



FINDING THE CALLS IN THE CHAOZ:

Marine mammals and oceanographic conditions off Alaska's northern slope

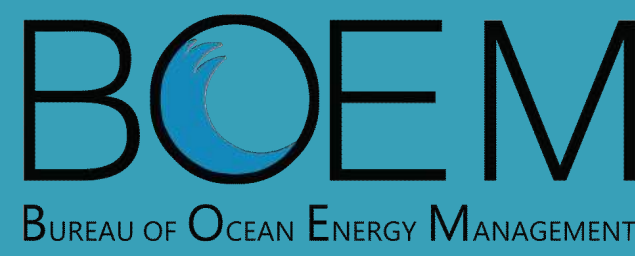
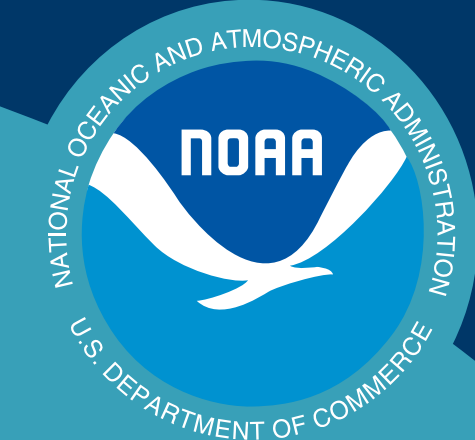
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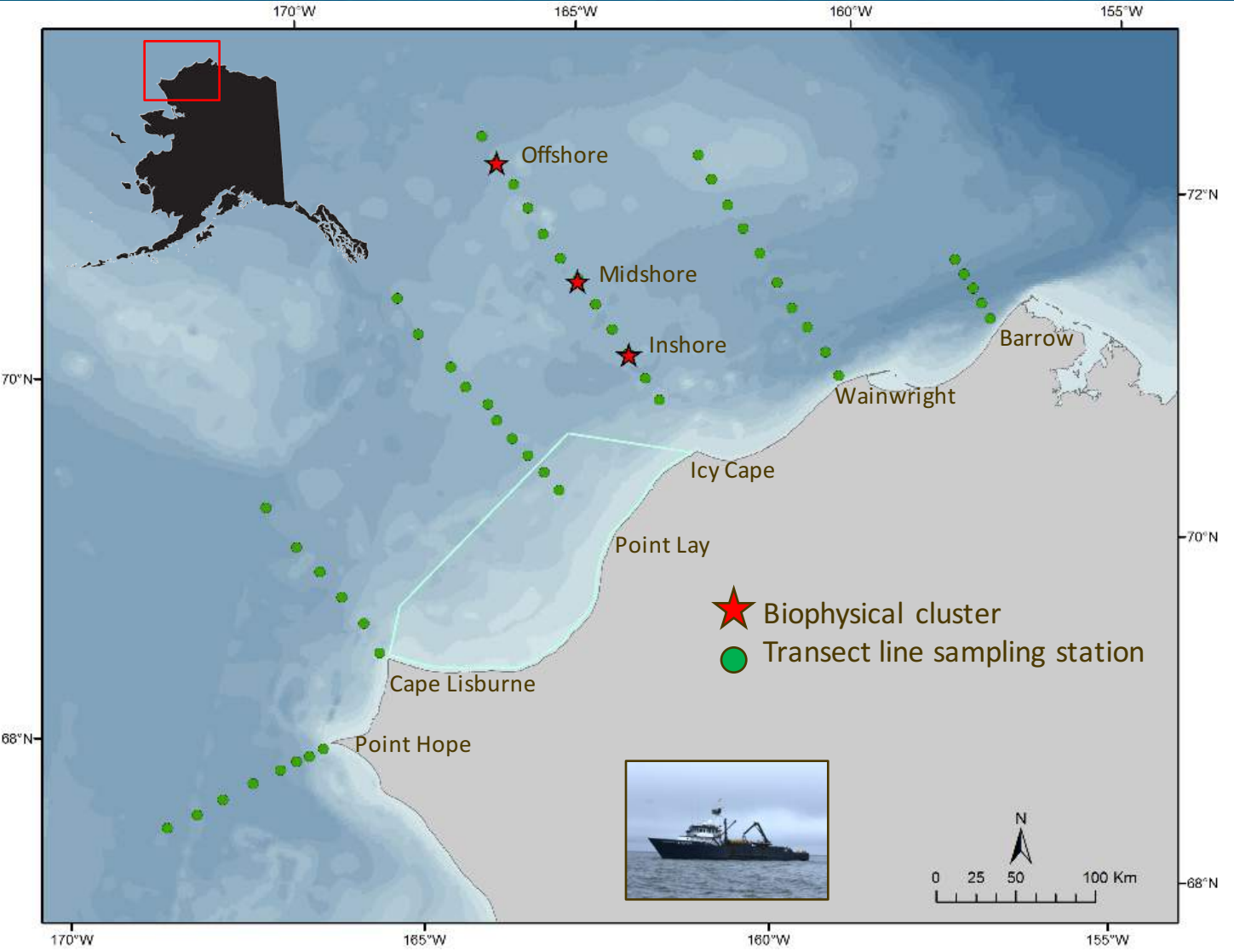


Abstract

The Chukchi Acoustics, Oceanography, and Zooplankton (CHAOZ) study was a five-year BOEM-funded, multi-disciplinary study (2010-2015). Its primary objective was to document the distribution of large whales in areas of potential seismic activity, and to relate these changes to oceanographic conditions, indices of potential prey density, and anthropogenic activities. Results presented here focus on the relationship between marine mammal distributions and oceanographic conditions. Three clusters of passive acoustic and biophysical moorings were deployed at 40nm, 70nm, and 110nm off Icy Cape, AK, and collected year-round passive acoustic data (16 kHz sampling rate, ~30% duty cycle) along with twelve different oceanographic measurements from two consecutive deployments (2010-2012). All acoustic recordings (100%) were analyzed using an in-house Matlab-based manual analysis program for twelve different Arctic and sub-Arctic cetacean and pinniped species, as well as for vessel, airgun, and ice noise. Generalized Additive Models (GAMs) were used to assess the effect of oceanographic conditions on marine mammal distribution, and marine mammal calling activity was plotted against eight oceanographic variables to determine if any positive/negative correlations existed on a temporal scale. Bowhead and beluga distributions showed similar patterns, with bimodal temporal distributions representing the fall and spring migrations. Ice concentration and month had the greatest effect on both bowhead and beluga presence, although bowheads were also strongly correlated with ice thickness and strong SSW winds. Gray whale detections (isolated on the inshore recorder) were too infrequent for conclusive results. Walrus and bearded seal calls were detected almost year-round; both species were correlated with ice concentration and variables that serve as proxies for prey availability. Detections of sub-Arctic species (e.g., humpback, fin, and killer whales) were rare. This study illustrates the importance of collecting concurrent passive acoustic and oceanographic data in a rapidly changing environment.

