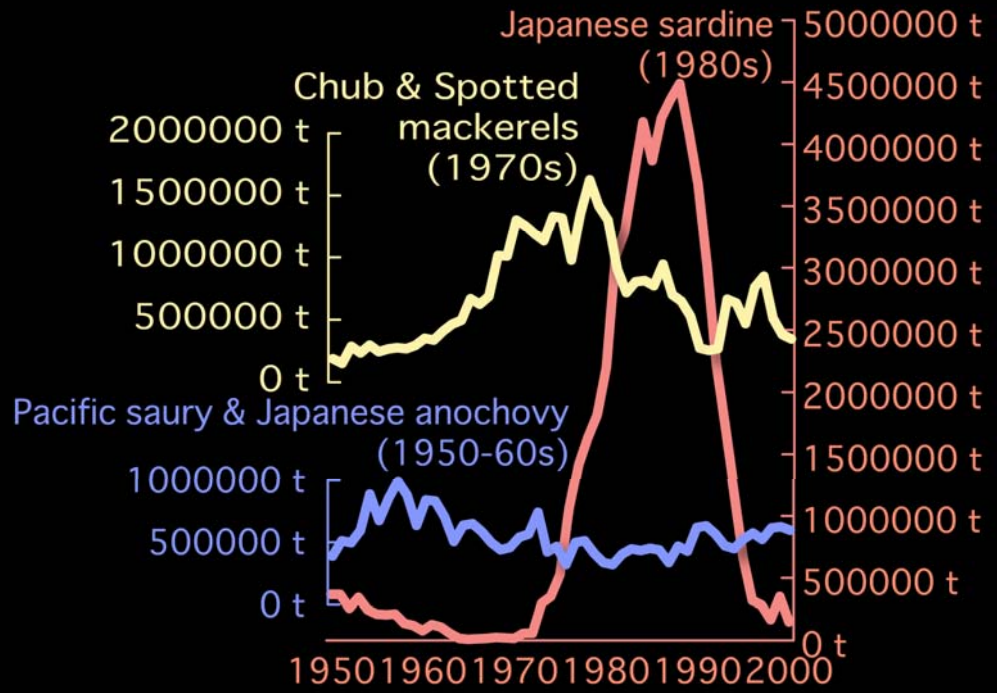
S6-3148

Species replacement between Japanese sardine and Pacific saury in relation to variation in feeding environment

Haruka Nishikawa and Ichiro Yasuda

Ocean Research Institute, University of Tokyo

Species replacement in the Northwestern Pacific



Catches of small pelagic fishes (Kawasaki, 1993)

