Environmental pressures on NW African small pelagics: state of play, needs and perspectives

Pressions environnementales sur les petits pélagiques d'Afrique de Nord-Ouest: état de lieux, besoins et perspectives

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STATE OF PLAY

WHAT DO WE KNOW SO FAR:

"The production of small pelagics (e.g. *Sardinella aurita*) and the fluctuations of their stocks in the CECAF region are significantly influenced by environmental variability"

TAKE HOME MESSAGE

- ✓ **A better knowledge of their habitat is needed to ensure a sustainable management of small pelagics' stocks**

- ✓ **Management models need to be improved to better take into account environmental variability**

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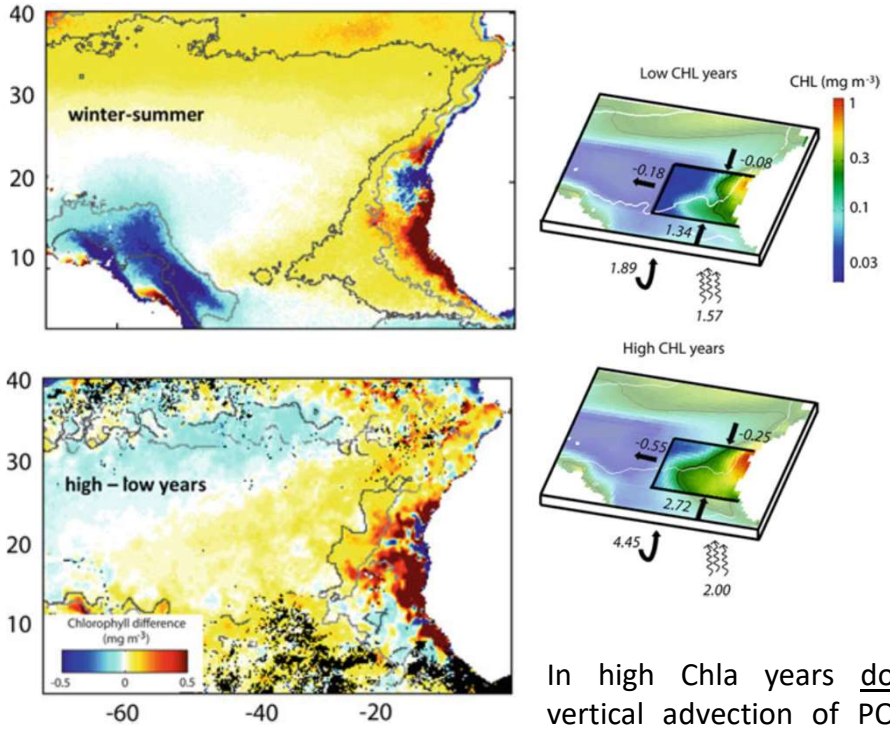
FISHERIES PRODUCTION IN THE CECAF REGION IS REGULATED BY BOTTOM-UP FORCING

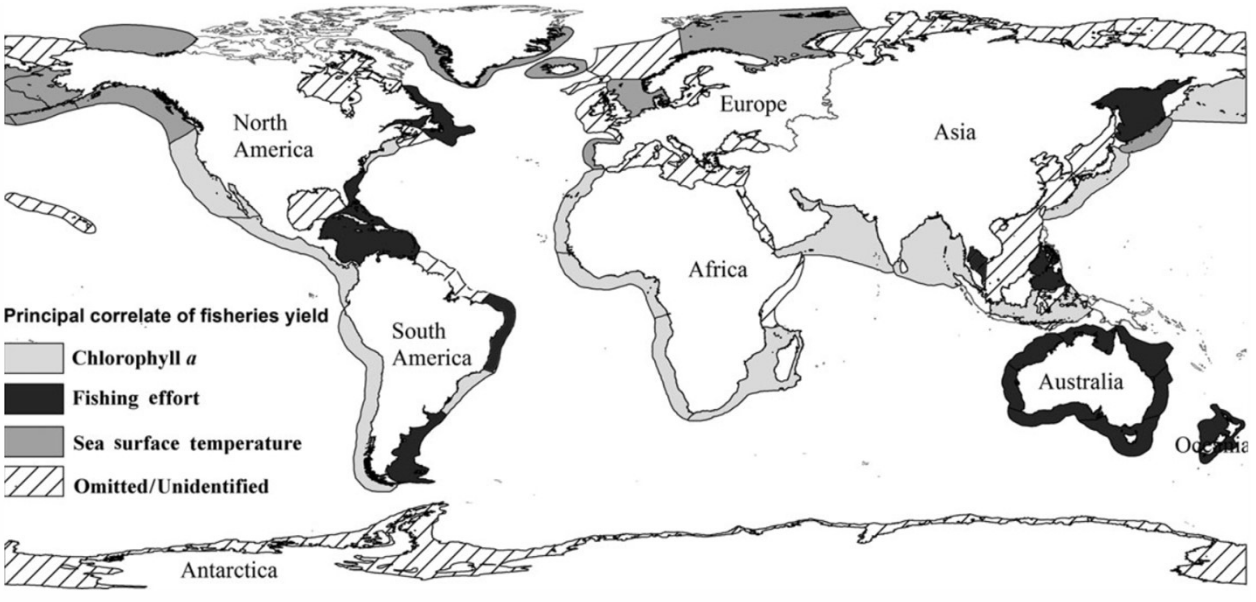
Understanding the mechanisms driving *S. aurita* production

Observed differences (seasonal & interannual) in surface chlorophyll & phosphate fluxes



In high Chla years <u>double</u> vertical advection of PO4 & northward transport at 10°N

Pelegrì et al, 2017



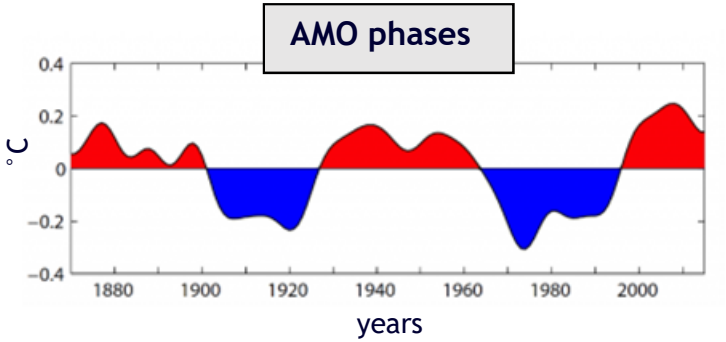
Mcgowen et al., 2014

"Wind-driven nutrient (nitrate) supply seems to be the dominant regulating factor of primary production off NW Africa"

Messié&Chavez, 2015

NW AFRICAN MARINE REGIONS ARE UNDER THE INFLUENCE OF LARGE SCALE CLIMATE VARIABILITY

Impact of the Atlantic Multidecadal Oscillation (AMO) on North Atlantic Seawater Surface Temperature

