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Large copepods as leading indicators of walleye pollock recruitment: observed and geostatistical model (VAST) results in the SE Bering Sea

Lisa Eisner, Ellen M. Yasumiishi, Alex Andrews

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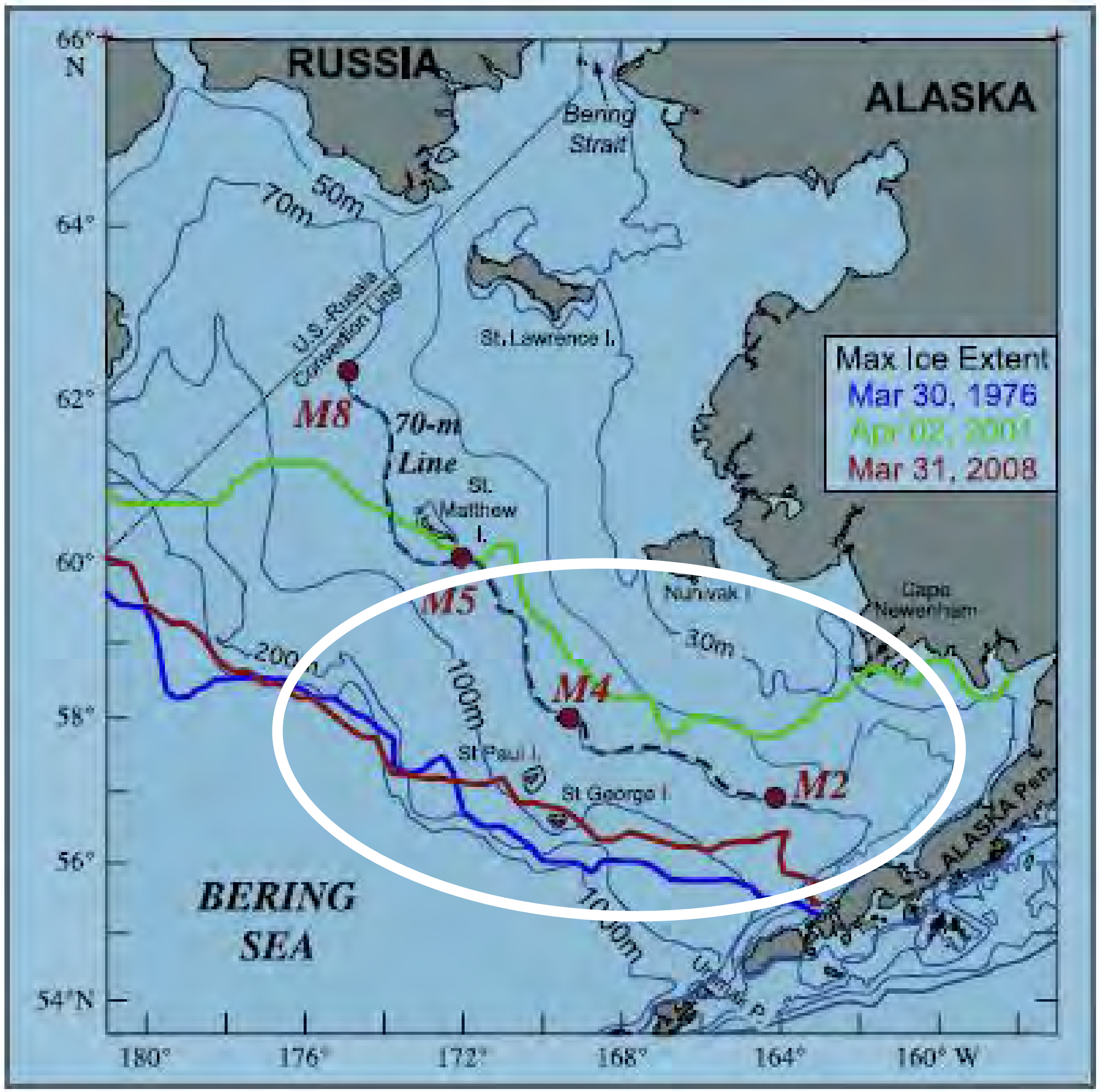
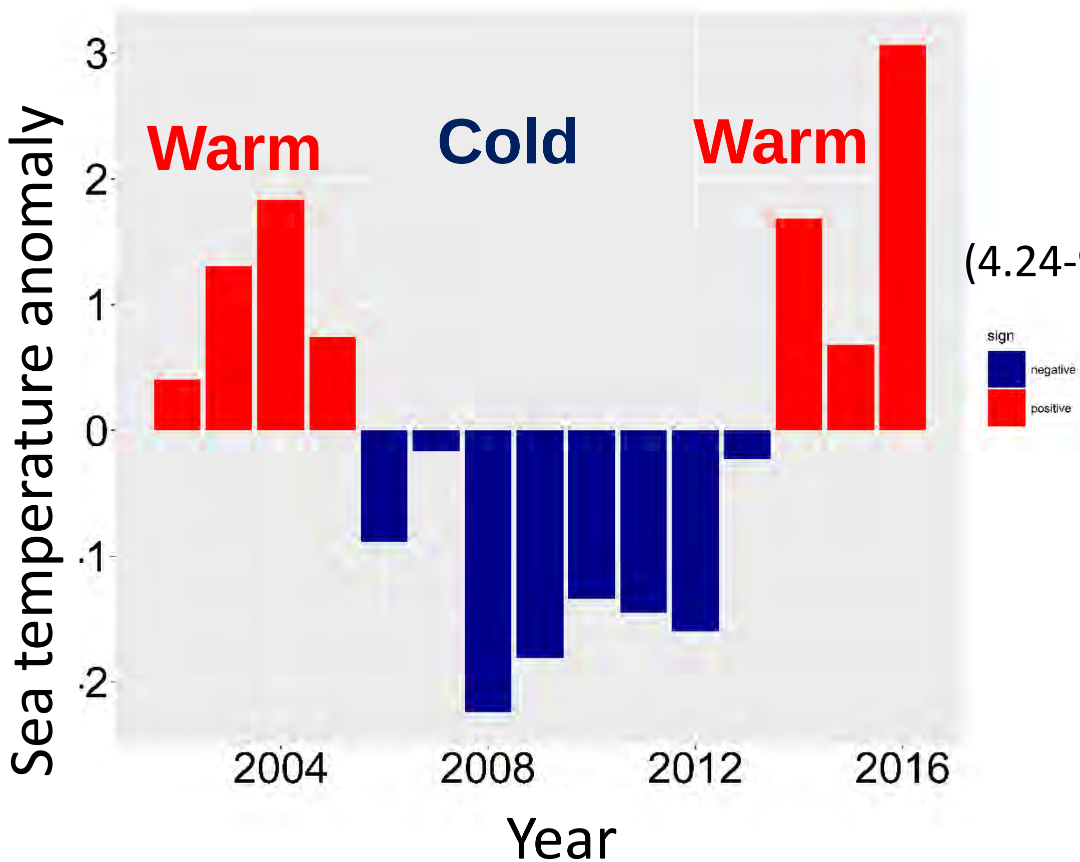
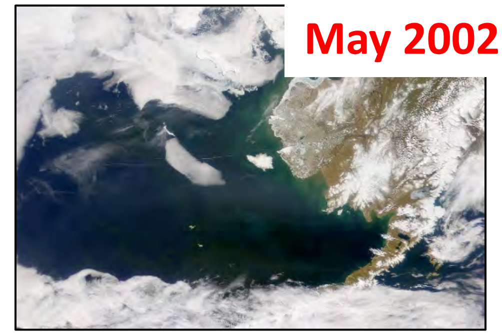
Study area: Southeastern Bering Sea

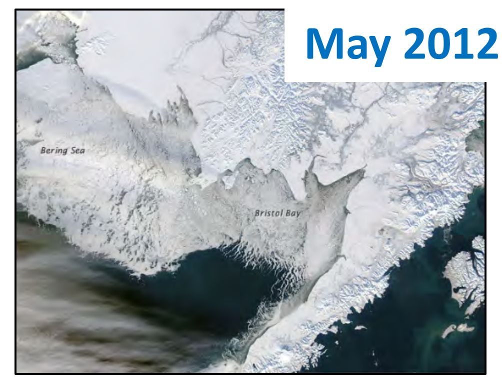


Stabeno et al. (2012), DSR2

Sea ice and temperature are important in establishing feeding conditions for pelagic species in the eastern Bering Sea







