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The IPSO State of the Oceans Report 2013

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January 29, 2014

IPSO meetings 2011 and 2012

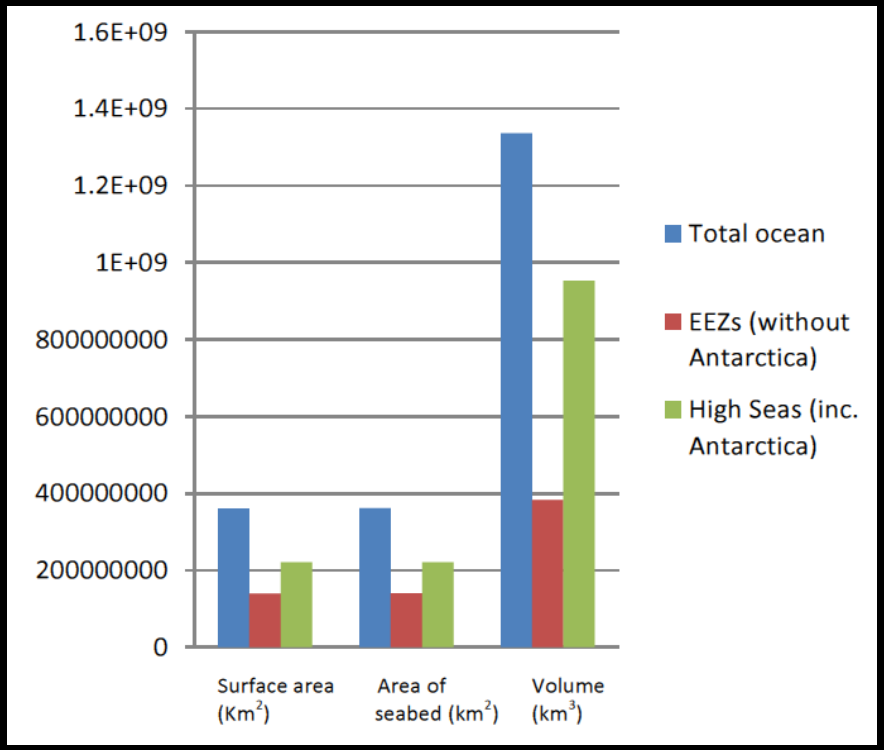
The Ocean

How inappropriate to call this planet Earth when it is quite clearly ocean
Arthur C Clarke

Oceans cover 71% Earth's surface

Deep-ocean (>200m depth) ~ 360 million km^2

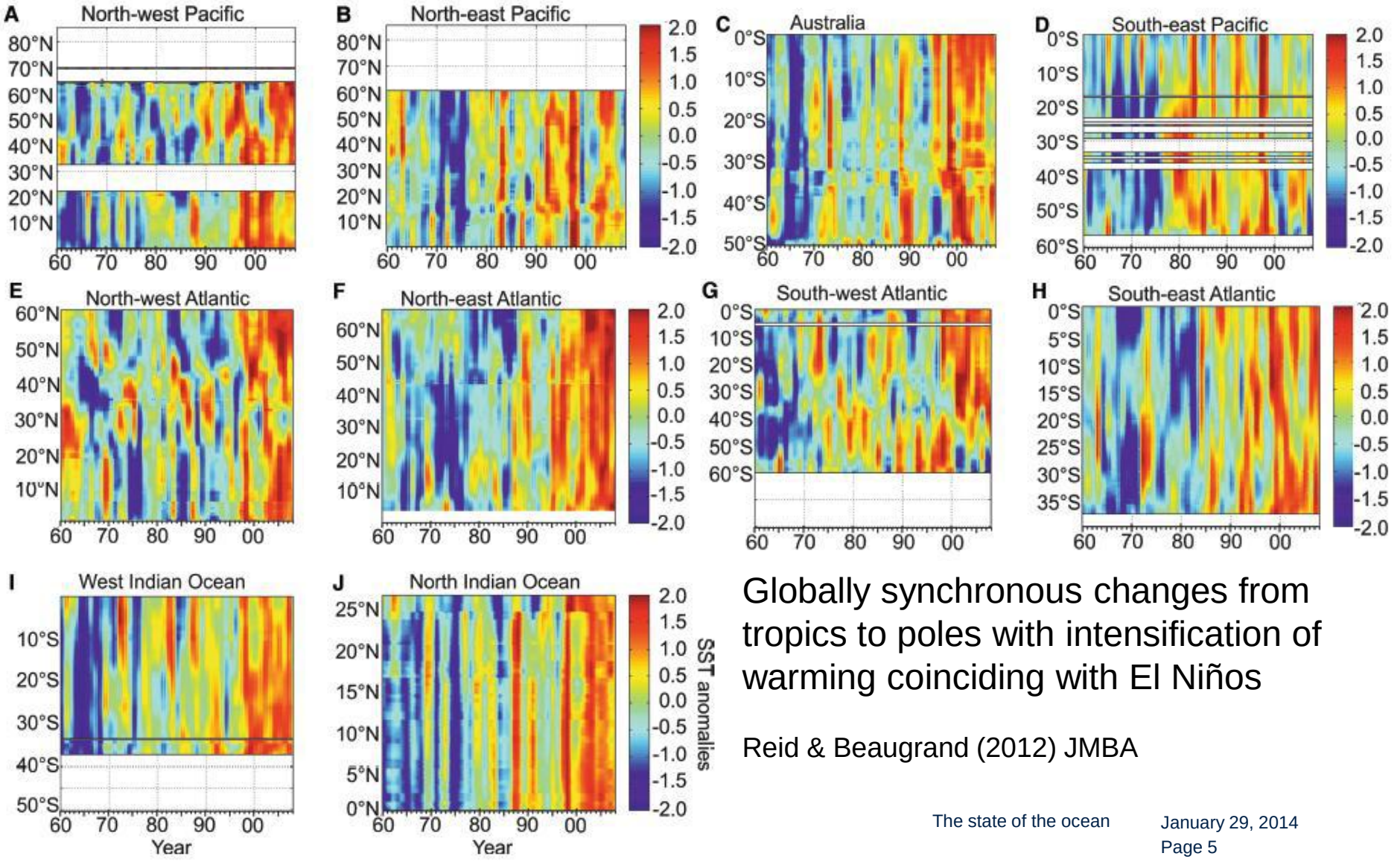
Ocean volume is >1.3 billion km^3 (70% High seas)



Goods and services provided by the oceans

- CO_2 sequestration & storage (~ third emissions)
- Oxygen production (40-50%)
- Major role in nutrient cycling
- Major role in Earth's hydrology
- Thermoregulation of the planet
- Food (fish, shellfish, algae)
- Fuel/energy
- Transport
- Waste disposal
- Coastal protection
- Medicines and technologies
- Cultural importance / biophilia

Long-term changes in latitudinal SST anomalies



Globally synchronous changes from tropics to poles with intensification of warming coinciding with El Niños

Reid & Beaugrand (2012) JMBA

The biological impacts of warming

Projections by Cheung et al., (2009) of changes in distribution of >1000 species by 2050

