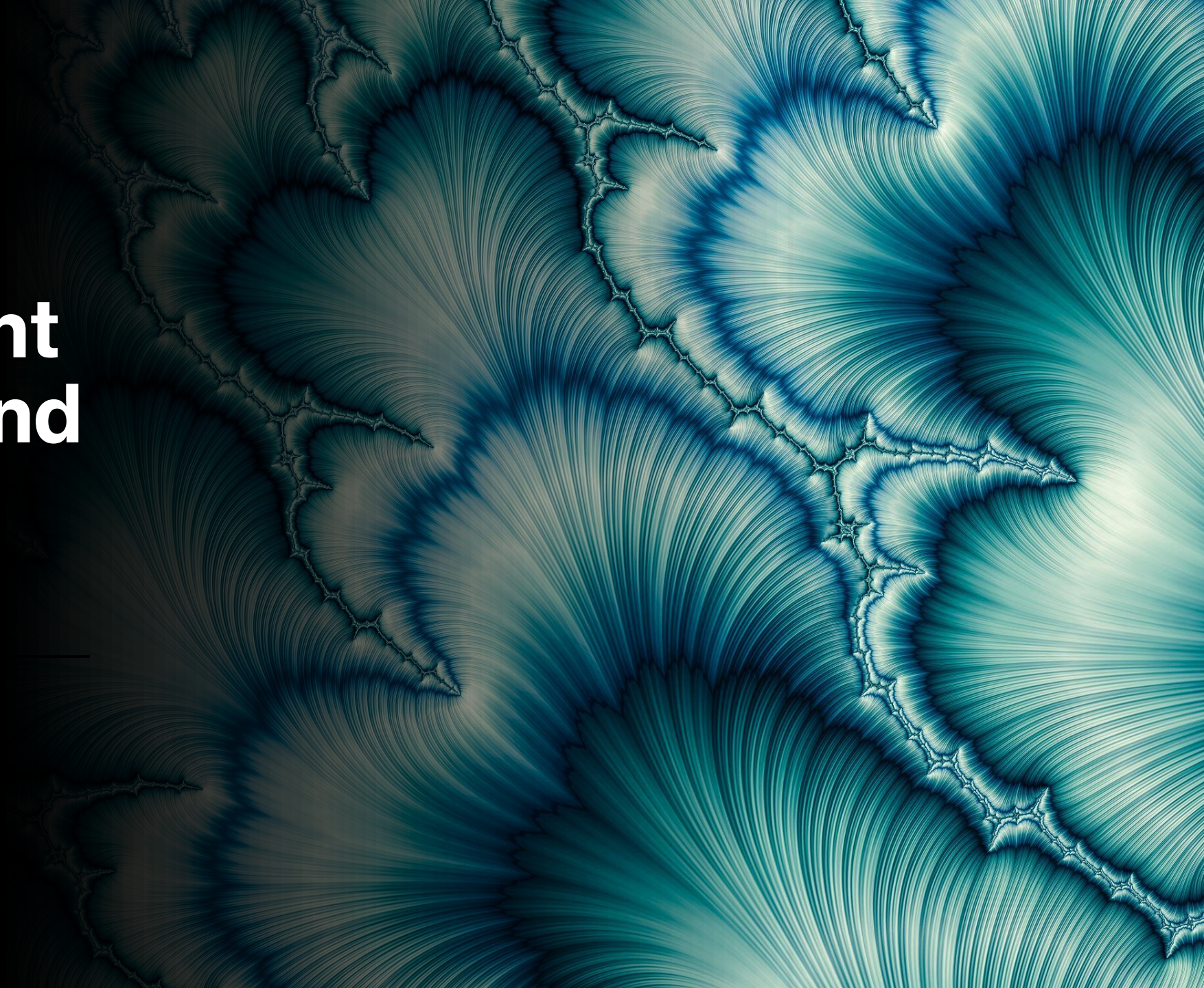
Strategic management of marine and coast

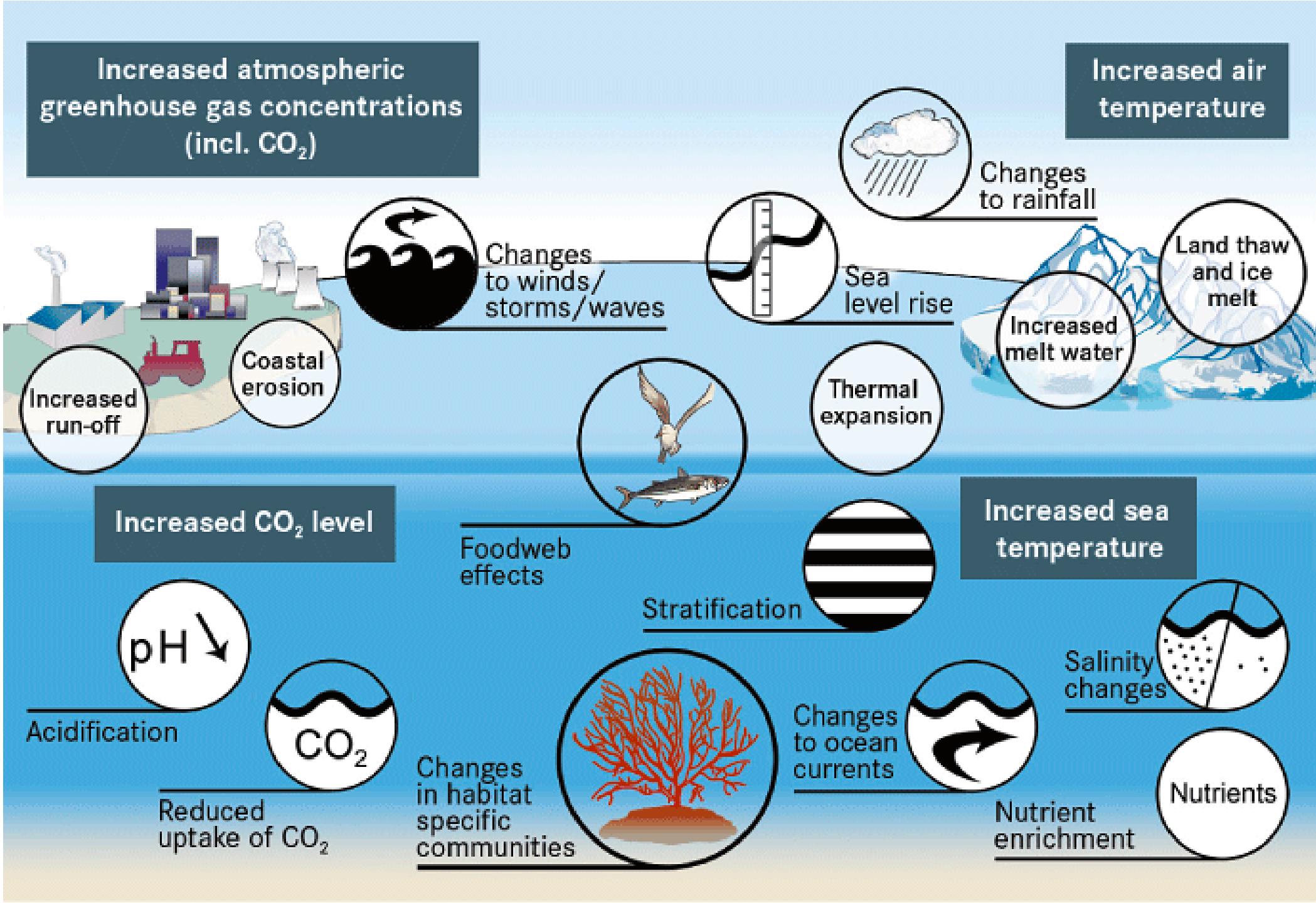


Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Lecture Outline

- What is coastal management?
- **Key issues**
- Key outcomes of recent horizon scanning activity (where we are, where are we going)

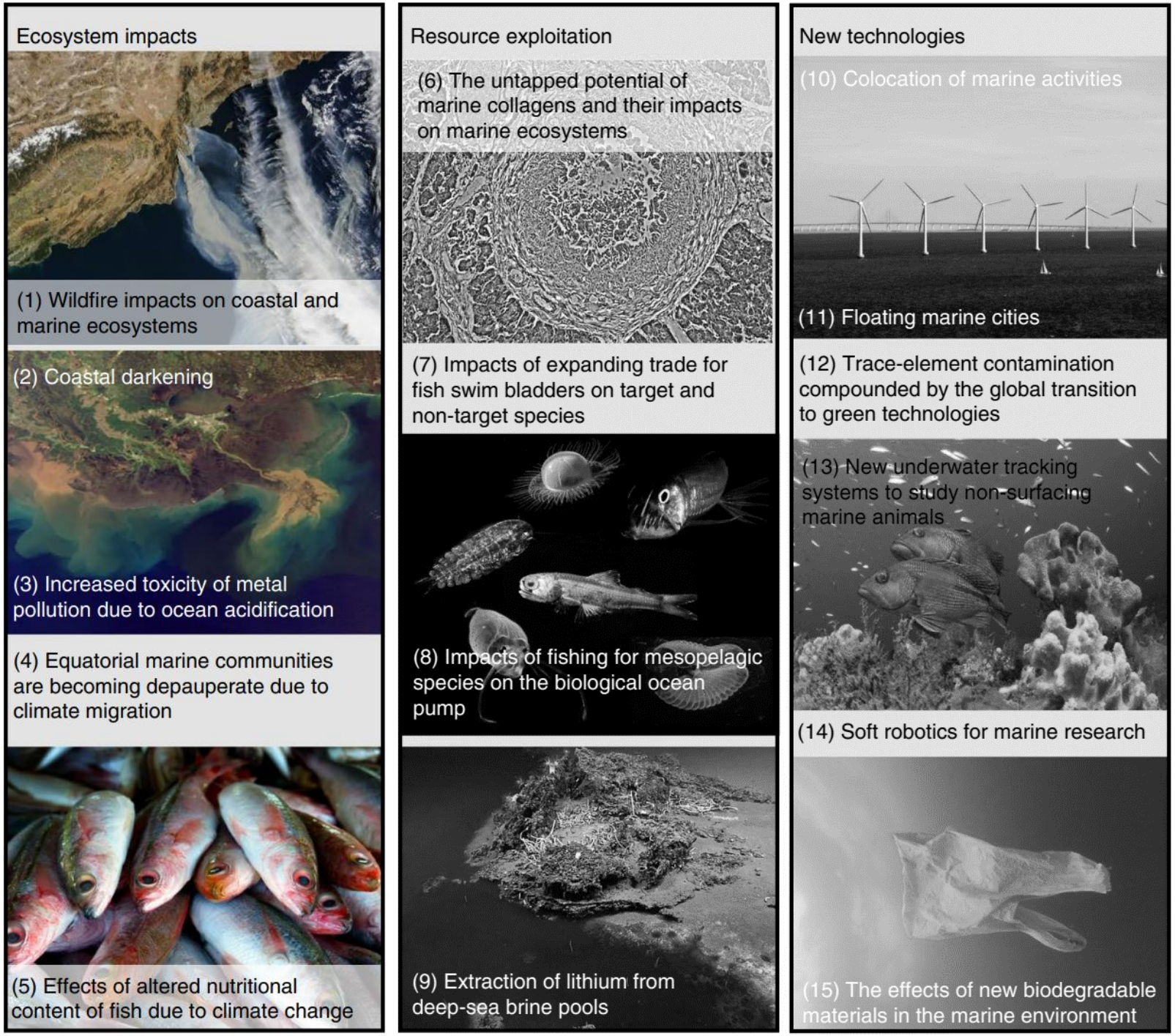
CLIMATE CHANGE



[Oceans - Climate change (weebly.com)]

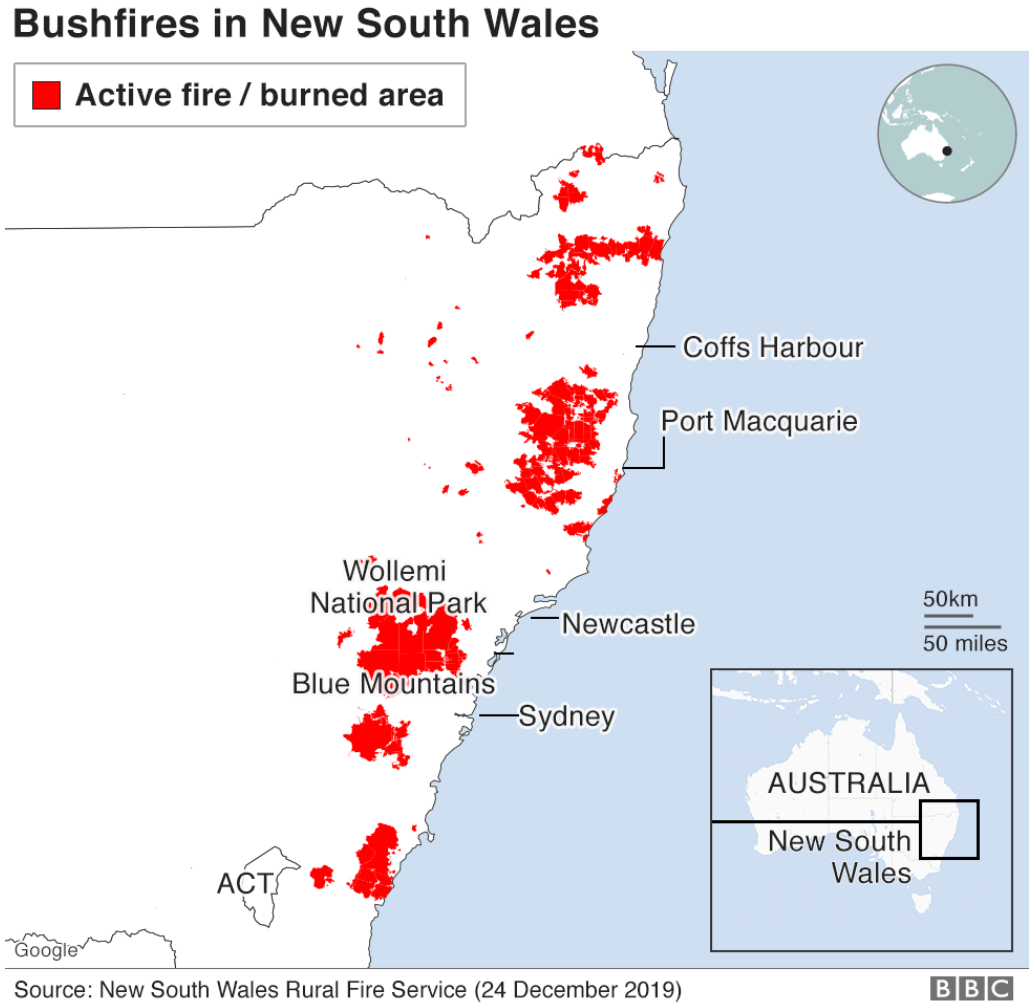
ECOSYSTEM IMPACTS

ECOSYSTEM IMPACTS



[A global horizon scan of issues impacting marine and coastal biodiversity conservation | Nature Ecology & Evolution]

