

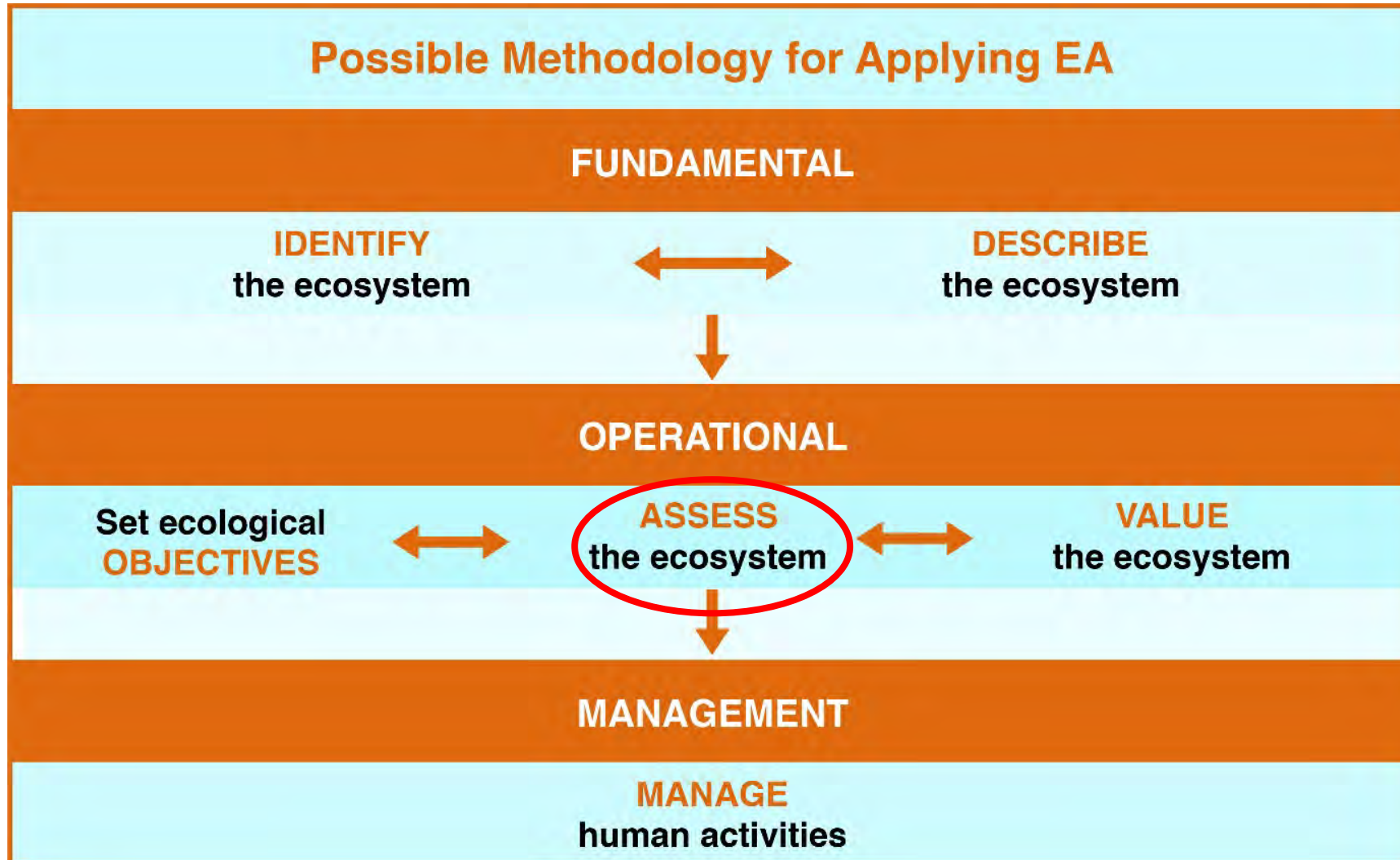
Integrated Ecosystem Assessment of  
the Central Arctic Ecosystem –  
ICES/PICES/PAME WGICA

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# ICES/PICES/PAME WGICA

- Working Group on Integrated Ecosystem Assessment of the Central Arctic Ocean
- ICES – **International Council for Exploration of the Sea**
  - Science and Advice
- PICES – **North Pacific Science Organization**
- PAME – Protection of the Arctic Marine Environment
- Established 2015 – 3-year period: 2016-2018
- 3 co-chairs:
  - John Bengtson, NOAA, USA
  - Sei-Ichi Saito, Univ. of Hokkaido, Japan
  - Hein Rune Skjoldal, IMR, Norway
- 3rd meeting in St. John's, Newfoundland, Canada
  - <http://www.ices.dk/community/groups/Pages/WGICA.aspx>