Species invasions

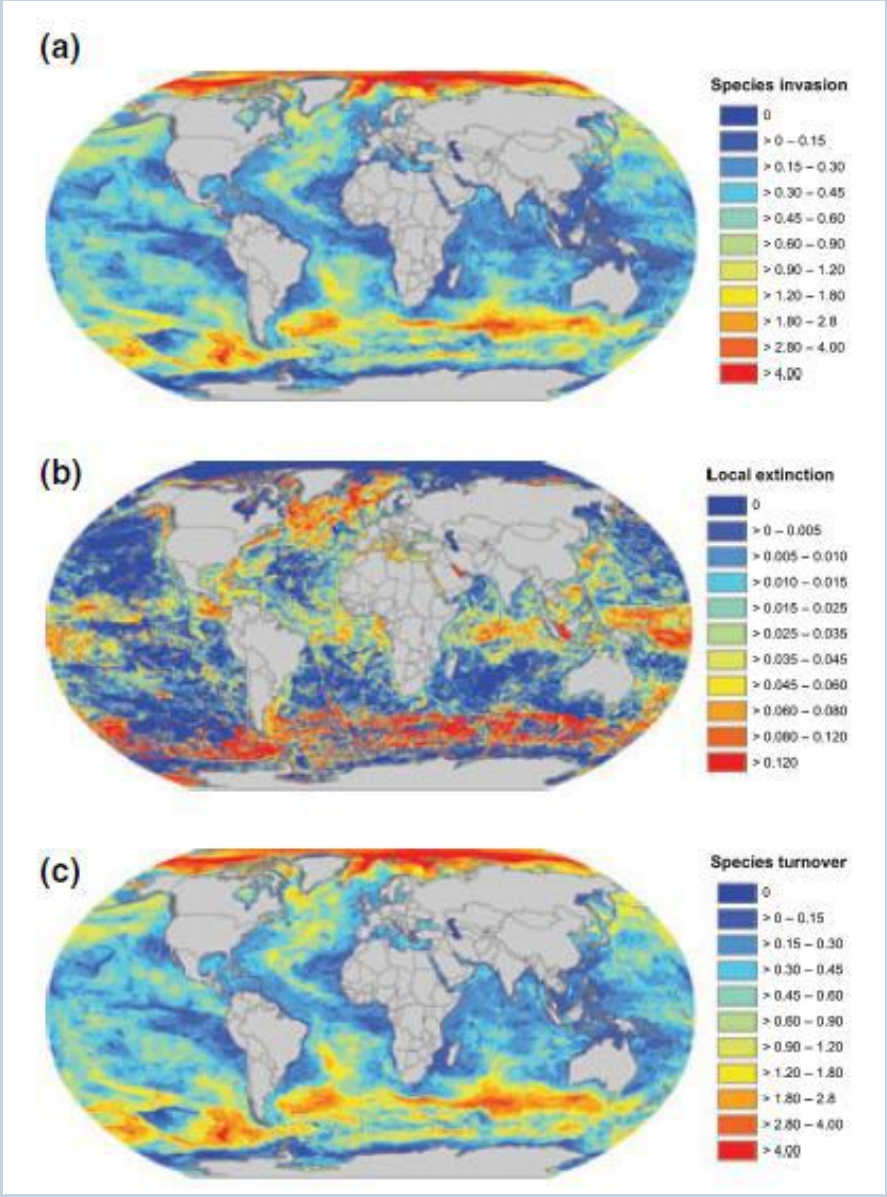
Mid-high latitude

Local extinction

Tropics and high latitude

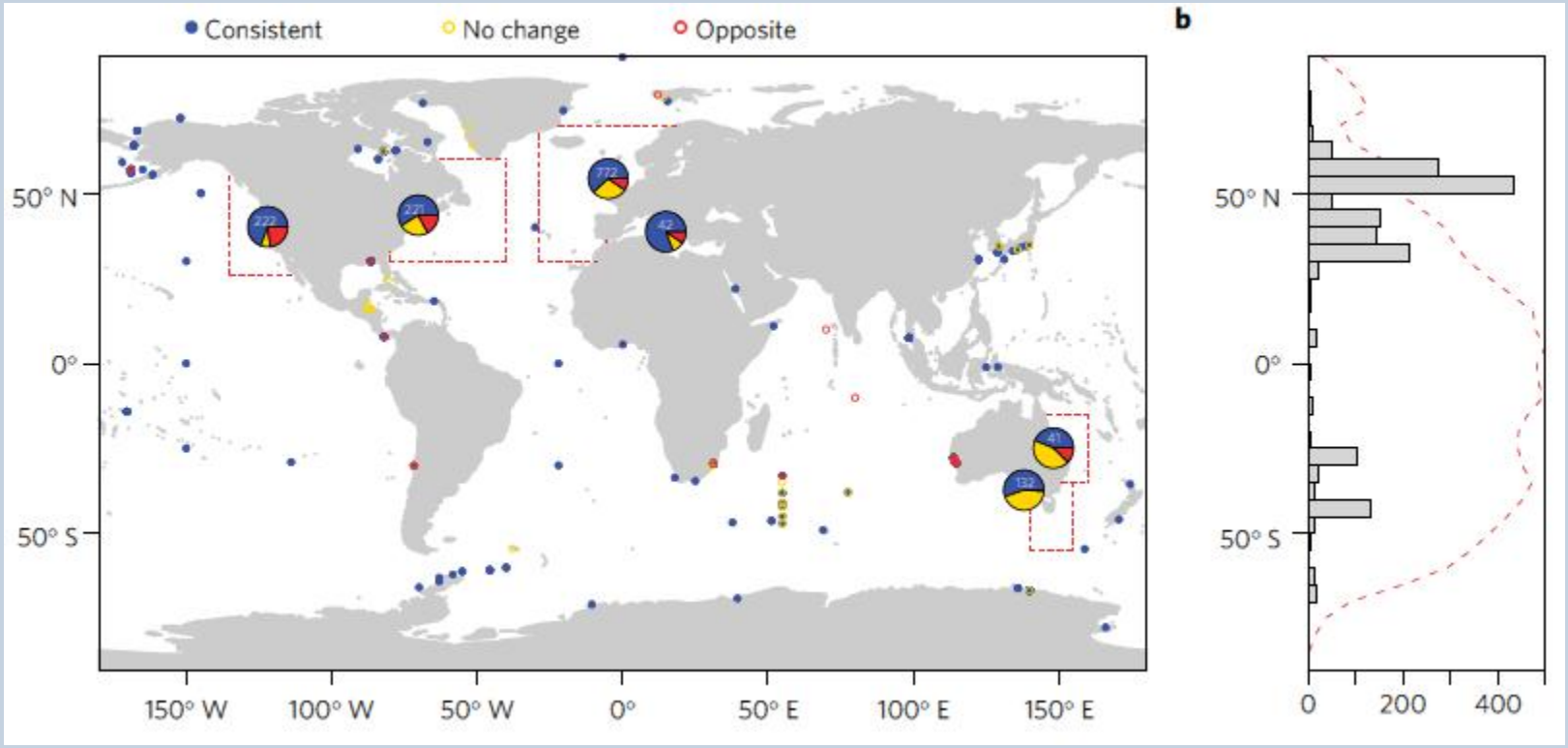
Species turnover

Mid-high latitudes



Cheung et al (2009) Fish & Fisheries 10: 235-251

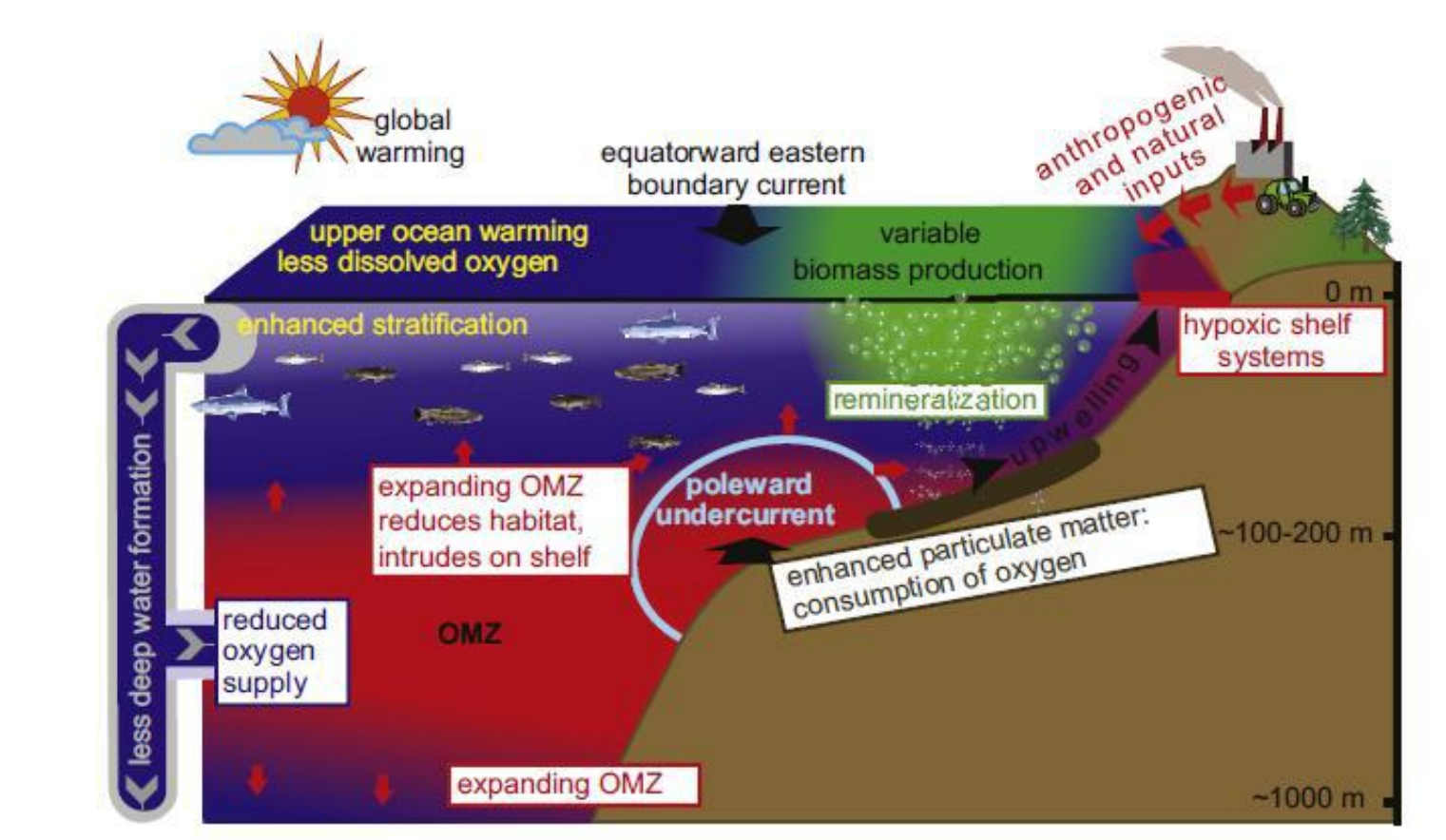
Broadly fits with observations of range shifts and changes in phenology



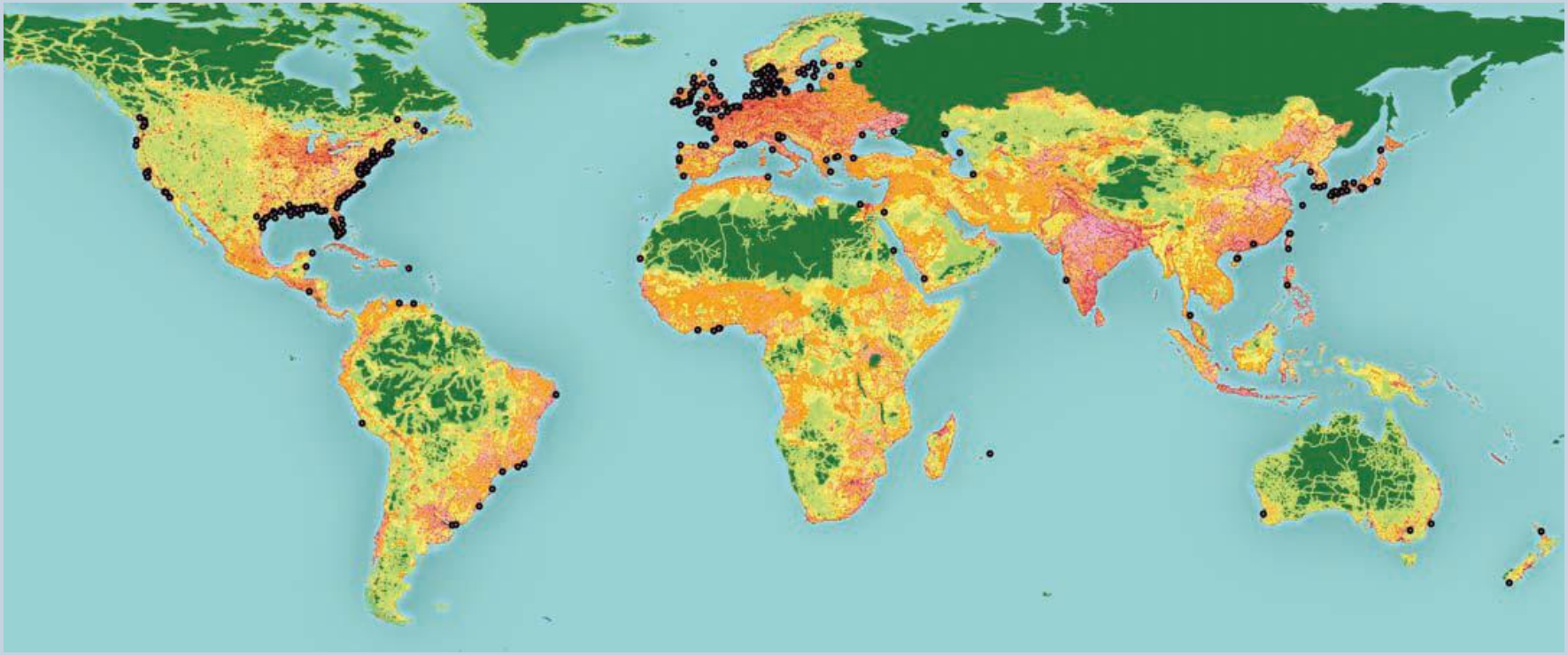
1735 studies / responses; 81-83% changes consistent with climate change expectations