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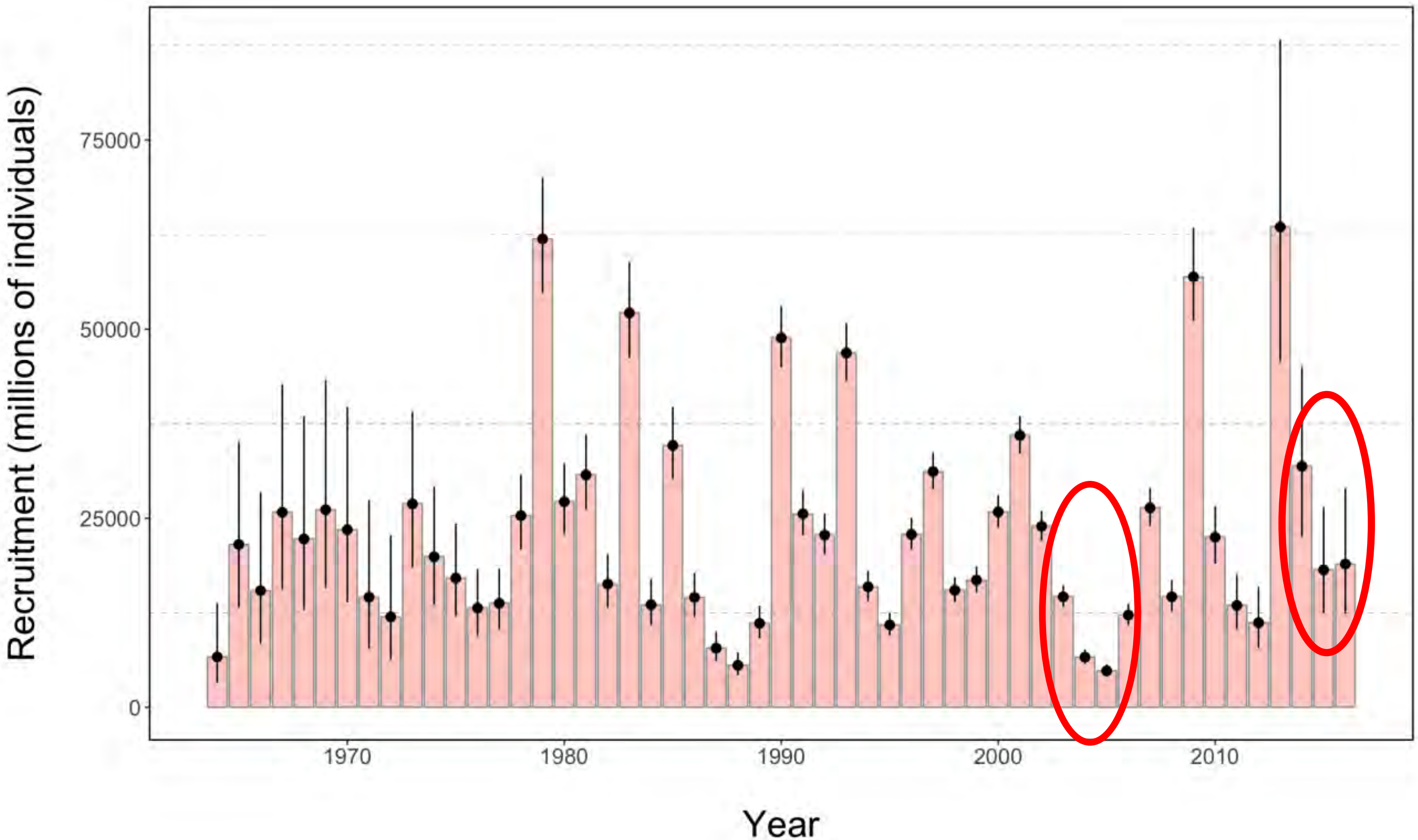
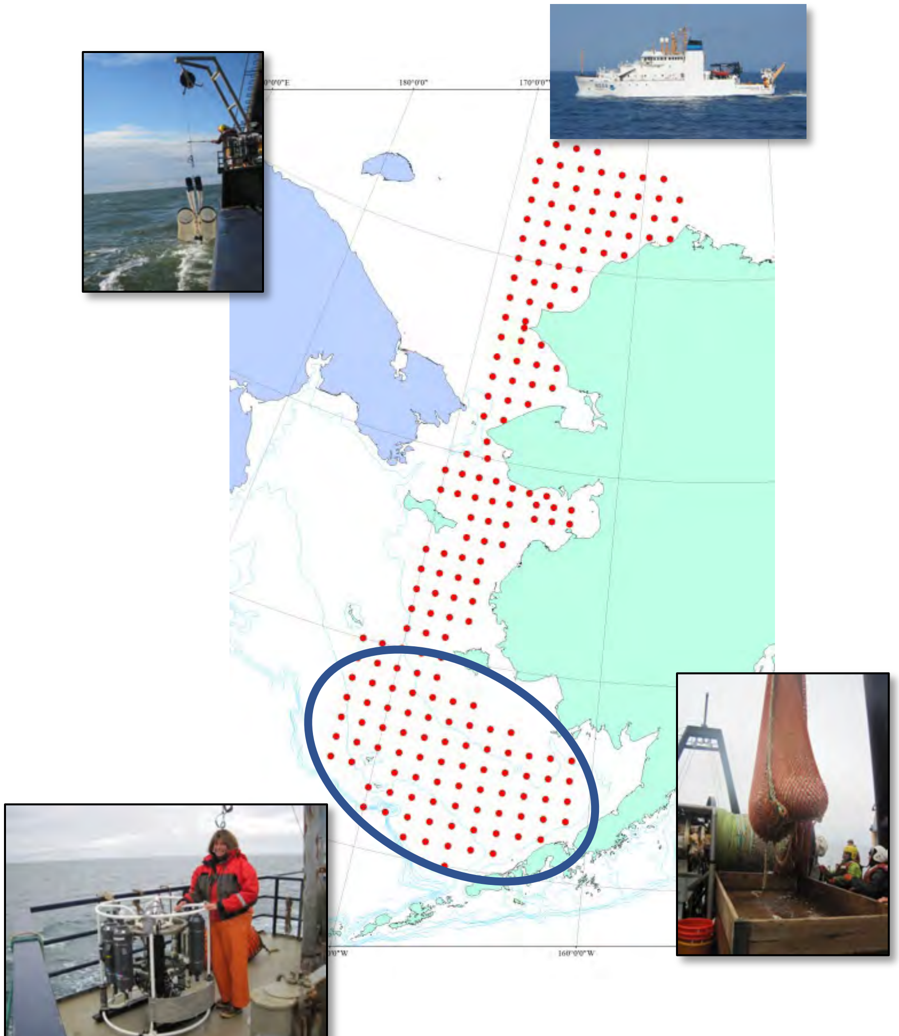
Connor & Lauth (2017)

Age-1 Walleye Pollock abundance by year



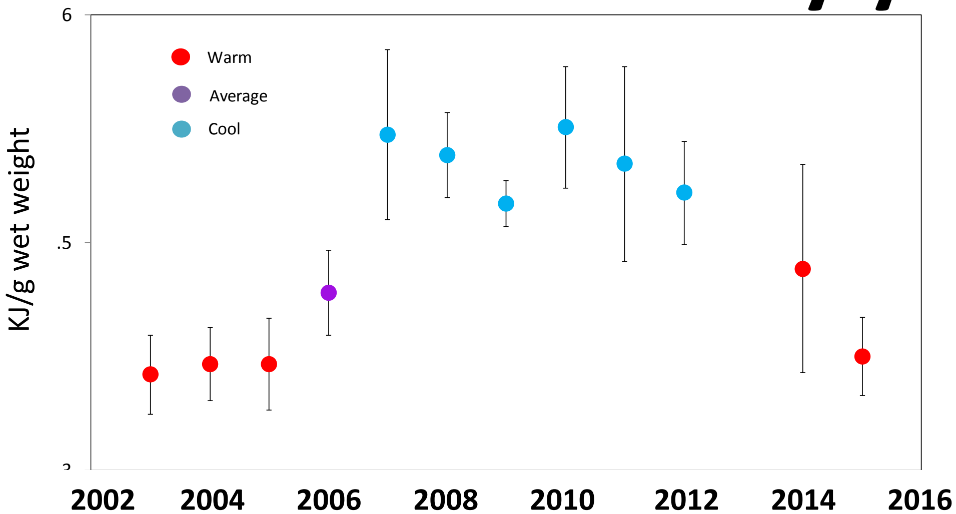
Ianelli, J. (2017)

