Present Trends and the Future of Fisheries

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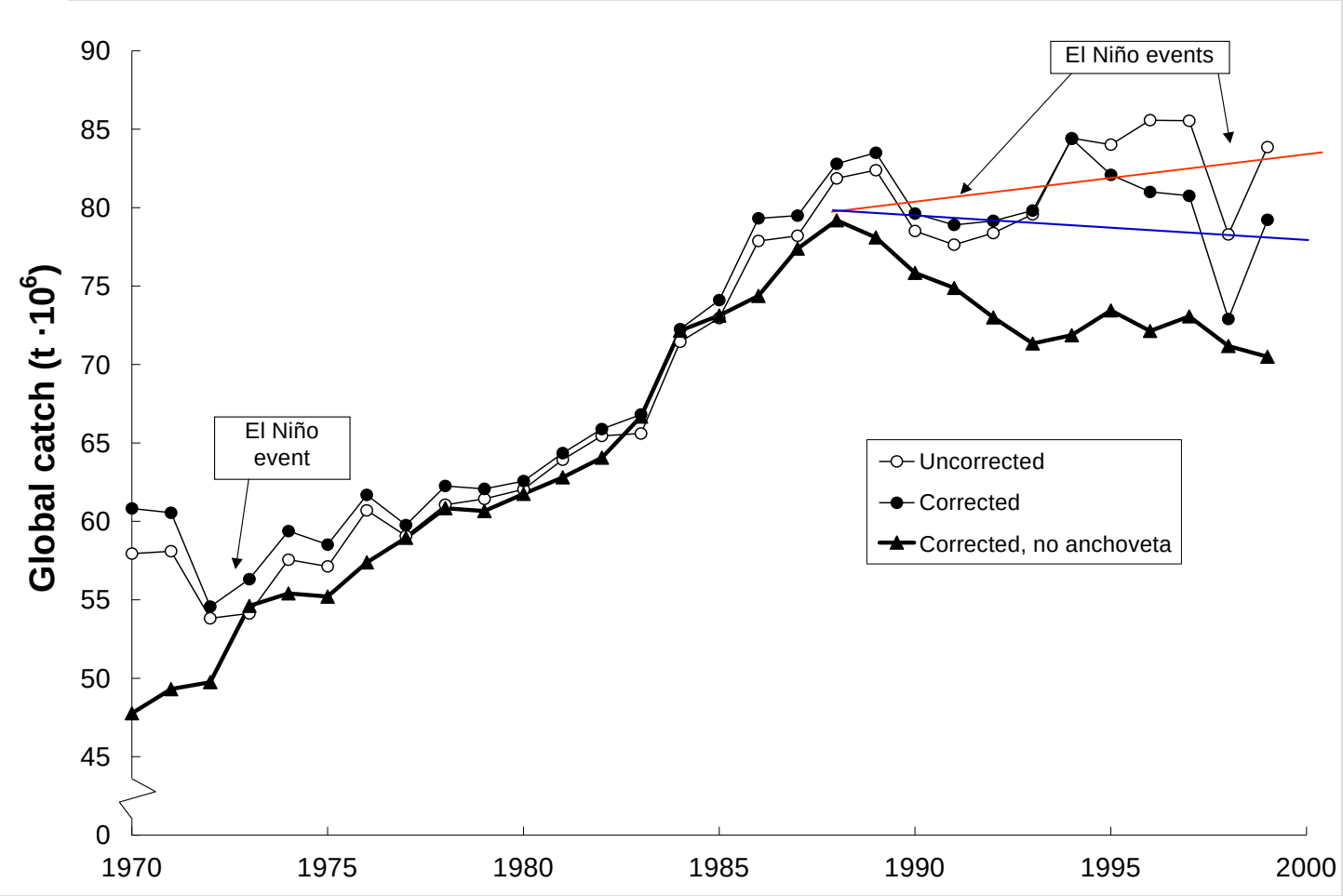
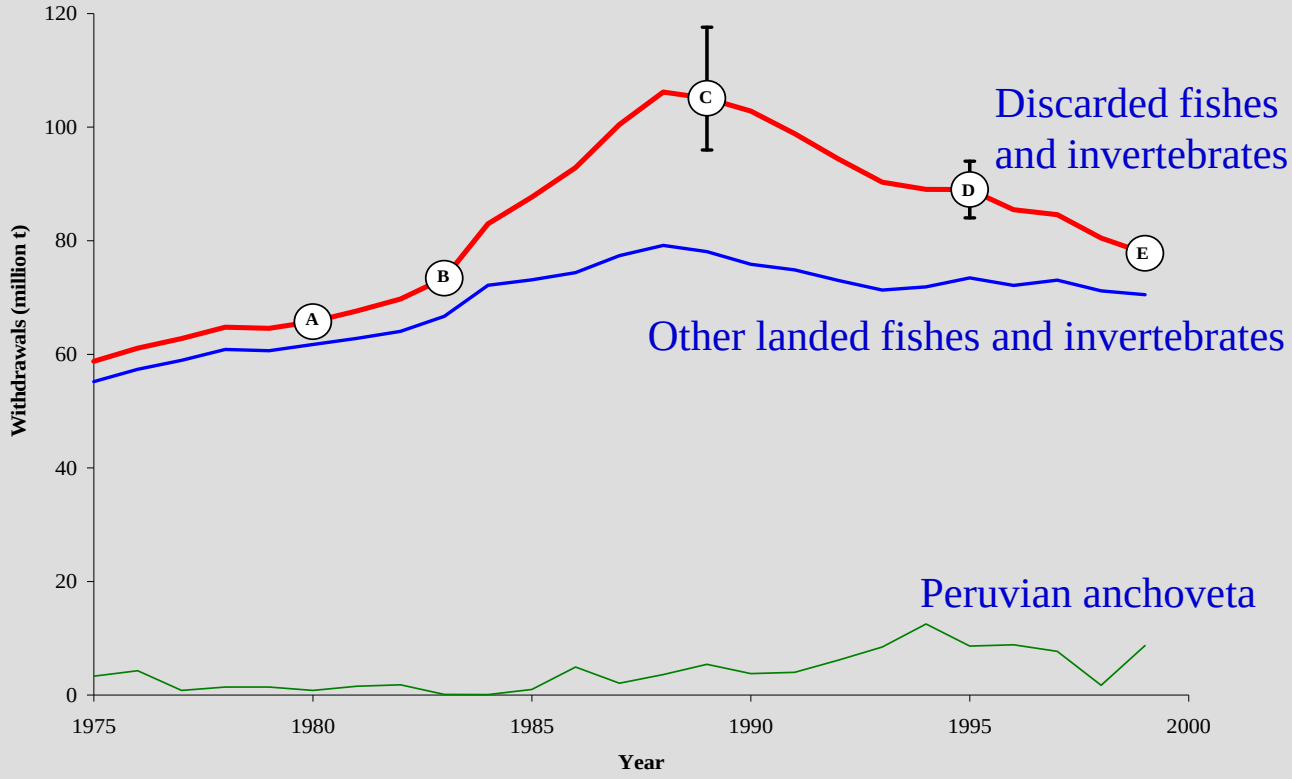
December 7, 2010

Fisheries landings, despite (or because of) increasing fishing effort, have been declining since the late 1980s, a fact long hidden by massive over-reporting by China:



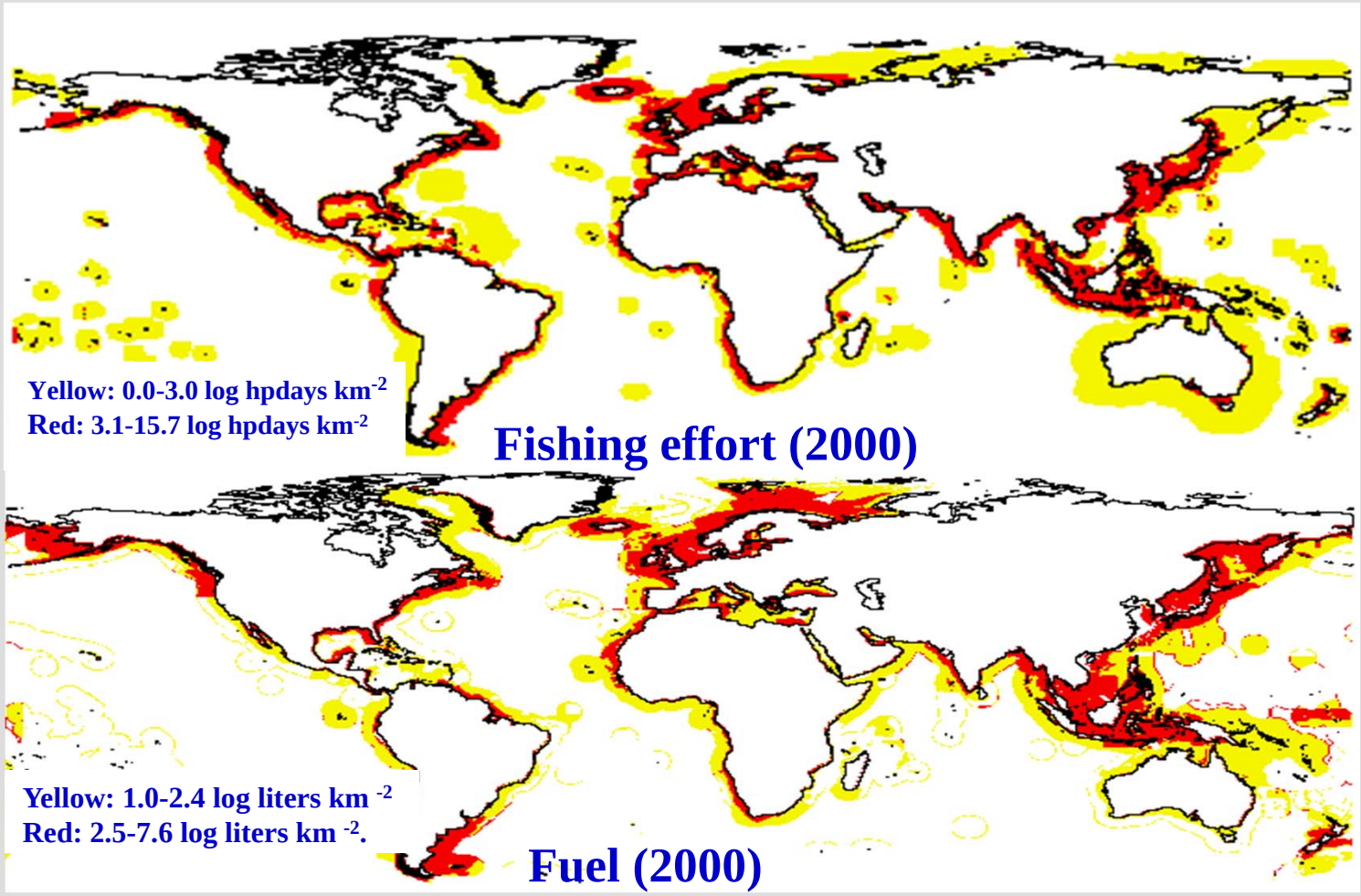
Watson and Pauly (*Nature)*, 2001.

In fact, the decline is even stronger if one considers discarded fish. This was generally overlooked when FAO's last estimate of discards (dot E; 7-8 million t) was released.



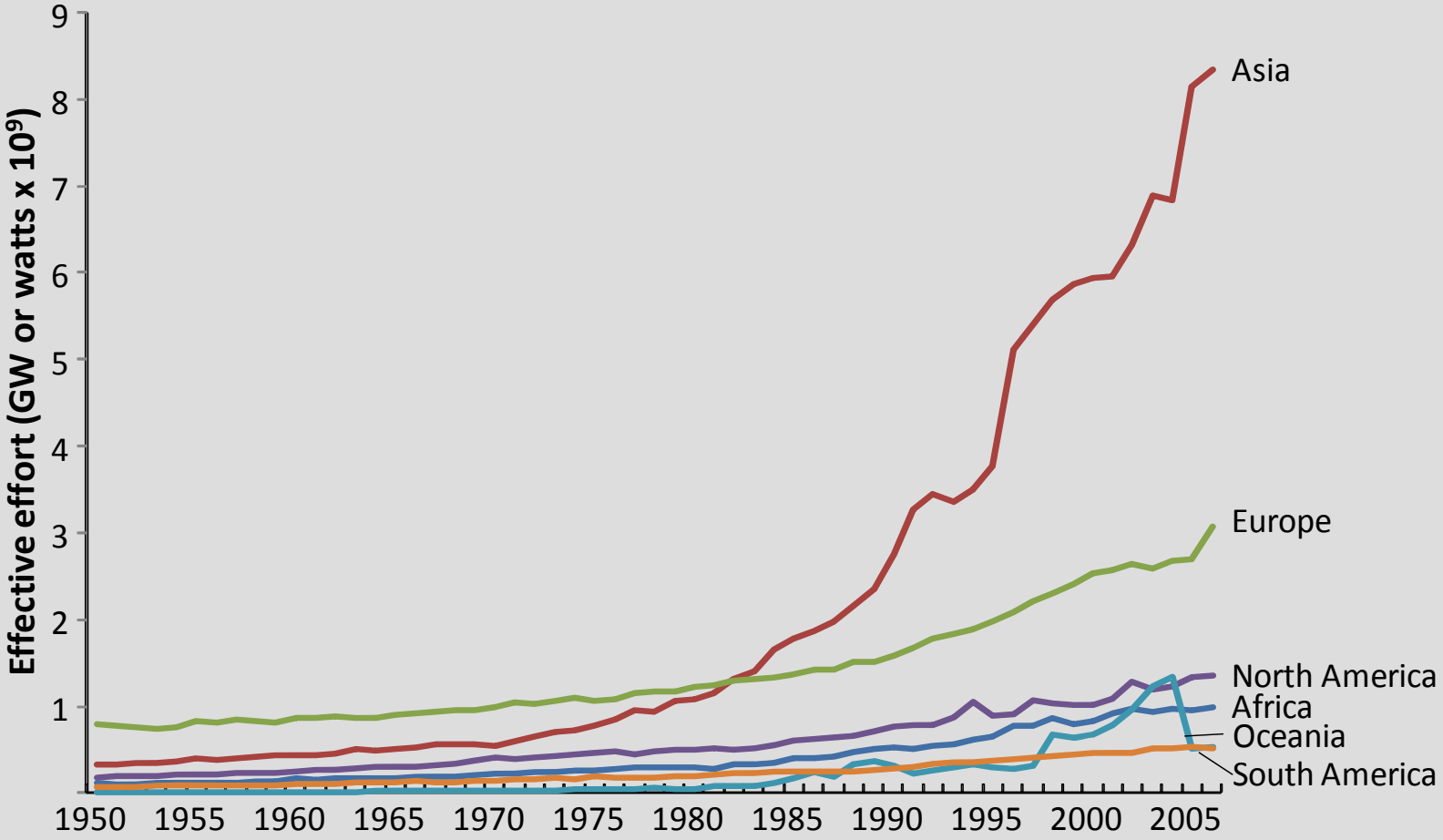
Zeller and Pauly (*Fish & Fisheries*, 2005)

It is our overfishing which is the cause for these catch declines...

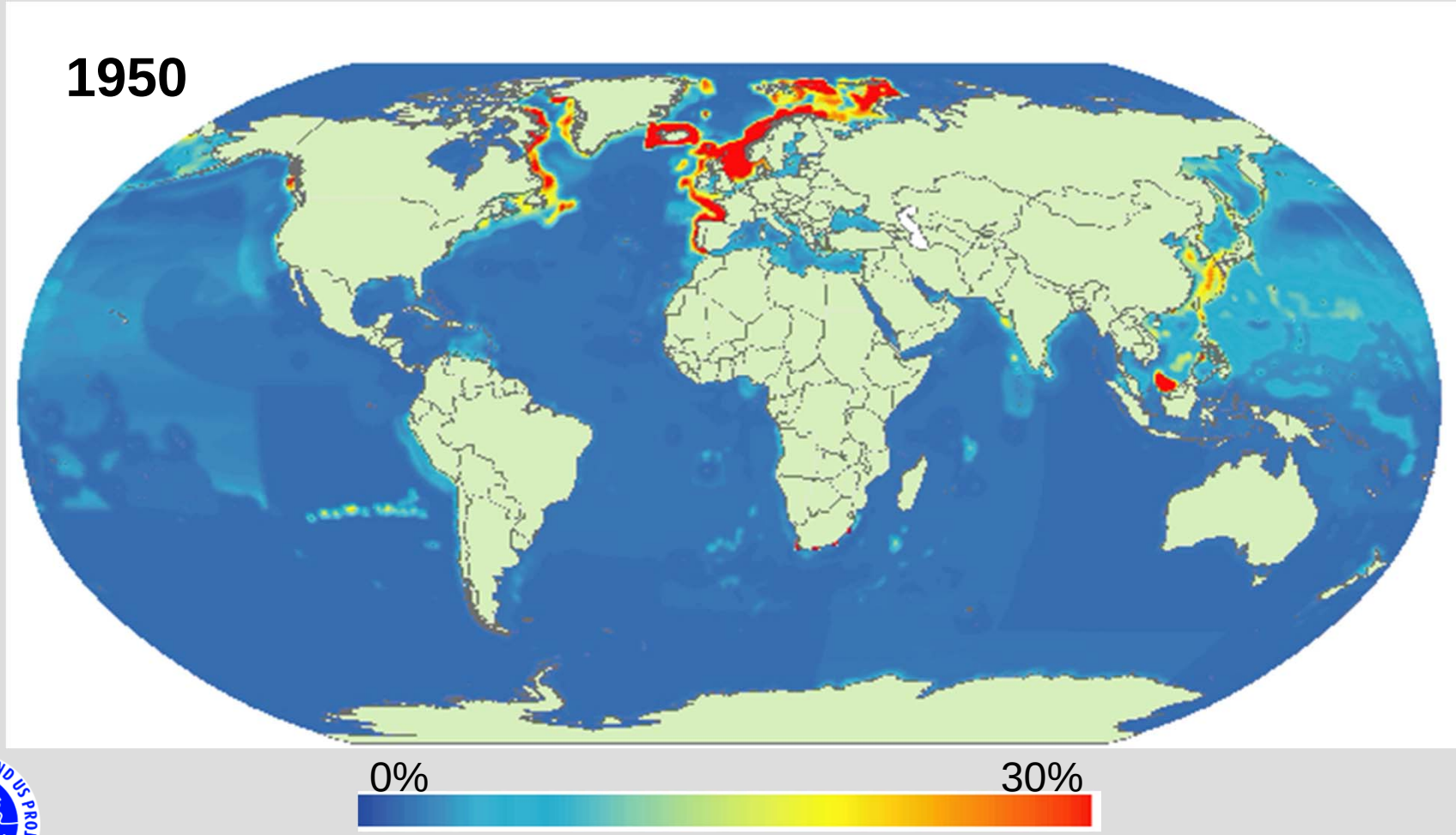


Effort data from Gelchu (2006); fuel data adapted from Tyedmers *et al.* (2005)

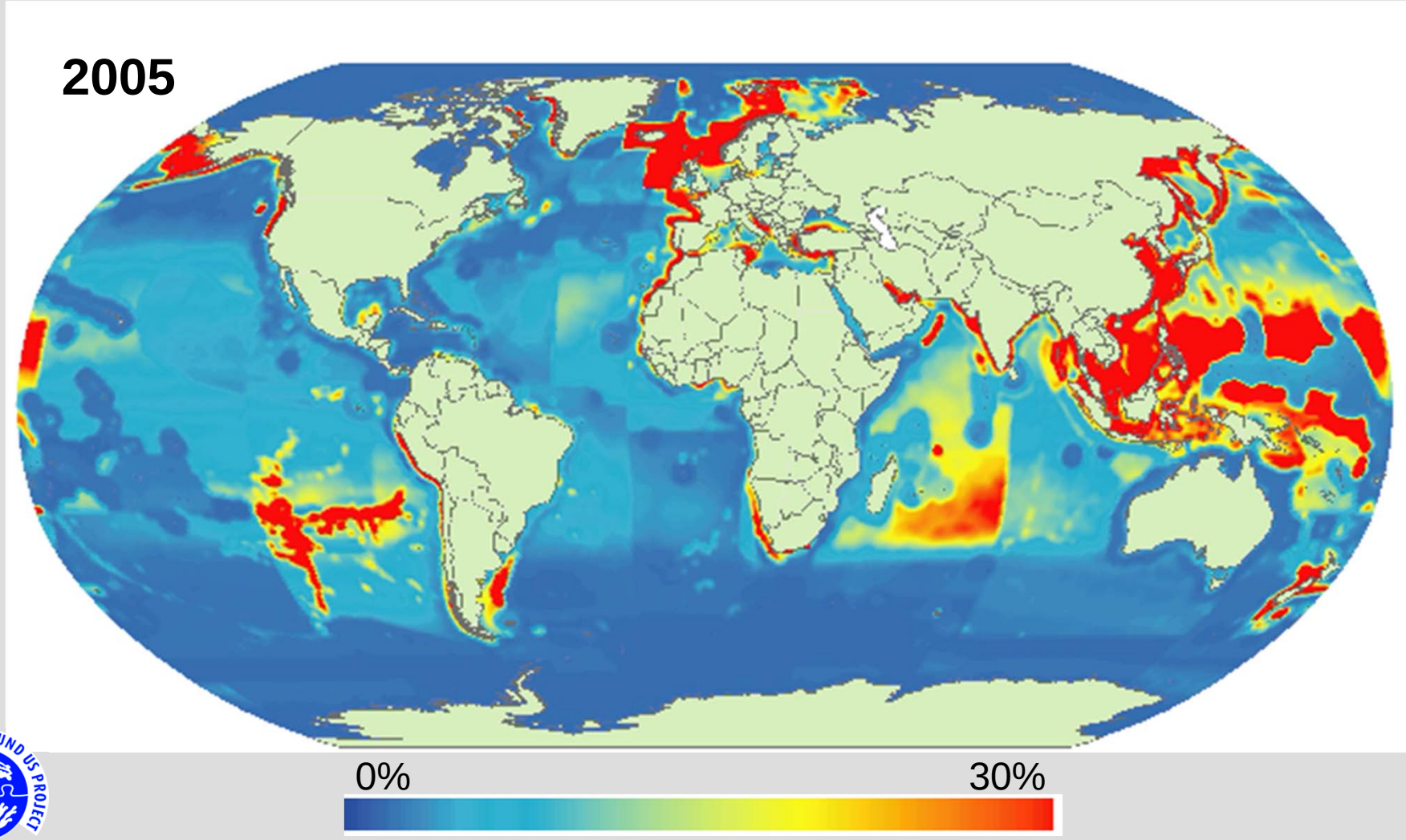
Growth of total standardized fishing effort, 1950-2006



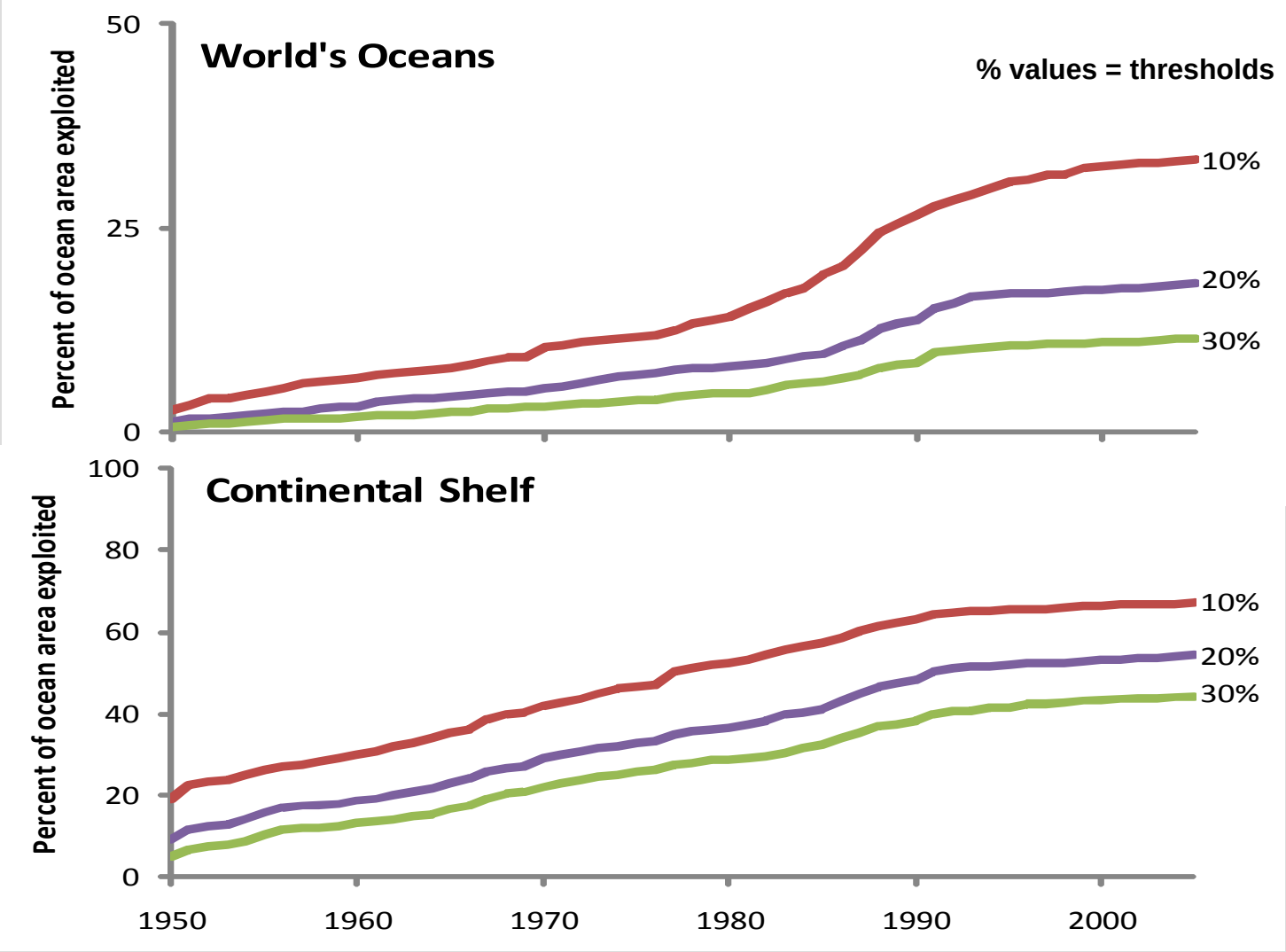
The footprint of fishing on the ocean has spread, as shown the fraction of marine ‘primary production’ required by fisheries in the 1950s…



