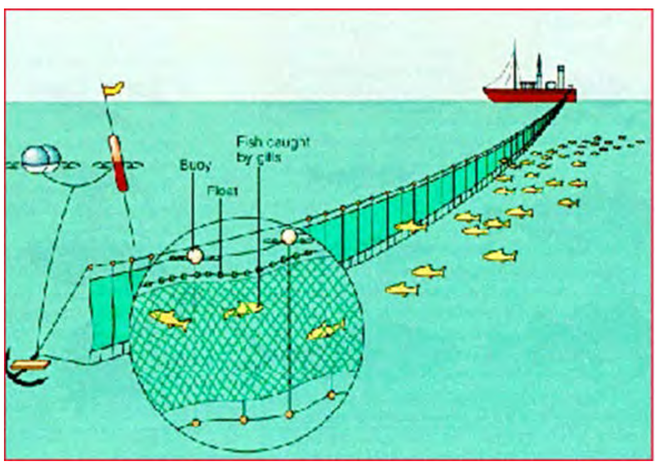
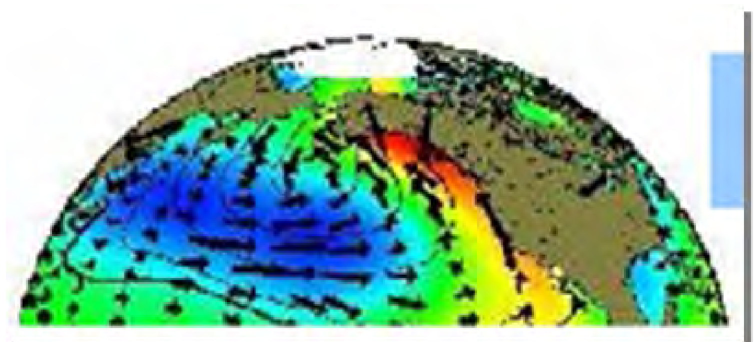
Impacts of extensive squid driftnet fishery and climate variability on epipelagic nekton in the Transition Region of the central North Pacific

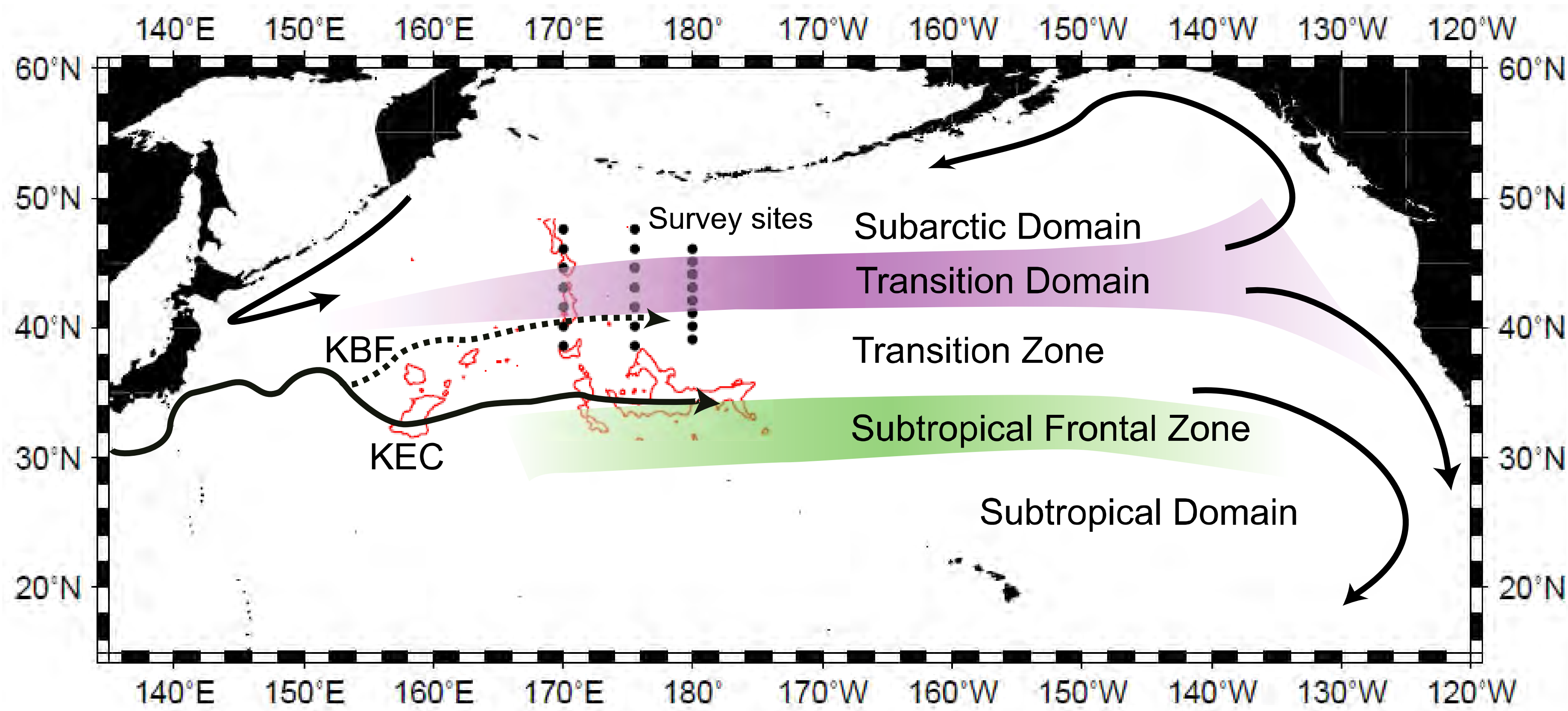
Taro Ichii (FRA), Haruka Nishikawa (JAMSTEC), Hiromichi Igarashi (JAMSTEC), Hiroshi Okamura (FRA), Kedarnath Mahapatra (TOKAI Uni.), Mituso Sakai(FRA), Toshie Wakabayashi(FRA), Denzo Inagake (FRA) & Yoshihiro Okada (TOKAI Uni.)





30th anniversary of moratorium of driftnet fishery

Survey areas and major oceanographic regions



Data

- Long-term driftnet survey data ⇒ CPUE (no./panel)
  - Hokkaido University Data (1979-1999)
  - National Research Institute of Far Seas Fisheries Data (2001-2006)

- Satellite data
  - Chl-*a* data from SeaWiFS (1998-2006)
  - Sea level anomaly data from AVISO (1994-2006)