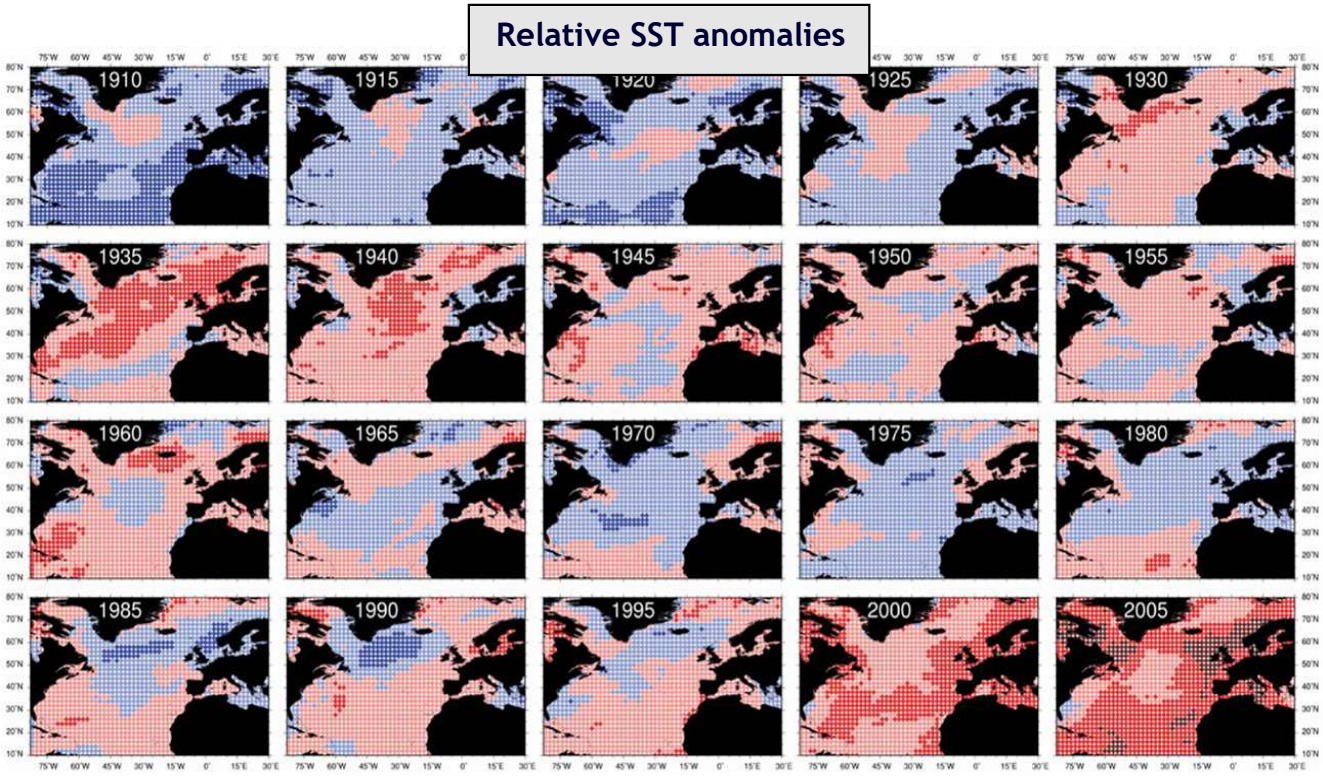


Warm Phases: 1860-1900, 1925-1965, since1995

Cool Phases: 1900-1925, 1965-1995

The AMO is a near-global scale mode of observed multidecadal climate variability with alternating warm and cool phases over large parts of the Northern Hemisphere (Knight et al. 2006).

This pattern of N Atlantic SST variations has a period of 65-80 years (Kerr 2000).



5-years averages, O'Brien et al. 2008

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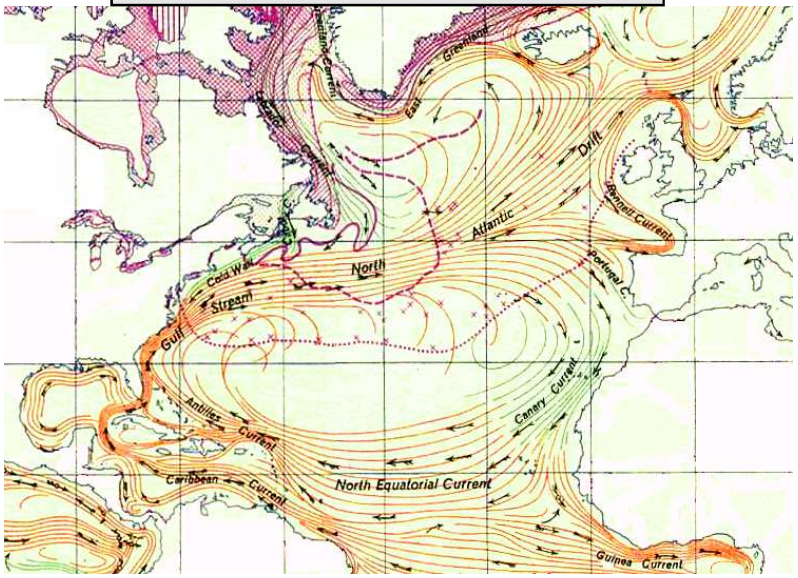
SYNCRONOUS CHANGES IN SARDINELLA IN NE ATLANTIC AND ADJACENT SEAS IN DIFFERENT AMO PERIODS

Years 1900 - 2010

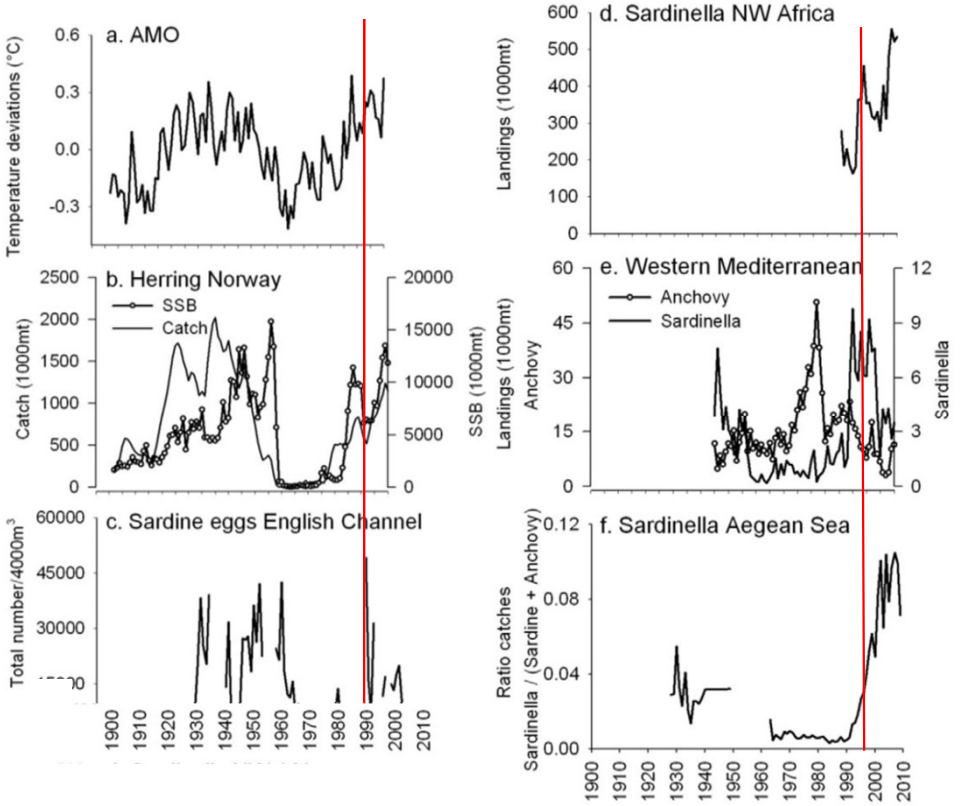
AMO impacts gyres' strength and hydrological features of small pelagics habitats