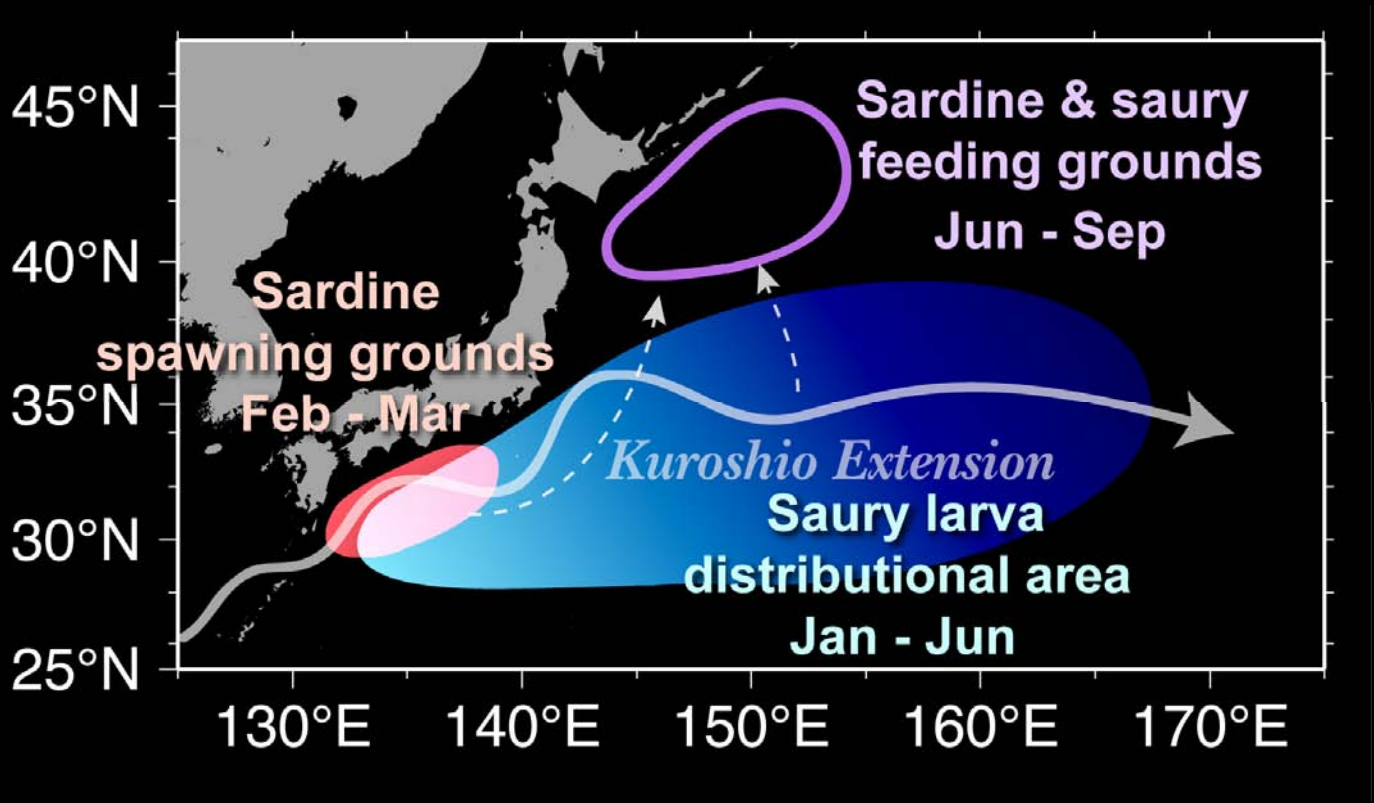
- Species replacement goes on **saury & anchovy**, **mackerels**, and **sardine**, in that order
- Fluctuation of sardine resources is drastic
- Recent replacement occurred in 1988 from sardine to saury

Previous works on sardine and saury fluctuation

- Japanese sardine larval mortality is significantly correlated with winter SST in the Kuroshio Extension and the southern recirculation zone (Noto and Yasuda, 1999)
- Pacific saury abundance is significantly correlated with SST in the Kuroshio region, Kuroshio-Oyashio transition zone and Oyashio region (Tian et al., 2003)

Both sardine and saury can be under the influence of environmental variation in the northwestern Pacific

