Effects of climate change on fisheries

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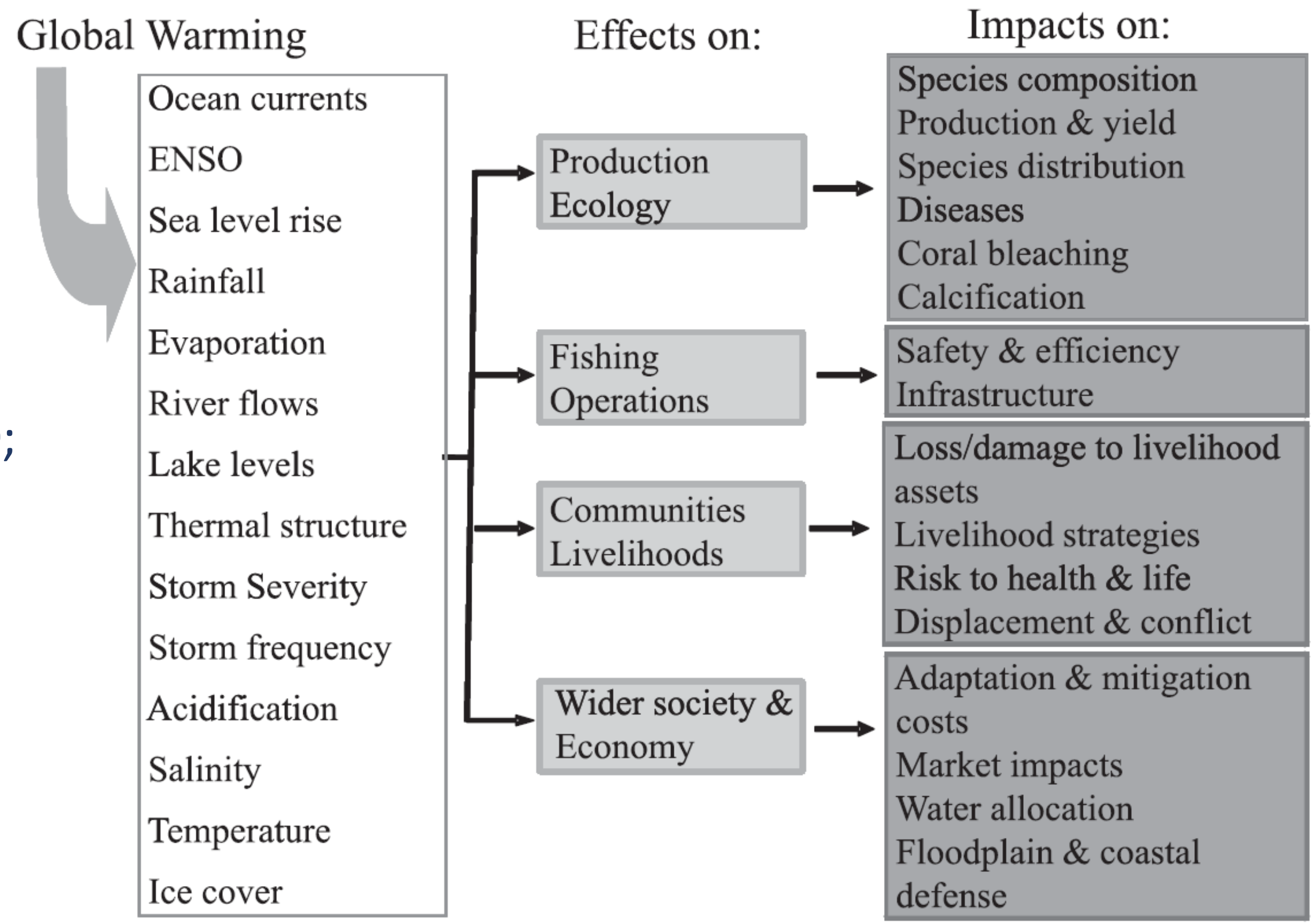
Some impacts of climate change on fisheries

There are several pathways that brings global warming effects to impact on fisheries. Several pathways acts simultaneously thus they are difficult to disentangle. Some are overlooked

Evaluations of vulnerability of the sector on the basis of perceived risk and impacts are semiquantitative (Fortibuoni et al.2020; Hidalgo et al., 2018). Quantitative direct assesments comprehensive of all factors are general.