Fisheries oceanography surveys (BASIS)



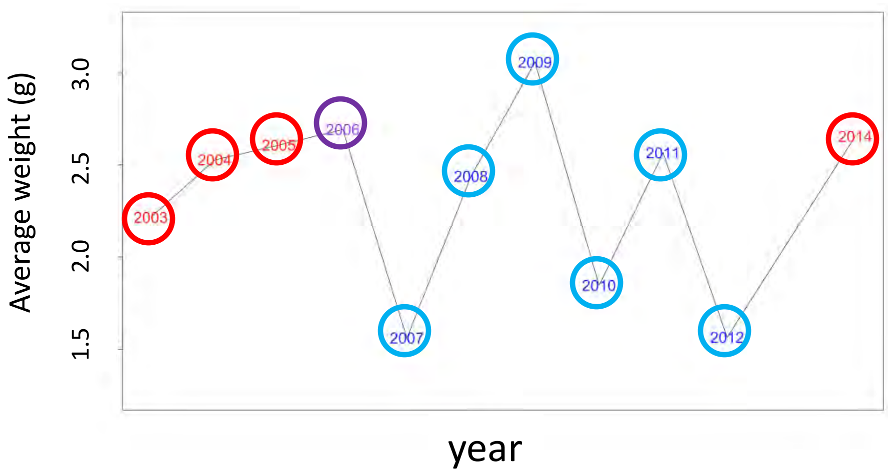
- mid-August to early Oct
- 2001-2018 (ongoing)
- Station spacing ~ 60 km
- CTD (T, S, Fluor, PAR, O2)
- Nutrients, Chla
- **Zooplankton bongo tows** (150 and 505 µm)
- **Surface (top 20 m) trawl** for forage fish (juvenile Walleye Pollock primarily age 0)

Age-0 pollock energy content and weight by year



Why study bioenergetics?.. To determine how much energy (nutritional quality) your food has!

›ur study, the lives of whales or seabirds could depend upon the occasional glance at the Nutrition Facts.

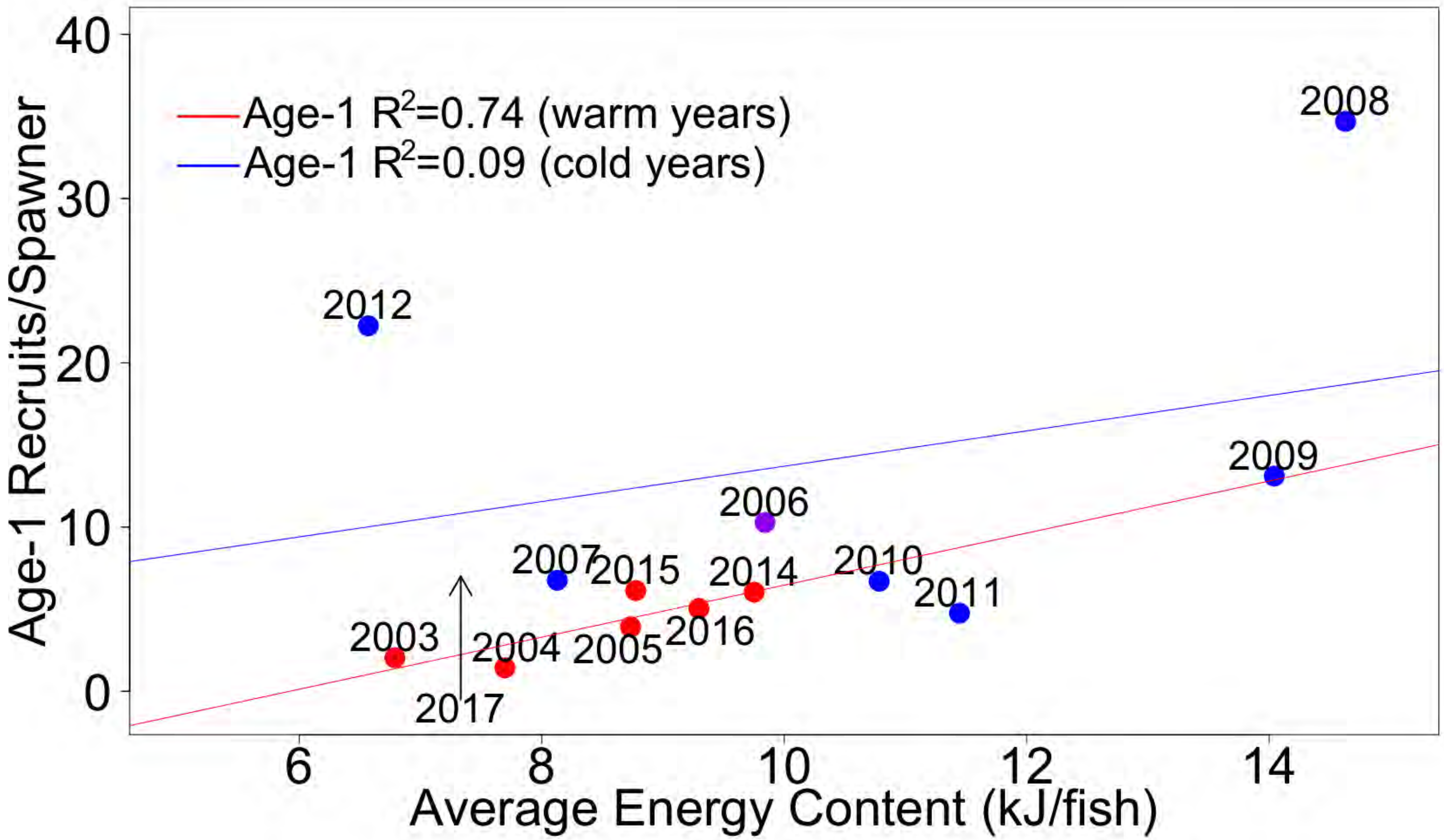


Energy content X weight
= energy content per fish

KJ/g X g/fish = KJ/fish

Heintz et al. (2013) DSR2

Age-0 pollock energy content (SE Bering Sea) vs. survivorship to year 1



Heintz, Siddon, Farley (2018) Alaska Marine Ecosystem Status Report

Age-0 pollock diets (% composition)

