Springtime Renewal of *Calanus glacialis* Populations in the Chukchi Sea

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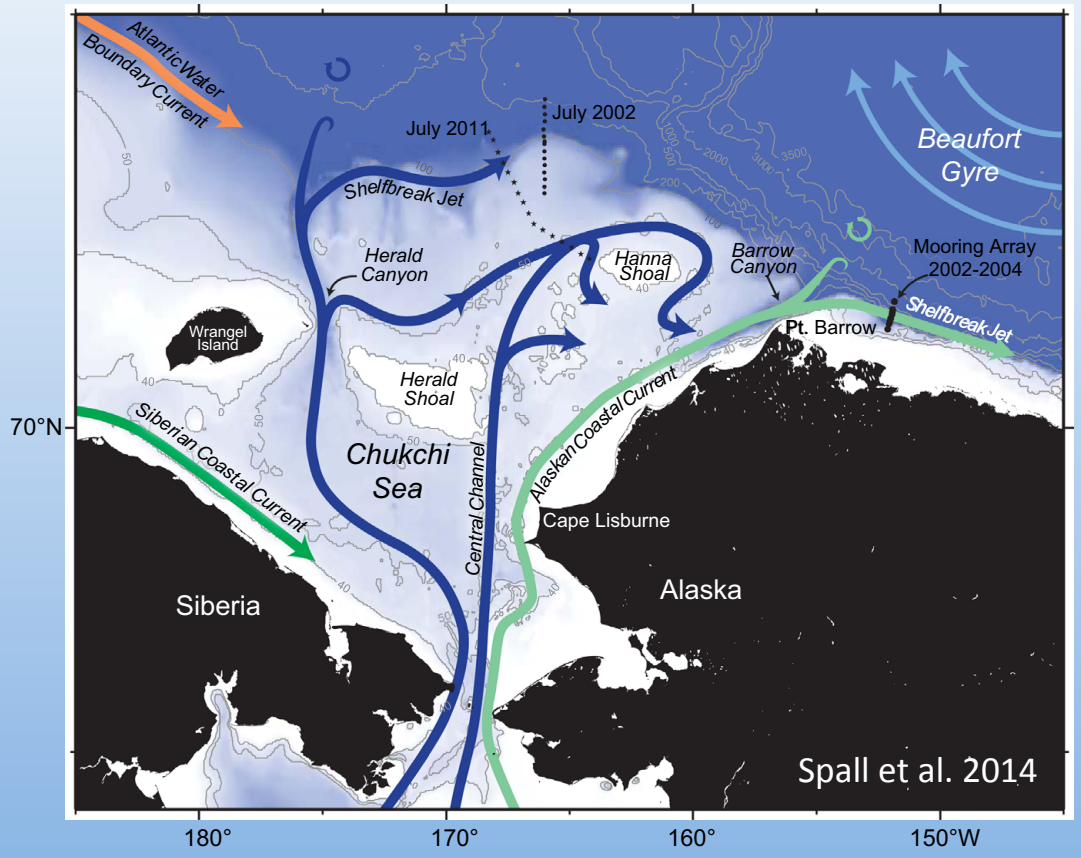
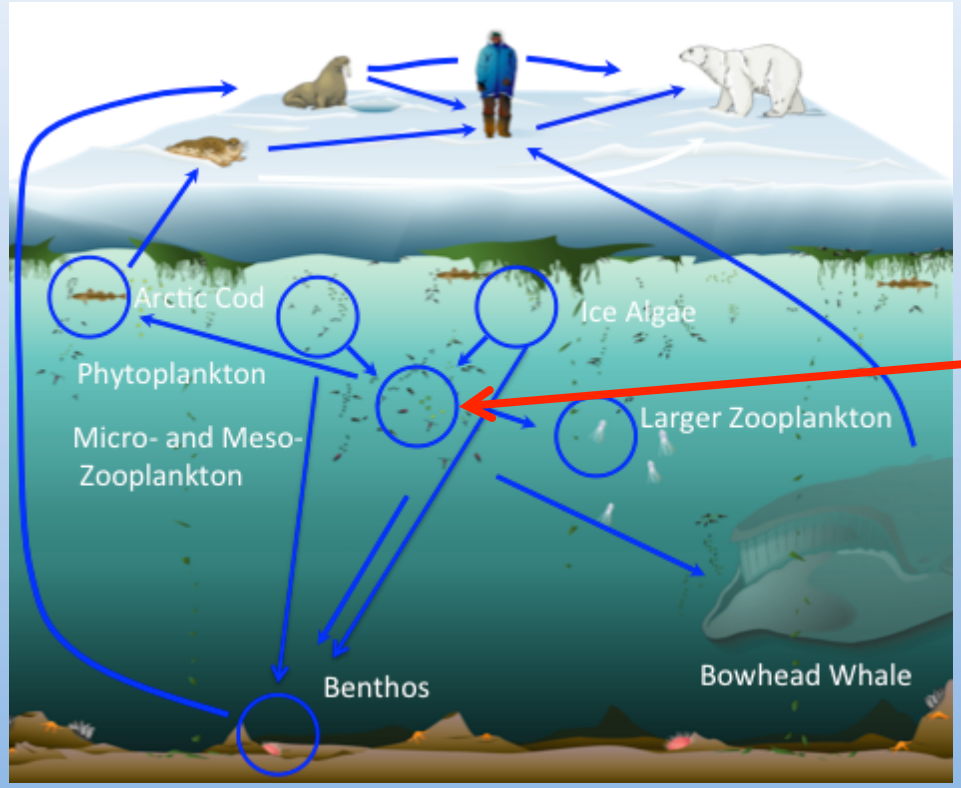
Chukchi Sea is a flow-through system and most plankton originate in Bering Sea



- Highly productive region
- High benthic biomass
- Zooplankton cannot eat all of the ice algal and phytoplankton 1° production

