Surveying euphausiid abundance to understand the central Gulf of Alaska ecosystem

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OVERVIEW

Goal: create an ongoing acoustic-trawl time series of euphausiid ('krill') abundance in the Gulf of Alaska for use in predator-prey models, fisheries management, and as an ecosystem indicator.

HOW IT WORKS

- Euphausiid backscatter from summer acoustic-trawl pollock surveys 2003-2015 was identified using backscatter frequency response, targeted trawling, and opportunistic camera imagery (Simonsen et al. accepted, ICES JMS; Figs. 1, 2)
- Euphausiid backscatter in key areas sampled in all years was used as a temporal and spatial index of euphausiid abundance (Figs. 2, 4).

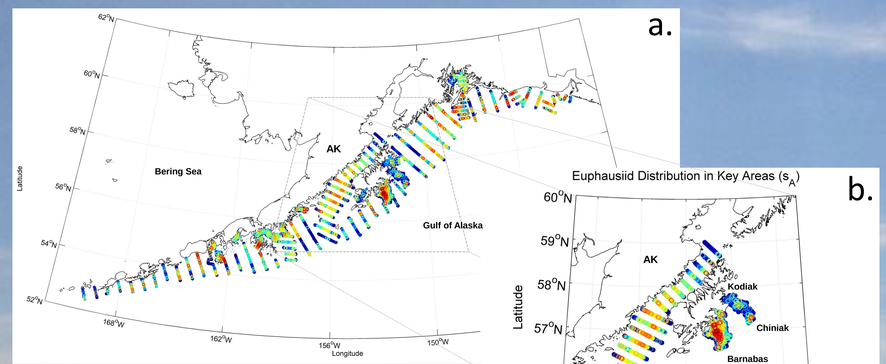

Fig. 1.

a. Acoustic backscatter (s_A, m^2 nmi^{-2}) from euphausiids, 2013 acoustic-trawl survey.

b. Zoomed-in view of euphausiid backscatter in key, consistently sampled areas, 2013.

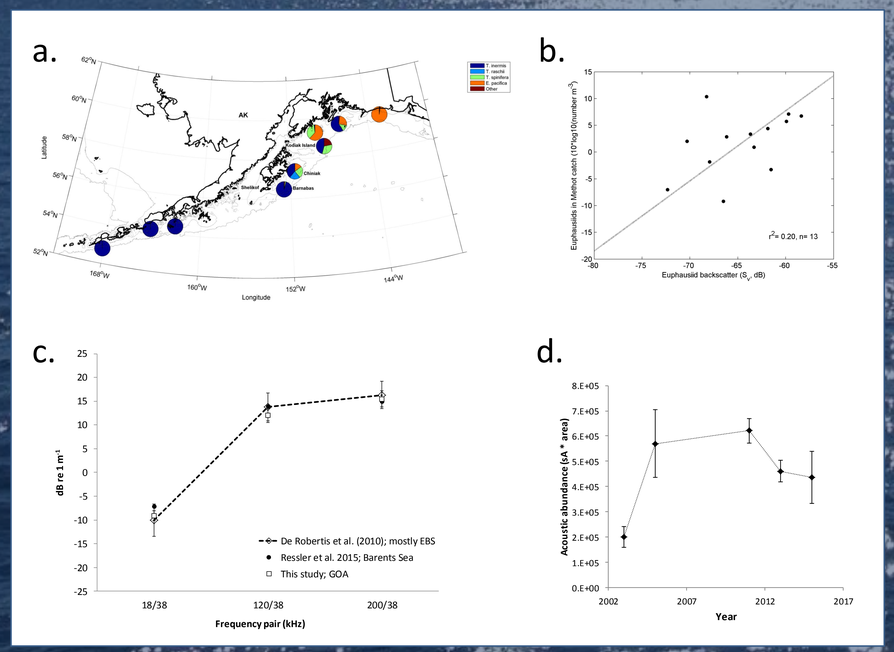

Fig. 2.

a. Euphausiid species composition is dominated by *Thysanoessa* spp., mainly *T. inermis*, with increasing contributions from *Euphausia pacifica* in the east.

