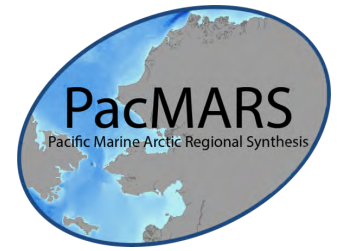


Pacific Marine Arctic Regional Synthesis



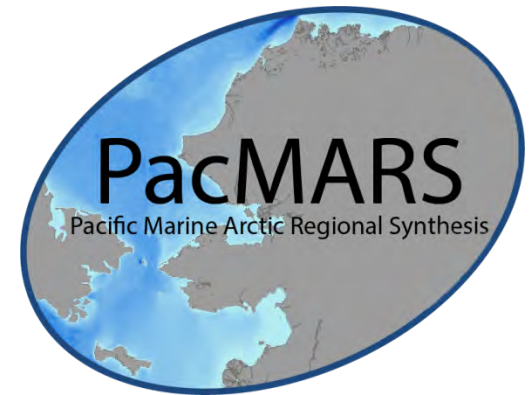
Jacqueline Grebmeier¹, Lee Cooper¹, Carin Ashjian², Bodil Bluhm³, Robert Campbell⁴, Kenneth Dunton⁵, James Moore⁶, Steve Okkonen³, Gay Sheffield³, John Trefry⁷, Sveta Yamin-Pasternak³

¹University of Maryland Center for Environmental Science, ²Woods Hole Oceanographic Institution, ³University of Alaska Fairbanks, ⁴University of Rhode Island, ⁵The University of Texas at Austin, ⁶James Moore, National Center for Atmospheric Research, ⁷Florida Institute of Technology

**Wakefield Fisheries Symposium
Captain Cook Hotel
Anchorage, Alaska, USA
March 29, 2013**



Overview



- What is PacMARS?
- Ongoing synthesis activities
- Preliminary science directions



Background

- Collaborative effort between North Pacific Research Board, National Science Foundation (OPP) and North Pacific Marine Research Institute
- Funding from Shell and ConocoPhillips, administered through NPRB
- Phase I: PacMARS
- Phase II: multi-agency Arctic Research program



Goal and Approach



- To facilitate new synergies in understanding of the marine ecosystem of the northern Bering, Chukchi and Beaufort Seas by
 - Identifying and synthesizing data sets critical for evaluating the state of knowledge (EOL data portal)
 - Defining high-priority, overarching scientific themes and research needs

<http://pacmars.cbl.umces.edu>



Themes

1. Ice cover- primary production relationships, currents, winds, bathymetry
2. Phenology of biological production cycles in relation to physical environment
3. Benthic-pelagic coupling in relation to physical-chemical environment
4. Current state of lower trophic prey-base and higher trophic feeding hot spots
5. Subsistence lifestyles in time of climate change
6. Chemical contaminants in sediment and biota





The PacMARS Principal Investigator Team.

Institution	PI	Expertise
University of Maryland Center for Environmental Science (UMCES)	Jacqueline Grebmeier and Lee Cooper	Benthic ecology, interdisciplinary project management, biogeochemistry, biological & chemical oceanography
Florida Institute of Technology (FIT)	John Trefry	Trace metals, contaminants, chemical oceanography
University of Alaska Fairbanks (UAF)	Bodil Bluhm, Steve Okkonen, Gay Sheffield, Sveta Yamin-Pasternak	Benthic ecology, biodiversity, physical oceanography, marine mammals, marine advisory program, cultural anthropology
National Center for Atmospheric Research (NCAR)	James Moore	Data management, GIS data services
University of Rhode Island (URI)	Robert Campbell	Zooplankton ecology, molecular approaches, biological oceanography
University of Texas at Austin (UT)	Kenneth Dunton	Food webs, stable isotopes, benthic ecology
Woods Hole Oceanographic Institution (WHOI)	Carin Ashjian	Zooplankton ecology and lifecycles, biological oceanography

Advisors and collaborators

PacMARS Advisors: Eddy Carmack (IOS/Canada) and Robert Ulanowicz (CBL/USA)

Advisory committee to ensure data flow, provide guidance

Plus ~10 other collaborators from oceanography to marine mammals and social science



Timeline

6/2012

Project start: June 2012

PI meeting Sept 2012

Data meeting Nov 2012

1/2013

SOAR/PacMARS open workshop Jan 2013

Local community meetings Jan / Feb 2013

End major data aggregation Feb / Mar 2013

6/2013

Synthesis and research needs Mar-May 2013

Major report June 2013 – to be used to inform management towards an interagency RFP estimated come out fall 2013

6/2014

Paper writing 2nd year



Synergy with SOAR

- Sharing information and participants
- SOAR: 5-year horizon, stronger in upper trophics
- PacMARS: 1-2 year horizon, identify research needs
- Joint workshop 20 Jan 2013



arctic.noaa.gov/soar/SOAR_products.shtml

Getting Started Latest Headlines ProgRes@ Bildaufnah... Aktuelle Nachrichten -... Google Scholar ArcOD Portal Animal Songs Wor

Synthesis of Arctic Research
SOAR

BOEM
NOAA

[Home](#) [Steering Committee](#) [Projects](#) [Science Products](#) [Links](#) [Contact/Info](#)

SOAR - Products

Publication: Sheffield Guy, L., S. E. Moore, and P. Stabeno (2012), [Marine ecosystem synthesis: From physics to whales in the Pacific Arctic](#), Eos Trans. AGU, 93(48), 501, doi:10.1029/2012EO480007.

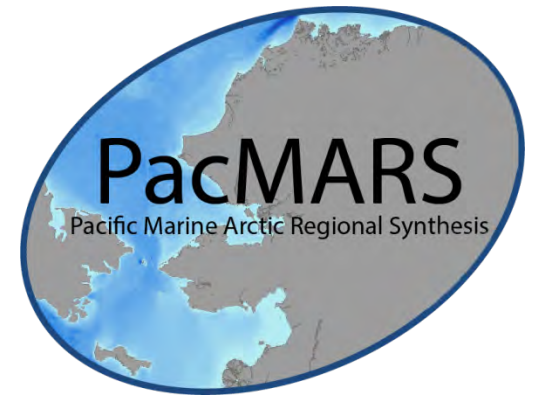
[SOAR presentation at the U.S.-Canada Northern Oil and Gas Research Forum, November, 2012 \(PDF\)](#)

SOAR Workshop, March 14-16, 2012 - Disciplinary Overview Talks, Final Report

- [Final Report](#) (pdf)
- H. Crowley, [Background](#) (pdf)
- S. Moore, P.J. Stabeno, L. Guy, [Introducing SOAR](#) (pdf)
- J. Overland, et al, [Alaskan Arctic Climate Change](#) (pdf)
- T. Weingartner, et al, [Chukchi/Beaufort Physical Oceanographic Overview](#) (pdf)
- J. Grebmeier & K. Ashjian, et al, [Lower Trophic Level Prey](#) (pdf)
- R. Suydam & R. Angliss, [Upper Trophic Levels](#) (pdf)
- T. Hepa, [Traditional Knowledge](#) (pdf)
- V. Metcalf, [Walrus](#) (pdf)
- C. Clark, et al, [Arctic Acoustic Ecology](#) (pdf)

[Town Hall Meeting Poster \(pdf\)](#), Jan. 18, 2012, Alaska Marine Science Symposium
[Town Hall presentation \(pdf\)](#), Jan. 18, 2012, "Introducing the Synthesis of Arctic Research"





