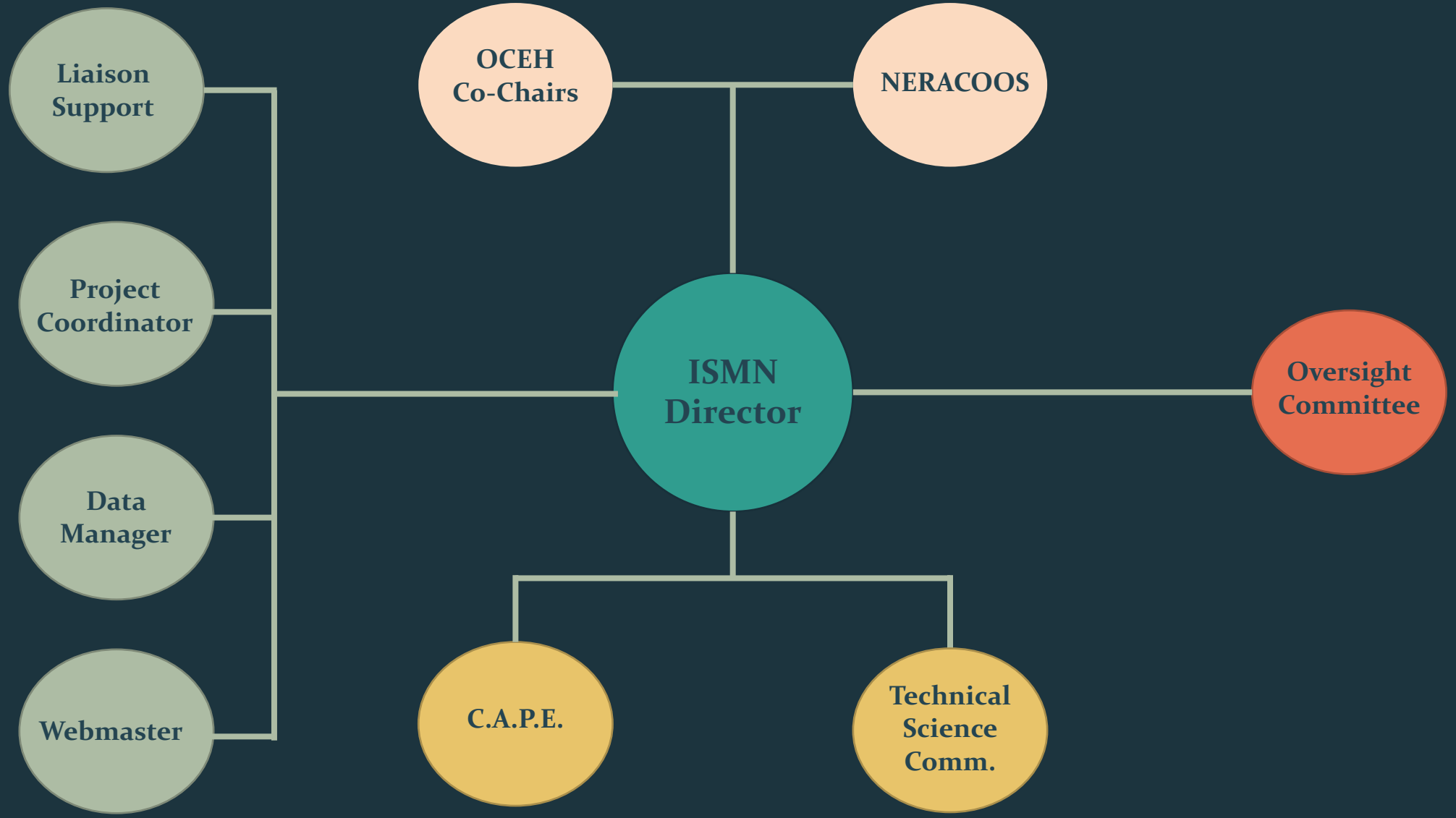
Regional Infrastructure to Facilitate Observing Change in NE Regional Ecosystems



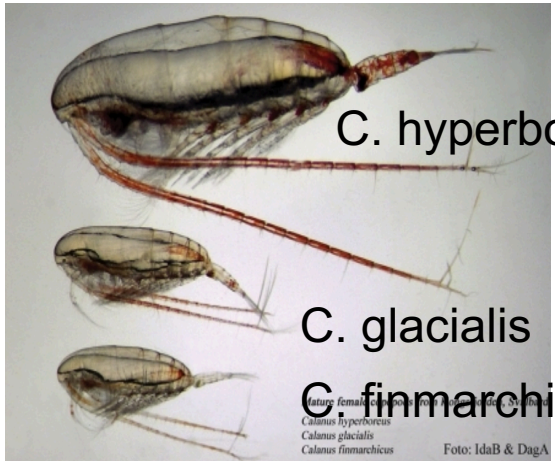
What is happening in the oceanography that is shifting the distribution of animals?