WILDFIRE IMPACTS ON COASTAL AND MARINE ECOSYSTEMS



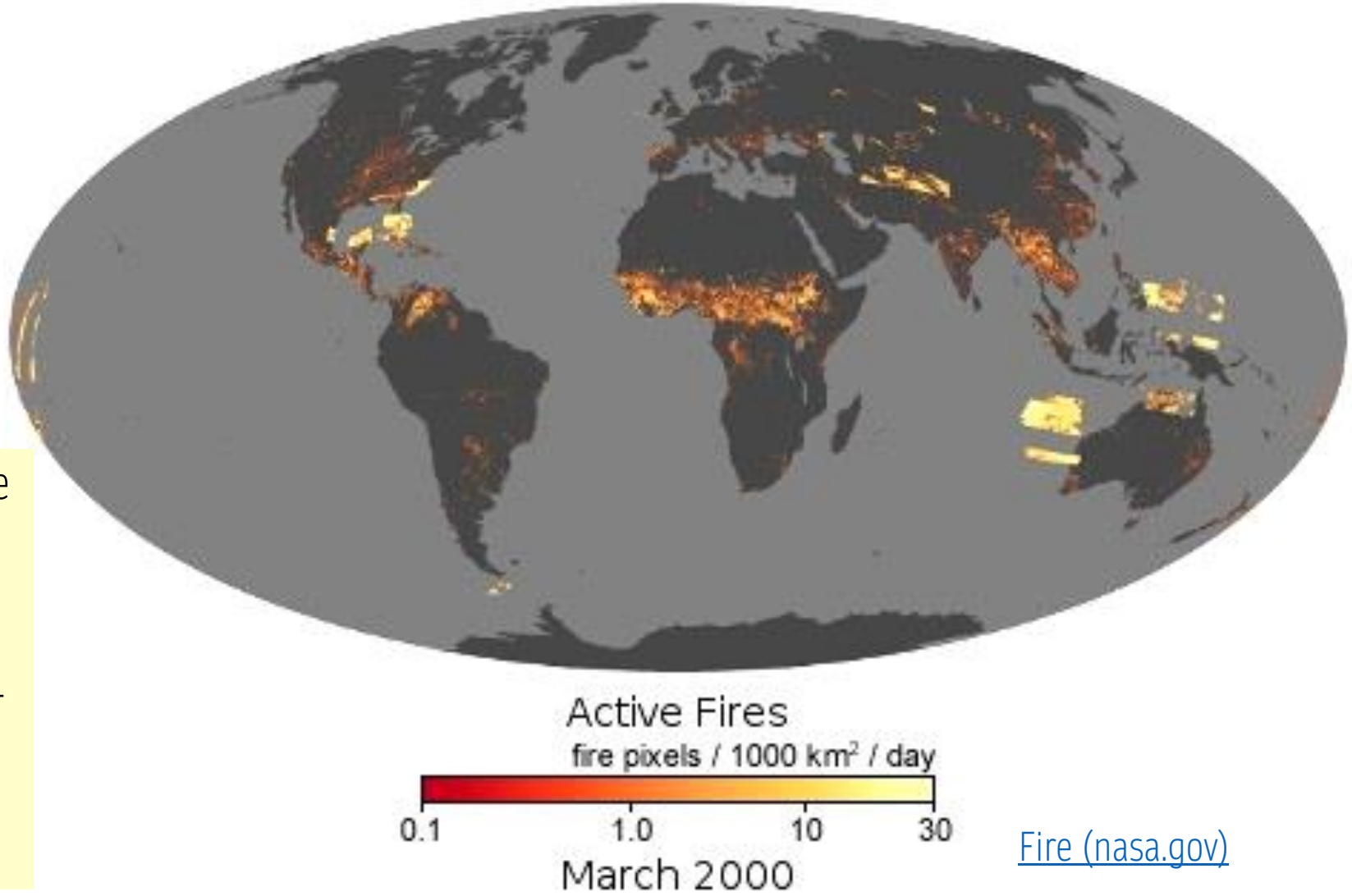
Brothers stand together on the beach during 2019/20 Bushfire Crisis. Forster, New South Wales. © Martin Von Stoll

[Bushfire-Report_February-2020_Final-full-for-web-1.pdf (marineconservation.org.au)]

WILDFIRE IMPACTS ON COASTAL AND MARINE ECOSYSTEMS

The fire maps show the locations of actively burning fires around the world on a monthly basis, based on observations from the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite.

The colours are based on a count of the number (not size) of fires observed within a 1,000-square-kilometer area. White pixels show the high end of the count — as many as 30 fires in a 1,000-square-kilometer area per day. Orange pixels show as many as 10 fires, while red areas show as few as 1 fire per day.



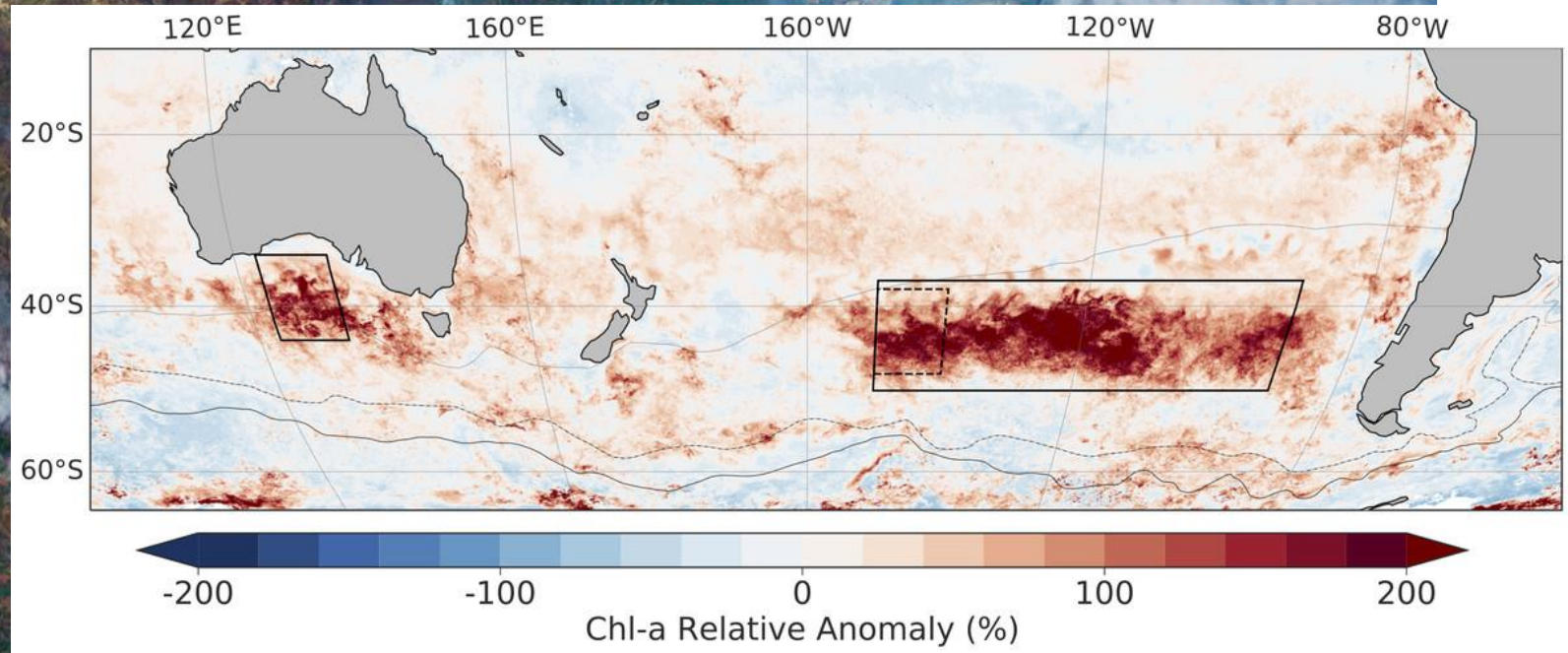
Fire (nasa.gov)

WILDFIRE IMPACTS ON COASTAL AND MARINE ECOSYSTEMS

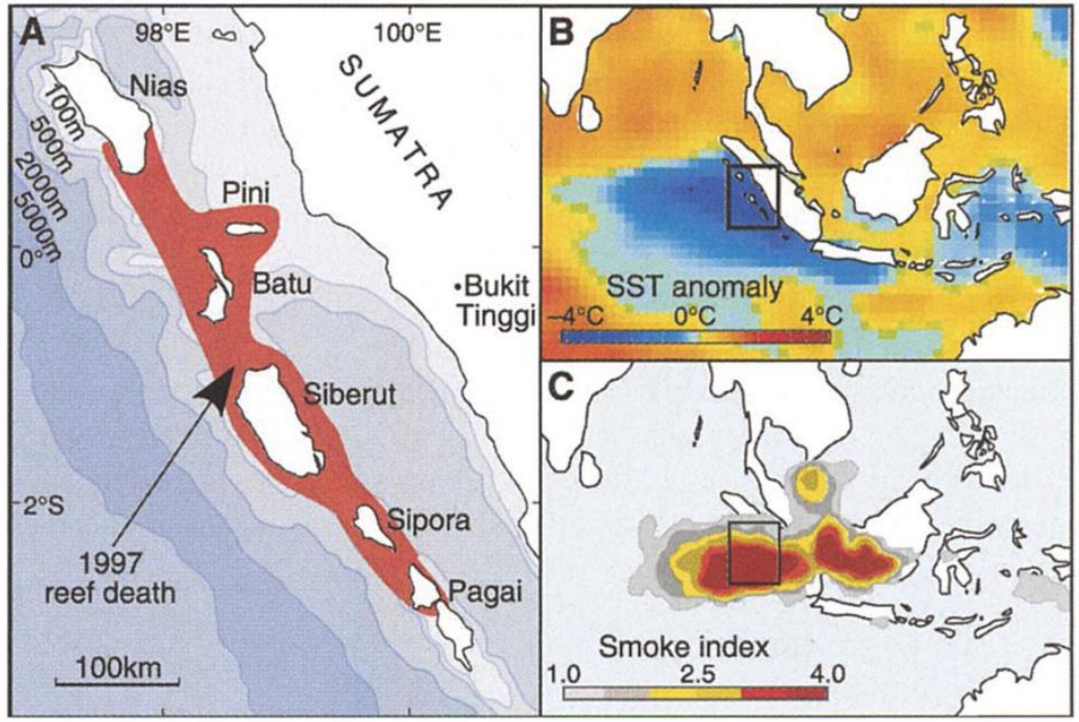
Sea water turned black by ash from wildfires laps onto a beach near Eden, NSW in January, 2020. © Mark Graham

Smoke rising from wildfires on the eastern coast of Australia in late 2019. New research finds that iron in smoke from these fires likely helped fuel an explosion of algae in oceans thousands of miles away. Courtesy of Japan's National Institute of Information and Communication Technology

Smoke rising from wildfires on the eastern coast of Australia in late 2019. New research finds that iron in smoke from these fires likely helped fuel an explosion of algae in oceans thousands of miles away. Courtesy of Japan's National Institute of Information and Communication Technology



WILDFIRE IMPACTS ON COASTAL AND MARINE ECOSYSTEMS



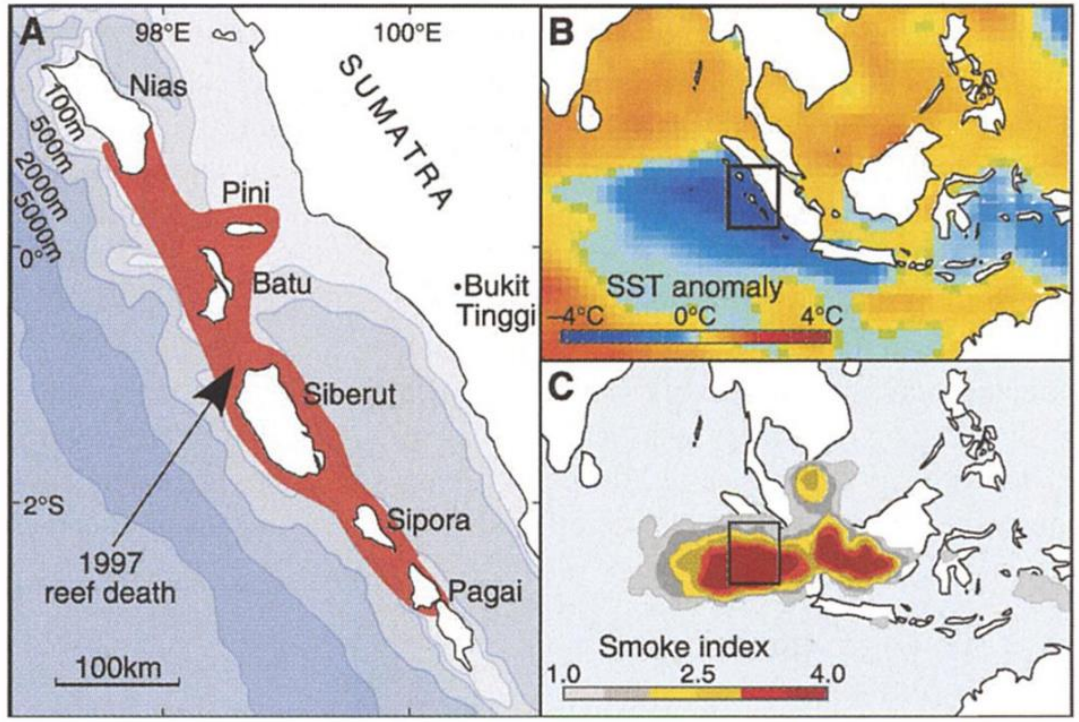
[Coral Reef Death during the 1997 Indian Ocean Dipole Linked to Indonesian Wildfires on JSTOR]

