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PICES Annual meeting

Simulated influence of the 1976–77 regime shift on anchovy and sardine in the California Current System

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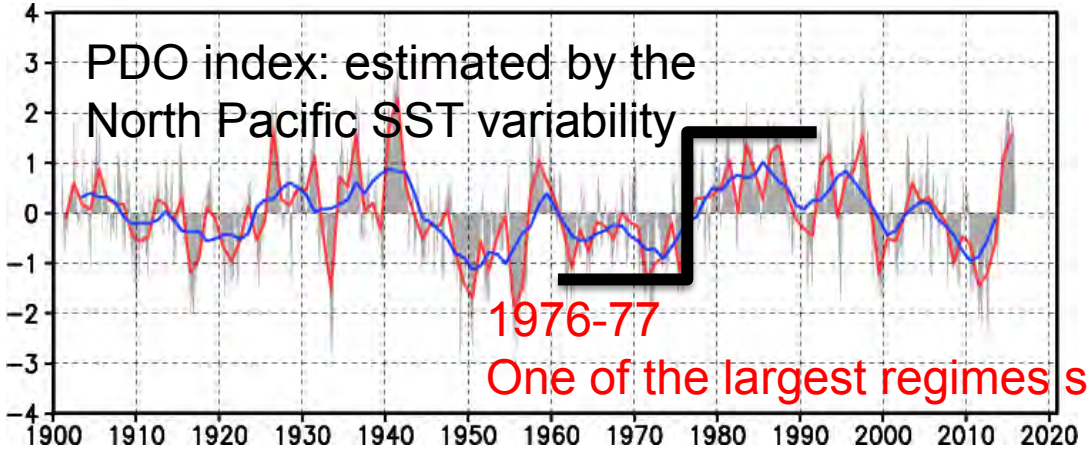
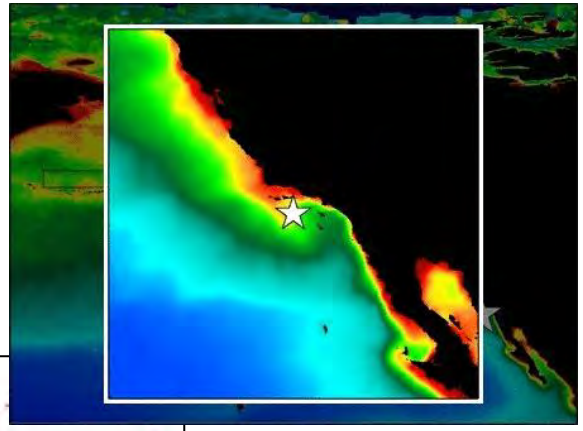
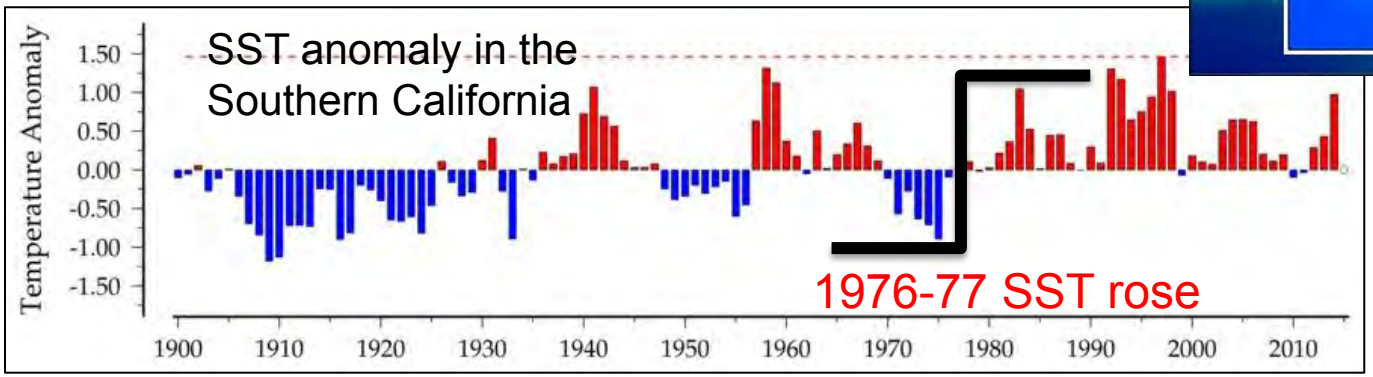
What is the regime shift in 1976-77?

Pacific decadal oscillation: **the atmosphere and the ocean display a trend of co-variance with a period of about 20 years.**







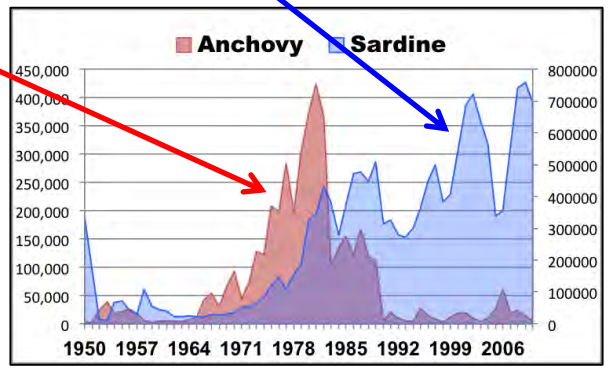
Purpose and method

Purpose

Different response between anchovy and sardine

Zooplankton density decreased in the CCS after 1977. →
The Northern anchovy catch also decreased,
but the Pacific sardine catch did not decrease.

