This book chapter, assembled by the editor based on my PPT presentation, may be cited as:

Pauly, D. 2016. Challenges to Ocean Life: Fisheries, Global Warming and Pollution, p. 239-250 *In*: R. Ragaini (ed.) *International Seminars on Nuclear War and Planetary Emergencies, 48th Session*, Erice, Italy. World Scientific Publishing, Singapore.

The bizarre book of which this 'chapter' is a part, put together by the editor, presents the bizarre proceedings of a bizarre meeting held in August 2015 in the mountain town of Erice, in Sicily, during which, like in some strange carnival, climate change denialists were kings for a week.

I didn't know, when I was invited to present '*Challenges to Ocean Life,*' that 50% of the invitees would consist of kooks and cheats (I was seated beside a gentleman who alleged that the sun has recently increased its output… and that he was at 'Harvard,' which was also not the case).

There was also a mathematics professor from the University of Toronto whose PowerPoint presentation consisted of snowy Canadian scenery: "With so much cold, how could there be global warming?" he said.

The captain of the 'Ship of Fools' was a physicist, an ex-official of CERN, who believed that only atomic energy would save us from the global warming (which 50% of the participants he invited denied was occurring) and who kept interrupting the presentations of participants who tried to evaluate the potential of renewable energy.

Fortunately, I was able to identify some participants who were not infected, and thus had a nice week in Erice, except for hours of panic on the last day, when I thought I had lost my passport (which I later found below my hotel bed).

Daniel Pauly
July 2025

SeaAroundUs

CHALLENGES TO OCEAN LIFE: FISHERIES, GLOBAL WARMING AND POLLUTION

DANIEL PAULY
UBC Fisheries Centre
Vancouver, BC, Canada

WHAT ARE THE MAJOR PROBLEMS FOR LIFE IN THE OCEAN NOW, AT THE DAWN OF THE 21ST CENTURY?

I would argue that they are, in decreasing order of importance:

1. Ever-expanding marine fisheries, whose impacts on marine life are still widely underestimated;
2. Global warming, whose effects on fisheries have already kicked in;
3. Pollution, whose impacts on marine life was long overestimated, and which now begins to live up to its reputation.

We won't deal with ocean acidification (too discouraging).

The first issue with fisheries is that we not only do not know precisely what they catch and where, but that some argue we don't need to know fisheries catches.

Yet, fisheries catches are one of our strongest interactions with the oceans.

COMMENT

ENERGY Shale gas and oil will run out faster than champions predict p.307 | ANTHROPOLOGY Napoleon Chagnon sets the record straight p.310 | BIOGRAPHY A flattering life of impish physicist Freeman Dyson p.311 | HEALTH Iran needs international help to fight HIV epidemic p.314

Does catch reflect abundance?

Researchers are divided over the wisdom of using estimates of the amount of fish hauled in each year to assess the health of fisheries.

POINT

Yes, it is a crucial signal

The only data available for most fisheries are the weight of fish caught each year, insists Daniel Pauly.

In developed countries such as the United States, Australia and members of the European Union, many fisheries are monitored by fisheries scientists using expensive stock assessments. To infer the size of the fish populations being exploited, scientists use the age and size distributions of the fish caught, the results of scientific surveys carried out from research vessels, and information about growth and migration from tag and recapture studies. Yet the only data ▸

COUNTERPOINT

No, it is misleading

Many factors as well as abundance determine the haulsof fishermen, warn Ray Hilborn and Trevor A. Branch.

The major database on all the fisheries of the world is the *FAO Yearbook. Fishery and Aquaculture Statistics*. This collates the amount (in weight) of haddock, bream, cod and more than 1,000 other species hauled in each year by fishermen, whether from commercial trawlers or canoes, using estimates sent in by officials from individual countries.

