Climate change and the socio-economics of fisheries

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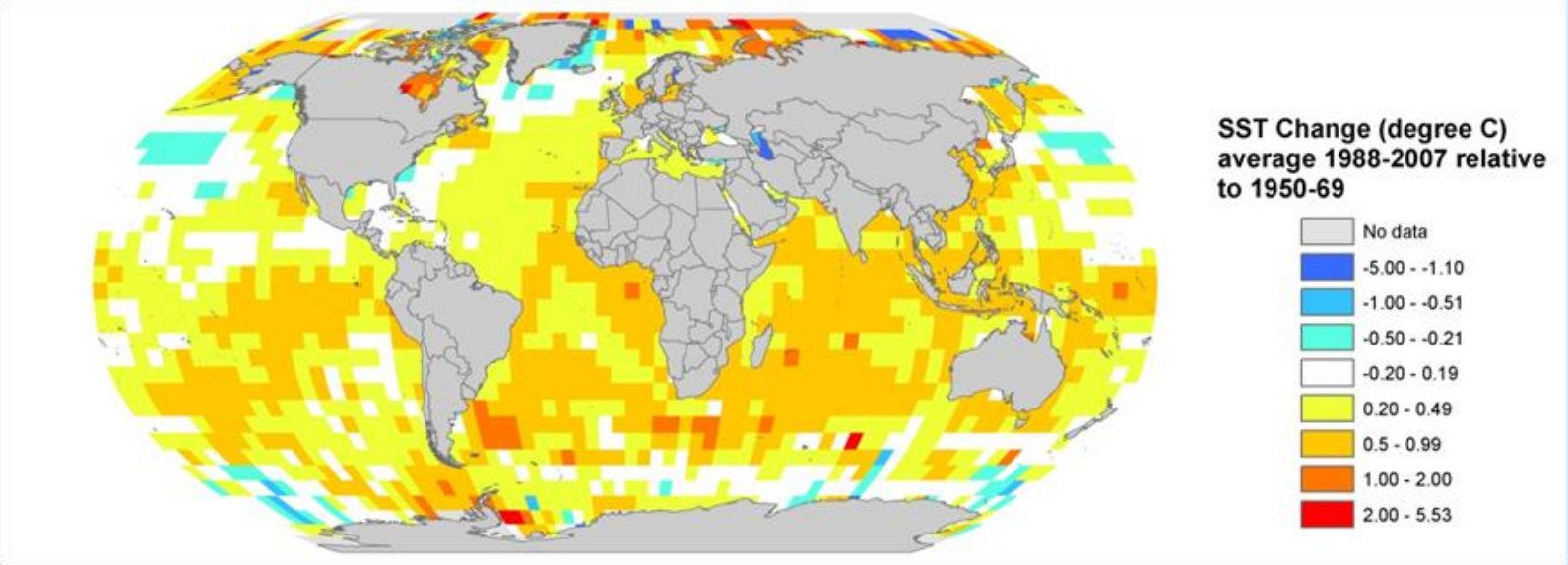
OCEAN CANADA

IOTC Working Party on Socio-Economics
April 1, 2026, Virtual

Fisheries Economics Research Unit
Global Fisheries Cluster

Ocean warming, acidification and deoxygenation



The ocean has become:

- **warmer** (an increase in average temperature of 0.2°C at the top 300 m of the ocean between the 1950s and1990s);
- with **less sea-ice** (summer Arctic sea ice extent is decreasing at 7.4% per decade);
- **more acidic**;
- **less oxygenated** in some area, **higher sea level**, **changes in primary productivity**.

Climate change biophysical impacts

Physical change in the ocean

- ↑ SST;
- retreat of sea ice;
- ↑ acidification;
- ↑ coastal hypoxic & oxygen min. zone;
- ↑ sea surface level.

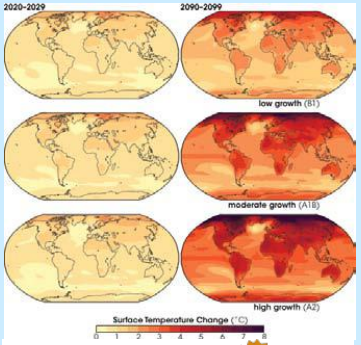
Biological / ecological change in the ocean

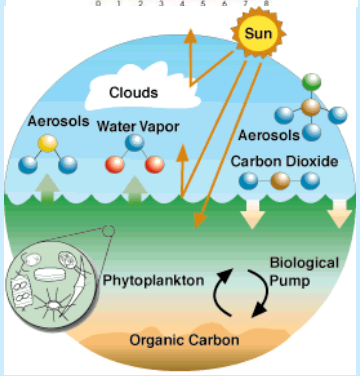
INDIVIDUAL
- Physiology;
- Growth; &
- Body size.

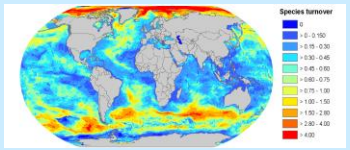
POPULATION
- Distribution;
- Abundance; &
- Recruitment.

COMMUNITY
- Species composition;
- Invasion/extinction.

ECOSYSTEM
- Productivity; &
- Species interaction.







Cheung *et al.* (2010); Hoegh-Guldberg and Bruno (2010); Brander (2010)

Climate change biophysical impacts

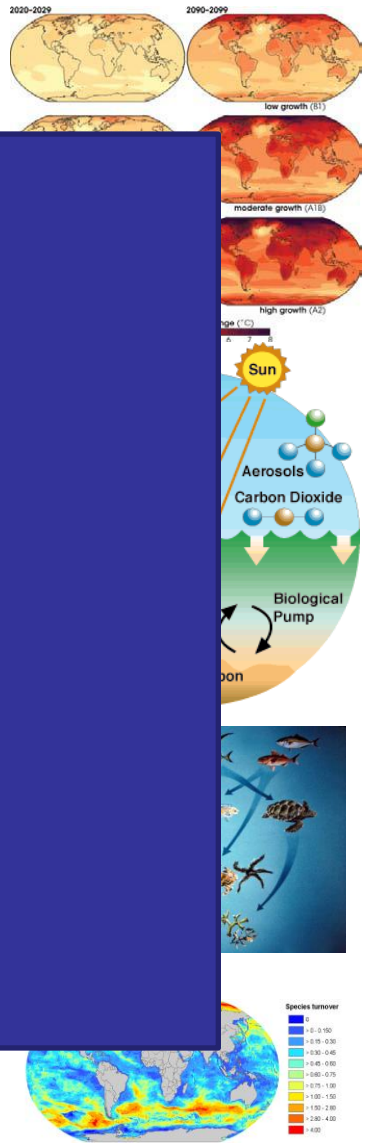
Physical change in

Biological / ecological

1) the productivity

2) distribution

of fish biomass in the global ocean.