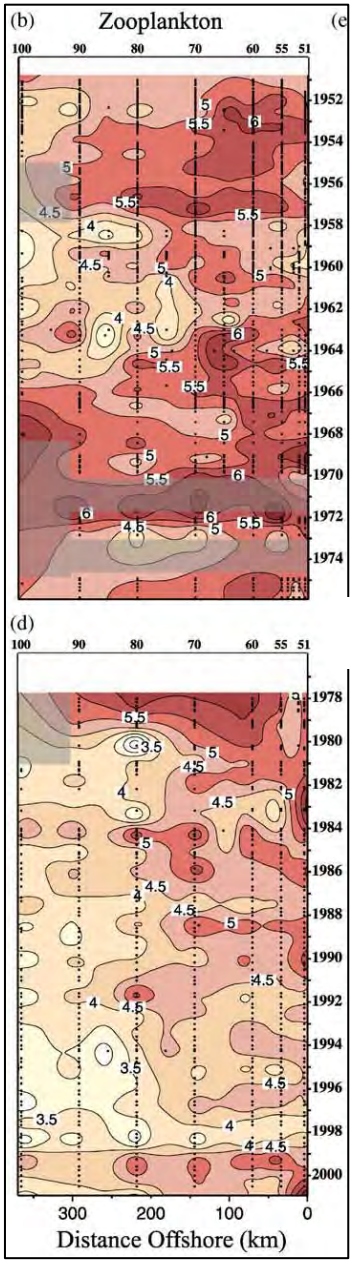
Our purpose is to understand why the difference occurred.



Catch weight (ton) time series (from FAO data)

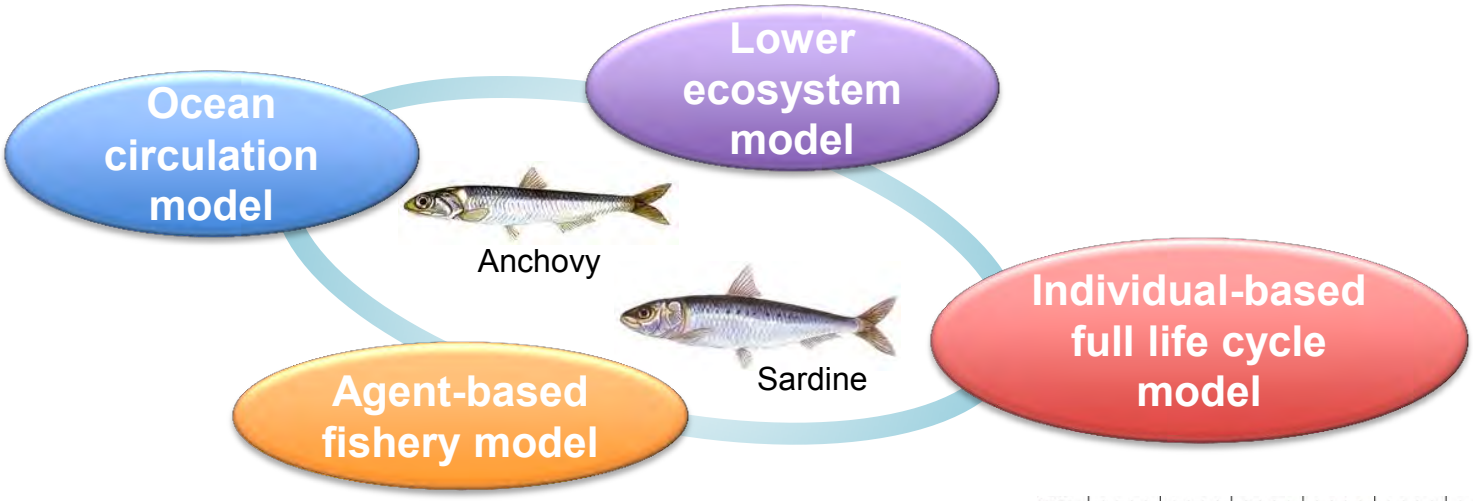
Method

We used a newly developed high resolution, long-term, fully coupled end-to-end (full life cycle) fish model to understand the relationship between climate change and fish stock variation.

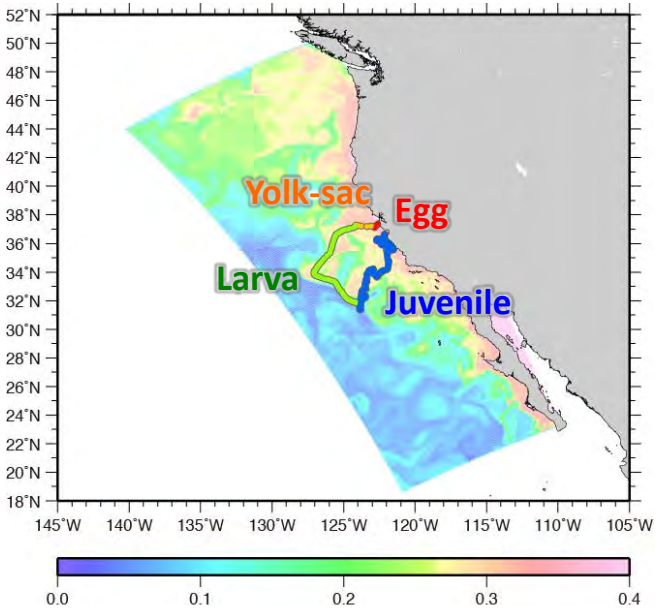


Zooplankton density
McGowan et al. (2003)

Fully coupled end-to-end model



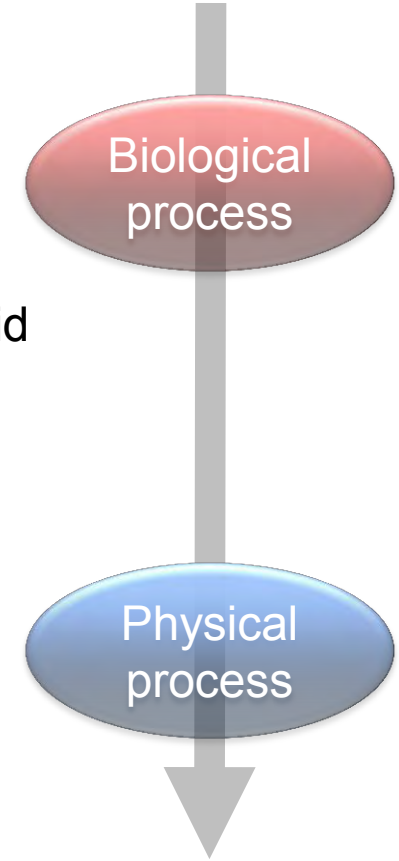
- **Model run: 1958–2008**
- **7km × 7km horizontal resolution and 50 vertical levels.**
- **Records all environments (ambient condition) during all life stages of anchovy and sardine**
- **More details are explained in Rose et al. (2015)**