Ongoing synthesis efforts



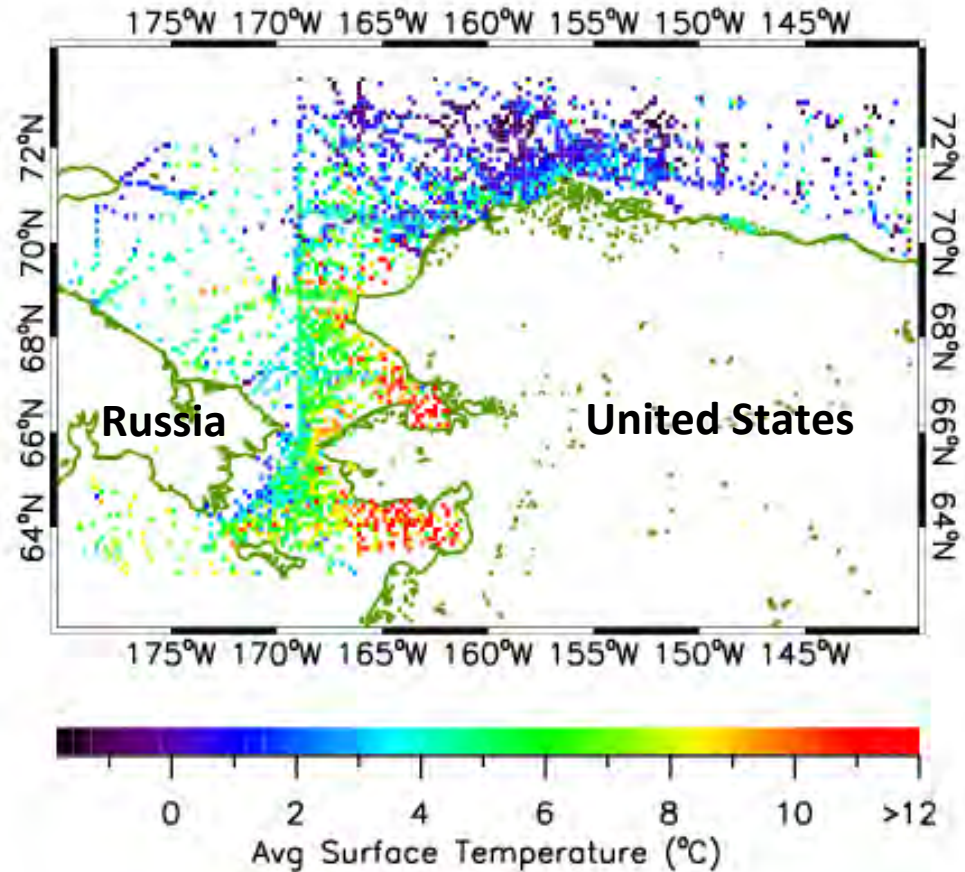
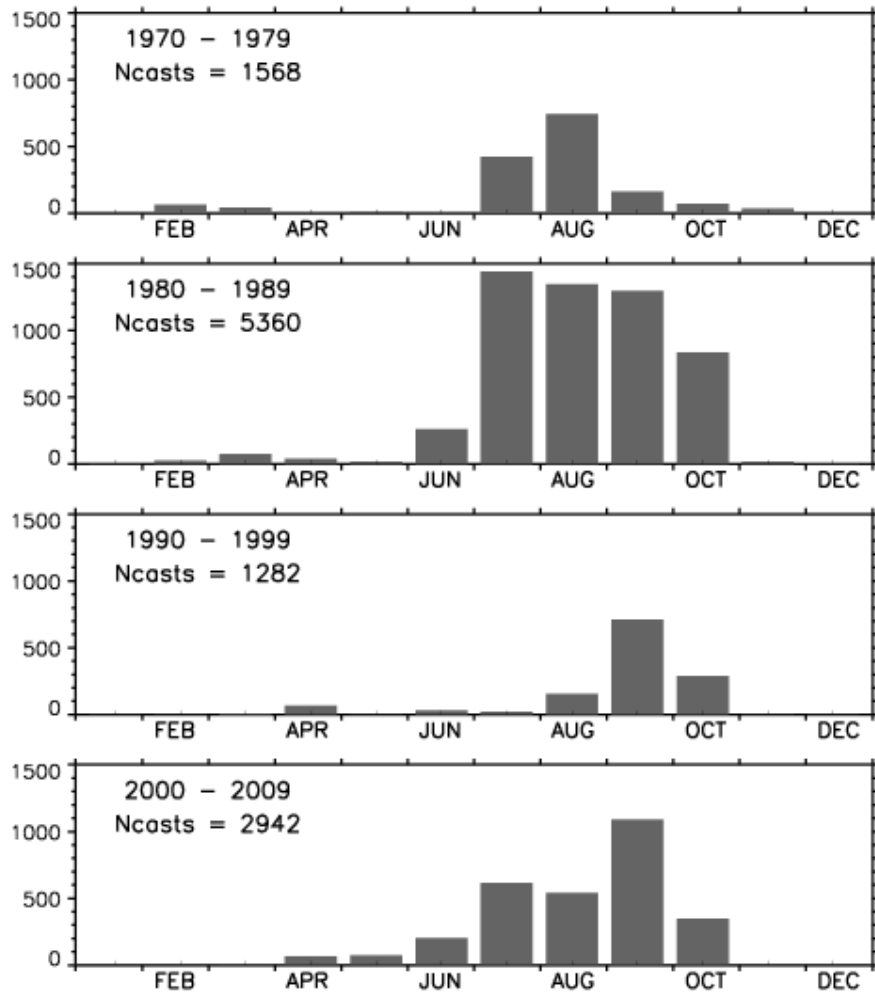
Data / Project	Description / Long Title	Theme (s)	Link	Evaluation Status & Investigators / Institution / Point of Contact
ANAMIDA	Beaufort Sea BOEM studies, 2004-2007	1-4,6	http://www.duxbury.battelle.org/cANIMIDA/home/index.cfm	Trefry is lead, Dunton also
AKMAP	Alaska Monitoring and Assessment Program	1-6	http://www.dec.state.ak.us/water/wqsar/monitoring/AKMAP.htm	We will coordinate when able with Doug Dasher and others
AHDR	Arctic Human Development Report	5	http://www.svs.is/AHDR/	On-going; Yamin-Pasternak
ANWAP	Arctic Nuclear Waste Assessment Program	1-6	http://www.nsidc.co	Cooper, some data already archived
	Alaska Department of Fish and Game Subsistence Division Publications Searchable Database	4,5,6	http://www.adfg.alaska.gov/sf/publications/	Sue Moore is going to help with contacts. Yamin-Pasternak annotating Technical Papers for the coastal settlements in the PacMARS region
AON	Arctic Observing Network and the Advanced Cooperative Arctic Data and Information Service	1-4,6	http://www.aoncadis.org/	CBL, UAF, EOL, URI, WHOI are all funded investigators via NSF
AOOS	Alaska Ocean Observing System Arctic Assets	1-6	http://data.aooos.org/maps/arctic_assets/	McCammon is involved as a collaborator
ArcOD	Species presence or abundance, biomass, benthos, zooplankton, fish, ice	1-4,6	www.arcdiv.org , www.iobis.org	Bluhm, Ashjian, Dunton all are involved
Arctic Biodiversity Assessment	Arctic Biodiversity Assessment	2	http://www.caff.is/aba	Bluhm involved in writing of two chapters
Arctic EIS	Arctic Integrated Ecosystem Survey 2012-2013 project, funded by BOEM Surface and bottom trawls ArcEIS	2,3,4,5,6	http://www.commerce.state.ak.us/dca/planning/cciap/ArcticEcosystemIntegratedSurvey.htm	UAF funded investigators will coordinate with: Franz Mueter Bob Lauth Mike Sigler
Arctic ERMA	ERMA (Environmental Response Management Application)	1-6	http://response.restoration.noaa.gov/maps-and-spatial-data/environmental-response-management-application-erma/arctic-erma.html	Large general effort, several PacMARS investigators likely to take advantage of this

Products

- Annotated table of data sets (living document, currently 11 pages and growing)