# EA Framework



WGICA

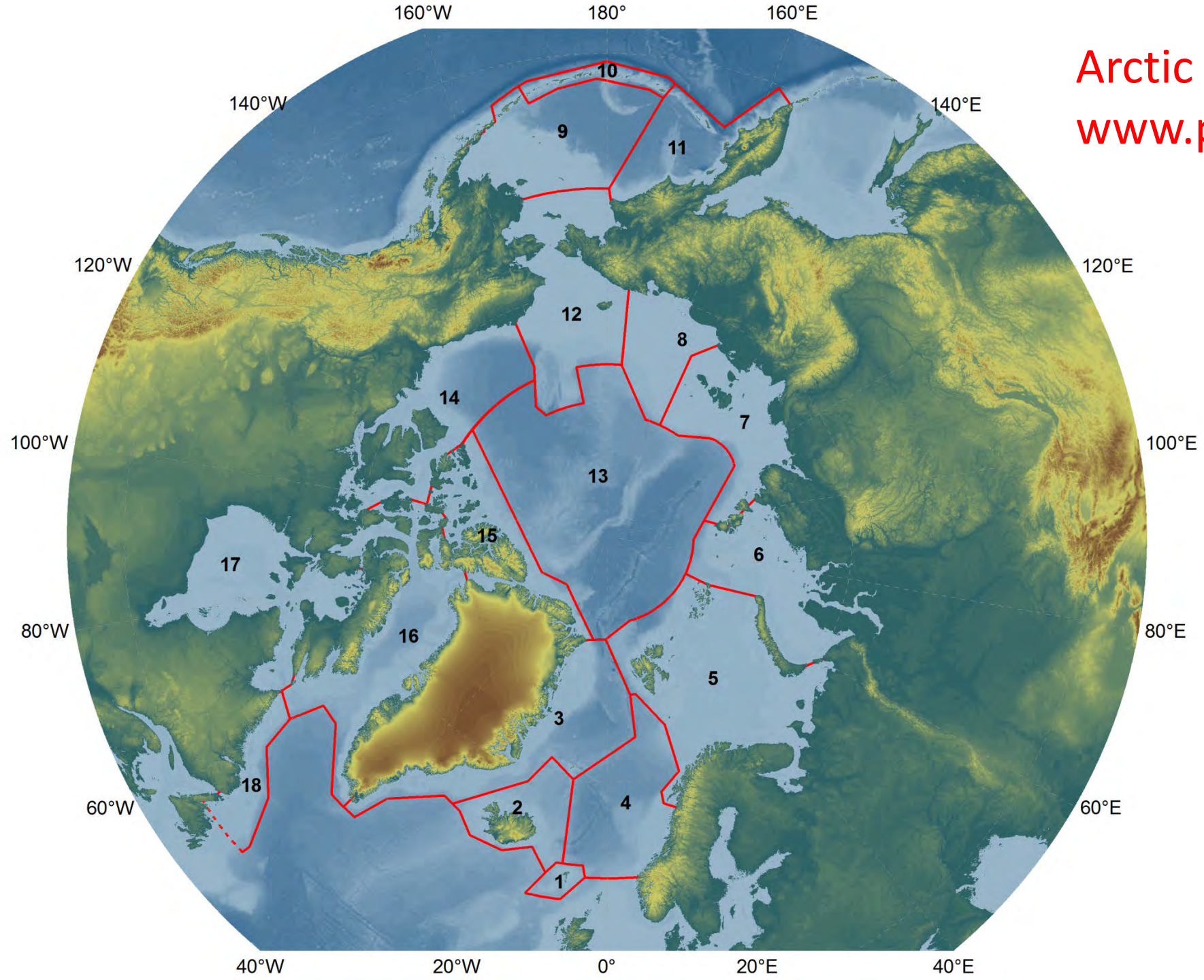


Integrated Ecosystem Assessment Groups in ICES

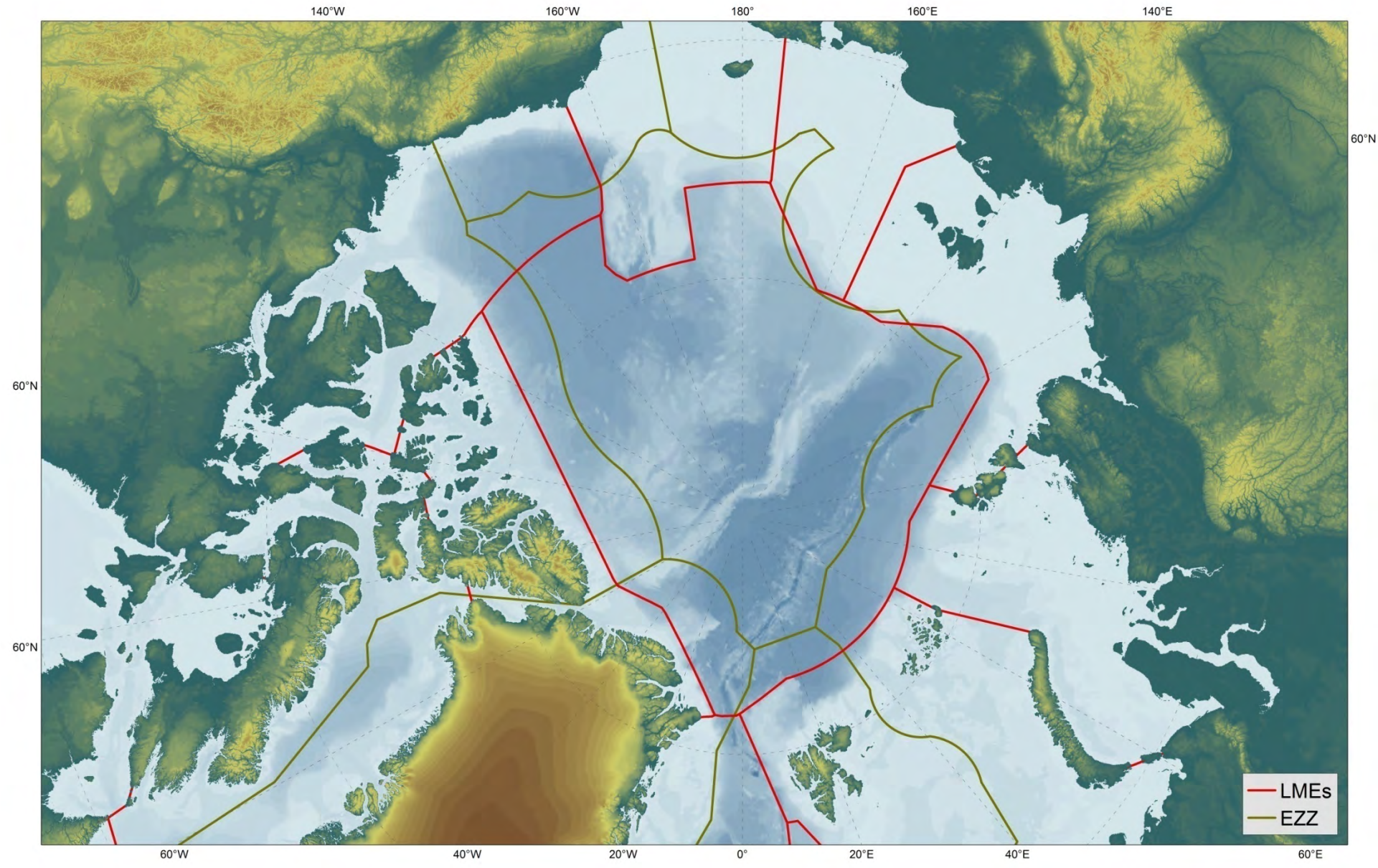


# IEA report for the CAO

- **Integrated Ecosystem Assessment of the Central Arctic Ocean: Ecosystem Description and Vulnerability Characterization**
- Ecosystem description with emphasis on **spatial aspects** and trophic (**food-web**) connections
- Oceanography, plankton, ice biota, benthos, fish, birds and marine mammals
- Vulnerability
  - general aspects (concepts, terminology, methodology)