Badjeck et al (2010) Marine Policy

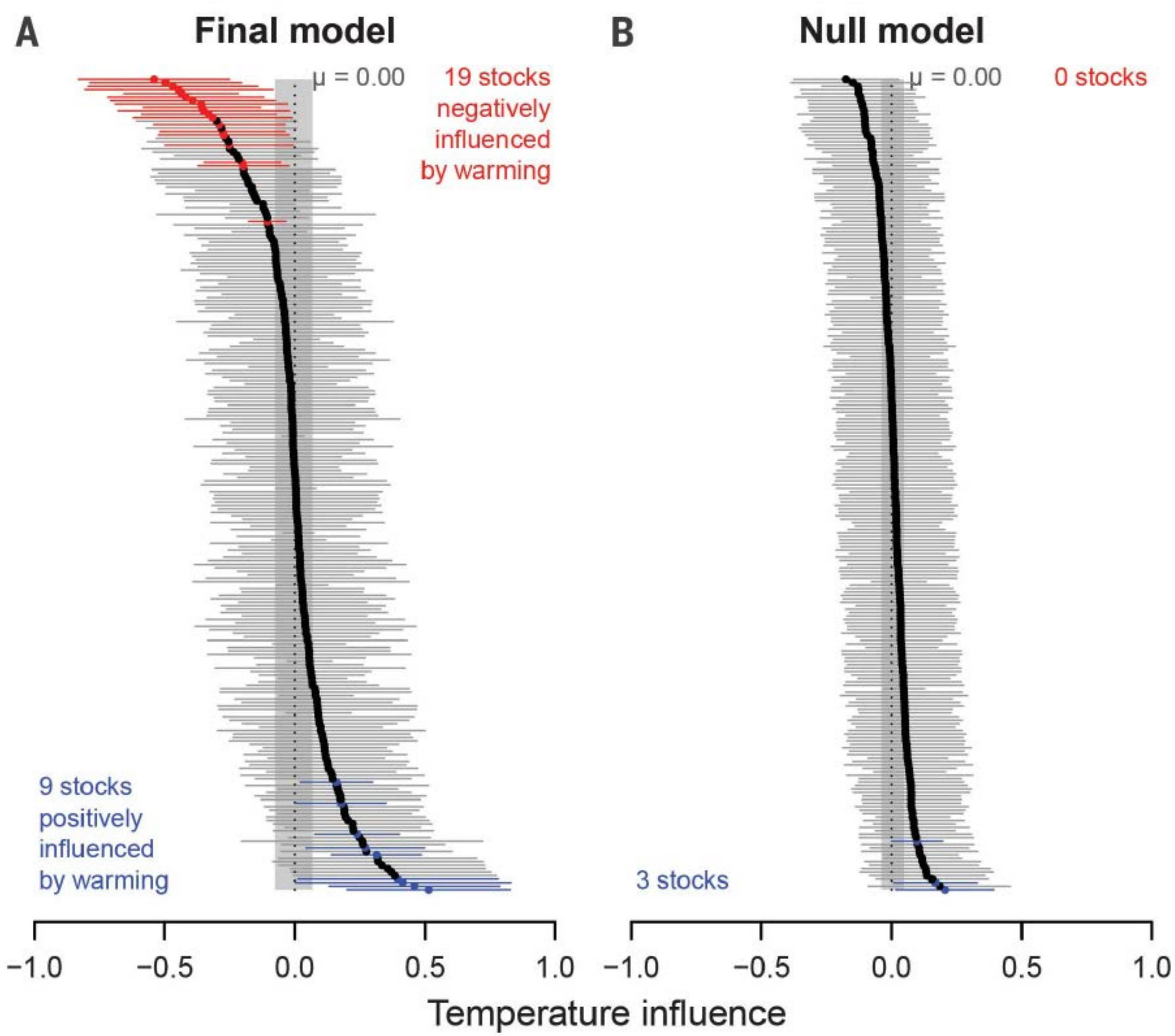
Impacts of warming on historical fish productions

Global work with stock assessment models to detect influence of warming on productivity of 235 fish and invertebrate populations worldwide.

The model is used to hindcast temperature driven changes in MSY from 1930 to 2010.

The analyzed populations represent 124 species, 38 ecoregions, and ~33% of reported global catch.

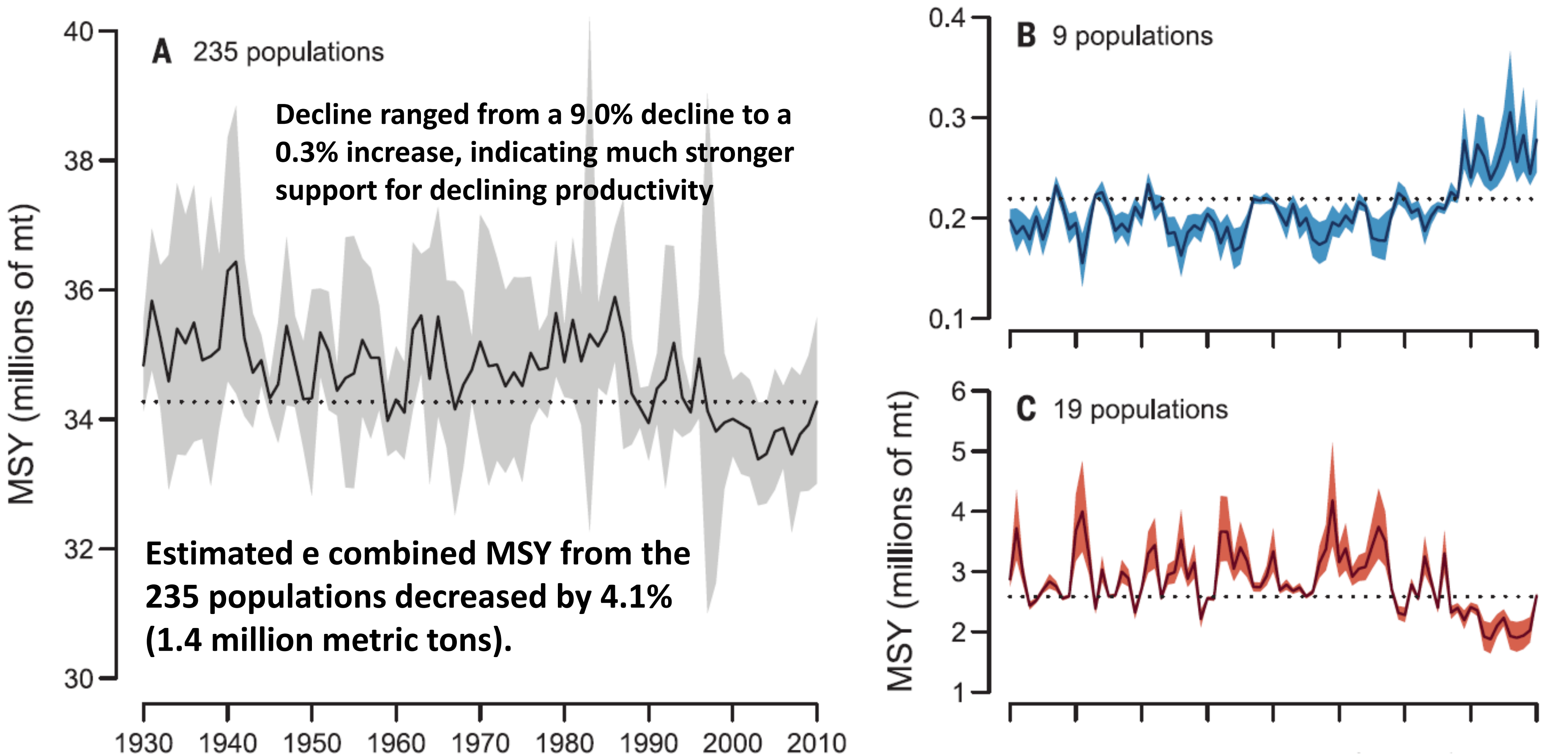
19 stocks are affected negatively by warming, 9 are affected positively.



