The ecosystem approach to the fishery: influence of low trophic levels

Impact of plankton on fish stocks

3-5 April 2023 | Abuja, Nigeria

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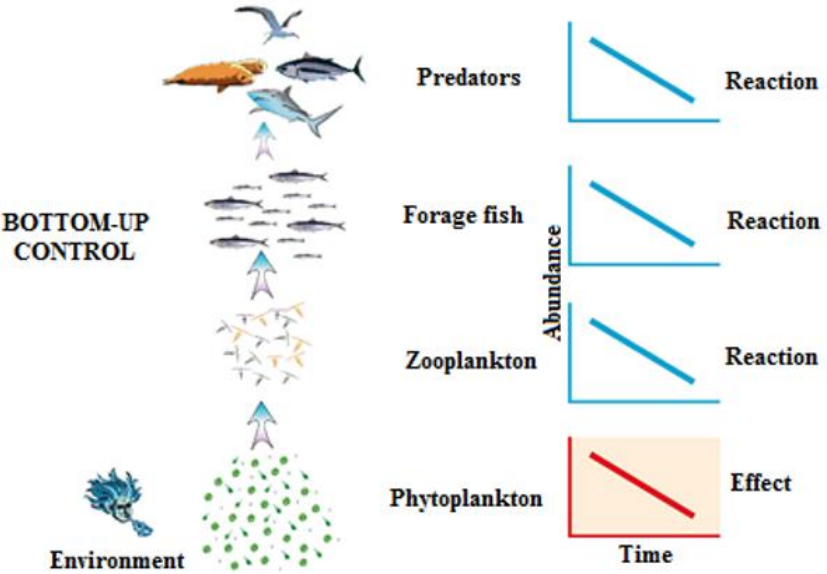
FISHERIES PRODUCTION IN THE CECAF REGION IS REGULATED BY BOTTOM-UP FORCING

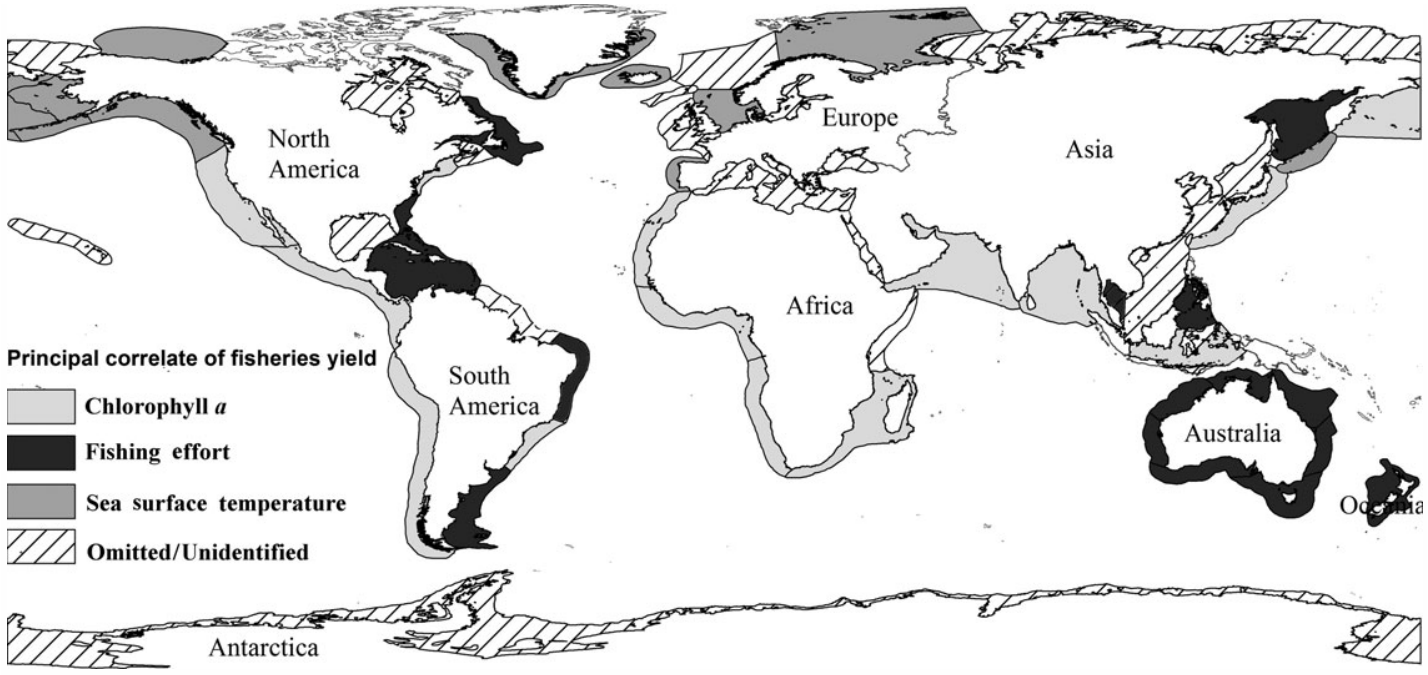
Simplified food chain



Bottom-up control or control through primary production

Cury et al., 2016

Mechanisms driving fisheries production



Geographical distribution of the correlates of fisheries yield within Large Marine Ecosystems

Mcgowen et al., 2014

"Wind-driven nutrient supply is the dominant regulating factor of primary production off NW Africa"

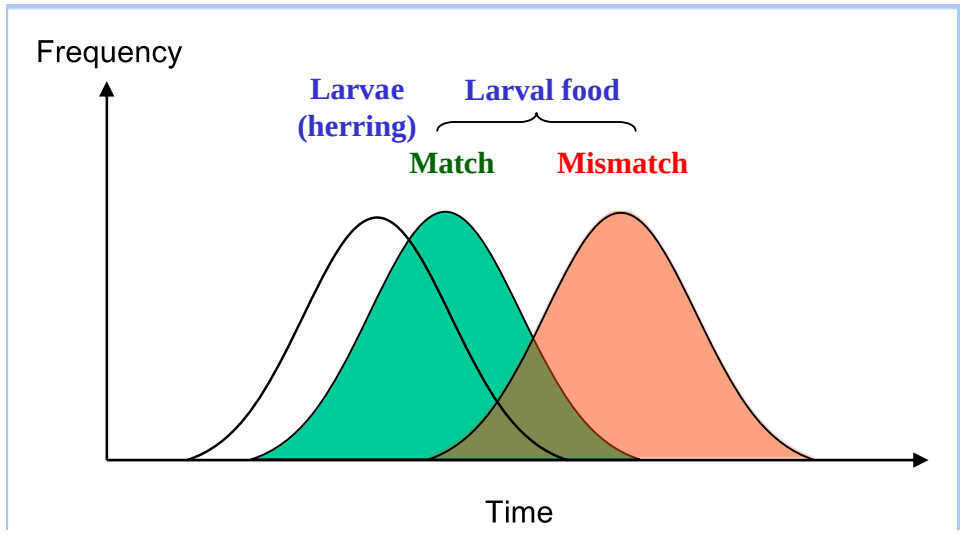
Messié&Chavez, 2015

REPRODUCTION OF FISH DEPENDS ON PLANKTON AVAILABILITY

The match-mismatch hypothesis

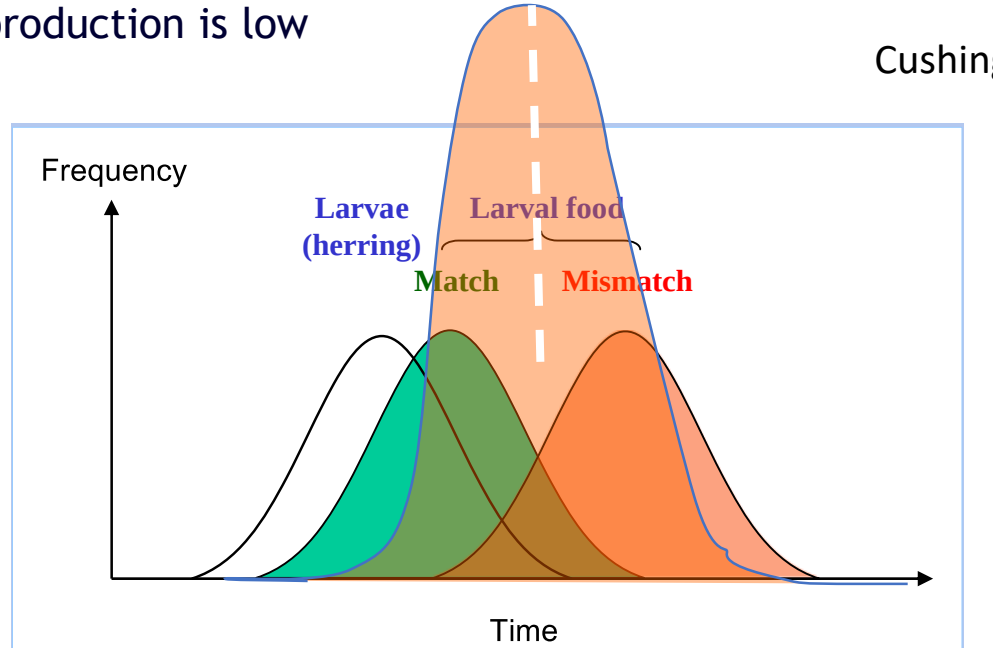
"If recruitment-production at a given trophic level matches food availability, effective recruitment will be profound.
If there is a mismatch between food requirement and food availability, effective recruitment will be low "

Cushing, 1969



The amount of plankton regulates the recruitment success.
If matched, recruitment would be high within the limits of Variation of plankton production.
If mismatched, recruitment will be particularly low if plankton production is low