The large bodied, lipid rich copepod *Calanus glacialis/marshallae* is a prominent member of the Chukchi Sea plankton



C. glacialis/marshallae C5-C1

- Key link in Arctic food web, food for upper trophic levels such as whales, fish and birds
- Multi-year life history
- Overwinters as juvenile stage IV or V in Chukchi Sea, subsisting on stored lipid and by reducing metabolism

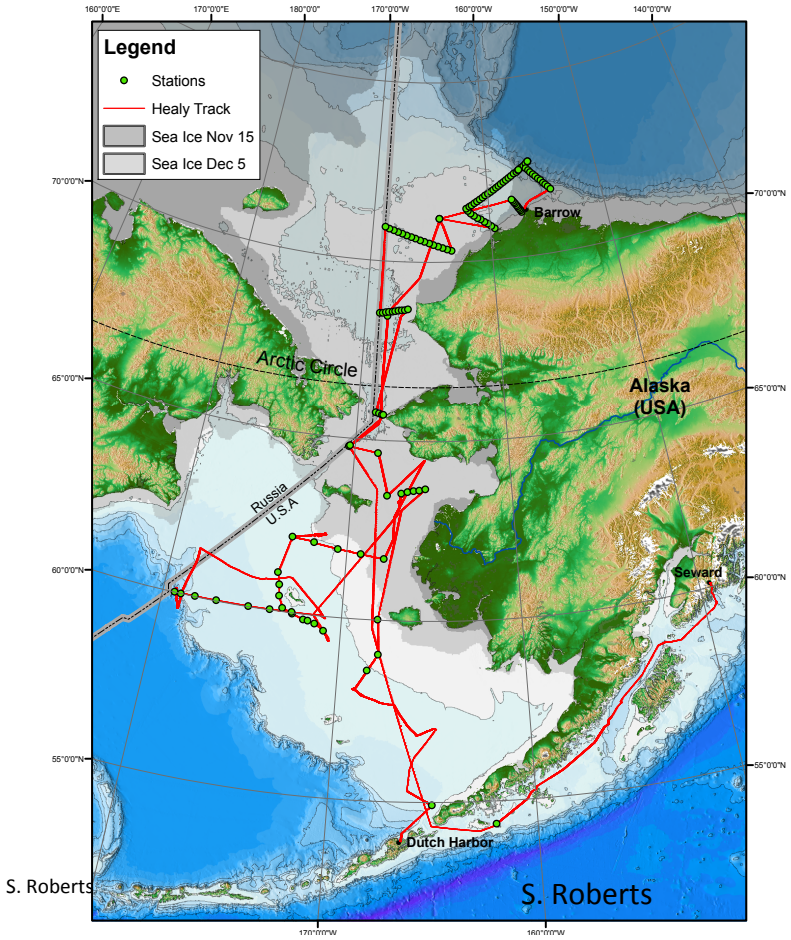
Questions

- Despite the high production of the Chukchi Sea, standing stocks and grazing impact on that PP of *C. glacialis* are relatively low

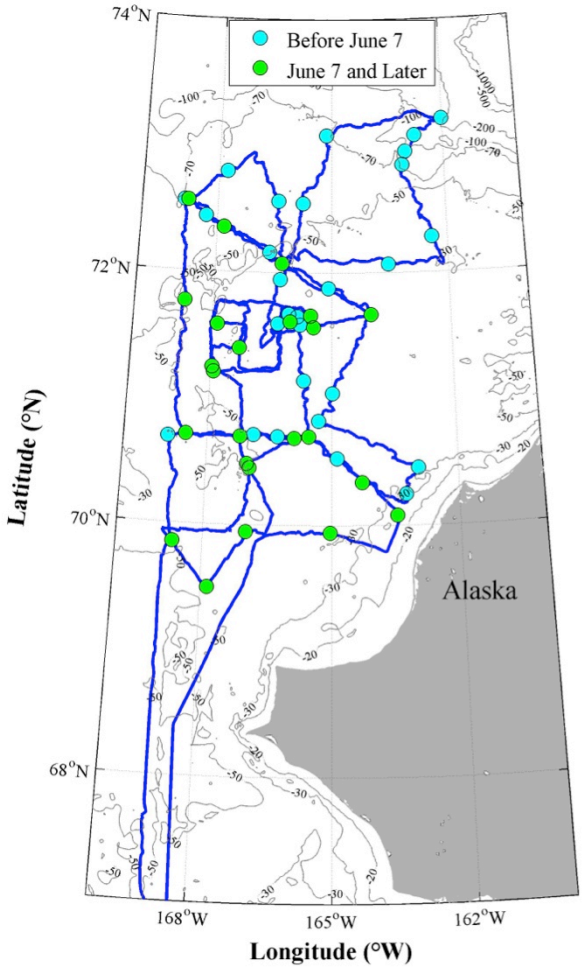
- Why are there not higher standing stocks?
- Can *C. glacialis* successfully overwinter (diapause) in the Chukchi Sea?