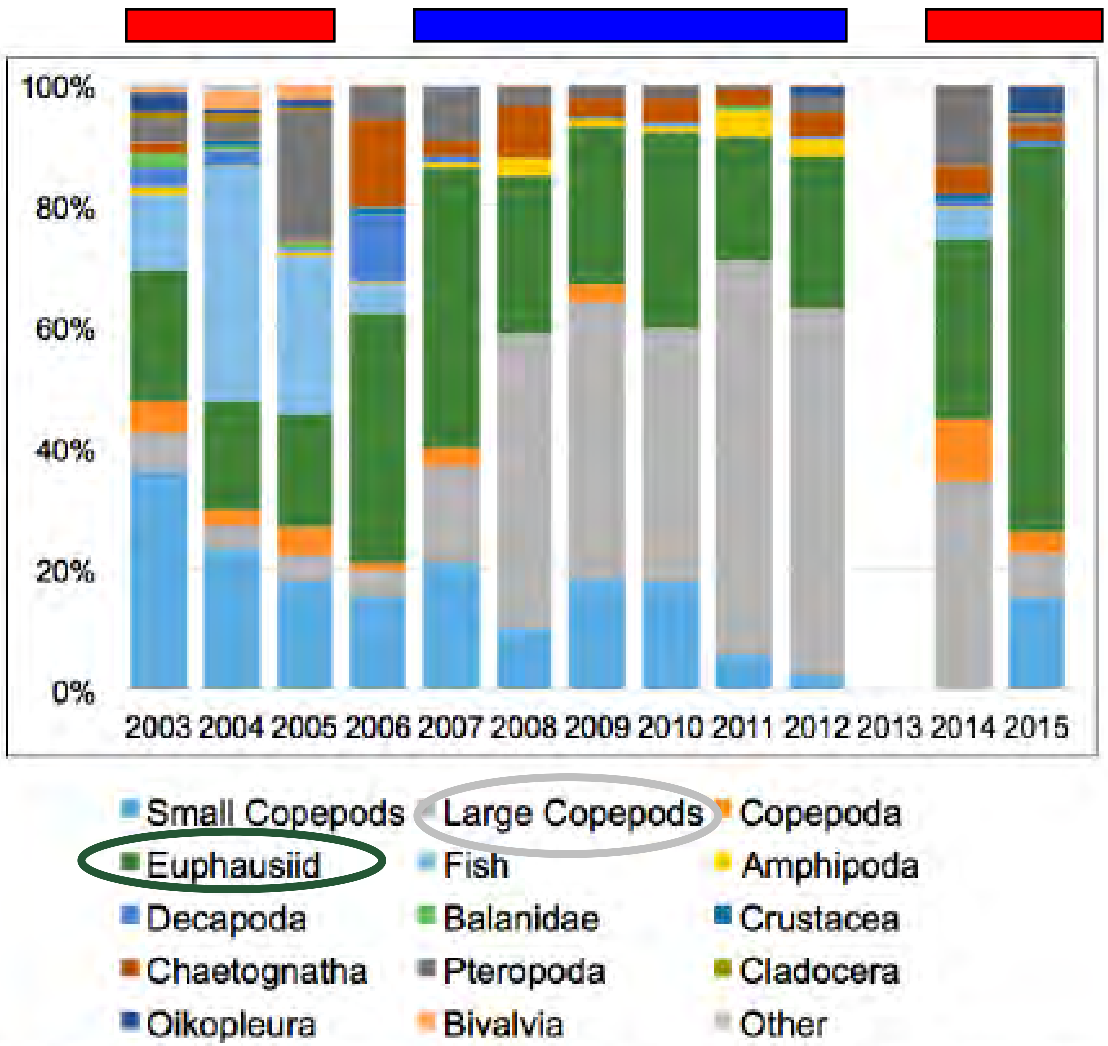
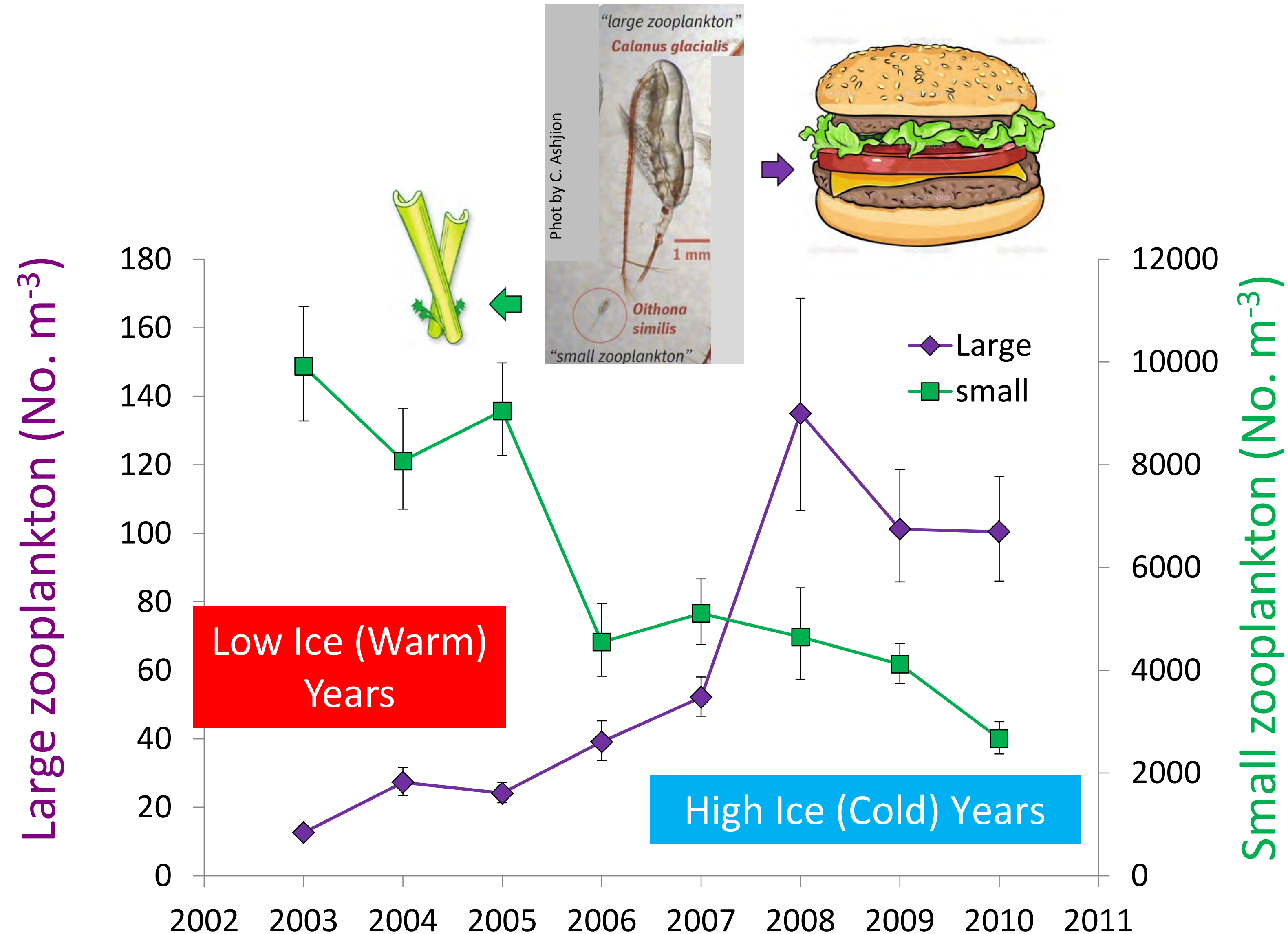


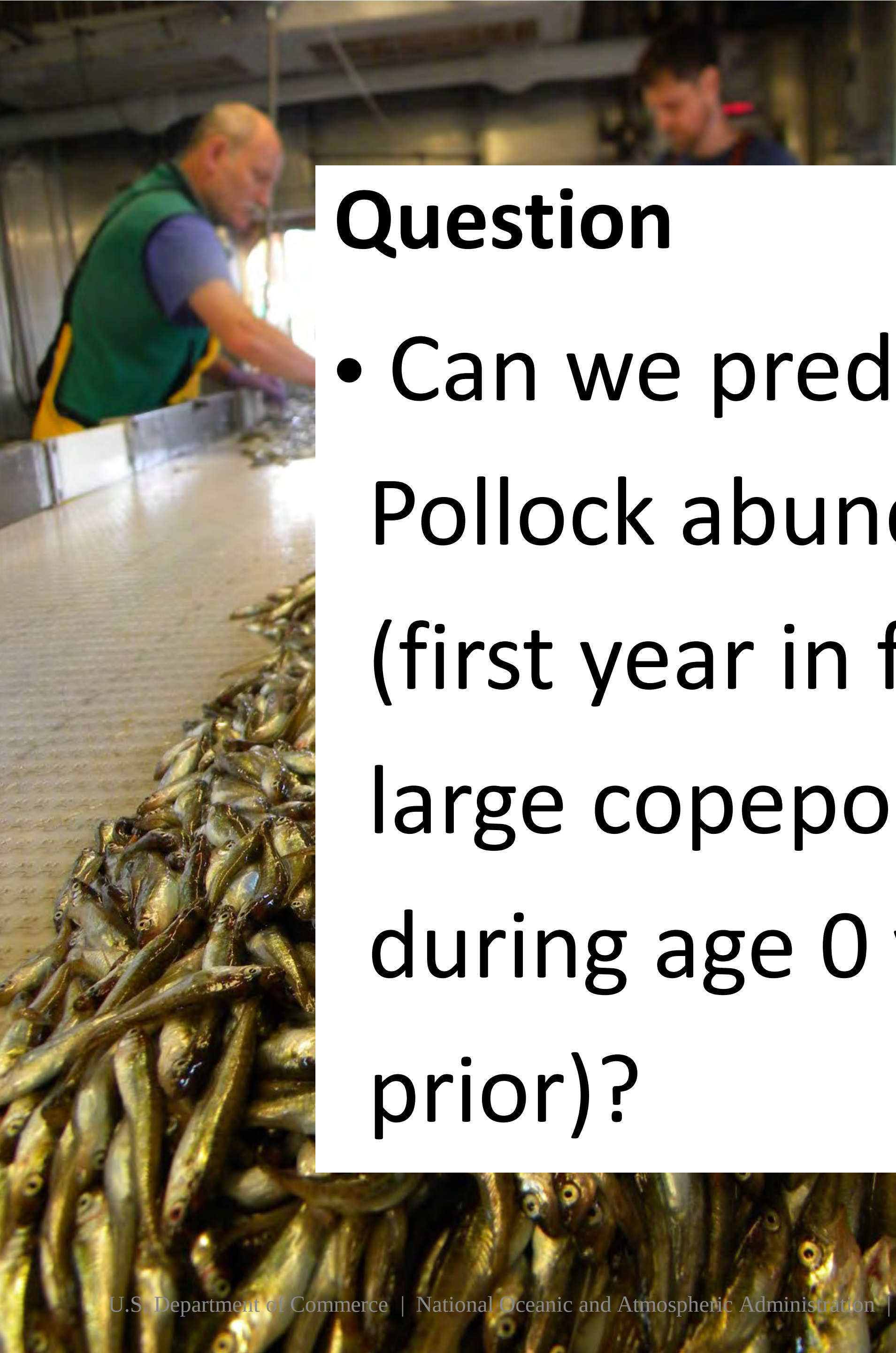
Figure 70: Percent composition of age-0 pollock prey from the middle domain in the southeastern Bering Sea. On-board diet analyses are conducted during the late summer/early fall BASIS survey and are available soon after the survey is completed.