Impacts of high seas squid driftnet fishery

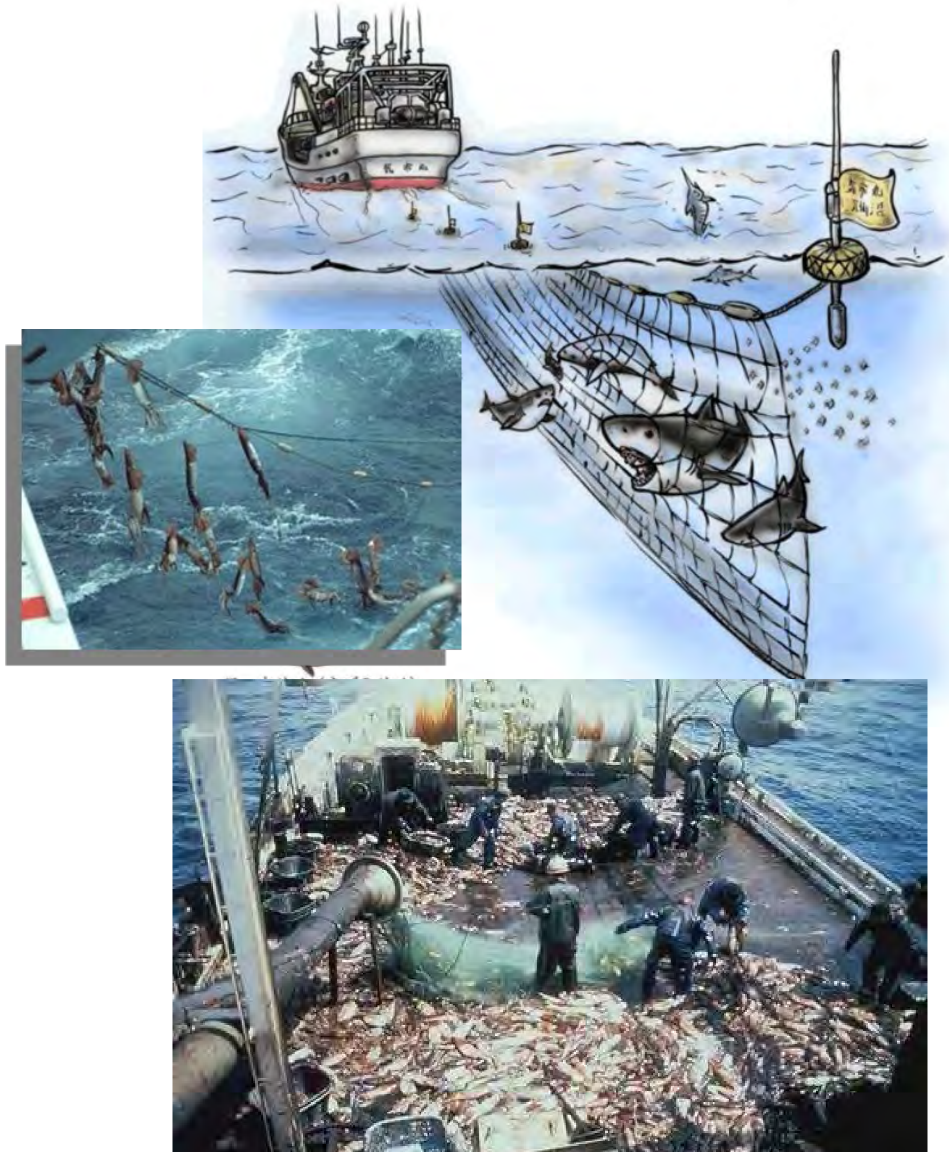
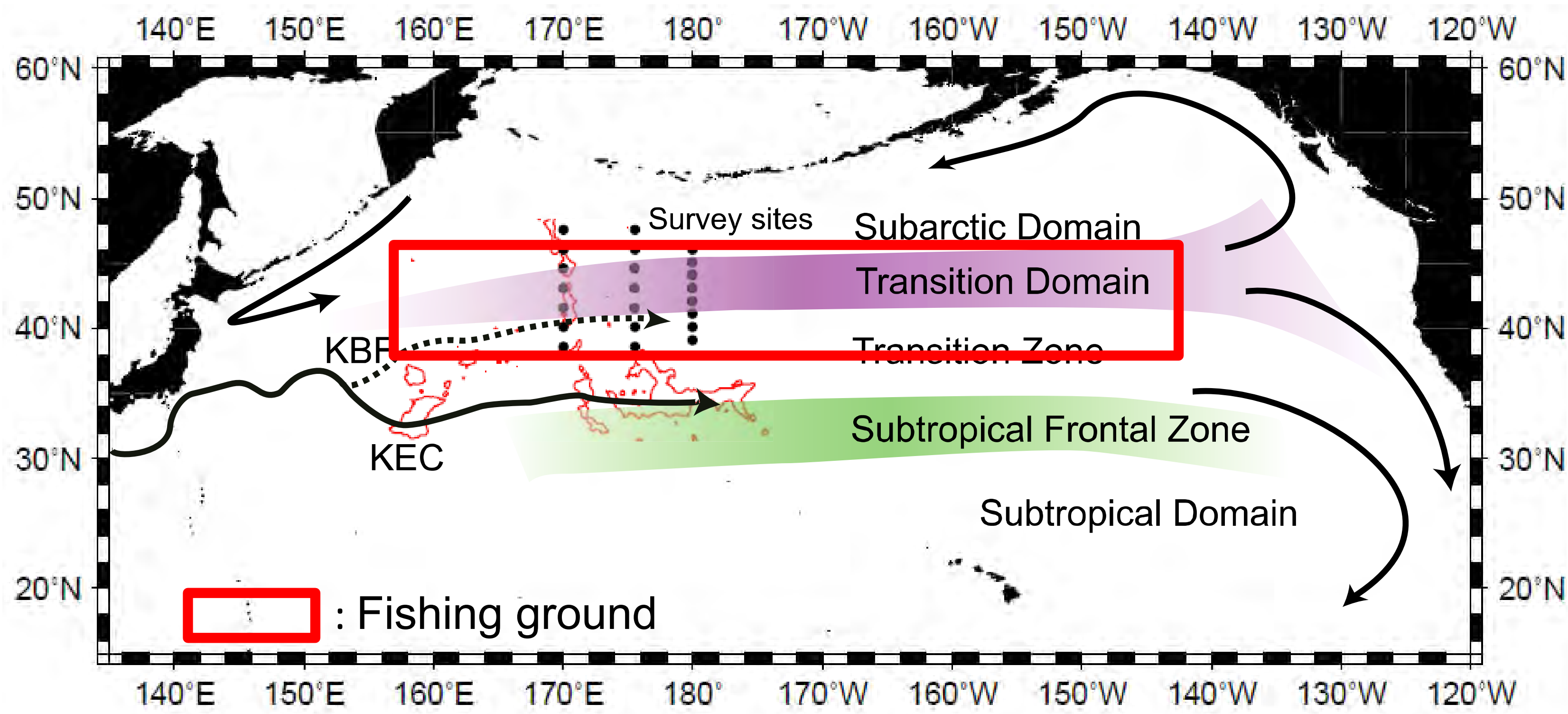


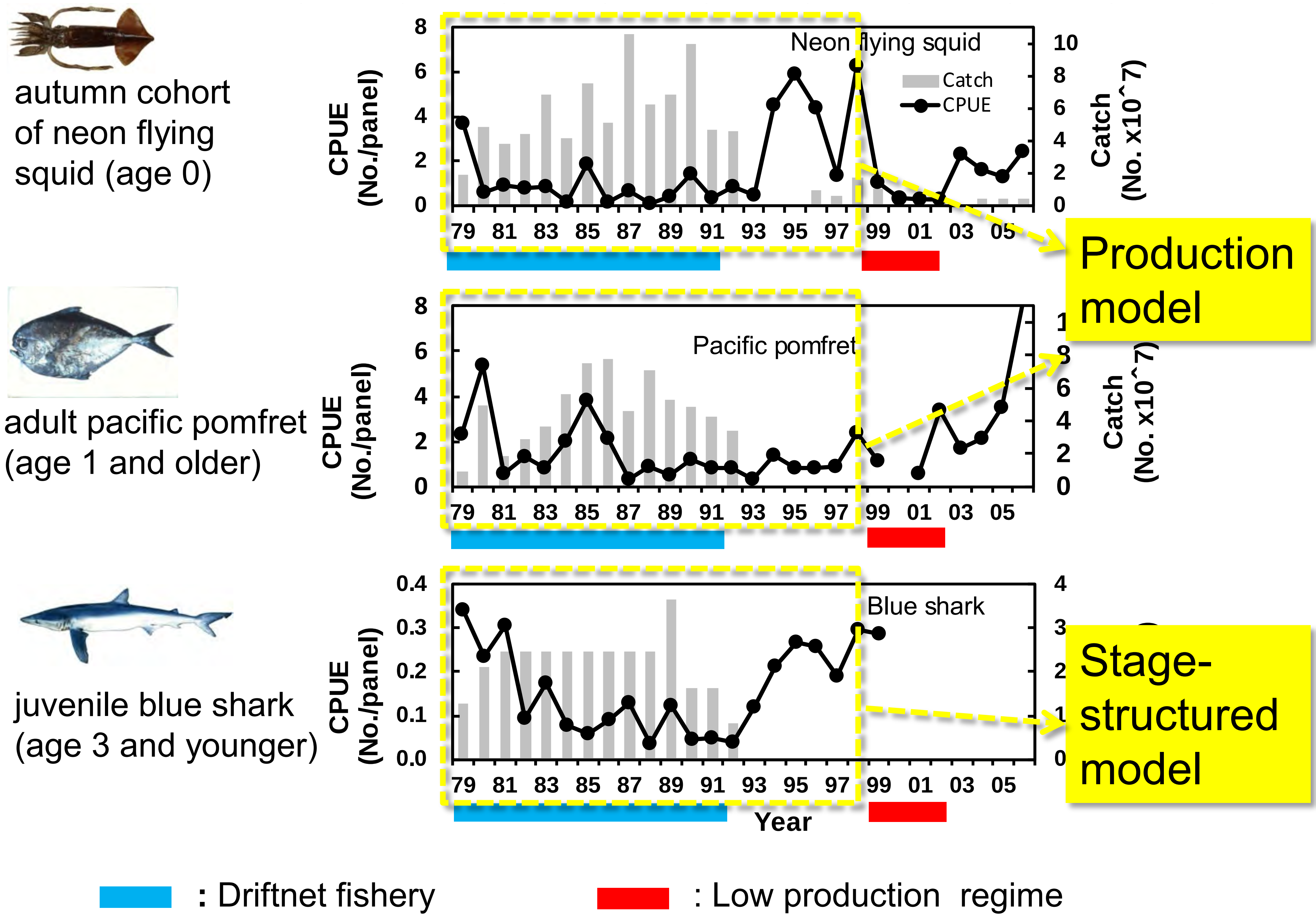
Photo by Seki

High seas squid driftnet fishery (1979-1992)



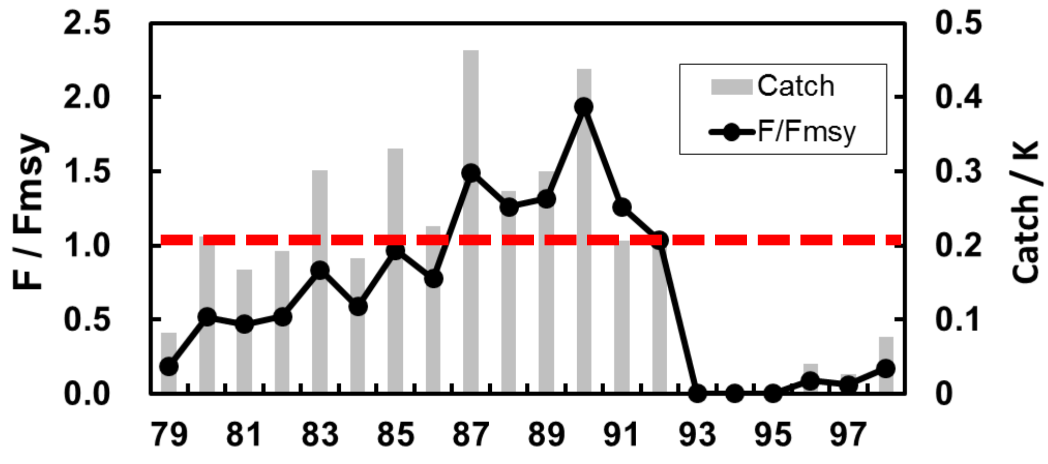
Fishing nations: Japan, Korea and Taiwan
Number of fishing vessels: 737 in 1990
Target species: neon flying squid (ca. 200,000 tons / year) 
Bycatch species: pacific pomfret (ca. 40,000 tons /year) 
juvenile blue shark (ca. 20,000 tons/year) 

