INTERNATIONAL SYMPOSIUM

DRIVERS OF DYNAMICS OF SMALL PELAGIC FISH RESOURCES

Are there early signals of a new "sardine cycle" in the Peruvian upwelling system?

Some implications for the fisheries management

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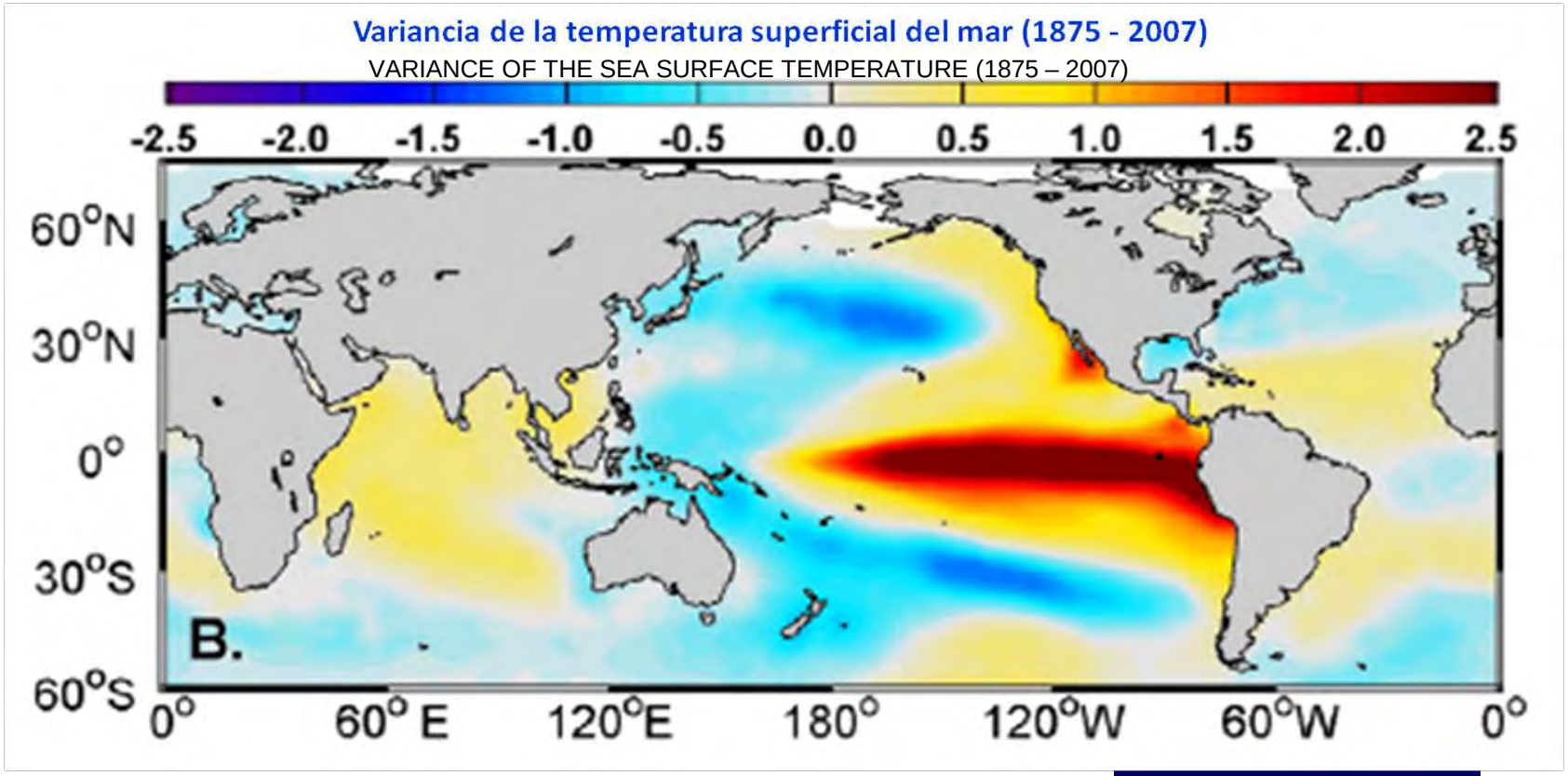
Variability at different timescales in the Peruvian sea

- SEASONAL SCALE: UPWELLING
- INTERANNUAL SCALE: ENSO
- INTERDECADAL SCALE: EV&LV / PIO / PDO
- VERY LONG TIMESCALE



Chavez et al. (2008)

Some historical facts…

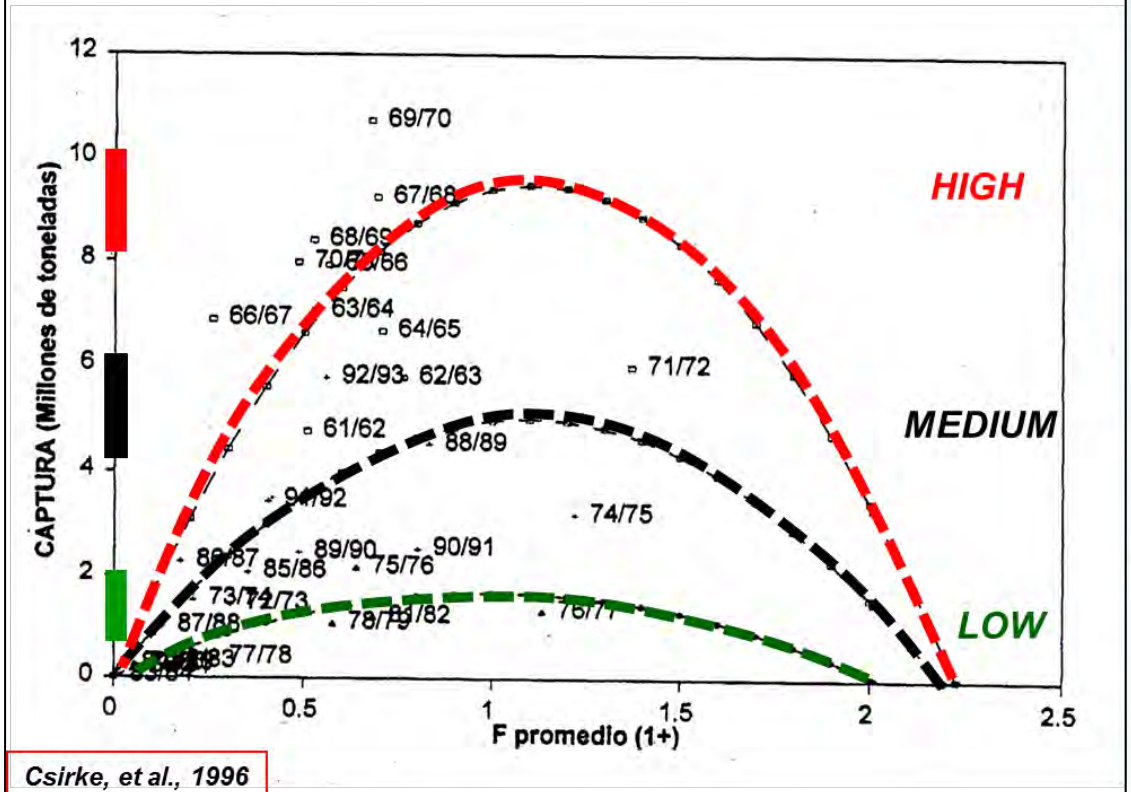
- In 1972, the collapse of Peruvian anchovy (the fishery and the population) raised a discussion on which was the fundamental cause: overexploitation or El Niño.
- Sardine had started its explosive invasion of all those spaces left by anchoveta.
- Meanwhile, paleoceanographic studies like that of De Vries (1979), shed light on the long term trend natural variability of populations in the Peruvian sea.

