping

Arctic

Global warming: Good for big whales

Author: Adam Popescu, Special to The Washington Post Updated: 1 day ago Published 1 day ago

A bowhead whale and calf. The Arctic's largest mammals, they sometimes grow to 60 feet long and live for 200 years. (Corey Accardo / National Oceanic and Atmospheric Administration)

BARROW – About 23,600 square miles of Arctic sea ice melted every day in May, a record-high

Washington Post, Aug 22, 2016

Photo of the Crystal Serenity in Ulukhaktok, NT by Katie Orlinsky, Bloomberg

Noise sources in the Bering, Chukchi, and Beaufort seas

- Marine life activity
- Natural seismic events
- Wind/Waves
- Sea ice

- Shipping and other anthropogenic sources
    - Concern: may mask low frequency whale vocalizations

Research goals

Within bowhead whale habitats, can we identify sources of noise from the *in-situ* hydrophone data using remote sensing (RS) products?

Goal is to identify the **background ambient noise levels** and isolate each source

METHOD

Compare RS products and *in-situ* hydrophone data in order to identify and quantify sources of noise

Extract cell values from RS imagery at different scales around our in-situ hydrophones

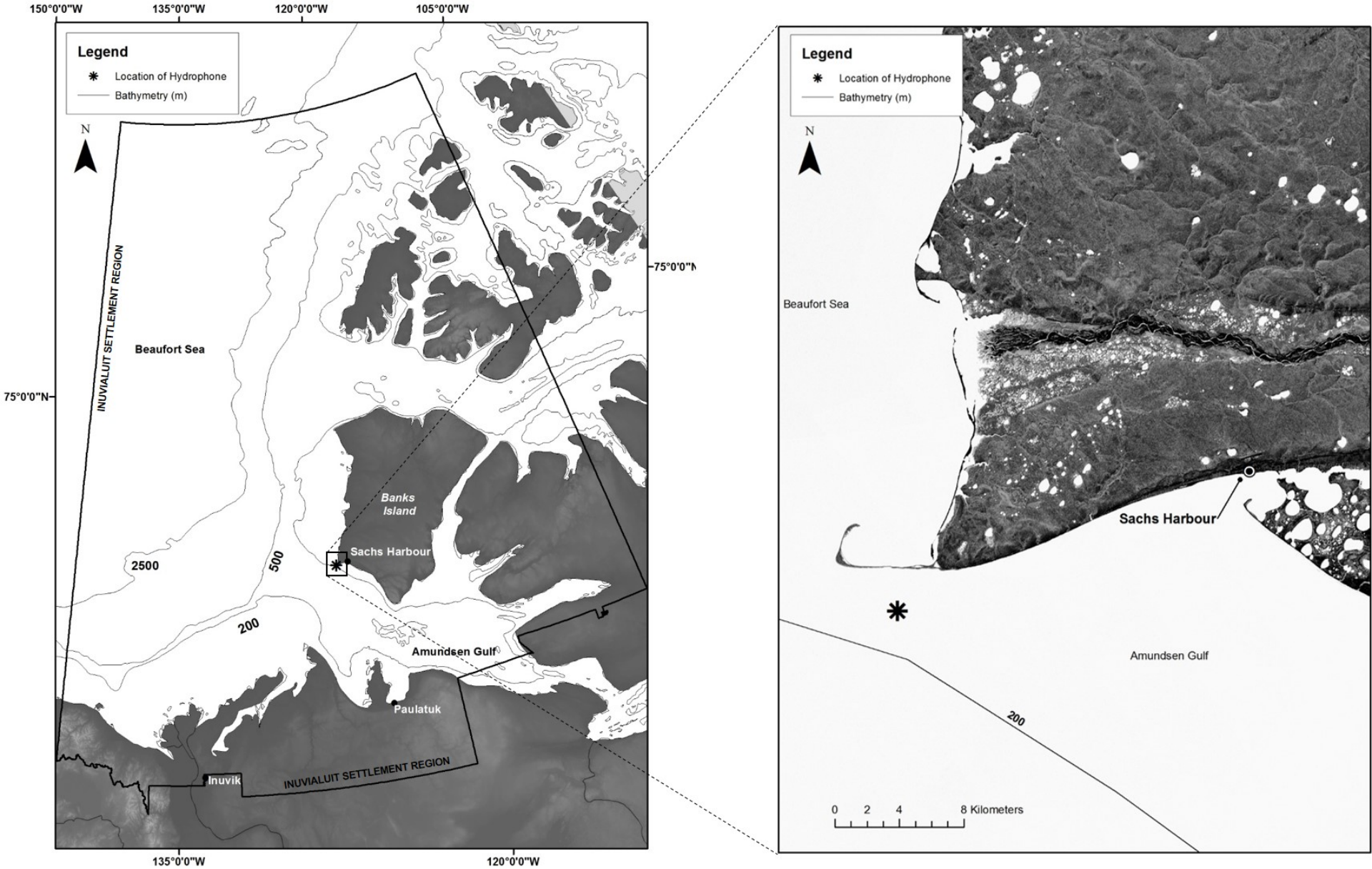
Hydrophone

- Continuously records underwater acoustics
  - Leads to very large datasets
- Frequency response: 10 Hz to 16 kHz
  - Range small seismic activity to large storms
- Anchored at 23.5 m below the surface (where water depth was 26.5 m)

Steve Insley deploying hydrophone

Study Area

- Amundsen Gulf, Western Canadian Arctic
- Hydrophone deployed near the hamlet of Sachs Harbour, NT
- Plans to expand into the Prince of Wales Strait


150°0'0"W
135°0'0"W
120°0'0"W
105°0'0"W
Legend
Location of Hydrophone
Bathymetry (m)
N
INUVIALUIT SETTLEMENT REGION
Beaufort Sea
75°0'0"N
Banks Island
Sachs Harbour
2500
500
200
Amundsen Gulf
Paulatuk
Inuvik
INUVIALUIT SETTLEMENT REGION
135°0'0"W
120°0'0"W
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Amundsen Gulf
200
0 2 4 8 Kilometers

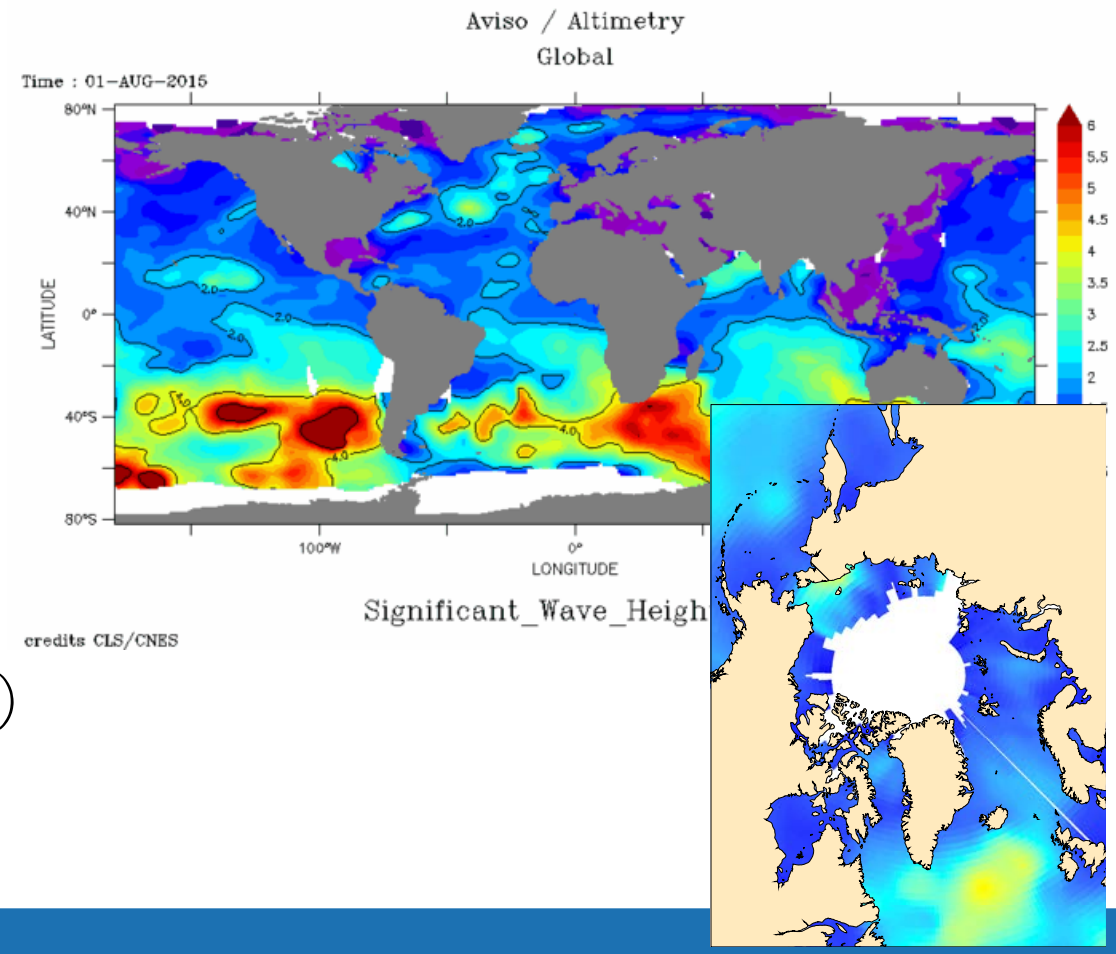
Remote sensing: a tool to assess habitat

