

The Arctic Marine Pulses Model

Linking Contiguous Ecological Domains in the
Pacific Arctic

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OUTLINE



2015, *PiO* Special Issue



- FOUR PAN-ARCTIC CONTIGUOUS DOMAINS
- BUILDING THE ARCTIC MARINE PULSES (AMP) MODEL
- SEASONAL BIOPHYSICAL PULSES IN THE PACIFIC ARCTIC
- THE AMP MODEL: A STEP TOWARDS HUMAN-INCLUSIVE ECOSYSTEM APPROACH
- NEXT STEPS: *DEEP-SEA RESEARCH II*, SOAR II SPECIAL ISSUE, PAPER IN REVISION

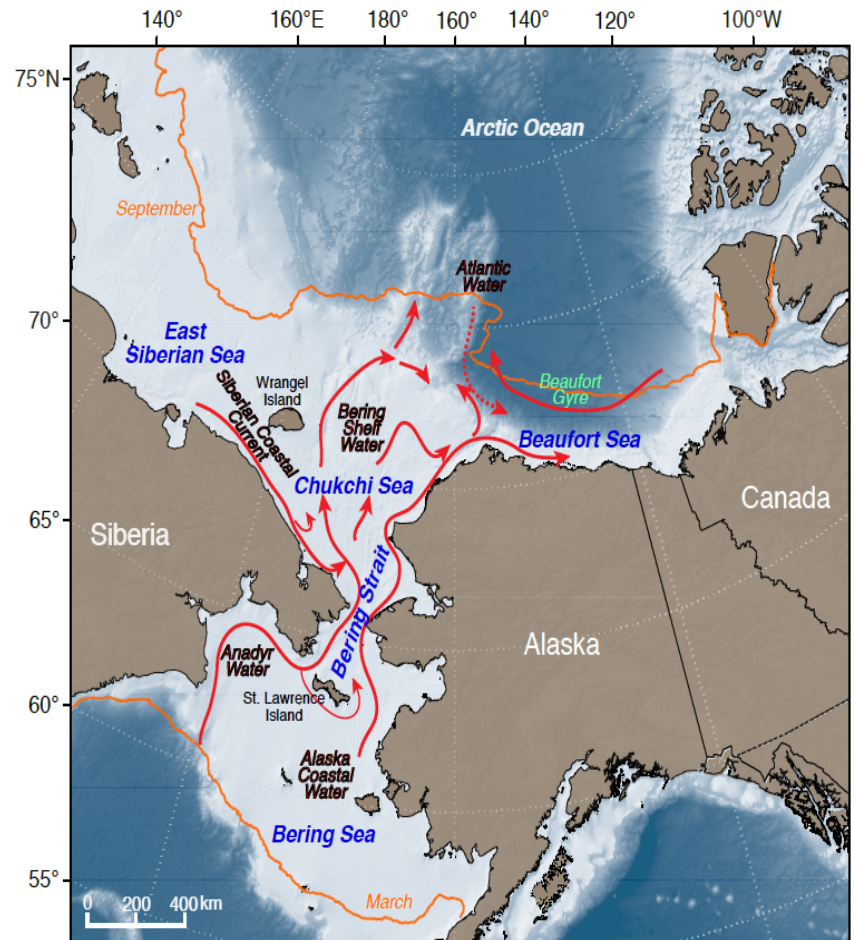
Overarching Goal : *linking the concept of contiguous domains to existing pelagic-benthic coupling and advective processes to provide an integrative approach to ecosystem assessment*