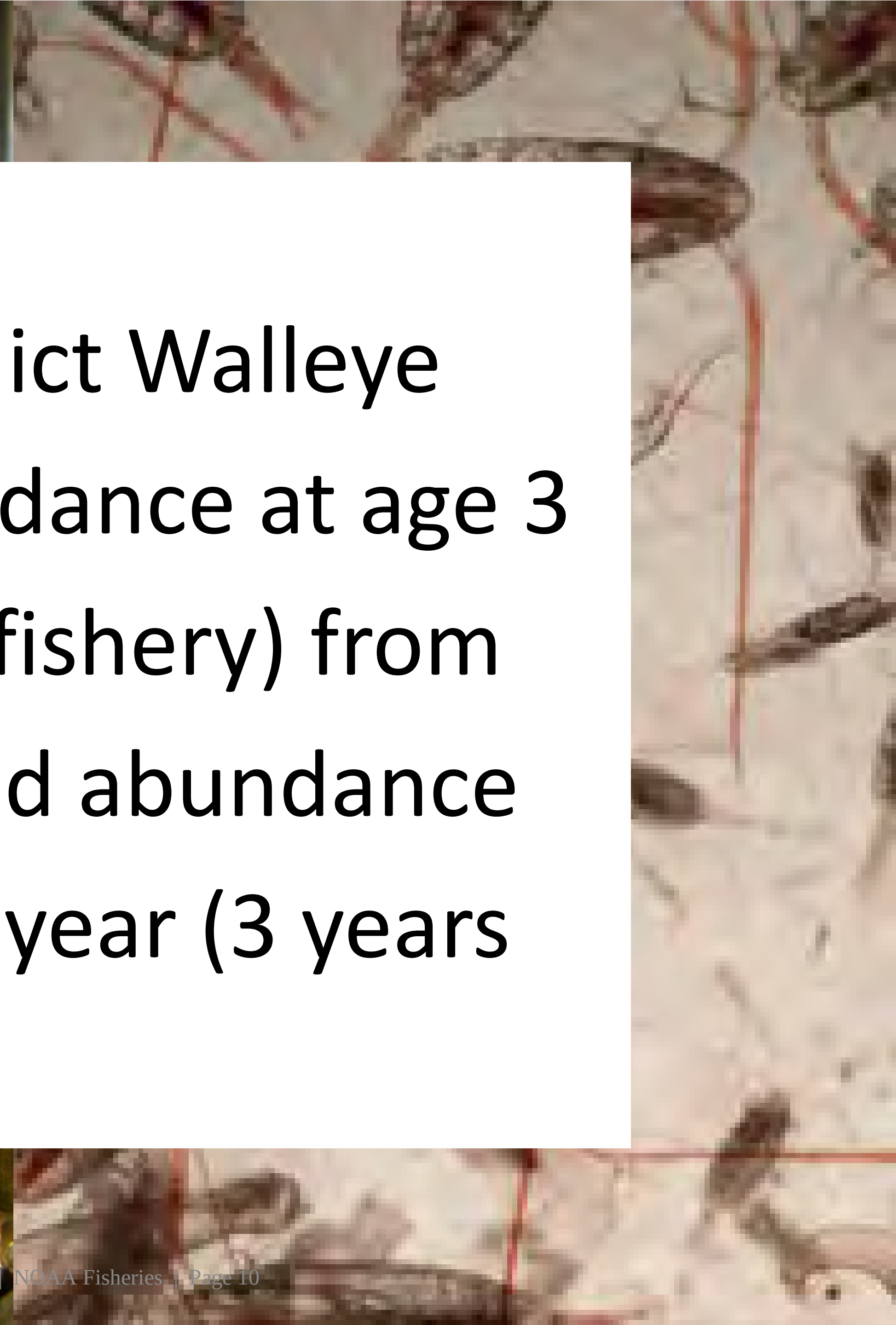
Heintz et al. (2016) Alaska Marine Ecosystem Status Report

Zooplankton: SE Bering Sea (Aug/Sept)



Eisner, et al. (2014), DSR2





Question

- Can we predict Walleye Pollock abundance at age 3 (first year in fishery) from large copepod abundance during age 0 year (3 years prior)?

Methods

Age 3 pollock abundance estimated from ground fish summer bottom trawl survey data (Ianelli, 2017).

Large copepods collected with bongo net oblique tows on BASIS surveys, mid-August to September.

Calanus marshalle/glacialis

***Neocalanus* spp.**

Metridia pacifica

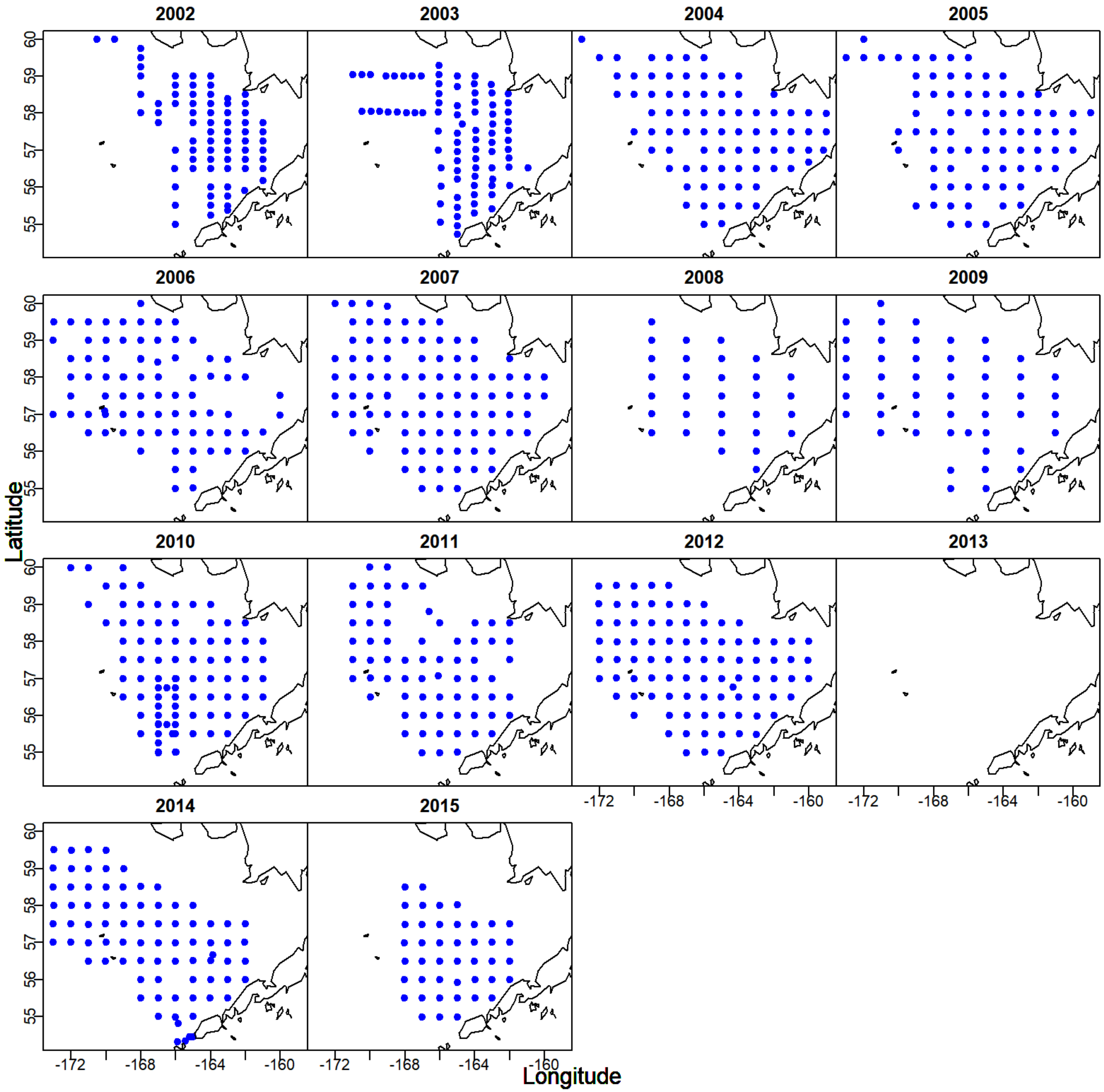
Large copepod abundance estimates (sum of 3 taxa)