Free et al., Science 363, 979–983 (2019)

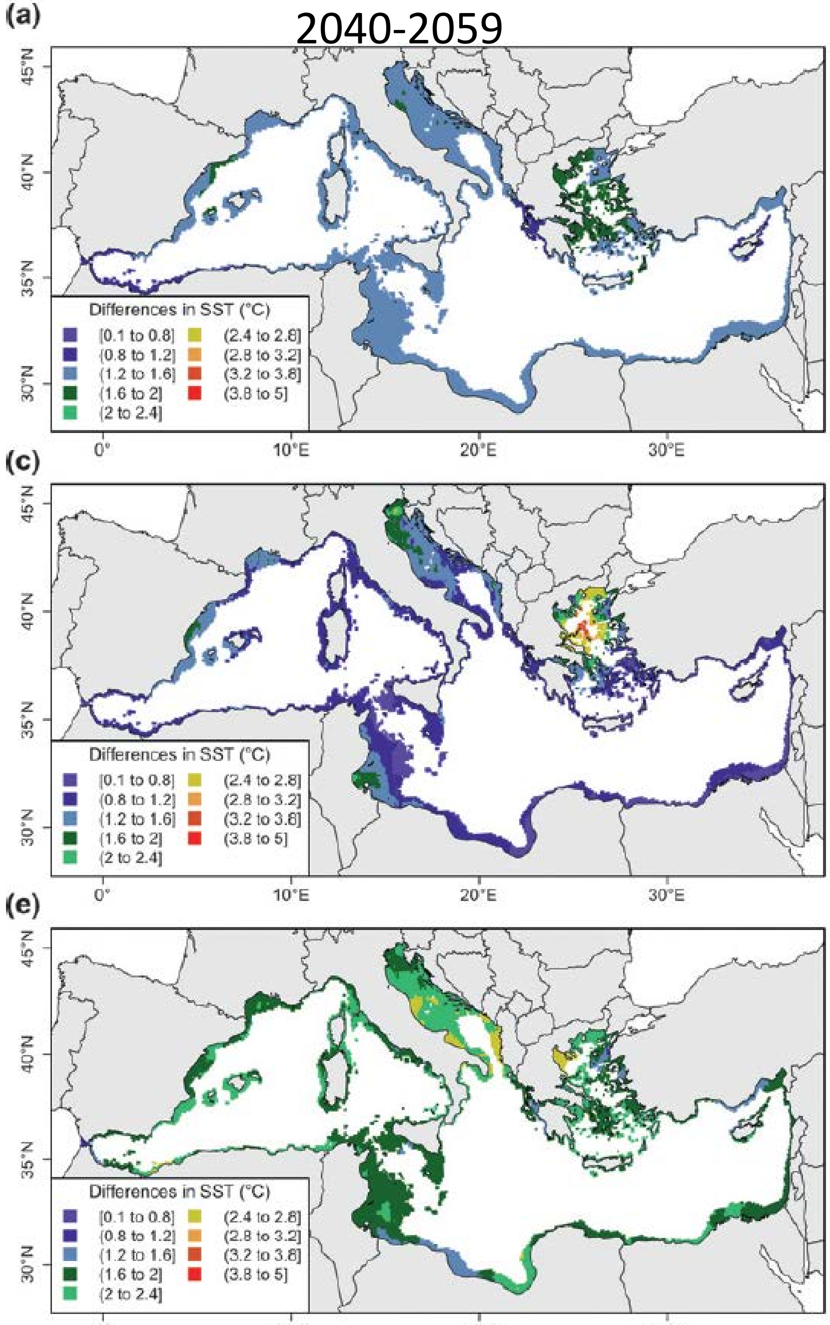
Warming effects on production

Free et al., Science 363, 979–983 (2019)



Losses from populations responding negatively to warming outweighed gains from those responding positively because negatively responding populations constituted a larger biomass. **Preventing overfishing and developing management strategies that are robust to temperature-driven changes in productivity are essentia**