Some historical facts.

- Other studies like that Kawasaki (1983) fueled the discussions on the sardine / anchovy paradigm, and how to use that knowledge in Peruvian fisheries management.
- As a consequence in 1990s an operational approach to manage anchoveta population was adopted under the hypothesis that: the population shows different "equilibrium states" of high and low biomasses. Each one corresponding to different carrying capacities.

OPERATIONAL MODELS WITH DIFFERENT POPULATION STATES

ANNUAL YIELDS OF PERUVIAN ANCHOVETA (NORTH - CENTRAL STOCK)



Csirke, et al., 1996

a) **High biomass:**

K = 19 million ton;

MSY = 9.5 million ton;

F_{MSY} = 1,02 $year^{-1}$

b) **Medium biomass:**

K = 9 million ton;

MSY = 5 million ton;

F_{MSY} = 1,01 $year^{-1}$;

c) **Low biomass:**

K = 3 million ton;

MSY = 1.5 million ton;

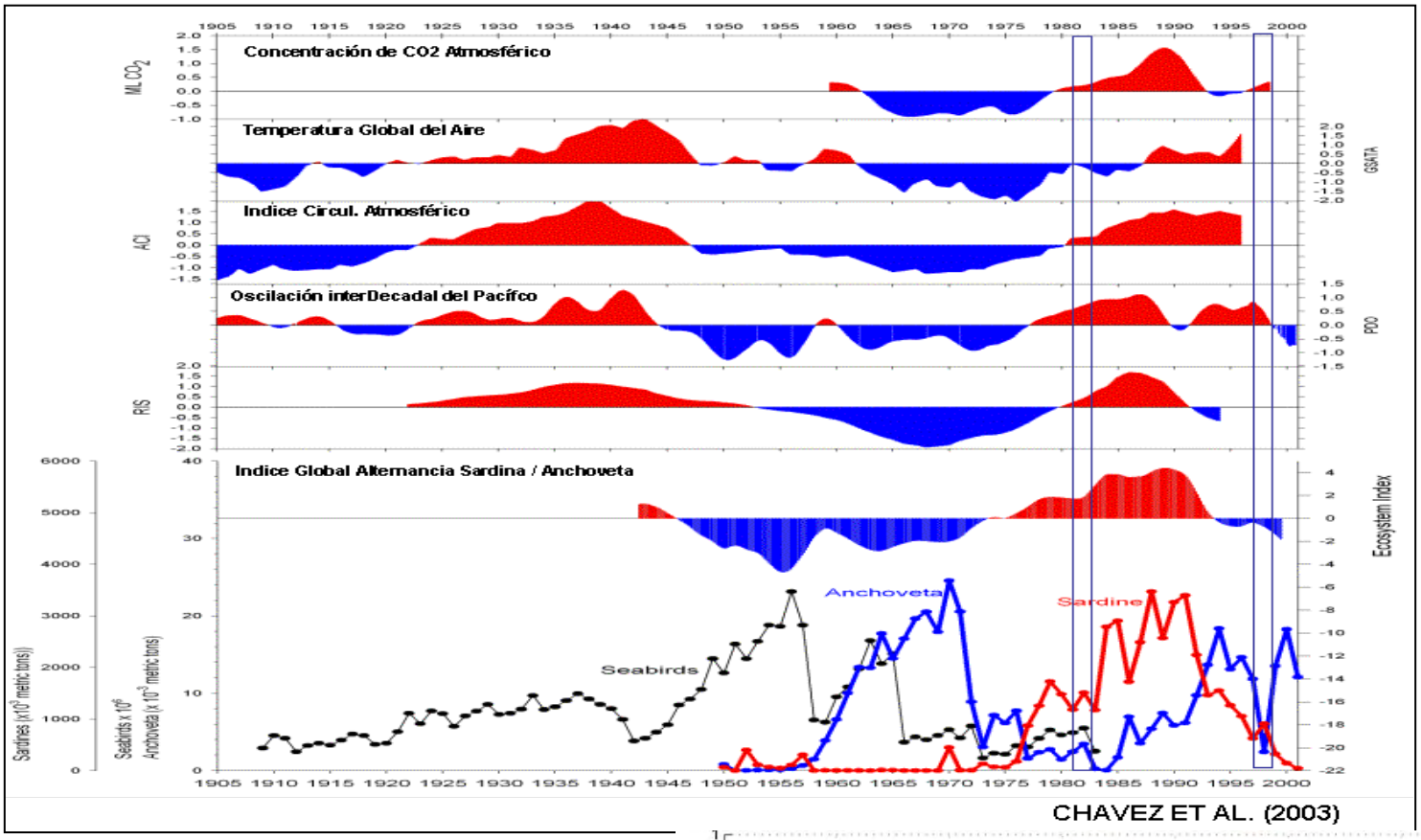
F_{MSY} = 1,01 $year^{-1}$

Some clarification was needed:

Warm "El Viejo" period
or
The "sardine period"

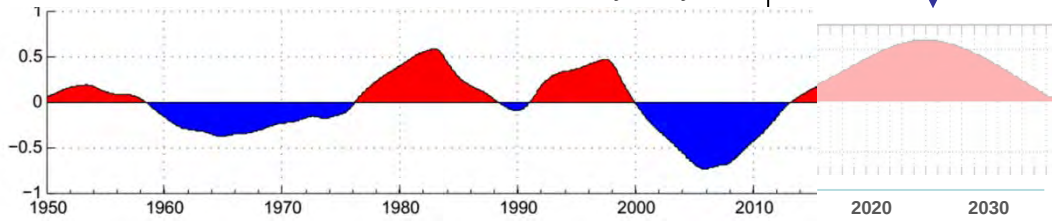
Cold "La Vieja" period
or
"The anchoveta period"