- Products used to assess bowhead whale habitat in the Amundsen Gulf:
    - *In-situ* hydrophone
    - AMSR2 Sea Ice Concentration
    - EUMETSAT Ice Drift
    - DUACS Wave Heights

DUACS Multimission Altimeter Product

Data Unification and Altimeter Combination System (DUACS) utilizes altimetry data from the following sensors:

- SARAL
- CryoSat-2
- Jason-1 & 2
- TOPEX/Poseidon
- Envisat
- ERS-1 & 2
- GeoSat
- GeoSat Follow-On (GFO)



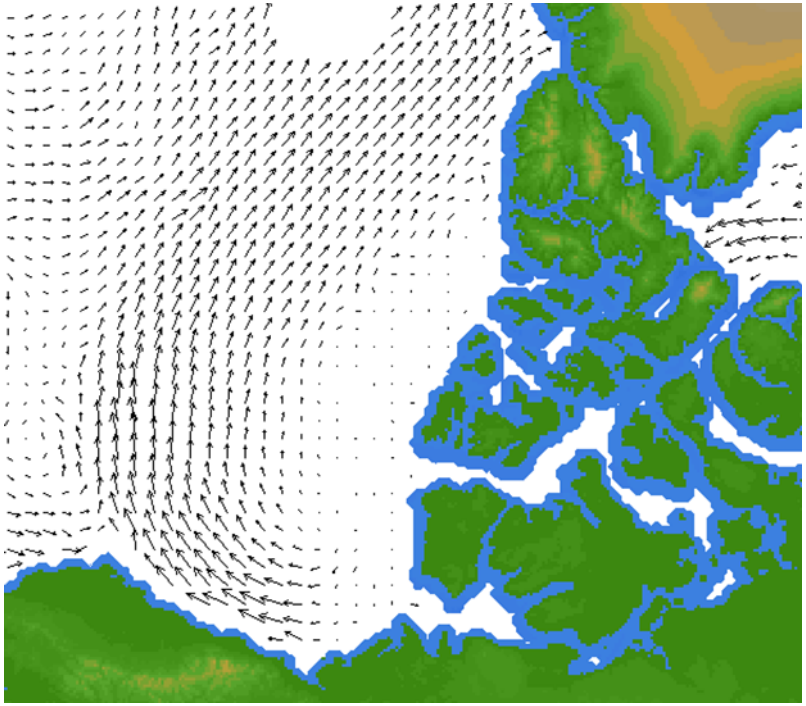
DUACS Multimission Altimeter Product

- Mean Significant Wave Heights (MSWH) from altimetry data will be used to compare with *in-situ* acoustic data
- Resolution: 1° x 1°
- Spatial coverage: global (up to 76°N)
- Temporal coverage: Daily (but a blend of the last two days of available data)

