Diet diversity of jack and chub mackerels and ecosystem changes in the Northern Humboldt Current System: a long-term study

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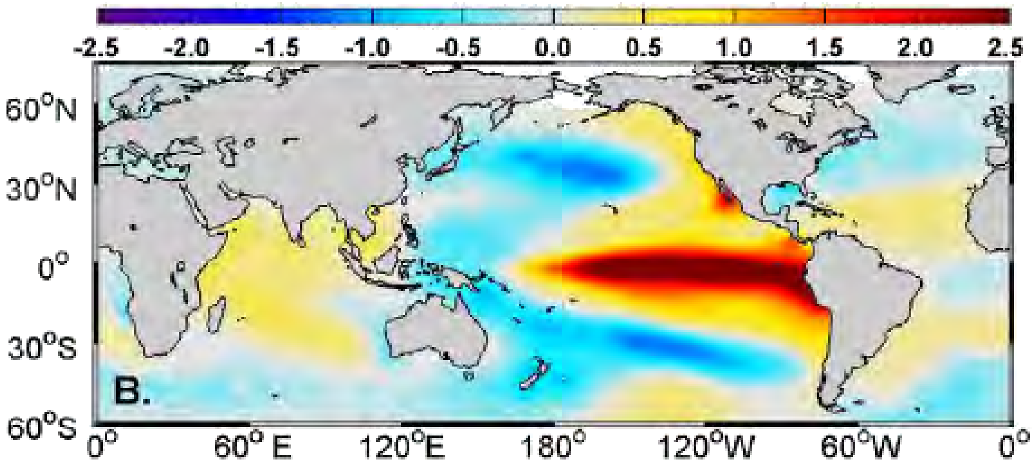
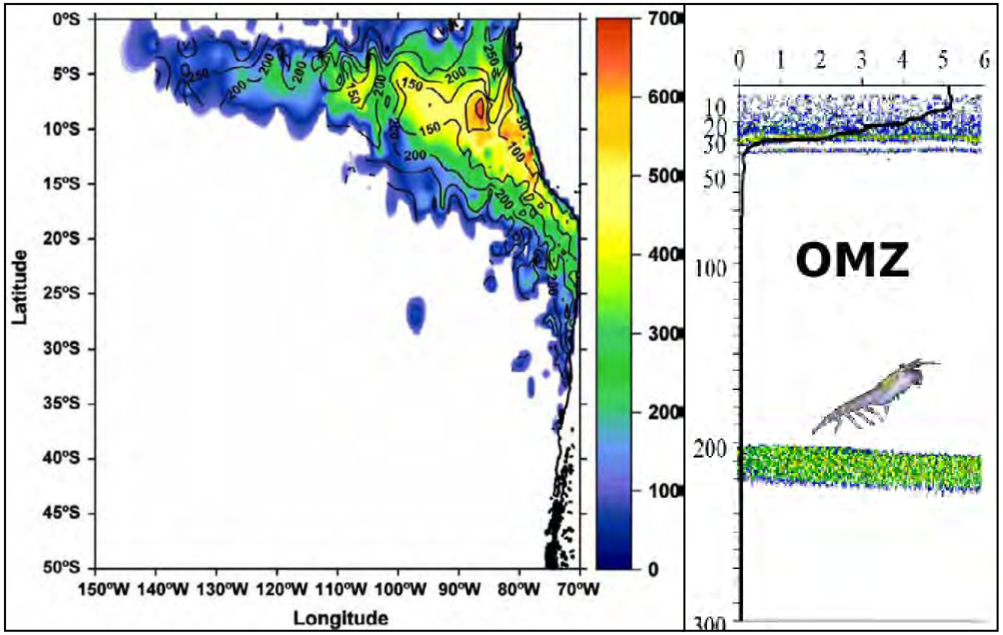
High climatic variability



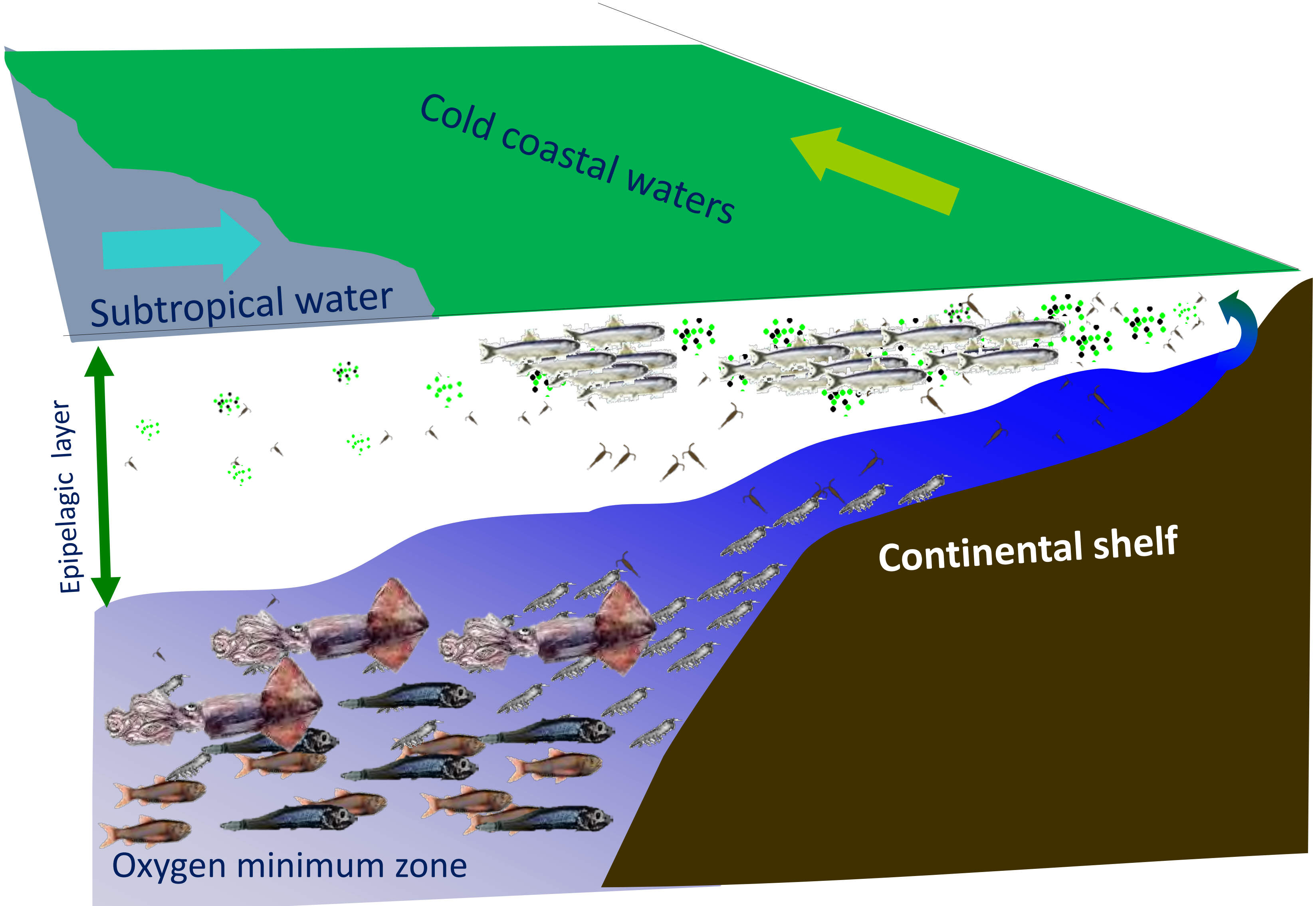
SSToC variability (1875 – 2007)