Interannual changes in CPUE



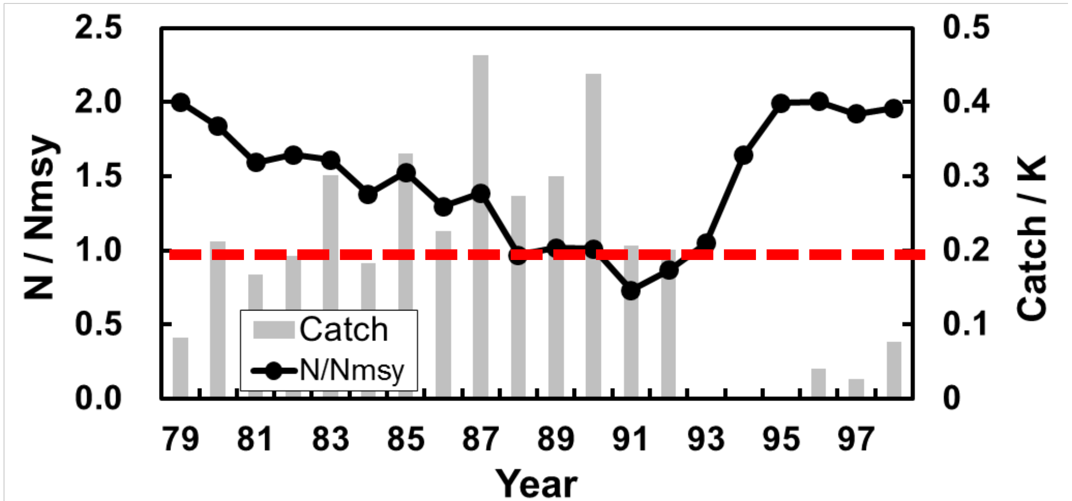
Assessments of neon flying squid stock

F/F_{MSY}



Overfishing

N/N_{MSY}



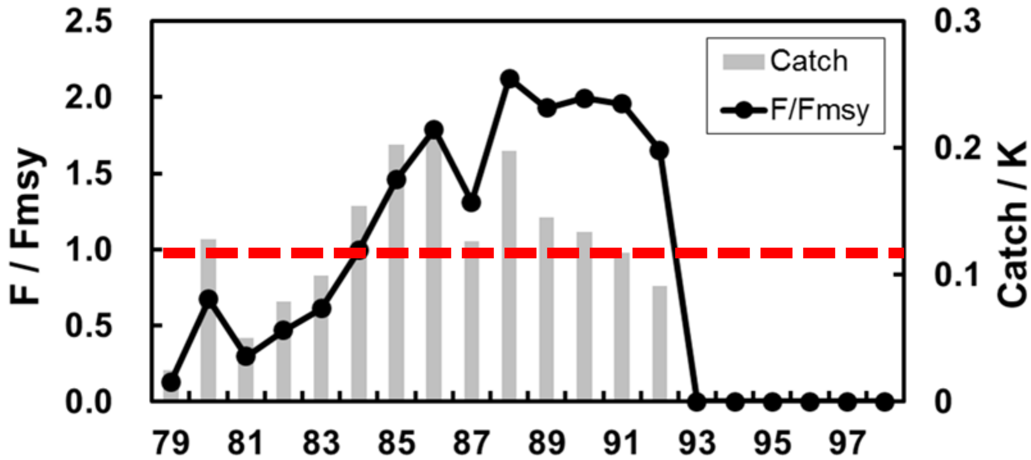
MSY level

No serious impact on the stock

This result supports the assessment based on driftnet fishery data (Ichii et al. 2006)

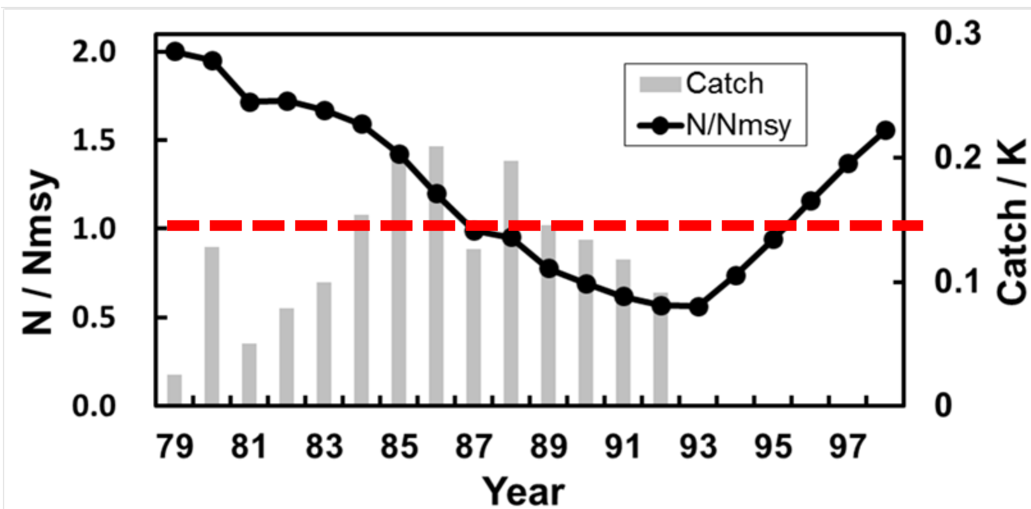
Assessments of the pacific pomfret stock

F/F_{MSY}



Overfishing

N/N_{MSY}

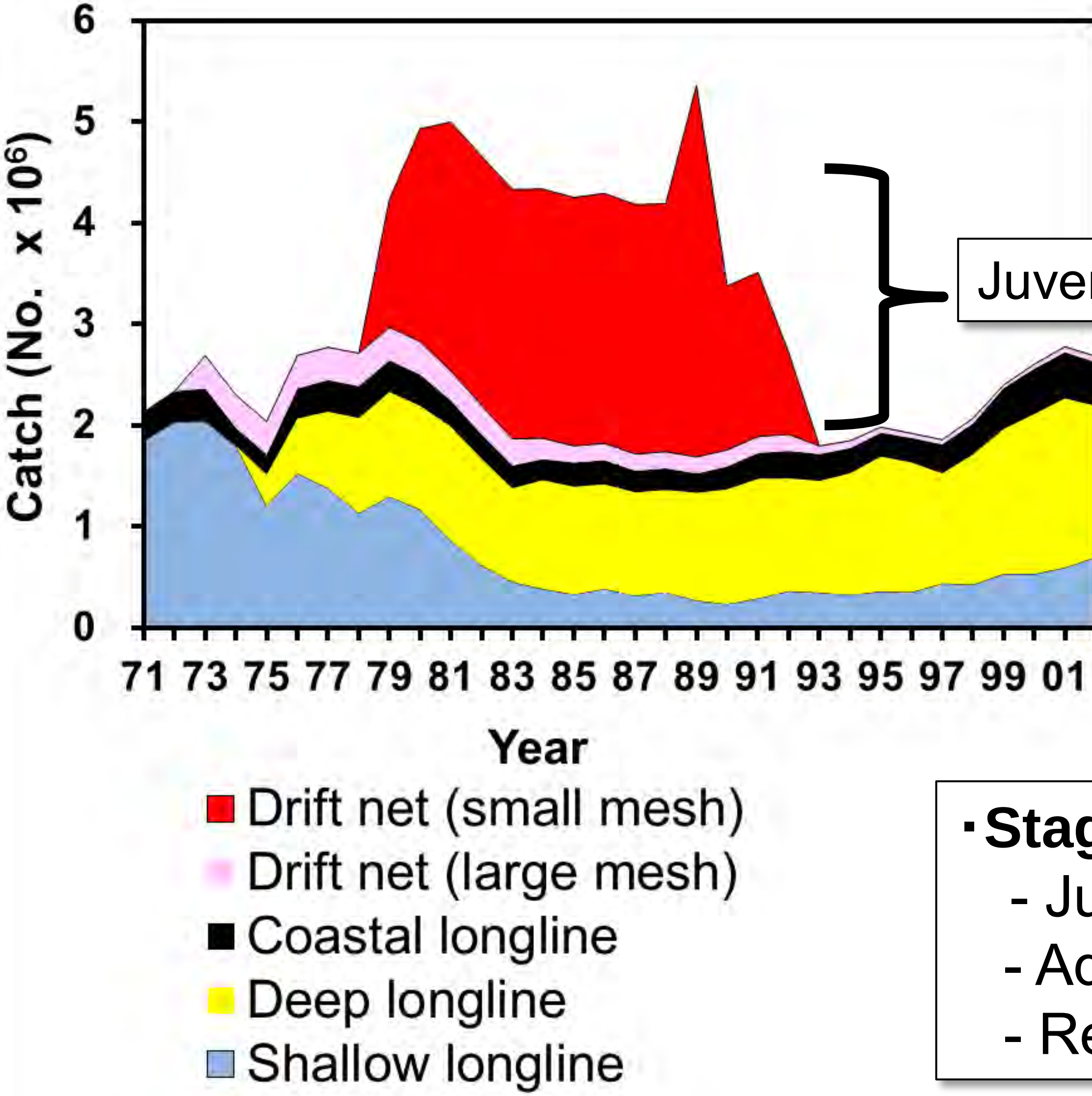


Depressed below MSY

Serious impact on the stock

This result disagrees with Pearcy et al. (1993), which based on much shorter time series data (1978-89) of the same survey, and so our result may be more reliable.

