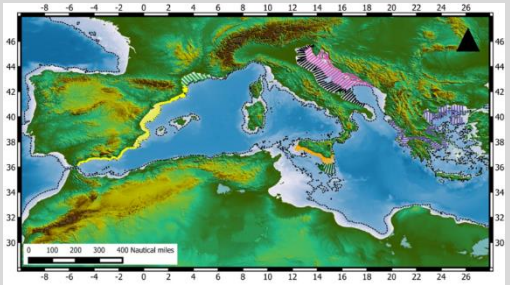
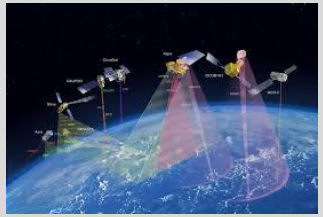
New science initiatives in the Mediterranean and Black Seas

Kostas Stergiou

Institute of Marine Biological Resources and Inland Waters, Hellenic Centre for Marine Research, Athens, Greece
School of Biology, Aristotle University of Thessaloniki, Thessaloniki, Greece

Big old and new data





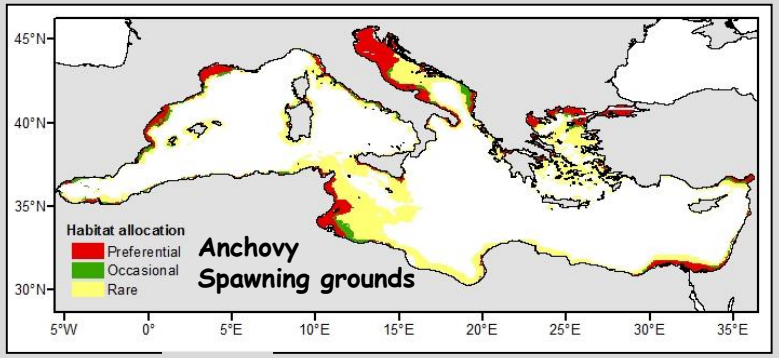
Ecopath with Ecosim
No fish is an island

Climate models
Niche models
IBM
GLMs, GAMs

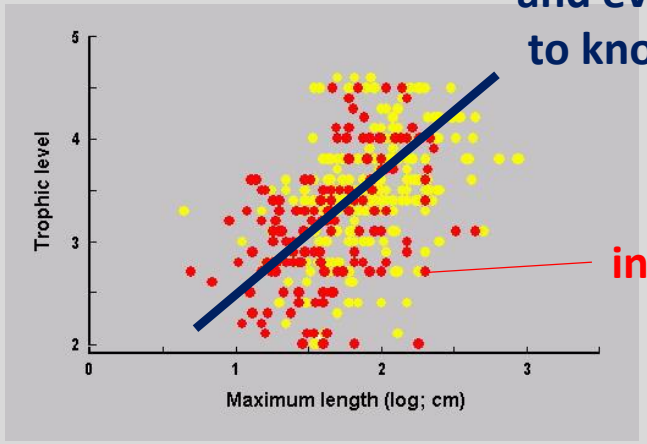
Classification Tree Analysis
Random Forests
Boosted Regression Trees
Multivariate Adaptive Regression Splines
Surface Range Envelope

Shiny new insights

for what is not directly observed



and eventually to knowledge



information

The authors propose a new framework

Global Change Biology

Global Change Biology (2014) 20, 730–741, doi: 10.1111/gcb.12467

From projected species distribution to food-web structure under climate change

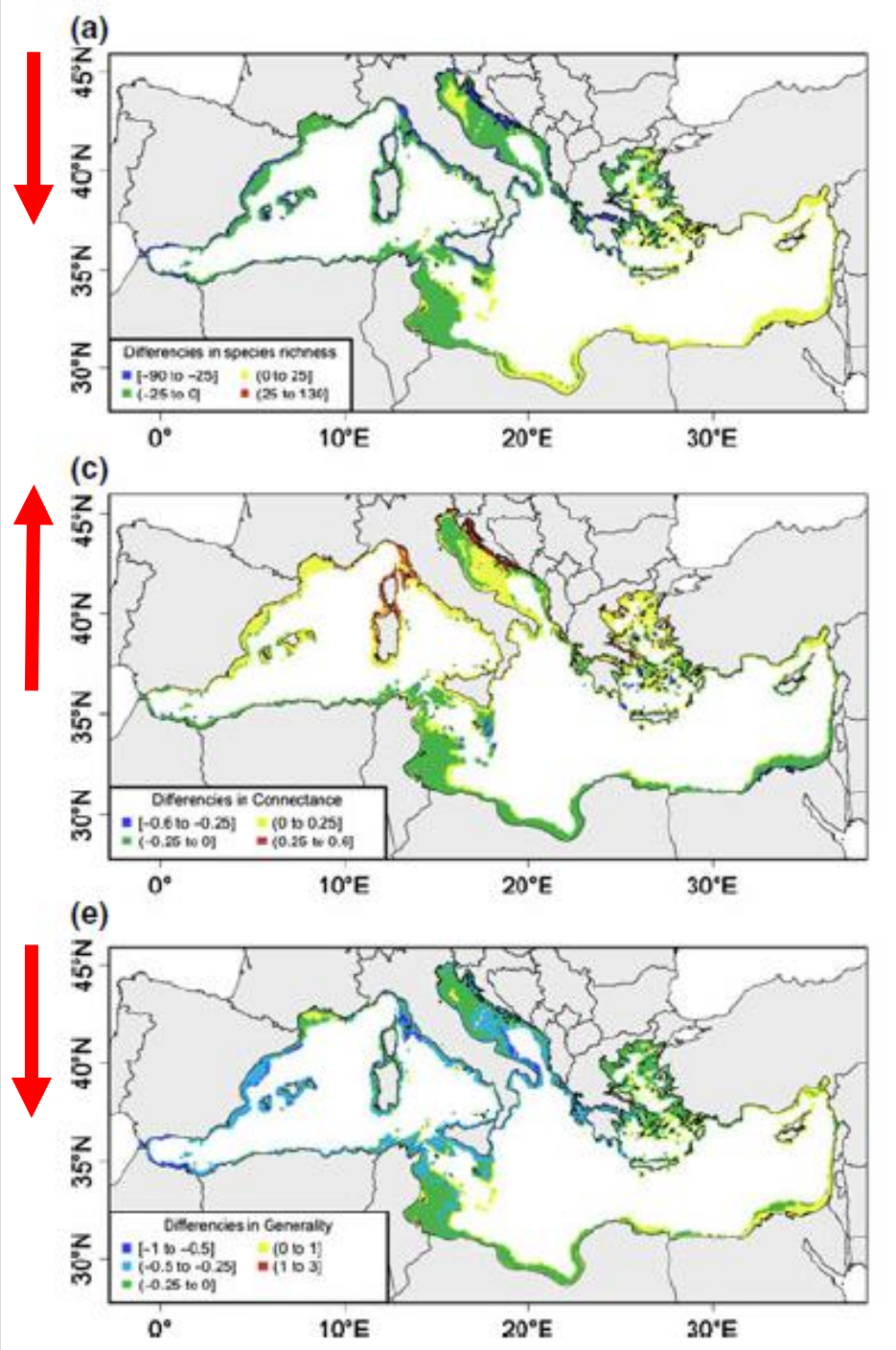
CAMILLE ALBOUY[1,2,3†], LAURE VELEZ[1,2†], MARTA COLL[4,5], FRANCESCO COLLOCA[6], FRANÇOIS LE LOC'H[2], DAVID MOUILLOT[1,7] and DOMINIQUE GRAVEL[3]