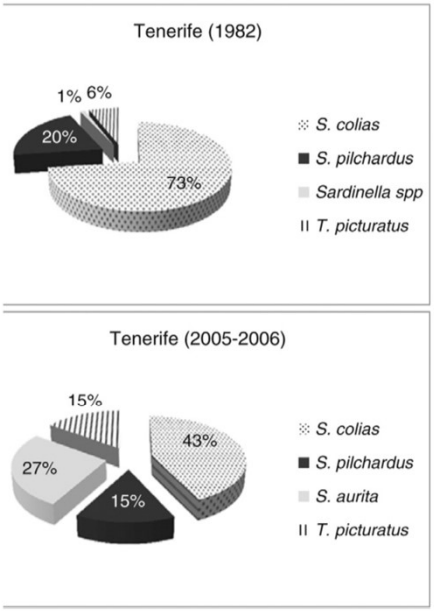
Gyre systems in the North Atlantic



Wikipedia

Time series of small pelagics in NE Atlantic 1900 - 2010





small pelagics
% of catch distribution

Alheit, Licandro et al. 2014

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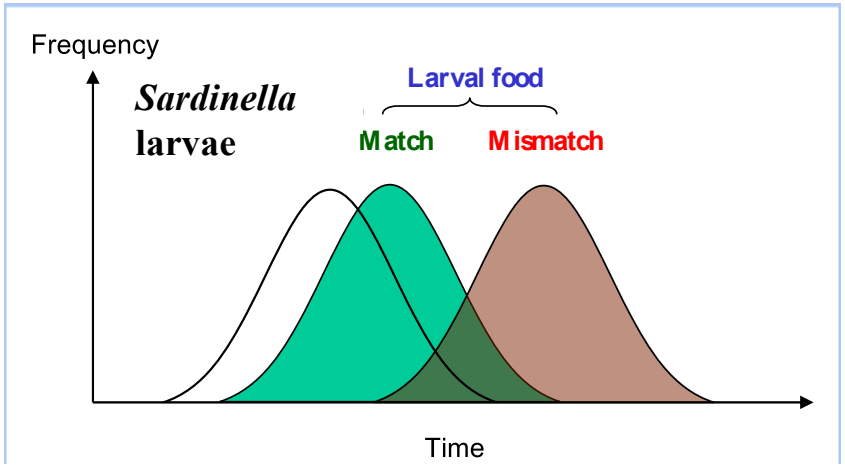
IN THE CECAF REGION RECRUITMENT OF SARDINELLA IS DRIVEN BY THE ONSET OF THE PHYTOPLANKTON BLOOM

Reproduction of round sardinella depends on plankton availability

The match-mismatch hypothesis

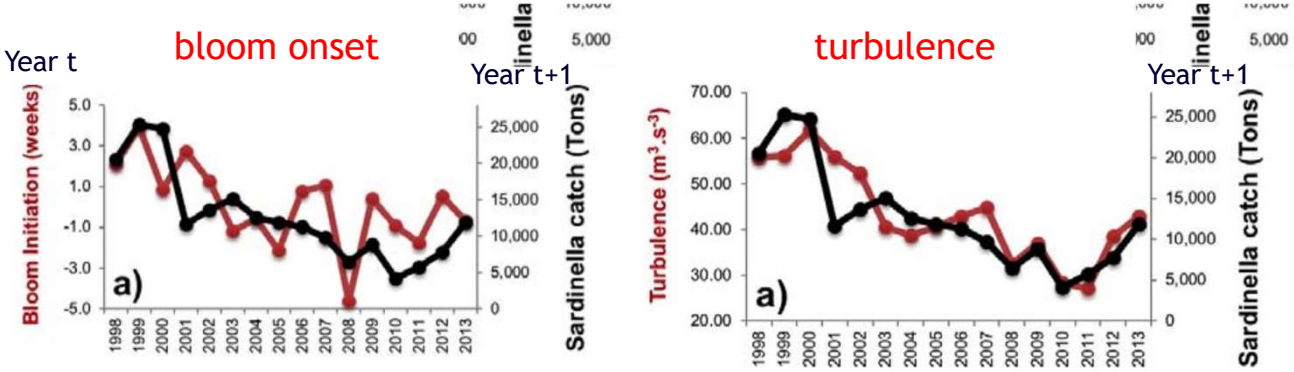
"If recruitment-production at a given trophic level matches food availability, effective recruitment will be profound. If there is a mismatch between food requirement and food availability, effective recruitment will be low "

Cushing, 1969



Durant et al., 2013

Recruitment of *S. aurita* in the Gulf of Guinea (Ivory coasts)



Years of study: 1998-2014

Physical drivers (resolution: 12.5 x 12.5Km x month)

- Wind: U and V components
- Sea Surface Temperature
- Water Turbulence & Upwelling index

Biotic parameters (resolution: 4 x 14Km x year)

- Chlorophyll a
- Phenological index, i.e. a proxy of phytoplankton bloom onset

Kassi et al., 2018

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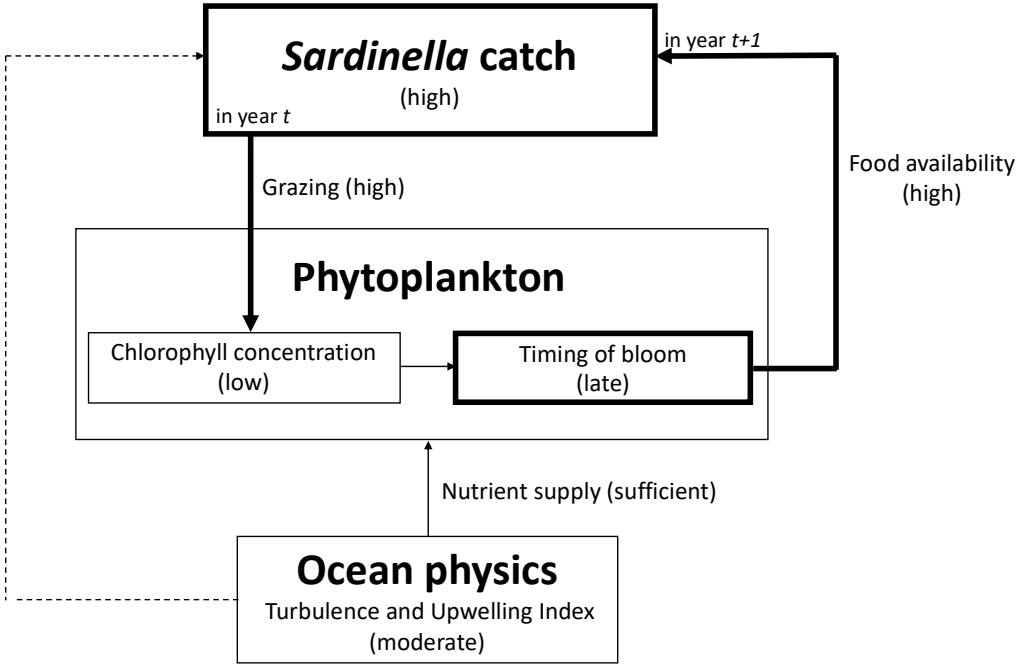
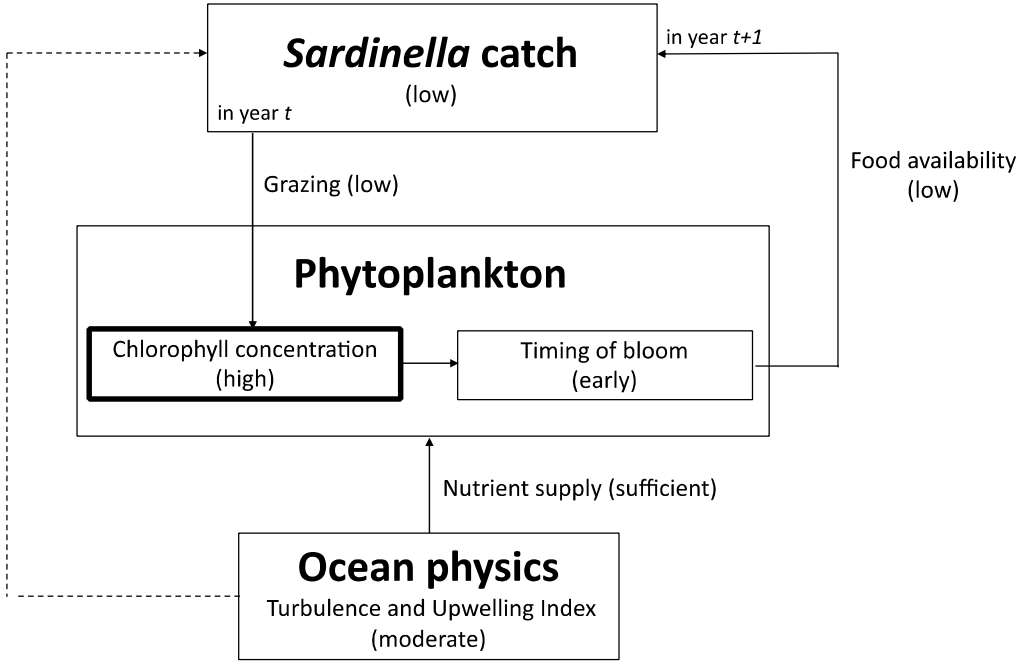
IN THE CECAF REGION RECRUITMENT OF SARDINELLA IS DRIVEN BY THE ONSET OF THE PHYTOPLANKTON BLOOM