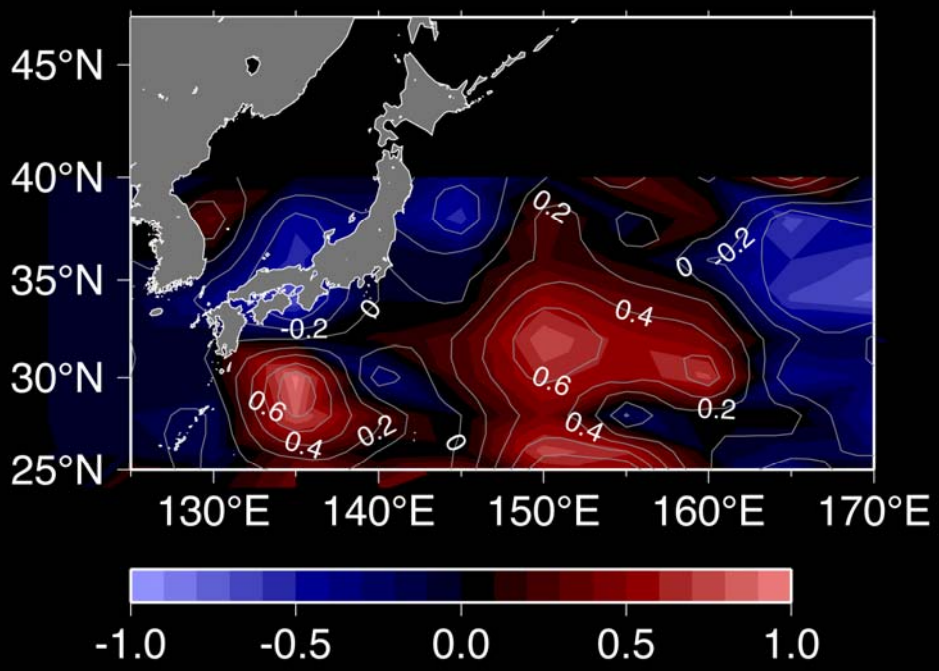
Sardine and saury larva distribution



Kuroshio Extension is the wintering place of saury larva and can be migration route of sardine larva in spring

Mixed layer depth in the Kuroshio Extension

Correlation map of
March-MLD & Apr-Chl (1998-2003)



MLD data: White (2003), Chl data: SeaWiFS

- Winter mixed layer depth in KE varied from 100m to 250m
- Spring chlorophyll density has a tendency to increase when winter ML is deep

Environmental variation in KE could influence on sardine and saury through their food

Questions

- Why dominant species of northwestern Pacific changed from Japanese sardine to Pacific saury since 1988?
- Why Japanese sardine resources fluctuates drastically?

Data and method

Correlation analysis

To find the relationship between environmental factor and sardine, saury resources by using observational data

Model analysis

To compare the estimated plankton density with sardine, saury resources

The model is NEMURO (Kishi et al., 2001) and tuned to KE

Observational data

Mortality coefficient anomaly of Japanese sardine…Kishida et al. (1994)

Large and medium saury abundance…Tian et al. (2003)

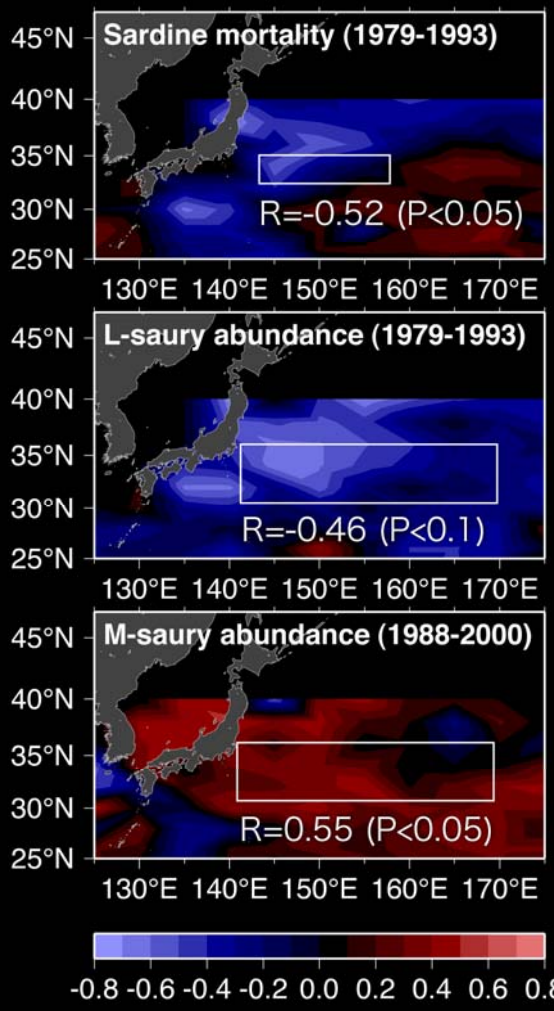
Mixed layer depth…White(2003)

Sea surface temperature…GISST

Shortwave radiation…NCEP/NCAR reanalysis data

Nitrate and silicate…World Ocean Atlas 2001

Correlation with winter MLD



Japanese sardine

Larvae could not survive in the year of shallow winter MLD.