[1]*Laboratoire Écologie des Systèmes Marins Côtiers UMR 5119 CNRS-UM2-IRD-IFREMER ECOSYM, Place E. Bataillon, Montpellier Cedex 5 34095, France,* [2]*Laboratoire Écosystèmes Marins Exploités UMR 212, IRD-IFREMER-UM2, avenue Jean Monnet BP171, Sète Cedex 34203, France,* [3]*Département de biologie, Chimie et Géographie, Université du Québec à Rimouski, 300 Allée des Ursulines, Québec G5L 3A1, Canada,* [4]*Institut de Ciències del Mar (ICM-CSIC), Spain & Ecopath International Initiative Research Association, Passeig Marítim de la Barceloneta 37–49, Barcelona 08003, Spain,* [5]*Department of Biology, Faculty of Science, Dalhousie University, 1355 Oxford Street, Halifax NS B3H4J1, Canada,* [6]*Istituto per l'Ambiente Marino Costiero, Consiglio Nazionale delle Ricerche, Via L. Vaccara, Mazara del Vallo 61- 91026, Italy,* [7]*ARC Centre of Excellence for Coral Reef Studies, James Cook University, Townsville, Qld 4811, Australia*

Use of the coupling of species distribution and trophic models for predicting climate change impacts on food-web structure across the Mediterranean.

They used data from the Mediterranean continental shelf:

- published food webs
- stomach contents from literature and FishBase
- actual geographical distributions (occurrence maps) for 256 endemic and native coastal fish species
- Sea Surface water Temperature (SST) as the main forcing variable
- the Mediterranean regional marine model (NEMOMED8) that predicts observed and future SST based on a variety of drivers
- projected SST values were extracted for 2080–2099 from NEMOMED8 outputs, based on the SERS IPCC A2 scenario
- this scenario is conservative but not the most pessimistic.



species richness, 54 out of 256 endemic and native species would disappear

connectance of the fish web would increase, mainly due to the decrease of feeding links and species richness.

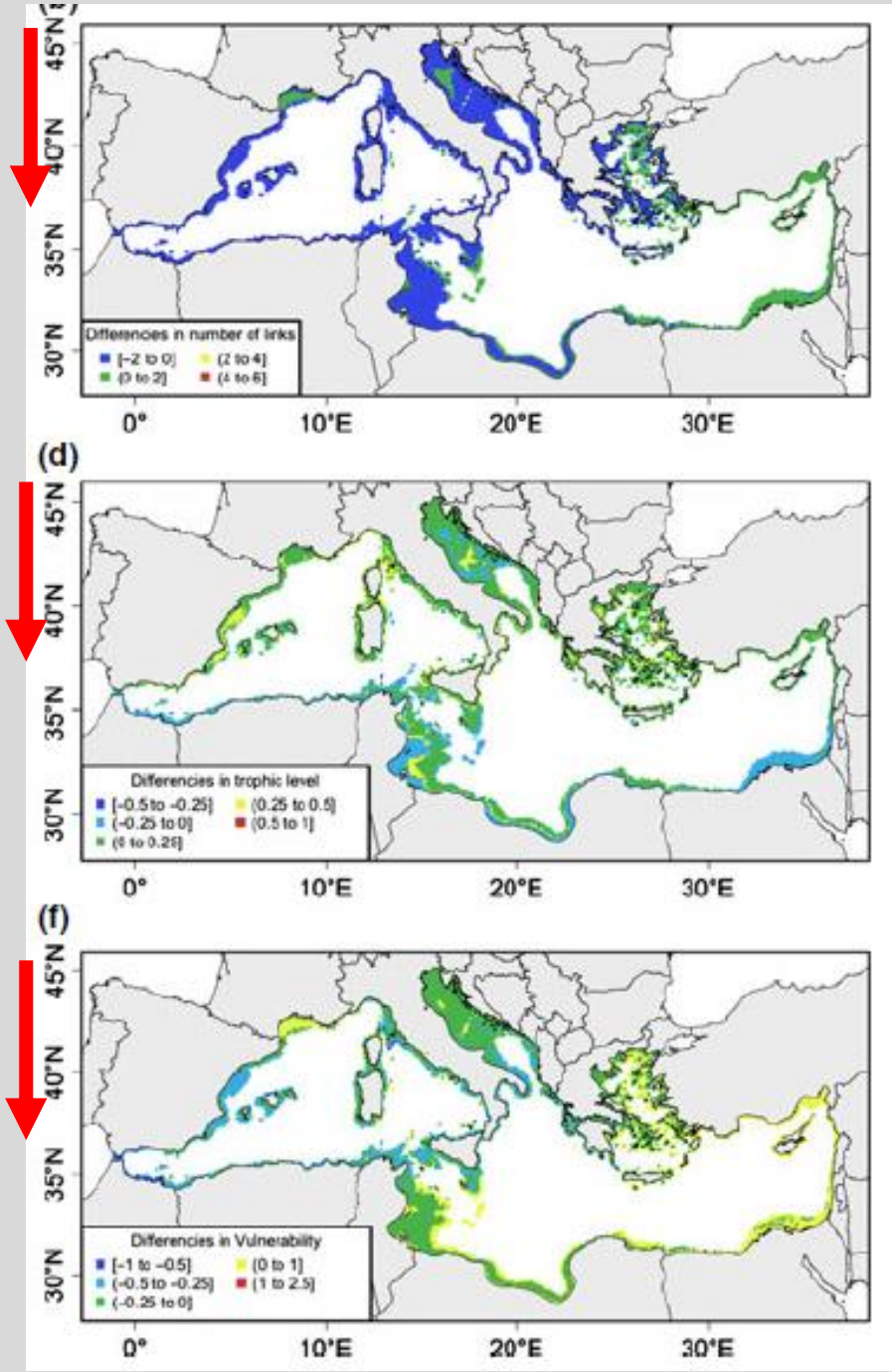
Predator generality, estimated as the number of prey species per predator species, would decrease.