Intense and shallow oxygen minimum zone (OMZ) O2 concentration <0.5 ml l-1

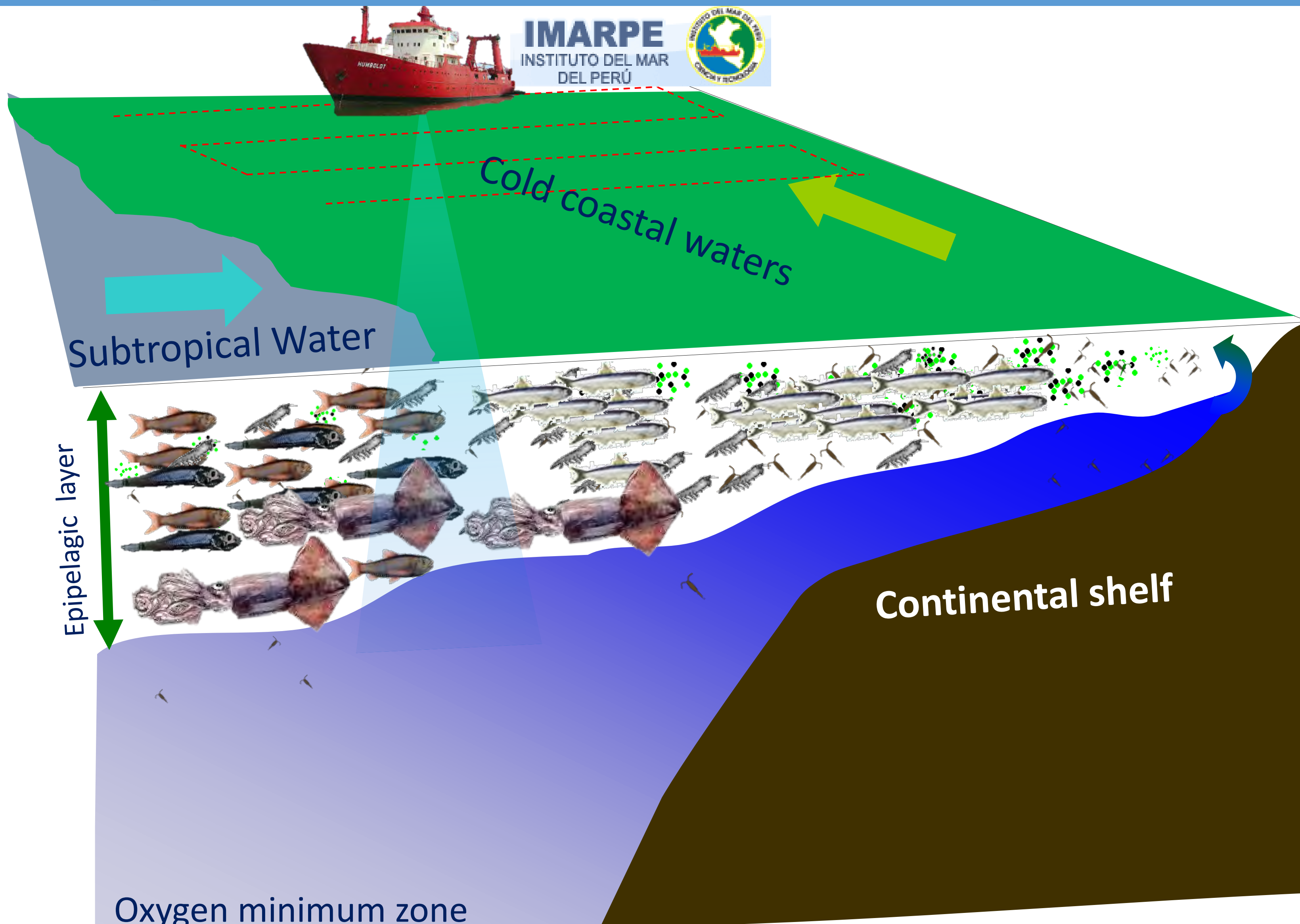
The NHCS is affected by intense climatic variability at multiple scales (seasonal, interannual, multidecadal,...).