Catches of blue shark by gear type in the North Pacific, 1971-2002 (Kleiber et al., 2009)



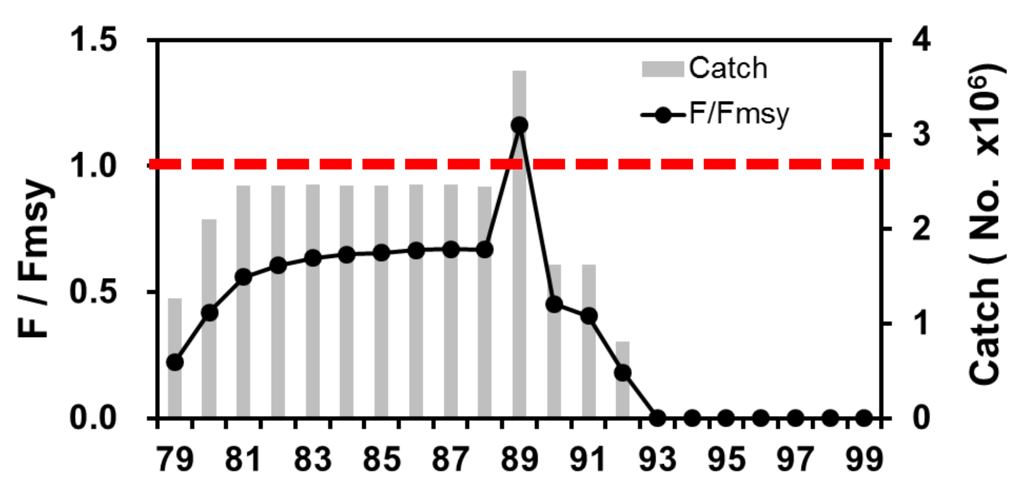
Juvenile (age 3+ and younger)

Adult

- **Stage-structured model**
  - Juvenile dynamic model
  - Adult dynamic model
  - Recruitment

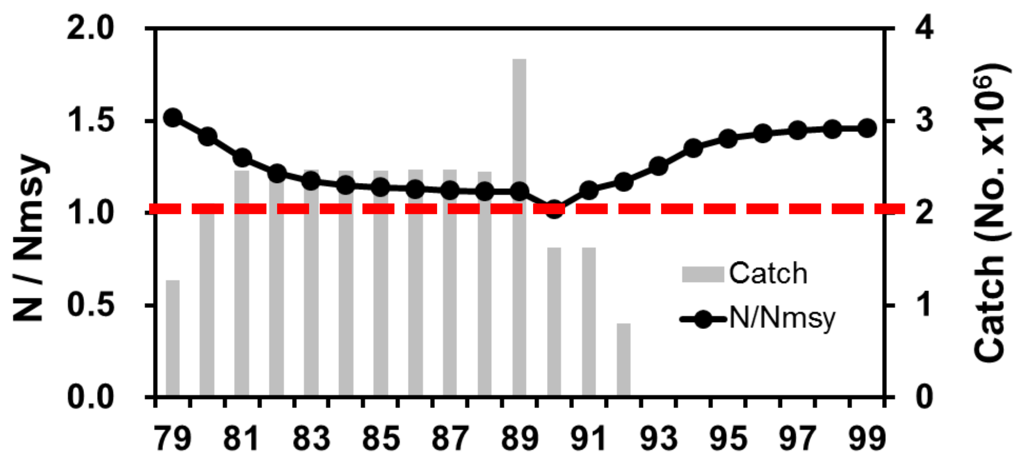
Assessments of juvenile blue shark stock

F/F_{MSY}



No overfishing

N/N_{MSY}



Higher than MYS

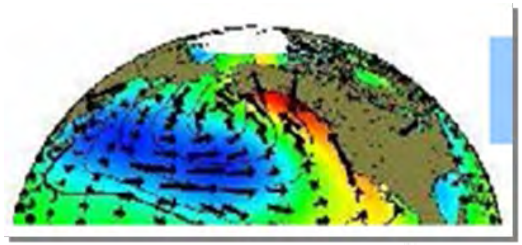
No serious impact on the stock

This result supports Kleiber et al. (2009) that adult population was sustainable level during driftnet fishery.

Summery on impacts by driftnet fishery

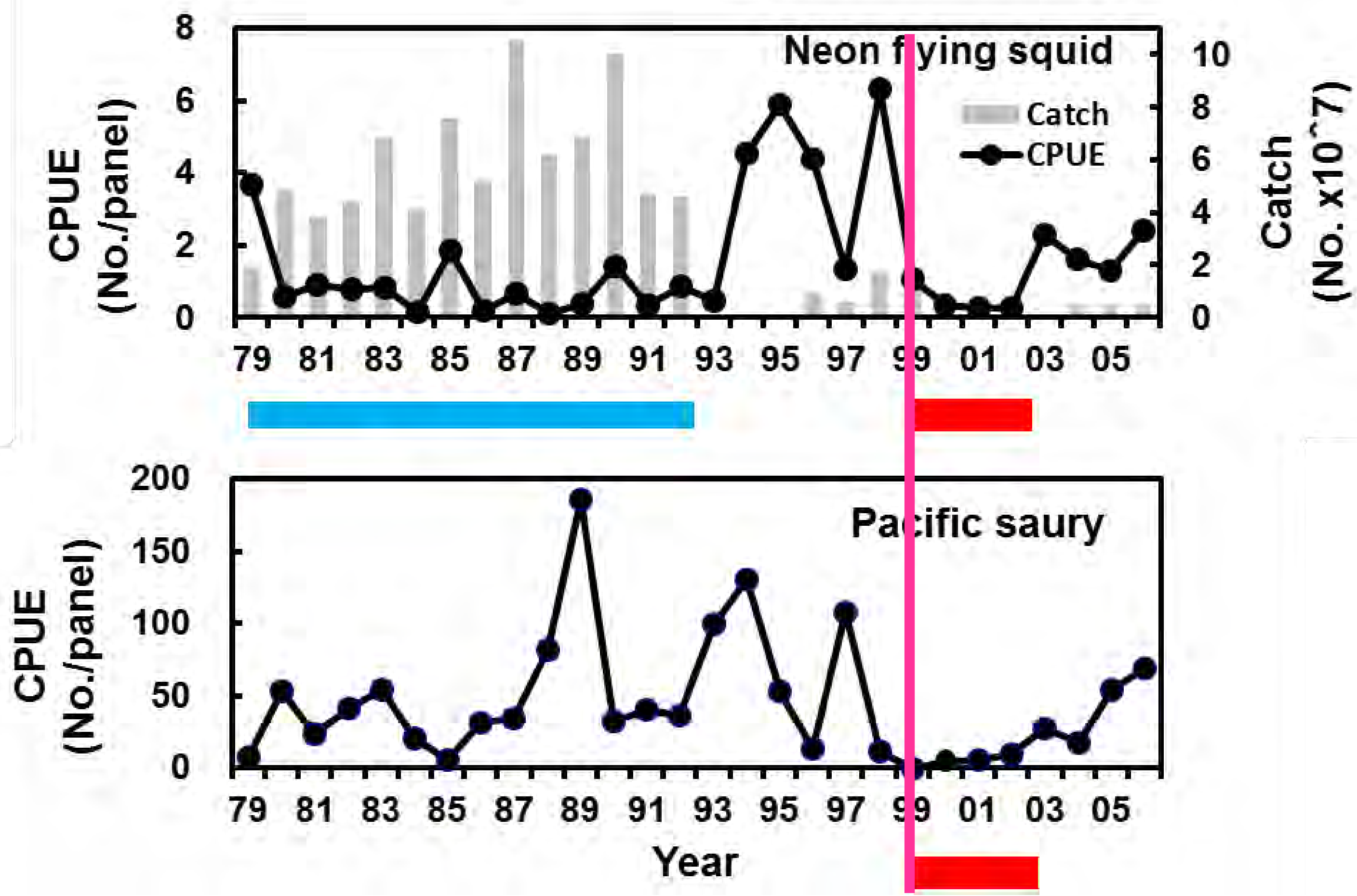
- Fishery-induced declines in stocks for neon flying squid (target species), pacific pomfret and juvenile blue shark (by-catch species).