Differences in various attributes between

1961–1980

(baseline scenario)

2080–2099.



number of feeding links between fish species would decrease on 73.4%

trophic level

Vulnerability, the mean number of consumer species per prey species, would decrease

Differences in various attributes between

1961–1980

(baseline scenario)

2080–2099.

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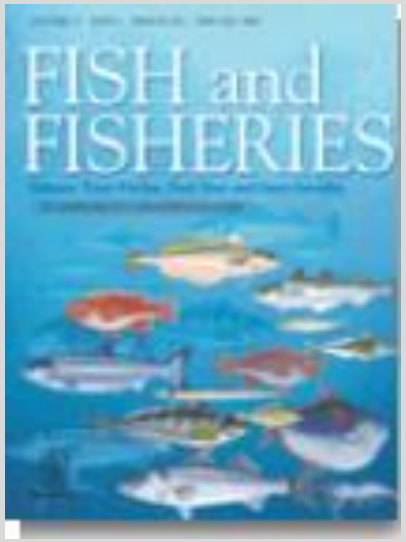
The study highlights:

- **the large-scale impacts of climate change on marine food-web structure**
- **with deep consequences on ecosystem functioning.**



FISH and FISHERIES

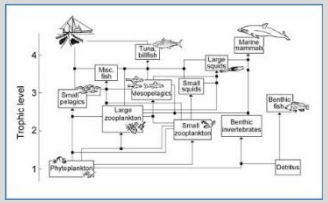
FISH and FISHERIES, 2012, **13**, 60–88

Contributions of food web modelling to the ecosystem approach to marine resource management in the Mediterranean Sea

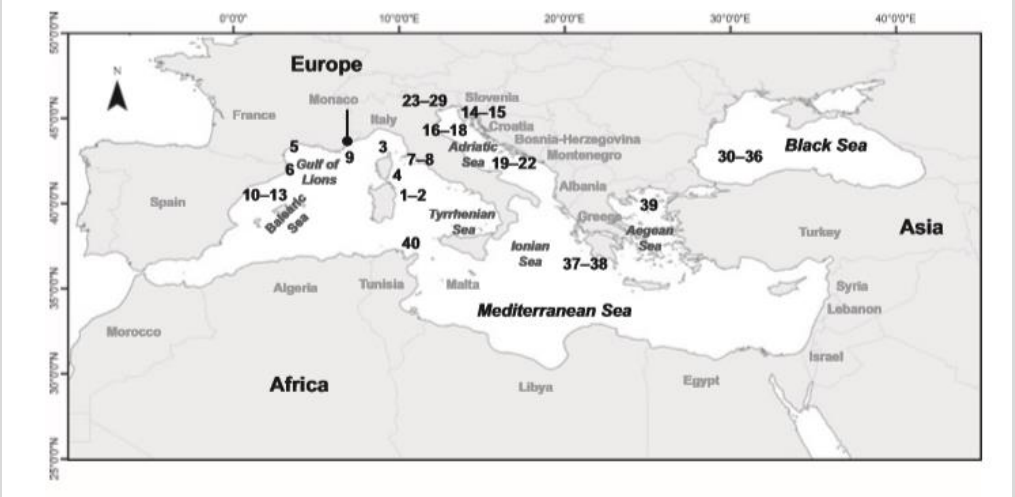
Marta Coll[1,2] *& Simone Libralato*[3]

[1]Biology Department, Dalhousie University, 1355 Oxford Street, Halifax, Canada B3H 4J1; [2]Institut de Ciéncies del Mar (ICM-CSIC), Passeig Marítim de la Barceloneta, 37-49, 08003 Barcelona, Spain; [3]Istituto Nazionale di Oceanografia e di Geofisica Sperimentale – OGS, Borgo Grotta Gigante 42/c, 34010 Sgonico (TS), Italy

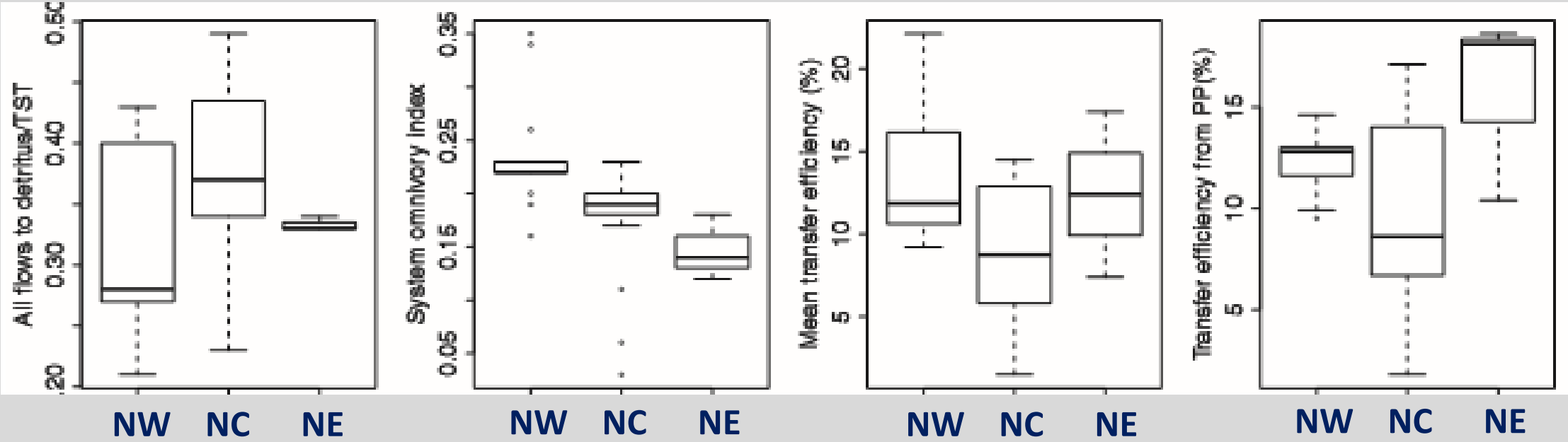
Meta-analysis of the contributions of food web modelling to marine science

