Geographical and temporal variations in mesozooplankton biomass around Japan, western North Pacific

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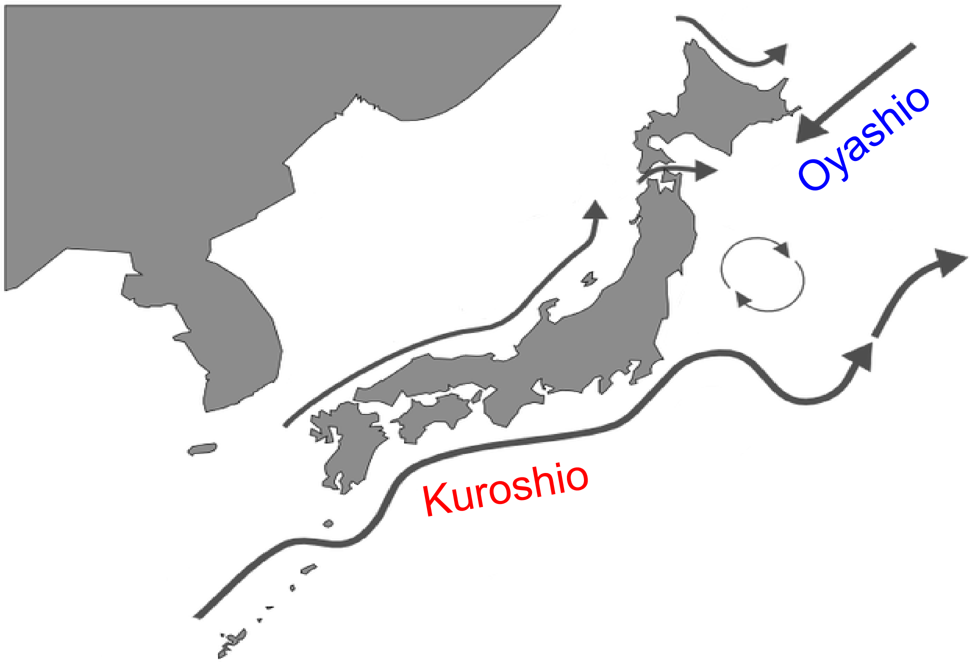
The complex oceanographic conditions is formed around Japan.

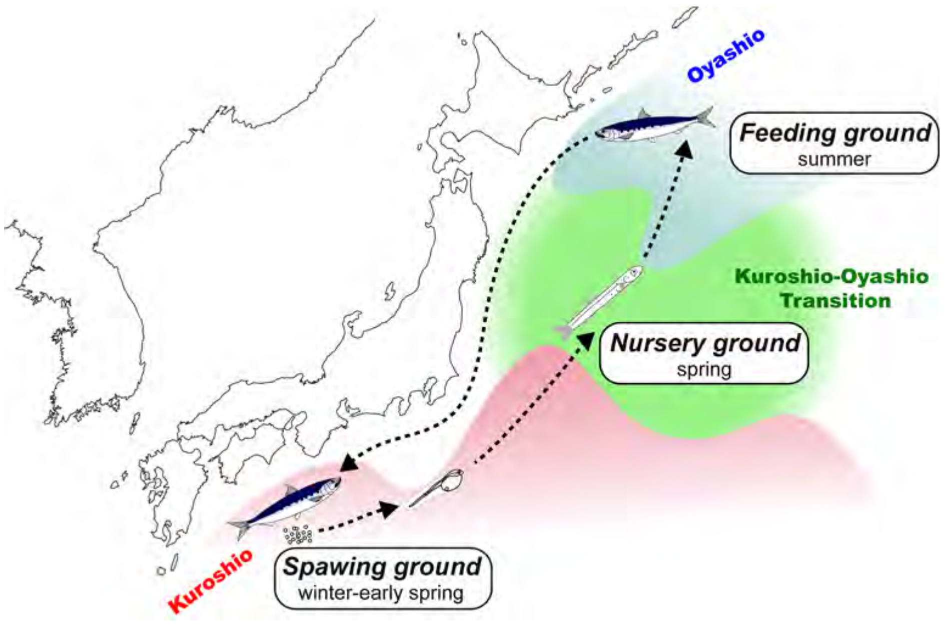


- Major two currents
- Meso-scale eddies
- subtropical and subarctic waters exits in narrow latitude.
- Open ocean and marginal seas

Zooplankton ecosystem strongly related to oceanographic conditions. As the result complex zooplankton ecosystem is formed.

Importance of the zooplankton study for understand the variation in pelagic fish stocks

Life history of Japanese sardine



- Pelagic fishes utilize the different oceanographic waters according to their growth stages.
- Change in the stock size were considered to be related to zooplankton.

To considered the variation the fishes, It is important to understand the spatial and temporal variation of zooplankton around Japan

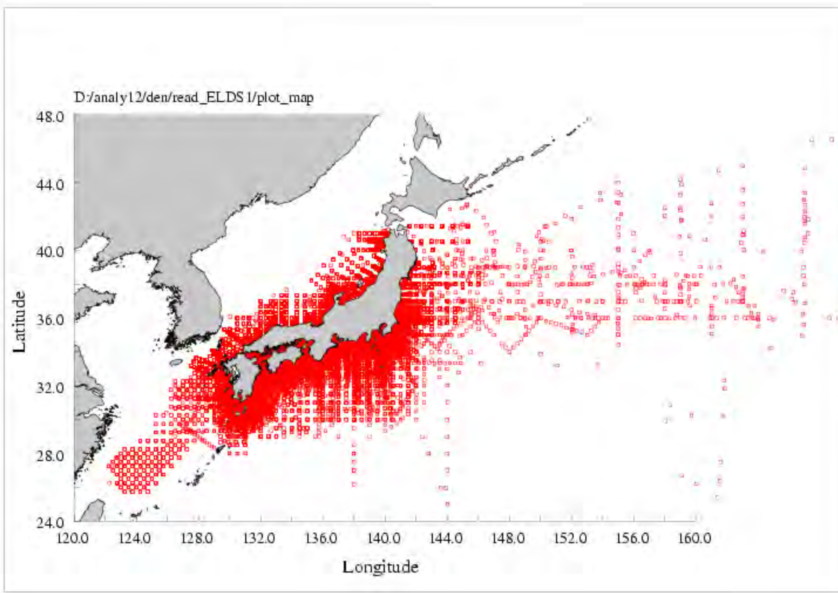
Contents

- Horizontal distribution of mesozooplankton biomass around Japa
- Seasonal variations of the biomass.
- Decadal scale variations in mesozooplankton biomass.

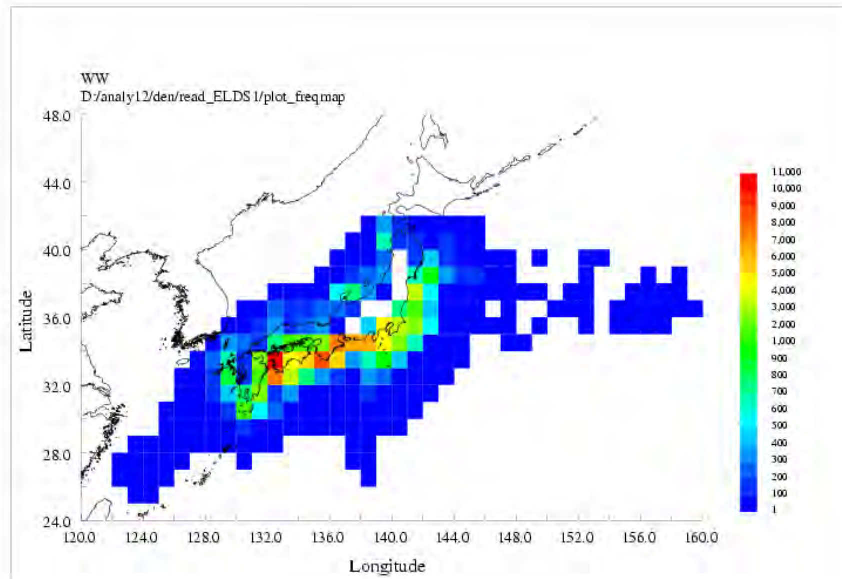
Materials: Data of Zooplankton biomass

- Data Wet weight of mesozooplankton (g m^{-2})
- Plankton nets NORPAC or Marutoku net （mesh size 0.330-0.335mm）
- Sampling Layer 0m-150m or 0m-sea floor (150m > sea floor depth)
- Period 1978-2007
- Total No. of data 123558

Plot of all data



No. of data in each grids (1° ×1° degree)



Materials: Chl-a and Nitrate

Chl-a

- Sensor SeaWiFS (Chl-a g m^{-2})
- Period 1998-2010
- Resolution monthly mean value of each 1° ×1° grids