Poloczanska et al. (2013) Nature Climate Change 3: 919-925

Habitat loss: hypoxia and anoxia in the coastal and open ocean



The spread of dead zones and relationship to human footprint



Relationship between human footprint and occurrence of dead zones generated by nutrient enrichment

Loss of habitat in blue marlin as a result of shoaling of oxygen minimum zone

OMZ defined as area where oxygen conc. drops below 3.5ml l^{-1}

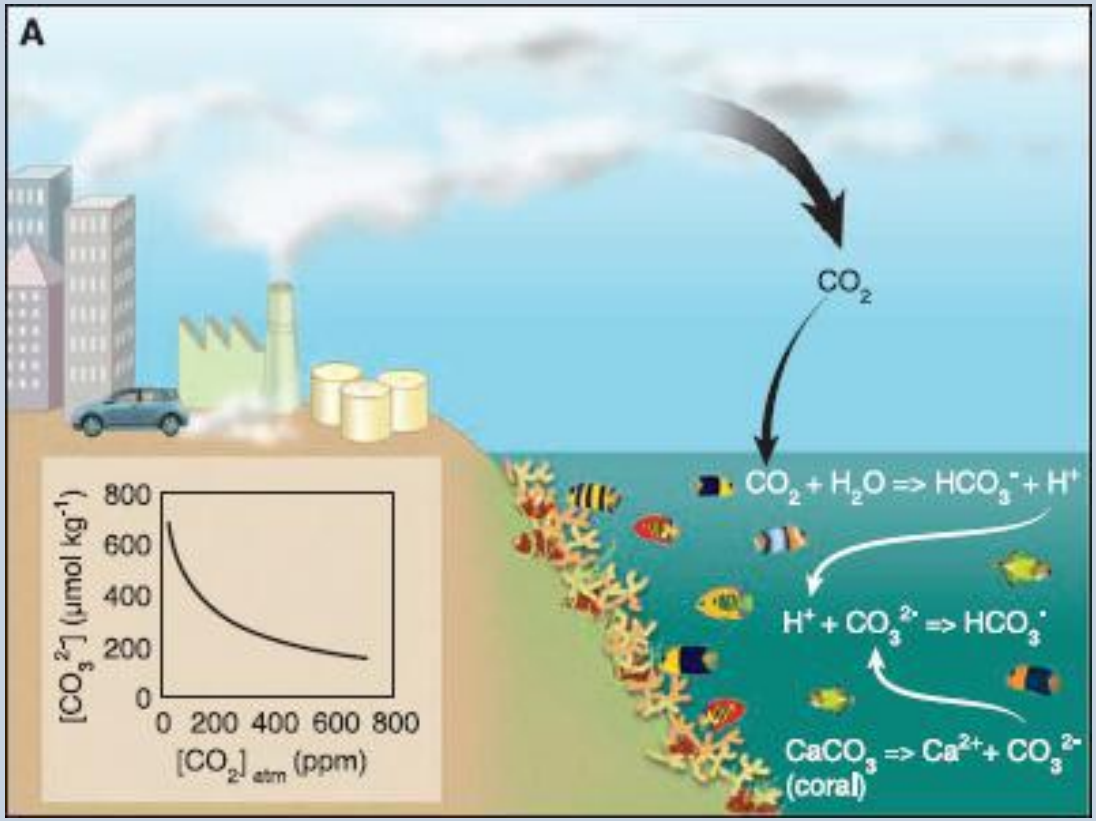
Lower habitat boundary for blue marlin and other pelagic fish

Estimated habitat has decreased by 15% from 1960-2010 in tropical Northeast Atlantic

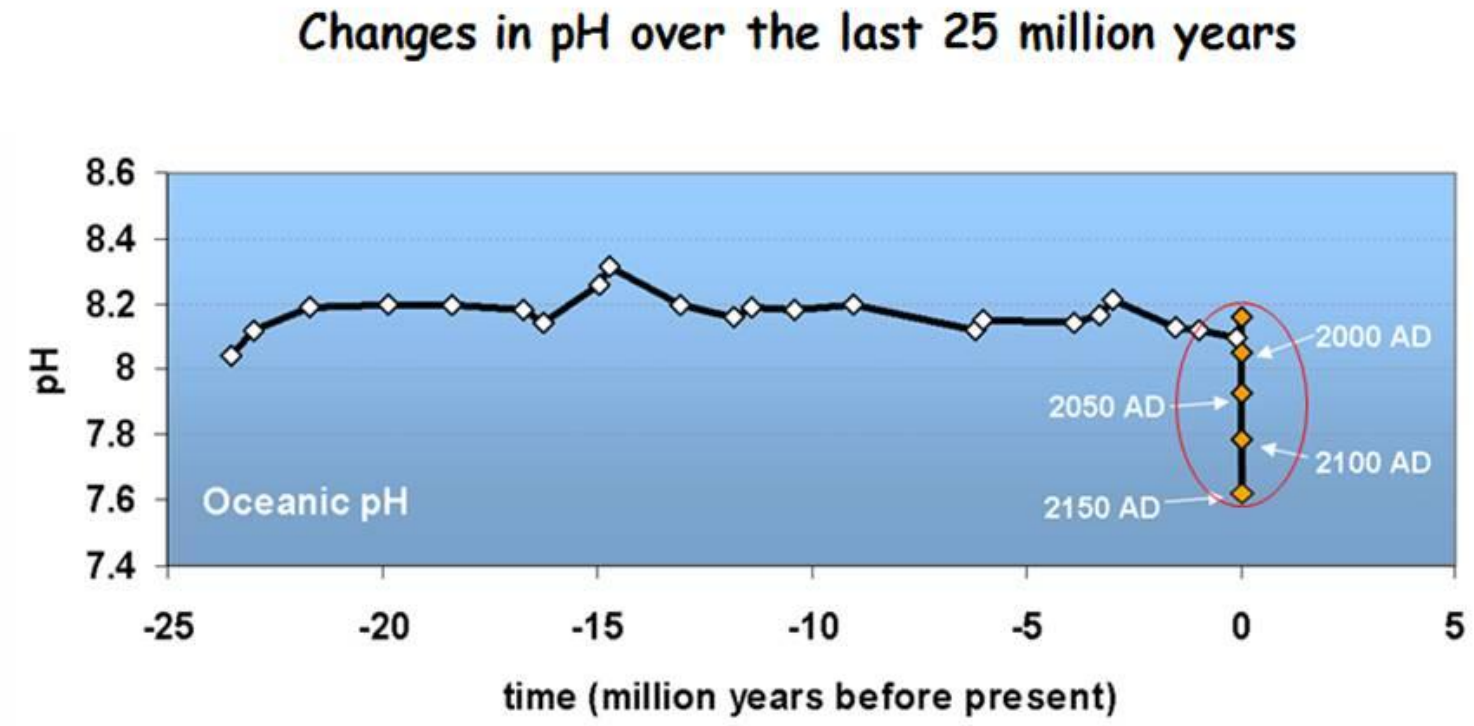
Stramma et al. 2011 Nature Climate Change 2: DOI:10.1038/NCLIMATE1304

CO_2 is converted to carbonic acid in seawater which then lowers pH and converts carbonate to bicarbonate

Result is a reduction in the availability of aragonite, the form of calcium carbonate that corals build their skeletons from.



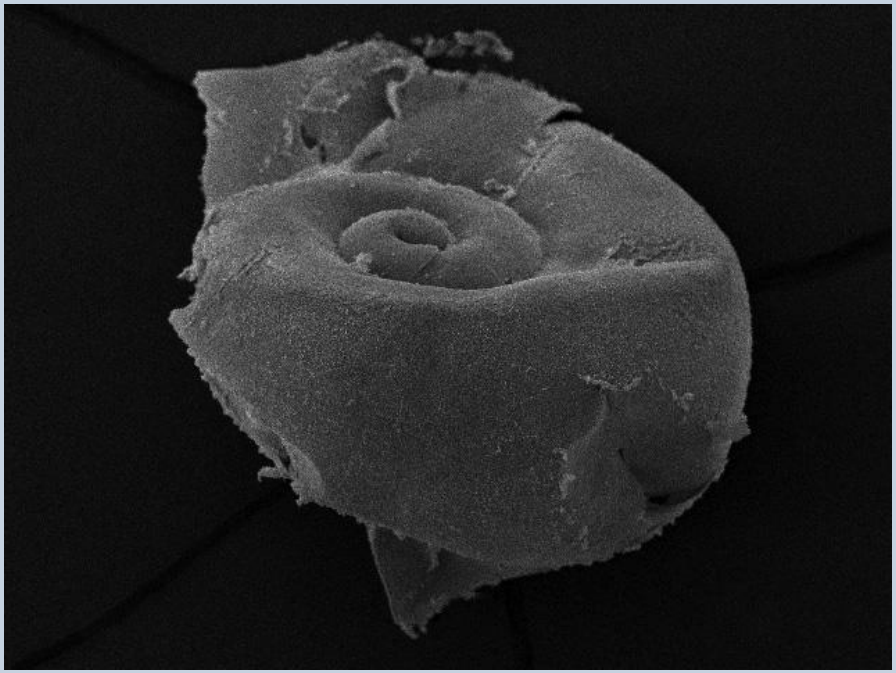
Oceans are Acidifying Fast .....