Cushing, 1990



IMPLEMENTING PLANKTON IN ECOSYSTEM APPROACH TO FISHERIES MANAGEMENT (EAFM) IN CECAF REGION

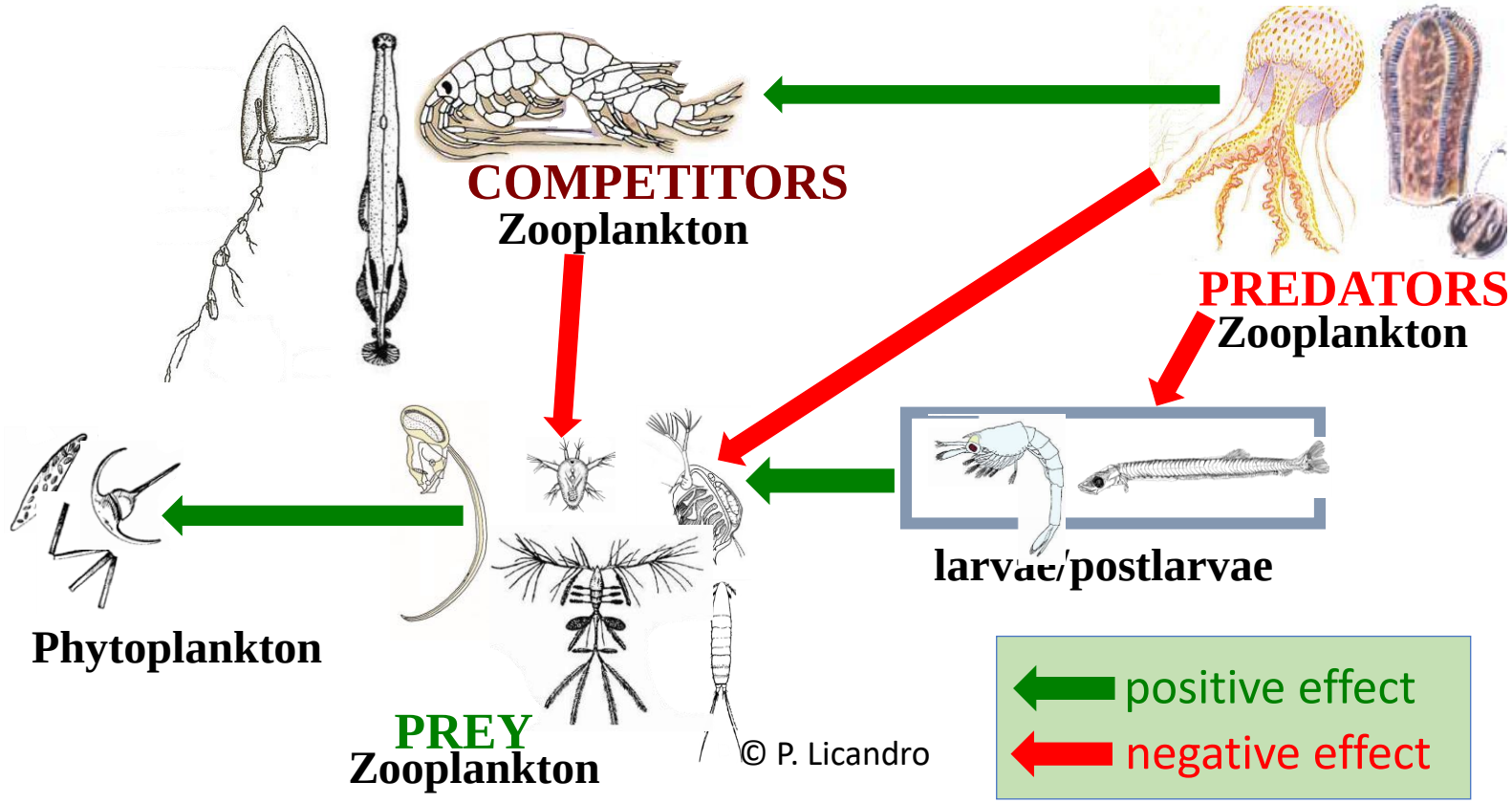
EAFM implementation issues

(from Garcia et el., 2003)- *EAF implementation faces, and needs to resolve, a number of difficulties, many of which are already hampering the effectiveness of more conventional fisheries management. These difficulties relate to, inter alia*:

- ✓ **Lack of information, lack of scientific assessment;**
- ✓ **Non-matching of ecosystem and jurisdiction boundaries;**
- ✓ **Unclear or conflicting objectives;**
- ✓ **Insufficient collaboration between institutions in charge of fisheries and environmental management at national or regional levels;**
- ✓ **Lack of integration of fisheries in coastal areas management;**
- ✓ **Need for more transparency and participation;**
- ✓ **Lack of capacity for decentralization, redefinition (and strengthening) of the role of science;**

DEMERSTEM CONTRIBUTION TO FILL KNOWLEDGE GAP ON MARINE PLANKTON IN CECAF REGION

Which are the main phytoplankton and zooplankton species/groups at the basis of the marine food chain in the CECAF region ?



DEMERSTEM CONTRIBUTION TO FILL KNOWLEDGE GAP ON MARINE PLANKTON IN CECAF REGION

GATHER NEW INFORMATION ON PLANKTON DIVERSITY & DISTRIBUTION

ACTIONS: Case studies in Mauritania and Guinea

Q: Which groups represent the bulk of the phyto- and zooplankton communities ?

Q: How diverse are plankton communities?

Q: Which are the main phyto- and zooplankton taxa/species?

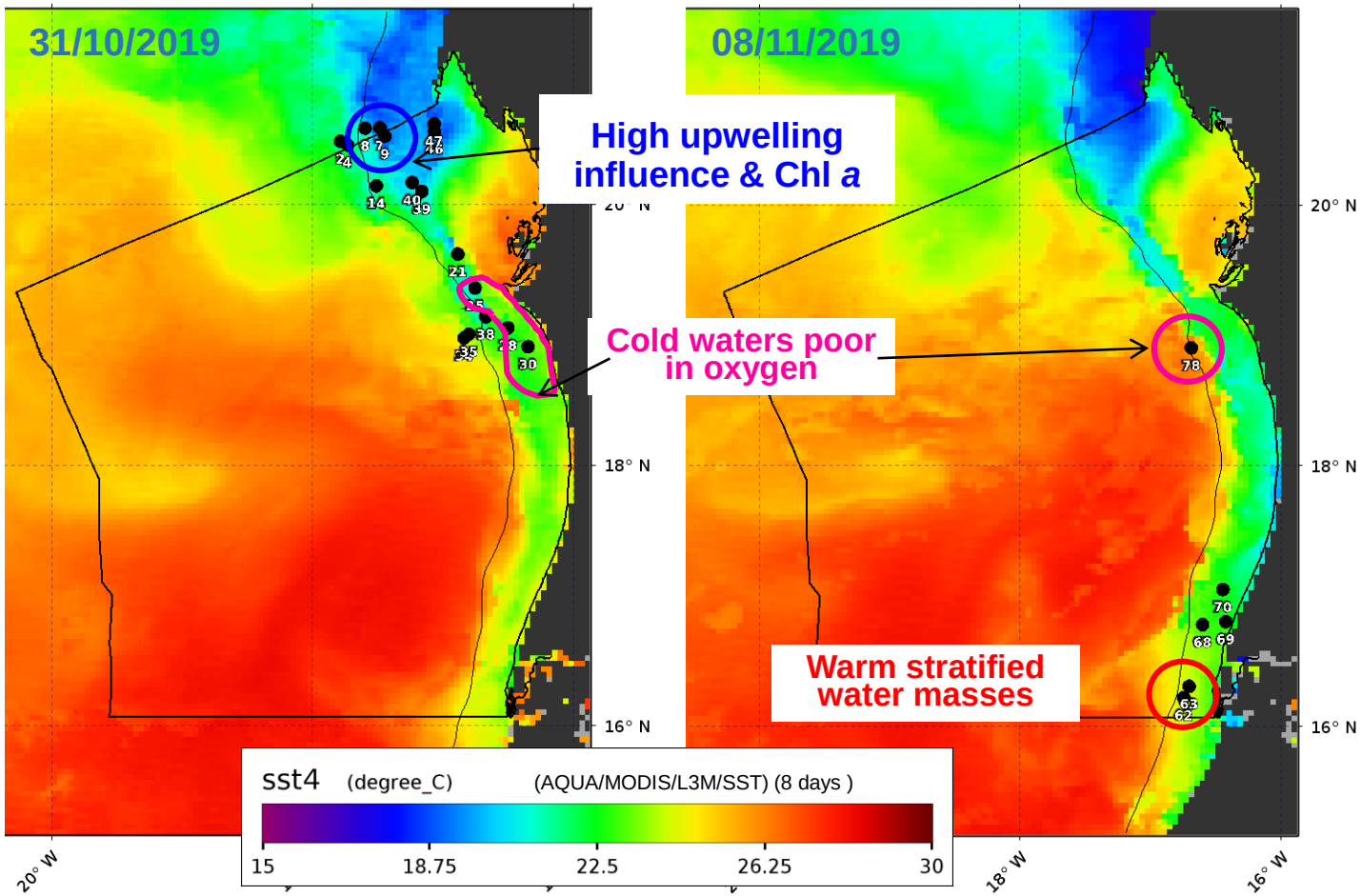
Q: Are jellyfish outcompeting demersal fishes?

FINAL AIM: Identify key plankton descriptors to then monitor their changes

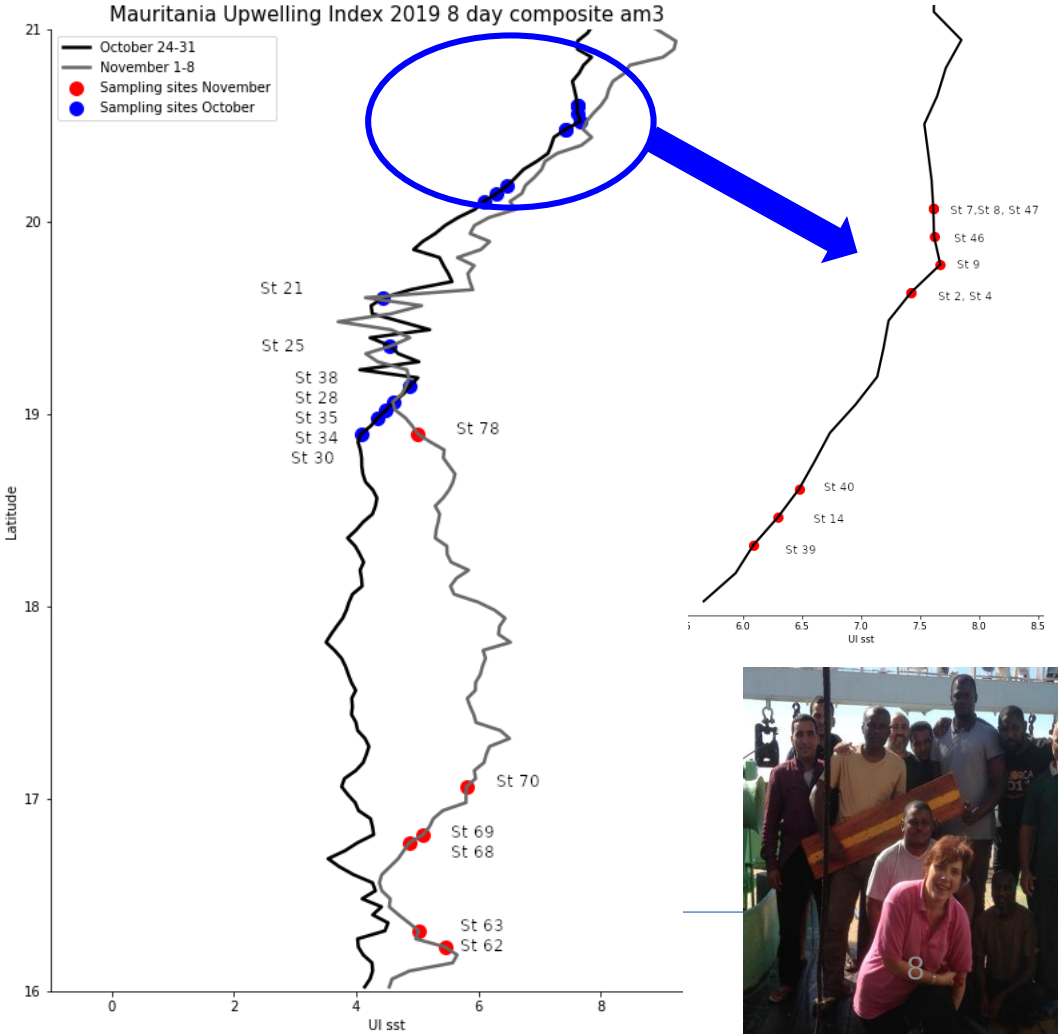
DEMERSAL CRUISE IN MAURITANIA (Oct-Nov.2019)