Methods

For more details on the CHAOZ project, see Berchok et al. poster!



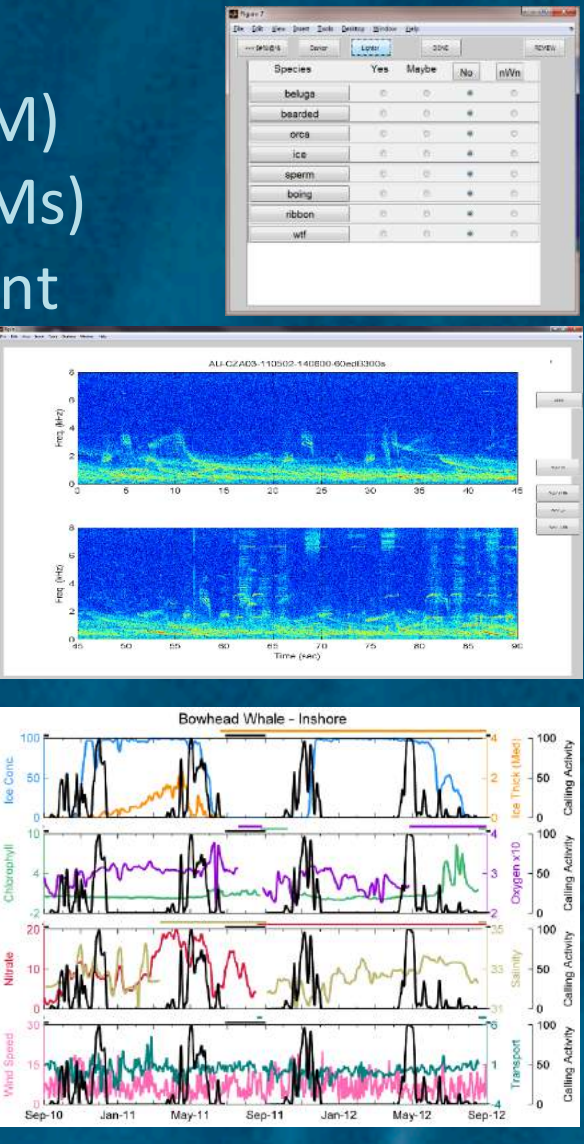
Field methods

- 2010, 2011, 2012
Biophysical mooring clusters
- Passive acoustic
 - Oceanographic
 - Zooplankton
- Transect line sampling
- CTDs, zooplankton tows
- Marine mammal surveys
- Visual and passive acoustic