- Available from aviso.altimetry.fr

EUMETSAT Ice Drift product

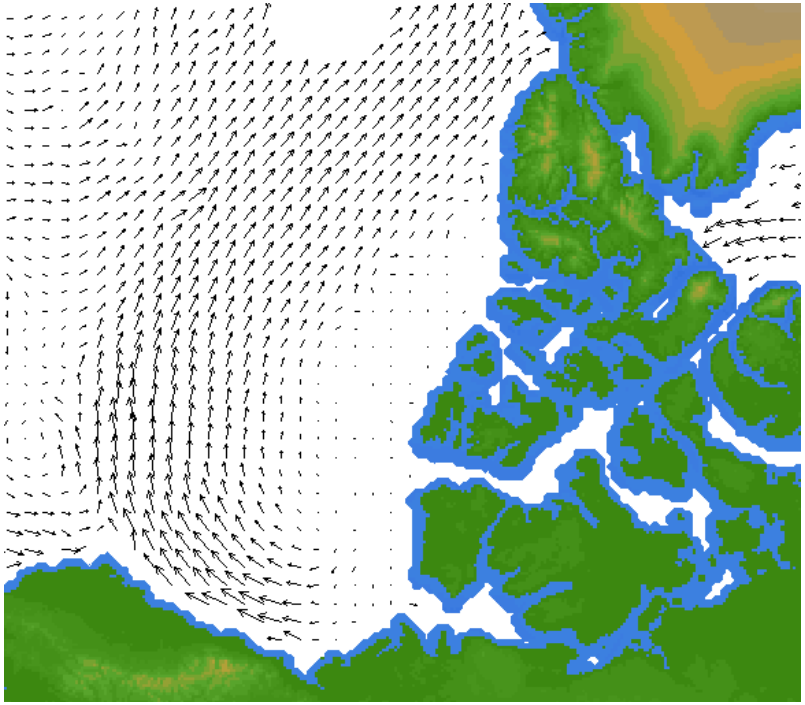
- Low resolution sea ice drift product of the EUMETSAT Ocean and Sea Ice Satellite Application Facility (Lavergne, et al. (2010))
- Sensors used: SSMIS (passive) / ASCAT (active) / AMSR2 (passive)
- Spatial resolution: 62.5 km
- Temporal resolution: 2 days



EUMETSAT Ice Drift product Results

- Uses a 'Maximum Cross Correlation' method to track ice displacement

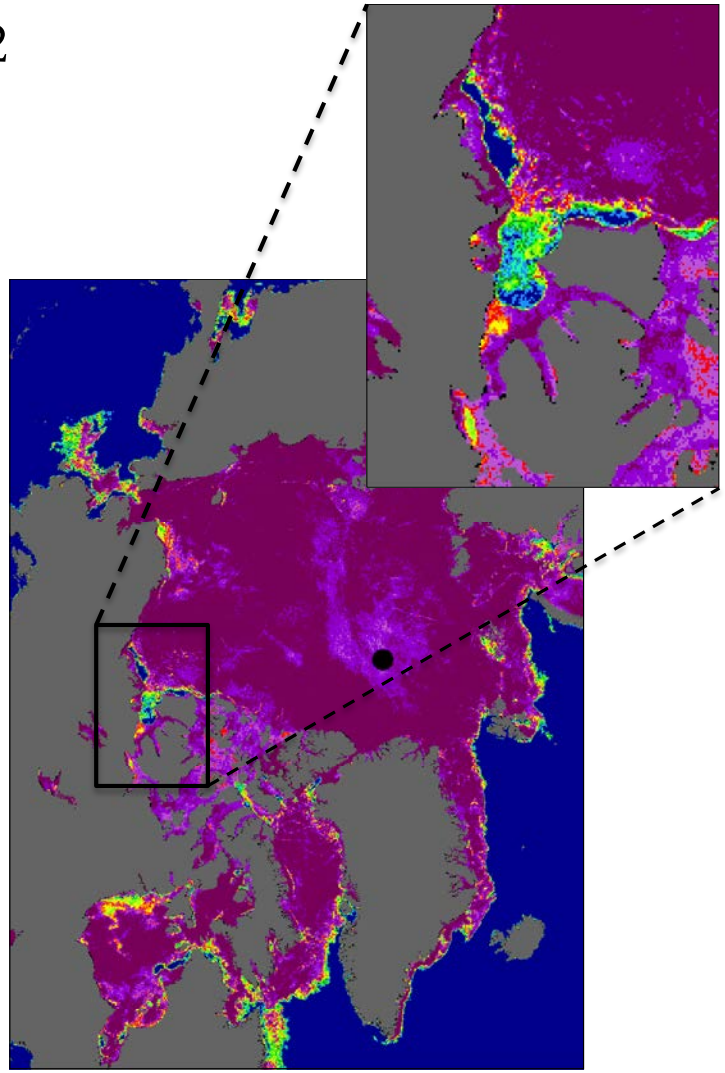
- Past studies (e.g. Kinda et al., 2013) have indicated that under sea ice conditions ice drift largely contributes to ambient noise levels