PAN-ARCTIC CONTIGUOUS DOMAINS

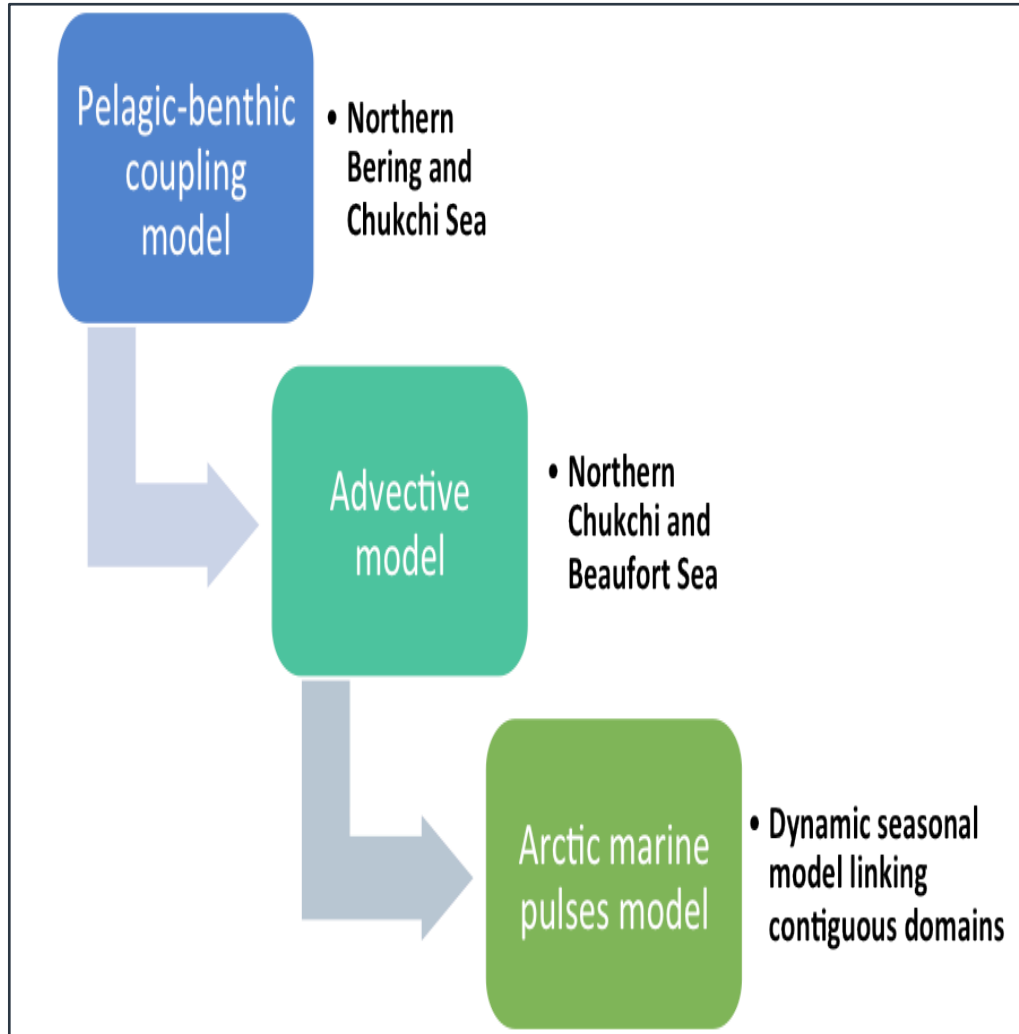
Carmack and Wassman (2006)

FOUR DOMAINS: associated processes

- **Pacific Arctic** (focal domain): strong seasonal and inter-annual variability of in flow @ Bering Strait
- **Seasonal Ice Zone**: phytoplankton blooms & ice algal deposition, which links pelagic-benthic coupling model to the AMP
- **Pacific Margin/Slope**: along-slope transport, upwelling & eddy formation, which links advective model to the AMP
- **Riverine and Coastal**: **heat** & **fresh water** input via Yukon, Colville, Sag and Mackenzie discharges in the focal domain