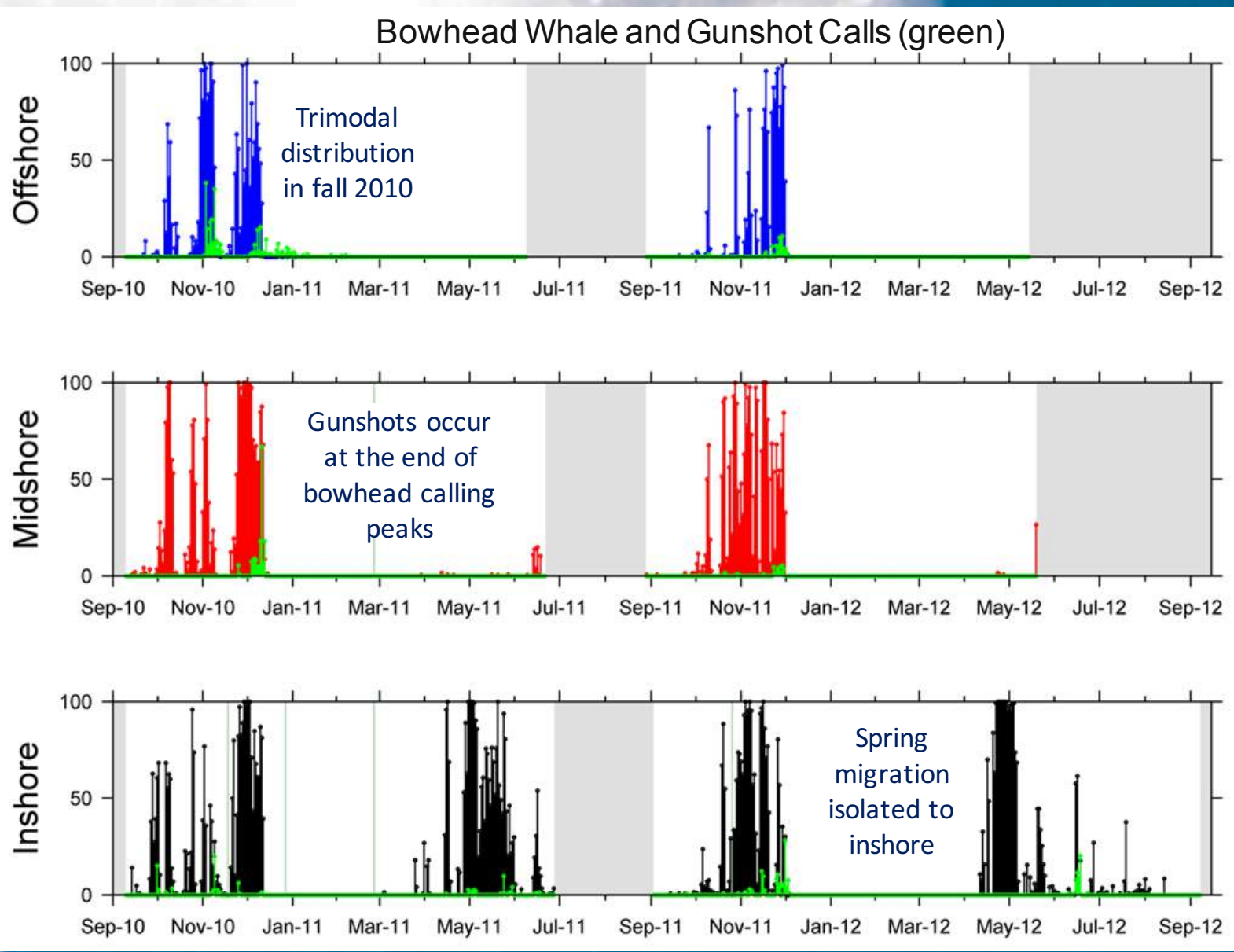


Analysis methods

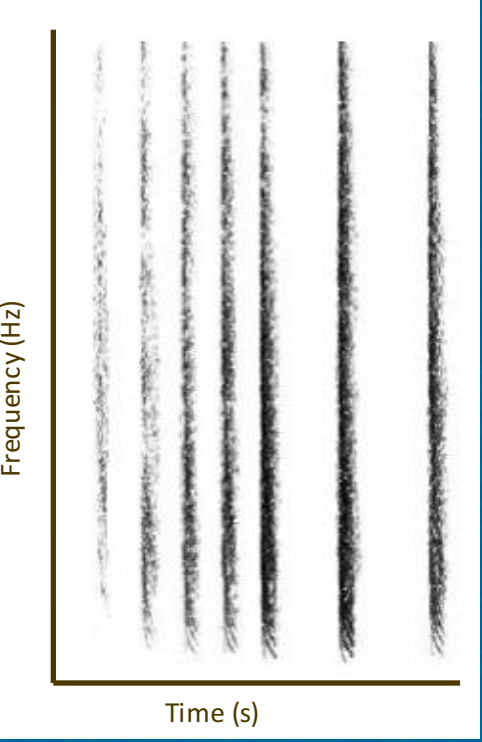
- 100% of acoustic recordings
- 12 spp. marine mammals (MM)
- Generalized Additive Models (GAMs)
- Correlate MM with 19 different oceanographic and environmental variables
- MM plotted vs. 8 variables
- Determine positive or negative associations
- Transect sampling data plotted against MM survey data
- Visual and passive acoustic



BOWHEAD WHALES



Gunshot call



- Produced by bowhead whales
- Impulsive, broadband call
- Produced when ice is forming
- Used for navigation?

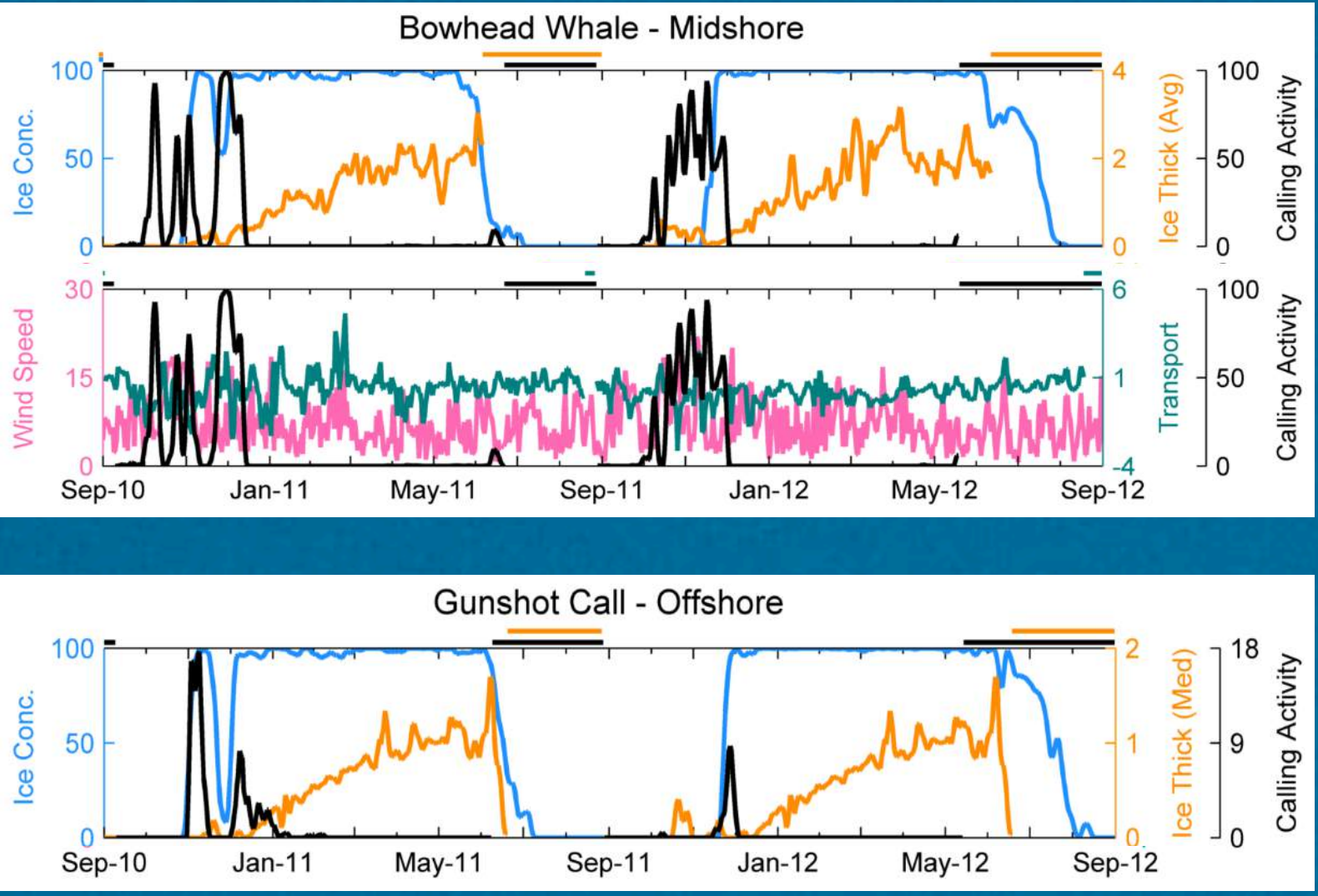
GAMs

- Month
- Ice concentration
- Wind speed

Long-term plots

- Ice concentration
- Ice thickness
 - Calling ceased when ice thickness reached 0.5m
- Wind speed
- Migratory cue?

No short-term data



*Note: reduced calling activity scale

Focused on 5 resident/migrant Arctic species



Results

GAMs: Significant parameters that are common among all top models are presented. Calling activity plots: Calling activity = % of intervals per day with at least one call present. Gray areas = no data. Calling activity vs. parameters plots: One representative location presented for each species. Only variables with correlations are presented. Horizontal bars above plots indicate no data.