Not only average temperature…

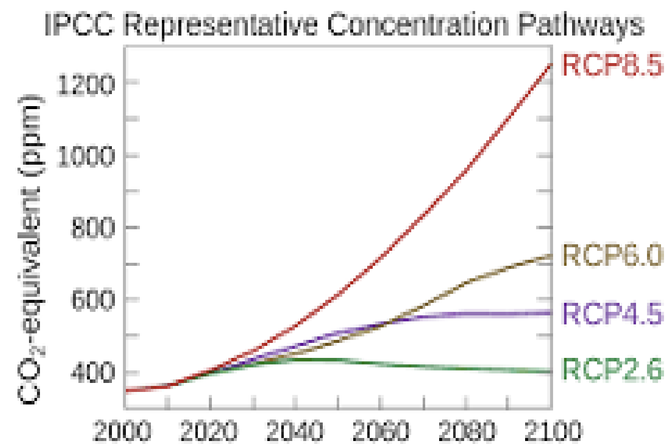


Mean SST

Min SST

Max SST

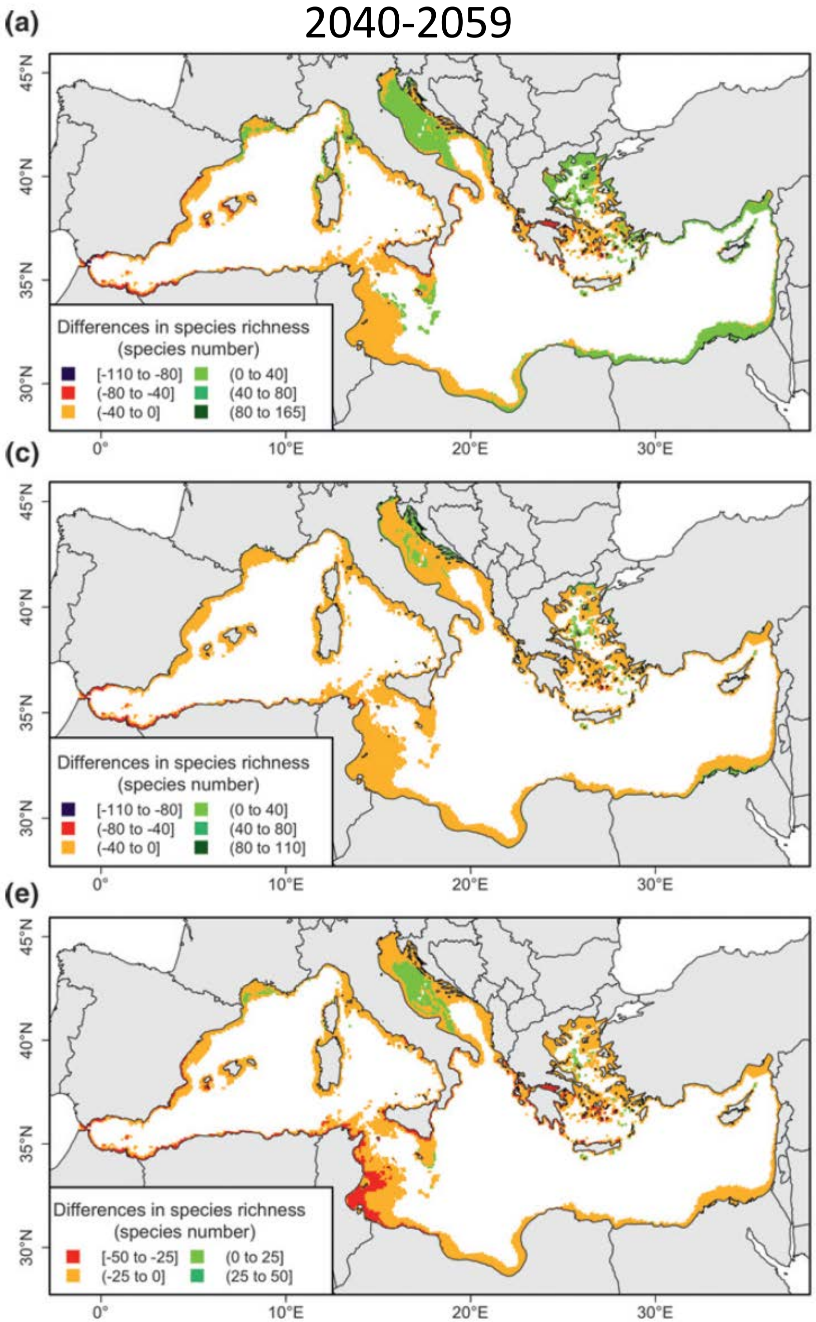
Differences between A2 scenario in 2040-2059 with reference in 1961-1980



This scenario was considered as conservative for future prediction of global warming (IPCC, 2007). It assumes a very heterogeneous world that preserves local identities, and which results from a continuously growing human population and an atmospheric CO2 concentration of 815 p.p.m. by 2099 (IPCC, 2007).