Influence of biophysical conditions on recruitment of round sardinella

Favourable conditions for *S.aurita* larvae

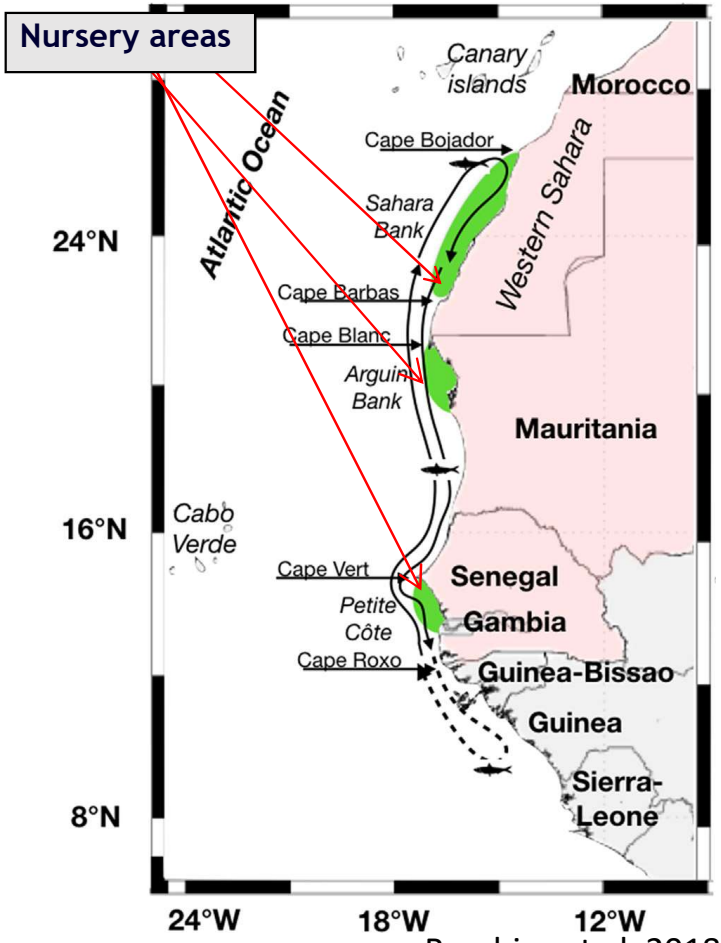


Less favourable conditions for *S. aurita* larvae

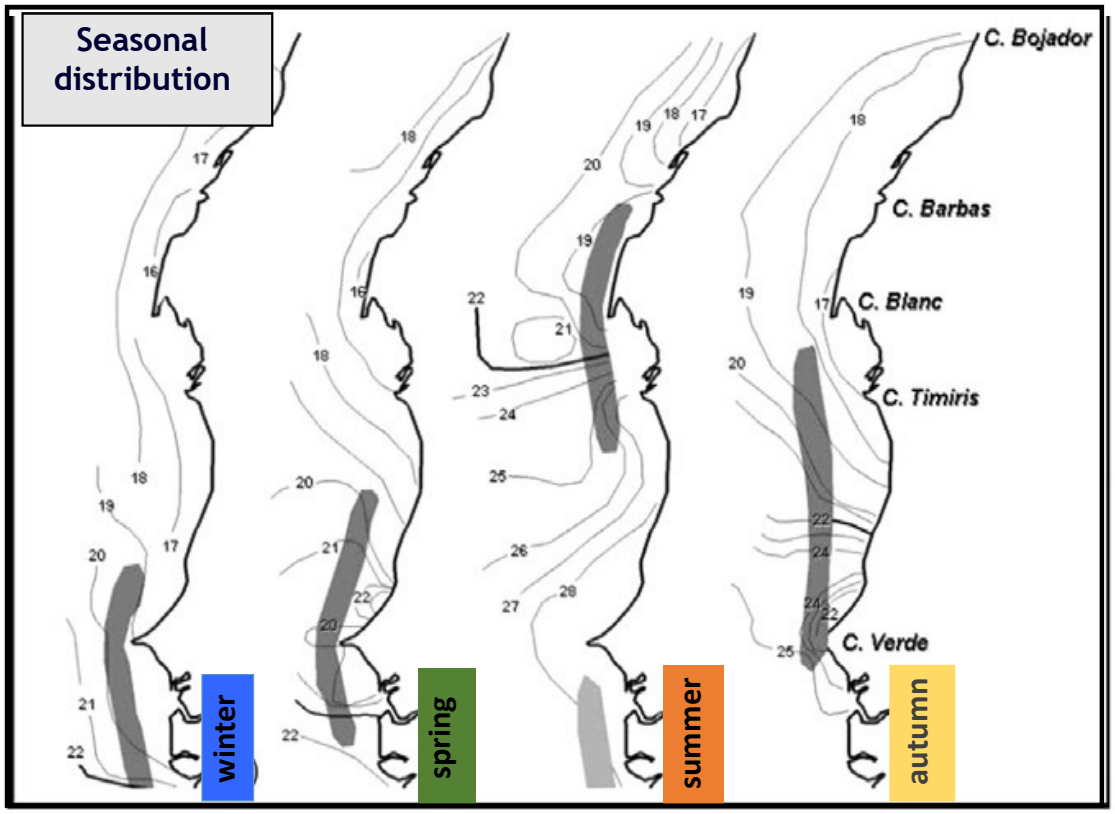


Kassi et al., 2018

SUISTANABLE MANAGEMENT OF NW AFRICAN SARDINELLA NEEDS : A CROSS-REGIONAL ECOSYSTEM APPROACH



Brochier et al, 2018

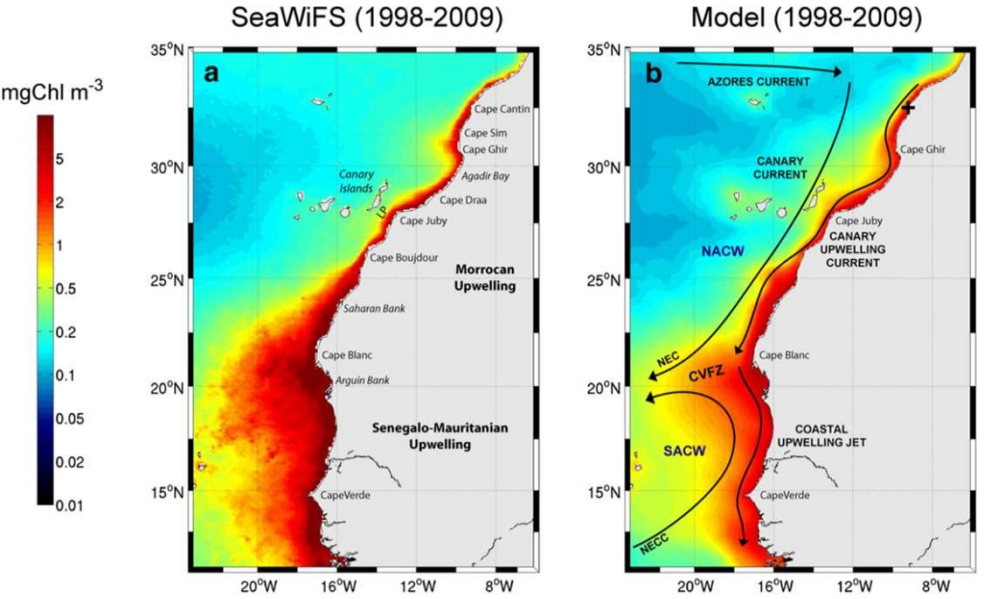


Aristegui et al, 2009

SUISTANABLE MANAGEMENT OF NW AFRICAN SARDINELLA NEEDS : ENVIRONMENTAL REGIONAL MODELS

MODELS TO PREDICT HYDRODYNAMIC FEATURES & PHYTOPLANKTON PRODUCTION

Coupled hydrodynamic/biochemical regional model (ROMS-PISCES)



Hydrodynamic model
Regional Oceanic Modelling System (ROMS)

Biochemical regional model
Pelagic Interactions Scheme for Carbon & Ecosystem (PISCES)

Functional types considered

- Phytoplankton: diatoms (pico 0.2-2 µm /nano 2-20µm phytoplankton)