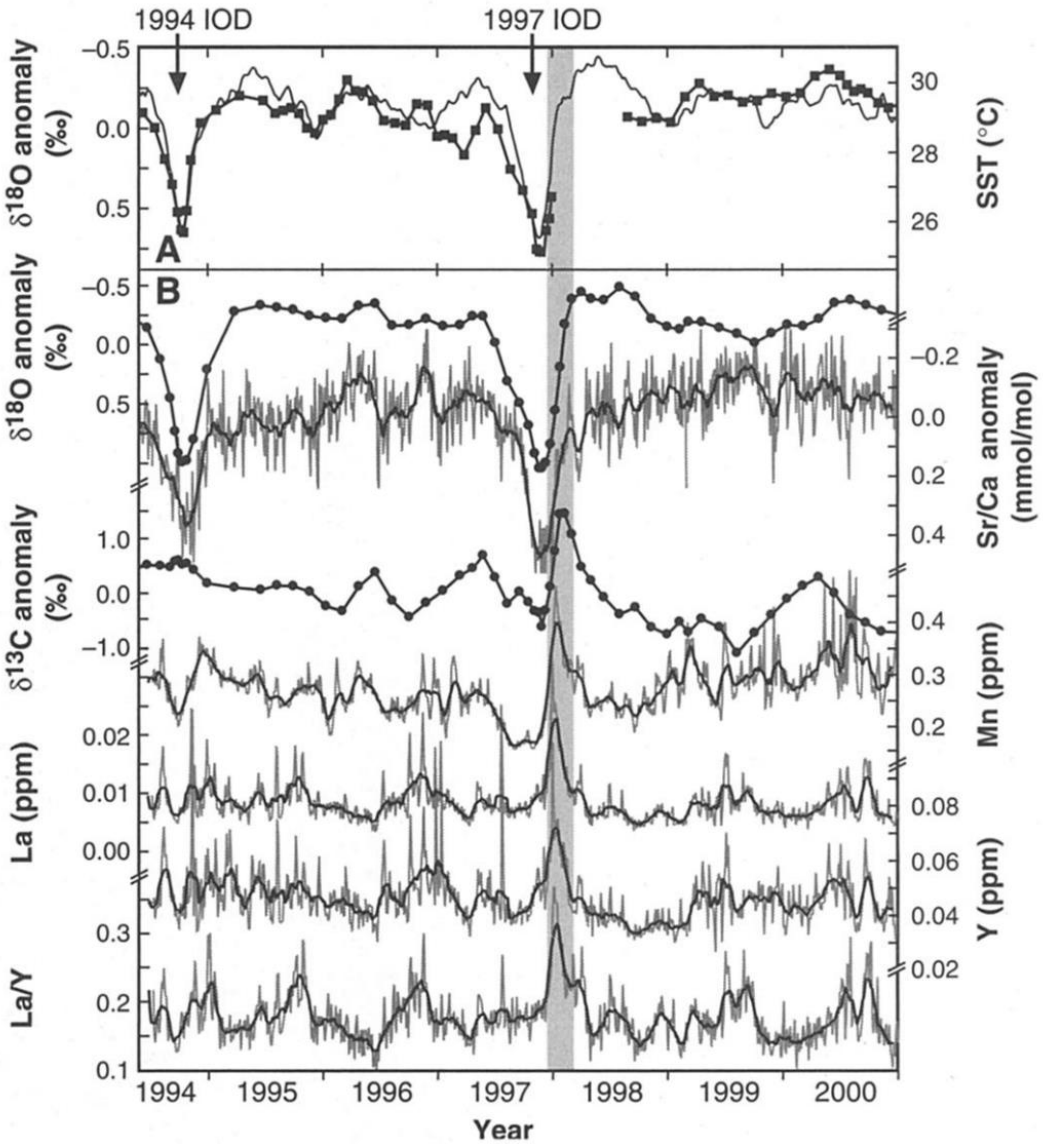
Coral Reef Death During the 1997 Indian Ocean Dipole Linked to Indonesian Wildfires

Nerilie J. Abram,[1]* Michael K. Gagan,[1] Malcolm T. McCulloch,[1] John Chappell,[1] Wahyoe S. Hantoro[2]

Geochemical anomalies and growth discontinuities in *Porites* corals from western Sumatra, Indonesia, record unanticipated reef mortality during anomalous Indian Ocean Dipole upwelling and a giant red tide in 1997. Sea surface temperature reconstructions show that although some past upwelling events have been stronger, there were no analogous episodes of coral mortality during the past 7000 years, indicating that the 1997 red tide was highly unusual. We show that iron fertilization by the 1997 Indonesian wildfires was sufficient to produce the extraordinary red tide, leading to reef death by asphyxiation. These findings highlight tropical wildfires as an escalating threat to coastal marine ecosystems.

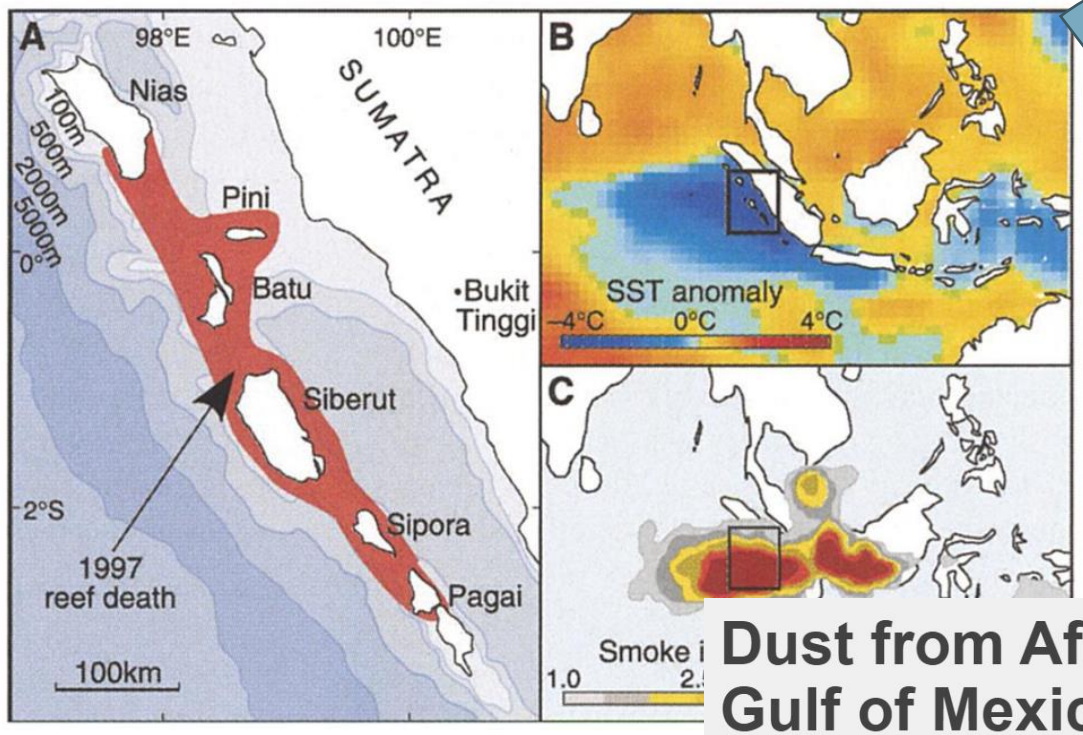
WILDFIRE IMPACTS ON COASTAL AND MARINE ECOSYSTEMS





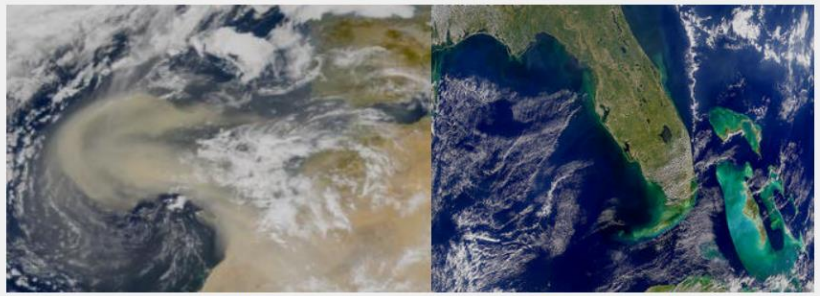
[Coral Reef Death during the 1997 Indian Ocean Dipole Linked to Indonesian Wildfires on JSTOR]

WILDFIRE IMPACTS ON COASTAL AND MARINE ECOSYSTEMS



[Coral Reef Death during the 1997 Indian Ocean Dipole Linked to Indonesian Wildfires on JSTOR]

Dust from Africa Leads to Large Toxic Algae Blooms in Gulf of Mexico, Study Finds



African Dust Toxic Florida Algae

[SVS Archived Story: /svs/db/stories/dust/index.html (nasa.gov)]

WILDFIRE IMPACTS ON COASTAL AND MARINE ECOSYSTEMS

WILDFIRE IMPACTS

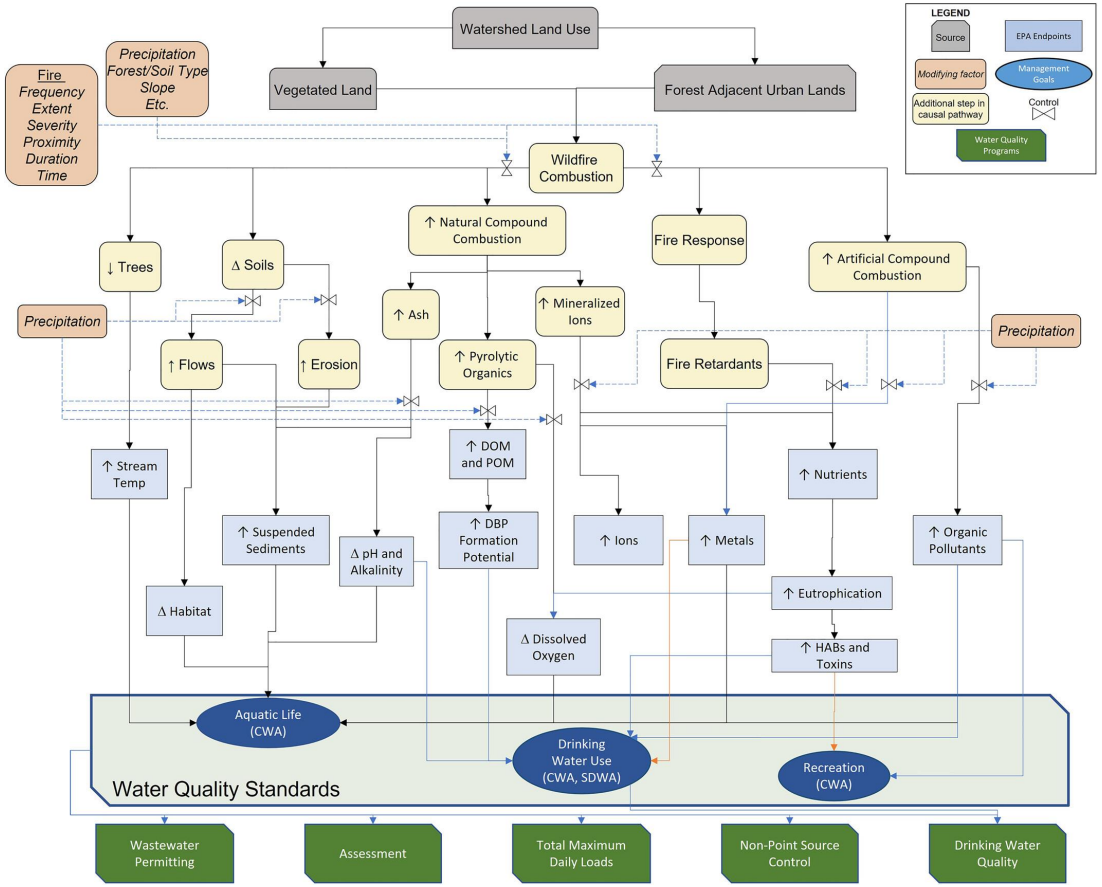
Hawaii fires

‘Coral are going to die’: Maui wildfires take toxic toll on marine ecology

Contaminants from the fires could damage marine life, and hardy non-native grasses might grow and kindle the next fire