Cheung *et al.* (2010); Hoegh-Guldberg and Bruno (2010); Brander (2010)

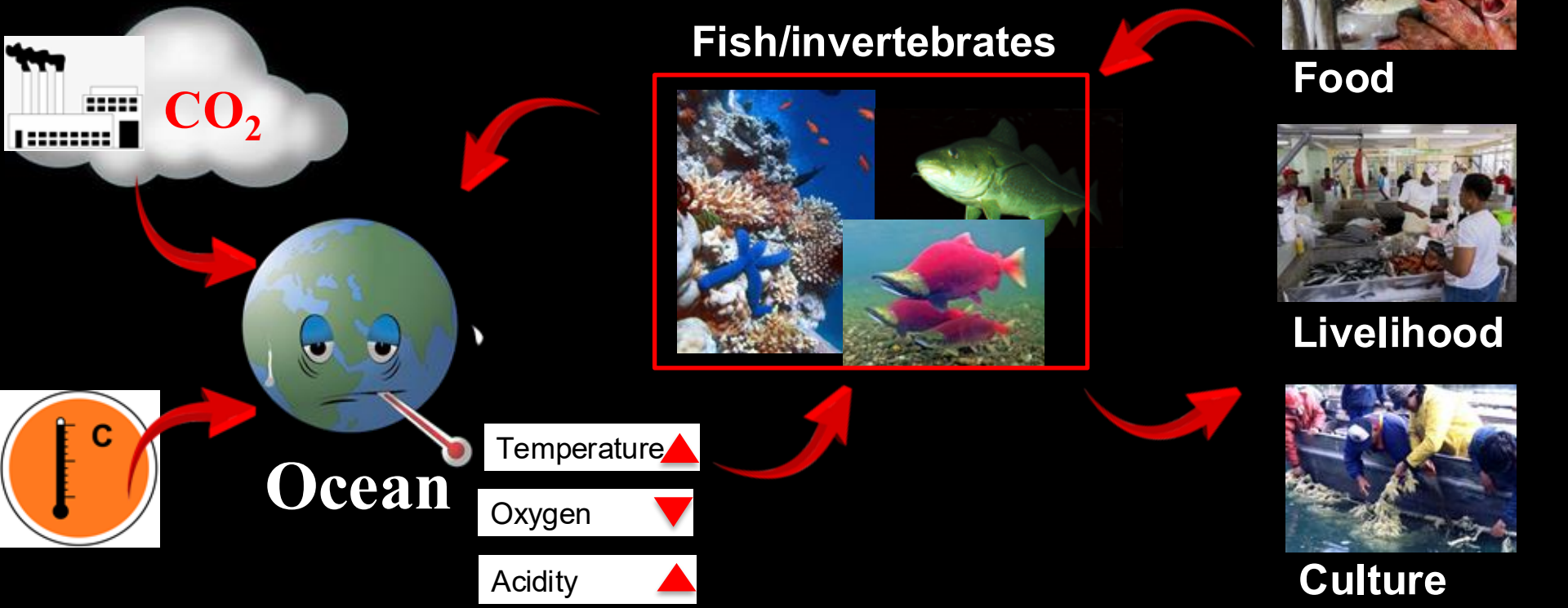
Climate change implications

- It will result in changes in the following:
  - Catches;
  - Food security;
  - Catch (landed) values;
  - Cost of fishing;
  - Profits to fishing companies;
  - Income to fishers;
  - The distribution of benefits to different countries, regions and groups.

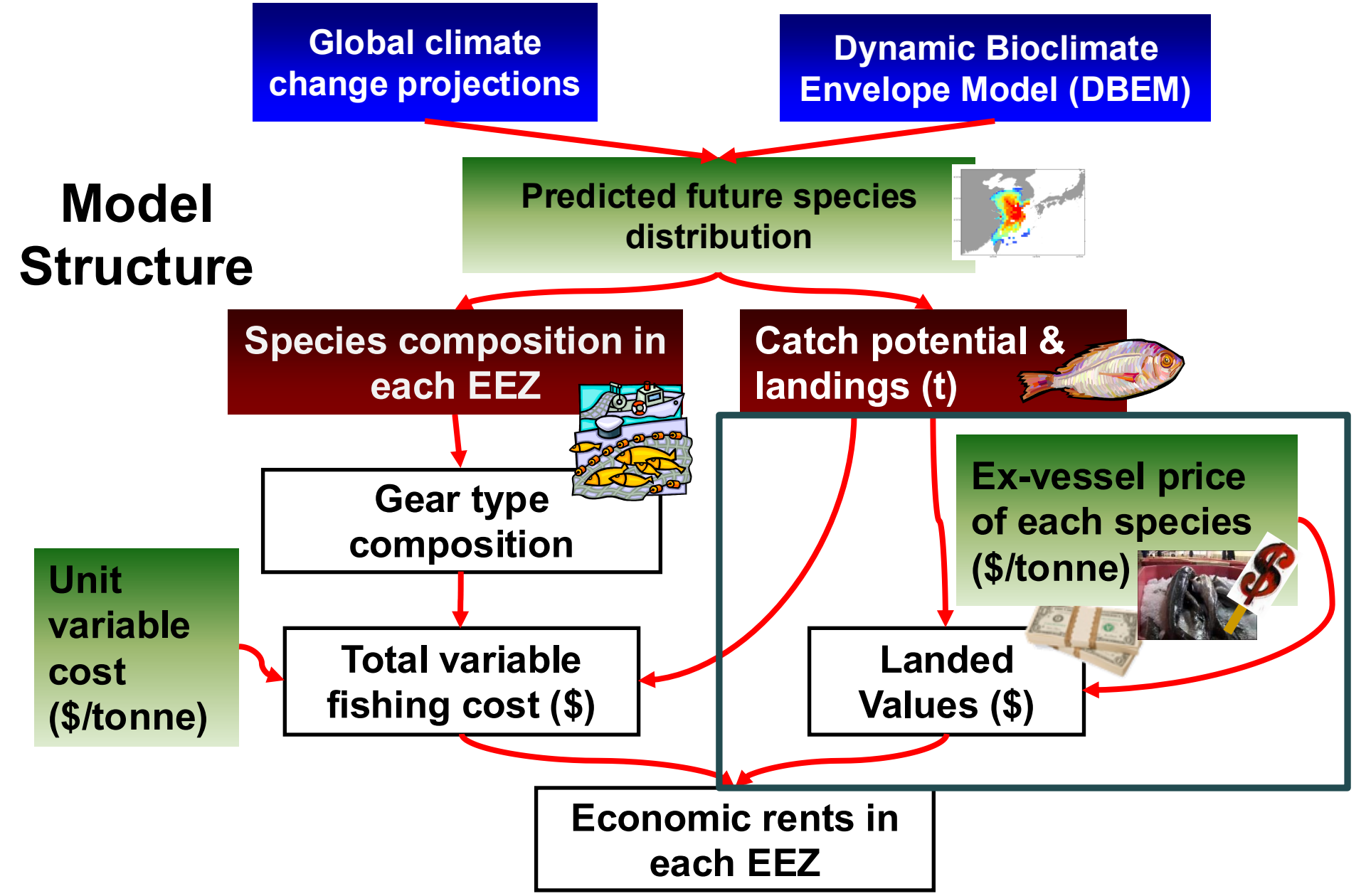
Sumaila *et al*. (2011) *Nature Climate Change*