Albuoy et al., Journal of Biogeography (2013)

Changes in species richness



all species

assessed the potential distribution of **288** fish species using spatial distribution models: species can move and can increase in density; they can also change in size

Commercial species

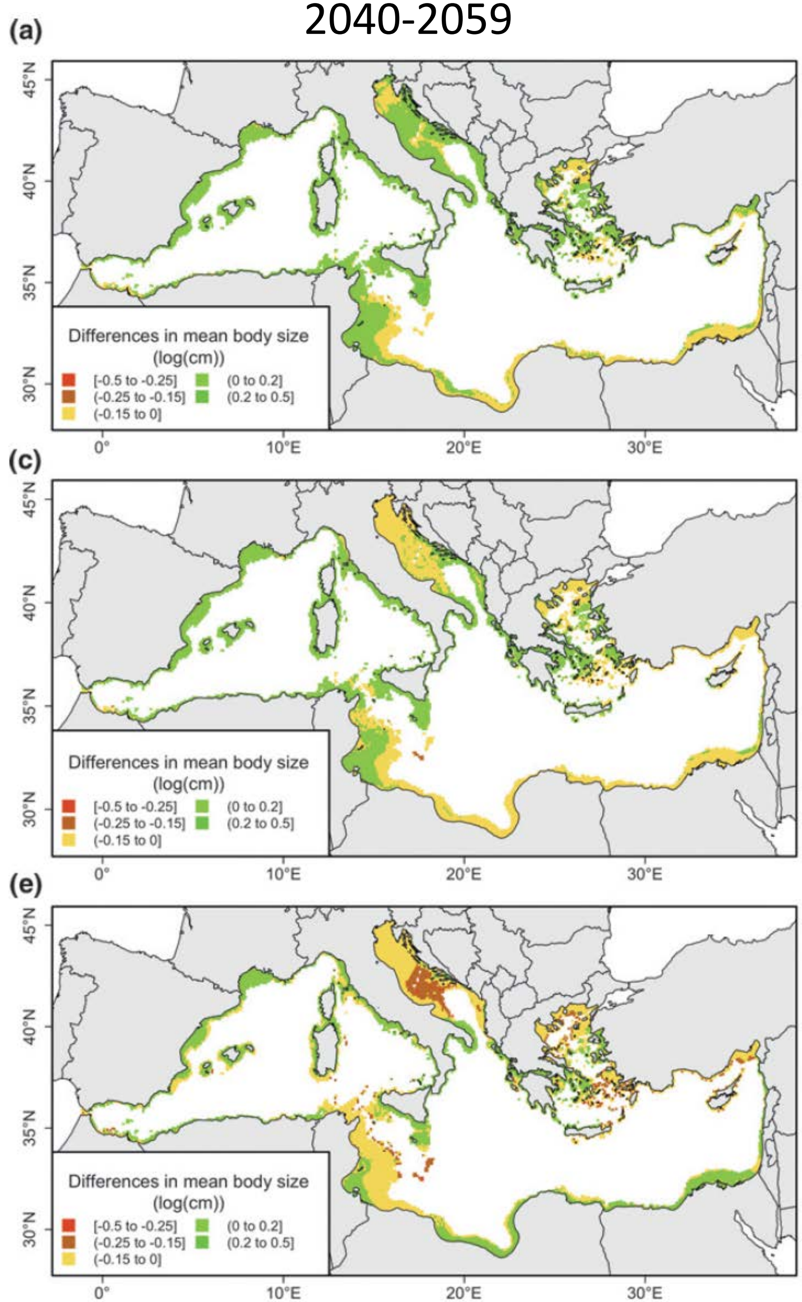
Differences between A2 scenario in 2040-2059
With reference in 1961-1980

Species of interest for recreational fisheries

By 2040–59, model projections showed that 61.4% of the continental shelf area would experience a reduction in species richness whereas the remaining area would gain species

Effects on mean body size

2040-2059



Mean body size all species

Commercial species

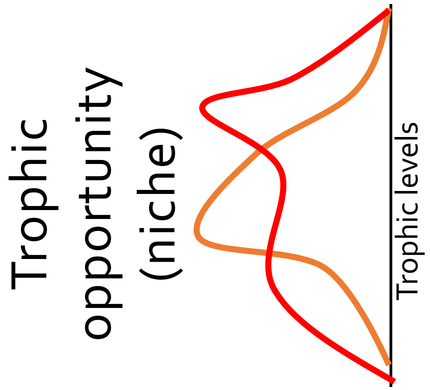
Species of interest for recreational fisheries

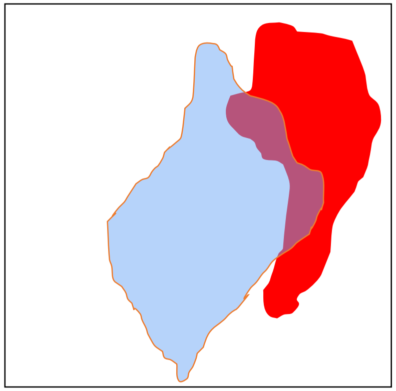
Differences between A2 scenario in 2040-2059
With reference in 1961-1980

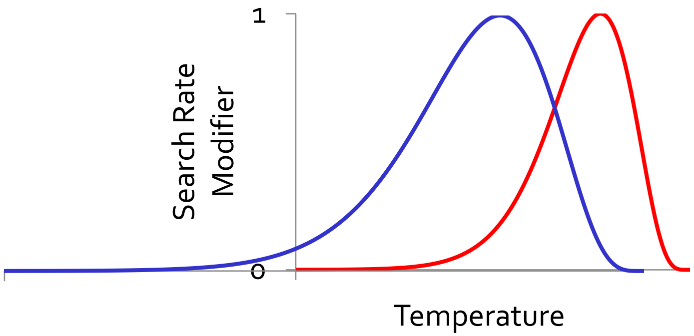
By 2040–59 SDMs projected a decrease in (geometric) mean body size for 25.7% of the continental shelf area and an increase over 74.3% of its area. By 2040–59, roughly half of the continental shelf area (56.2%) showed a projected increase in geometric mean body size for commercial fish species. Similarly, 53.9% of the continental shelf area showed a decrease in geometric mean body size for recreational fish species

Combining food and thermal preferences

Although there are evidences that population productions, movements and opportunities for invasion of species in marine enviroments are driven mainly by temperature changes (Givan et al., 2017), these are not the only factor. Warming effects is important but not the only one.