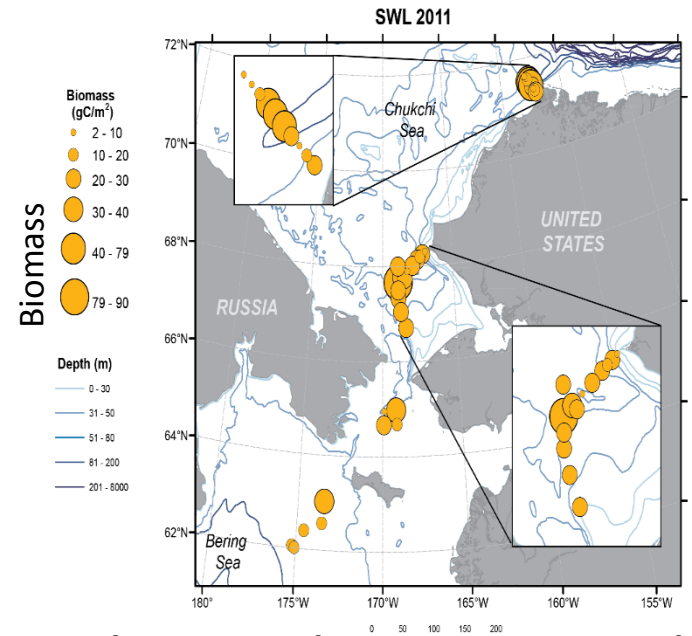
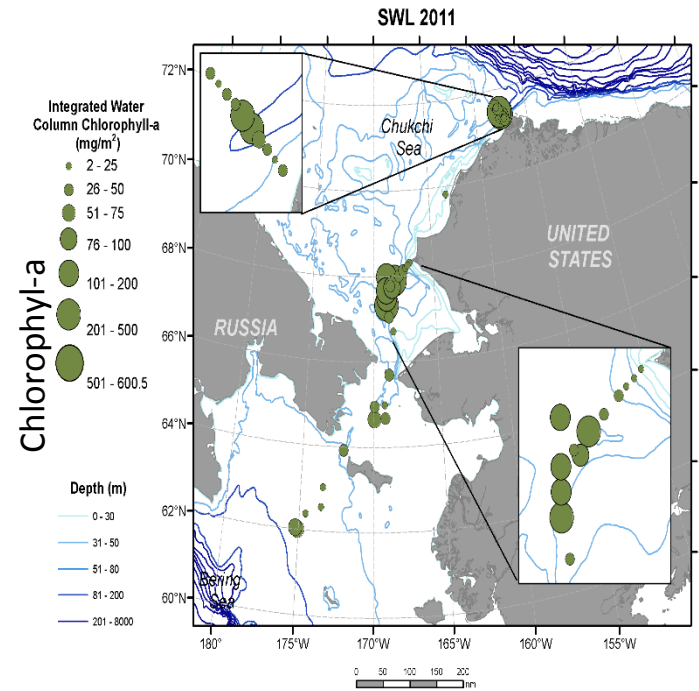
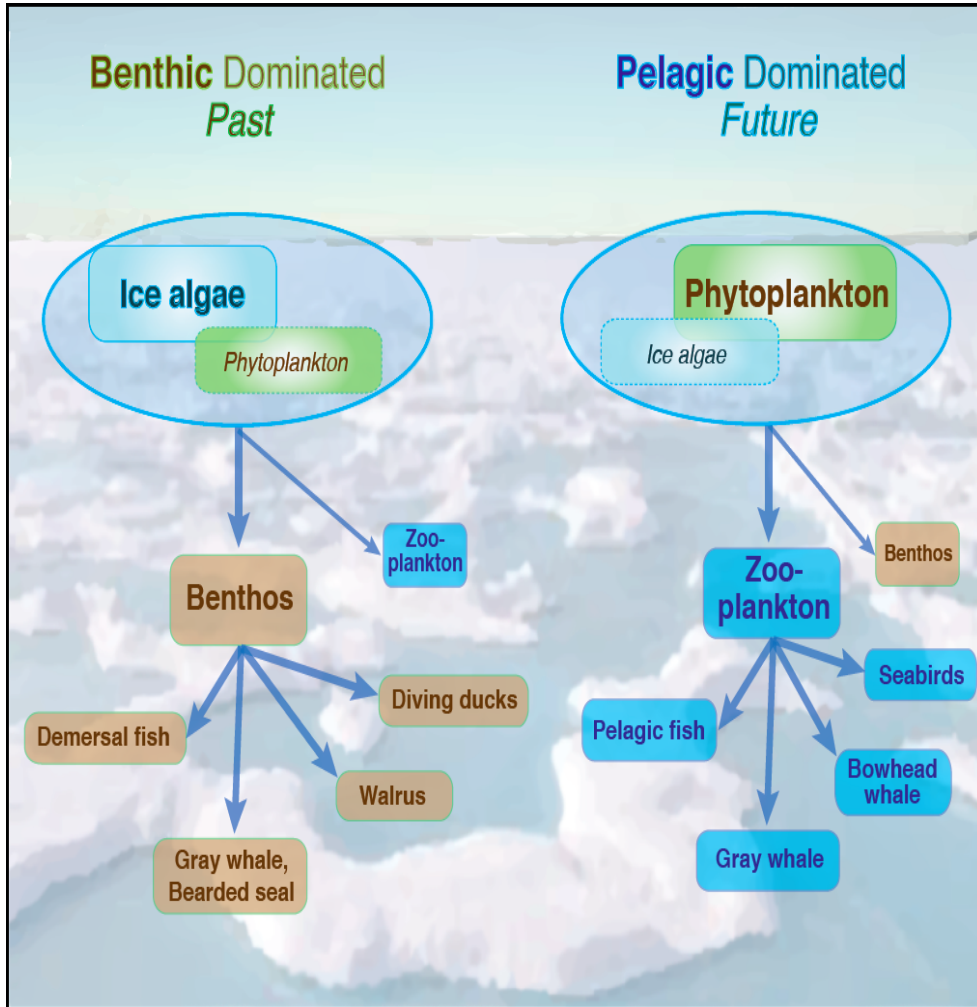