CTD spatio-temporal distribution

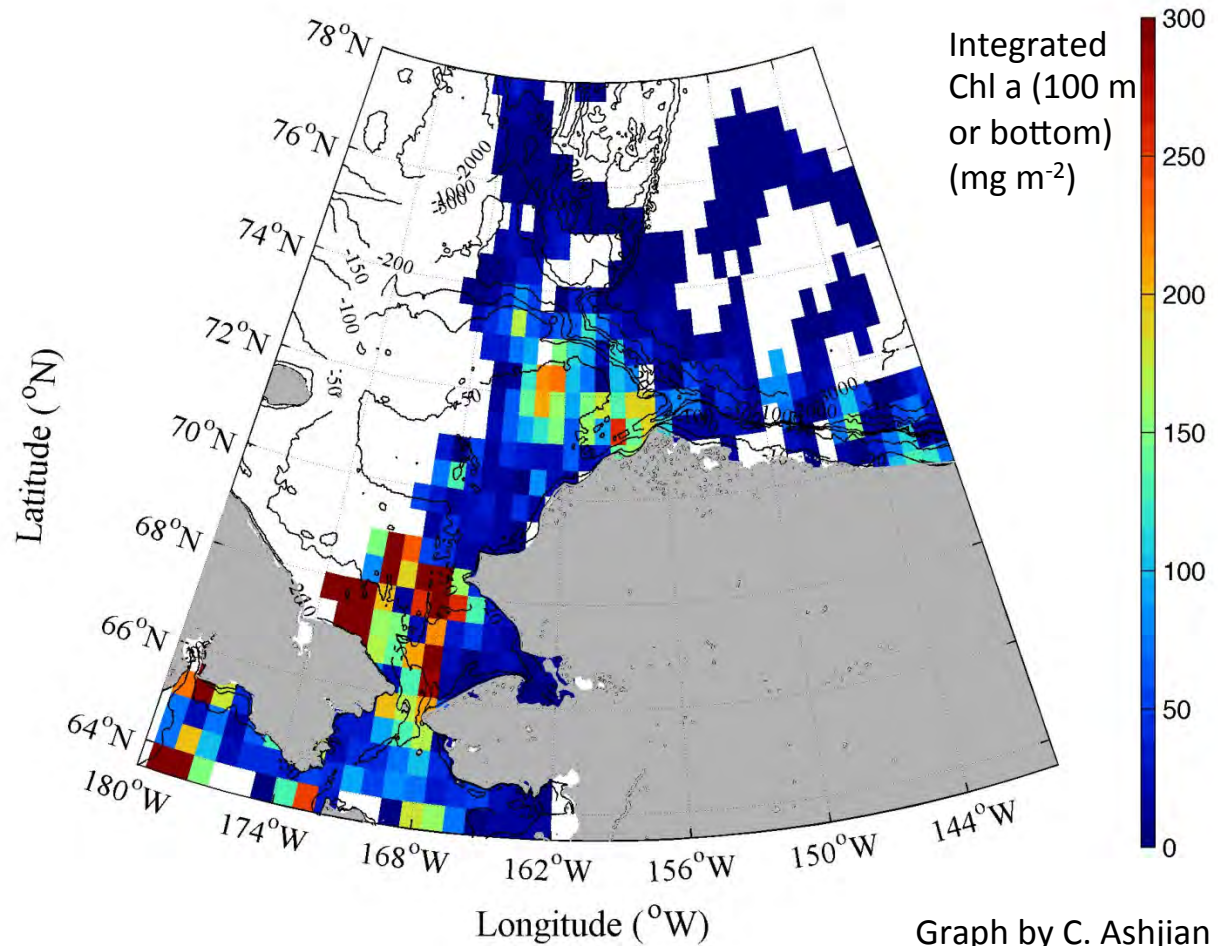


Graphs by Steve Okkonen

Theme 2: Phenology of biological production cycles in relation to physical environment

Indicator of food supply: chlorophyll distribution

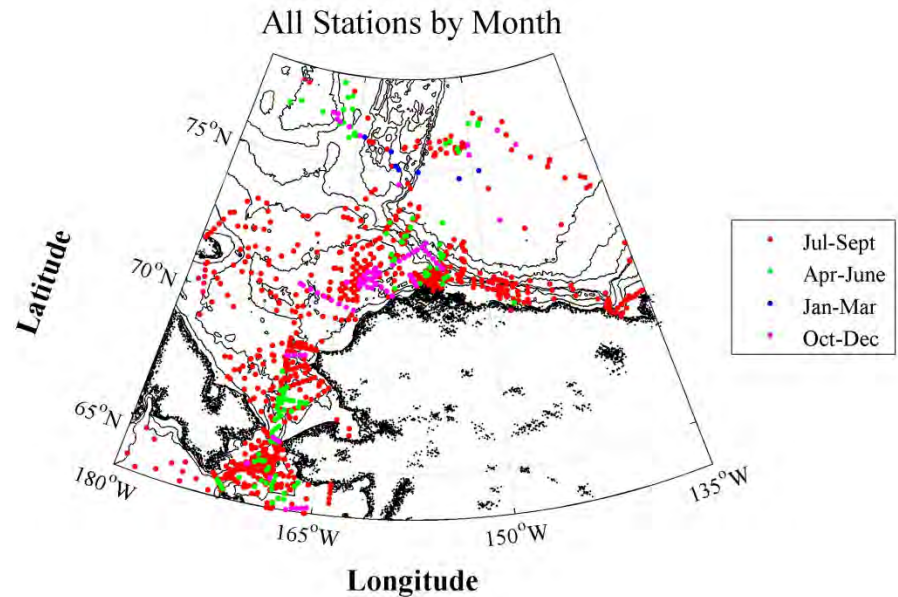
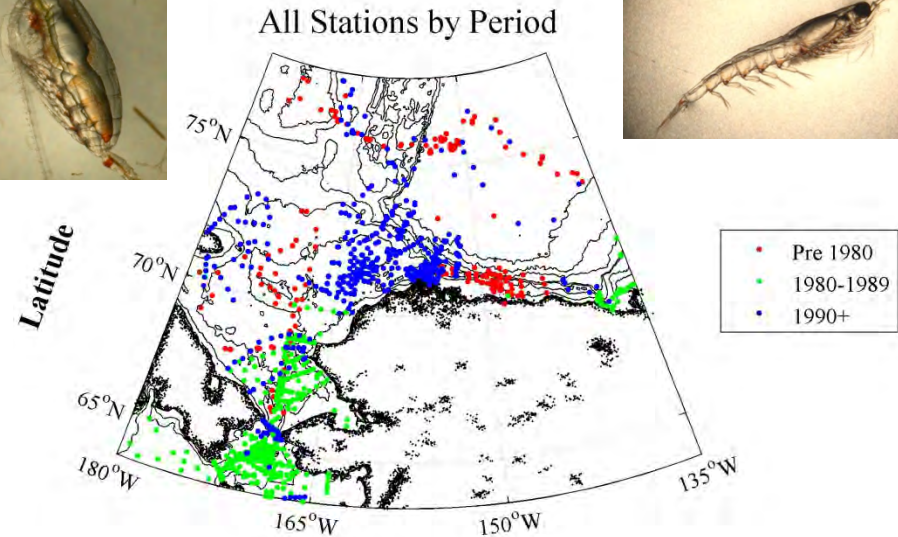
- *Data sources:*
Matrai et al. 2011
(bottle data 1954-2004), being updated with ICESCAPE, C30, RUSALCA, Canadian Beaufort Sea data
- Chl *a* hot spots in Hope Basin, Barrow Canyon/NE Chukchi



Theme 2: Phenology of biological production cycles in relation to physical environment

Indicator of food supply: zooplankton

- *Data sources:* Ashjian & Campbell, ArcOD/ Hopcroft, EOL, IOS, OBIS, et al.
- Regional foci per decade limit analysis of long-term patterns
- Goals: link with pelagic production, predator distributions and water mass tracers