Distribution data collected during two cruises

Nov.-Dec. 2011



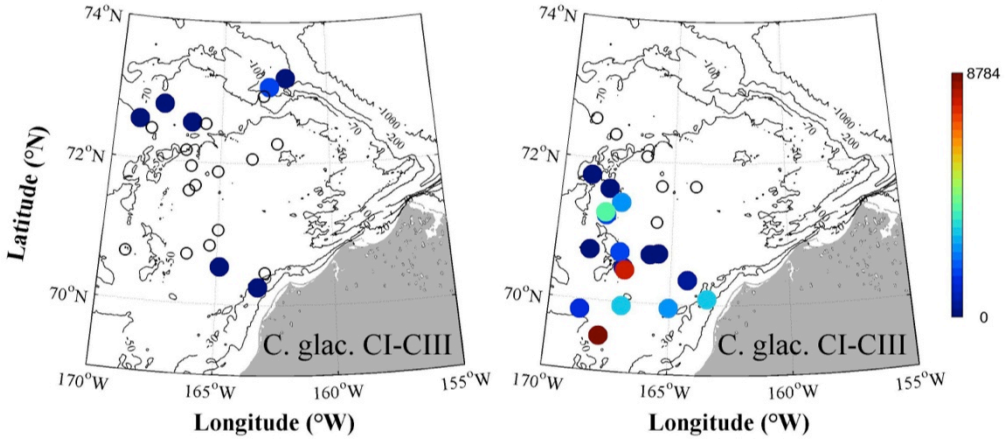
May-June 2014



Startling temporal and spatial patterns seen in spring

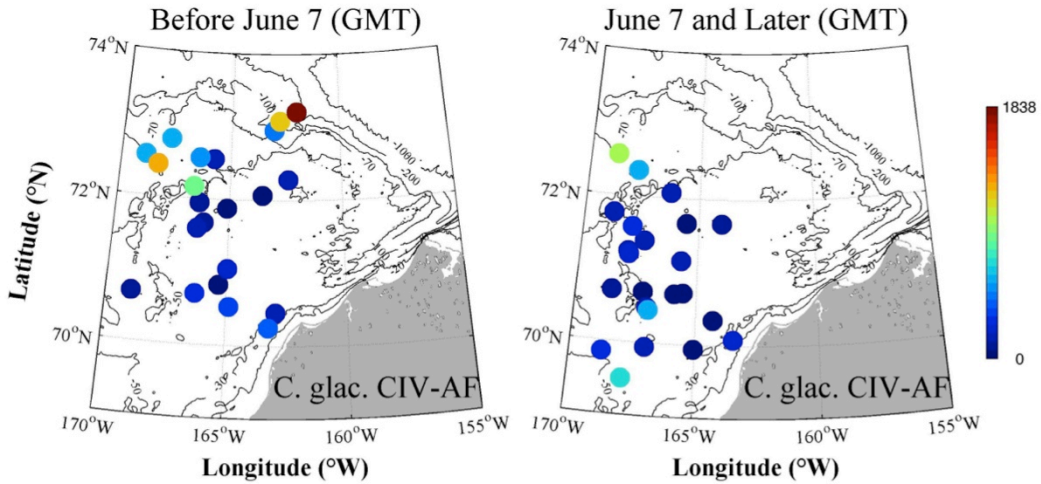
Early copepodid stages of *C. glacialis* much more abundant during second portion of cruise in southern part of study region