(An example of how ISMN could work)

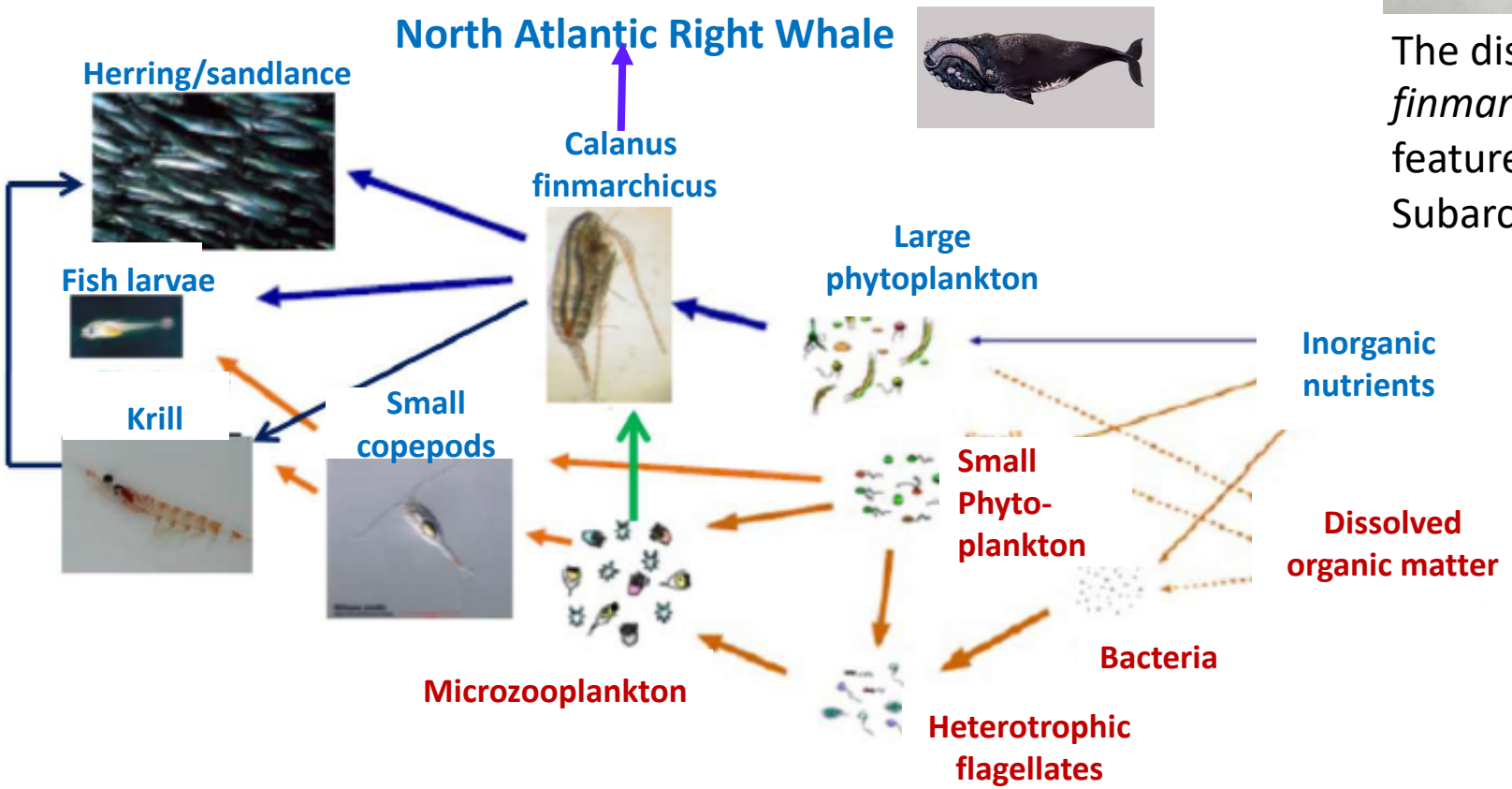
Definition of a sentinel variable:

- **hypothesis-based** variable informing predictions of responses to environmental pressures
- **key ecosystem properties** that are known to be fundamental to ecosystem structure and function, without necessarily understanding the mechanisms or impacts of change (i.e., covering for the unexpected)