GRAY WHALES

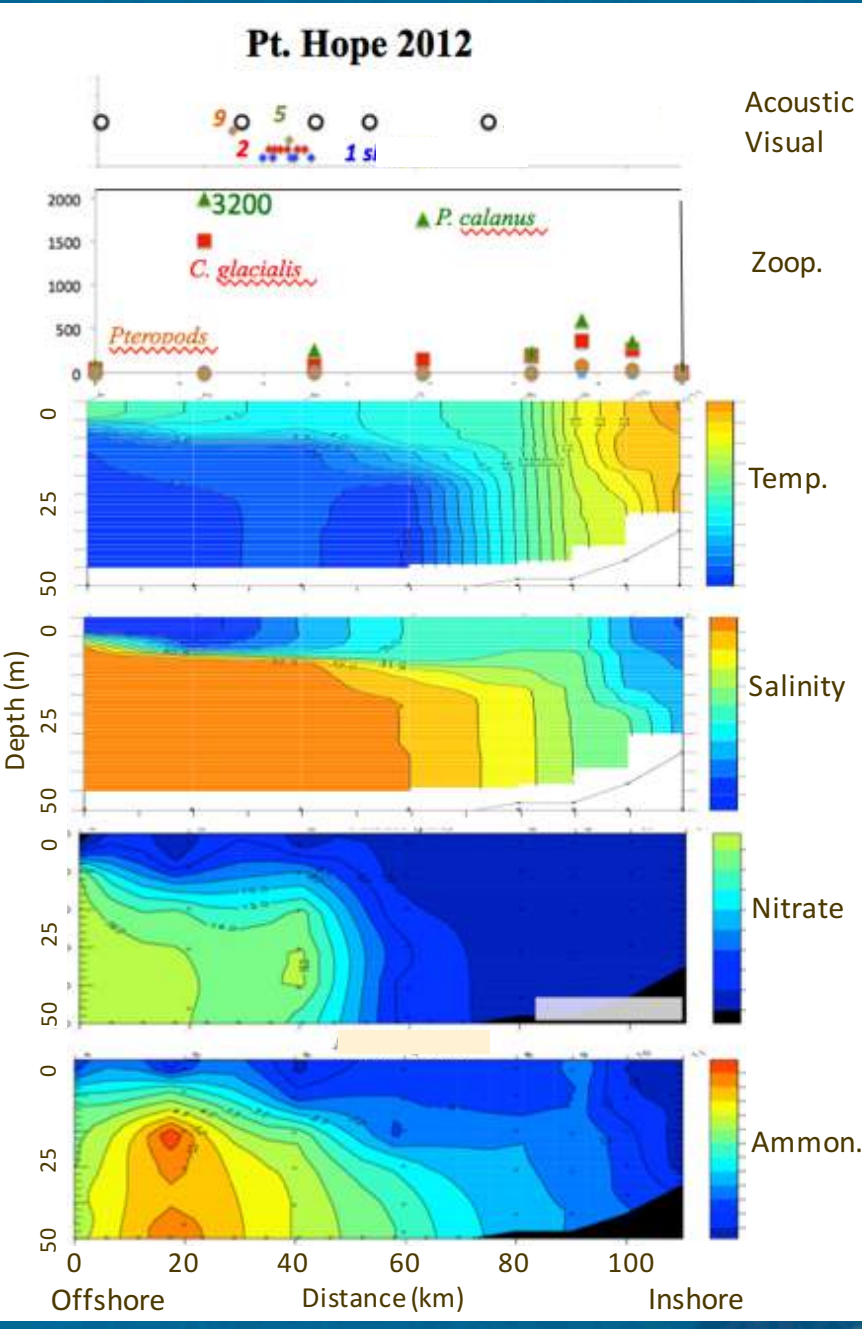
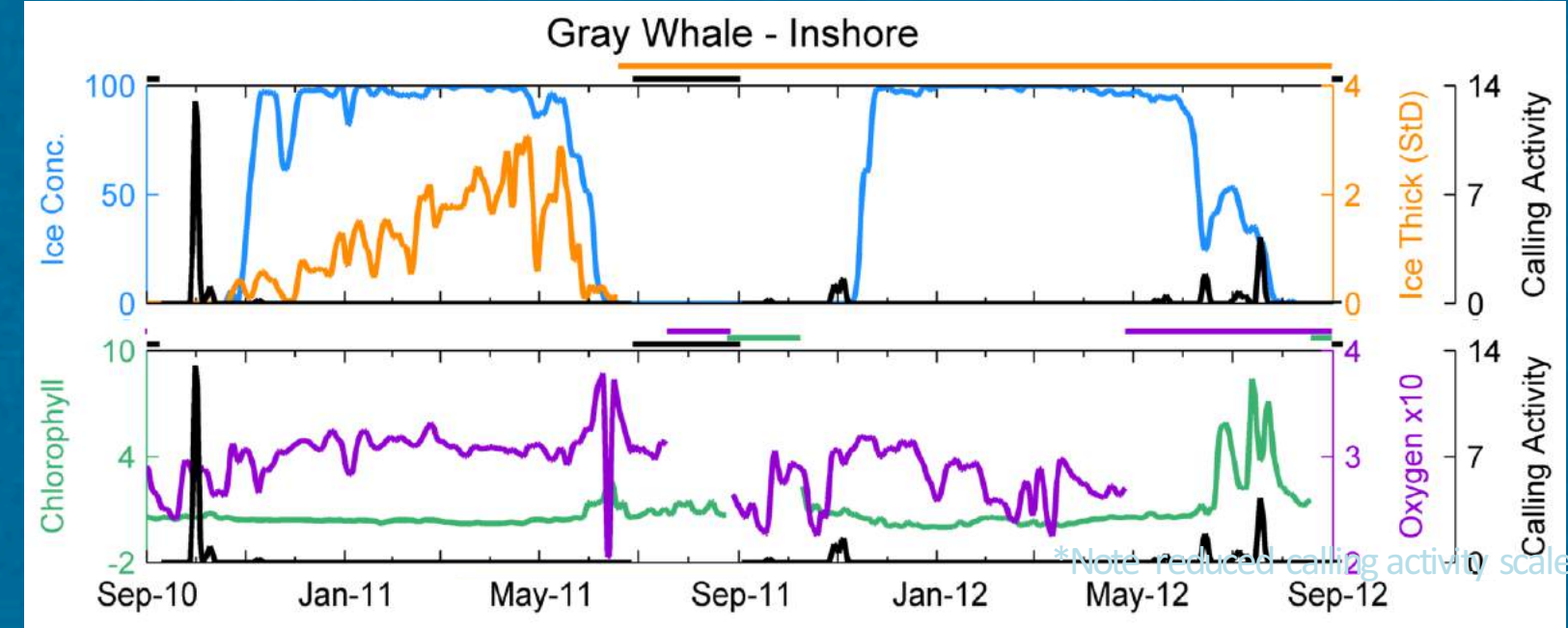
- Acoustic detections were rare
- Isolated to inshore recorder
- GAMs inconclusive