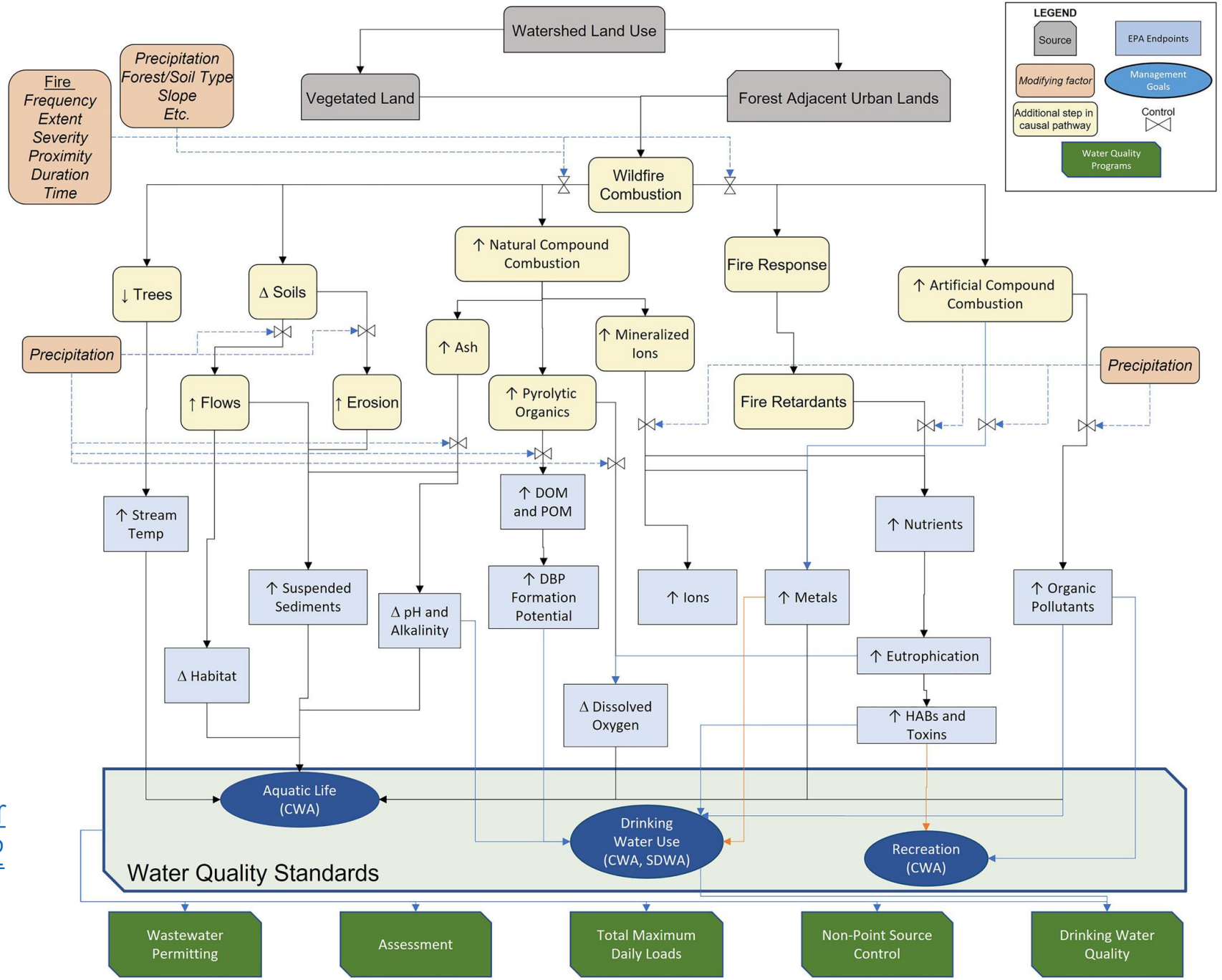
The wildfire left the historic Hawaiian town of Lahaina in charred ruins. Photograph: Patrick T Fallon/AFP/Getty Images

[‘Coral are going to die’: Maui wildfires take toxic toll on marine ecology | Hawaii fires | The Guardian]



WILDFIRE IMPACTS

WILDFIRE IMPACTS ON COASTAL AND MARINE ECOSYSTEMS



[Wildfire Induces Changes in Receiving Waters: A Review With Considerations for Water Quality Management - Paul - 2022 - Water Resources Research - Wiley Online Library]

WILDFIRE IMPACTS ON COASTAL AND MARINE ECOSYSTEMS

Hawaii fires

‘Coral are going to die’: Maui wildfires take toxic toll on marine ecology

Contaminants from the fires could damage marine life, and hardy non-native grasses might grow and kindle the next fire

The wildfire left the historic Hawaiian town of Lahaina in charred ruins. Photograph: Patrick T Fallon/AFP/Getty Images

‘Coral are going to die’: Maui wildfires take toxic toll on marine ecology | Hawaii fires | The Guardian

Researchers label these as toxic to marine organisms. The ash also brings organic matter such as **nitrogen** and **phosphorus** to the water. These excess nutrients lead to an overgrowth of algae. Eventually, the algae die, depleting the oxygen supply for all other marine life present.

Excess nutrients

HAB

Iron fertilisation, red tides, dead coral

Contaminants, water quality..... ☹

COASTAL DARKENING

Coastal Darkening Is Threatening Marine Life - The Atlantic

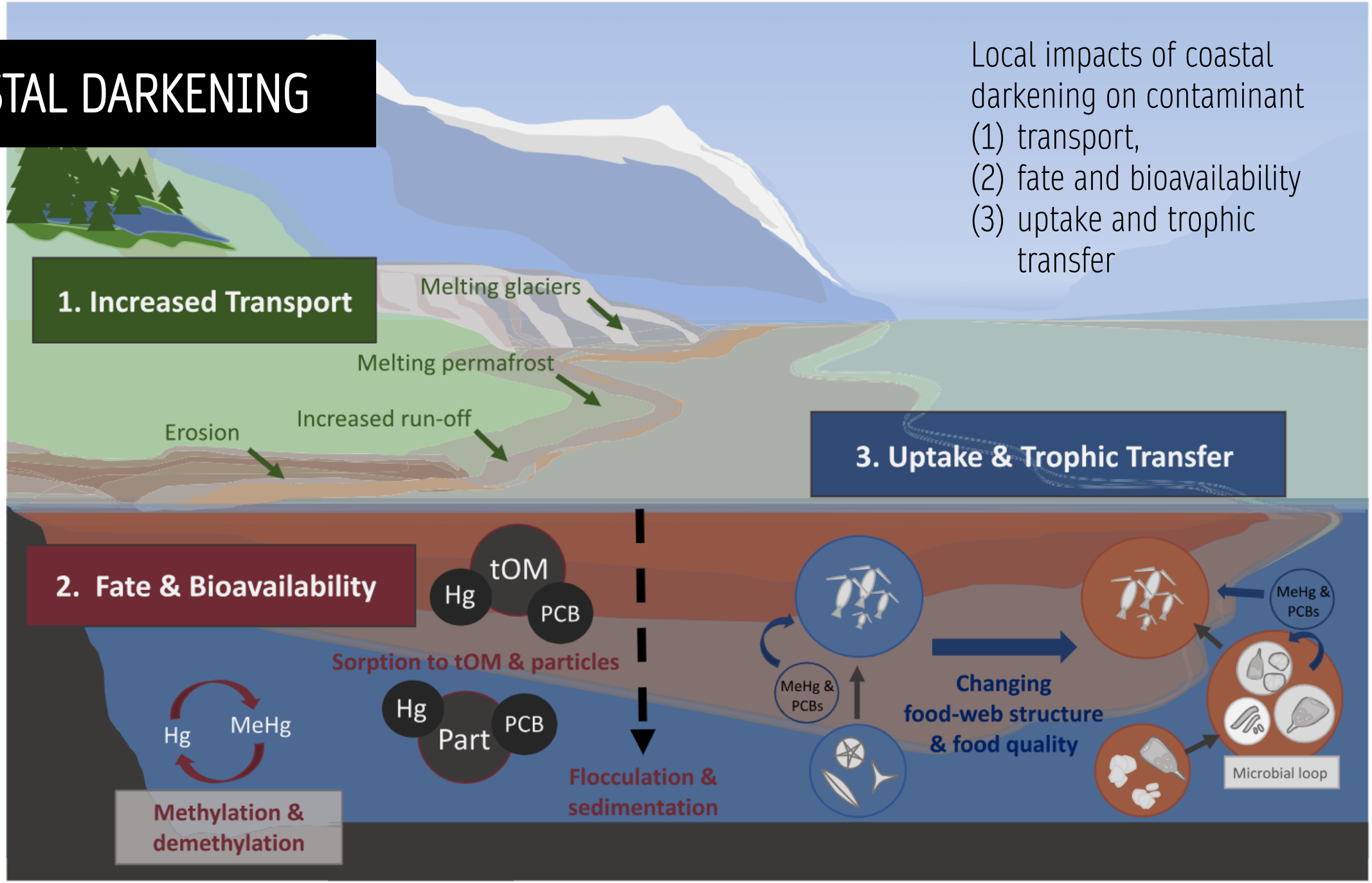
COASTAL DARKENING

Coastal waters may become darker (coastal darkening) due to increased input of coloured compounds from terrestrial run-off and sediment resuspension

[The Environmental Threat You've Never Heard Of | Hakai Magazine]

COASTAL DARKENING

Local impacts of coastal darkening on contaminant
(1) transport,
(2) fate and bioavailability
(3) uptake and trophic transfer



McGovern et al (2019). [Implications of Coastal Darkening for Contaminant Transport, Bioavailability, and Trophic Transfer in Northern Coastal Waters | Environmental Science & Technology (acs.org)]

INCREASED TOXICITY OF METAL POLLUTION DUE TO OCEAN ACIDIFICATION

Seawater pH?

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Prior to the Industrial Revolution, average ocean pH was about 8.2. Today, average ocean pH is about 8.1.

INCREASED TOXICITY OF METAL POLLUTION DUE TO OCEAN ACIDIFICATION

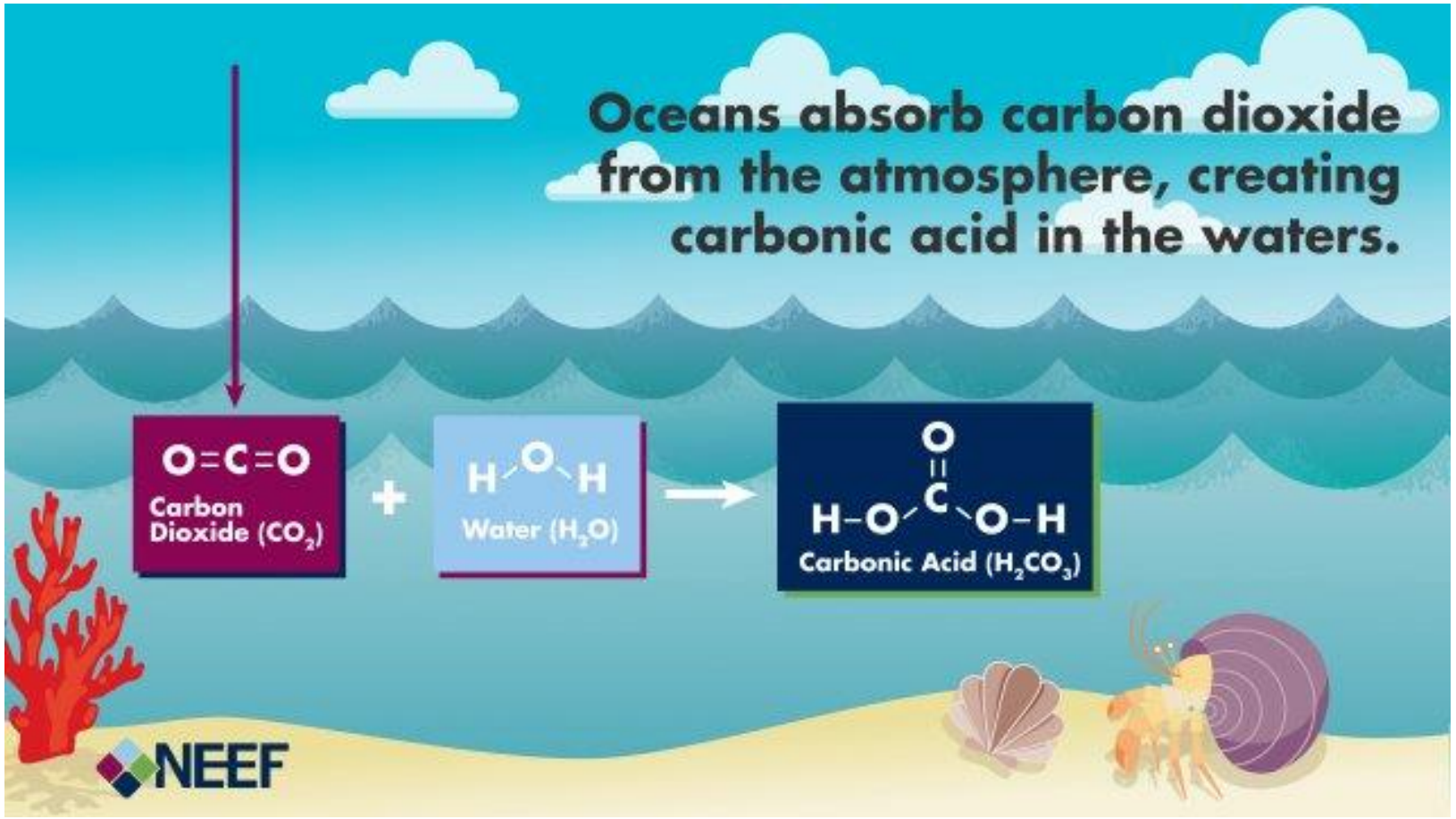
Seawater pH?

Prior to the Industrial Revolution, average ocean pH was about 8.2. Today, average ocean pH is about 8.1.

This might not seem like much of a difference, but the relationship between pH and acidity is not direct. Each decrease of one pH unit is a ten-fold increase in acidity. This means that the acidity of the ocean today, on average, is about 25% greater than it was during preindustrial times.