Graphs by C. Ashjian, R. Campbell

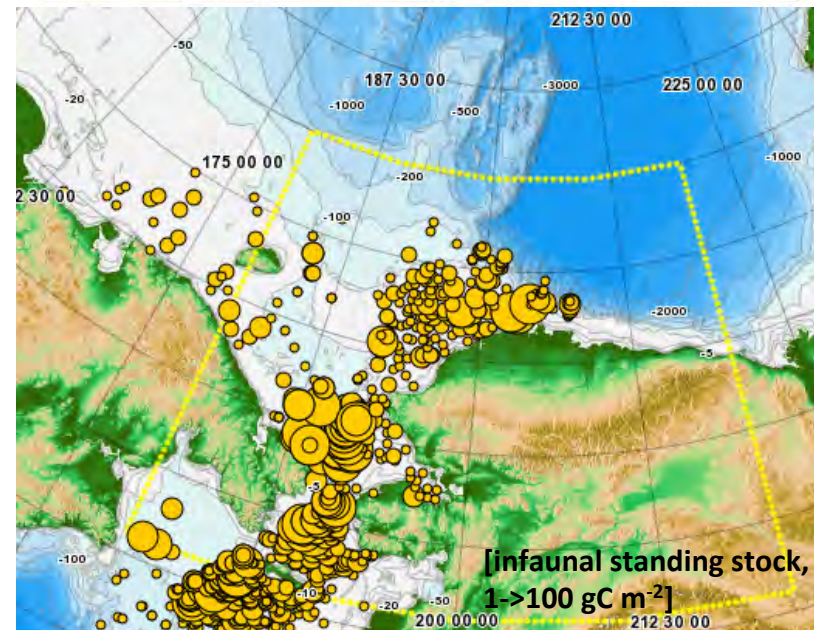
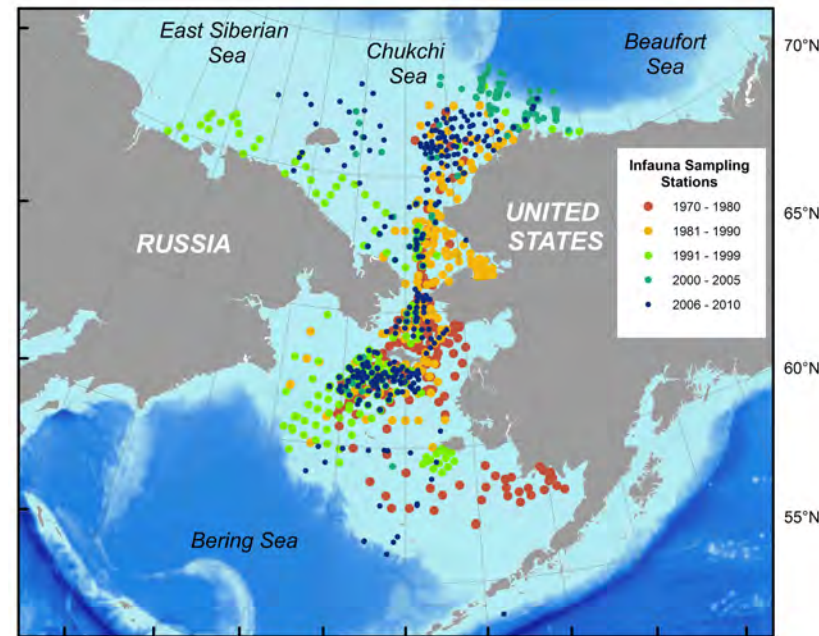


Theme 3: Benthic-pelagic coupling in relation to physical-chemical environment

Benthic infaunal biomass

- *Data sources:* Grebmeier (4 decades), Stoker, (1970s), Feder (1980s); adding Blanchard (2008-2010)
- Benthic infauna is indicator of benthic-pelagic coupling
- Hot spot: St. Lawrence Island Polynya, Chirikov Basin, Hope Basin, Barrow Canyon

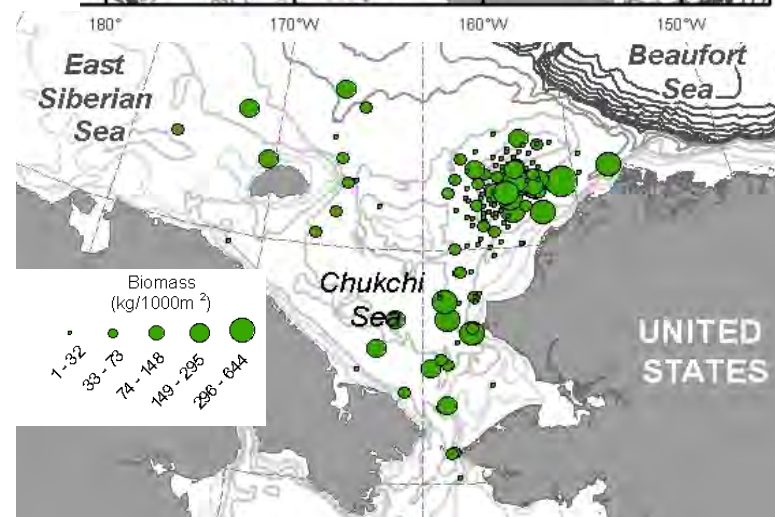
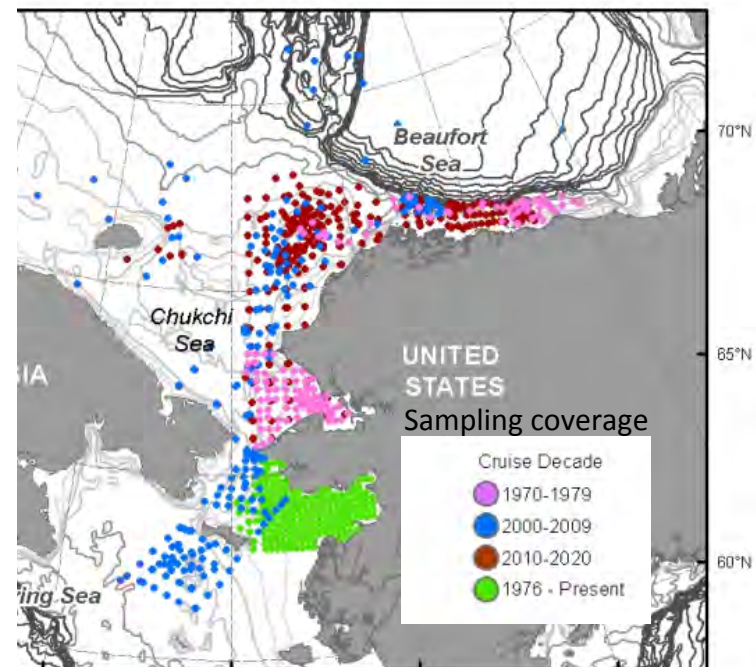
Based on van Veen grabs, 1 mm mesh
Graph: J. Grebmeier, EOL Map Server



Theme 3: Benthic-pelagic coupling in relation to physical-chemical environment

Benthic epifauna biomass

- *Data sources:* WEBSEC, OCSEAP, CESP, Feder (2005), Hidden Ocean, Norton Sound survey, RUSALCA, Oshoru Maru, COMIDA, others
- Epifauna biomass influenced by bottom T/S, sediment features, carbon supply/prey field; contribute to remineralization; mobility distributes carbon