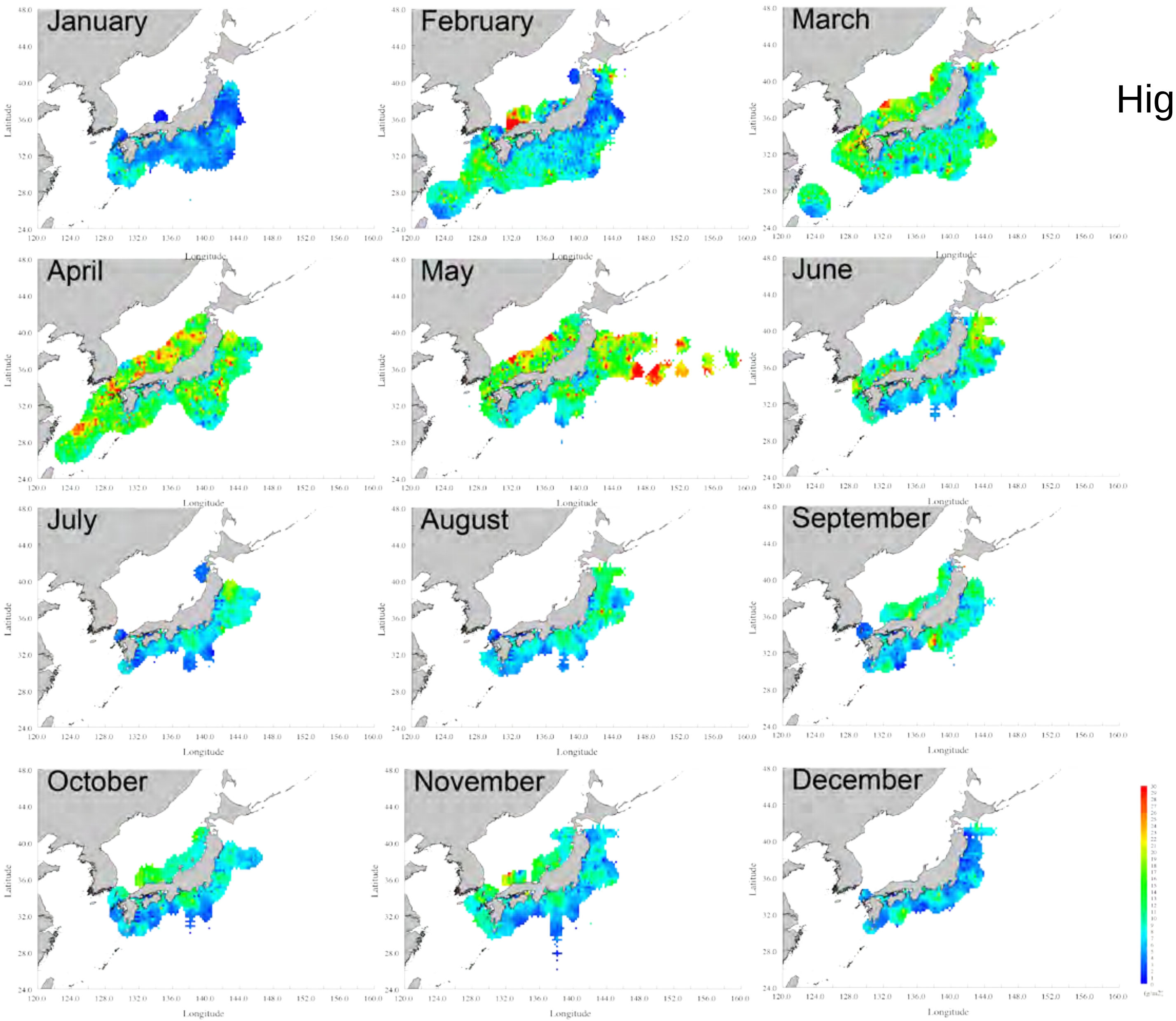
Nitrate*

- Collected by Japan Meteorological Agency
- Period 1965～2010, Winter (January-March)
- Sampling layer 0-30m
- Resolution monthly mean value of each 1° ×1° grids

*The data were composited by Prof. T. Fujiwara.

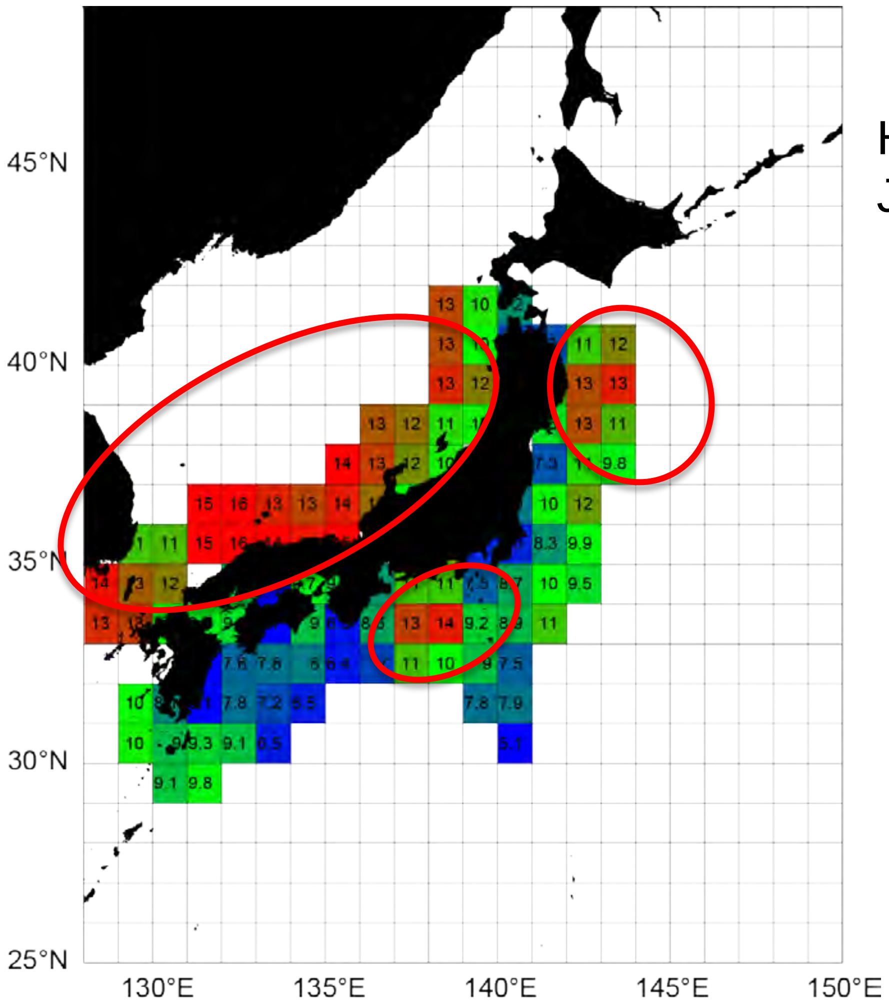
Horizontal variation of zooplankton biomass

Horizontal variation of monthly mean zooplankton biomass



High biomass appeared

Mean zooplankton biomass (May-June, September-November)



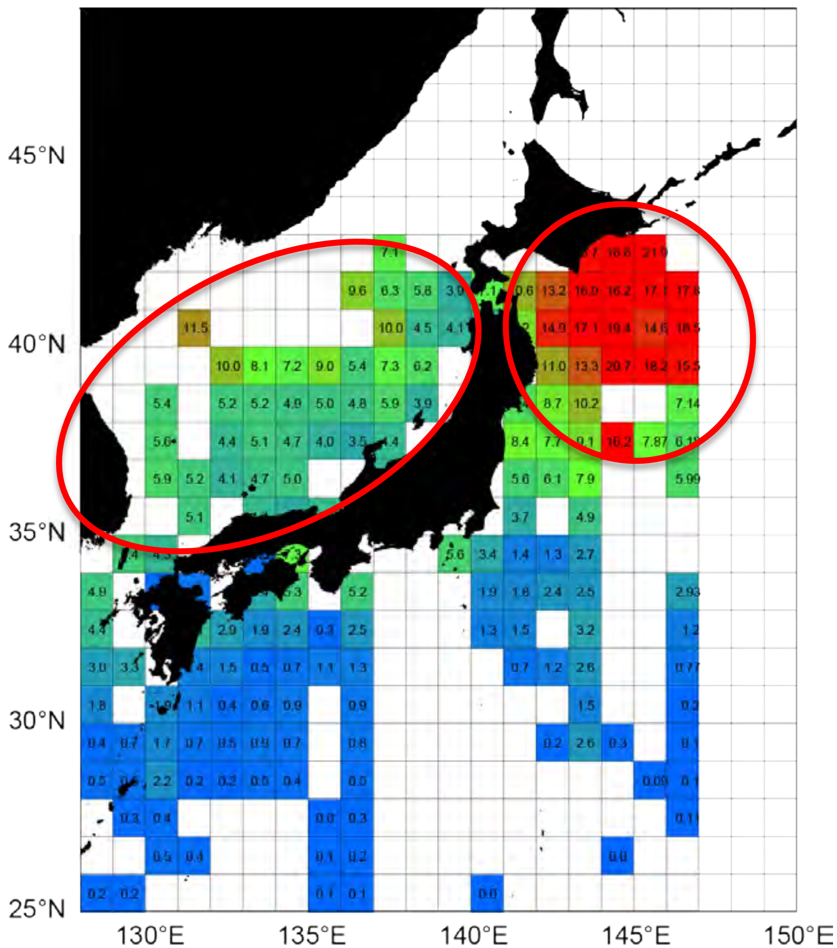
Wet weight (g m^{-2})

High biomass appeared in the Sea of Japan and offshore waters of the Tohoku.