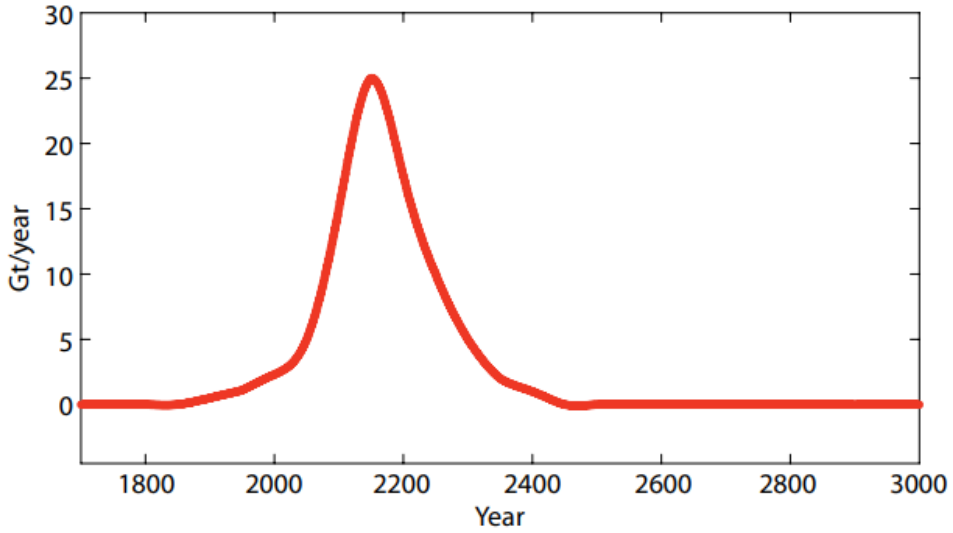
INCREASED TOXICITY OF METAL POLLUTION DUE TO OCEAN ACIDIFICATION

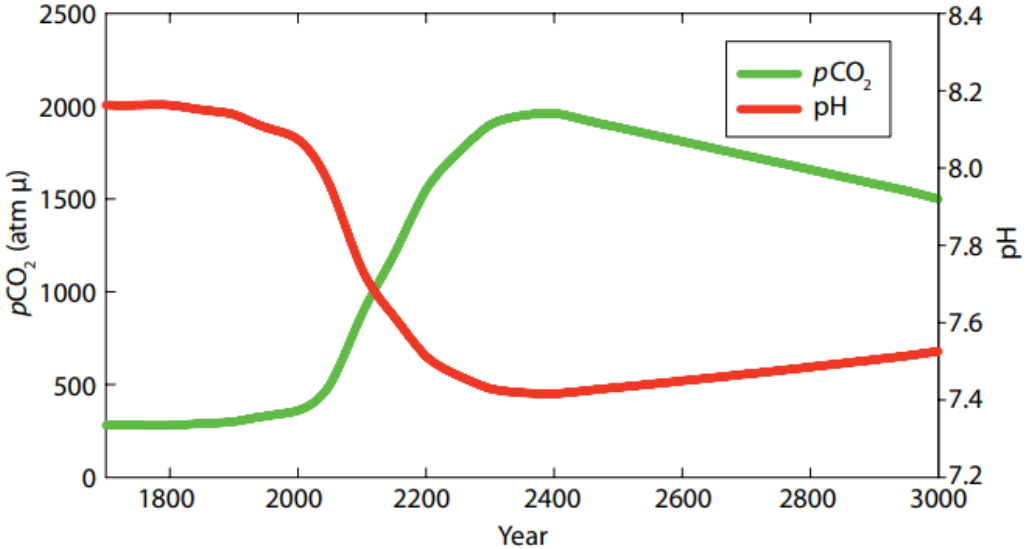
Seawater pH?



Understanding the Science of Ocean and Coastal Acidification | US EPA Credit: National Environmental Education Foundation (NEEF).

INCREASED TOXICITY OF METAL POLLUTION DUE TO OCEAN ACIDIFICATION



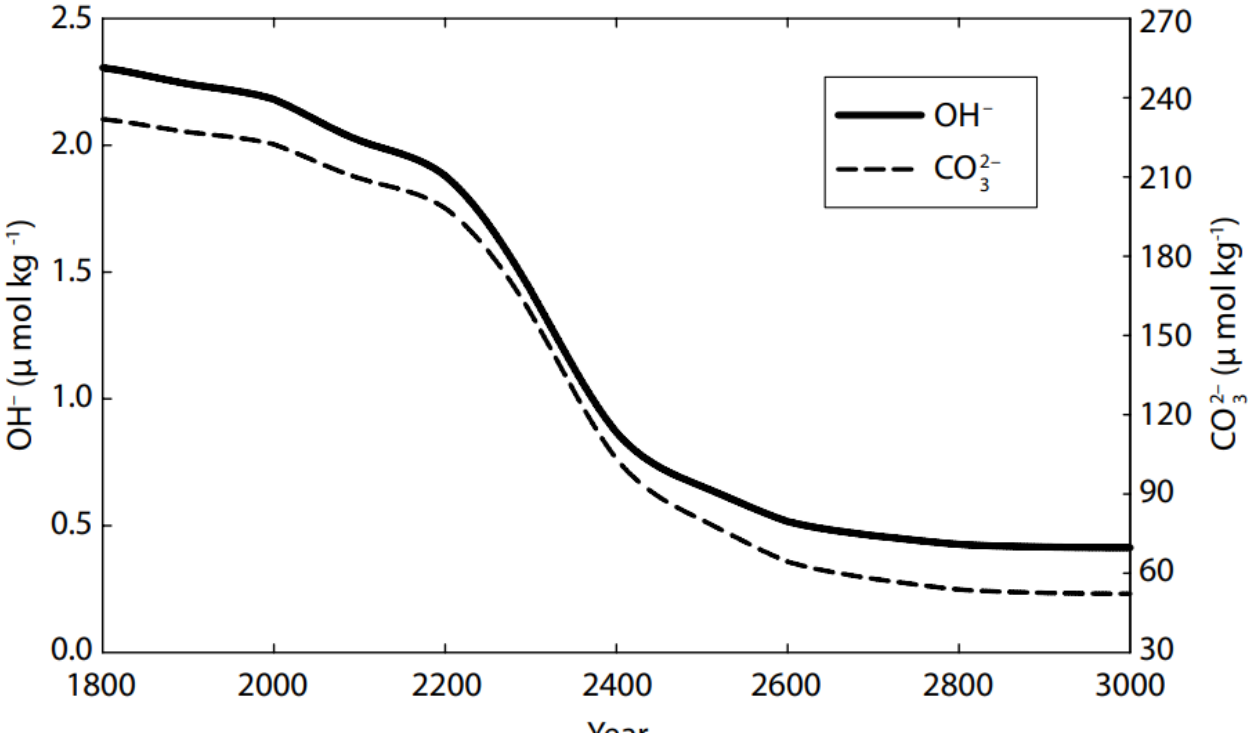


GtC yr^-1 = Gigatons of carbon (that's 10 x 10^9 tons of carbon per year) or 1,000,000,000 tonnes

pCO2 = partial pressure of carbon dioxide

The top graph shows the expected emissions of carbon in GtC yr-1. The bottom graph shows expected pCO2 in the atmosphere (green line), and the change in pH (red line) as a function of time (Caldeira and Wickett, 2003). 22-4_millero.pdf (tos.org)

INCREASED TOXICITY OF METAL POLLUTION DUE TO OCEAN ACIDIFICATION

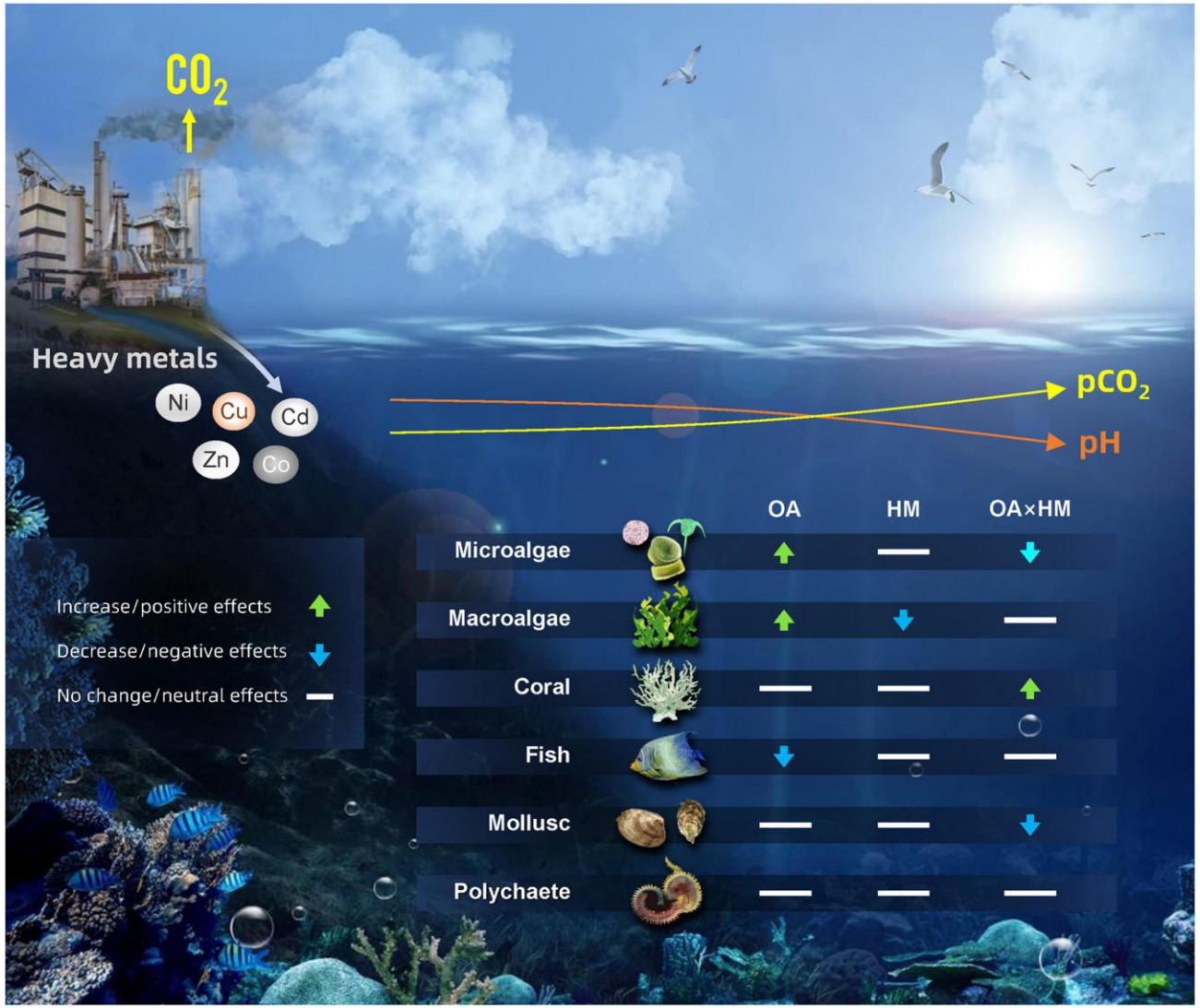


The decrease in the concentrations of OH– and CO3 2– ions in seawater due to ocean acidification (calculated using the Millero et al., 2006, carbonate constants).