Strong influence of the upwelling, particularly in Northern Mauritania

SST

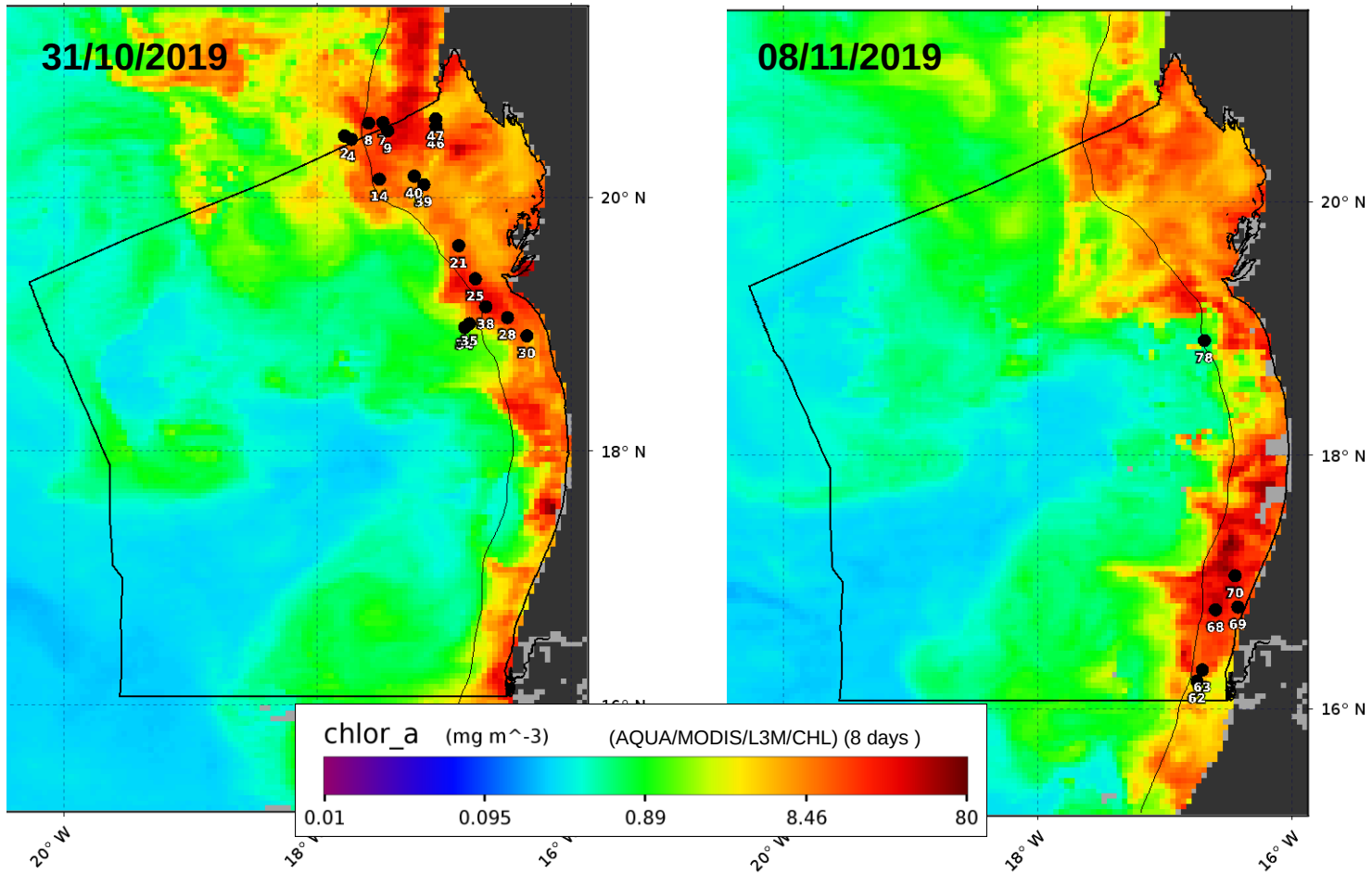


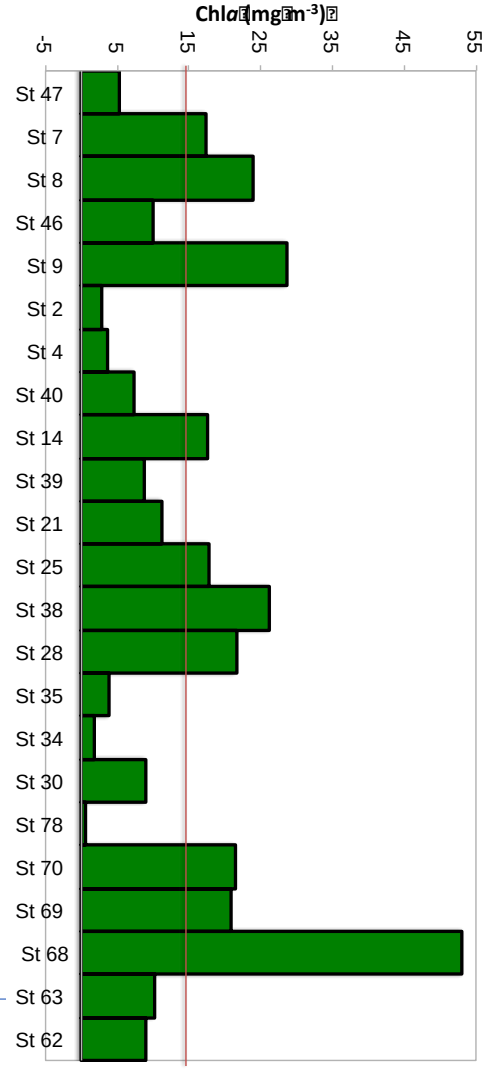
Upwelling index, 8 days composite



DEMERSAL CRUISE IN MAURITANIA (Oct-Nov.2019)

Surface Chlorophyll *a* peaks in zones influenced by the upwelling (North) and on the shelf (Centre/South)

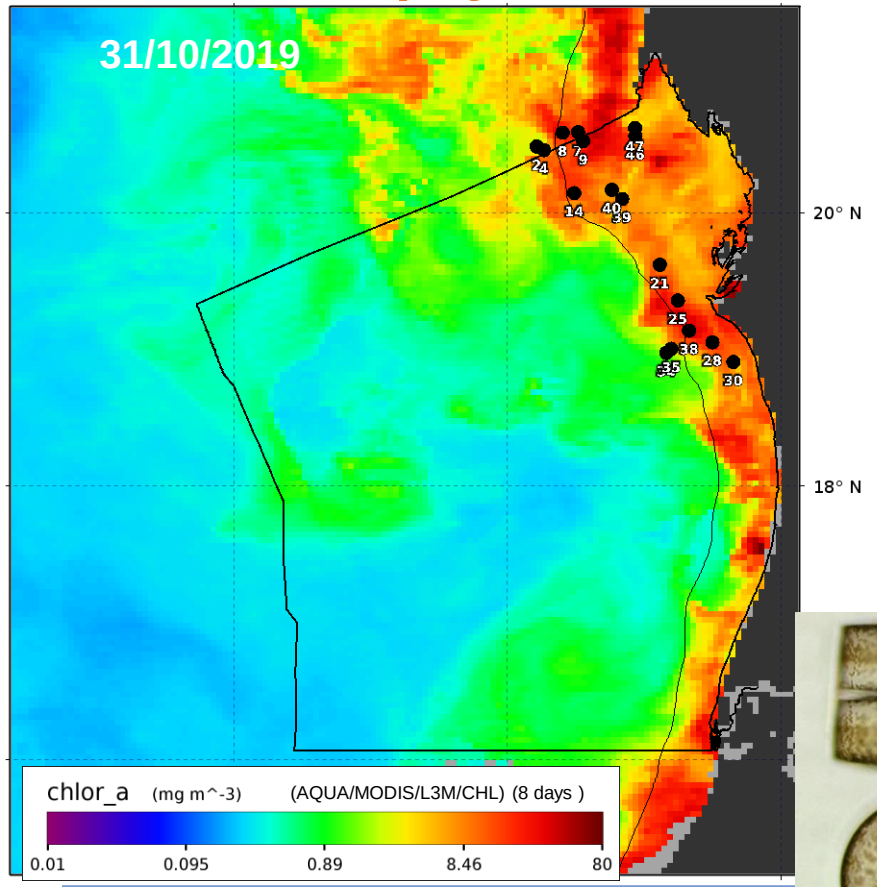




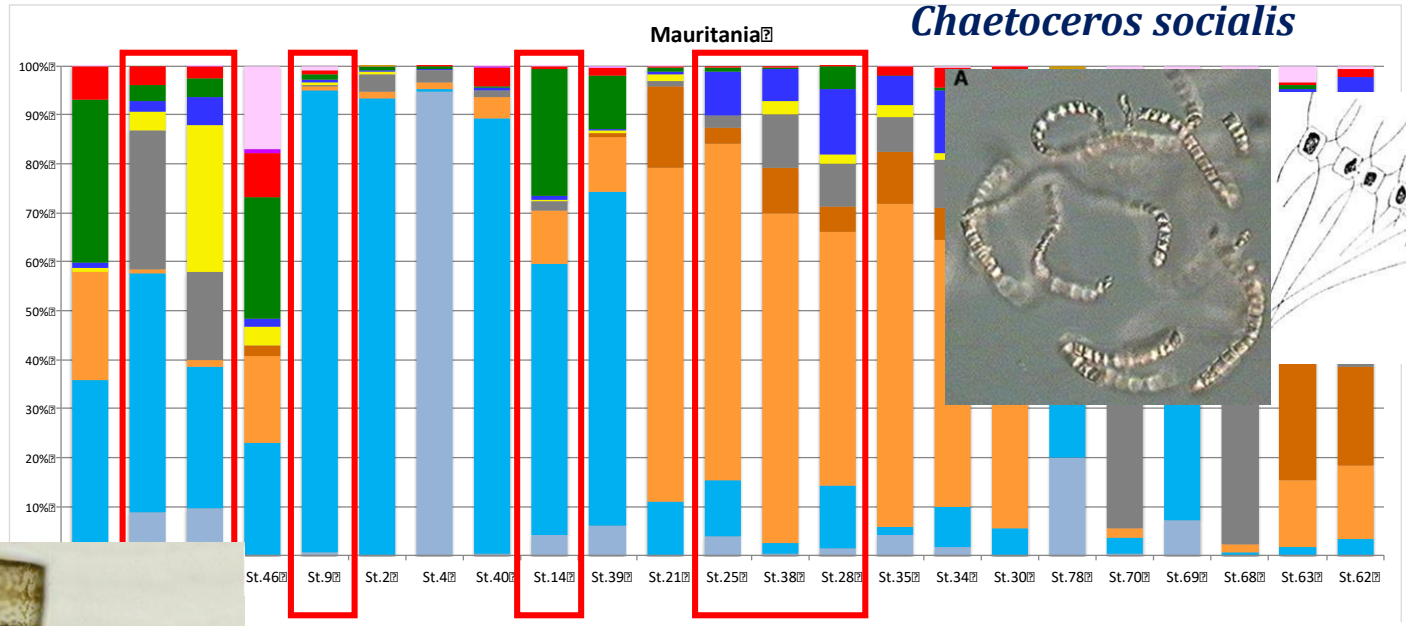
DEMERSAL CRUISE IN MAURITANIA (Oct-Nov.2019)

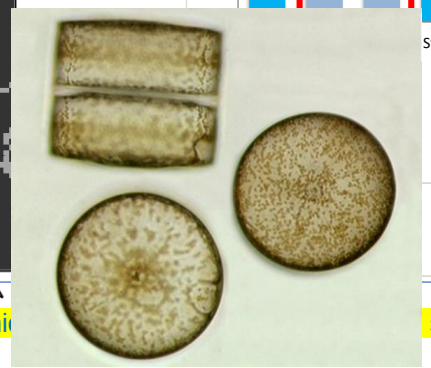
Different diatom taxa dominate the phytoplankton standing stock : North & Central regions