- Zooplankton: Ciliates & copepods (up to 20mm zooplankton groups)
- Small/large detritus (that can be remineralized by bacteria)

Parameters used for configuration

- Nutrients (nitrate, phosphate, silicate, iron)

Parameterization assumptions

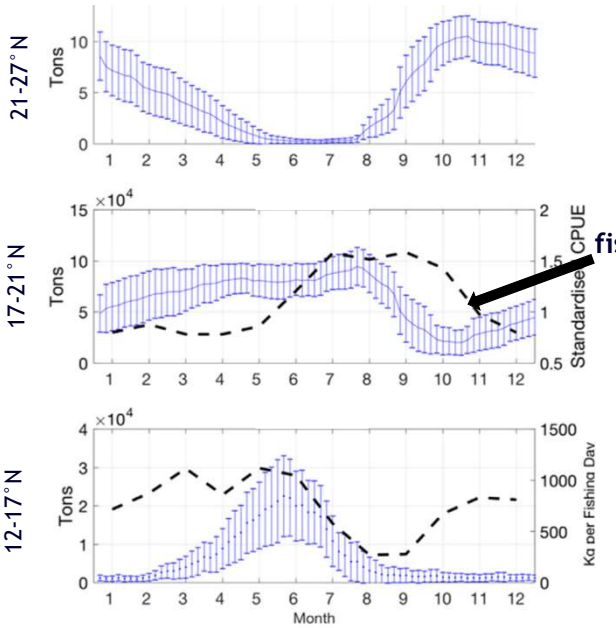
- Phytoplankton growth depends on light, temperature & the external availability in nutrients.
- Phytoplankton-types have different nutrients requirement & distribution
- Zooplankton types have different food diet, grazing rates and mortality

Auger et al., 2015

SUISTANABLE MANAGEMENT OF NW AFRICAN SARDINELLA NEEDS : MODELS PREDICTING SARDINELLA VARIABILITY

Coupled regional & Individual-based model (Evol-DEB)

Sardinella seasonal variability

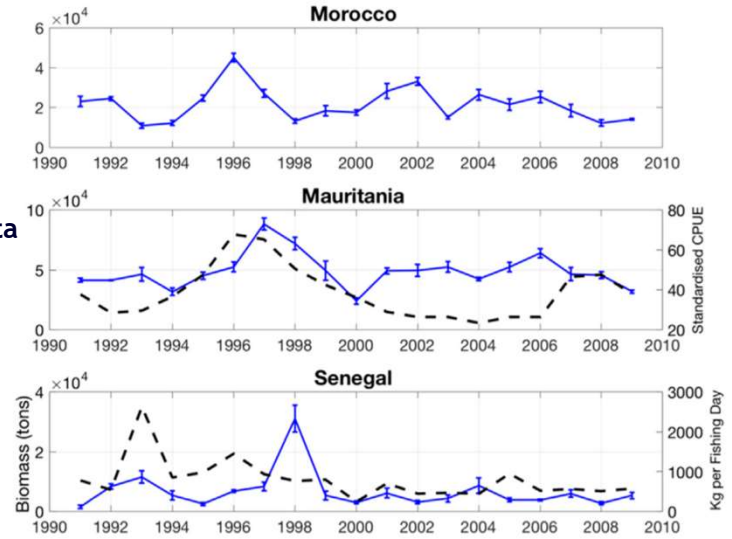


Hydrodynamic environment & plankton [regional model ROMS-PISCES]

Parameters used for configuration

- Sea Surface Temperature
- Food proxy (total biomass of 4 plankton groups)
- Currents in the mixed layer