After Chavez, et al.,2003…



Peruvian Oscillation Index

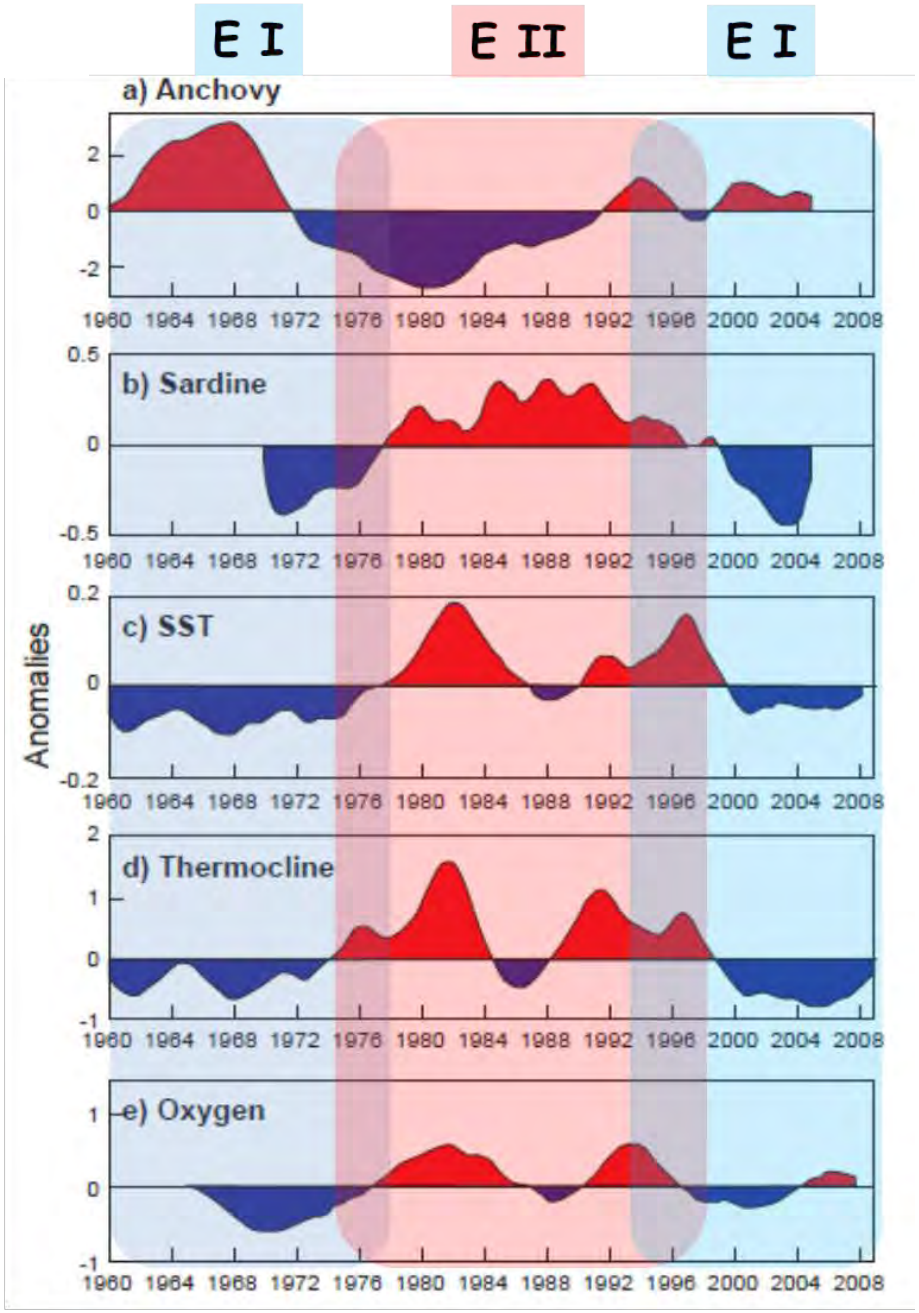
(Purca, 2005)



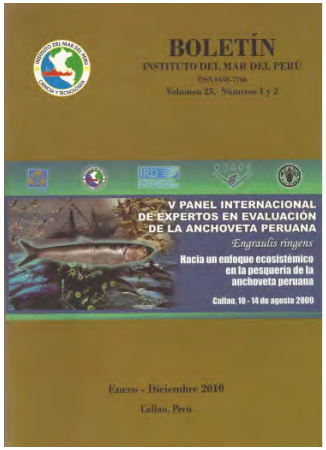
Will the warm cycle come back?

¿ ?

Alternate scenarios

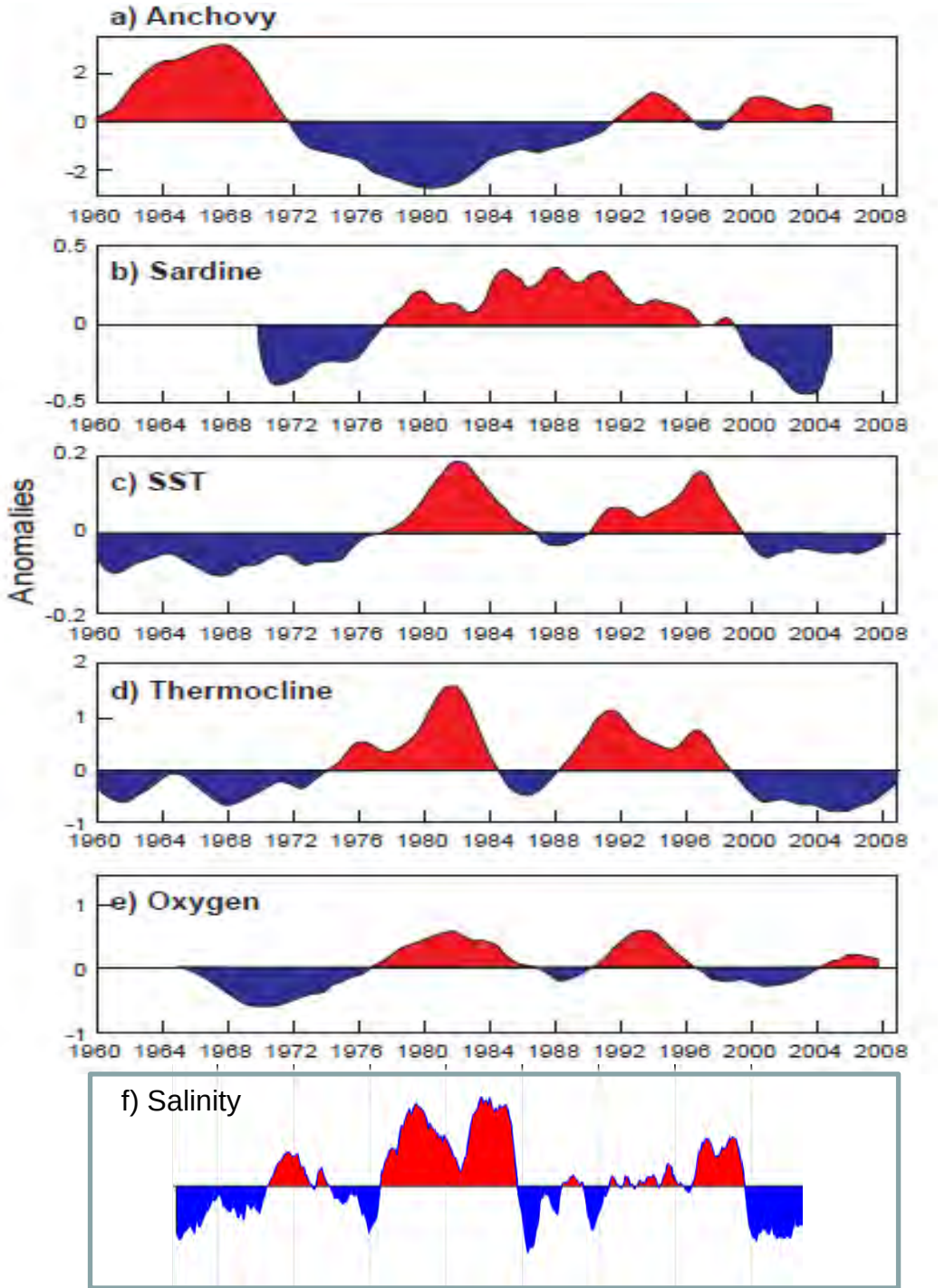


5th International Panel on Peruvian anchoveta and Its ecosystem (2009/2010)