For the past few years, researchers have been conducting analyses ▸

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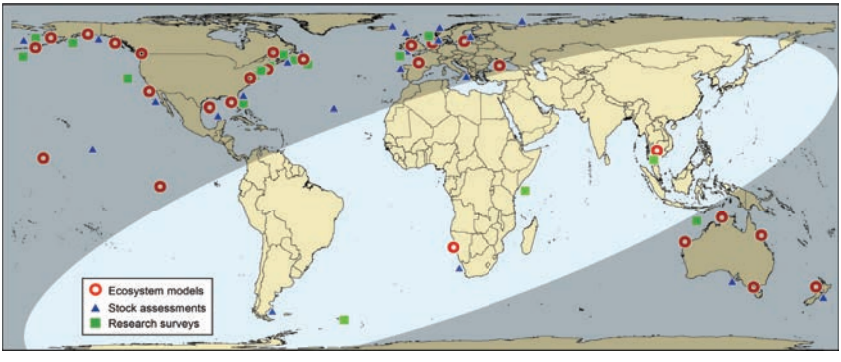
EXTENT OF THE GEOGRAPHIC BIAS IN 'GLOBAL' STUDIES OF FISHERIES STATUS PUBLISHED BY *SCIENCE*



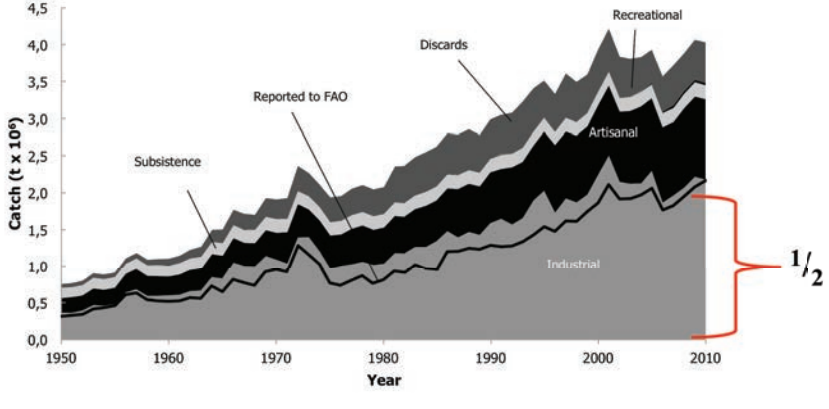
*Based on an article by Worm, Hilborn et al. (*Science*. 2009)*

Official fisheries catches, as submitted by member countries to FAO are incomplete.

We addressed this by doing 'catch reconstructions', i.e., bottom-up re-estimation of total catches for all countries of the world, based on the principles that:

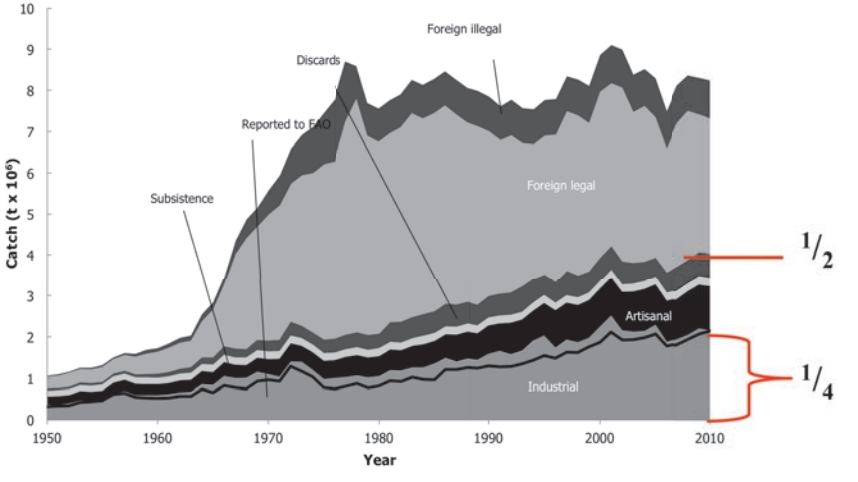
1. Every fishery casts a ''shadow' on the society in which it occurs, and
2. Zero is never a good estimate for a positive number that is not precisely known.

