

CHAOZ in a nutshell: Five years of work in twelve minutes



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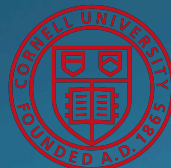
² Alaska Fisheries Science Center/Resource Assessment and Conservation Engineering Division (RACE)

³ Pacific Marine Environmental Laboratory (PMEL)/Ocean Environment Research Division

⁴ Bioacoustics Research Program (BRP)/Cornell University



NOAA
FISHERIES

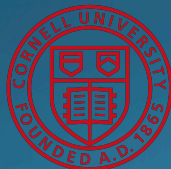


BOEM
BUREAU OF OCEAN ENERGY MANAGEMENT

CHAOZ = Chukchi Acoustics, Oceanography and Zooplankton Study

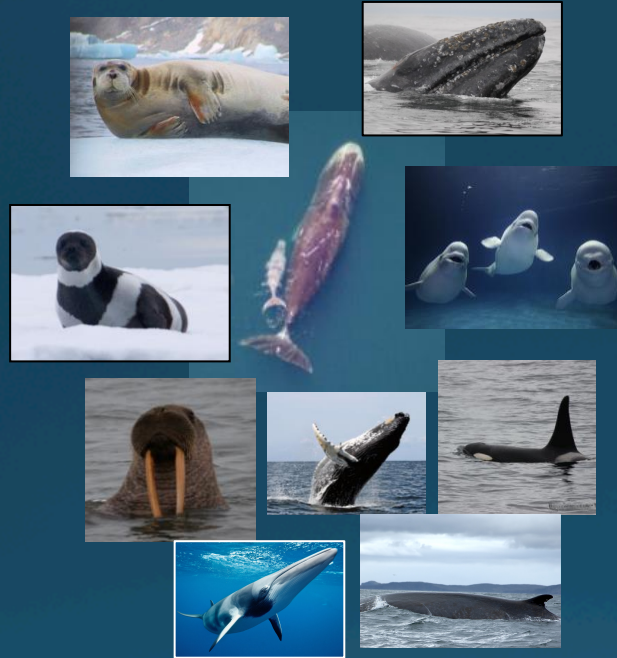


NOAA
FISHERIES

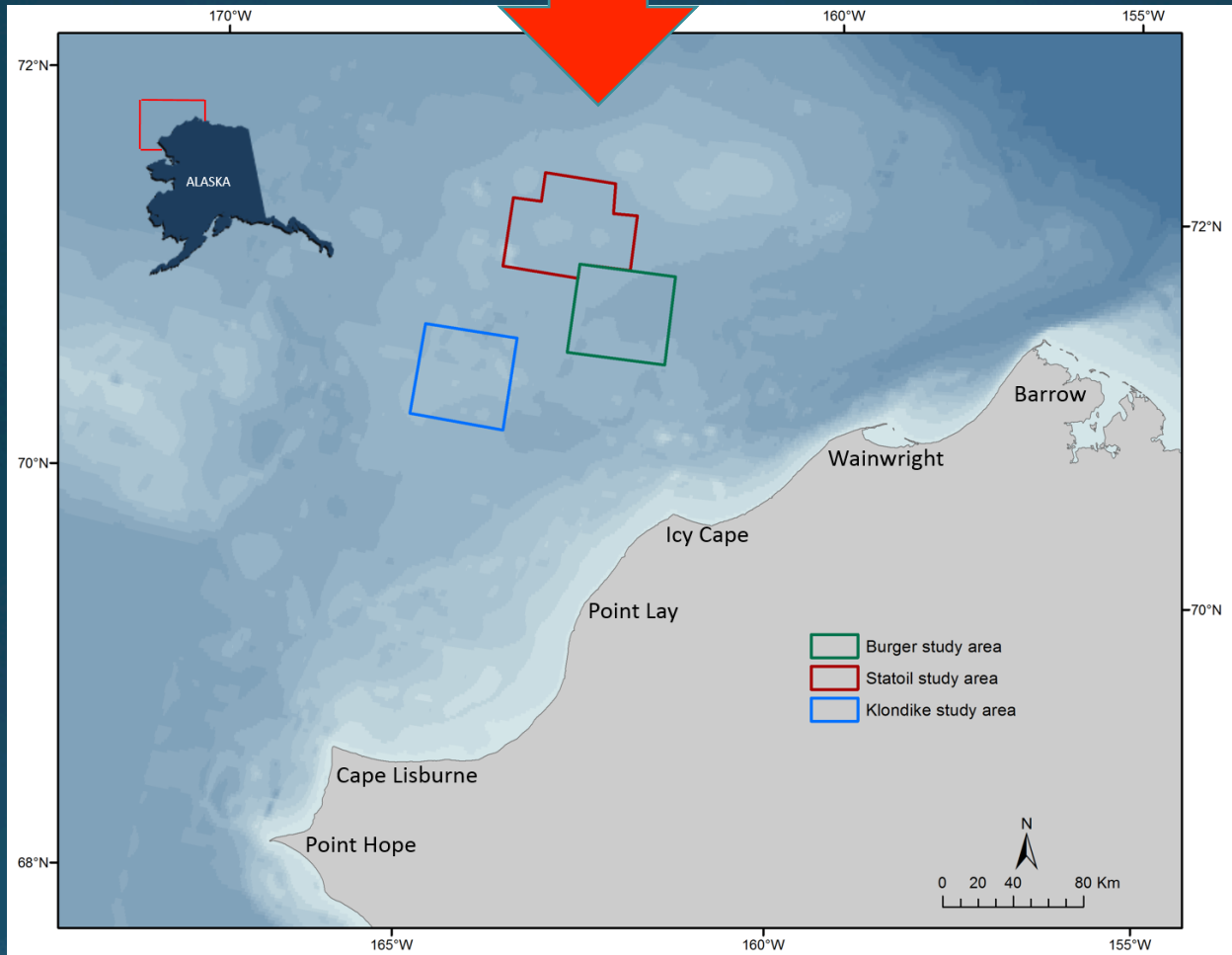


BOEM
BUREAU OF OCEAN ENERGY MANAGEMENT

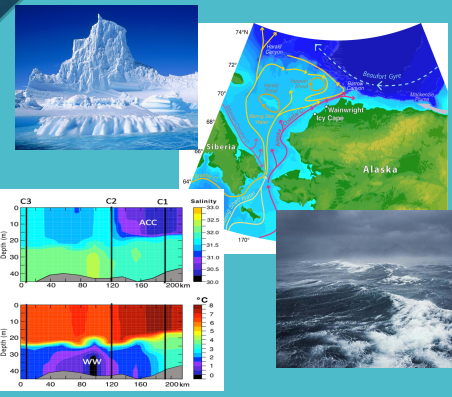
CHAOZ Objectives:



Document the distribution and relative abundance of whales ...



... in areas of potential industrial activity



Oceanography

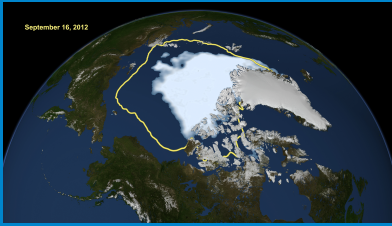


Noisy Humans

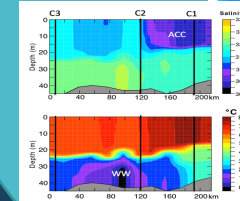
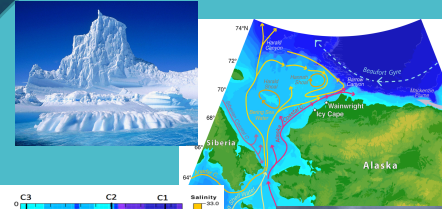


Zooplankton

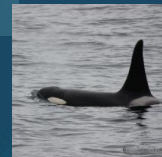
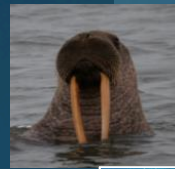
Relate changes in those variables to oceanographic conditions, indices of potential prey density, and anthropogenic activities...



Climate modeling



Oceanography



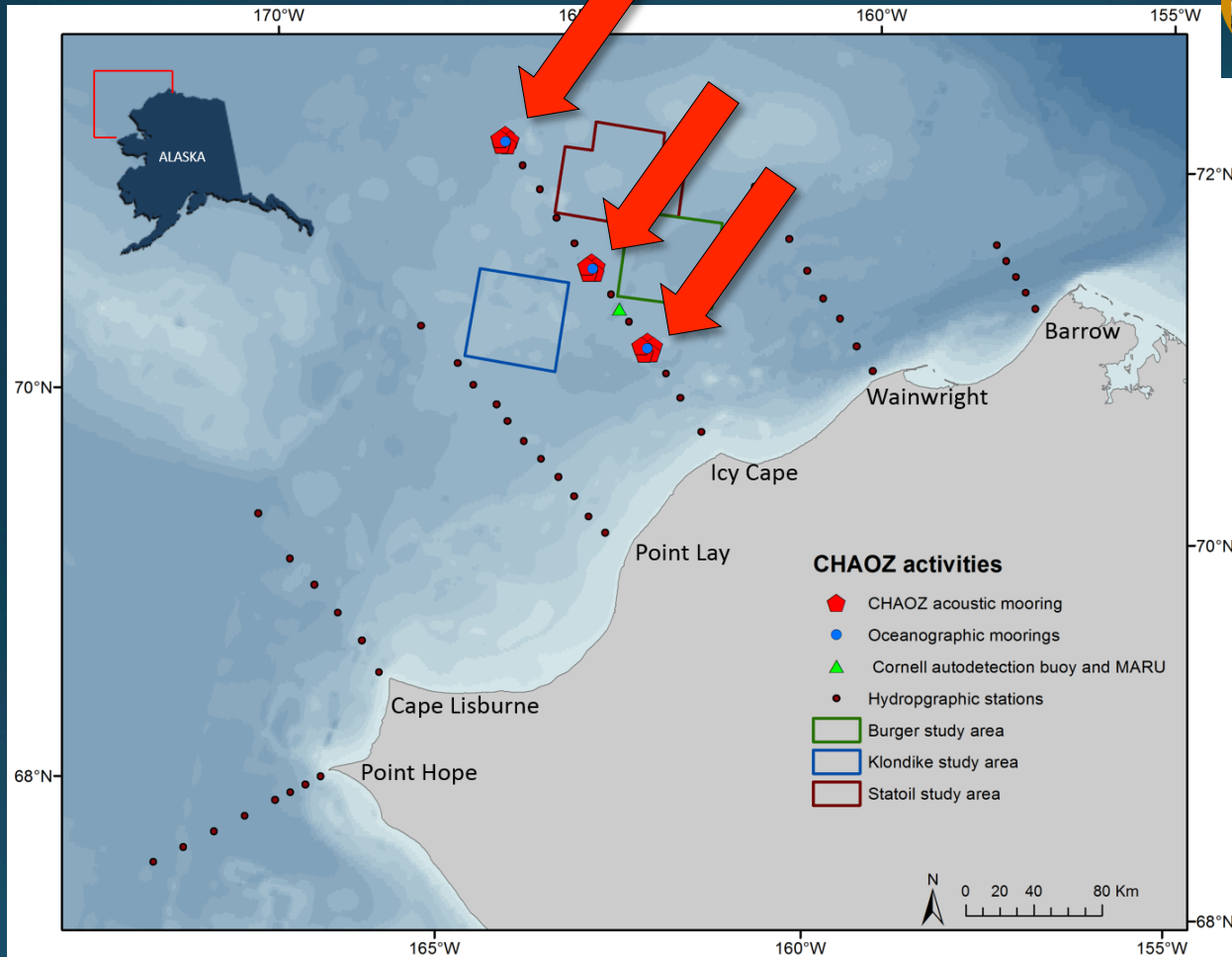
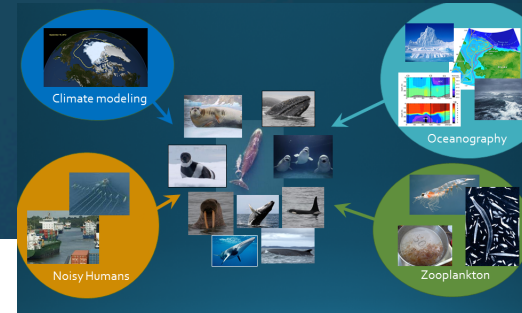
Noisy Humans