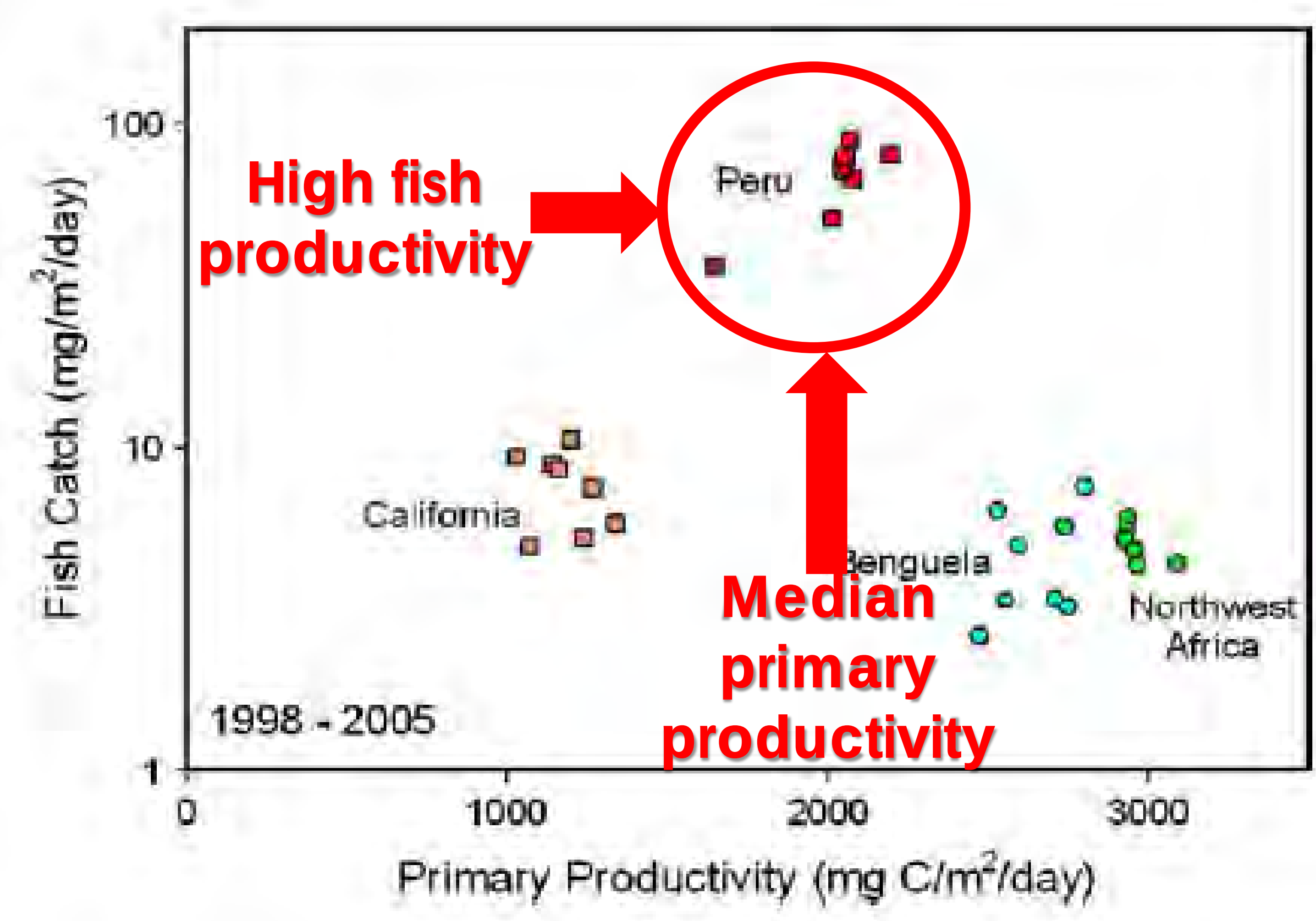
NHCS – Day situation



NHCS – Night situation



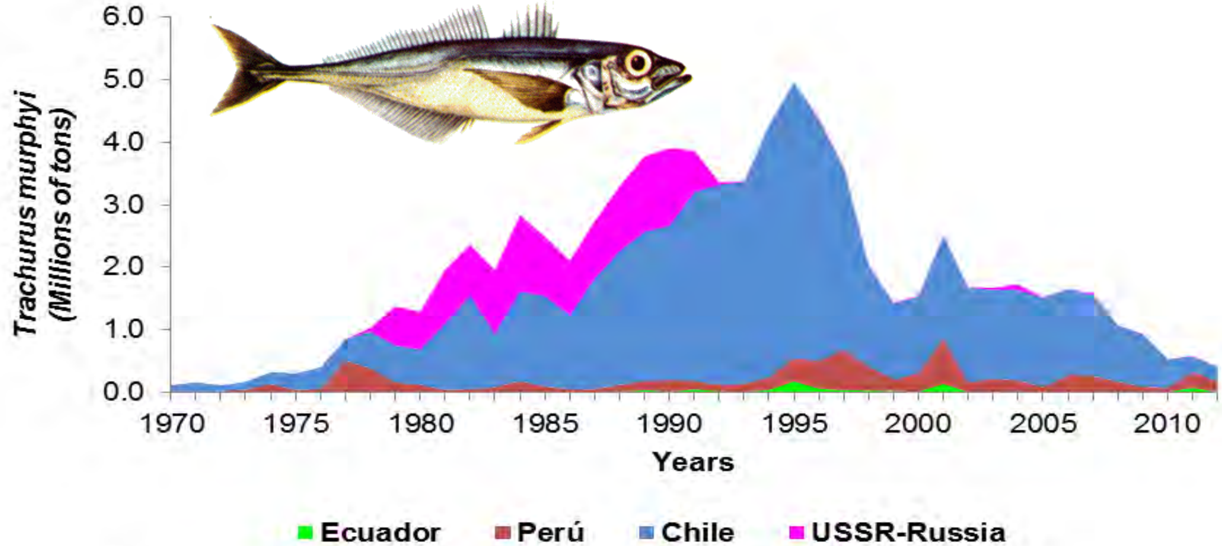
What is the secret for such high fish productivity?

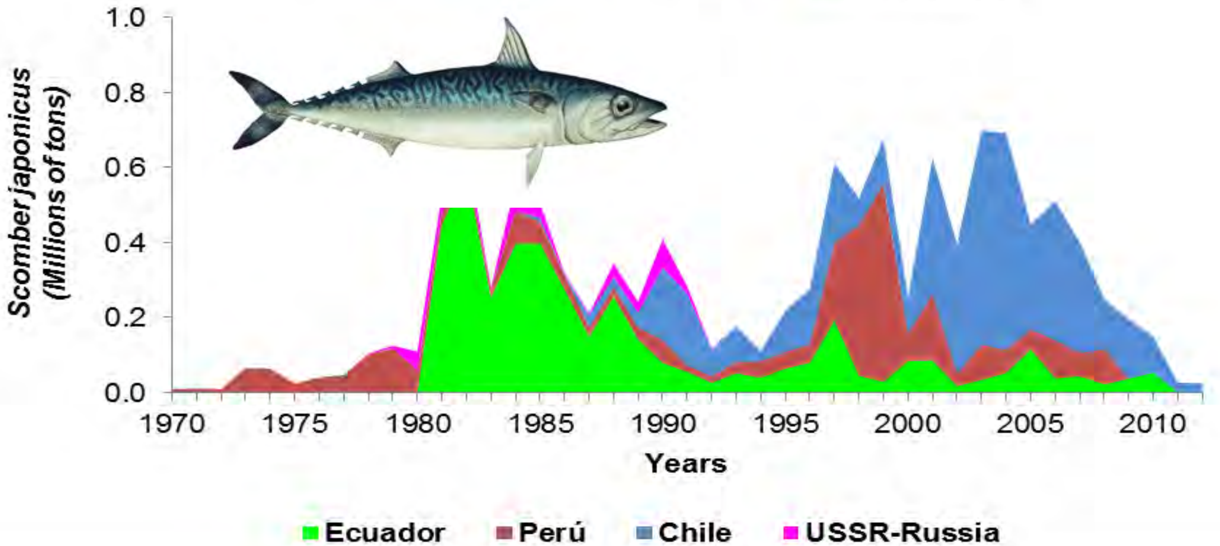


(Source: Chávez et al. 2008)

Food does matter → need to study the trophic structure and energetic transfer

Jack and Chub mackerel population decreased dramatically in the late 1990s



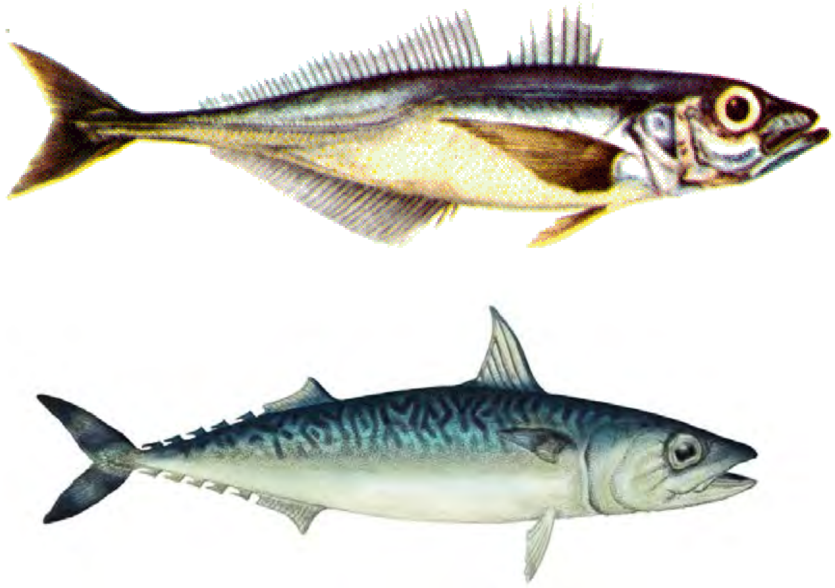


JM and CM distribution depends on food availability.

→ need to better understand the spatiotemporal patterns of JM and CM diet composition.