OH– = Hydroxide

CO_3^{2-} = Carbonate

INCREASED TOXICITY OF METAL POLLUTION DUE TO OCEAN ACIDIFICATION

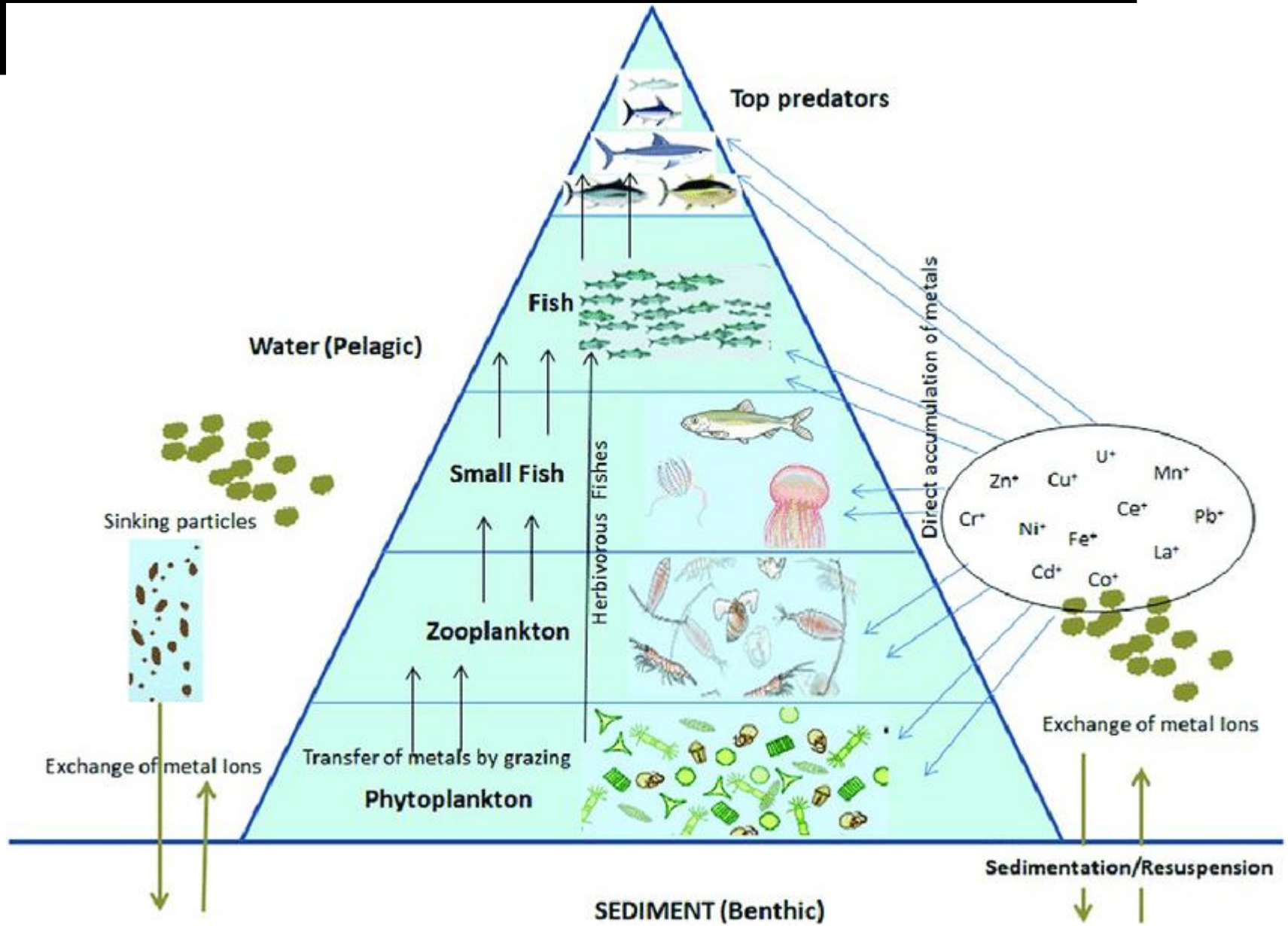


OA = Ocean Acidification

HM = Heavy Metals

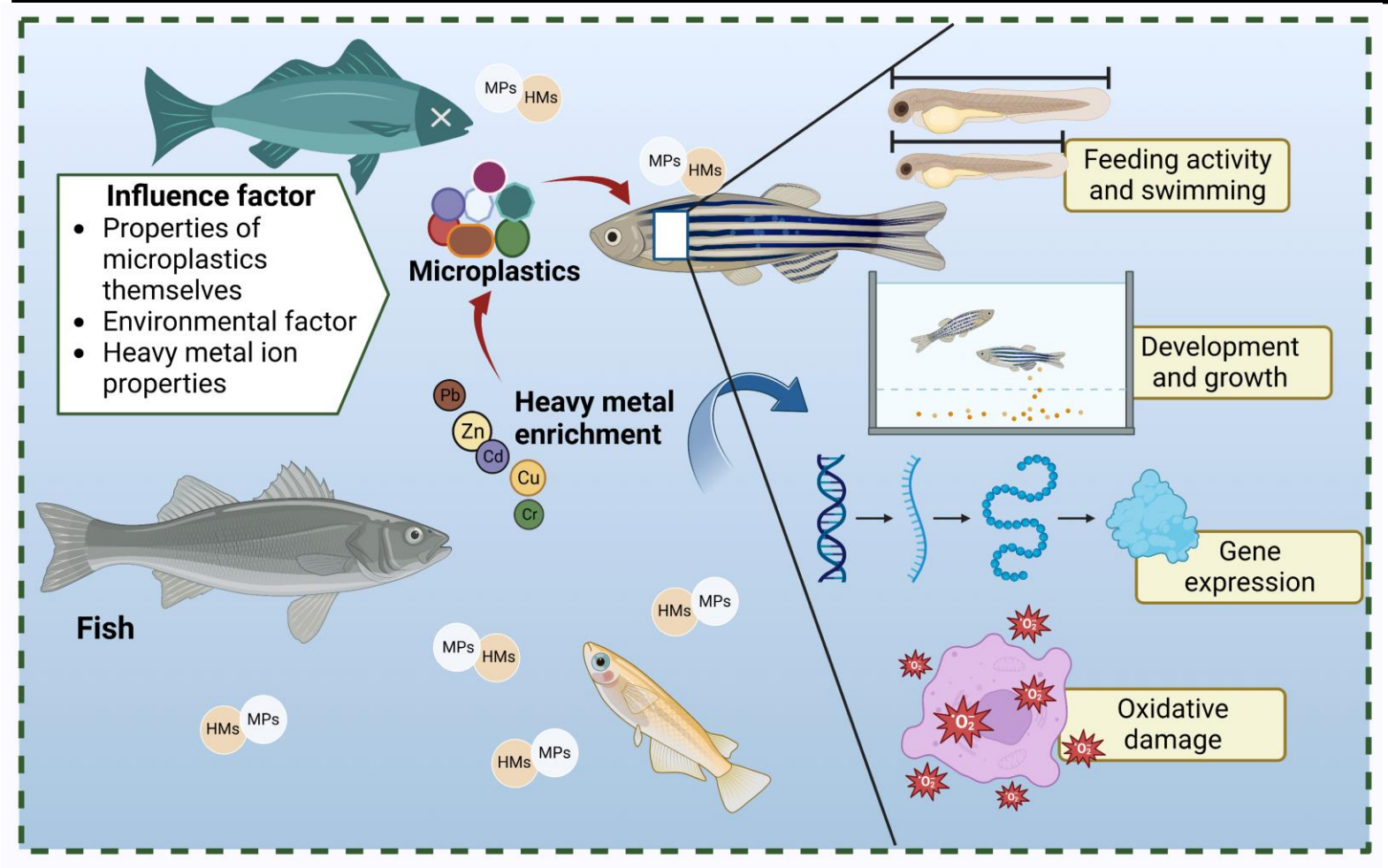
[Frontiers | The Combined Effects of Ocean Acidification and Heavy Metals on Marine Organisms: A Meta-Analysis (frontiersin.org)]

INCREASED TOXICITY OF METAL POLLUTION DUE TO OCEAN ACIDIFICATION



[Ocean acidification increases copper toxicity differentially in two key marine invertebrates with distinct acid-base responses | Scientific Reports (nature.com)]

INCREASED TOXICITY OF METAL POLLUTION DUE TO OCEAN ACIDIFICATION



Toxics | Free Full-Text | Factors Affecting the Adsorption of Heavy Metals by Microplastics and Their Toxic Effects on Fish (mdpi.com)

Assessing Ocean Acidification as a Driver for Enhanced Metals Uptake by Blue Mussels - NCCOS Coastal Science Website (noaa.gov)

Blue Mussels (*Mytilus edulis*). Credit: NOAA NMFS.

CLIMATE MIGRATION: EQUATORIAL MARINE COMMUNITIES ARE BECOMING DEPAUPERATE

Earthcommission.org

Coral reefs – under pressure

Overfishing

Connected habitat destruction

Trade

Destructive fishing

Pollution

Disease

Irresponsible tourism

Climate change

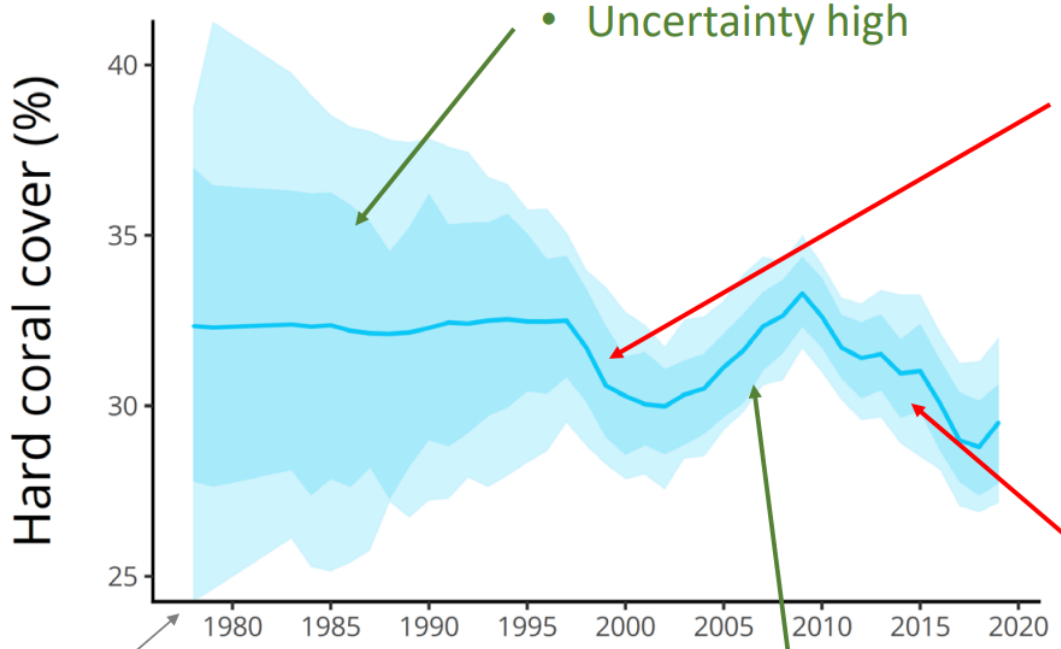
CLIMATE MIGRATION: EQUATORIAL MARINE COMMUNITIES ARE BECOMING DEPAUPERATE

Earthcommission.org

Global results

Pre-1998 - global average coral cover is high and stable

- Uncertainty high



1998 - first mass coral bleaching event

- Number of surveys increased dramatically and so did confidence in the estimate
- Killed 8% of the world's corals

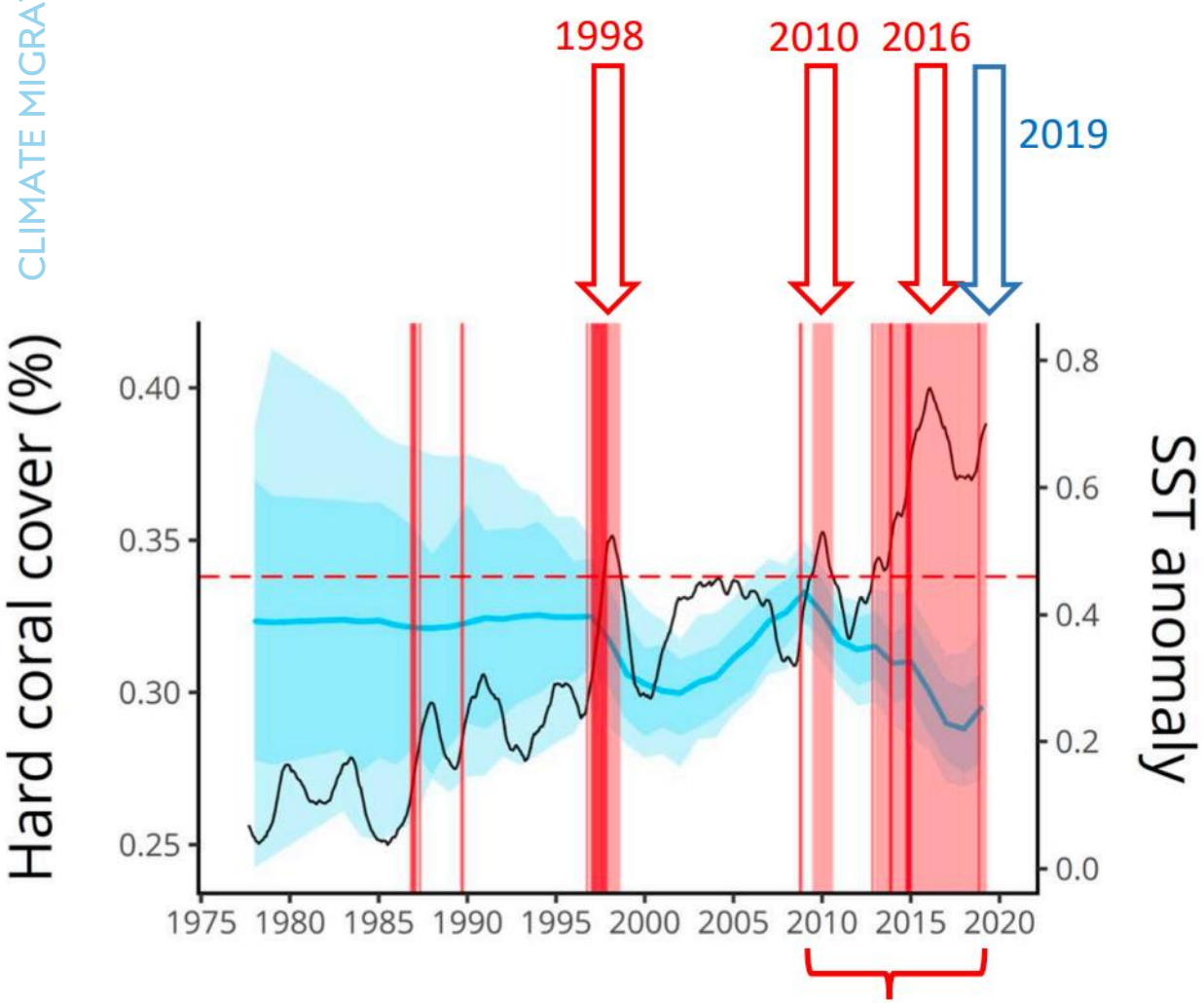
2009-2018 – 14% loss of the world's corals

Higher baseline (50-90%) from Eddy et al. 2021 was from small number of 1950-1970 studies