Migration route of an age-0 anchovy and Surface zooplankton density (April 1, 1965)

Analysis flow chart

1. **Growth stage survival**
   - Larval stage survival of anchovy decreased after the regime shift, but sardine did not.
2. **Feeding environment of both larvae**
   - Anchovy larvae's became worse, but sardine larvae's did not.
3. **Distribution area and season of anchovy and sardine larvae**
   - Anchovy: Coastal and winter-early spring
   - Sardine: Offshore and late spring
4. **Mechanism why the food (zooplankton) density decreased only in the coastal area from winter to early spring**

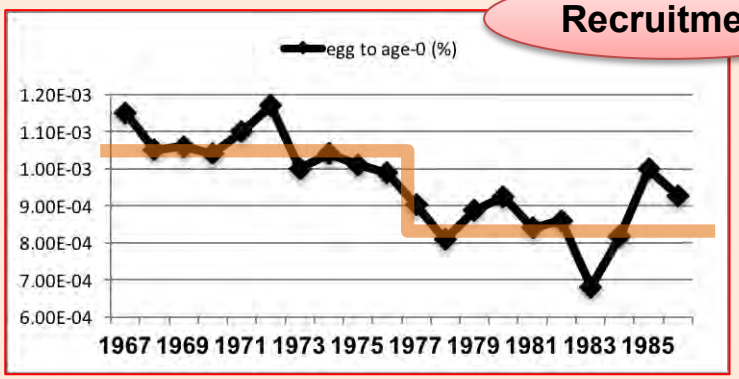


Growth stage survival

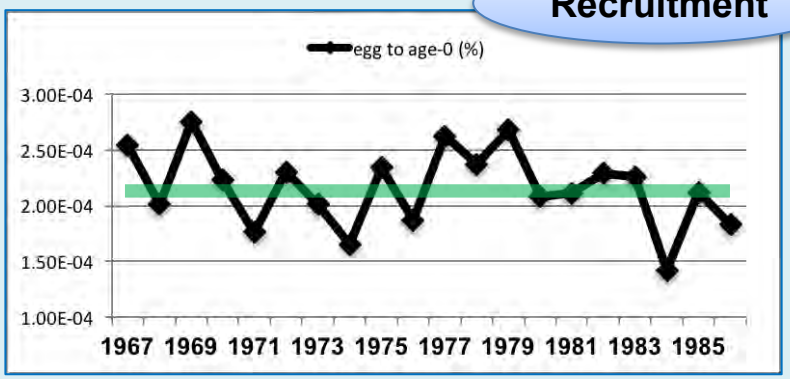
Anchovy

Sardine

