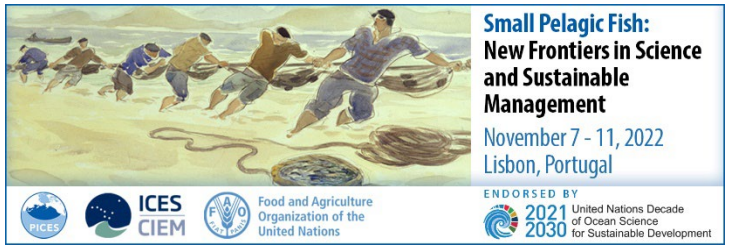
Winners, losers and shifts of the pelagic ecosystem of the Western Mediterranean Sea

Marta Coll, 9th of November 2022

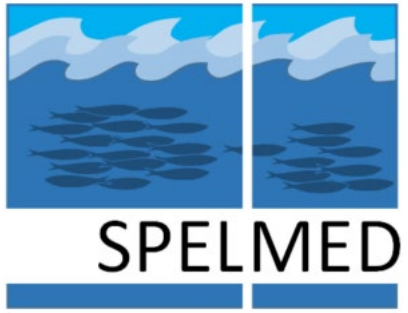
Institut de Ciències del Mar

EXCELENCIA SEVERO OCHOA

CSIC



Improve and integrate SPF knowledge to quantify the impacts of their change and project future trajectories



2018 ---------- 2023

We aimed at ….

- Identifying **historical changes of small pelagic fish** population traits (e.g. abundance, distribution, body condition, …);
- Quantifying the **ecological and socio-economic consequences** of the changes in SPF populations on fisheries, iconic predator species, and ecosystem-wide dynamics;
- Analysing **future management options** to achieve resilient and healthy SPF populations and a sustainable exploitation under climate change.

SPELMED

PelWeb

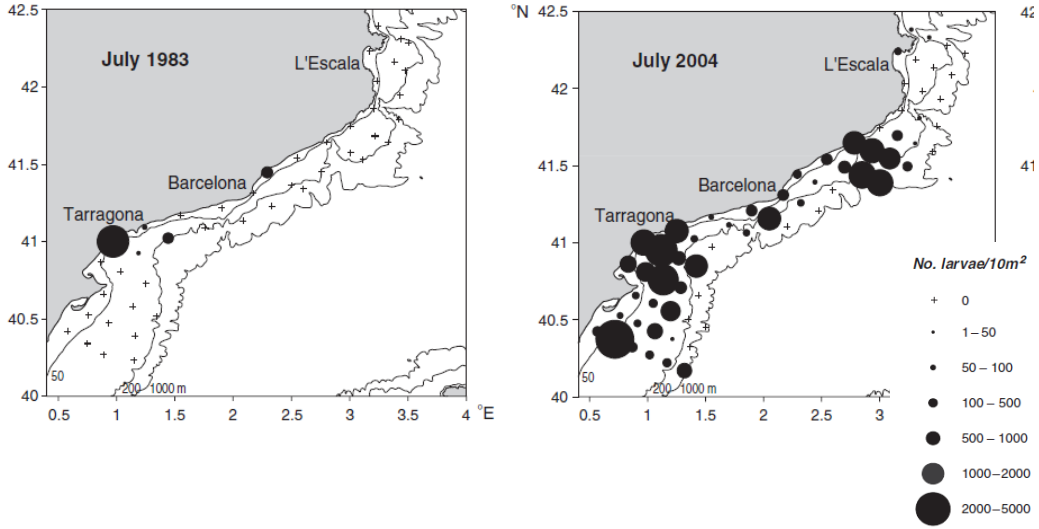
pelCAT
PETITS PELÀGICS AL MAR CATALÀ

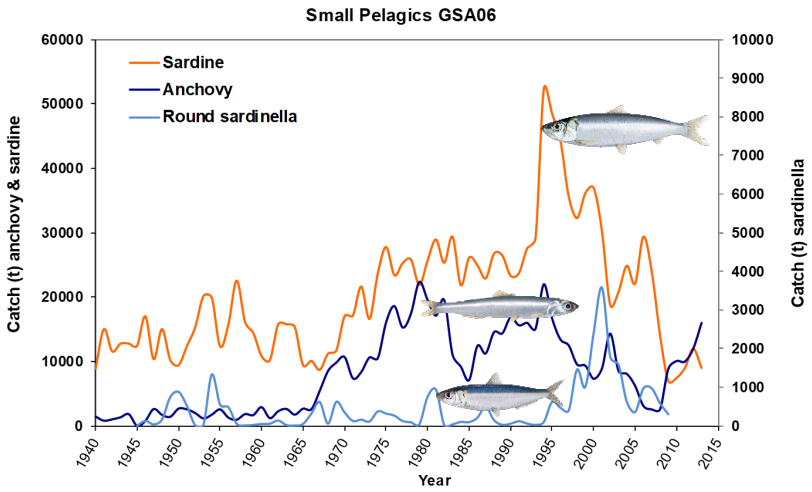
SEINE ETP

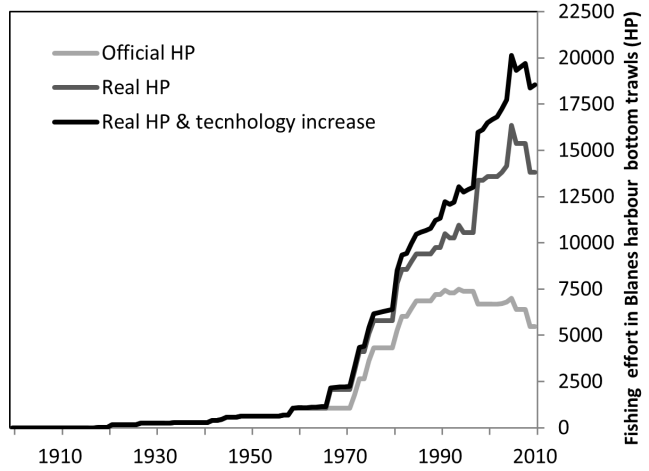
The Western Mediterranean pelagic system is changing

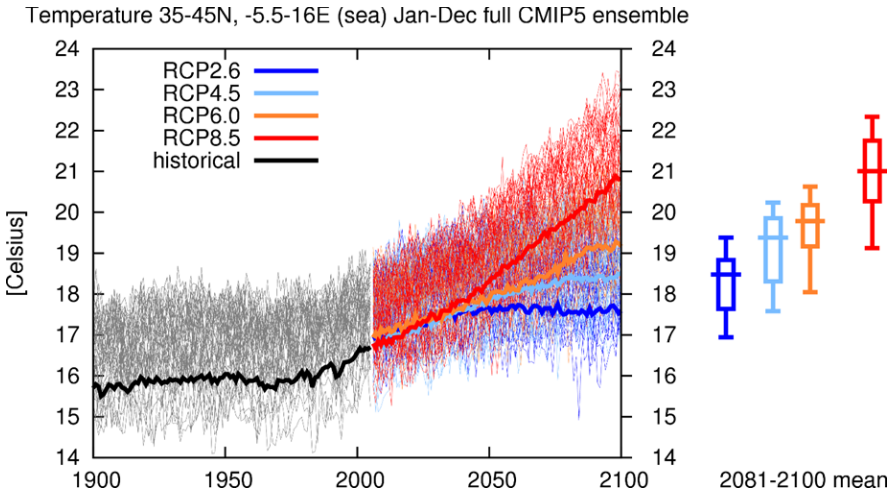
- Declines in commercial species
- Increases and proliferations
- Recoveries

- Changes in climate & ecological conditions
- Changes in human activities









Sabates et al. 2006. GCB; Palomera et al. 2007. PiO; Calvo et al. 2012. CR; Coll et al. 2014. PLoSONE; Salat et al. 2019. OD

http://climexp.knmi.nl/plot_atlas_form.py

The Western Mediterranean pelagic system is changing

- Anchovy and sardine catches are low
- Pelagic fish shows small sizes
- Proliferations of jellyfish
- Recent recovery of predators


ECONOMIA ARENYS DE MAR - 29 març 2016 2.00 h

Poca sardina i seitó petit

- La flota d'encerclament del port d'Arenys pateix la crisi del peix per captures de sardina i la reducció de la talla del seitó, que en de
- El govern es compromet a encarregar un estudi per esbrinar-

Volum de captures de seitó i sardina

SEITÓ (quilos)

Arenys de Mar
2010 551.085
2015 941.568
Catalunya
2010 5.627.584
2015 10.150.3

SARDINA (quilos)

Arenys de Mar
2010 424.918
2015 310.729
Catalunya
2010
2015

el Periódico

SOCIEDAD

PORTADA | INTERNACIONAL | POLÍTICA | ECONOMÍA | SOCIEDAD | BARCELONA | DEPORTES | OCIO Y CULTURA

Castellers | Ciencia | Educación | Medio ambiente | Tiempo | Sanidad | Sucesos

El desplome de las capturas de sardinas pone en jaque a la flota de cerco

Las cofradías catalanas han solicitado al Gobierno y la Generalitat medidas urgentes

205 2

COMENTARIOS 16

Pescadores de la barca L'Avi Juanito seleccionan las capturas de pescado azul a su llegada al puerto de Tarragona.

JOAN REVILLAS


ECONOMÍA

La superpoblación de atún rojo deja a los pescadores de Castellón sin sardina y boquer

Las embarcaciones hablan de "plaga" y piden aumentar las capturas

Elena Aguilar

Castellón | 24-04-21 | 06:01

Ejemplares de atún rojo capturados estos días en aguas valencianas. / MEDITERRÁNEO


MEDI AMBIENT PALAMÓS - 22 gener 2019 2.00 h

Preocupació per la mida del peix blau, a Palamós

- Les barques d'encerclament van tornar ahir a pescar després d'un mes de veda biològica
- Es constata un increment de captures però no de talla, com ara en l'anxova

PUBLICITAT

PUBLICITAT

Gix

VENDA ONLINE DE GAMBA FRESCA

gambapalamos.com

Després de la veda de les barques de peix blau, ara toca a les de la gamba J.T.

NOTÍCIES DE ...

Palamós

PUBLICAT A

El Punt Avui. Girona

22-01-2019, Pàgina 25

MÉS LLEGIDES


La superpoblación de atunes amenaza las capturas de pescado azul en TGN

Los pescadores exigen medidas para frenar la superpoblación de atunes y que se garantice el futuro del sector

ACN

18/04/2021 17:44 | Actualizado a 18/04/2021 17:44

Whatsapp Facebook

La superpoblación de atunes amenaza las capturas de pescado azul en TGN


LA VANGUARDIA

LOS EXPERTOS ALERTAN

Las condiciones del Mediterráneo son idóneas para la proliferación de Medusas este verano

• Un invierno cálido y poco lluvioso y un verano caluroso son el caldo de cultivo para que se produzca la invasión de este animal marino

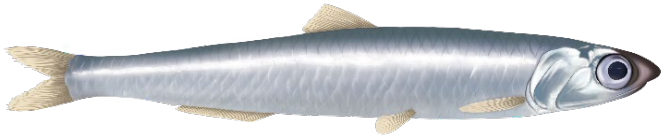
Los expertos han detectado una mayor presencia de medusas en los últimos años en las costas del Mediterráneo (Sebastian Silva / EFE)

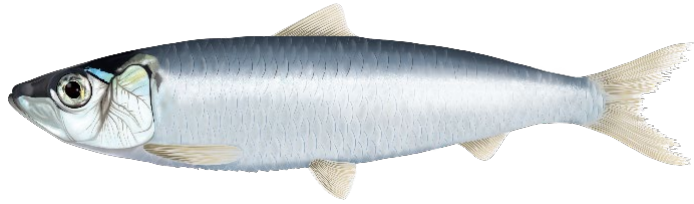
Antonio Cerrillo
Barcelona

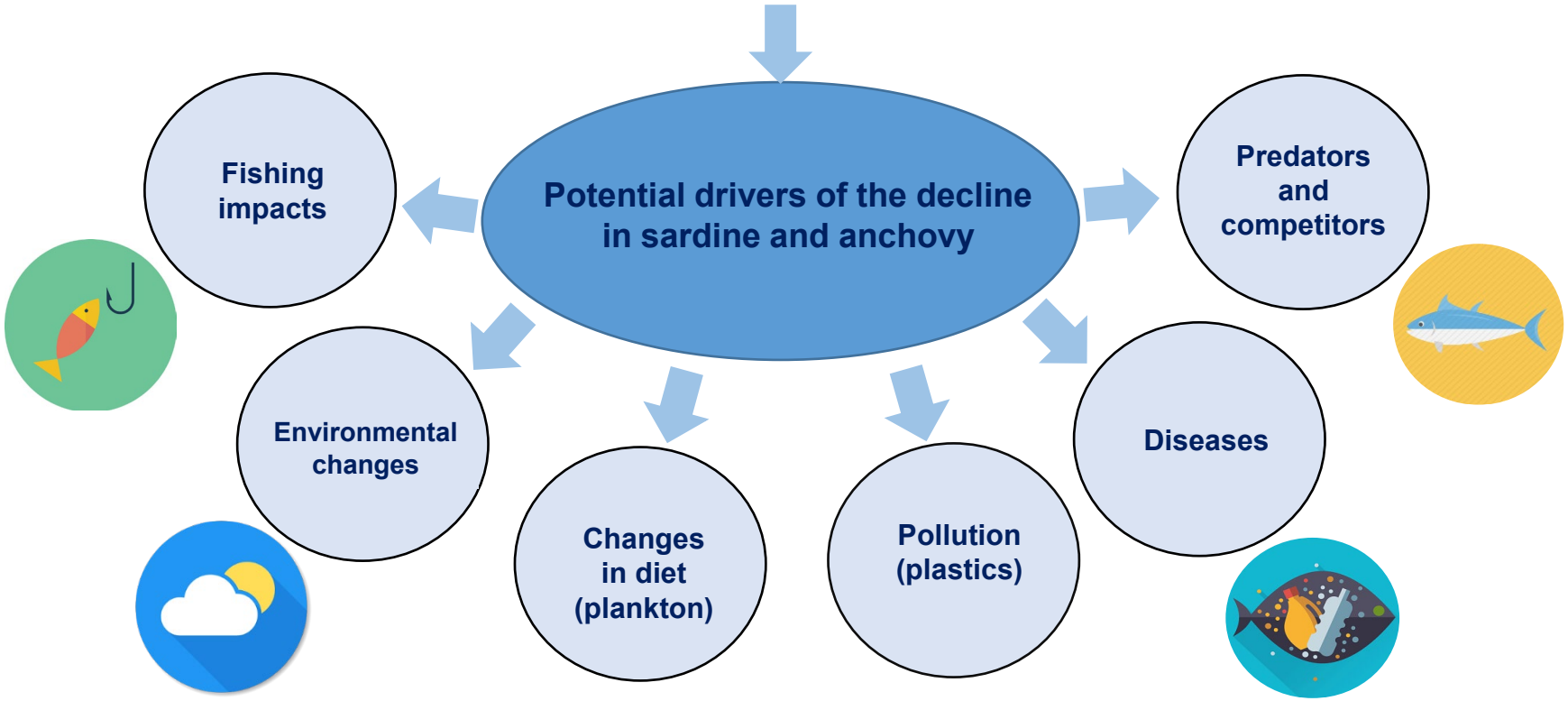
31/05/2016 01:07 | Actualizado a 31/05/2016 10:41

What is happening in the pelagic system?

- Several scientific hypothesis

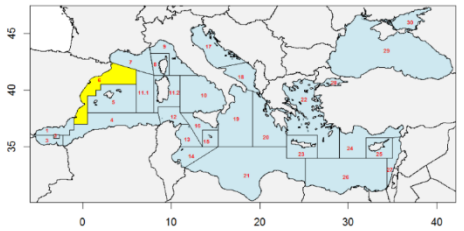




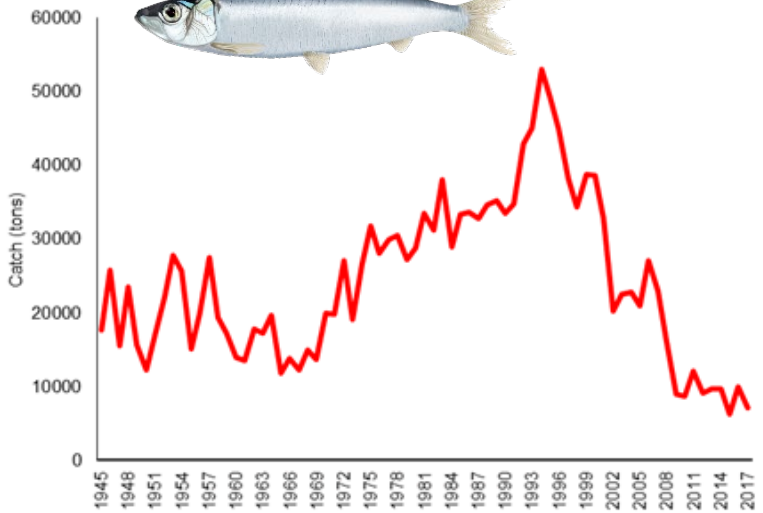


Palomera et al. 2007. PiO; Saraux et al. 2019. DSR; Coll et al. 2019. MEPS

Stock assessments

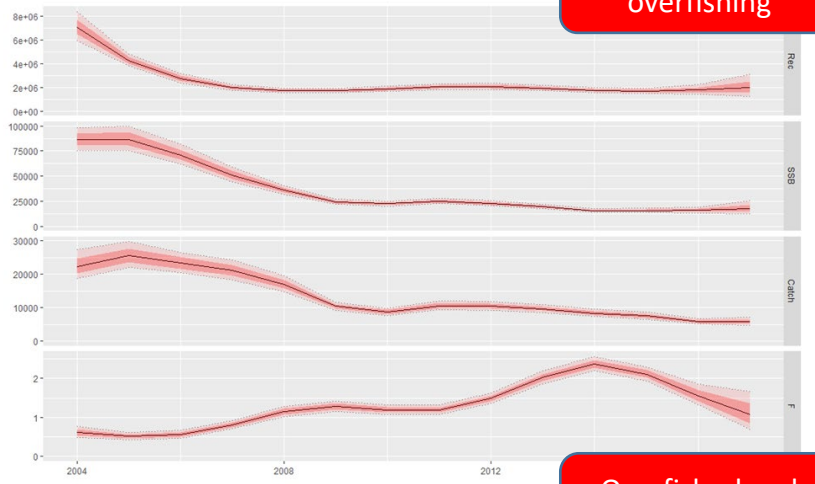


Fisheries and stock assessments

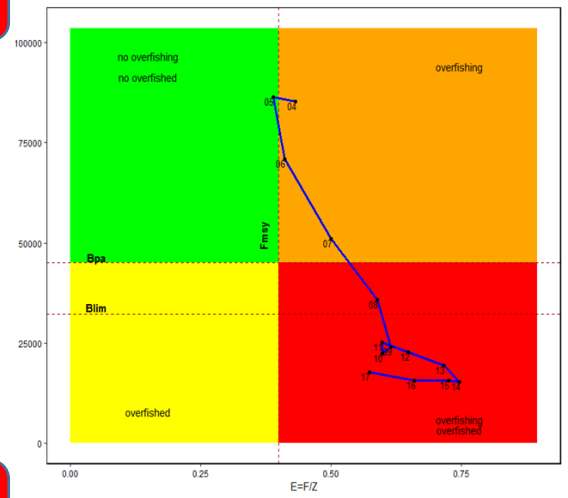


A) Sardine

Overfished and overfishing



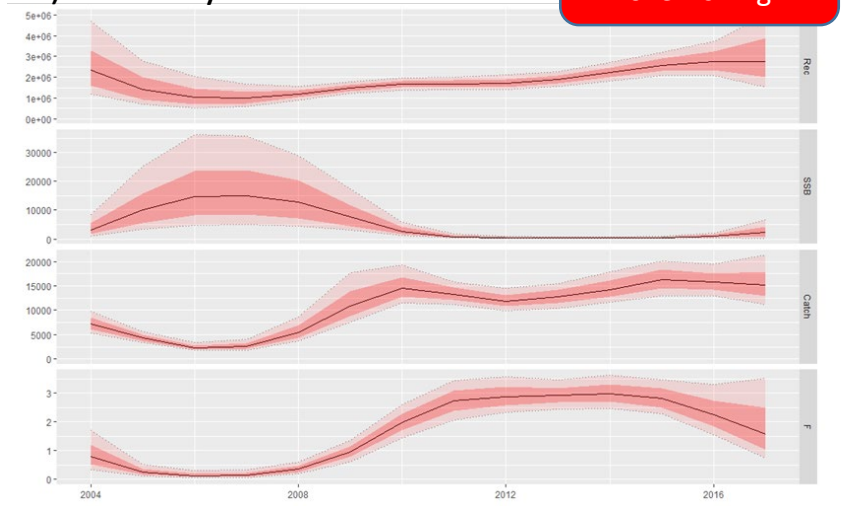
A4a & two-stage biomass models

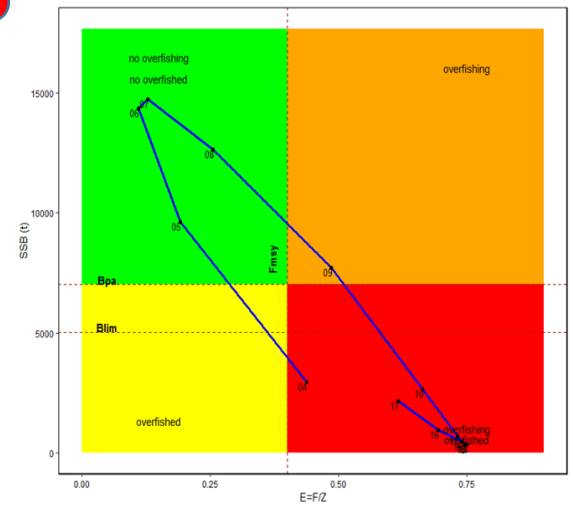


Fcurr=1.19
Fmsy=0.47

B) Anchovy

Overfished and overfishing





Fcurr=0.64
Fmsy=0.54

Coll and Bellido 2019, Ramirez et al., 2019

https://op.europa.eu/en/publication-detail/-/publication/f1bd2c63-084e-11eb-a511-01aa75ed71a1

Stock assessments

Food and Agriculture Organization of the United Nations

General Fisheries Commission for the Mediterranean
Commission générale des pêches pour la Méditerranée

Scientific Advisory Committee on Fisheries (SAC)

Working Group on Stock Assessment of Small Pelagic Species (WGSASP)

Benchmark session for the assessment of sardine and anchovy in GSAs 6 and 7

Online, 18–23 January 2021

REPORT

EXECUTIVE SUMMARY

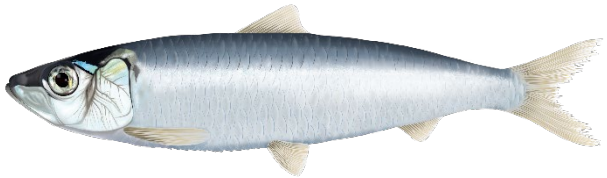
The Working Group on Stock Assessment of Small Pelagic Species (WGSASP) benchmark session for the assessment of sardine and anchovy in geographical subareas (GSAs) 6 and 7[1] was held online through Microsoft Teams on 18–23 January 2021, and continued and finalized online on 9 and 10 February 2021.