C. glacialis CI-CIII



Low abundance early
Much higher abundances late

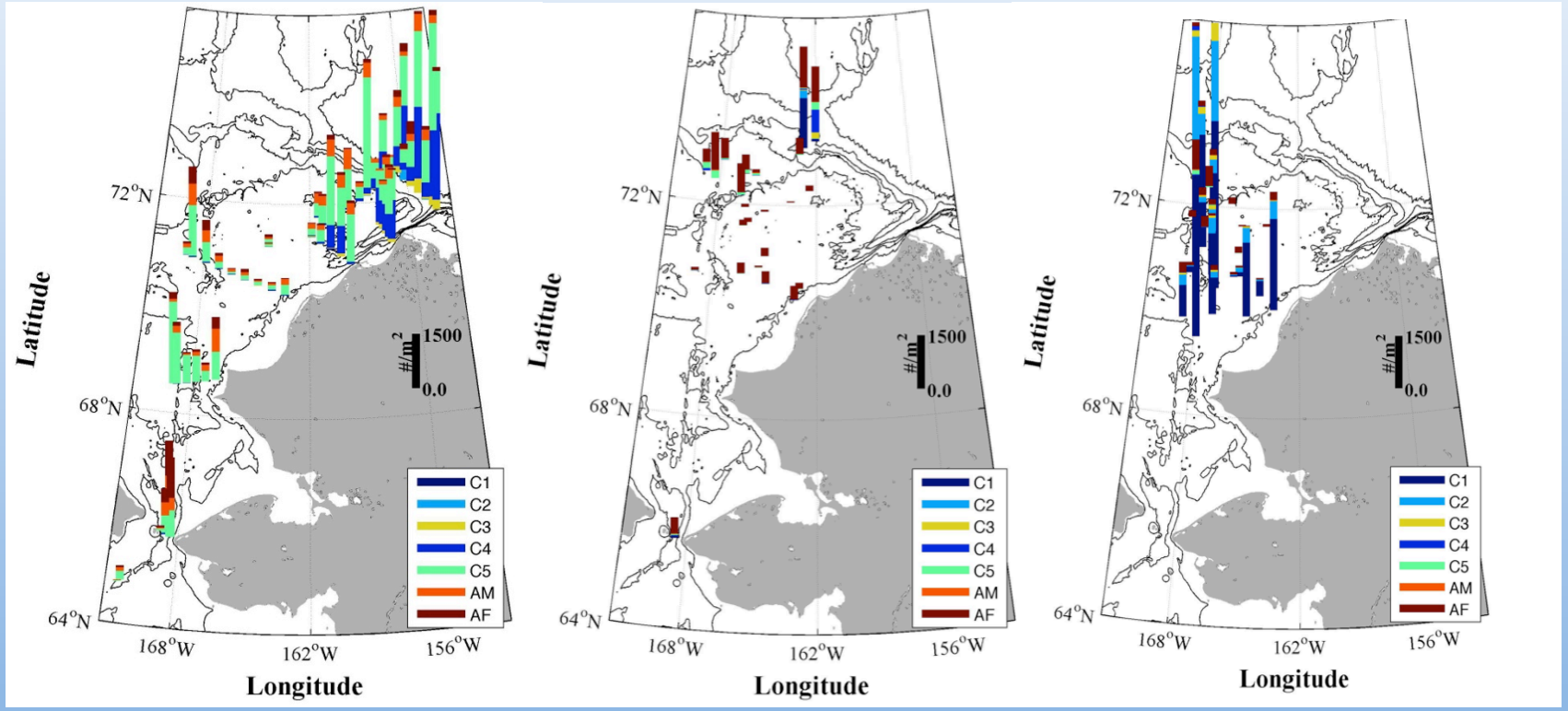
C. glacialis CIV-AF



Approximately equivalent abundances during both periods

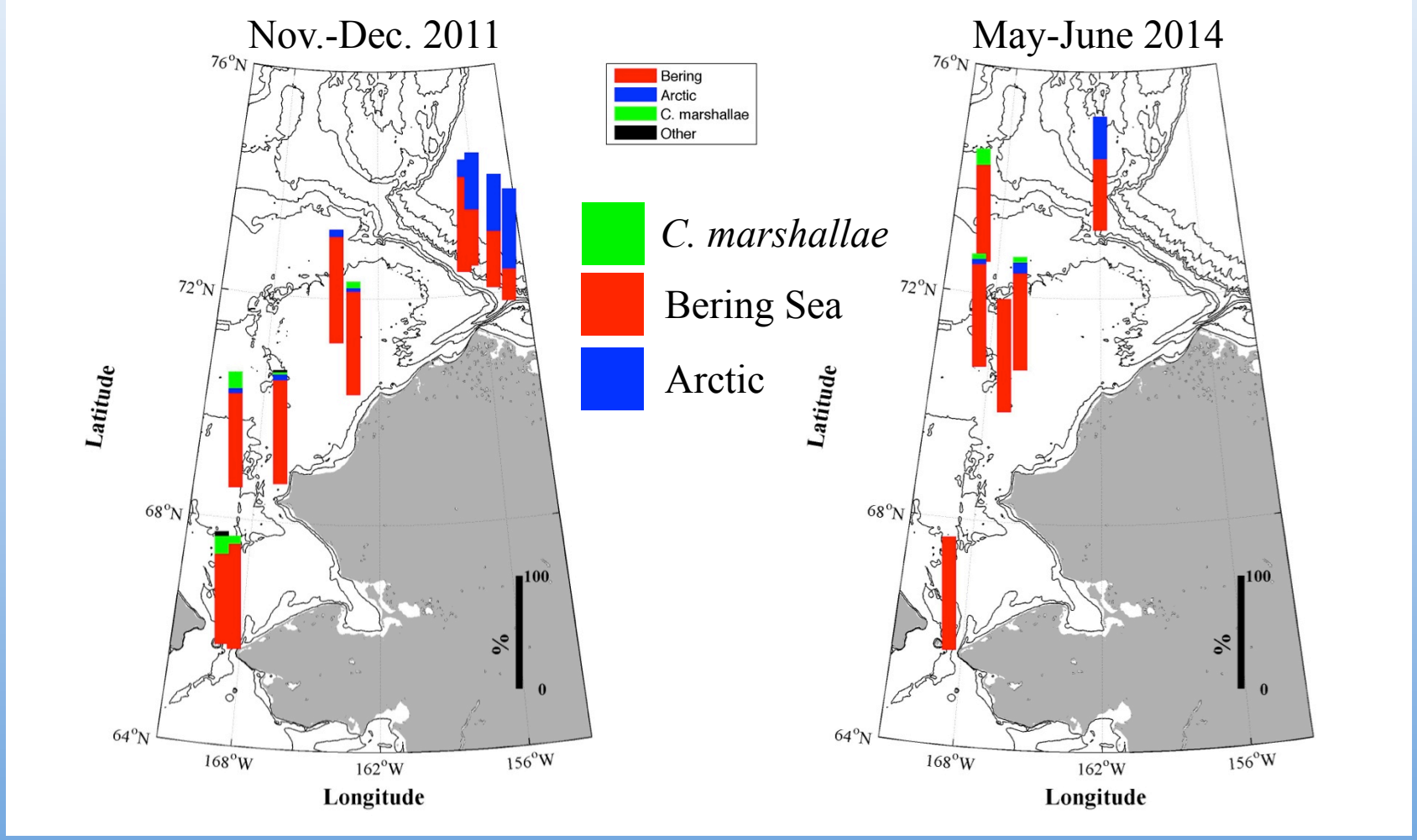
Most *Calanus g/m* in the Chukchi do not seem to successfully overwinter

November 2011 | May 17 – June 7, 2014 | June 7 - 19, 2014



- Two distinct populations, Bering/Chukchi and Arctic Basin, were seen in the northern Chukchi during both cruises based on population structure and genetics (not shown)

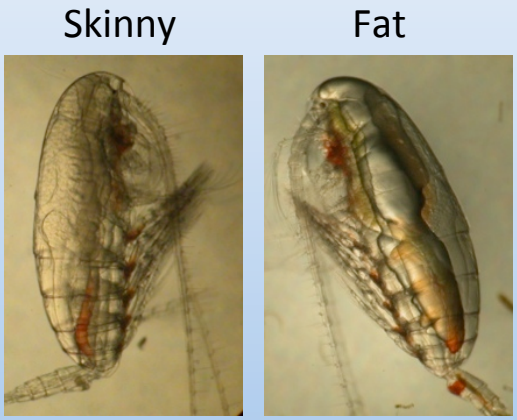
Genetics confirms northern locations contained Arctic populations and that Chukchi contained Bering Sea populations