Current CO_2 levels highest for 15MY and possibly 34MY. Rate of change of CO_2 is possibly highest for 300MY (Bijma et al. (2013) MPB

Turley et al 2006.

First evidence of direct impacts of acidification from Antarctica



Pteropods in natural area of upwelling found to have severely corroded shells as a result of acidification and natural low pH of upwelled seawater.

Tarling et al. (2012) Nature Geoscience

Fisheries: food security and employment

- Marine fisheries ~ 79.5 million tonnes per year (drop from 86.3mt)
- 20% protein intake for 1.5 billion people; 15% for 3 billion people (>40% popn)
- >230 million people dependent on small-scale fisheries for livelihoods
- Artisanal fisheries ~ 25% of the global marine catch ~ 40% of the catch for human consumption
- What have the high seas got to do with coastal fisheries?

The state of fisheries

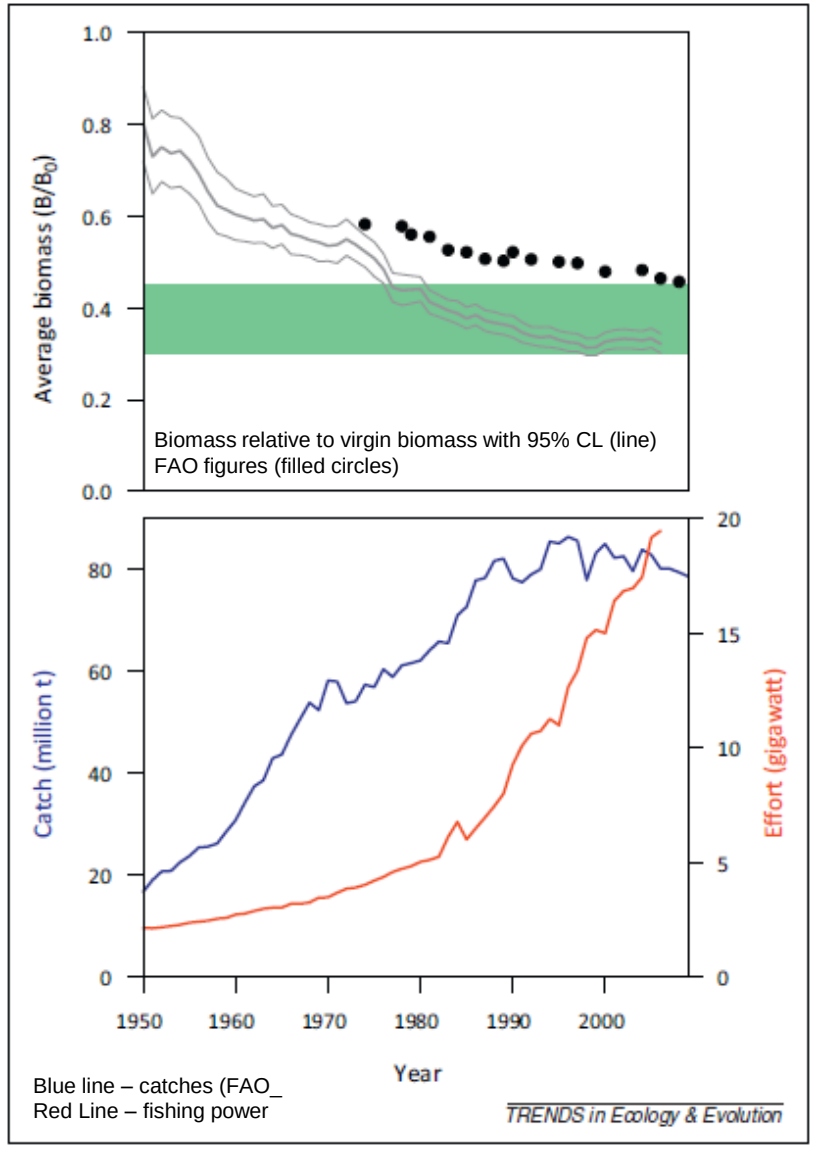
Overall, global catches are declining

Masks very different regional trends

N America, Europe and Oceania (20-25% of global catch) catch is stabilising at ~32% virgin biomass. About half of these stocks are expected to rebuild with careful management

445 large stocks monitored by FAO (80% of global catch) show a continuous declining trend (illustrated)

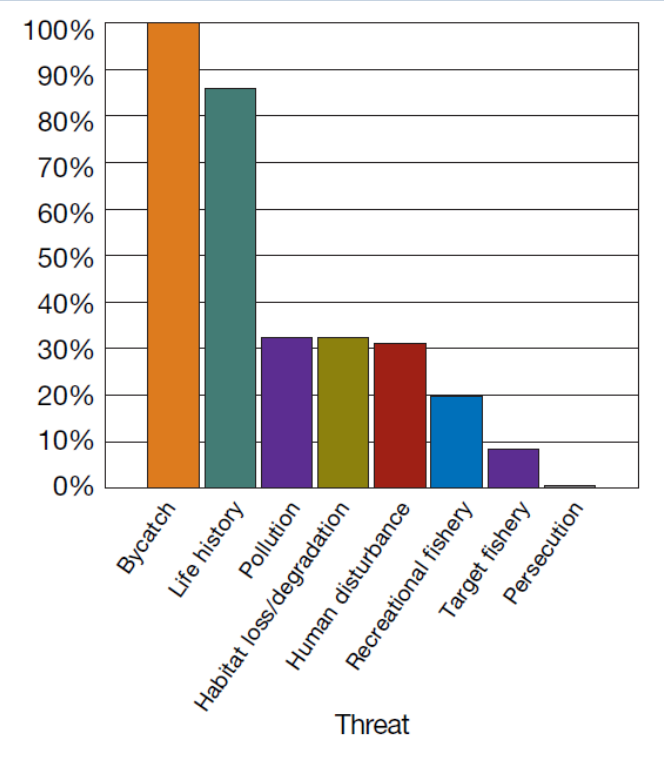
Worm & Branch Trends Ecol Evol



Unused and unmanaged catch (by-catch)

- Estimated as 38.5 million tonnes in 2009 for landed catch of 95.2 million tonnes (40.4% Davies et al., 2009 Marine Policy 33: 661)
- Catch that is unused or unmanaged
- Tendency to use more of the by-catch as previous target species become depleted
- In Europe 10-60% of the catch is discarded depending on fishery

Out of sight out of mind: the ecosystem impacts of fishing



Reasons for decline of endangered/ threatened species: Mediterranean (42% species threatened) IUCN SSG

Angelshark (Squatinidae). Puerto del Carmen, Lanzarote, Canary islands, Spain. November 2006 © Carlos Suárez (Oceana)

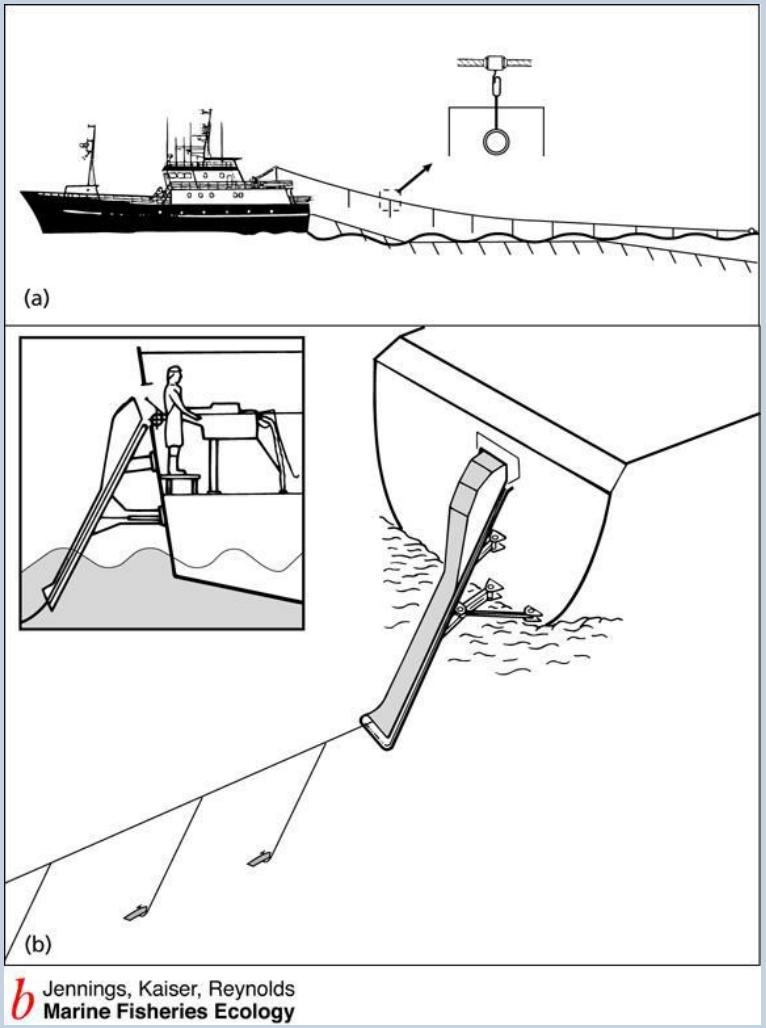
Critically Endangered	
White skate (EN)	*Rostroraja alba*
Spiny dogfish (VU)	*Squalus acanthias*
Gulper shark (VU)	*Centrophorus granulosus*
Porbeagle (VU)	*Lamna nasus*
Angel shark **	*Squatina squatina*
Smalltooth sawfish	*Pristis pectinata*
Common sawfish	*Pristis pristis*
Common skate **	*Dipturus batis*
Endangered	
Basking shark (VU)	*Cetorhinus maximus*
Leafscale gulper shark (VU)	*Centrophorus squamosus*
Portuguese dogfish (NT)	*Centroscymnus coelolepis*
Blackchin guitarfish	*Rhinobatos cemiculus*
Common guitarfish	*Rhinobatos rhinobatos*
Undulate ray	*Raja undulata*
Giant devilray**	*Mobula mobular*
Scalloped hammerhead	*Sphyrna lewini*