Zooplankton

...and to develop a climate model

CHAOZ Field Methods:



Passive acoustics
(sound, T, P)

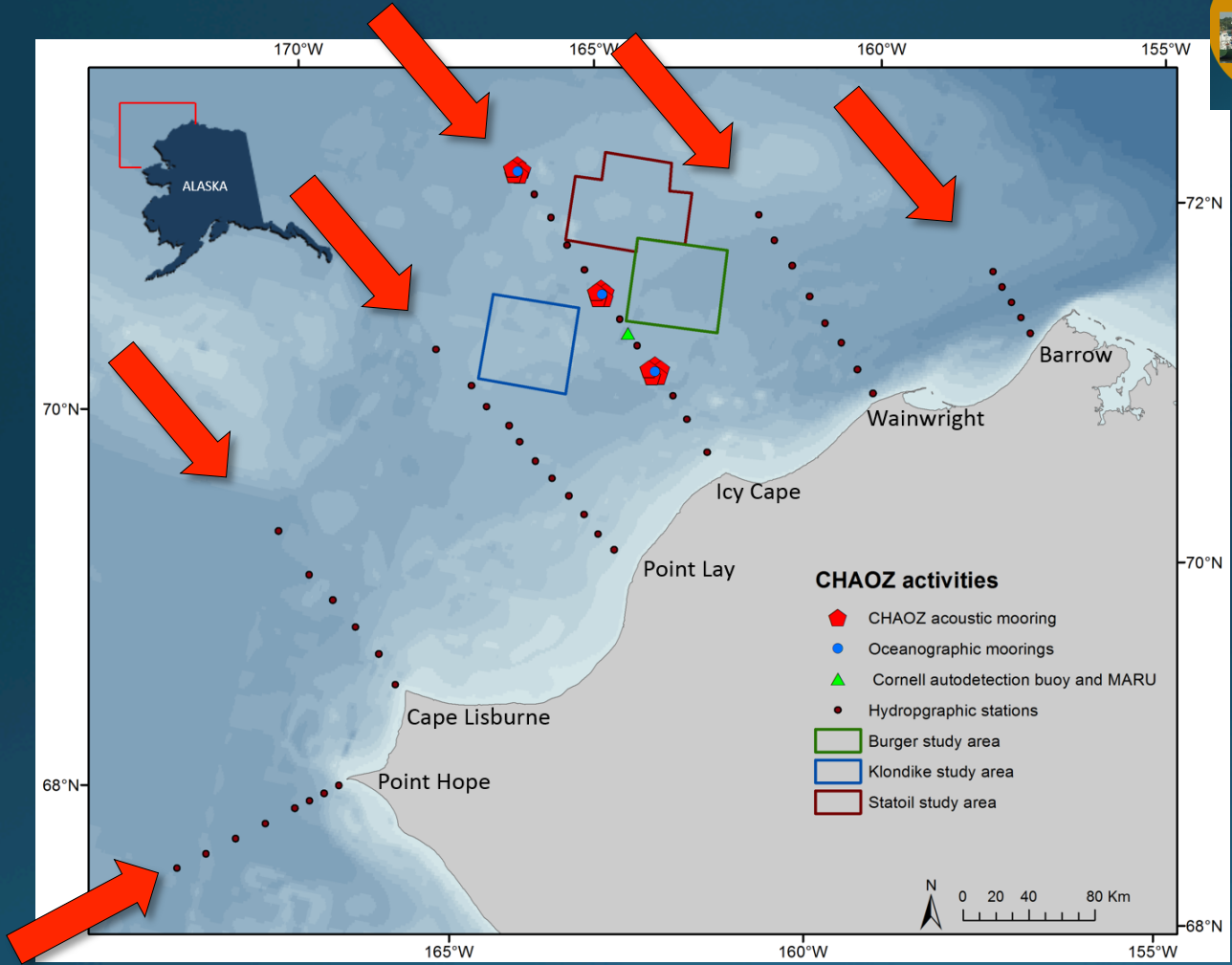
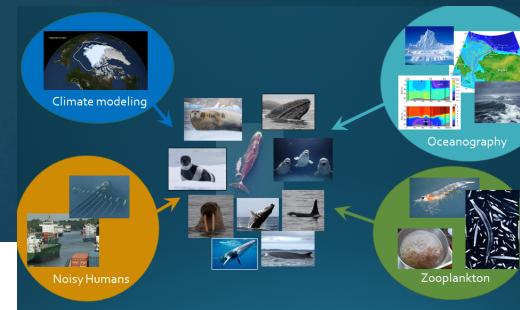
ADCP
(currents, T, P, Par, S, fluorescence, N)

Ice profiler
(ice depth, T, P, O₂, S, bot. currents, turbidity)

TAPS
(zooplankton)

Long-term mooring clusters

CHAOZ Field Methods:

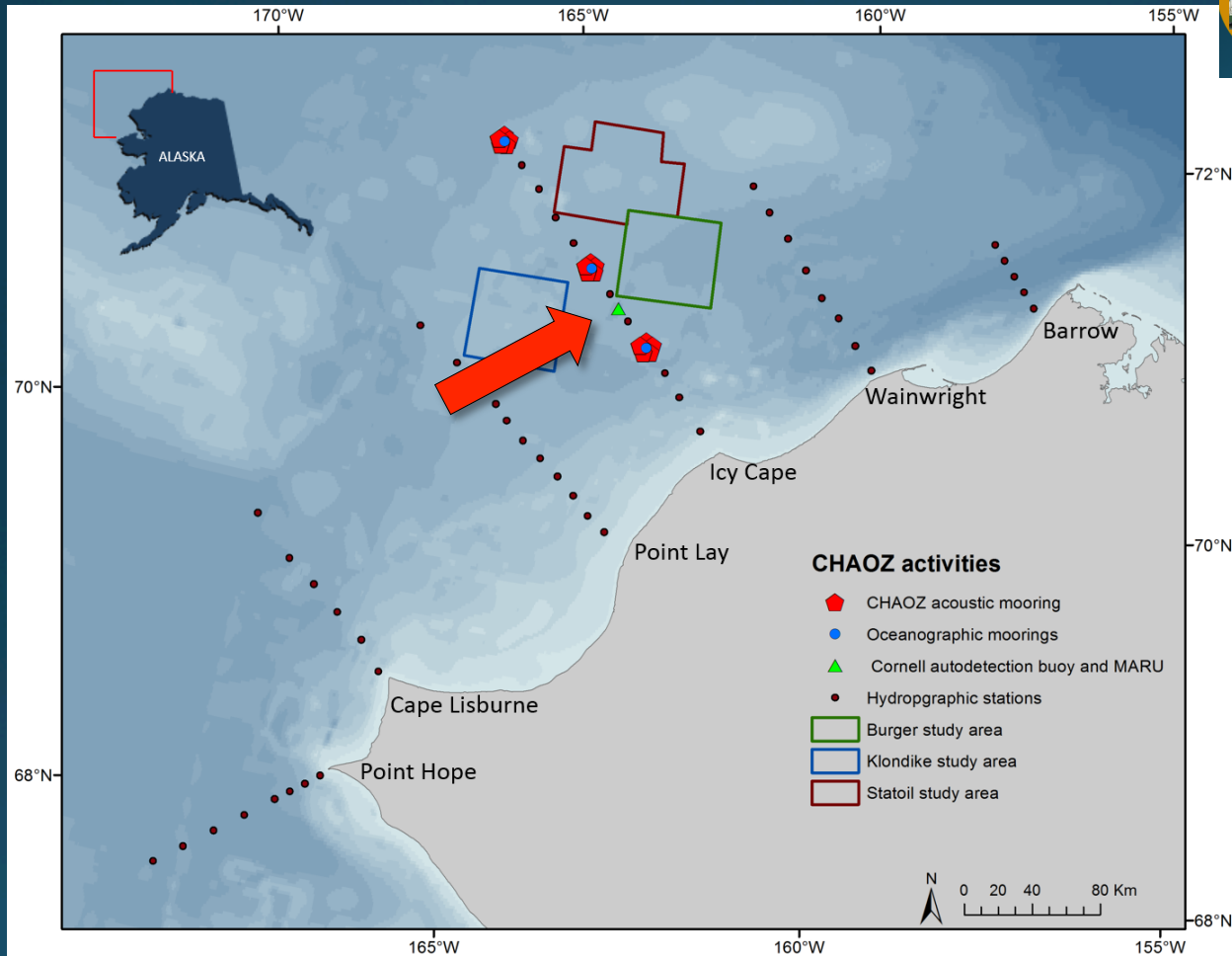


CTD
(T, O₂, Par, S, Fluor, Nutrients)

Tucker Sled
(zoops, larval fish)