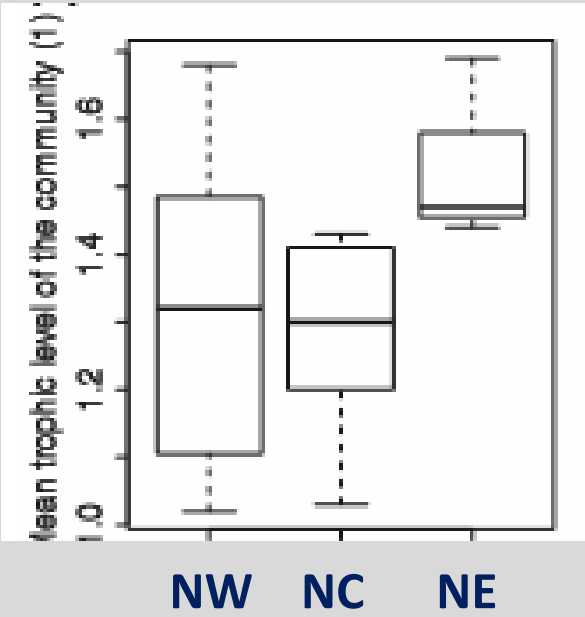


39 EwE models for the Mediterranean



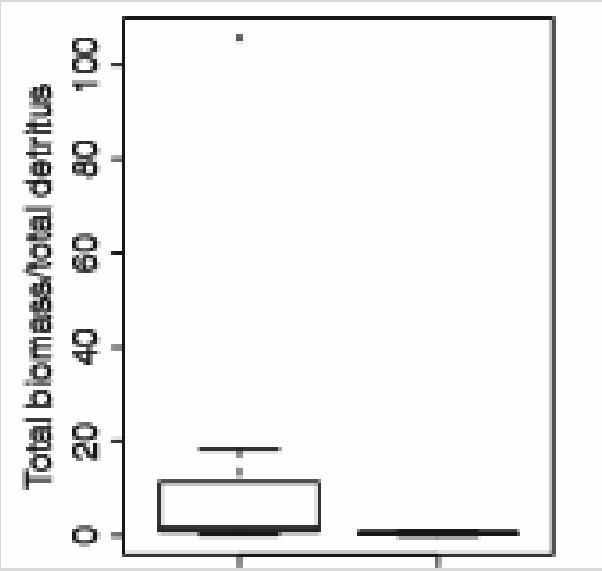
Differences in ecosystem traits by Mediterranean sub-basin





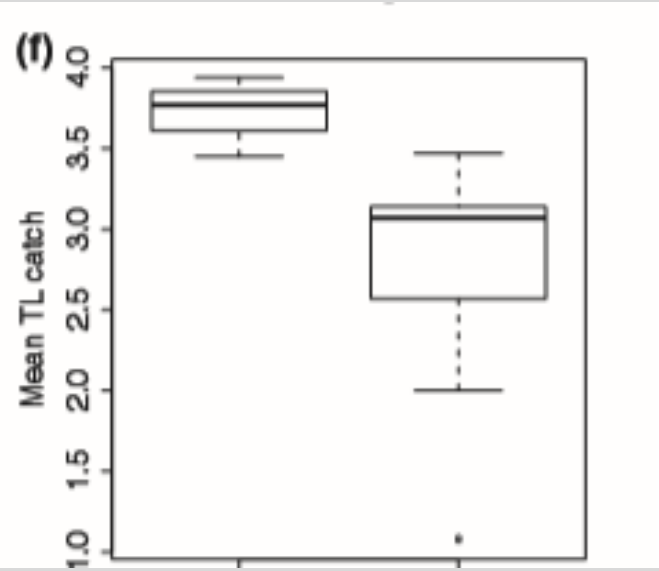
- Relative flows of detritus
- System omnivory
- Mean transfer efficiency
- Transfer efficiency from PP
- Mean community trophic level

Differences in ecosystem traits by fishing intensity



No fishing

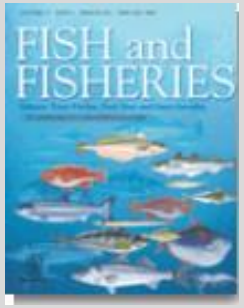
High fishing



No fishing

High fishing

More detritus and smaller mean trophic level of catch in fished ecosystems



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The results highlight differences in ecosystems structure and function between:

- **ecosystem types**
- **sub-basins**
- **fished and non-fished areas**
- **which illustrate the environmental heterogeneity of the Mediterranean.**

The results are important for supporting

- **the ecosystem approach to fisheries management.**

Annual probability maps and habitat allocation of the main small pelagic species

A series of solid work done within the framework of several projects with the participation of the different “Small pelagic” research groups in the Mediterranean

MARIFISH WP7: Collaborative Research Programmes
Regional Scale Study-The Mediterranean

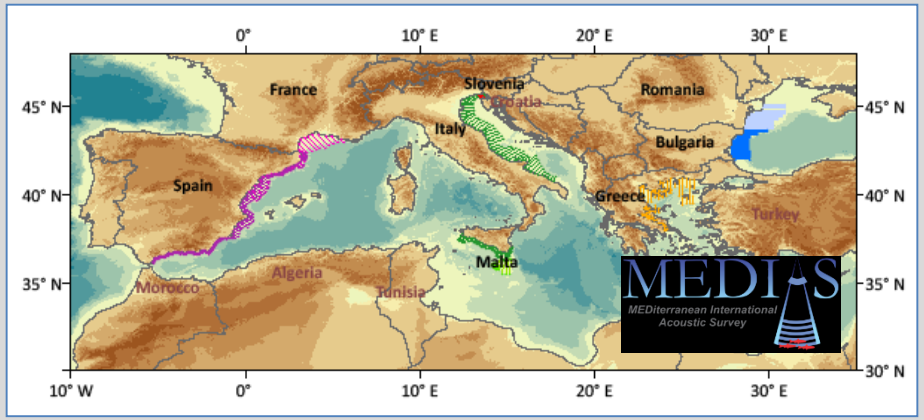
REPROdUCE: MARIFISH Framework

EU FUNDED project, FP6 Framework

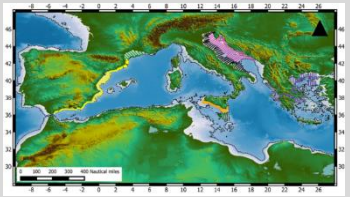
MEDISEH

DG MARE Contract Service

- Mediterranean Acoustic Survey since 2008
- Internationally coordinated
- Simultaneous hydrographic sampling



Data used to develop habitat maps:



Biological data (at different seasons/years/areas):

- Acoustic surveys (MEDIAS)
- Ichthyoplankton surveys
- Pelagic trawl data

Environmental data (satellites):

- Sea level anomaly
- SST, depth
- Chl-a
- Salinity
- Photosynthetic active radiation