- No adverse effect on neon flying squid and juvenile blue sharks, but adverse effect on pacific pomfret



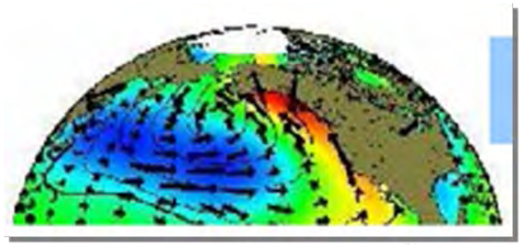
Late 90s regime shift

large size
pacific saury
(age 1)

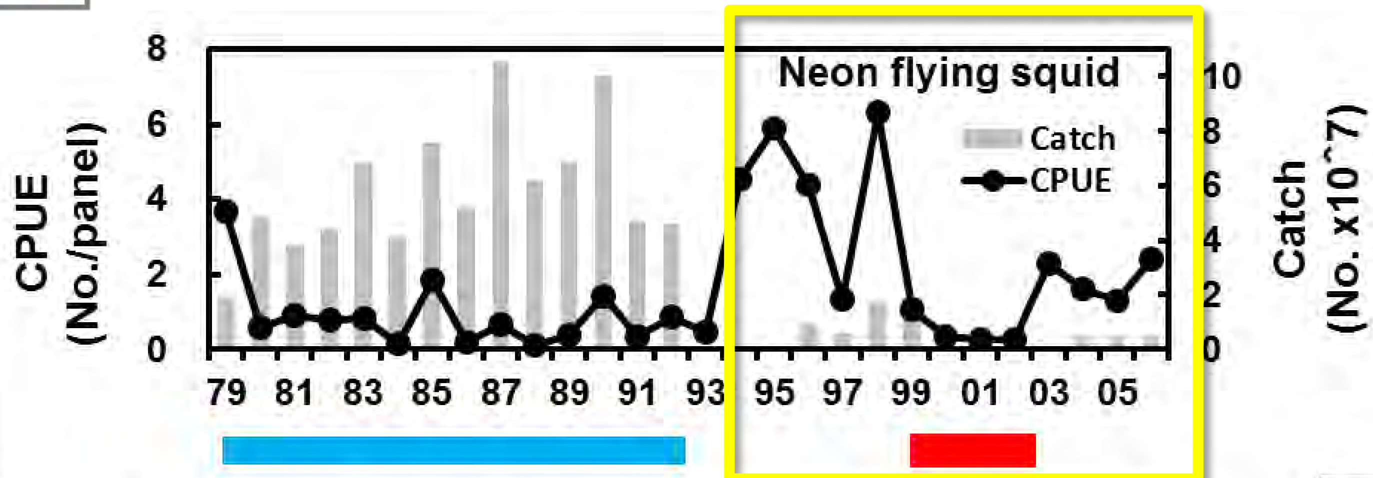


: Driftnet fishery

: Low production regime



Late 90s regime shift

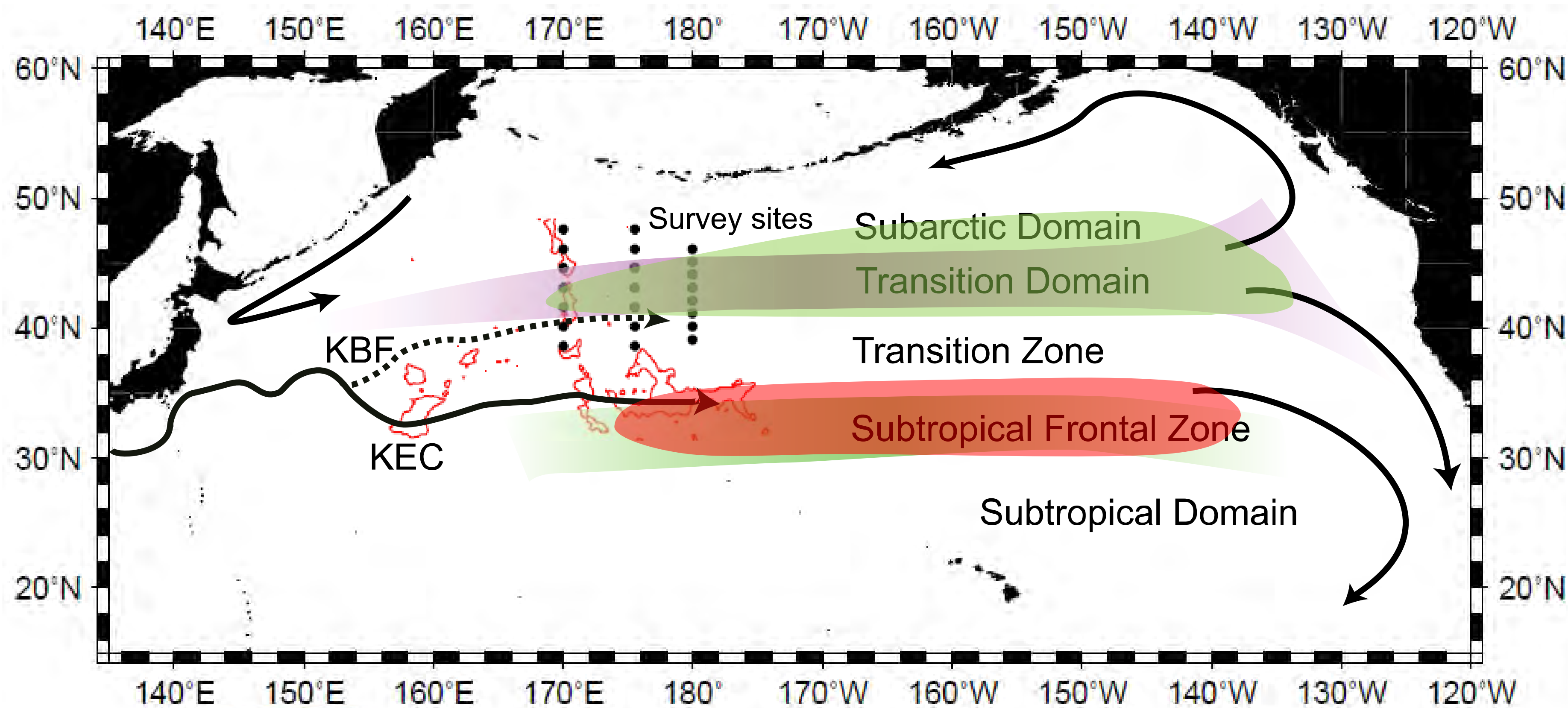


Good correlation between CPUE and sea level anomaly (SLA) during spawning and nursery period in the STFZ. (Ichii et al. 2011)