The pelagic Gulf of Maine ecosystem lies at the southern margin of the North Atlantic Subarctic Biome

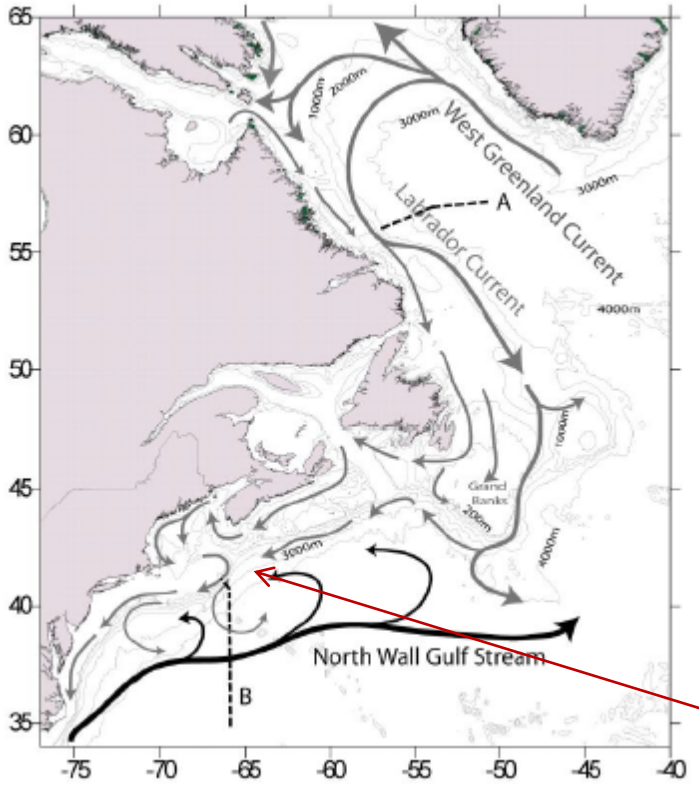


The distribution of *Calanus finmarchicus* is a characteristic feature of the North Atlantic Subarctic Biome



The Gulf of Maine food web (simplified here) lies at the southern margin of the subarctic North Atlantic Biome

Warmer water and shifting *Calanus* abundance in the Gulf of Maine



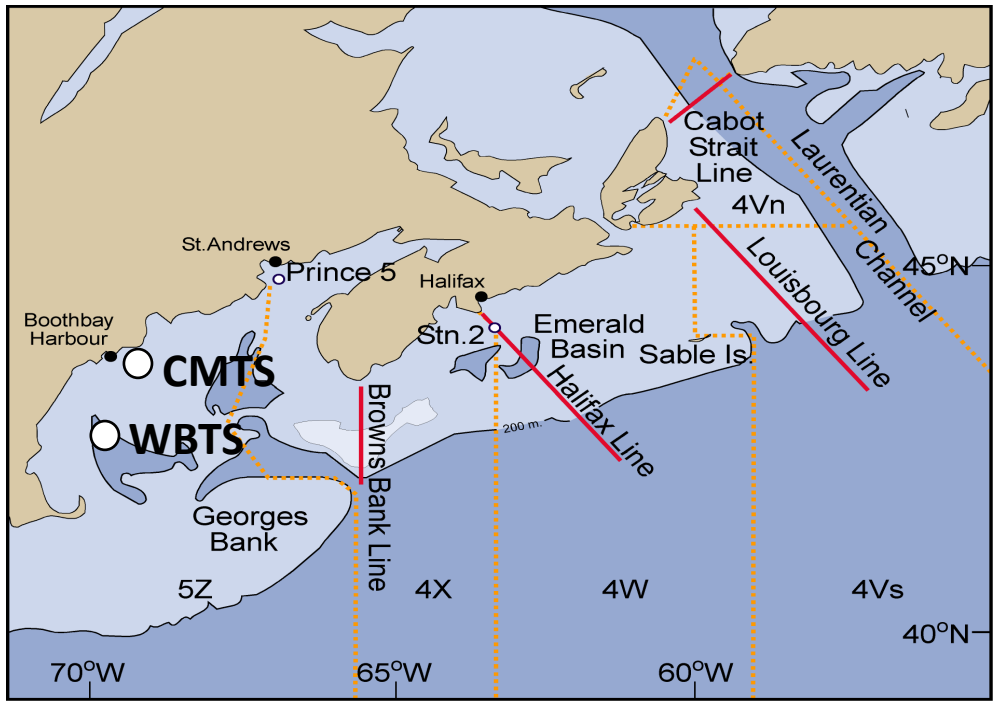
1. Warmer and saltier water in the eastern Gulf of Maine, linked to weakening of AMOC and northward shift of Gulf Stream
2. Transport into Gulf of Maine previously from the *Calanus*-rich Scotian Shelf, now more from the *Calanus*- poor Atlantic slope water off the Northeast Channel
3. North Atlantic Right Whales respond to lower *Calanus* concentrations by shifting foraging areas more to the Gulf of St. Lawrence