TOTAL RECONSTRUCTED CATCHES FOR WEST AFRICA: DOMESTIC



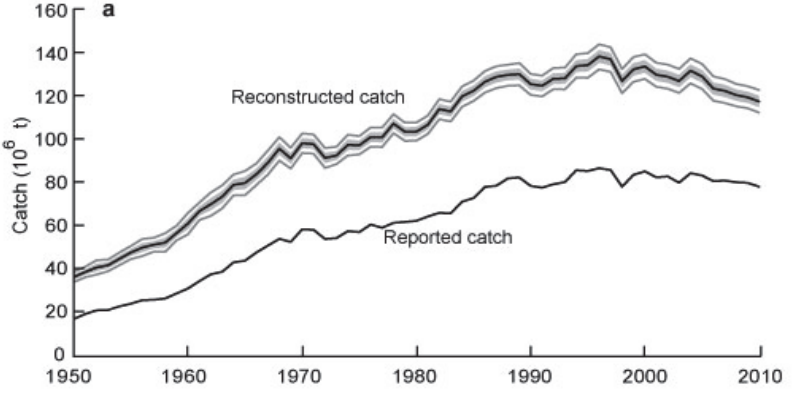
*Belhabib et al. (*Environmental Development*. in press)*

TOTAL RECONSTRUCTED CATCHES FOR WEST AFRICA: DOMESTIC AND FOREIGN



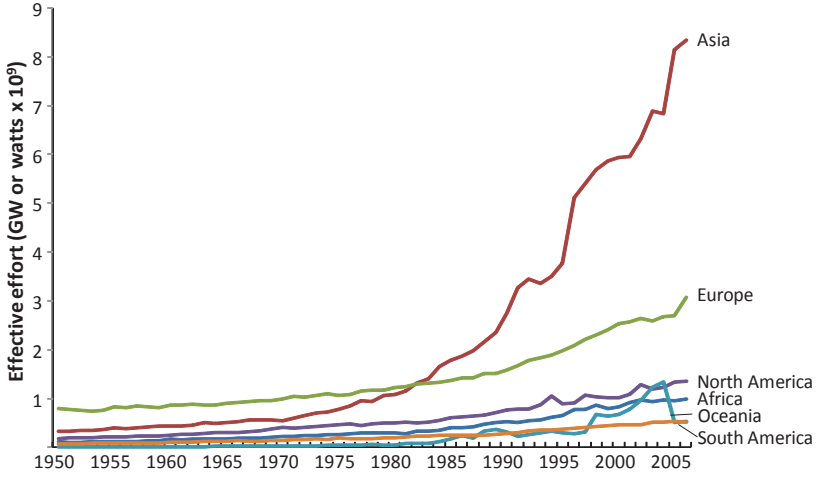
*Belhabib et al. (*Environmental Development. *in press)*

The reconstructions confirm that the world catch is declining; this trend is more marked that in the officially reported catch.



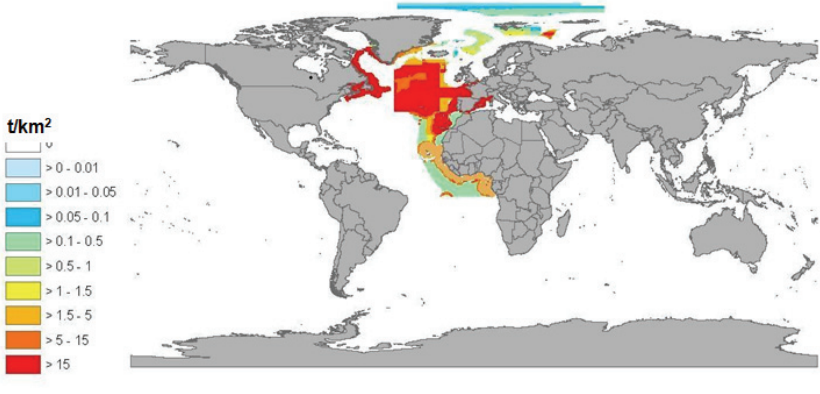
*Pauly and Zeller (*Nature Communication. *in review)*

This catch decline is not surprising, given the growth of 'effective' fishing effort (1950-2006).