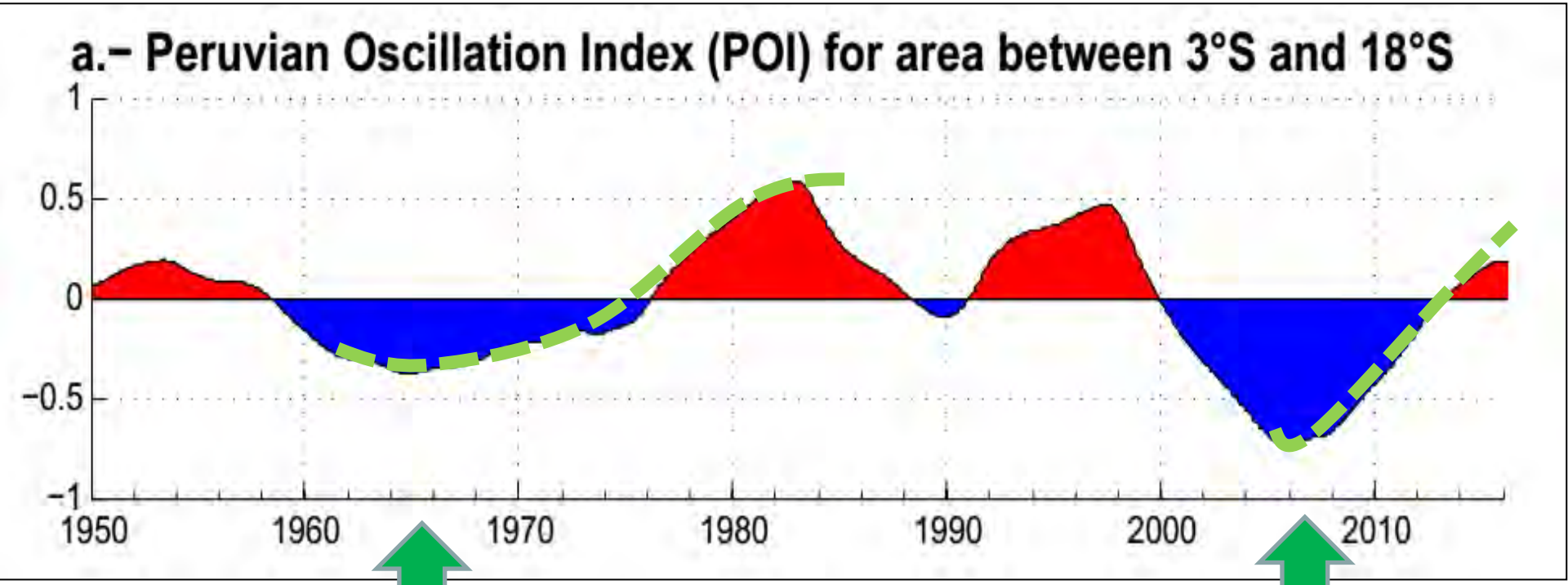


Characteristics of the "sardine period"

- predominance of positive anomalies of sea surface temperature;
- deeper thermocline
- higher oxygen content
- higher salinity of surface waters



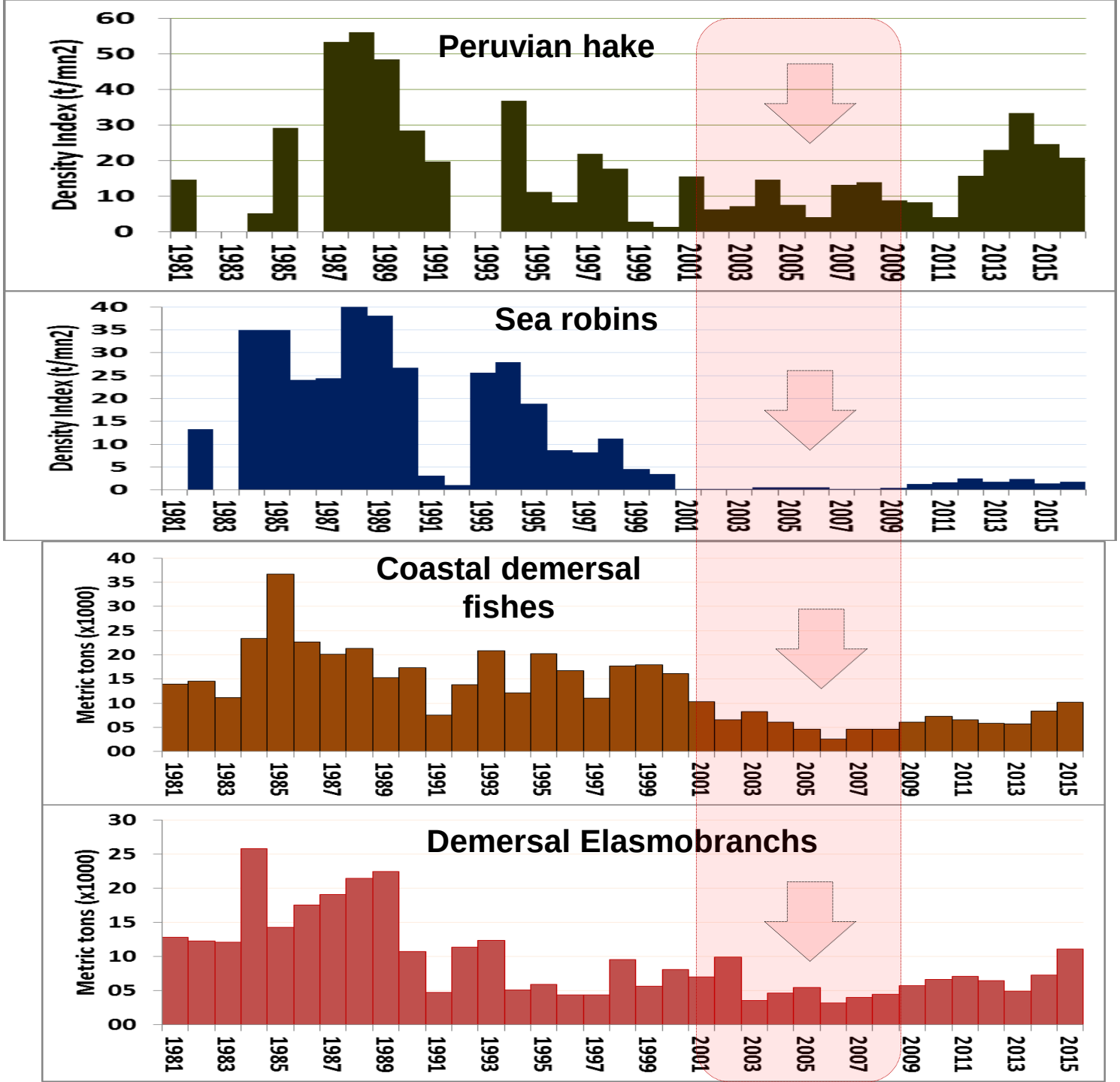
INDICATOR OF A NEW REGIMEN SHIFT… AN UPDATE