2002-2009 – Coral cover recovered to pre-1998 levels

CLIMATE MIGRATION: EQUATORIAL MARINE COMMUNITIES ARE BECOMING DEPAUPERATE

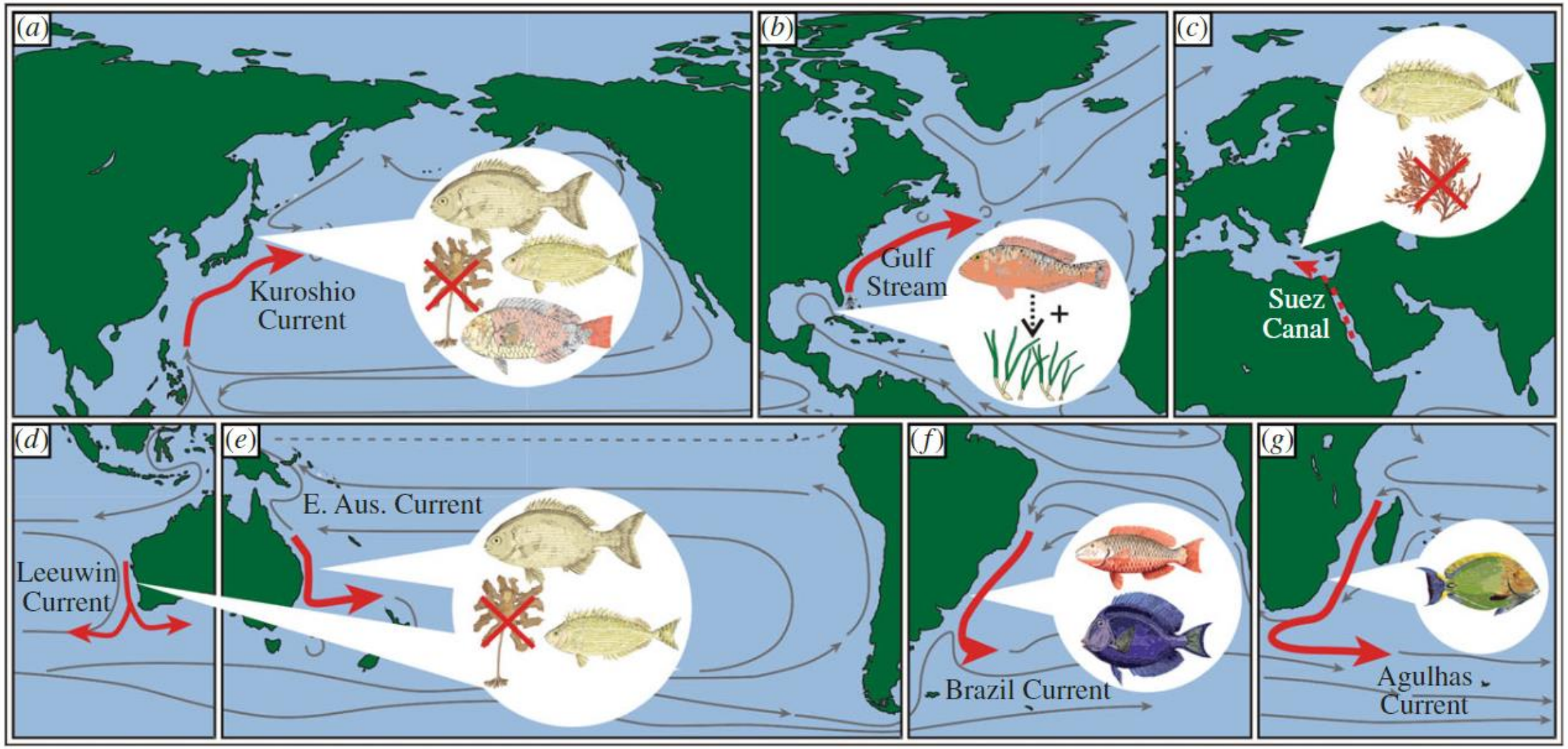
Earthcommission.org



- Very strong association between global hard coral cover and mean global SST anomaly (dark red)
- Rapid increases in the global SST anomaly (dark red)
- Periods of sustained SST anomalies (light red)
- All three global bleaching events have coincided with periods of rapid increase in SST anomaly.
- Sustained high SST anomaly during the last decade coincides with progressive decline in coral cover.
- Direct impact of climate change

PowerPoint Presentation (earthcommission.org)

CLIMATE MIGRATION: EQUATORIAL MARINE COMMUNITIES ARE BECOMING DEPAUPERATE



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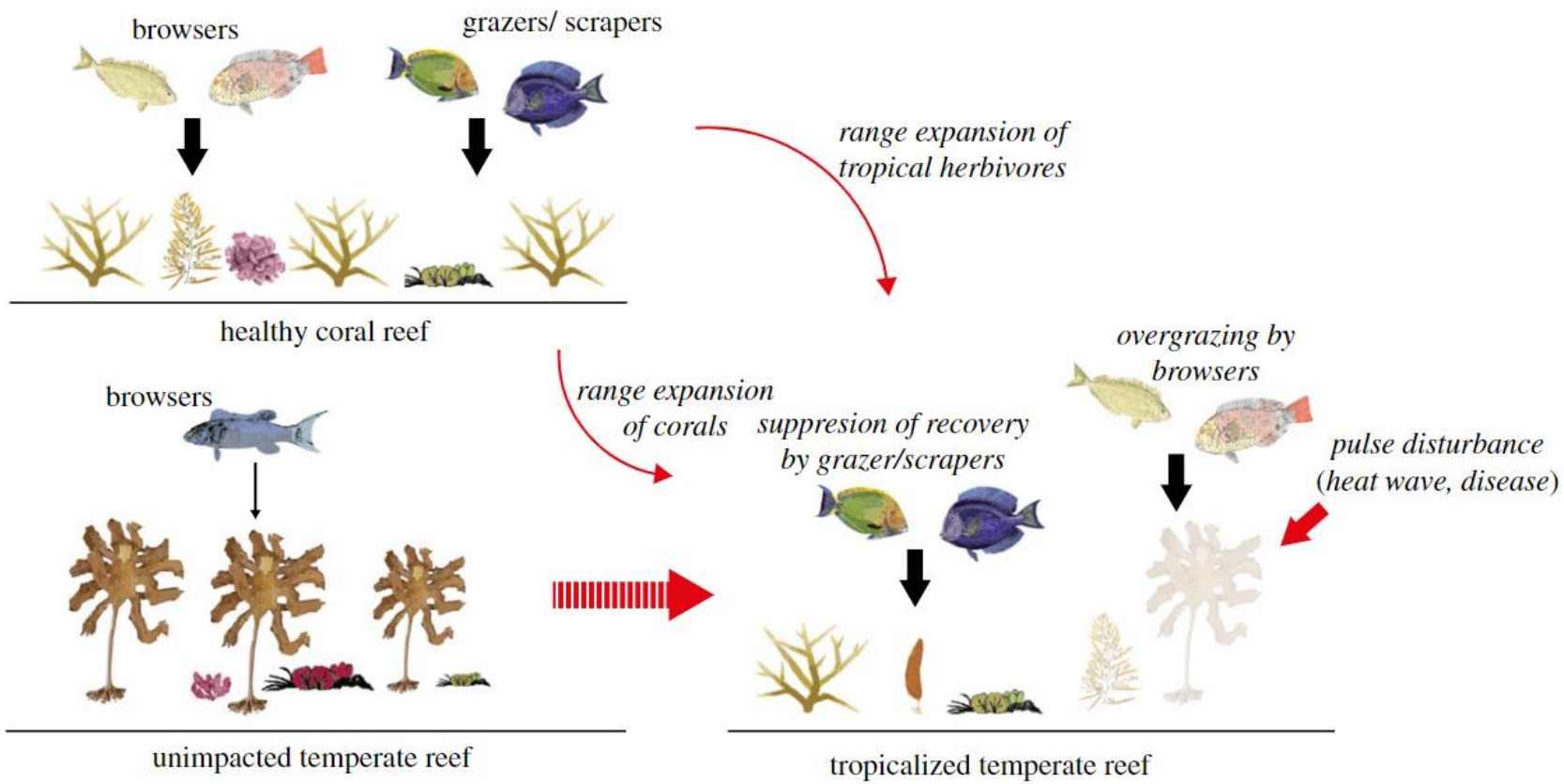
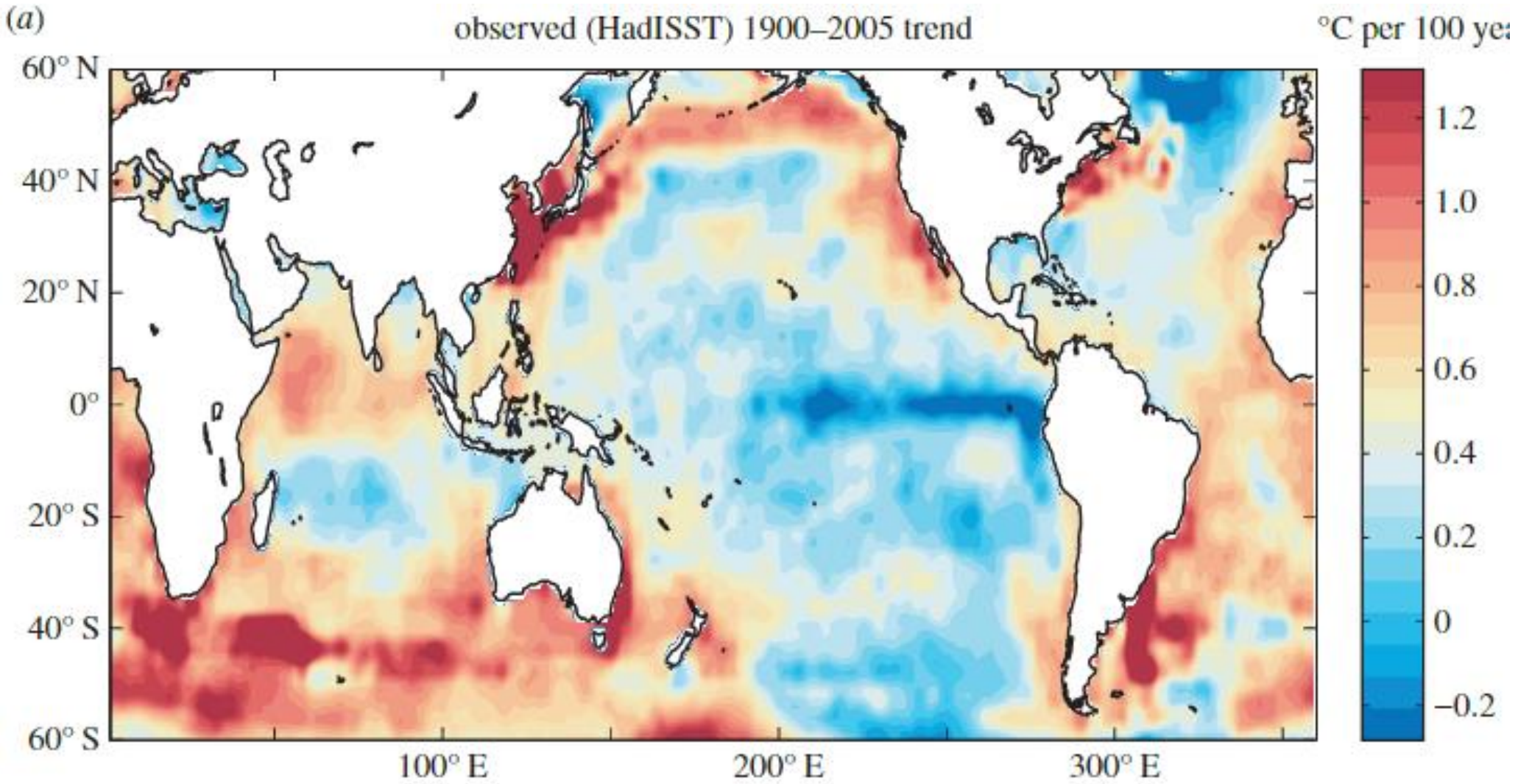


http://dx.doi.org/10.1098/rspb.2014.0846

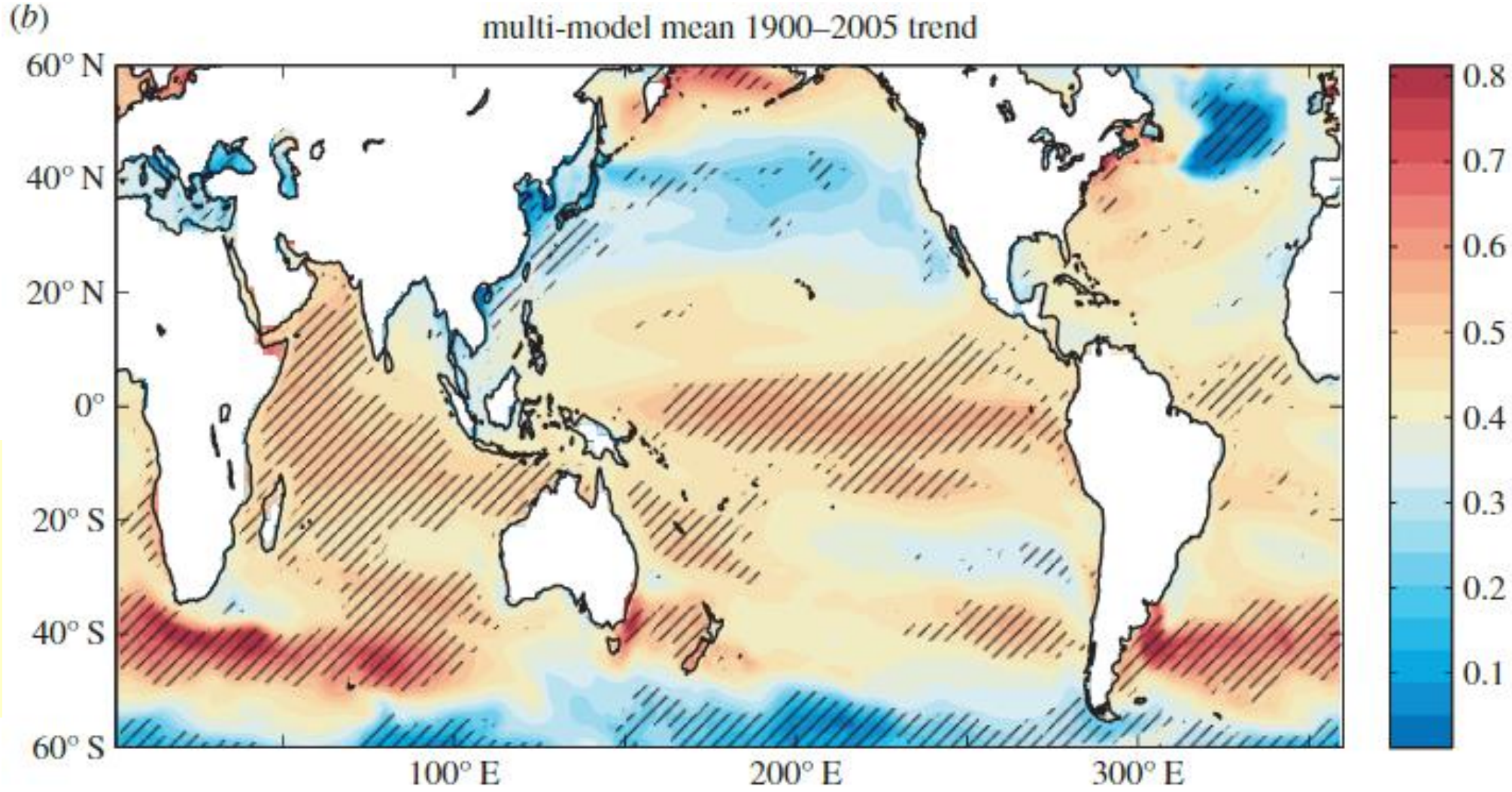
Conceptual model of fish control of macroalgal biomass on coral reefs, unimpacted and 'tropicalized' temperate reefs. Black arrows of different widths symbolize dissimilar levels of herbivory. Faded macro-algae represent their decline in tropicalized systems owing to: (i) direct overgrazing by browsers, or (ii) prevention of recovery by grazers and scrapers when other sources of stress first initiate macroalgal decline.