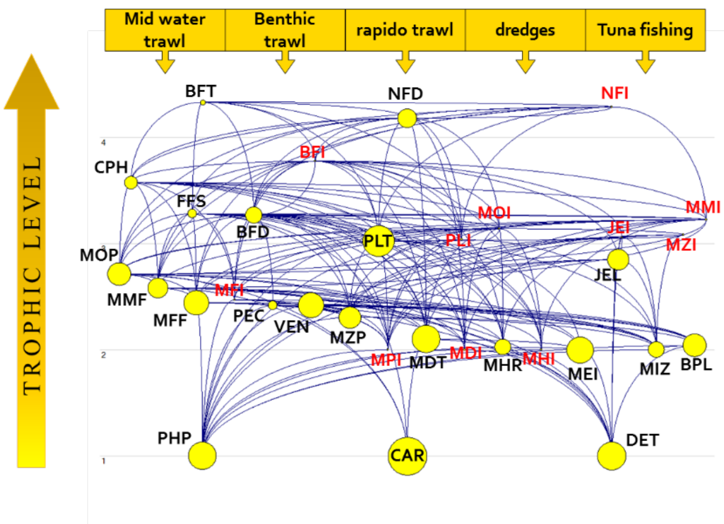


For instance competition for trophic ecological niches are also important for explaining dynamics of residents and potential invasive species

Libralato et al., Frontiers in Marine Science (2015)

Combining effects of warming, competition and alien species

Northern Adriatic case study. Medium complexity model (based on # functional groups). Professional fishing accounted; Increase of Temperature by 1 °C, allowing invasion at all trophic levels