Endangered sharks

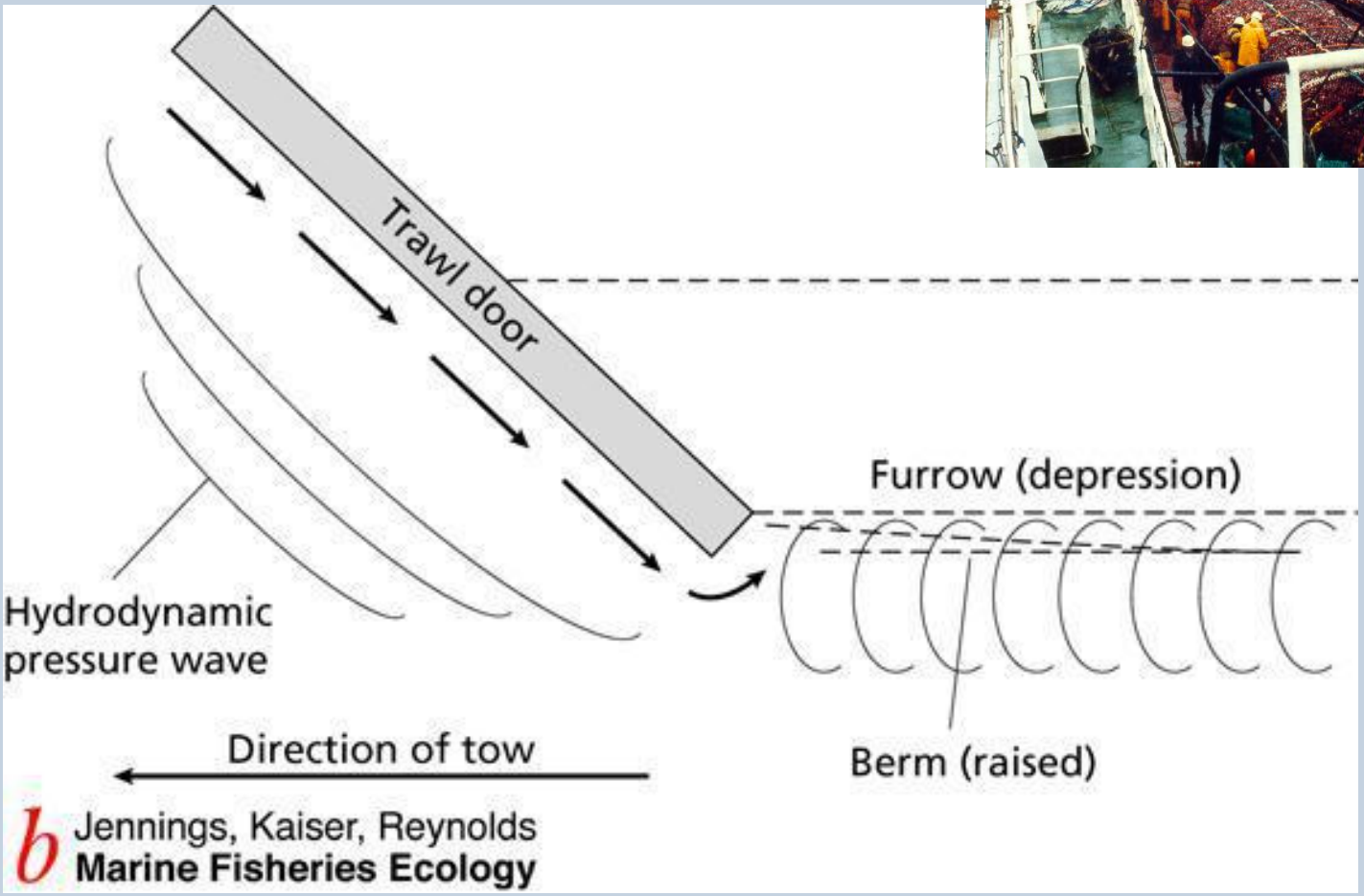
NE Atlantic

IUCN SSG

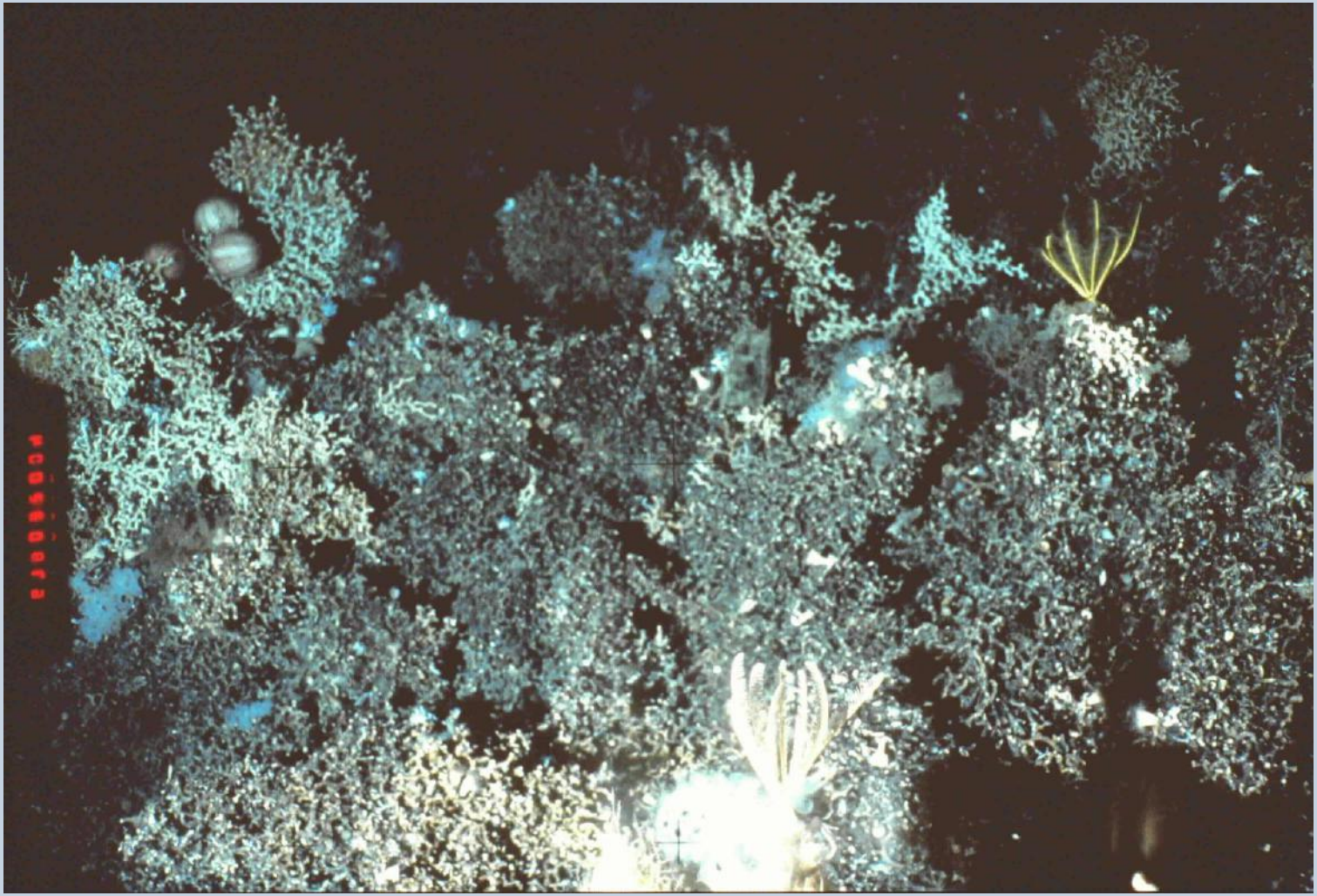
Albatross bycatch



Impacts of trawling



South Australian (Tasmanian) Seamounts

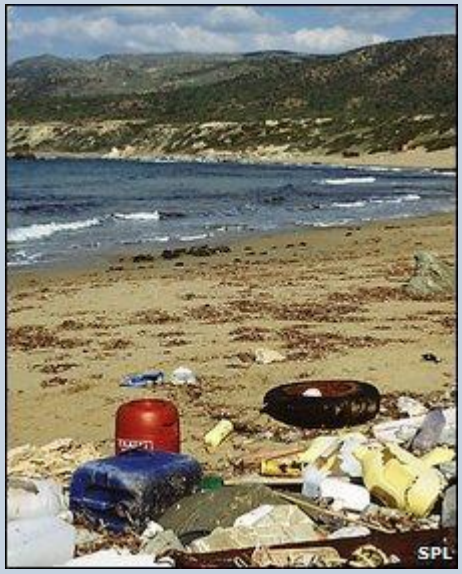


Habitat alteration or destruction

Pollutants

- **Legacy contaminants**

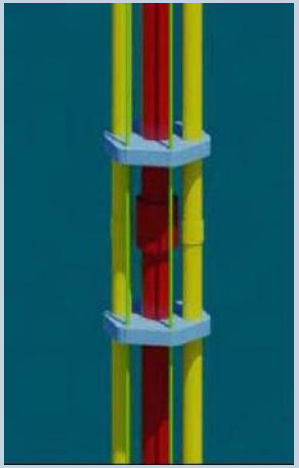
  - Antifoulants (e.g. tributyltin)
  - Heavy metals
  - Polychlorinated biphenyls
  - Polycyclic aromatic hydrocarbons