Mean NO_3 and Chl-a concentration

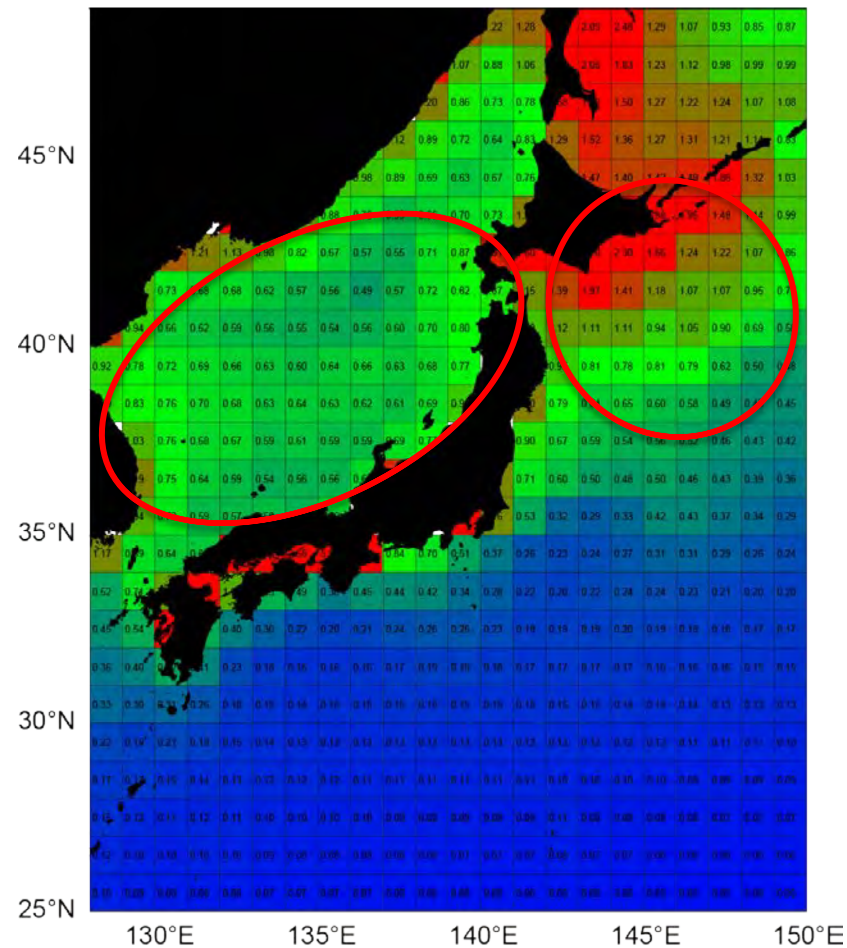
NO_3

(mean Jan.-May in 0-30m)



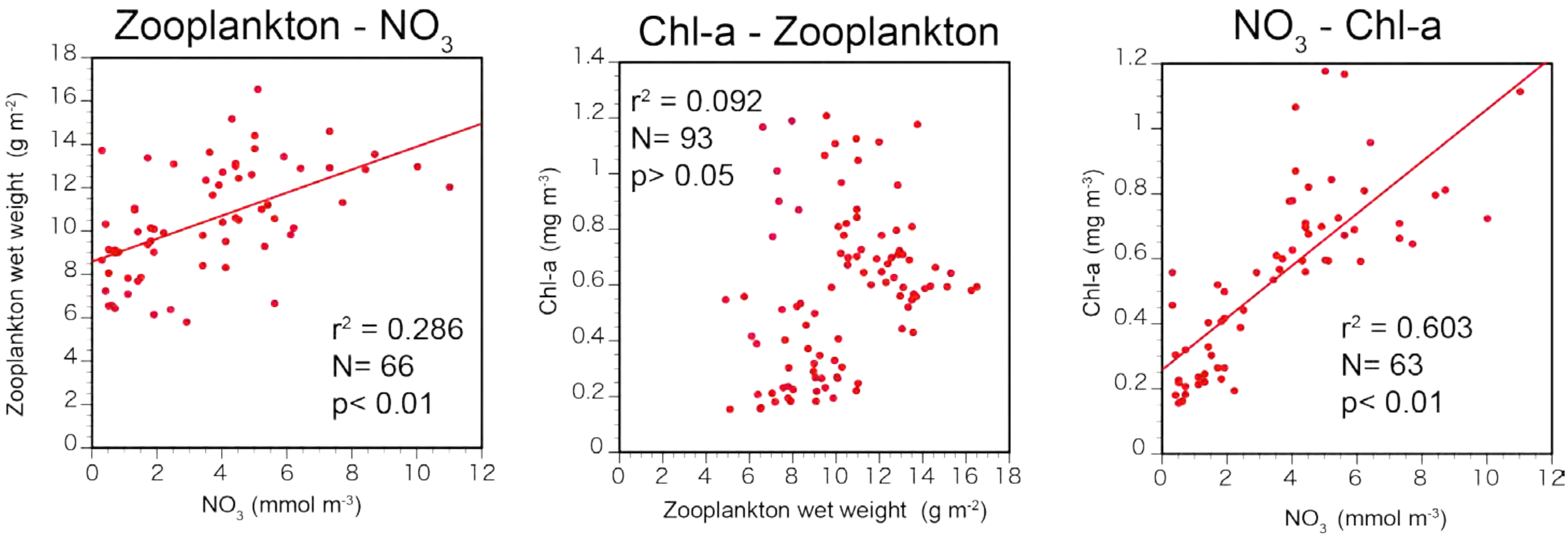
Chl-a

(mean May-June, September-November)



High values appeared in the Sea of Japan and Oyashio waters for the NO3 and Chl-a

Relationship between NO_3 and zooplankton biomass / Chl-a.

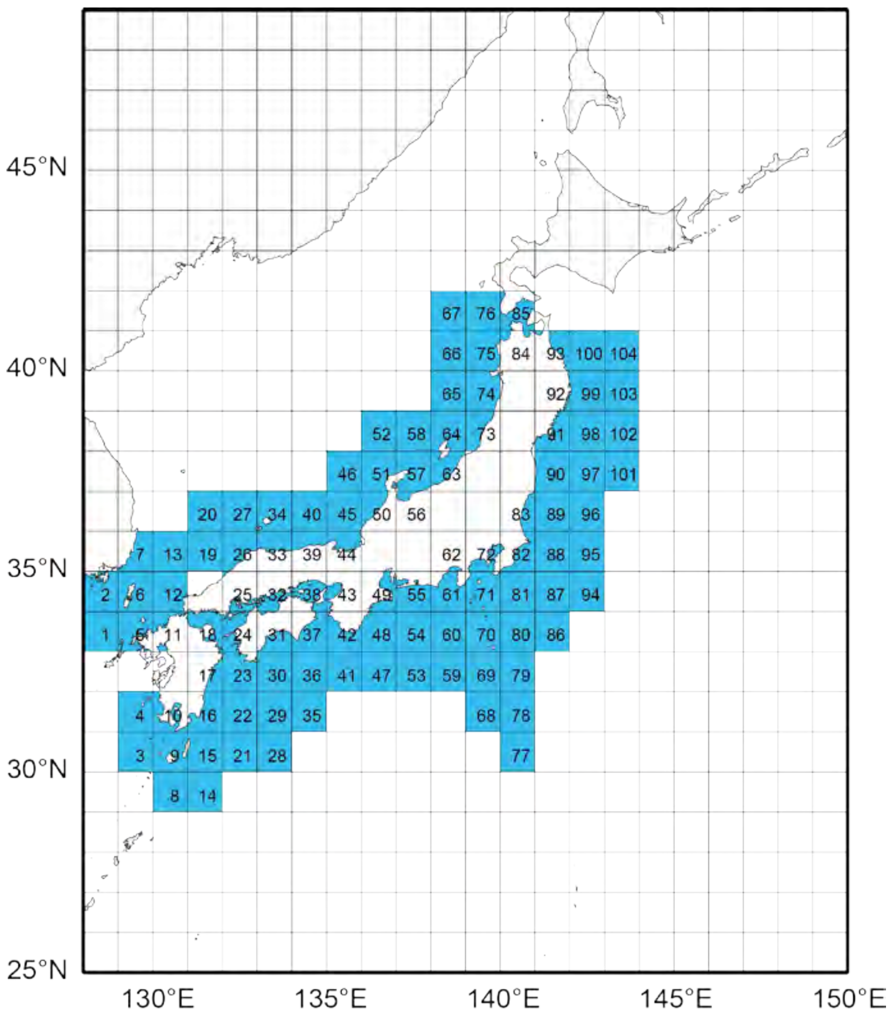


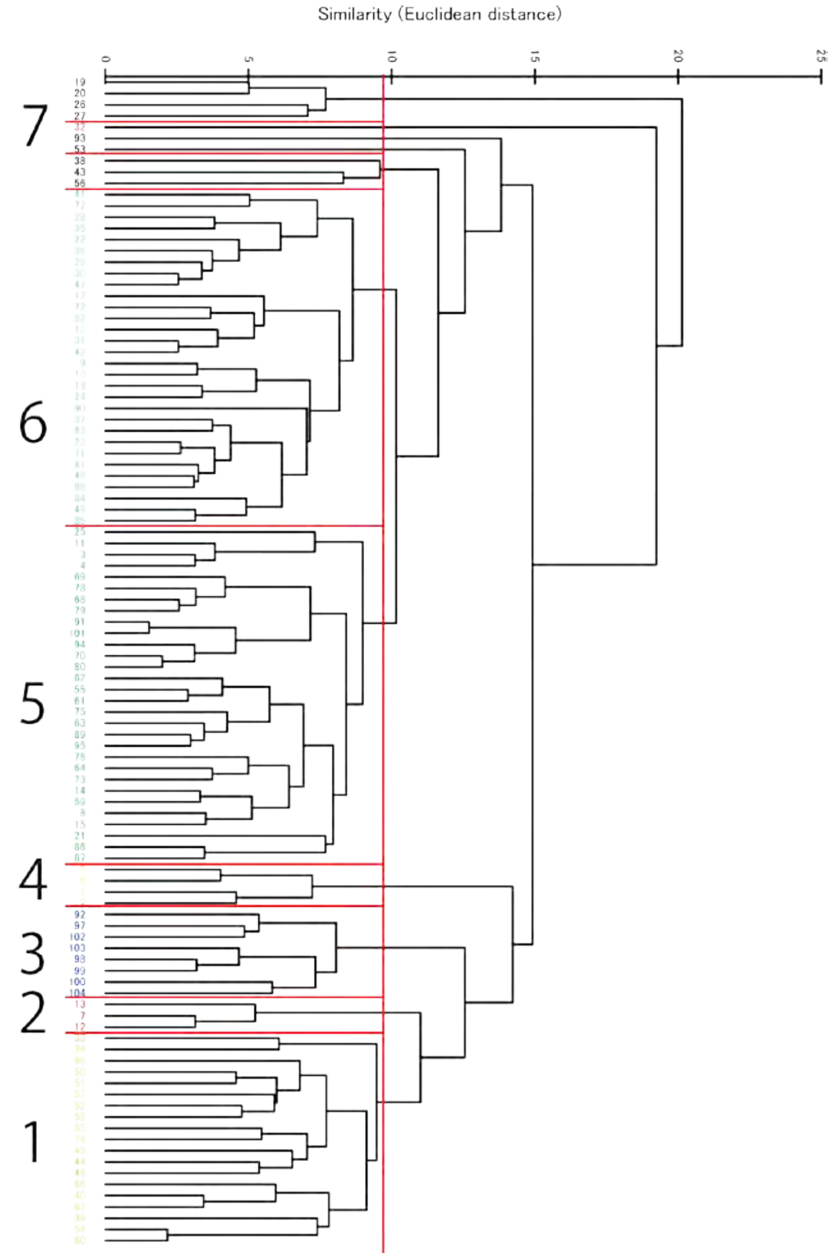
(May-June, September-November)

Nitrate had positive relationship with zooplankton biomass / Chl-a.
This suggests Nitrate concentration related to the horizontal distribution of the primary and zooplankton productivity around Japan.