Building the AMP Model



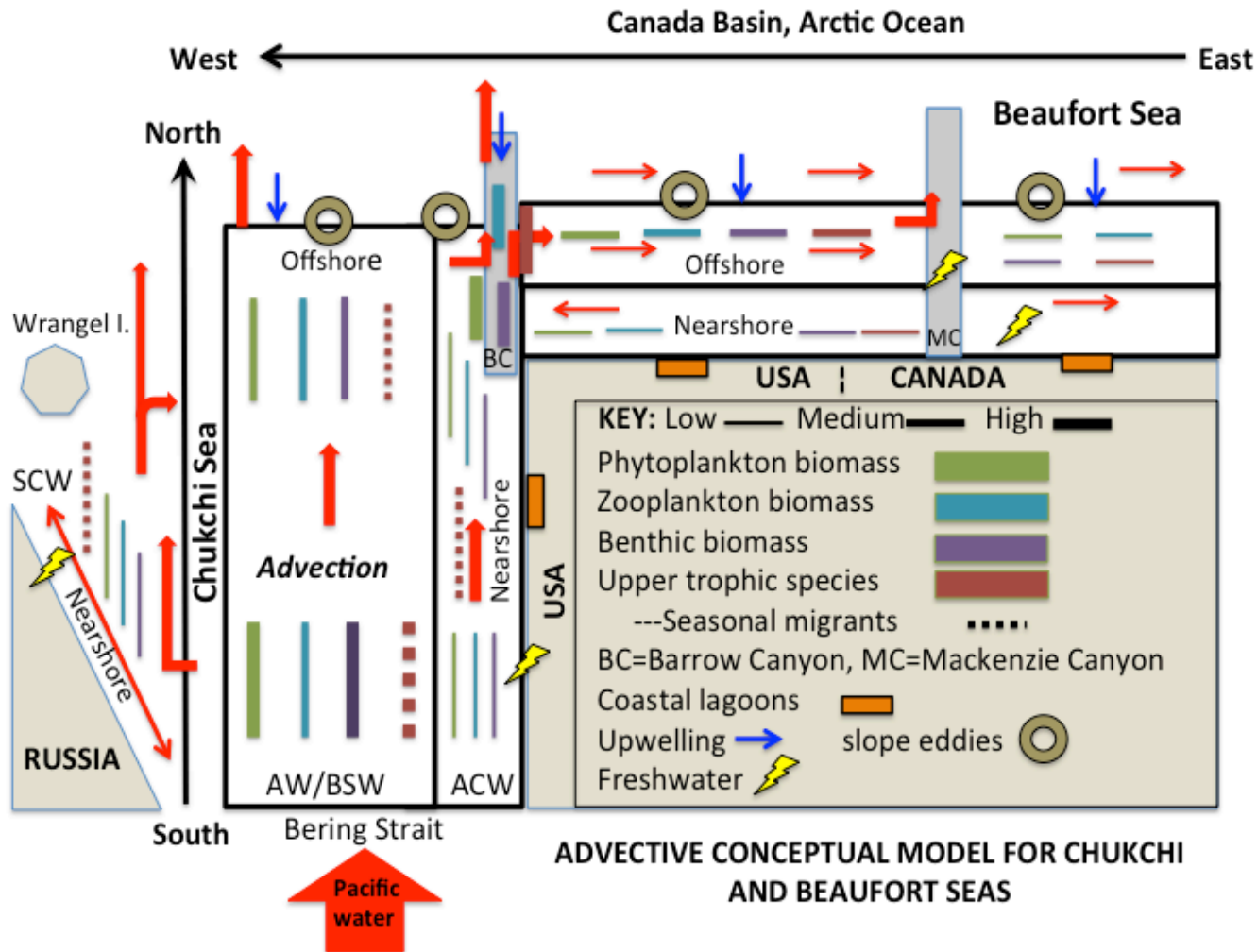
- Ice retreat triggers phytoplankton production and deposition of ice algae to shelf-benthos
- Ice retreat corresponds with Bering Strait inflow, with late-summer retreat into basin fostering wind-driven upwelling and eddy formation along slope
- Rivers pulse fresh-warm water into coastal systems, influencing local production and prey aggregation