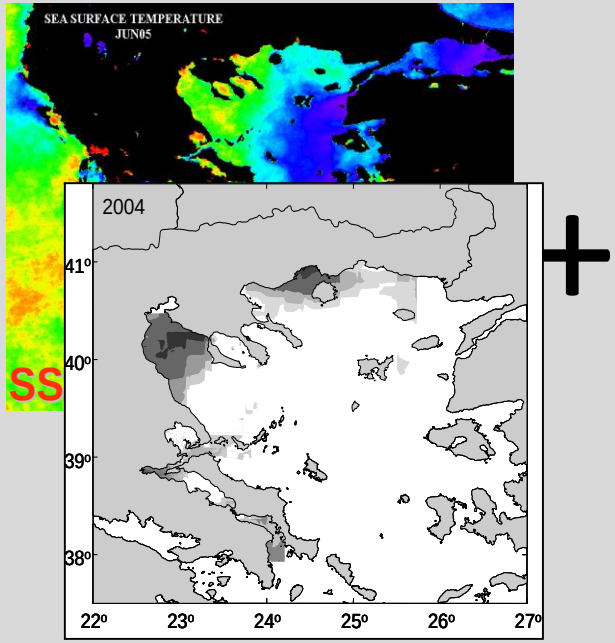
OCEANOGRAPHY
FISHERIES OCEANOGRAPHY Fish. Oceanogr. 22:2, 69–89, 2013

Characterizing the potential habitat of European anchovy *Engraulis encrasicolus* in the Mediterranean Sea, at different life stages

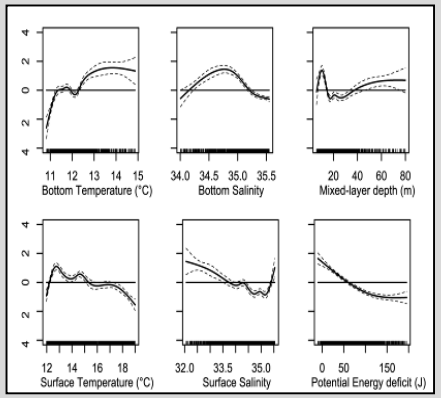
M. GIANNOULAKI[1,*], M. IGLESIAS[2], M. P. TUGORES[2], A. BONANNO[3], B. PATTI[3], A. DE FELICE[4], I. LEONORI[4], J. L. BIGOT[5], V. TIČINA[6], M. M. PYROUNAKI[1], K. TSAGARAKIS[1], A. MACHIAS[1], S. SOMARAKIS[1], E. SCHISMENOU[1], E. QUINCI[3], G. BASILONE[7], A. CUTTITTA[3], F. CAMPANELLA[4], J. MIQUEL[2], D. OÑATE[2], D. ROOS[5] AND V. VALAVANIS[1]

summer ichthyoplankton surveys were used to model potential spawning habitat. Selected models were used to produce maps presenting the probability of anchovy presence (adults, juveniles and eggs) in the entire Mediterranean basin, as a measure of habitat adequacy. Bottom depth and sea surface chlorophyll concentration were the variables found important in all models. Potential anchovy habitats were located over the continental shelf for all life stages examined.