Seasonal variation of zooplankton biomass

Grouping of the grids Cluster analysis

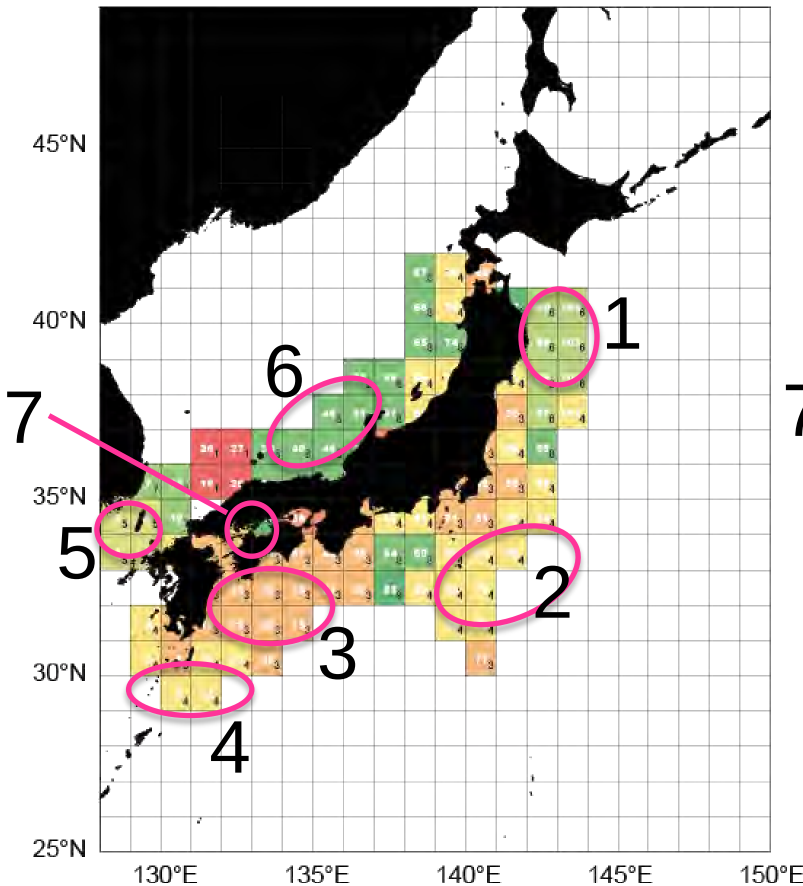




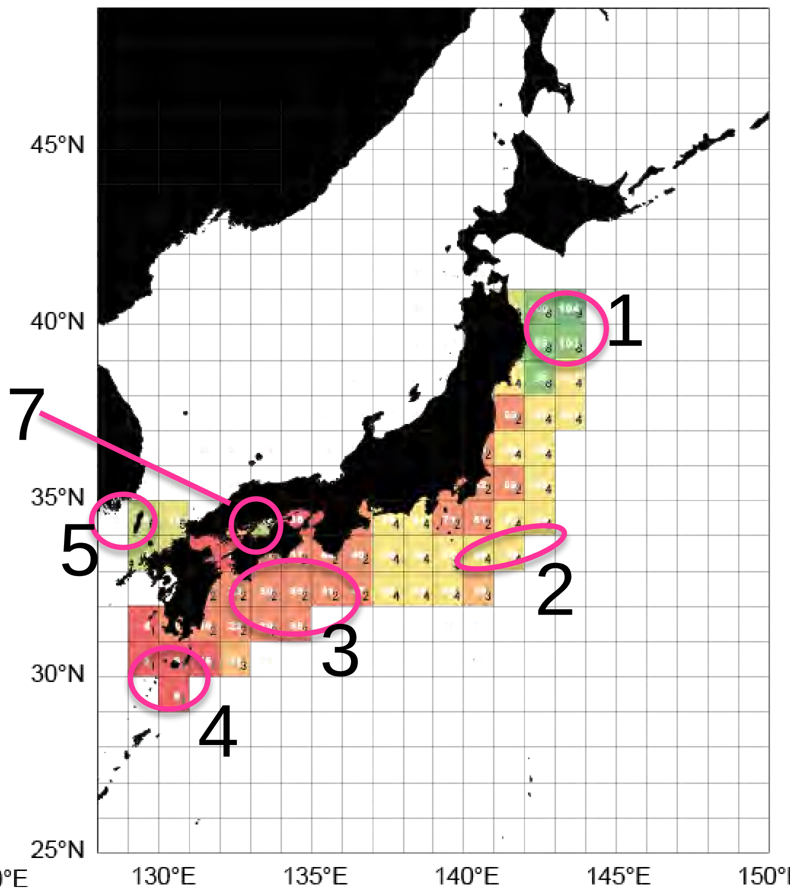
Divided to 7 groups

Grouping of the grids

Result from Spring and Autumn data

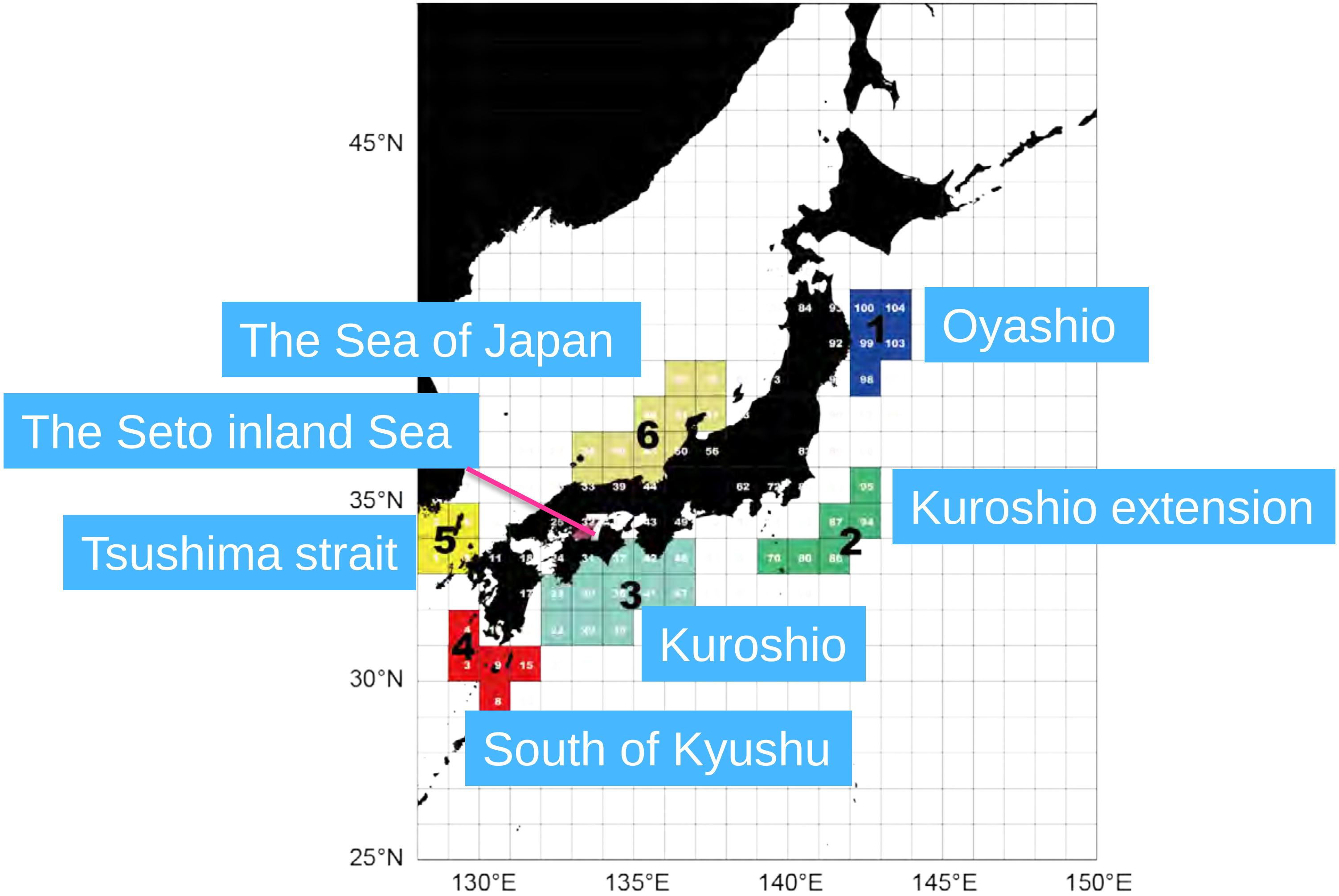


Result from year round data

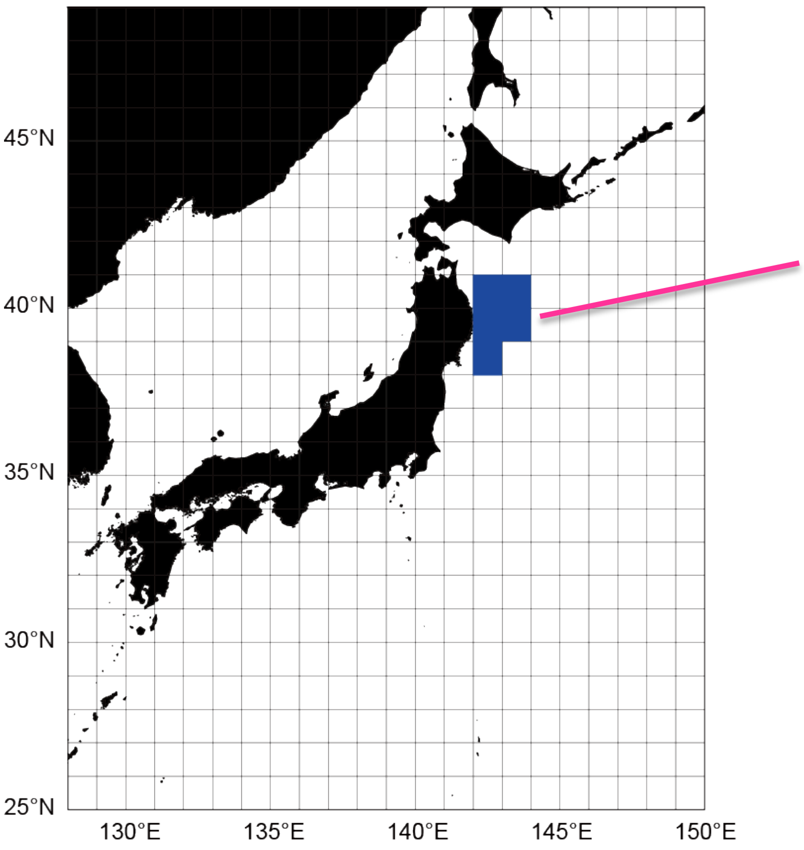


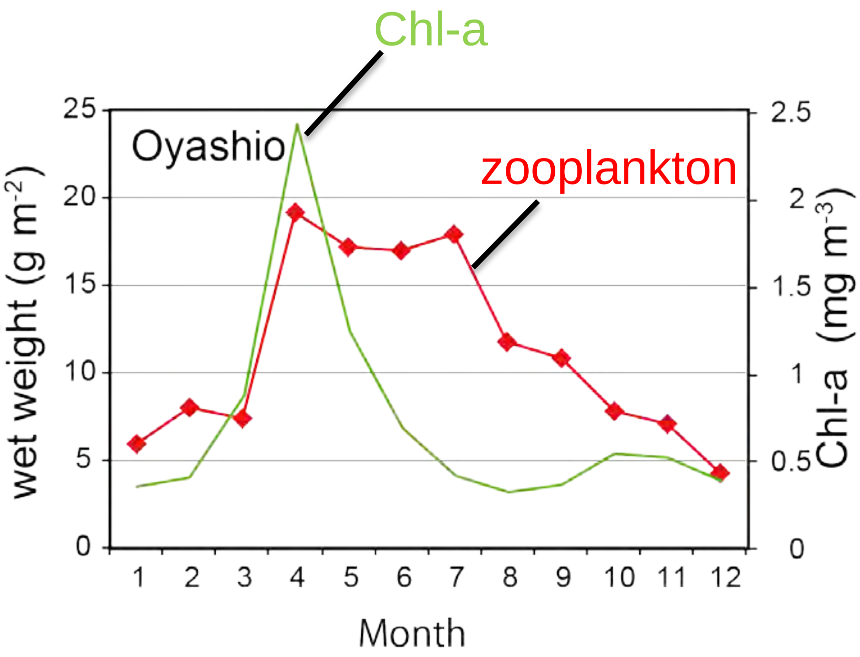
We grouped 7 waters around Japan based on Spring and Autumn data.
We also confirmed the result by using the year round data.