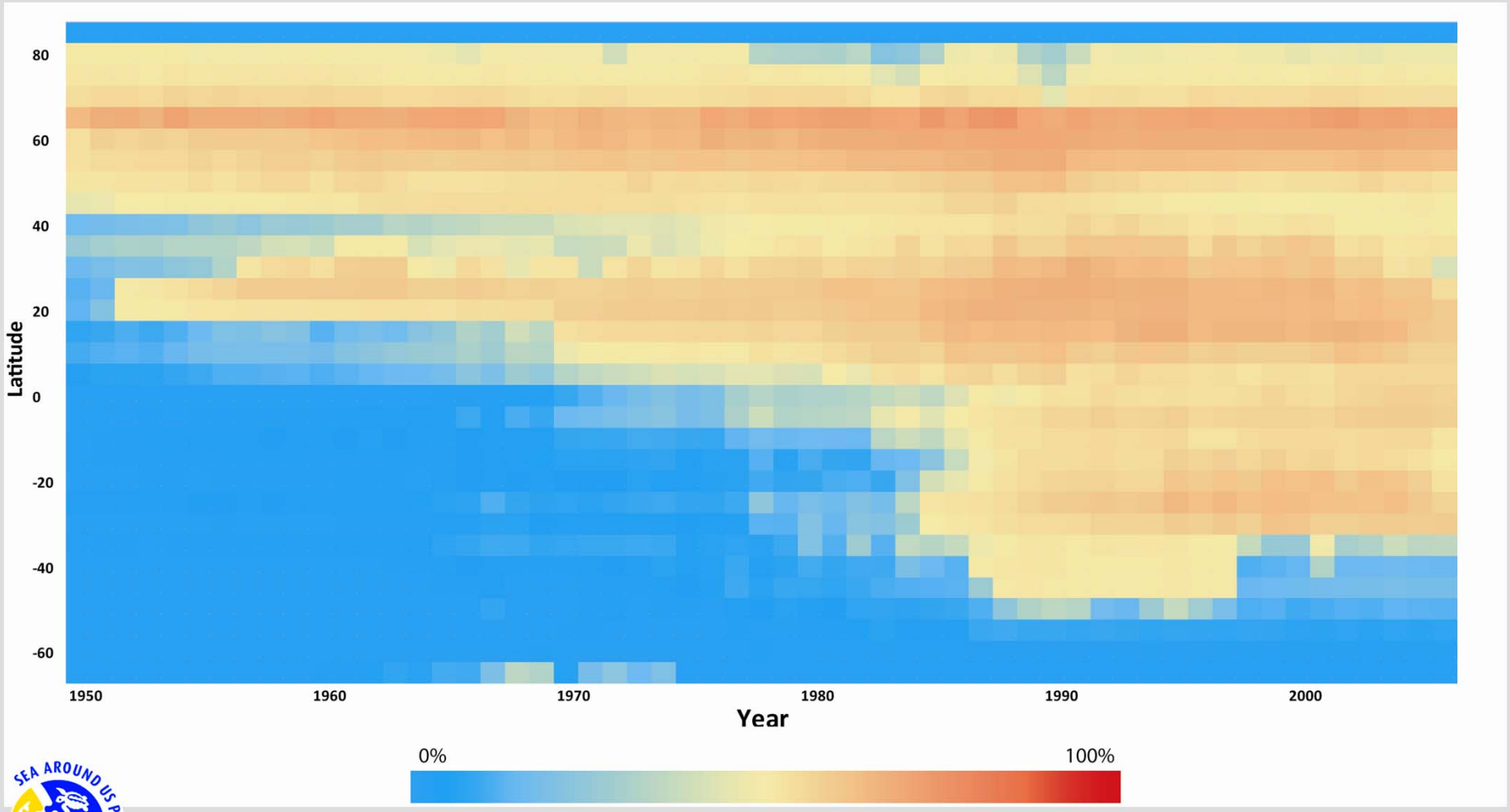
…and in the 2000s



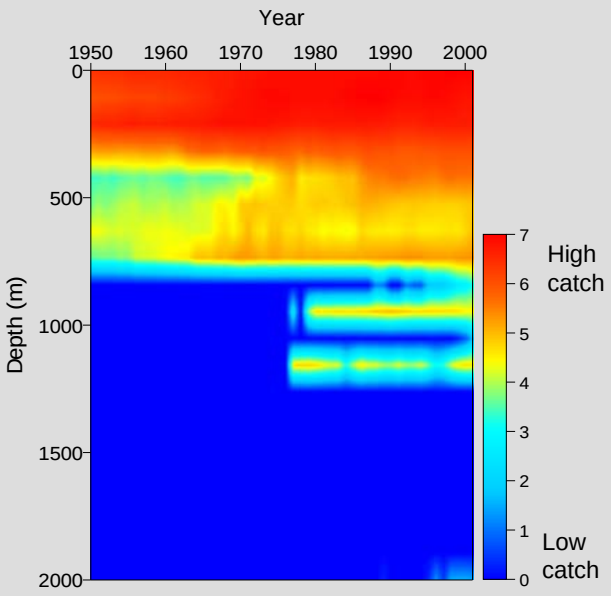
In fact, we are running of space to expand into, as illustrated here by the increase, since 1950, of the fraction of the ocean that is exploited by fisheries…

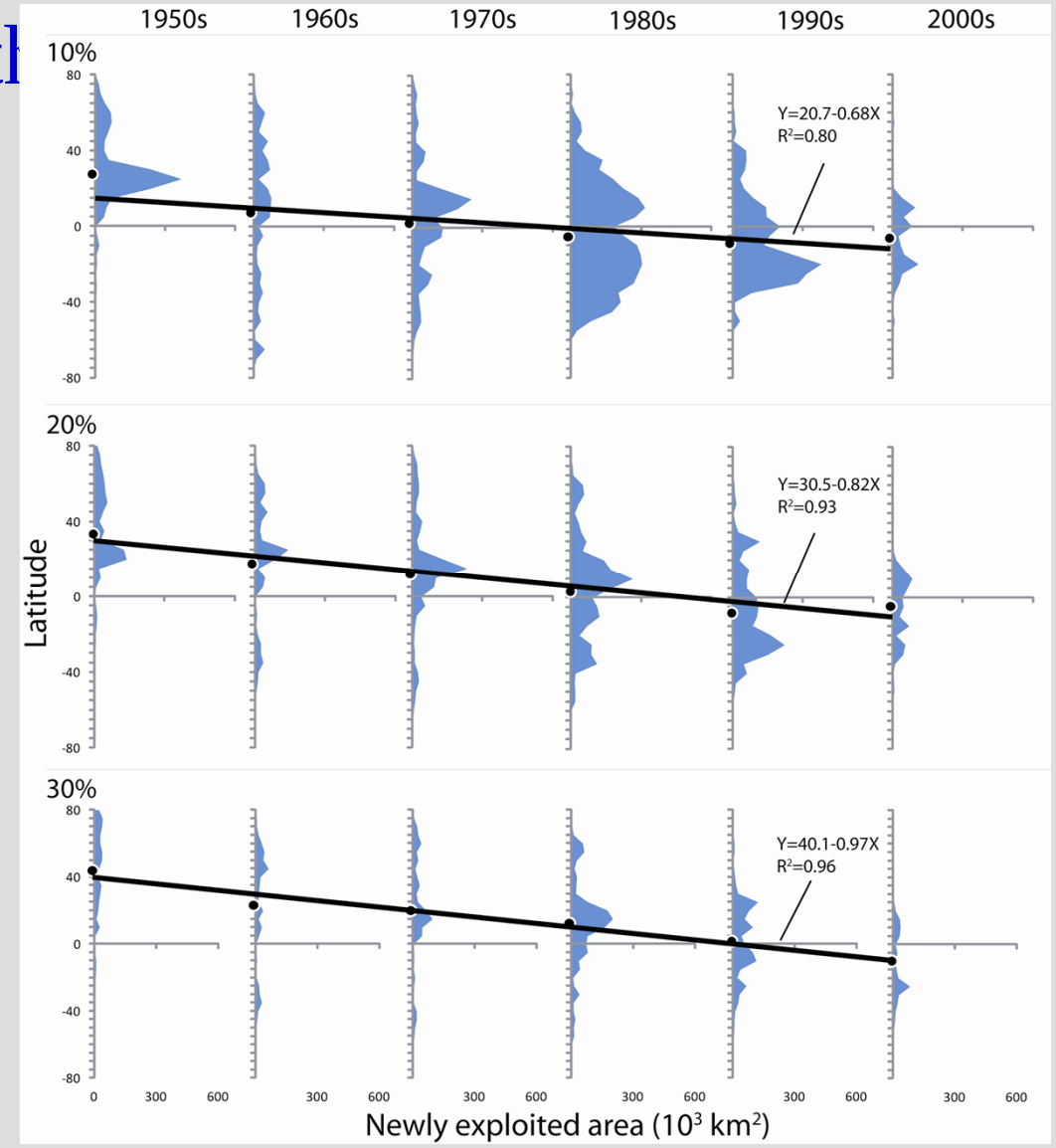


We cannot move much further south, either, as the southern latitudes are now also exploited…



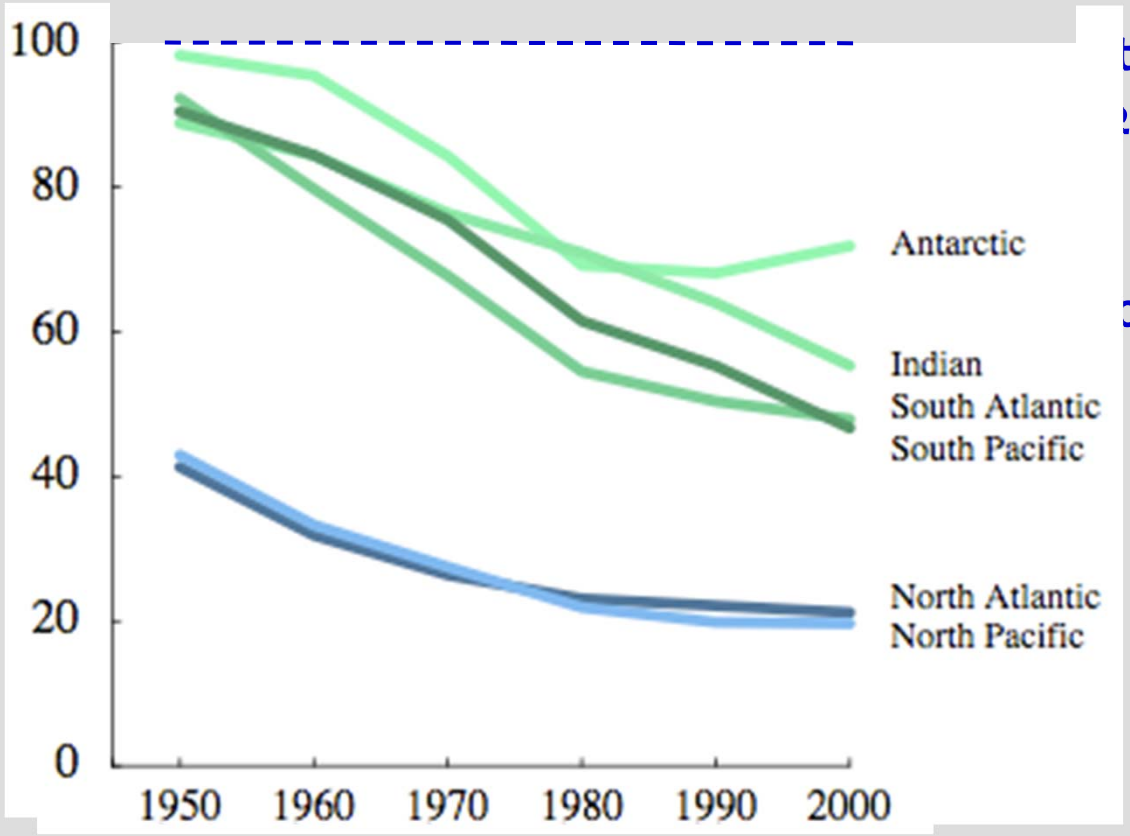
Fisheries have expanded not only offshore, but deeper and south





General biomass trends

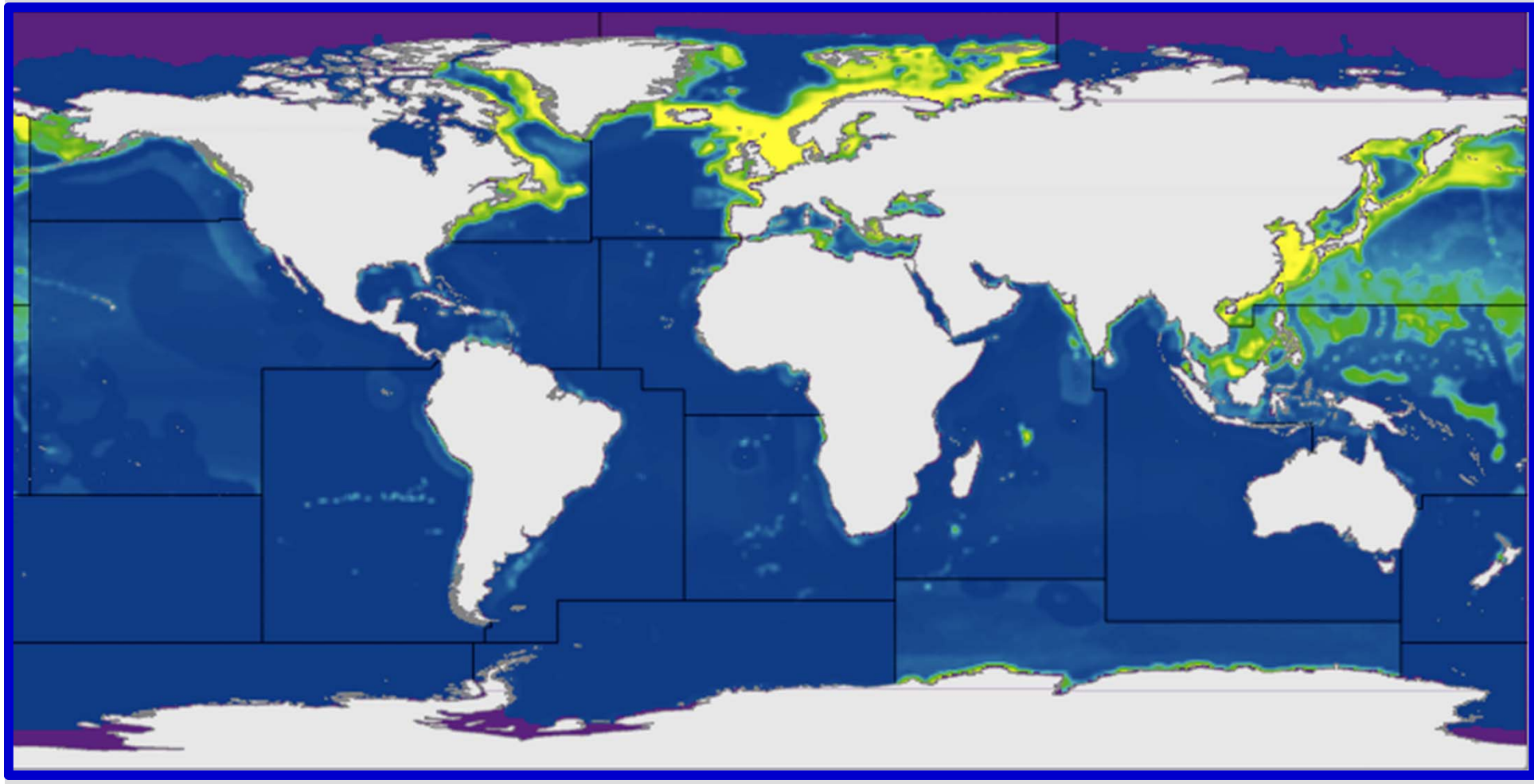
Predators in EEZs:



tem biomass
:000: 87.7%

or biomass left:

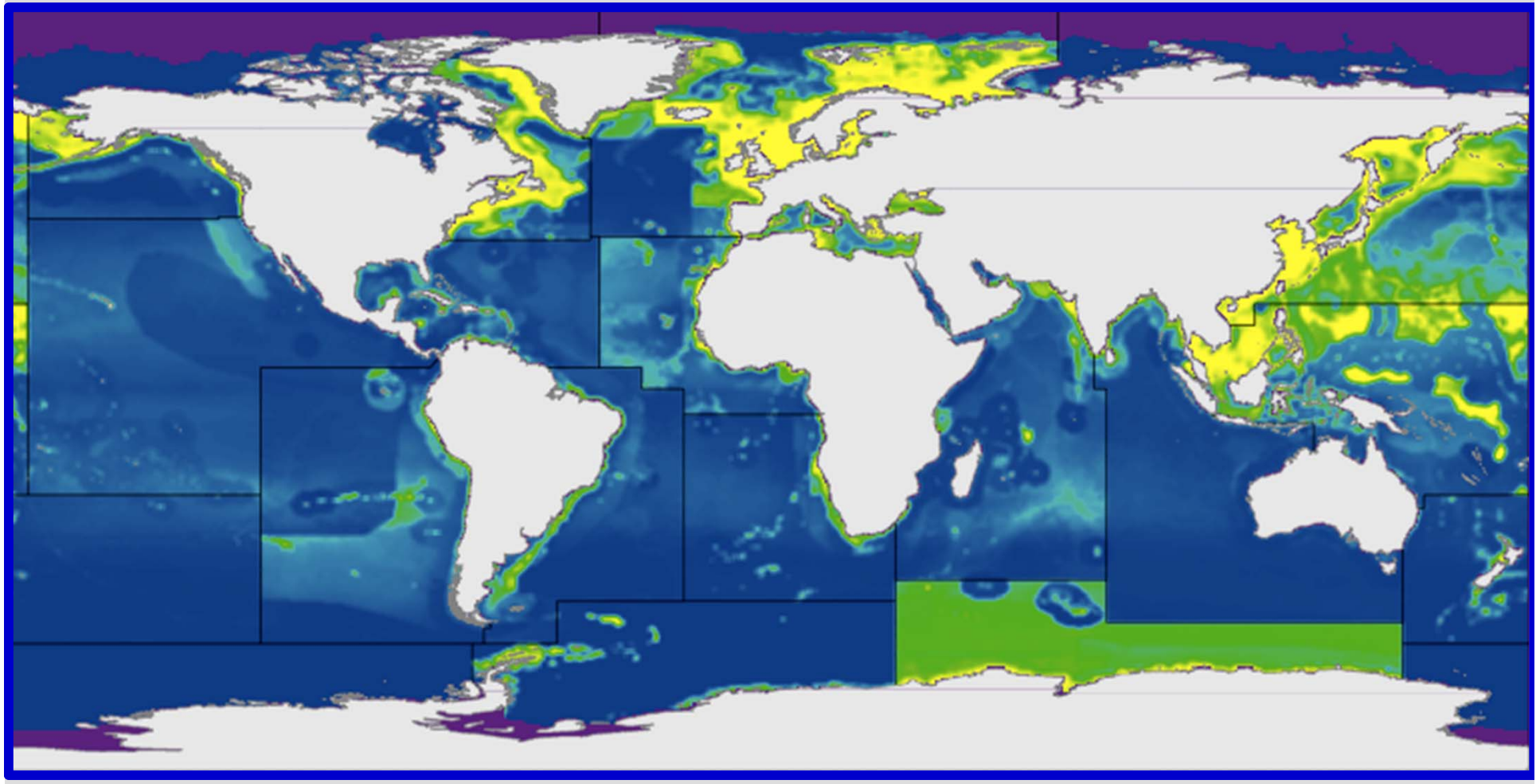
1950 1960 1970 1980 1990 2000



Predator biomass remaining (%):

100% 0%

1950 1960 1970 1980 1990 2000

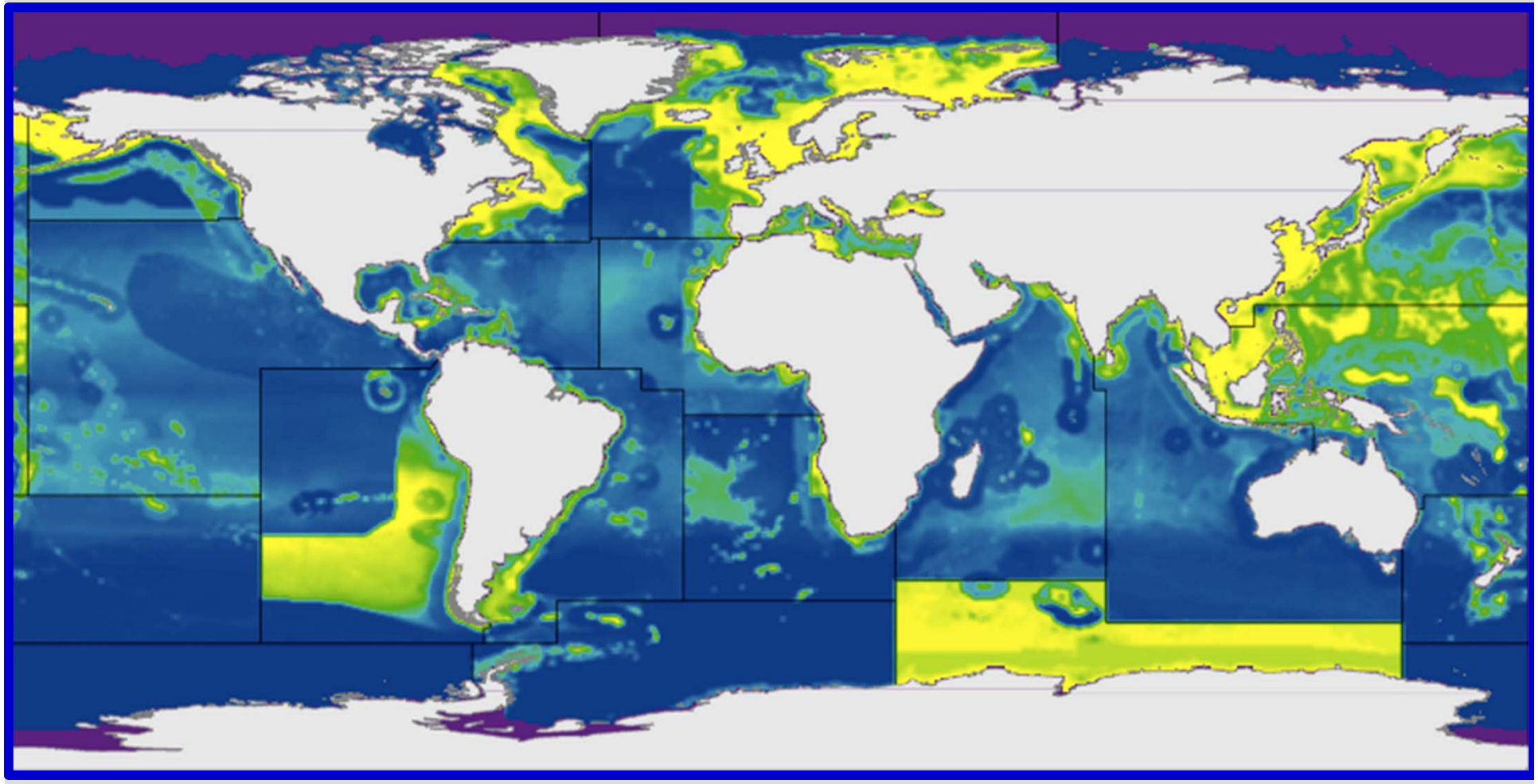


Predator biomass remaining (%):

100%

0%

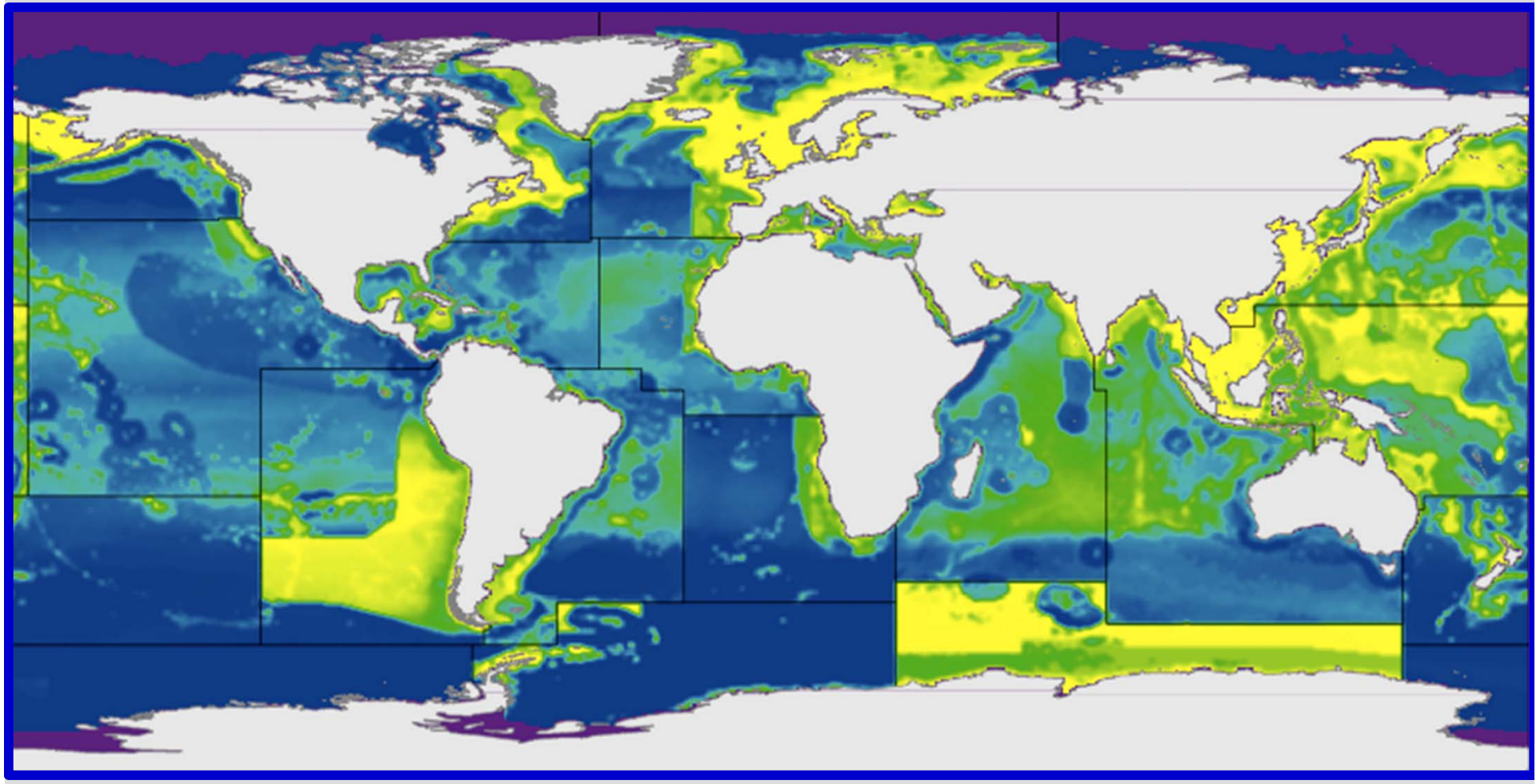
1950 1960 1970 1980 1990 2000



Predator biomass remaining (%):

