Response of lower trophic organisms to recent environmental changes in the Arctic

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The Arctic marine ecosystem has been facing on extremely variable environmental changes (e.g., sea ice decline, warming, and freshening). The lower trophic organisms are known to response quickly to such changes because of their short life cycle. Since the Arctic marine food web forms short and efficient energy transport system, even the small changes in lower trophic organisms can have a large cascading impact on whole marine ecosystem. Therefore, we have investigated how primary and secondary producers are sensitive to the ongoing environmental changes using in situ and satellite observation during ArCS project.

We found sensitive responses of phytoplankton to the sea ice decline. Annual net primary production showed significant increasing with sea ice decrease and temperature warming especially in the shelf and inflow waters since the historical largest sea ice reduction occurred in 2007. During the spring bloom season, phytoplankton community composition showed large spatiotemporal variability corresponding to the timing of sea ice melt as a result of adaptation to different nutrient and light regime. Earlier sea ice melt also impacted significantly on zooplankton distribution. Unusual community type, which is composed of the Pacific origin species, has appeared in the Pacific Arctic shelf region during the summers of remarkably early ice retreat occurred years (i.e. 2012, 2015 and 2017). Such distributional shift was also found for the benthic species. Furthermore, it is notable that sea ice decrease affects not only on the planktonic organisms but also on the nutrient cycle. Increasing of light penetration into the ocean due to longer open-water period can cause changes in the balance of nitrogen cycle inhibiting nitrification process. It may modify available nutrient type for phytoplankton growth widely in the Arctic Ocean. Integrating the knowledge about the tightly linked relationship between sea ice dynamics and lower trophic organisms would improve our understanding of the present new normal and the future Arctic ecosystem.

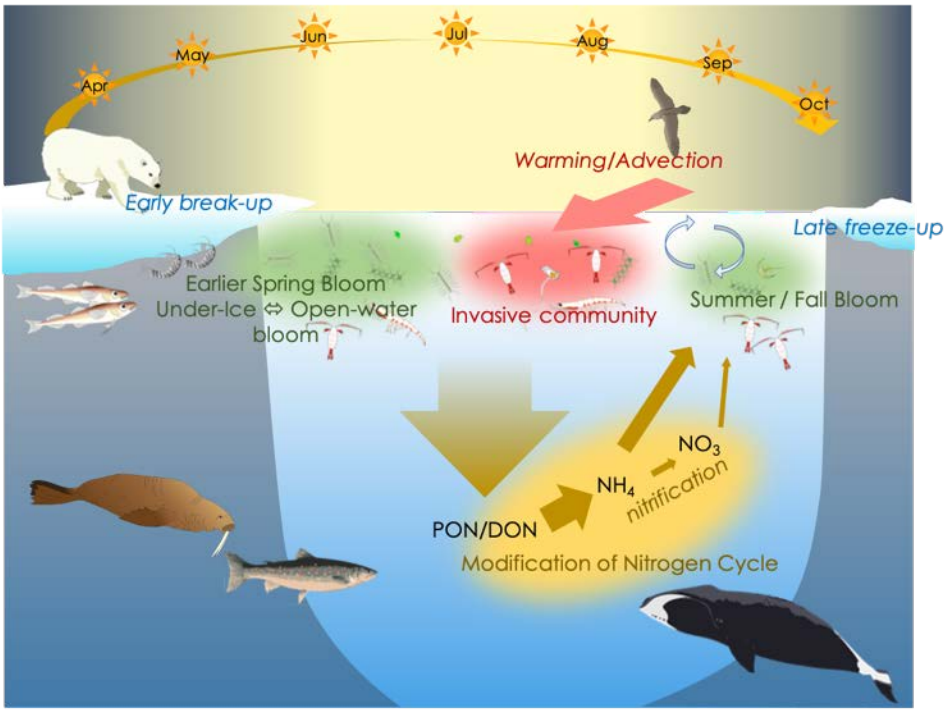

Figure 1. A schematic of the responses of lower trophic organisms to the Arctic sea ice decline that we found from the observations conducted under ArCS project.