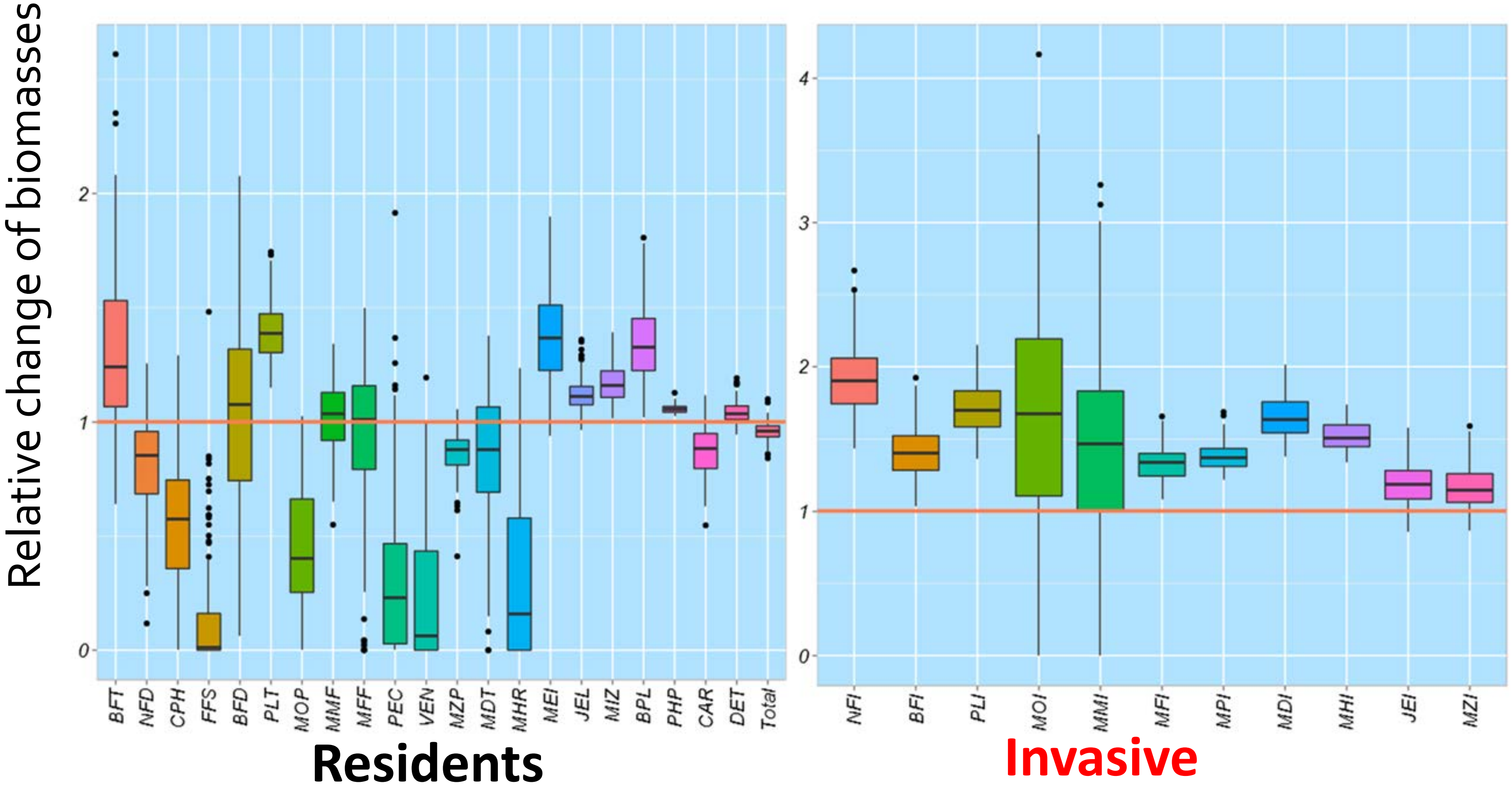


Invasive resident

	Autochthonous groups		**Invasive groups**
BFT	Bluefin Tuna		
NFD	Nekton Feeders	NFI	Nekton Feeders Invasive
CPH	Cephalopods		
FFS	FlatFish		
BFD	Benthic Feeders	BFI	Benthic Feeders Invasive
PLT	Planktivores	PLI	Planktivores Invasive
JEL	Jellyfish	JEI	Jellyfish Invasive
MOP	Macrobenthic Predators	MOI	Macrobenthic Predators Invasive
MMF	Macrob. Mixed-Feeders	MMI	Macrobenthic Mixed-Feeders Invasive
MFF	Macrob. Filter-Feeders	MFI	Macrobenthic Filter-Feeders Invasive
PEC	Pectinidae		
VEN	Veneridae		
MZP	Macrozooplankton	MPI	Macrozooplankton Invasive
MDT	Macrobenthic Detritivores	MDI	Macrobenthic Detritivores Invasive
BPL	Bacterioplankton		
MHR	Macrobenthic Herbivores	MHI	Macrobenthic Herbivores Invasive
MEI	Meiobenthos		
MIZ	Microzooplankton		
PHP	Phytoplankton		
	Non-living groups	**Fishery**	
CAR	Carcass	Tuna Fishing	
DET	Detritus	Otter Trawl	
		Rapido Trawl	
		Midwater Pair Trawl	

Estimating winners and loosers

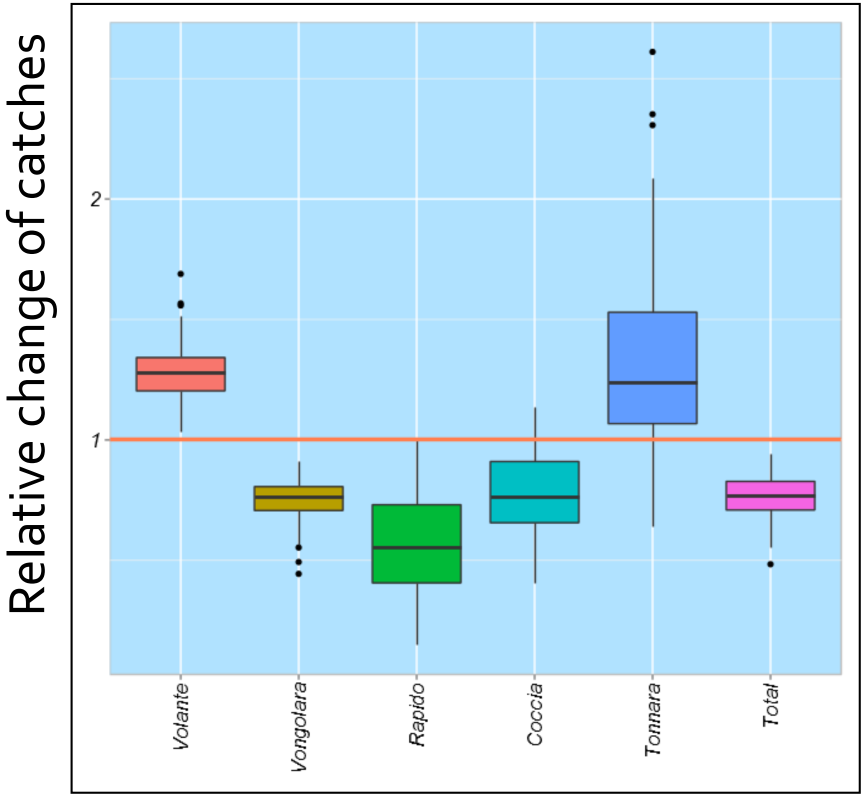
Temperature increase of 1°C in 10 years, results taken at 30 years. Results show that success of invasion depends not only on thermal preference but also on complex prey-predatory opportunities (trophic niche). Residents also have winners and loosers



Libralato et al., Frontiers in Marine Science (2015)

Effects on realistic local fisheries

Temperature increase of 1°C in 10 years, results taken at 30 years. Results show that success of invasion depends not only on thermal preference but also on complex prey-predatory opportunities (trophic niche)