Climate change implications for fisheries economics and management

Climate change, fish stocks, fisheries and dependent human communities



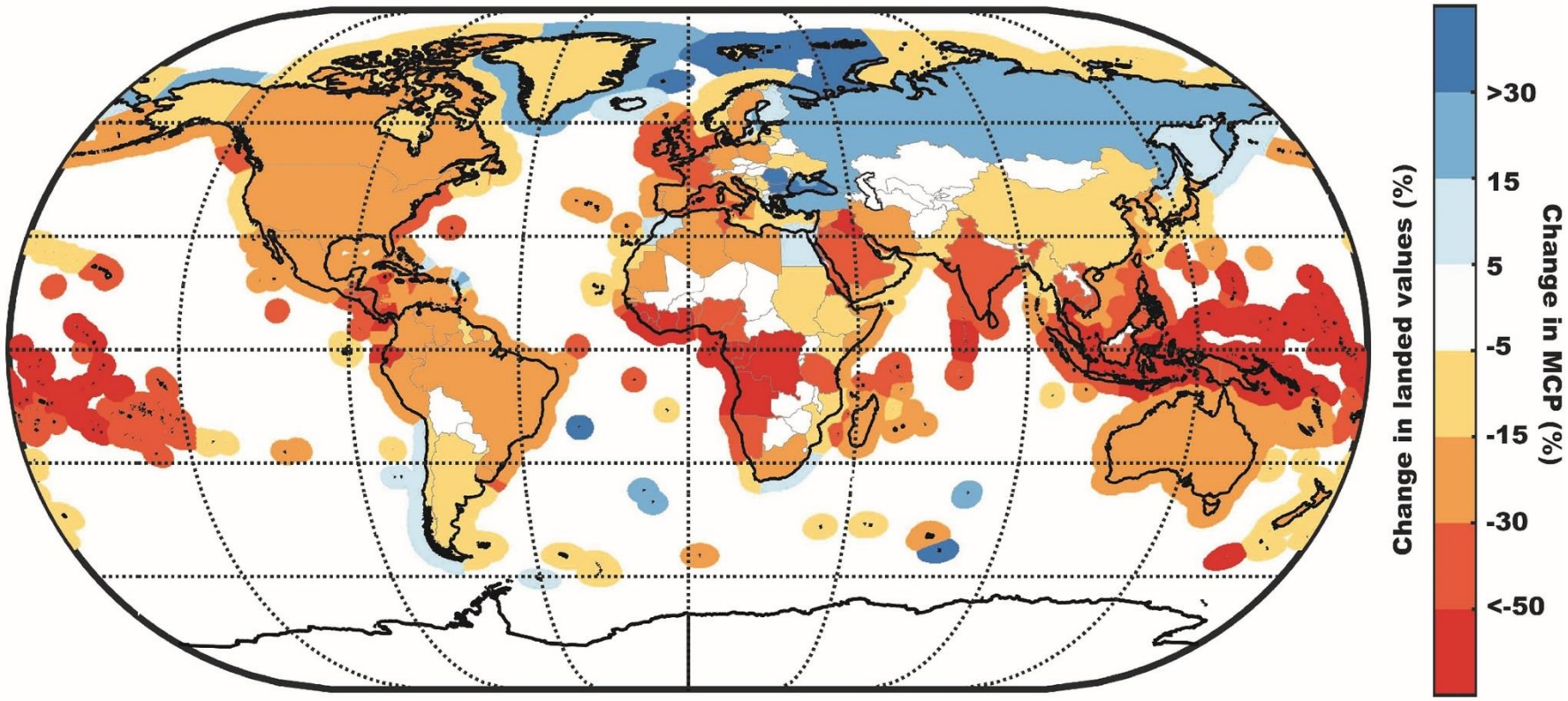
Model Structure



Two contrasting scenarios

- The current high emissions trajectory (Representative Concentration Pathway 8.5, RCP8.5); and
- A reduced emissions scenario (RCP2.6) consistent with the Copenhagen Accord of keeping the global atmospheric temperature increase below 2°C in the 21st century.

Mean percentage change in maximum catch potential (MCP) and revenues in the 2050s relative to current status under RCP 8.5 scenario



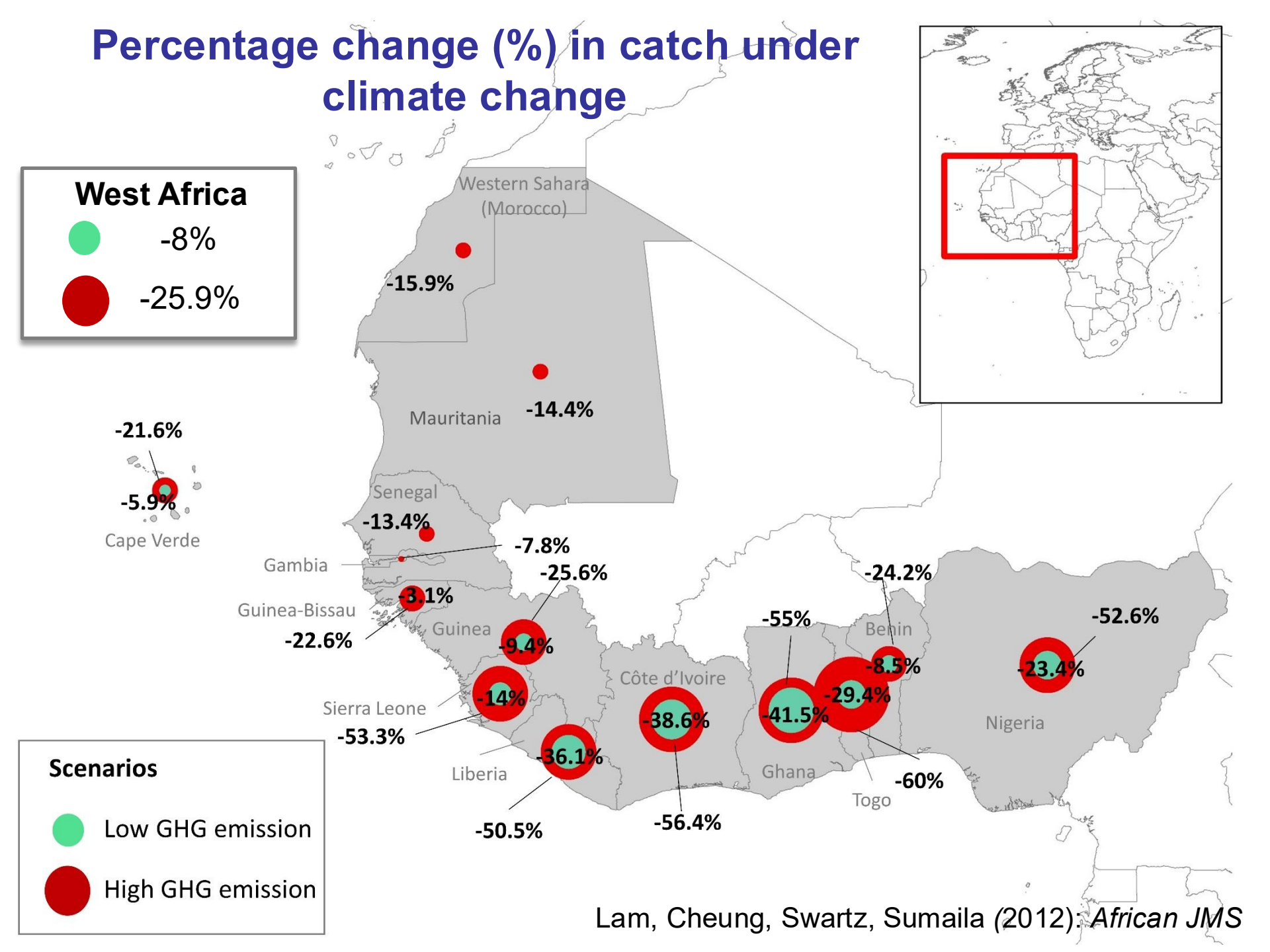
The map is created using MATLAB R2012b, http://www.mathworks.com

	Mean	Standard deviation
% change in MCP	-7.71	4.36
% change in revenues	-10.37	4.20