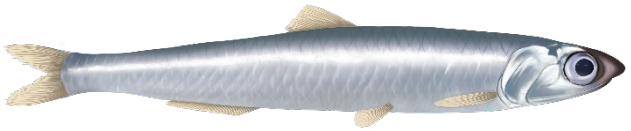
The objective of the meeting was to perform full analysis and review the available information and methods used to provide advice on the status of the stocks, focusing on the considerations of old and new data sources as well as old and new (or improved) assessment models and assumptions. The session was attended by a total of 47 experts, including experts from the region and experts on the species and/or on stock assessment models discussed, as well as an external reviewer (Dr Alexandra Silva).

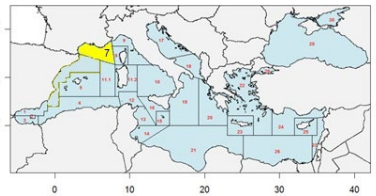
The session investigated all available input data and carried out an analysis of the performance of three different stock assessment methods: FLR assessment for all (a4a) models, surplus production in continuous time (SPiCT) models and two-stage biomass model. After detailed exploration of all available data on life history and fisheries, it was decided that the two GSAs should be treated separately as evidences on possible changes on growth parameters along time series for both species are highlighted. Finally, sardine (*Sardina pilchardus*) in GSA 6 and anchovy (*Engraulis encrasicolus*) in GSAs 6 and 7 were assessed using a4a. Additional assessments were performed on sardine in GSA 6 and anchovy in GSAs 6 and 7 using SPiCT. Sardine in GSA 7 was assessed using a two-stage biomass model. Sardine in GSAs 6 and 7 as well as anchovy in GSA 7 were benchmarked. Anchovy in GSA 6 was assessed providing qualitative advice. The group decided to keep the benchmark open and ongoing in order to assess improvements in data and finalize it within the following year in the presence of an external reviewer.

Sardine in GSAs 6 & 7 as well as anchovy in GSA 7 were benchmarked
Anchovy in GSA 6 was assessed providing qualitative advice

In 2019





	GSA06	GSA07
		
In 2019	In overexploitation	Ecologically unbalanced
	a4a, SpiCT	Two-stage biomass model, acoustic estimates
	In overexploitation	Low biomass
	a4a, SpiCT	Acoustic estimates

Important information gaps

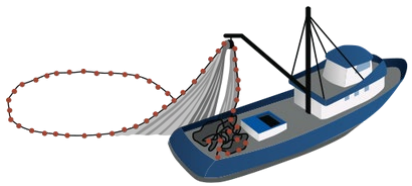
- Species differentiation - Genetics
- Species health - Biology
  - Body condition, reproduction, growth and mortality
  - Distribution and abundance
  - Environmental factors and preferences
- Species roles and drivers - Ecology
  - Trophic behaviour
  - Contaminants
  - Predators and competitors
  - Fisheries
- Species changes and their consequences – Socio-ecology
  - Changes in ecosystem components
  - Changes in fisheries
  - Projections (fisheries and CC) and management options

Engraulis encrasicolus – European anchovy

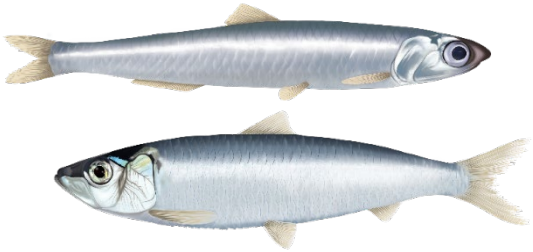
Sardina pilchardus – European sardine

Sardinella aurita – round sardinella

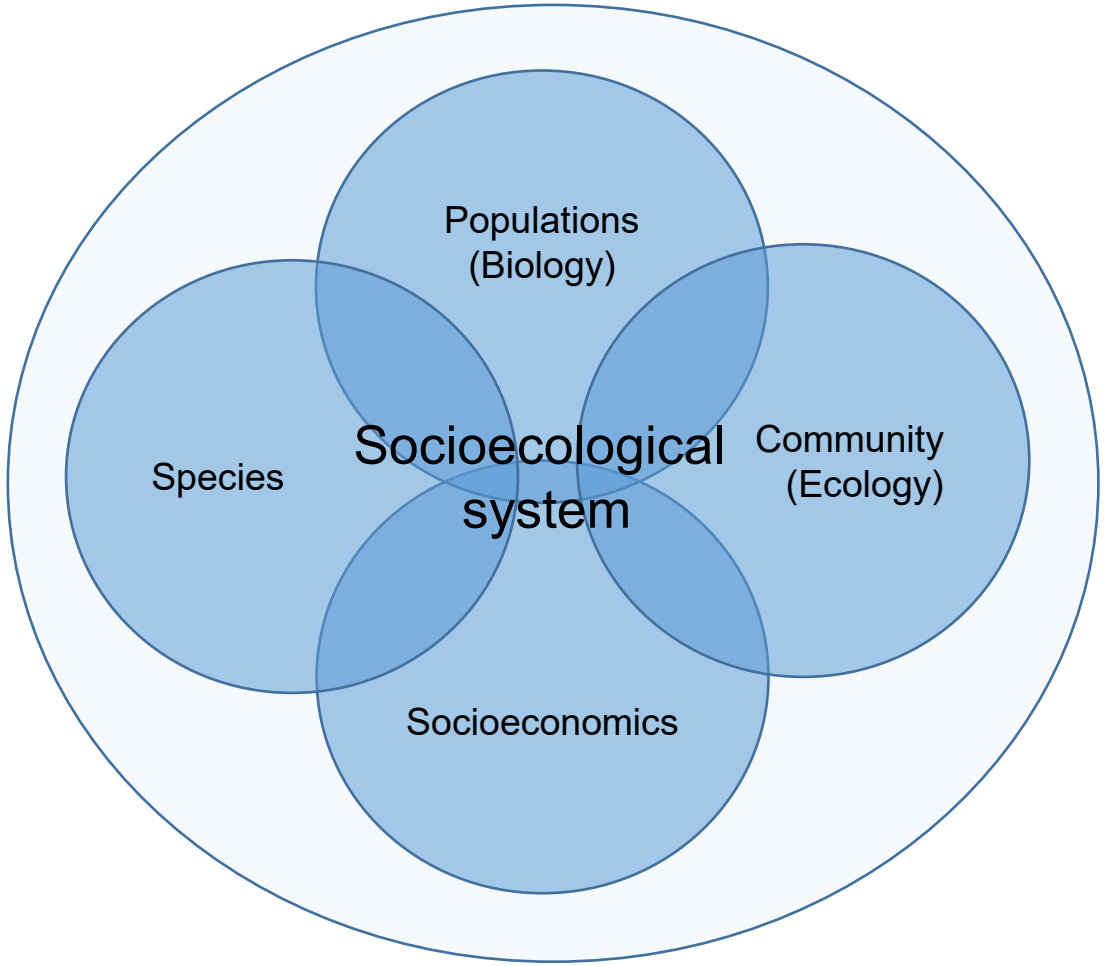
Euthynnus alletteratus - little tunny

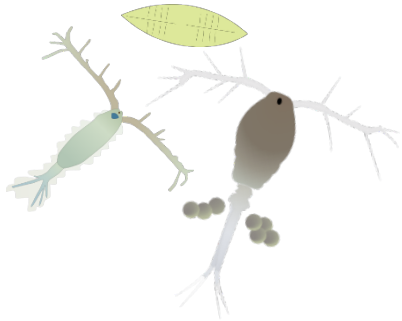


Body conditions, reproduction
Growth, mortality
Environmental factors, distribution & abundance

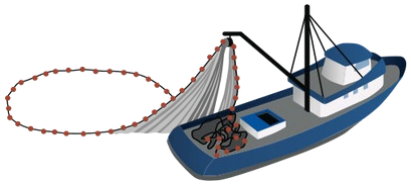


Population structure





Trophic ecology
Predators, competitors



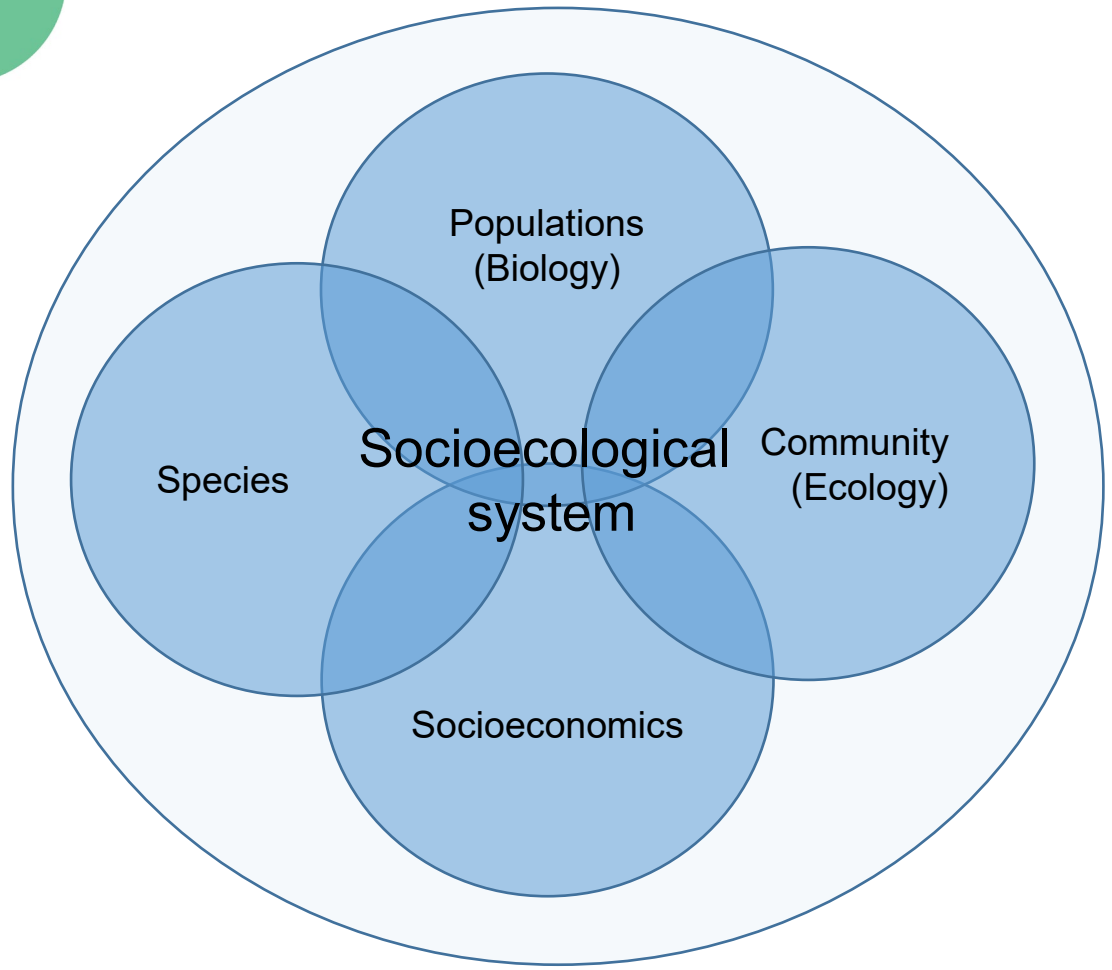
Fishing dynamics, trade-offs
Catch, effort

Literature review
Oceanographic campaigns
fishing-dependent data

Population structure

Integrated analyses

Body conditions, reproduction
Growth, mortality
Environmental factors, distribution & abundance



Fishing dynamics, trade-offs
Catch, effort

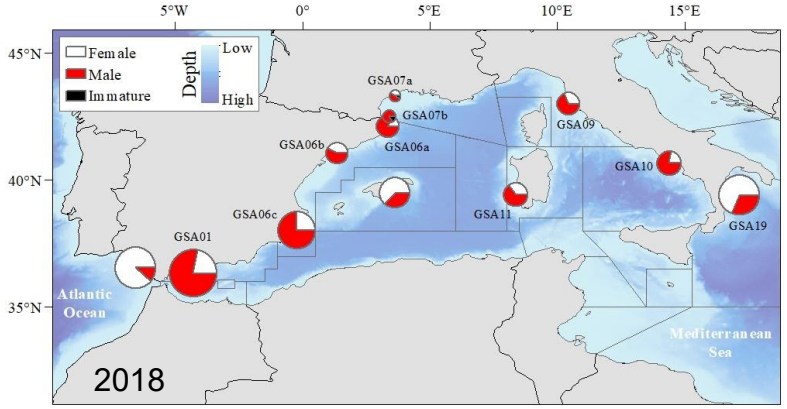
Dissections
Laboratory analyses, Calorimeter
SIA, SCA, Metabarcoding
Barcoding

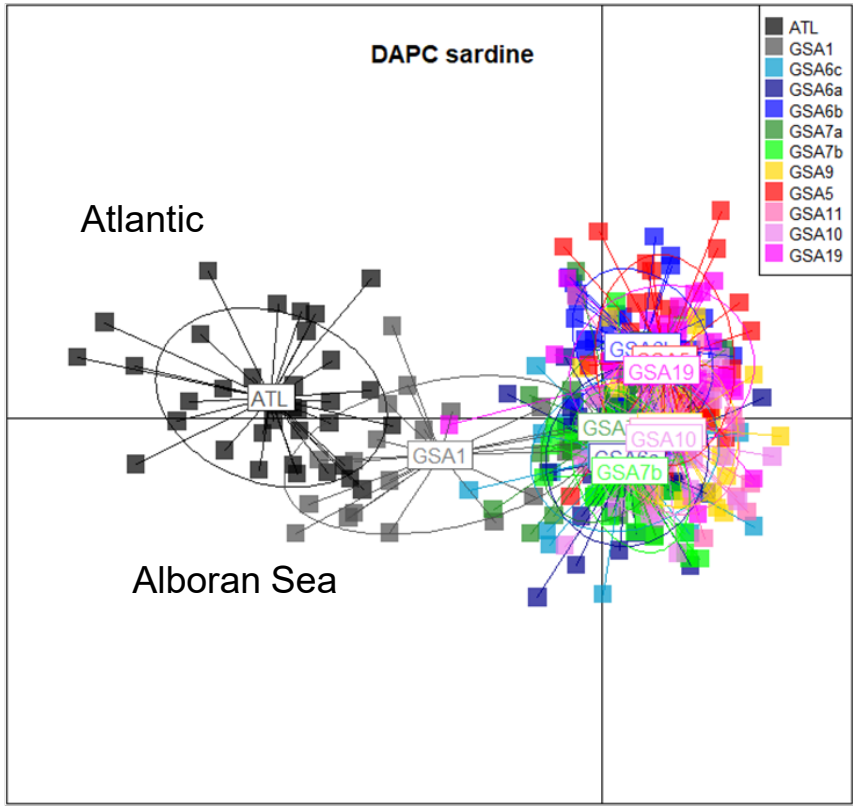
Trophic ecology
Predators, competitors

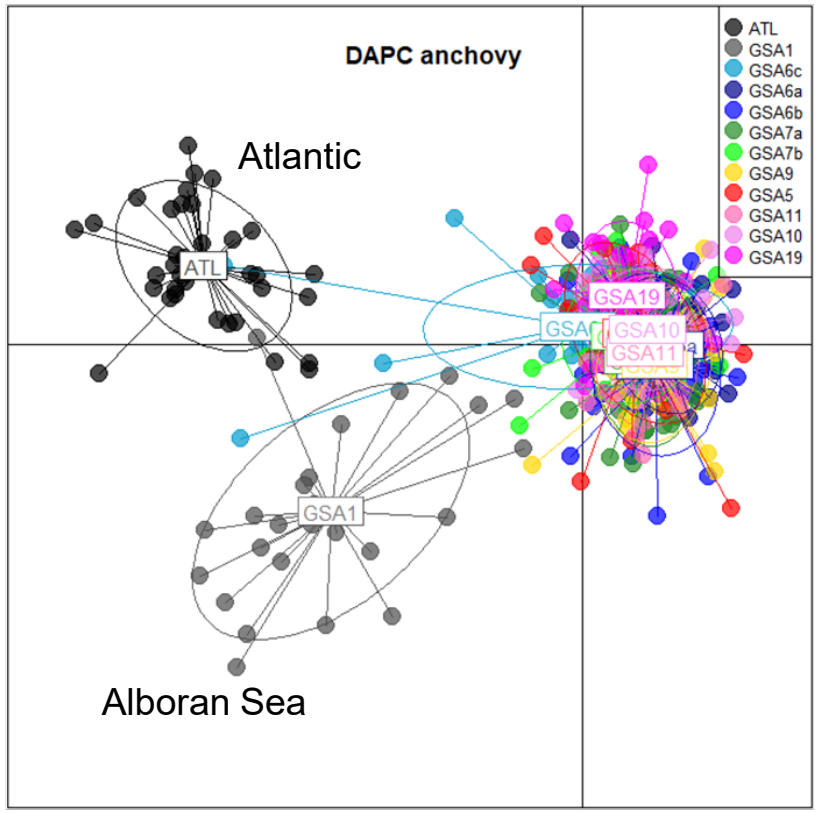
Statistical modelling
Mechanistic modelling

Species differentiation - Genetics

Low differentiation between populations in the Mediterranean Sea







Population structure:
Genotyping through high-throughput sequencing (ddRAD libraries, SNPs)

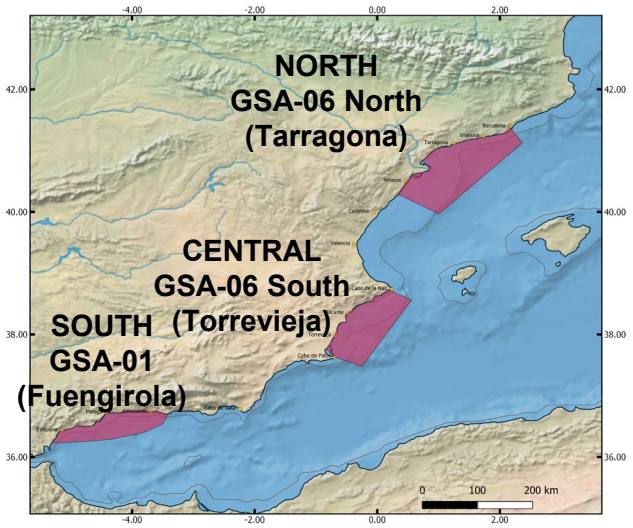
Seascape genomics:
Genome-environmental patterns associated with neutral and adaptive genetic variation

Coll and Bellido 2019; Antoniou et al. 2021.Submitted. ME.

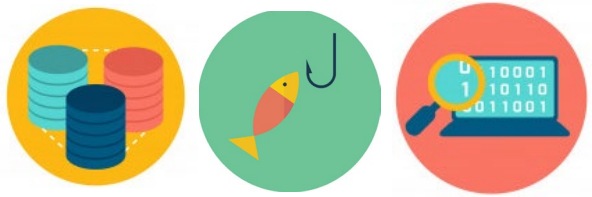
https://op.europa.eu/en/publication-detail/-/publication/f1bd2c63-084e-11eb-a511-01aa75ed71a1

Species health

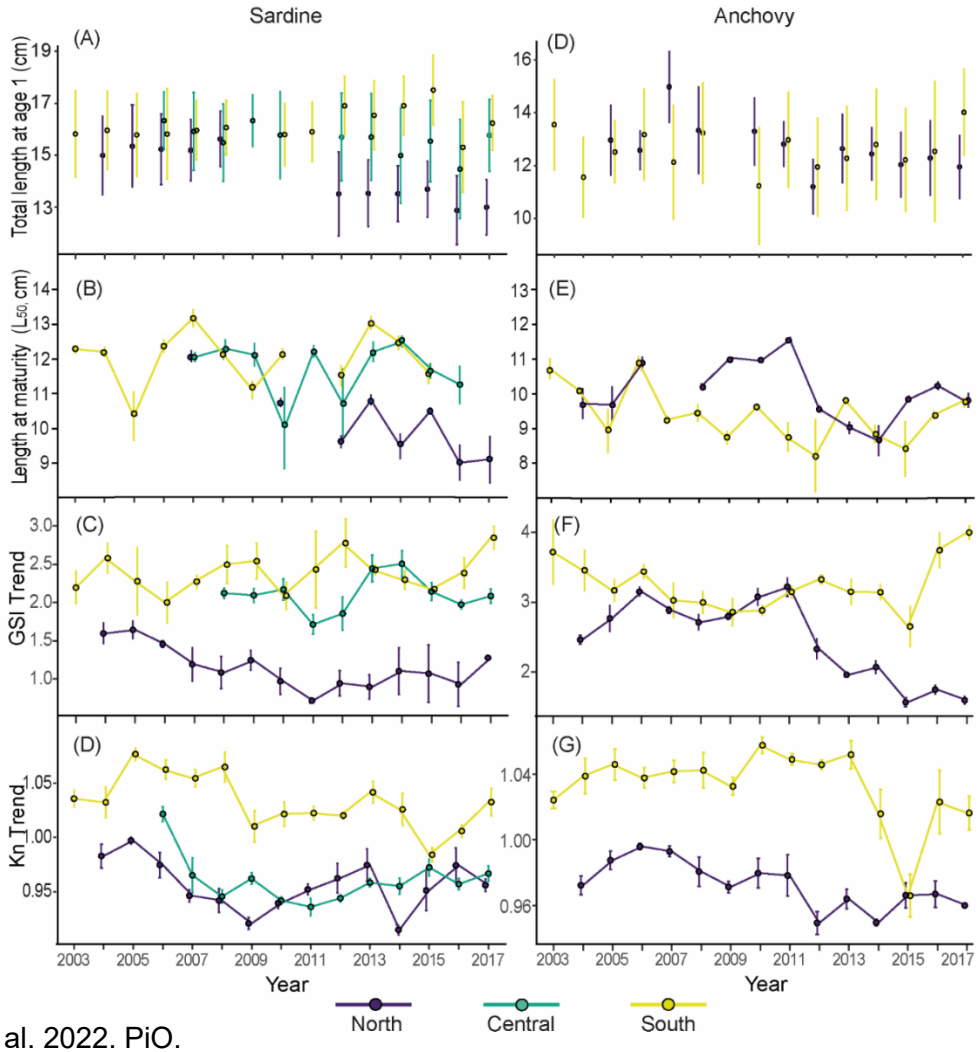
Changes in body condition, reproduction, growth and energy



Monthly time-series of biological parameters from 2003-2017



GAMs



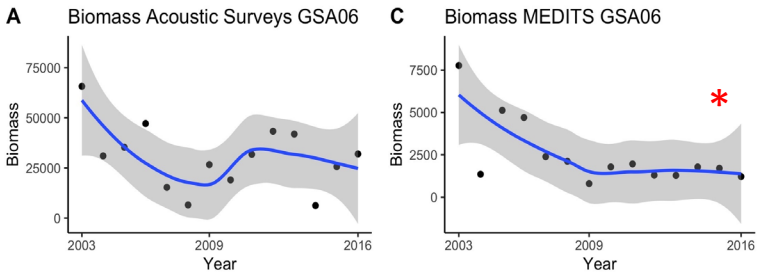
Evaluated the seasonal and inter-annual variability of key life-history traits along a latitudinal gradient and related changes to potential environmental variability and trophic conditions

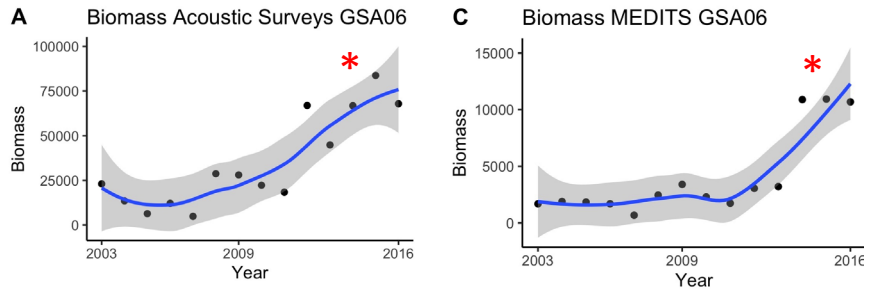
Fish price
Shorter crisis
Small size
No sardina
Area specific

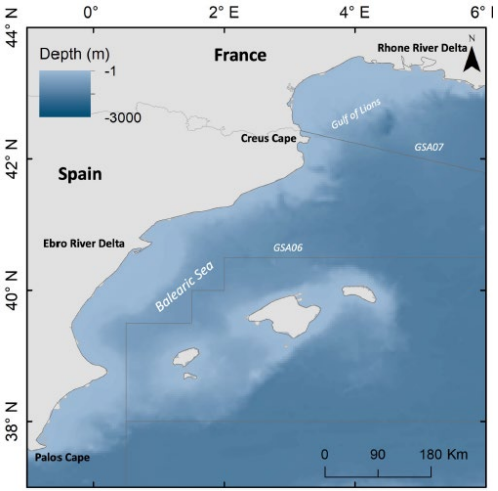
Albo et al. 2020. MERE; Albo et al. 2021. FMS; Lloret-Lloret et al. 2022. PiO.