Available from http://osisaf.met.no/p/ice/lr_ice_drift.html

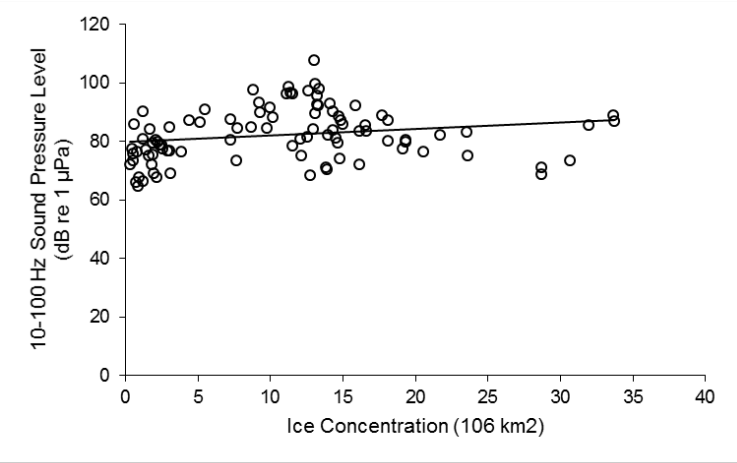
AMSR2 Sea Ice Concentration Product

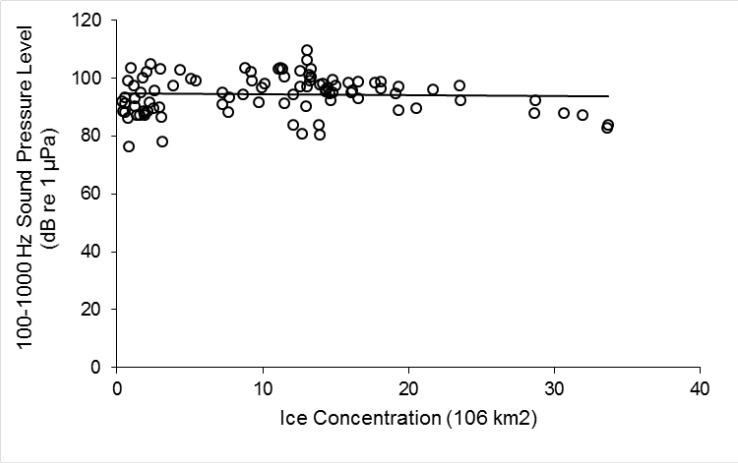
- Advanced Microwave Scanning Radiometer 2 (AMSR2) from the Japan's GCOM-W satellite (Global Change Observation Mission - Water)
- Sea ice concentration data obtained from the PHAROS (PHysical Analysis of RemOte Sensing images) group at the University of Bremen
- 6.25 km^2 resolution (finest available sea ice concentration product)
- The sensor records wavelengths ranging from 7 to 89 GHz, and the strength of the returned signal is what enables surface characteristics to be defined (i.e. water versus ice)