100% 0%

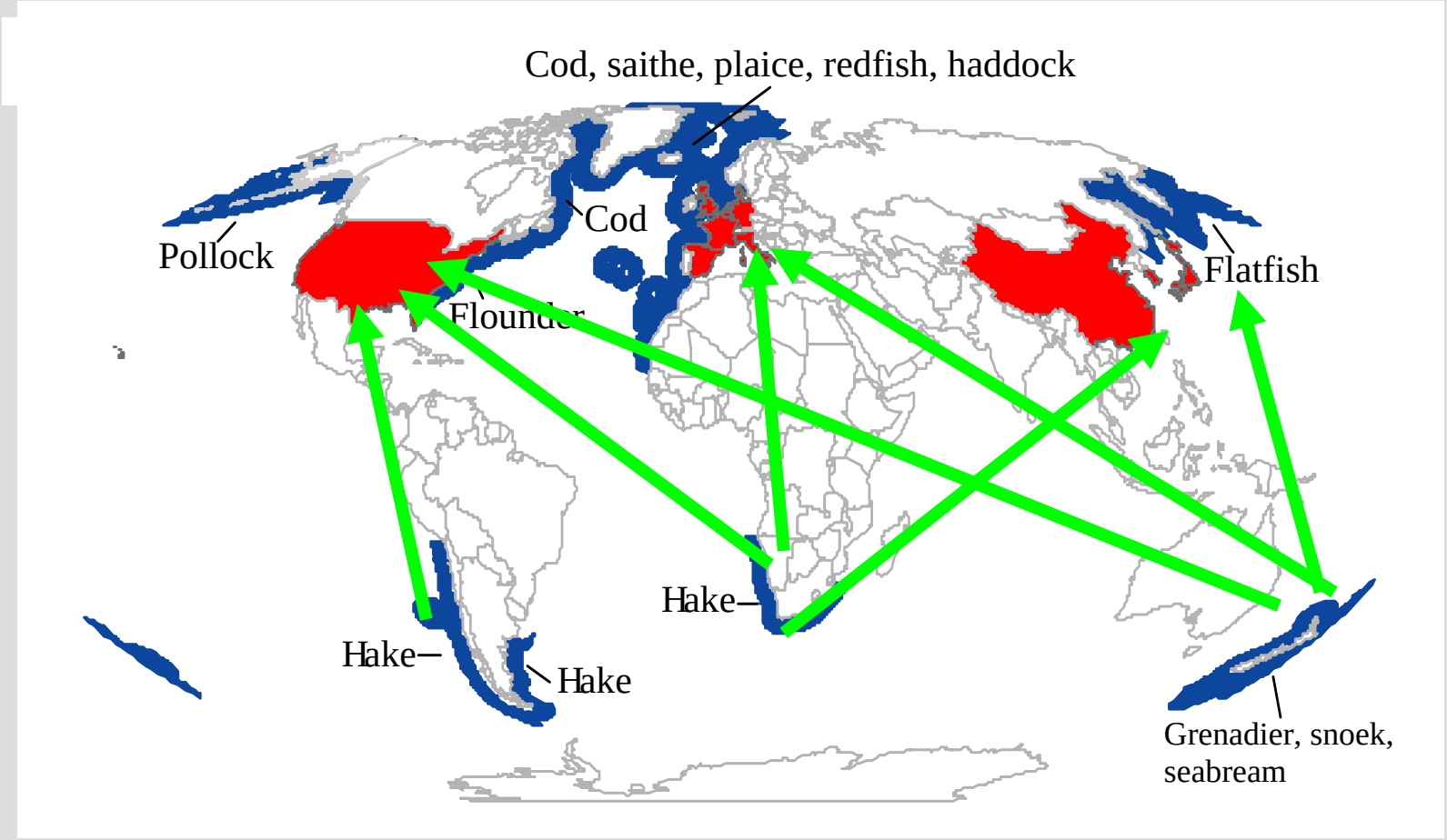
1950 1960 1970 1980 1990 2000

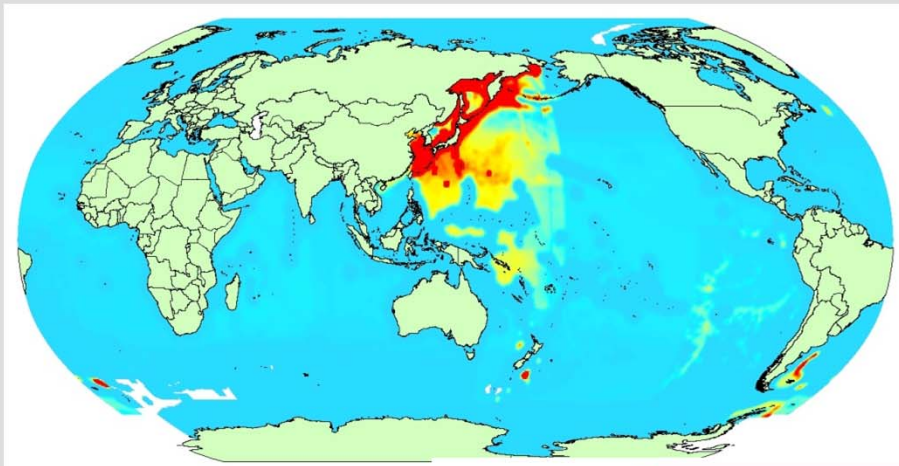


Predator biomass remaining (%):

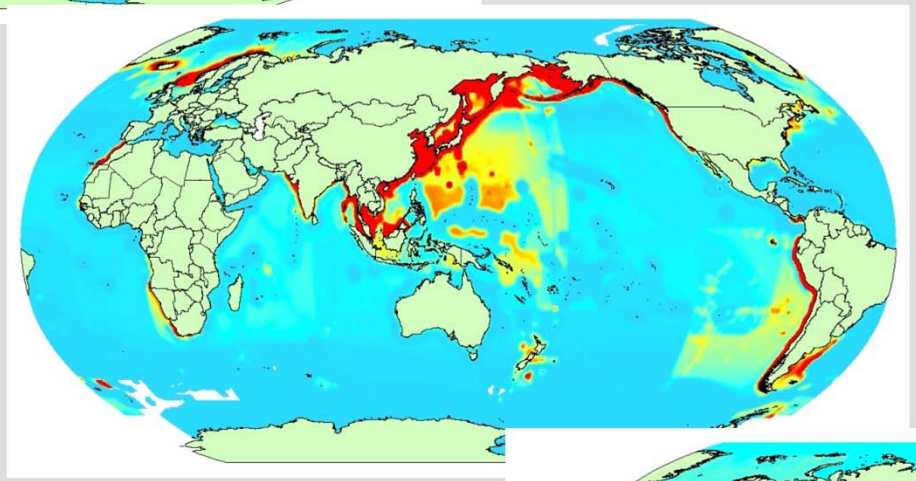
100% 0%

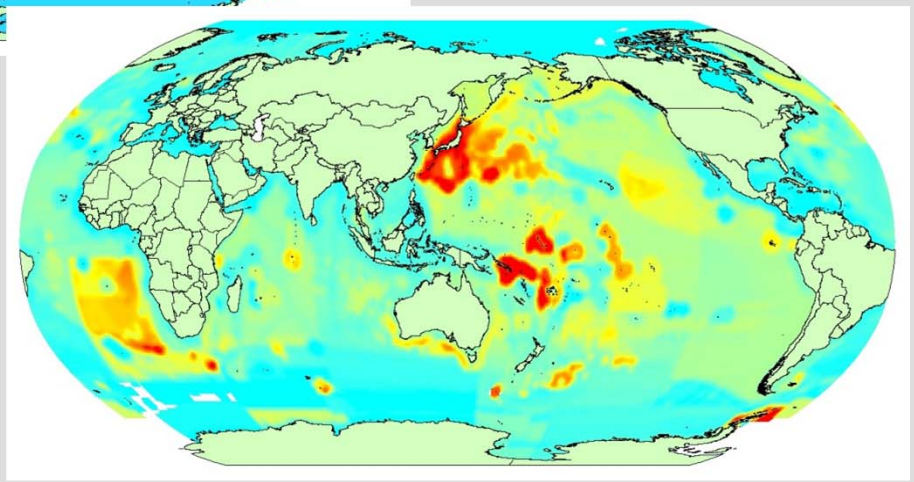
Consumers in the ‘North’ are now utterly dependent on seafood from the ‘South’….





Top: catch by Japan in 2000-2005; center: areas from which seafood is imported into Japan (same period); below: fraction of the total catch per area that goes to Japan.





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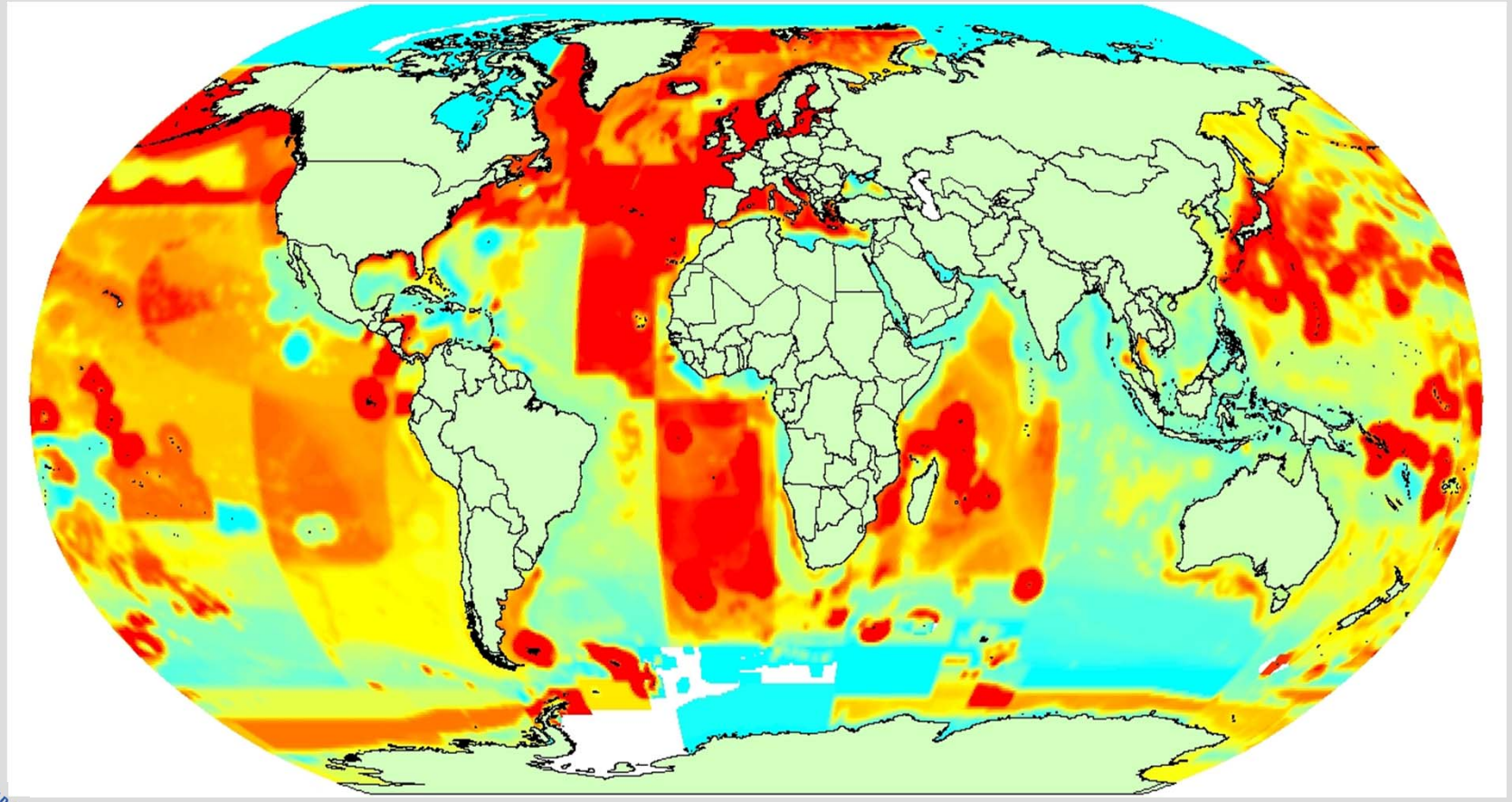
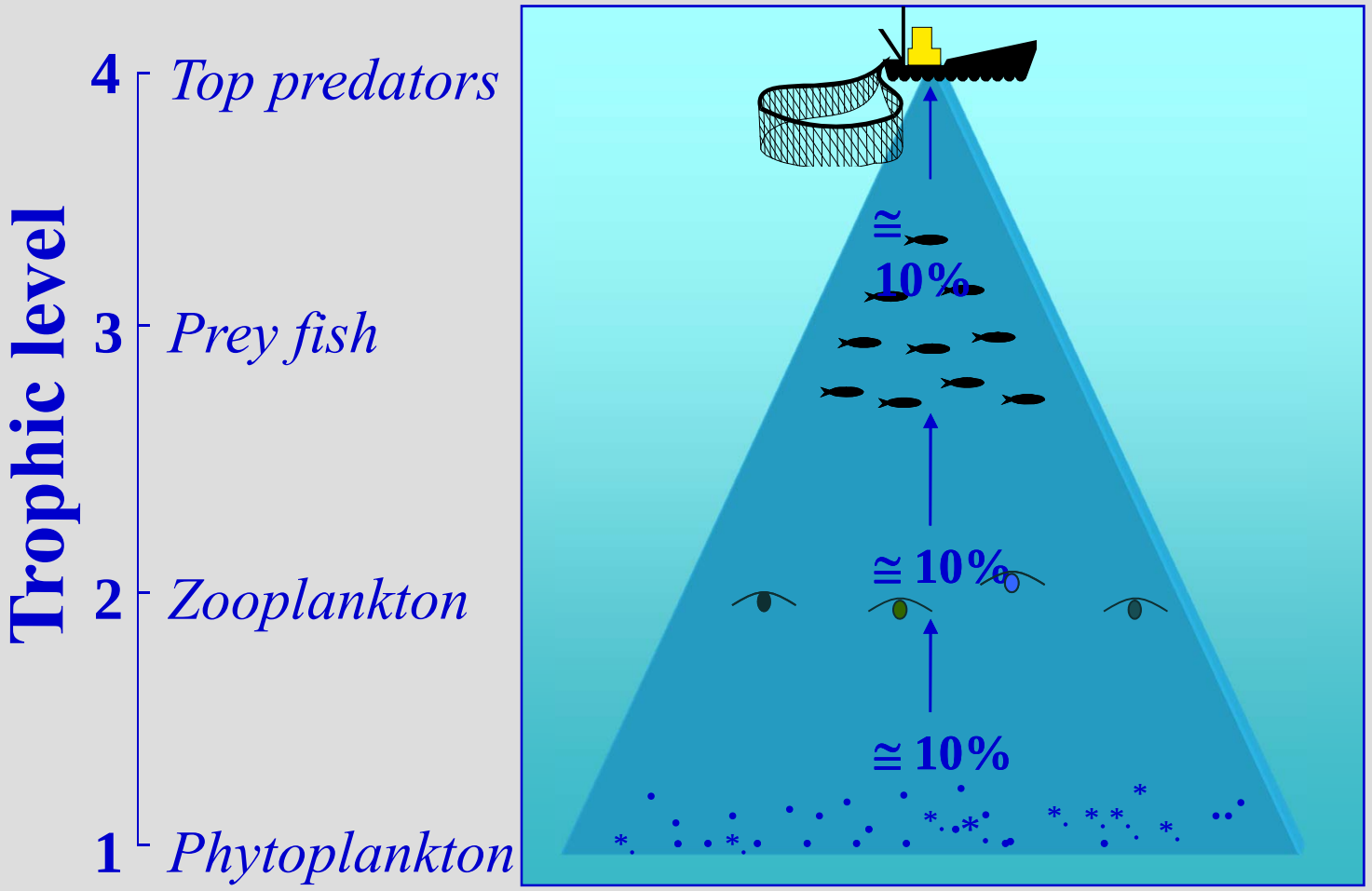
In the 2000s, three markets (the EU, US and Japan) access much of the marine resources of the world ocean (scale is % of catch destined for one of these three markets; with red=100% and blue= 0%)



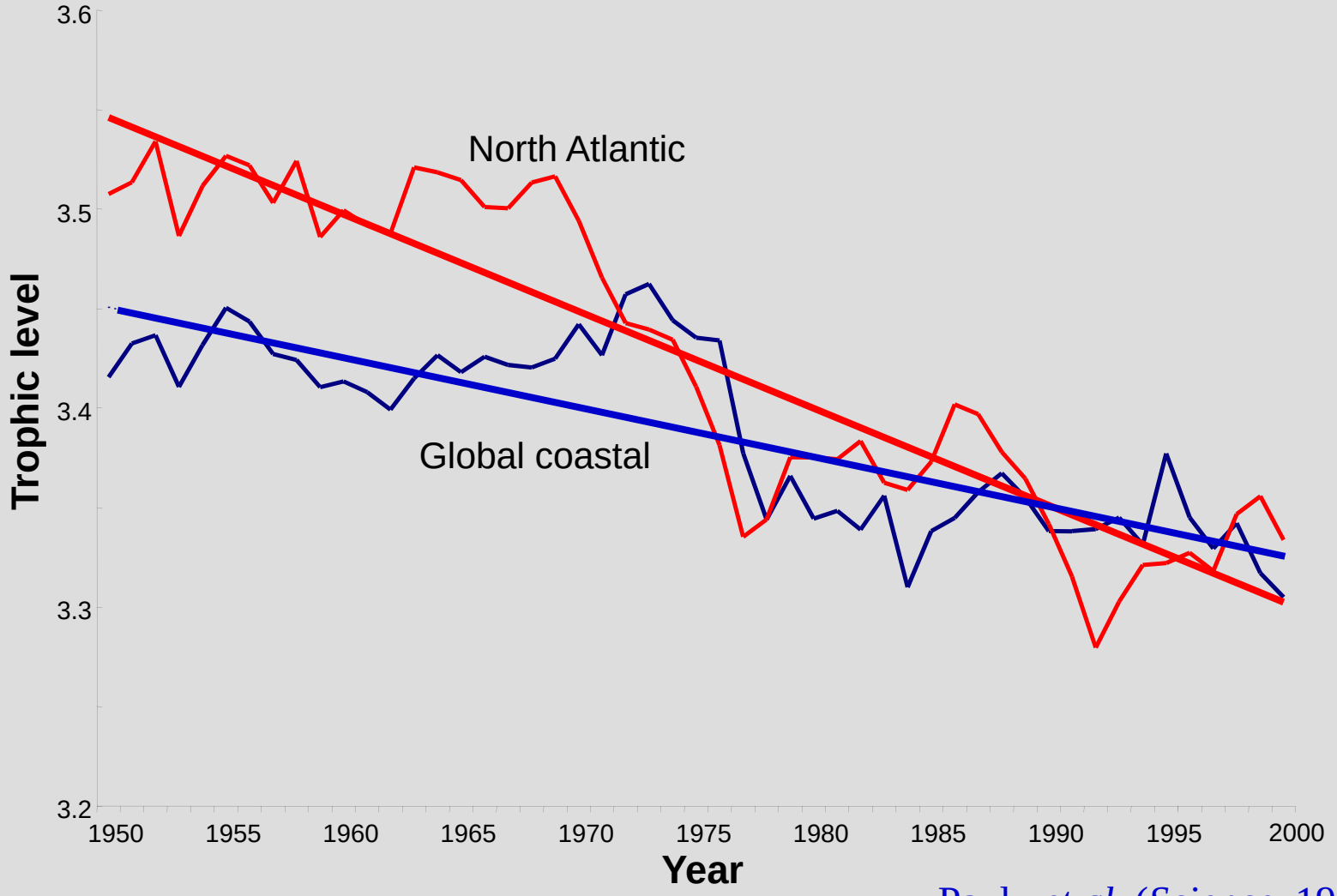
Sustainable?

Back to basics: ecosystem fluxes move up ‘trophic pyramids’…



and each species tends to have its own trophic level…

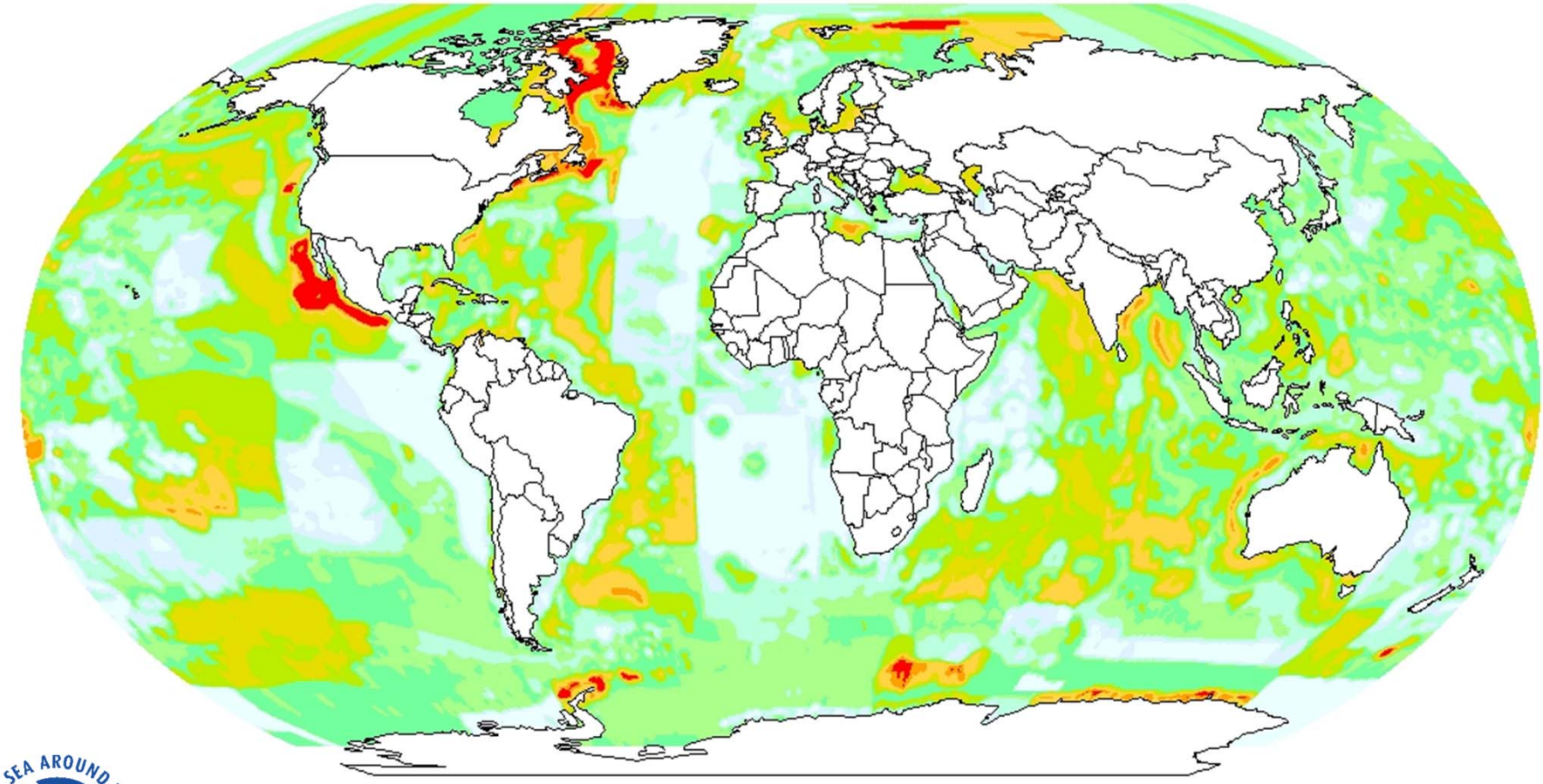
Another ominous trend emerges when we compute the mean trophic level of world catches. This shows a global decline…



Pauly *et al.* (*Science*, 1998)

In fact, ‘fishing down’ is so widespread that the Convention on Biological Diversity (CBD) now uses mean trophic levels as an index of biodiversity, the “Marine Trophic Index”.