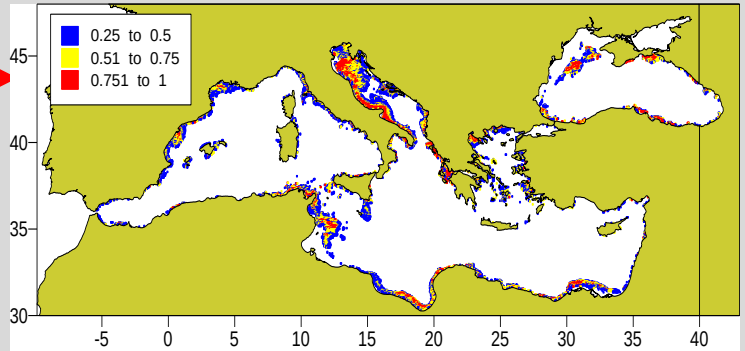
Biological & environmental data

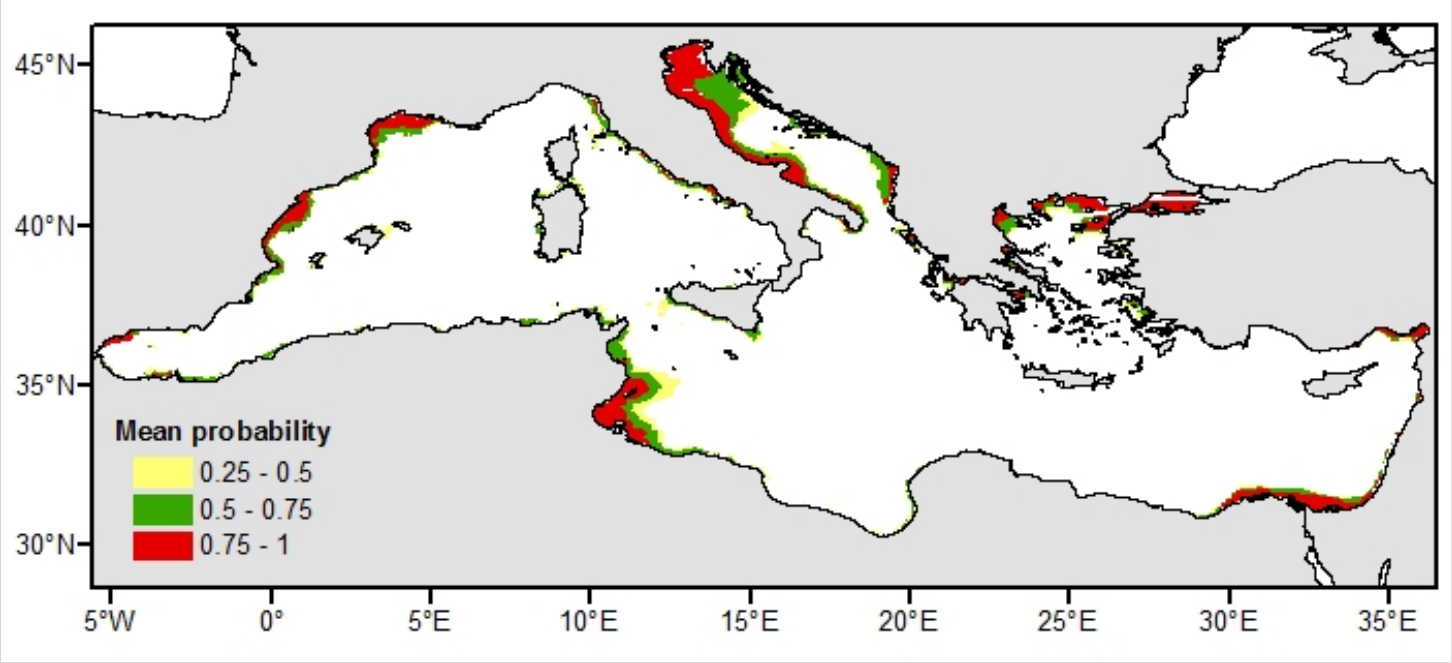


Statistical models



Habitat maps at the Mediterranean scale





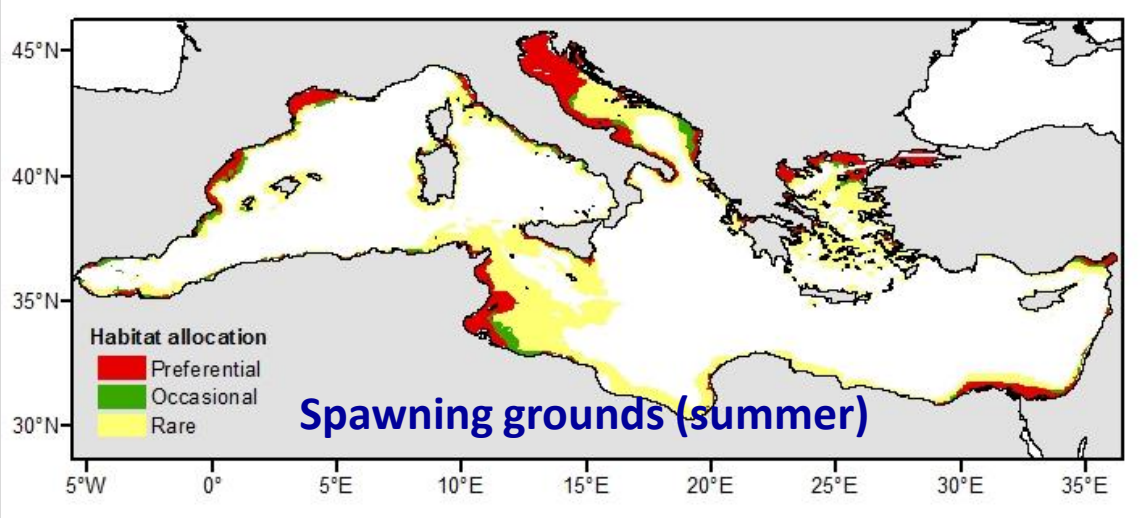
Giannoulaki et al. (2013), Fisheries Oceanography

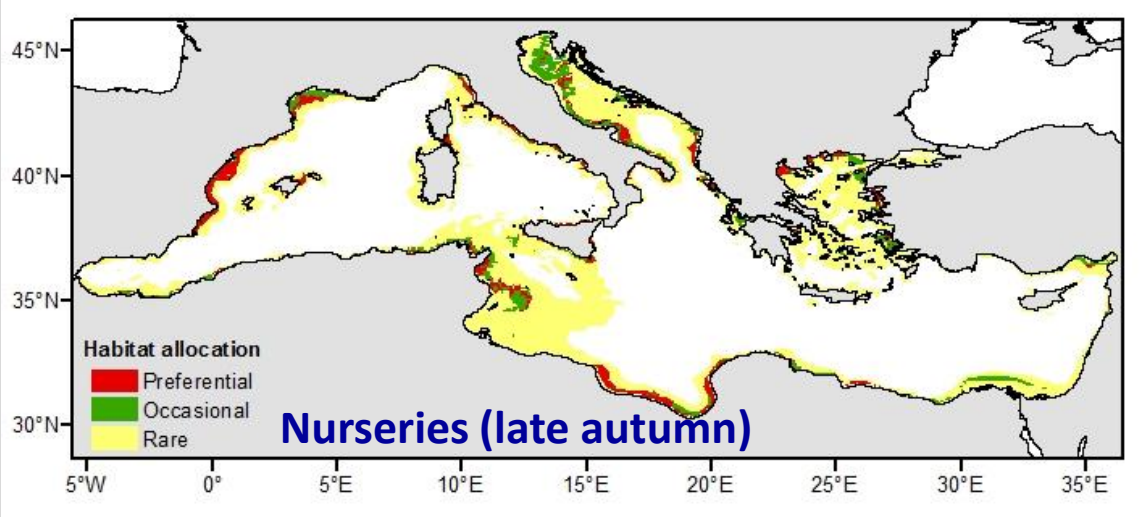
Initially development of

annual probability maps

mean probability maps
standard deviation maps

for the whole Mediterranean





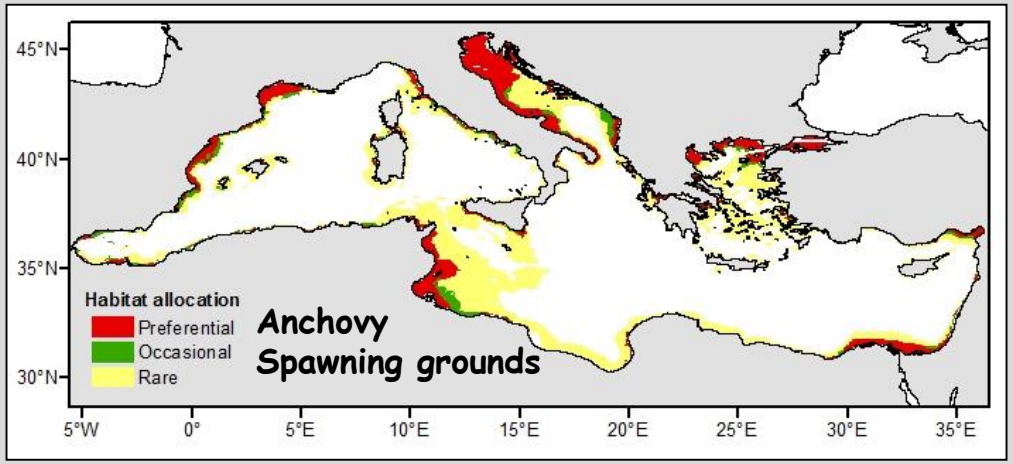
Giannoulaki et al. (2013), Fisheries Oceanography