  - Initial considerations of vulnerability to human activities – climate, pollution, fisheries,
  - **Shipping**



Arctic LMEs  
[www.pame.is](http://www.pame.is)





# Water masses – 4 vertical layers

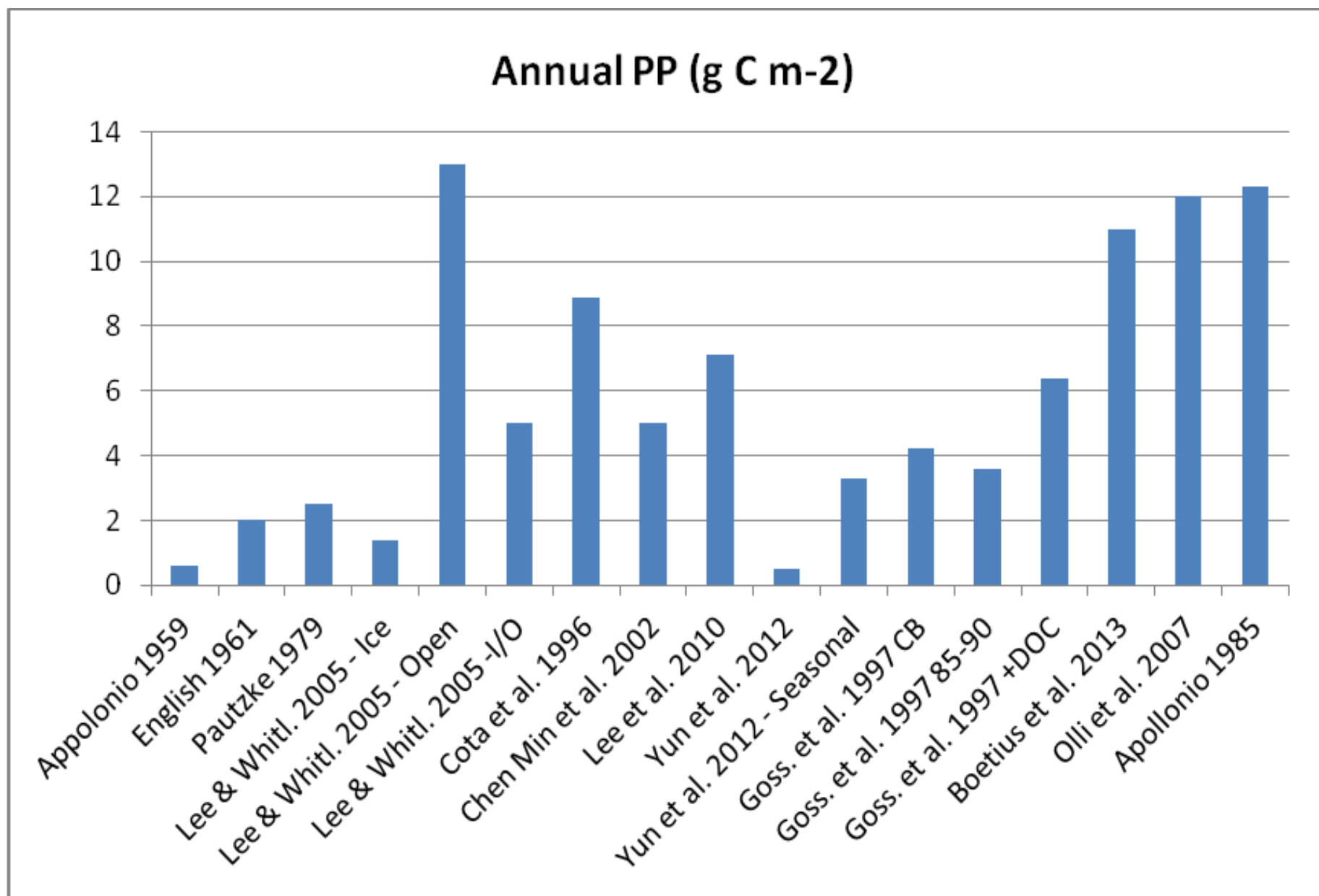
- **Top layer** (ca 50 m)
  - Seasonal dynamics – sea ice formation and melting
- **Gradient layer** (**cold halocline**) – ca 50-200 m
  - Atlantic and Pacific origins
- **Atlantic layer** – ca 200-1000 m
  - Two branches – Fram Strait and Barents
- **Deep layer** - >1.000 m