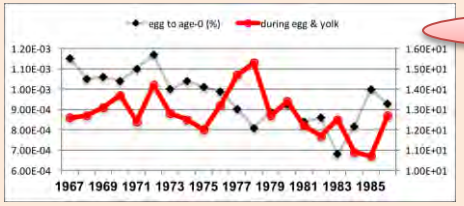
Recruitment



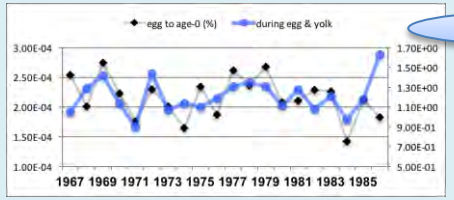
Recruitment



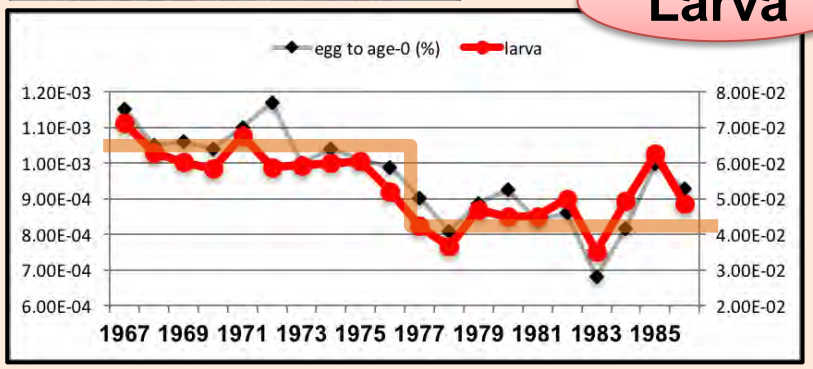
Egg & Yolk-sac



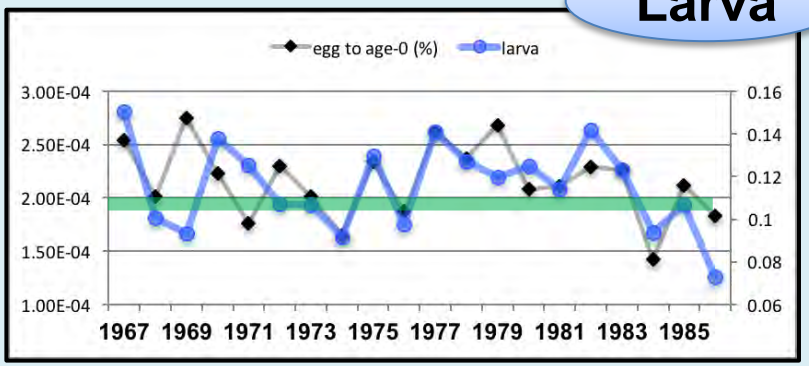
Egg & Yolk-sac



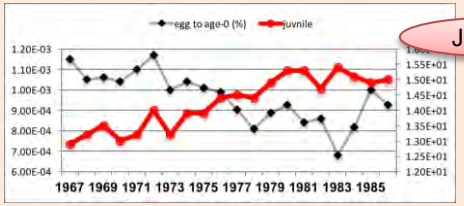
Larva



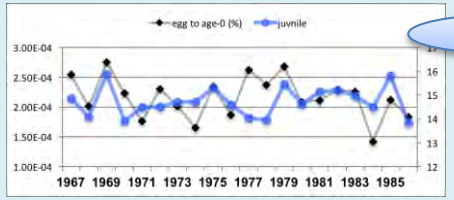
Larva



Juvenile



Juvenile

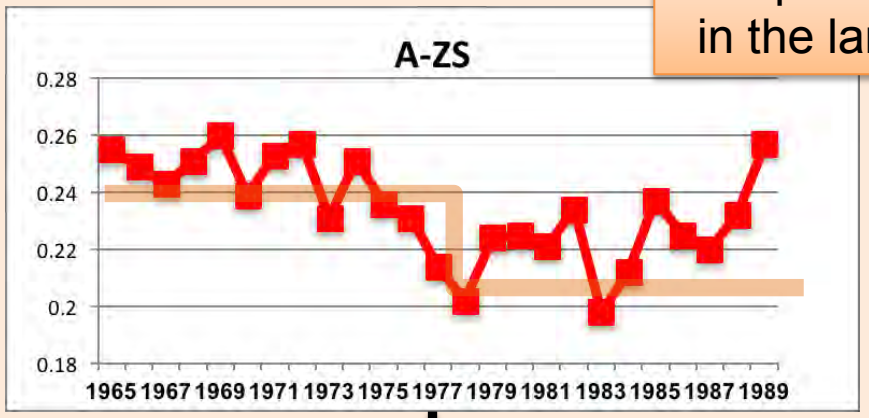


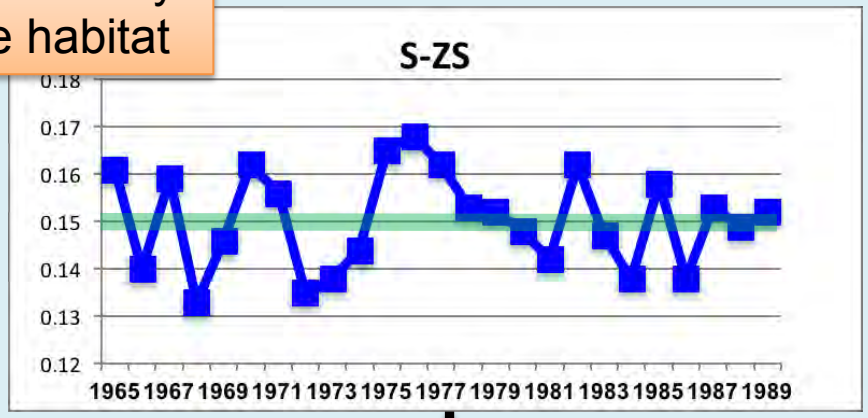
Feeding environment of larvae

Anchovy

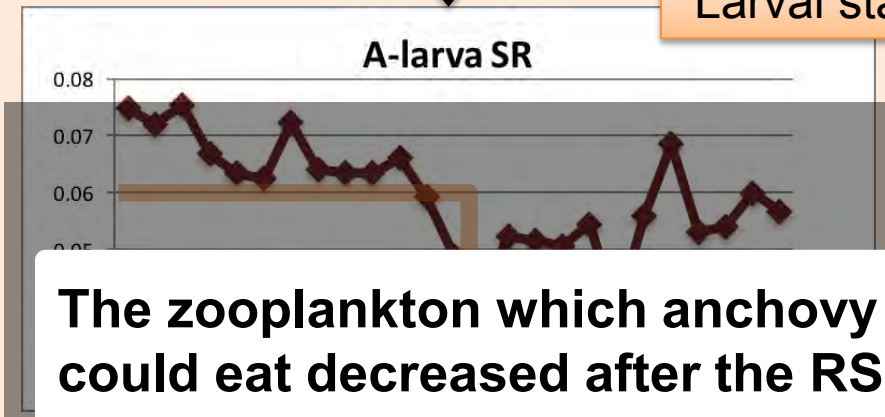
Sardine

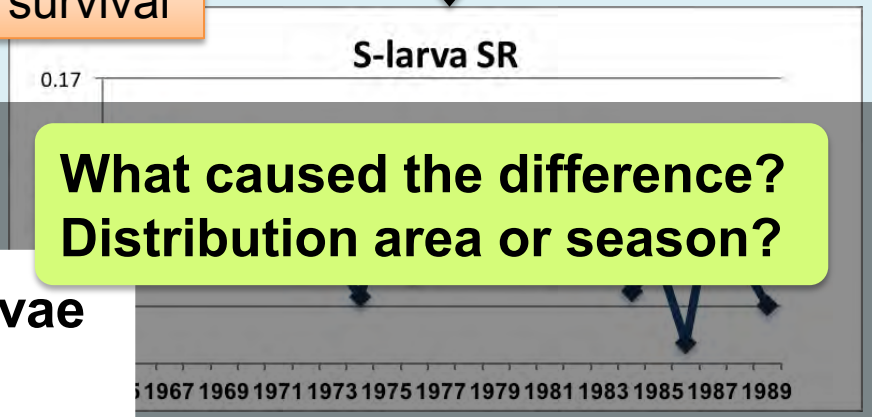
Zooplankton density in the larvae habitat





Larval stage survival





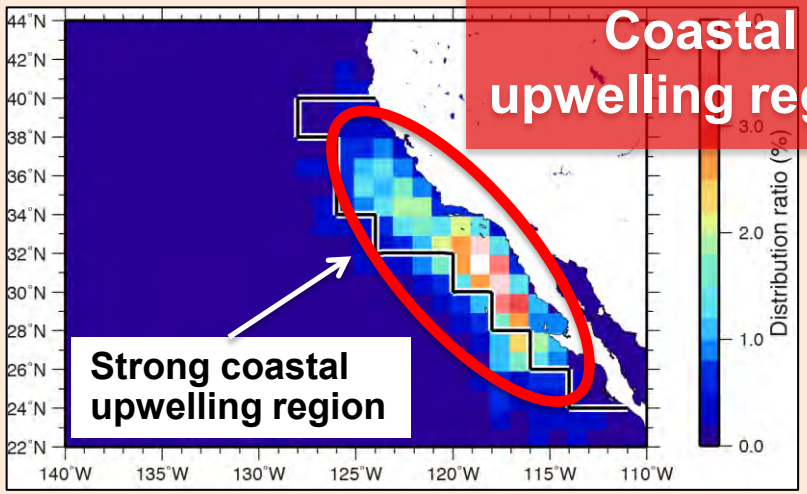
What caused the difference? Distribution area or season?