Long-term plots

- Negative association with ice
- Association with chlorophyll
 - Summer 2012
 - Proxy for prey availability

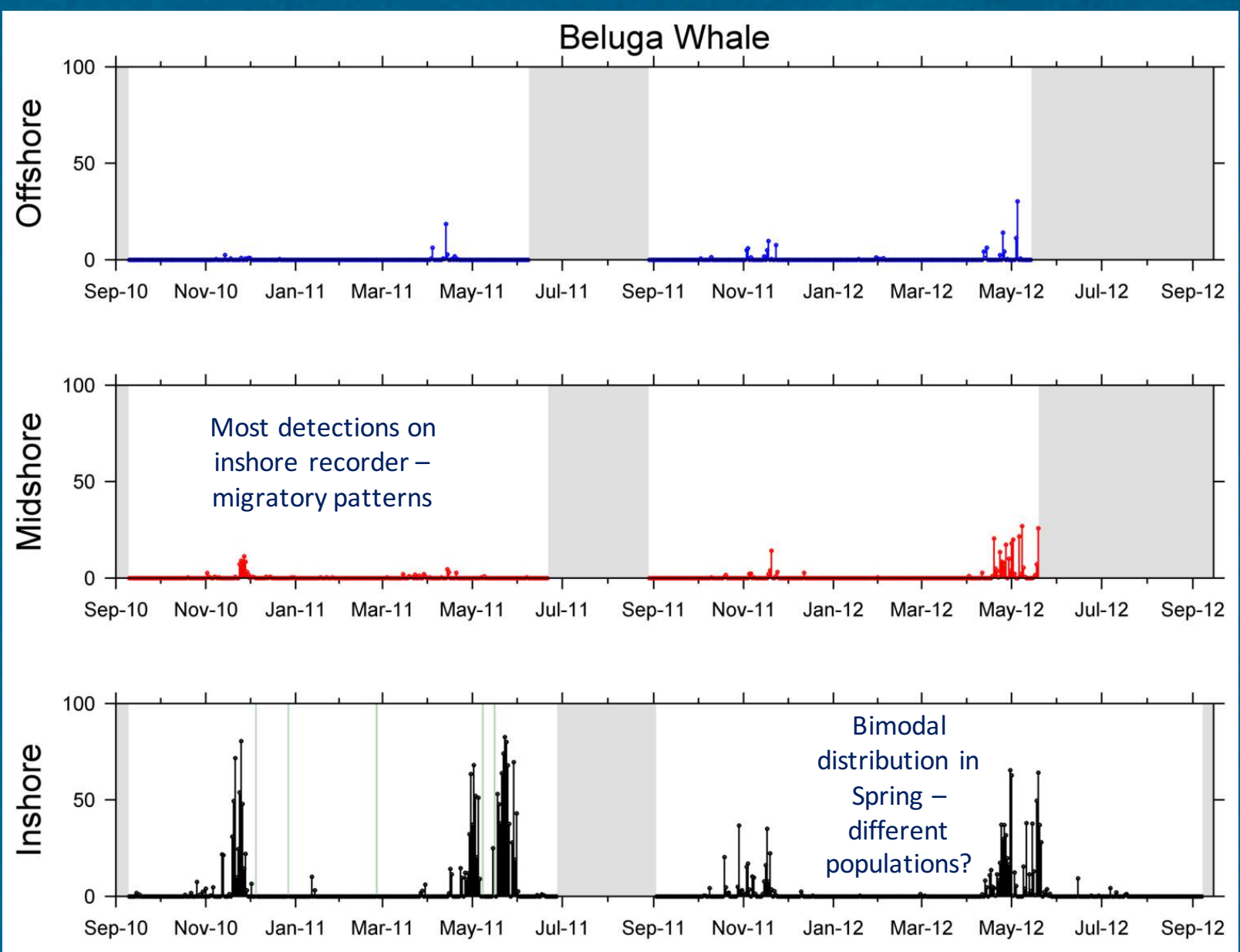
Short-term sampling data

- Gray whales detected in areas of:
- High zooplankton concentrations
 - High ammonium, nitrate
 - High benthic biomass



Gray whales are consistently seen at this location every year.

BELUGA WHALES



GAMs

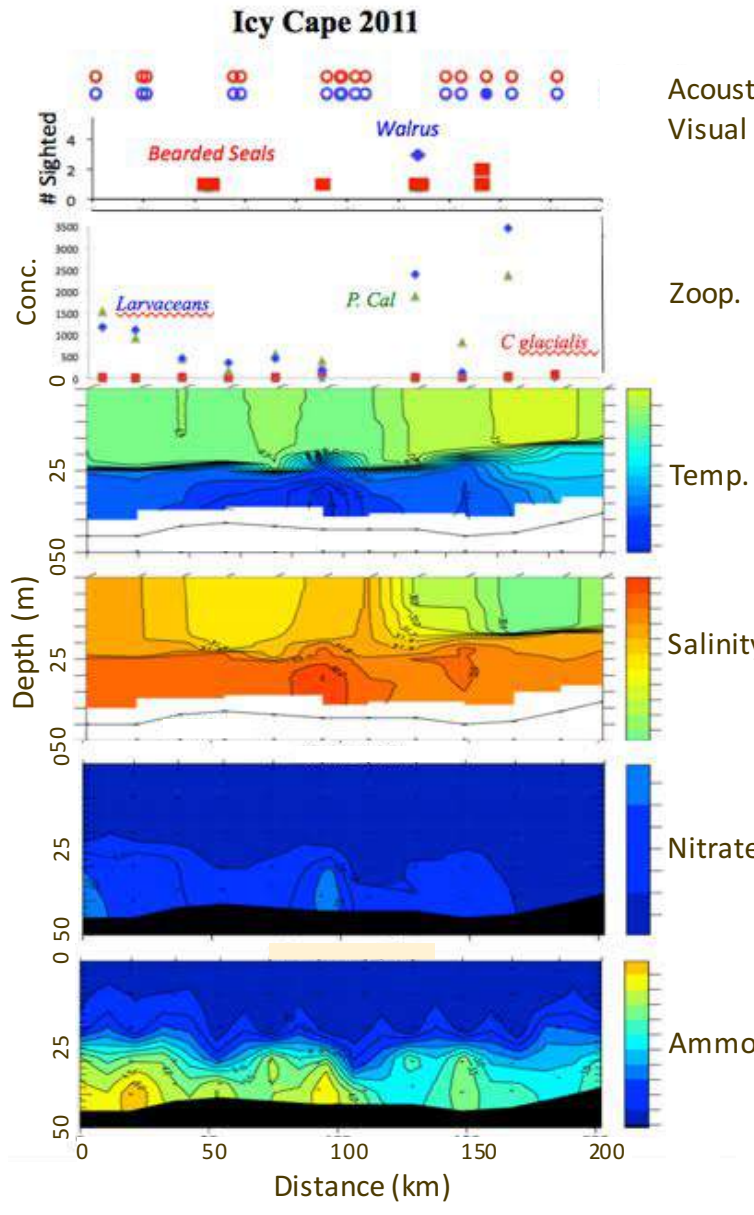
- Month
- Temperature
- Ice concentration