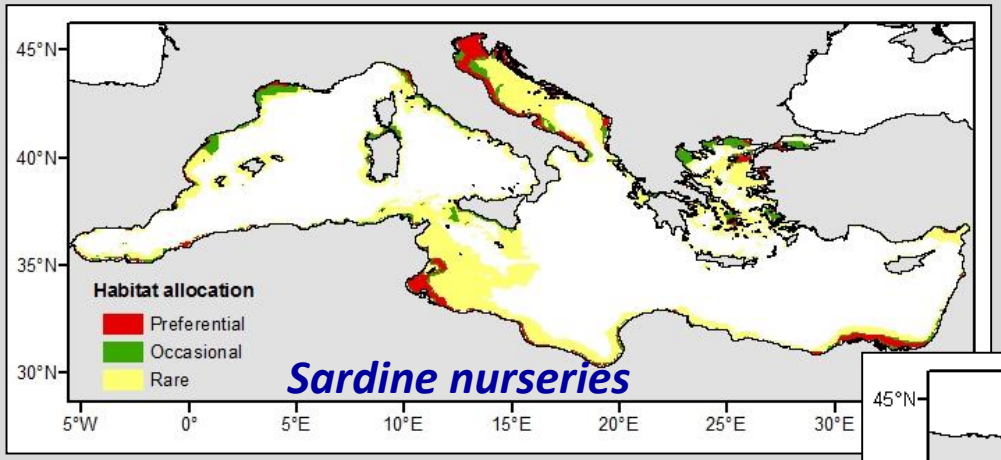
Then habitat allocation maps were obtained based on the following:

Preferential habitat: High mean, low SD

Occasional habitat: High mean, high SD

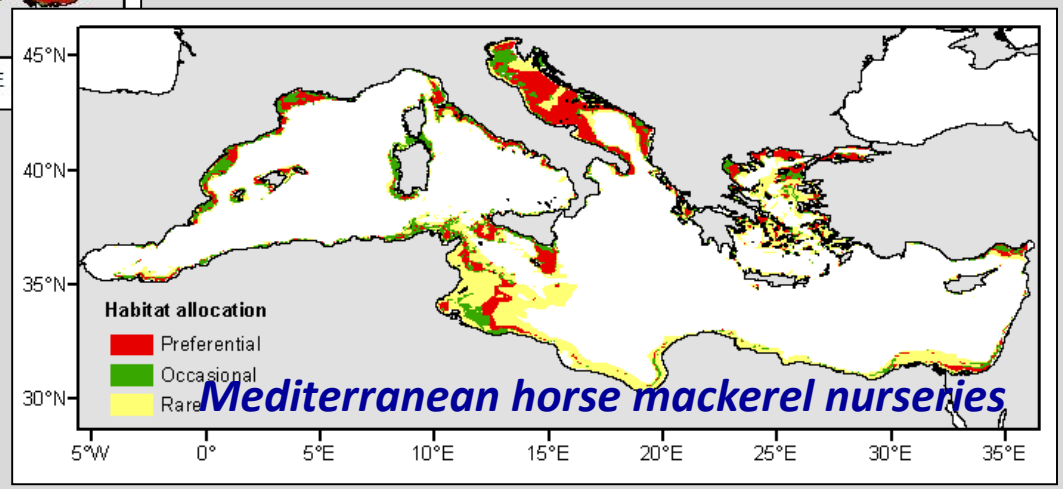
Rare habitat: Low mean



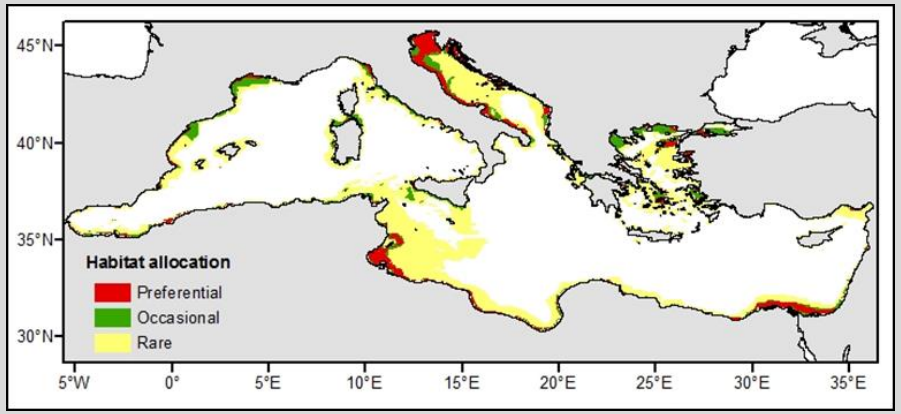


This has been done for the following species (in different publications):

- Anchovy
- Sardine
- Mediterranean horse mackerel
- Mackerel



Practical uses of habitat suitability maps



Provide input to IBMs
&
Examine climate change scenario

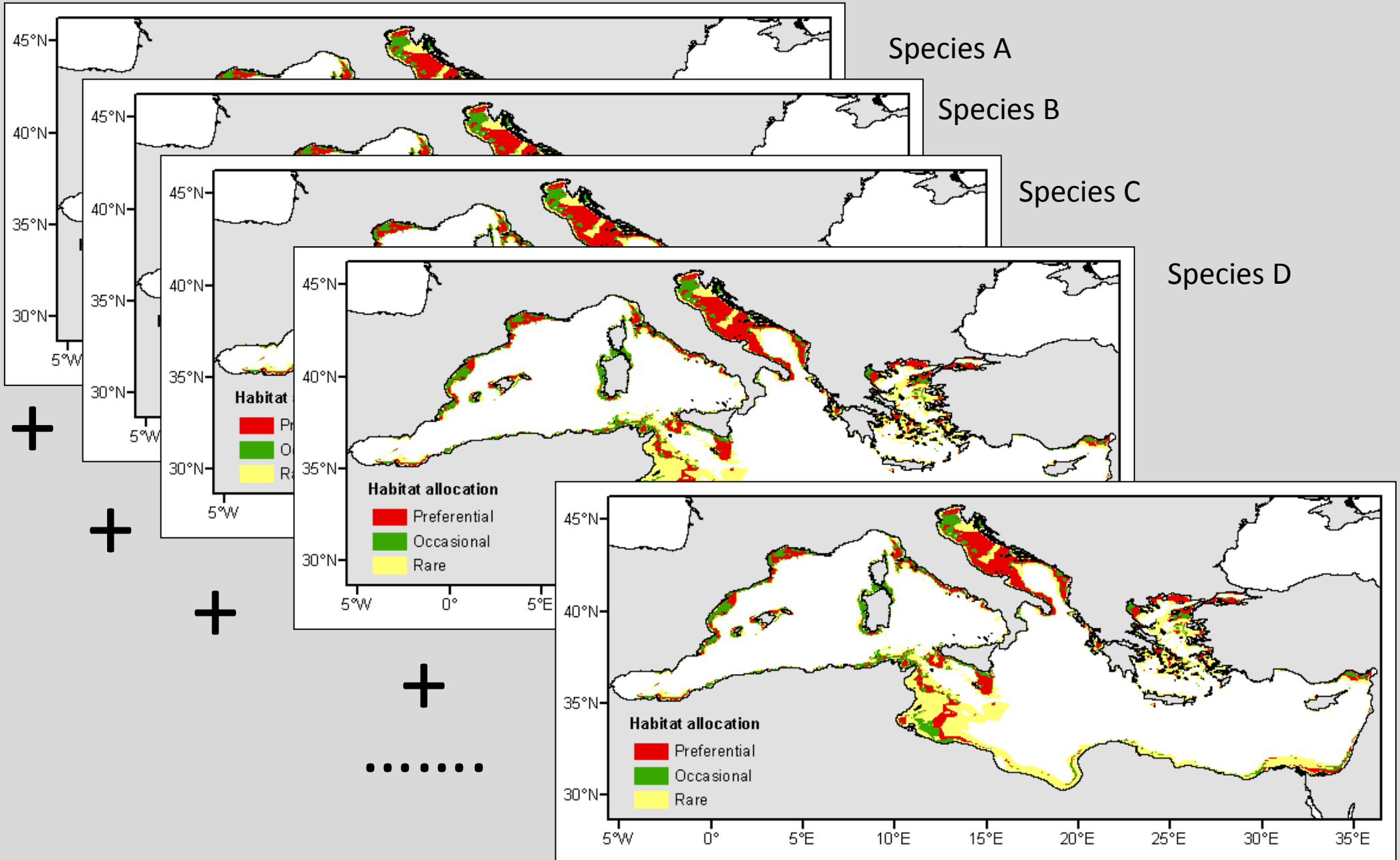
Covariates in other habitat suitability models