- Observed means among stations (number m^{-2})
- Vector Auto-regressive Spatial Temporal (VAST) model to estimate encounter probability and positive catch rate (Thorson et al, 2016)

  Estimated spatial and spatial-temporal variation

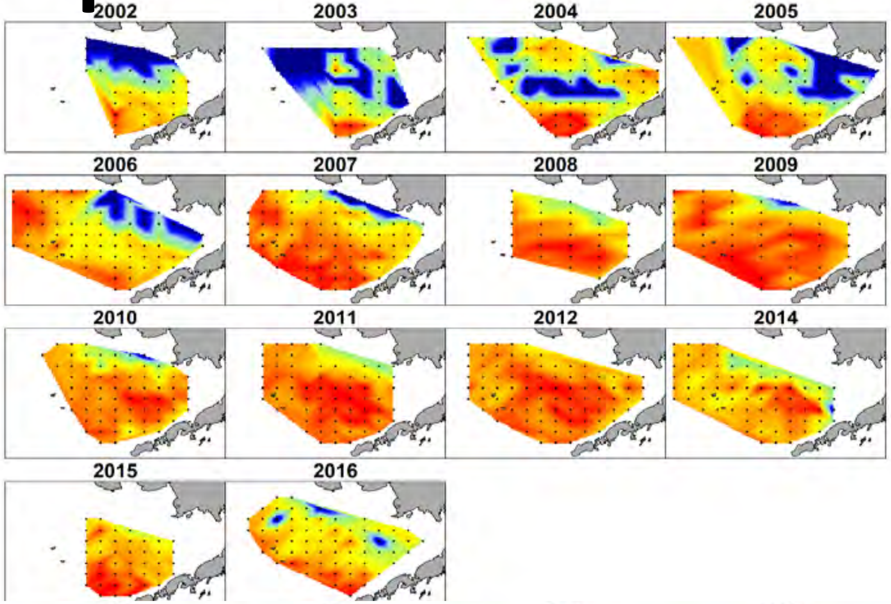
  Specified gamma distribution, spatial resolution of 50 knots

Station grid by year

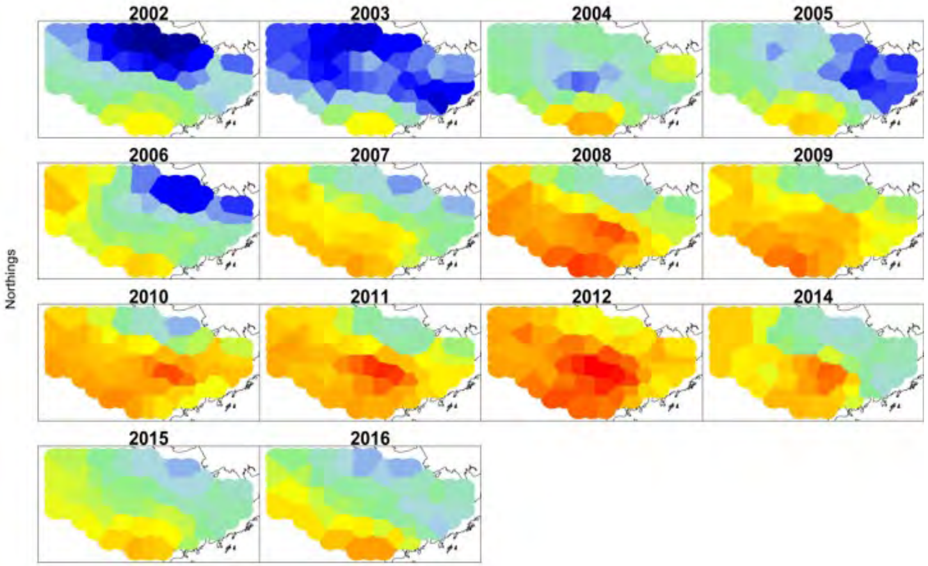


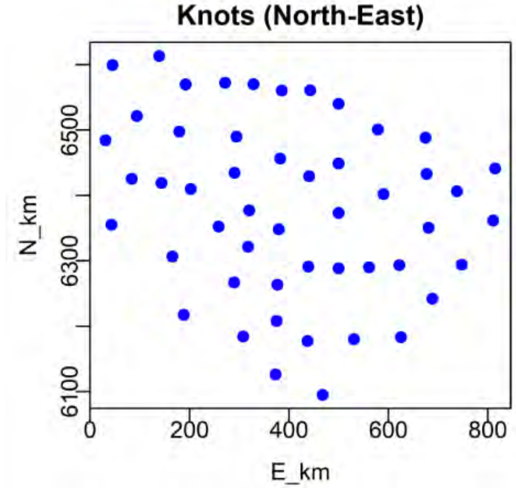
Observed & VAST model estimates of large copepod abundance