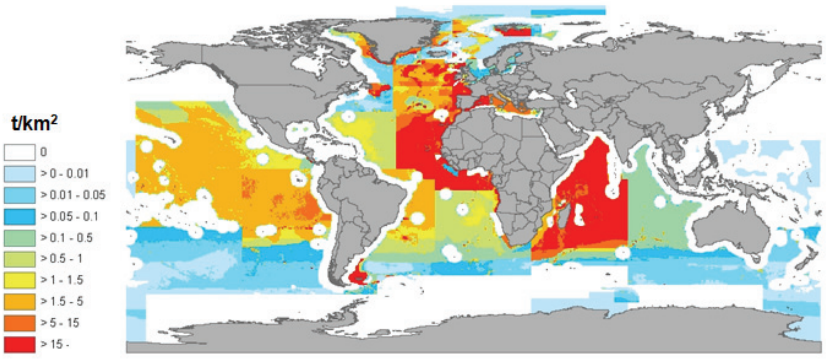
*Anticamara et al. (*Fisheries Research*. 2011)*

This issue was long masked by fisheries expansion, here illustrated by mapping the catch of Spain in the 1950s…



See www.searoundus.org

…and in the 2000-2004 (remember: Spain!)



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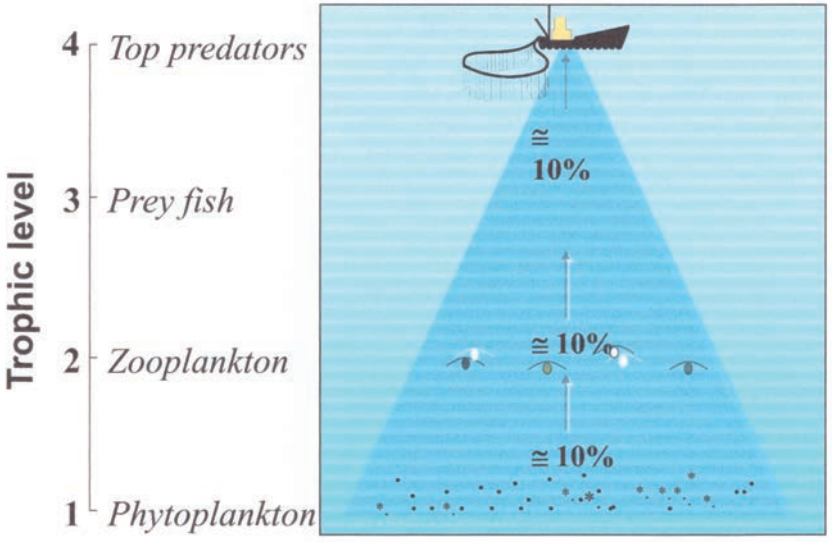
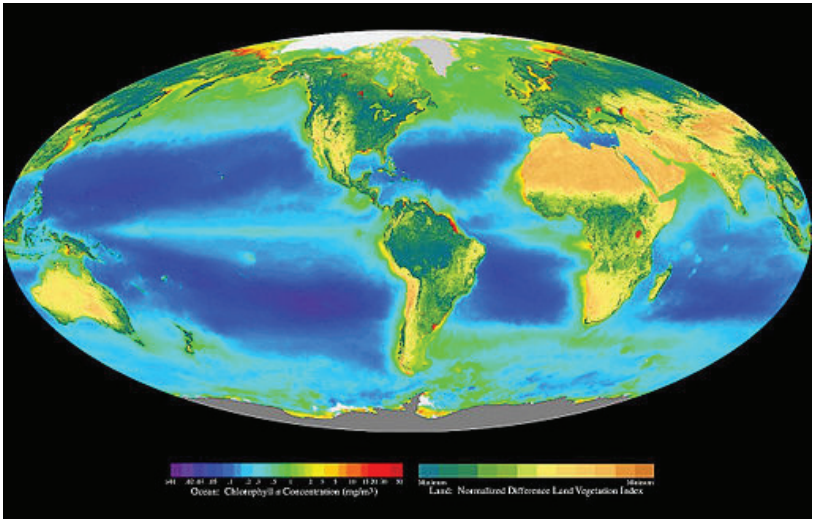
Now recall that ecosystem fluxes move up 'trophic pyramids,' and each species tends to have its own trophic level.