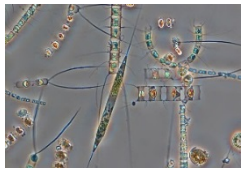
North Atlantic Temperate Water enters Gulf of Maine through the Northeast Channel

Record, N.R., J.A. Runge, D.E. Pendleton, W.M. Balch, K.T.A. Davies, A.J. Pershing, C.L. Johnson, K. Stamieszkin, R. Ji, Z. Feng, S.D. Kraus, R.D. Kenney, C.A. Hudak, C.A. Mayo, C. Chen, J.E. Salisbury, and C.R.S. Thompson. 2019. Rapid climate-driven circulation changes threaten conservation of endangered North Atlantic right whales. *Oceanography* 32(2)

ISMN fills a sampling gap and integrates multiple data sets to predict future NARW foraging distributions

- Monthly sampling at CMTS and WBTS
  - Strategically placed to capture phenology for dynamic modeling of Calanus
  - Suite of biodiversity estimates, from eDNA to euphausids and jellyfish to observe phenology and ecosystem change
  - Complements Canada Atlantic Zone Monitoring Program (AZMP) and NOAA ECOMON surveys
- Management of multiple data sets
- CAPE project: Integration with coupled b-p models to predict spatial landscape of Cfin (lipid) concentration and NARW foraging distribution