: Driftnet fishery

: Low production regime

Life history and migration pattern of neon flying squid

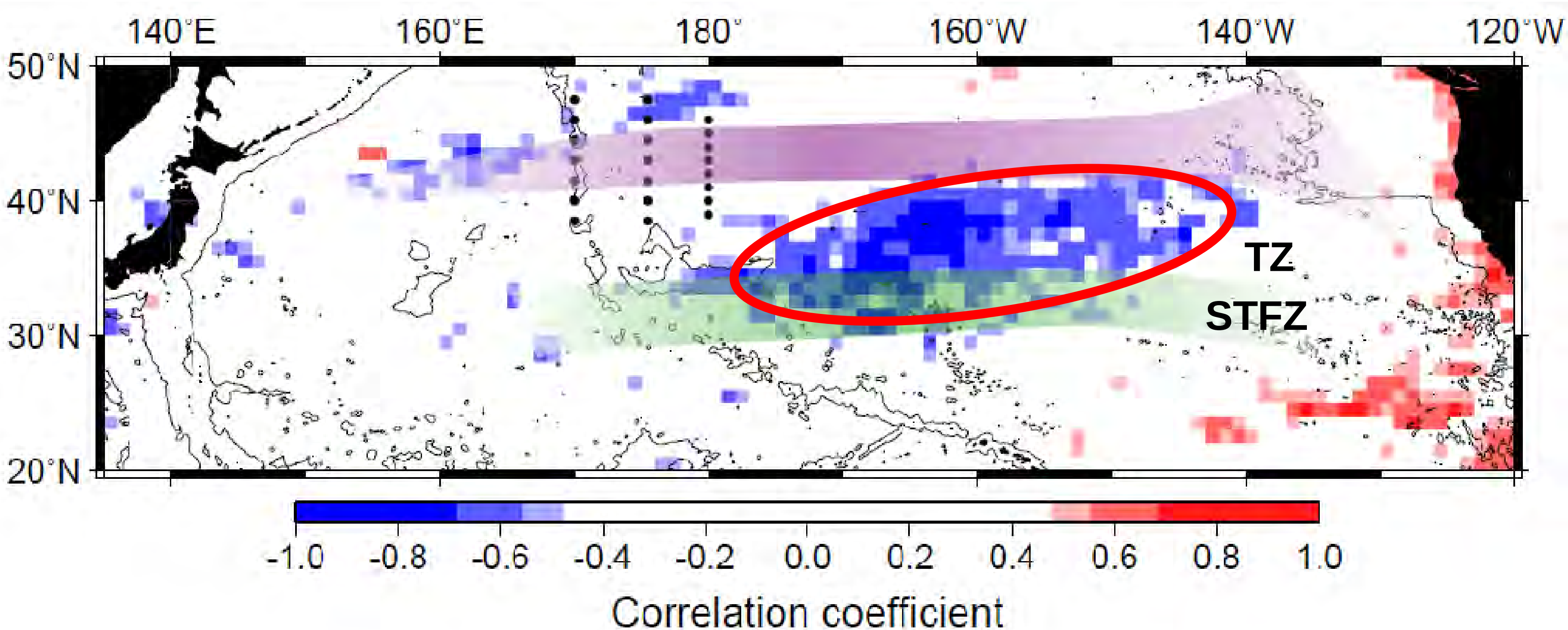


Neon flying squid

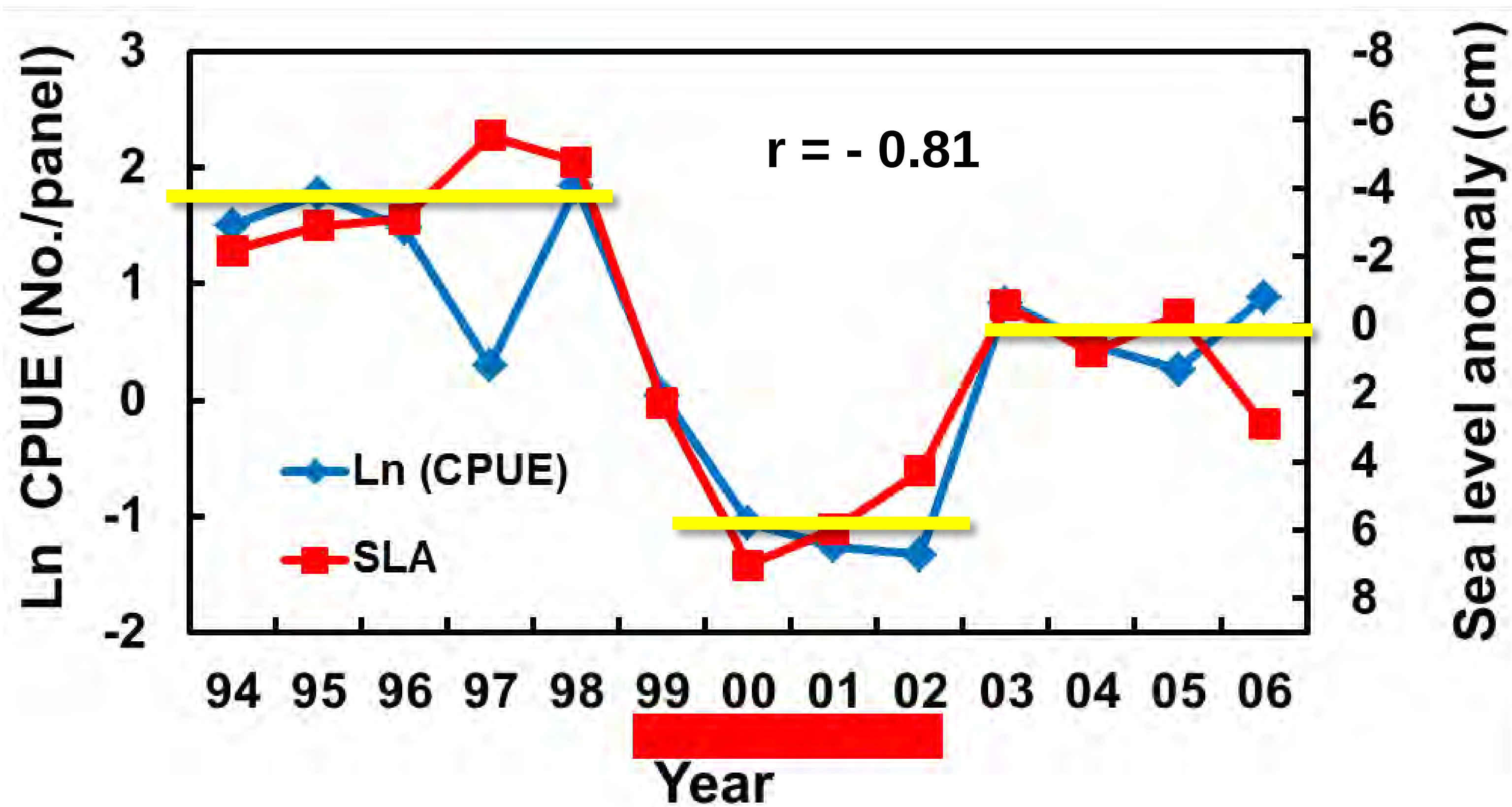
: feeding area

: spawning/nursery area

Correlation between squid CPUE vs Sea level anomaly (SLA)
winter (January-March)



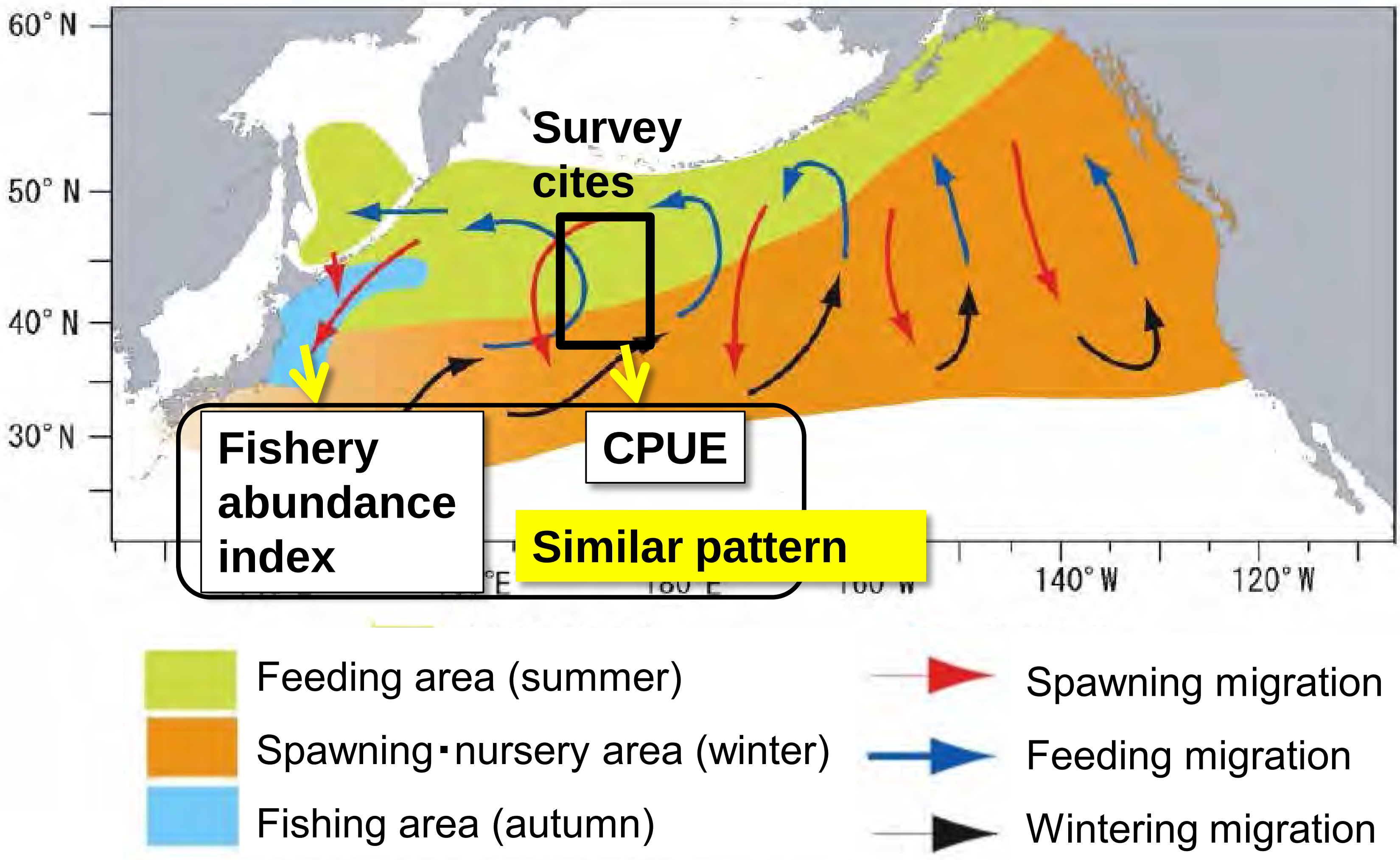
Comparison of time series data of sea level anomaly (SLA) during winter and squid CPUE