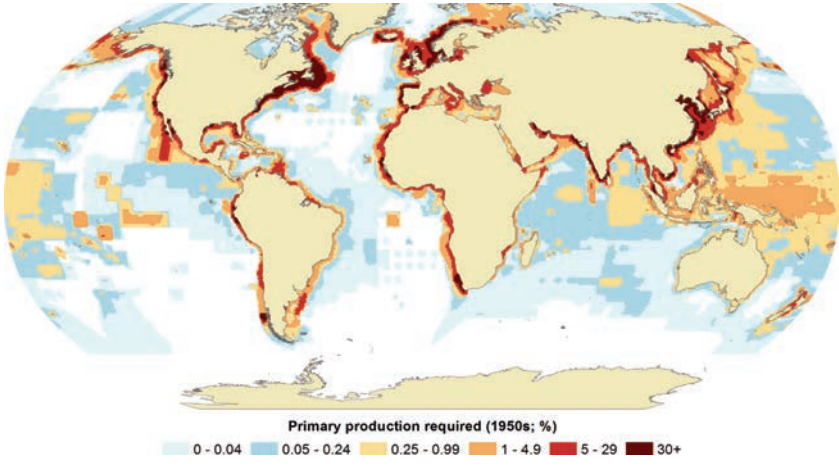
*Pauly and Christensen (*Nature*. 1995)*

Now we know (from satellite data) the primary production of the ocean, which is usually high in coastal waters, and very low in the 5 central gyre of the oceans.



SeaWiFS data, NOAA

We can thus map the footprint (or 'seafoodprint') of fisheries onto the world ocean, here in the 1950s…



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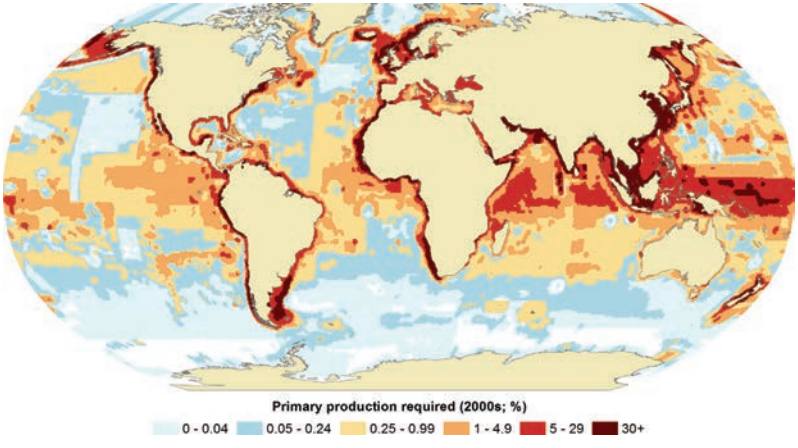
…and in the 2000s.



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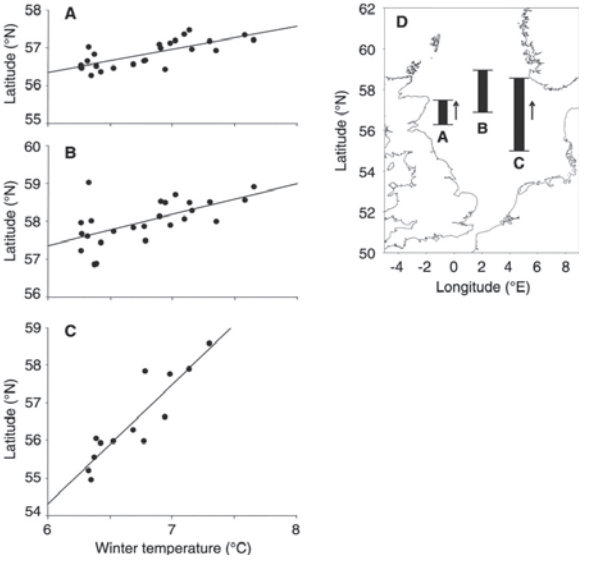
Observed climate-induced shifts in distribution ranges.