Observed



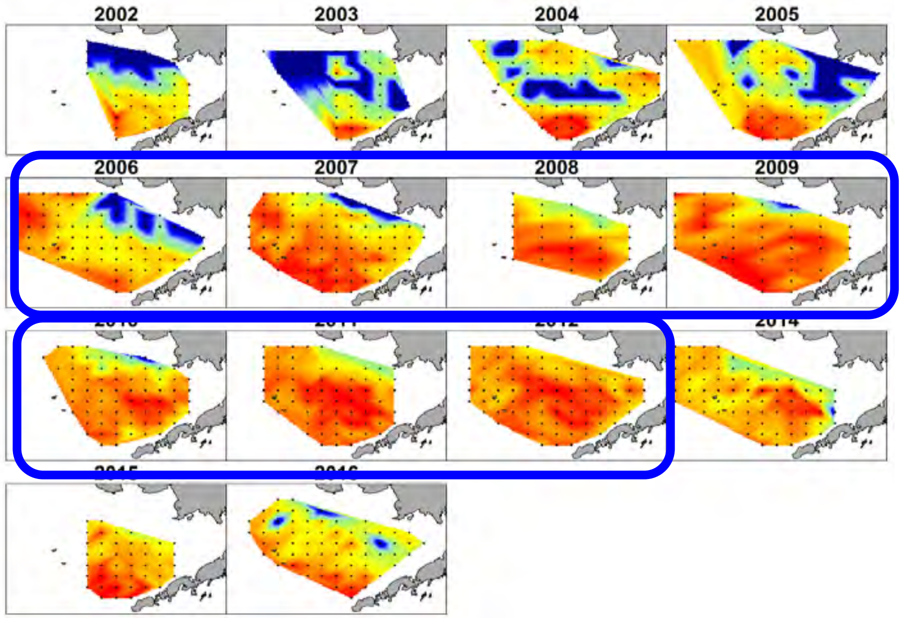
VAST



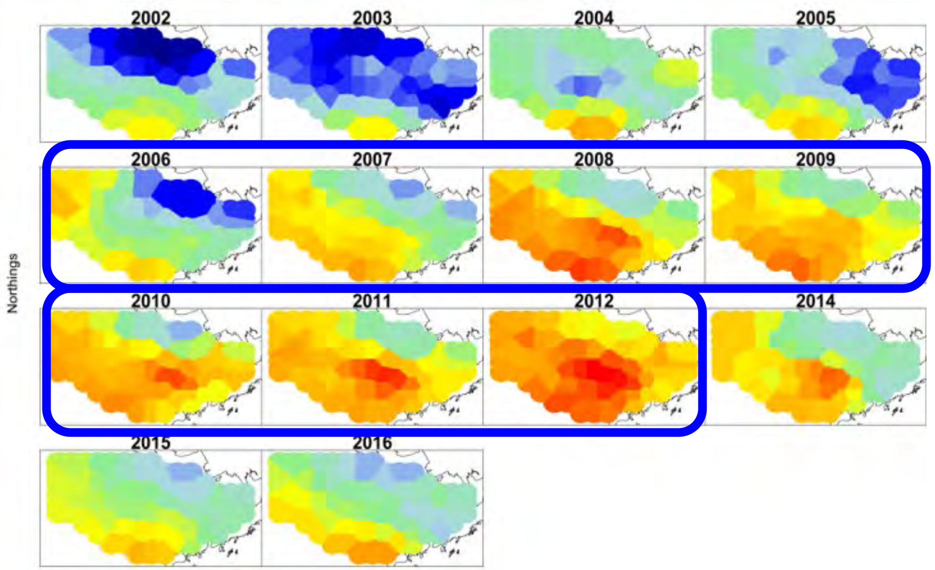


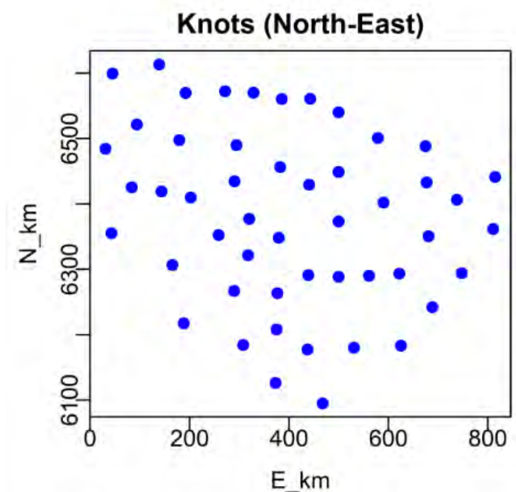
Observed & VAST model estimates of large copepod abundance