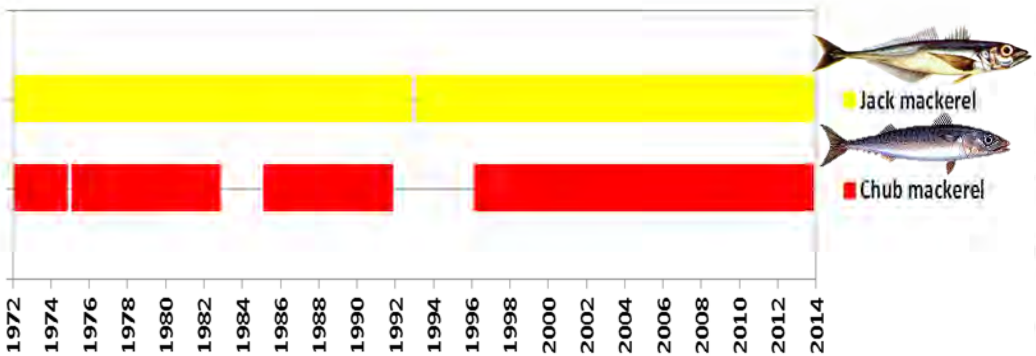
→ Need to better understand the reason of this collapse

Objective

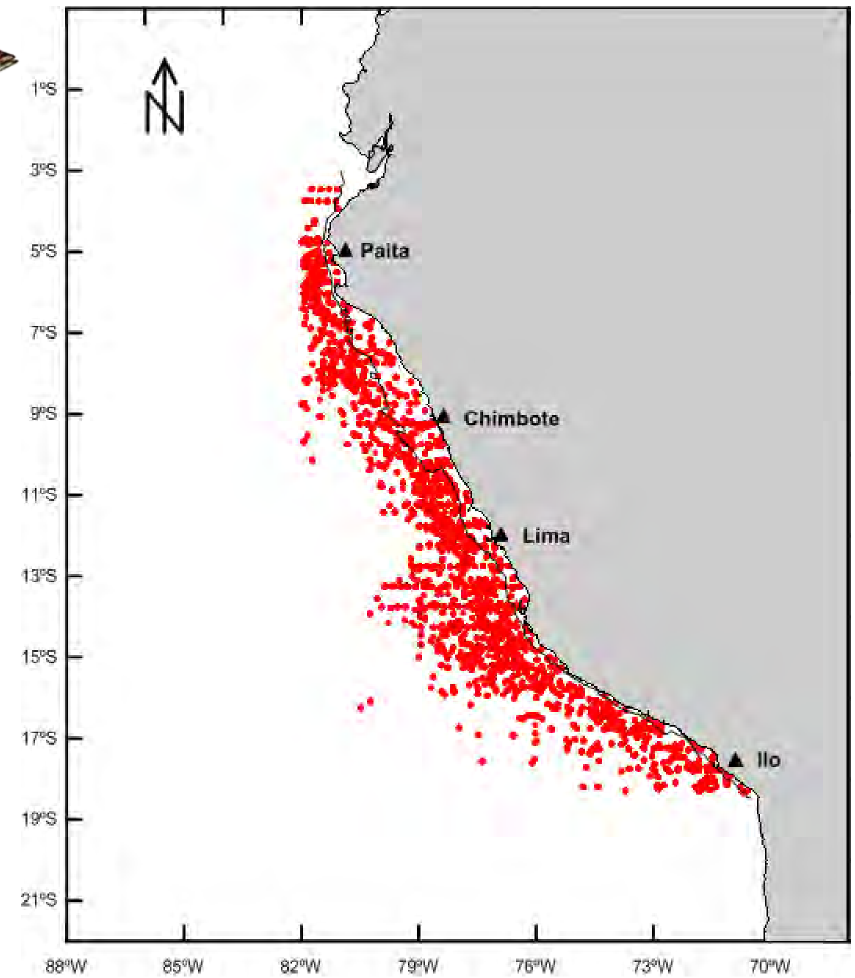


We investigate the spatiotemporal patterns of Jack mackerel *Trachurus murphyi* and chub mackerel *Scomber japonicus* diet composition.

Data



Data recovered | analyzed



Time series diet of two species

29,158 stomachs → 1973-2013

18,377 stomachs → 1973-2013

Total stomachs → 47,535

Methods

29,158 and **18,377** Stomachs

90 and **102** prey taxa
Weight (%W)
Occurrence (%O)

13 dietary groups

STOMACH FULLNESS WEIGHT INDEX (FWI, in %) compare with Kruskal-Wallis and Wilcoxon rank sum tests

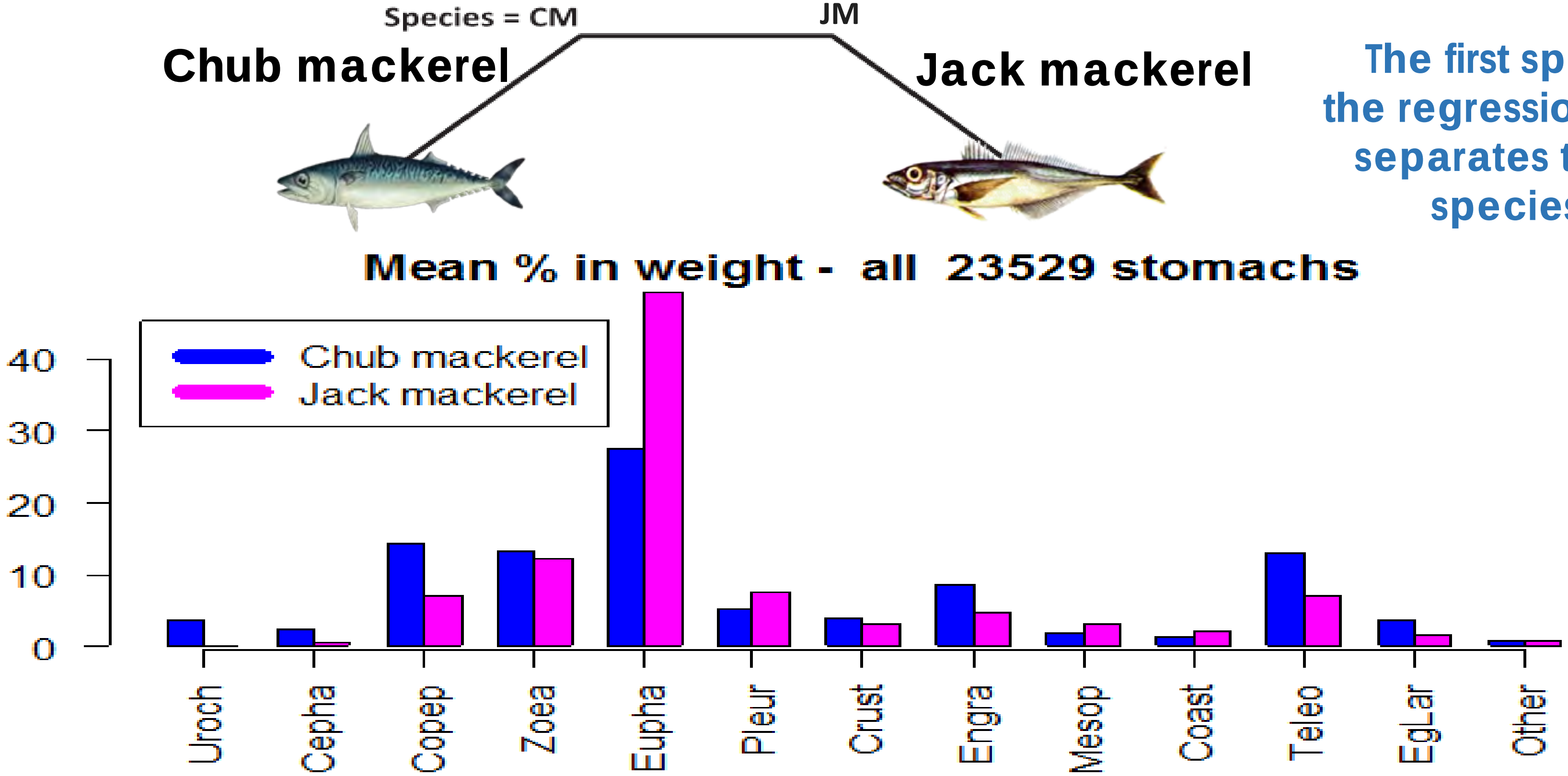
INDEX OF CONDITION FACTOR (Kn)