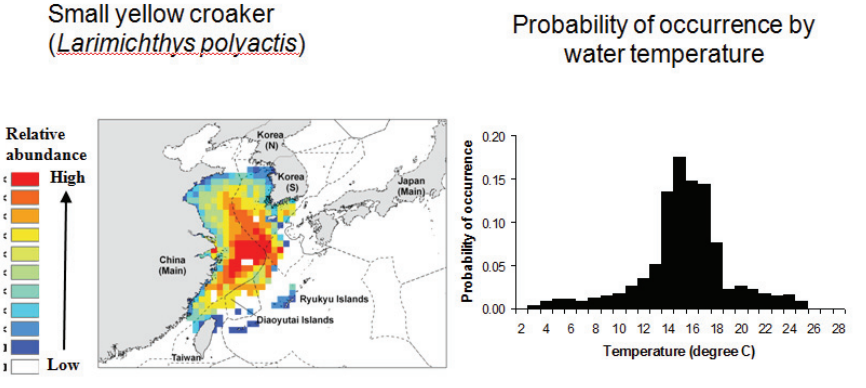


Poleward shifts in distribution ranges of marine species, e.g., in the North Sea (Perry et al. Science. *2005).*

Specifically, as ocean temperature increase, we would expect that many marine fishes and invertebrates would shift towards the pole to find cooler refuges. In fact,

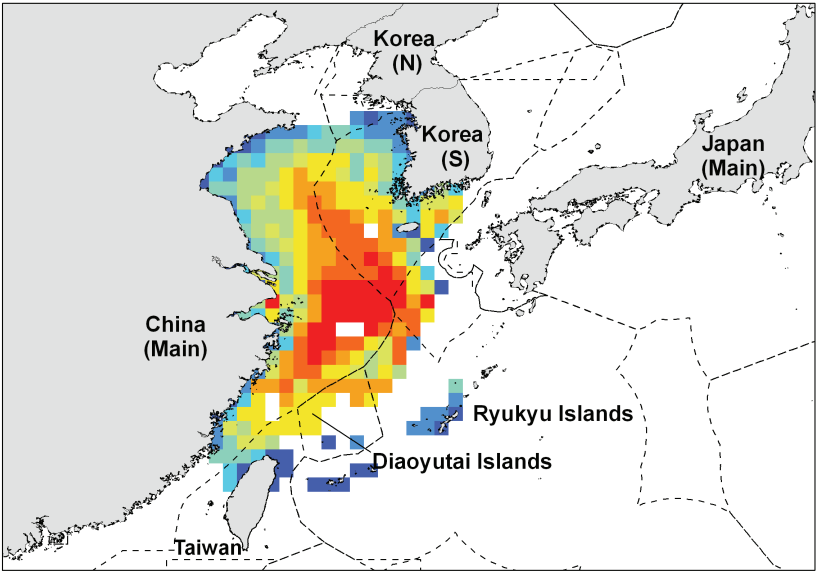
evidence of such climate-induced range-shifting has been observed in various regions. For example, in the North Sea, Perry *et al*. showed poleward shifts in mean distributional ranges of demersal fishes in the North Sea. Here, the y-axis is the mean latitudine of the species' ranges while the x-axis is the winter water temperature. As temperature increases, the mean range moves northward.

Simulating poleward shifts using temperature-abundance profiles.