Interannual variability

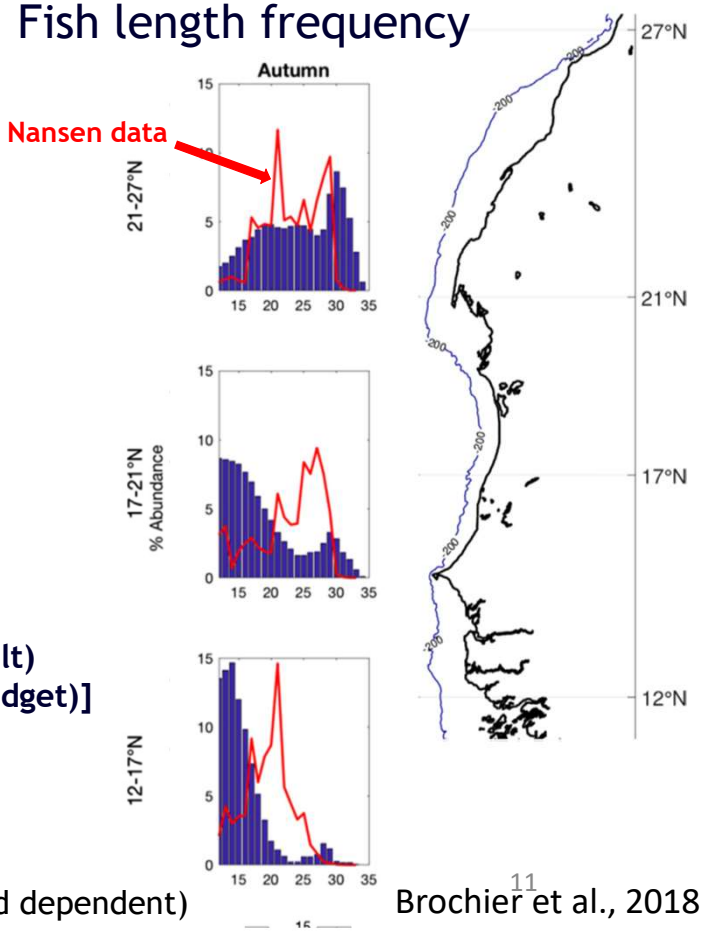


Virtual sardinella population (from egg to adult) [Individual-based model-DEB (Dynamic Energy Budget)]

Parameters used for configuration

- Swimming behaviour
- Growth rate (temperature/food dependent)
- Preferred temperature (e.g. 21°C)
- Habitat Quality Index (HQI) (temperature/food dependent)

Fish length frequency



Brochier et al., 2018

SUISTANABLE MANAGEMENT OF NW AFRICAN SARDINELLA NEEDS : IN SITU ENVIRONMENTAL OBSERVATIONS

Observational programs - abiotic factors

RAPROCAN (Radial Profunda de Canarias)

Deep hydrographic section around the Canary Islands

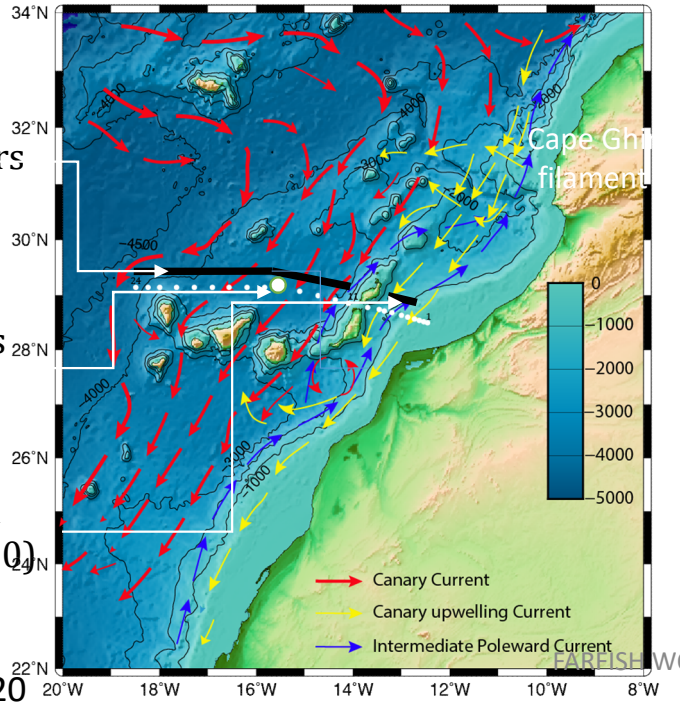
(Lead by IEO, https://www.oceanografia.es/raprocan/)

Twice a year since 2012. Records back to 1997.

Oceanic Waters stations (11-22)

European Stations Time Series (ESTOC), sta 15.

Coastal Transition Zone stations (5-10)



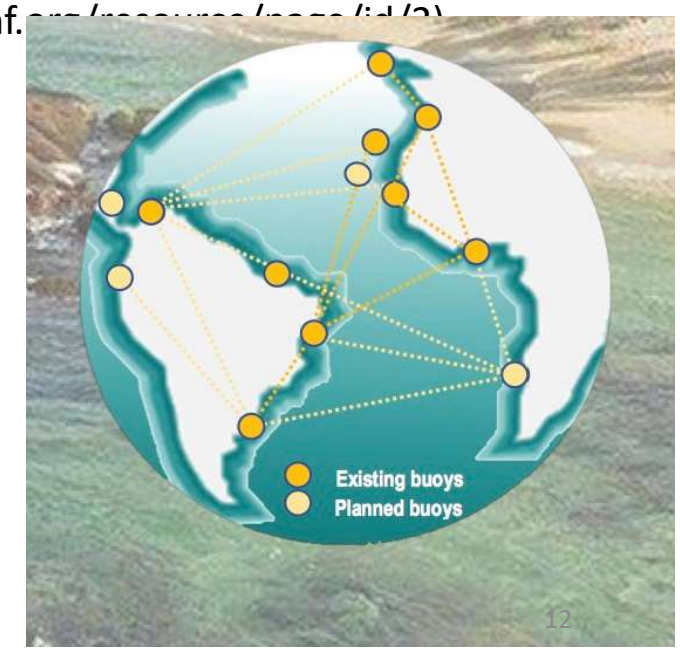
Velez-Belchi et al., 2020

COCAS

(Coastal Observatory for Climate, Co2 and Acidification in the Atlanto-Pacific)

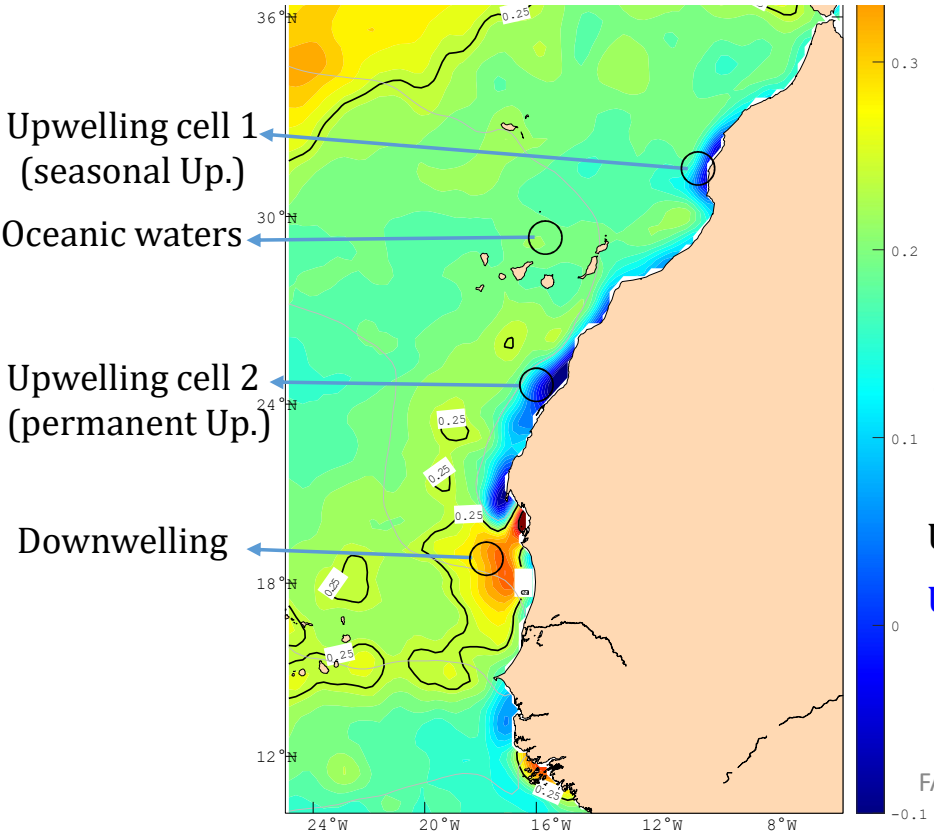
Tropical ocean-atmosphere buoy network

(Lead by U. Sorbonne, https://cocas-workshop.sciencesconf.