Pacific saury

Large

Abundance rose in the year of shallow winter MLD.

Medium

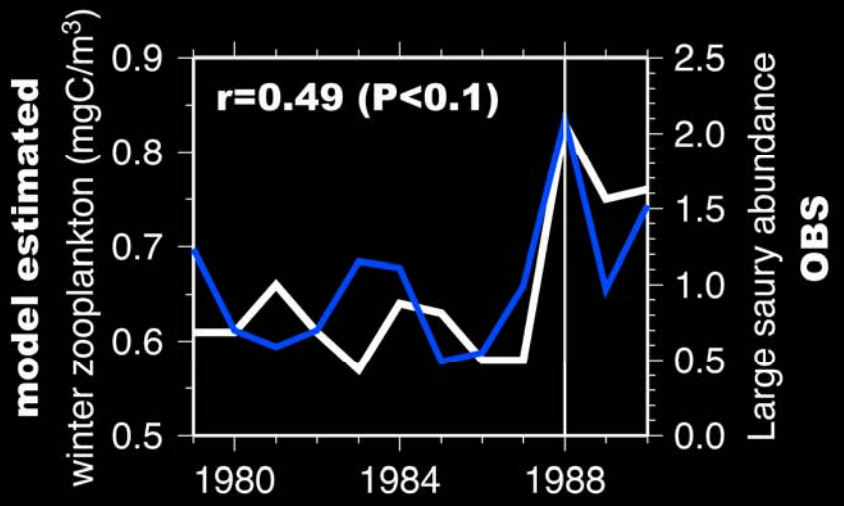
Abundance didn’t have any correlation with winter MLD in sardine dominated years. But they had positive correlation in saury dominated years.

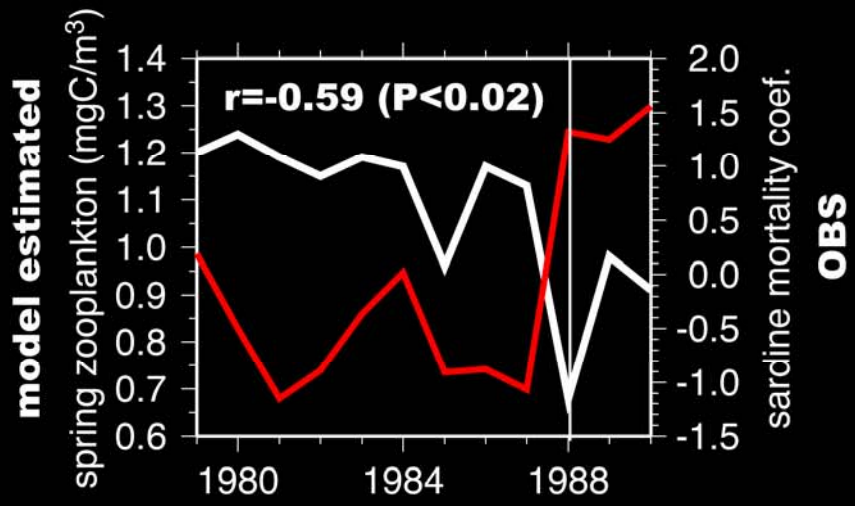
Correlation with winter MLD

- Winter MLD in the KE could affect both sardine and saury
- Correlation with sardine resources was positive while large saury was negative in 1980s
  - 1988's species replacement occurred between sardine and large saury
- Medium saury had positive correlation on condition sardine resources were small
  - Medium saury might compete with sardine for food
- These results are consistent with previous works because winter MLD variation corresponds to winter SST variation