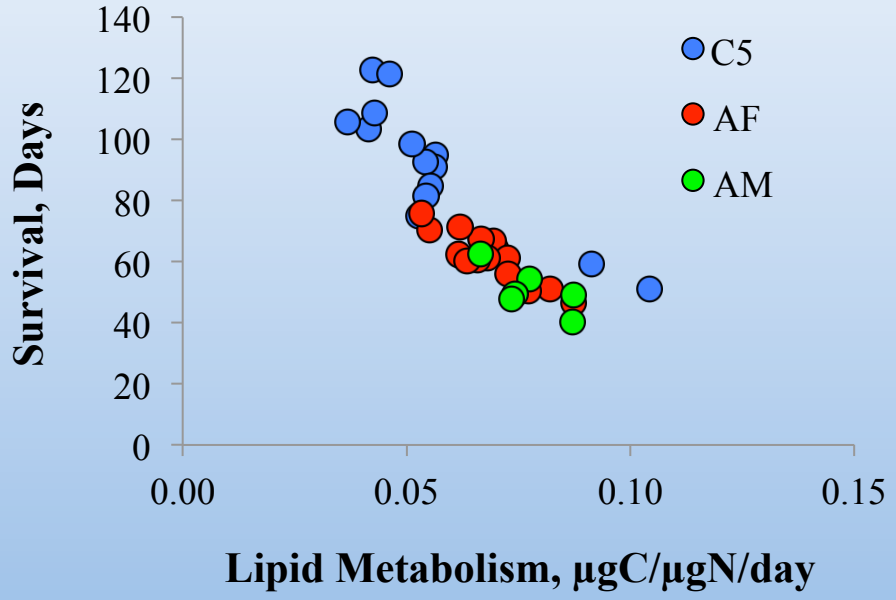


MtCOI haplotypes

Did the copepods die off or were they carried off of the shelf in currents over the winter?

Calanus utilizing stored lipid may not survive until spring

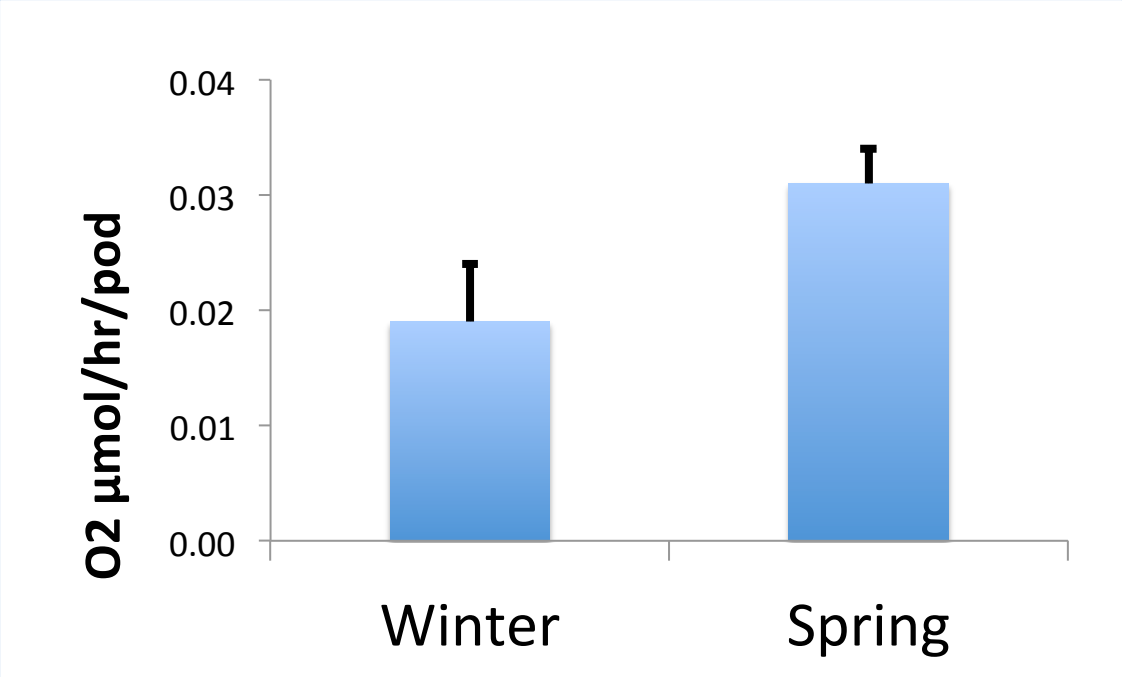


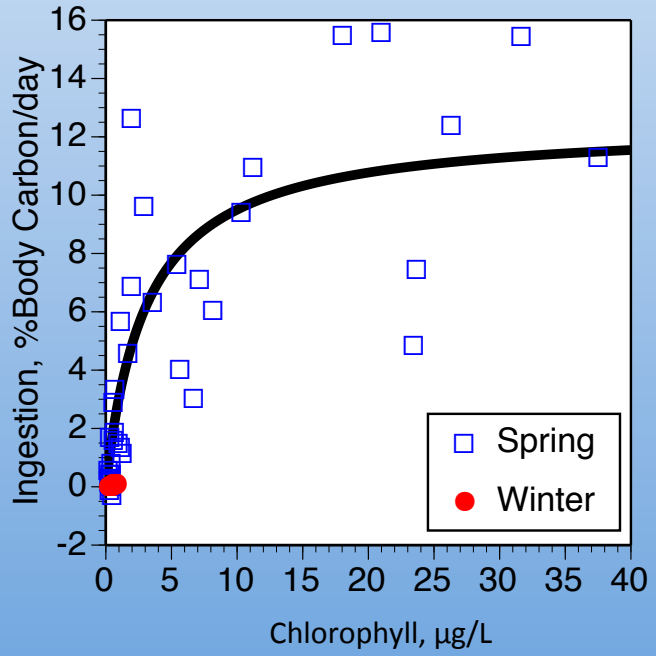


- Lipid metabolism rate in early winter (November) was estimated based on respiration experiments; survival time based on lipid metabolism rate and estimated lipid content
- The data show that survival time is at most 3-4 months for C5 and less for adults