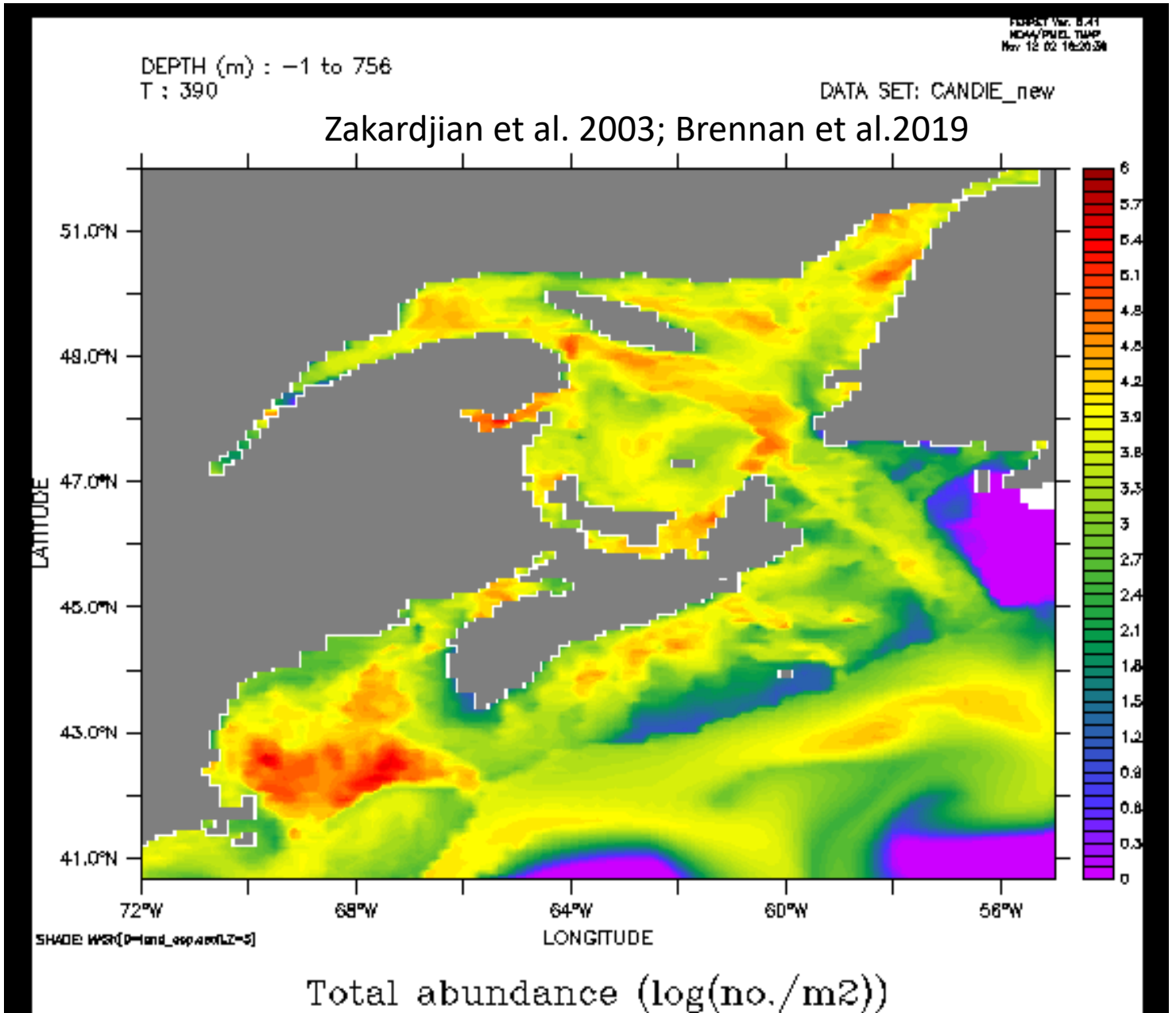


Microplankton, especially diatoms

Calanus finmarchicus

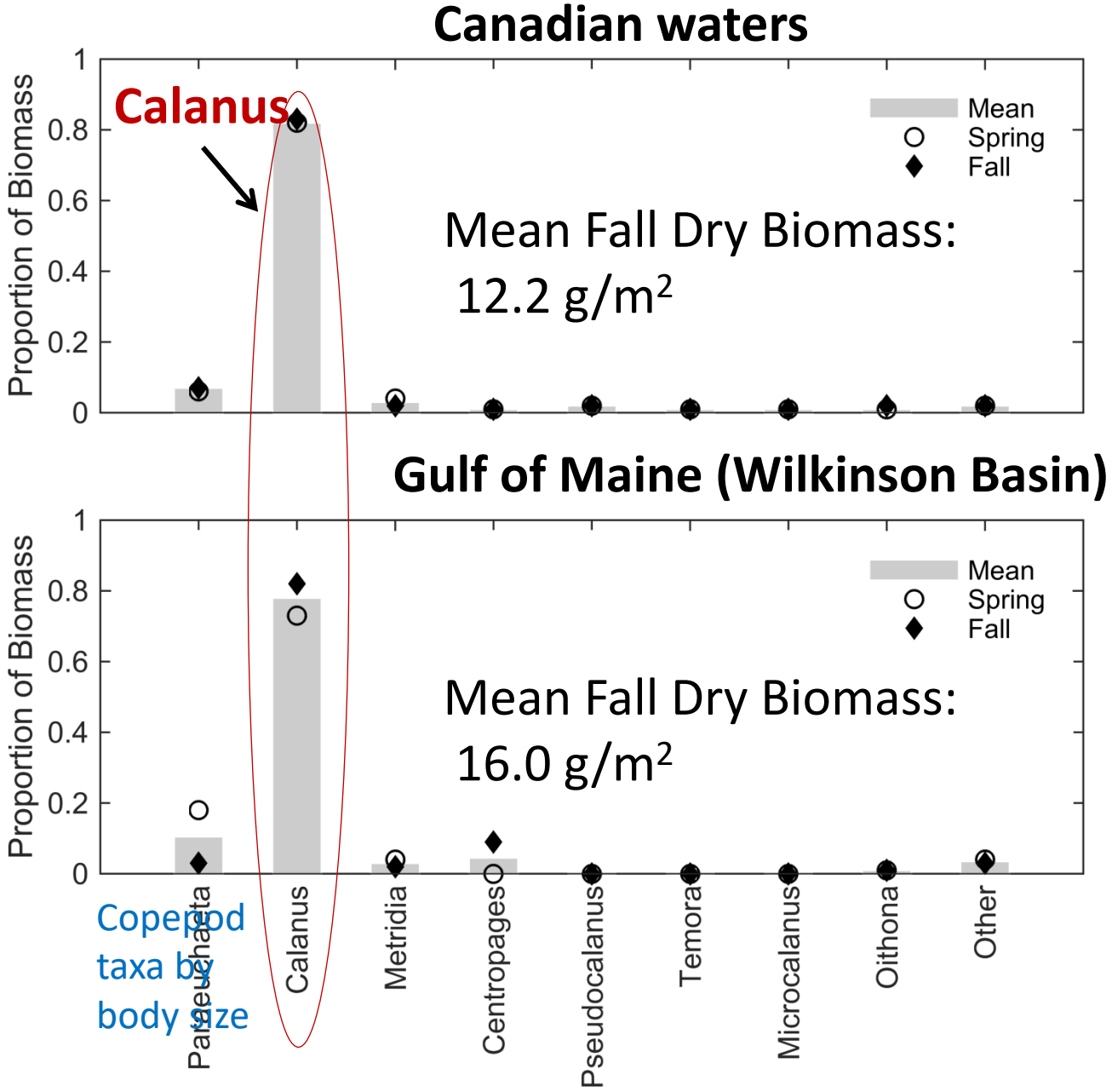
Eubalaena glacialis

Coupled physical biological modeling of *C. finmarchicus* distribution



- Parameterization of *C. finmarchicus* vital rates embedded in physical circulation model
- FVCOM model (NERACOOS support)
- Great strides in knowledge of *C. finmarchicus* vertical distribution and diapause behavior for modeling of planktonic lipidscape
- Collaboration with Canadian colleagues also working on *C. finmarchicus* and NARW foraging patterns