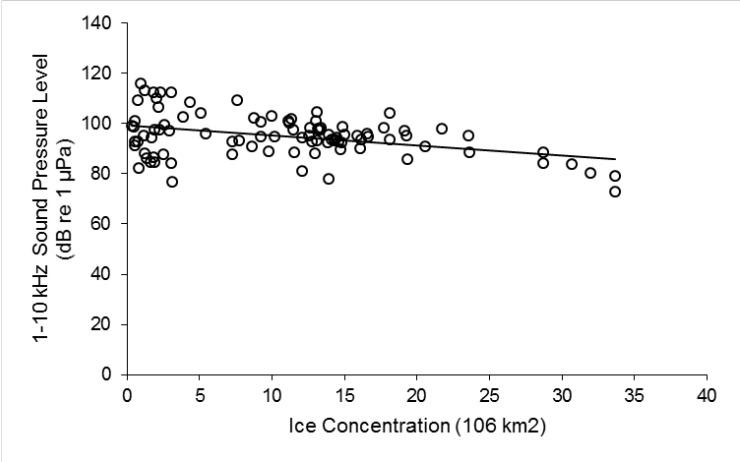


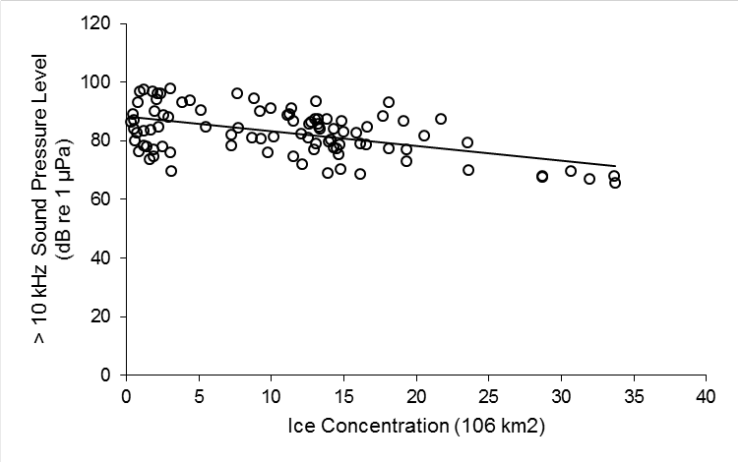
AMSR2 Sea Ice Product Concentration Results

Summer 2015





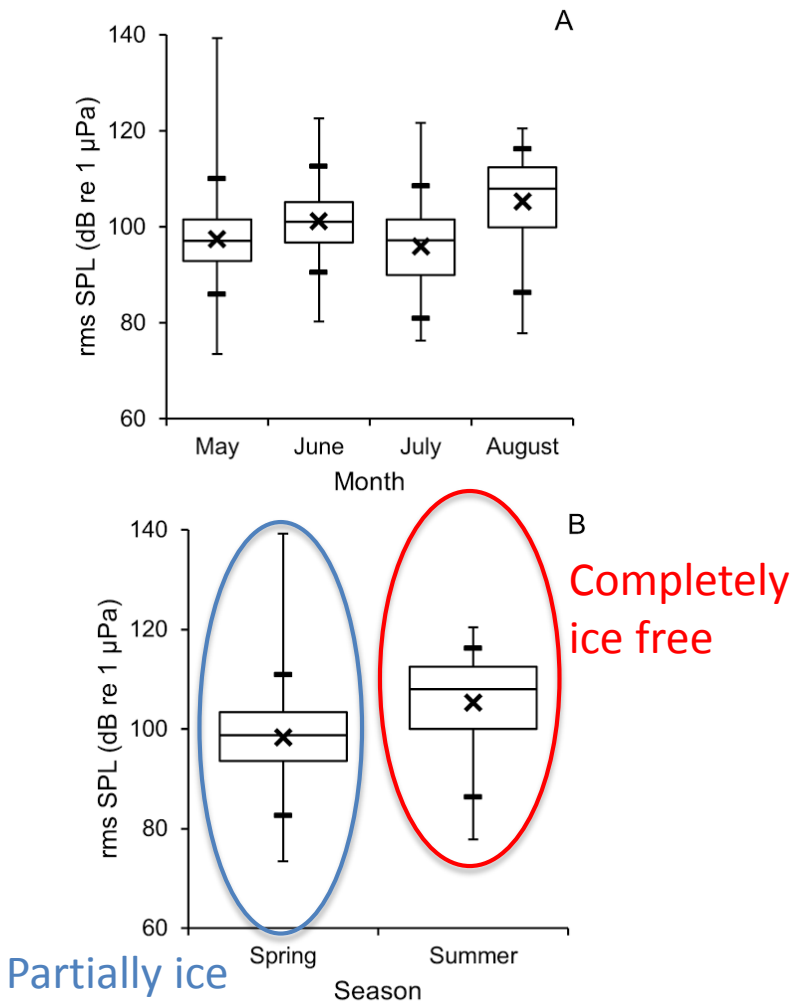




Courtesy W. Halliday

AMSR2 Sea Ice Product Concentration Results

- Sound Pressure Levels are generally higher in ice free conditions
  - Influenced by wind/wave action
- Ambient noise levels are lower when ice cover is present
  - Mainly influence by ice drift during these conditions