% change in revenues is 35% more than % change in MCP

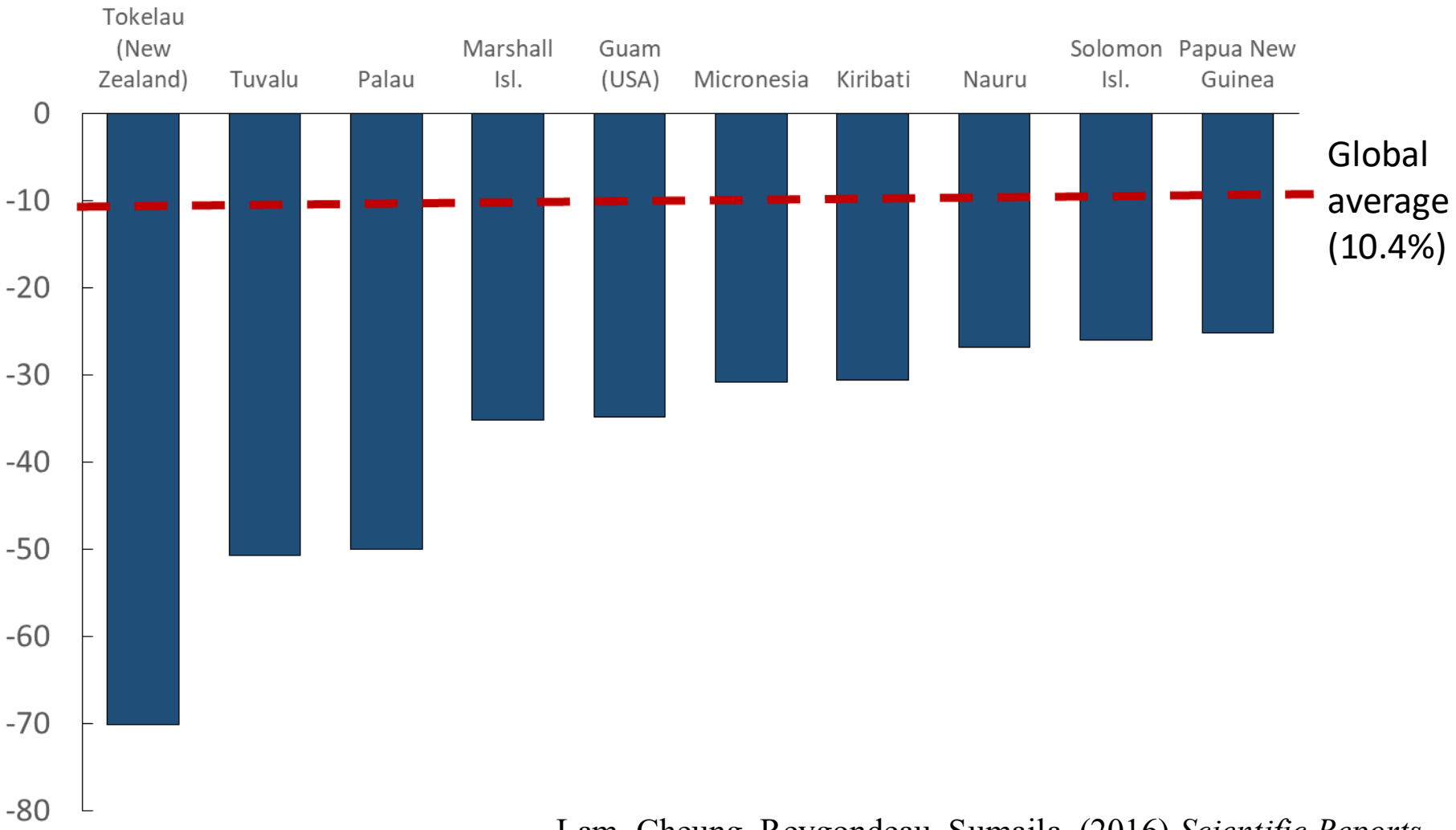
Lam, Cheung, Reygondeau, Sumaila. (2016) *Scientific Reports*

Percentage change (%) in catch under climate change



Lam, Cheung, Swartz, Sumaila (2012): *African JMS*

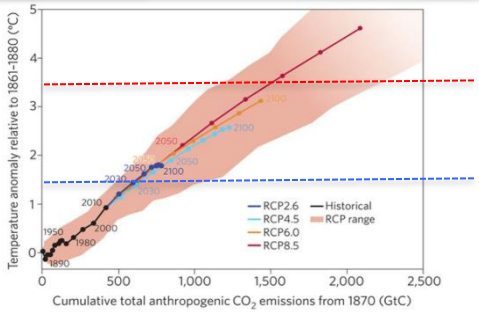
Impact on fisheries revenues in Pacific islands under RCP 8.5 in the 2050s



Lam, Cheung, Reygondeau, Sumaila. (2016) *Scientific Reports*

Methods: Paris Agreement

Step 1: Warming scenarios

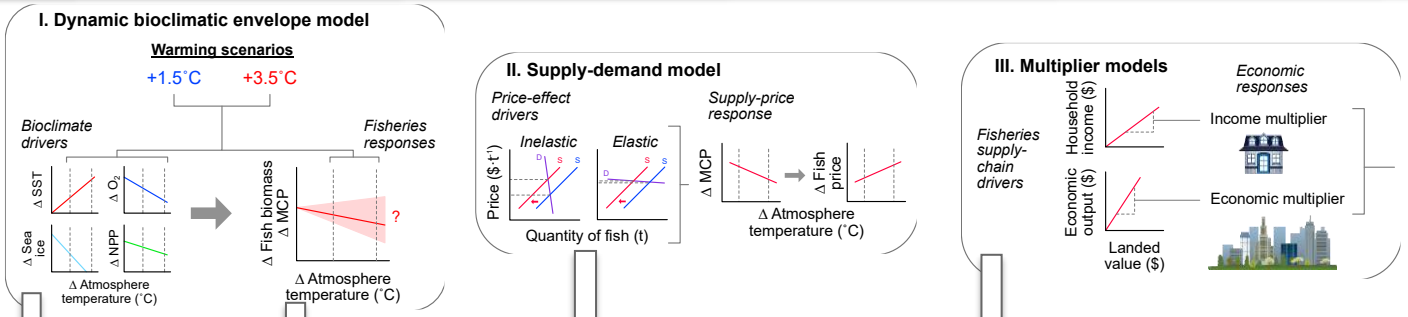


+3.5˚C — Status quo "business as usual"

+1.5˚C — Paris Agreement warming target

Cheung et al 2016 – Science; Frame et al 2014 – Nat Geosci

Step 2: Modelling impacts



Step 3: Objectives

i. Fish biomass (FB)

ii. Maximum catch potential (MCP)

iii. Fishers' revenues (FR)

iv. Seafood workers' income (SWI)