Trophic level change (1950-2000)



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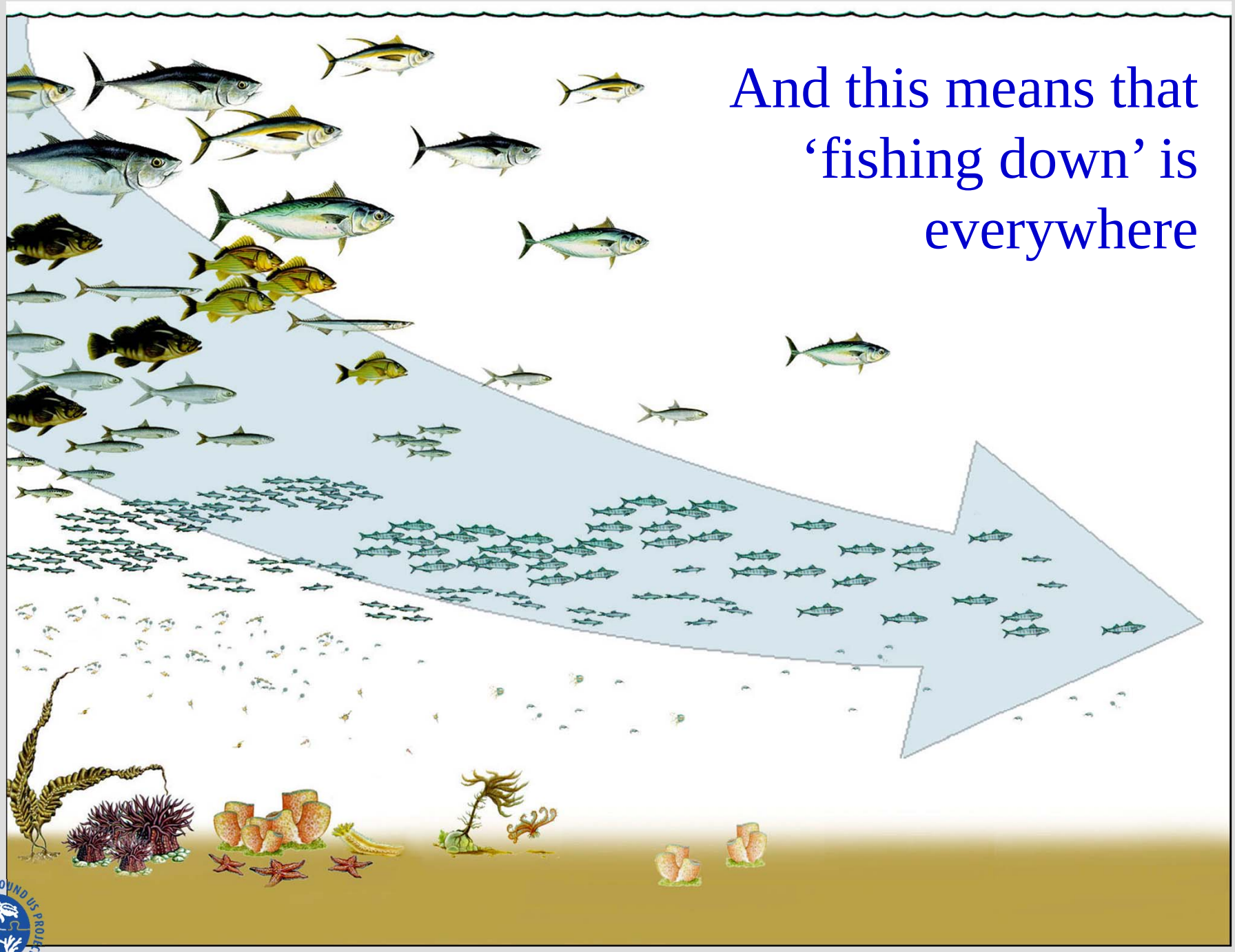
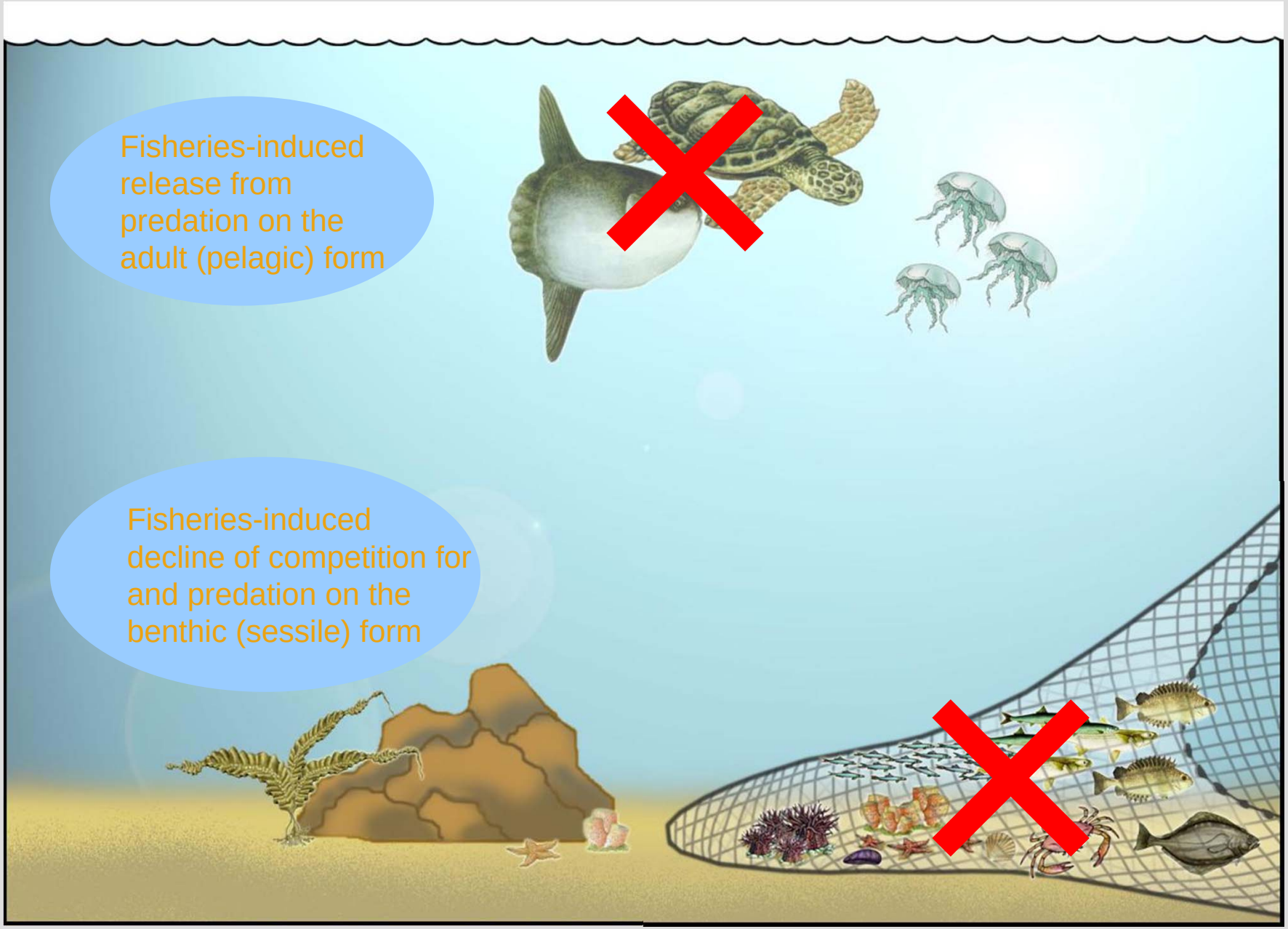
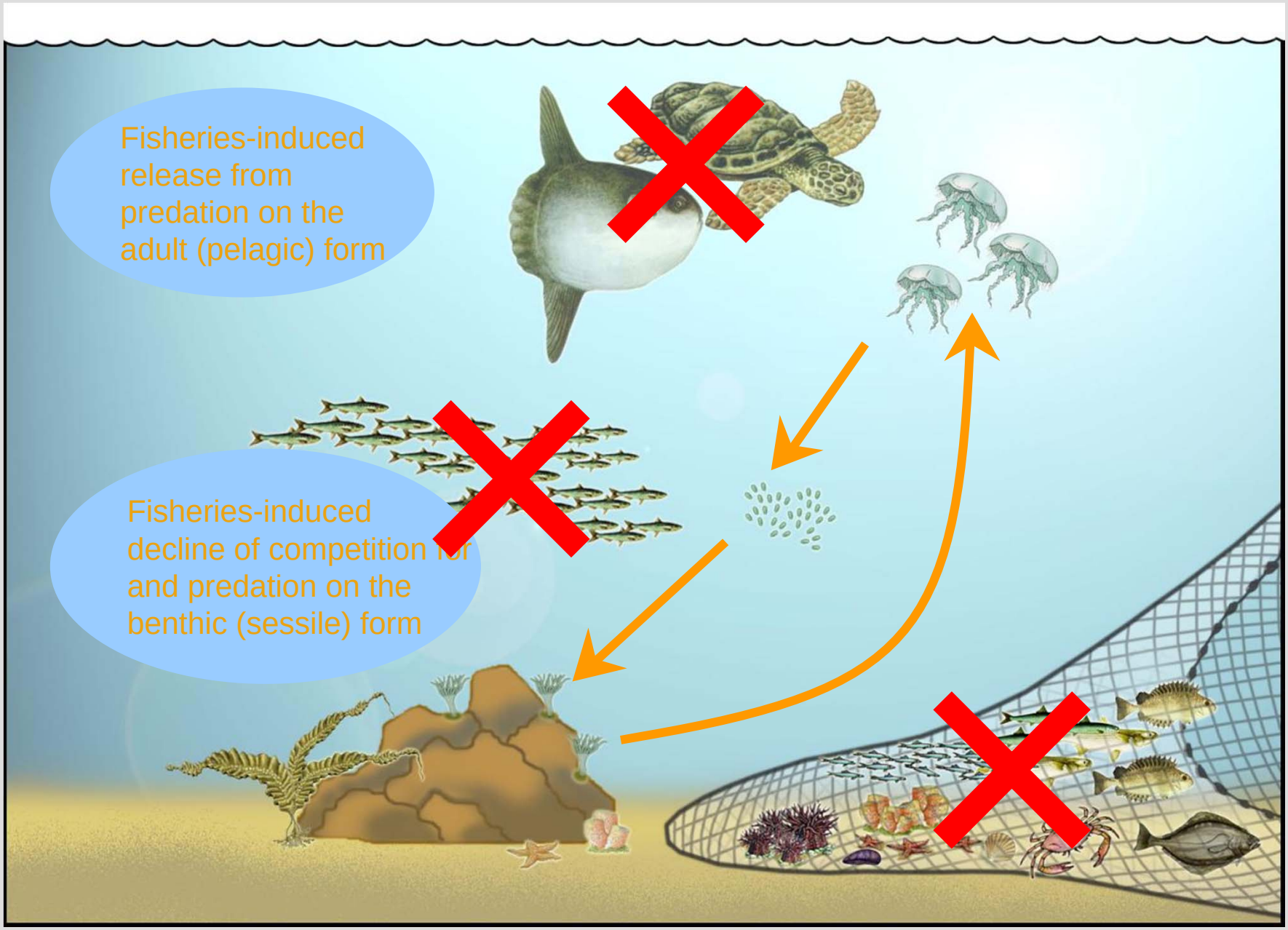

And this means that
‘fishing down’ is
everywhere

We can see from space how trawlers stir up sediment…

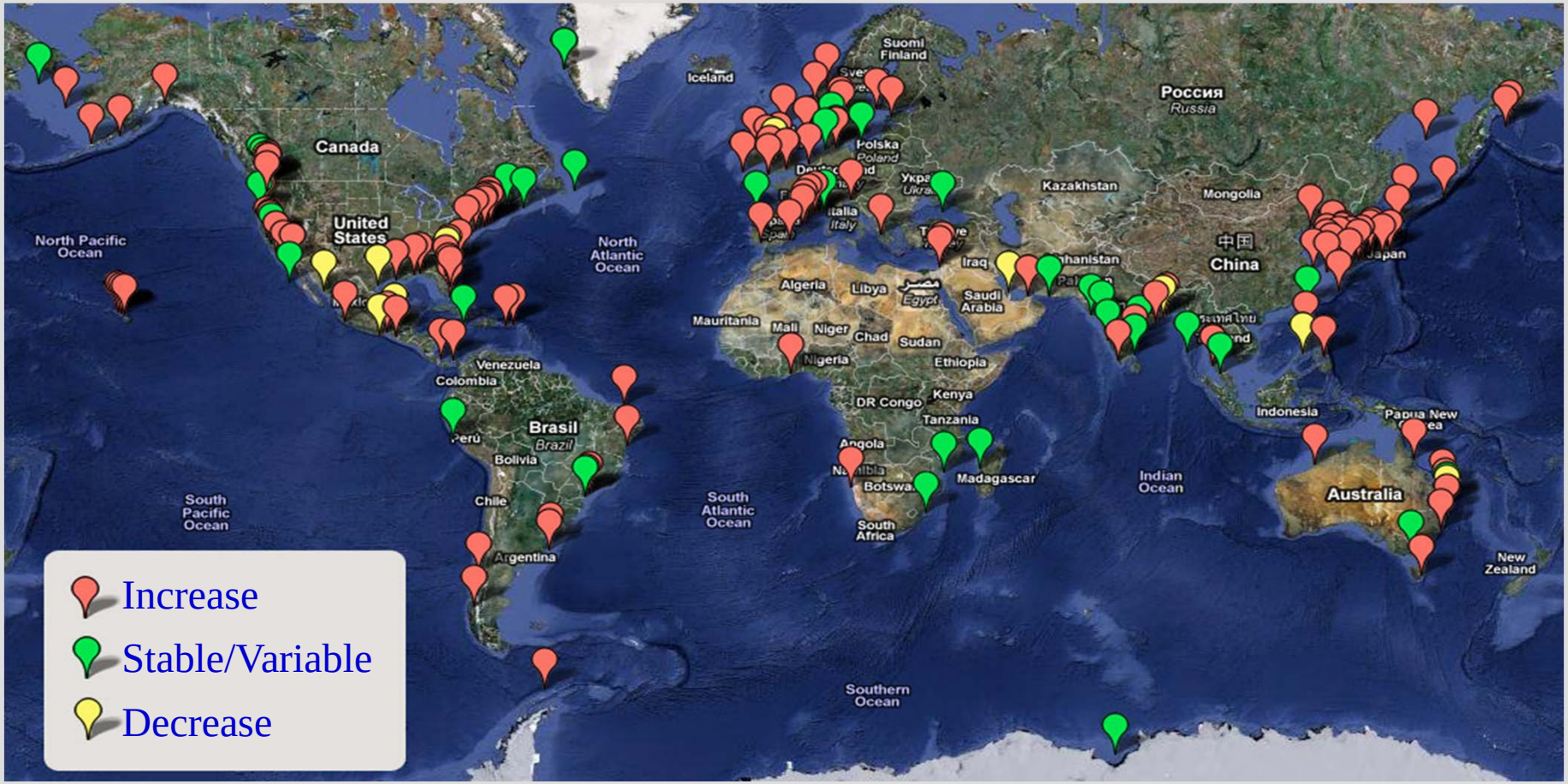
Here: shrimp trawlers off the Texas Coast, Gulf of Mexico

Photo courtesy of Dr. Kyle van Houten (Duke University)

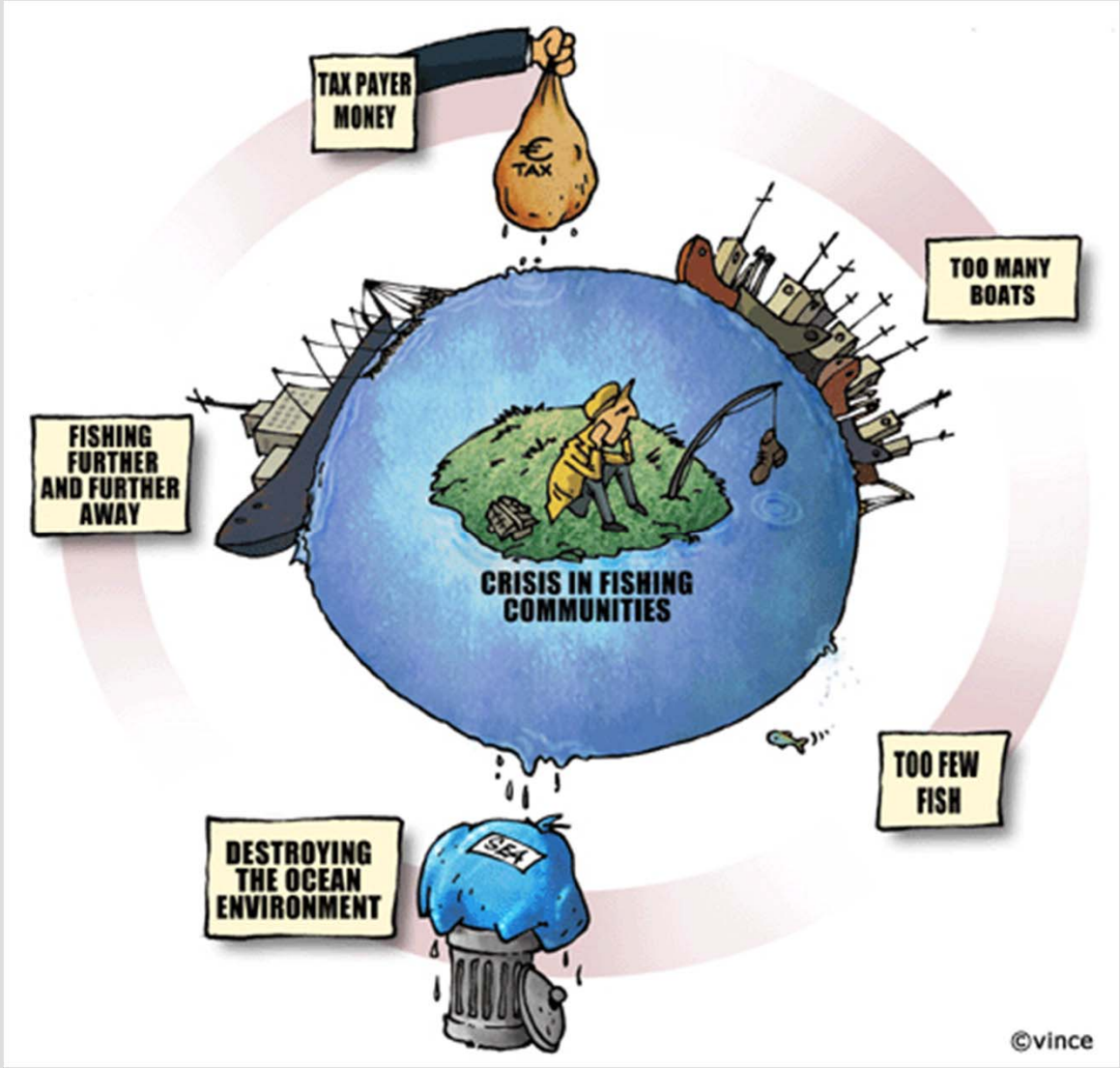

Fisheries-induced release from predation on the adult (pelagic) form
Fisheries-induced decline of competition for and predation on the benthic (sessile) form


Fisheries-induced release from predation on the adult (pelagic) form
Fisheries-induced decline of competition for and predation on the benthic (sessile) form

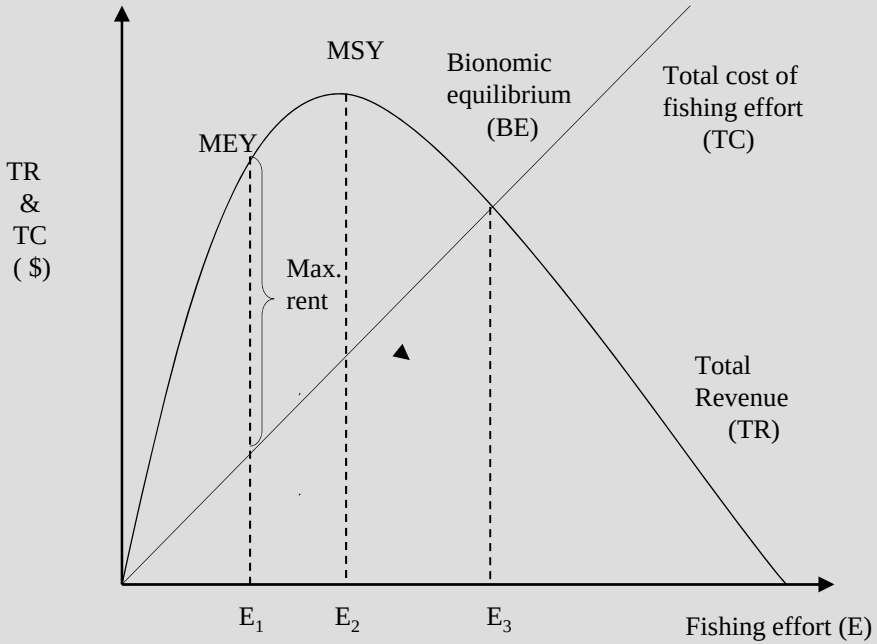
An indeed, jellyfish are increasing almost everywhere…



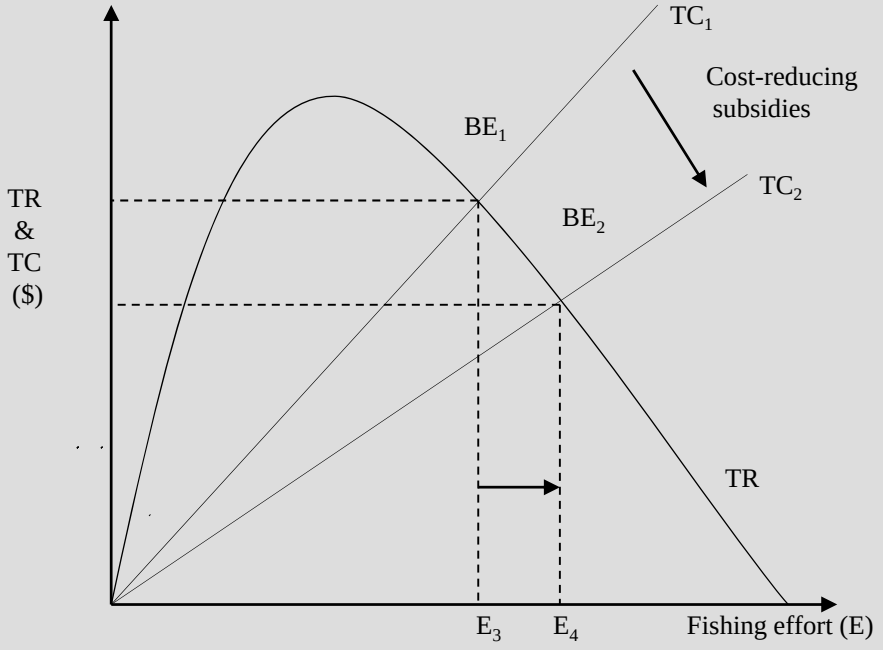
The vicious circle of contemporary fisheries management is to a large extent driven by subsidies….