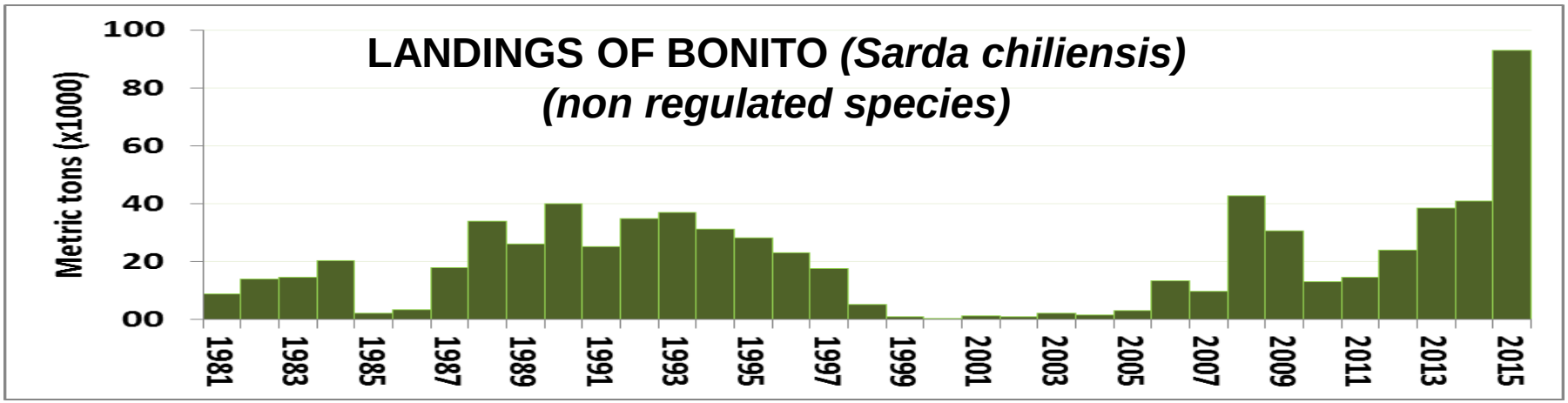
breakpoint

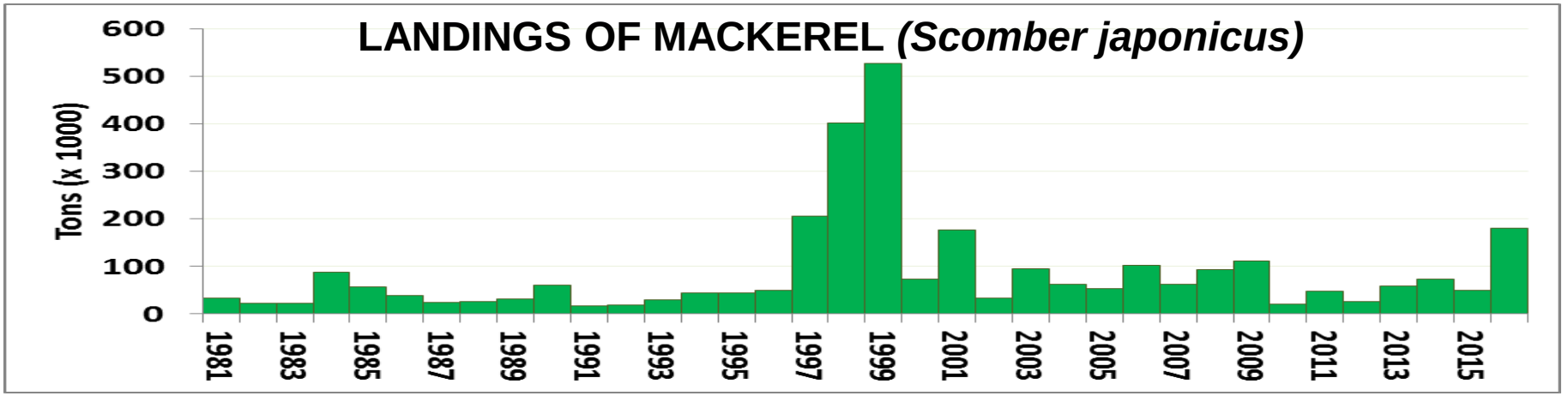
breakpoint

Signals from the bottom

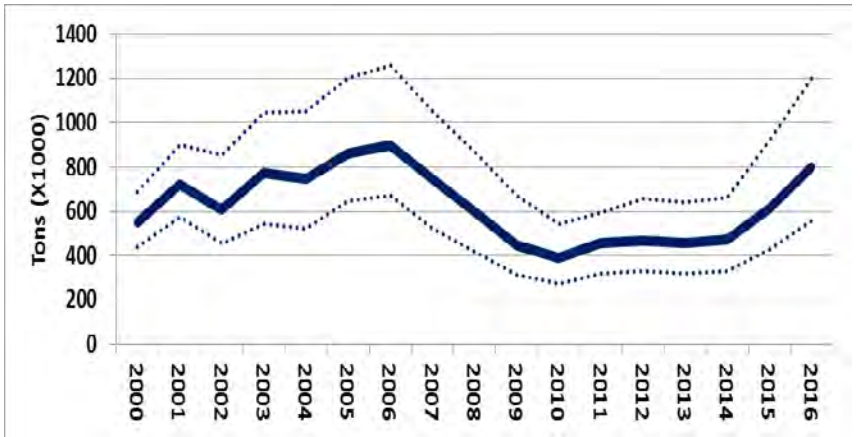

Peruvian hake
Density Index (t/mn2)
Sea robins
Density Index (t/mn2)
Coastal demersal fishes
Metric tons (x1000)
Demersal Elasmobranchs
Metric tons (x1000)

Signals from the surface



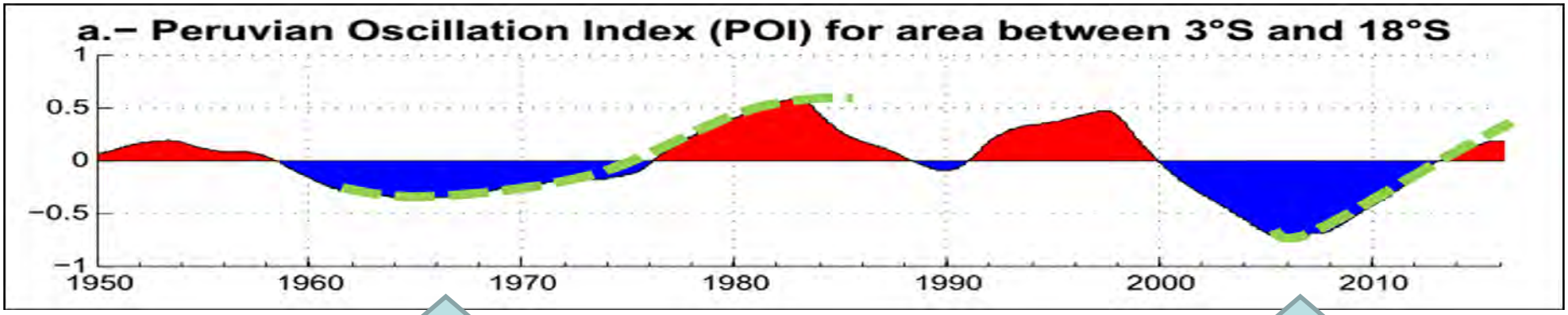


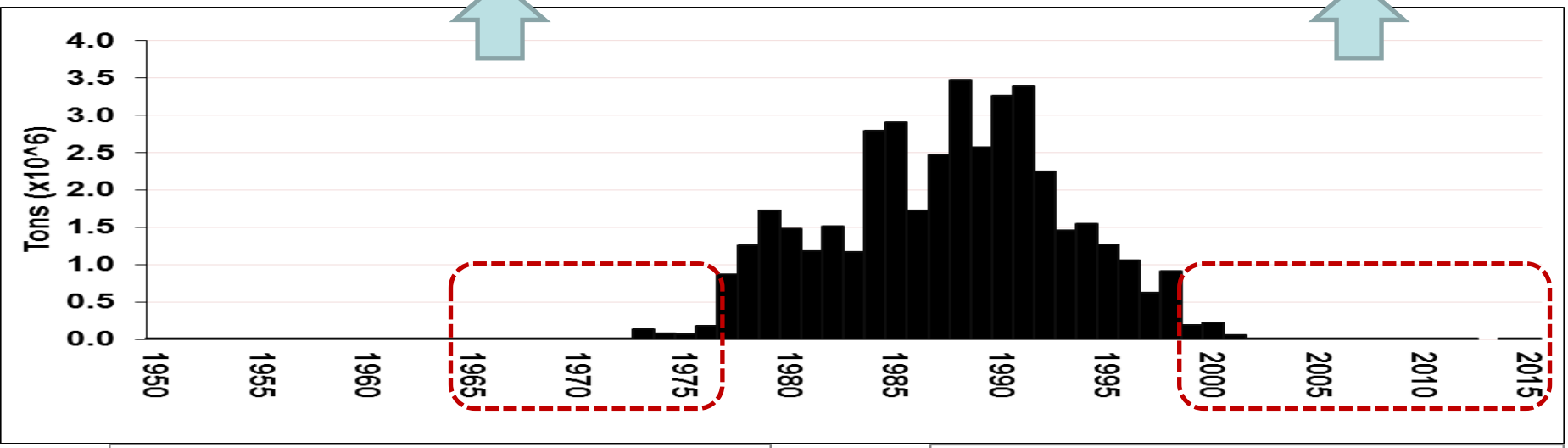
BIOMASS OF MACKEREL
(Species with TAC)