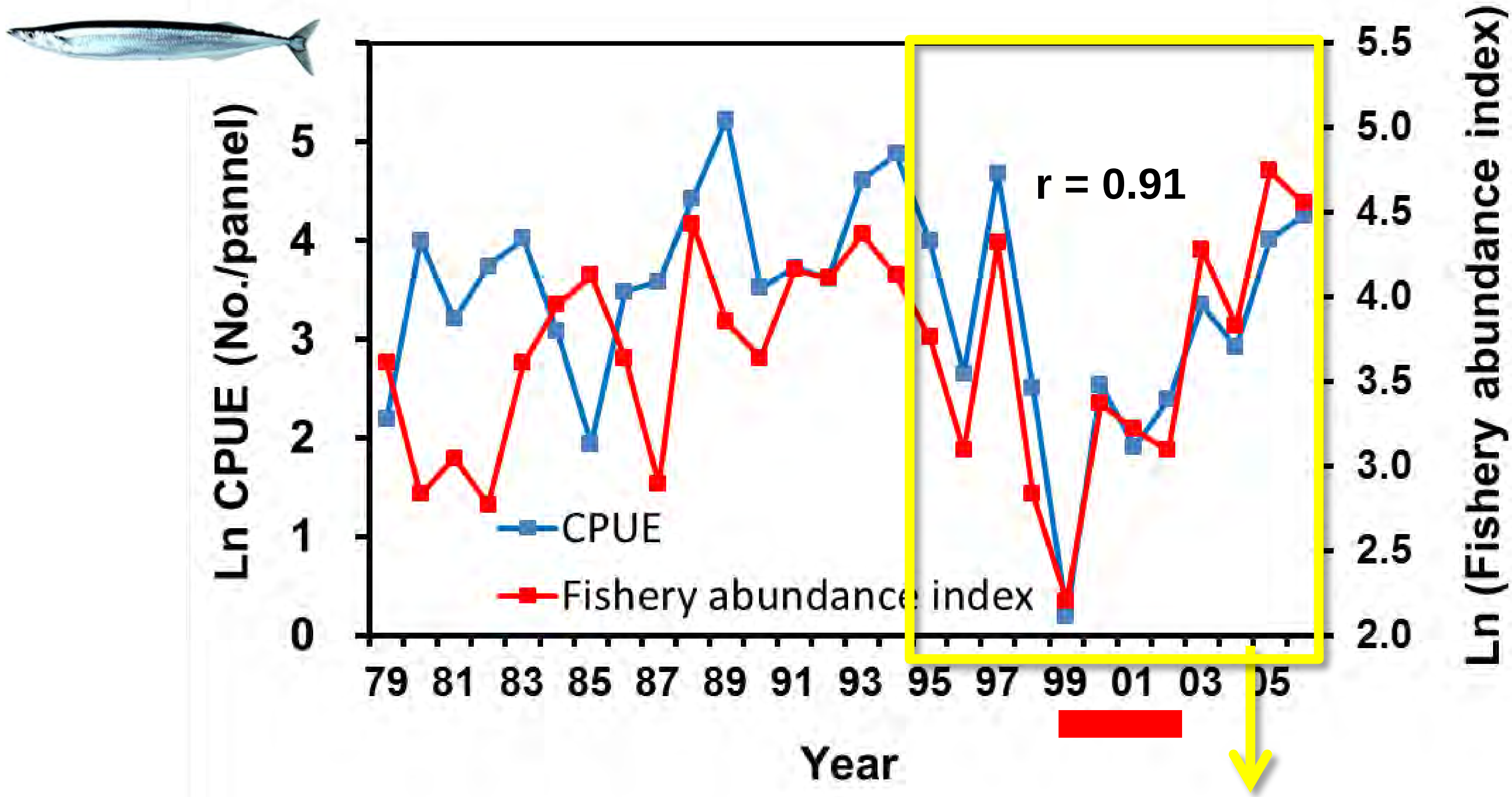
Neon flying squid stock respond quickly to the large-scale changes in productivity of the STFZ and TZ. (Ichii et al. 2011)

: Low production regime

Life history and migration pattern of Pacific saury



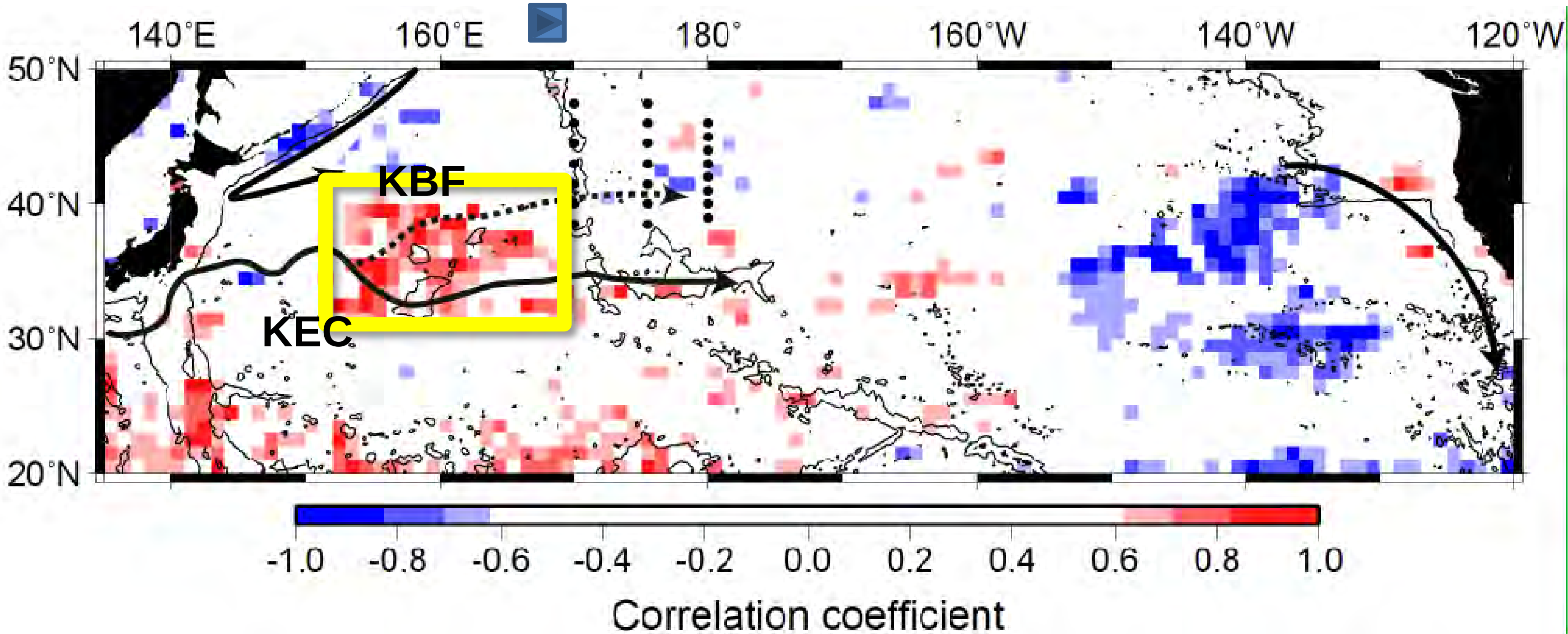
Comparison of time series of CPUE and Fishery abundance index



Decline in saury stock may be occurred around late 90s over the western half of the North Pacific

: Low production regime

Correlation between saury CPUE vs Chl-*a* spring (March-May)

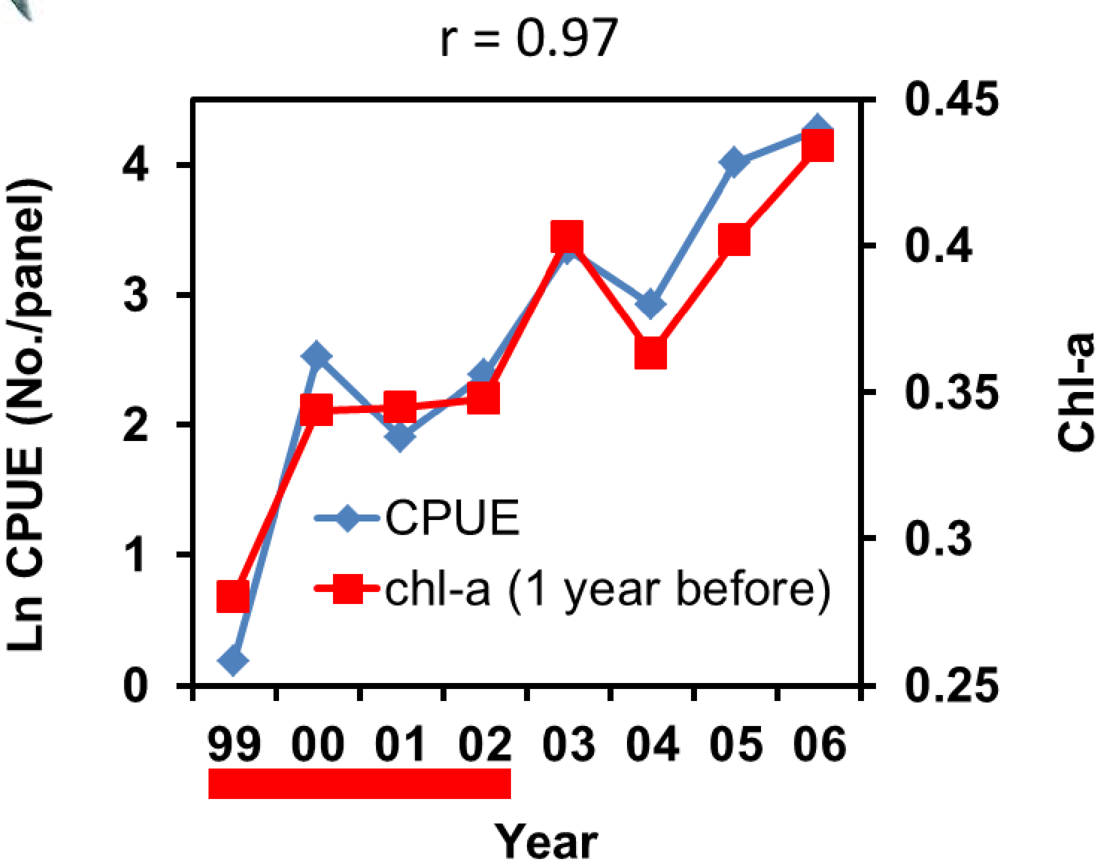


- **Kuroshio Extension Bifurcation Region (KEBR)**
  - The highest primary productivity during spring in the North Pacific
  - Important habitat for a number of species, such as juvenile bluefin tuna and juvenile loggerhead sea turtles

(Polovina et al. 2006)

Comparison of time series of chl-*a* concentration in spring (Mar.-May) one year before and saury CPUE