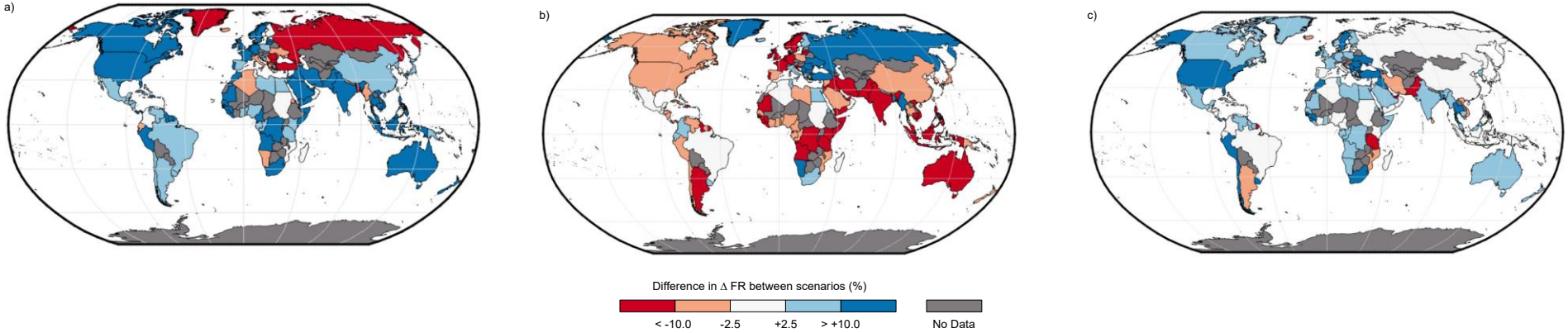
v. Households' seafood expenditure (HSE)

Sumaila *et al.* (2019): *Science Advances*

Supply and price effects of the Paris Agreement

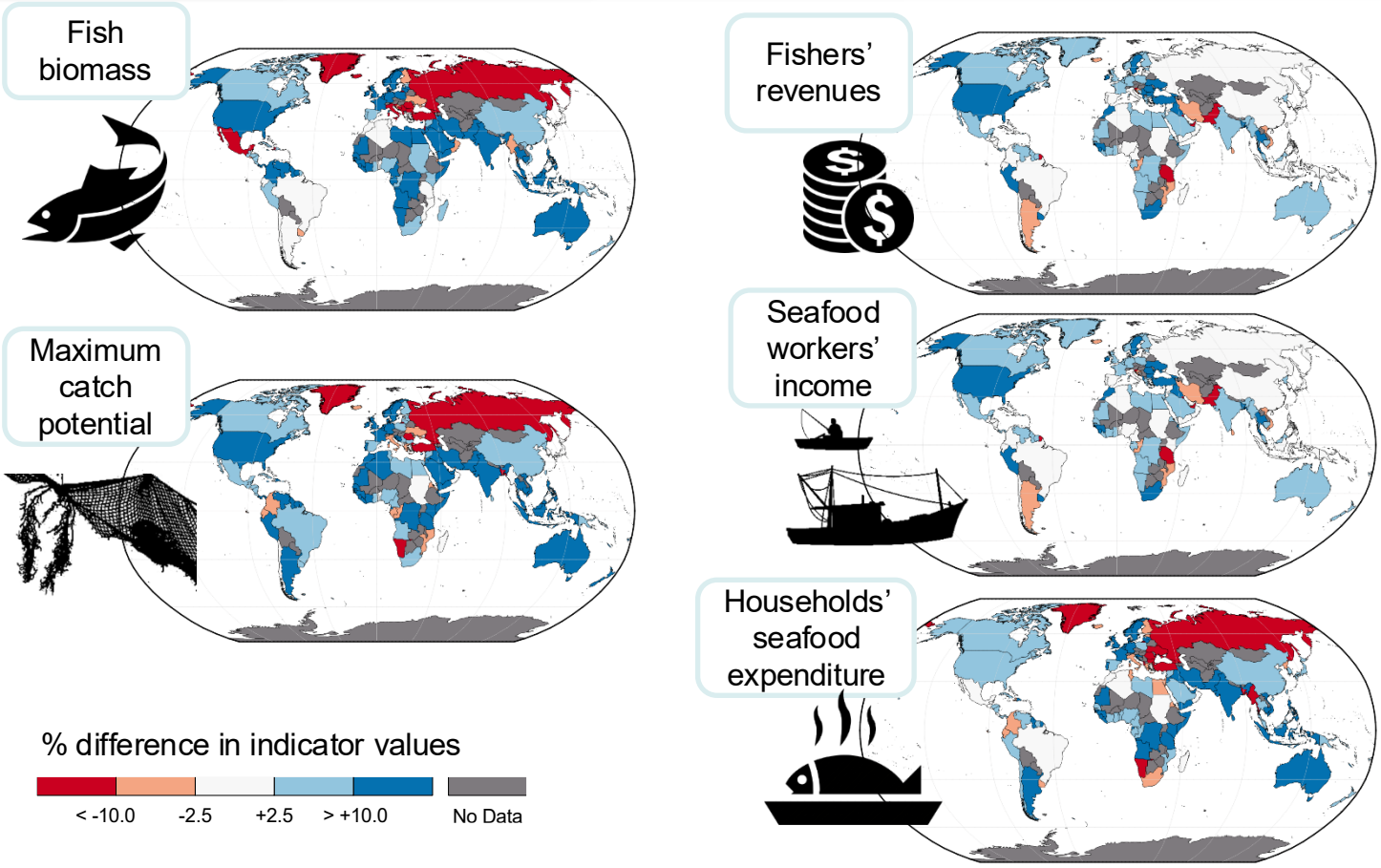
- Effects on fishers' revenues due to changes in:

Catch + Price = Catch and price

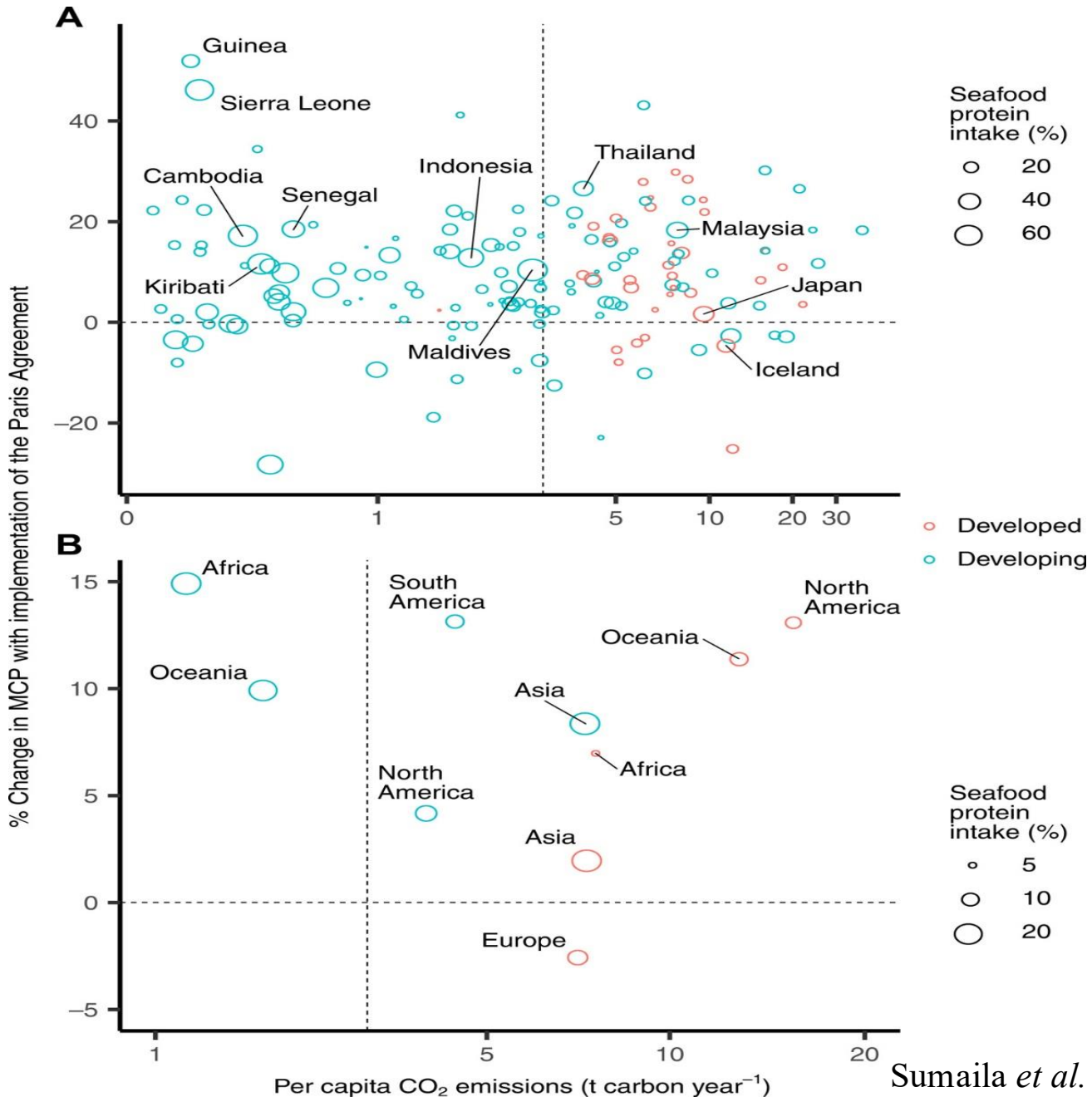


Sumaila *et al.* (2019): *Science Advances*

Outcomes of achieving Paris Agreement targets



Sumaila *et al.* (2019): *Science Advances*

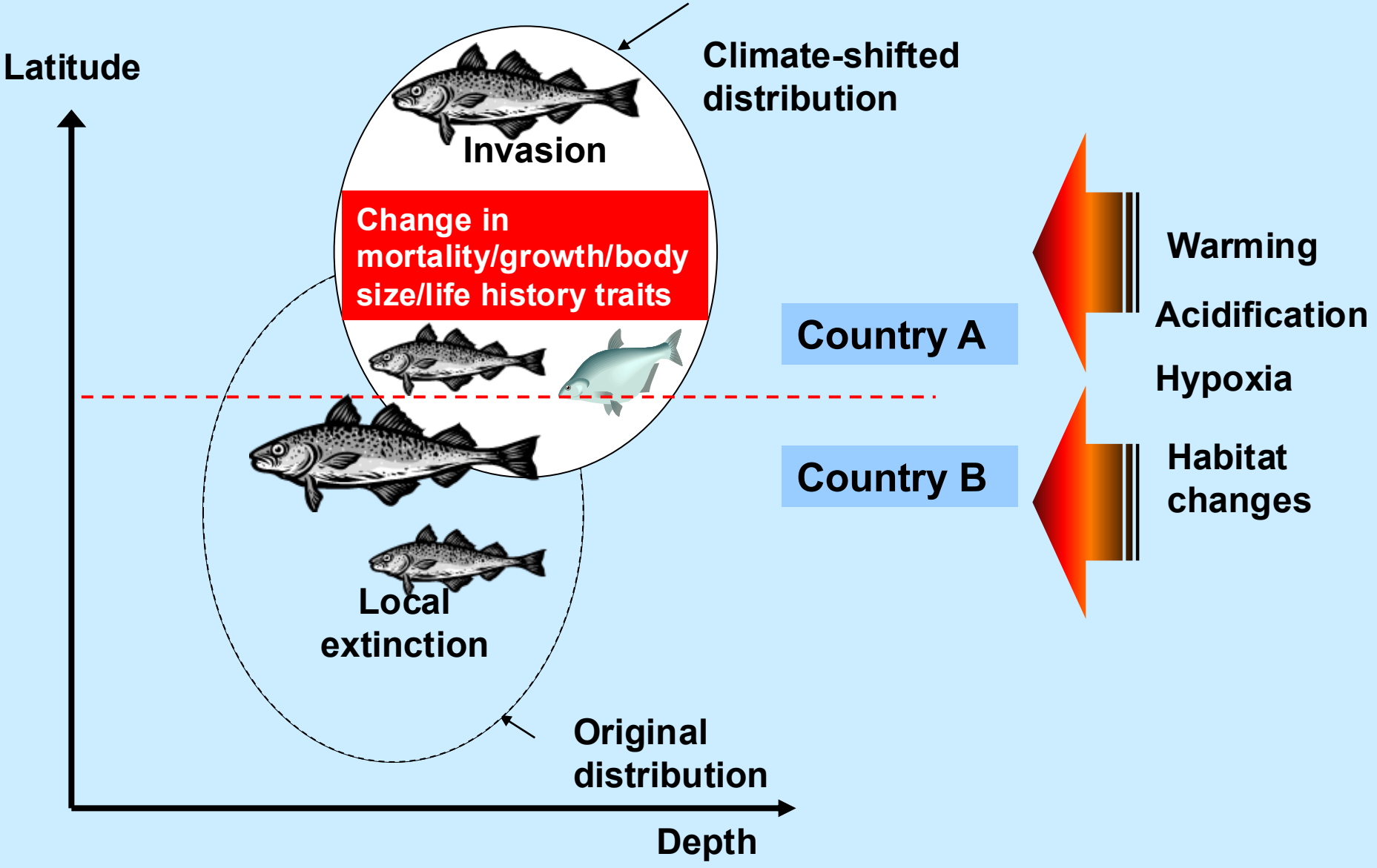


Projected gains in catch if Paris Agreement targets are met (1.5°C relative to 3.5°C warming) and the 2015 CO2 emissions by (A) country and (B) continent.