PELAGIC-BENTHIC COUPLING MODEL



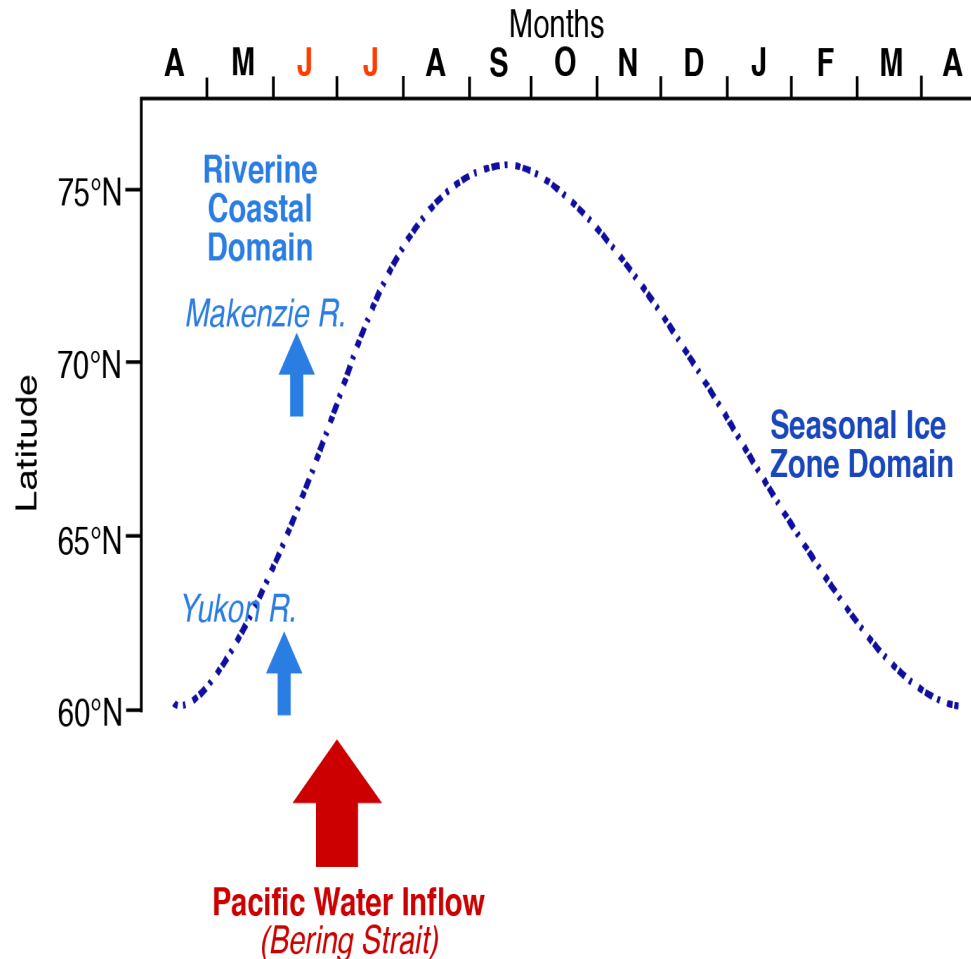
ADVECTIVE MODEL

Grebmeier et al. (2015) PacMARS Final Report



THE ARCTIC MARINE PULSES (AMP) MODEL

a seasonal 'construct' linking contiguous domains in the Pacific Arctic



Seasonal Biophysical Pulses

Pacific Water Inflow

- Peak inflow through Bering Strait in June-July: **50% increase**, 2001-2013 (Woodgate et al. 2015)

↑ Initiates Advective & AMP model

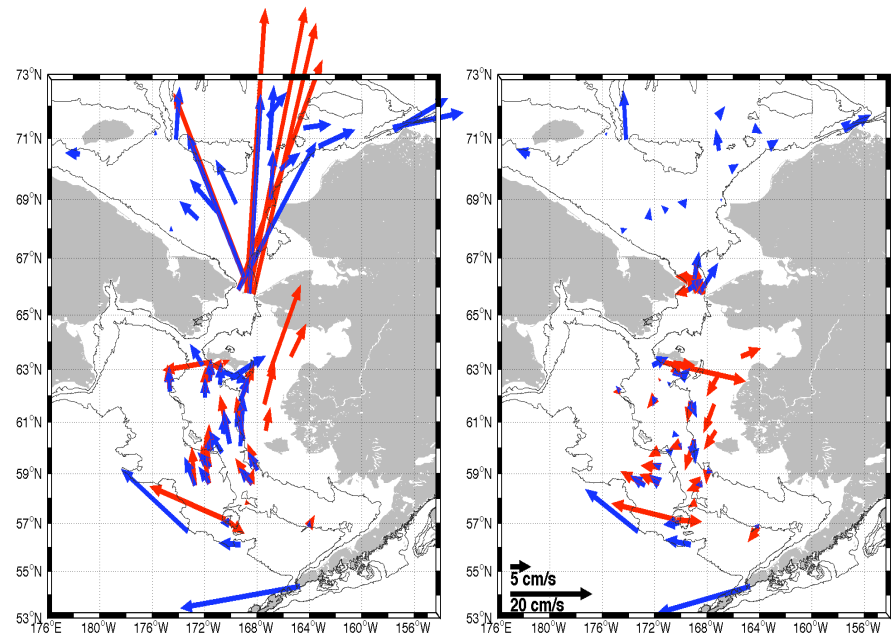
- Atmospheric drivers?