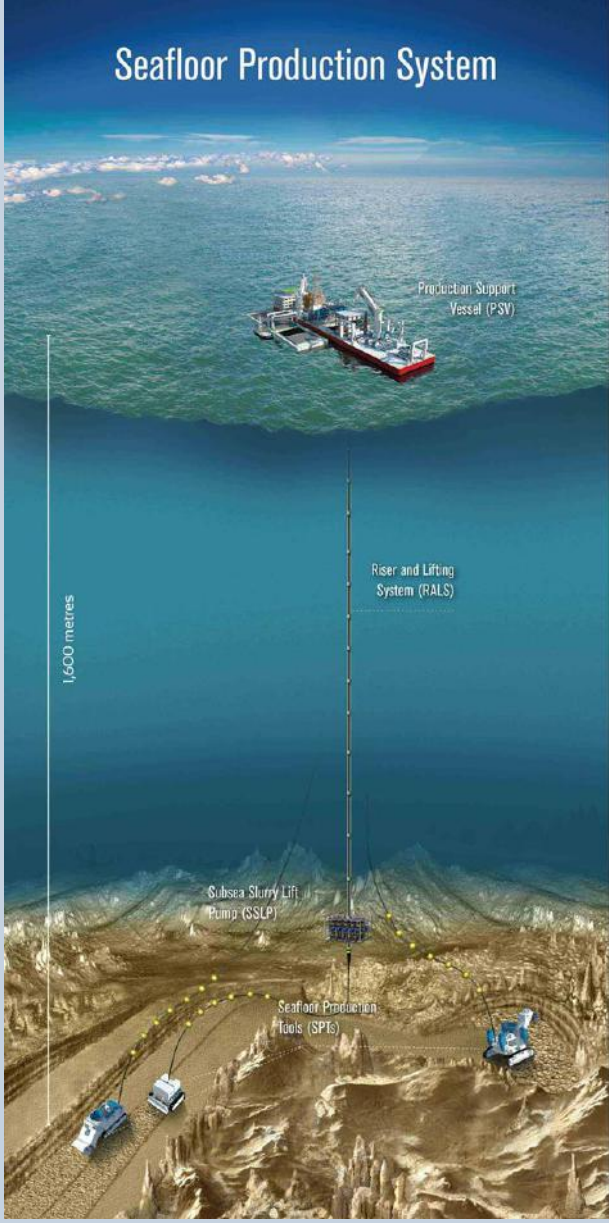
- **Emerging contaminants**

  - Endocrine disrupters
  - Flame retardants
  - Fragrances
  - Pharmaceuticals
  - Plastics

New activities – new stakeholders



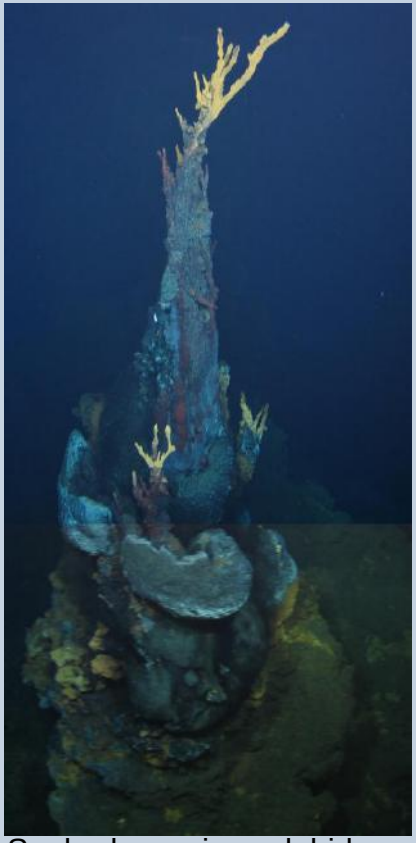
Marine mining (Nautilus Minerals PNG – currently halted)



Four different deposits of interest in very different environments

Marine phosphates (Namibia Phosphate)

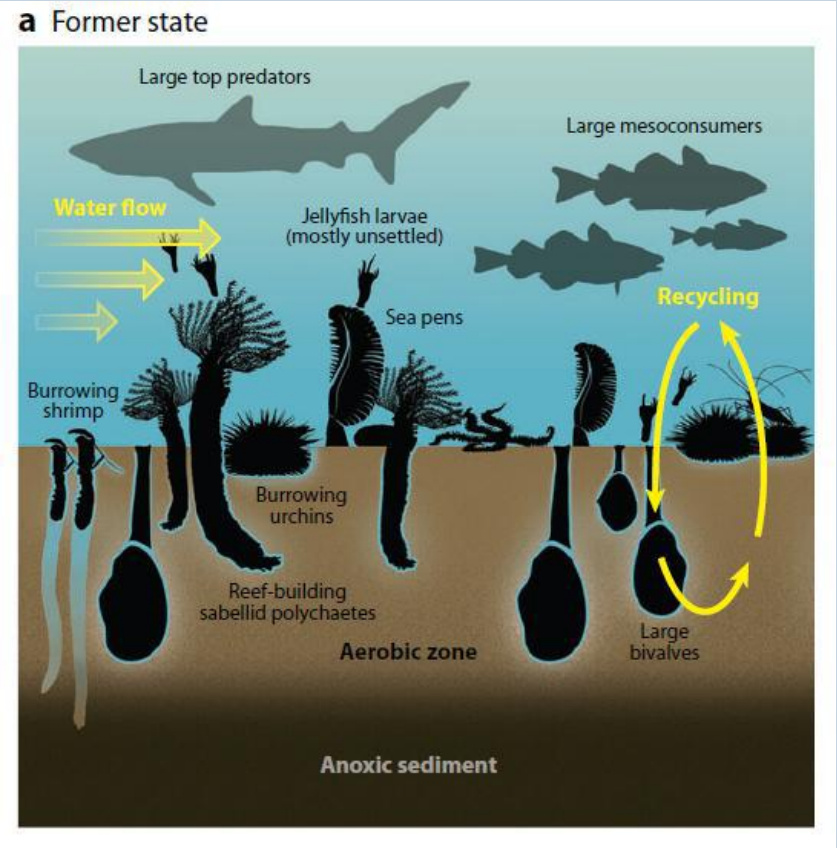
Seamount cobalt crusts (BGR)

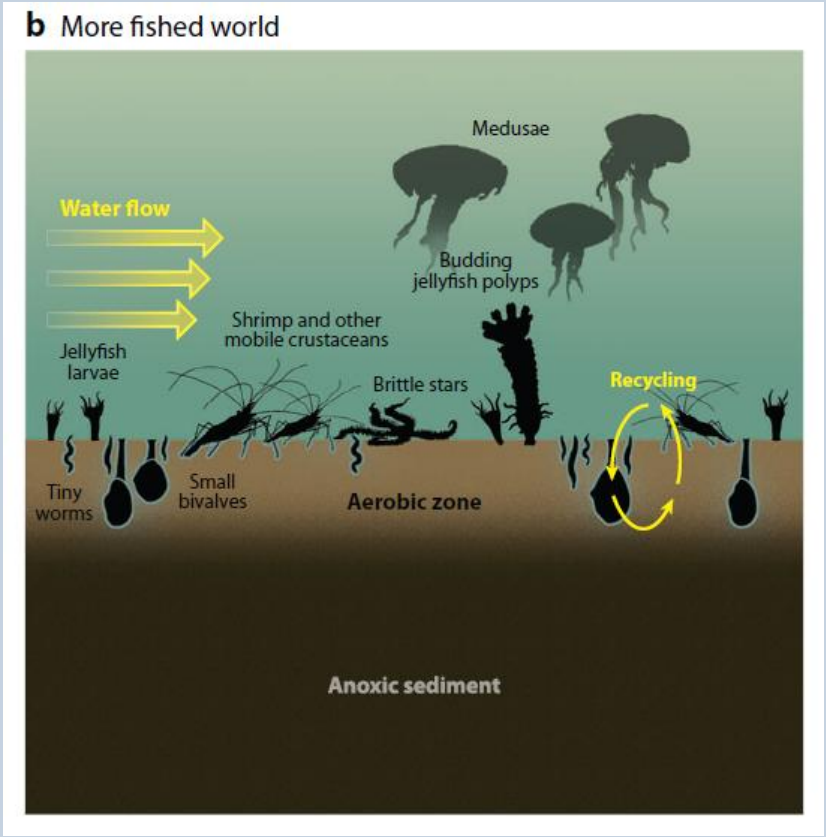


Seabed massive sulphides (Dragon vent field – NERC)

Manganese nodules (Census of Marine Life / Aker Wirth)

Ecosystem-based management: maintaining a healthy ocean





Goal: maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services we need

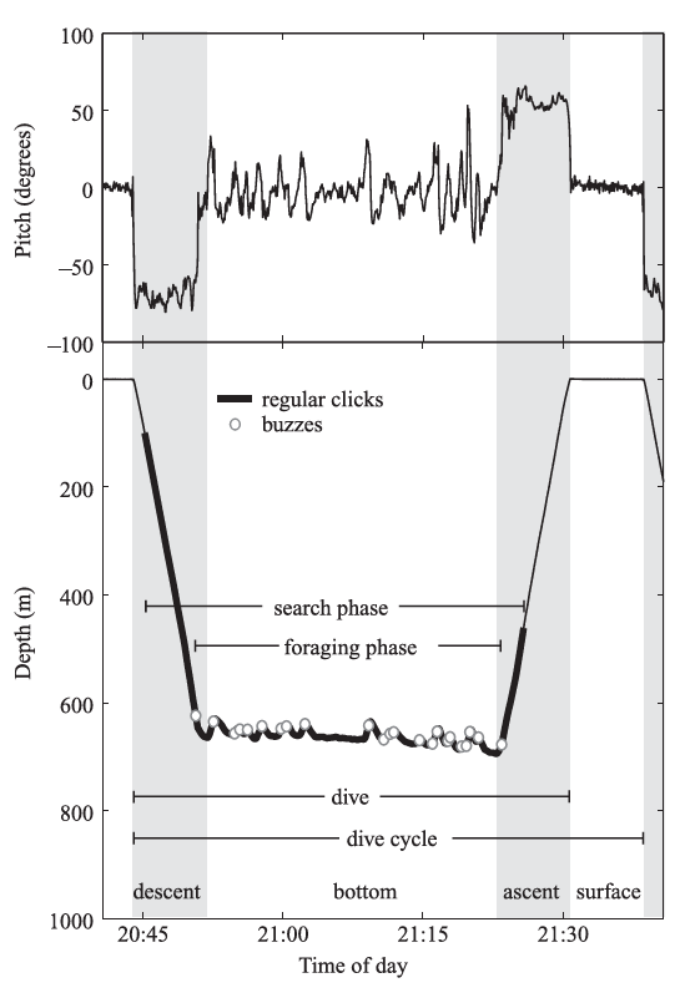
Reforming fisheries management

- Decisions based on science
- Transparent decision making
- Technical modification of gear to reduce by-catch, eliminate most destructive fishing practices
- Improved monitoring, control and surveillance, better enforcement
- Classify illegal fishing as a transnational crime, penalise flag states that do not control their vessels
- Reduce overcapacity and eliminate harmful (capacity enhancing) subsidies

What do whales do for us?