No short-term data

Long-term plots

- Ice concentration
- Polynyas

BEARDED SEALS

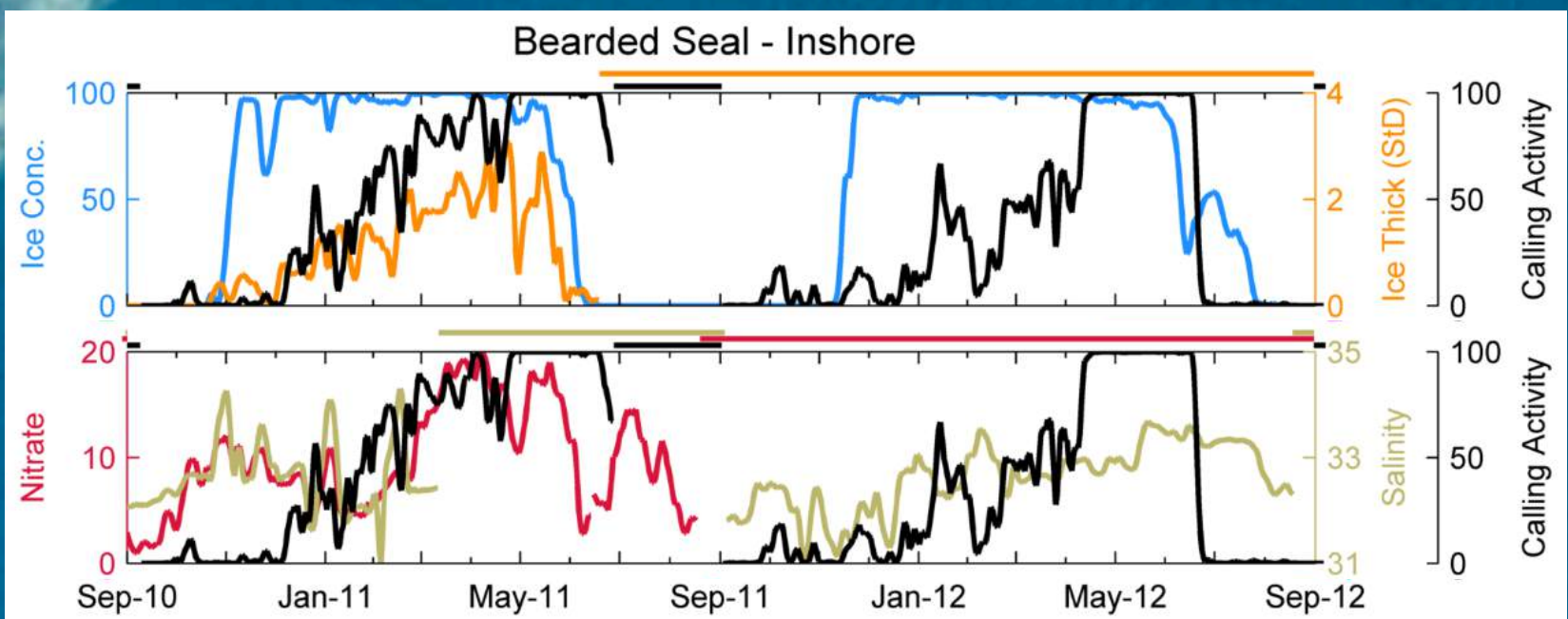
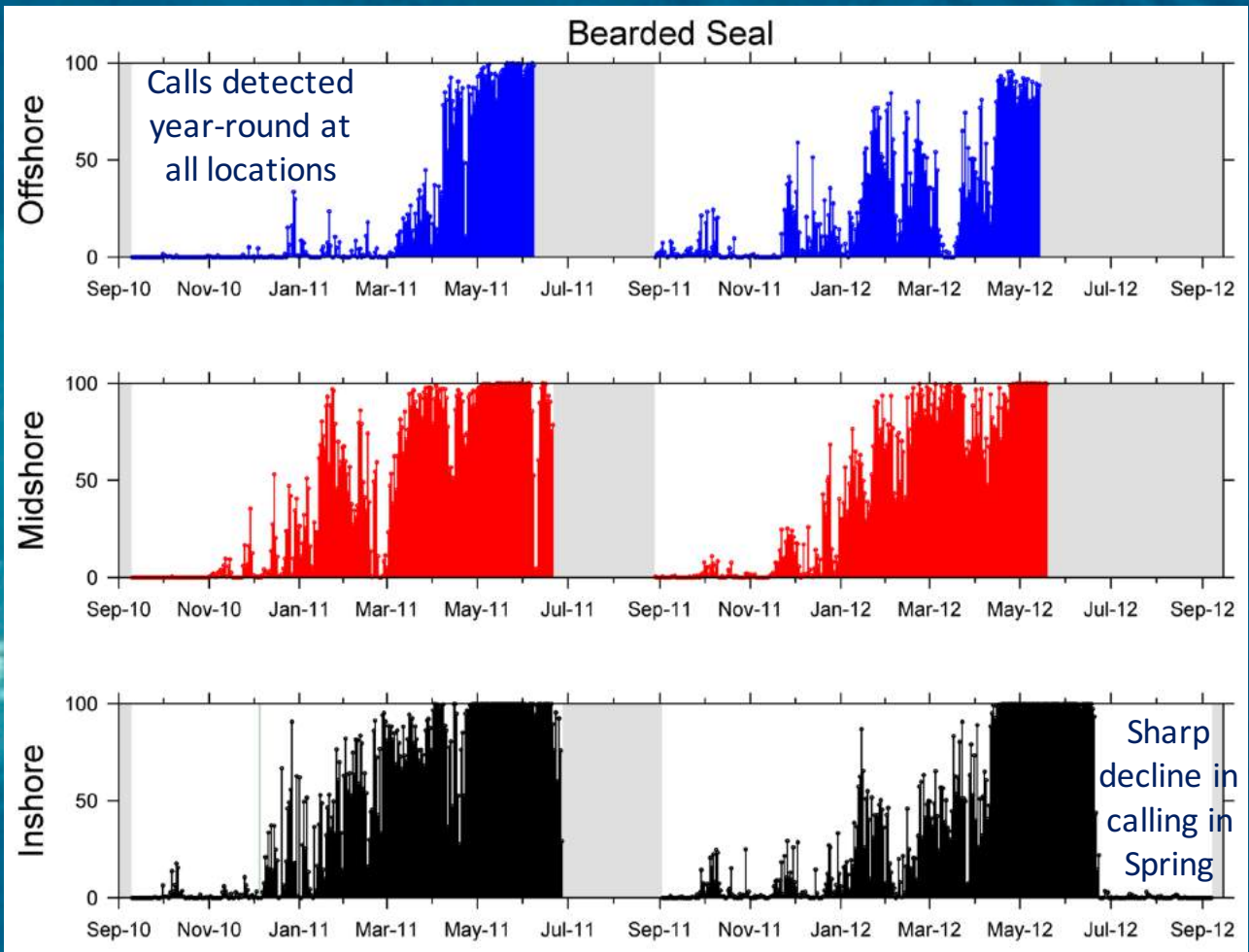