Grouping of the grids



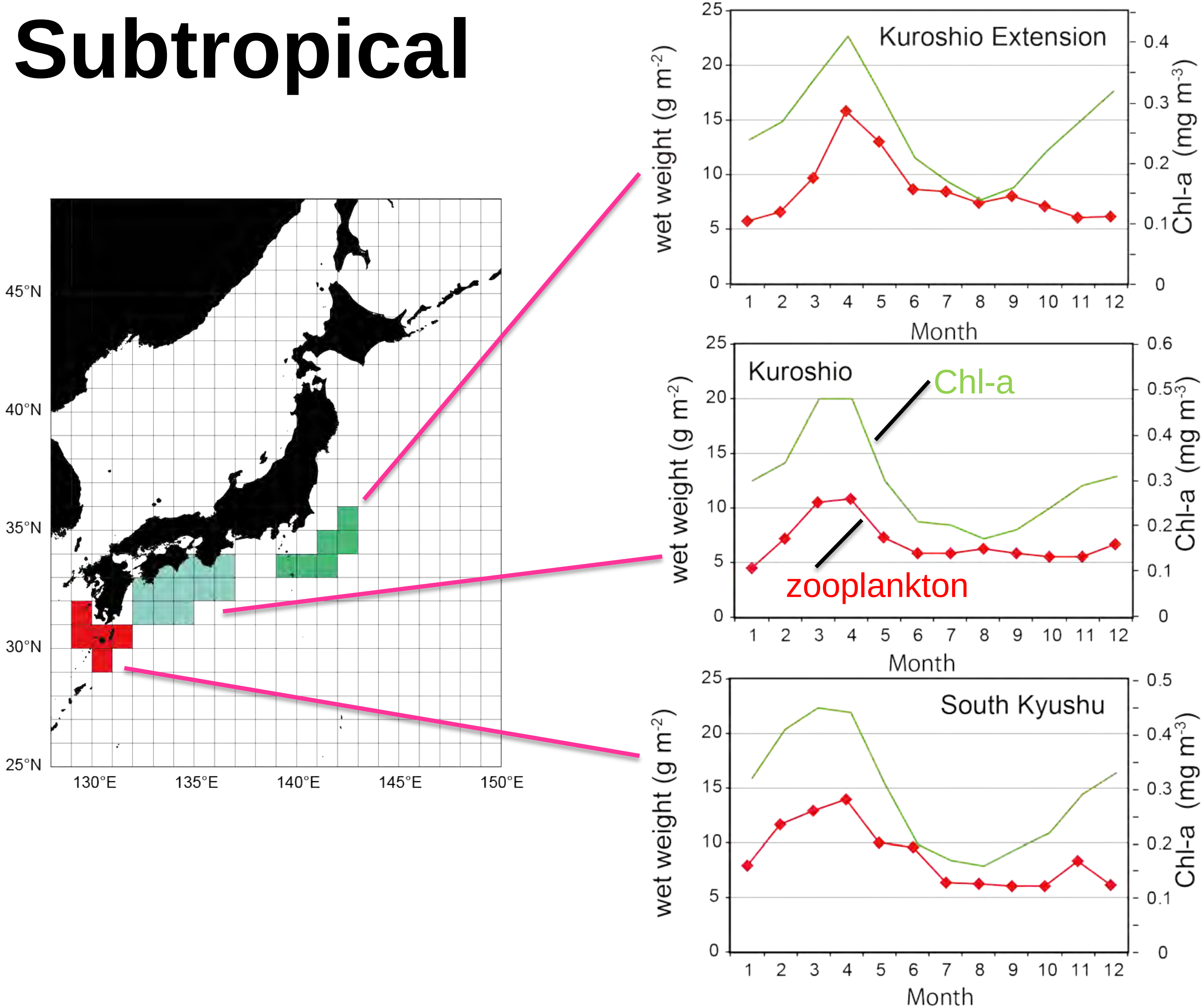
Subarctic



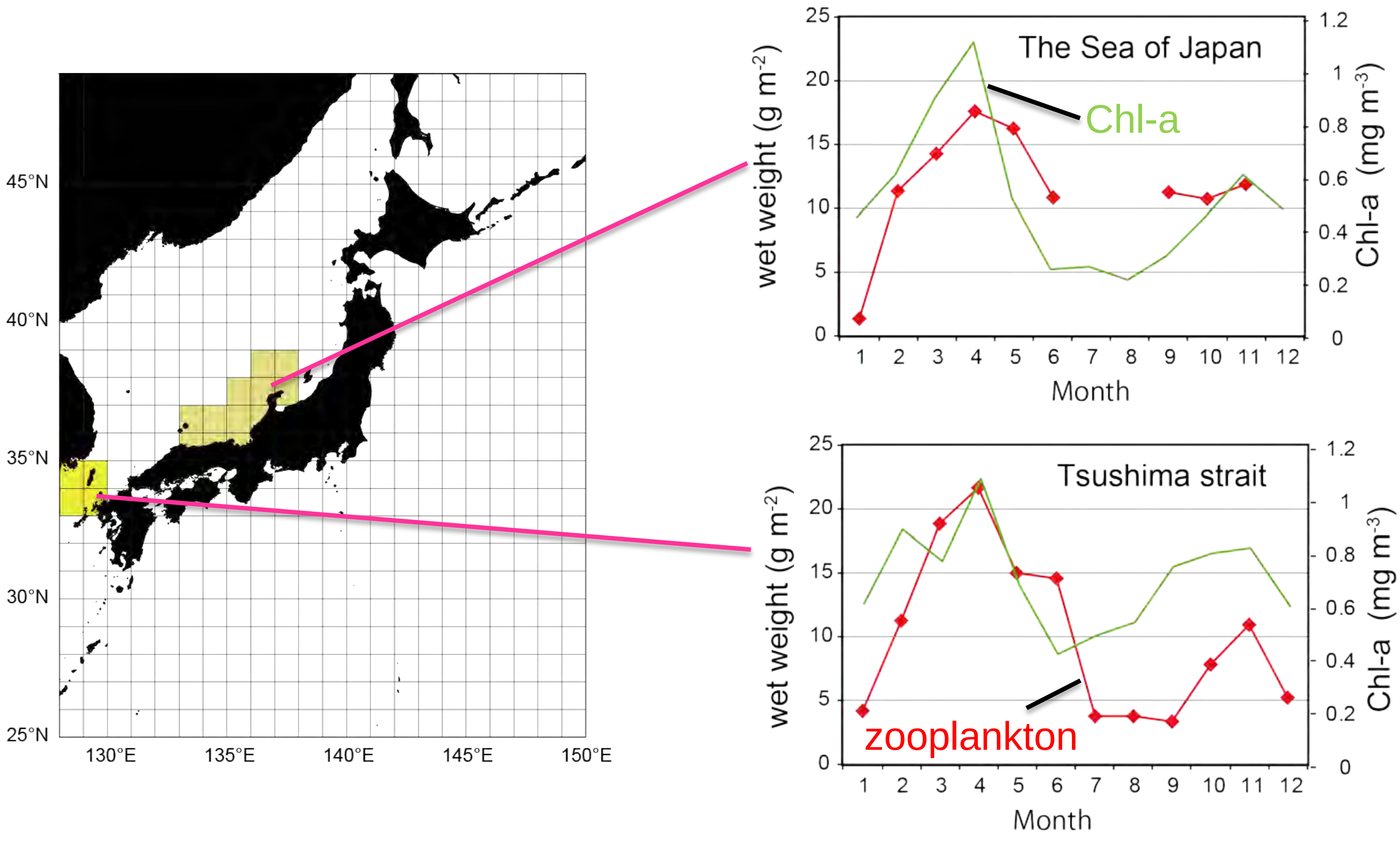


Biomass increased in April.
High biomass appeared from April to July.

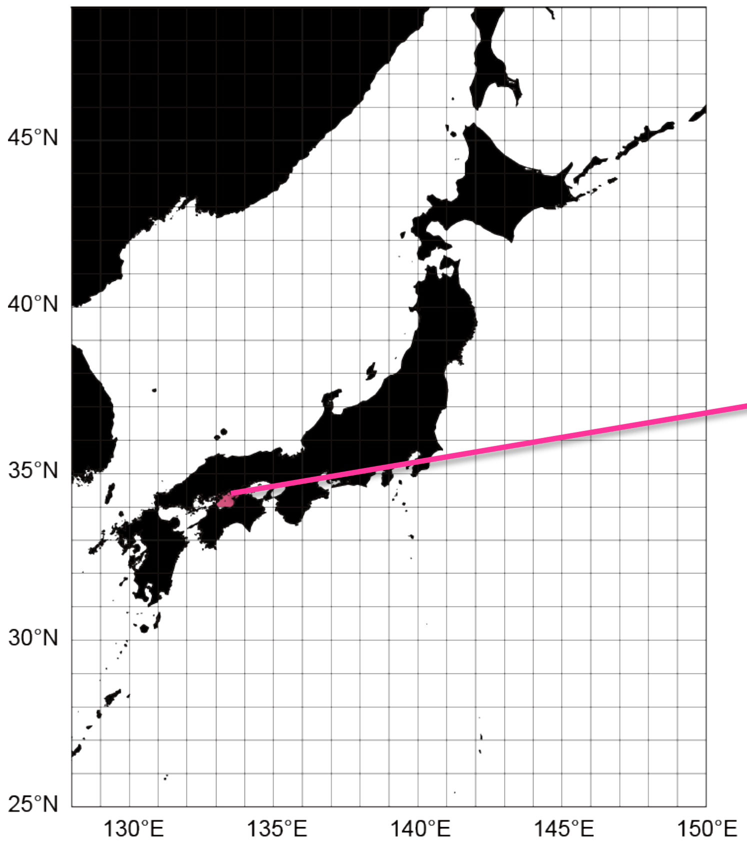
Subtropical

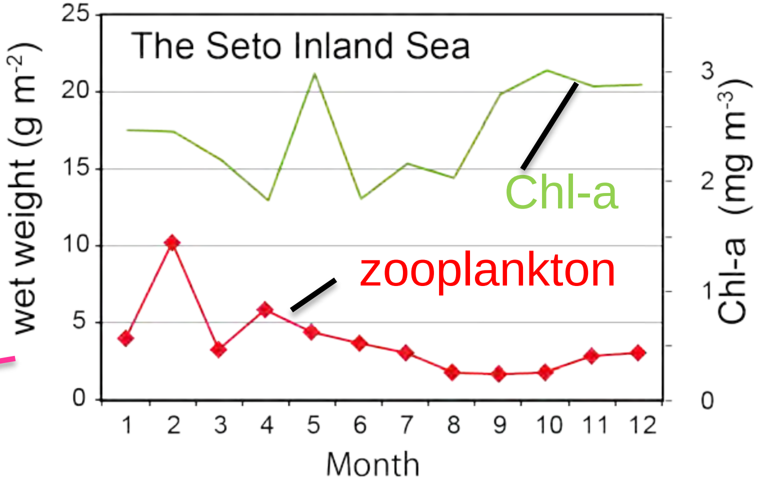


Tsushima strait and The Sea of Japan



The Seto Inland Sea





Comparison of annual mean value of zooplankton biomass Chl-a and NO_3 among waters