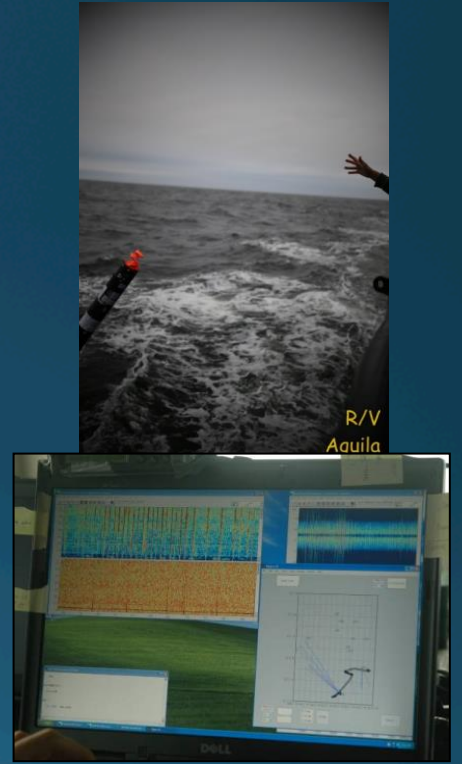
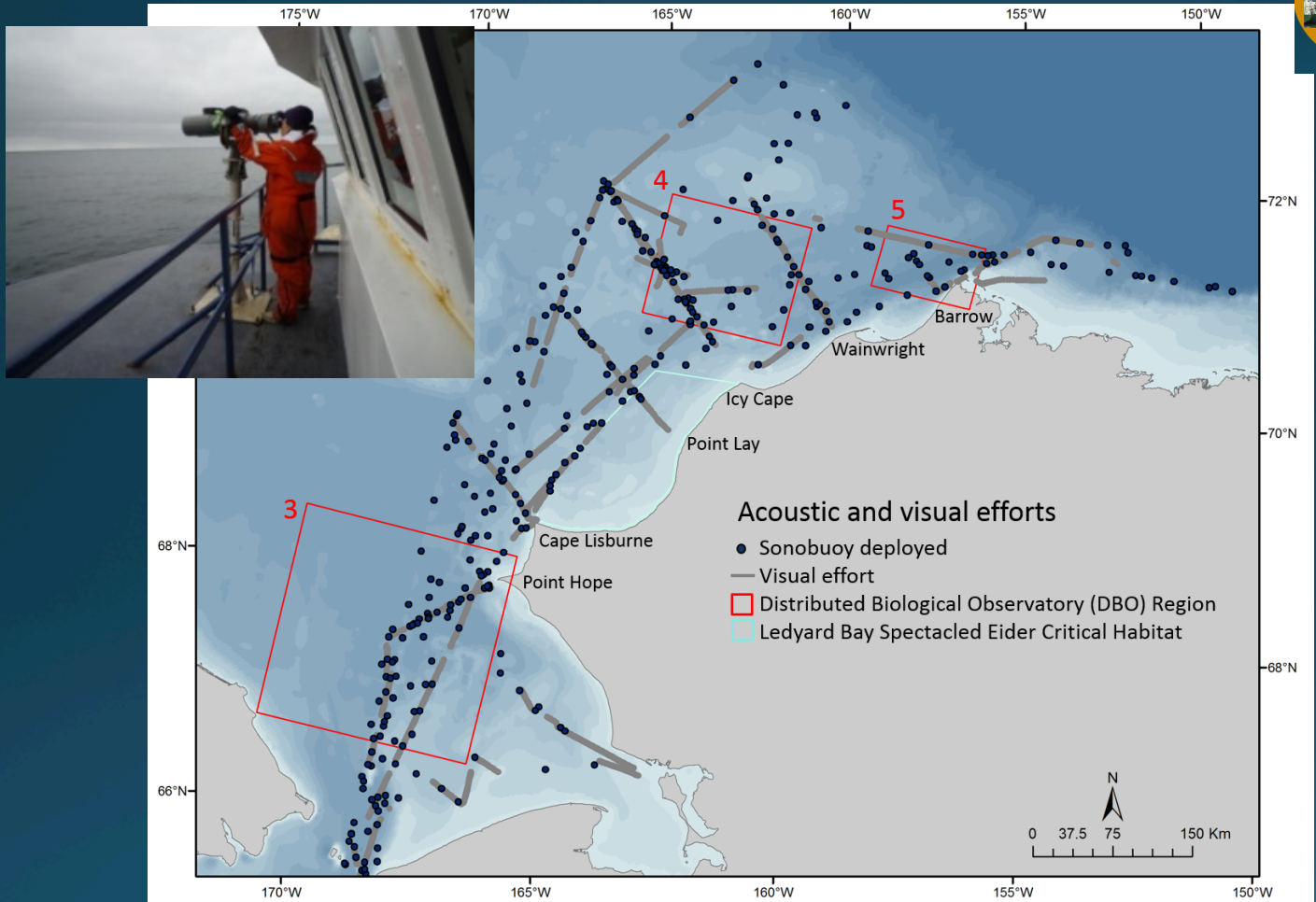
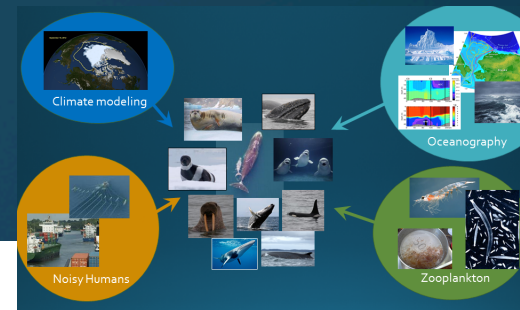
Biophysical sampling stations

CHAOZ Field Methods:



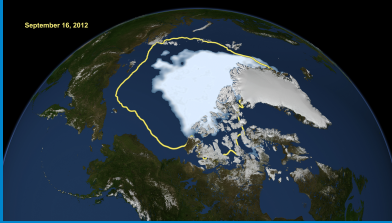
A near-real-time autodetection buoy

CHAOZ Field Methods:

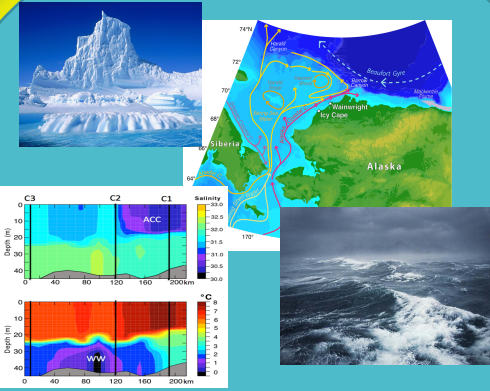


Visual survey and passive acoustic monitoring

Key Findings



Climate modeling



Oceanography



Noisy Humans



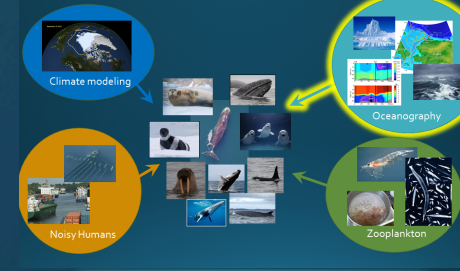
Zooplankton



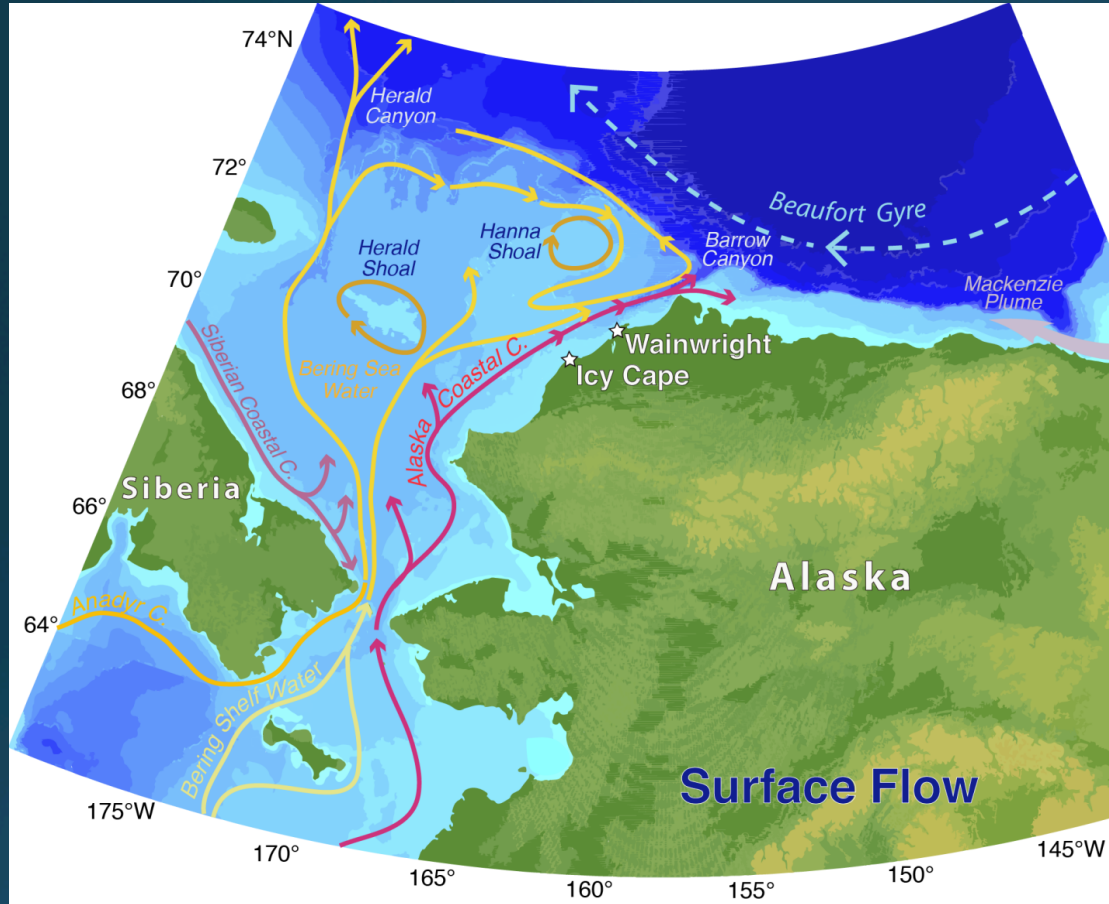
See Phyllis Stabeno's
talk at 4pm today!!!!