How subsidies work to undermine fisheries…

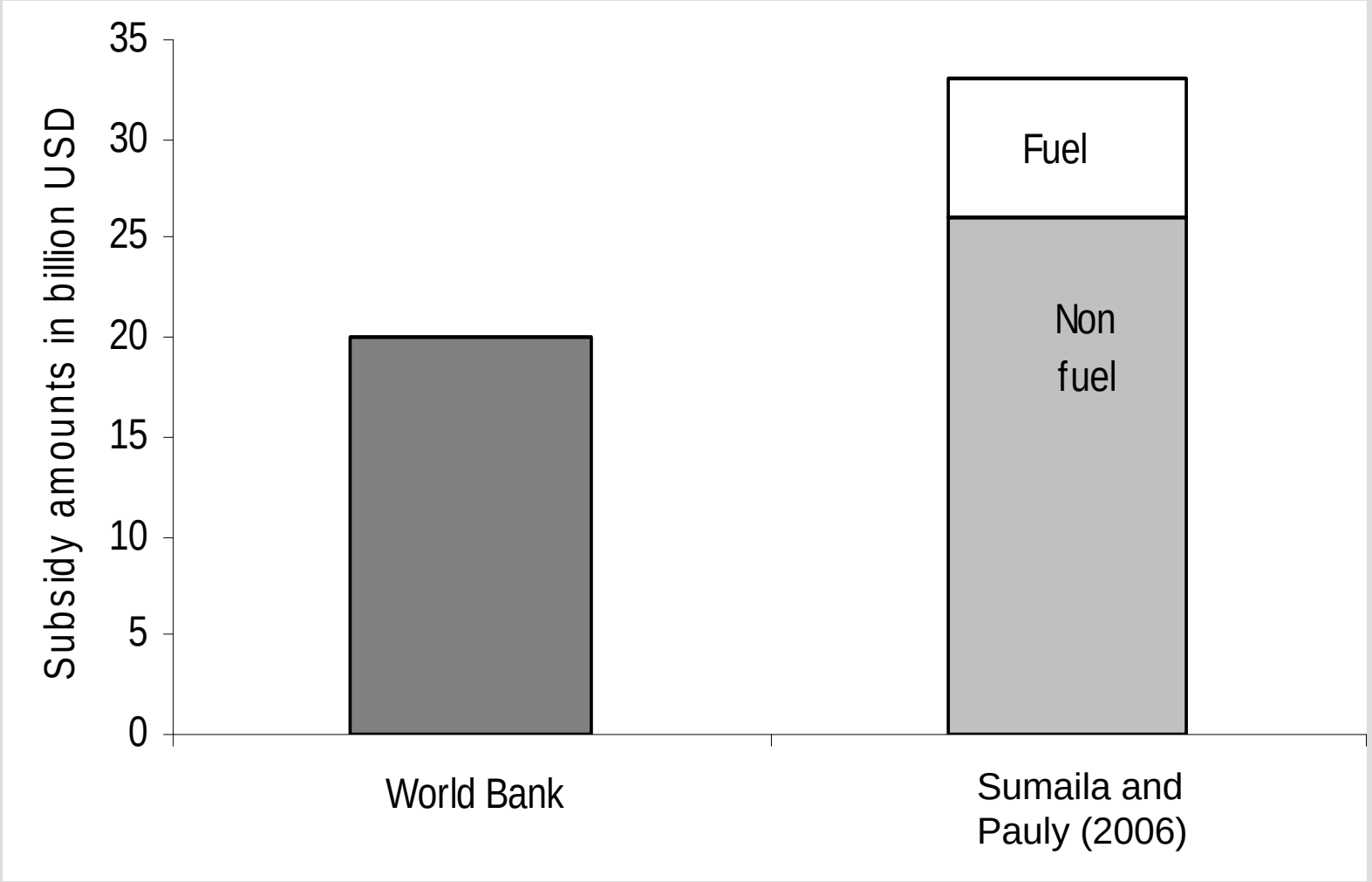


Let's assume a Gordon-Schaefer bioeconomic model

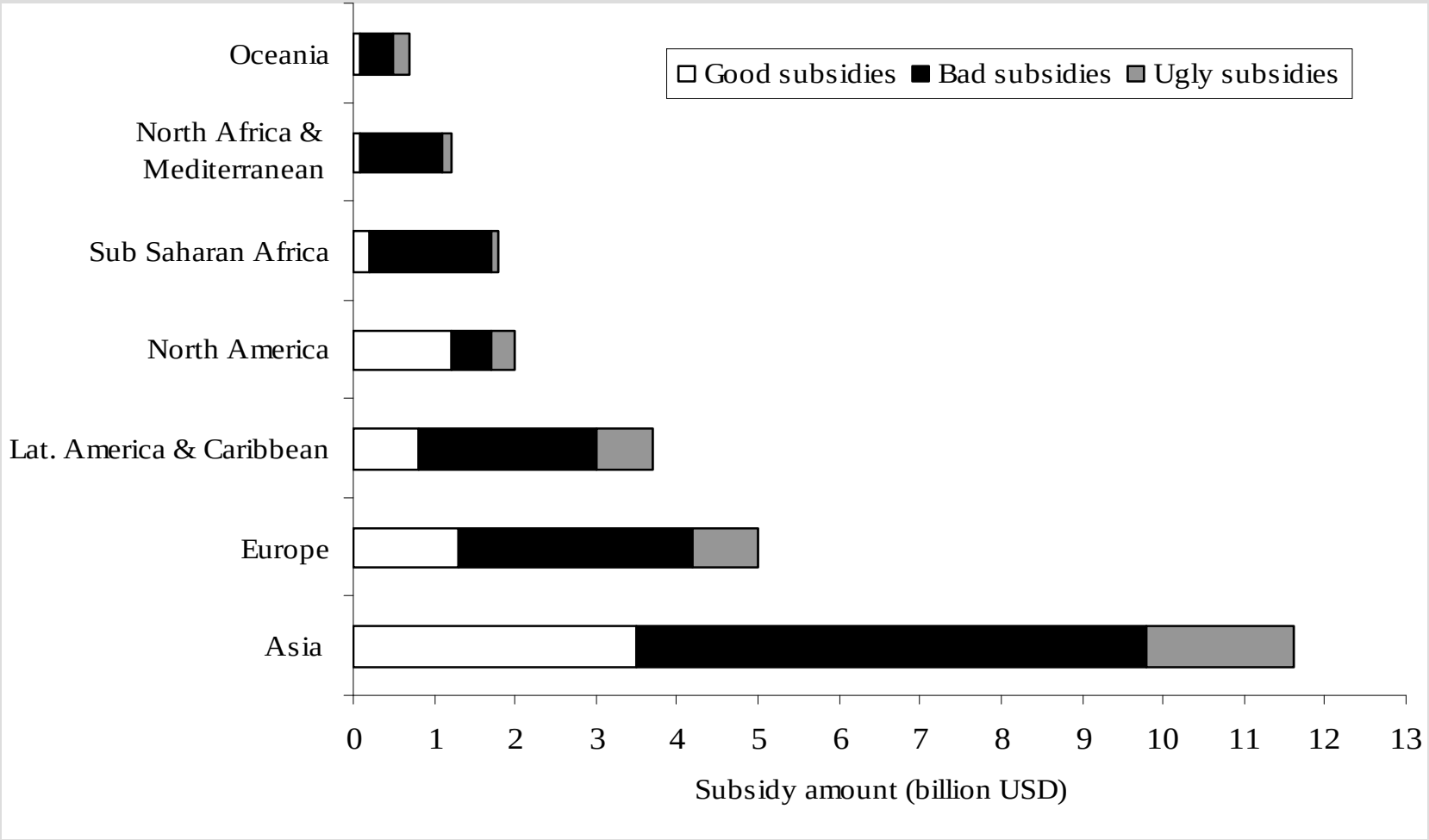


How subsidies induce overfishing

Global subsidy comparisons

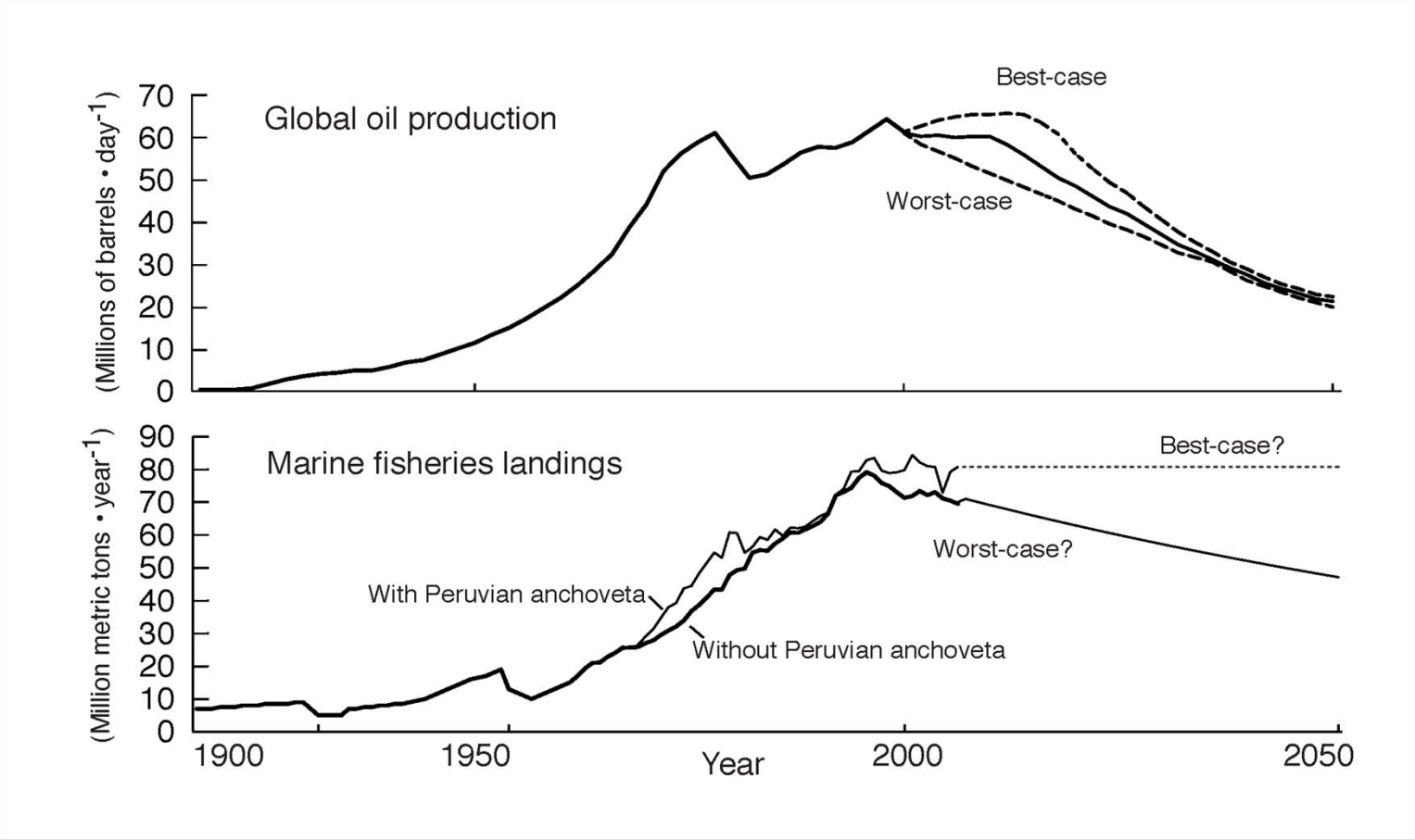


Subsidies come in different flavors…

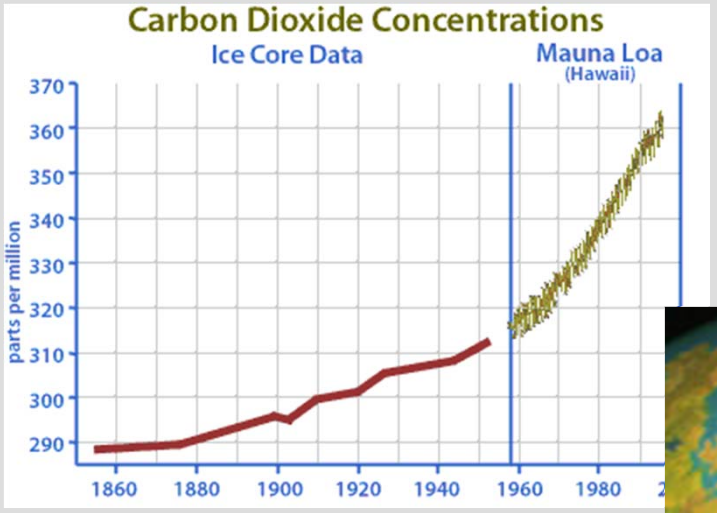


Sumaila and Pauly (2006)

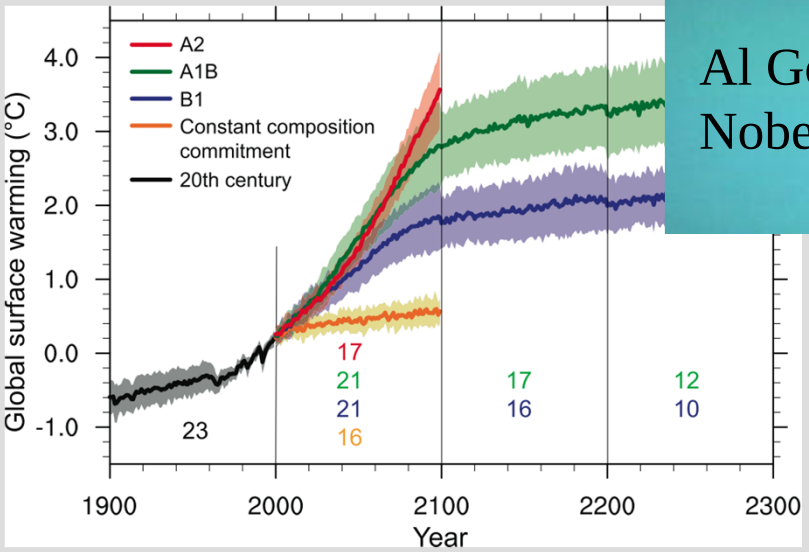
Fuel subsidies are very important to certain fisheries (e.g., trawlers). Fuel prices are likely to increase, however (remember Summer 2008?), and cause big problems to industrial and distant-water fishing...



Pauly *et al*. (*Science*, 2003)

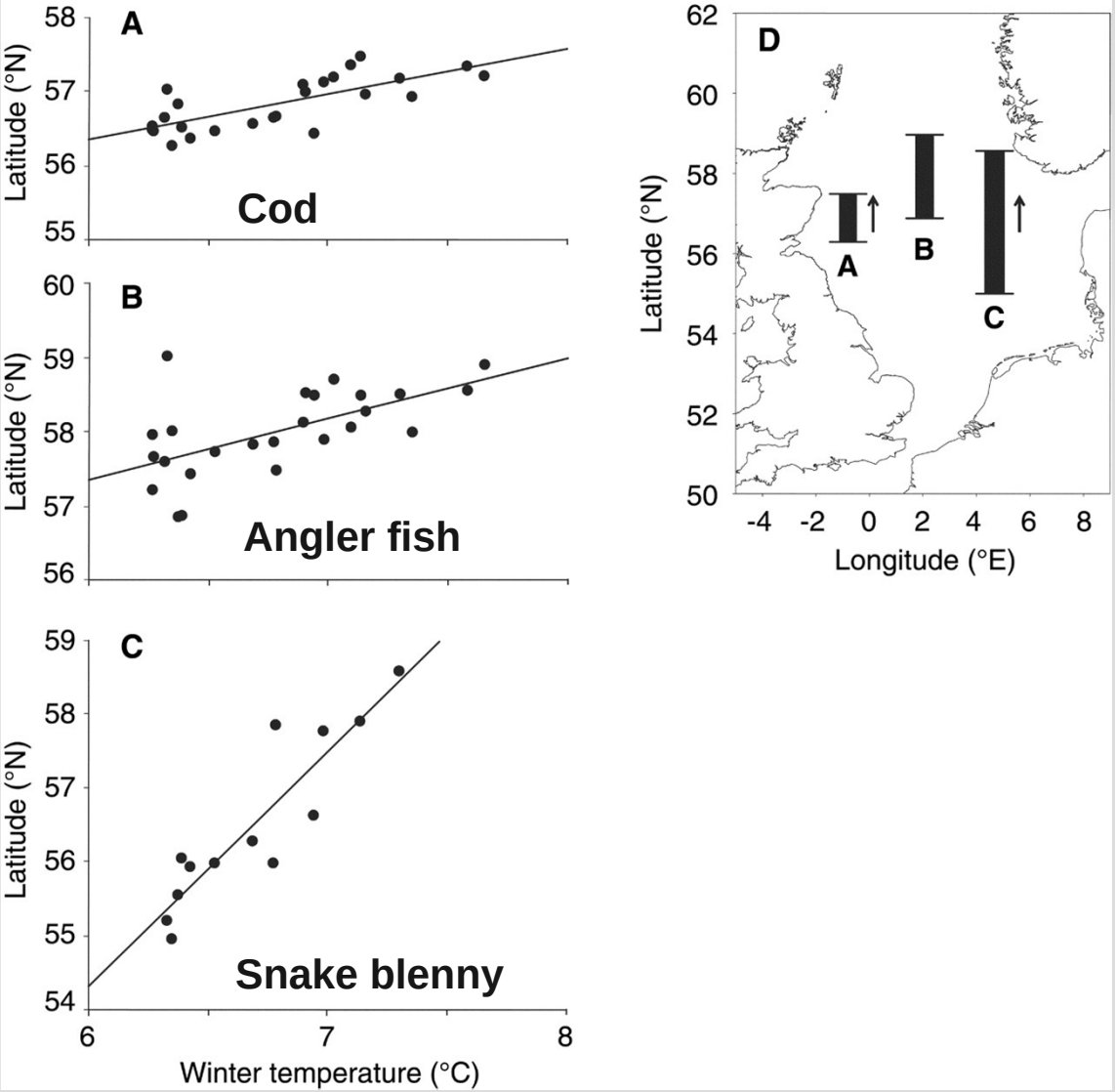


Meanwhile, thing are heating up…



Observed climate-induced shifts in distribution ranges

Poleward shifts in distribution ranges of marine species, e.g., in the North Sea.

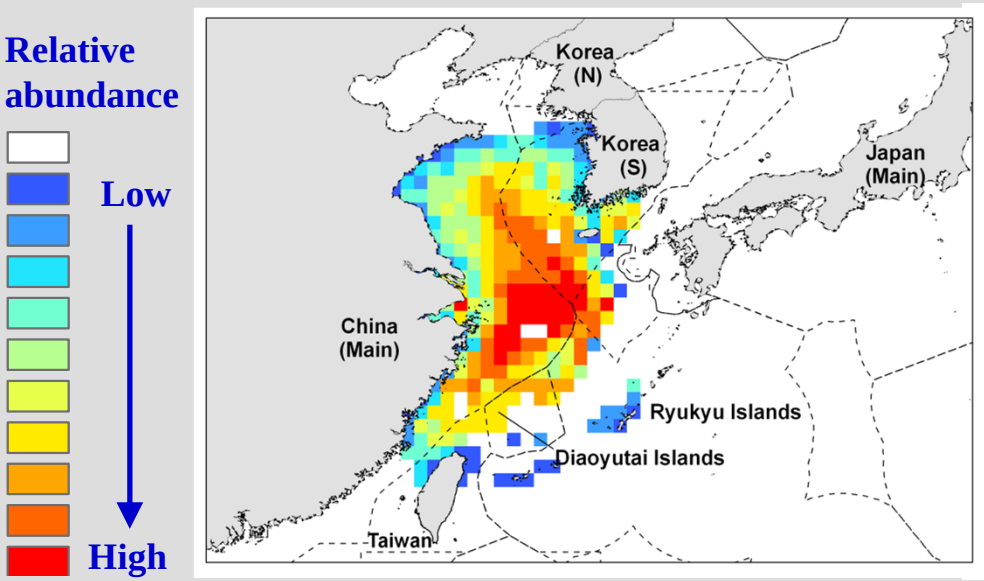


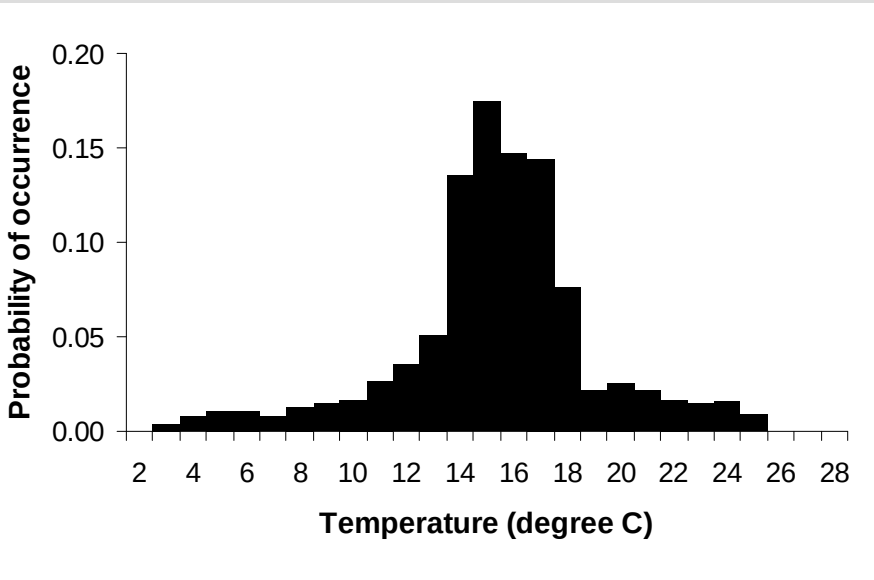
Perry *et al.* (*Science*, 2005)

Simulating poleward shifts using temperature-abundance profiles…

Small yellow croaker
(*Larimichthys polyactis*)

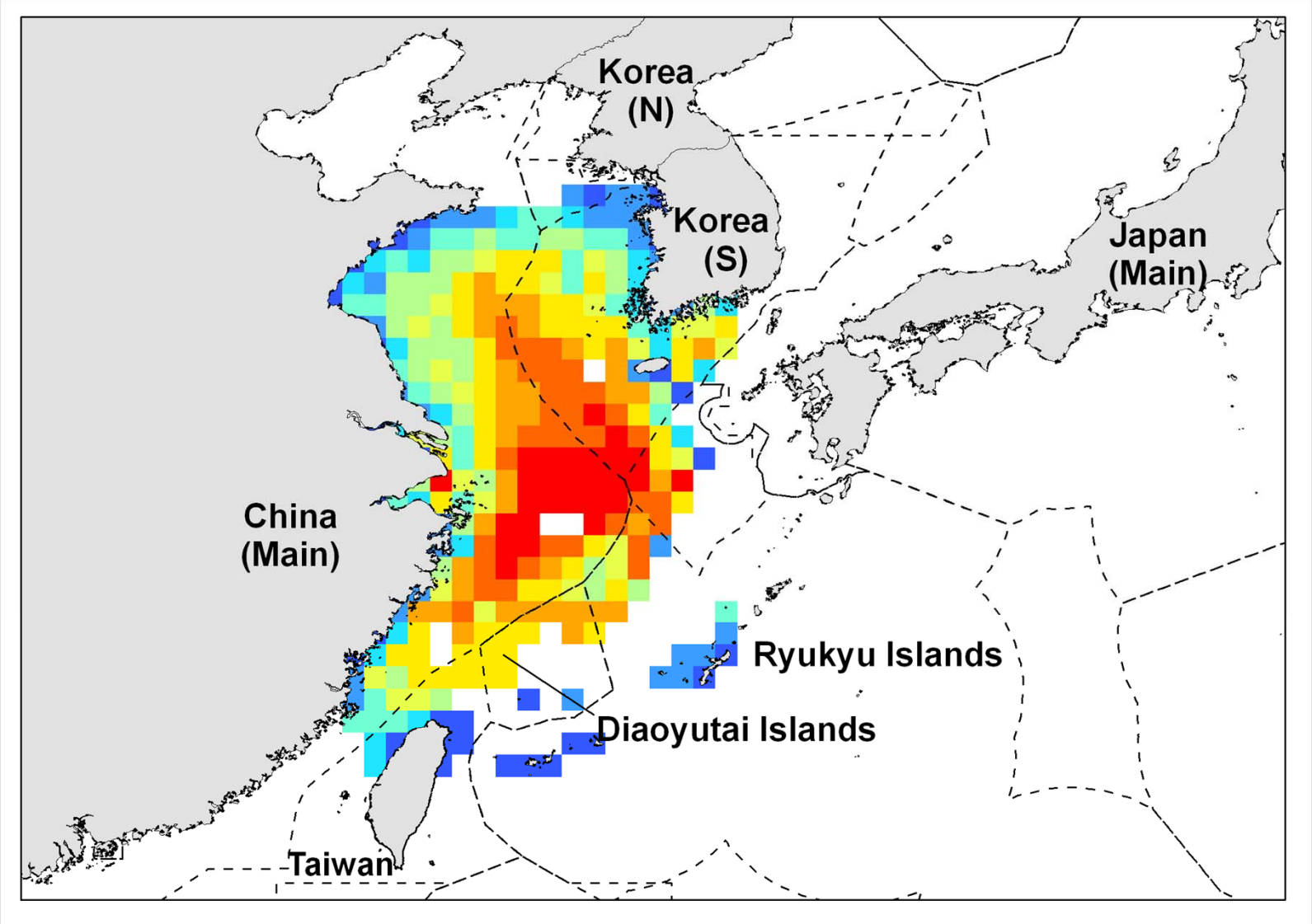
Probability of occurrence by water temperature