2 CART: MULTIVARIATE REGRESSION TREE:
Group ~ Species + SSTA+Size + $Z_{15ºC}$ + Zones+DistShelf
Group ~ Year + SSTA +Size + $Z_{15ºC}$ + Zones + DistShelf

CORRESPONDENCE ANALYSIS to order the prey taxa richness per year

BOOTSTRAP to compute the diet composition by year, distance to the shelf break and latitudinal zones

Comparative diet

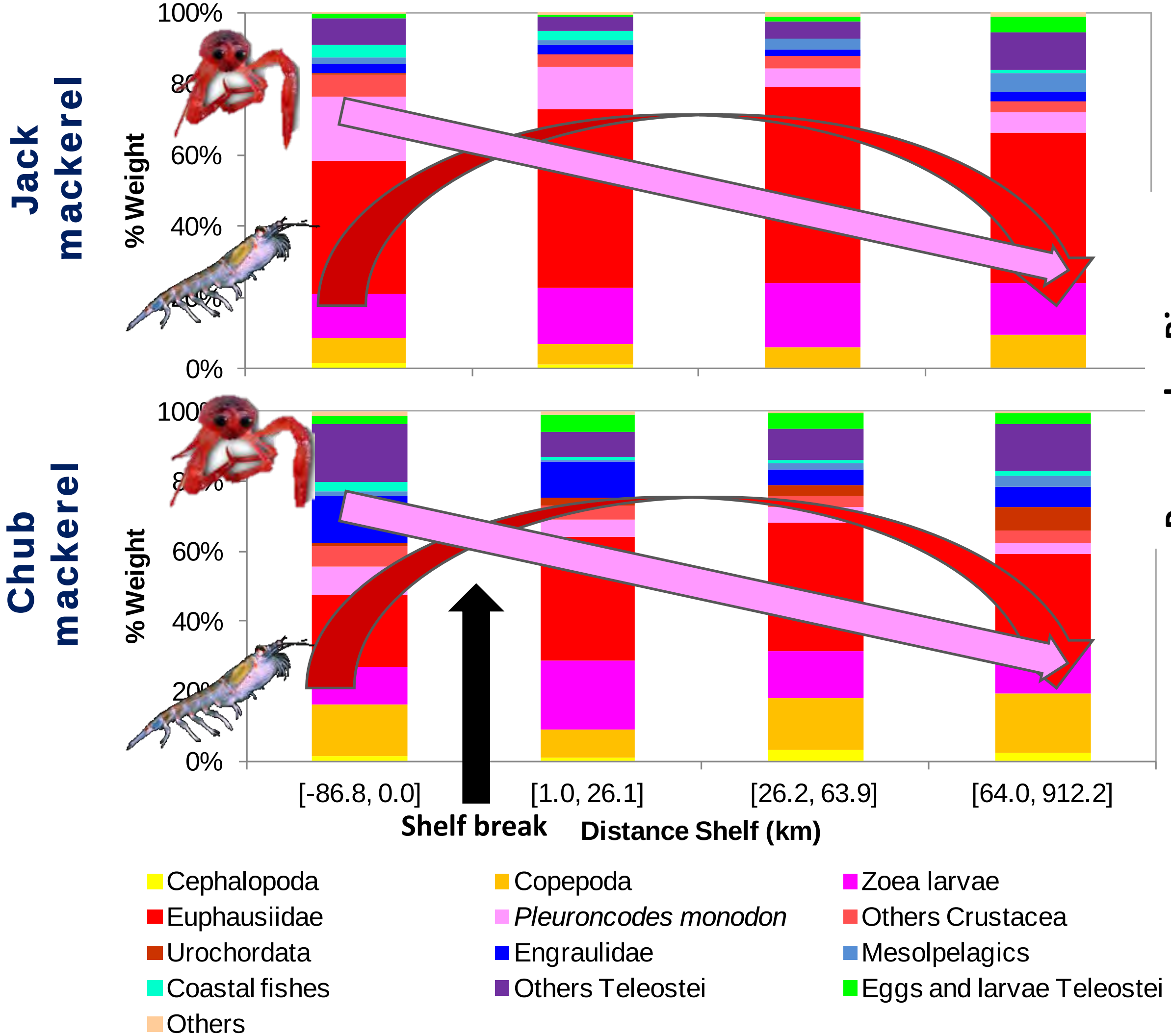


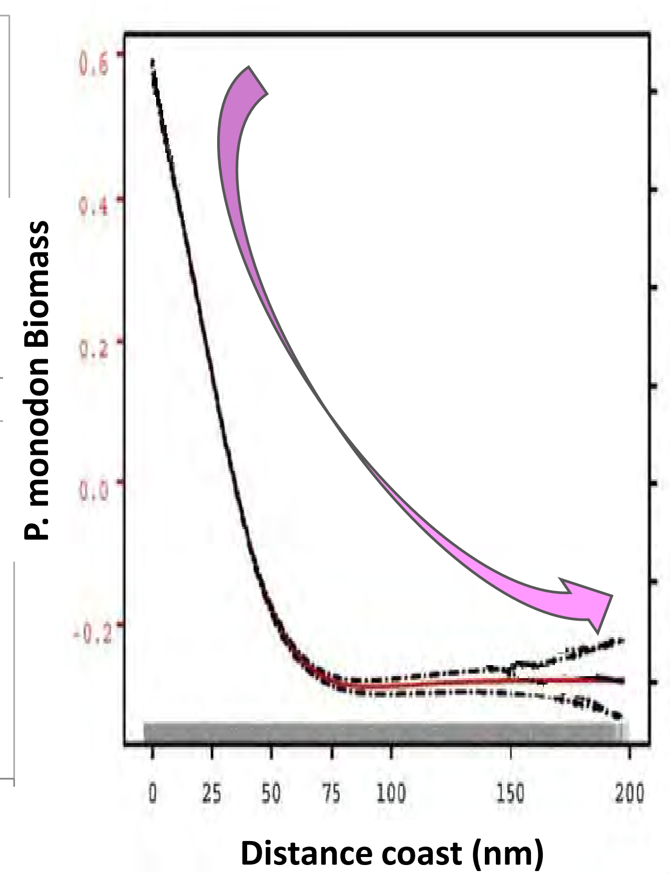
The first split of the regression tree separates the 2 species

→ **Medina and Arancibia 1998: JM selects much larger prey than CM.**

→ **Our study question this: we found overall higher percentage of fish (especially Engraulidae) in CM (29%) than in JM (19%).**