Oceanography



Stabeno



Modified from T. Weingartner

Nutrients

Bering Shelf Water

Anadyr Current

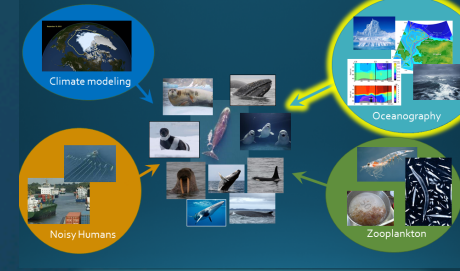
Heat

Alaska Coastal current

Fresh Water

Alaska Coastal Current

Oceanography



Stabeno

Nutrients

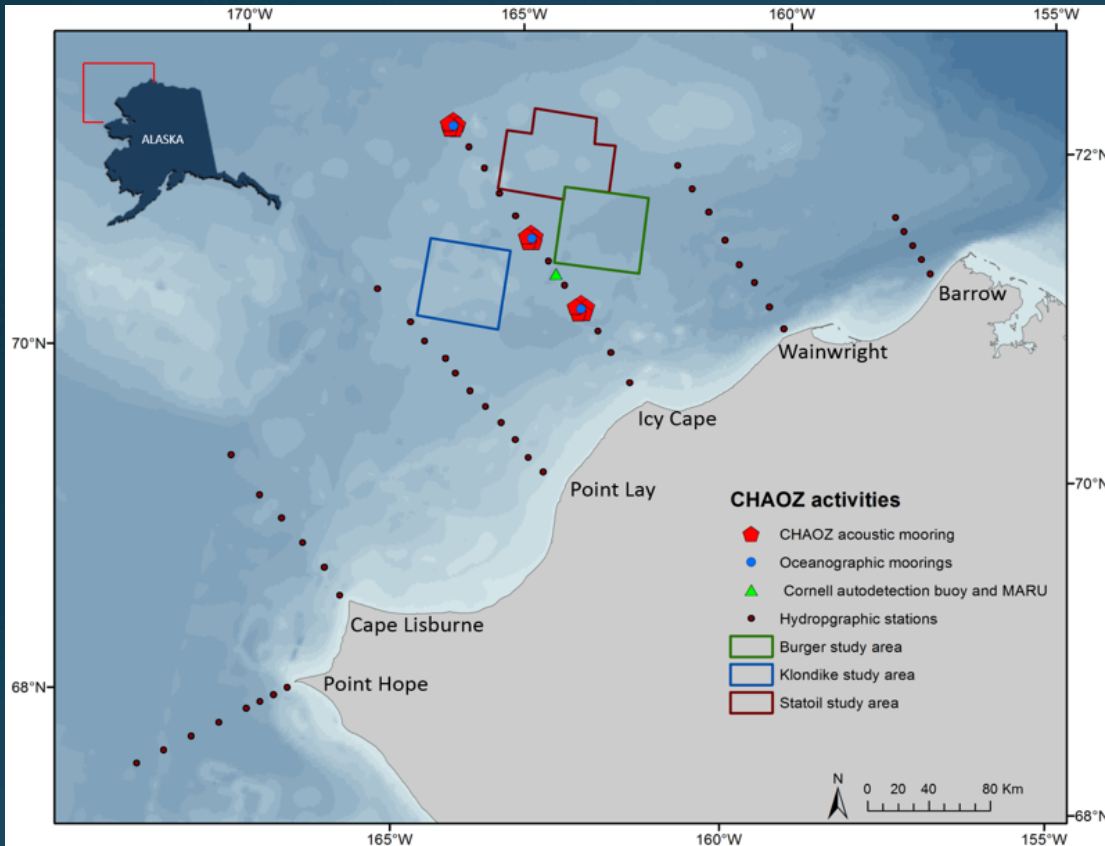
Bering Shelf Water
Anadyr Current

Heat

Alaska Coastal current

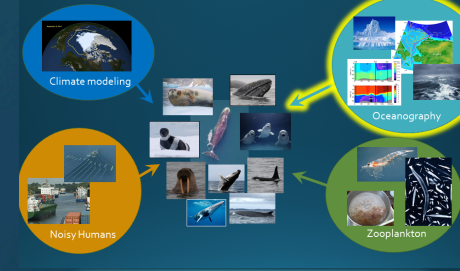
Fresh Water

Alaska Coastal Current

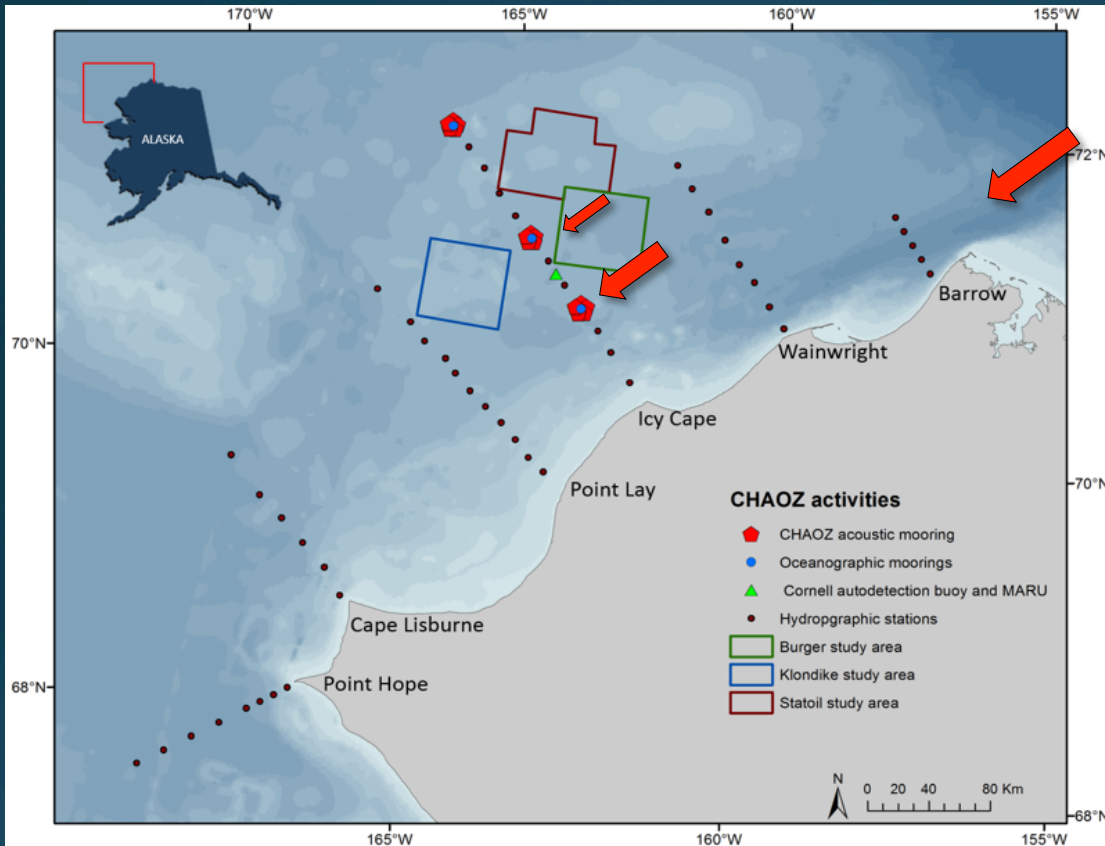


- 30-50% of transport through Bering Strait goes past Icy Cape
- Variations in flow correlate with local winds

Oceanography



Stabeno



Nutrients

Bering Shelf Water
Anadyr Current
Atlantic water

Heat

Alaska Coastal current
Atlantic water

Fresh Water

Alaska Coastal Current

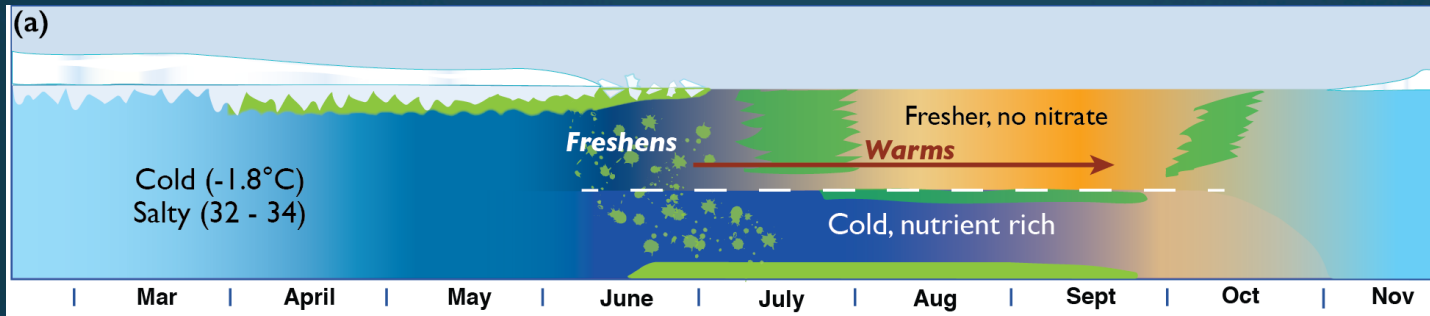


- Atlantic water seen as far as Icy Cape.
- Slope water can intrude >200 km onto Chukchi Shelf

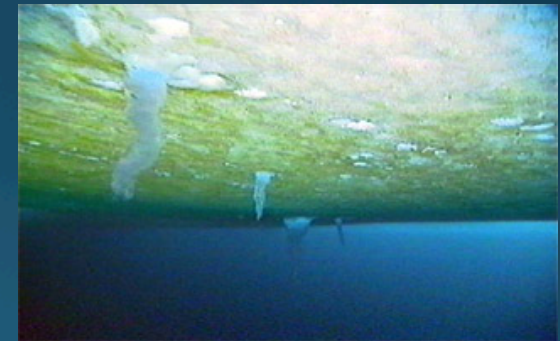
Oceanography



Stabeno



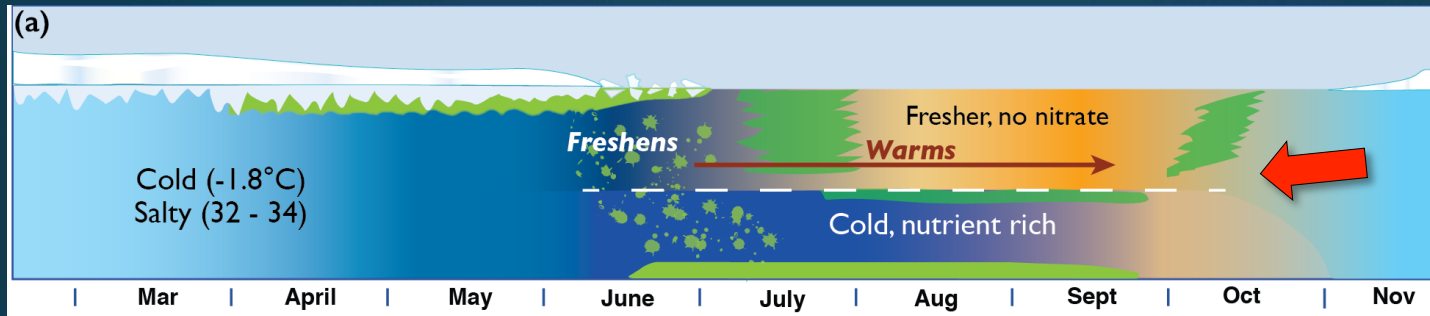
- Algae blooms below the ice
- Exported to bottom as ice melts
- Produces oxygen throughout summer