Courtesy W. Halliday

Discussion/Conclusion

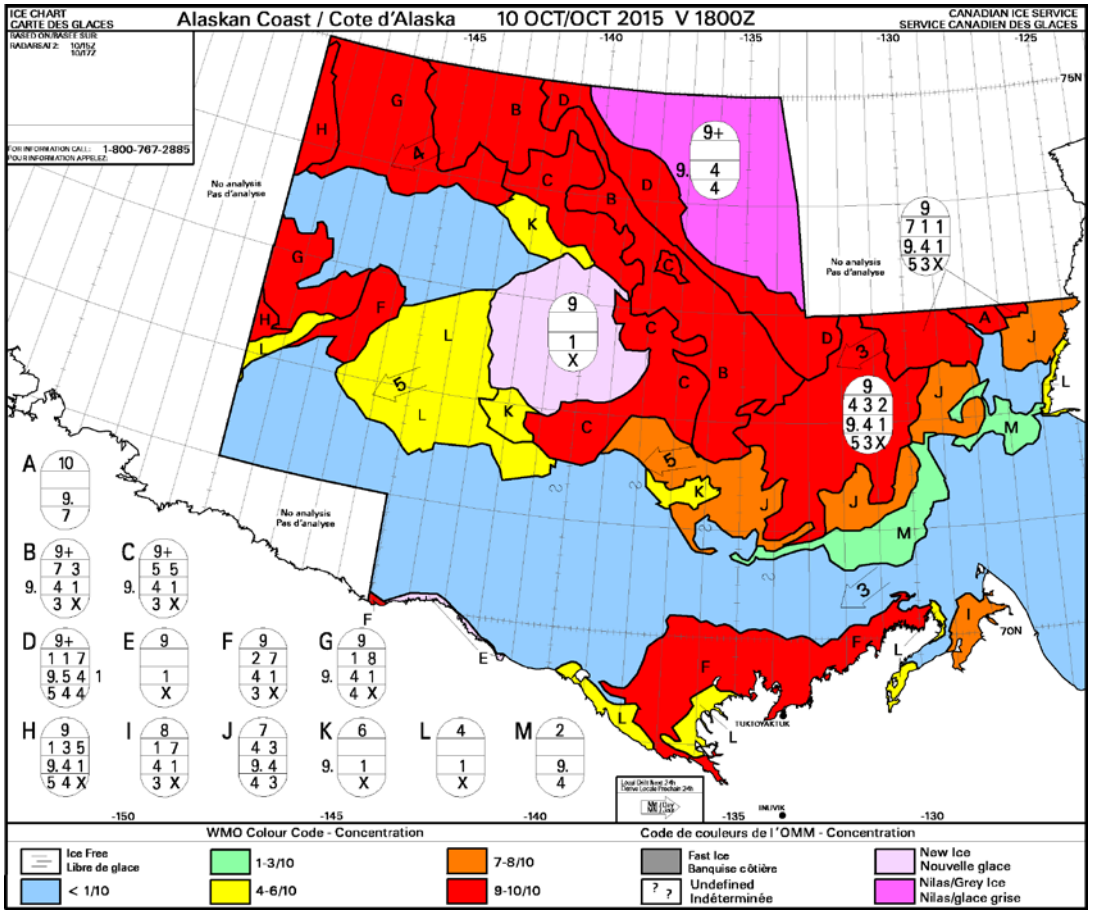
- Ambient noise levels within the Amundsen Gulf are relatively quiet
    - However, a decrease in sea ice will increase the noise levels cause by waves action in the shoulder seasons (Fall/Spring)
    - The ice drift component of ambient noise will become less of a factor
- A decrease in sea-ice and increase in shipping will cause the noise levels in the Gulf to increase
- Thus, arctic marine mammals may be more susceptible to increases in anthropogenic activity

Future work

- Continue analysis comparing RS data and *in-situ* acoustic data
- Deploy more hydrophones in the Amundsen Gulf (in particular the Prince of Wales Strait (west of Banks Island)
- Include finer resolution SAR data to map sea ice cover / sea ice type in Amundsen Gulf
- Incorporate bowhead whale migration data
- Incorporate AIS Ship tracking data