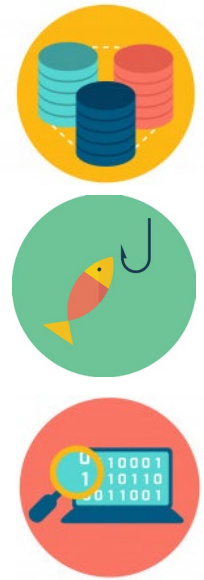
Species health

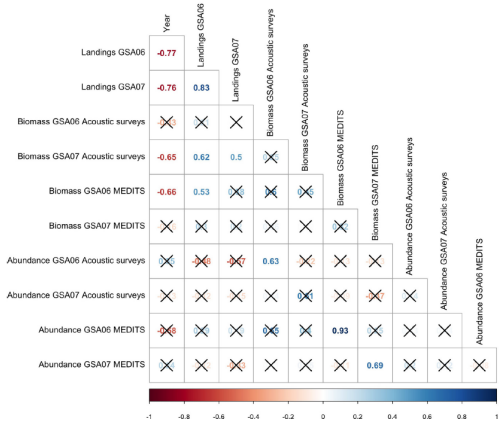
Changes in abundance, biomass

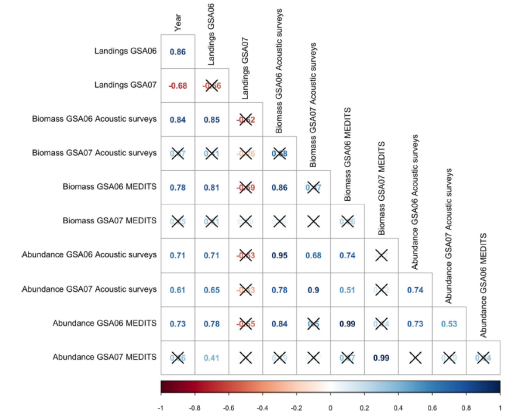










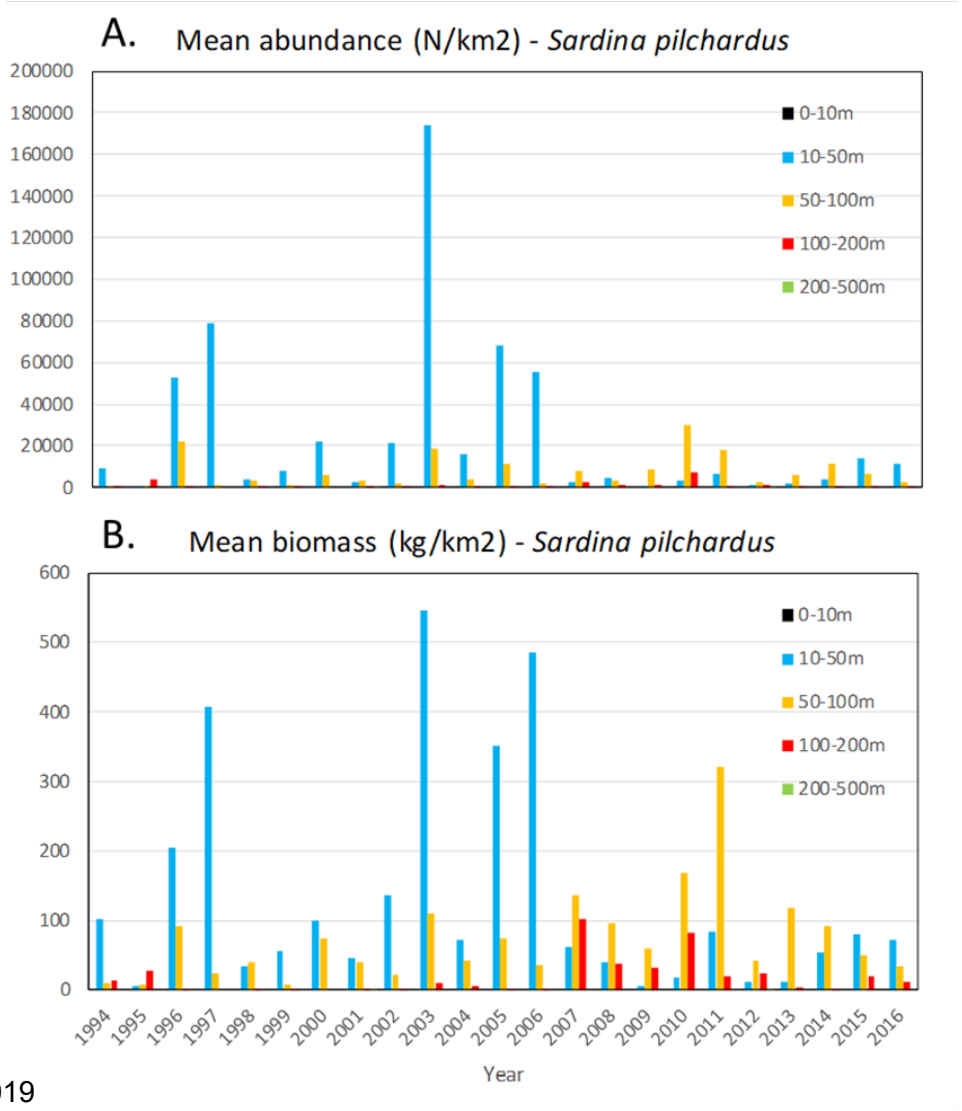


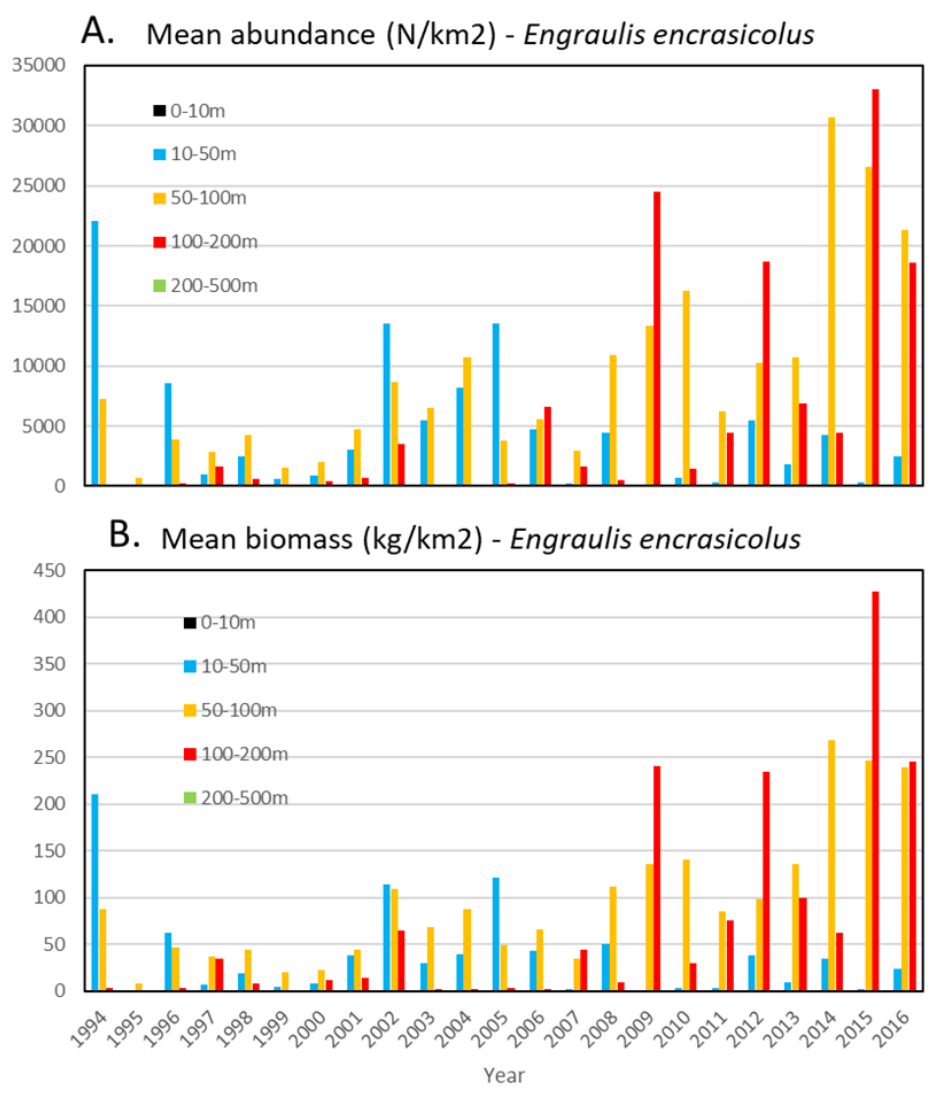
Spearman's correlation

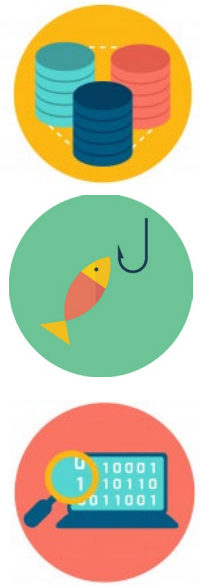
Pennino et al. 2020 FMS; Baez et al., 2022. RSMS

Species health

Changes in distributions



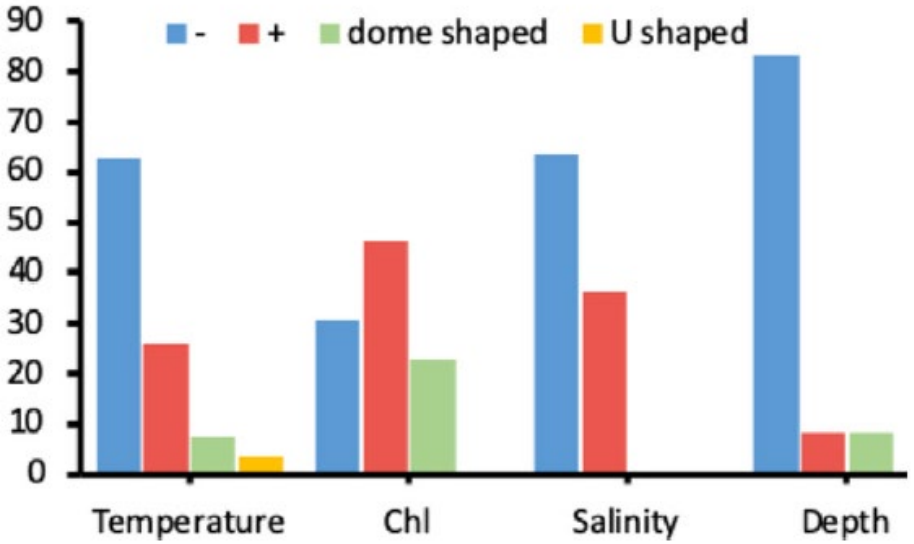




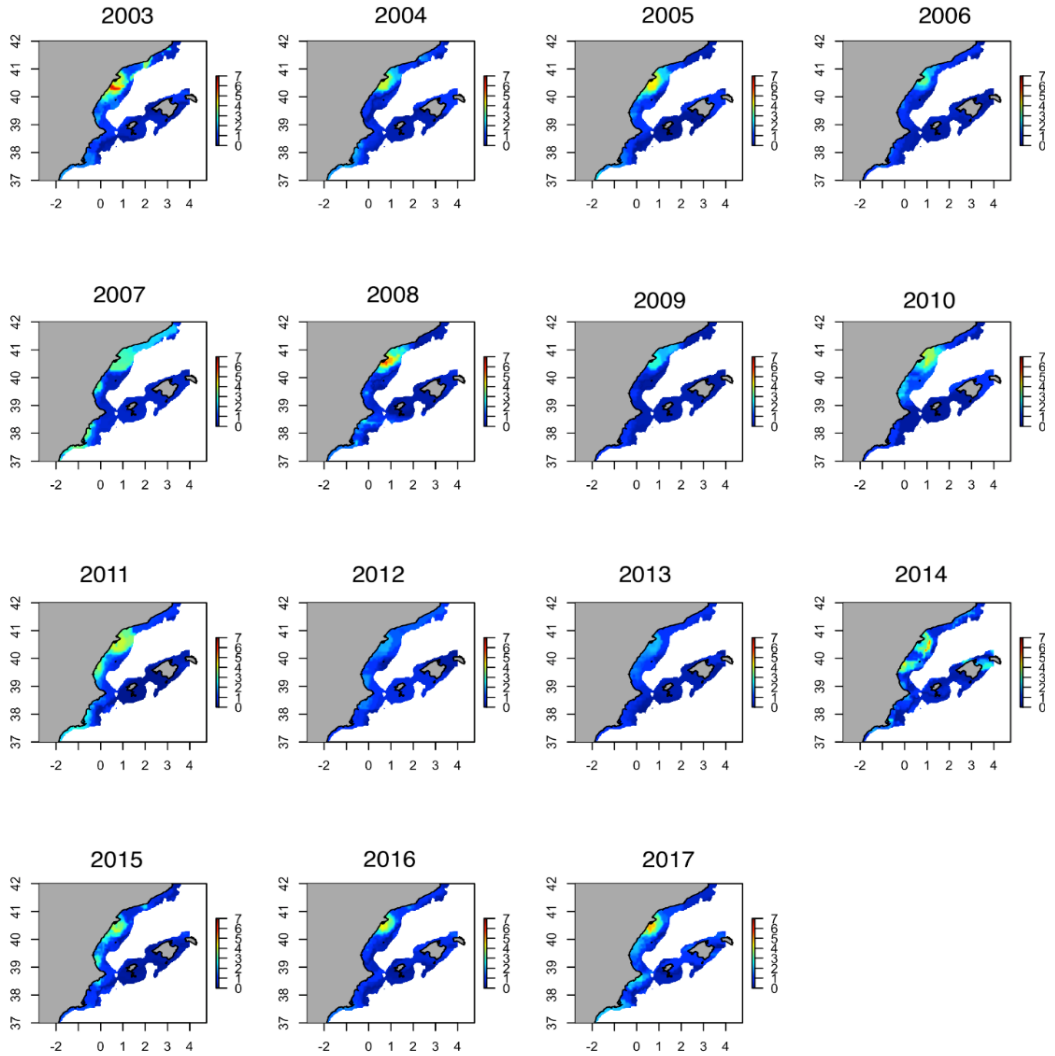
Coll and Bellido 2019

Species health

Changes in distributions & environmental factors and preferences



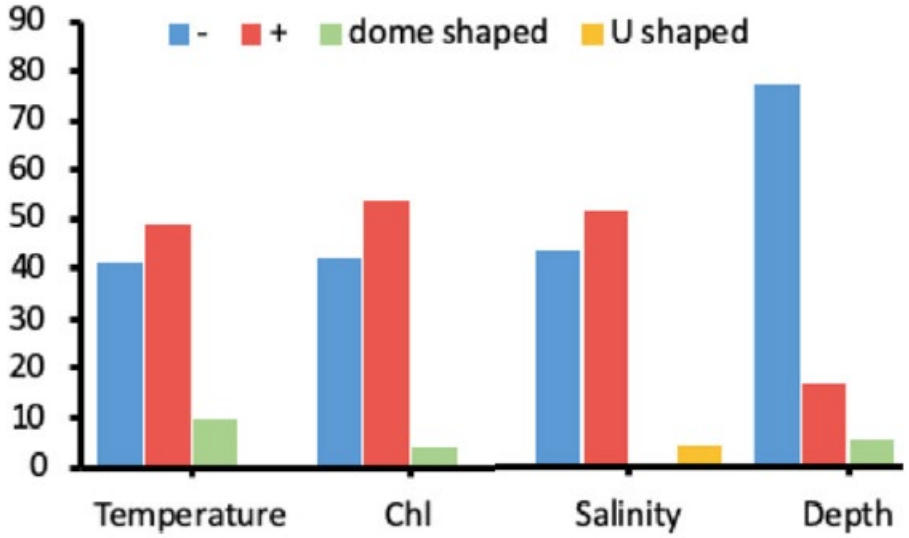
Boosted Regression Trees



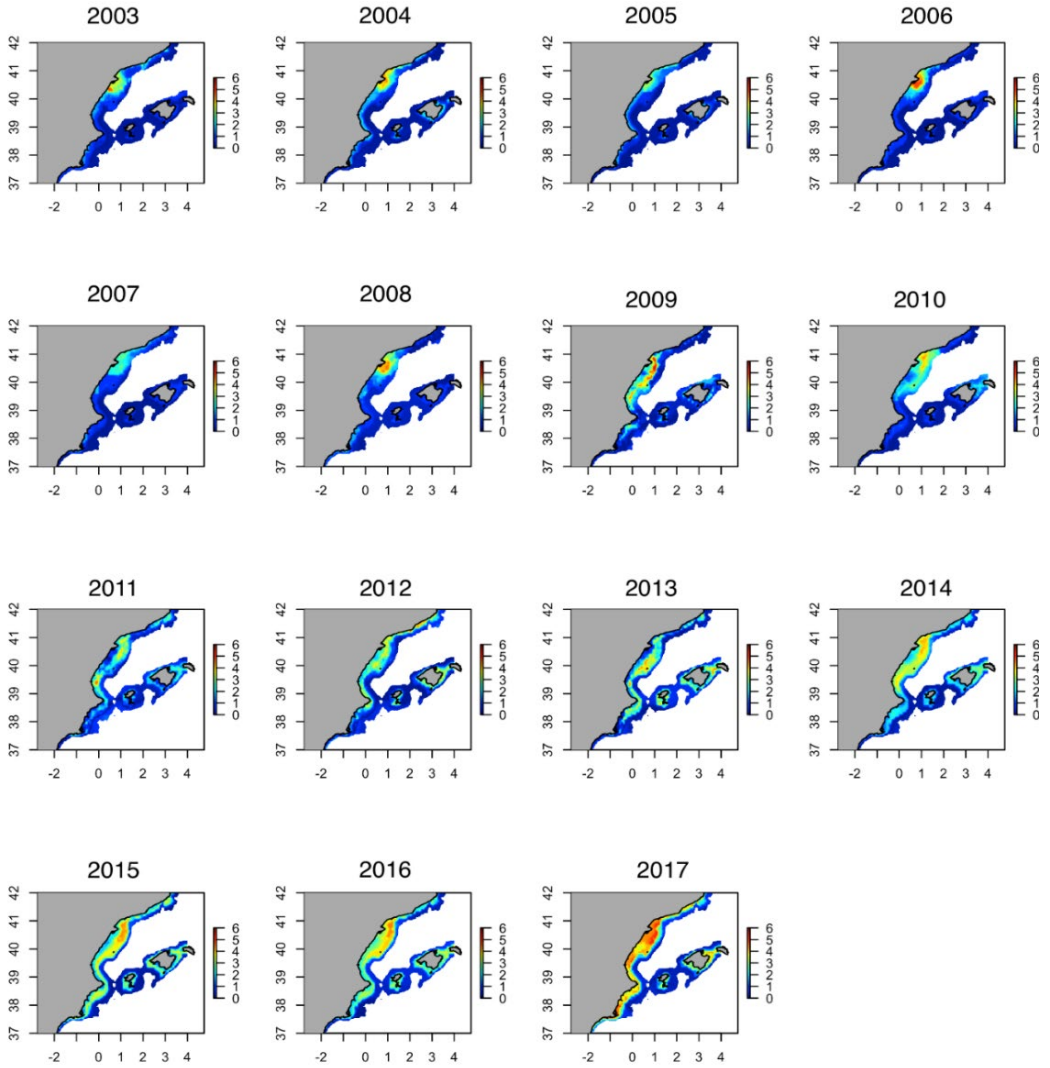
Pennino et al. 2020. FMS; Fernandez-Corredor et al. 2021. RSMS

Species health

Changes in distributions & environmental factors and preferences



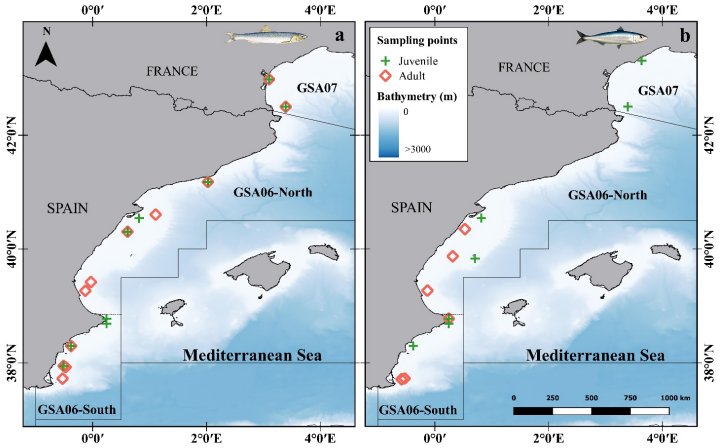
Boosted Regression Trees



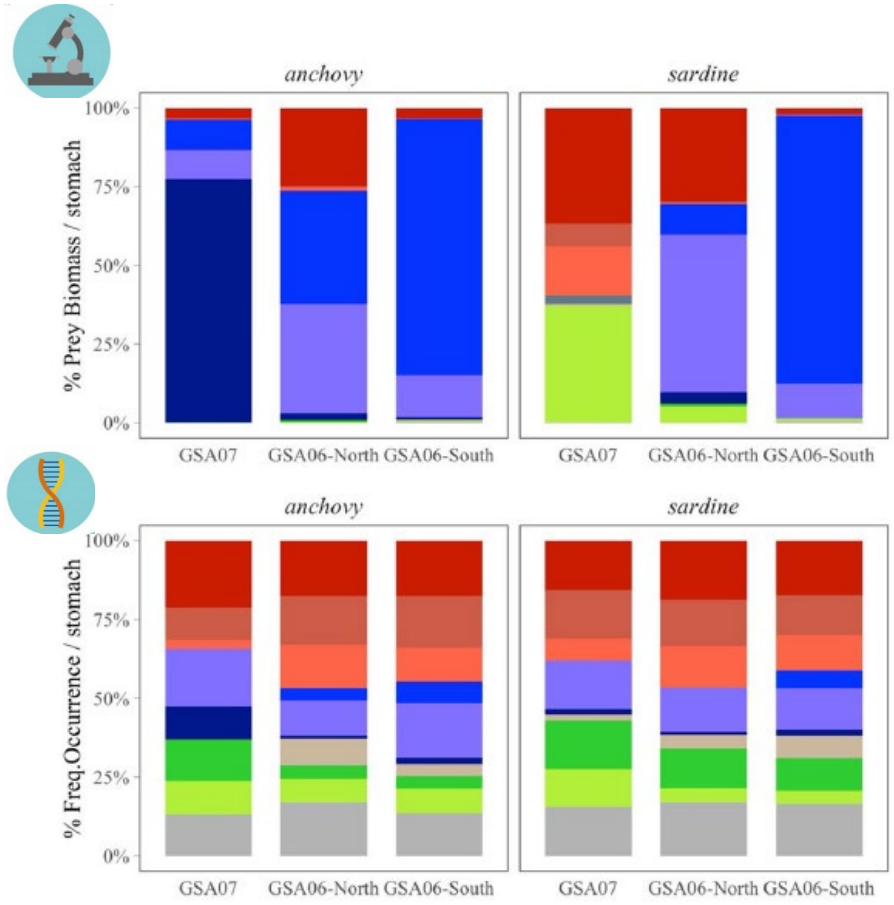
Pennino et al. 2020. FMS; Fernandez-Corredor et al. 2021. RSMS

Species roles and drivers

Trophic behaviour along a latitudinal gradient



Stomach contents | DNA-metabarcoding | Stable isotopes



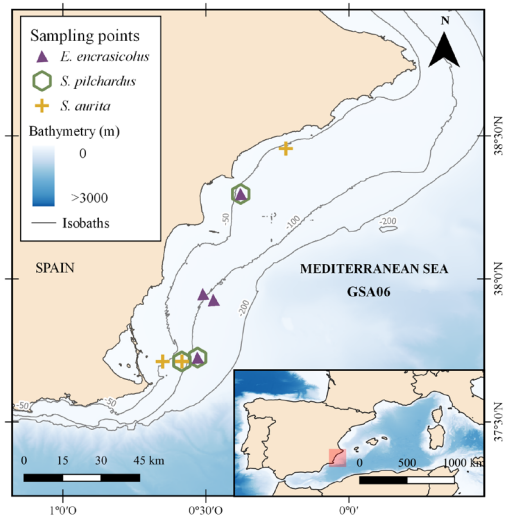
SCA: opportunistic ingestion of available prey in a certain area and/or time.
DNA-M: Ingested prey reflect a latitudinal signal that may indicate a higher large prey ingestion by both species southwards, and more effective predation on large prey like krill by anchovy
SIA: lower $\delta^{15}N$ in the northernmost area.