Distance to the shelf break changes

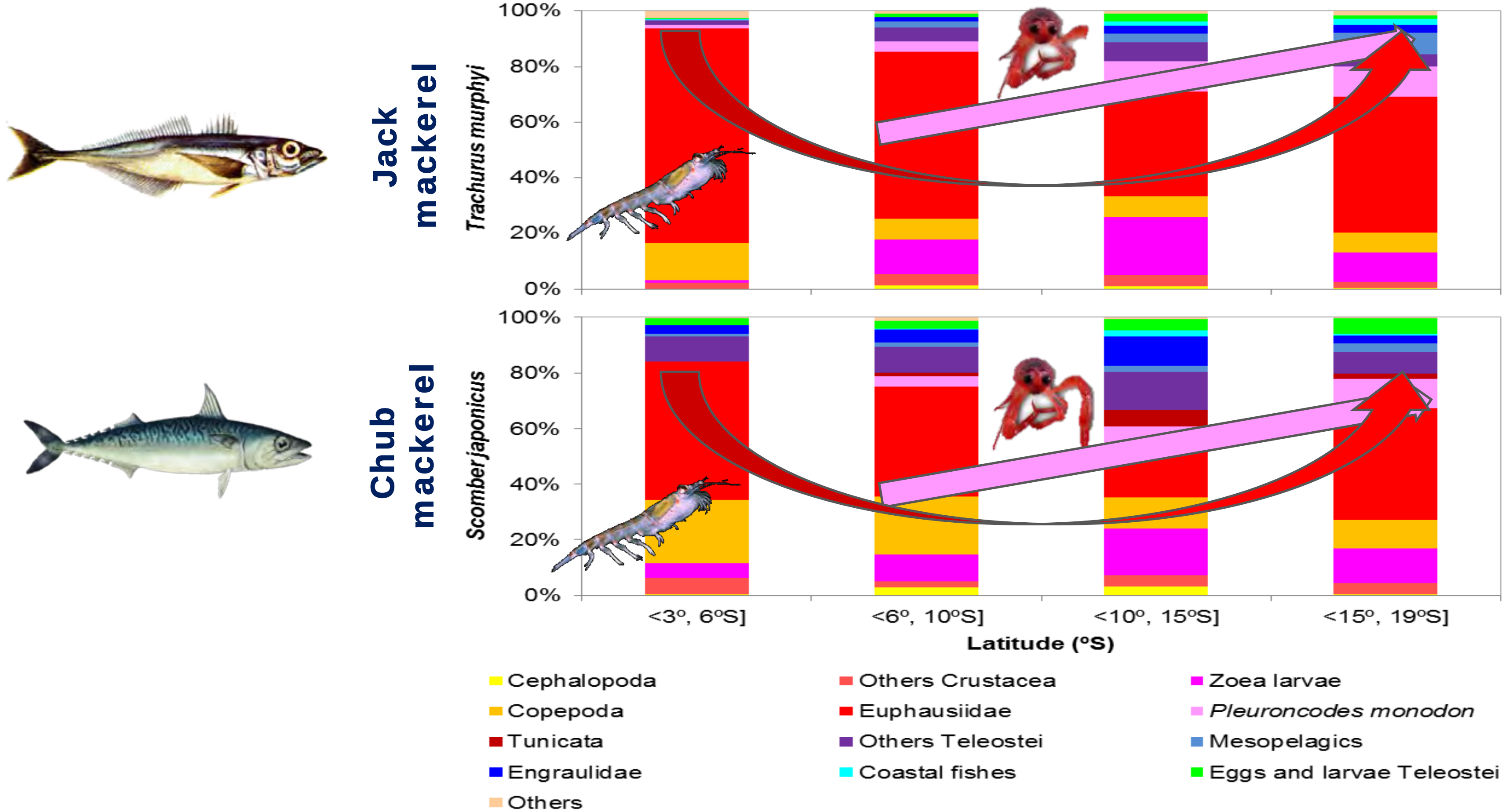




(Gutiérrez *et al.* 2008)

→ The shelf break appears to be a biogeographic barrier

Latitudinal changes

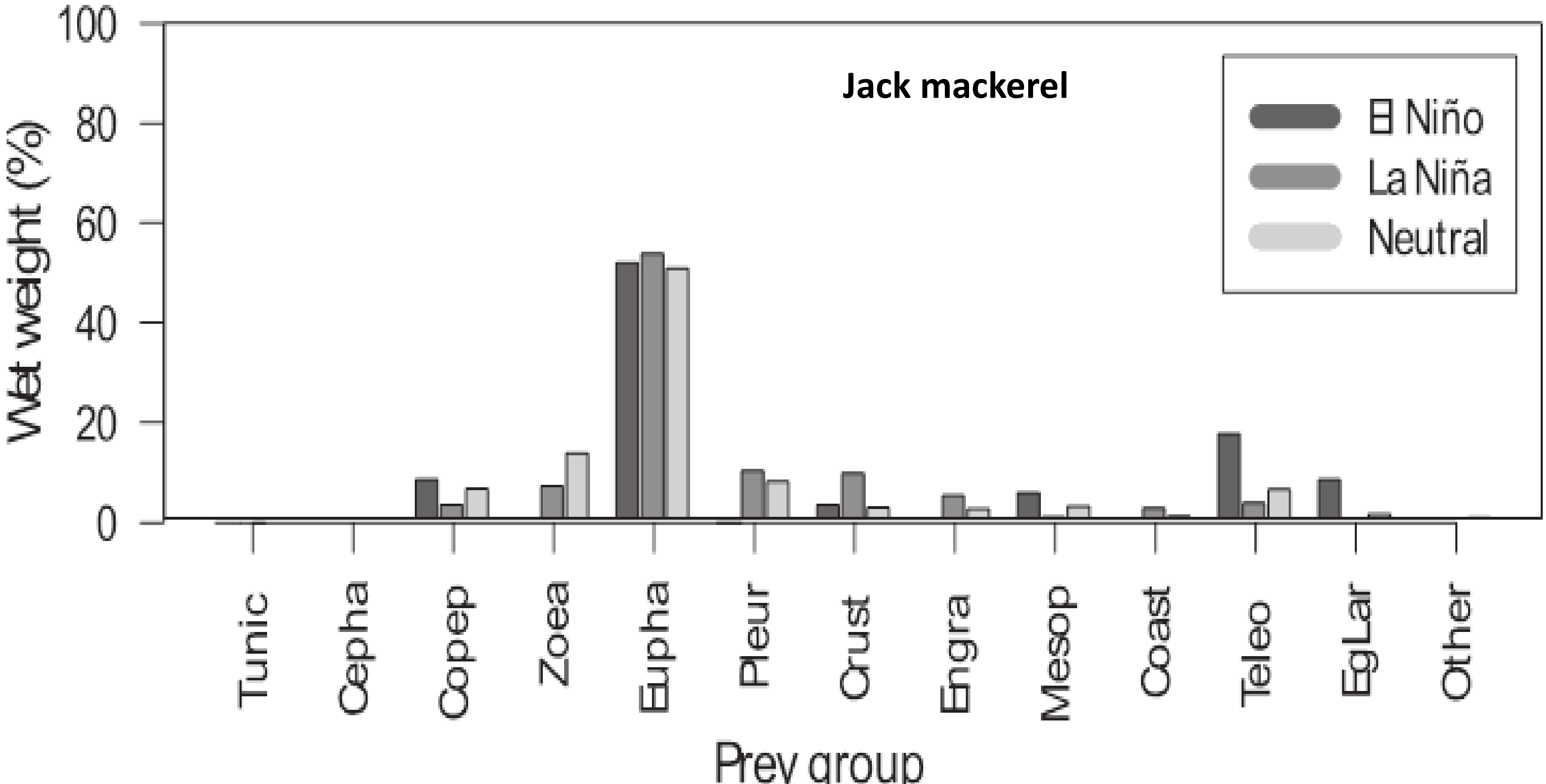


→ **Oceanic prey (euphausiids) dominated where the shelf is narrow (North and South).**

→ **Coastal prey (squat lobster and anchovy) are more important in Central Peru where the continental shelf is larger**