Sumaila *et al.* (2019): *Science Advances*

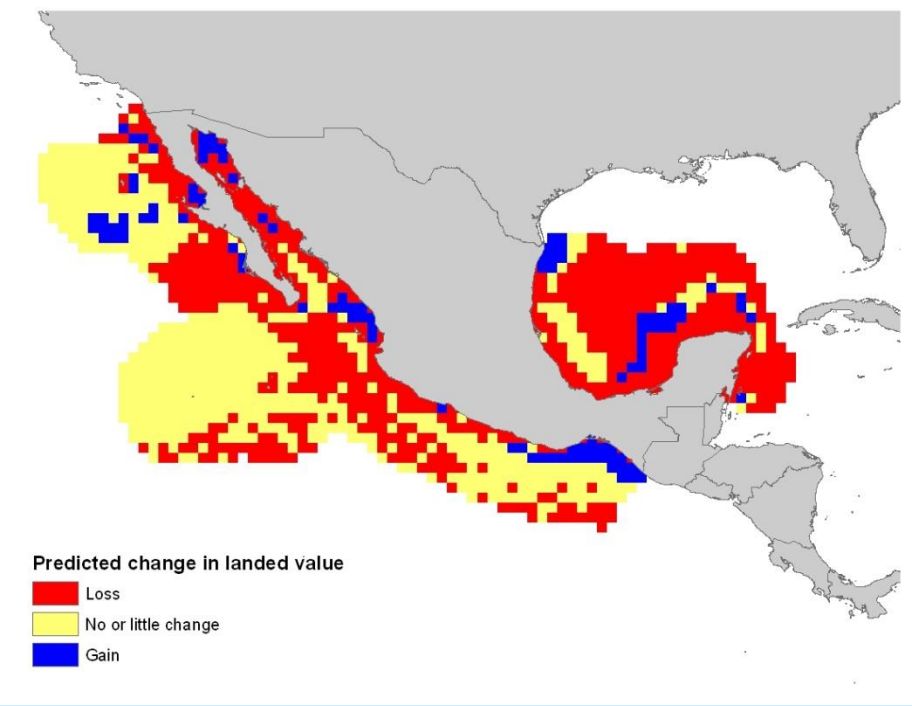
Management implications

Management implication of climate change and ocean acidification

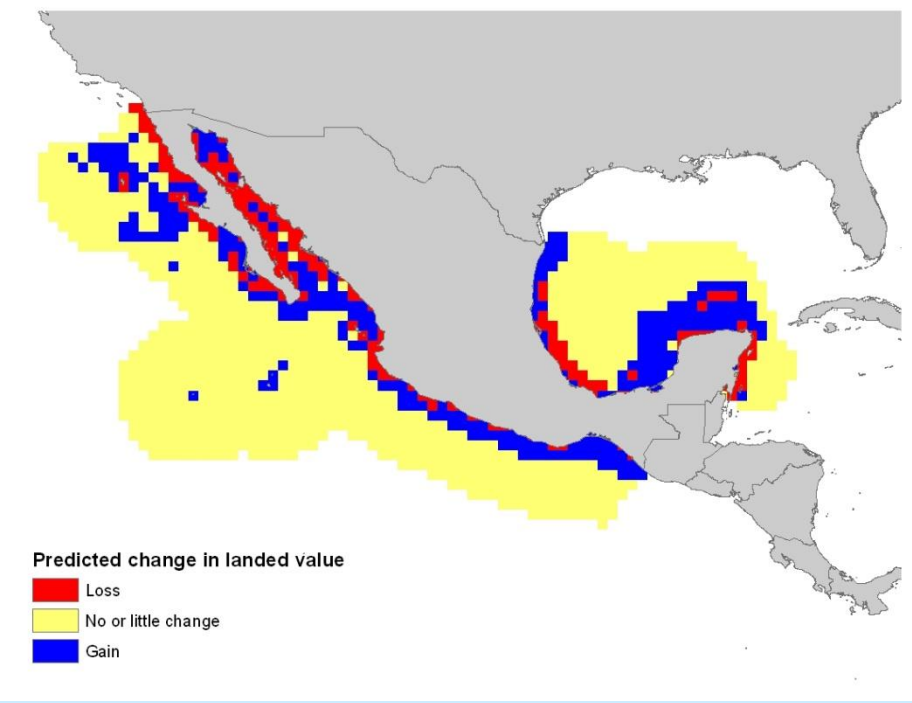


Example: Change in landed values in Mexican EEZ

SEVERE climate change scenario



MILD climate change scenario



Sumaila, Lam & Cheung (in press)

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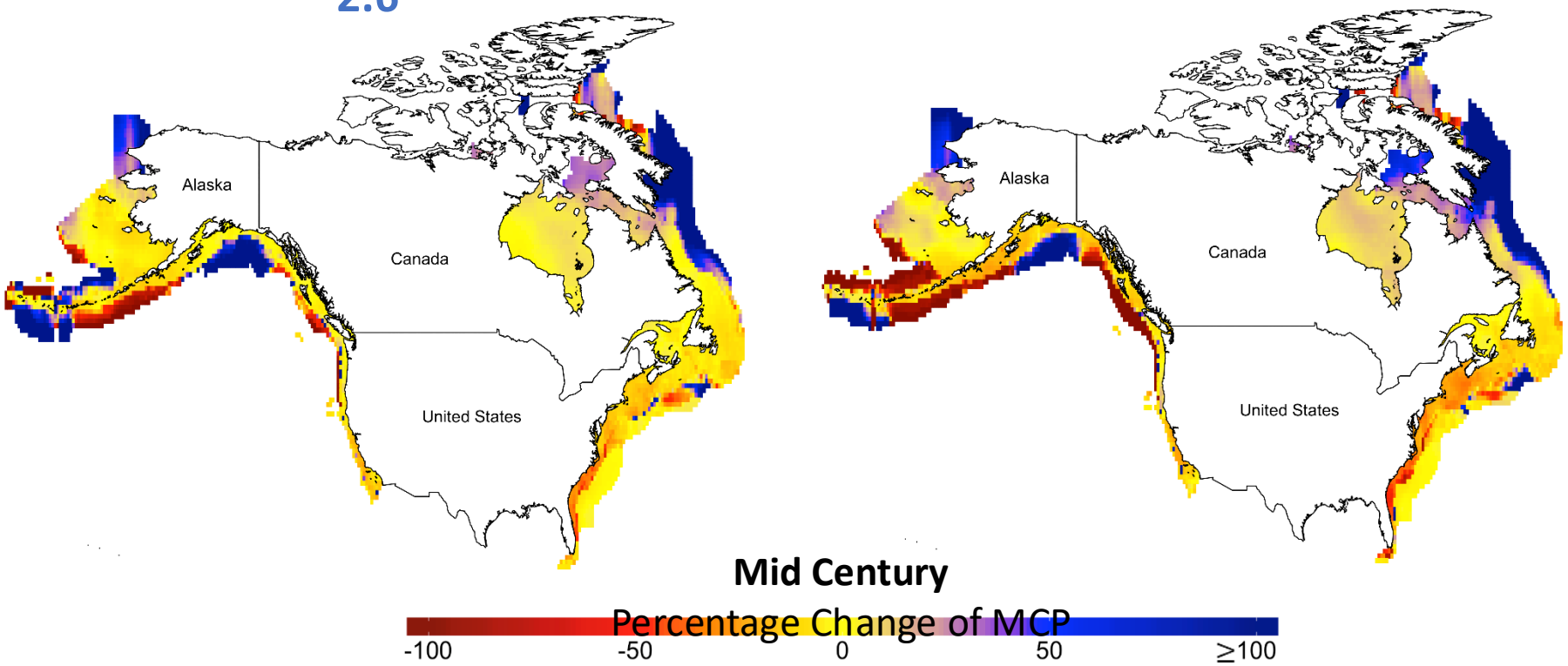
Results|Different RCP and coast (Mid 21st Century)

RCP 2.6

RCP 8.5



Palacios-Abrantes, Sumaila, Cheung (Ecology & Soceity *in press)*.

Implications for resource sharing/allocations

England | Northern Ireland | Scotland | Wales | UK Politics | Education | Magazine

24 August 2010 Last updated at 11:56 GMT

Why is Britain braced for a mackerel war?

By Andrew McFarlane
BBC News Magazine

Mackerel stocks had recovered well during the past decad

Britain is said to be bracing itself for a re-run of Iceland - except this time the fish being fought Yet, until recently, few were interested in a fish unclean.

WORLD NEWS

Fishery

Mackerel war could hurt Iceland's EU bid

27/08/10 17:19 CET

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EU warns Iceland, Faroes over 'mackerel war'

25 August 2010, 20:50 CET

— filed under: Iceland, fish, environment, Headline1, Faroes

(*BRUSSELS*) - Iceland and the Faroe Islands are overfishing mackerel way above a level deemed safe for the survival of the fish, the European Union's executive arm said Wednesday.

Fishing boat

Iceland's fishing policies, notably its refusal to share its cod fishing waters, has been identified as a thorny issue to resolve with the EU in the North Atlantic island's bid to join the 27-nation club.

Oliver Drewes, the European Commission's spokesman for maritime affairs, said the dispute over mackerel would be discussed with Iceland and the Faroe Islands at a technical meeting in September.

"They are overfishing more than which is justifiable on the basis of scientific evidence," Drewes said at a news briefing.