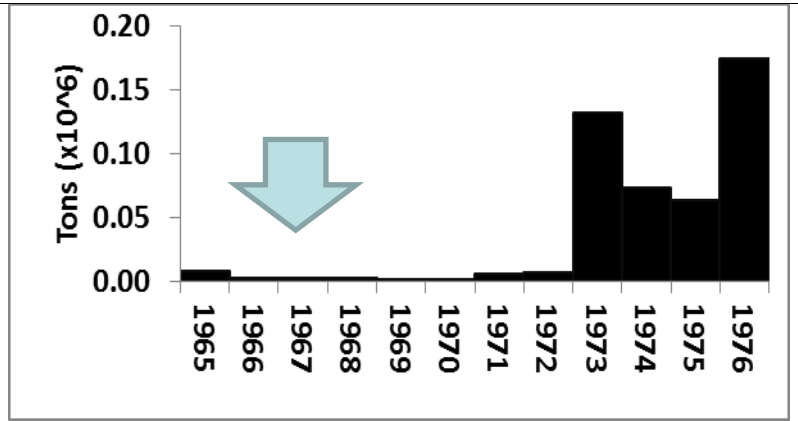


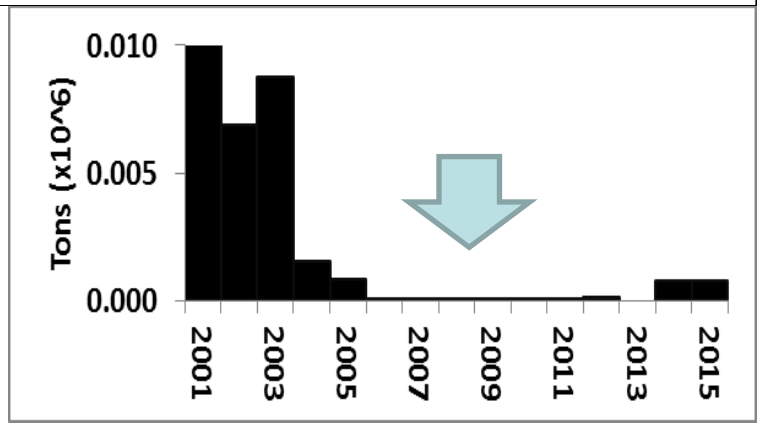
What about sardine?