Oceanography



Stabeno

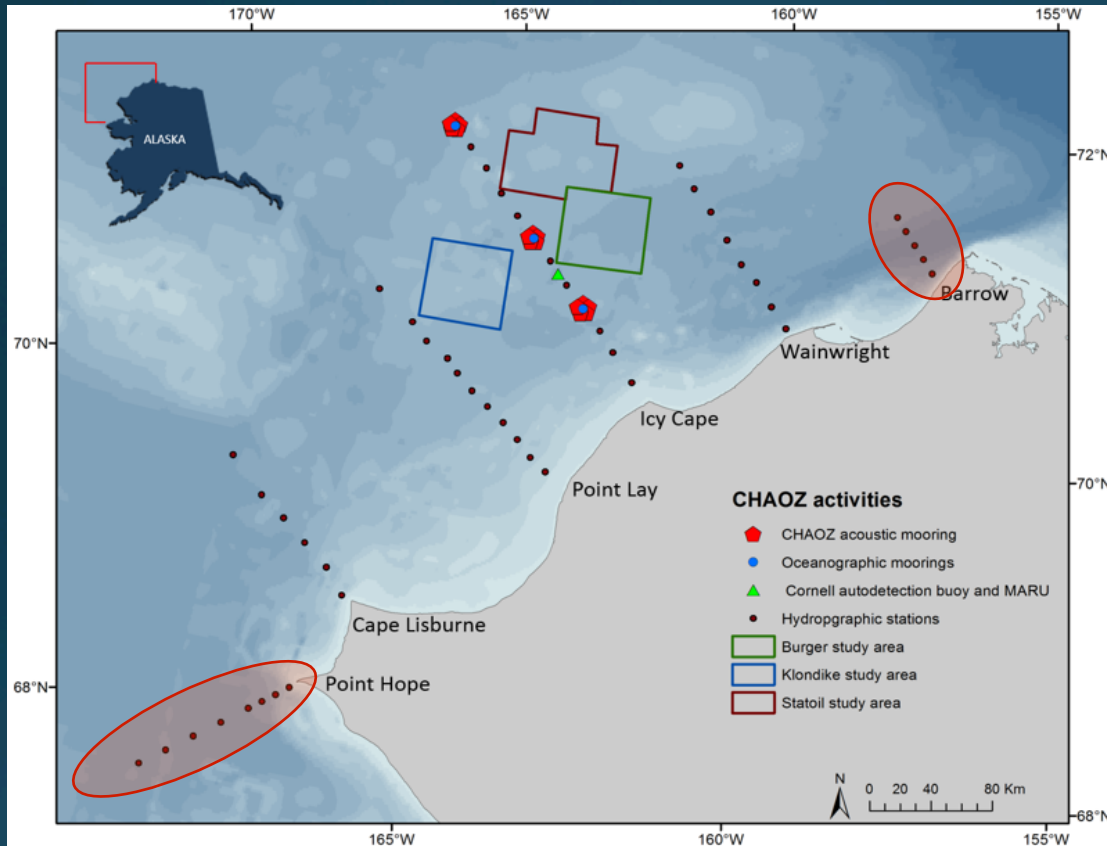


- Subsurface phytoplankton blooms are common during summer
- Fuel secondary productivity.

Oceanography

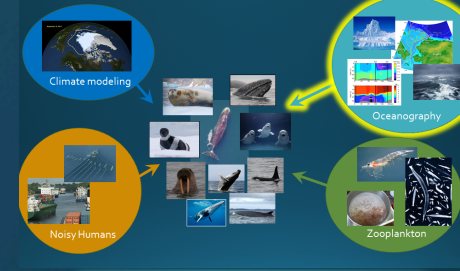


C. Mordy/PMEL

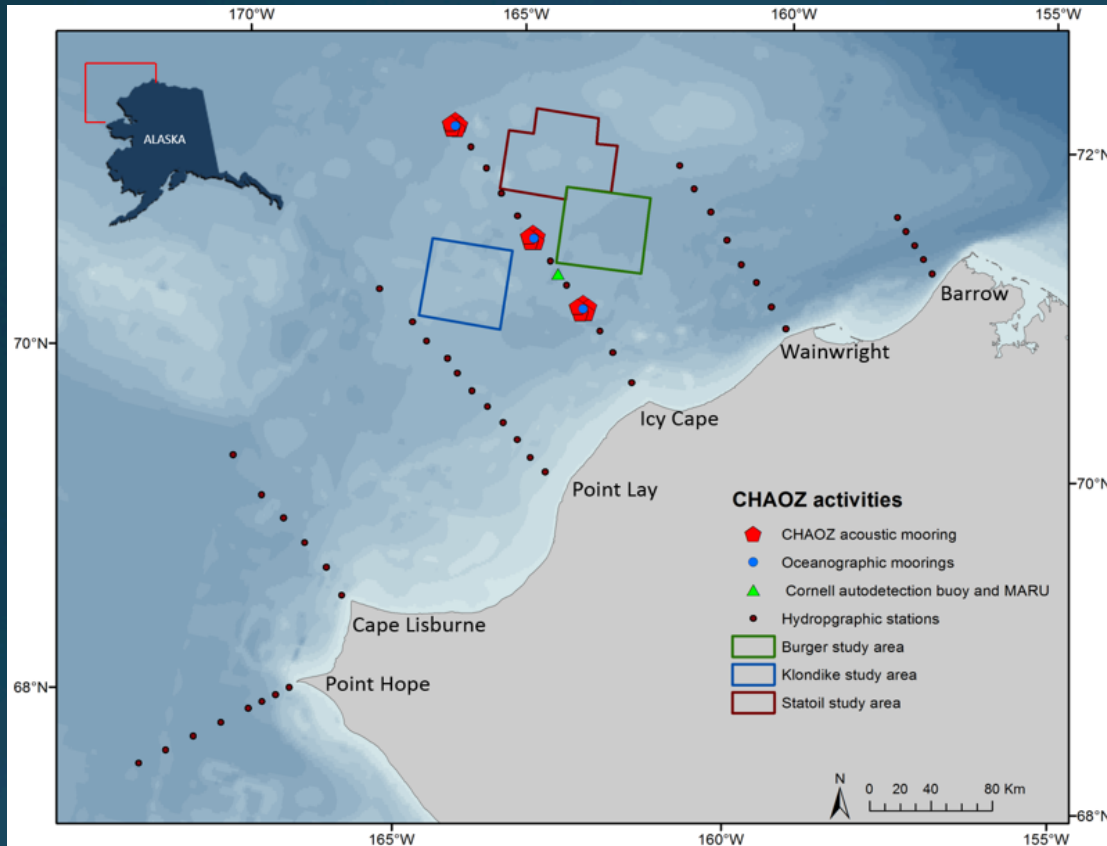


- High ammonium concentrations
 - Pt Hope
 - Barrow Canyon
- Microbial loop
 - Detritus to Ammonium
- Ammonium
 - Preferred nitrogen form for many phytoplankton

Oceanography



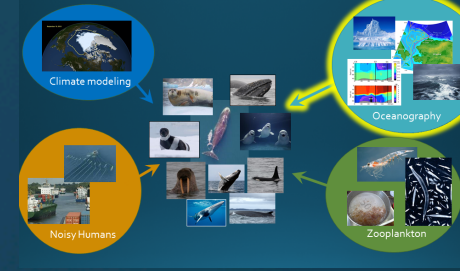
Stabeno



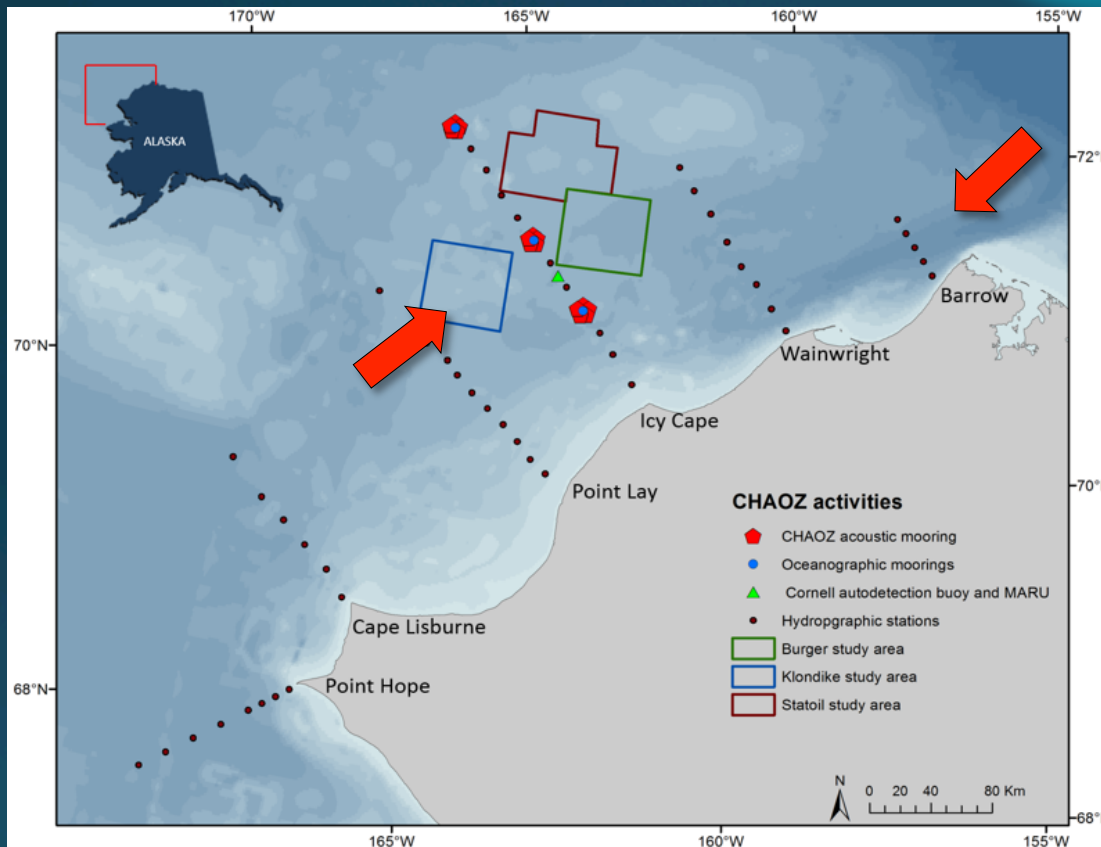
- Ice keels on Icy Cape line often $>20\text{m}$ (some $>25\text{m}$).
- Deep keels found in the spring.