A latitudinal gradient indicating changes in the trophic ecology of anchovy and sardine coinciding with described better biological conditions for fish in the south

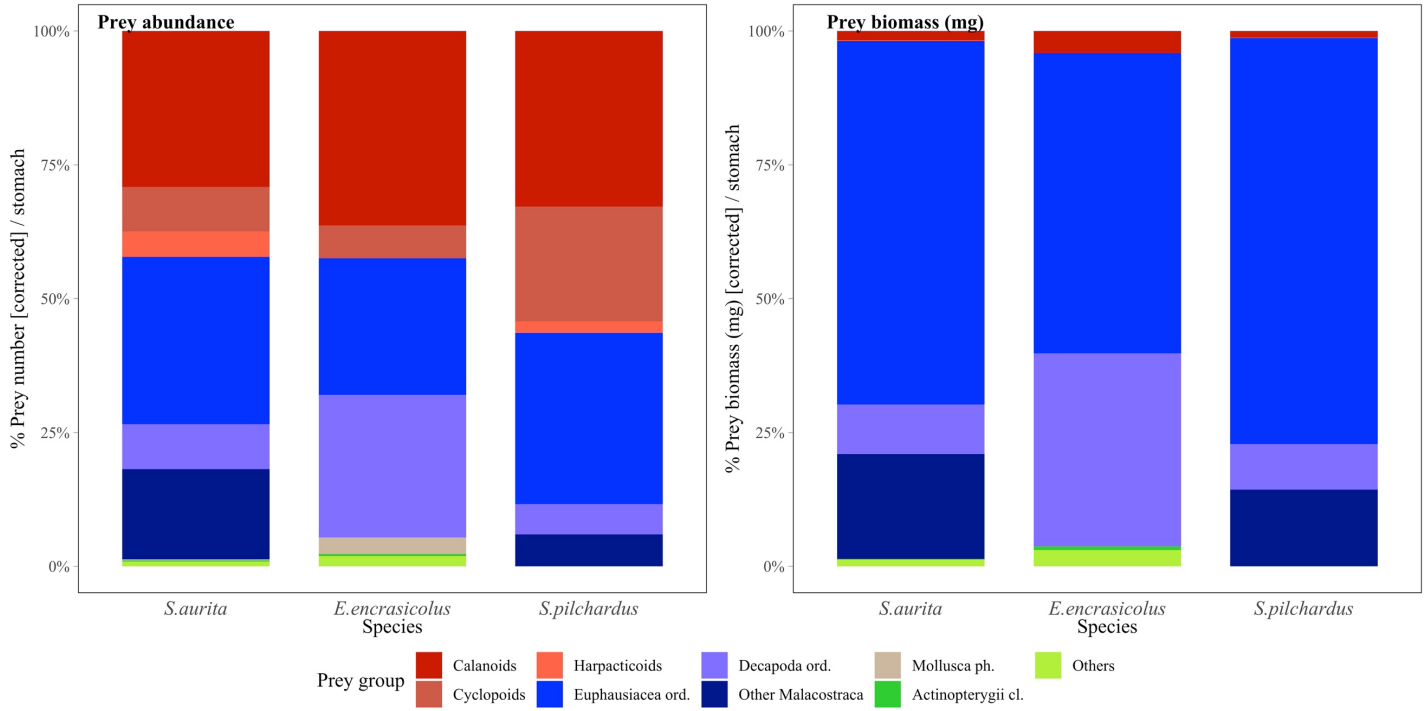
Bachiller et al. 2020. SR; ; Gimenez et al., in press. CJFAS

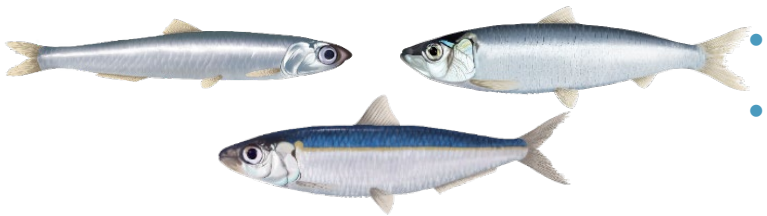
Species roles and drivers

Trophic behaviour along a latitudinal gradient (competitors)



Stomach contents | DNA-metabarcoding | Stable isotopes



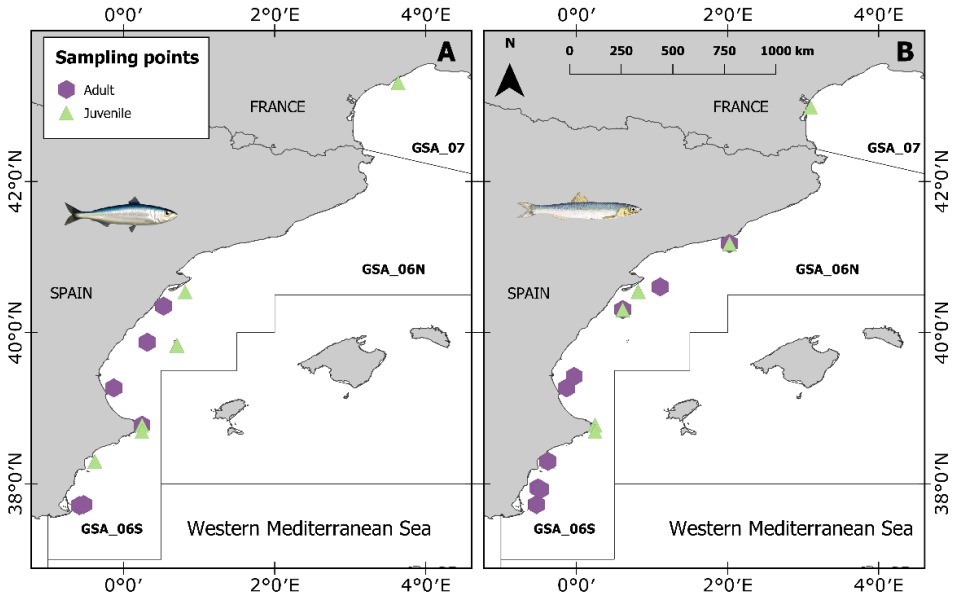


- Predation on relatively large krill is equally important for sardinella, anchovy & sardine;
- Effective use of food resources by sardinella, being able to predate in gelatinous org.;
- An important overlap is found in their isotopic niche, especially with anchovy, using nitrogen (δ15N) and carbon (δ13C) stable isotopes in muscle tissue.

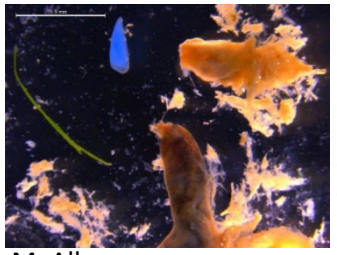
Albo-Puigserver et al. 2019. MEPS; Bachiller et al. 2021. EE

Species roles and drivers

Contaminants (microplastics, plasticizers) and parasites



Pennino et al. 2020. MPB; Bachiller et al. 2021. EE; Sala et al. 2022. EP



M. Albo

Ingestion of microplastic in the European sardine and anchovy in the northwestern Mediterranean sea

- The microplastics incidence in the gastrointestinal tracts for sardine was 58% and 60% for anchovy
- Among several physiological, environmental and spatial variables the abundance of microplastics ingested was more influenced by latitude (+) and relative body condition (-) for sardine, and GSI index (+) total fish length (-) for anchovy
- Parasite prevalence (trematode larvae and nematodes) was positive related with the abundance of microplastic in both species
- Areas with the highest probabilities of microplastics ingestion were the Gulf of Alicante (Spain) for sardine and Gulf of Lions (France) for anchovy

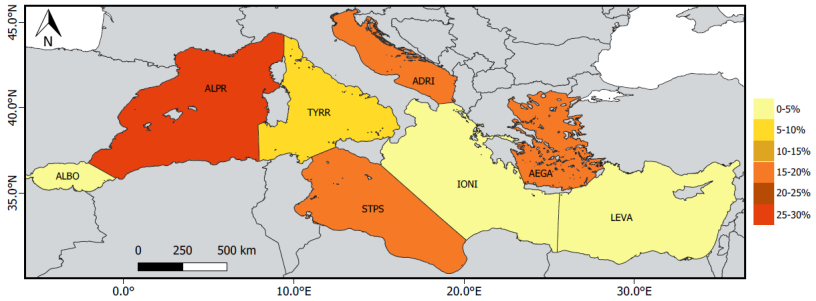
Sardinella showed larger concentrations of parasites and plastics

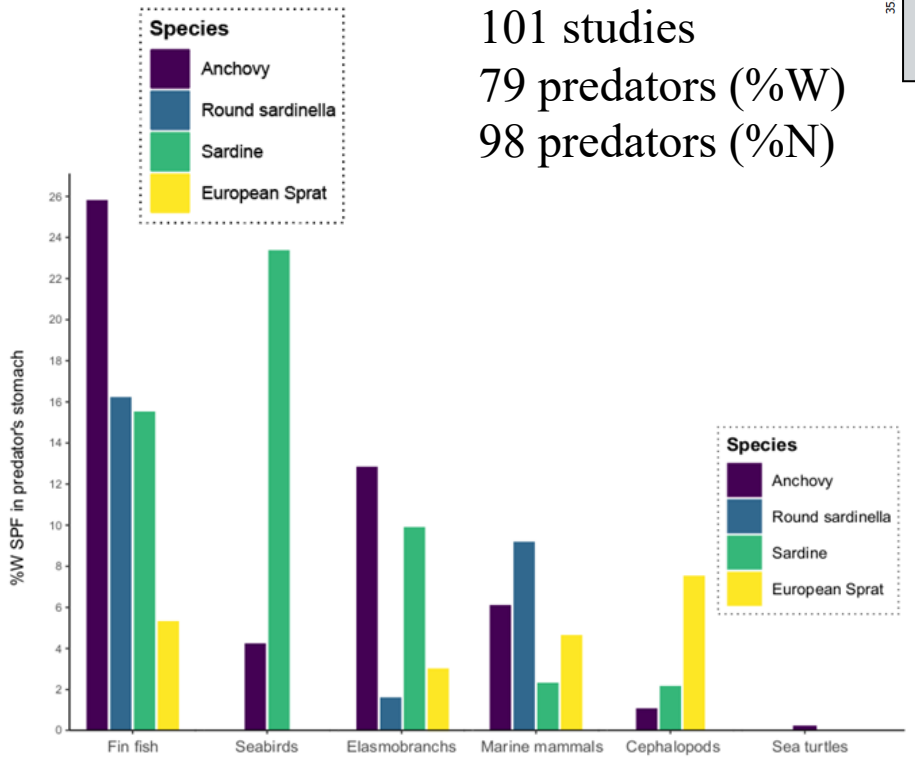
Species roles and drivers

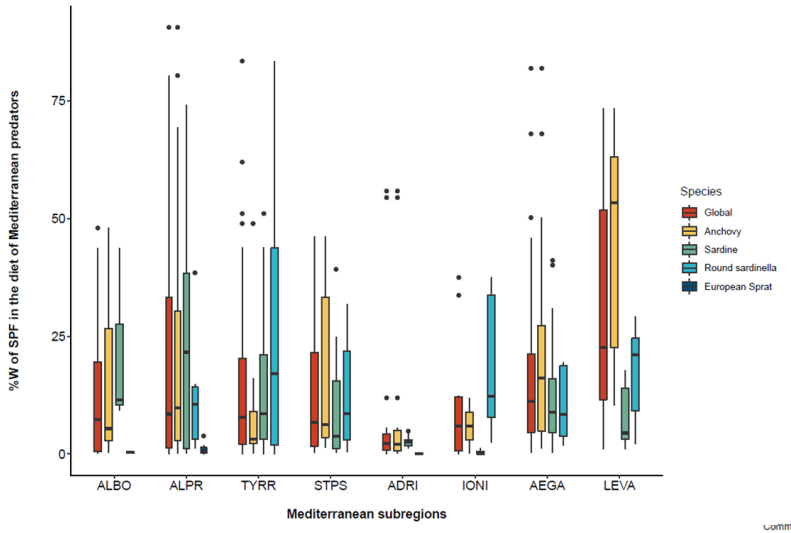
Trophic ecology of predators

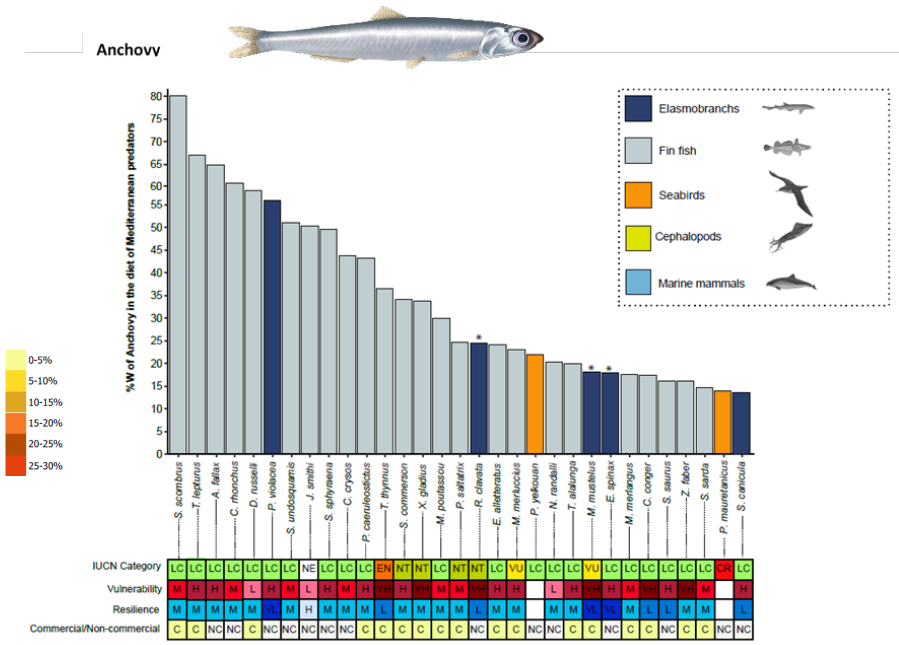
1961-2019

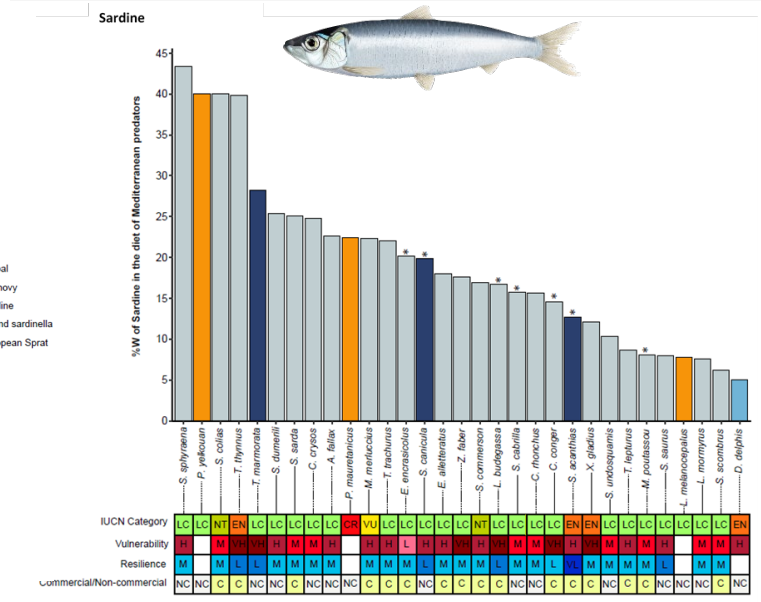
101 studies
79 predators (%W)
98 predators (%N)









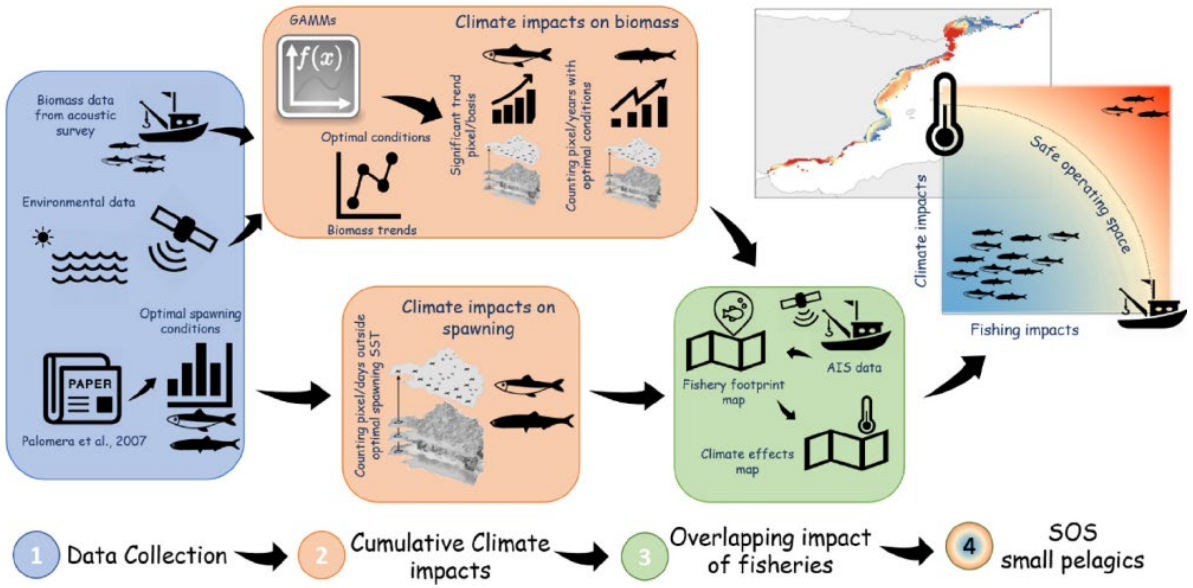


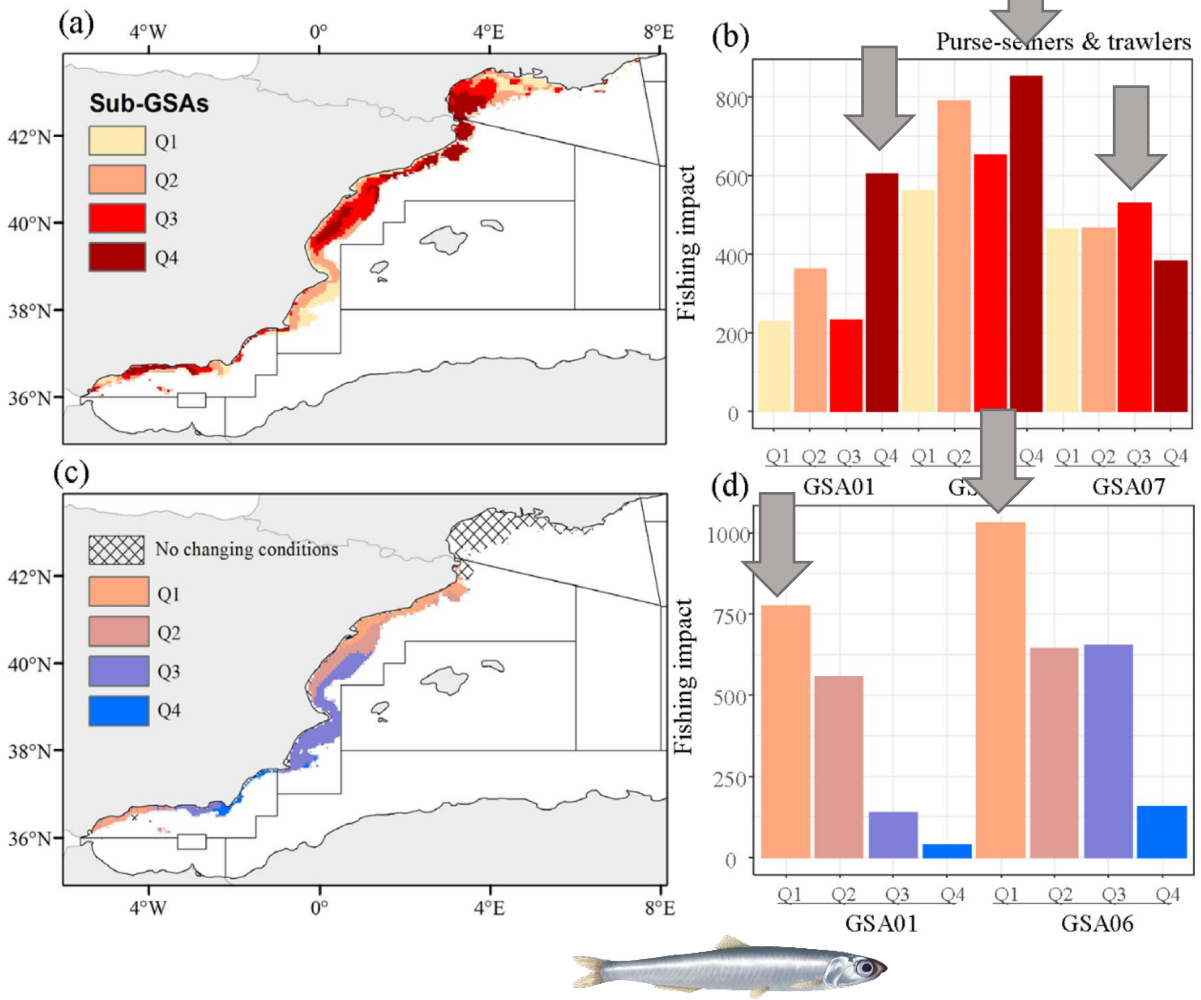
Ouled-Cheikh et al. 2022. MEPS

Species roles and drivers

Fisheries and environmental factors and preferences

"Safe Operating Space" (SOS)
by Rockström et al. (2009)