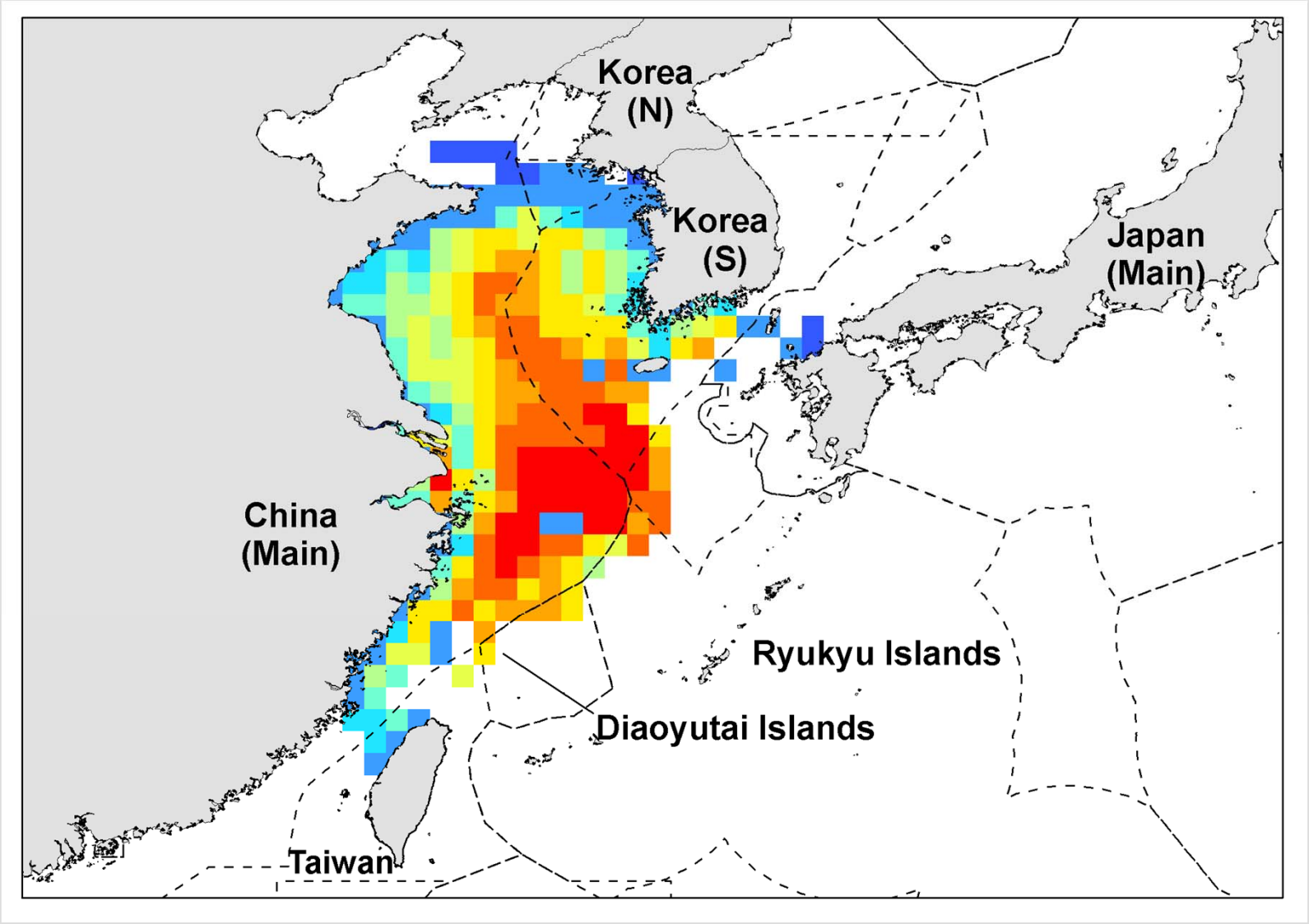
Small yellow croaker

Year 0



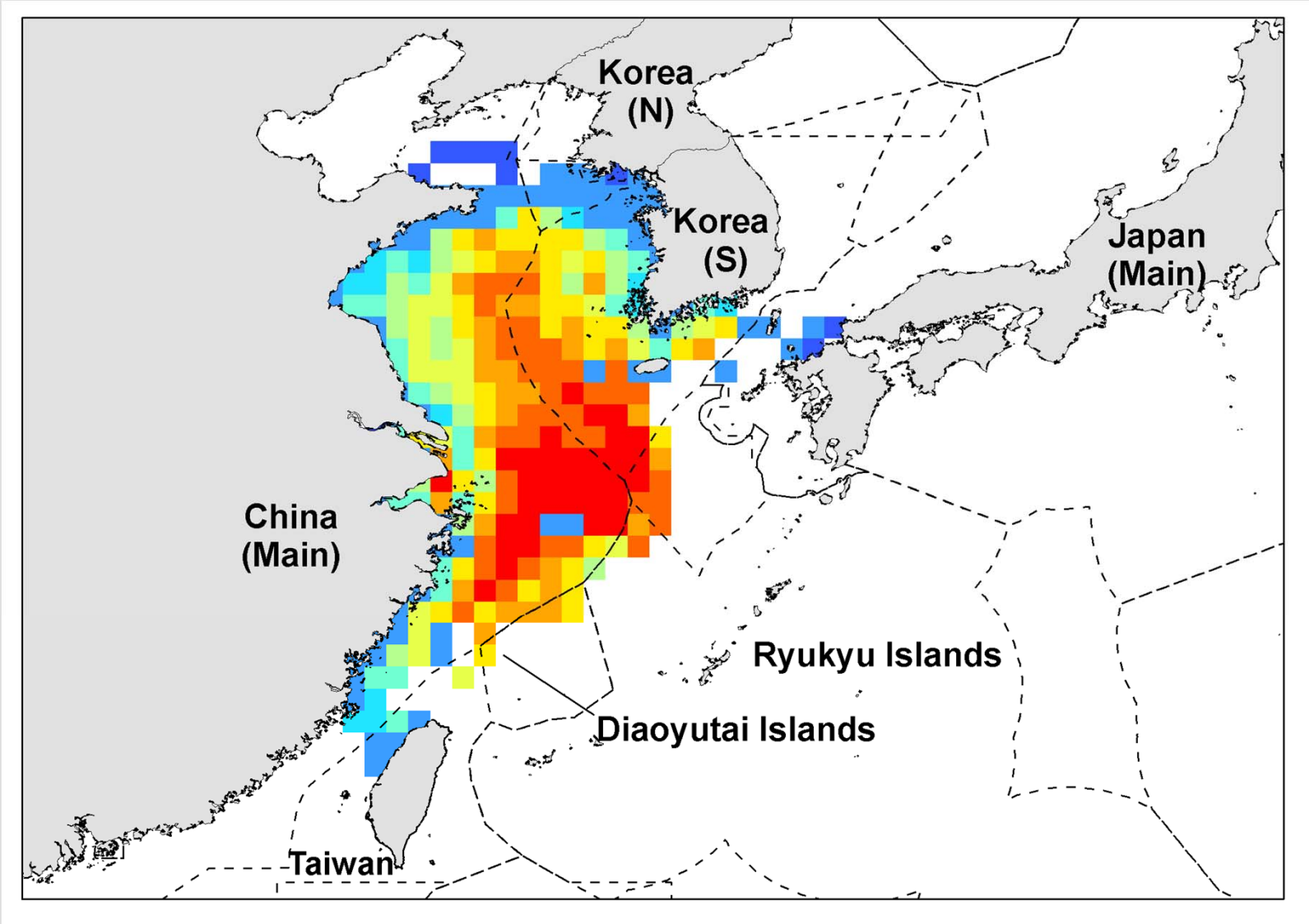
Small yellow croaker

Year 2



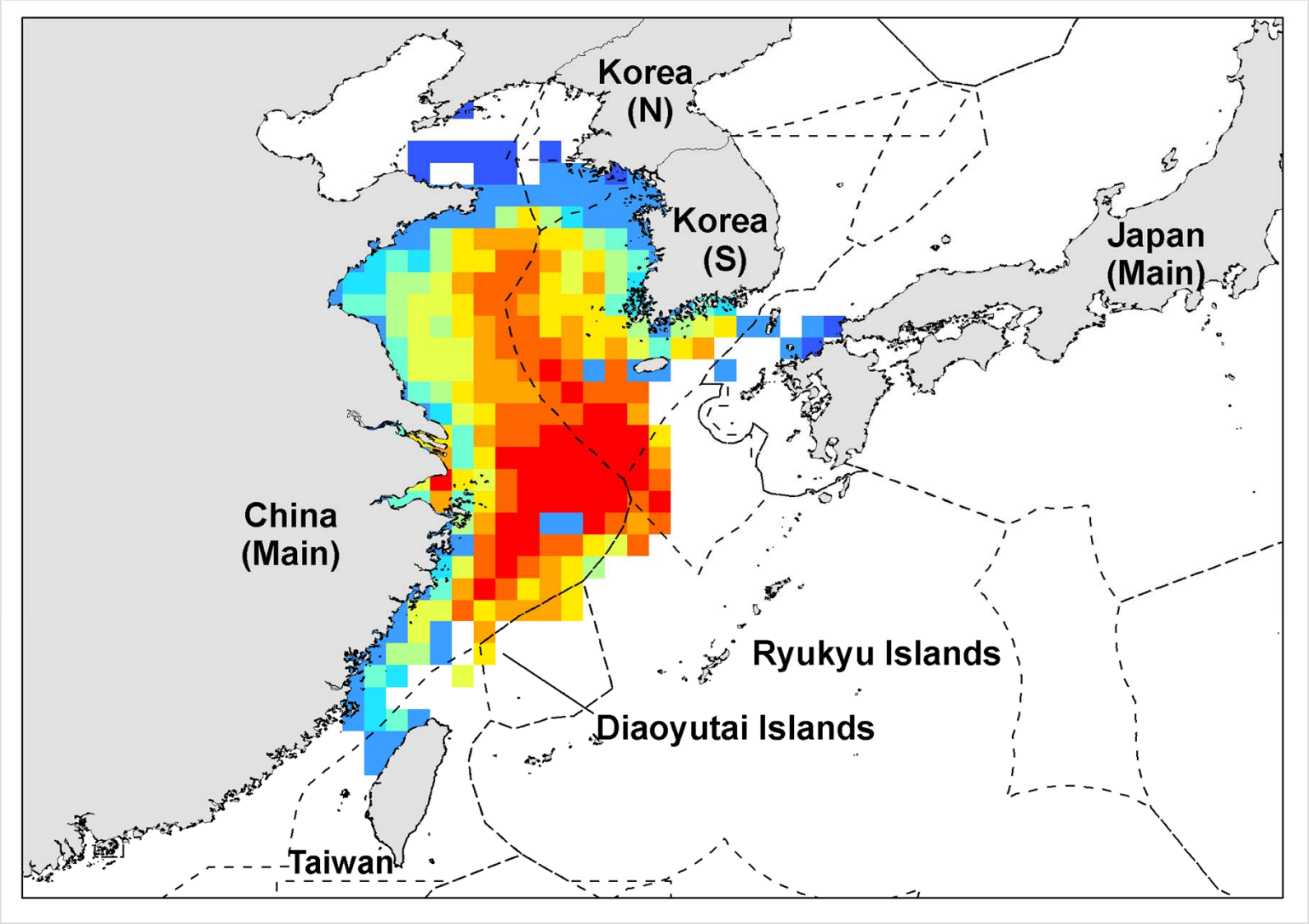
Small yellow croaker

Year 4



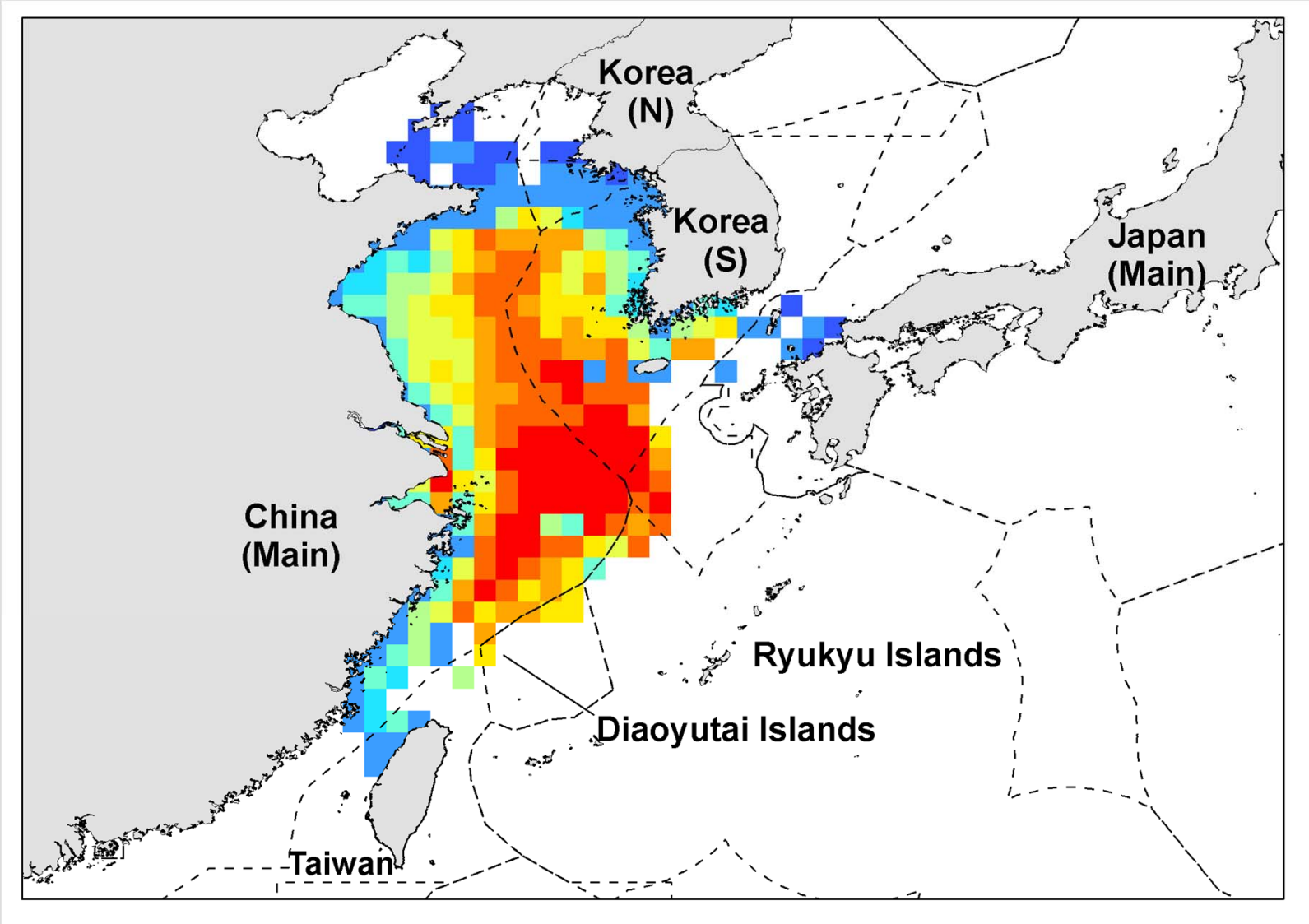
Small yellow croaker

Year 6



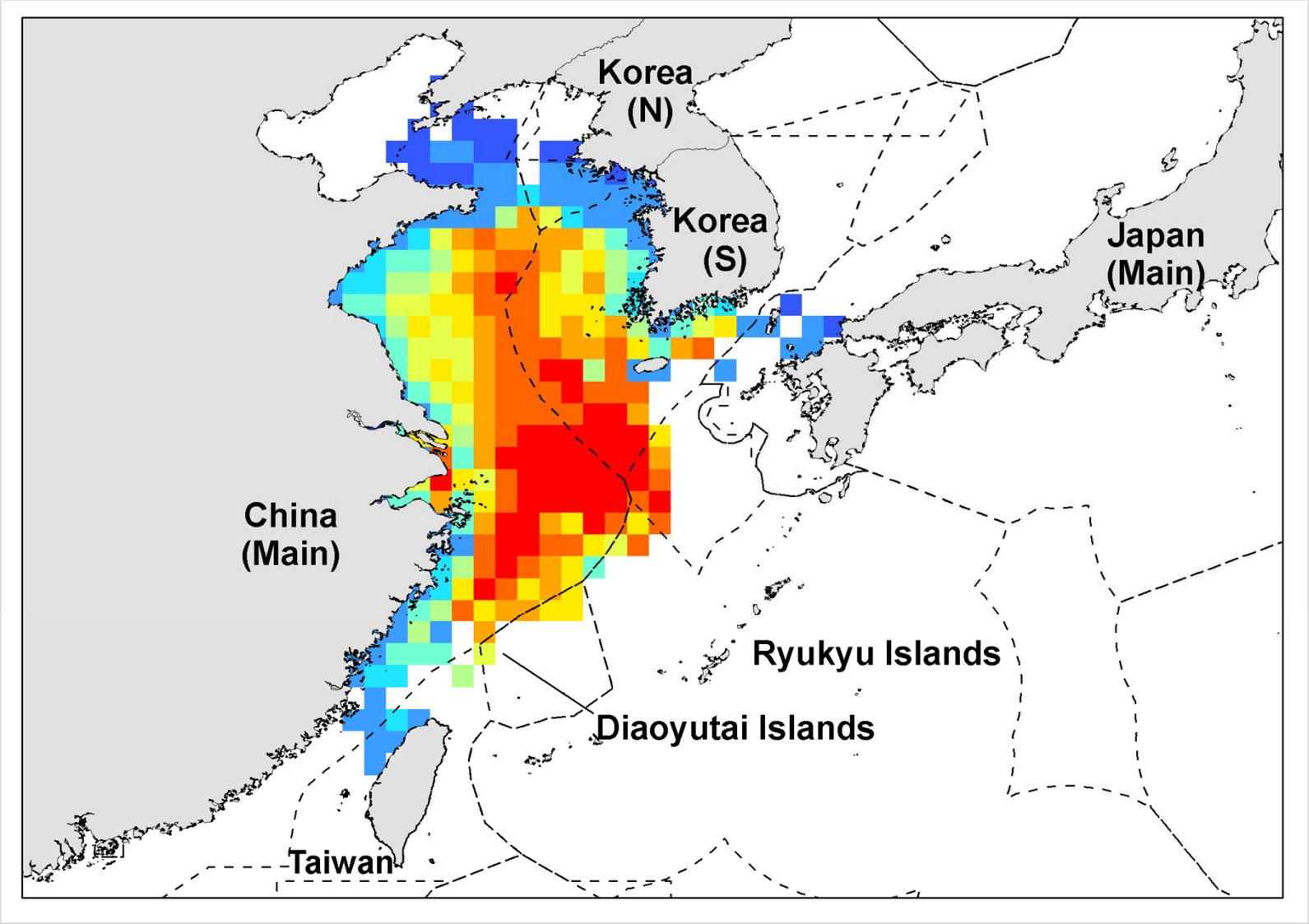
Small yellow croaker

Year 8



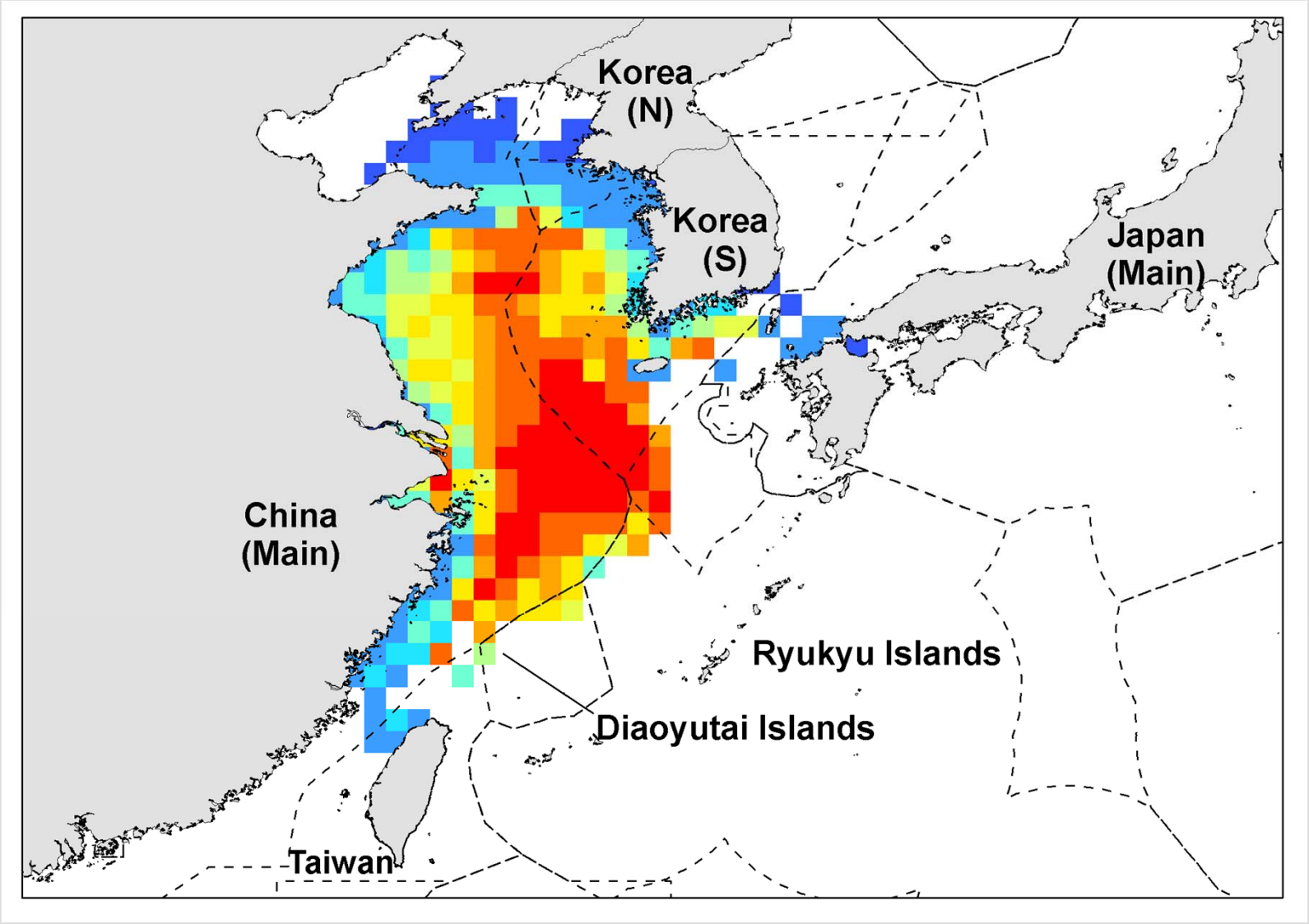
Small yellow croaker

Year 10



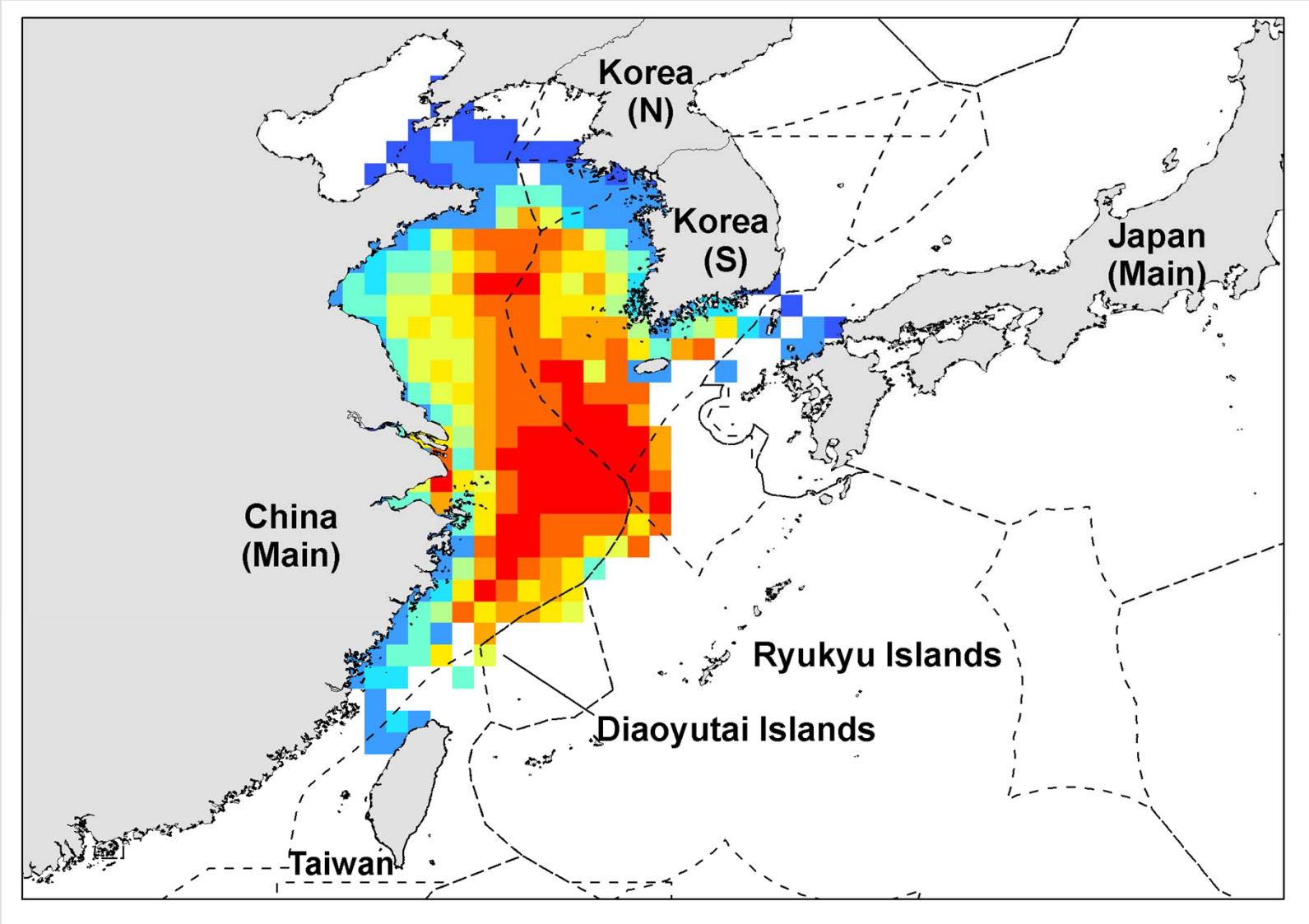
Small yellow croaker

Year 12



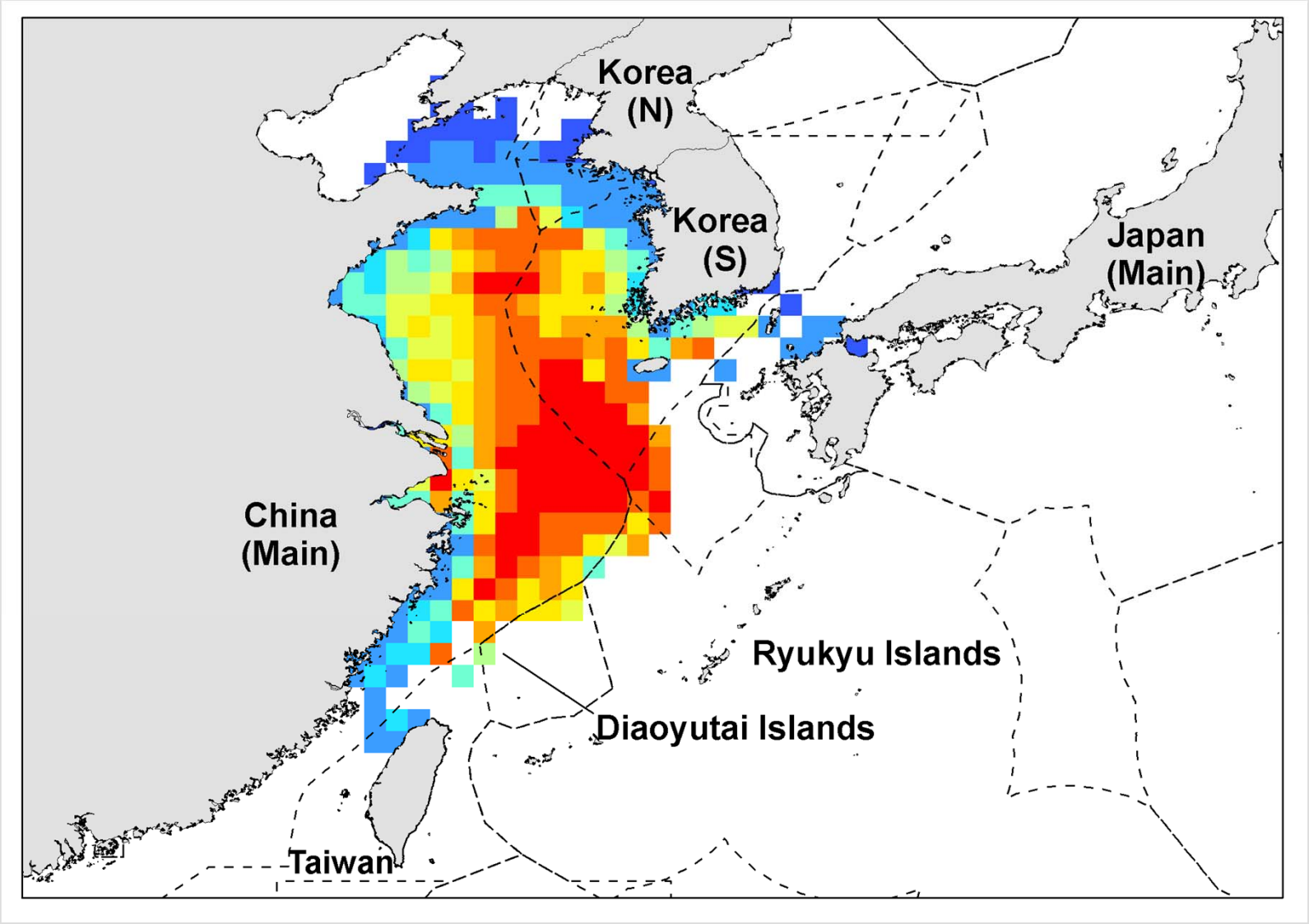
Small yellow croaker

Year 14



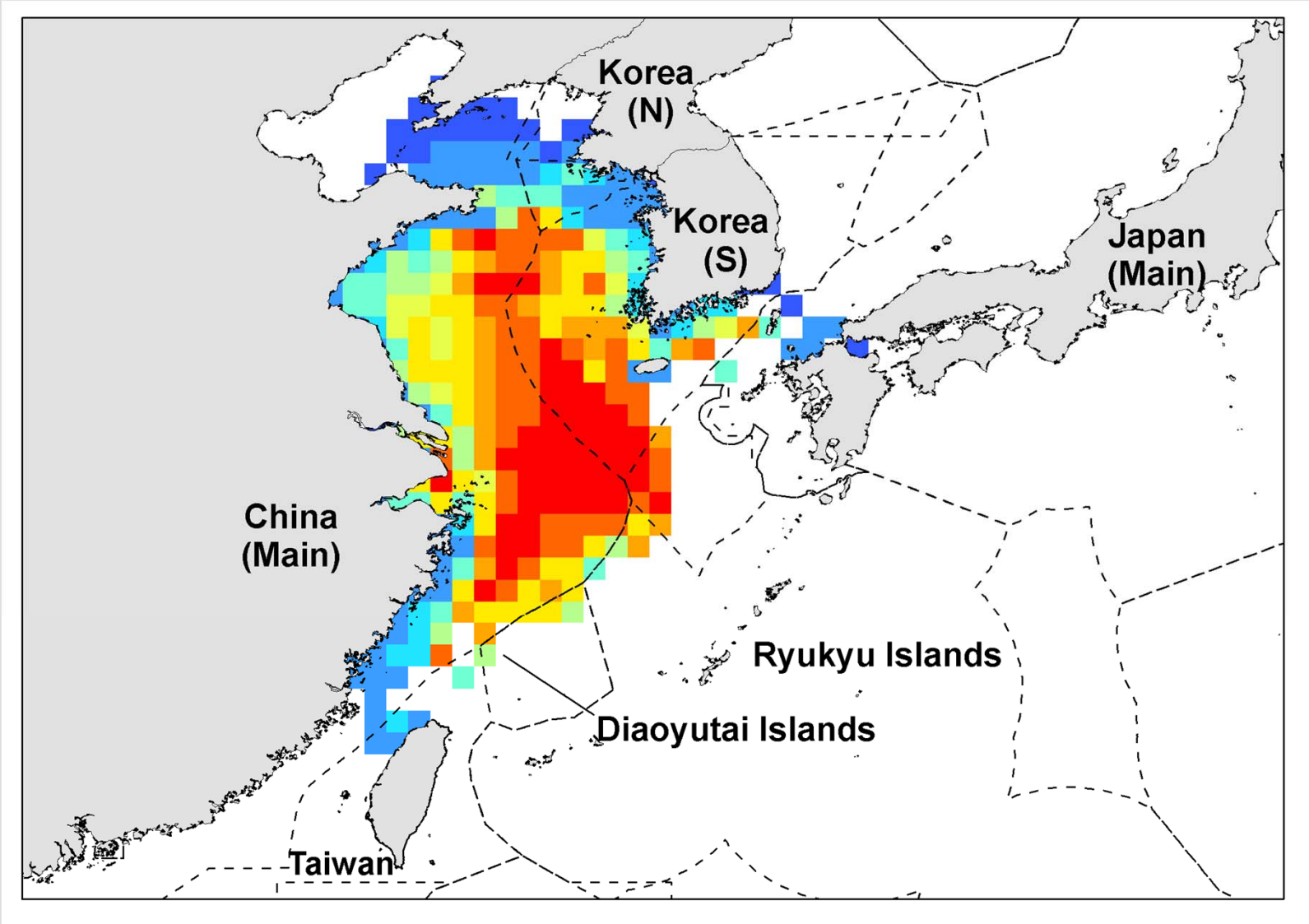
Small yellow croaker

Year 16



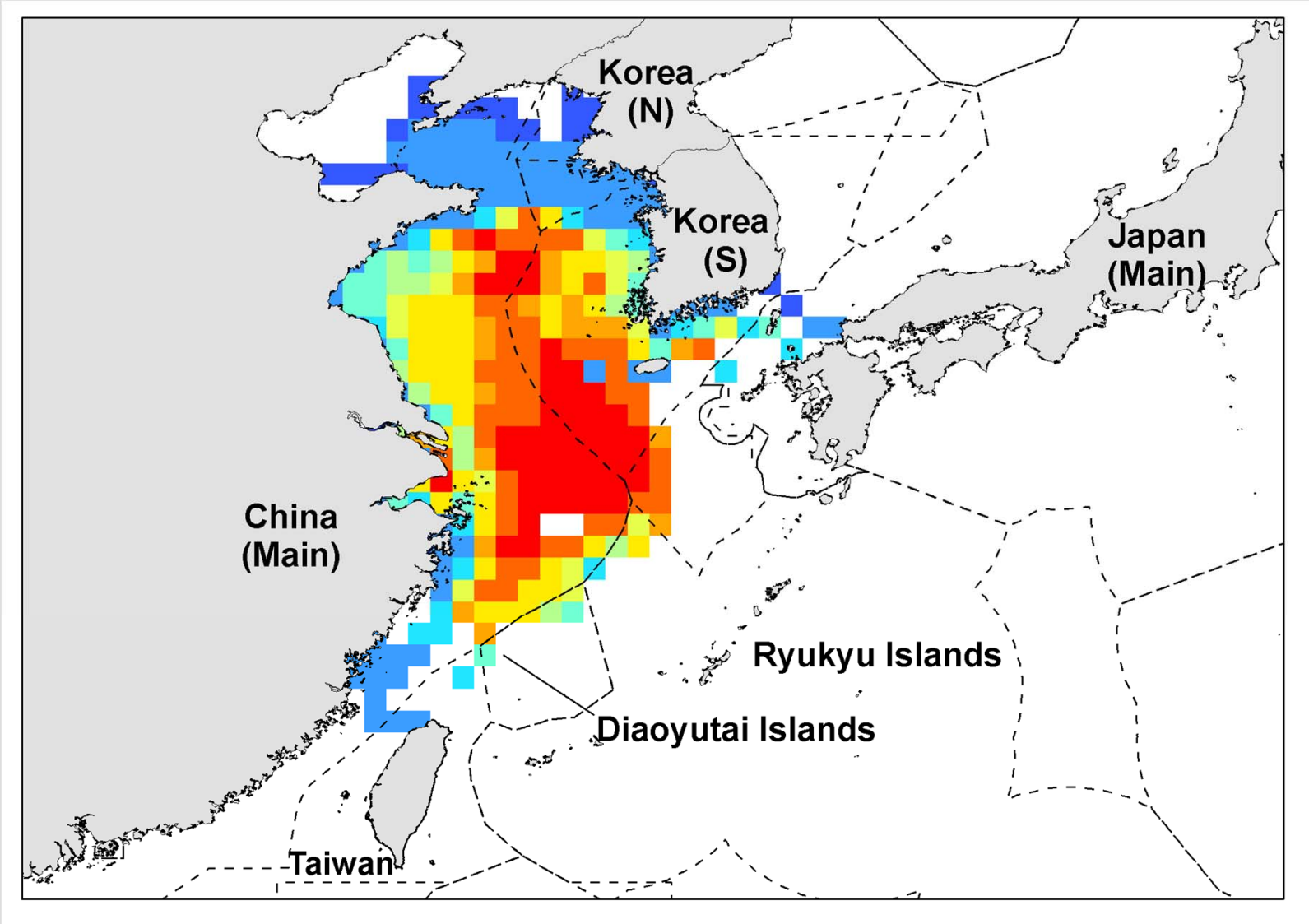
Small yellow croaker

Year 18



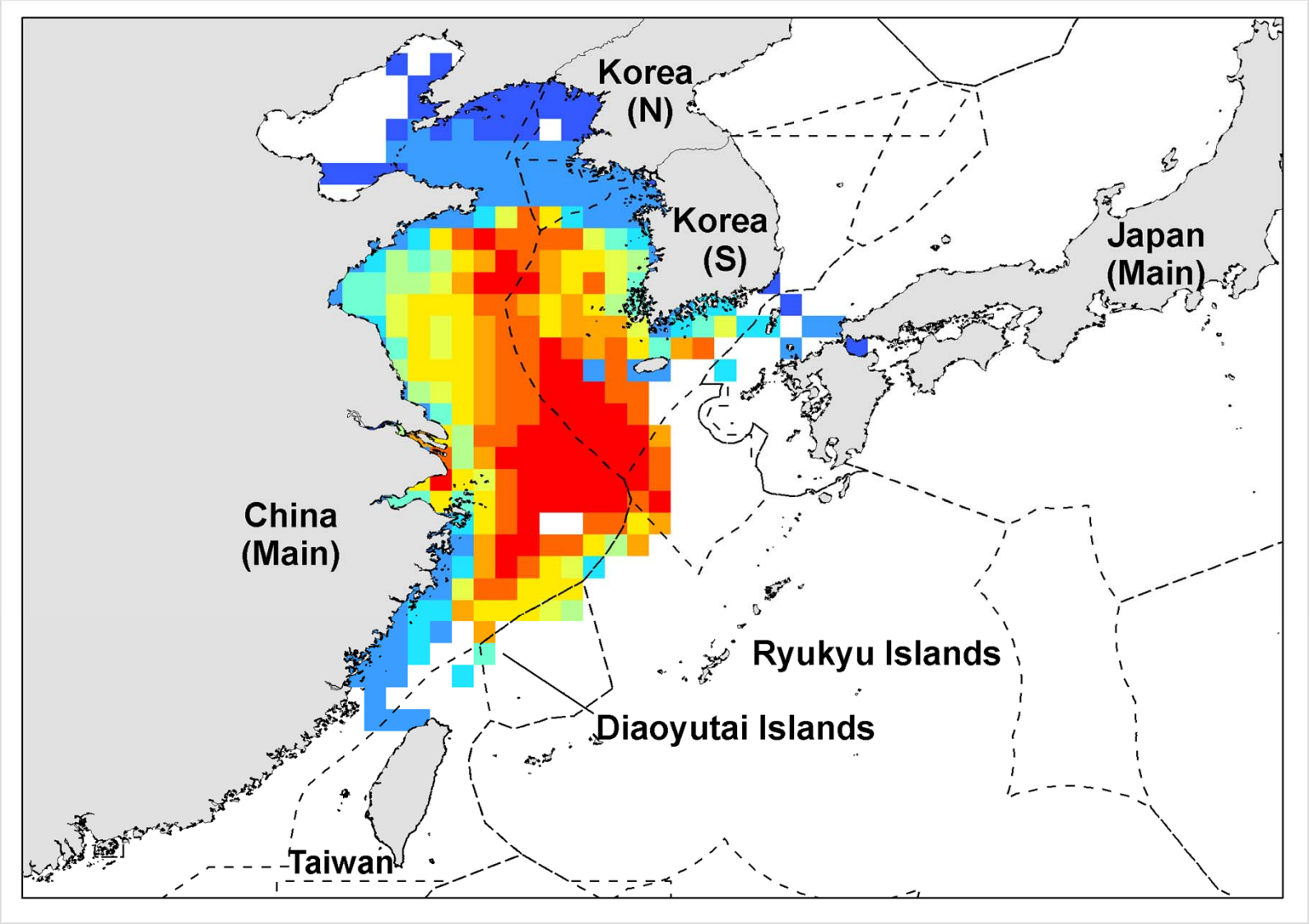
Small yellow croaker

Year 20



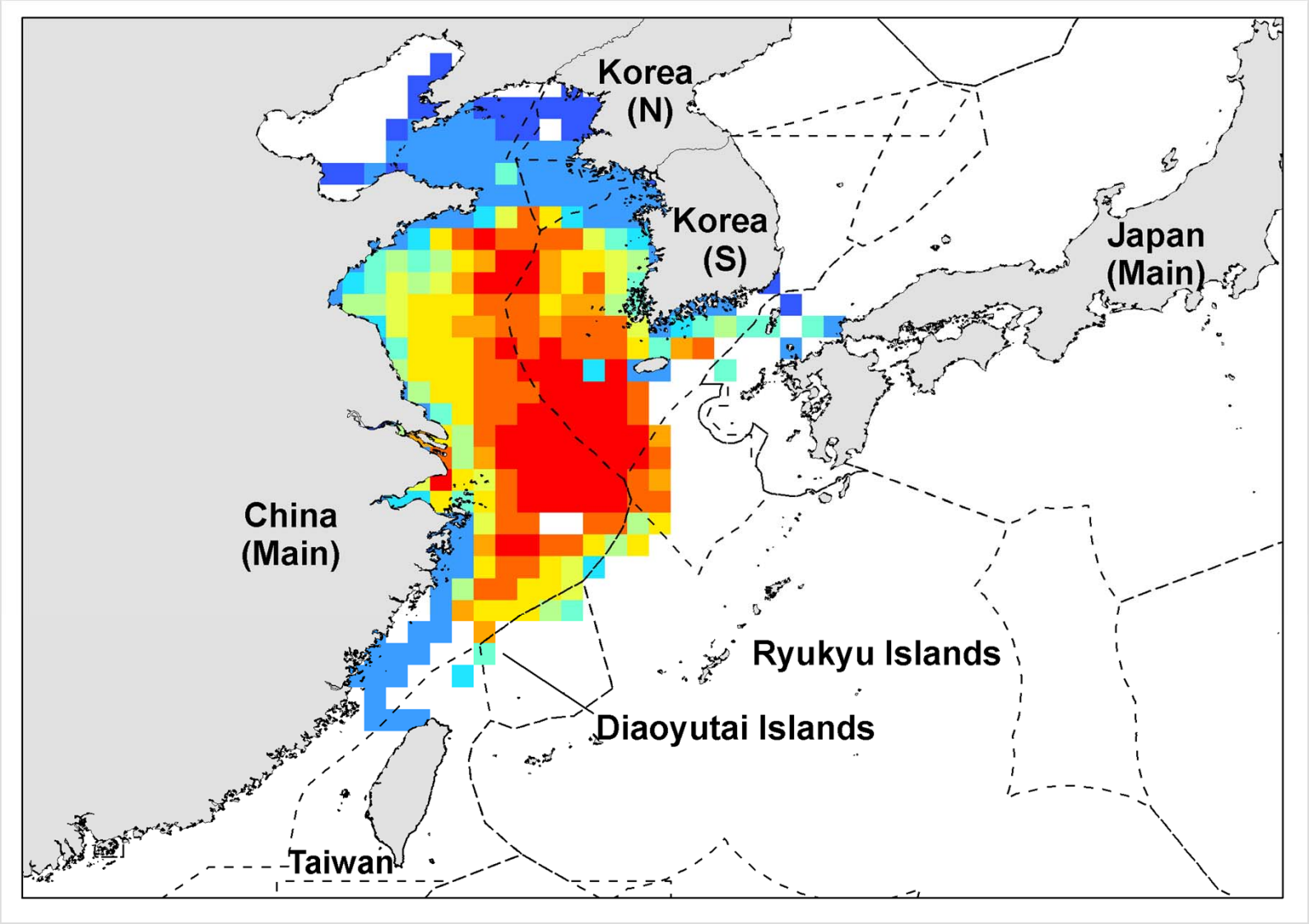
Small yellow croaker

Year 22



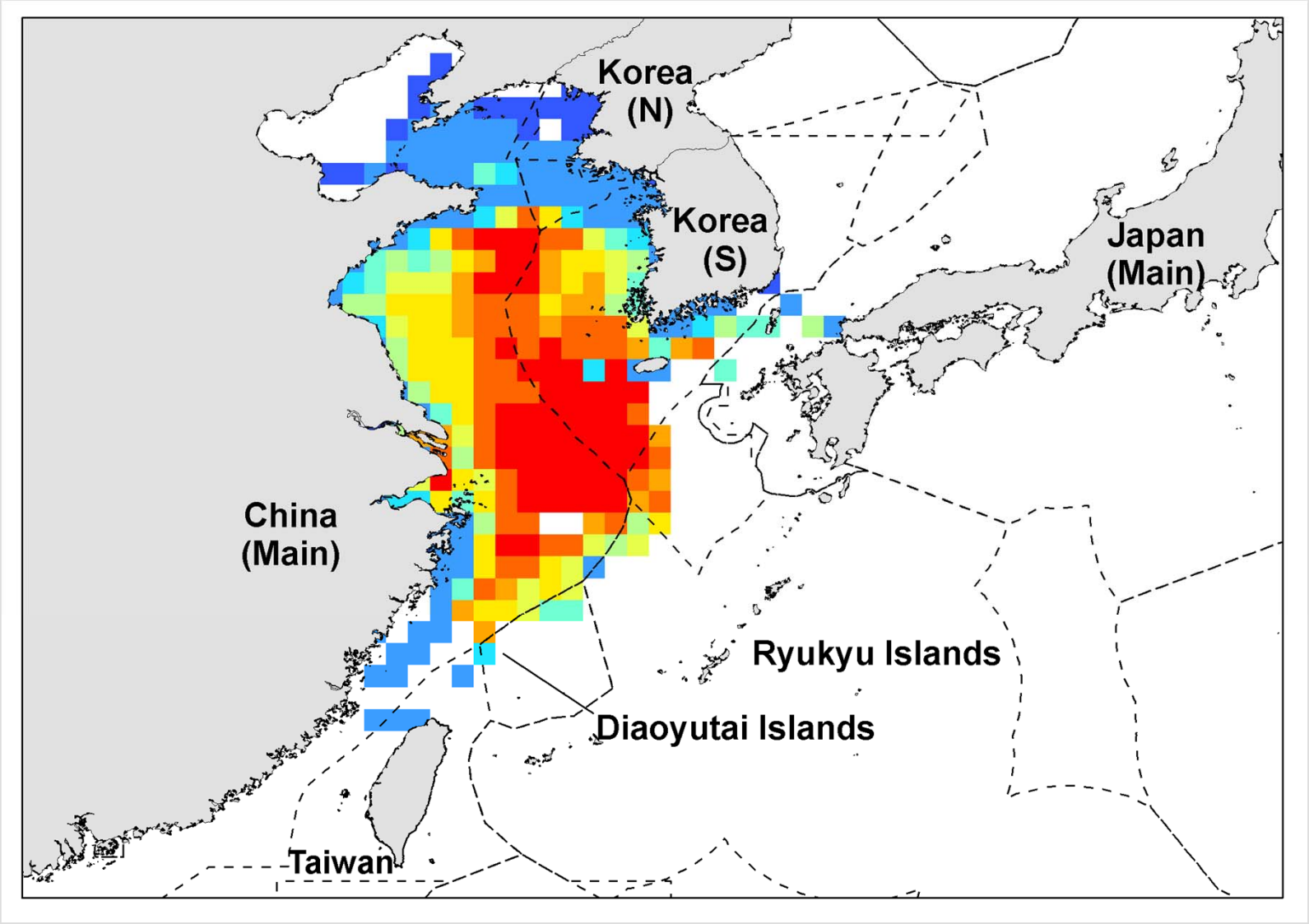
Small yellow croaker

Year 24



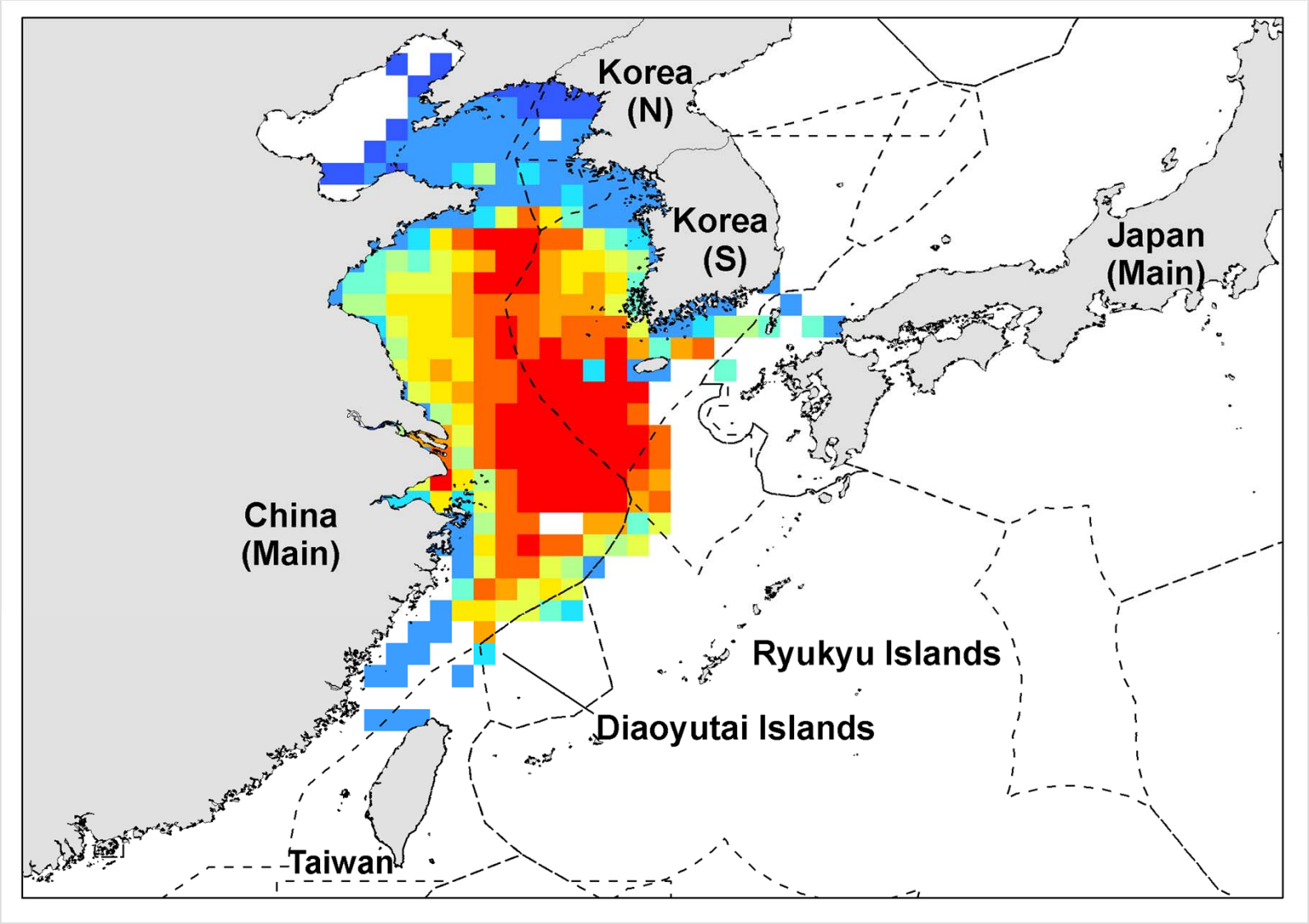
Small yellow croaker

Year 26



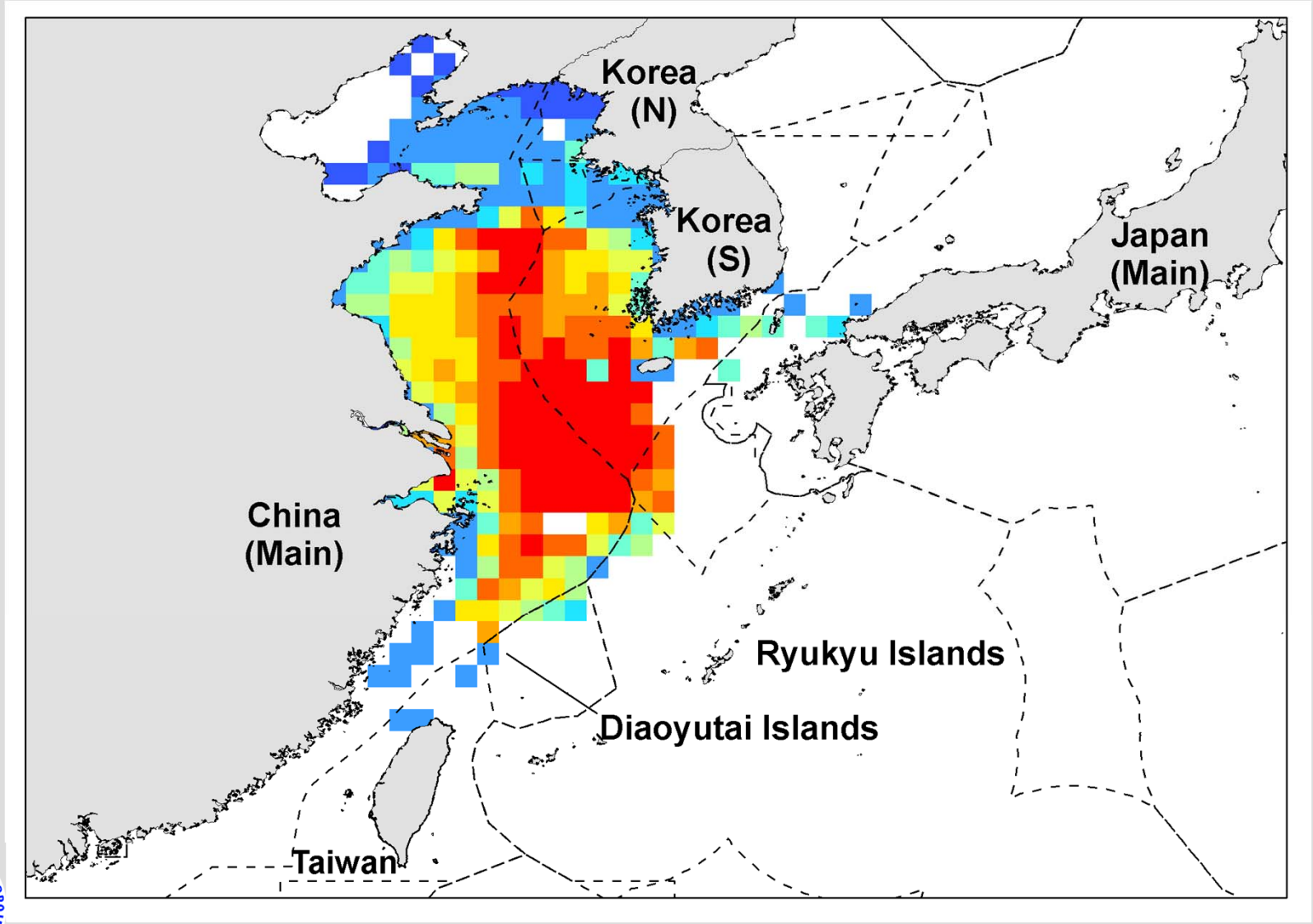
Small yellow croaker

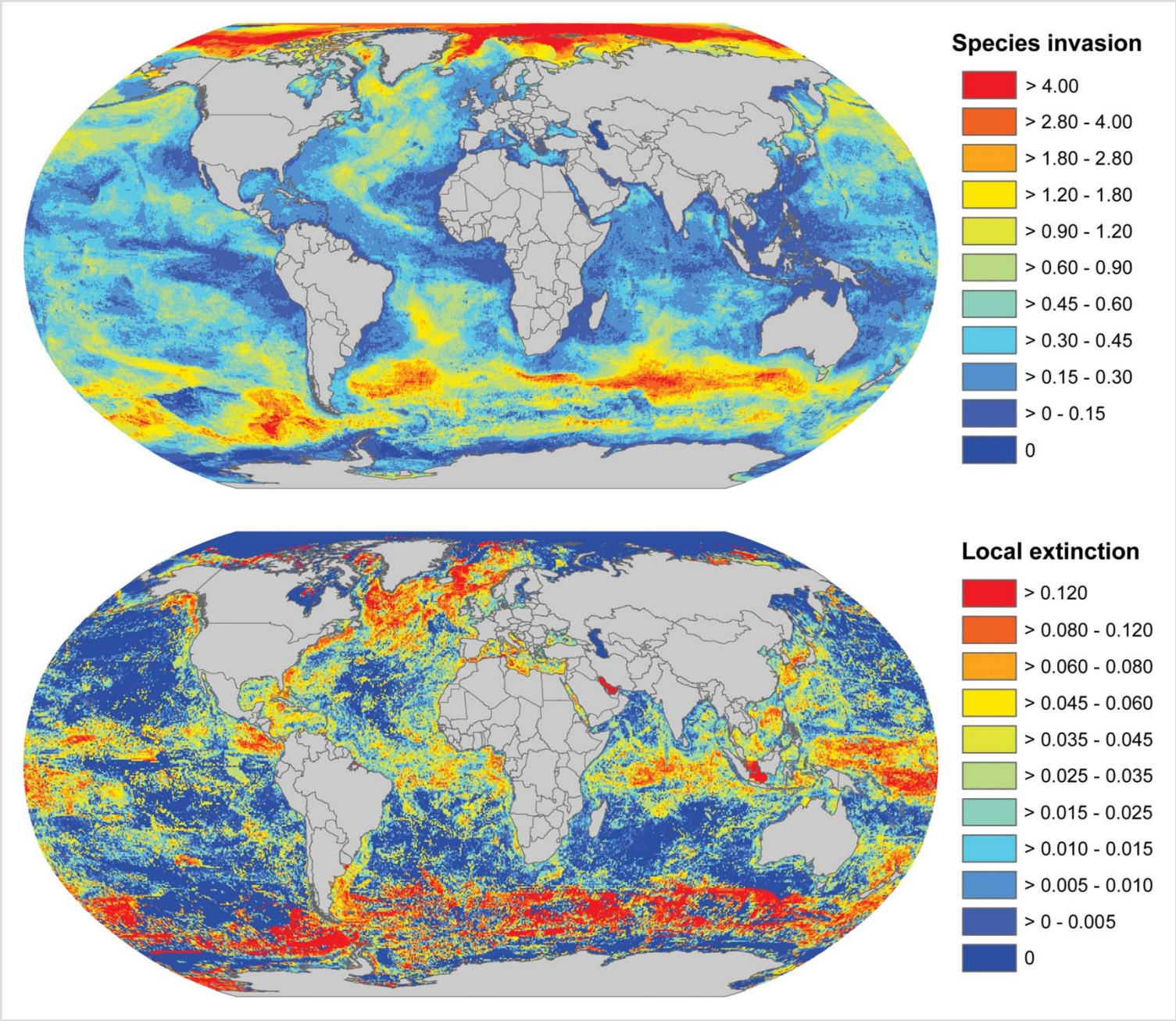
Year 28



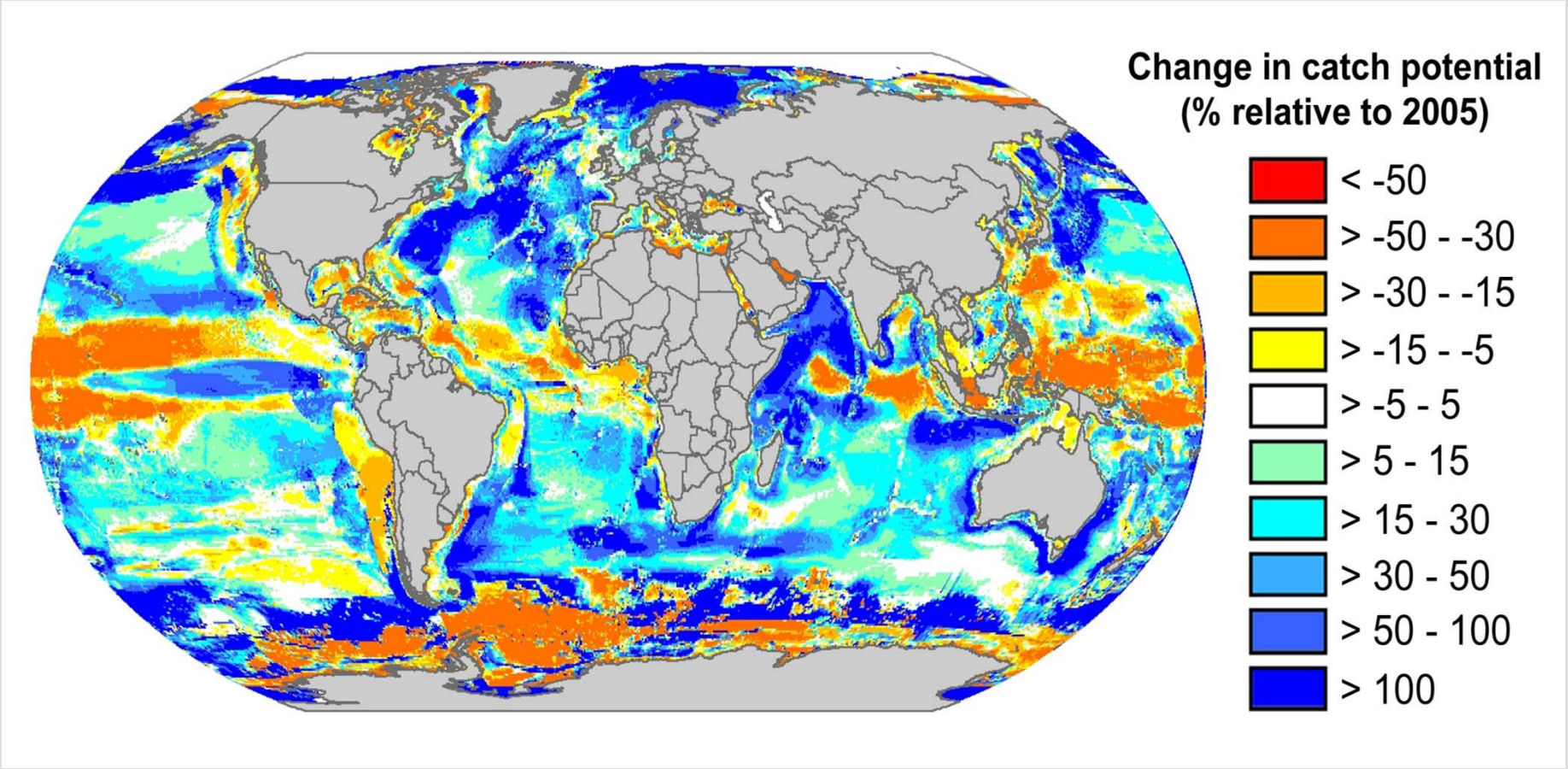
Small yellow croaker

Year 30



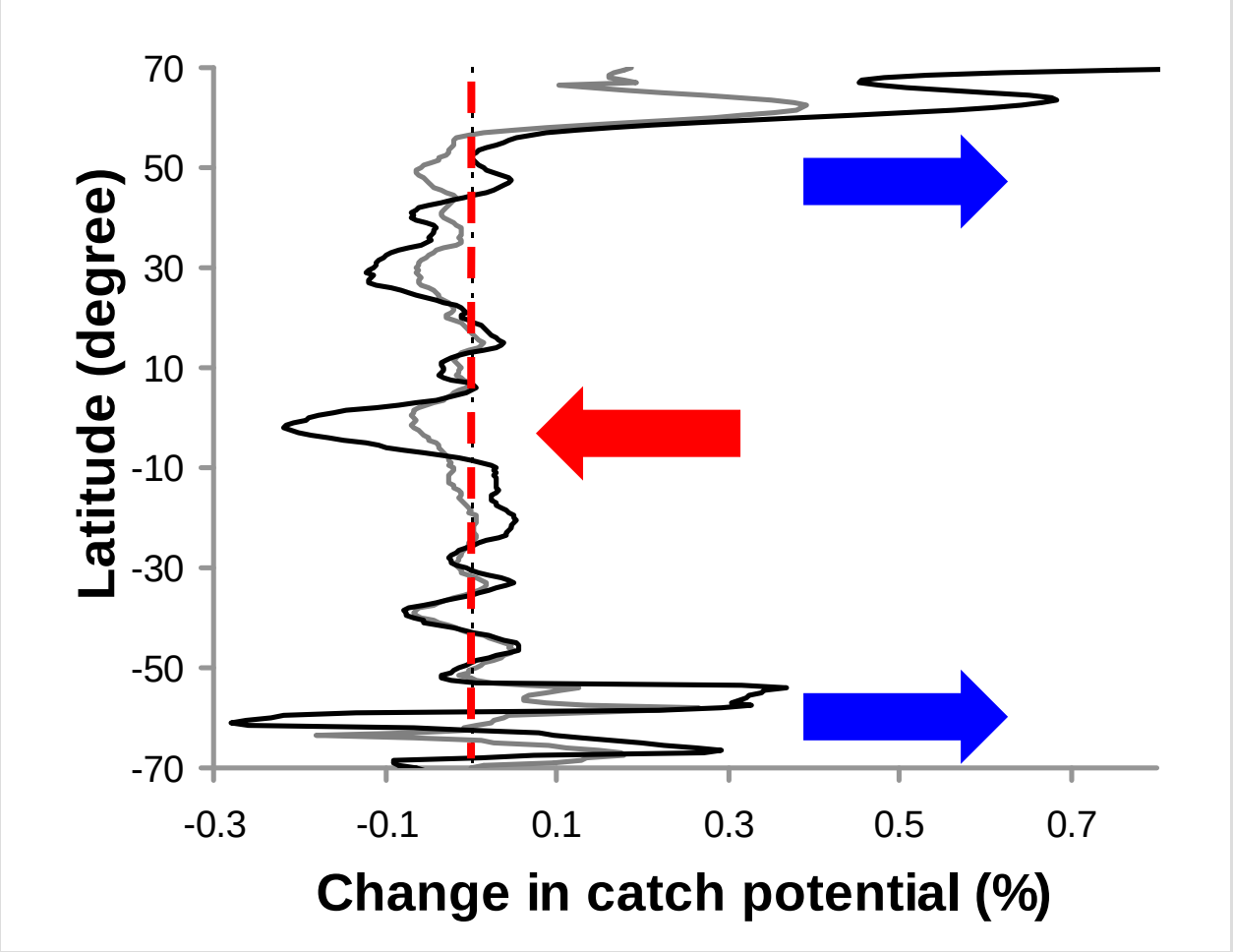