Mean biomass and concentration

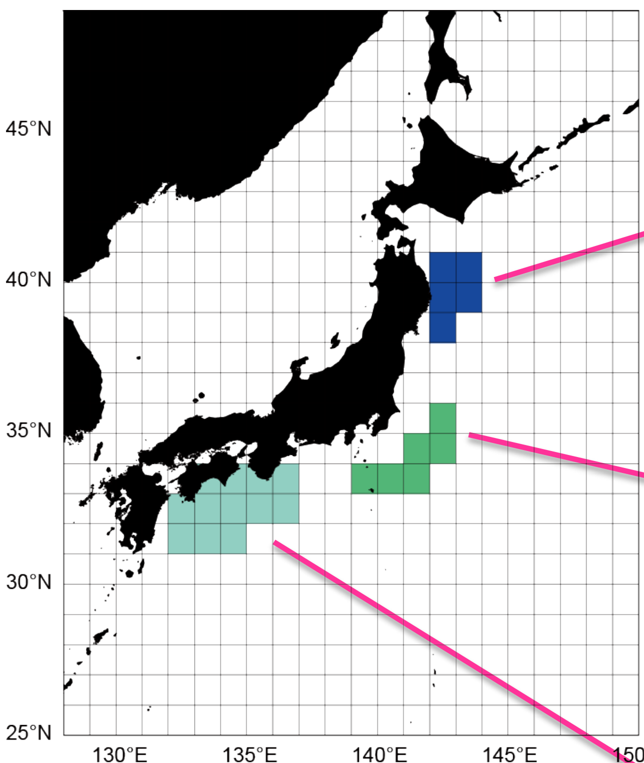
	Annual mean		Winter	Peak month	
	Zooplankton	Chl-a	NO_3	Zooplankton	Chl-a
Oyashio	11.2	0.72	8.6	4	4
Kuroshio extension	8.5	0.26	1.6	4	4
Kuroshio	6.8	0.29	1.2	3	3 & 4
South Kyushu	8.7	0.29	1.0	4	3
Tsushima strait	10.0	0.71	4.0	4	4
The Sea of Japan	11.7*	0.52	4.1	3	4
The Seto Inland Sea	3.7	2.46	-	2	5

