Increased stratification and decreased primary productivity in the western subarctic North Pacific - a 30 years retrospective study -

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The Oyashio Water locating along the western edge of the North Pacific subarctic circulation is one of the most productive regions of the world oceans. Analyzing the time series data sets collected from 1970s to 1990s in the Oyashio Water, we observed a sign of alteration of physical, chemical and biological environments of the water column in the western subarctic North Pacific.

Salinity, phosphate concentration and apparent oxygen utilization (AOU) in winter subsurface layer (on isopycnals between 26.7 and 27.2) linearly increased for the 30 years, by averages of 0.0008 psu a^{-1}, 0.9 µmol l^{-1} a^{-1} and 0.005 µmol kg^{-1} a^{-1} respectively. At the same time, salinity and phosphate of winter surface mixed layer decreased. Increase of density gradient between the surface and subsurface suggested that upper water column stratification be intensified to retard vertical water exchange during the period. Net community production, which was estimated from the phosphate consumption from February through August, also declined by an average of 0.51 gC m^{-2} a^{-1} for the decades. Average springtime diatom abundance (cell number) decreased one order of magnitude while that of wintertime more than doubled during the 30 years, consistent with the multi-decadal decreasing trend of net community production. Nevertheless, no negative influence was observed in secondary production. As for dominant herbivorous zooplankton, *Neocalanus plumchrus*, the abundance increased, maturity timing was shifted earlier by ca. 30 days and the prosoma length increased by ca..3% for 20 years after 1980.

In the Oyashio Water, extensive phytoplankton spring bloom is reported to occur when the surface water becomes stratified to form a stable, shallow mixed layer with sufficient nutrients supplied during winter. Our results suggested that attenuation of winter vertical water mixing limited nutrient supply to the level decreasing winter-summer net community production for these 3 decades. With the fact of doubled wintertime diatom abundance, it is speculated that earlier stabilization of the mixed layer might have gradually expedited the timing of phytoplankton bloom. This condition might have allowed zooplankton to effectively utilize phytoplankton from earlier timing, resulting in its apparent abundance increase, although further investigation should be made to clarify the link between primary and secondary productions.