→ **The shelf break extend can thus be an important factor**

Interannual changes

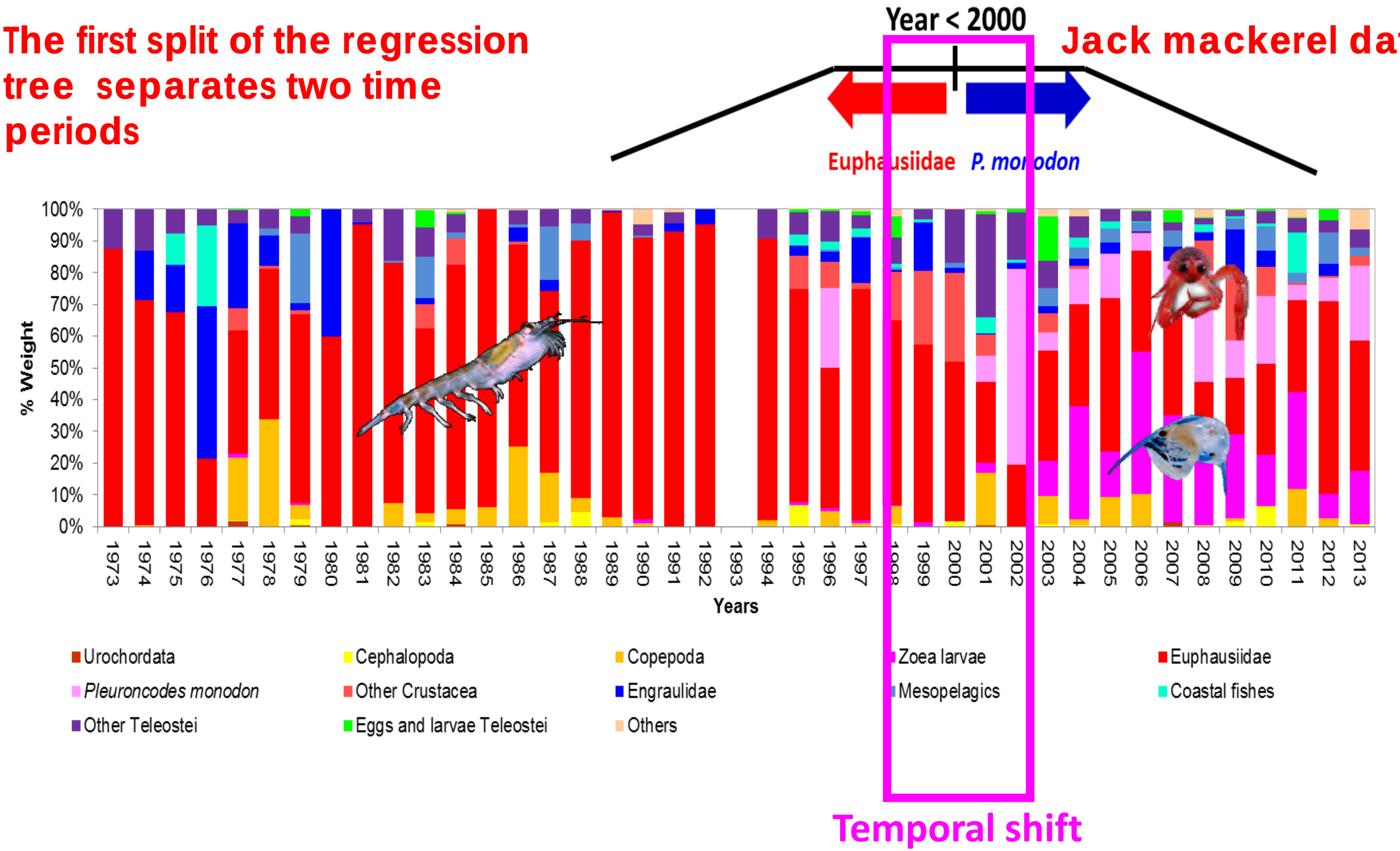


No evidence of strong interannual effect of ENSO (El Niño and La Niña). Question the results of Sanchez and Muck (1987) based on few data and confirm the findings of Espinoza and Bertrand (2014) on anchovy diet

Decadal changes

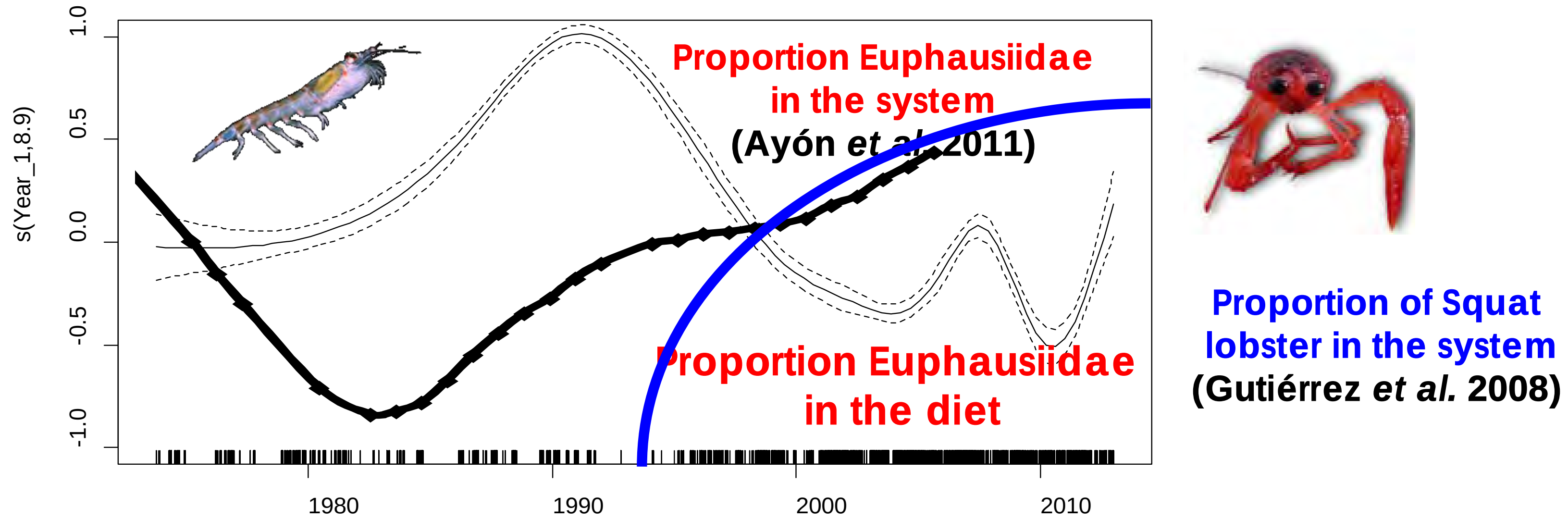
The first split of the regression tree separates two time periods

Jack mackerel data



Condition factor before 2000 = 0.96 ± 0.11 - since 2000: 1.05 ± 0.10 (signif. diff.)