Observed



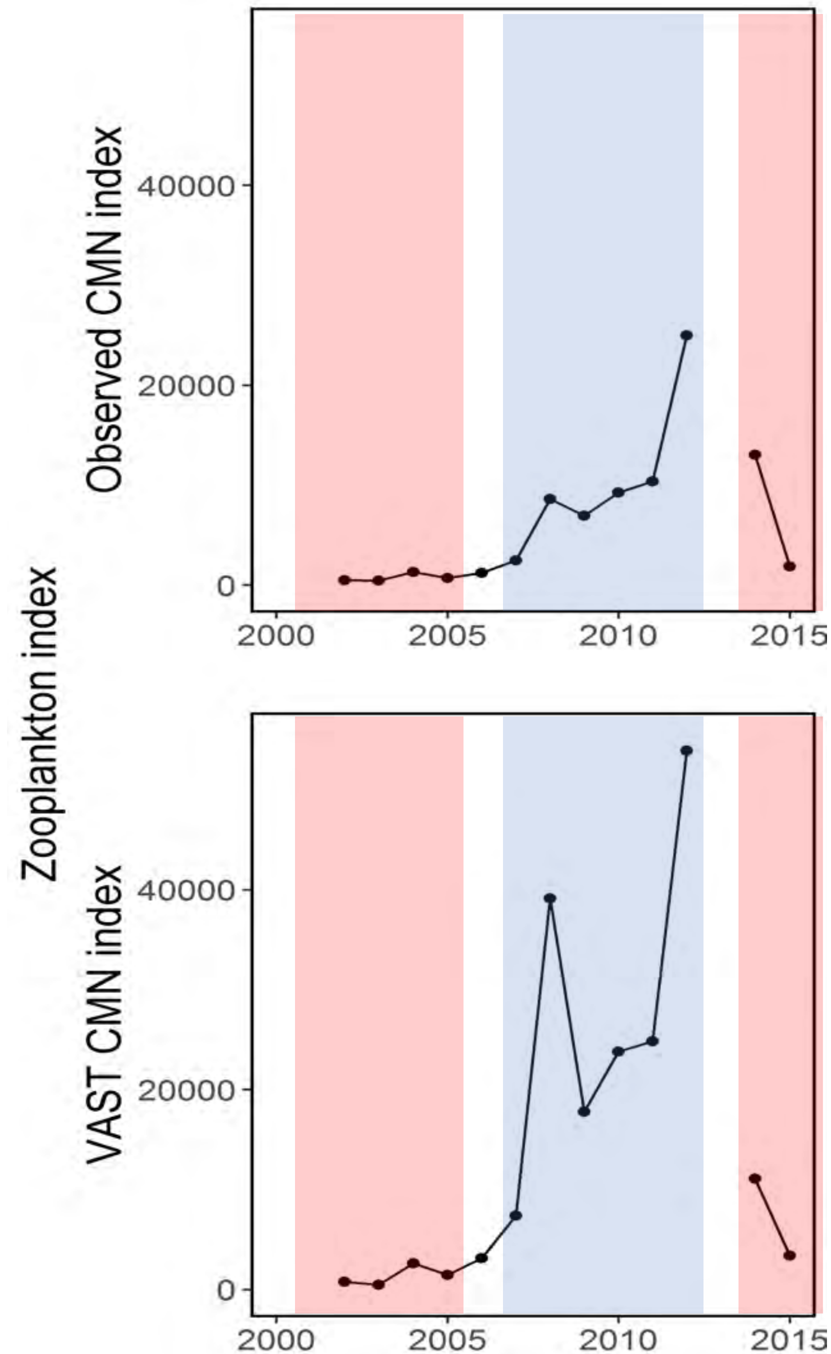
VAST



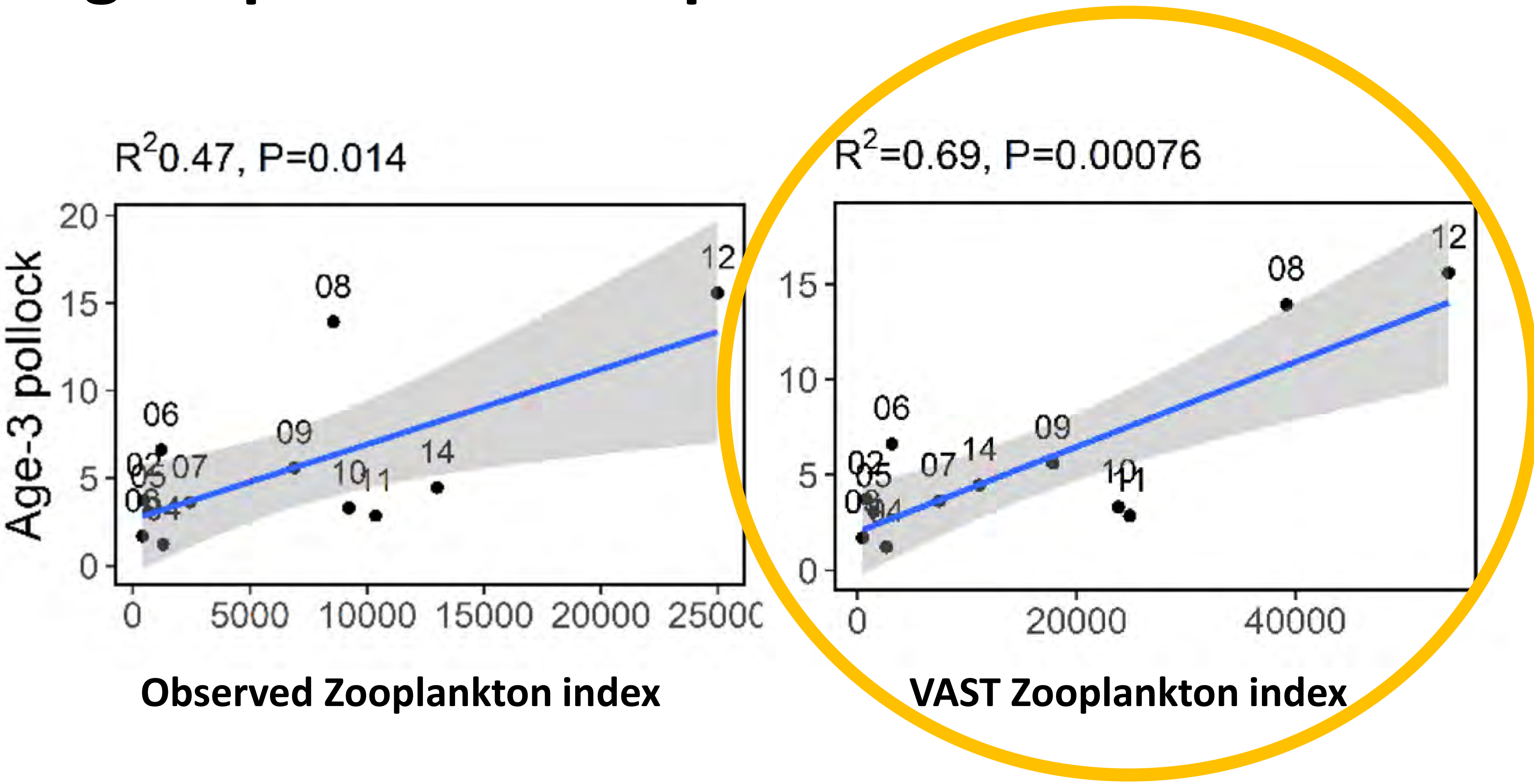


Mean large copepod abundance index (Number m^{-2}) by year

Pink = warm, low ice
Blue = cold, high ice



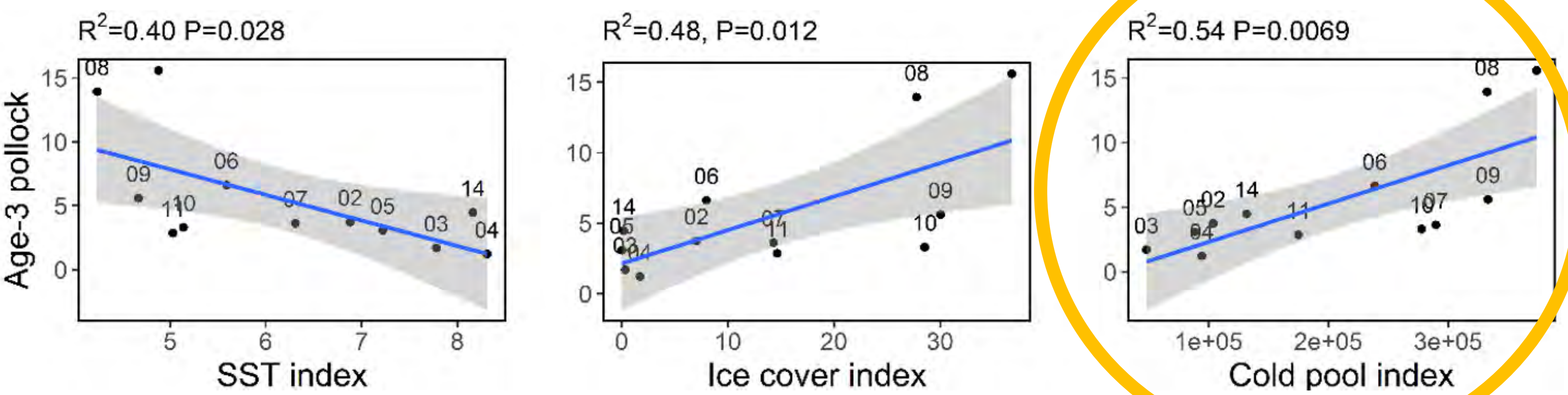
Age-3 pollock & zooplankton indices



VAST zooplankton abundance estimate explains 69% (an additional 22%) of the variability in pollock abundance

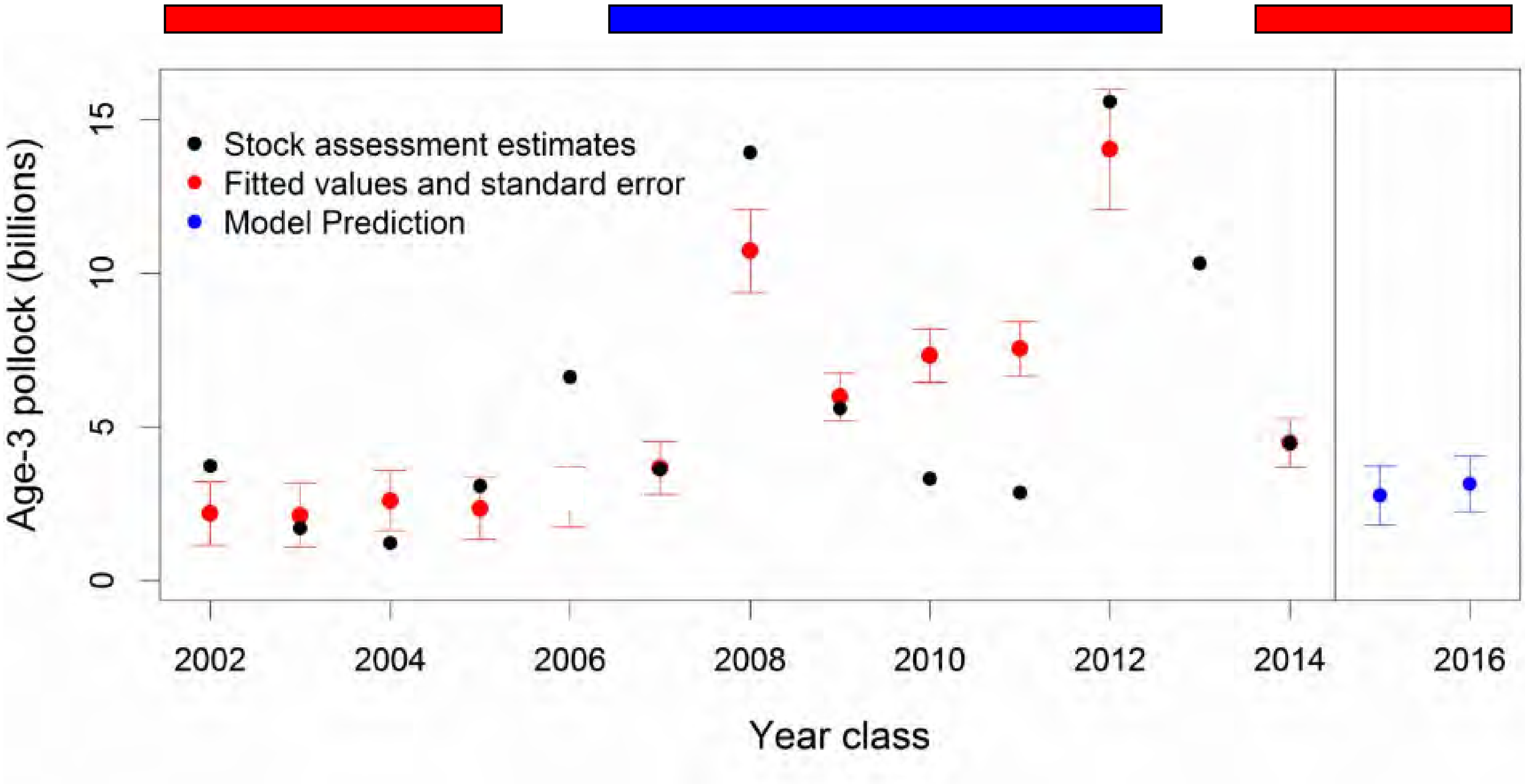
Age-3 pollock & environmental indices

- SST from bottom trawl survey, Jun-mid Aug
- Ice cover index = average ice concentration for box (56°-58°N, 163-165°W) for Jan-March
- Cold pool index = areal extent of cold pool (< 2°C), Jun-mid Aug



Cold pool index explains 54% of the variability in age-3 pollock abundance

Predictions from large copepod index (VAST model)



Conclusions

- Age-3 pollock abundance is best estimated by large copepod abundance (VAST model) from age 0 year; estimates using cold pool area may also be useful (R^2 = 0.69 vs 0.54).
- VAST model improves fit, particularly for years with reduced sampling effort (e.g., 2008).
- Age-3 pollock abundances for 2015 and 2016 year classes (abundances in 2018 and 2019) are predicted to be below average in the southeastern Bering Sea.
- Plans to use the large copepod indicator in pollock stock assessment modeling efforts in future.