Oceanography

Stabeno

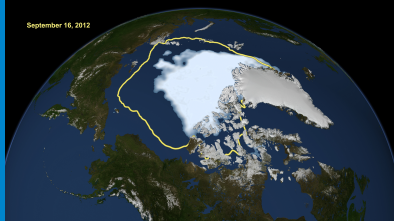


- Large interannual variability: 2010-11; 2011-12; 2012-13

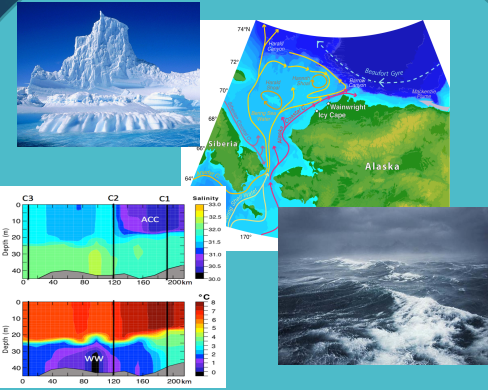


- Greatest transport
- More incidents of flow up Barrow Canyon
- More polynyas

Key Findings



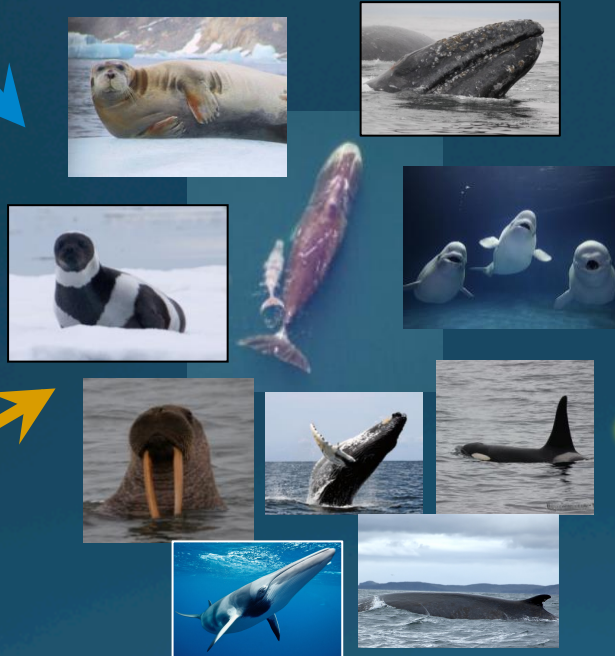
Climate modeling



Oceanography

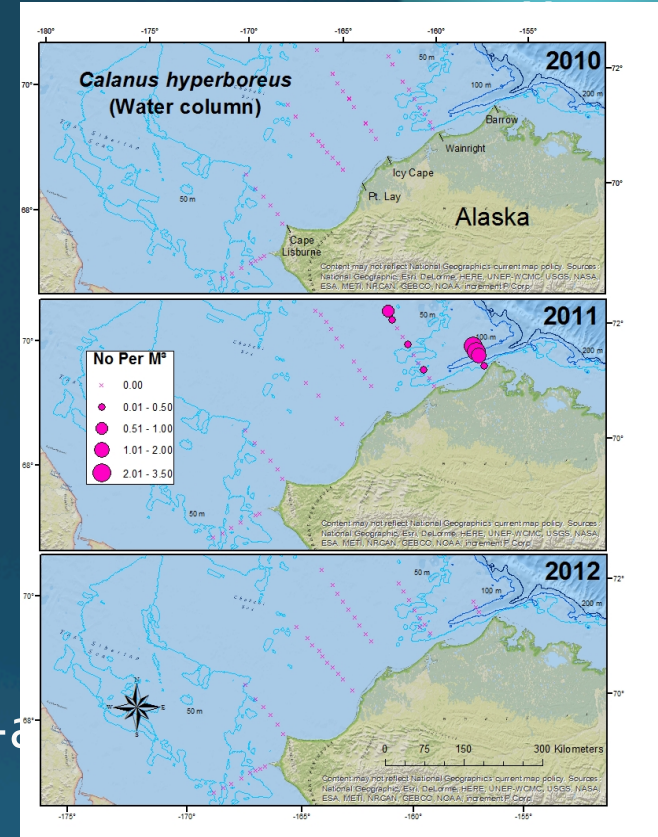
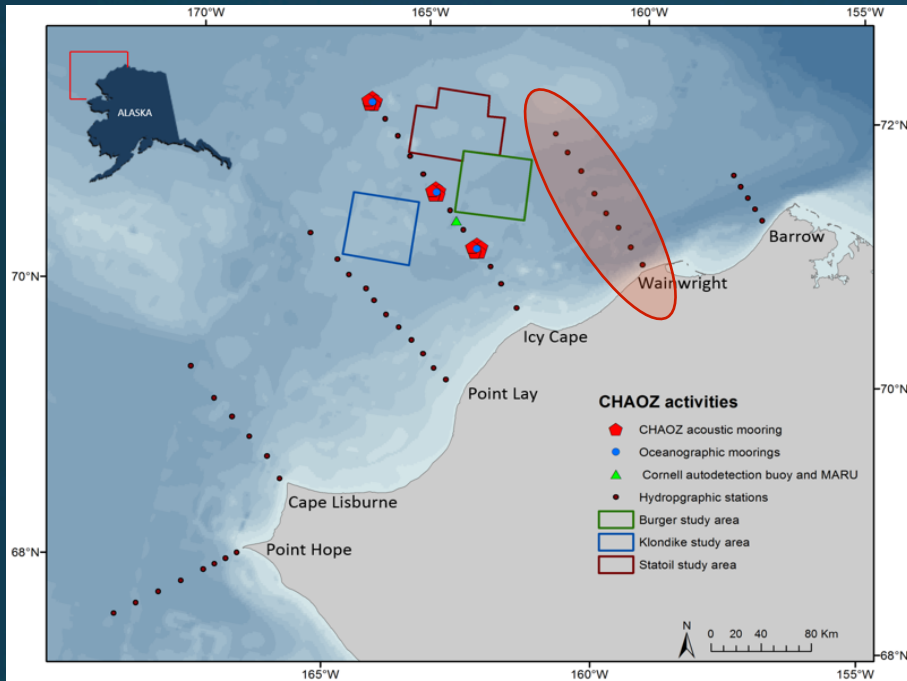
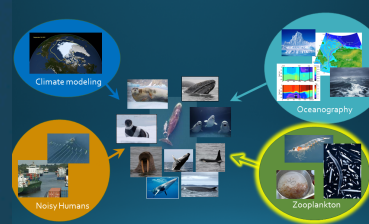


Noisy Humans



Zooplankton

Zooplankton



- Community composition –high inter-annual variability
- Concentration high on bottom
- Upcanyon transport along Wainwright line
- On-shelf advection - introduced Arctic basin species to the shelf.
- Temporal vertical migration patterns varied among sites



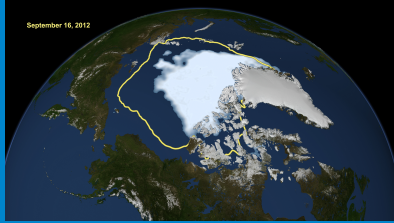
Zooplankton



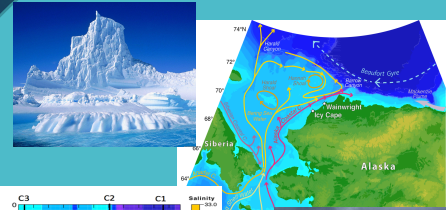
- Euphausiids
 - Adults and juveniles
 - Highest concentrations in 2012
 - Low numbers– no conveyor belt
 - Furcilia
 - Much greater concentrations than older stages (OOM)
 - Present at all stations
 - No consistent warm/cold difference
 - Calyptopis
 - High concentrations found in 2010 – spawning.
- Hyperiid and gammarid amphipods
 - Concentrations similar to adult euphausiids
- Copepods
 - Oithona spp. highest concentrations
 - Pseudocalanus spp. Very abundant in all years



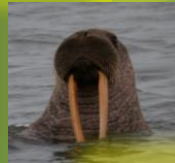
Key Findings



Climate modeling



Oceanography



Zooplankton



Noisy Humans



See Jessica Crance's talk
after the break!!!!



Long-term passive acoustics



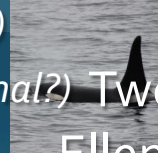
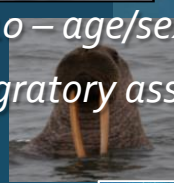
Ice Thickness ($> 0.5m$)

Winds from SSW (*ice arrival/tailwind?*)

Trimodal distribution (*fall 2010 – age/sex cohorts?*)

Gunshot call (*Navigation aid/migratory assembly signal?*) Two population move through area
Ellen Garland working on repertoires

Icy Cape close to important molting/ breeding lagoon.



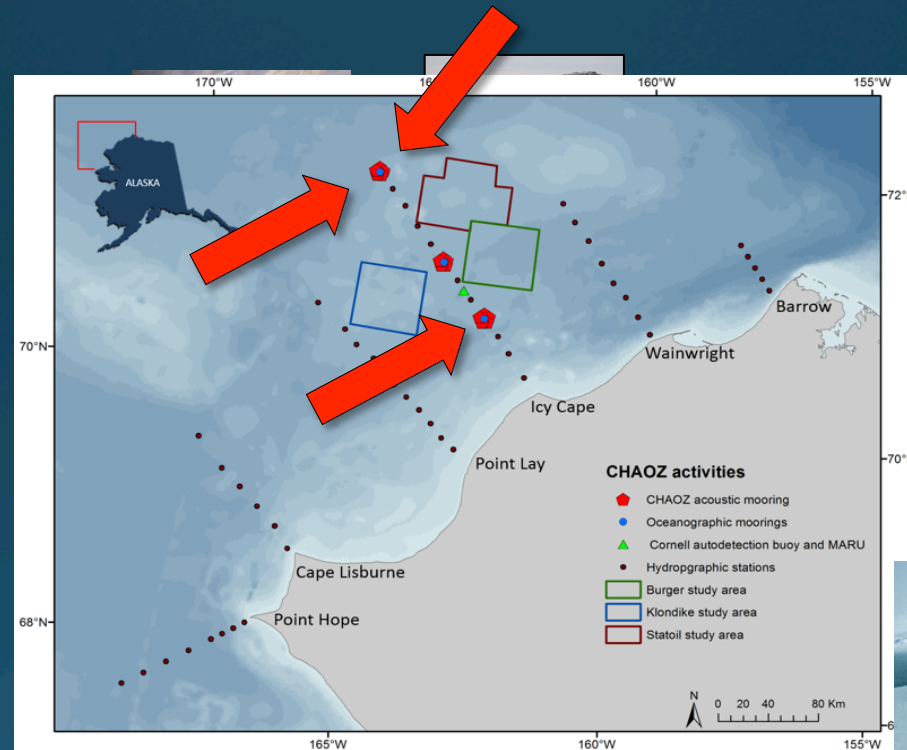
- Undergo predictable seasonal migrations – strongly correlated with month and ice concentration

Long-term passive acoustics



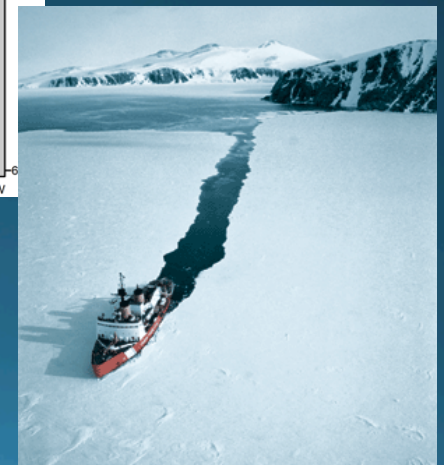
Berchok

High numbers of walrus calling activity at offshore Icy Cape site !!