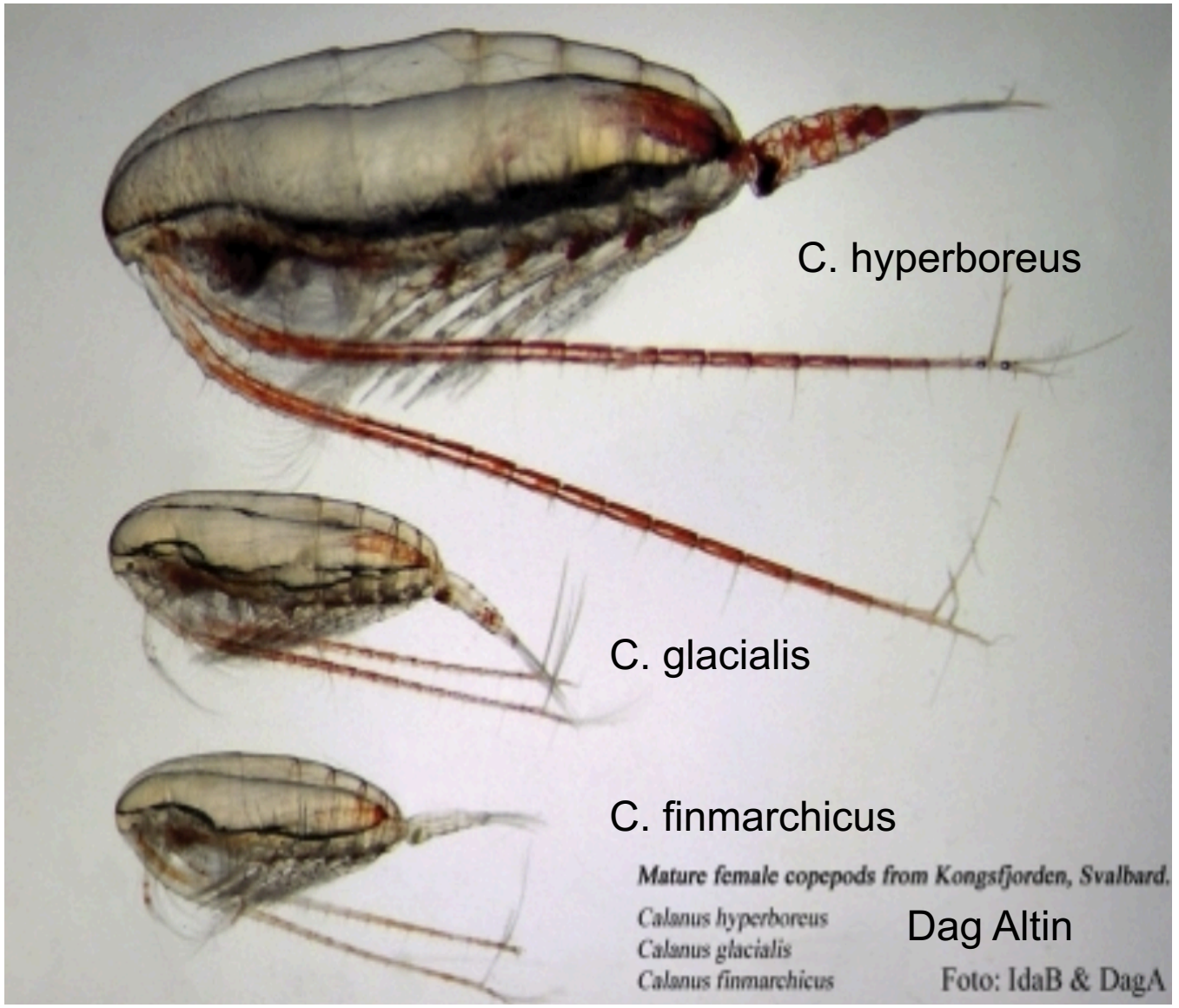
Copepod Biomass: Canada and GoM



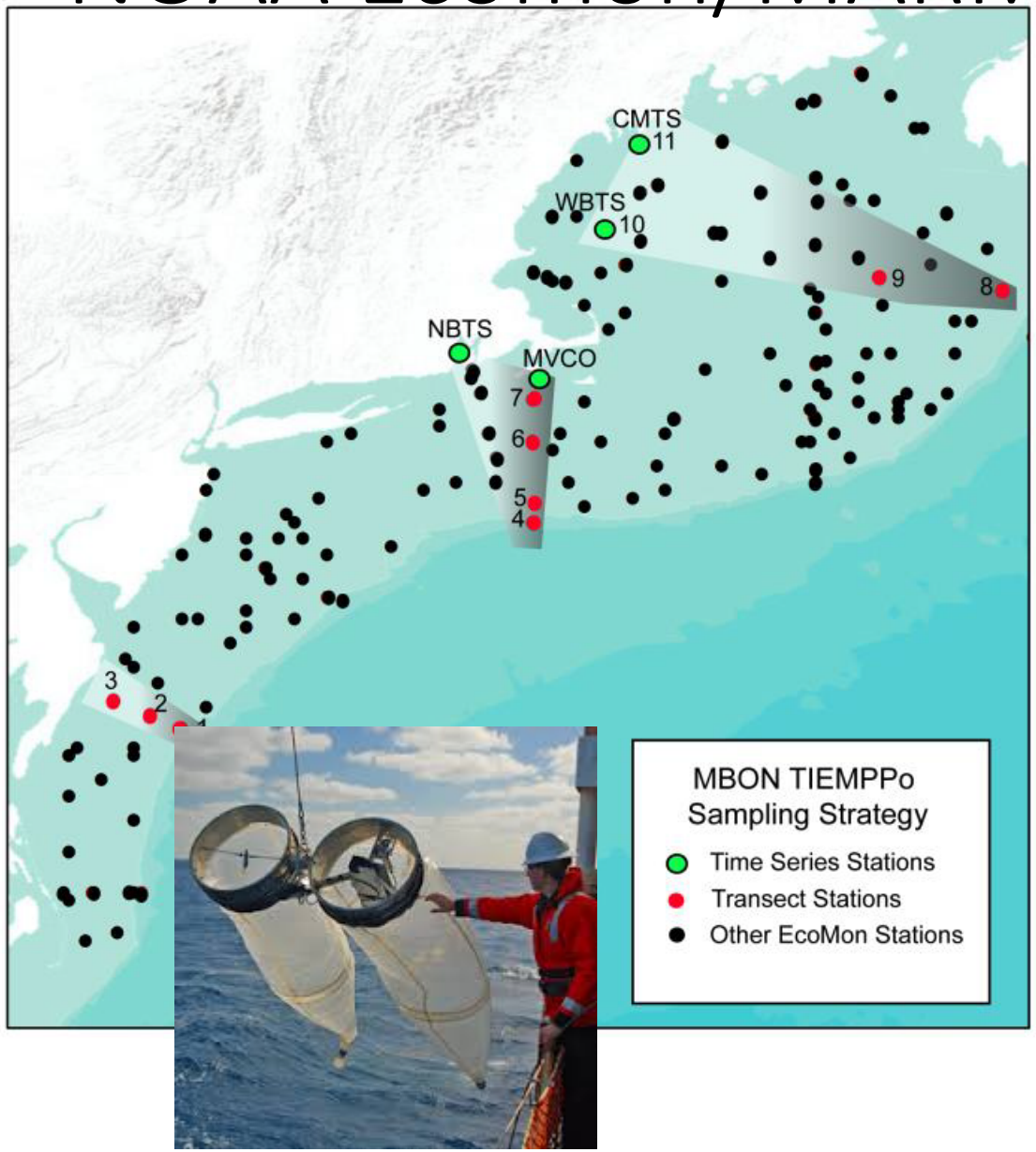
Atlantic Zone Monitoring Program
DFO Canada