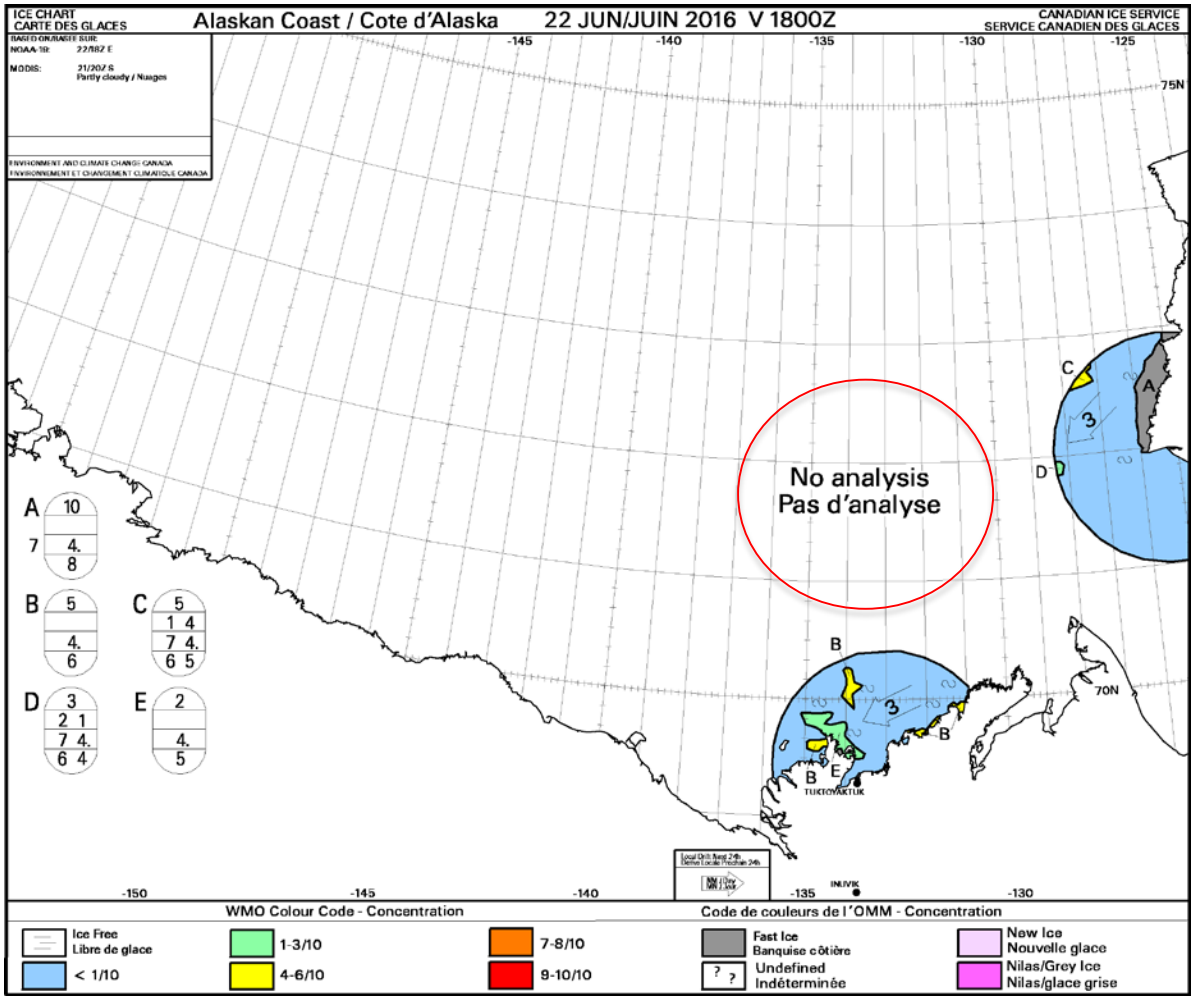
Canadian Ice Service Charts

- Produced mainly from RADARSAT-2
- Provides ice type and ice concentration data



Challenges

- Lots of missing data
- RADARSAT coverage isn't daily
- MODIS used



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