Model result 1

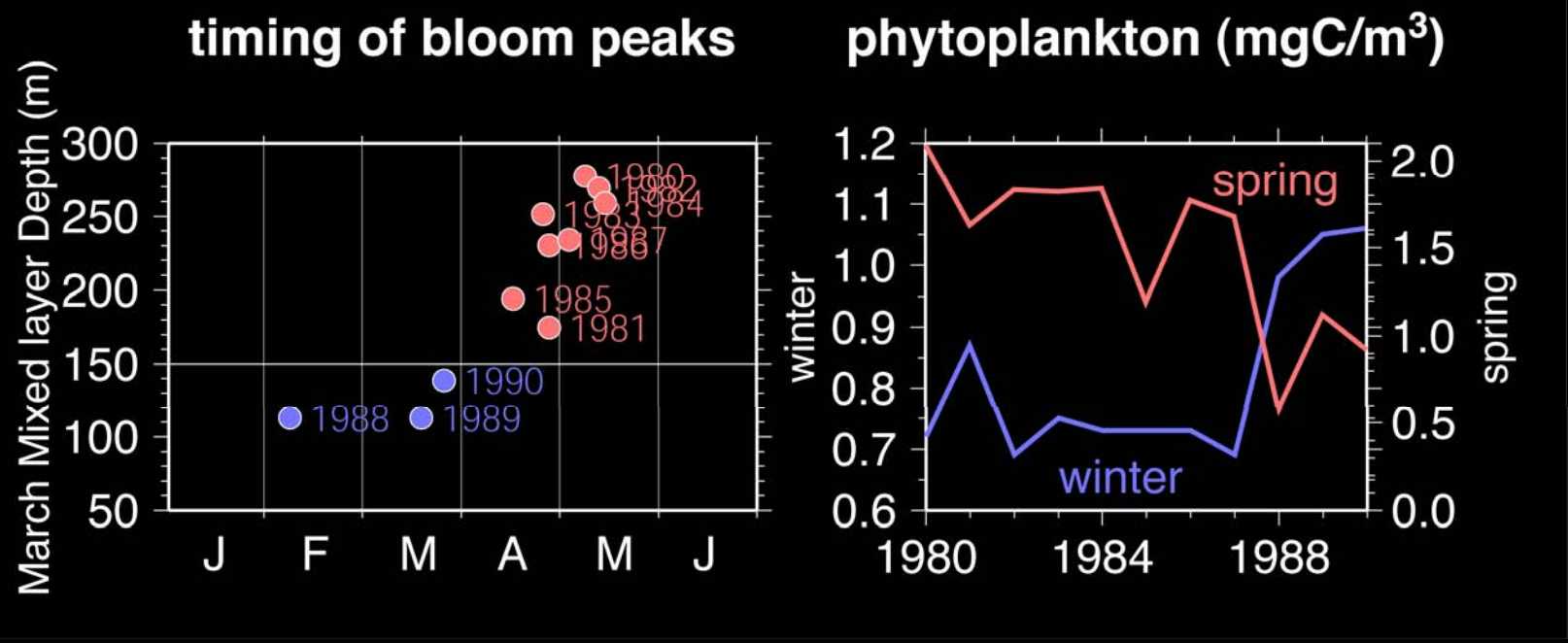
In KE (33-35N,143-148E) 1979-1990





Winter/spring zooplankton density increase/decrease in 1988 corresponding to large saury/sardine increase/decrease

Model result 2



- Deep winter MLD inhibits photosynthesis in winter and causes spring phytoplankton bloom (-1987)
- Shallow winter MLD causes winter phytoplankton bloom (1988-)

MLD regime shift in 1988 might change the spring/winter food availability of sardine/large saury

Discussion 1
Species replacement in 1988

-1987
Sardine dominated

-1987	winter	spring
sardine		○
M-saury		△
L-saury	×	

Deep winter MLD set bloom in spring in the Kuroshio Extension and sardine could match the bloom.

1988-
Sardine decreased, L-Saury increased

1988	winter	spring
sardine		×
M-saury		×
L-saury	○	

Shallow winter MLD set bloom in winter. Large saury could match the winter bloom while sardine mismatched the bloom.

Discussion 2
Fluctuation pattern

	Japanese sardine	Pacific saury
main spawning season	short February to March	long November to May
environmental change influence	Most of year class	Part of year class
resources fluctuation	drastic	moderate

END