LANDINGS OF SARDINE

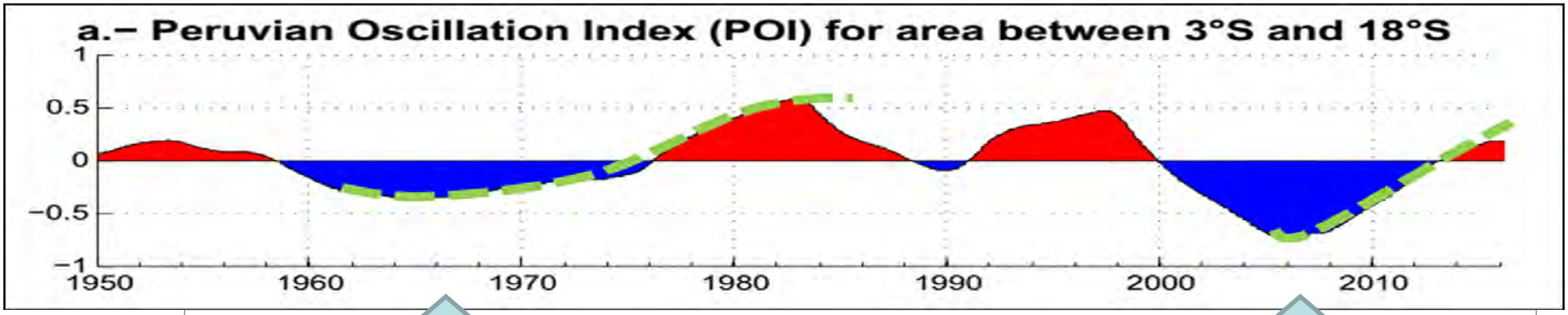


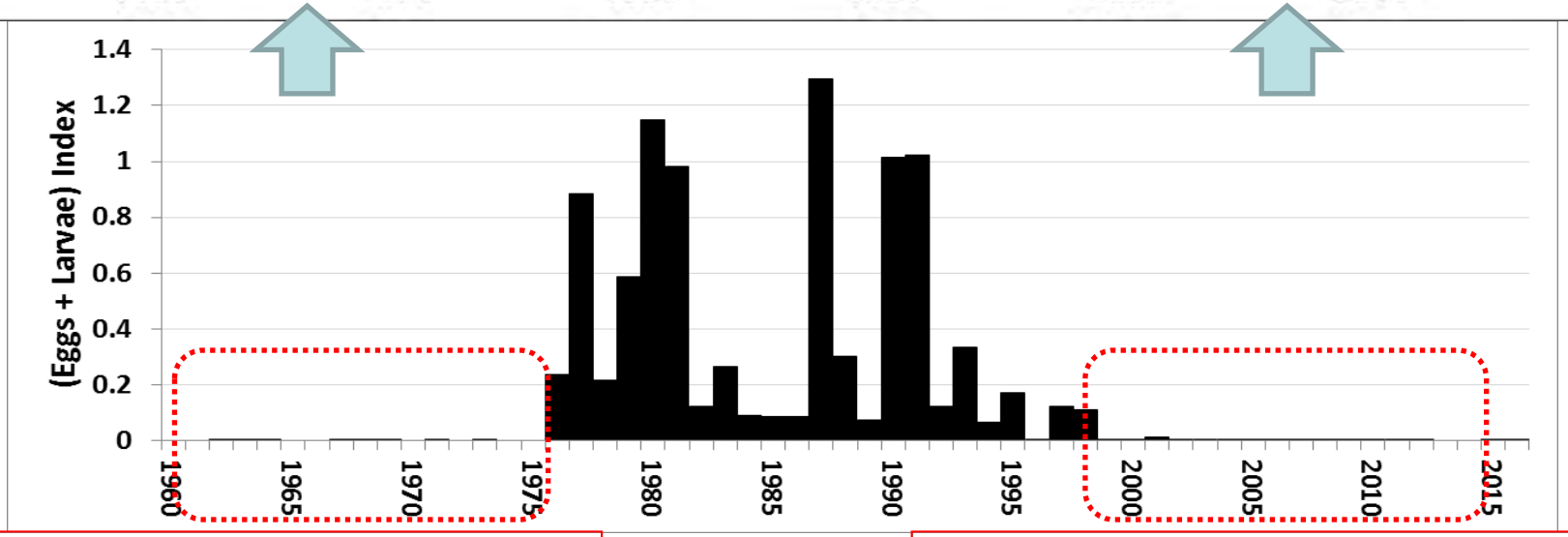


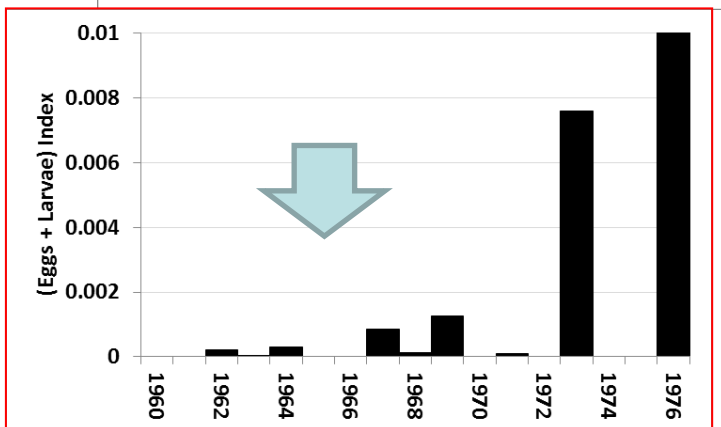


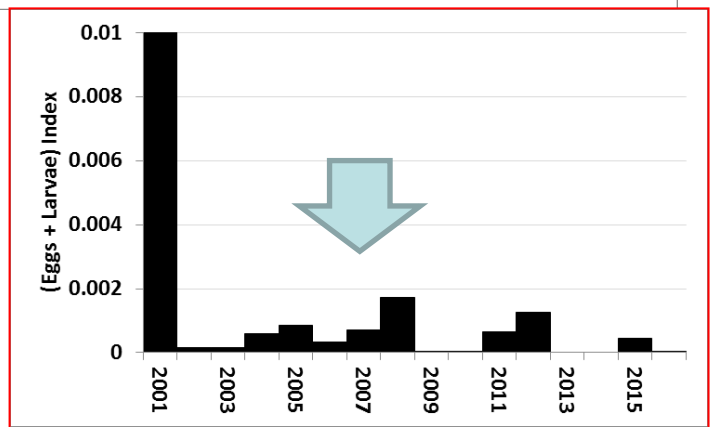


EGGS + LARVAE OF SARDINE (*Sardinops sagax*)