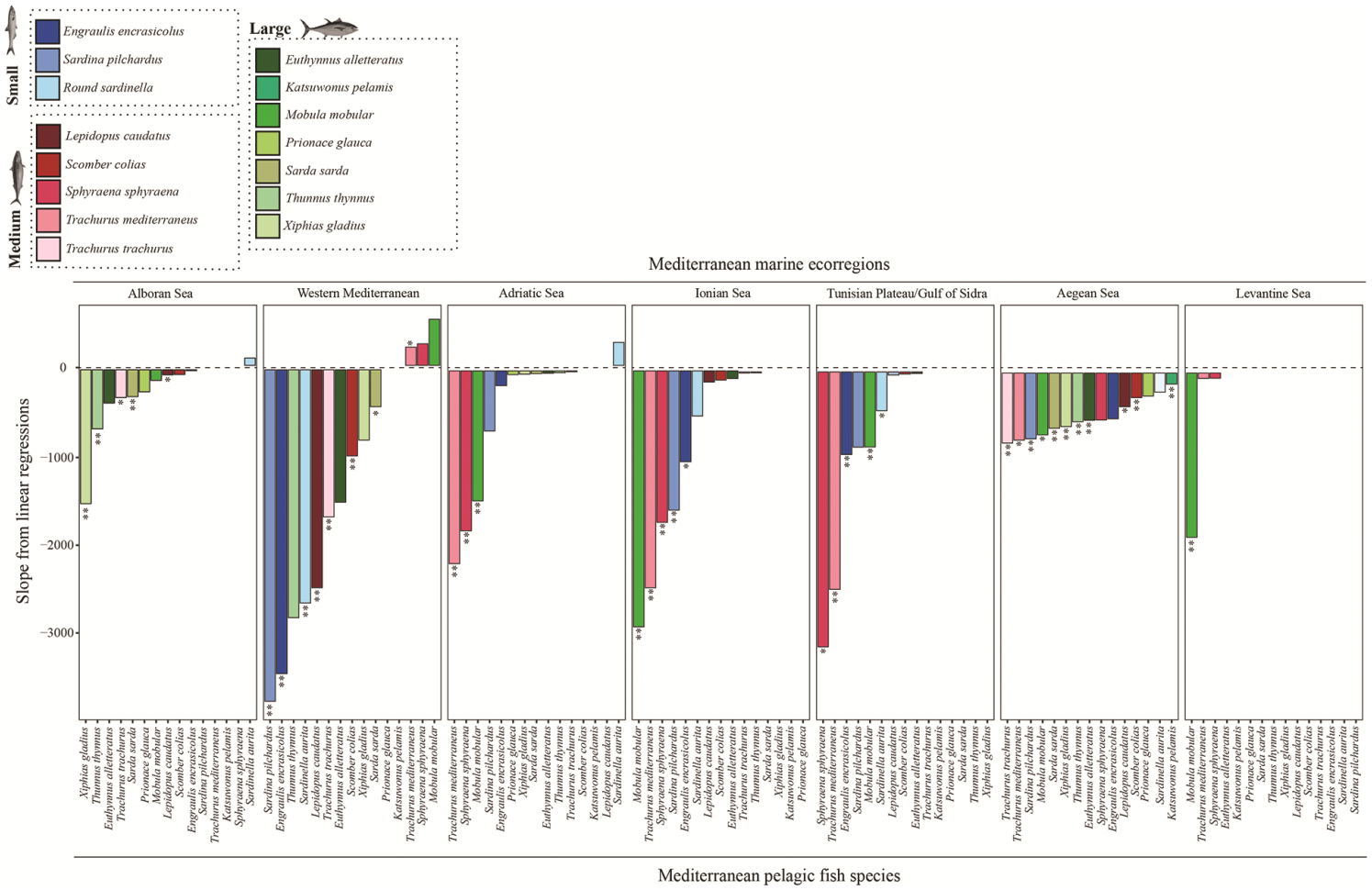


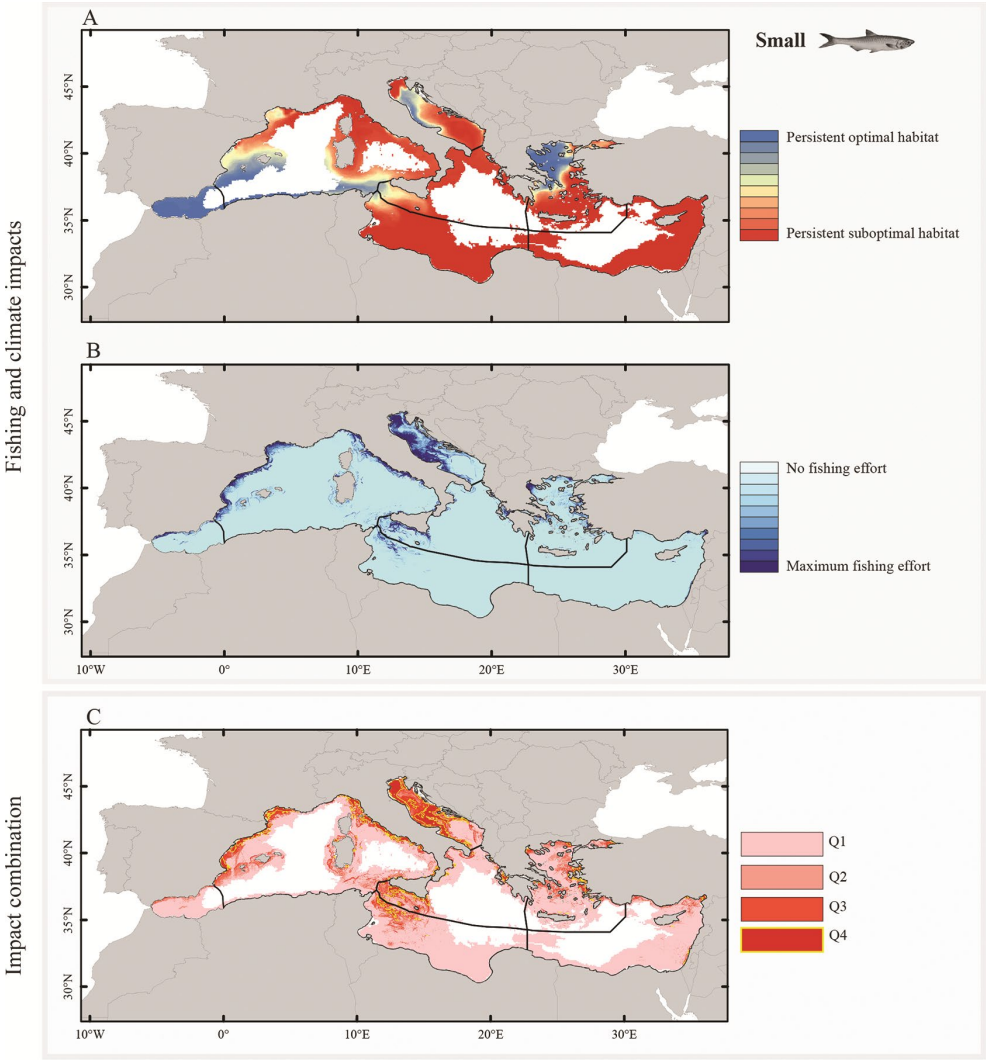
Identification of areas with larger cumulative impacts show as well a latitudinal gradient

Ramirez et al. 2018. SR, Ramirez et al. 2021. STOTEN

Species roles and drivers

Fisheries and environmental factors and preferences





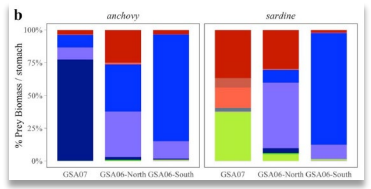
Ouled-Cheikh et al. 2022. Elementa: Science of the Anthropocene

Species changes and their consequences

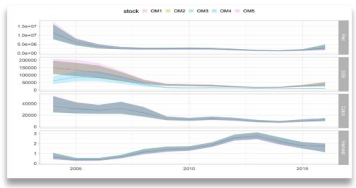
Changes in ecosystem components (target species, predators) & fisheries
Projections (fisheries and CC) and management options

Sectorial studies

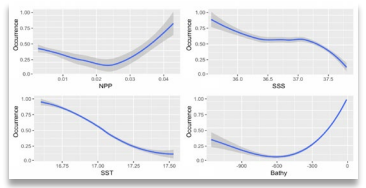
Re-parameterized with input variables



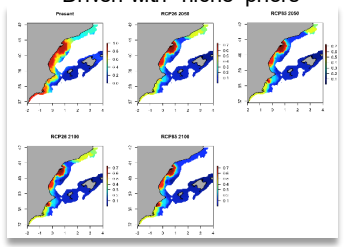
Fitted and driven with historical fisheries data



Driven with environmental data

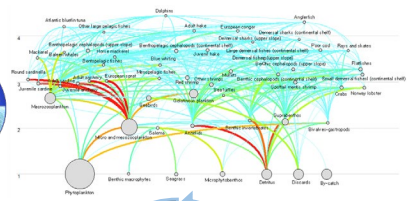


Driven with "niche" priors

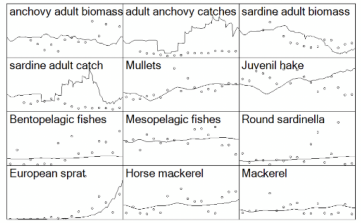


Spatial-temporal MEM

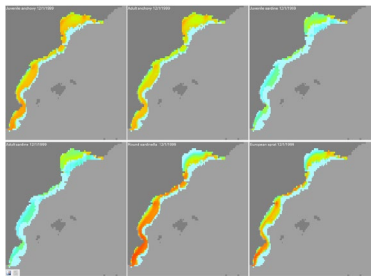
Ecospace-HFCM



* 59 fg



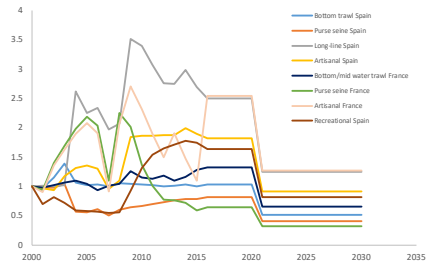
2000-2020



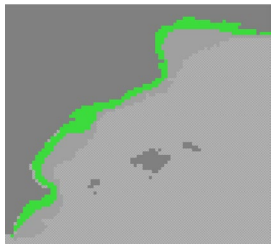
45547 km2, 0.0833 dd

Spatial-temporal management scenarios

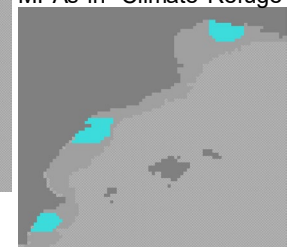
Fishing effort change for juveniles & adults

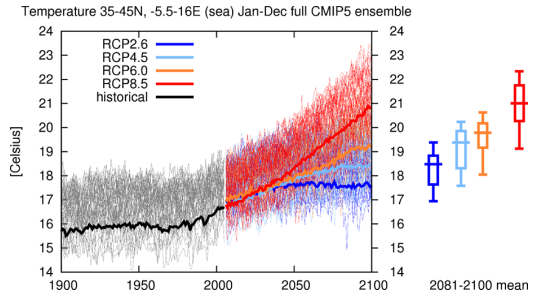


MPAs in coastal areas



MPAs in "Climate Refuge"



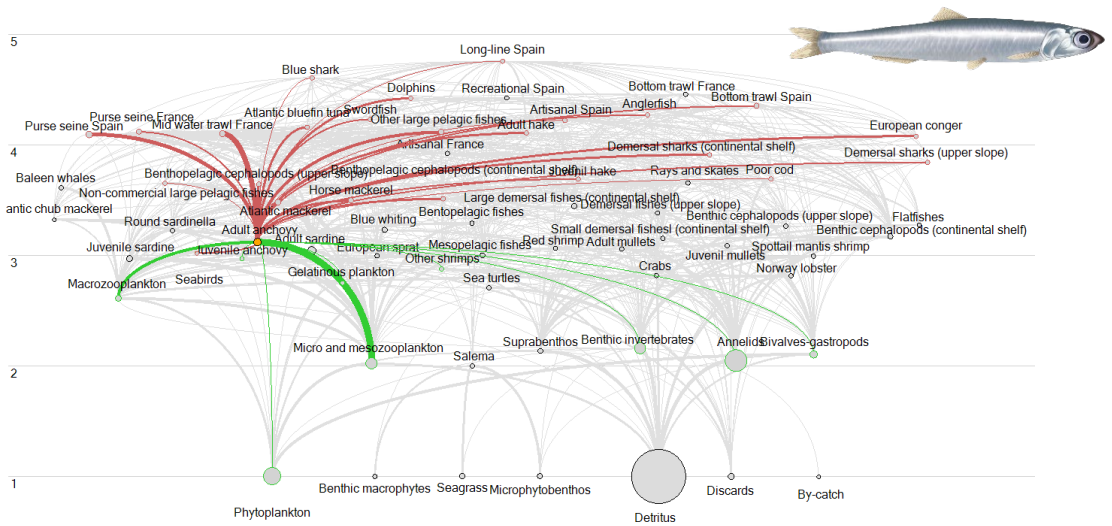


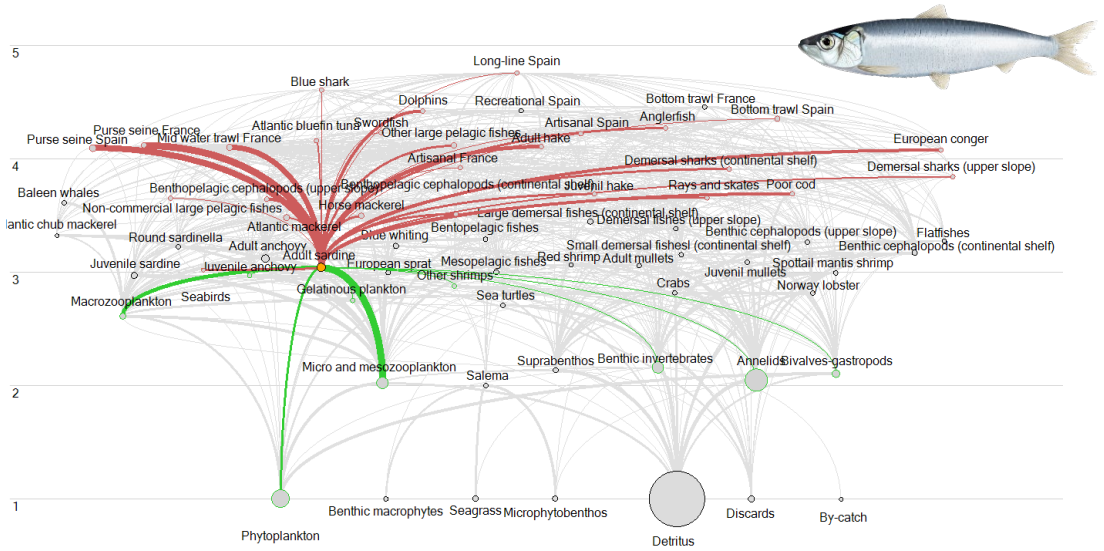
Under climate change projections

* Modified from Corrales et al. 2015. JMS; Biogeochemical GETM-MedERGOM model (JRC, D. Macias)

Species changes and their consequences

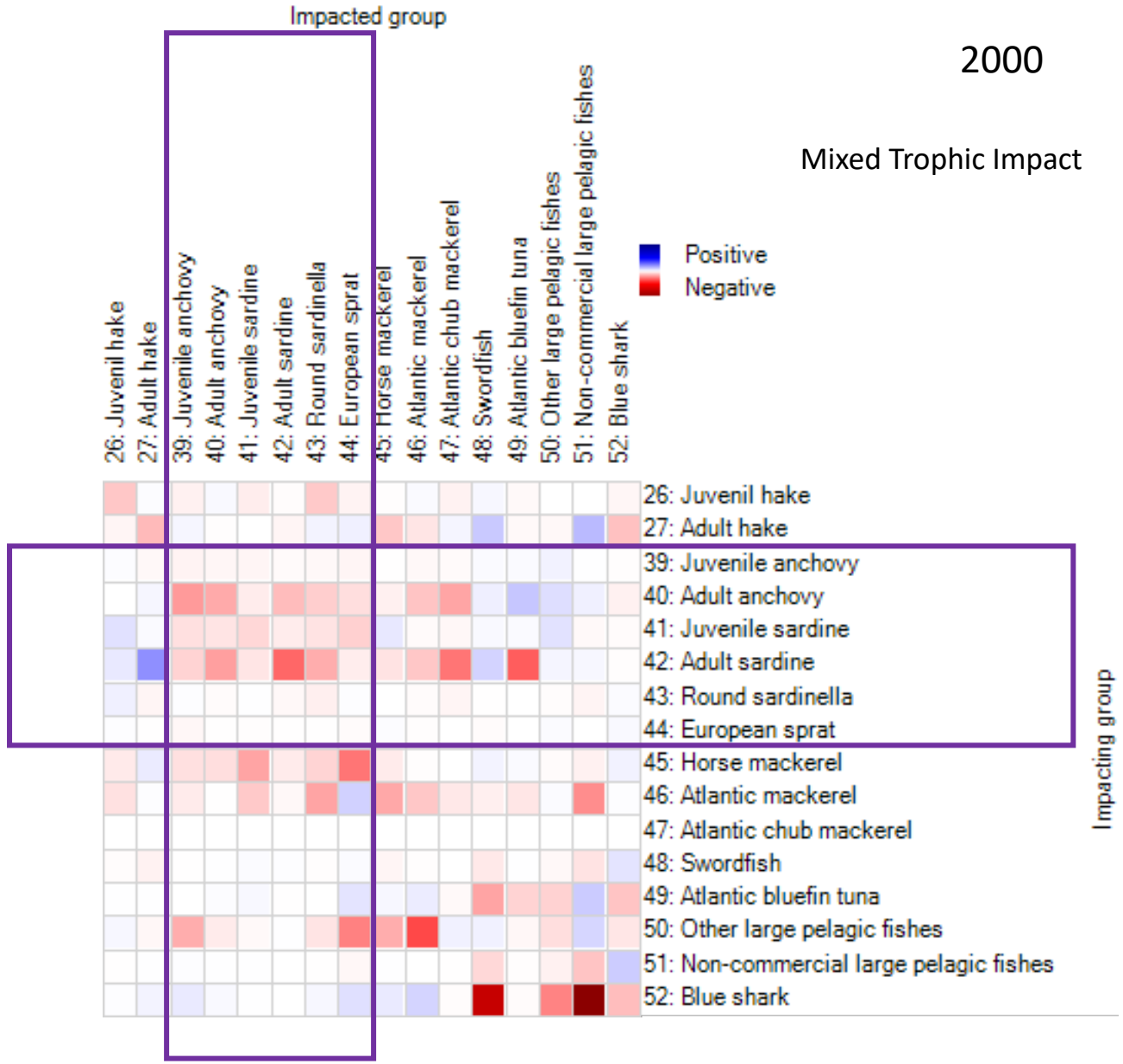
Changes in ecosystem components





2000

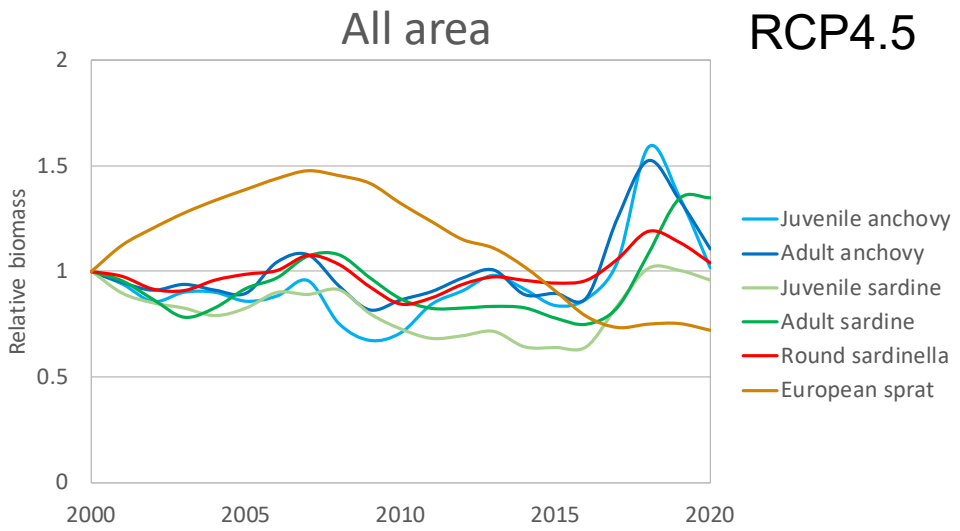
Mixed Trophic Impact

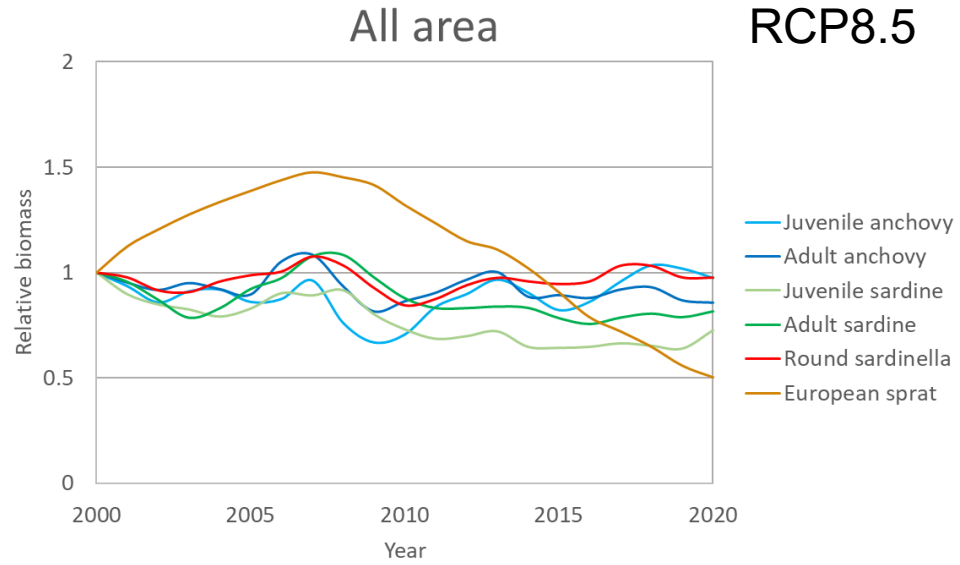


Coll et al., in prep.