Species invasion
> 4.00
> 2.80 - 4.00
> 1.80 - 2.80
> 1.20 - 1.80
> 0.90 - 1.20
> 0.60 - 0.90
> 0.45 - 0.60
> 0.30 - 0.45
> 0.15 - 0.30
> 0 - 0.15
0
Local extinction
> 0.120
> 0.080 - 0.120
> 0.060 - 0.080
> 0.045 - 0.060
> 0.035 - 0.045
> 0.025 - 0.035
> 0.015 - 0.025
> 0.010 - 0.015
> 0.005 - 0.010
> 0 - 0.005
0

Projected change in catch potential in 50 years



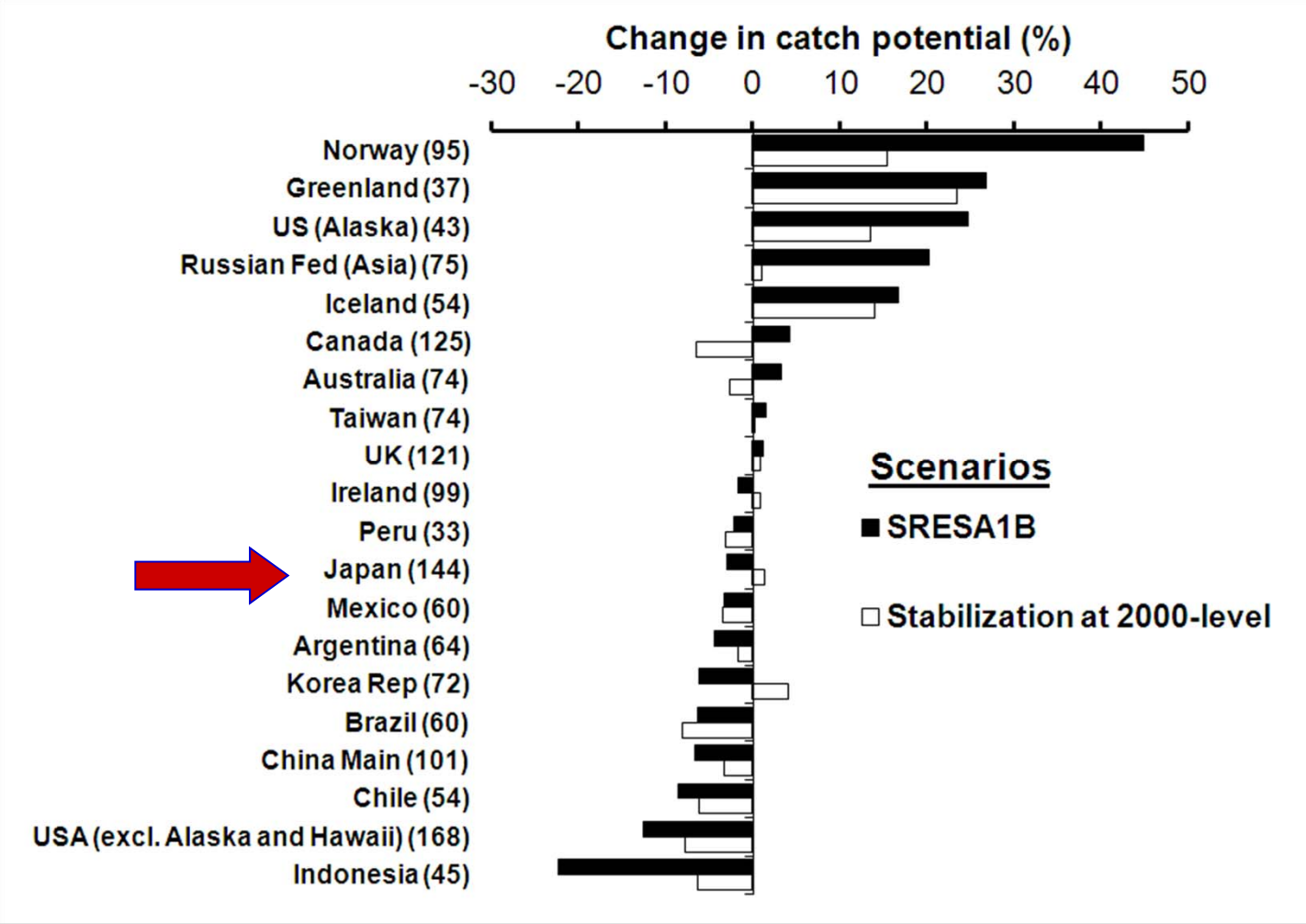
Cheung, Lam, Kearney, Sarmiento, Watson, Zeller and Pauly (*Global Change Biology*, 2009)

Global changes of fishery potential, by latitude



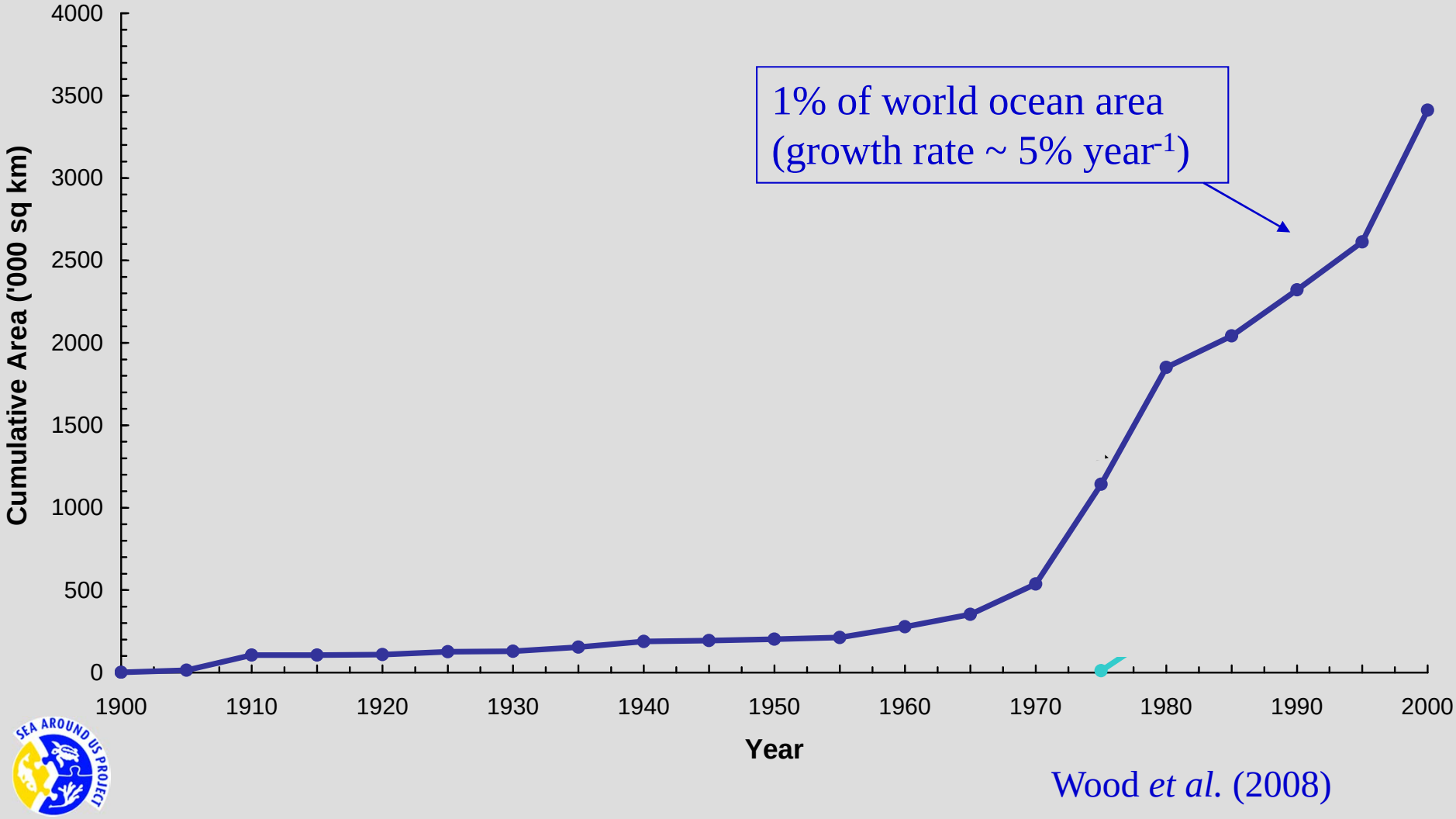
Cheung, Lam, Kearney, Sarmiento, Watson, Zeller, Pauly (*Global Change Biology*, 2009)

…which will affect all countries on Earth, directly or indirectly



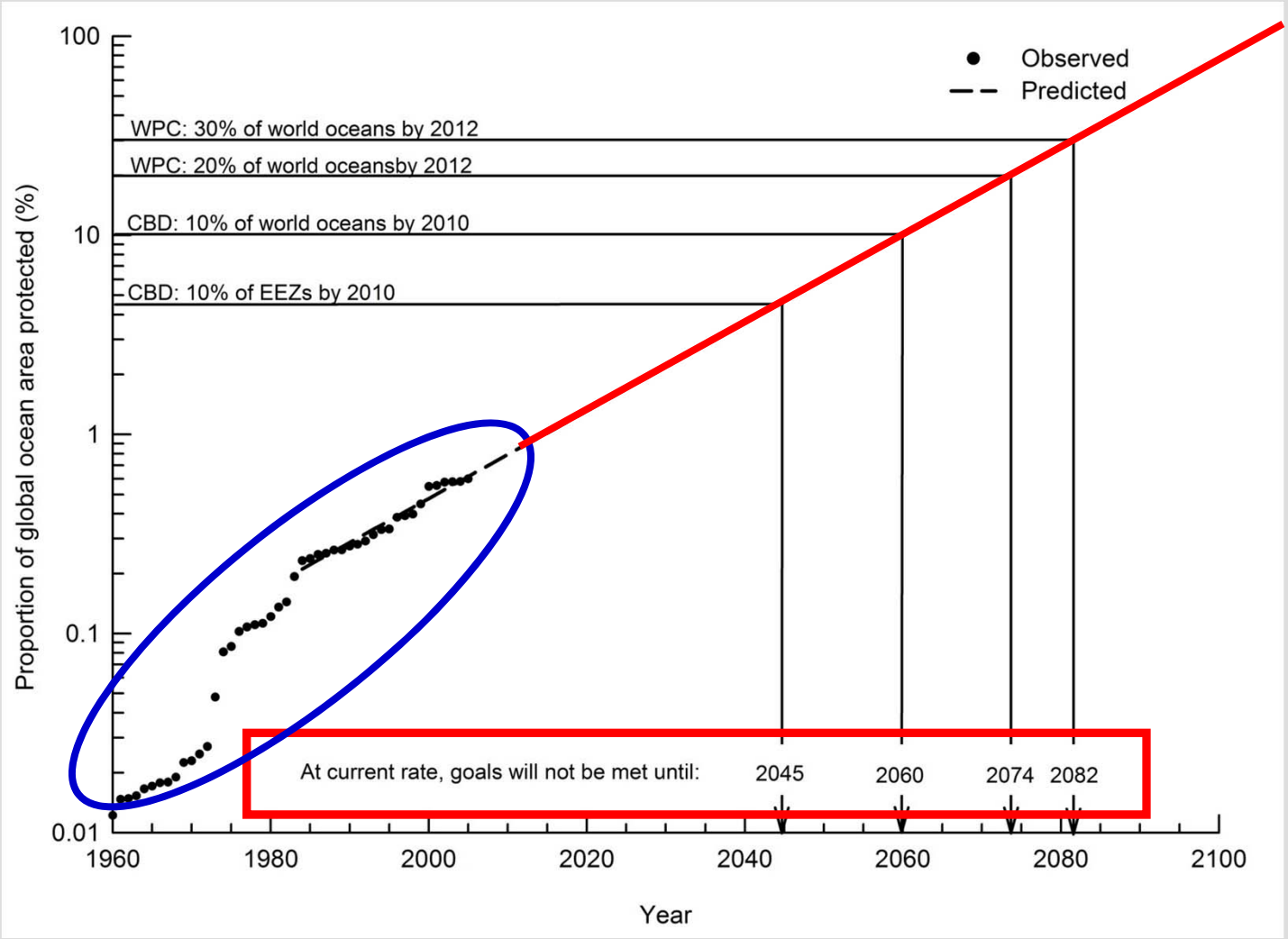
Cheung, Lam, Kearney, Sarmiento, Watson, Zeller and Pauly (*Global Change Biology.* 2009)

Marine Protected Areas are part of the solution. There are many, but most of them are tiny…



Wood *et al.* (2008)

As a result, the growth of the global MPA network is so slow that we will miss all the targets…



Wood *et al.* (2008)

Summarizing: This graph, which compares small-scale with large-scale fisheries on a global basis, probably underestimates the role of small-scale fisheries, because official statistics underestimate their catch. We would achieve most stated aims of fisheries management plans (particularly with regards to jobs and sustainability) by getting rid of subsidies, which are directed mainly at industrial fisheries.

FISHERY *BENEFITS*	**LARGE SCALE** 	**SMALL SCALE** 
Number of fishers employed	 about ½ million	 over 12 millions
Annual catch of marine fish for human consumption	 about 29 million tonnes	 about 24 million tonnes
Capital cost of each job on fishing vessels	 $30,000 - $300,000	 $250 - $2,500
Annual catch of marine fish for industrial reduction to meal and oil, etc.	 about 22 million tonnes	 Almost none
Annual fuel oil consumption	 14 – 19 million tonnes	 1 – 3 million tonnes
Fish caught per tonne of fuel consumed	 2 – 5 tonnes	 10 – 20 tonnes
Fishers employed for each $1 million invested in fishing vessels	 5 - 30	 500 – 4,000
Fish and invertebrates discarded at sea	 10-20 million tonnes	Little

Acknowledgements…

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- Fisheries Centre, University of British Columbia;
- Members of the *Sea Around Us* project,

and many others...

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