A = Aleutian Low-west & Beaufort High-enhanced

B = Aleutian Low-east & Siberian High-enhanced

Moored current meter measurements, October-April (1979-2010);

red = 10-20m; blue = 30-60m



A

B

Danielson et al. (2014)

Seasonal Biophysical 'Pulses'

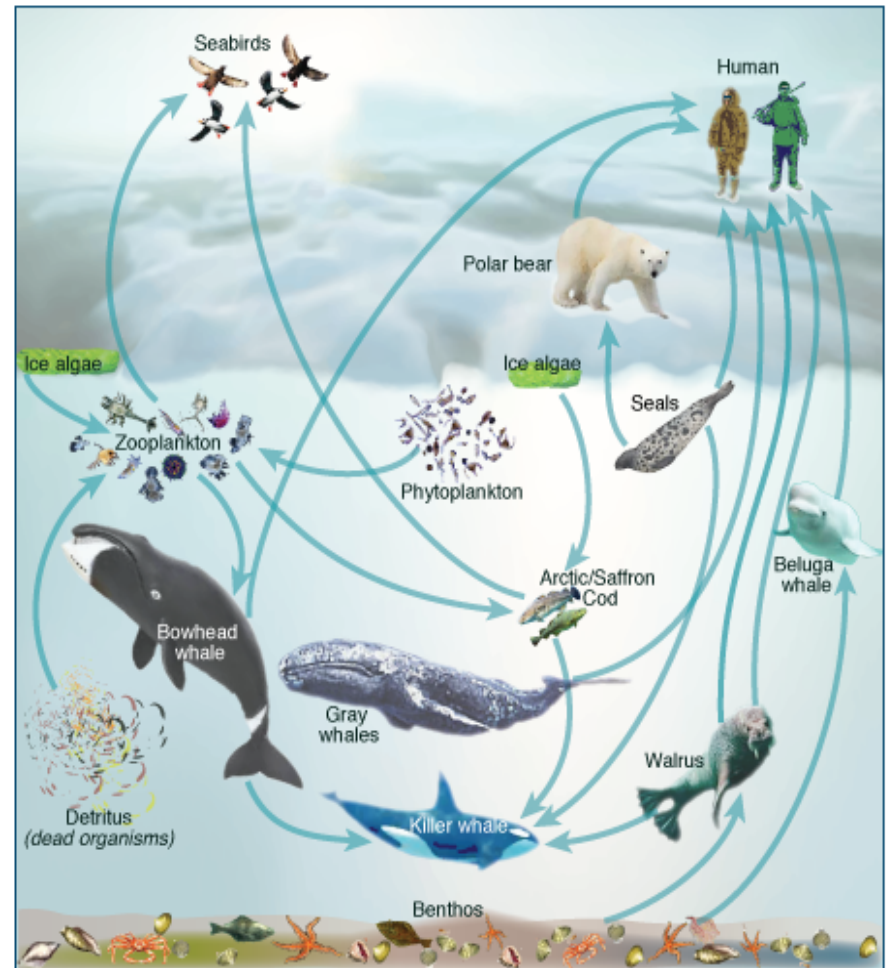
- a few examples -

- Summer – fresh-warm inflow-pulse @ Bering Strait ([Woodgate et al. 2015](#)), and offshore Icy Cape ([Stabeno et al. 2016](#))
- Spring & Early Summer – regional phytoplankton-bloom pulses ([Arrigo and van Dijken 2015](#); [Ardyna et al. 2014](#)) + riverine discharge pulses ([Wood et al. 2015](#))
- Late Spring & Summer – latitude dependent, pelagic-benthic coupling pulses on shelves ([Grebmeier et al. 2015](#))
- Late Summer, Fall & Winter – advection, upwelling & eddy pulses along slope ([Okkonen et al. 2014](#); [Pickart et al. 2013](#); [Llinás et al. 2009](#)) and 'polynya pulses' from Barrow Canyon up-canyon flow ([Ladd et al. 2016](#))
- Late Fall & Winter – rapid-cooling 'pulse', coincident with sea ice formation ([Stabeno et al. 2016](#))