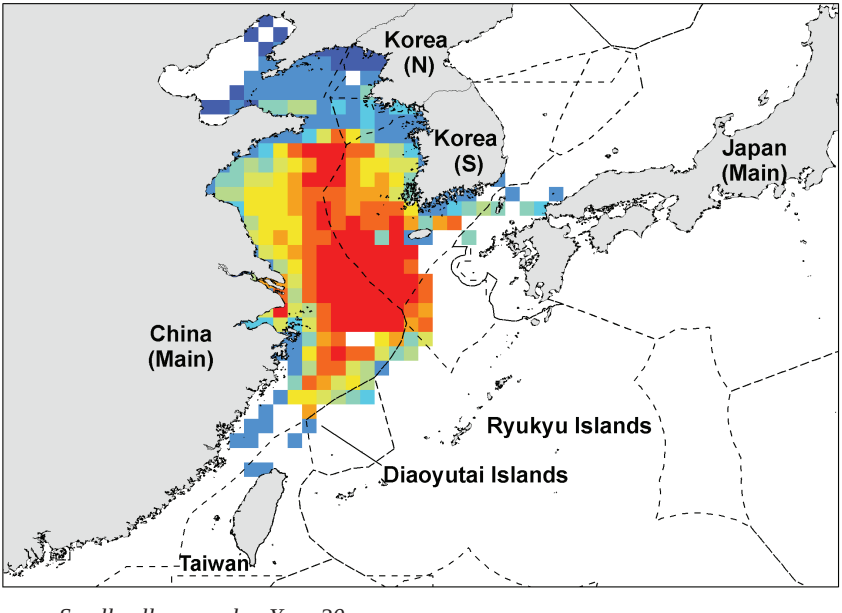


*Cheung et al. (*Marine Ecology Progress Series. *2008)*

The probability of occurrence by water temperature is inferred from overlaying predicted relative abundance map on map of sea water temperature. The resolution of the distribution maps is half degree lat by half degree long.