Paradox



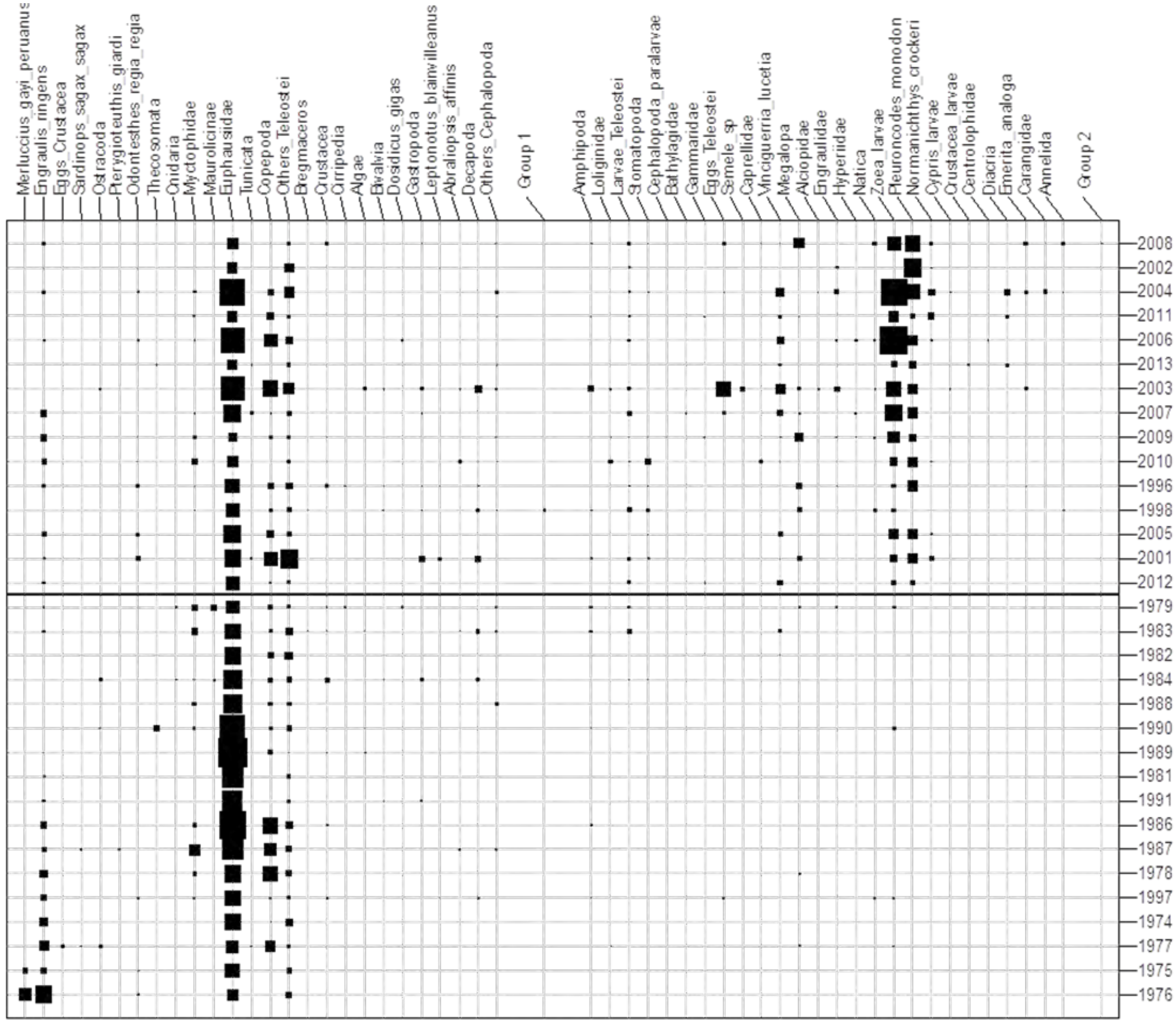
- **Both species Jack and Chub mackerel are opportunistic species with high plasticity. They feed on prey that are more accessible.**
- **During the 1970-1980s the euphausiids were not so abundant but they are easy prey for JM and CM**
- **Since the last decade the Squat lobster was present on the Peruvian coast.**

Richness

Mean occurrence of *Trachurus murphyi* prey taxa per year.

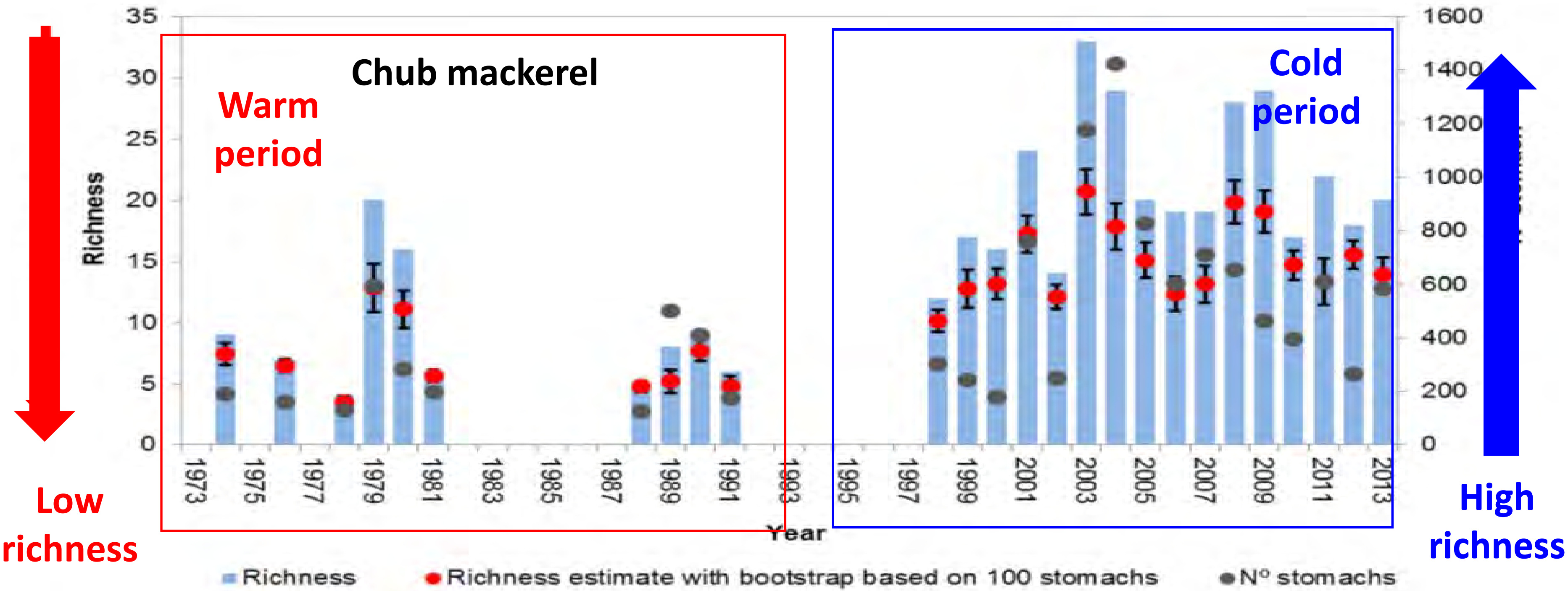
Second period from 1996 characterized by a larger number of taxa

First period before 1996 characterized by low diversitiy



Temperature vs. Richness

Hypothesis:
Temperature and species richness are positively correlated (Frank et al., 2007)



Our results challenge such paradigm: prey diversity was higher during cold period than warm period.

What did we know before?

The diet of these two species is dominated by zooplankton (then fish) (Konchina et al. 1996; Castro & Santana 2000); they are considered as opportunistic foragers (Konchina et al. 1981).

What have we learned in this study about the diet of JM and CM?

- Both species are opportunistic and present a trophic overlap but surprisingly, JM does not seem more voracious than CM.

- Fish diet presented high spatiotemporal variability, the shelf break being a clear biogeographical frontier.

- Fish diet composition is not necessarily a good indicator of changes in prey biomass since prey accessibility and energy content does matter.

- Unexpectedly, El Niño events have a weak effect on stomach fullness and on the diet of CM and JM;

- Finally our results challenge the paradigm of positive correlation between diversity and temperature in the case of the NHCS.

Thank you!

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