b. Functional regression of Methot net catch on euphausiid S_v in 2011 and 2013 revealed a positive relationship with net catch; 95% confidence intervals on the slope indicated a 1:1 relationship. Euphausiid backscatter was also positively correlated with trawl camera counts (not shown).

c. Mean backscatter frequency response relative to 38 kHz is comparable for euphausiid aggregations in several high-latitude ecosystems (eastern Bering Sea, Barents Sea, and Gulf of Alaska). Error bars indicate ± 1 standard deviation.

d. A combined annual index of euphausiid backscatter ($\Sigma \Sigma s_A$ x area, m^2) for the key areas surrounding Kodiak Island indicated highest values in 2011 and 2005. Error bars are 95% confidence intervals.

MODELING EUPHAUSIID ABUNDANCE

- Ressler et al. (MEPS, 2014) created a generalized additive model (GAM) of euphausiid abundance in the Bering Sea as a function of temperature, walleye pollock abundance, and spatial location. **Temperature was a much better predictor than pollock abundance in the Bering** (more euphausiids at colder water temperatures; deviance explained 47%).
- We formulated a similar GAM for the GOA (Simonsen et al. accepted, ICES JMS), using a region factor (Shelikof, Barnabas, and Chiniak) in lieu of a smooth spatial function. **No strong negative relationship with temperature was observed** (Fig. 4; deviance explained 26.4%), but note that the **GOA is much warmer than the Bering year-round**. **Walleye pollock abundance was a statistically significant but very weak predictor of euphausiid abundance in both systems.**

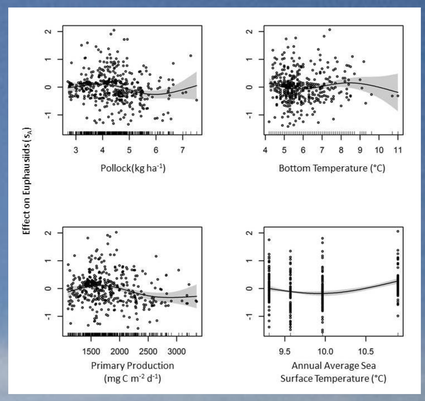

Fig. 4. Partial effects plots for smooth functions in the GOA euphausiid GAM. The units of euphausiid backscatter and pollock biomass have undergone a $\log_{10}(x+10)$ transformation. The points on the plots are residuals from the full model without the effect of the covariate on the x-axis; the shading denotes a 95% confidence interval around the fit.

EUPHAUSIIDS AND FISH CONDITION

- Since euphausiids are key prey for GOA pollock and other fishes, their availability in the environment may influence fish condition and growth.
- We fit a length-weight relationship to GOA pollock specimens collected during acoustic-trawl surveys 2003-2015. Length-weight residuals were positively associated with average euphausiid backscatter (Fig. 5).

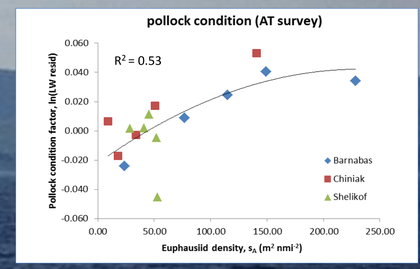

Fig. 5. Mean pollock condition (length-weight residuals) as a function of euphausiid backscatter density (s_A) in key areas.

CONCLUSIONS AND FUTURE WORK

- Multifrequency acoustic backscatter and net catches can be used as a spatial and temporal proxy for euphausiid abundance (5 surveys, 2003-2015).
- The Gulf of Alaska does not experience the cold temperatures (bottom and surface) nor the seasonal ice cover observed in the Bering Sea, perhaps a key difference relevant to annual variation in the abundance of euphausiids in these systems.
- Preliminary results suggest that the condition of pollock captured in acoustic-trawl surveys may be positively associated with the availability of euphausiid prey.
- Future directions: further evaluation of possible association of euphausiid abundance and fish condition, assess the spatial relationship of euphausiids and key predators (Simonsen et al. in prep.), investigate scattering properties of EBS and GOA euphausiids (NPRB #1501), continue to use these results as an ecosystem indicator and stock assessment consideration.

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