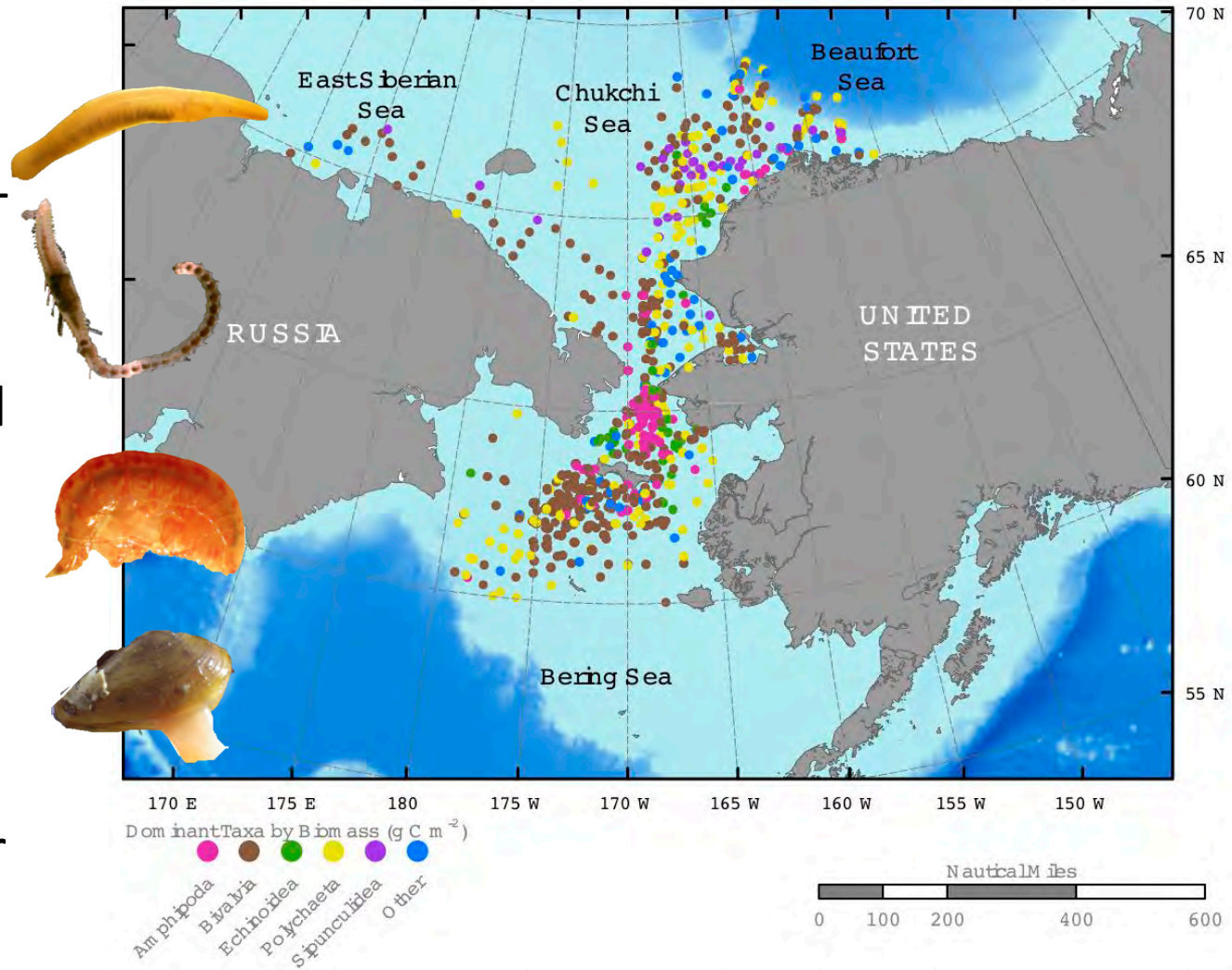


Biomass plot: Sub-set of data sources that used same beam trawl (2.26 m opening, 7 mm mesh, 4 mm cod end liner);
Graph: B. Bluhm, A. Bayard

Theme 4: Current state of lower trophic prey-base and higher trophic feeding hot spots

Benthic community structure (infauna)

- *Data sources:* Grebmeier (1980s-present), Stoker (1970s), Feder (1980s), Blanchard (2008-2010 being added)
- Prey base for invertebrates and vertebrates dominated by four taxon groups



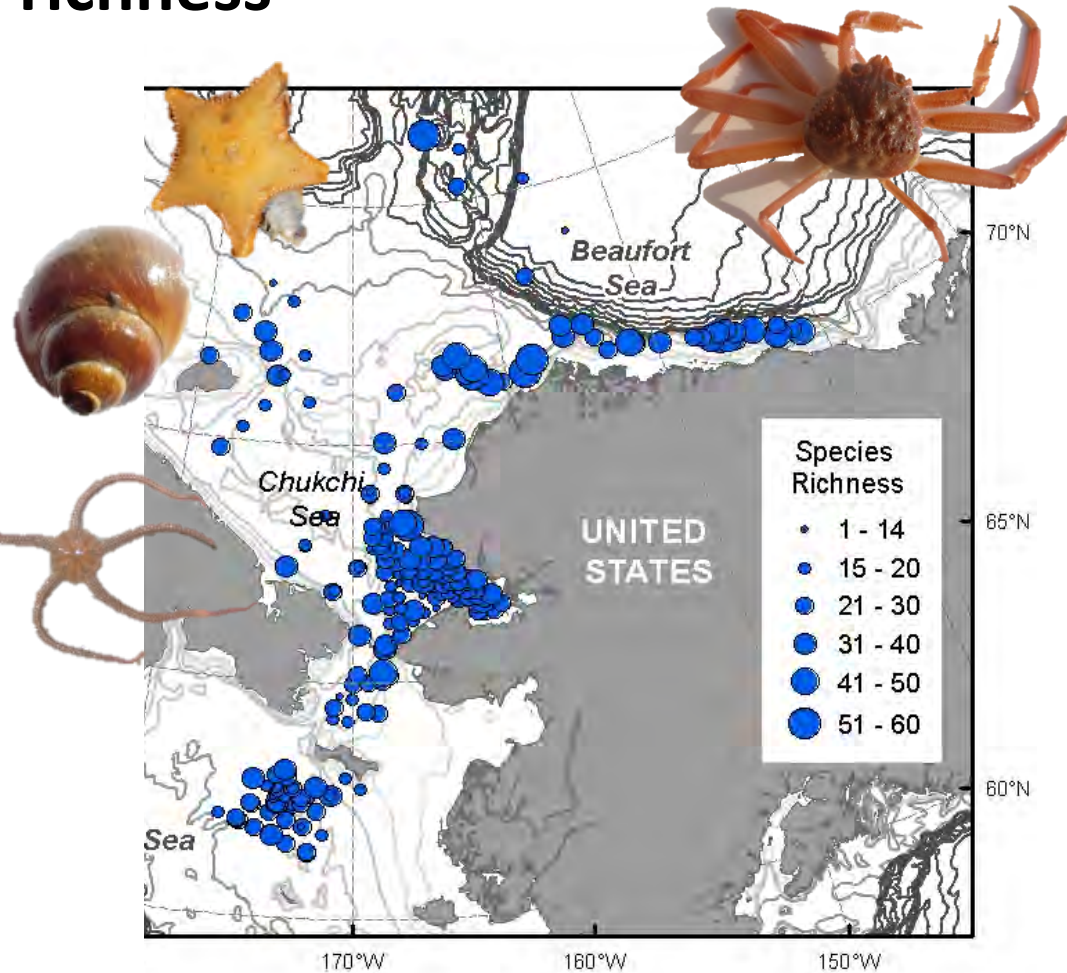
Based on van Veen grabs, 1 mm mesh; graph: J. Grebmeier, A. Bayard



Theme 4: Current state of lower trophic prey-base and higher trophic feeding hot spots

Benthic community structure: epifaunal species richness

- *Data sources:* Blanchard, Bluhm/Iken, Feder, Frost & Llowry, Lovvorn
- Goal: link benthic biodiversity data to productivity gradients to anticipate future diversity changes



Preliminary!

