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Modeling the prey base of North Pacific right whales on the eastern Bering shelf to gain insight into possible shifting distributions of feeding whales

The southeastern Bering Sea is the core feeding ground of the critically endangered eastern population of North Pacific right whale (NPRW). Decreasing sea ice in this region is influencing trophic dynamics. NPRWs in this region target the zooplankton Calanus marshallae/glacialis but they could prey on other zooplankton species given their diet in the Gulf of Alaska. Therefore, we constructed a dynamic, state-space joint species distribution model of zooplankton species from the eastern Bering Sea to provide insights into the potential future distribution of feeding whales. The model quantifies how zooplankton species will respond to changing climatic conditions through both direct effects of environment and indirect effects that emerge from environment propagating through the community of interacting species. We modeled the abundance of 26 zooplankton species from annual fall surveys (Aug-Oct; 2006-2016) along the 70-meter isobath of the eastern Bering shelf using temperature, ice, and wind variables. The zooplankton community was best described by density independent growth driven by bottom and surface temperature and movement (immigration/emigration) driven by ice extent. Density independent growth described the majority of variance for all zooplankton species, but the proportion described by movement generally increased with zooplankton size, which we hypothesize reflects transport of larger zooplankton in water masses and high abundance of smaller zooplankton throughout the study region. Species interactions minimally described the data but were most important for small omnivores (< 1,200 micrometers), which we hypothesize reflects the annual fall sampling design and the small omnivore life history strategy of multiple life stages within a season. For NPRW prey, C. marshallae/glacialis showed a strong negative relationship with bottom temperature and strong positive relationship with ice. Other large calanoids like Neocalanus spp. had a strong positive relationship with bottom temperature, possibly due to advection onto the middle shelf during warm periods. Together, our findings support that hydrographic features, annual reseeding, and advection drive the zooplankton community in this region – suggesting that the core feeding ground of NPRW in the Bering Sea will move farther north with the receding ice, possibly outside of the right whale critical habitat, if NPRWs continue preying on C. marshallae/glacialis.