Chlorophyll *a*



Main phytoplankton taxa

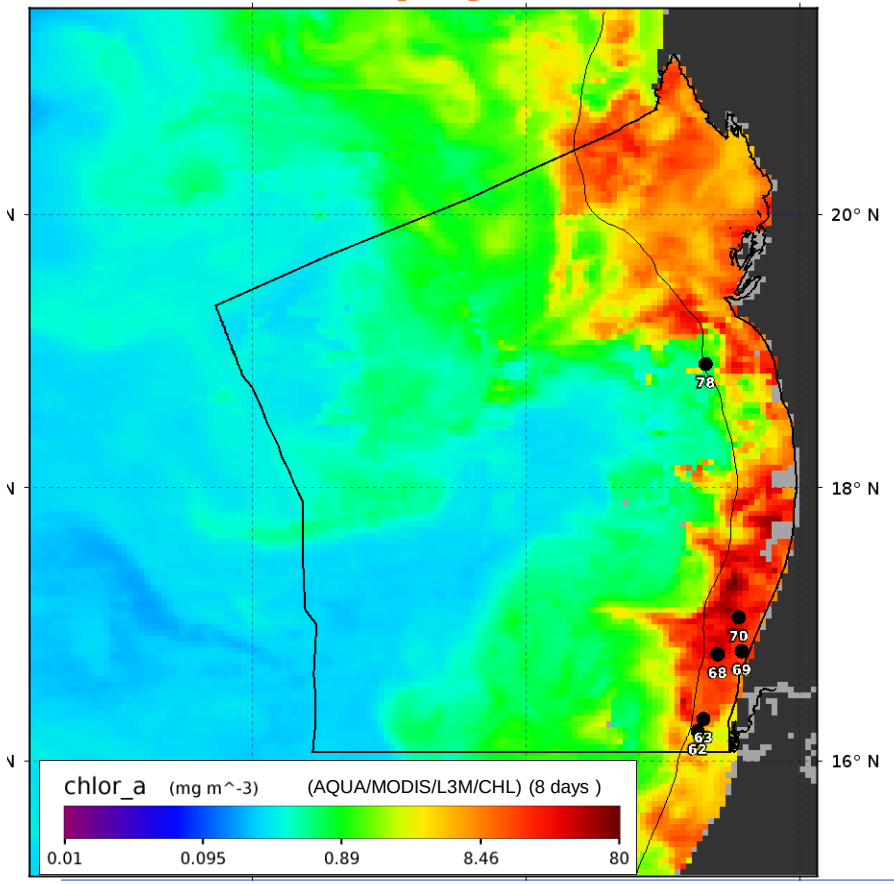




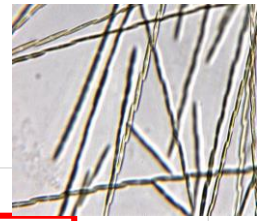
DEMERSAL CRUISE IN MAURITANIA (Oct-Nov.2019)

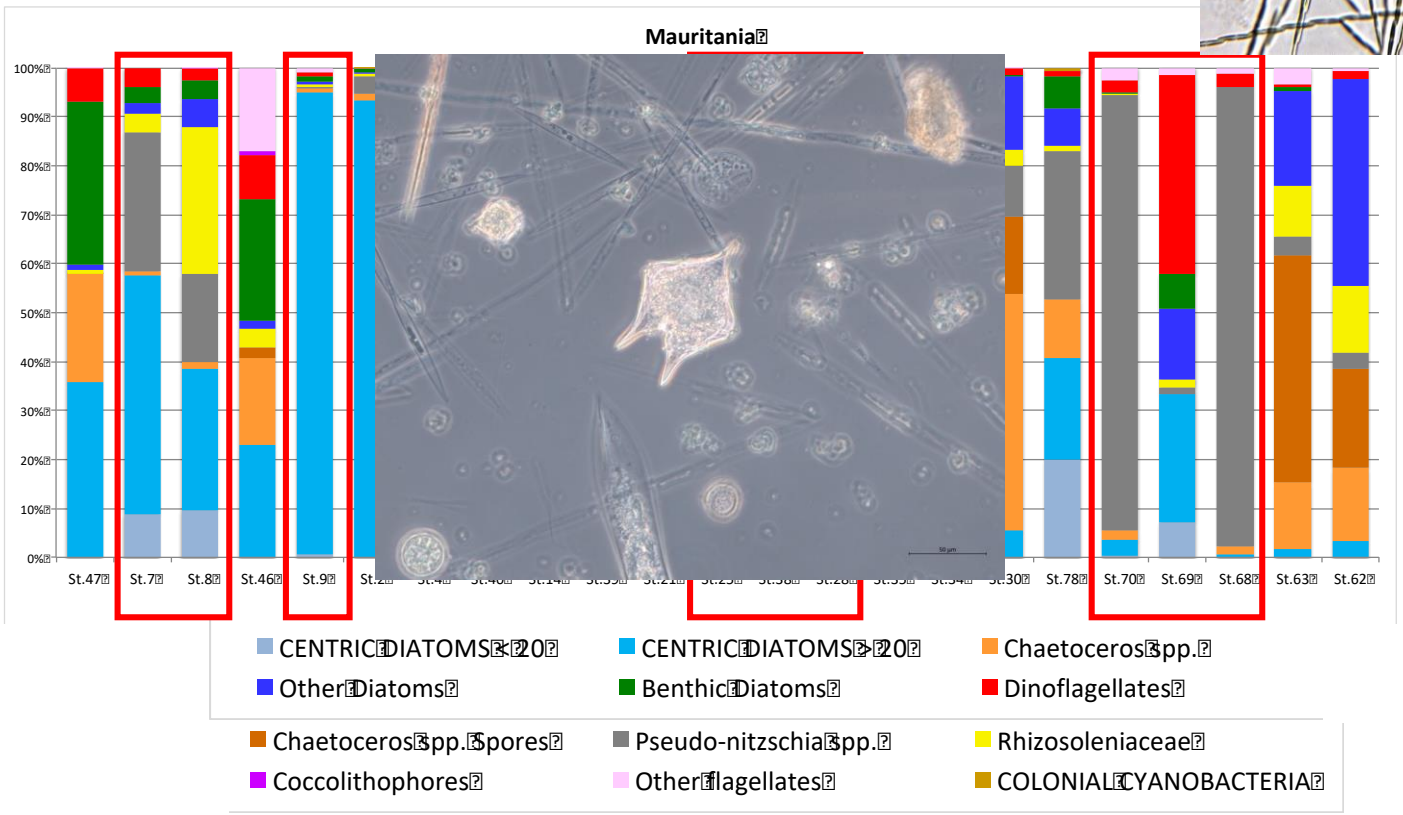
Different diatom taxa dominate the phytoplankton standing stock : Southern region

Chlorophyll *a*



Main phytoplankton taxa

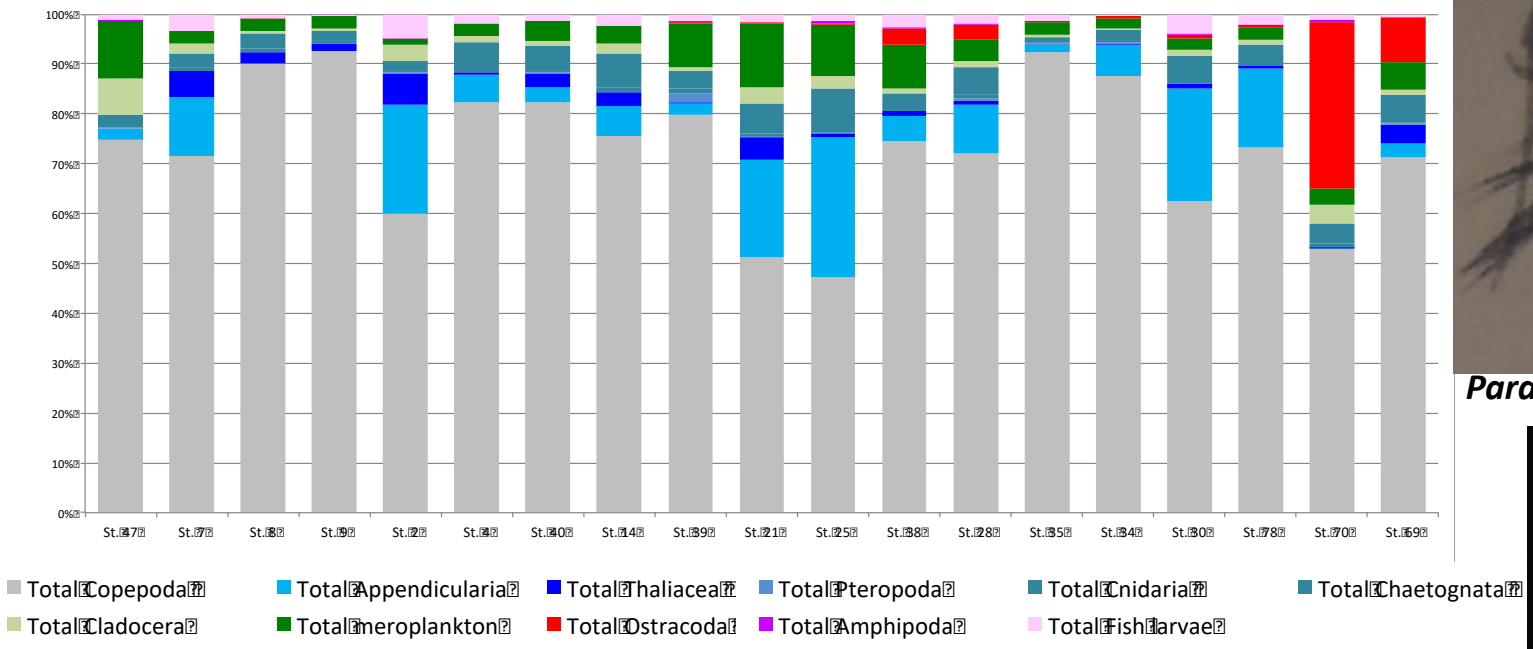




DEMERSAL CRUISE IN MAURITANIA (Oct-Nov.2019)

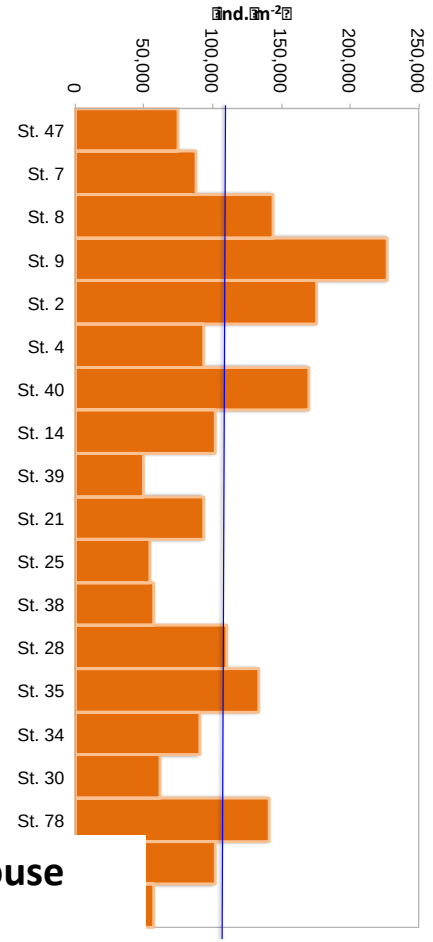
Zooplankton standing stock is dominated by copepods, but gelatinous filter feeders tend to increase in highly productive areas

Main zooplankton groups



Paracalanus indicus

Total zooplankton



Appendicularia in its house
(©www.taxateca.com)