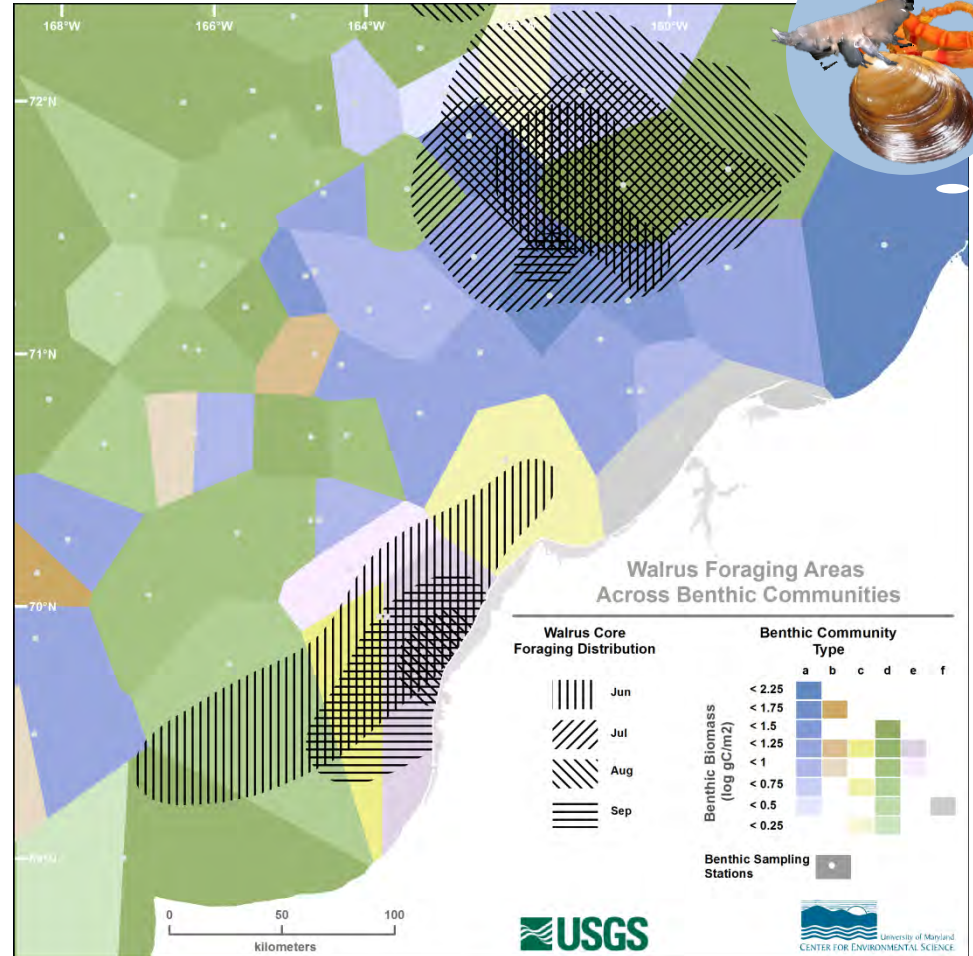
Graph by B. Bluhm, A. Bayard



Theme 4: Current state of lower trophic prey-base and higher trophic feeding hot spots

Feeding hot spots: Walrus habitat use 1

- *Data sources:* Grebmeier (2008-2010); Jay, Fischbach (USGS)
- Satellite-tagged walrus movements over benthic communities identifies feeding sites in different benthic community types



Graph by Jay, Fischbach, Grebmeier

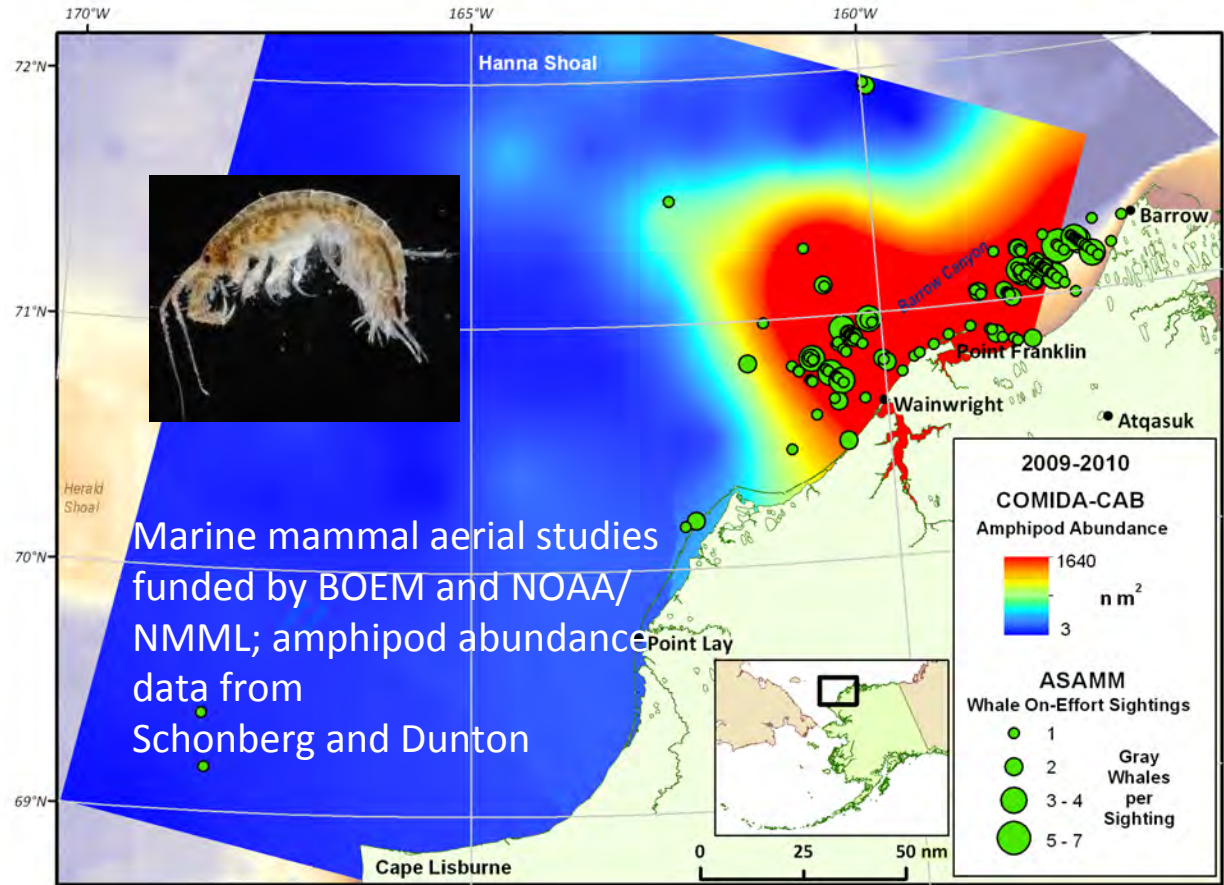
Photos: Bluhm, Iken, Voronkov, www.alaska-in-pictures.com, www.invertebrates.si.edu



Theme 4: Current state of lower trophic prey-base and higher trophic feeding hot spots

Gray whale habitat use

- *Data sources:* NOAA/NMML, Schonberg and Dunton
- Habitat utilization: High density of gray whale sightings in area of high amphipod density