# Circulation and ice drift

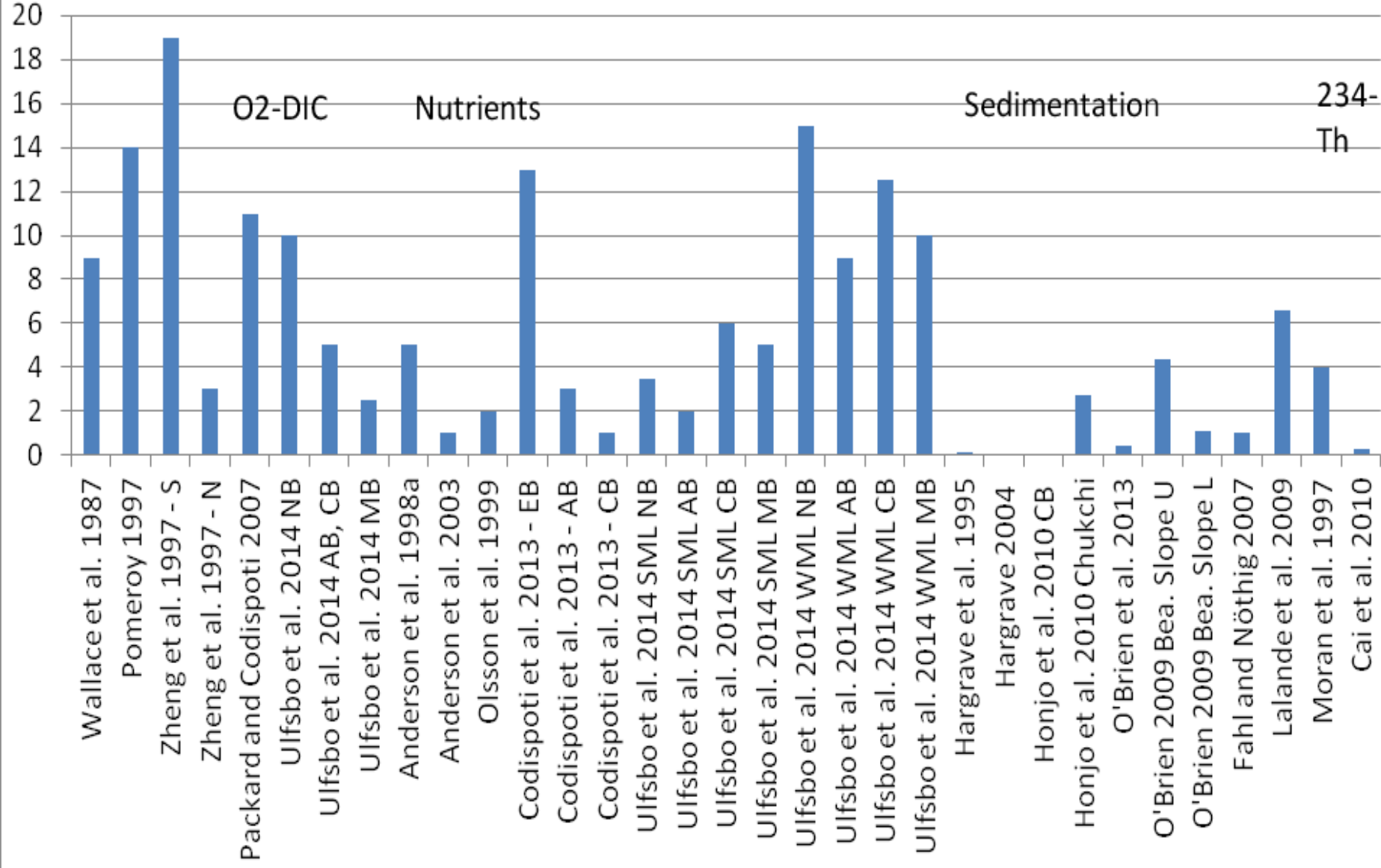
- Top layer
  - Beaufort Gyre
  - Trans-Polar Drift
- Halocline
  - Origin and spread of **Atlantic water**
  - Spread of **Pacific winter and summer water**
- Atlantic layer
  - Counter-clockwise
  - Circulation cells in basins
  - Pathways for **Fram Strait and Barents branches**