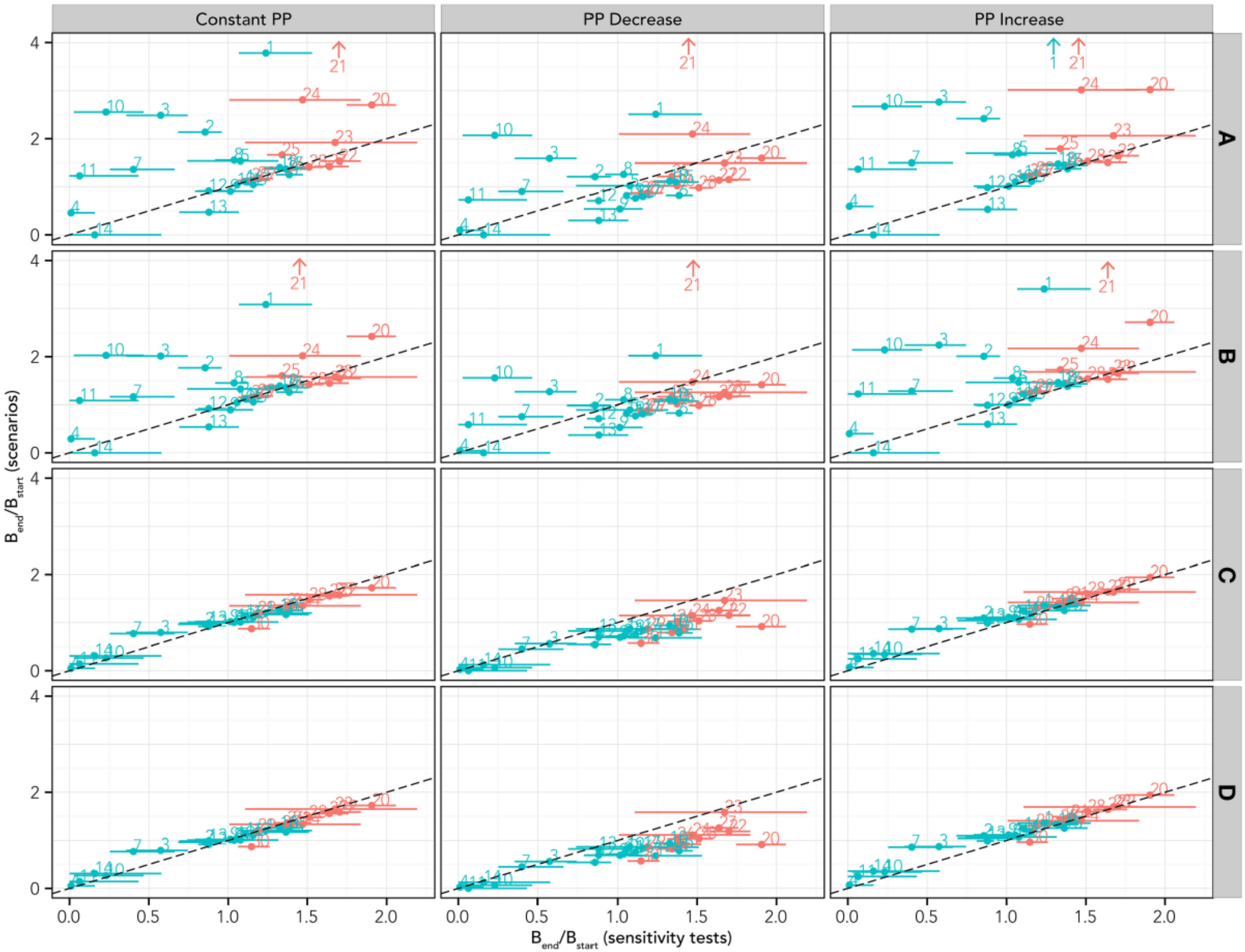


Libralato et al., Frontiers in Marine Science (2015)

At local scale, on a projected increase of temperature such as 1°C (2040-2050), allowing species compensation, invasion and resident decline will result in increased opportunities for fishing fleets targeting some pelagic groups (large pelagics mainly).
Important negative effects however on total fisheries (decline of catches in the order of -25%) are projected with consistent decline for beam trawl fisheries (-40%), and otter trawl (-25%). Also dredges are affected.
The limitations of the work is also on the poor capabilities to represent all future fisheries opportunities with new species

warming and primary productivity (PP)

Index	Group	
1	BFT	AUTOCHTHONOUS
2	NFD	AUTOCHTHONOUS
3	CPH	AUTOCHTHONOUS
4	FFS	AUTOCHTHONOUS
5	BFD	AUTOCHTHONOUS
6	PLT	AUTOCHTHONOUS
7	MOP	AUTOCHTHONOUS
8	MMF	AUTOCHTHONOUS
9	MFF	AUTOCHTHONOUS
10	PEC	AUTOCHTHONOUS
11	VEN	AUTOCHTHONOUS
12	MZP	AUTOCHTHONOUS
13	MDT	AUTOCHTHONOUS
14	MHR	AUTOCHTHONOUS
15	MEI	AUTOCHTHONOUS
16	JEL	AUTOCHTHONOUS
17	MIZ	AUTOCHTHONOUS
18	BPL	AUTOCHTHONOUS
19	PHP	AUTOCHTHONOUS
20	NFI	INVASIVE
21	BFI	INVASIVE
22	PLI	INVASIVE
23	MOI	INVASIVE
24	MMI	INVASIVE
25	MFI	INVASIVE
26	MPI	INVASIVE
27	MDI	INVASIVE
28	MHI	INVASIVE
29	JEI	INVASIVE
30	MZI	INVASIVE



No Fishing

-20% Fishing effort

Fishing only residents

Fishing BAU

Some remarks

Scienetific literature is bringing us several evidences that climate change are negative on fisheries

- The main studied effect is the increased temperature and SOME of its direct effects on population growth/metabolism/reproduction success.
- In this context the impacts of increased temperatures are having winners and loosers even among resident local species
- In general however there is an increase of metabolic costs and thus a net loss with decreased future productions
- Movements of species and arrival of alien species is going to represent in some cases a compensation of criticalities (e.g. bluefish; bluecrab)
- Accounting for termall, alien and competition effects results in negative future effects even including some adaptation of fisheries to new species;
- Other effects might be considered relevant however, such as increase pH and especially future changes in primary production: at the level of phytoplankton the climatic effects (less mixing, higher SST etc) are resulting in decrease in PP (because of nutrient limitation and higher metabolism) with overwhelming general effects on marine food webs.

Thank you!

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