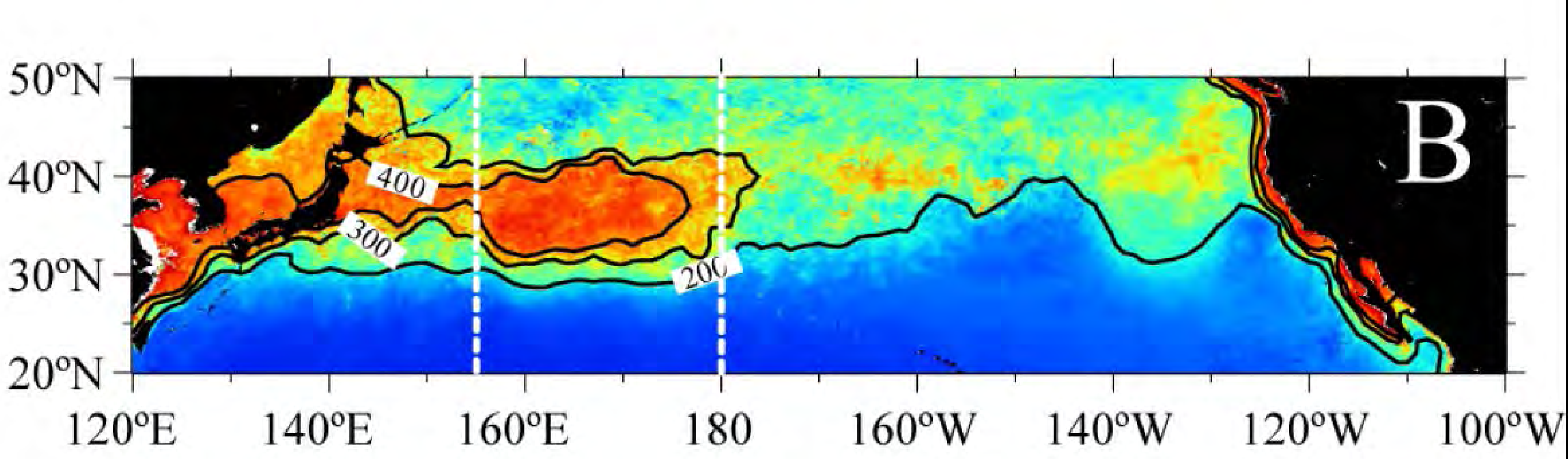
Age one year



: Low production regime

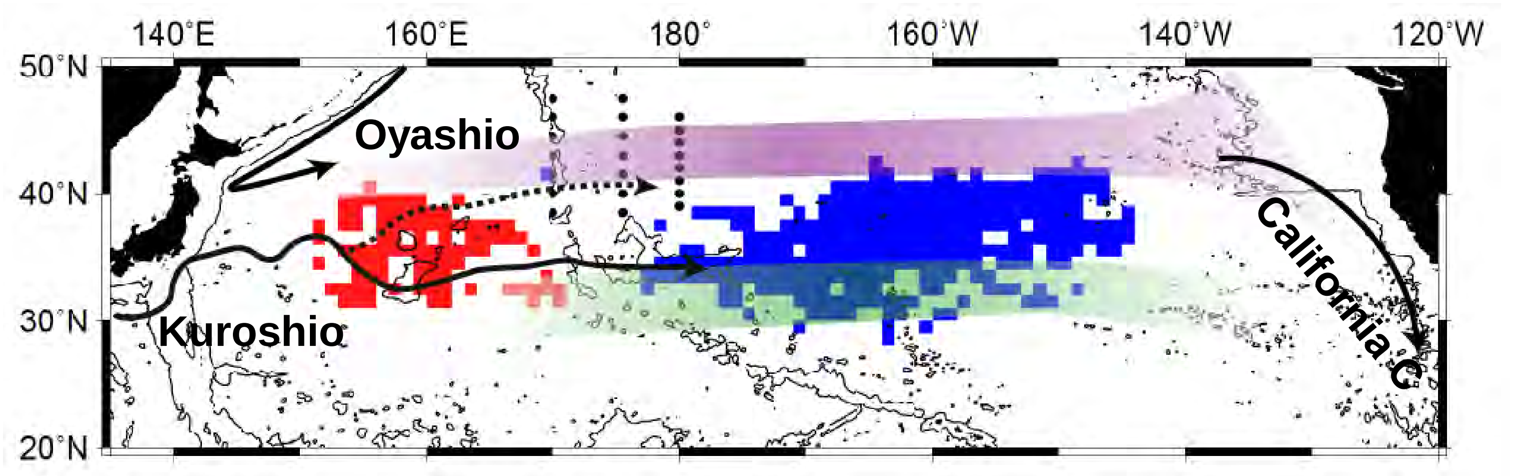
MODIS depth-integrated primary production (Polovina et al. 2006)

Apr.-Jun. 2003



KEBR supports highest productivity in NP during spring

Summery on impacts by late 90s regime shift



- Squid : Low productivity in central STFZ and TZ ( ) during winter may be responsible for low recruitment.

- Saury : Low productivity in KEBR ( ) during spring may be responsible for low recruitment.

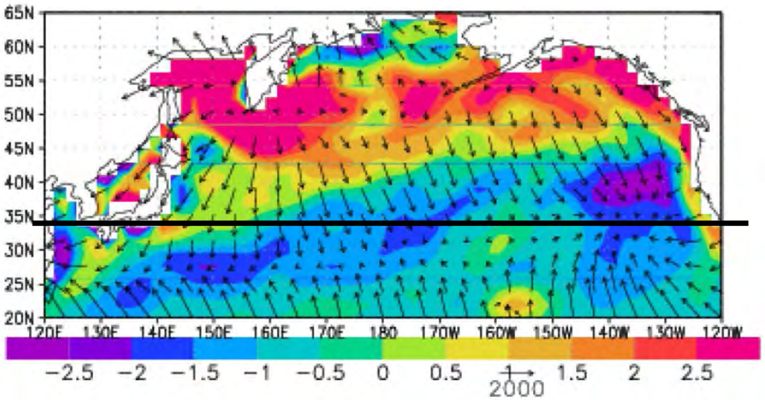
*Yamanishi et al. (unpublished) suggested that late 90s regime shift occurred one year earlier in the western STFZ than in central STFZ.

Conclusions

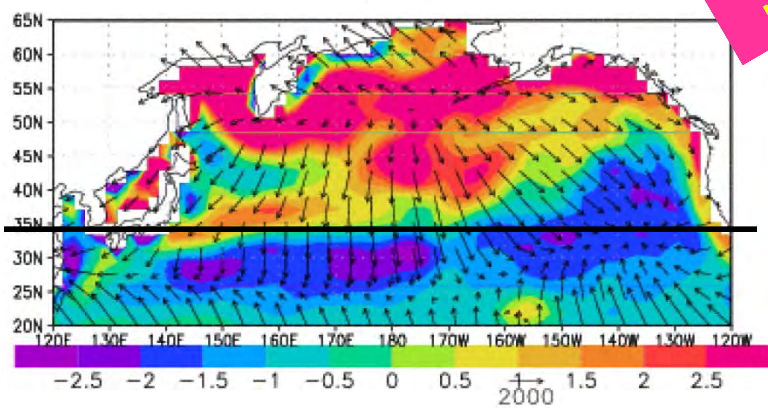
Big changes in Curlτ, Ekman transport during regime shifts

1976/77 shift

1976 Jan.-Mar. (Low production)



1977 Jan.-Mar. (High production)

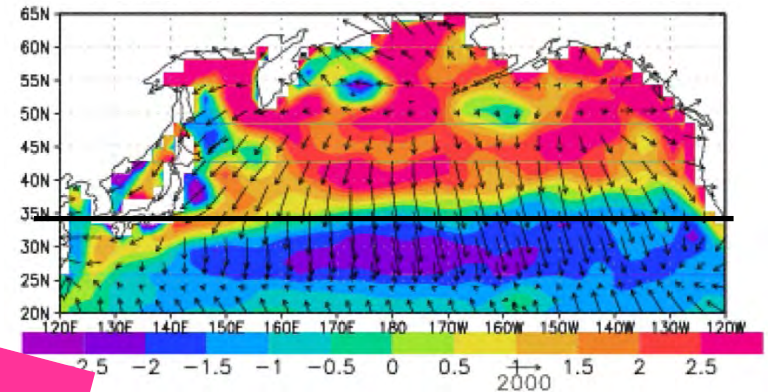


High production regime (1977-98)

1998/99 shift

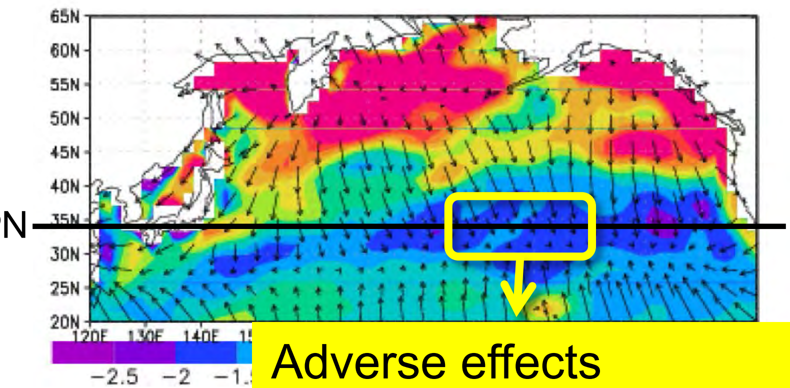
1998 Jan.-Mar. (High production)

35ºN



1999 Jan.-Mar. (Low production)

35ºN



Adverse effects throughout the food web (Polovina et al. 2005)

Upwelling

Downwelling

Conclusions

- The low production regime fortunately did not occur during the driftnet fishery period, otherwise overfishing could have caused extensive damage to stocks especially of the target species.

- It is important to know whether the regime is productive enough or not for sustainable management of fishery stocks.

FYI

North Pacific Fisheries Convention (new RFMO) intends to include saury and neon flying squid for management.