DEMERSAL CRUISE IN MAURITANIA (Oct-Nov.2019)

Identification of zooplankton species that characterise the different zones

Central region

Medium/large copepods >1mm

(*Centropages typicus*)

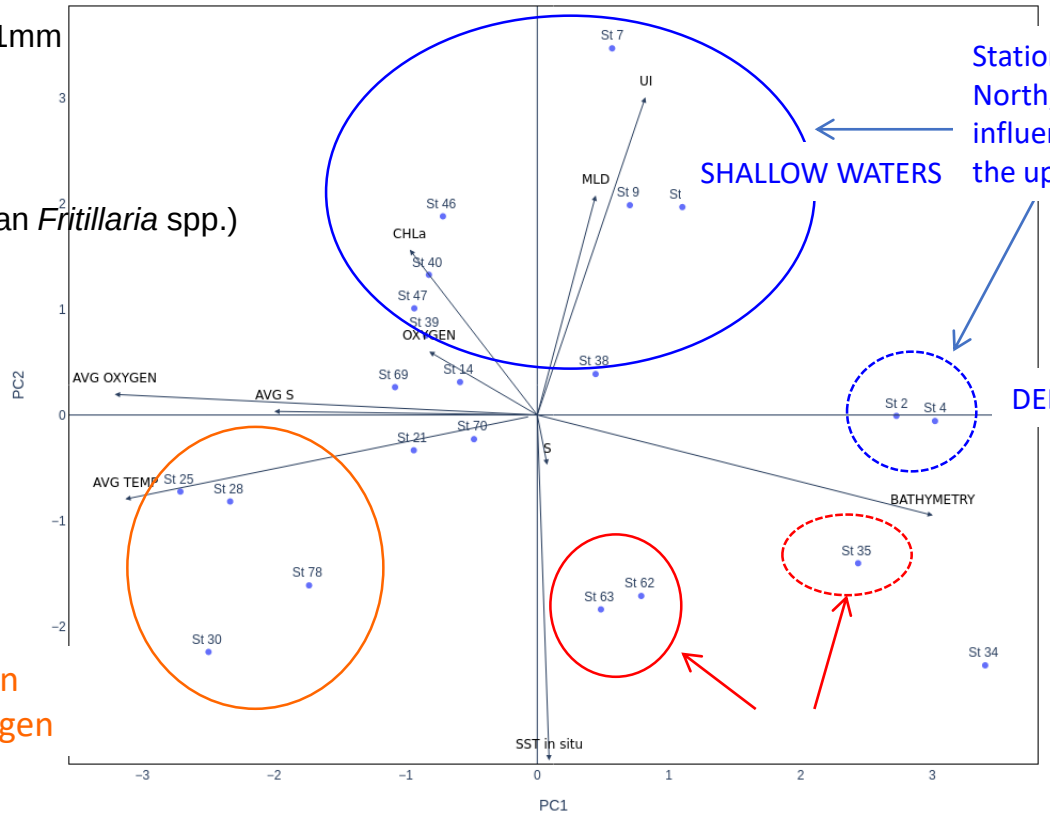
Calanoides natalis

Gelatinous filter feeders (appendicular *Fritillaria* spp.)

Medusae

Echinoiderm larvae

Fish larvae



SHALLOW WATERS

Stations in the North, strongly influenced by the upwelling

DEEP WATERS

Stations in the Centre, in cold waters poor of oxygen

Northern region

Small copepods <1mm (*Oithona nana, Oncaea venusta*)

Temora turbinata

Gelatinous filter feeders (appendicularian *Oikopleura* spp., doliolids)

Medusae and Colonial siphonophore jellyfish (*Liriope tetraphylla, Muggiaea atlantica*)

Echinoderm larvae

Fish eggs

Southern region

Ostracods

Bivalvi larvae

Some small copepods

Fish larvae

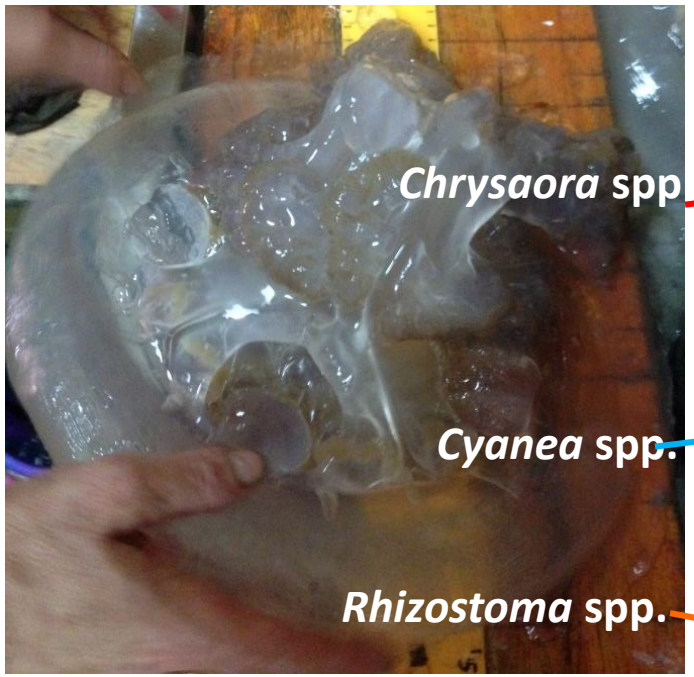
Clausocalanus furcatus

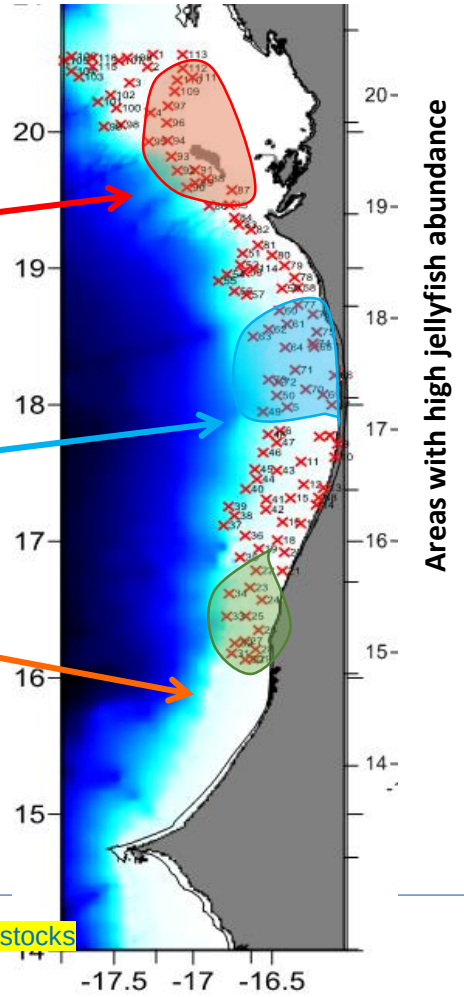
MLD = mixed layer depth
OXYGEN measured in ppm
UI = temperature derived upwelling index
CHRL = satellite measured chlorophyll a concentration, expressed in mg m^-3
AVGs = depth-averaged measurements
S = salinity

DEMERSAL CRUISE IN MAURITANIA (Oct-Nov.2019)

Gather basic knowledge to better understand if jellyfish are outcompeting demersal fishes

Case study in Mauritania (2019) and in Guinea (2020)





Results from 2019-2020 Demersal Campaigns shows that different zone are characterised by different jellyfish species

NEXT STEP

Define environmental preferences of key jellyfish species

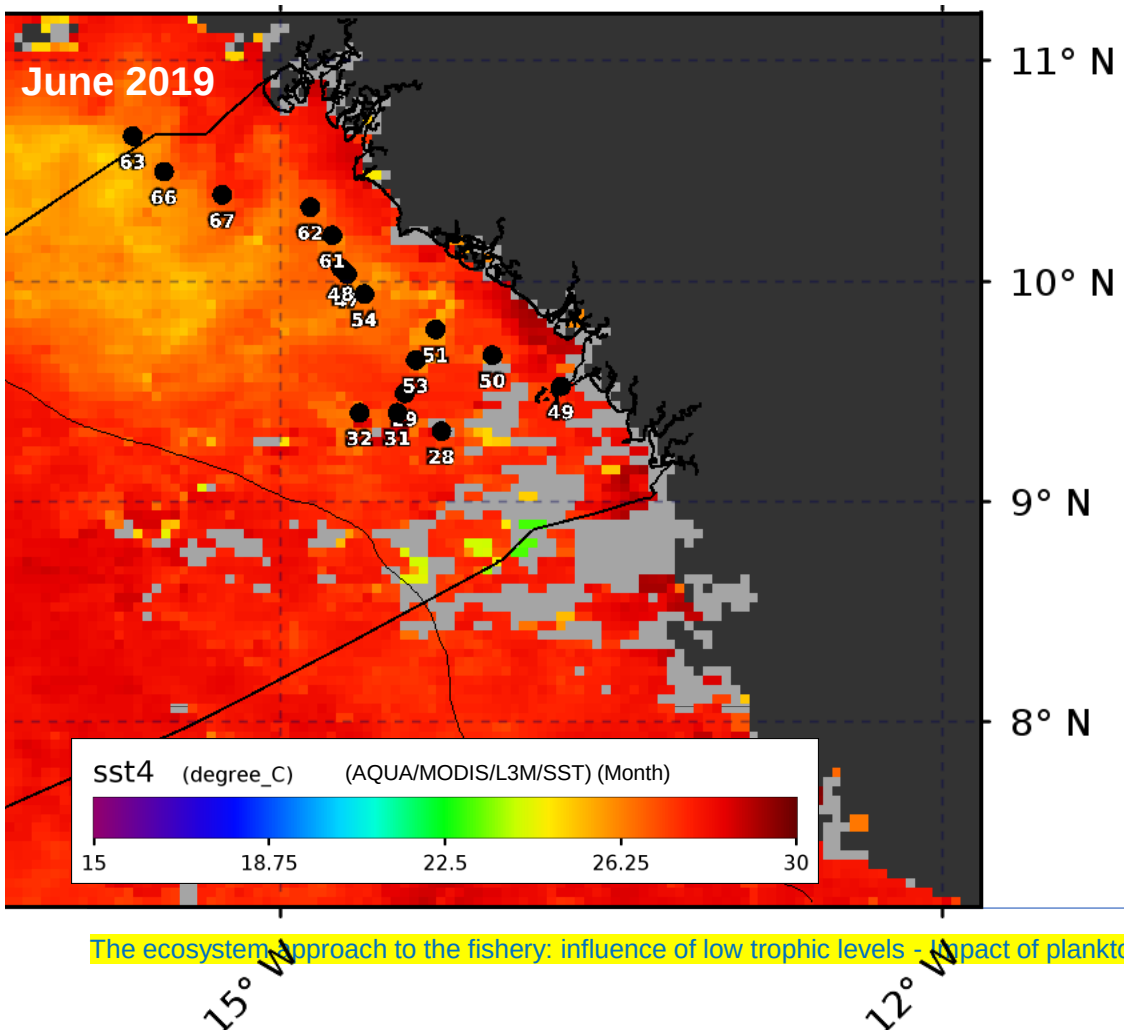
Is acidification favouring Jellyfish vs fish?