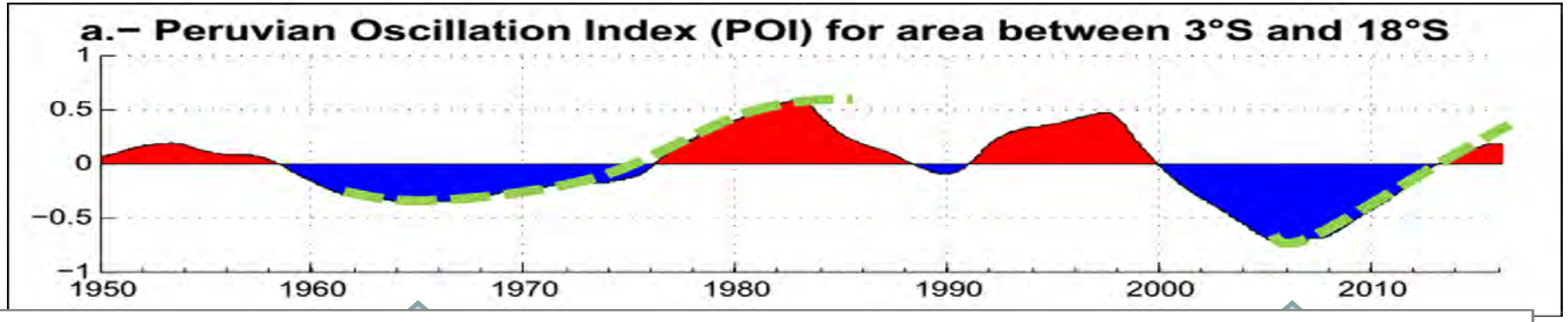


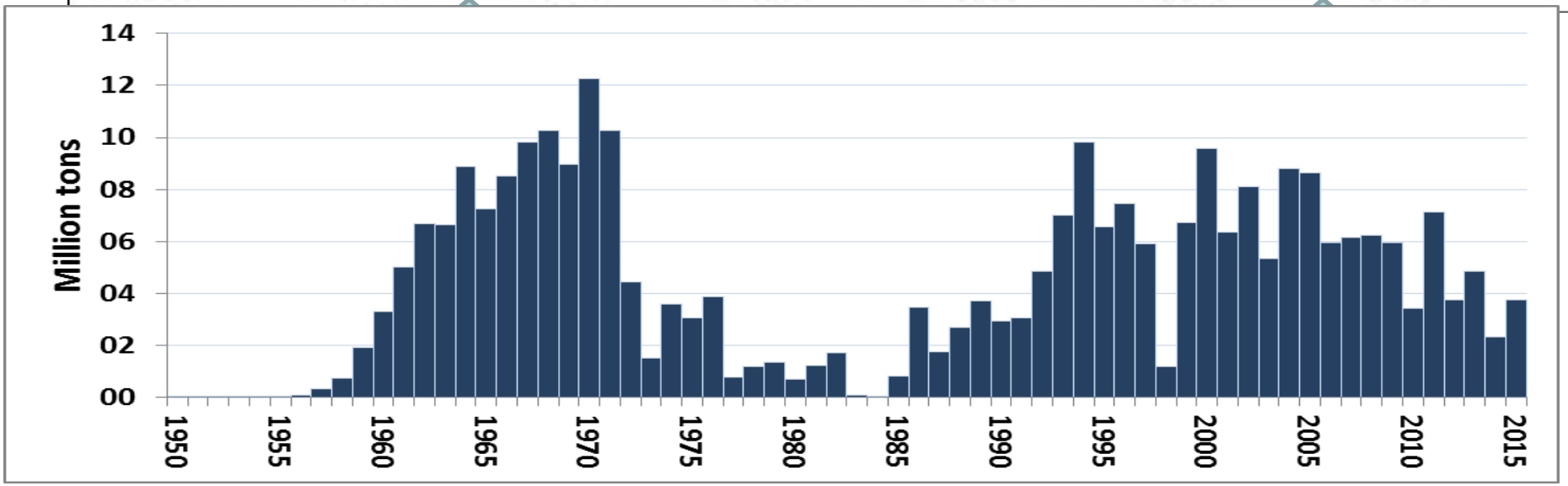




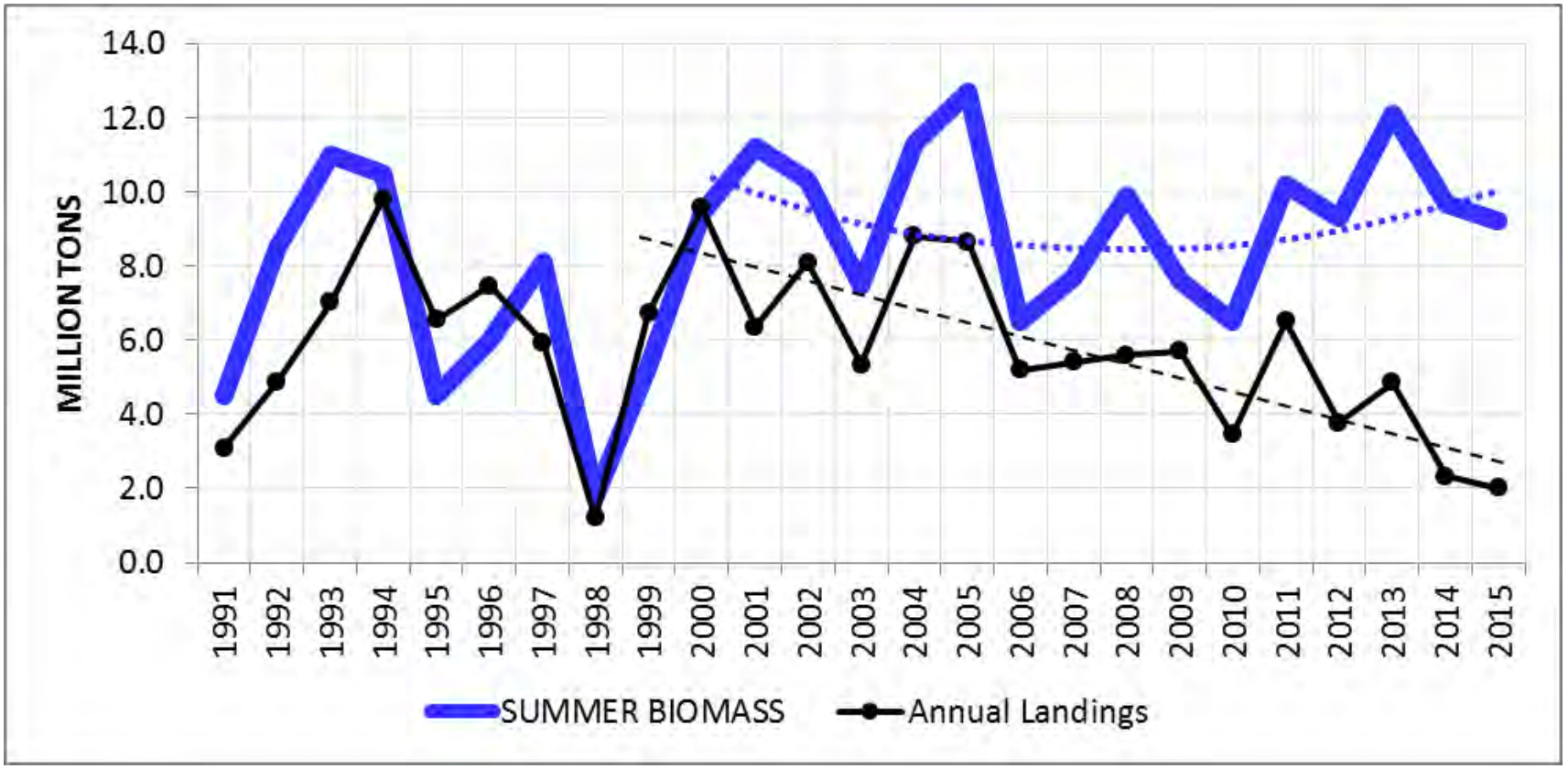
What about anchoveta?

LANDINGS OF ANCHOVETA





LANDINGS AND BIOMASSES (*) OF ANCHOVETA (NORTH – CENTRAL STOCK)



(*) Biomass estimated with the acoustic method in the austral summer.

How could be the ecosystem of reference, in the near future?

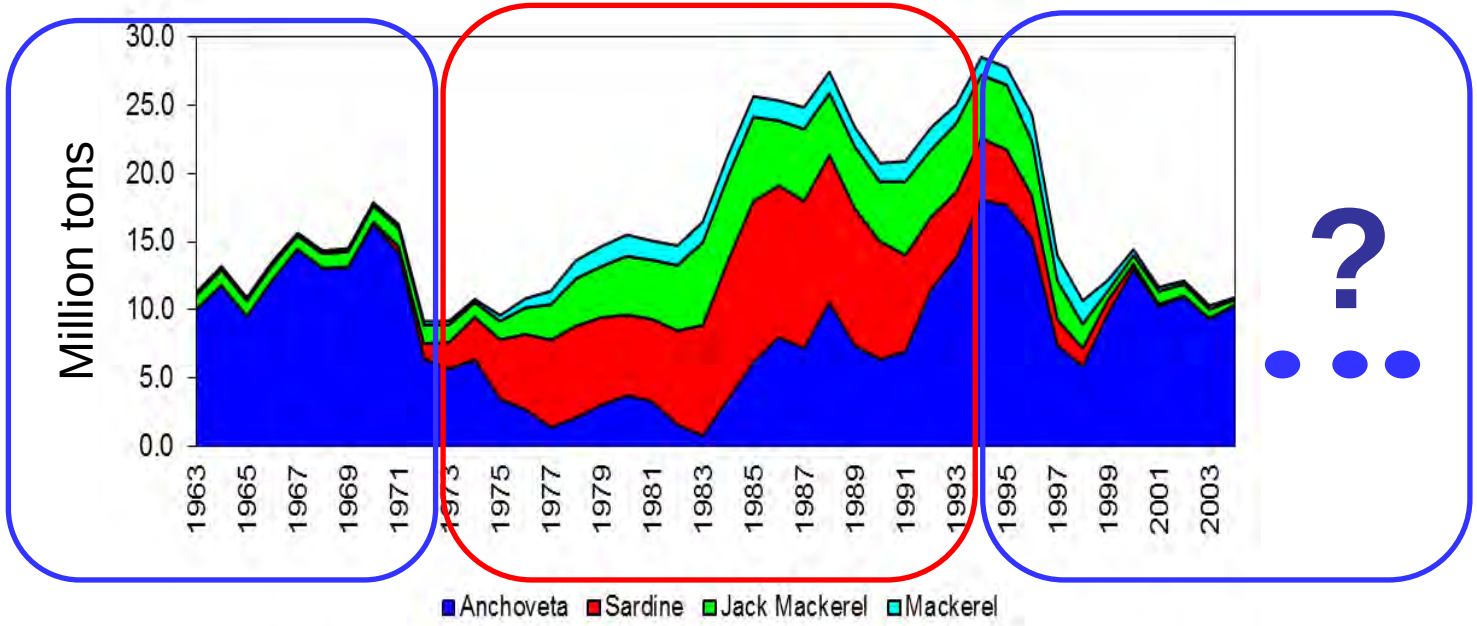
(For fisheries management)

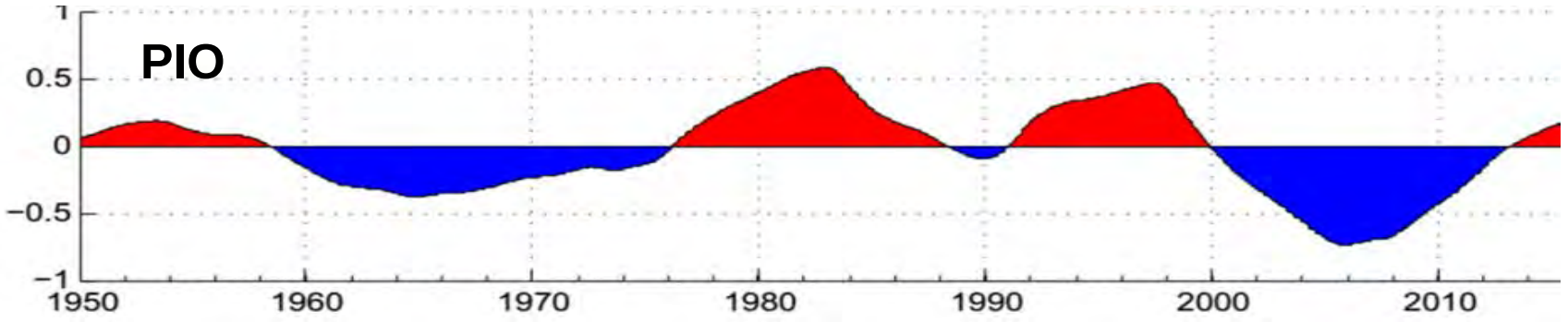
PELAGIC SYSTEM (BIOMASS)

Monospecific fishery

Multispecific fishery

Monospecific fishery … Will continue?





Main conclusions

- Most of the signals point to a regime shift in the Peruvian coastal waters, toward a warm state and probably a multispecific pelagic fishery;
- Sardine can not colonize the neritic grounds now with presence of anchoveta;
- Maybe mackerel, jack mackerel and bonito (more oceanic) can have a better development in a new warm regime;
- If this happens, other questions may arise, about the use of these species, if their biomasses increases significantly;
- But by the moment, it seems that the probable next warm regime could hardly be named as "sardine regime".

THANK YOU!