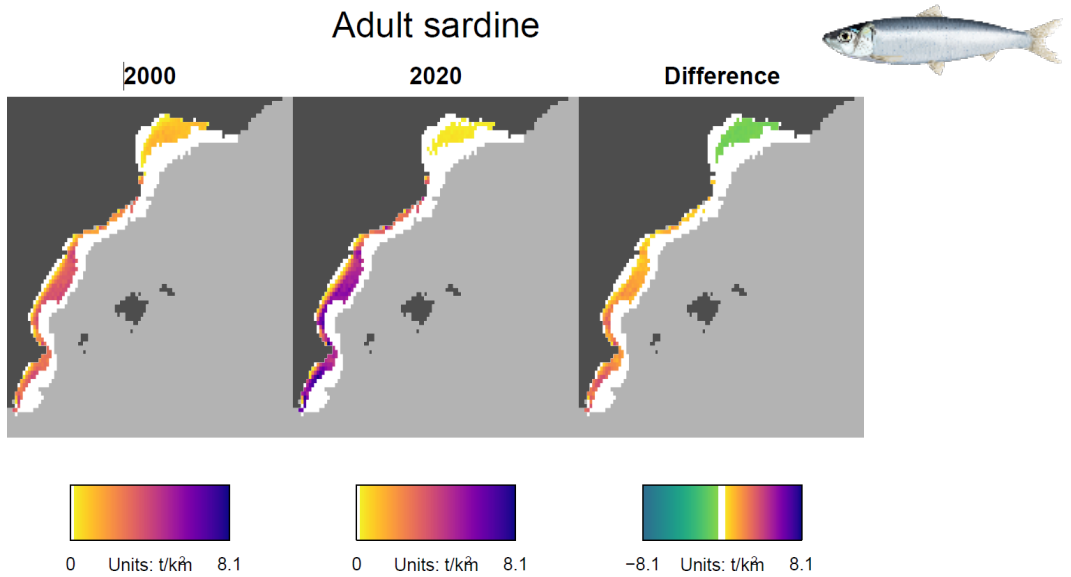
Species changes and their consequences

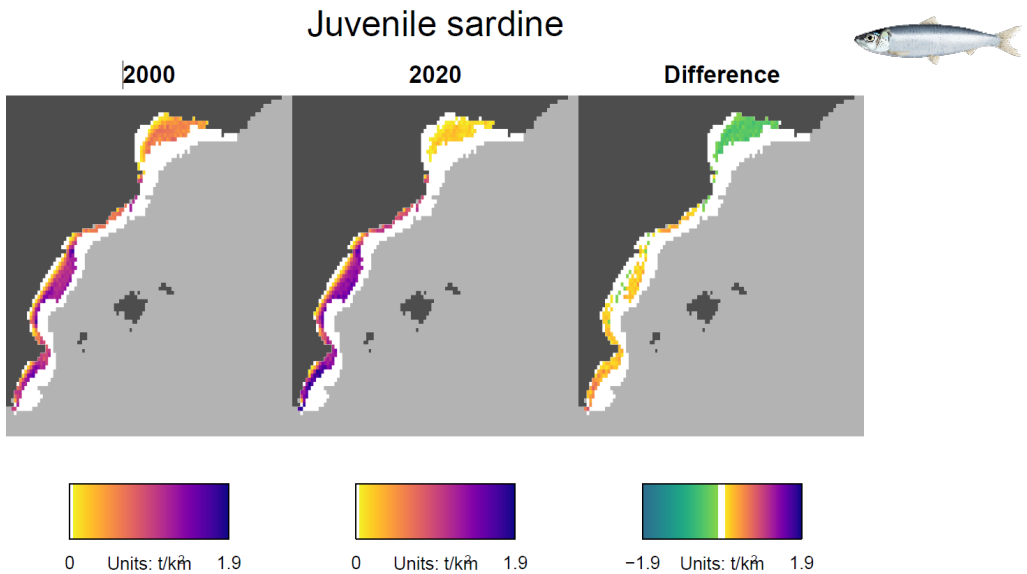
Changes in ecosystem components





Relative biomass (2020/2000) under RCP4.5

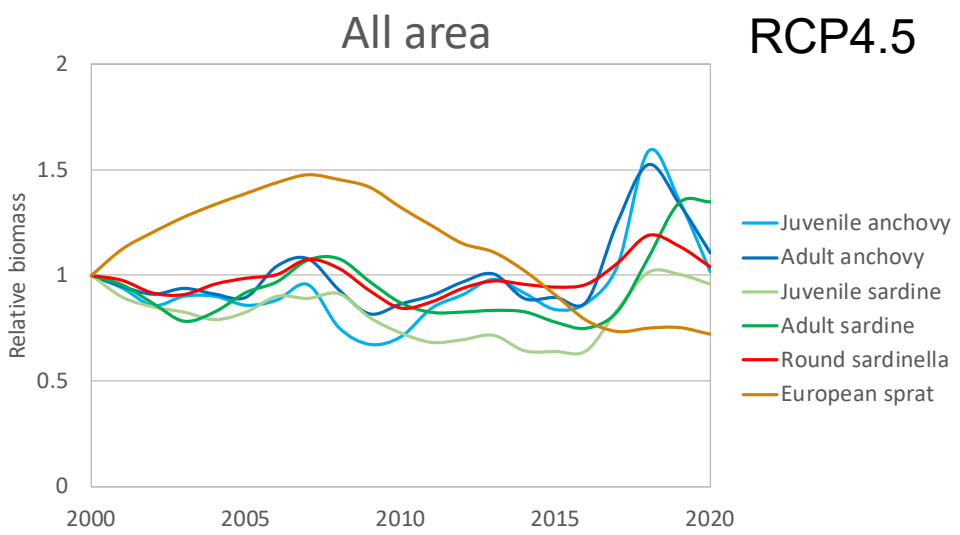


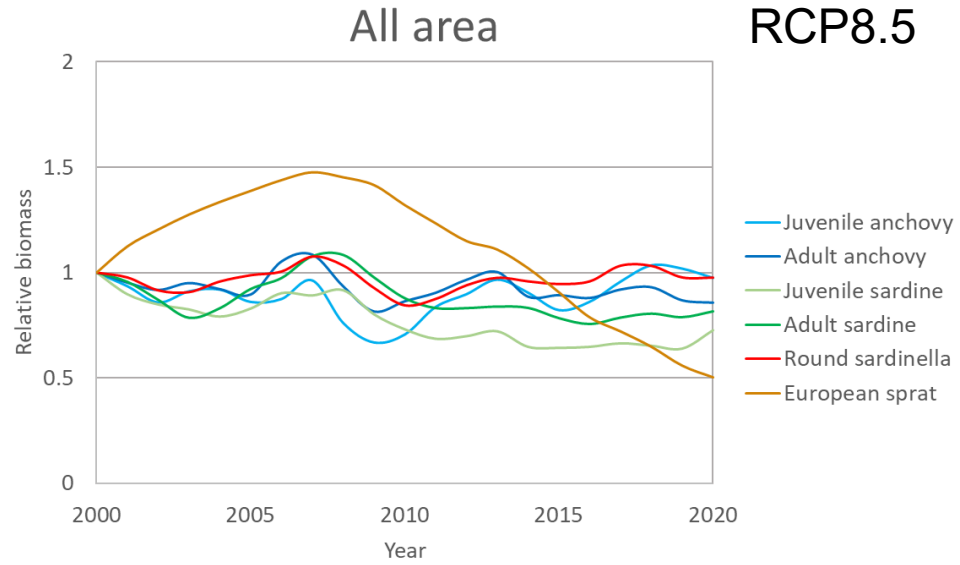


Coll et al., in prep.

Species changes and their consequences

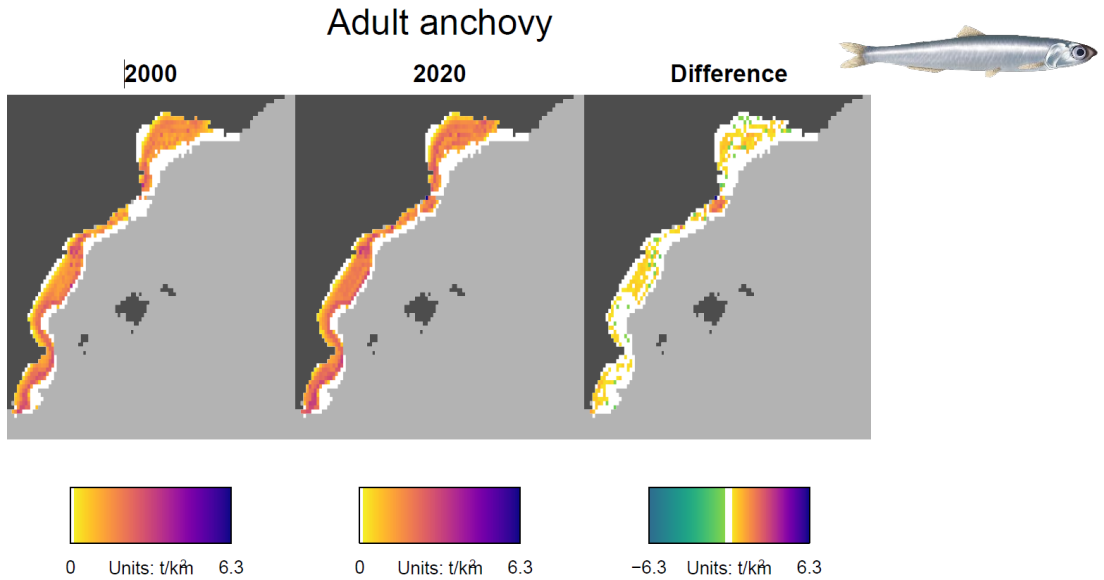
Changes in ecosystem components

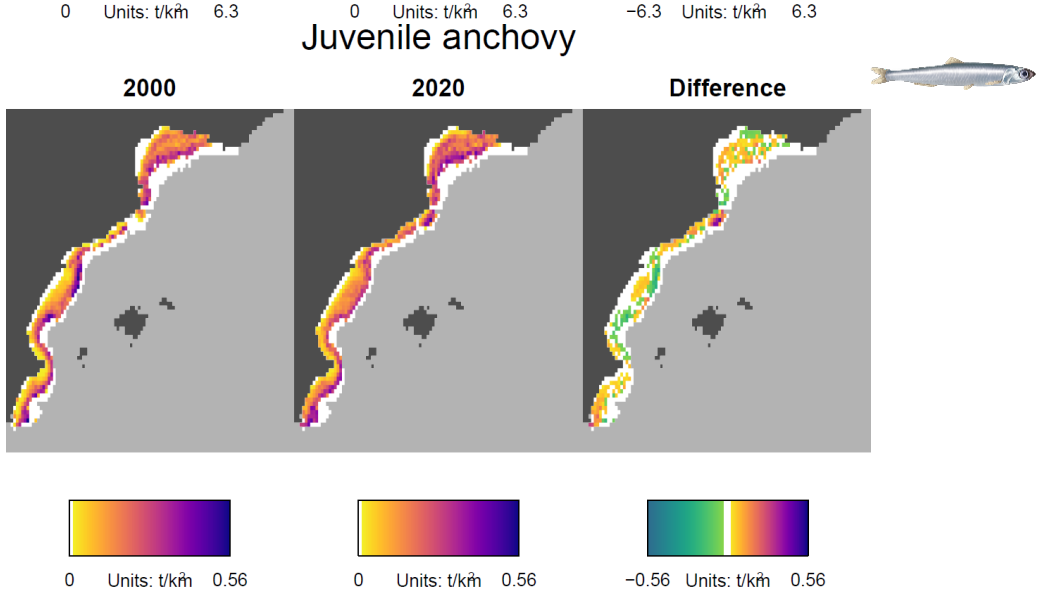




Coll et al., in prep.

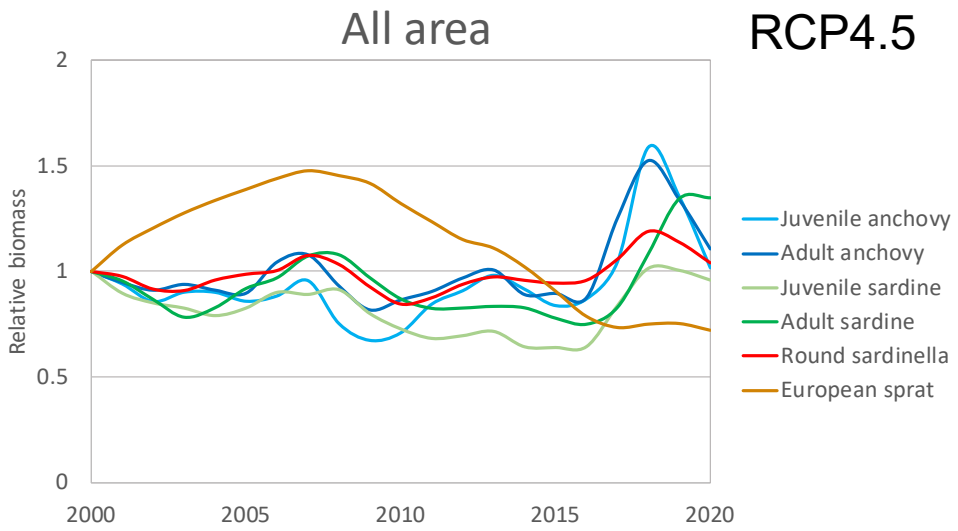
Relative biomass (2020/2000) under RCP4.5

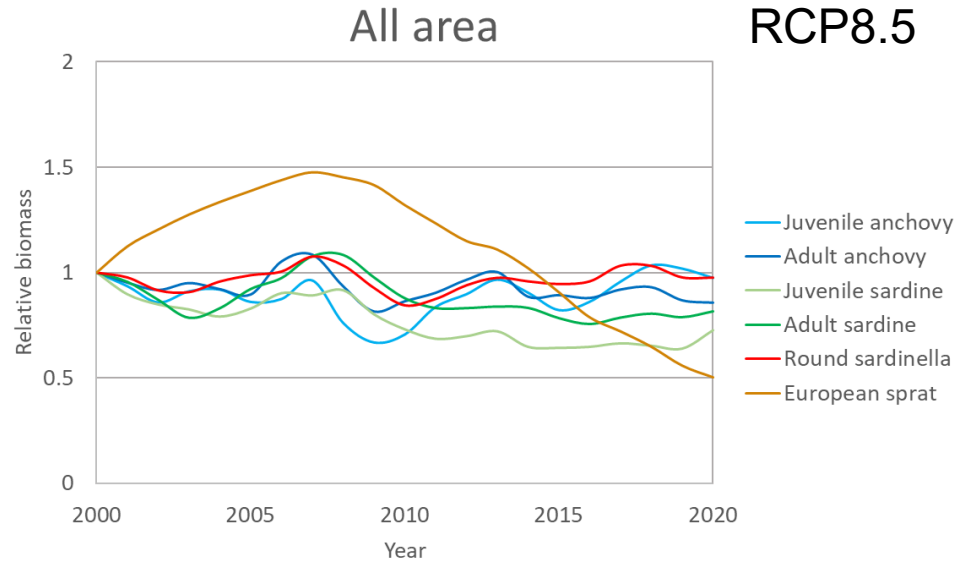




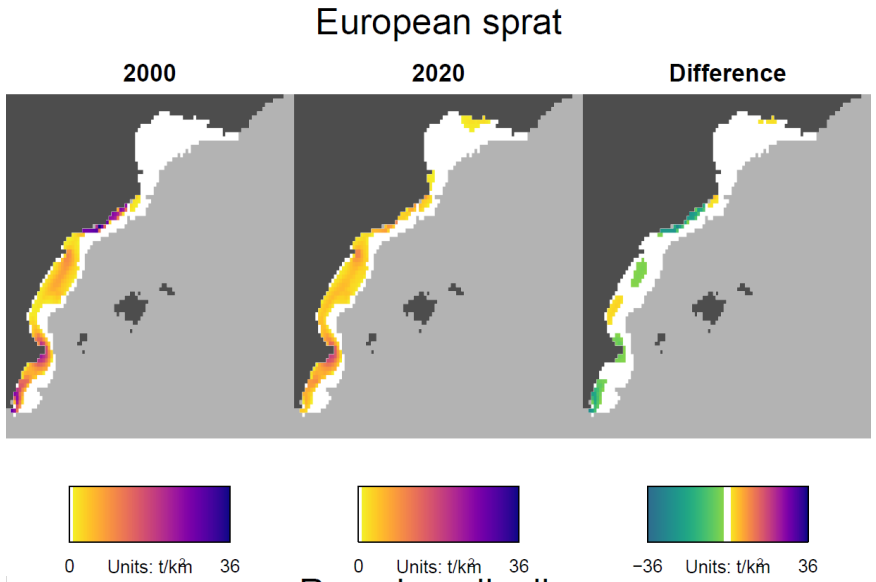
Species changes and their consequences

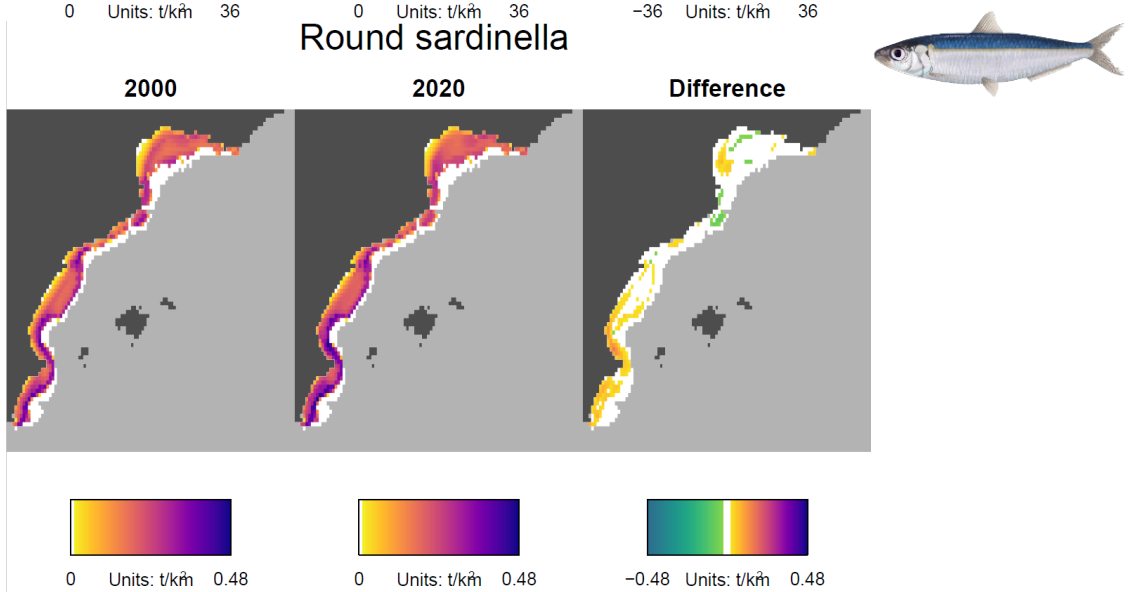
Changes in ecosystem components





Relative biomass (2020/2000) under RCP4.5

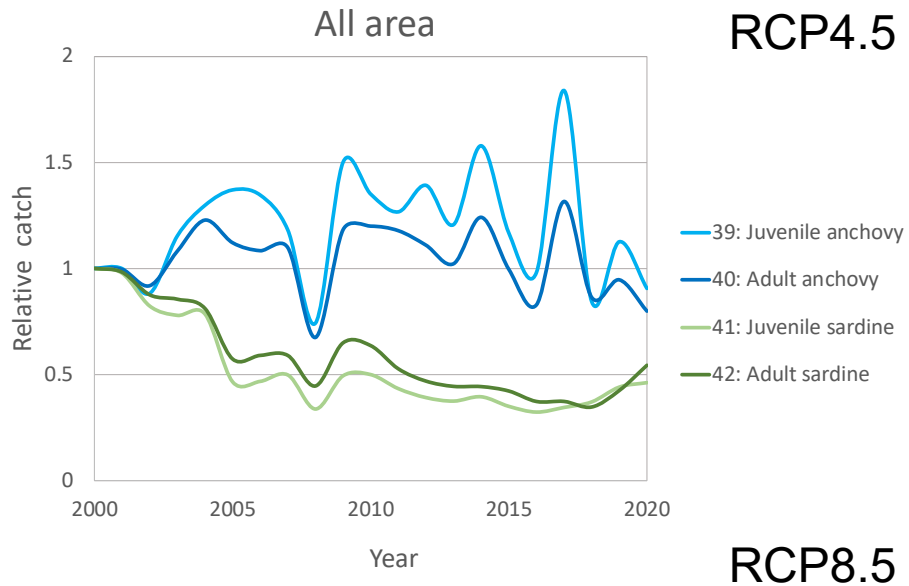


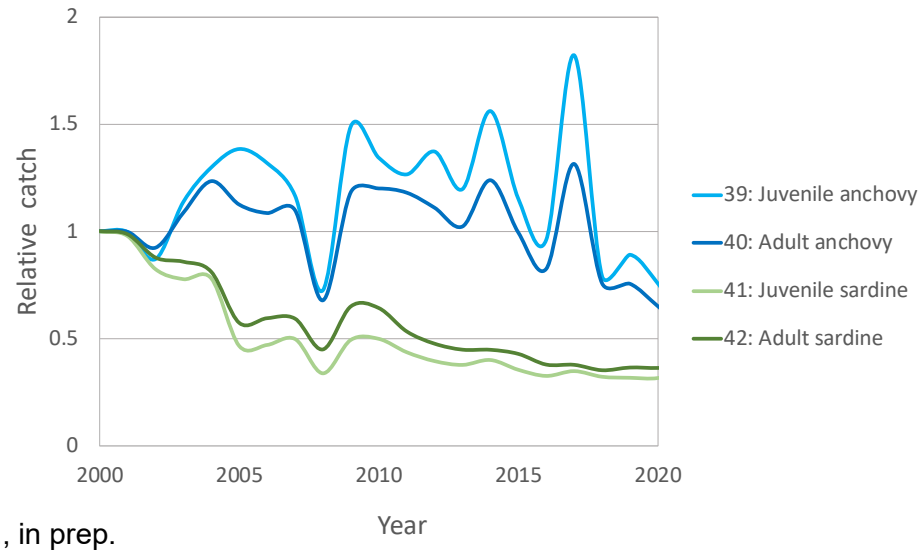


Coll et al., in prep.