THE AMP MODEL

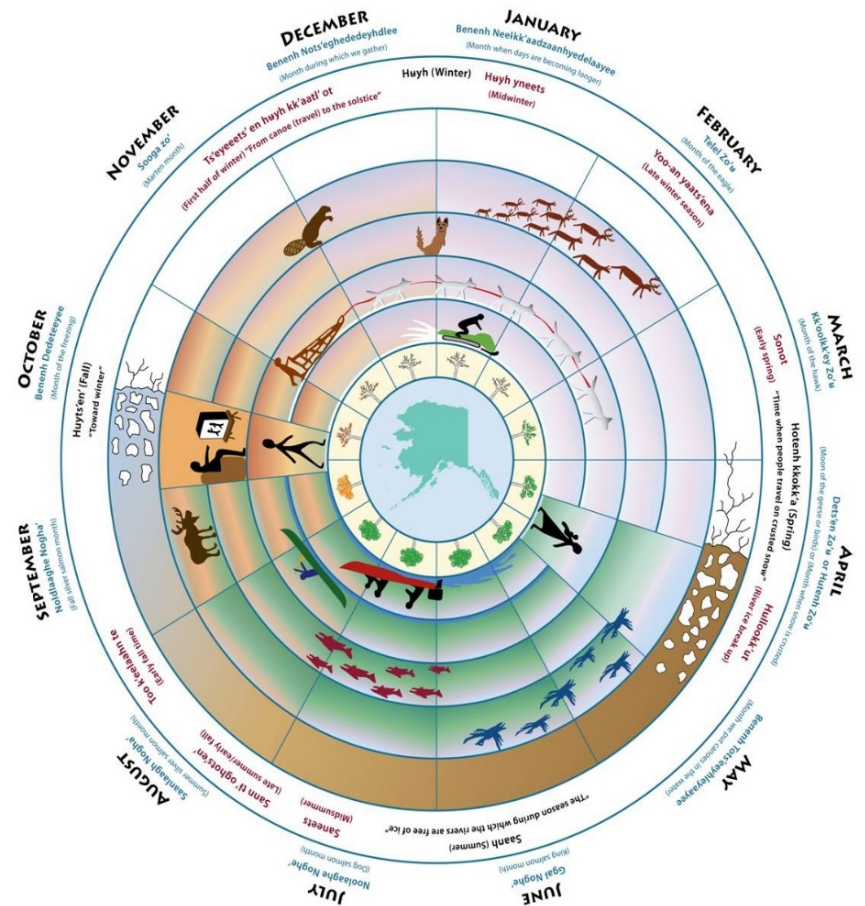
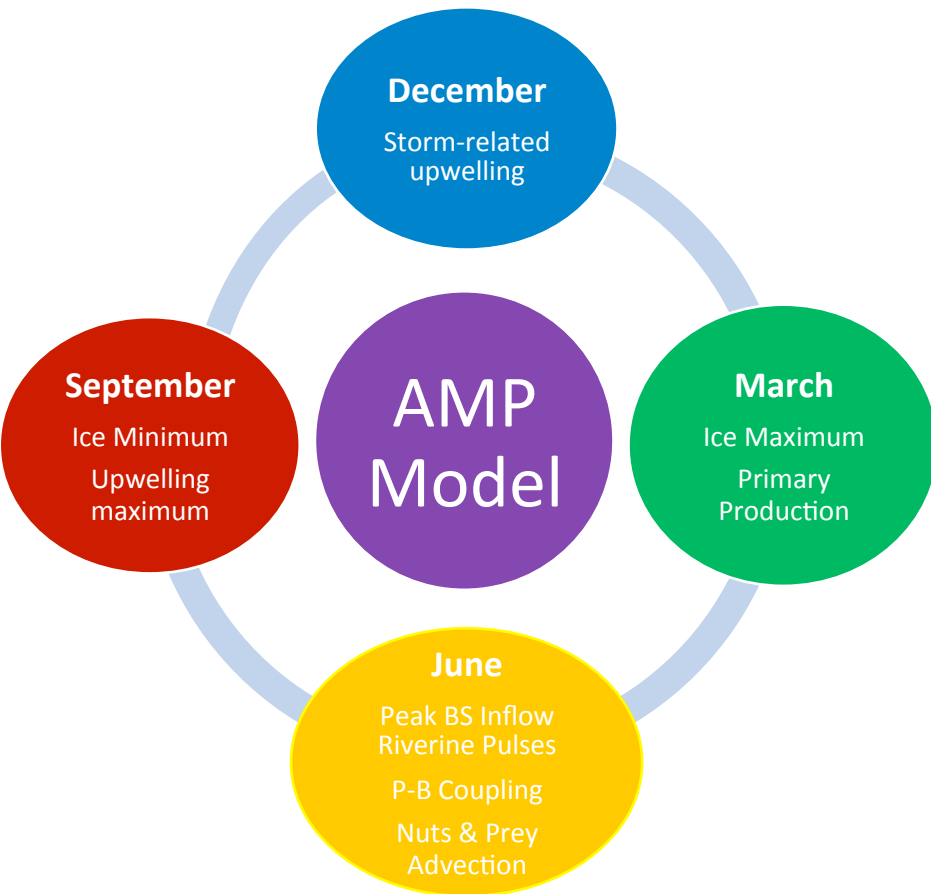
A Step Towards Human-Inclusive Ecosystem Assessments?

- Humans are at the apex of Arctic food webs and rely on marine resources for food and culture
- The AMP Model emphasizes **temporal events** (pulses), which can link biophysical processes with human subsistence activities
- Goal = holistic assessment of ecosystem processes and state