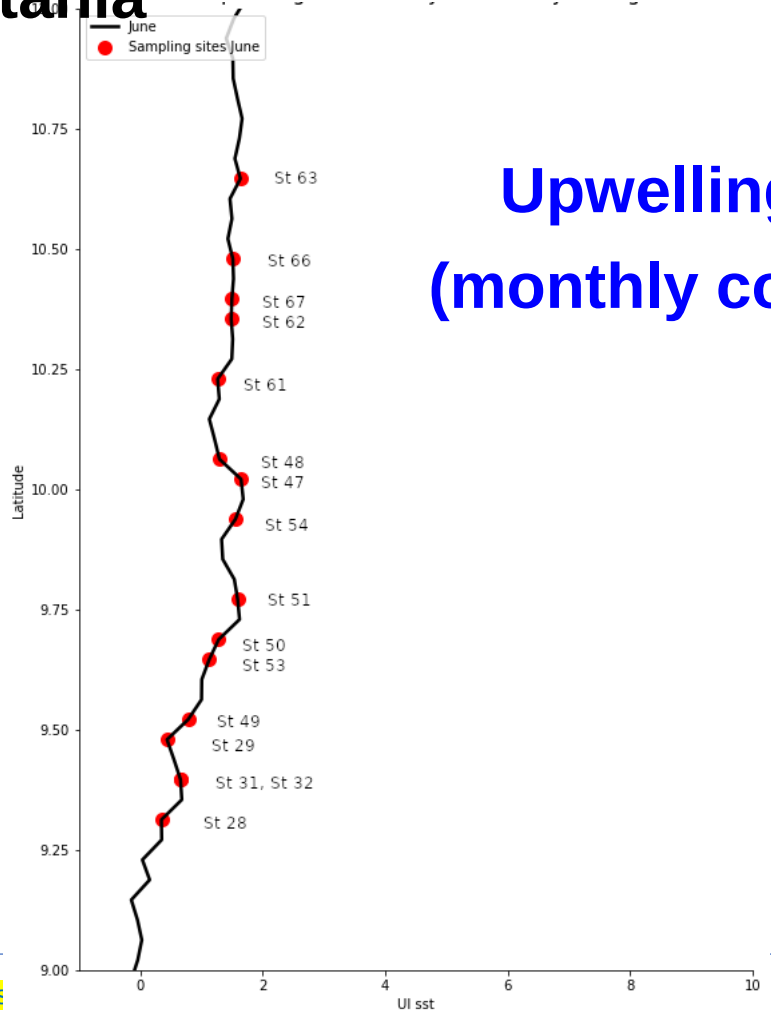
(PhD project SZN-Uni. Cadiz (Spain) & NANSEN project

DEMERSAL CRUISE IN GUINEA (June 2019)

Lower influence of the upwelling in the Guinean region, when compared with Mauritania

SST





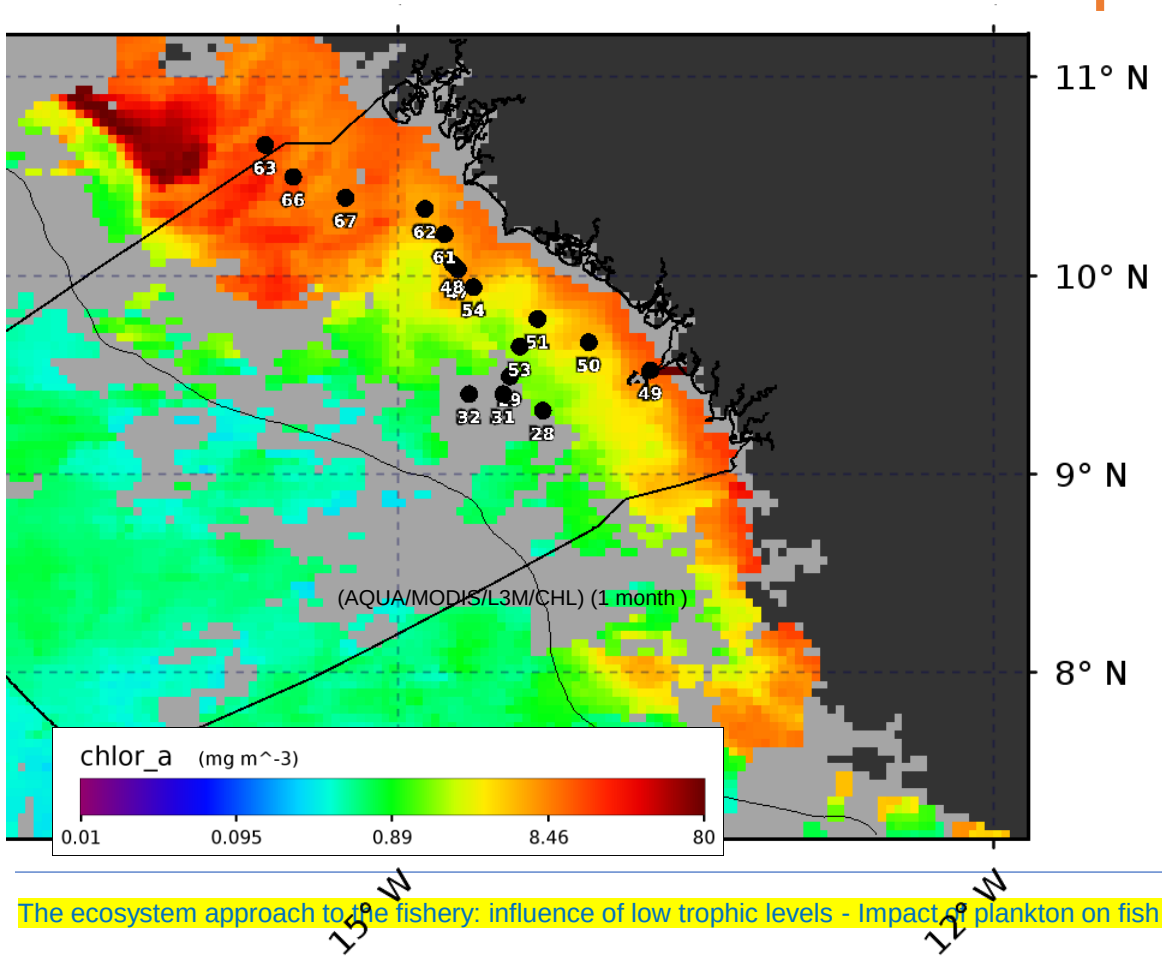
Upwelling index (monthly composite)

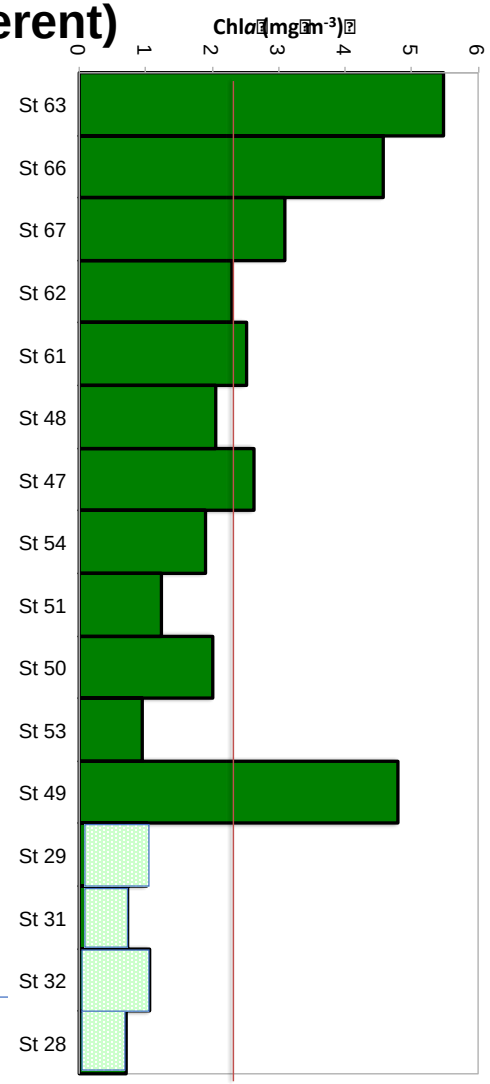
DEMERSAL CRUISE IN GUINEA (June 2019)

Lower surface chlorophyll *a* in Guinea than in Mauritania

(Note: seasons were different)