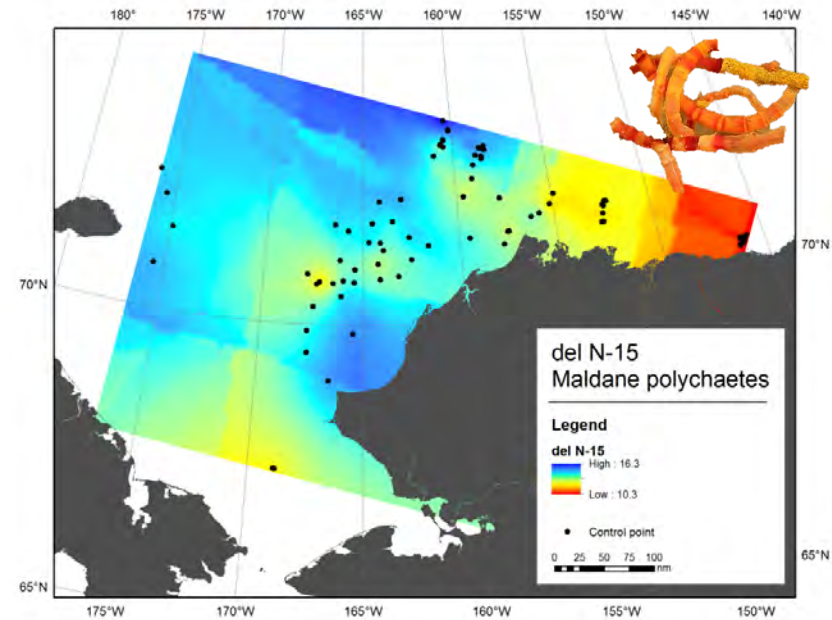


Graph by Schonberg and Dunton

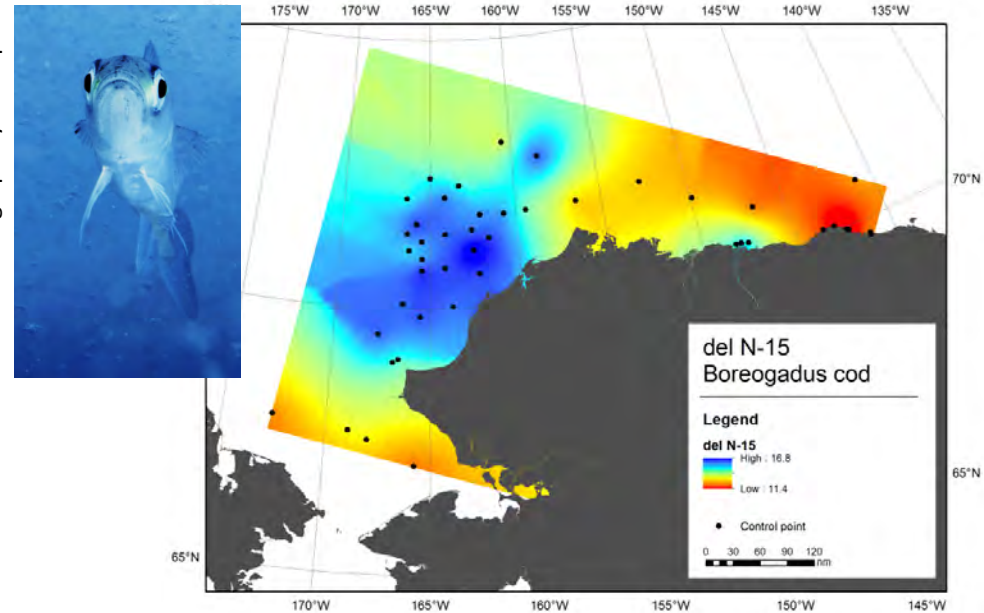
Theme 1-4: Food web

Longitudinal trends in consumer isotopic values

- *Data sources:* Dunton
- Increasing dependence of both lower (benthic polychaetes) and upper trophic (pelagic carnivorous arctic cod) level consumers on terrestrial organic matter based on decreased N isotopic values.



Photograph by S. Harper



Graphs by K. Dunton



Theme 5:

Subsistence Lifestyles: Defining the scope

“despite much change in rural communities in the second half of the twentieth century, the cultural value of subsistence has persisted as an essential organizing element of Native culture and community” (Braund and Moorehead 2009).

“... human food preferences are very resilient, tending to persist after other aspects of culture, such as housing, language, and clothing go through change.” (Yamin-Pasternak 2013)



Interviewing a Sireniki elder, 2004,
Sveta Yamin-Pasternak

“Whereas the indigenous ways of procuring, preparing, and sharing “whom”/what they eat, and how much, has remained central to local cultural values through several intense periods of social change, how will it fair in the face of climate change, understood as a social disruption? “ (Yamin-Pasternak 2013)



Theme 5: Subsistence Lifestyles: aggregating sources

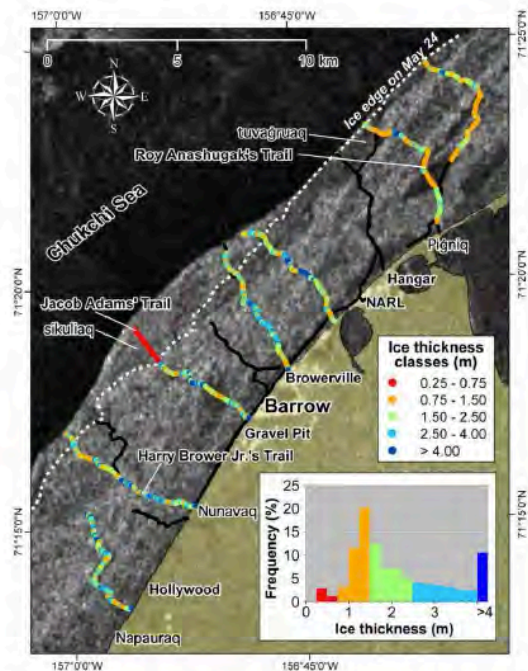


Figure 3.12 Map of the 2008 whaling trails. Trails are shown here with ice thickness data overlaid on select trails where measurements were made. The two trails south of Nunavaq were not fully mapped since they were incomplete at the time of mapping in early to mid-April. The trail off Barrow was abandoned before making it to the ice edge. The SAR image, acquired by the RADARSAT-1 satellite and provided by the Canadian Space Agency, is from April 5, 2008.



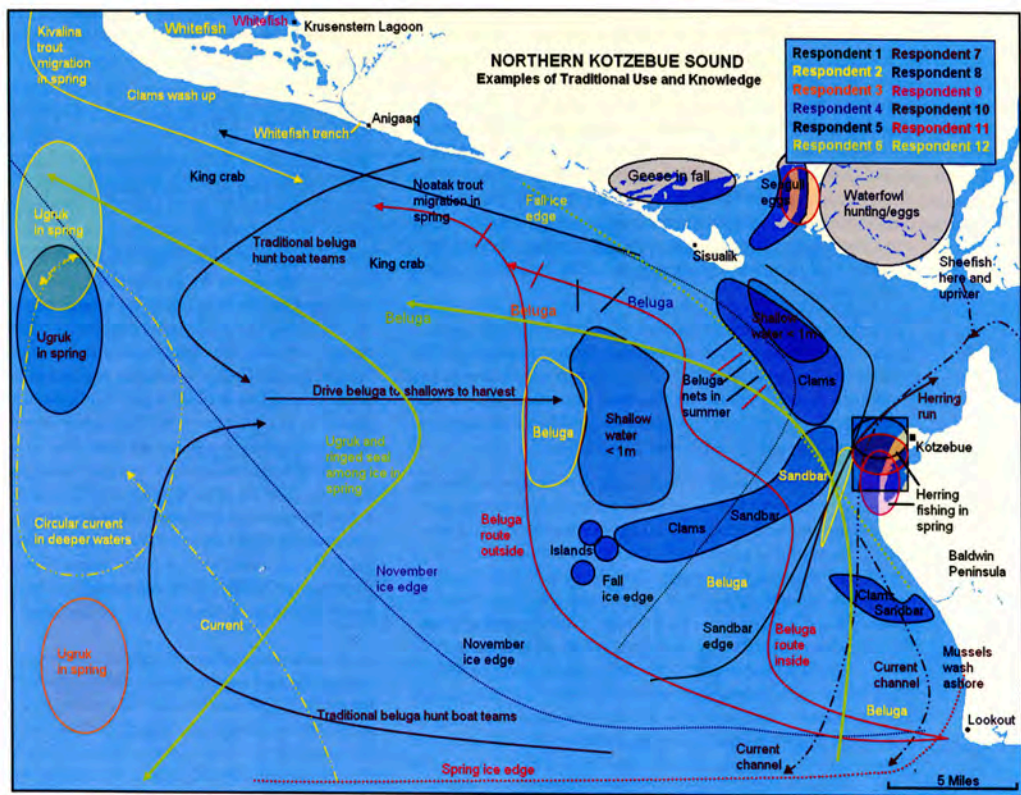
Braund & Associates 2009

Druckenmiller et al. 2011.