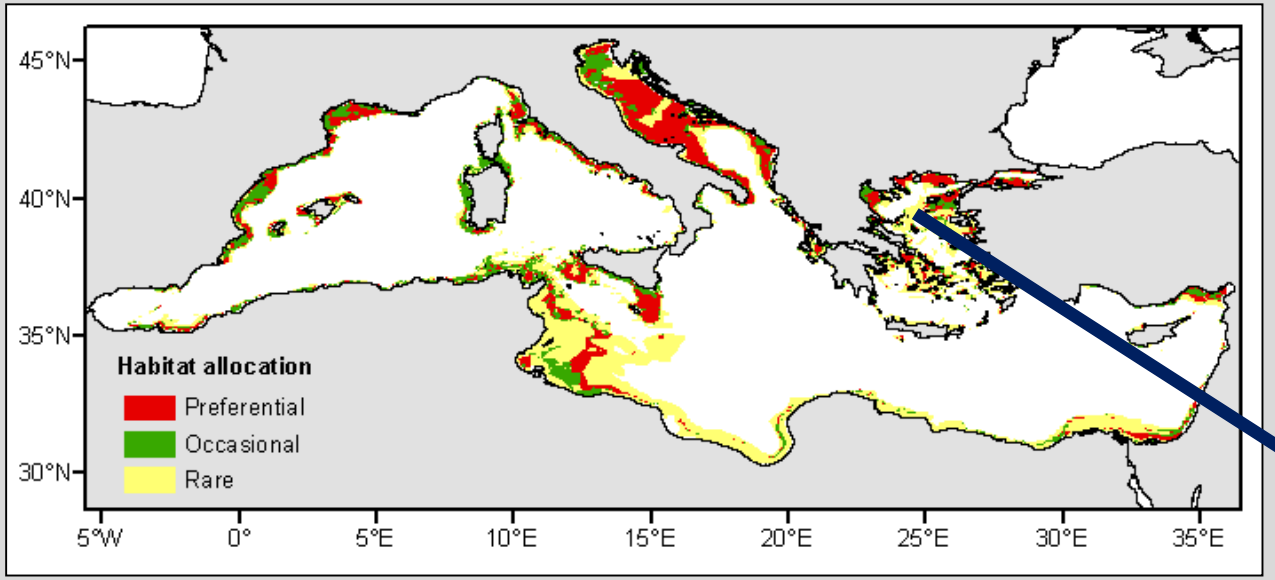
Provide input to Ecosystem models with spatial perspective

Evaluate existing FRAs /MPAs
&
Define new FRAs/MPAs

Set a framework to minimize discards
H2020 MINOW

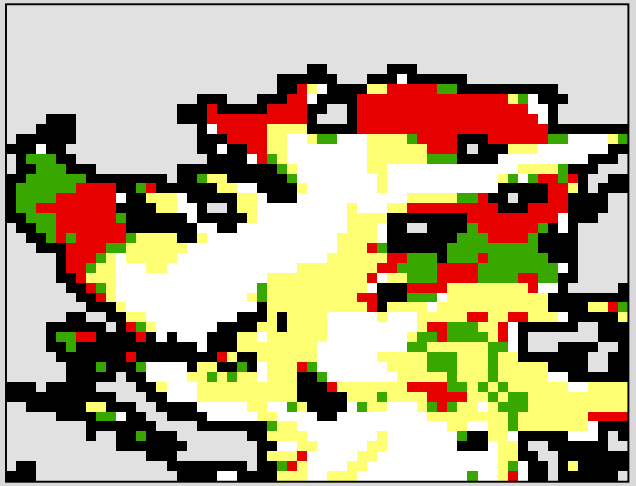
H-2020 MINOW Project… mapping of discards

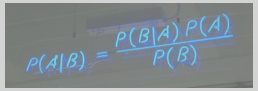




Mapping of total discards online and in real-time with options for incorporating Bayesian priors from fishers

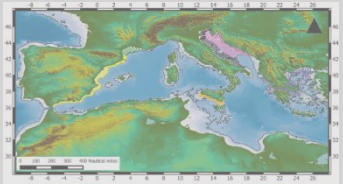
Fishers can zoom in their own area of operation avoid areas and enrich the database



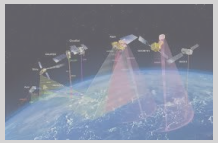
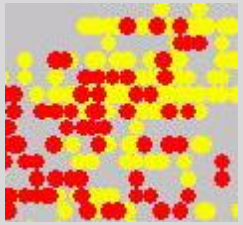


Ecopath with Ecosim
No fish is an island

Climate models
Niche models
IBM
GLMs, GAMs



Classification Tree
Analysis
Random Forests
Boosted Regression Trees
Multivariate Adaptive
Regression Splines
Surface Range Envelope



our ecoscope