Wilkinson Basin Time Series Station (WBTS)
Univ. Maine

C. Johnson ,BIO and J. Runge (unpubl)

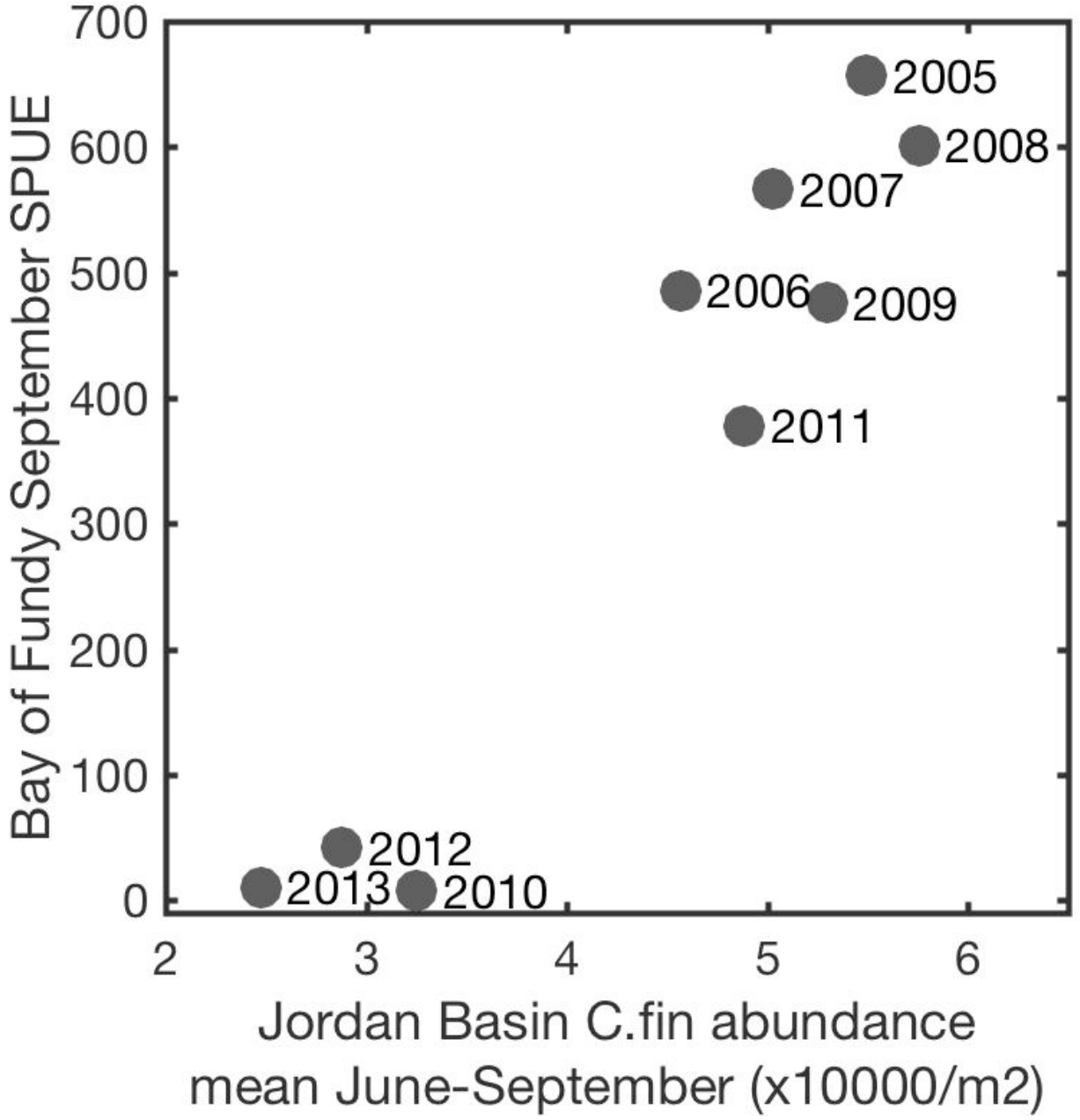

C. hyperboreus
C. glacialis
C. finmarchicus
Mature female copepods from Kongsfjorden, Svalbard.
Calanus hyperboreus
Calanus glacialis
Calanus finmarchicus
Dag Altin
Foto: IdaB & DagA

NOAA Ecomon/MARMAP surveys



Example annual survey station locations: Time series stations (not part of EcoMon) also shown

- Surveys since 1977
- Stratified random design: each year different
- Bongo net tows with 333µm mesh
- 4-6 surveys per year; now 2 surveys per year



Sightings of right whales (SPUE) in the Bay of Fundy way down since 2010, correlated with eGoM *C. finmarchicus* abundance

N. Record et al. submitted