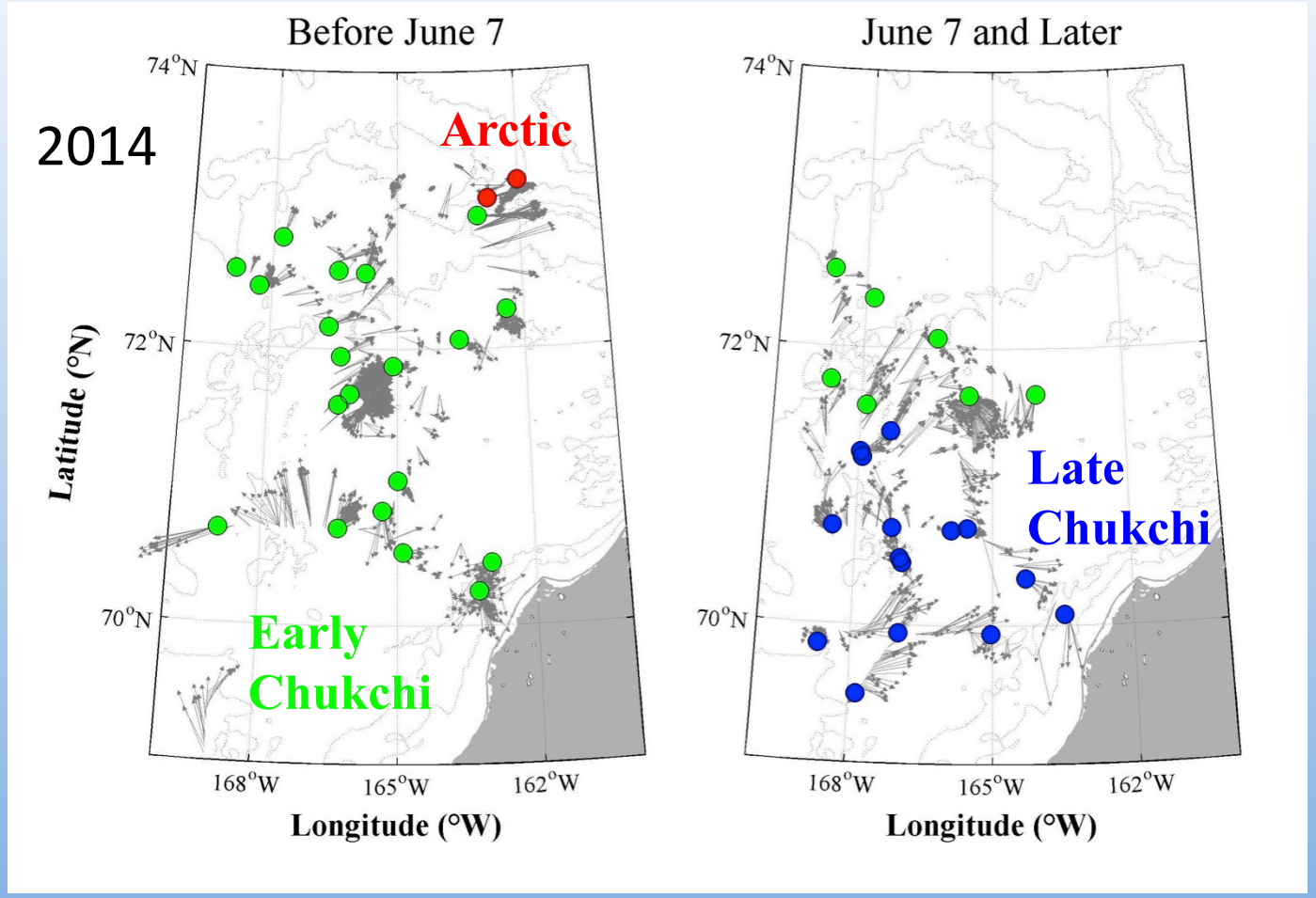
C. glacialis may be able to survive if metabolism is further reduced

- Early winter respiration of adult females was 2/3 that of spring
- *C. glacialis* was still grazing at very low but detectable rates in early winter