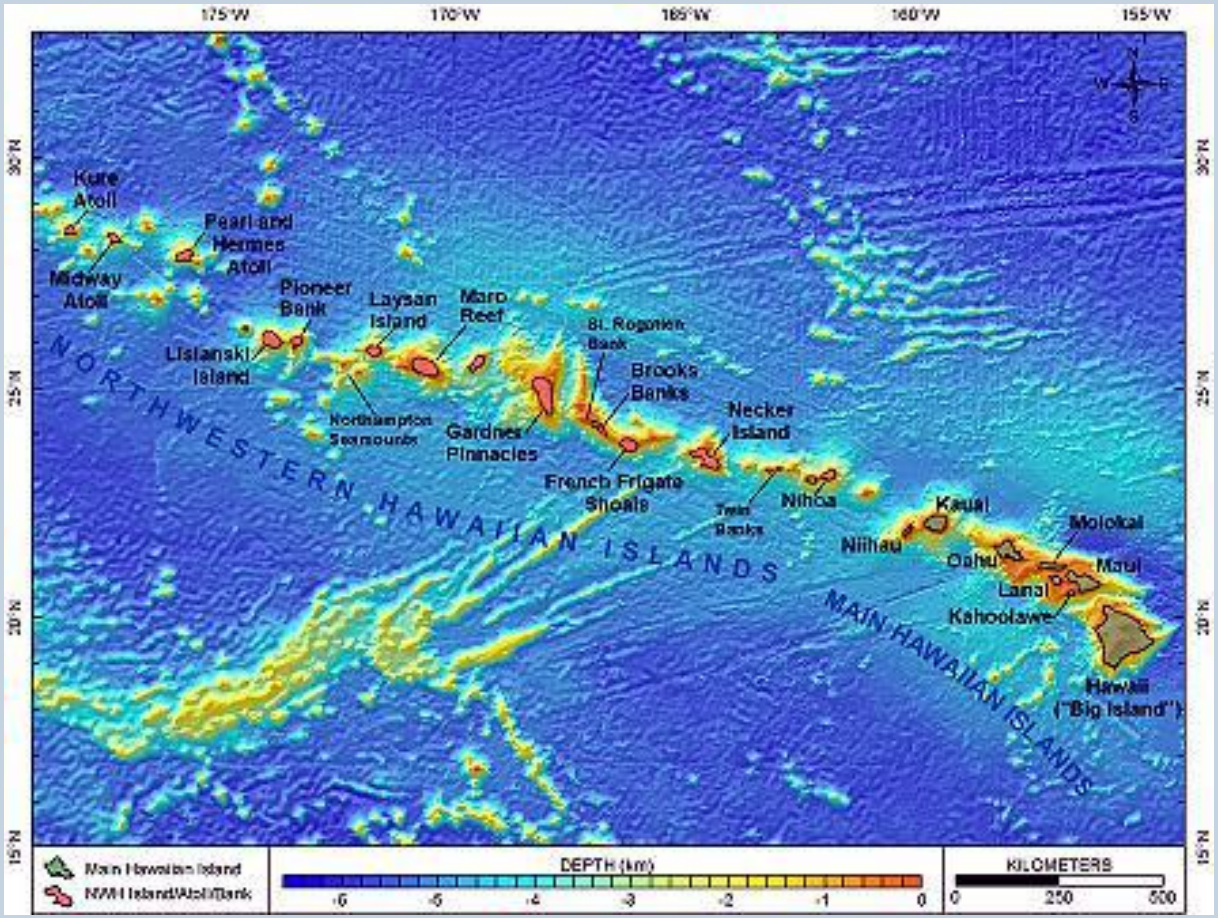
Whales swim around in the ocean and dive to fantastic depths

Sperm whales dive to a depth of 1,200m or more to forage for food (squid)



Watwood et al. (2006) J Anim Ecol 75: 814-825

The importance of swimming / diving toothed whales in a vertically-stratified ocean



Toothed whales may contribute ~17Gw yr^{-1} of energy to ocean mixing

About 0.5-1% of the total required energy for ocean mixing.

Approximately the “stirring” effect of the entire Hawaiian Island chain.

Total biological stirring ~1Tw
stirring from physical effects ~2-3 Tw

Dewar et al. (2006) Oceanography 20: 162-171

Whale defecation and iron

12,000 sperm whales in the Southern Ocean release 50t yr^{-1} iron into surface waters

This is a high nutrient-low chlorophyll ocean, i.e. it is iron limited

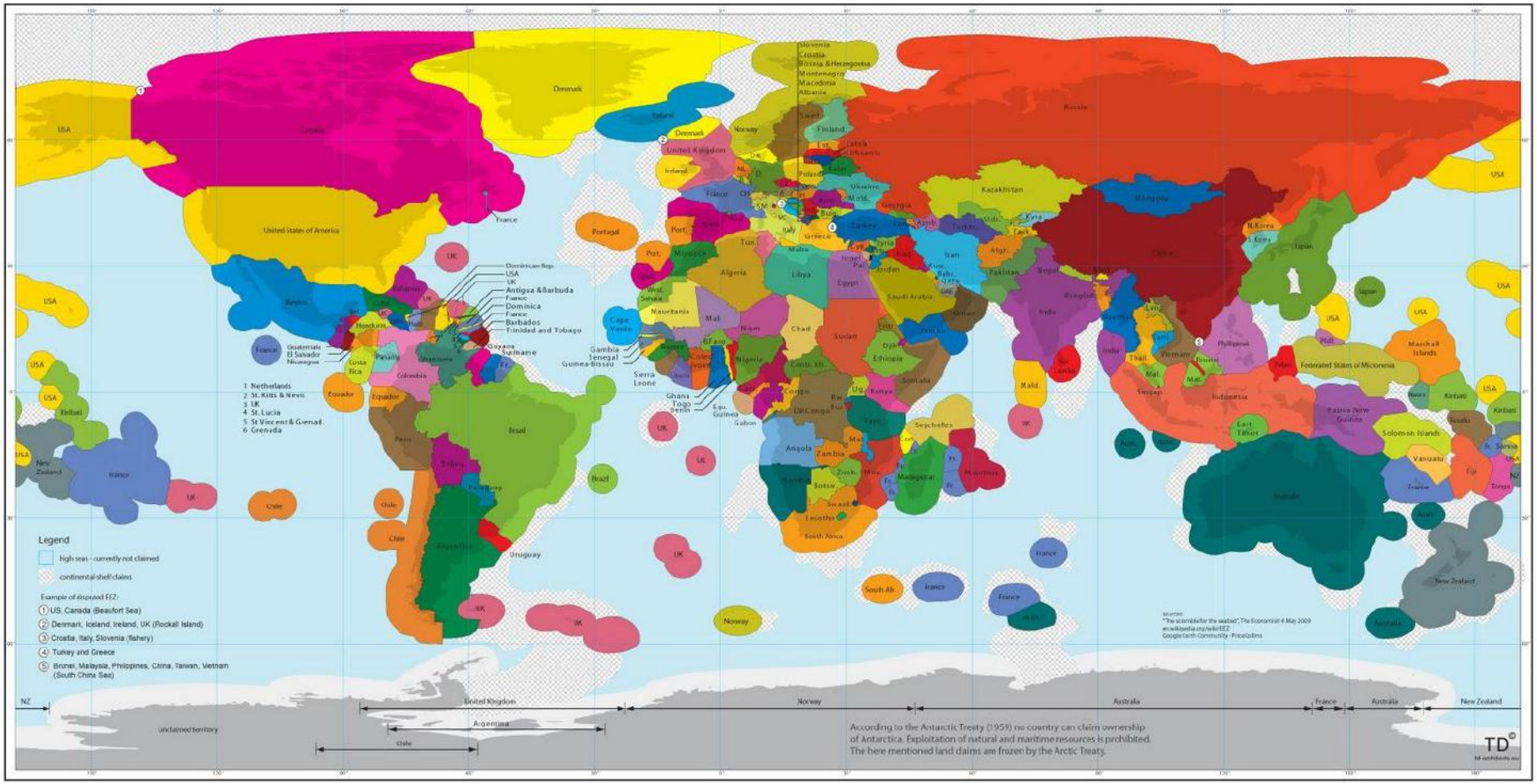
Stimulates the export of 4 x 10^5t carbon from euphotic zone.