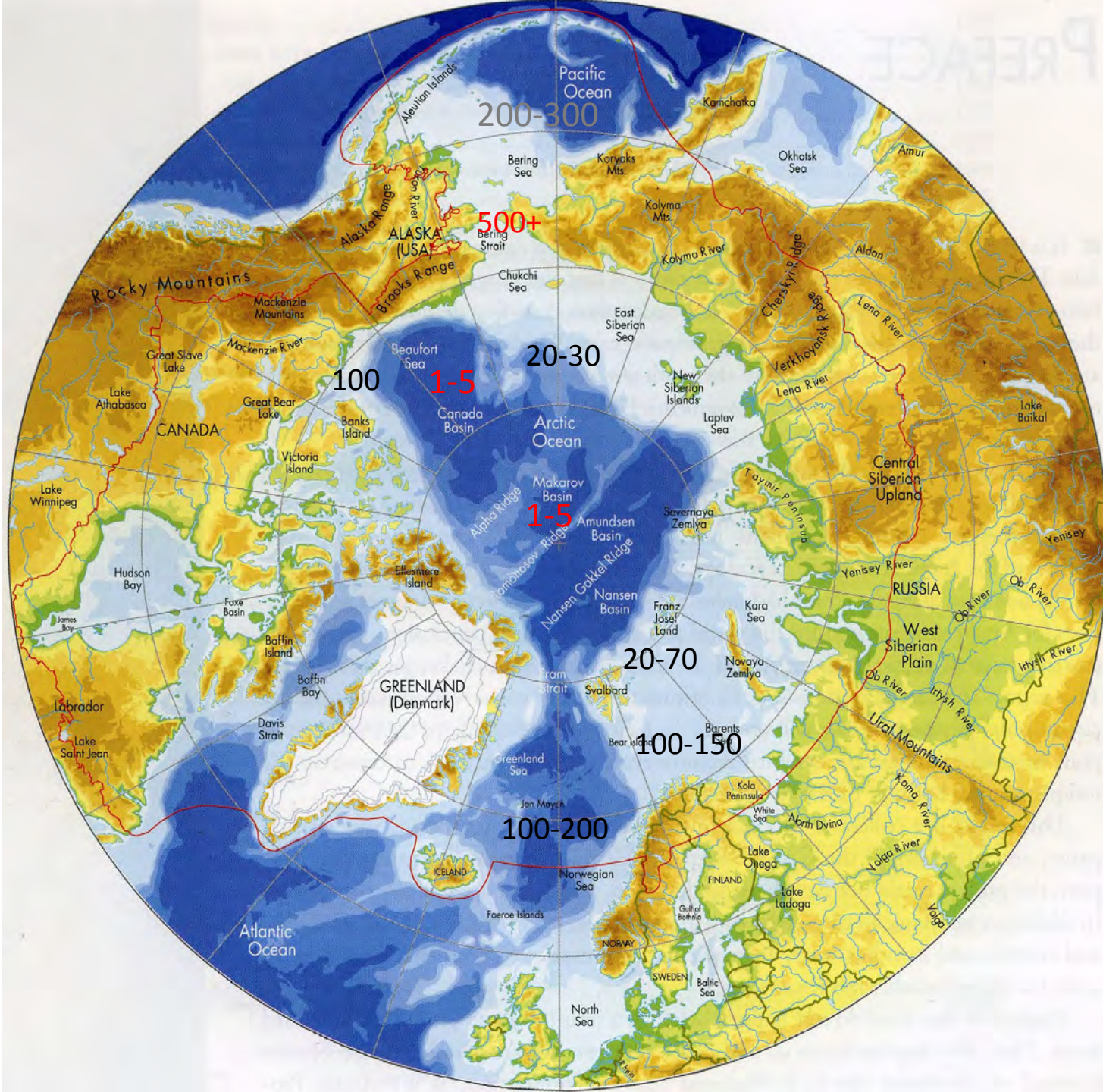
# Primary production by phytoplankton and ice algae

- **Light limitation** due to sea ice and high latitude, also **CDOM**
- **Nutrient limitation** (Nitrogen) due to strong vertical stratification – low replenishment, low winter values
- Phytoplankton dominated by small flagellates (and centric diatoms)
- Ice algae dominated by pennate diatoms
- Level of primary production is generally low
- **Microbial loop** – bacteria, heterotrophic flagellates and dinoflagellates, protozoans, small copepods, a.o.