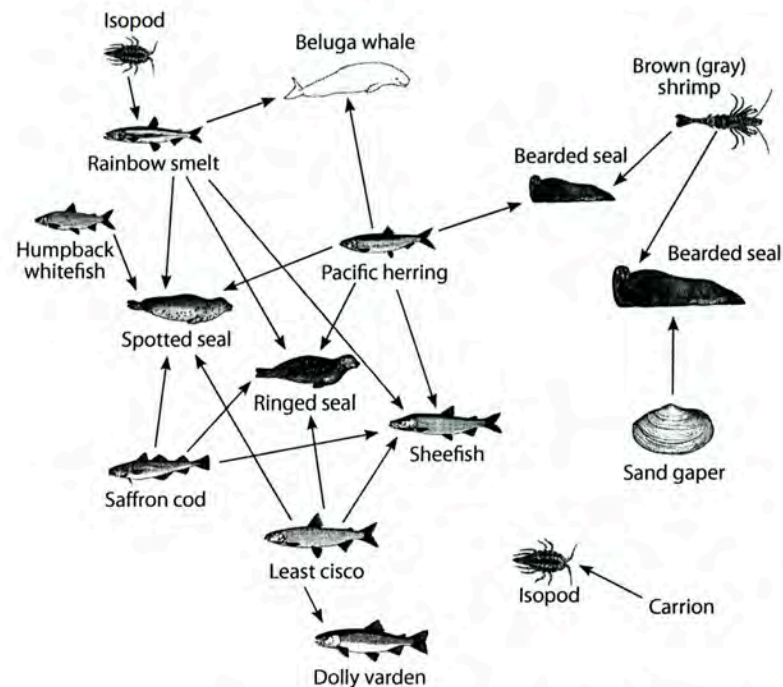


Theme 5:

Integration of Knowledge Systems



A representation of Inupiaq observations on the environment, based on 11 informants.



Marine mammal food web according to the Inupiaq. The arrows refer to predator-prey relationships (e.g., an arrow points from least cisco to Dolly Varden; Dolly Varden preys on least cisco).

Alex Whiting, David Griffith, Stephen Jewett, Lisa Clough, William Ambrose
Combining Inupiaq and Scientific Knowledge: Ecology in Northern Kotzebue Sound, Alaska,
2011 pp. 15, 13

Theme 5: Subsistence Lifestyles

Regional Community Meetings

BARROW

Barrow

Wainwright

Point Lay

Nuiqsut

Kaktovik

FEBRUARY 11

KOTZEBUE

Kotzebue

Point Hope

Kivalina

Buckland

FEBRUARY 22

NOME

Nome / Diomedes / Wales

King I. / Brevig Mission

Teller / Shishmaref

FEBRUARY 25

ST. LAWRENCE I.

Gambell

Savoonga

JANUARY 28-29



Pacific Marine Arctic Regional Synthesis (PacMARS)



Theme 5: Subsistence lifestyles in times of climate change

Community Meeting Objectives



G. Noongwook, Savoonga
IRA, with L. Cooper Jan 2009

- Explain PacMARS
- Updates on research in the respective areas
- Discuss marine issues important to the communities including gaps for future study
- Discuss useful ways of communicating science results
- Find good examples of regional knowledge and western science working together



Some Community Hub Meeting Results



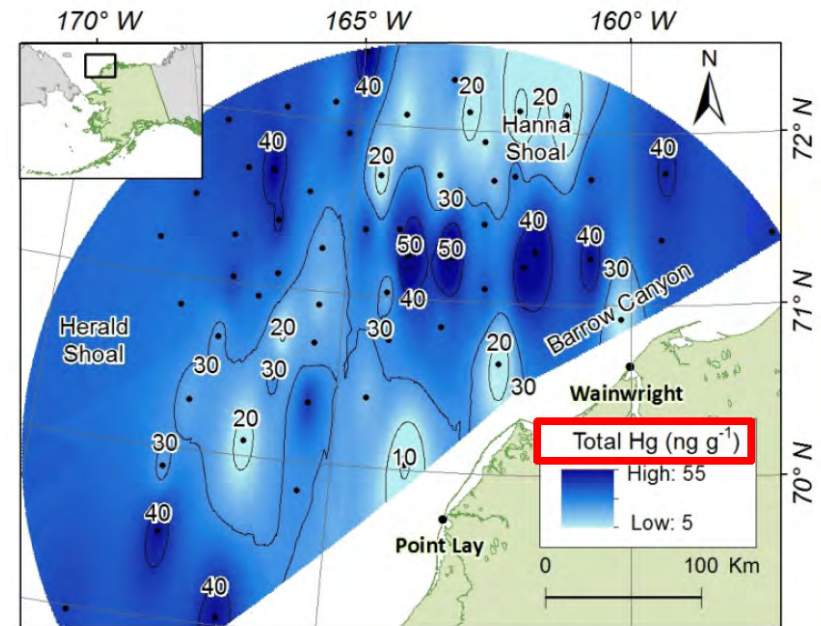
Issues

- Ecosystem is changing same time increasing oil industry development
 - Ship traffic and contamination
 - Food security
 - Loss ice thickness, coastal erosion
 - Outreach: regular updates marine science issues, return results to community
 - “Things are changing, but we have got to go forward”
- Community involvement-research partnerships
 - Invasive species, new species, migration north, shifting populations
 - People emphasized they are part of the ecosystem
 - Need input from the elders on studies in area
 - Ice plays important role for where walrus drift
 - Toxicity of subsistence foods of concern
 - People notice anomalies, new species, young Opilio crabs wash onto shore in late fall storms
 - Interest including local people in science for education and local hires
 - Train next generation, take on cruises; possible socio-ecological training program?
 - Seal disease of concern
 - Arctic pack ice breaking up, changing weather
 - Bowhead whales not seen close to shore near Barrow in recent years as in the past-why?
 - Impact warming coastal waters on foodwebs
 - Changes in timing of animal migration with climate change



Theme 6: Chemical contaminants in sediment and biota

- *Data sources:* ANIMIDA, cANIMIDA, UAF (Naidu et al. 2012), Shell Camden Bay & Harrison Bay, COMIDA, CSESP
- Data being acquired/evaluated from: ACADIS, AMAP, ADF&G, BERPAC, USFWS, NMML, PWID, NSB, OCSEAP, SNACS



Trefry, Cooper, COMIDA unpubl.

Future study needs from PacMARS-SOAR workshop, January 20, 2013

Physical/chemical/contaminants group:

- Issues of coastal sea level, contaminants, ice cover, primary production, sea ice conditions and sediment transport
- Important topics included documenting change in various physical/chemical parameters, monitoring (historic, real-time, and future), especially key variables needed for developing a biophysical model for predictive scenarios analyses

Biology group:

- Adaption of organisms to changing environmental condition requires understanding growth rates, survivability, and impacts of temperature changes
- Changes in organism and carbon products transiting into and being modified in the Chukchi Sea and utilized or transported downstream into the Beaufort Sea in the future in relation to timing and magnitude of current transport
- Issue whether expatriate organisms have ability to adapt, survive, and persist in the Chukchi/Beaufort as environmental conditions (e.g., temperature, timing) change



Future Issues from PacMARS-SOAR workshop

Social

- Socioeconomic effects of climate change on local people and their lifestyles
- Coastal erosion
- Changes in hunting and harvest activities
- Social impacts (adaptive, destructive or multidirectional)

Upper trophics/ acoustic ecology:

- Flows between regions/organisms suggests progression of organisms and ecosystems north
- Understand bottom up versus top down systems and how we should measure changes in function
- Use variable acoustic type to identify species, reproduction, migration and foraging patterns as well as for estimating abundance and density of prey (fishes/invertebrates)
- Need to integrate wind and current models with biological data
- Key locations included Bering Strait (chokepoint), Point Hope, Barrow Canyon, Hanna Shoal, Peard Bay, regions of the Beaufort Sea, and the Mackenzie River



Thanks – Questions?

- NPRB, F Wiese, D Dickson, Advisory Committee, E Carmack, R Ulanowicz
- EOL Team J Moore, J Scannell, D Stott et al.
- GIS wizards A Bayard, T Whiteaker et al.
- **Contributors, data providers!**