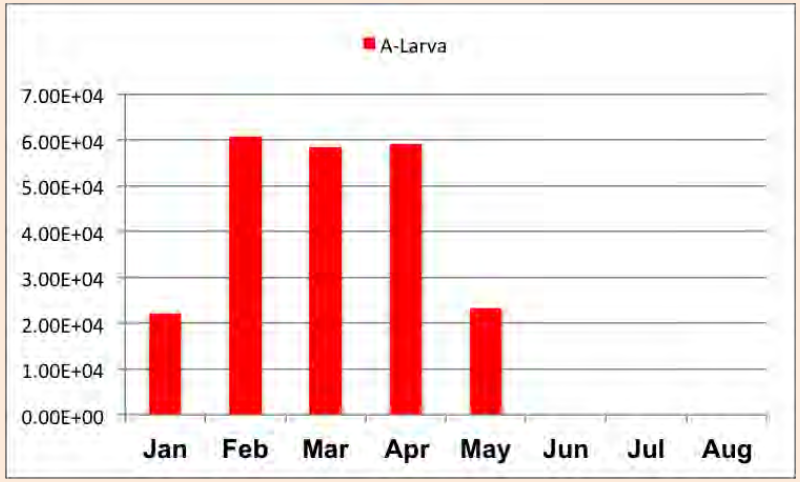
The zooplankton which anchovy larvae could eat decreased after the RS.

But for sardine larvae, the feeding condition was not affected by the RS.