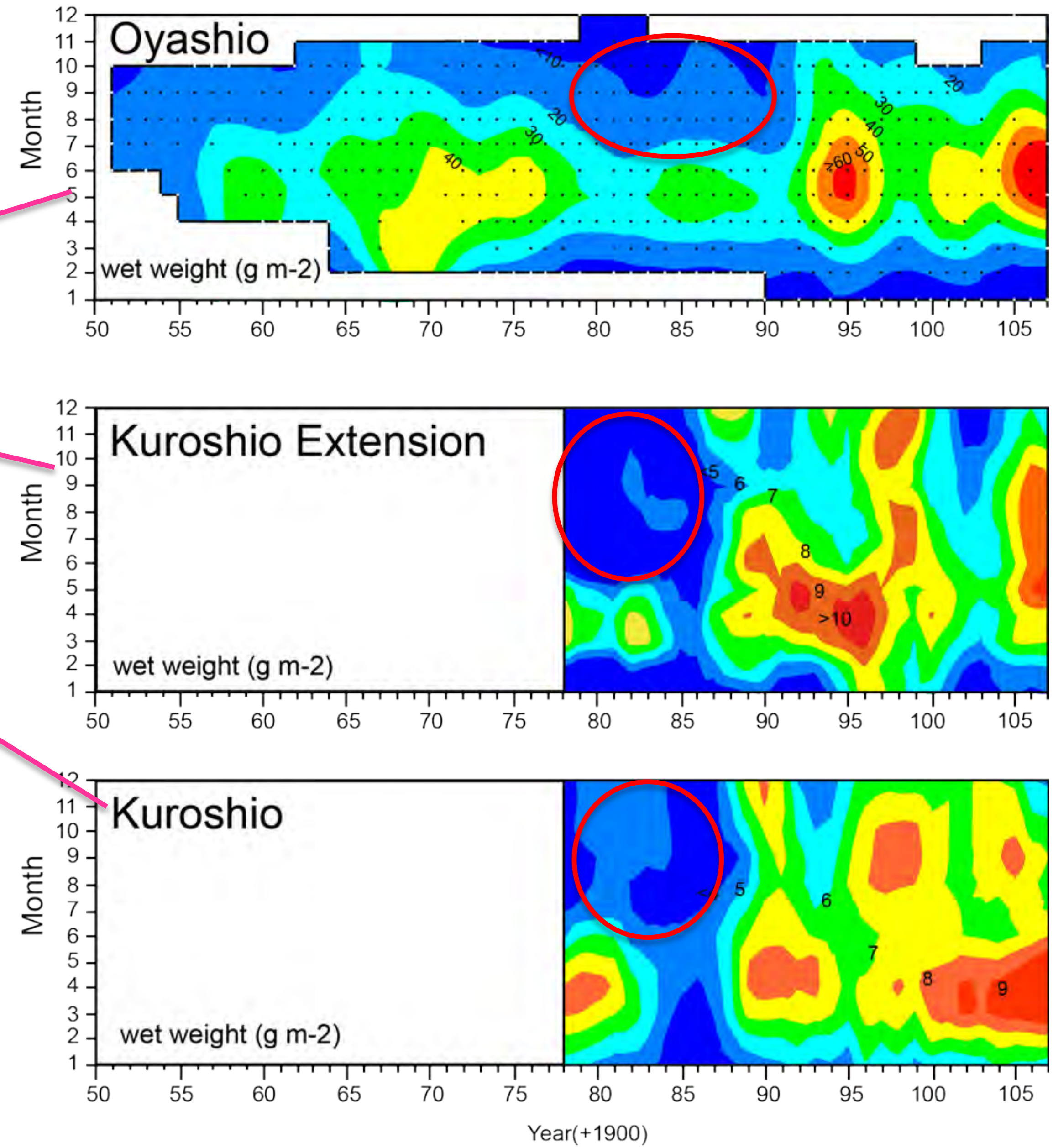
Units

Zooplankton	$g\ m^{-2}$
Chl-a	$mg\ m^{-3}$
NO_3	$mmol\ m^{-3}$

Decadal scale variations

Decadal scale variation in the three waters



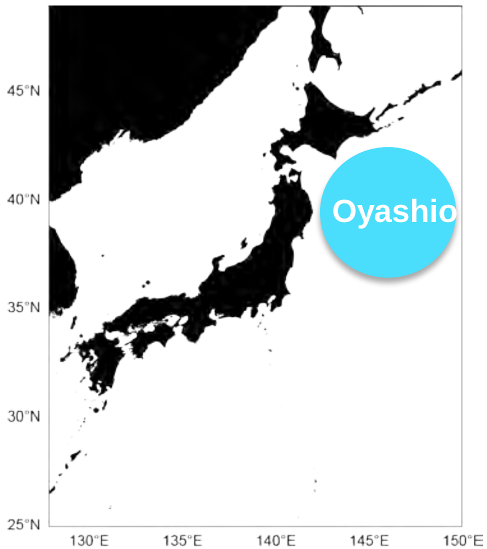


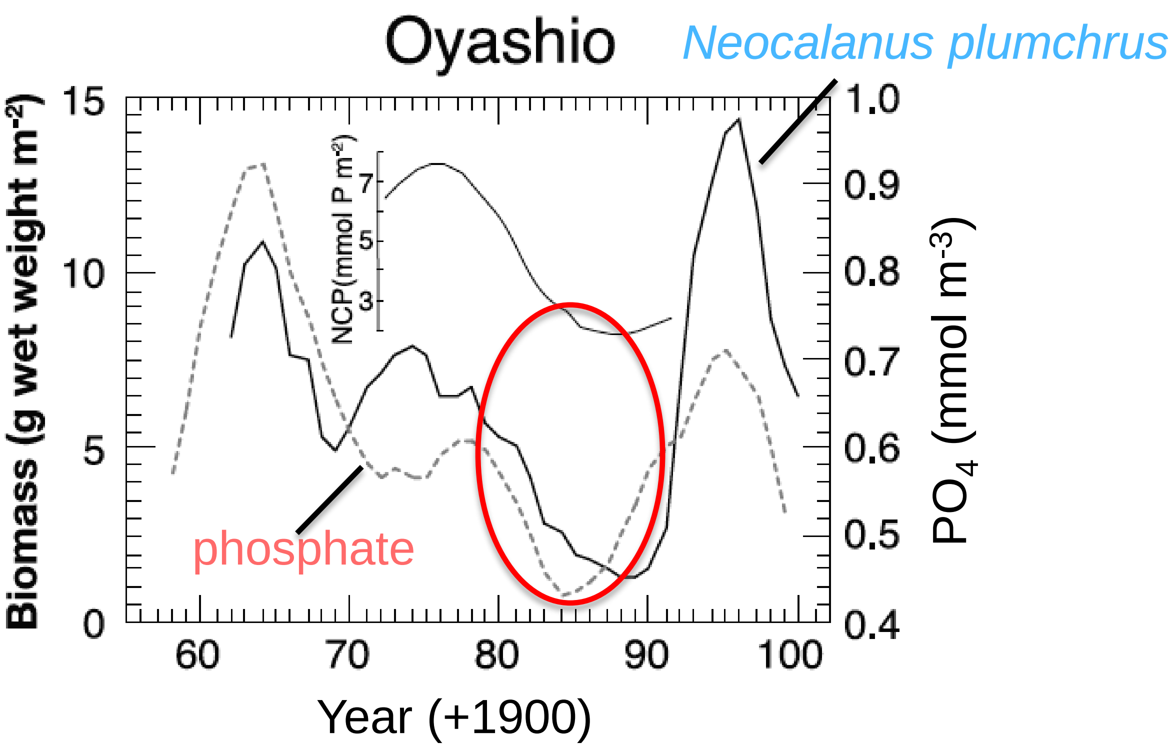
- Oyashio
  Low biomass appeared from late 70s to late 80s.
- Kuroshio & Kuroshio Extension
  Low biomass appeared from late 70s to mid 80s.

Possible mechanism of variation of zooplankton biomass

Nutrients supply change

Relationship between phosphate concentration and biomass of *Neocalanus plumchrus* in the Oyashio waters.

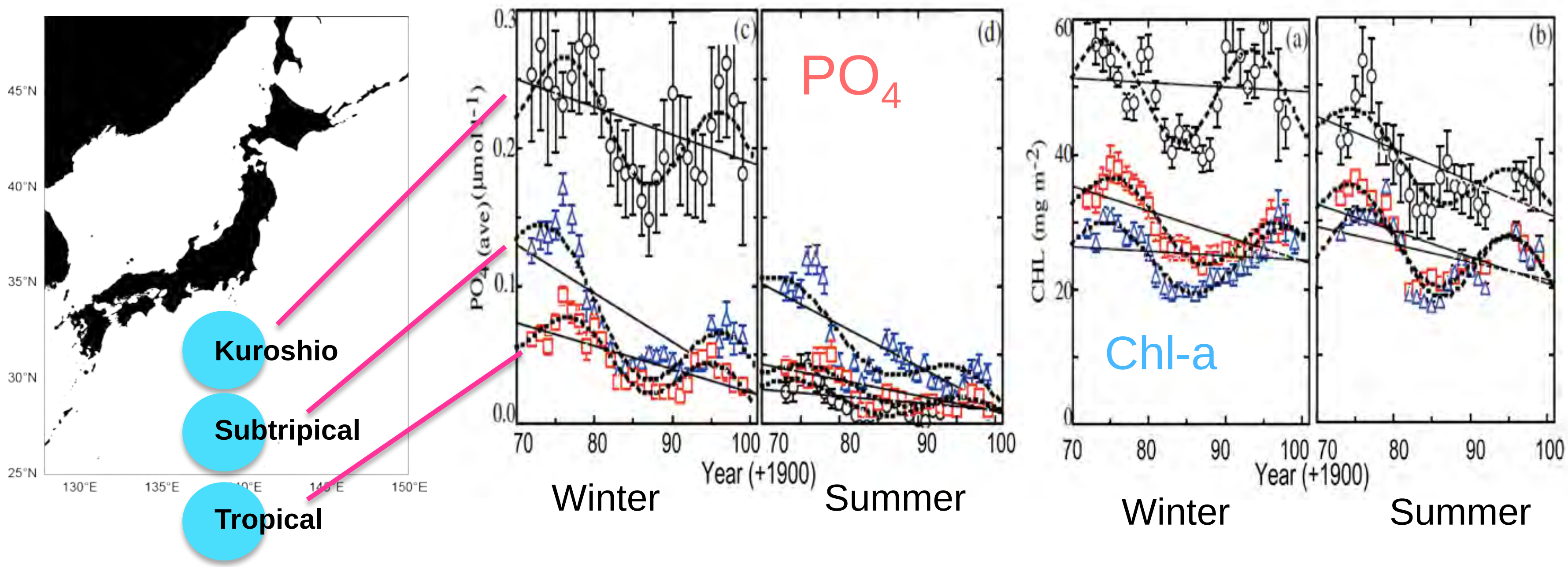




Tadokoro et al., (2009)