Chlorophyll *a*

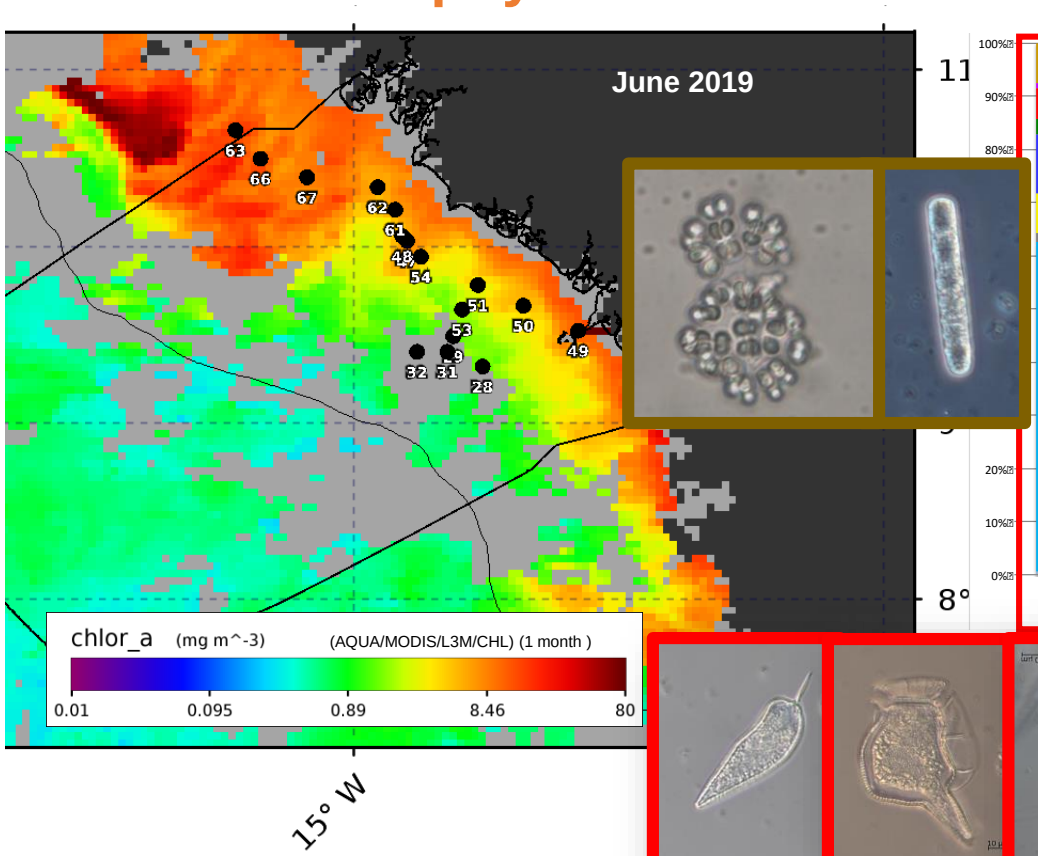




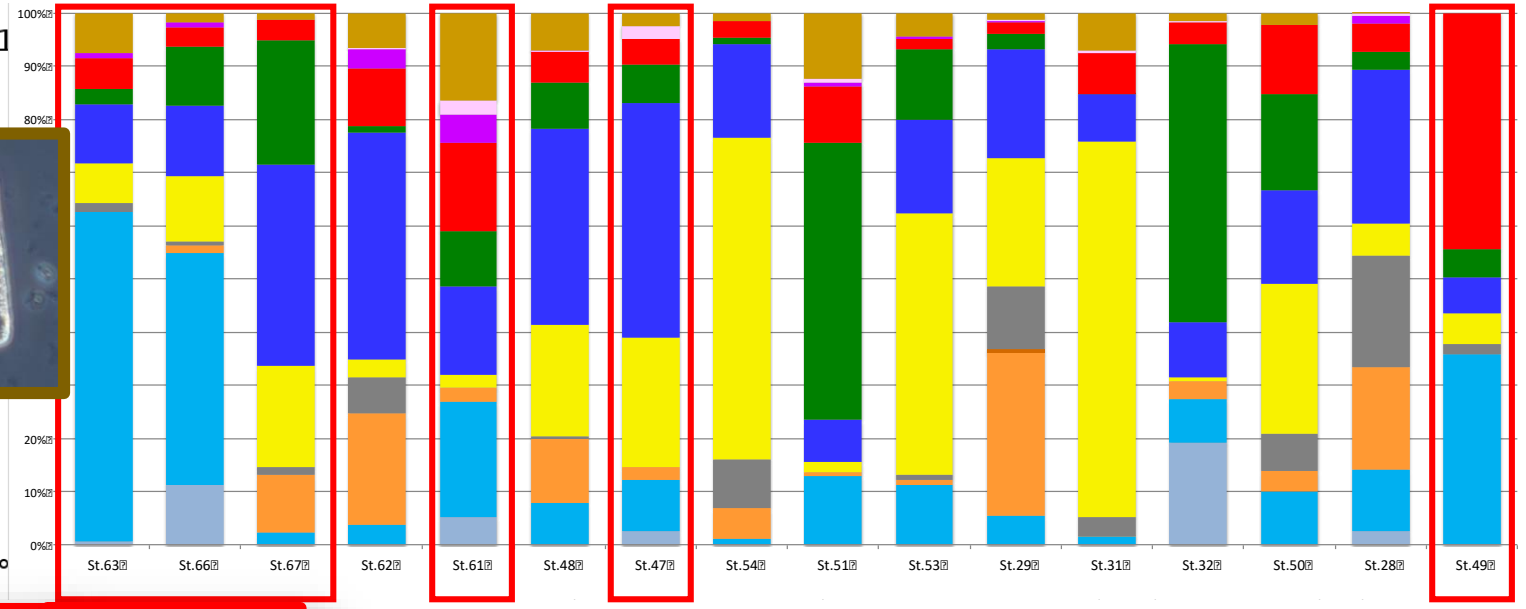
DEMERSAL CRUISE IN GUINEA (June 2019)

Diatom taxa dominate the phytoplankton standing stock but it rises the contribution of other groups (dinoflagellates, cyanobacteria, coccolithophores)

Chlorophyll *a*



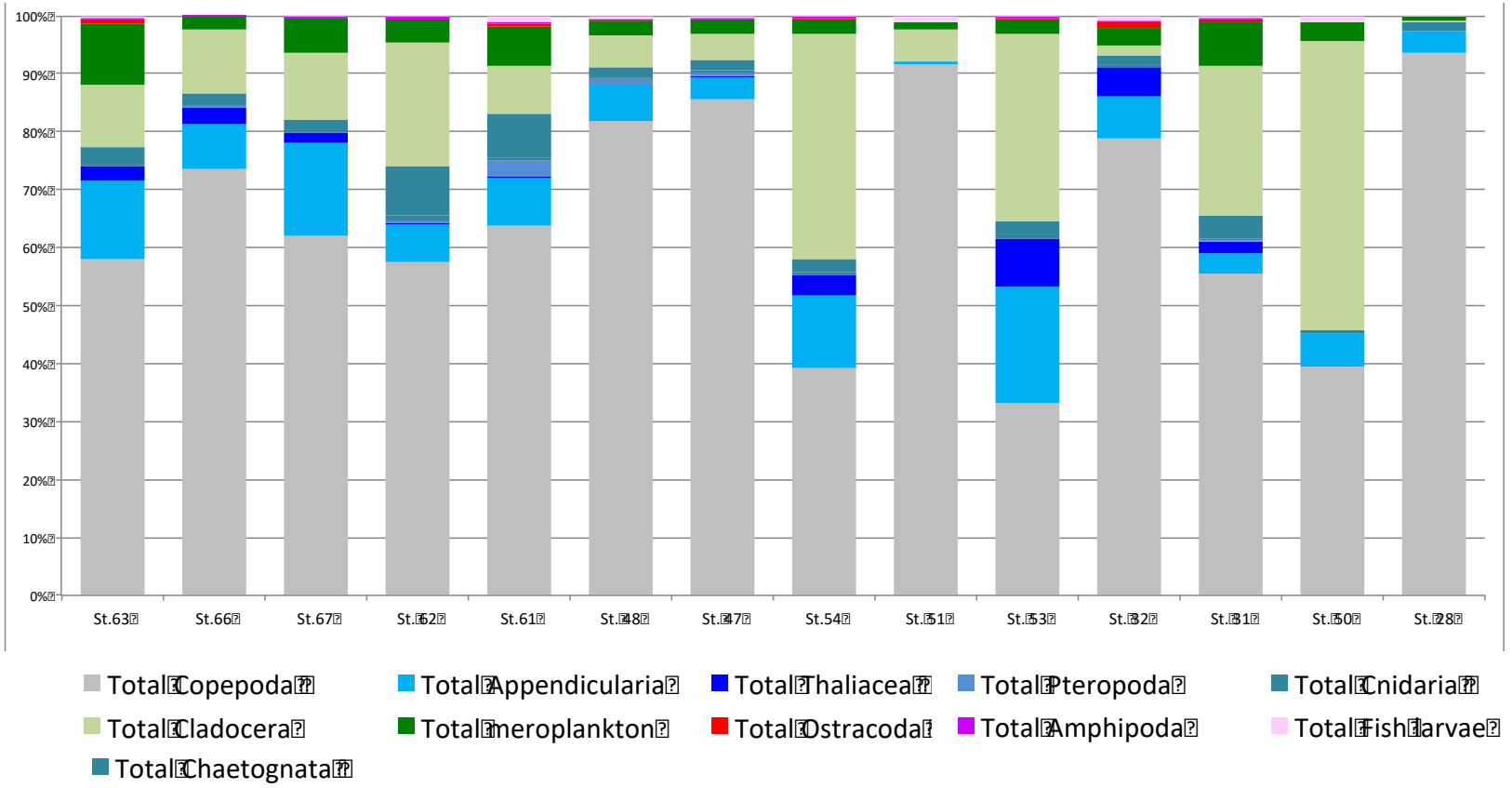
Main phytoplankton taxa



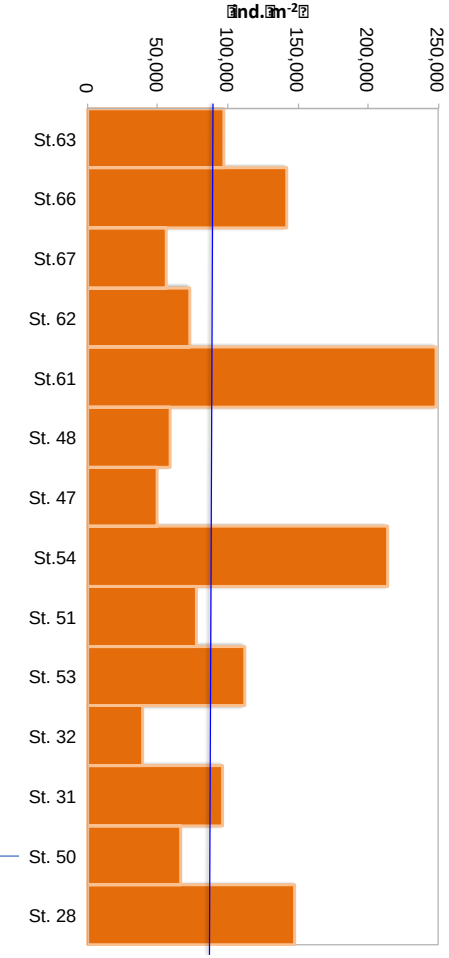
DEMERSAL CRUISE IN GUINEA (June 2019)

Zooplankton standing stock is dominated by copepods, cladocerans and gelatinous filter feeders. Similar size of zooplankton stock in Guinea and Mauritania

Main zooplankton groups



Total zooplankton



DEMERSAL CRUISE IN GUINEA (June 2019)

Identification of zooplankton species that characterize different zones (but we need more environmental data to better define the habitats)

Northern region

Gelatinous carnivorous (Chaetogneths)

Appendicularian *Oikopleura* spp.)

Small copepods (*Ditrichocorycaeus africanus*)

Different meroplanktonic larvae

Medusae

Decapod larvae

Fish eggs

Central region

Cladocerans *(Penilia avirostris, Evadne tergestina,*

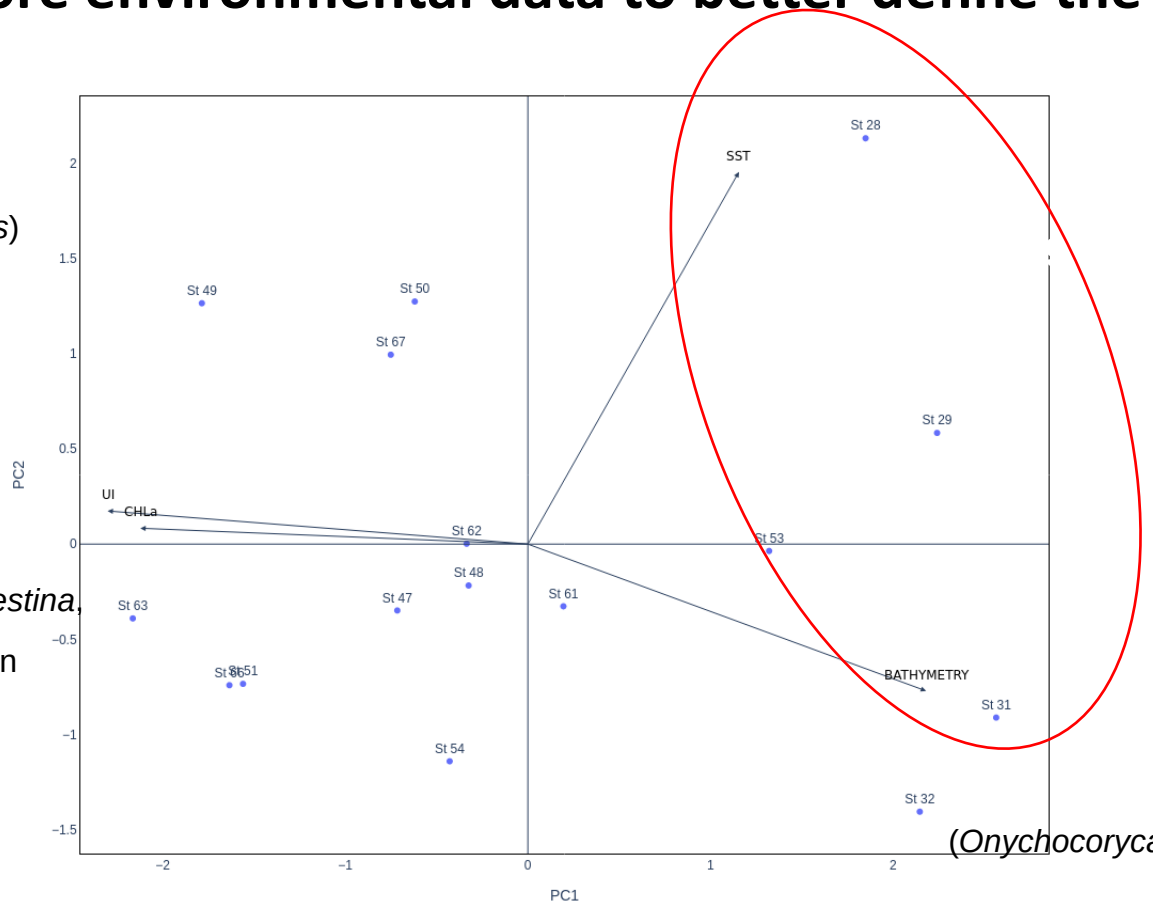
Gelatinous filter feeders (appendicularian *Oikopleura* spp.)