GAMs

- Month
- Wind speed
- Prey proxies

Long-term plots

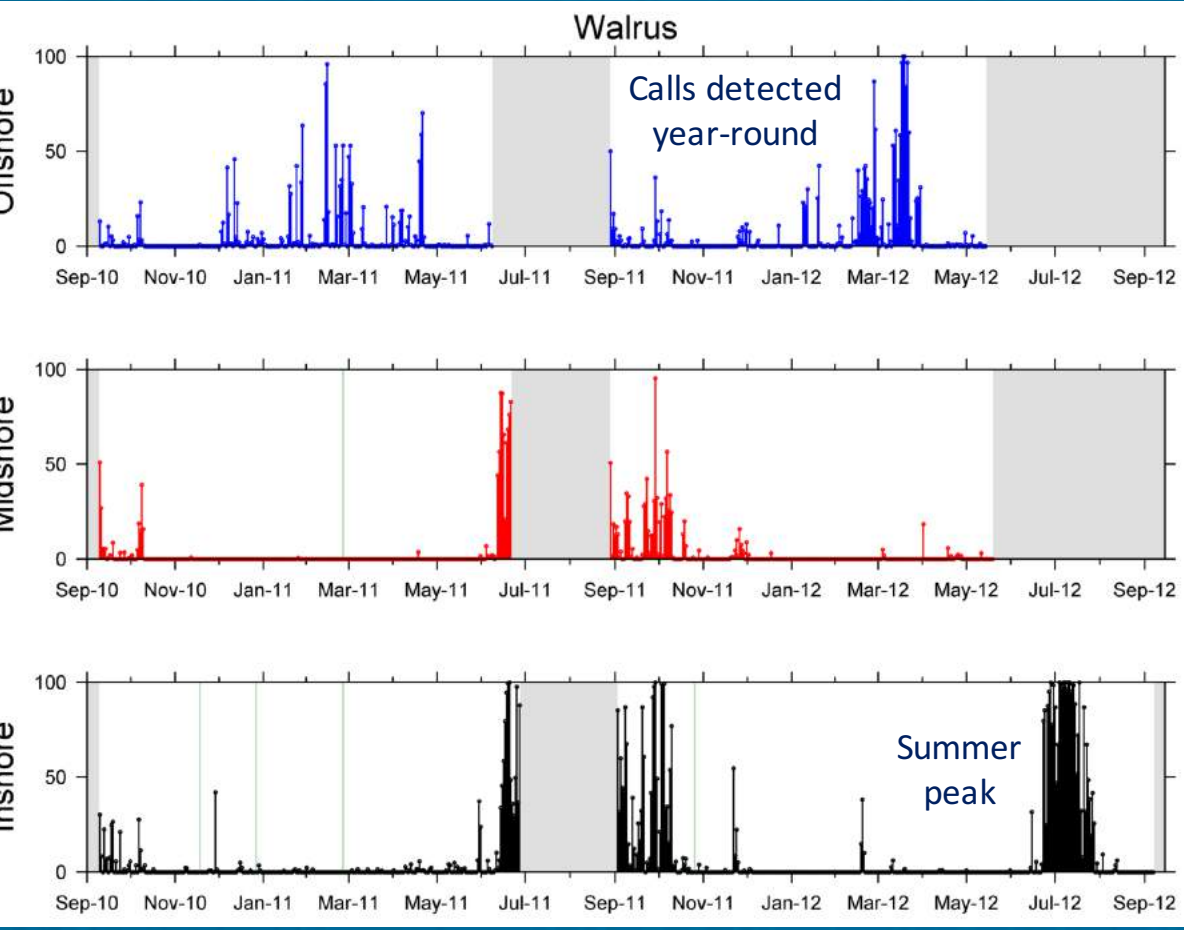
- Ice - positive
- Thickness
- Prey proxies
- Nitrate