Possible mechanism of variation of zooplankton biomass

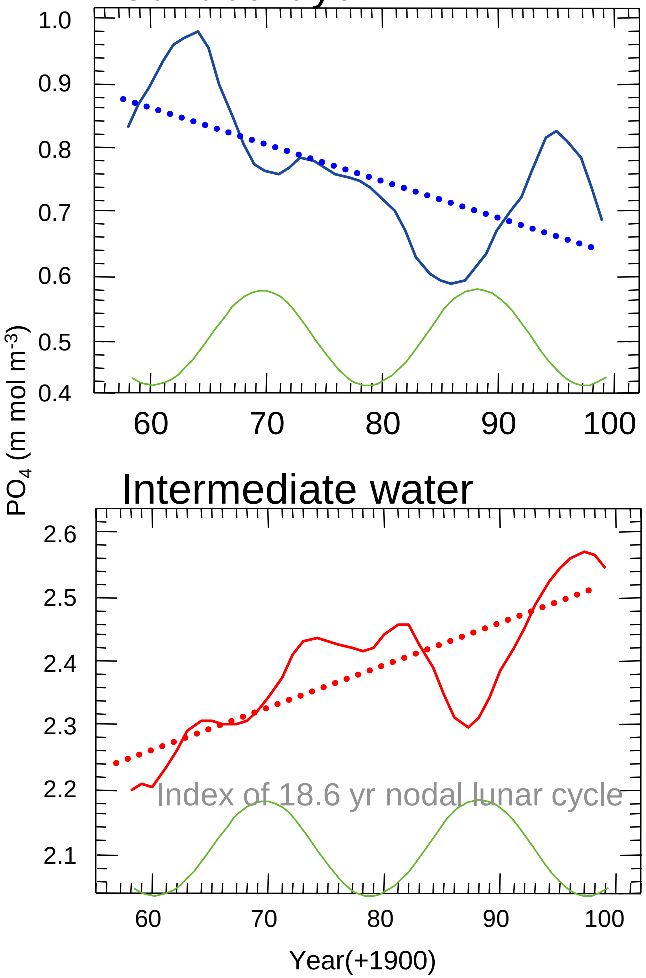
Nutrients supply change



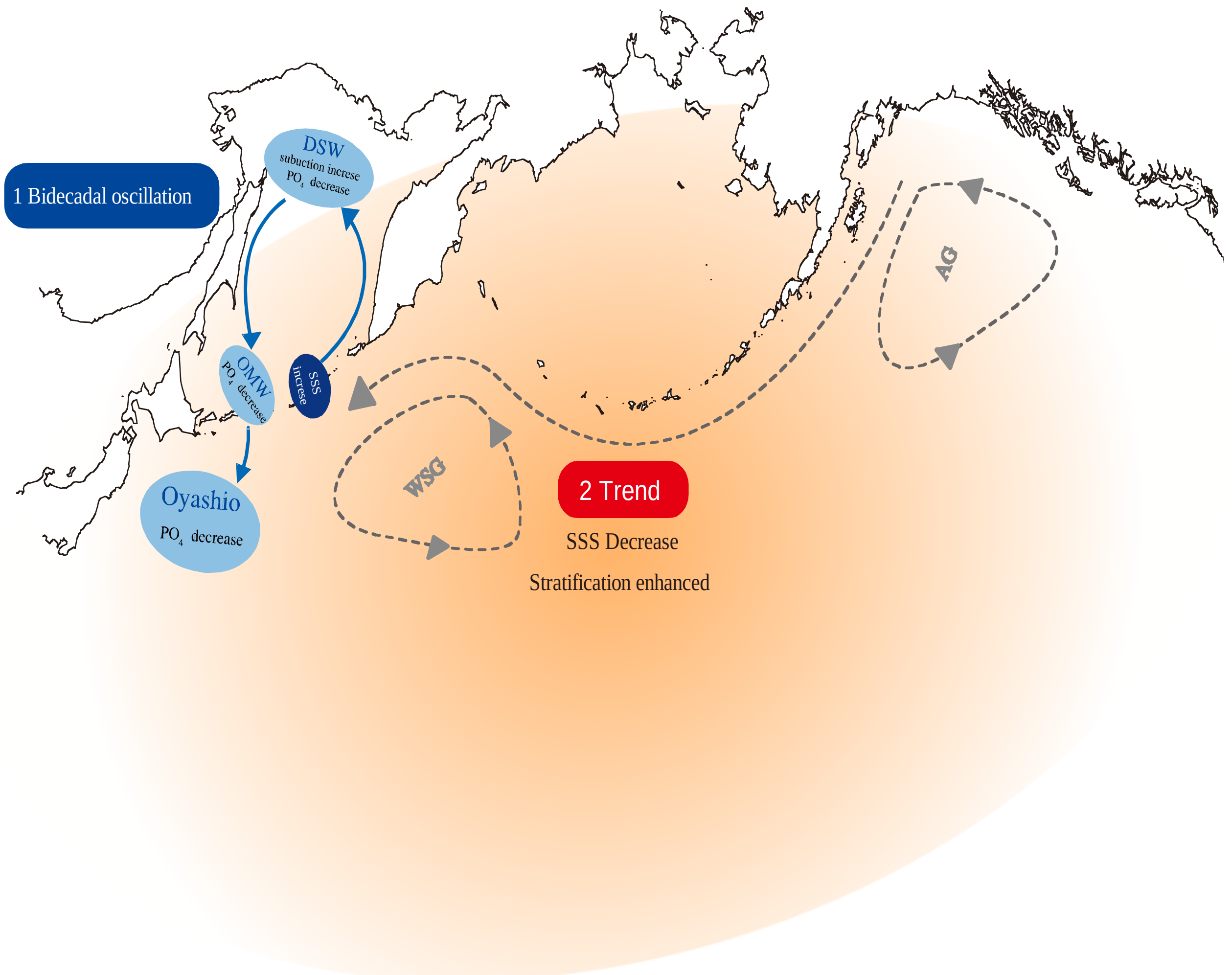
Phosphate decreaesd in 80s in the Kuroshio waters.

Watanabe et al., (GRL. 2005)

Possible mechanisms of decadal scale variation in PO_4



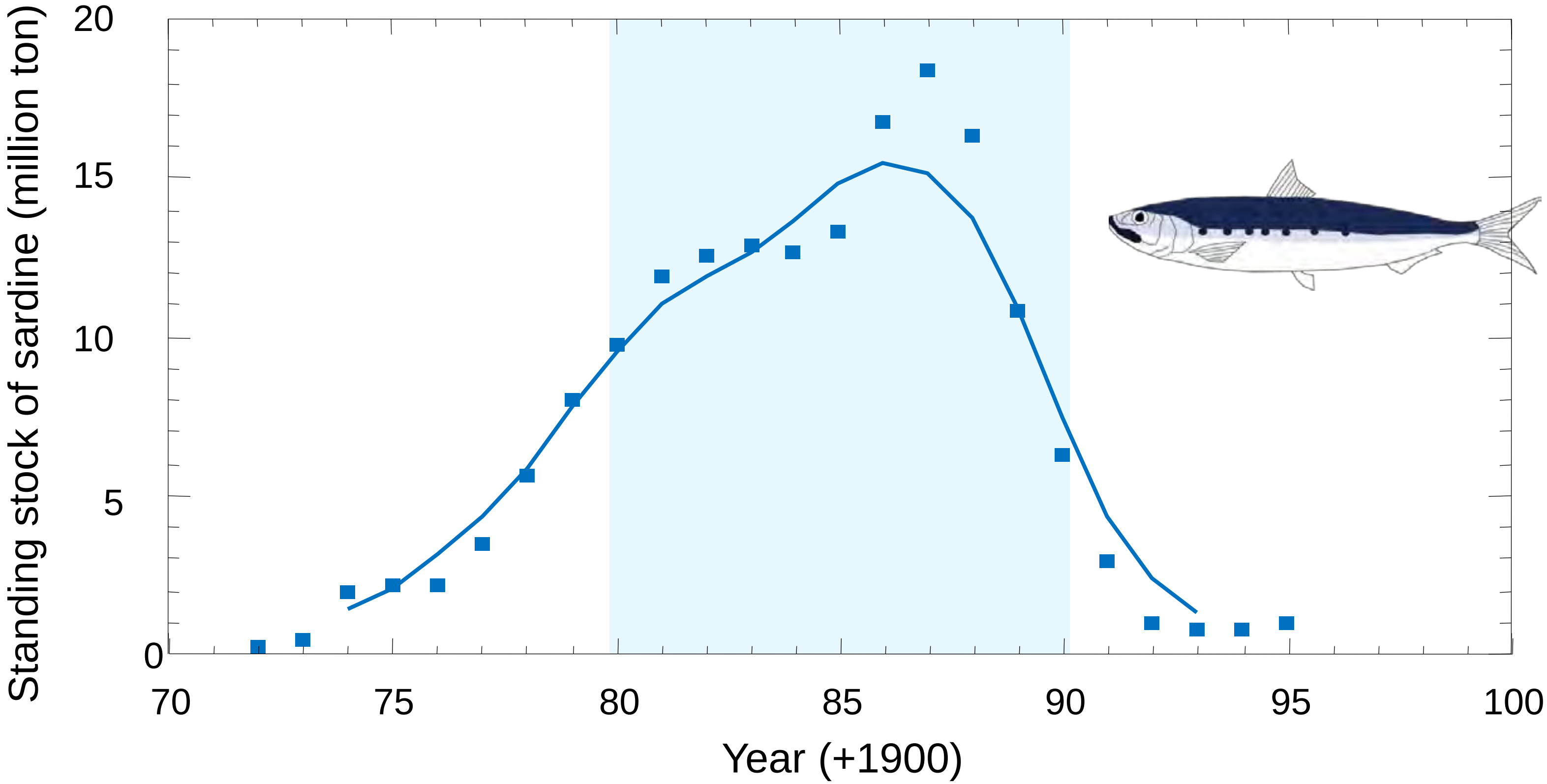
Bidecadal oscillation: 18.6 yr tidal oscillation by nodal lunar cycle



Possible mechanism of variation of zooplankton biomass

Feeding pressure of Japanese sardine

Feeding rate of Japanese sardine was estimated
32-138% of *Neocalanus* production rate in 1984 in the Oyashio



Tadokoro et al. (2005)

Summary

Horizontal distribution & Seasonal variations

Horizontal distribution

- High biomass appeared in the Oyashio, Tsushima Strait and the Sea of Japan.
- The biomass had positive relationship with NO_3.

Seasonal variations

- We classified the seven waters around Japan.
- Timing of Increasing of the zooplankotn biomass is different among waters.

Start timing of the biomass is February in the marginal Seas (), is March in the subtropical waters, and is April in the Oyashio.

Summary: Decadal scale variations

- The low zooplankton biomass appeared in late 1970s-mid 1980s in the Oyashio, Kuroshio extension, Kuroshio warers.

- The two mechanism were considered to the low biomass.

1 The decrease in nutrient supply might affect the productivity of zooplankton due to decrease the primary production.

2 The feeding pressure of Japanese sardine might decrease the zooplankton biomass.