One detected in April at inshore Icy Cape

- Overwinter detections along Icy Cape line

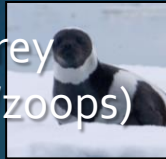


Sonobuoys and visual surveys



GRAY WHALES

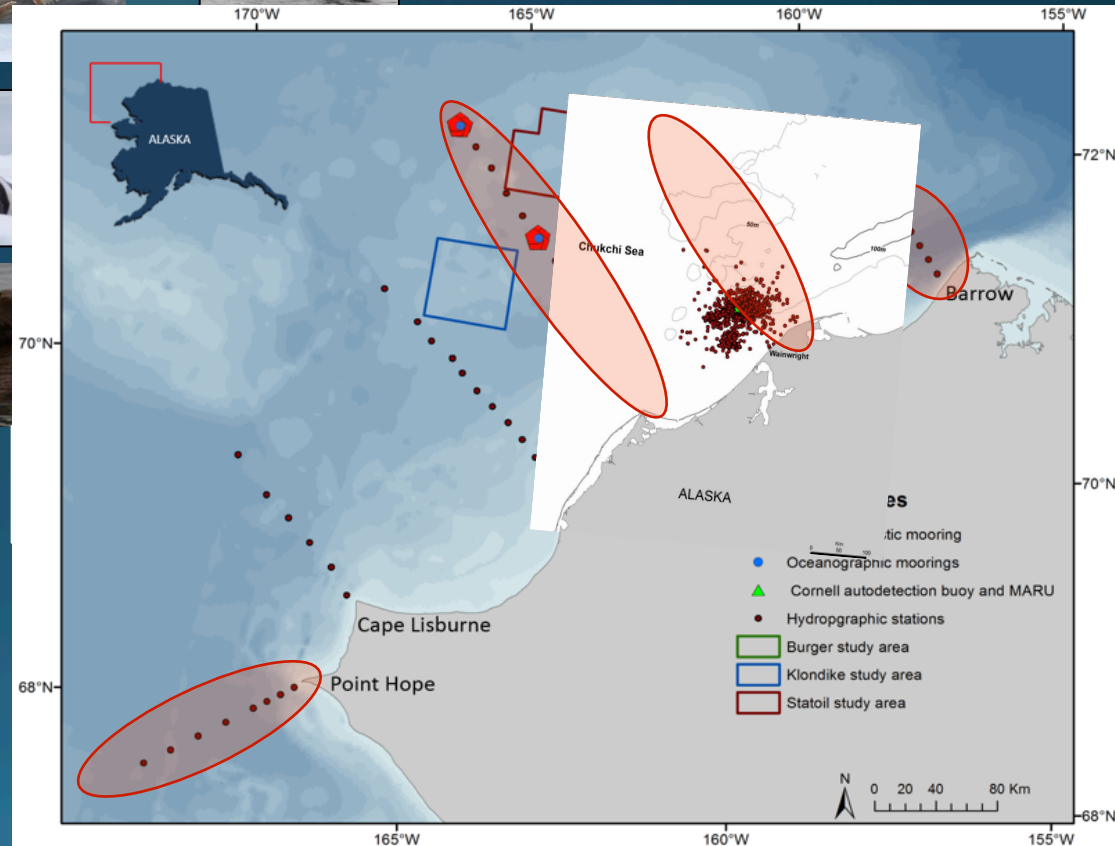
- Strongly correlated to prey availability (ammonium/zoops)
- Satellite tagged animal foraged in small area



BEARDED SEALS and WALRUS



- Like same shallow offshore areas with high benthic biomass



Relative densities: visual survey

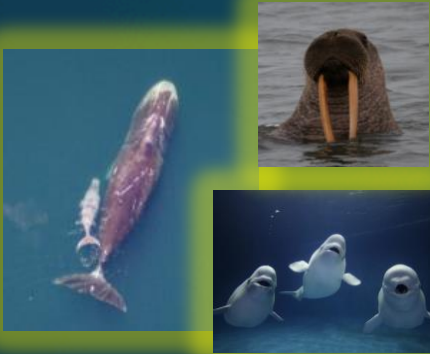


Species	Density (#/km ²)
Bowhead whale	0.0043 (0.65)
Fin whale	0.0019 (0.88)
Humpback whale	0.0004 (0.97)
Gray whale	0.0030 (0.86)

Techniques: Acoustic vs. Visual



Berchok/Rone



Comparable results
(no beluga seen or heard)

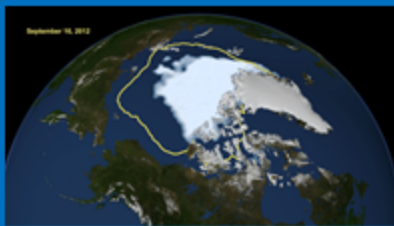
Visual survey better
(plus for Dall's and Harbor porpoise)



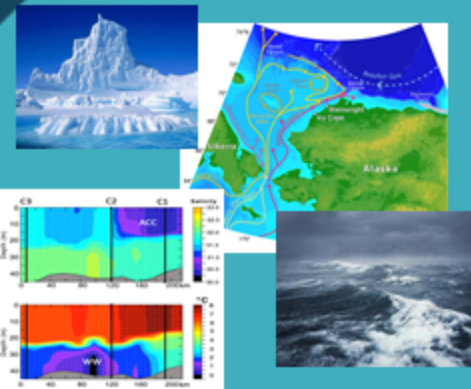
Passive acoustics better
(fin whale acoustic detection off Barrow Canyon)¹

¹. Crance et al. 2015. *Polar Biology*

Key Findings



Climate modeling



Oceanography



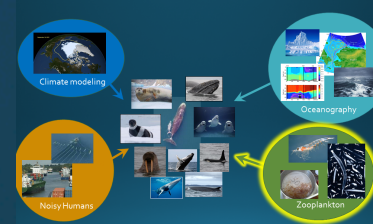
Noisy Humans



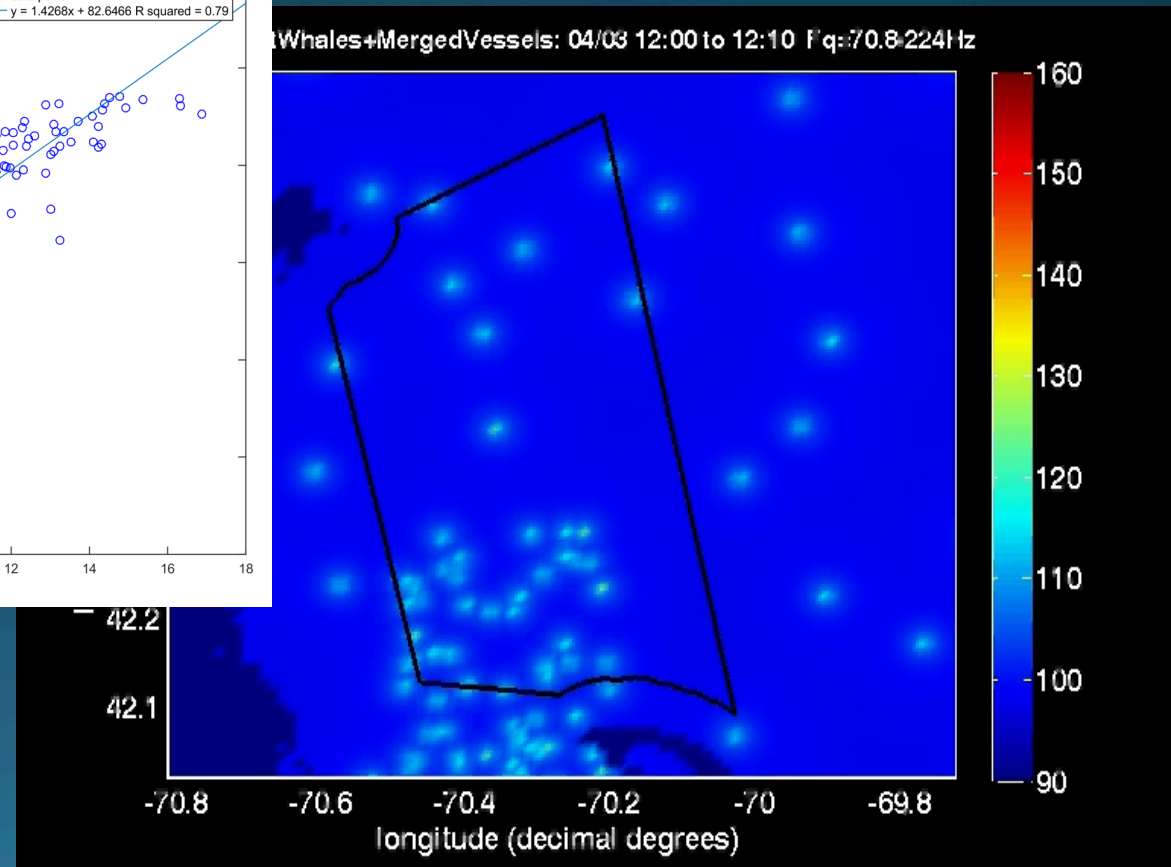
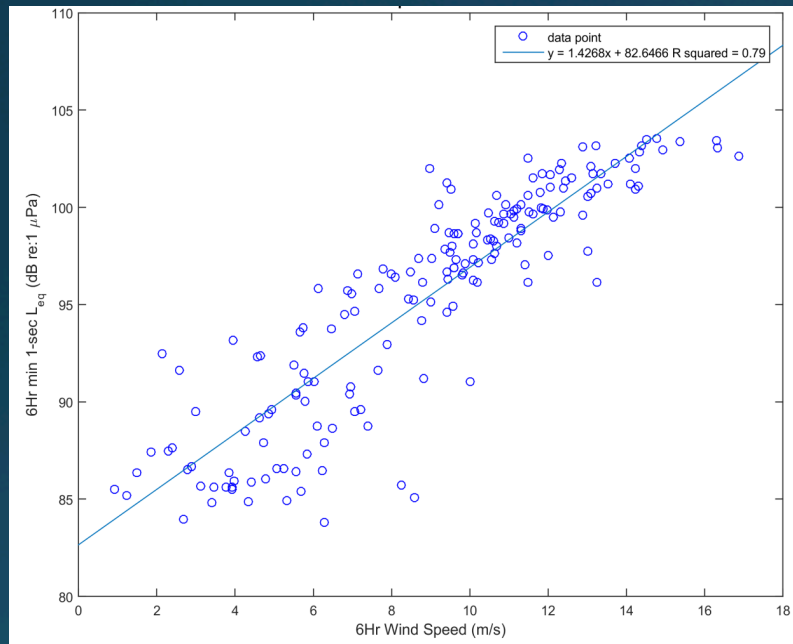
Zooplankton