Conventional Science & Local Observations/Partnerships

Finding Complementary Sampling Scales





Research 'Partnerships': The Bowhead Example

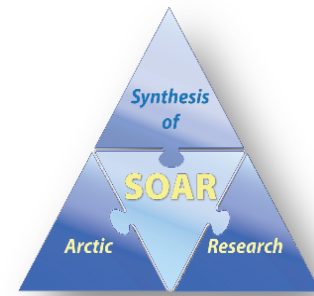
Local Ecosystem Observers & Samplers



photo by Sue Moore

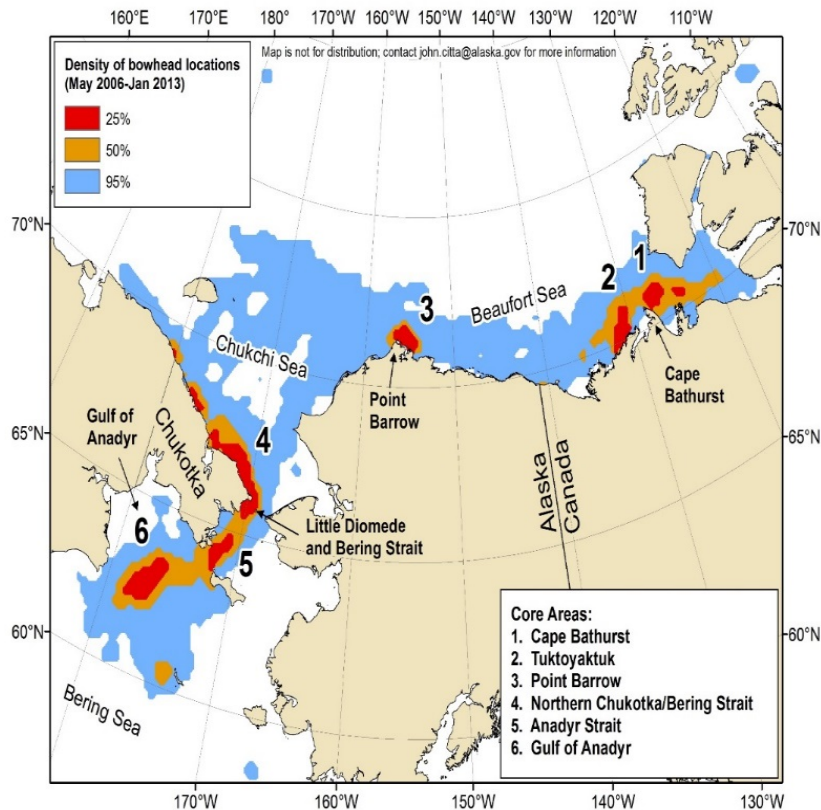
Bowhead whaling = nutritional & cultural 'keystone'

Resulting in 'Conventional Science' papers on Bowhead Whale Habitat Use and Body Condition based upon Partnerships with Local Hunters:



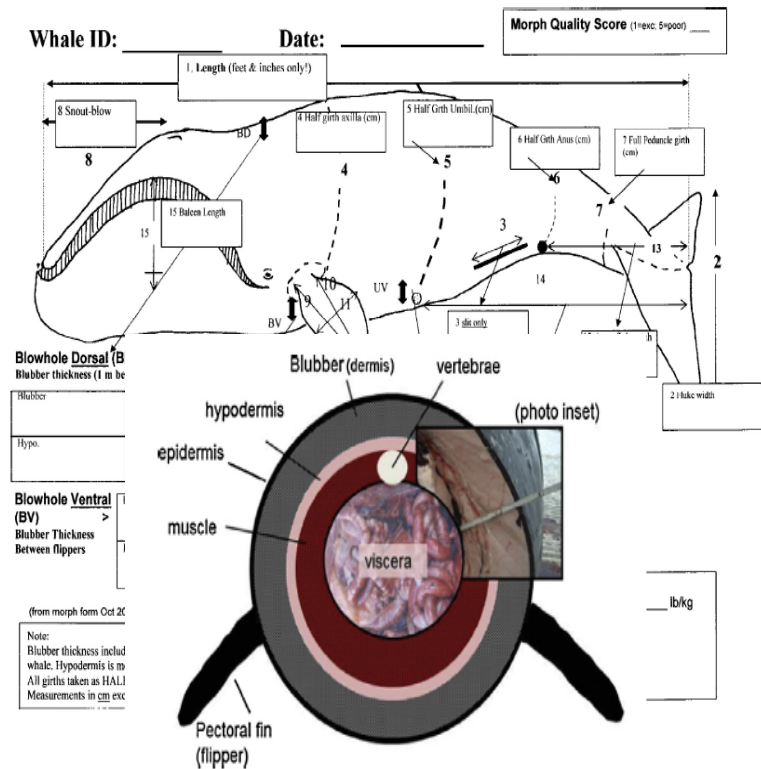
TWO EXAMPLES

• Core-Use Areas



Citta et al. 2015

• Body Condition



George et al. 2015

THE AMP Model: Next Steps

- Paper in Revision for *Deep-Sea Research II*, SOAR II Special Issue
- Expand on the temporal focus of the AMP model – how has/is the **phenology** of the Pacific Arctic marine ecosystem changed?
- Explore connections to Community Based Observations
- Investigate the utility of AMP Model for other Arctic regions



With THANKS to:

BOEM for SOAR \$upport

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

PAME Ecosystem Approach
Conference Organizers!