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SOCIOECONOMIC IMPLICATIONS OF THE OBSERVED CLIMATE CHANGE DISTRIBUTIONAL IMPACTS IN COMMERCIAL MARINE SPECIES

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MOTIVATION

Although broad evidence exists on the response of marine life to climate change (Poloczanska et al., 2013), few studies address the implications of those shifts for fisheries and fishery-dependent communities (Sumaila et al., 2011). One of the main impacts on fisheries are the changes in stock distribution due to climate change. We collect the evidence on these shifts and discuss socioeconomic implications for affected fishing countries.

GOAL

This study aims to contribute to the understanding of the economic consequences of climate change driven responses of exploited marine species.

RESEARCH QUESTIONS

- What is the existing evidence on climate change driven distributional changes for commercial marine species?
- What countries and fisheries are more heavily impacted?

METHODS

1. Literature review for studies that meet the 4 criteria:

Evidence of distributional shift	Marine commercial species
Shift explained by climate change	Has the magnitude of the shift

17 of 124 potential **studies met the criteria**

2. Systematic data collection to construct a dataset (n=number of observations)

Latitude n=224	Depth n=209	Boundary Latitude n=32	Area n=19

Dataset of 496 impact observations for 146 marine commercial species

3. Data standardization. Common species names, countries, units, measures, etc.

4. Data analysis. Integration of new data on country catches and species

Fishbase → Species information

Sea Around Us → Country catches and landings

Figure 1. Location of the 17 case studies of distributional impacts from our literature search. Colors indicate the number of observations per study. Note that Pinsky et al., 2013 comprises 9 spatial locations.

Figure 2. A) Latitude, B) Depth and C) Boundary latitude frequency distributions of fish shift rates. D) Climate change variables used to explain the spatial impacts. E) Demersal, pelagic and reef associated fish frequency distributions (source: Fishbase, 2017). F) Price category frequency distribution (source: Fishbase, 2017).

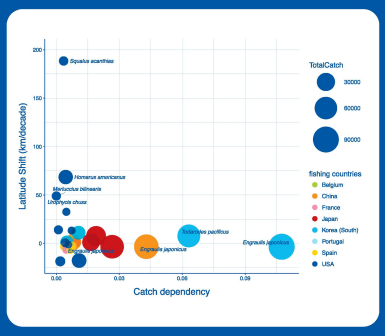

Figure 3. Countries dependency on fish species with latitudinal shifts. Impacts are shown for fishing countries in the EEZ where climate change has been studied, and we show the fishing country dependency on that specis catch (x axis) and the total country total landings (tonnes).

RESULTS

- Around 40% of our observations are concentrated in the North Atlantic Ocean and 25% in the Bering Sea. No observations have been recorded in the southern hemisphere (Fig. 1).
- Latitude presents a strong directionality with around 70% of latitude and 80% of boundary latitude observations moving poleward (Fig. 2 A, C). Around 57% of depth observations indicate stocks shifts towards deeper zones (Fig. 2 B), while the area occupied shows a mixed response.
- Climate velocity -the rate and direction that climate shifts across the landscape- is the main variable used to explain latitudinal and depth shifts (Fig. 2 D); compromising the 67% of the observations (Pinsky et al., 2013).
- Demersal species are the most well-represented group, compromising at least the 60% of the observations for each distributional impact (Fig. 2 E).
- Spatial shifts mostly happen to species with high and very high commercial importance, although almost 40% of them keep low market values (Fig. 2 F).
- Japan, South Korea and China are the fishing countries having a higher dependency on the impacted species for their capture fisheries (Fig. 3)

CONCLUSIONS

- Results highlight a poor scientific coverage of evidence on shifting stocks for commercial species around the world, and more evidence is needed over the globe that significantly links climate change with changes in stocks distribution.
- Most studied species are demersal, have low market values and climate change has been considered as climate velocity due to one large study conducted by Pinsky (2013).
- From our socioeconomic analysis with Sea Around Us Project data (Pauly and Zeller, 2015), we can see that the stocks where countries present the greatest economic dependency (Fig. 3) are not associated with the greatest impacts. In other words, the greatest impacts that we collect are not related to highly dependent countries for that fishery.
- However the socioeconmic analysis looses some observations when catch data for the species is not available for that specific EEZ and time. Further global databases need to be explored to overcome this.
- The higher latitude shifts observed in the database take place in the United States waters to 3 different species (Fig. 3).
- The main evidence that we are able to collect from the literature relies on latitudinal and depth shifts, while area changes and boundary changes are less studied an the evidence is not enough to perform a socioeconomic analysis.
- Future research should look at the implications of these shifts in terms of the countries fishing strategies to further understand the implication of climate change in shifting stocks and the potential of countries and fisheries for adaptation.

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Socioeconomic implications of the observed climate change distributional impacts in commercial marine species

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Abstract

The role of climate change in marine species distributional shifts is now broadly recognized and globally reported. Although wide evidence exists on the ecological impacts to marine taxa worldwide, the socioeconomic impacts of such changes remain unexplored. Here, we synthesize the implications for fisheries and fishery-dependent communities behind this evidence. First, we conduct a systematic literature search for distributional impacts of climate change on commercial species. Only 18 out of 112 potential articles meet our criteria of a spatial shift significantly explained by climate change. Second, based on these articles we construct a dataset gathering 175 observations for 70 species. We find four types of distributional impacts: latitude, depth, area and boundary changes. Third, we relate our database to stock information (Fishbase) and to country catches and landings (Sea Around Us) using R. While latitudinal and depth shifts show a strong directionality (poleward and deepening shifts), area and boundary changes show a mixed response. The greatest impacts in area and northward shifts happen to lower catchability species. Observed impacts mostly happen to species with high and very high commercial importance although 40% of them keep low market values. Expectedly, Northern countries are the most affected in terms of catches and landed value. Around 70% of our observations are concentrated in the North Sea and North East US shelf. This highlights a poor scientific coverage on shifting stocks of commercial species elsewhere, and thus a lack of knowledge on the socioeconomic implications, a crucial matter for climate change adaptation.

Keywords: climate change, shifting stocks, latitude shift, fisheries, commercial stocks, fishbase, sea around us, meta-analysis, fisheries dependence.

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