Paracalanus parvus

Echinoderm larvae

Fish larvae

Decapod larvae



UI = temperature derived upwelling index
CHRL = satellite measured chlorophyll a concentration, expressed in mg m^-3
SST = satellite measured sea surface temperature

Southern region, shallow warm waters

Small copepods <1 mm

(*Onychocorycaeus giesbrechti, Oncaea venusta venella*

Temora turbinata

DEMERSTEM CONTRIBUTION TO FILL KNOWLEDGE GAPS ON MARINE PLANKTON IN CECAF REGION

NEXT STEPS:

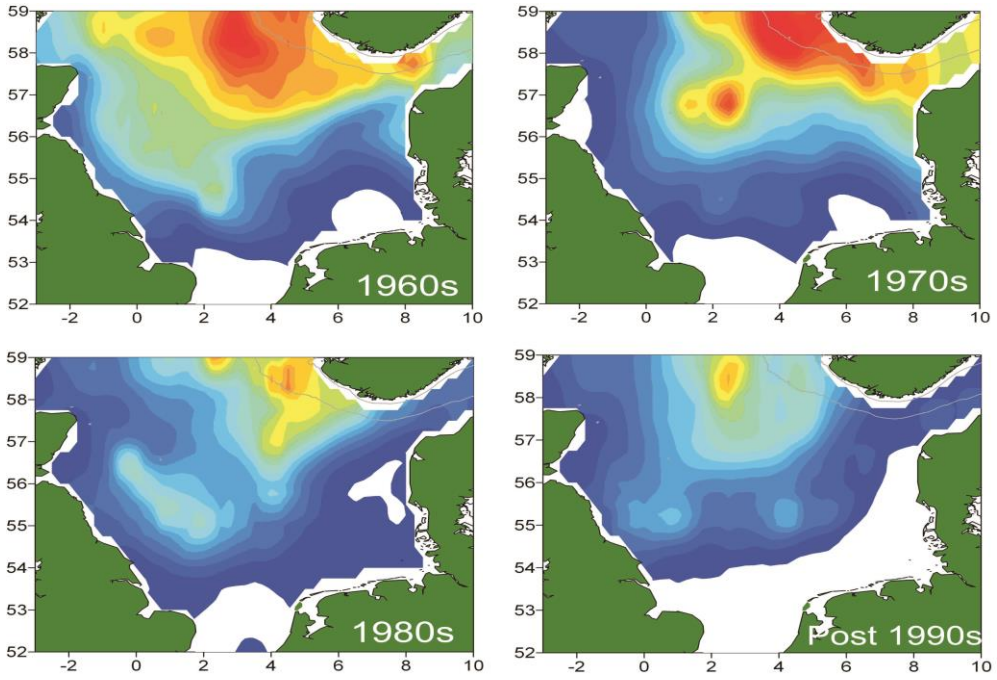
Measure the impact of different plankton community on fish stocks

ACTIONS: Estimate zooplankton C-mass available to fish & fish larvae feeding on zooplankton in the different regions/subregions, as depending on the species that compose the zooplankton community C stock could significantly change

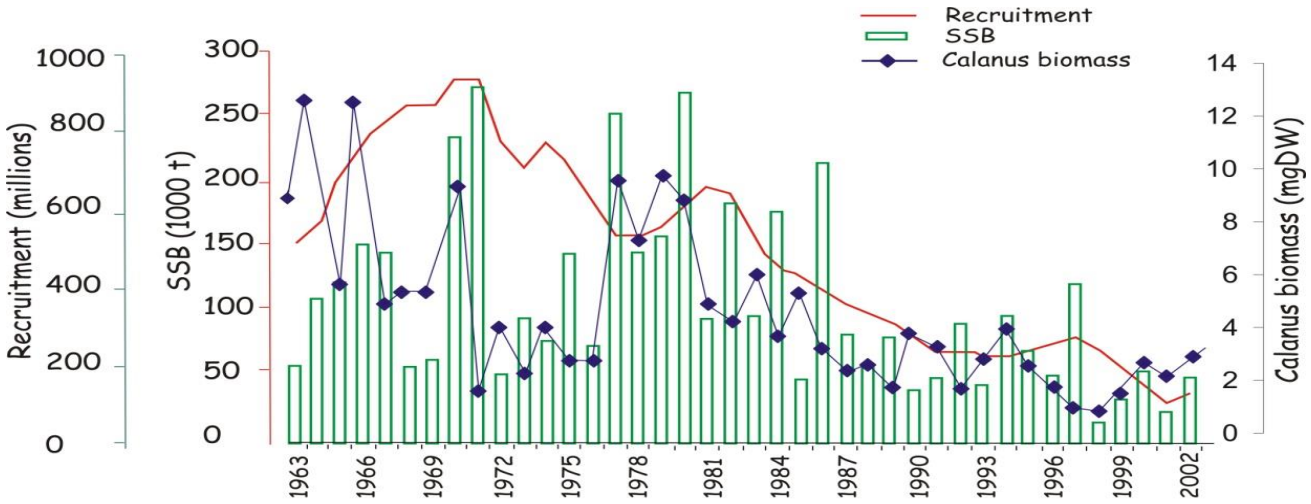
CHANGES IN DOMINANT COPEPOD SPECIES CAN NEGATIVELY IMPACT FISH STOCKS

Plankton community changes in the North Sea with shift in dominance between the cold water species *Calanus finmarchicus* and warm water species *C. helgolandicus*

Change in *Calanus* biomass in the North Sea:
up to 70% decrease after the 1990s



North Sea cod stock (SSB) and recruitment have decreased since the late 1980s, in parallel with a decrease in zooplankton (mainly *Calanus)* biomass

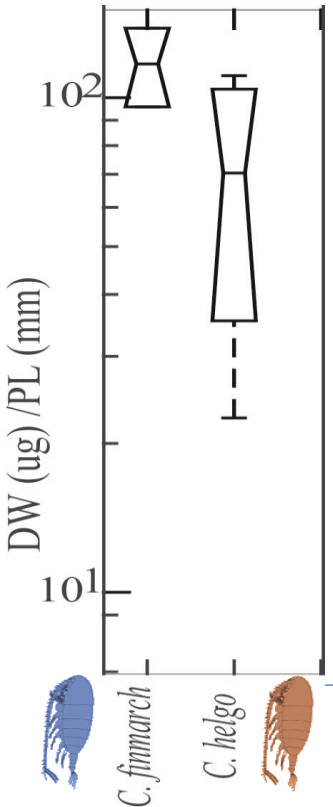


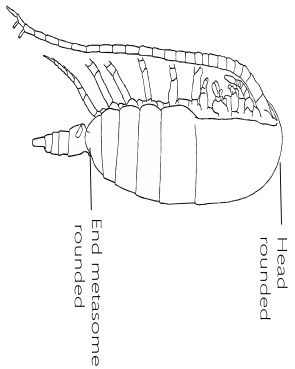
Licandro, 2007. DEFRA Marine Fisheries Science Year Book 2006/2007, pp 16-18.

CHANGES IN DOMINANT COPEPOD SPECIES CAN NEGATIVELY IMPACT FISH STOCKS

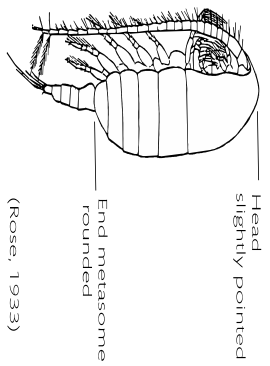
Biomass of *C. finmarchicus* is significantly higher than that of *C. helgolandicus* due to its particular life cycle

Calanus biomass per unit Lenght





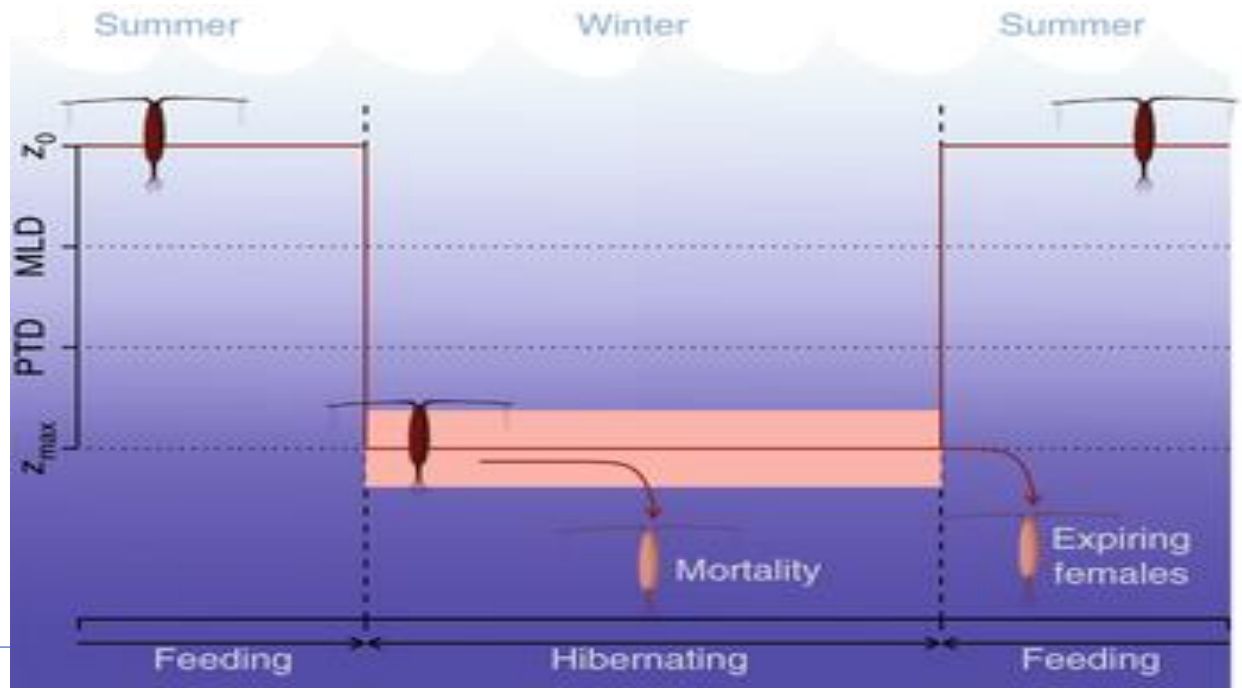
C. finmarchicus



C. helgolandiicus

Licandro et al., in preparation

C. finmarchicus accumulates lipid reserves to survive during the diapause duration



Brun et al., Nature Ecology and Evolution, 3:416-423

IMPLEMENTING PLANKTON IN ECOSYSTEM APPROACH TO FISHERIES MANAGEMENT (EAFM) IN CECAF REGION

DEMERSTEM LEGACY

- ✓ **Some baseline information on phyto- & zooplankton composition and distribution.**
- ✓ **Contribution to building capacity to promote research on plankton in the CECAF region** (new plankton nets and microscopes; information on plankton taxonomy made available).

POLICY MAKERS ROLE

- ✓ **Implement actions aimed to establish a harmonized network of environmental monitoring across ALL the Countries of the CECAF region**

Thank you
Merci