Noise model for Chukchi Sea

- Determine current ambient noise levels
- Predict future levels

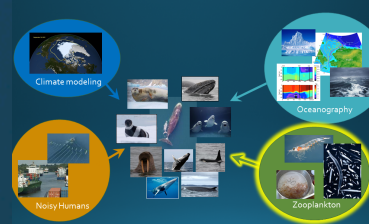


Clark



Autodetection buoy

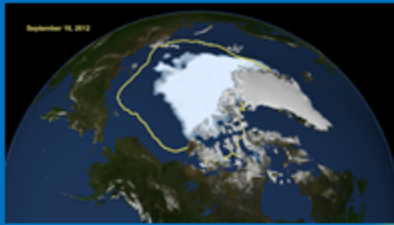
- First for Arctic (*Sept 1 – Nov 1, 2012*)
- Detected and transmitted biotic and abiotic signals via satellite in near-real time
- Monitor for ambient noise levels



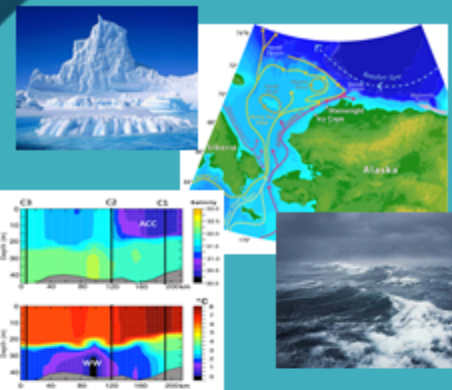
Clark



Key Findings



Climate modeling



Oceanography



Noisy Humans



Zooplankton

Climate Modeling



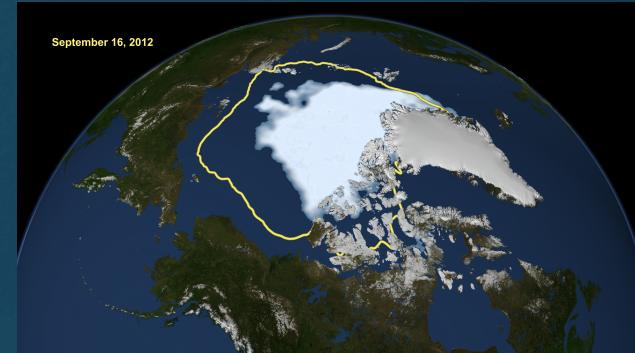
Wang

Ice coverage

Dismal

Ice thickness

Large inter-annual variability (no sig. trends)



Models predict late arrival of ice in fall and early ice retreat in spring

Permits greater solar heating into system

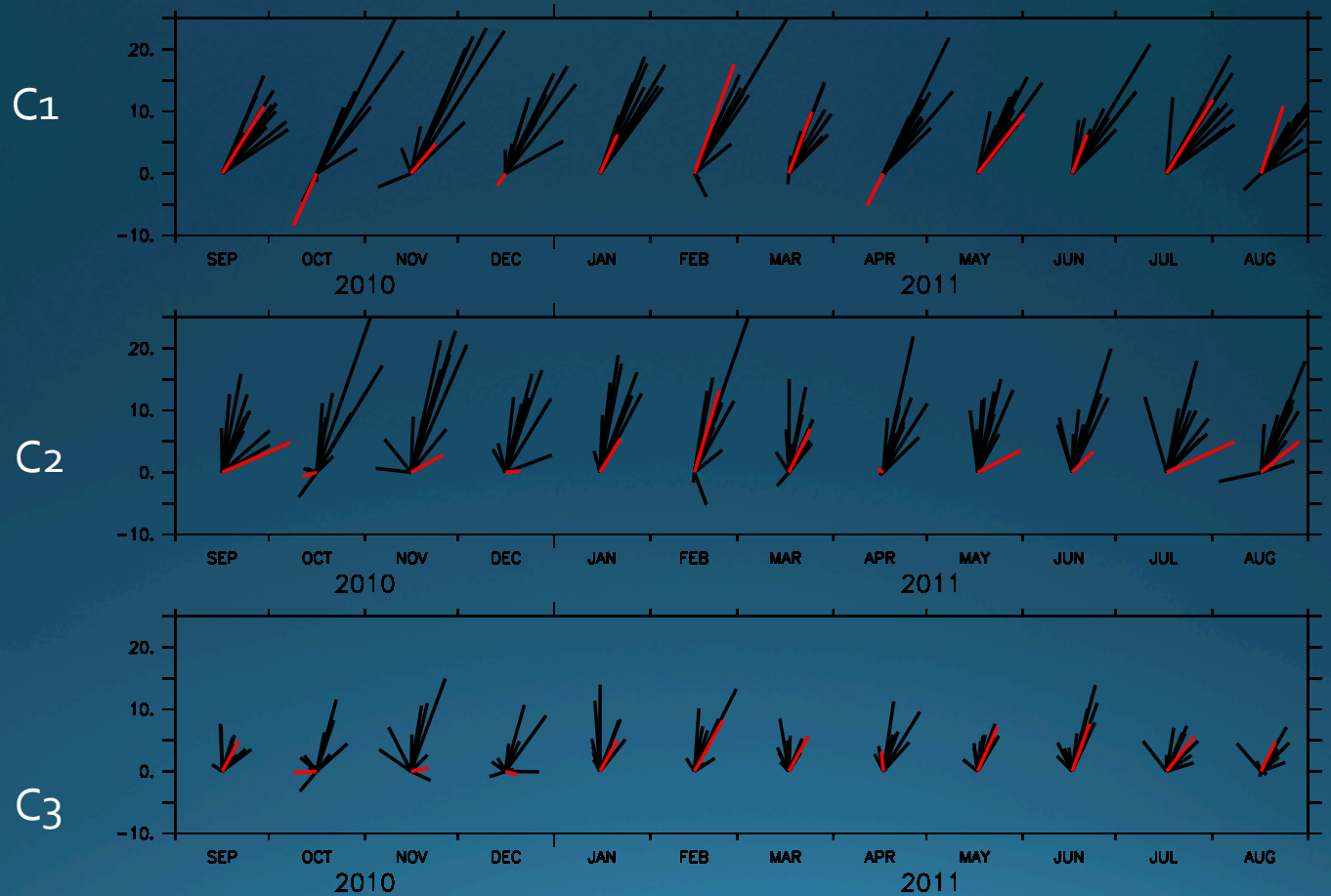
Climate Modeling



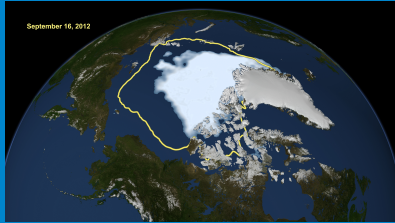
Wang

Magnitude and Direction of Ocean Current

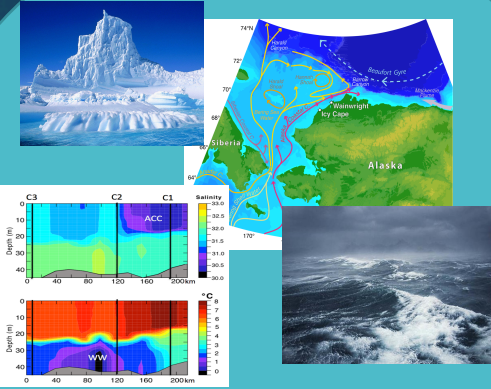
— Model
— Measured



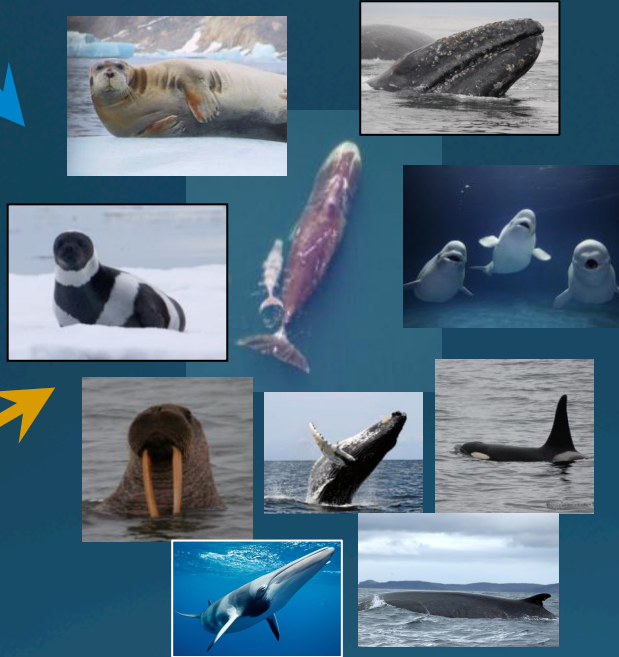
Future predictions



Climate modeling



Oceanography



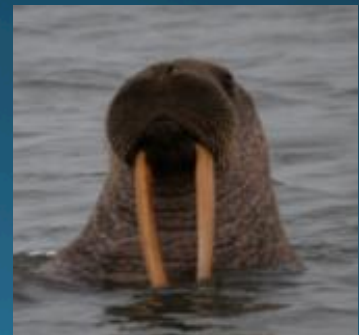
Noisy Humans



Zooplankton

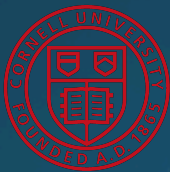
Future predictions

- Results consistent with recent publications predicting a regime shift
 - Shift may have already begun
- Two scenarios based on winds
 - Generalist feeders might be okay
 - Specialist feeders (like walrus) will not do well
 - Ambient noise levels will increase



Acknowledgments

- Bureau of Ocean Energy Management (BOEM): Heather Crowley, Chuck Monnett – Funding and project support
- Sonobuoys: Jeff Leonhard, Ed Rainey, Todd Mequet, and Edgar Brown (Naval Surface Warfare Center, Crane Division), Theresa Yost (Naval Operational Logistics Support Center), Capt. Robin Fitch (I&E Director Marine Science, Office of the Assistant Secretary of the Navy), Anu Kumar
- Captain and crew of F/V *Mystery Bay*, F/V *Alaskan Enterprise*, F/V *Aquila*
- Field crew and analysts
- Stephanie Grassia, Jessica Crance, Eliza Ives, Ellen Garland, Julie Mocklin, and Alex Ulmke
- Sue Moore for her advice and expertise



Questions?

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