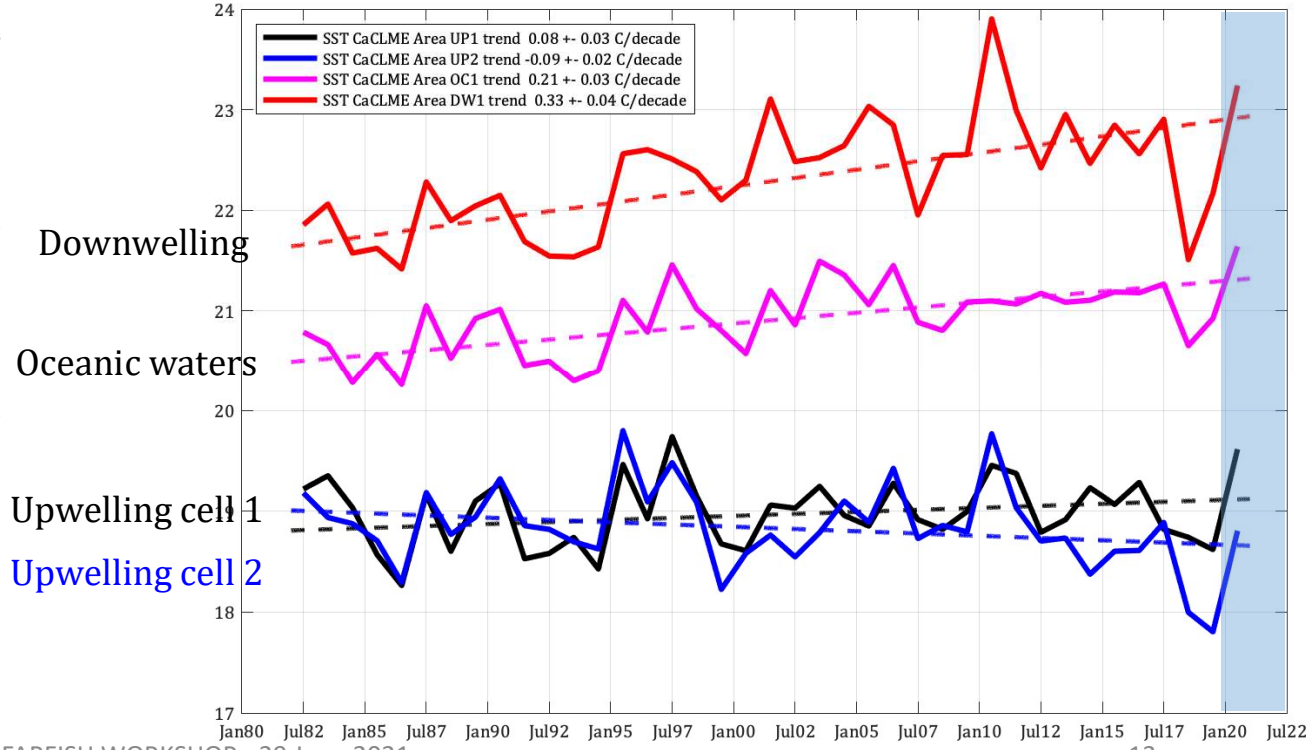


Long term changes of Sea Surface Temperature [Calibrated with CTD obs] in the Canary Current Large Marine Ecosystem

NOAA high-resolution (1/4°) blended analysis of Daily SST for the 1982–2020 period.