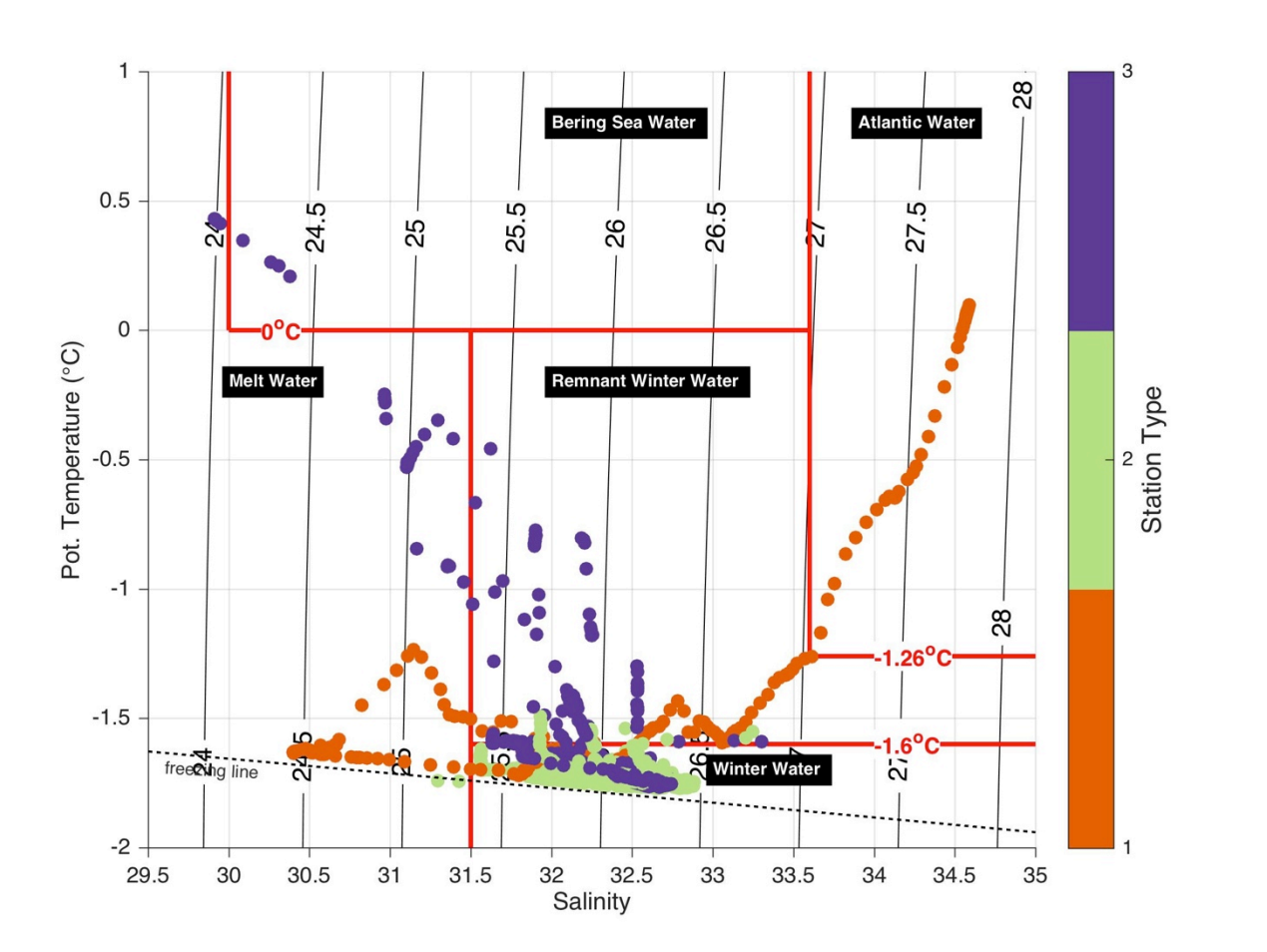


What about advection?



- Station groups separate out spatially and temporally
- Late Chukchi stations had young *C. glacialis*

“Late Chukchi” stations had warm Bering Sea Water, indicating inflow



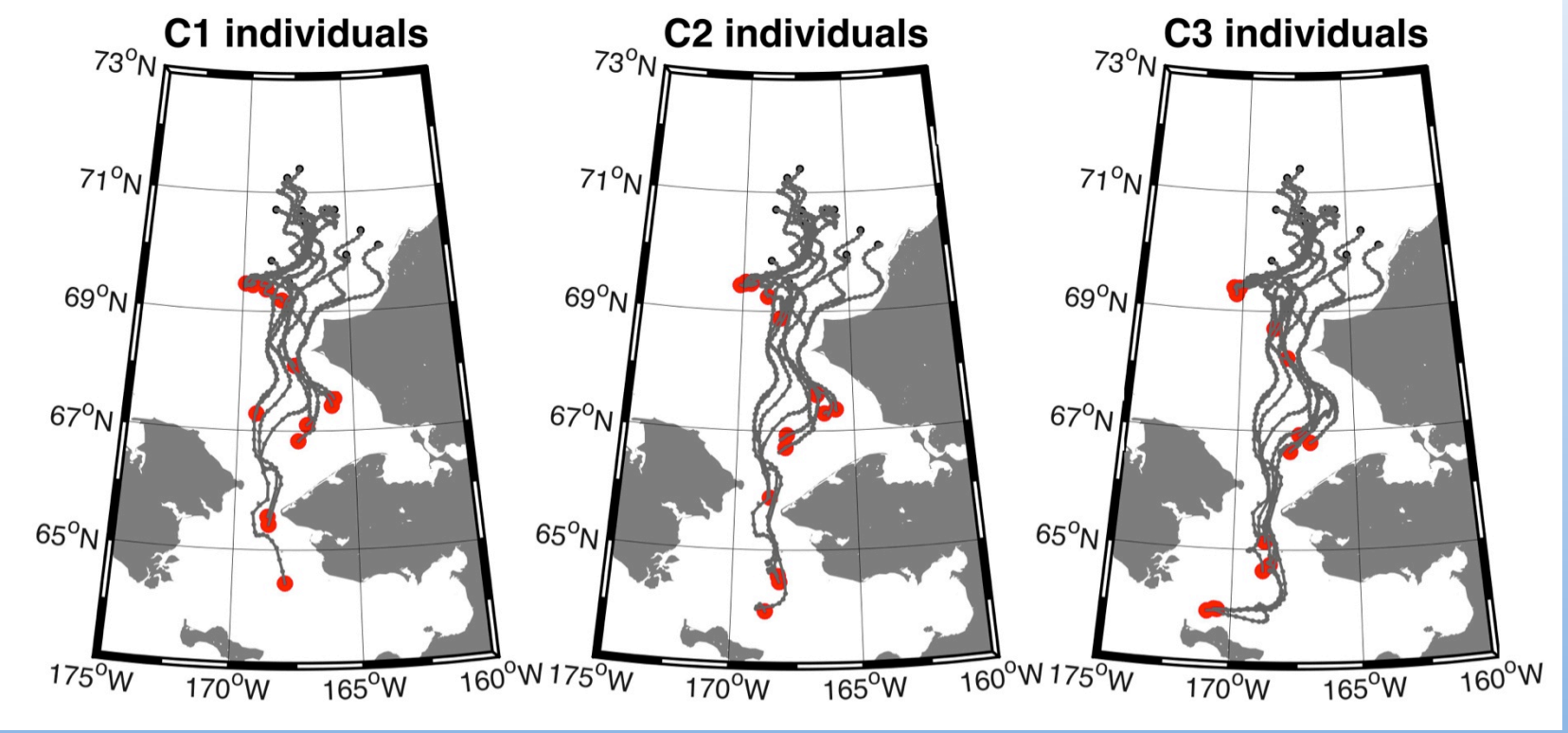
Arctic Type (Red): Cold, fresh Melt water and mixing with warm, salty Atlantic Water