Distribution of larvae

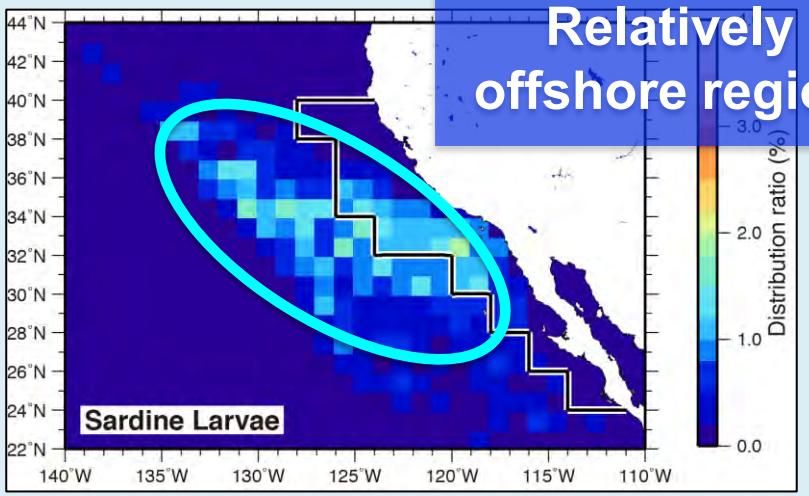
Anchovy

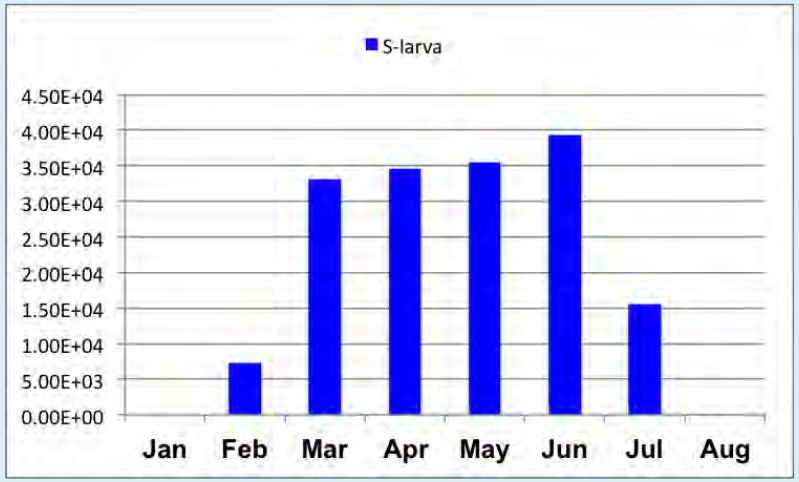




Winter to early spring

Sardine



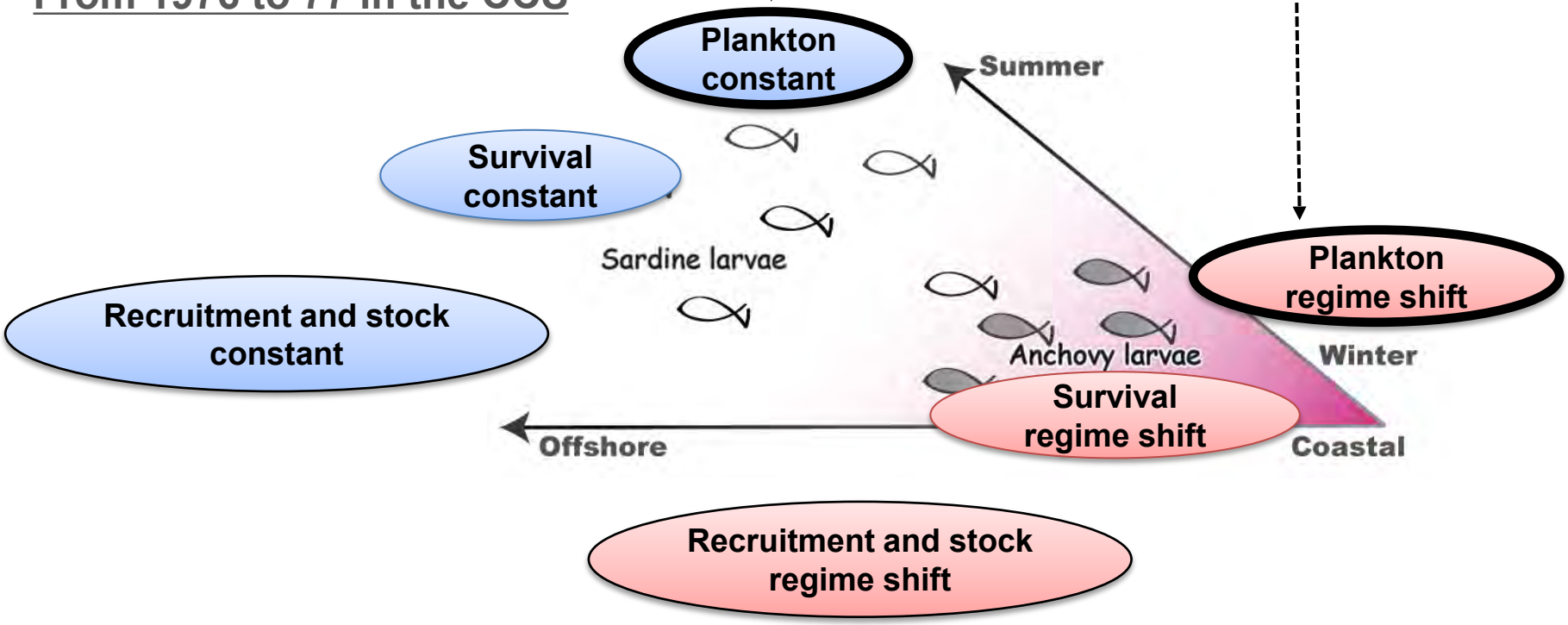


Spring

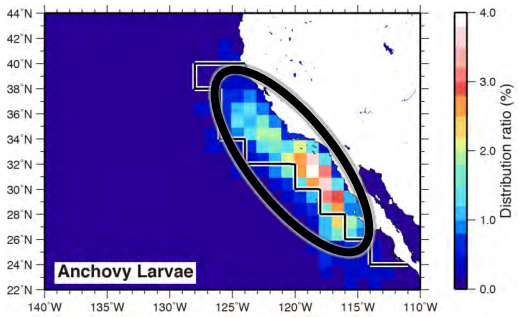
Anchovy and sardine during the 1976–77 regime shift

Why this spatial and temporal difference occurred for zooplankton?

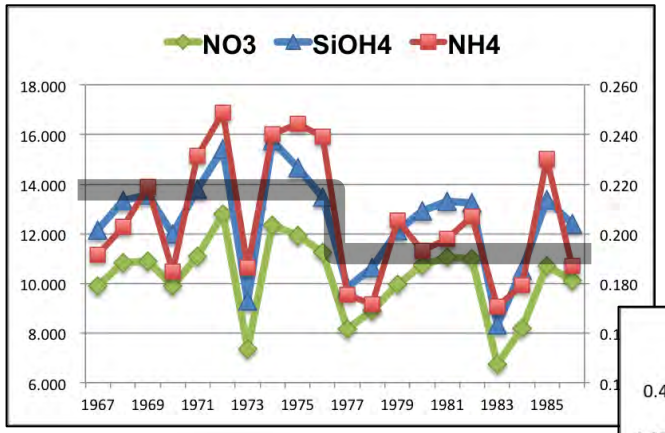
From 1976 to 77 in the CCS



From nutrients to zooplankton

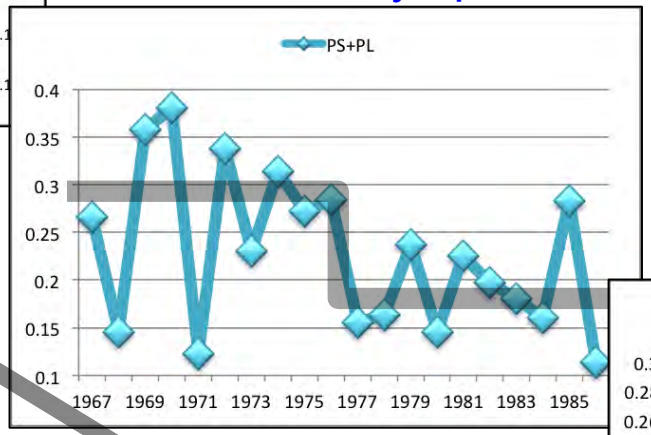


Nutrients



Nutrients, phytoplankton and zooplankton density averaged in the coastal region from January to April.