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EU response to Hungarian sludge danger

11/10 19:42 CET

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11/10 19:42 CET

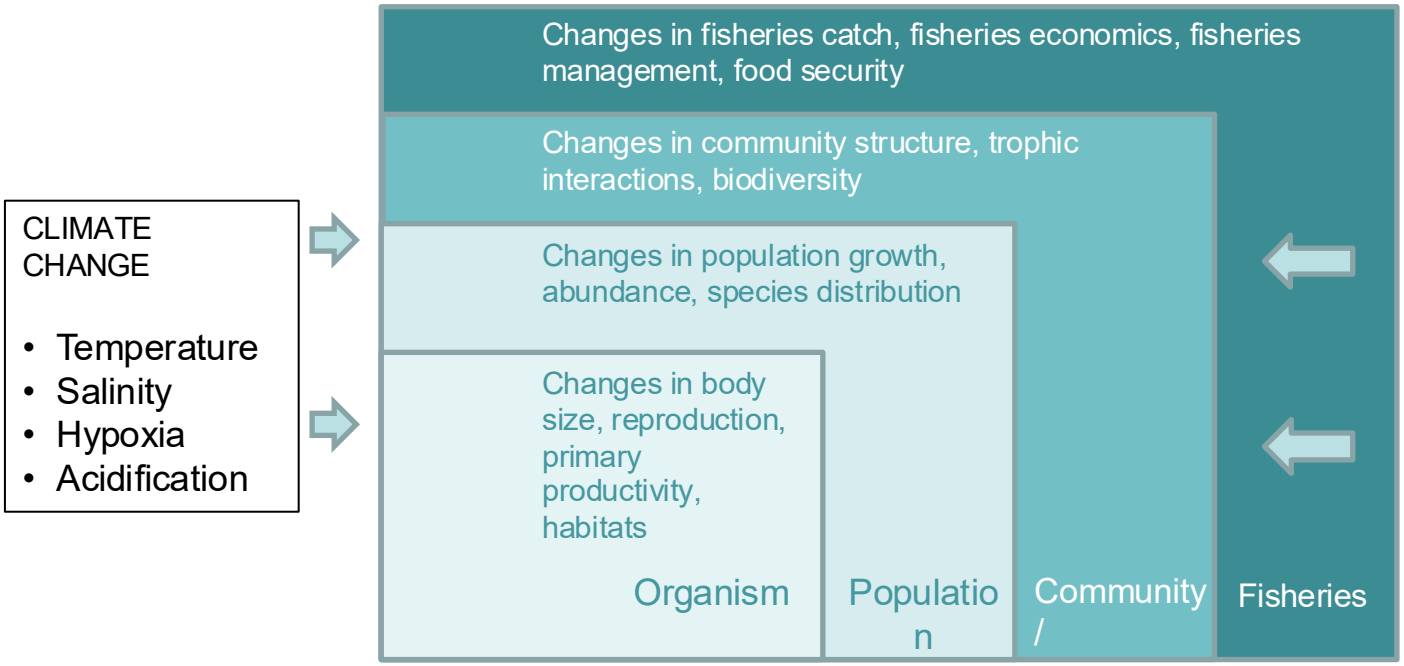
US grenade may have killed British aid worker

11/10 19:42 CET

Key messages

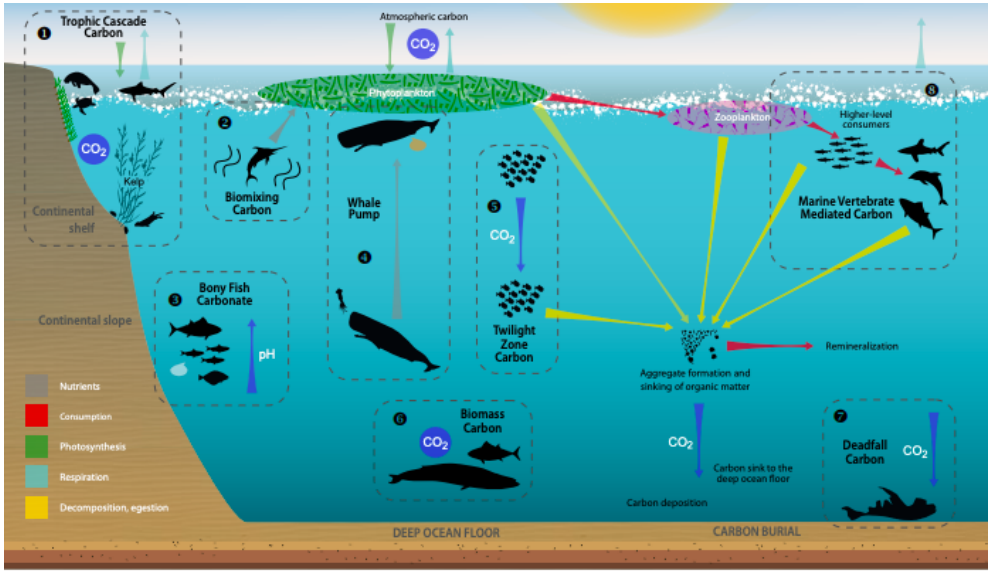
- Fisheries are important to people;
- Even without climate change, global fisheries, in general, are in trouble;
- Climate change will affect the biophysics of the ocean;
- It would therefore have implications for fisheries economics and the management ocean resources.

Fisheries contribution to climate change



Sumaila *et al.* (2011): *Nature Climate Change; Sumaila & 2020: Frontiers in Mar. Sc.*

How an ocean full of life is also climate action



1	Trophic Cascade Carbon	Food web dynamics help maintain the carbon storage and sequestration function of coastal marine ecosystems (e.g. the health of primary producers such as seagrass meadows and kelp forests is maintained by herbivory and predation).
2	Biomixing Carbon	Turbulence and drag, associated with the movement of marine vertebrates, causes enhanced mixing of nutrient rich water from deeper in the water column towards the surface, where it enhances primary production by phytoplankton and thus the uptake of dissolved CO_2 .
3	Bony Fish Carbonate	Bony fish excrete metabolised carbon as calcium carbonate ($CaCO_3$) enhancing oceanic alkalinity and providing a buffer against ocean acidification.
4	Whale Pump	Nutrients from the faecal material of whales stimulate enhanced primary production by phytoplankton, and thus uptake of dissolved CO_2.
5	Twilight Zone Carbon	Mesopelagic fish feed in the upper ocean layers during the night and transport consumed organic carbon to deeper waters during daylight hours.
6	Biomass Carbon	Marine vertebrates store carbon in the ocean as biomass throughout their natural lifetimes, with larger individuals storing proportionally greater amounts over prolonged timescales.
7	Deadfall Carbon	The carcasses of large pelagic marine vertebrates sink through the water column, exporting carbon to the ocean floor where it becomes incorporated into the benthic food web and is sometimes buried in sediments (a net carbon sink).
8	Marine Vertebrate Mediated Carbon	Marine vertebrates consume and repackage organic carbon through marine food webs, which is transported to deep waters by rapidly sinking faecal material.

Ending overfishing is climate action

- Ending overfishing now would:
  - strengthen the ocean, making it more capable of withstanding climate change; while contributing to mitigating climate change;
  - Briefly on fisheries subsidies.
- A healthy person is more likely to survive an epidemic than a person who is less healthy, and because of overfishing we have severely weakened the ocean's immune system;
- In this way people and the ocean are not that different.

Acknowledgements

- Thanks to you all for your attention!

Fisheries Economics Research Unit