Short-term sampling data

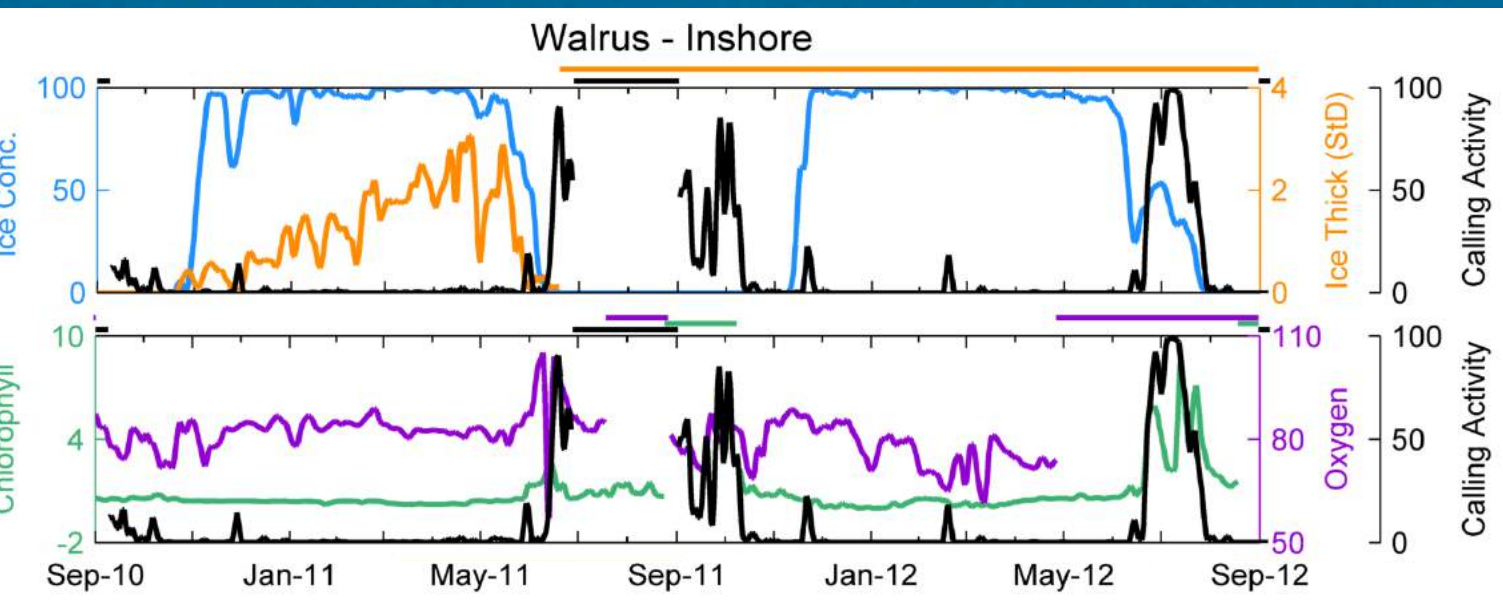
- Bearded seals detected in areas of:
- High zooplankton concentrations
 - High ammonium
 - High benthic biomass

WALRUS



Long-term plots

- Ice - negative
- Proxies for prey (Chlorophyll & Oxygen)

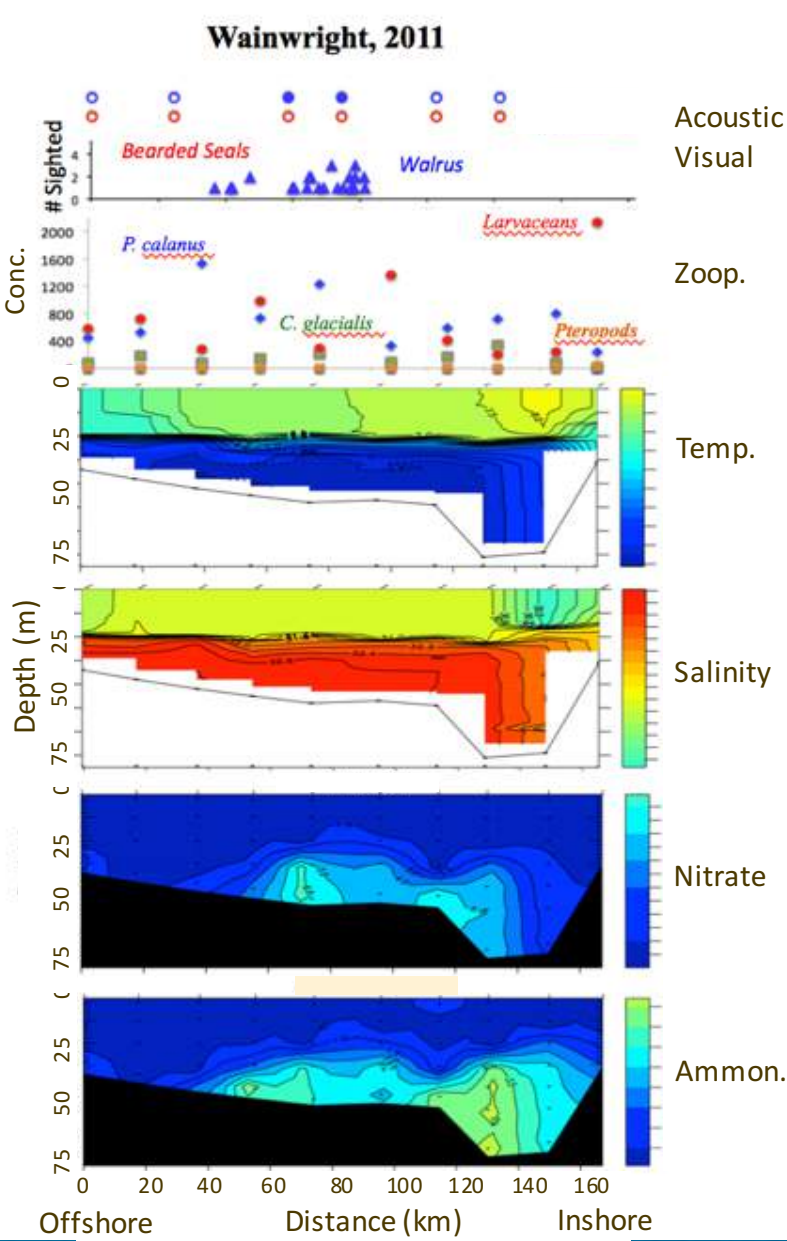


Short-term sampling data

- Walrus detected in areas of:
- High zooplankton concentrations
 - Ammonium/nitrate
 - High benthic biomass
 - Hanna Shoal

GAMs

- Month
- Wind speed
- Proxies for prey



Summary

- Correlated marine mammal calling activity with oceanographic, environmental, and prey indices
- Determined positive/negative associations
- Obtained an ecosystem-based analysis of the Alaskan Chukchi Sea

Acknowledgements

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Next Steps

- Apply these techniques to larger, more robust dataset
 - Inclusion of CHAOZ-X study and ARCWEST study data
- Quantitative, statistical analyses on positive/negative associations

What will these species do as sea ice continues to change?