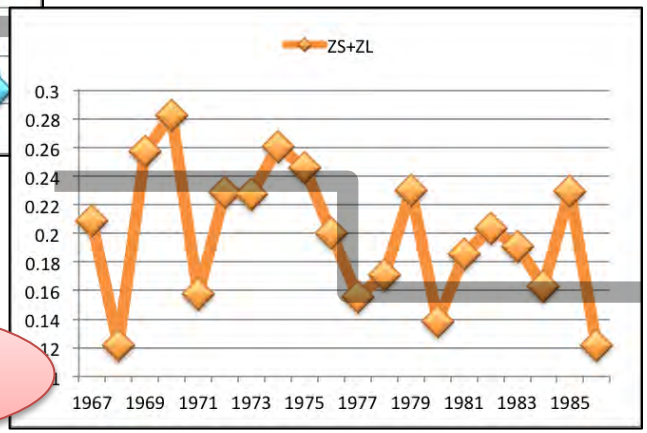
Phytoplankton



Nutrients decline

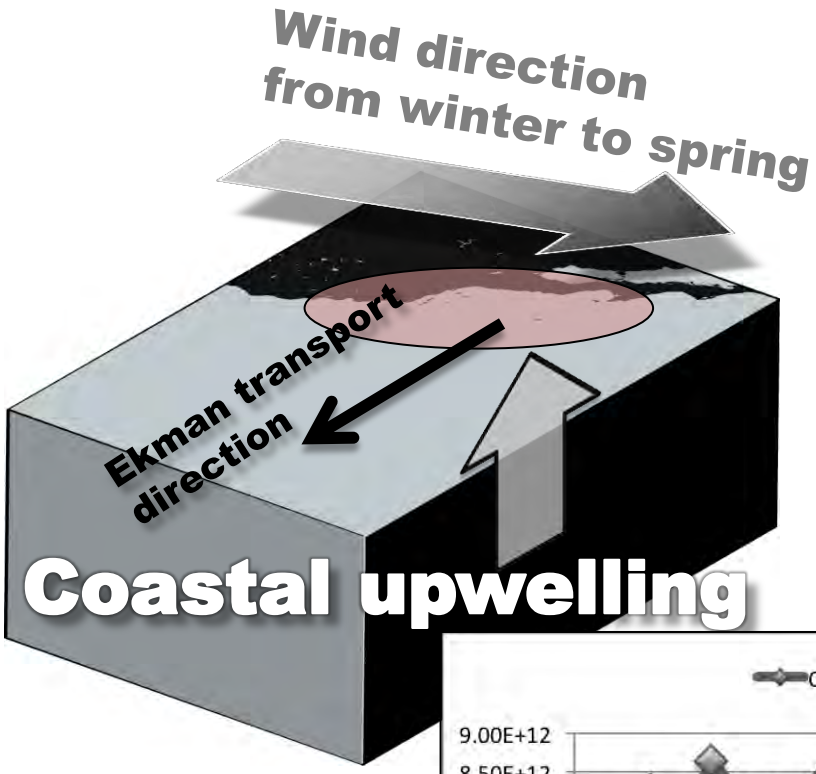
Bottom-up control

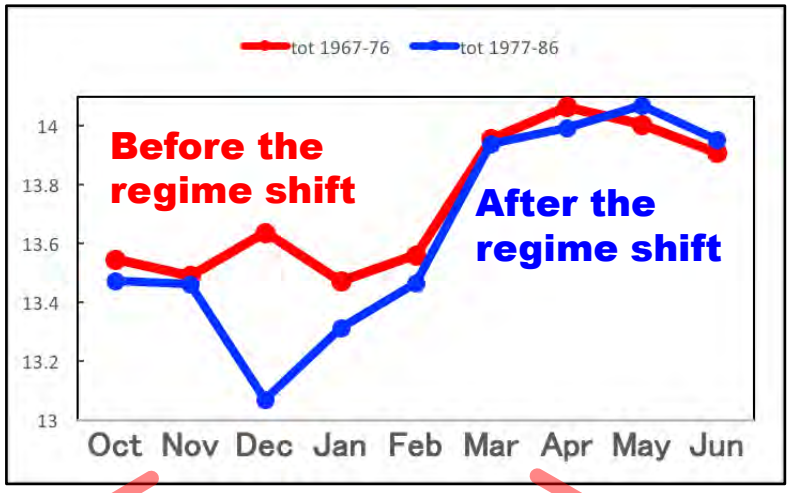
Zooplankton



Low zooplankton

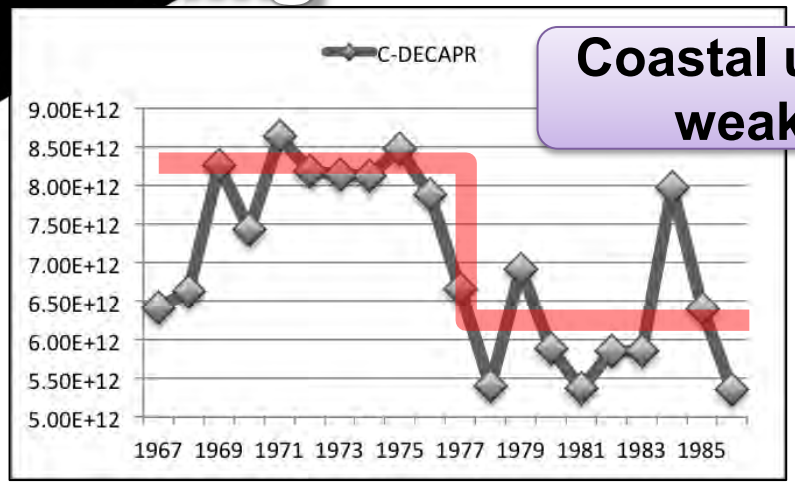
From coastal upwelling to nutrients supply