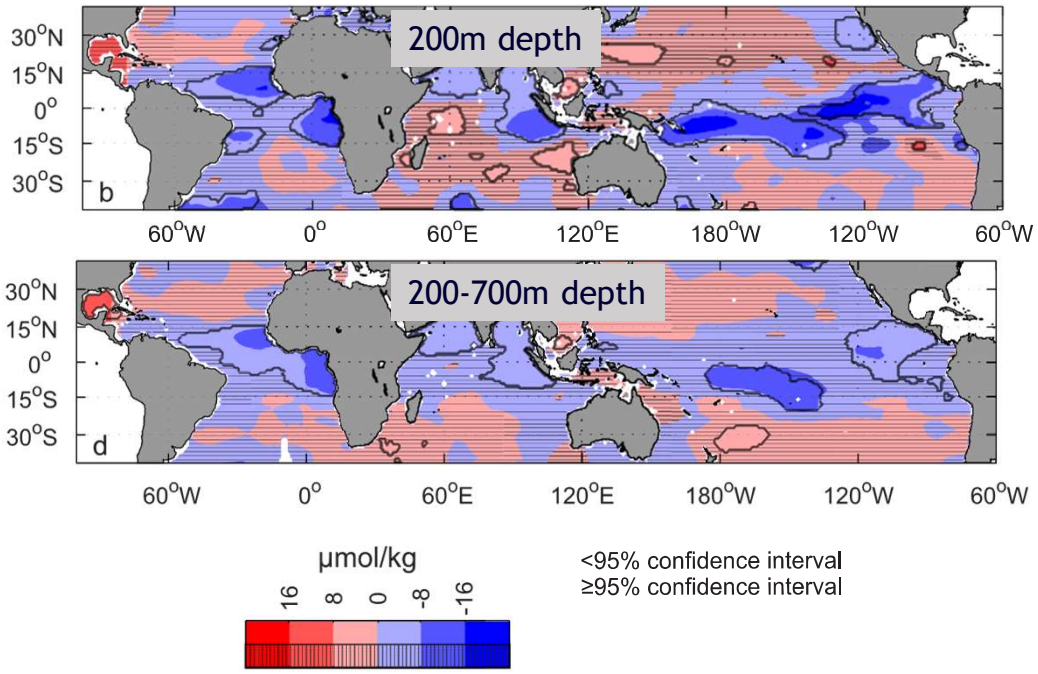
RAPROCAN SECTION



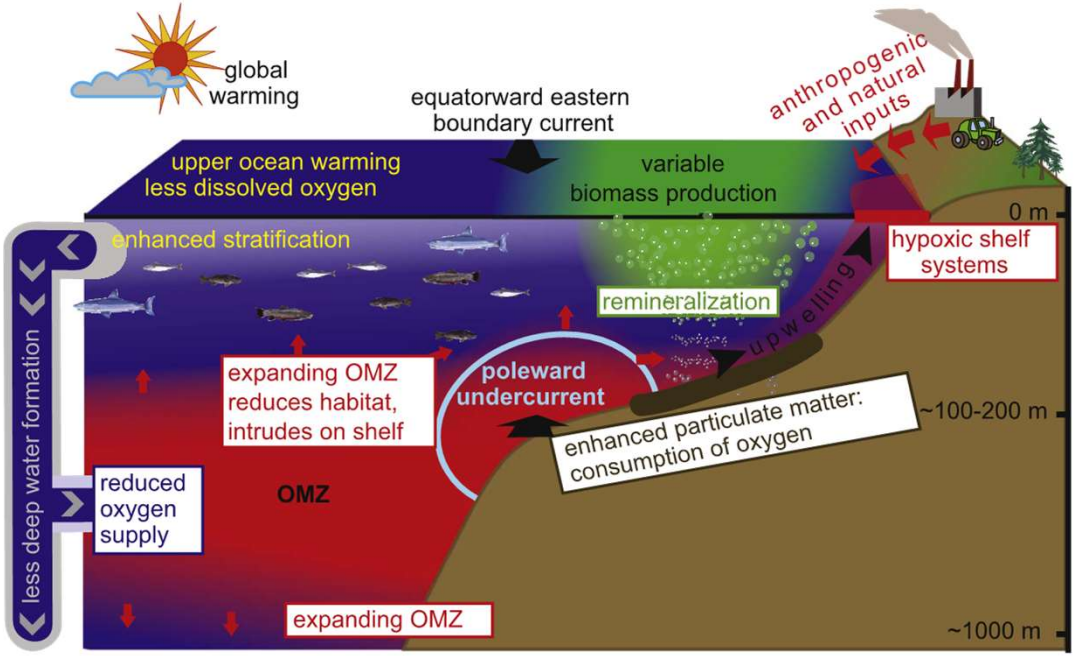
Velez-Belchi et al., 2020

Ocean oxygen minima expansions and their impacts on fish stocks

Dissolved Oxygen (DO) anomaly
1990-2008 vs 1960-1974



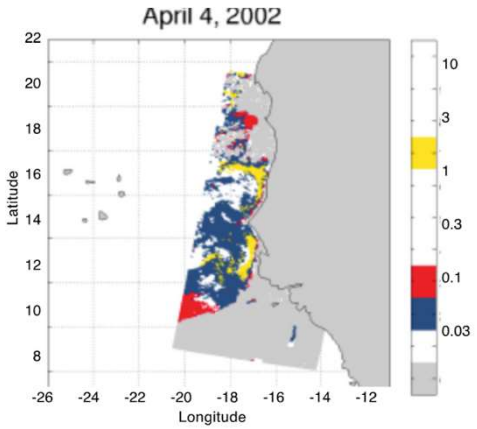
Interactions of open ocean Oxygen Minimum Zones (OMZ, red)
with hypoxic shelf systems along eastern ocean boundaries regions



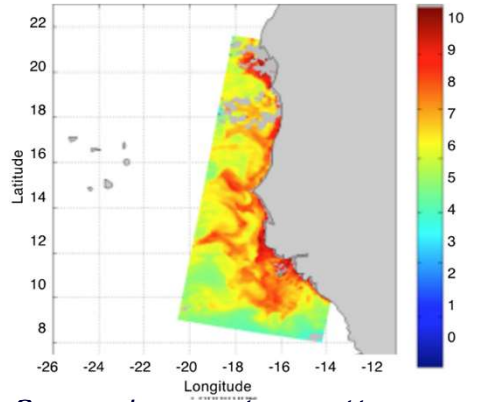
Stramma et al., 2010

Identify key plankton descriptors and monitor their changes

Which phyto/zooplankton taxa/species are
the main responsible for regional primary/secondary production ?

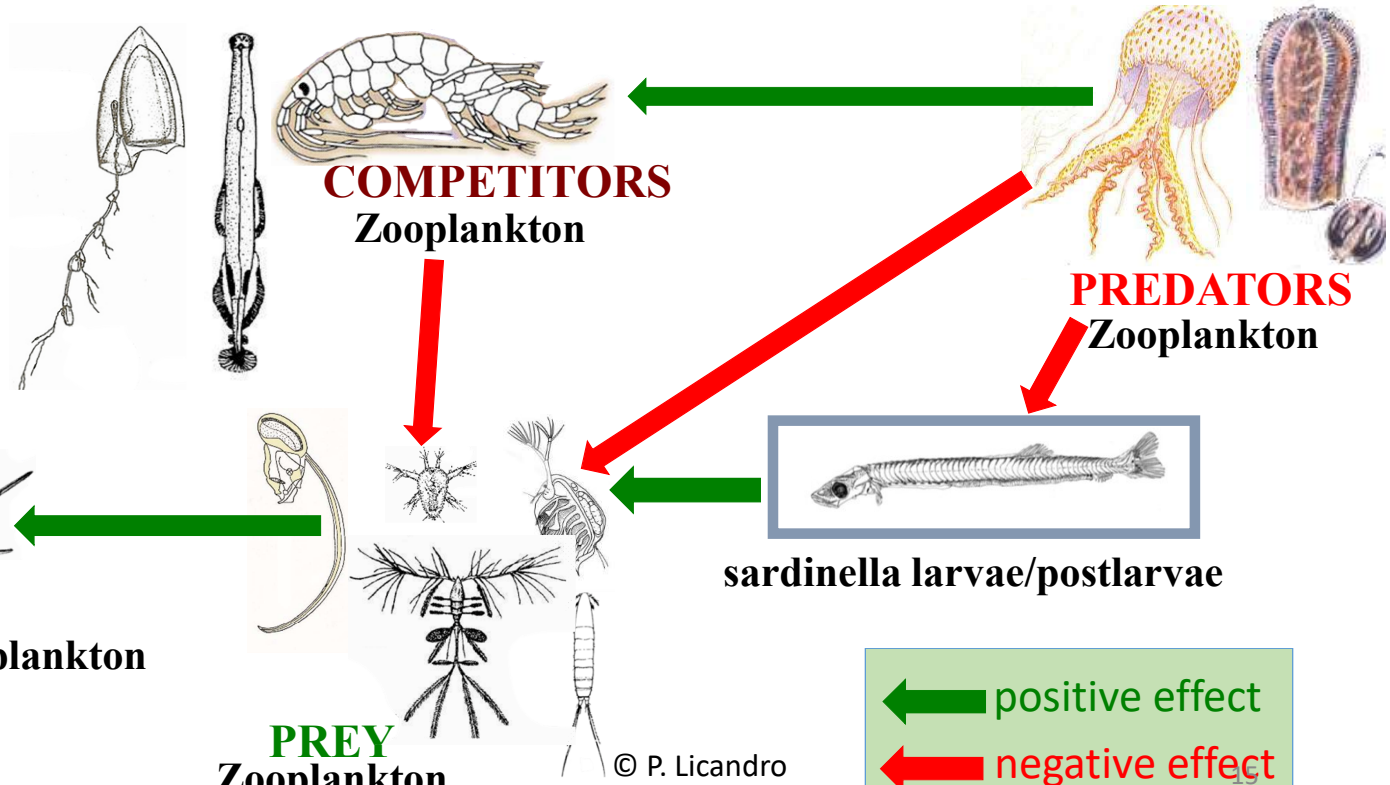


Chlorophyll a concentration



Ocean colour spectrum patterns
- *Class 2 & Class 3 = diatoms*
- *Class 7 = phytoplankton groups*

Farikou et al., 2015



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SUSTAINABLE MANAGEMENT OF ROUND SARDINELLA IN THE CECAF REGION

1) Are the data from this research available?

Yes, see cited references and websites

2) What additional data (or analysis) would benefit this research?

Observations on additional abiotic (e.g. oxygen) and biotic (e.g.phyto-zooplankton) habitat descriptors

3) What are the implications of your findings for the CECAF area?

Environmental changes needs to be take into account to ensure that the management of round sardinella is really sustainable

4) What would suggests as next steps to advance knowledge on this topic?

To implement actions aimed to establish a harmonized network of environmental monitoring in the CECAF region

Acknowledgements (contributions to this talk)

DEMERSTEM team

M. Grazia Mazzocchi

Diana Sarno

Bouya M'Bengue

Pedro Velez-Belchi