Early Chukchi (Green): Winter Water

Late Chukchi (Blue): Winter Water and mixing with warm Bering Sea Water

C. glacialis copepodids originated in northern Bering and southern Chukchi Sea

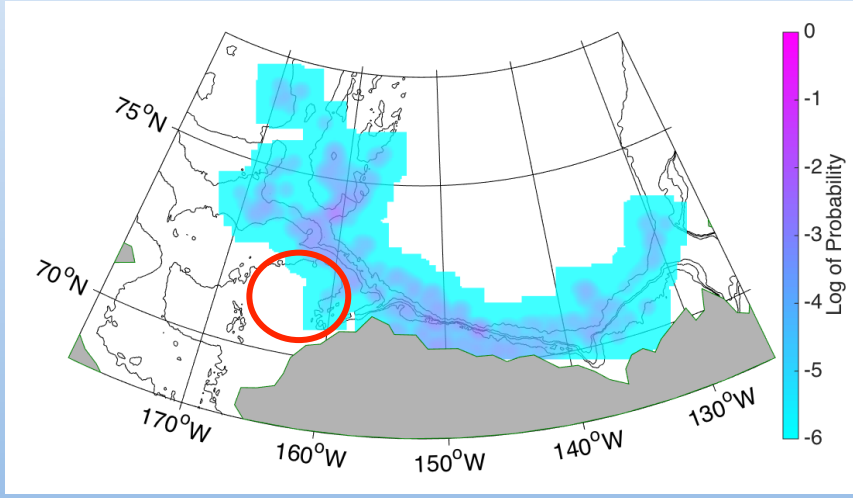
Three different origins and advective pathways for the copepodids



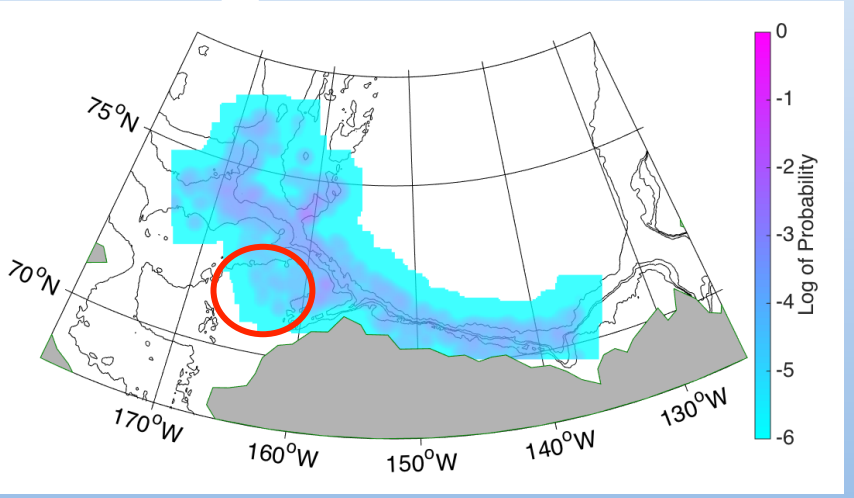
Backwards advection to source latitude during backwards development time from copepodid stages at collection to production as eggs using temperature and circulation from BIOMAS model of Zhang et al. 2010, 2014 and temperature development from Ji et al. 2012

C. glacialis in northern Chukchi in August would be distributed across Beaufort Shelf break, Beaufort Shelf, and towards Chukchi Cap by winter

2012



2013



Elliott et al., submitted, DSRII

Forwards advection circulation from Arctic Ocean FVCOM (Chen et al., 2009; 2013)

Conclusions

- Bering Sea plankton in the Chukchi Sea either **die** or are **advected off** of the shelf during winter and are renewed annually by inflow from the Bering Sea
  - During the second portion of the 2014 spring cruise, the central Chukchi was flooded by water and plankton originating in the Bering Sea that renewed populations on the shelf
  - *Calanus* in the Chukchi may have been born in Bering Sea and can easily be advected off of the shelf in the same year
  - During winter, the supply of *Calanus* from the Bering must be low
  - At measured early winter metabolic activity, they had insufficient lipid stored to survive without feeding until spring unless metabolism is further reduce
  - Another intriguing possibility is that Calanus that migrate to depth to overwinter on the shallow shelves may encounter the sea floor and/or be eaten by the abundant benthos

Big Picture

- Most Chukchi Sea plankton originate in the northern Bering Sea and are advected through the Chukchi Sea in less than a year
- This may explain why, despite abundant phytoplankton and ice algal food, standing stocks of water column grazers remain low relative to the available food and are unable to graze all of it, resulting in strong benthic-pelagic coupling
- Earlier sea ice retreat, later sea ice formation, and potentially increases in under-ice blooms may provide earlier and later grazing opportunities and a more protracted growth season (see poster by Z. Feng)
- However, warmer ocean temperatures later in the year may lead to periods of high respiration and more rapid utilization of lipid reserves, decreasing overwintering survival of lipidic copepods

Acknowledgements

- P. Alatalo, C. Gelfman and C. Nobre
- The Captain, Officers, crews, and marine technicians of the *USCGC Healy* and of the *R/V Sikuliaq* for their help and support during the cruises
- The U.S. National Science Foundation and U.S. Bureau of Ocean Energy Management for supporting the cruises and much of the data analysis
- WHOI Independent Study Award to C. Ashjian

R/V Sikuliaq

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