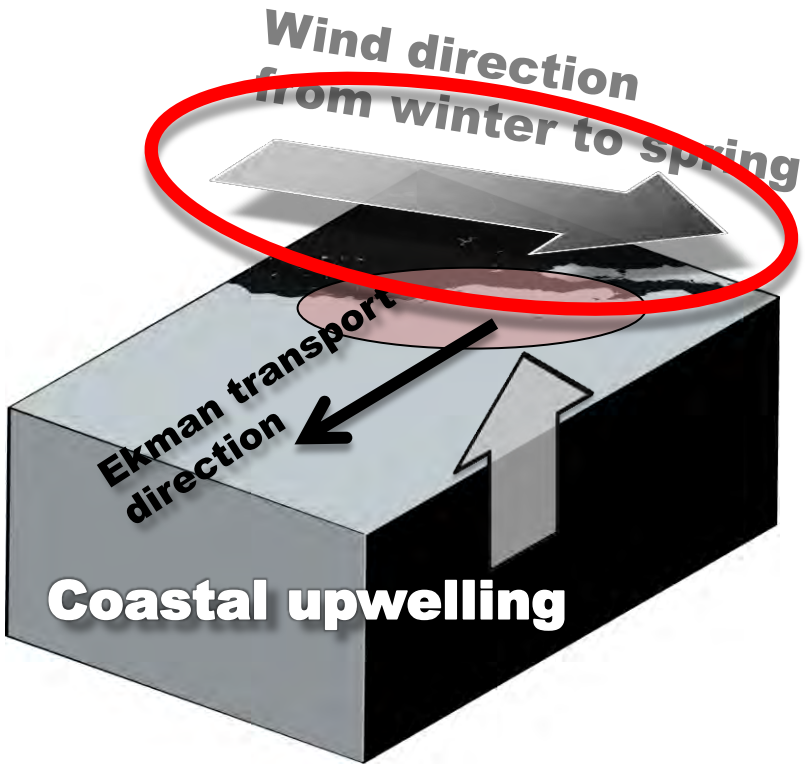


Vertical NO_3 flux decreased after the RS

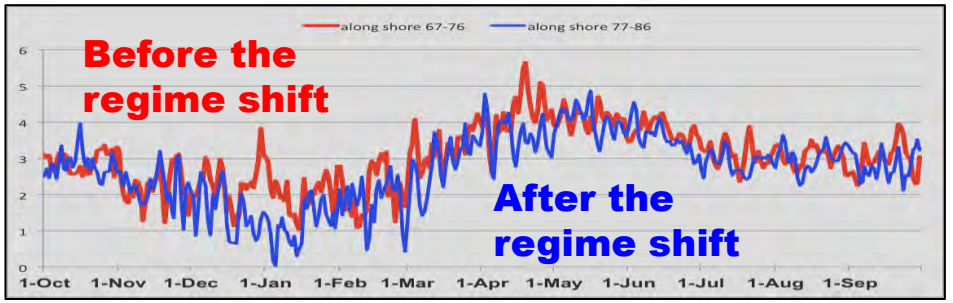
Coastal upwelling weakened

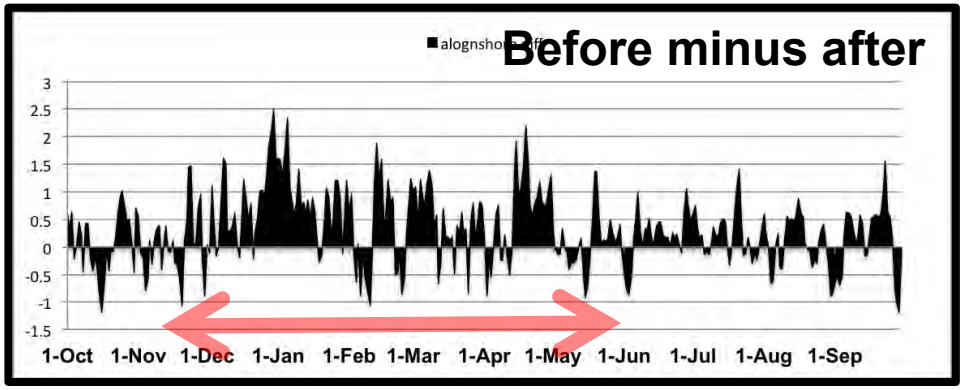


Wind regime shift



Along shore wind speed from October to September



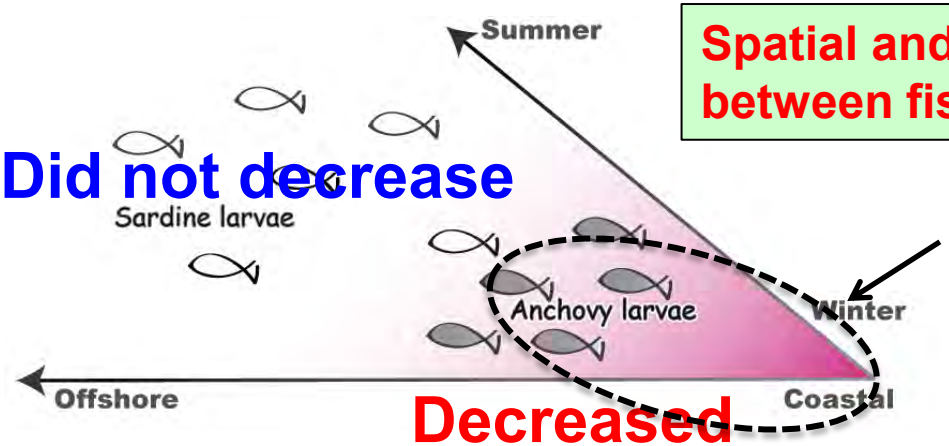


Alongshore wind RS from winter to early spring weakened the coastal upwelling after the RS.

Thus the zooplankton density only decreased in the anchovy larvae habitat, coastal region from winter to early spring.

SUMMARY

Why the responses of anchovy and sardine against the 1976/77 RS were different?



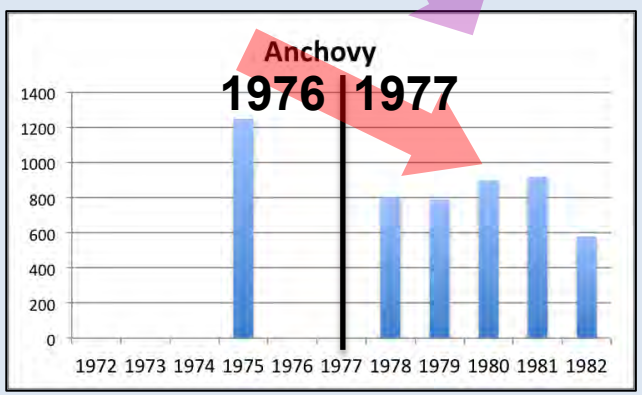
Spatial and temporal match-mismatch between fish and wind system RS.

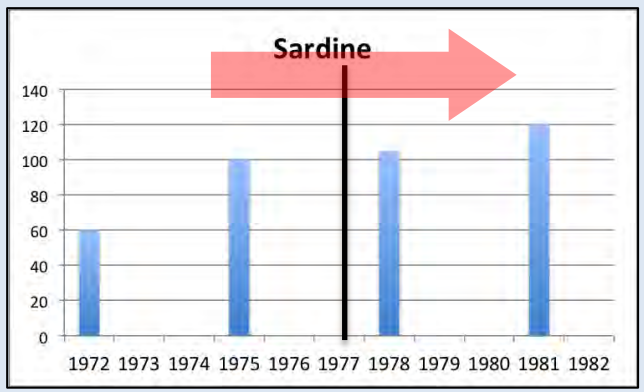
Did not decrease

Decreased

Wind induced zooplankton decrease occurred from winter to early spring in the coastal area.

These results are not inconsistent with observation data.





CalCOFI larvae abundance (/10m^2)