## Annual PP (g C m<sup>-2</sup> y<sup>-1</sup>)

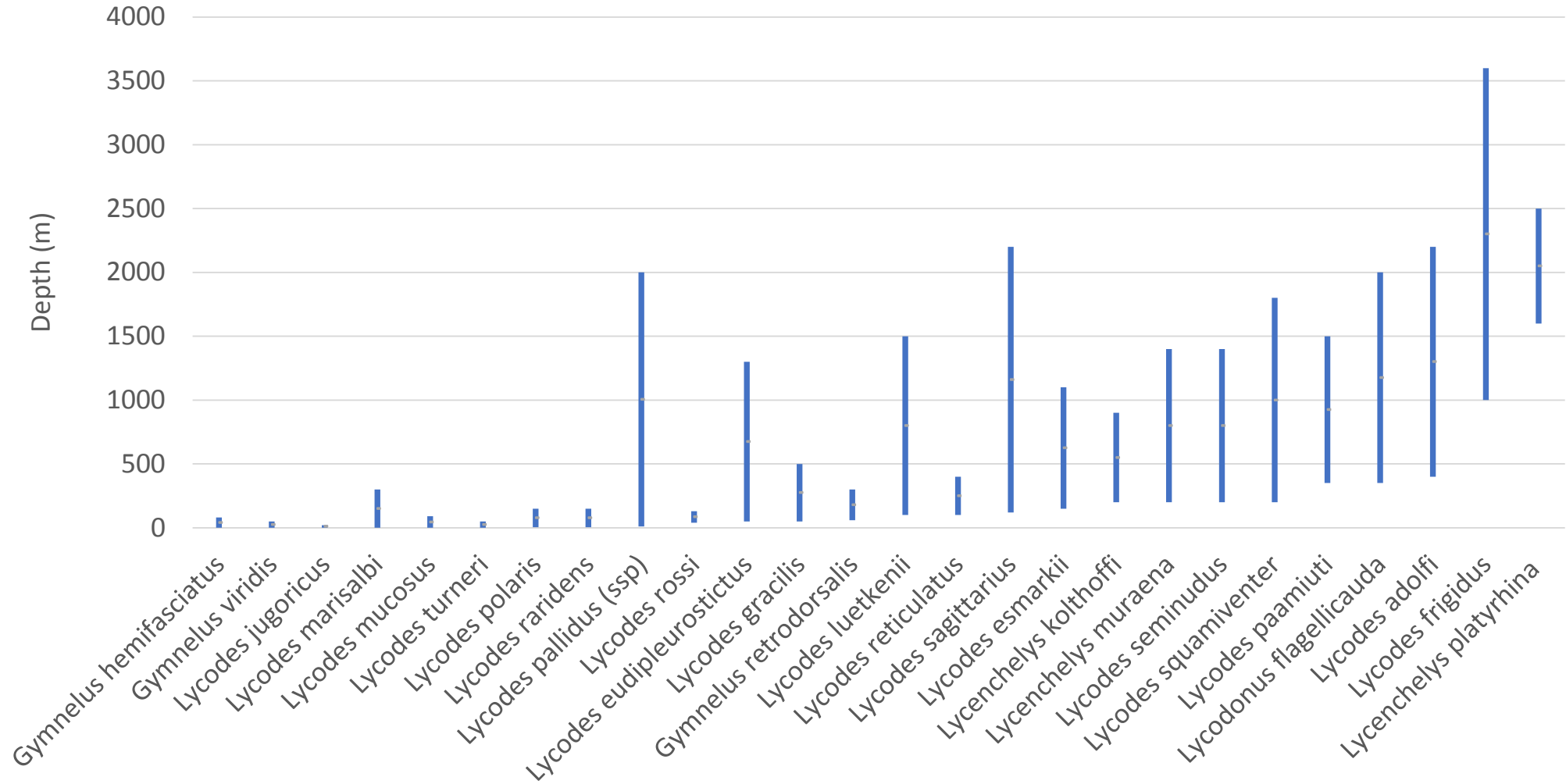




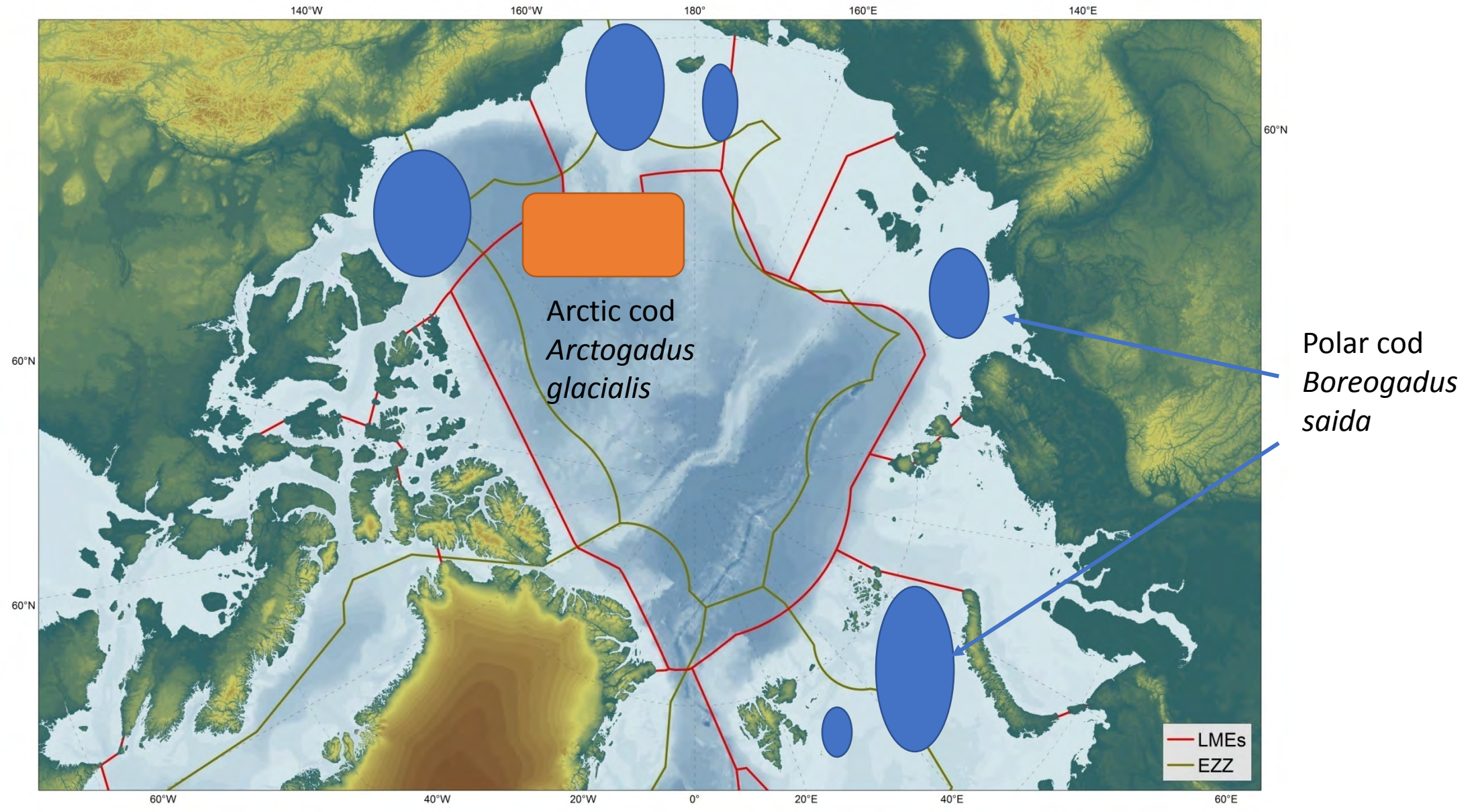
# Zooplankton and sea ice amphipods

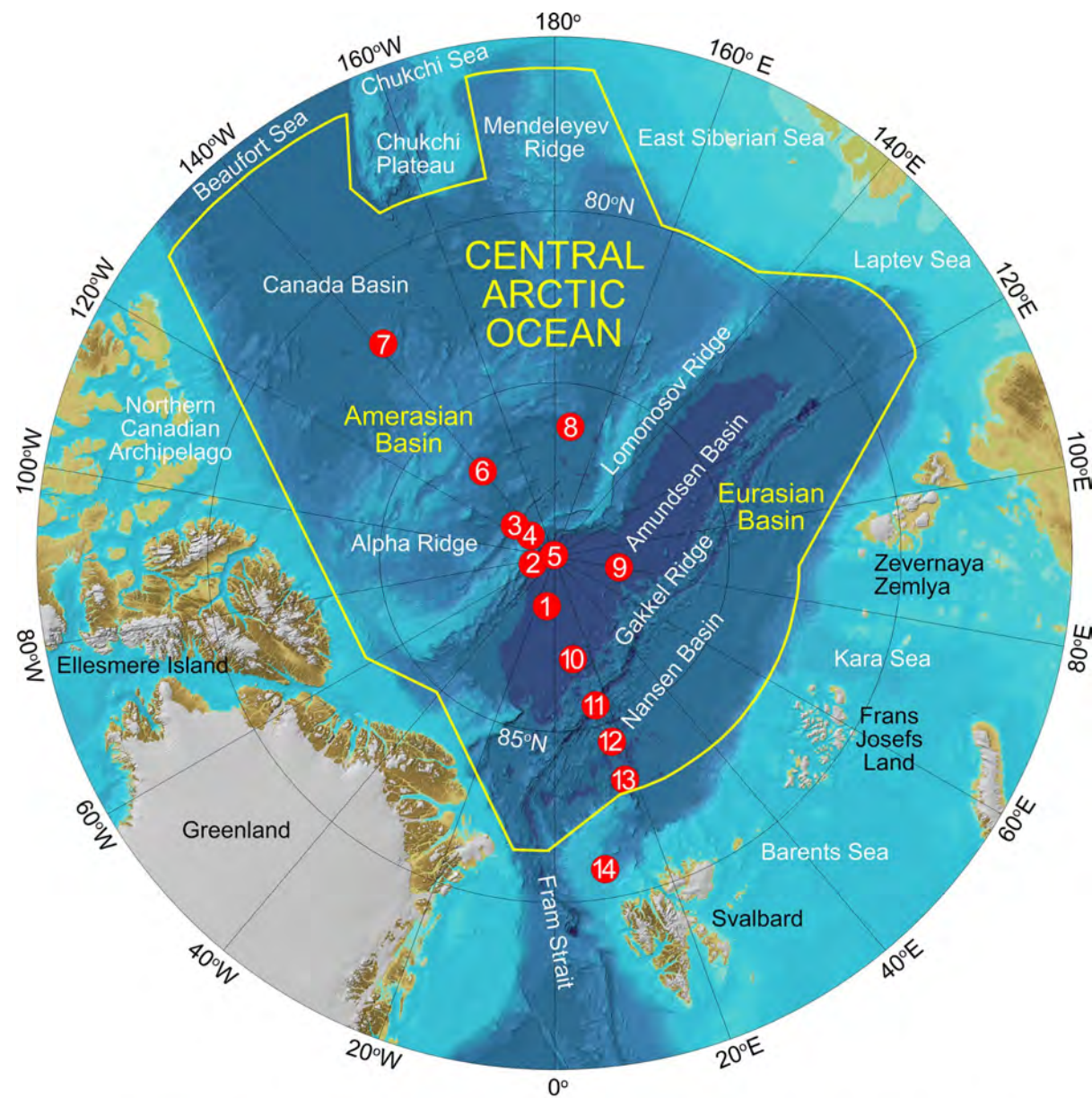
- Four dominant 'herbivorous' copepods – *Calanus hyperboreus*, *C. glacialis*, *Meridia longa* and *C. finmarchicus*
- Smaller copepods are omnivores – *Oithona*, *Microcalanus*
- Limited reproduction by the herbivores – 4 hotspots?
- Ice amphipods live associated with the underside of the ice – mainly omnivores. Over-summering, colonization of new ice
- Expatriates from the Pacific side – *Neocalanus*, *Eucalanus bungeii*, *Metridia pacifica*
- *Themisto libellula* – ecological equivalent of pelagic fish??