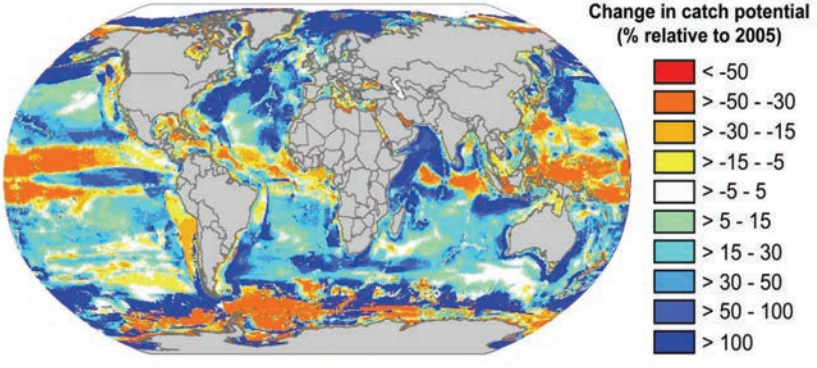


Small yellow croaker Year 0



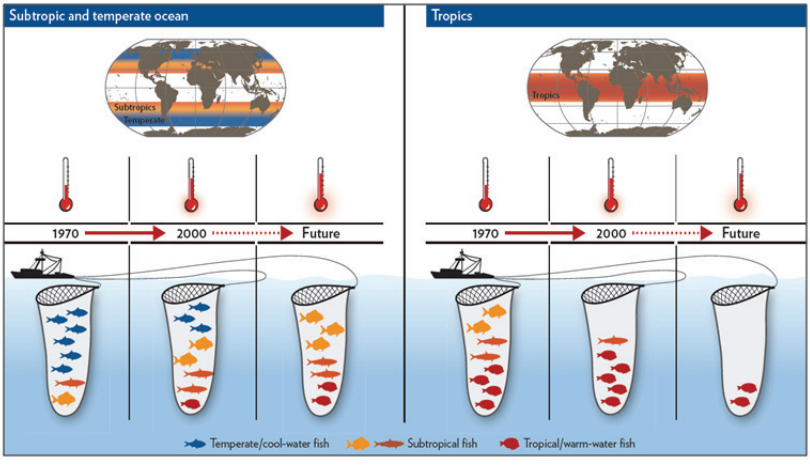
Small yellow croaker Year 30

PROJECTED CHANGE IN CATCH POTENTIAL IN 50 YEARS



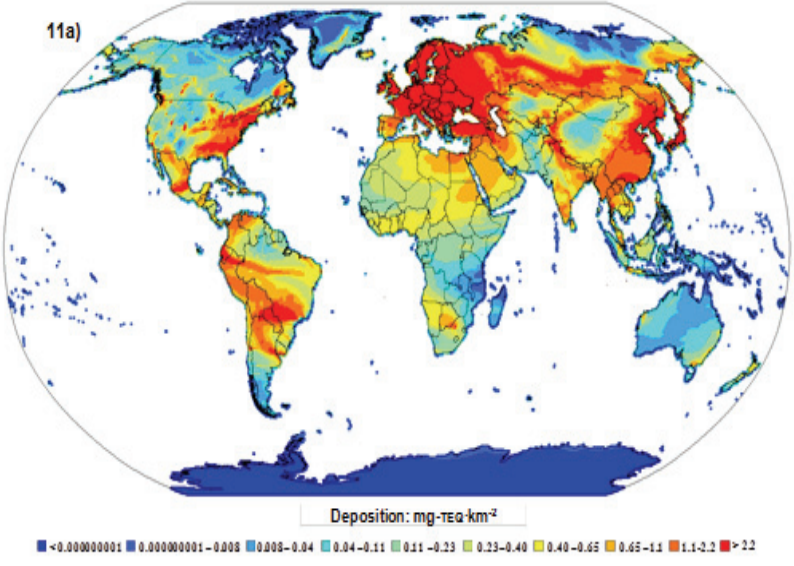
*Cheung, Lam, Kearney, Sarmiento, Watson, Zeller and Pauly (*Global Change Biology. *2009); see also IPCC, 5th Assessment, Summary for Policy Makers.*

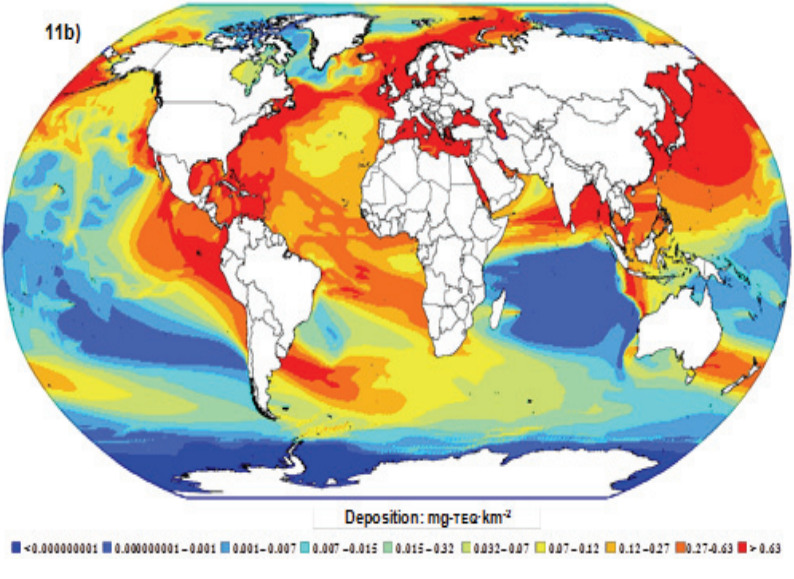
IN SUMMARY



*Cheung, Watson and Pauly (*Nature. *2013)*

Marine pollutants take several forms; one of them are persistent Organic Pollutants (POPs), such as dioxin, whose land and ocean deposition we modeled as an input to food-web based models.





*Booth et al. (*Marine Pollution Bulletin, *2013)*

Plastic pollution is an emerging problem, caused in part by fisheries, strongly affecting seabirds and marine mammals, but not strongly affecting fisheries.

ACKNOWLEDGEMENTS

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THE PEW CHARITABLE TRUSTS

THE PAUL G. ALLEN FAMILY FOUNDATION

- Thanks to other funding sources: FAO, US Western Pacific Fisheries Management Council, EU-Parliament, UNEP, BOBLME, MAVA Foundation, Rockefeller Foundation, WWF
- Thanks to all members of the *Sea Around Us*, past and present…

… sorry, I ran out of pictures….

and thanks to many other colleagues

visit us at **www.seaaroundus.org**