Species changes and their consequences

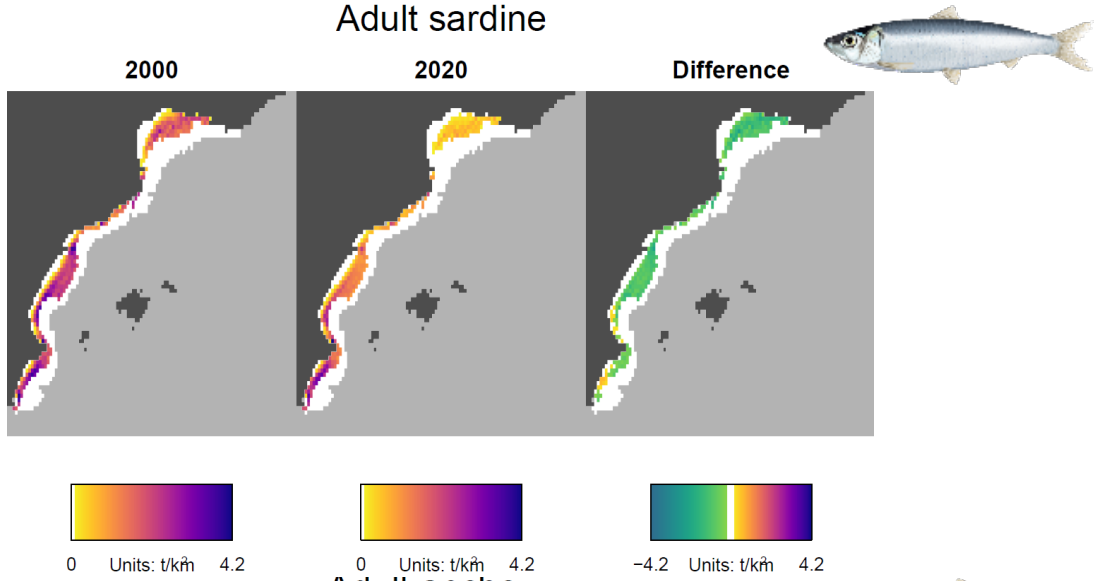
Changes in fisheries

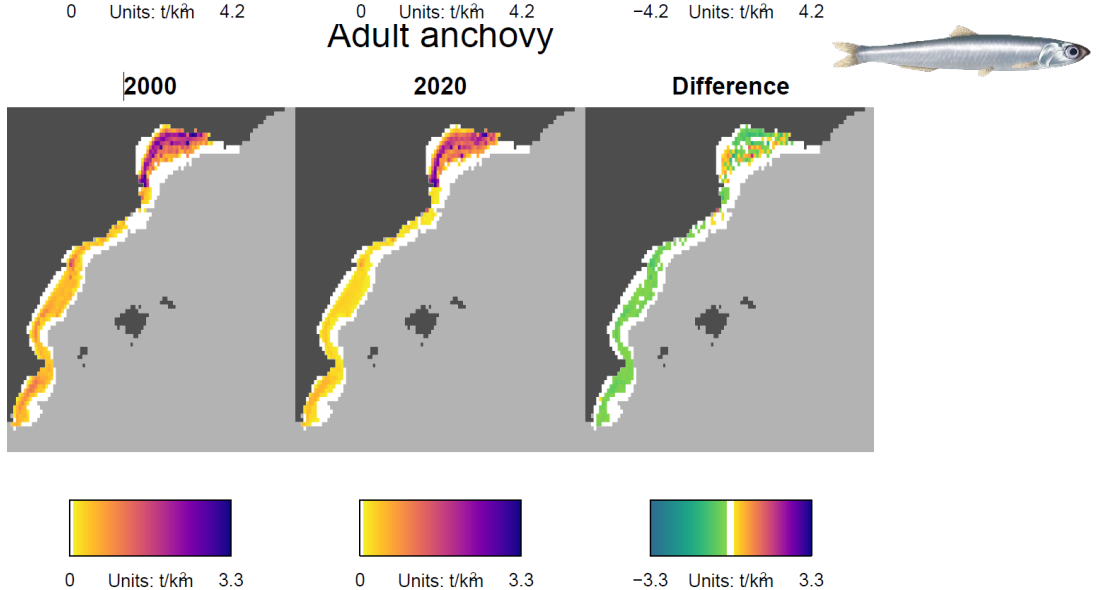




Coll et al., in prep.

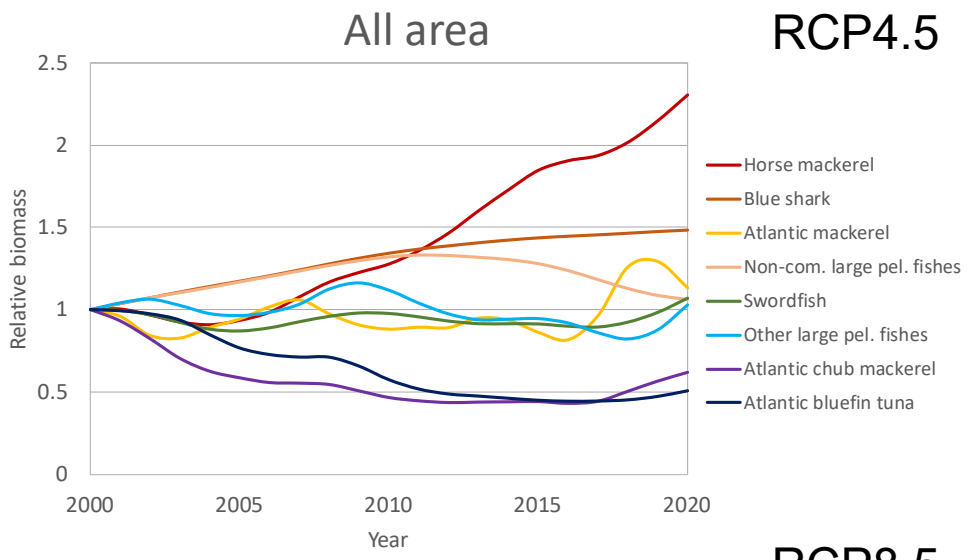
Relative catch (2020/2000) under RCP4.5

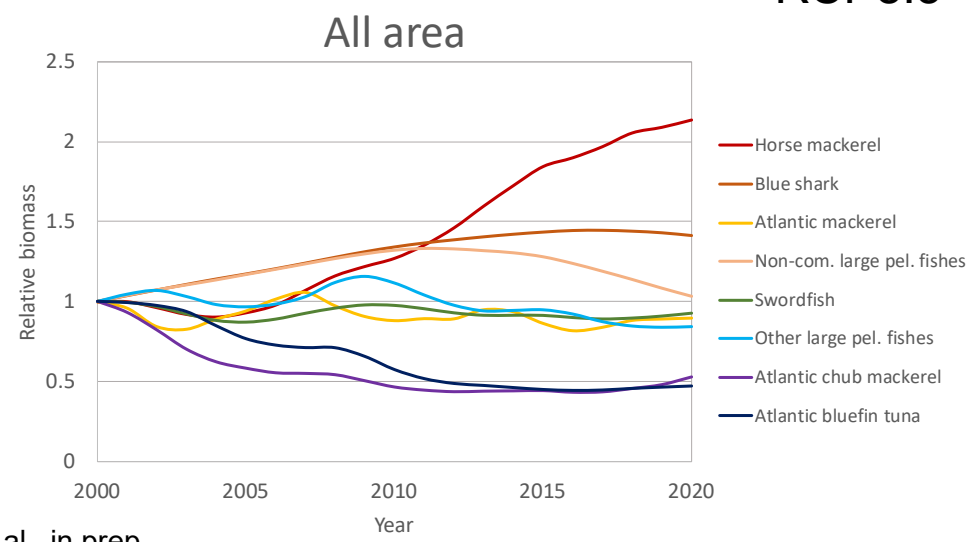




Species changes and their consequences

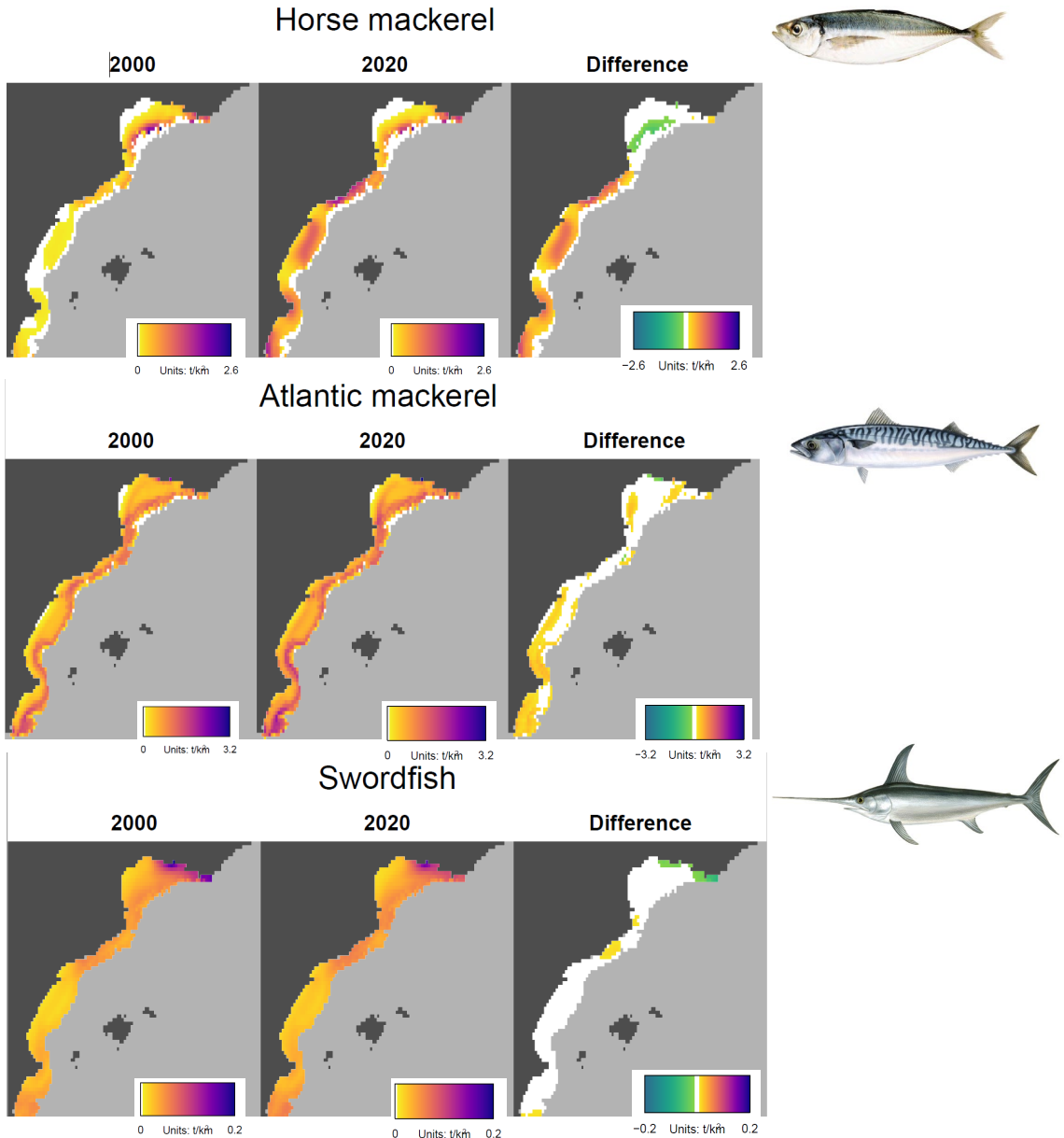
Changes in ecosystem components





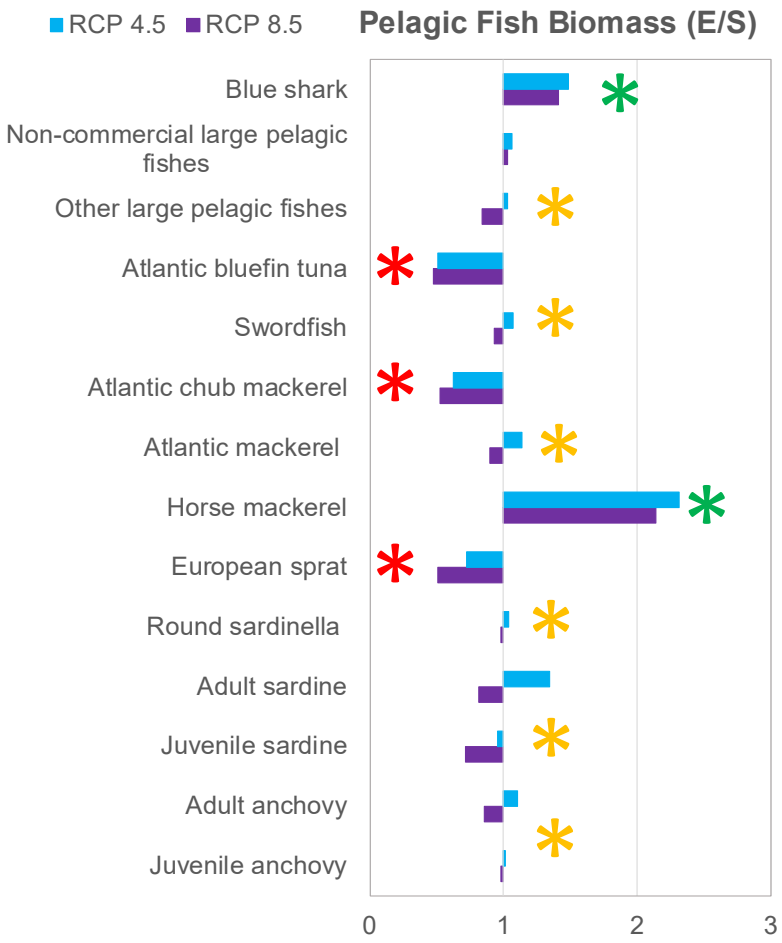
Coll et al., in prep.

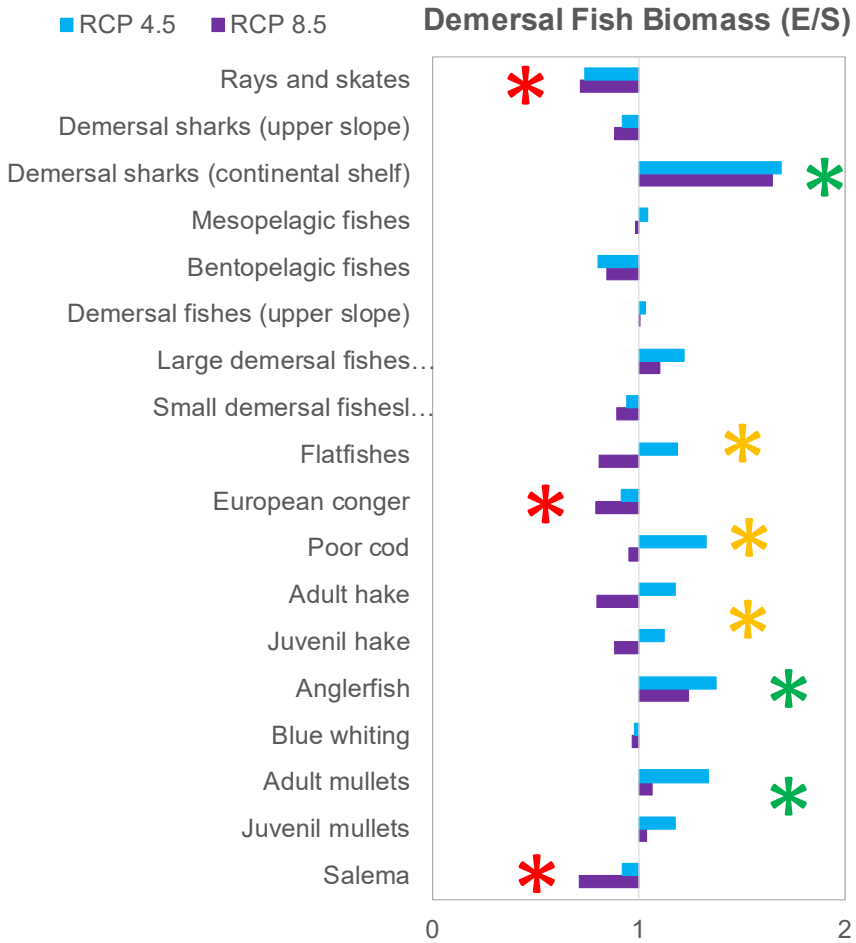
Relative biomass (2020/2000) under RCP4.5

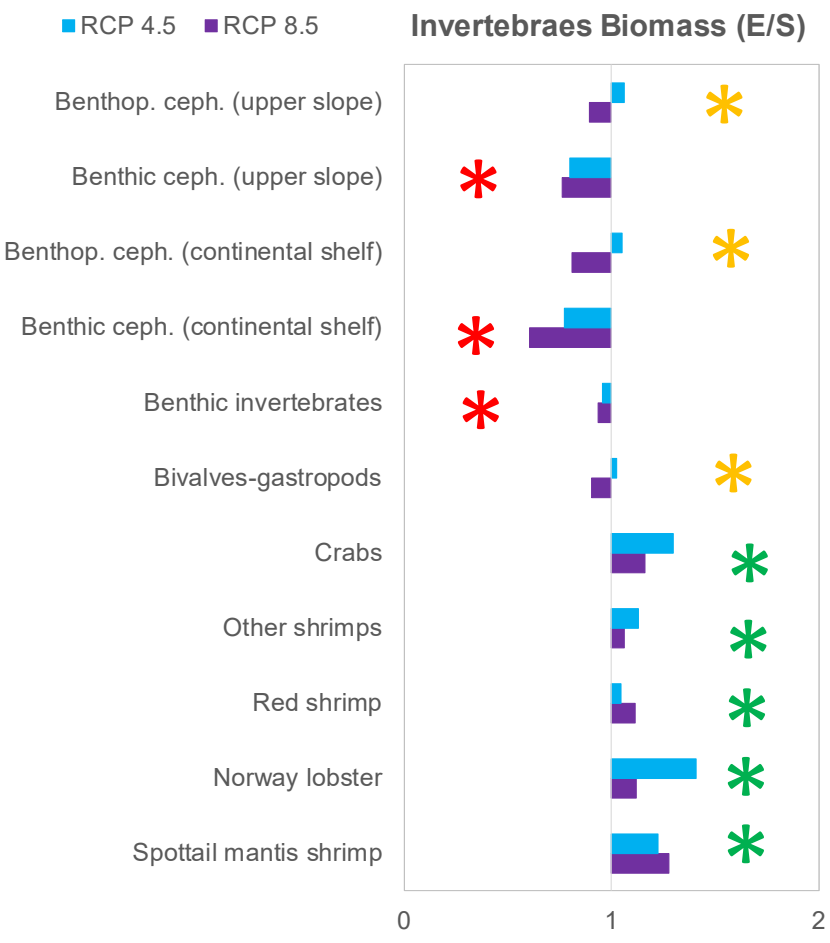


Species changes and their consequences

Identify winners and losers under fishing and different climate conditions (2020/2000)





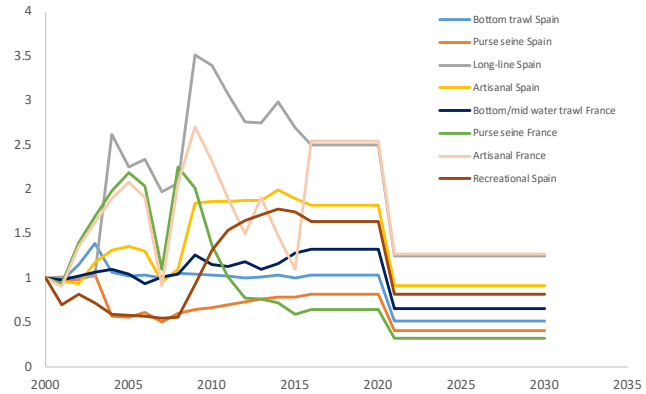


Coll et al., in prep.

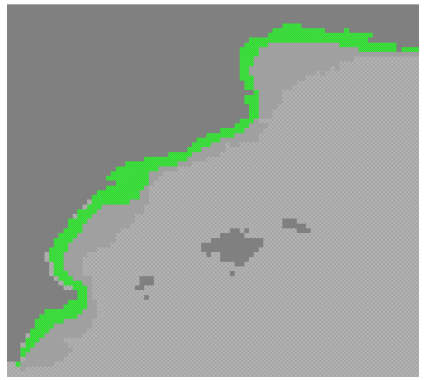
Species changes and their consequences

Alternative management options

Fishing effort change

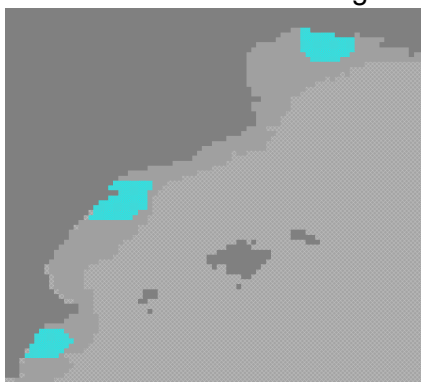


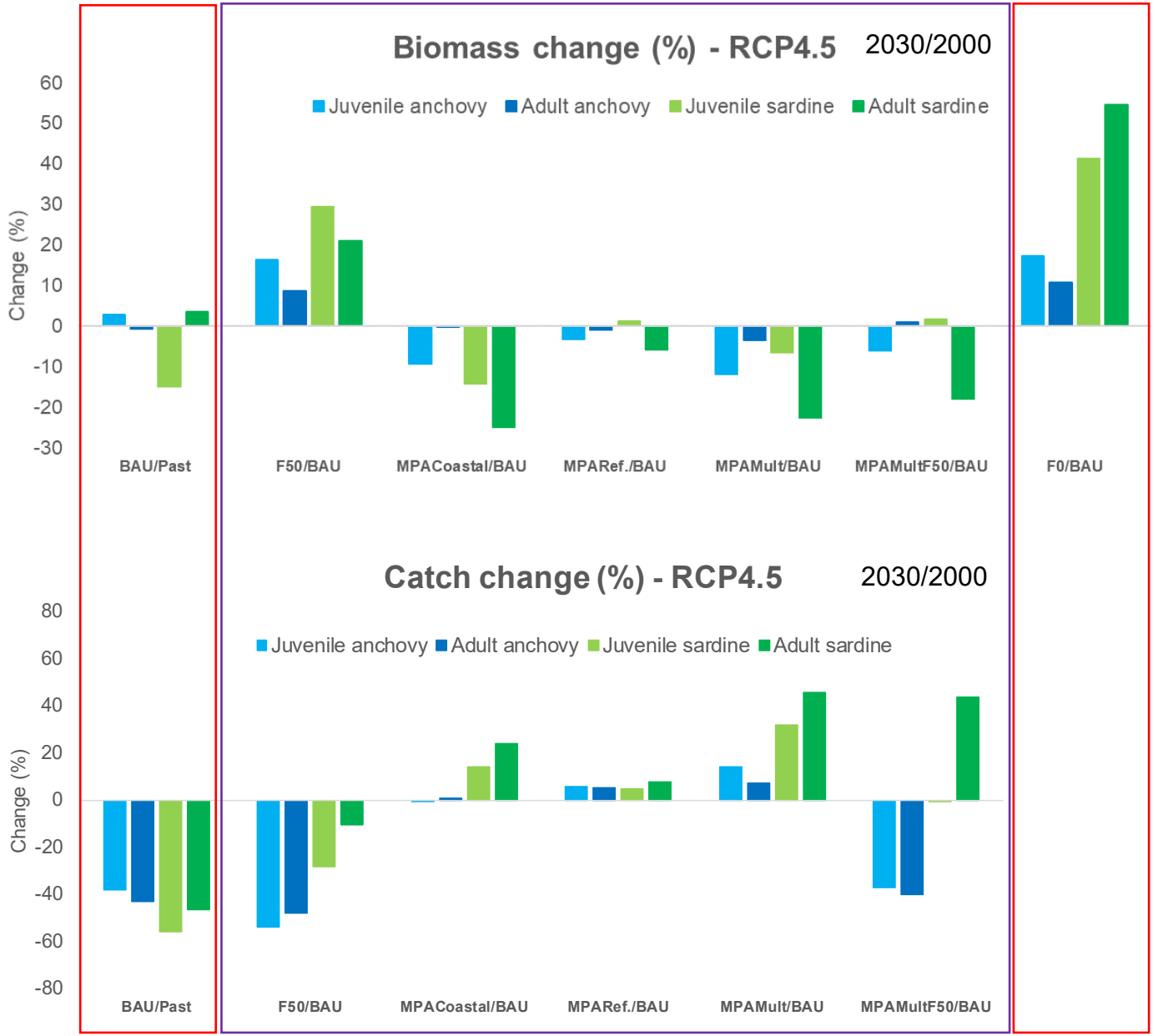
Spatial management options



MPAs in coastal areas

MPAs in “Climate Refuge”