## Eelpouts - Lycodidae









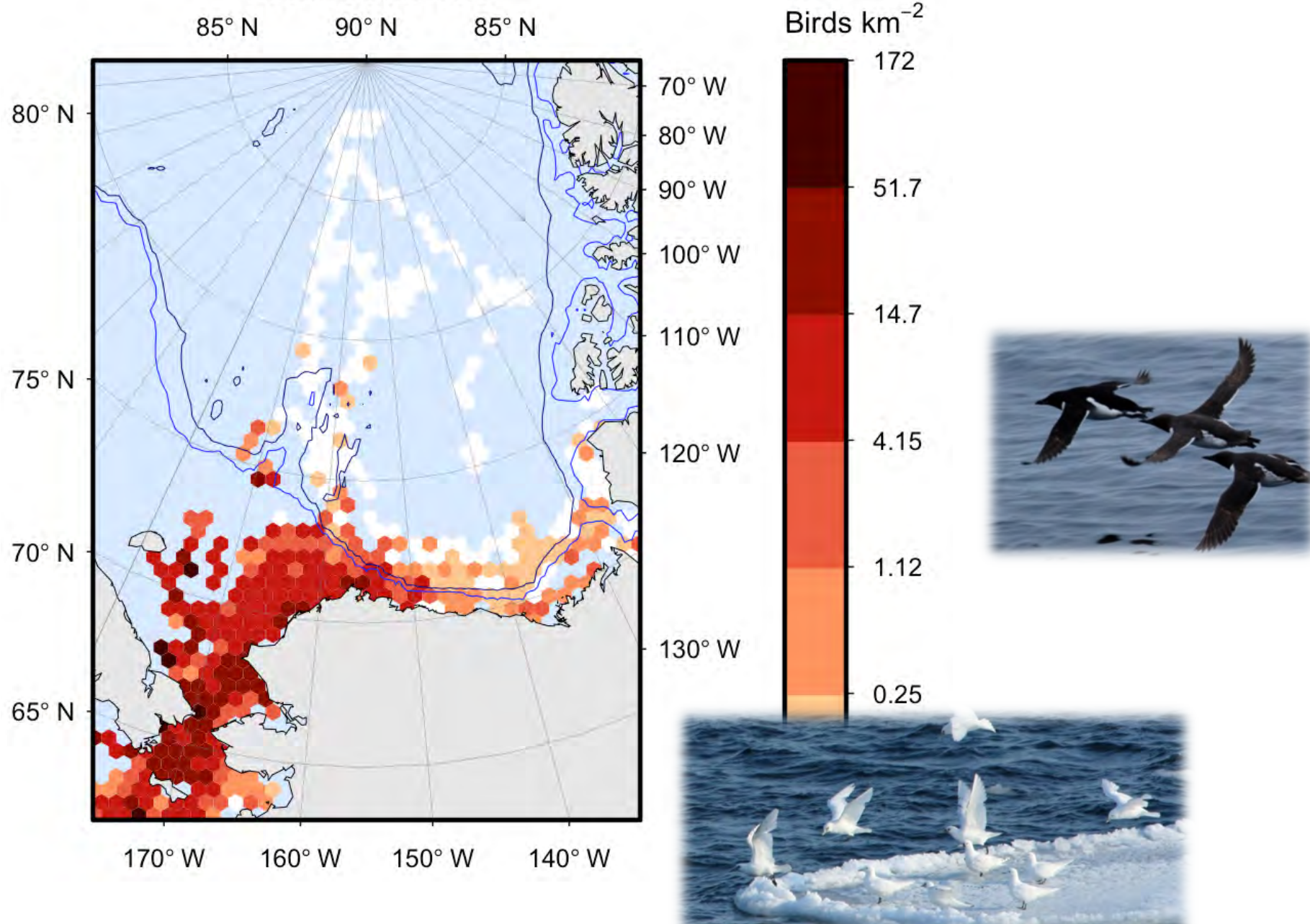
Swedish ice-breaker  
 'Oden', 2016 cruise

Pauline S. Lejonmalm  
 et al. - manuscript

Bathymetric and topographic colours indicate meters above and below Mean Sea Level



# Total seabirds



USFWS survey data, 2006-2017 (Kuletz, unpubl data); maps by D. Cushing