Whales respire 2x10^5

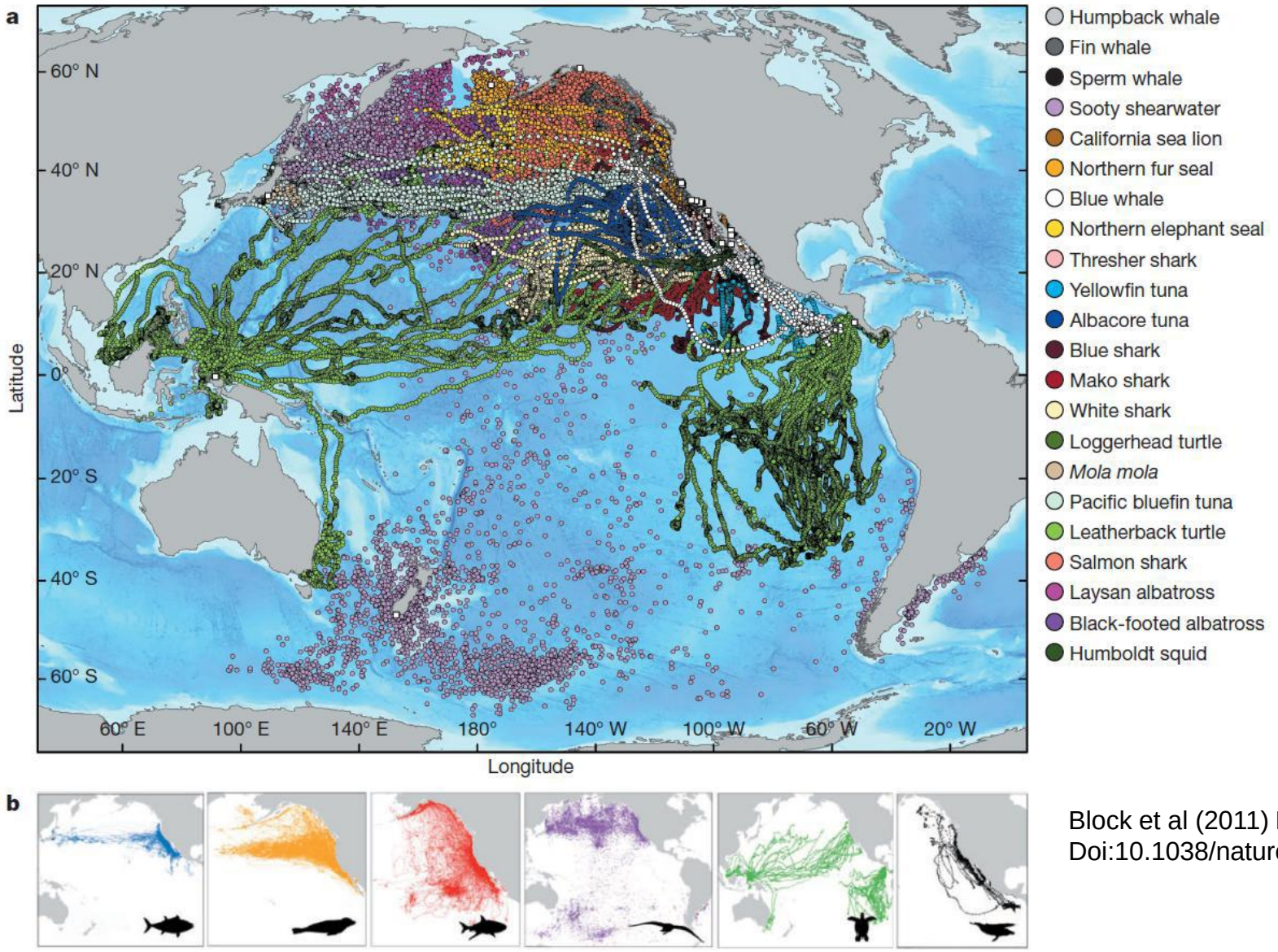
Lavery et al. (2010) Proc. Roy Soc B: 277: 3527-3531.

No legal framework for MPAs on The High Seas

No matter the economical situation, natural resources are hot. Since many of the easy accessible resources on the main land are exhausted more and more afford is done for off-shore exploitation.
Today a countries marine economic area is defined by its Exclusive Economic Zone (EEZ), a 200 nautical miles (370 km) wide offset from the countries national coast line. This regulation, which was installed by the "UN Convention on the Law of the Sea" in 1982 grants a state special rights to explore natural (e.g. oil) and marine (e.g. fish) resources, including scientific research and energy production (e.g. wind-parks).
Practically this means that if a country owns a minuscule rock somewhere in the ocean, this rocks exploitable surface increases from almost zero on-shore to 430.000km² off-shores. In the case EEZ's overlap, it is up to the involved states to delineate the actual boundary; a rule which led in certain case to decennia's of dispute. Yet there is more underwater land to claim and more squabbles ahead, since the 200 nautical miles definition got supplemented by a clause which allows its expansion till the continental shelf. The first deadline for this so called 'continental shelf submissions' passed this year May and land (seabed) allocation will start soon. If underwater land grabbing goes on like this the 'Freedom of the Seas' might soon shrink to the 'Freedom of the Ponds'.



Why should we care about the high seas?
Highly connected nature of marine ecosystems…



Block et al (2011) Nature
Doi:10.1038/nature10082

Species that live in the high seas and in EEZs represent 67.5% of annual catch (56.7 million tonnes)

Species	Average catch from High Seas (1,000 t)	Average landed values from High Seas (million USD)	% of catch from High Seas	% of landed values from High Seas
Pelagic fishes	2,228	4,085	25	29
Bigeye tuna	469	2,280	84	84
Yellowfin tuna	1,017	2,176	71	72
Skipjack tuna	1,491	1,784	61	62
Albacore	206	473	72	67
Swordfish	82	417	68	62
Inca scad	936	415	51	51
Argentine shortfin squid	343	413	61	61
Marine molluscs	248	403	29	30
Natantian decapods	63	304	14%	15

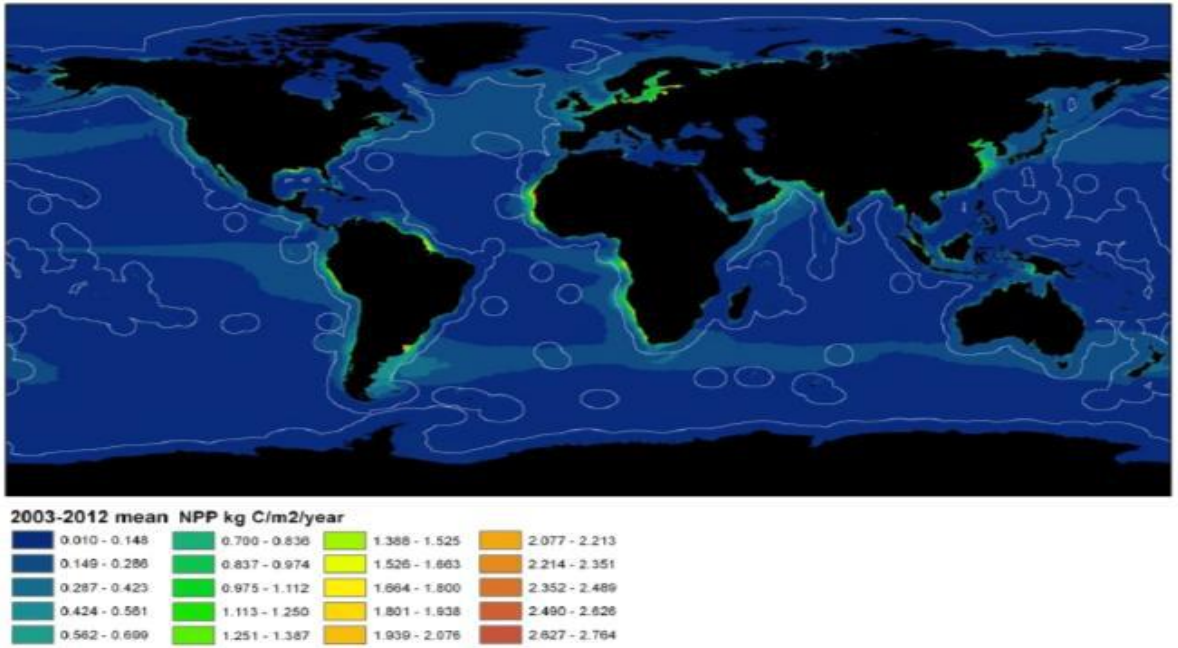
Fishing country	Average catch from High Seas (1,000 t)	Average landed values from High Seas (million USD)	% of catch from High Seas	% of landed values from high seas
Japan	1,035	3,466	23	30
Korea Rep	693	1,479	40	45
China Main	978	1,097	10	9
Taiwan	654	1,074	63	58
Malaysia	519	971	41	49
Spain	321	740	34	33
USA	237	707	5	9
Indonesia	581	657	14	14
Chile	994	572	24	18
Total	6,012	10,763		
Top country as % of total catch	85	84		

Caught in high seas ~ 10.7Mt ($17 billion)
Only caught in EEZs ~ 27.8 Mt ($31 billion)
Only caught in high seas ~ 3500t ($3.4 million)

Sumaila

UNIVERSITY OF OXFORD

Patterns of primary production and carbon export



Influenced by:
Climate change
Fishing
Shipping?
Pollution?
Mining?

	Total ocean	EEZ	High seas
Net primary production	47.045 Gt yr^{-1}	24.0 Gt yr^{-1} (51%)	23.045 Gt yr^{-1} (49%)
Production buried in seabed ≤200m depth or exported below 200m	2.46 Gt yr^{-1}	1.35 Gt yr^{-1} (55%)	1.111 Gt yr^{-1} (45%)
Production buried in seabed ≤1000m depth or exported to 1000m	0.417 Gt yr^{-1}	0.141 Gt yr^{-1} (+/-0.088; 34%)	0.276 Gt yr^{-1} (+/-0.172; 66%)
Production buried in seabed ≤2000m depth or exported to 2000m	0.209 Gt yr^{-1}	0.071 Gt yr^{-1} (+/-0.075; 34%)	0.138 Gt yr^{-1} (+/-0.146; 66%)

Value of the high seas as a carbon sink

	Carbon sequestration (Gt per year)*		
Carbon price ($ per tCO_2)	Low = 0.318	Medium = 0.636	High = 0.954
Low = 11	3.5	7.0	10.5
Medium = 55	17.5	35.0	52.5
High = 101	32.1	64.2	96.4
*1 Gigatonne (Gt) = billion t. ** Values are in $ billion.			

Sumaila & Rogers

Should the high seas be closed to fishing?

Reduce fishing pressure on stocks

More sustainable and economically viable fisheries

Greater global equity in economic terms

Less destruction of ecosystem

What we don't know.....

Increasing evidence life structures marine ecosystems – examples: stirring of the oceans; active transport; fertilisation of surface

Summary

- The oceans are under multiple human stressors at a range of spatial and temporal scales
- Change in marine ecosystems is occurring at a very rapid pace often with little knowledge or understanding of the implications
- Main impacts to date are from overexploitation of marine living resources, pollution, habitat destruction and climate change
- Technical fixes to some problems understood (e.g. fishing)
- There needs to be a complete revision of our relationship to the ocean that fully values the ecosystem goods it produces
- Lack of knowledge is a major barrier to ecological economic approaches