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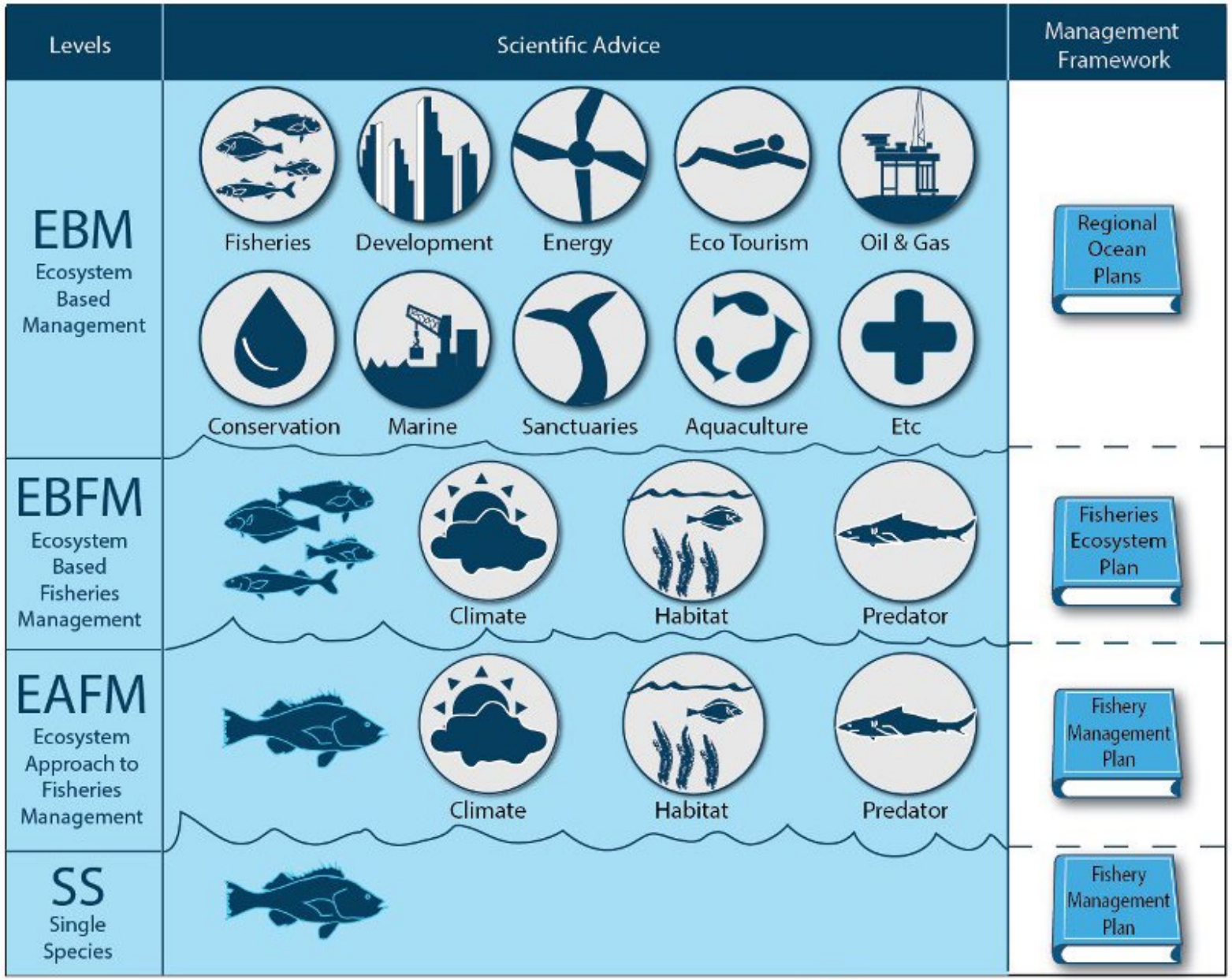
- Winners and losers of observed changes
- Management alternatives need to be strong to curve the trends around (MEM prototype to use)
- New questions emerged (role of pollution, adaptation, induced evolution)

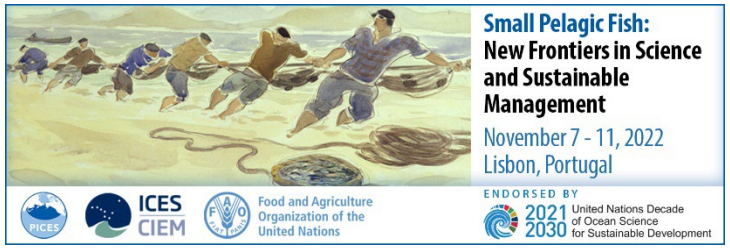


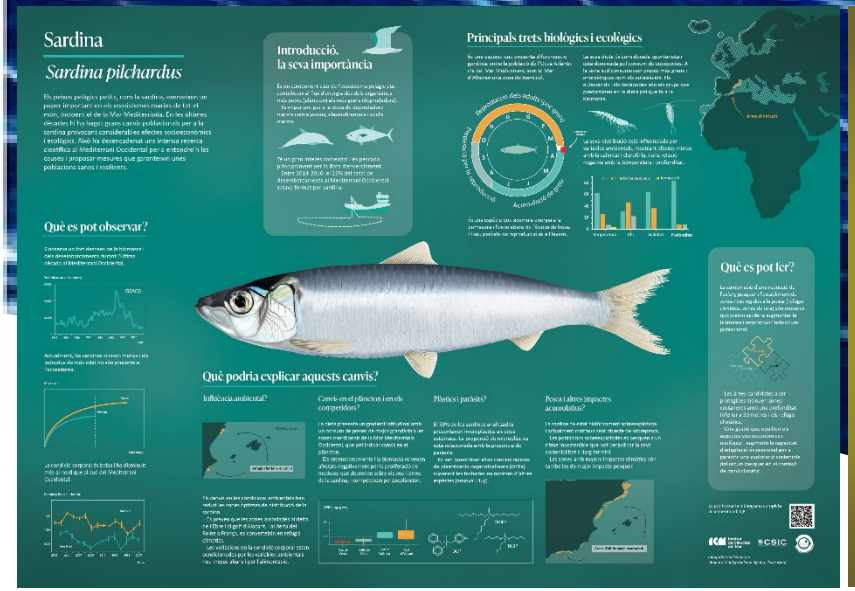
NOAA FISHERIES

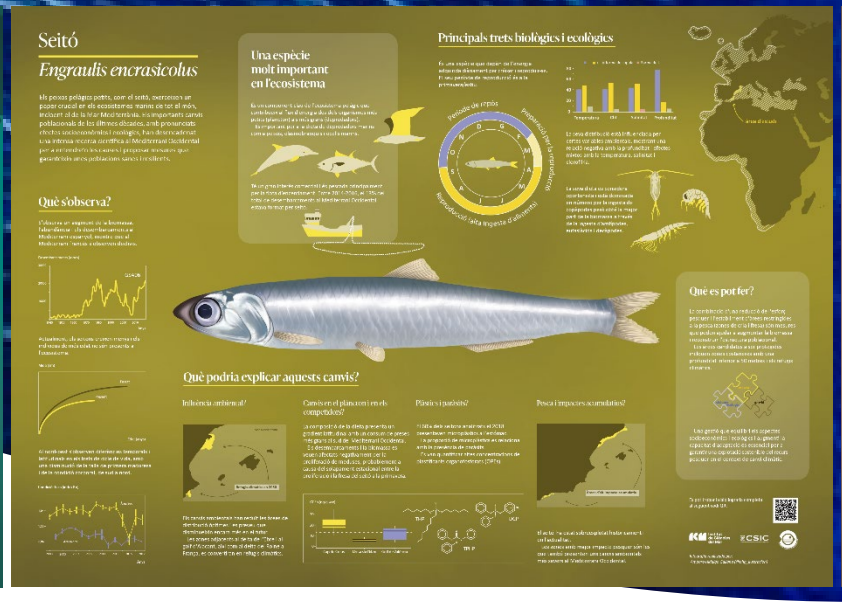
After Dolan et al. 2016. ICESJMS

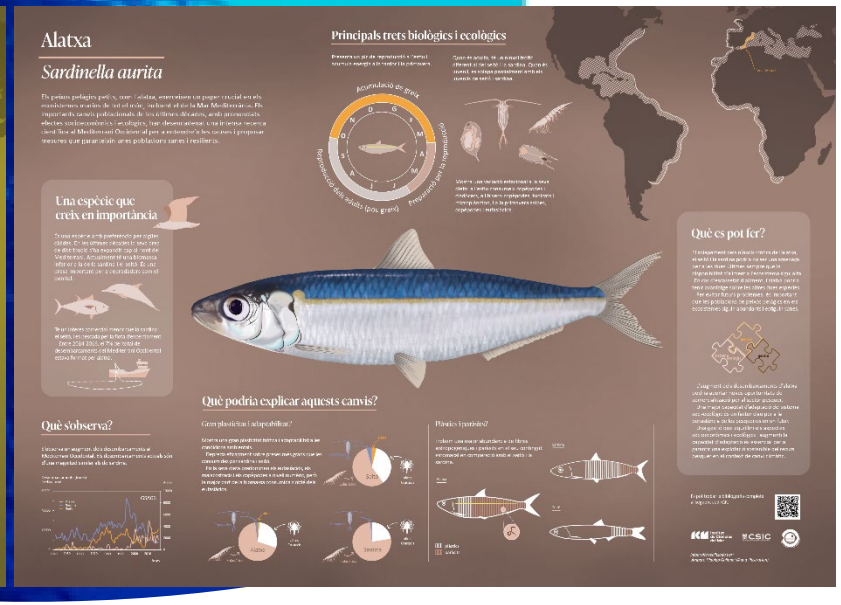
Obrigada!

Presenting at the conference





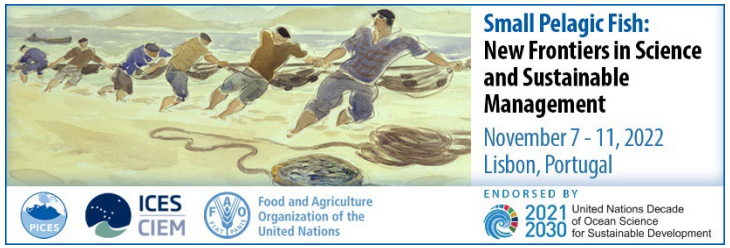




http://martacollmarine.science/spf-contributions/
https://martacollmarine.science/pelweb-infographics/

Infografia realitzada per:
Amparo Hidalgo Galiana (@ahg_ilustracion)

Obrigada!



Species roles and drivers

Trophic ecology of predators

1422

NRC Research Press

ARTICLE

Predator–prey interactions in the face of management regulations: changes in Mediterranean small pelagic species are not due to increased tuna predation

Elisabeth Van Beveren, Jean-Marc Fromentin, Sylvain Bonhommeau, Anne-Elise Nieblas, Luisa Metral, Blandine Brisset, Marko Jusup, Robert Klaus Bauer, Pablo Brosset, and Claire Saraux

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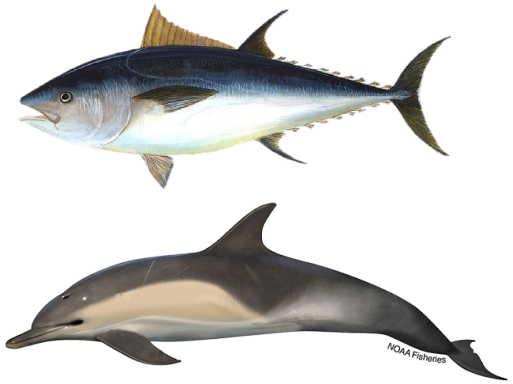
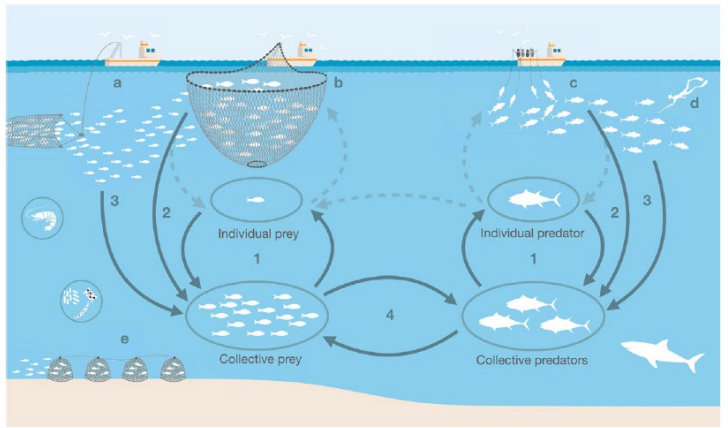
MARINE ECOLOGY PROGRESS SERIES
Mar Ecol Prog Ser

Published September 17

Dolphin predation pressure on pelagic and demersal fish in the northwestern Mediterranean Sea

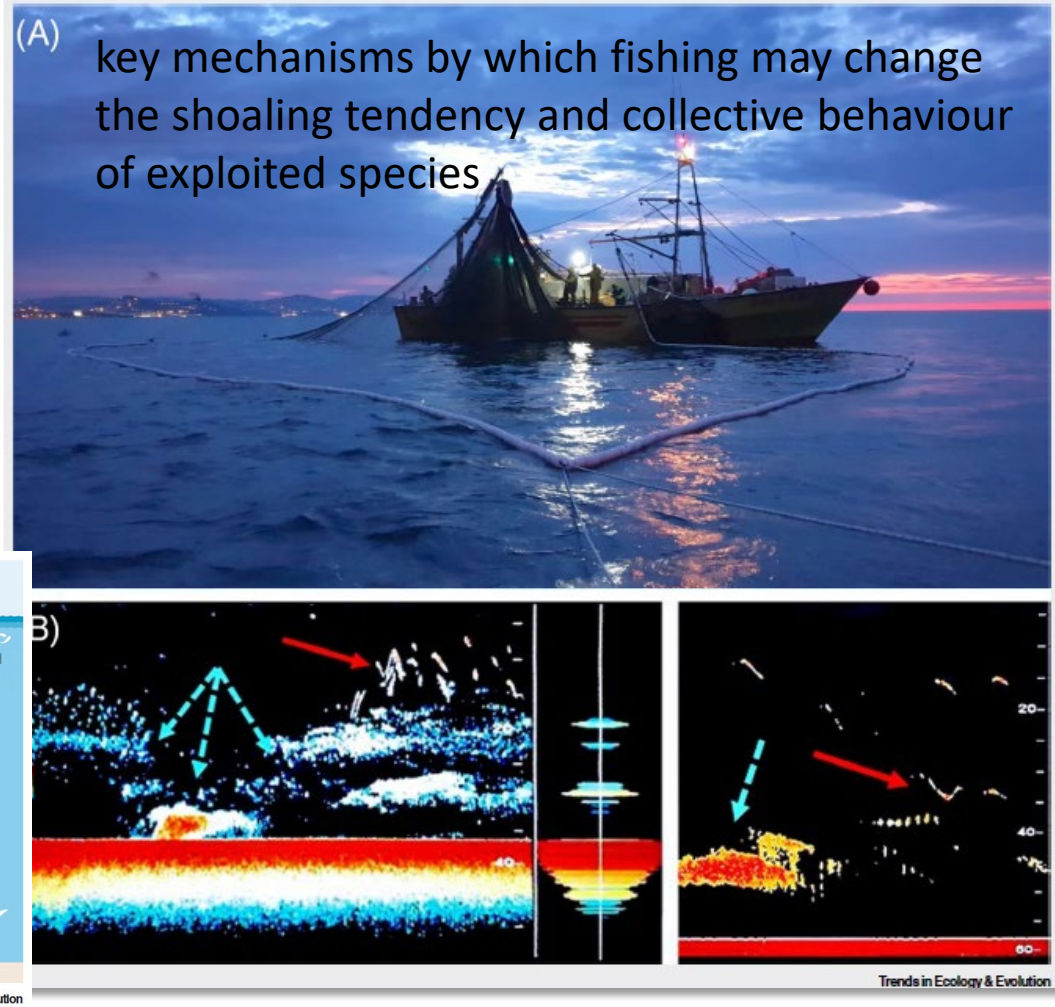
Quentin Queiros[1,*], Jean-Marc Fromentin[1], Guillelme Astruc[2], Robert Klaus Bauer[1], Claire Saraux[1]





Box 1. A case study of small pelagics fisheries

In the North-western Mediterranean, small pelagics such as sardines (*Sardina pilchardus*) and anchovies (*Engraulis encrasicolus*) support purse seine fisheries (Figure I). Over the past few decades, biomass and landings of small pelagics in the area have substantially dropped and catches have been increasingly of smaller-sized fish [12]. Anecdotal evidence by fishers suggests that the drop in captures of small pelagics may be related to changes in their behaviour. In particular, fishers are reporting that small pelagics do no longer form as large and cohesive groups as in the past, and are generally less accessible to fishing. Fishers associate these behaviours to the increasing presence of bluefin tuna (*Thunnus thynnus*), whose abundance locally increased after the establishment of effective tuna management measures [12]. In general, risk of predation is expected to trigger increased cohesion rather than prey splitting in smaller and more dispersed shoals [5]. However, the various mechanisms we explain here could underlie the observed changes in shoaling behaviour, link to changes in the phenotypic composition of shoals caused by fisheries, and thereby explain why small pelagics no longer show the expected shoaling behaviour in the presence of tunas.



Sbragaglia et al. 2021. TREE

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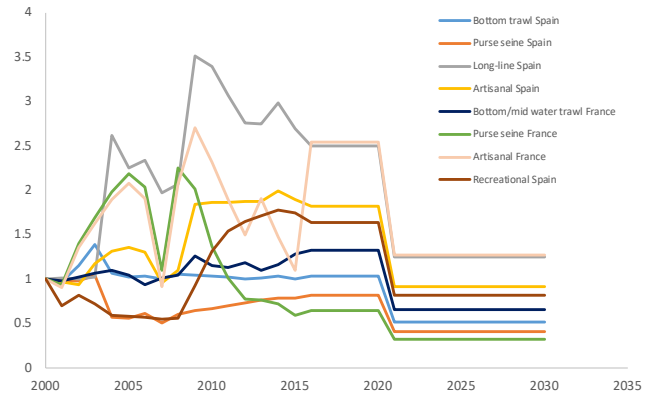

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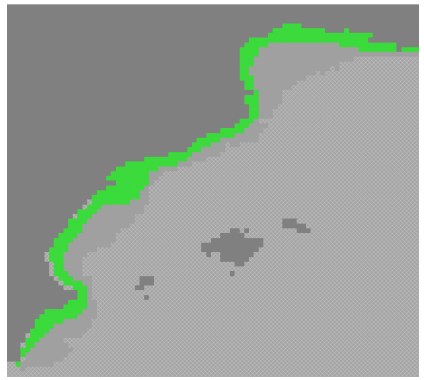

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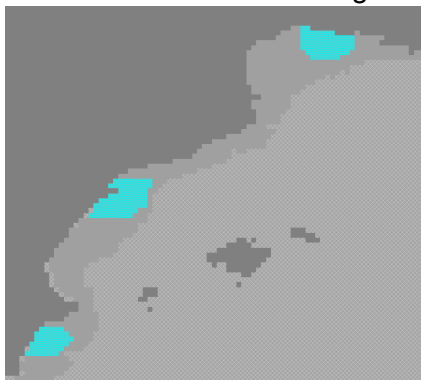
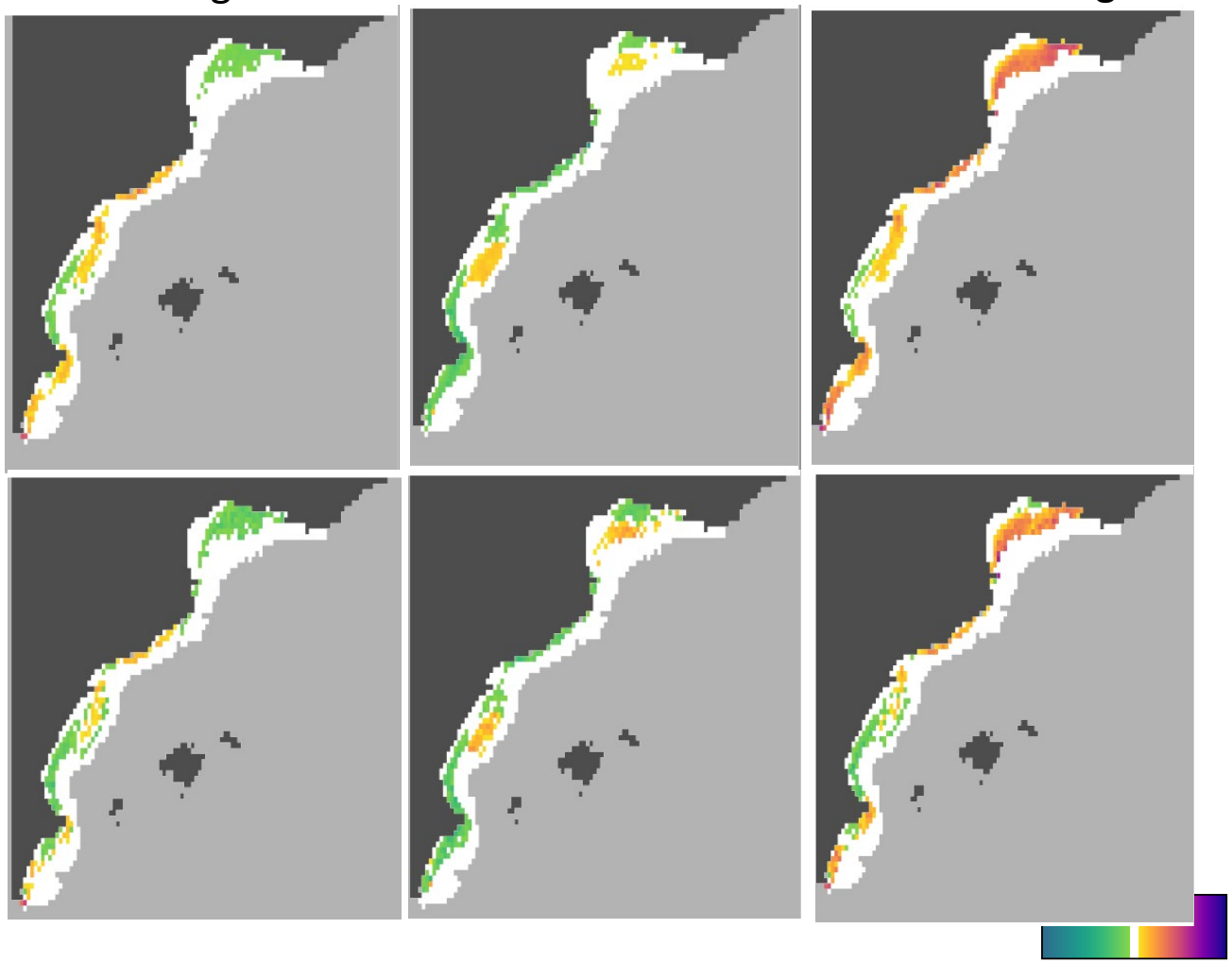


2030/2000

Fishing

50%Red&MPAs

No fishing



Coll et al., in prep.