CLIMATE MIGRATION: EQUATORIAL MARINE COMMUNITIES ARE BECOMING DEPAUPERATE



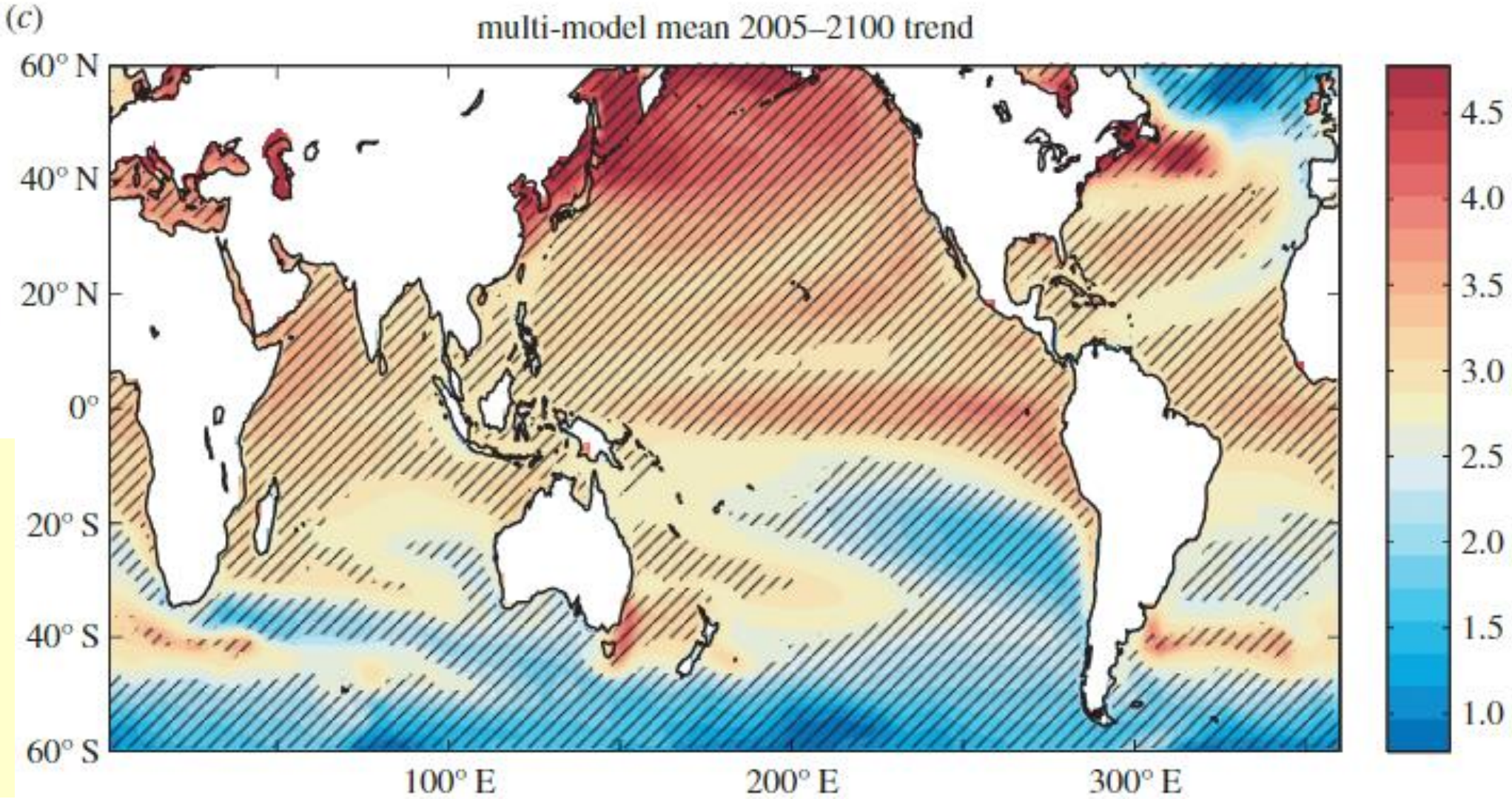
Trends in global sea surface temperatures (SST). (a) 1900–2005 trend in observed (HadISST) SST

CLIMATE MIGRATION: EQUATORIAL MARINE COMMUNITIES ARE BECOMING DEPAUPERATE



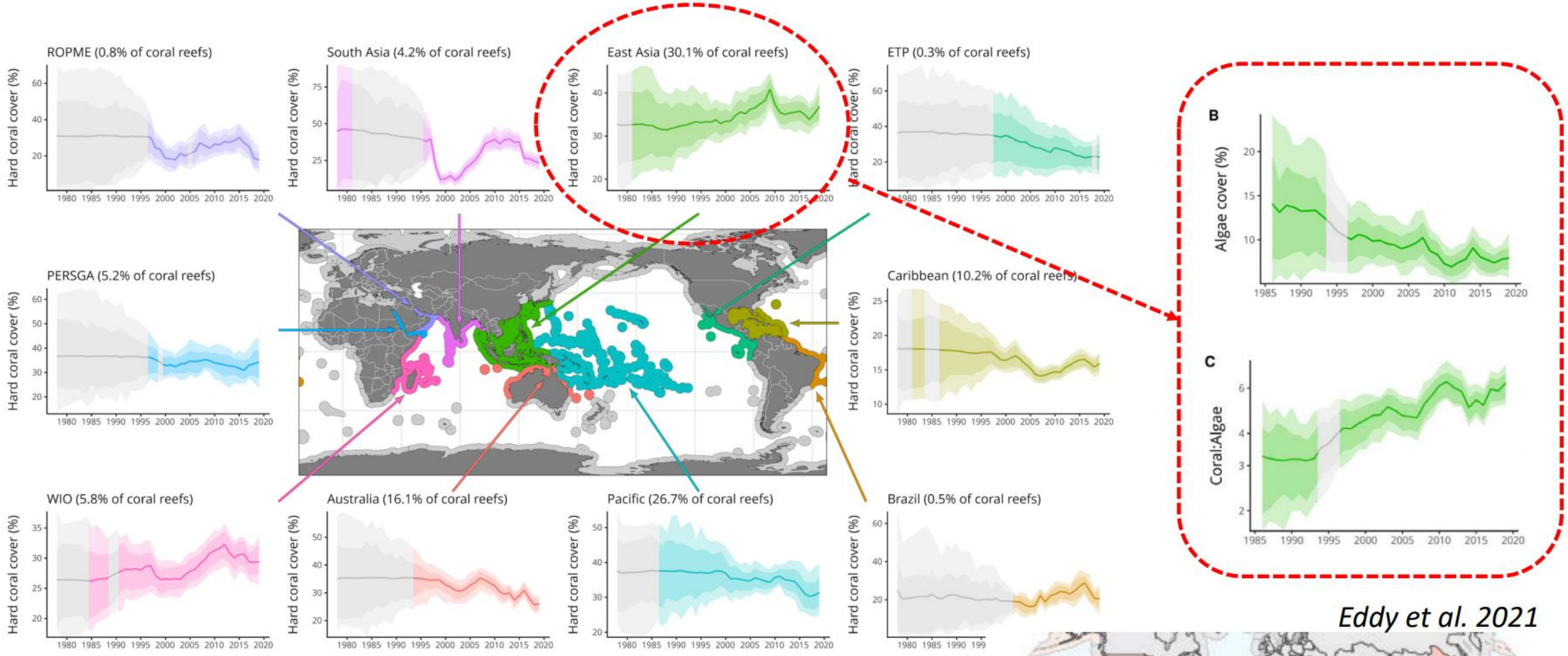
Trends in global sea surface temperatures (SST). (b) multi-model mean SST trend for the same period based on 34 CMIP5 models

CLIMATE MIGRATION: EQUATORIAL MARINE COMMUNITIES ARE BECOMING DEPAUPERATE

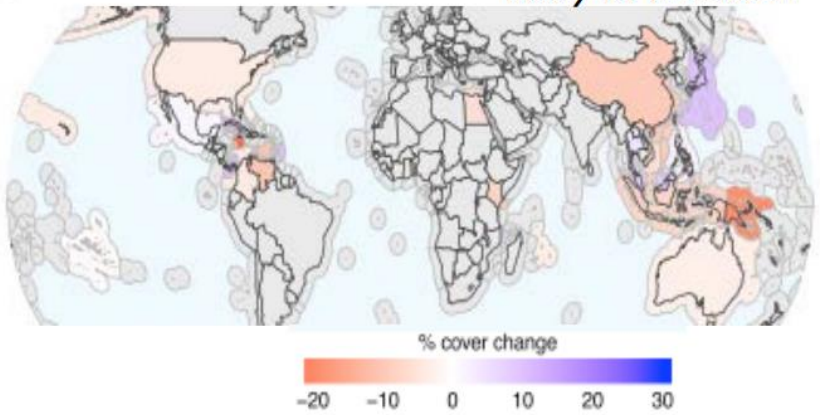


Trends in global sea surface temperatures (SST). (c) multi-model mean SST trend for 2005–2100 based on 28 CMIP5 models under the 'business as usual' RCP8.5 scenario

CLIMATE MIGRATION



Eddy et al. 2021



- Variation among regions
- Most followed similar trends: East Asian seas show greatest resilience
- Some degree of recovery capacity is shown, but hard to see with sampling.

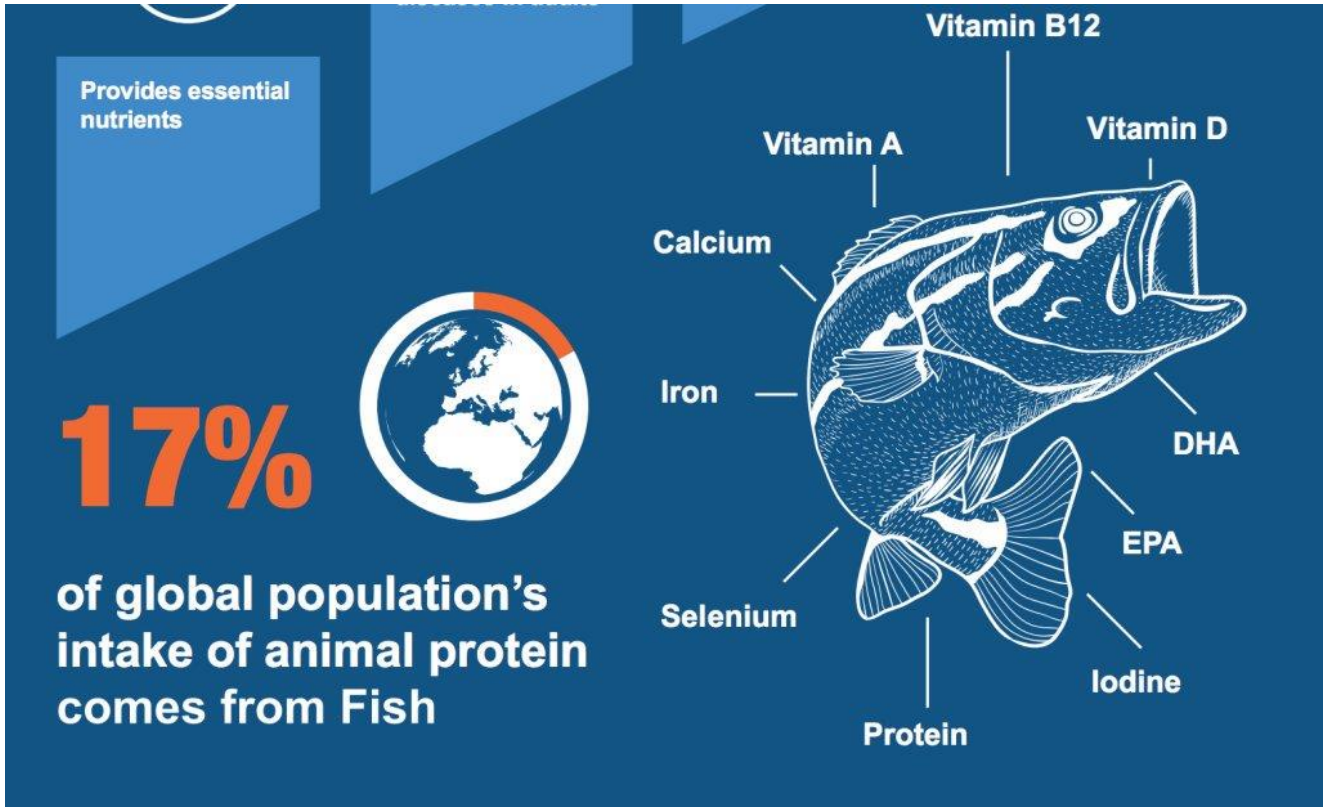
PowerPoint Presentation (earthcommission.org)

ALTERED NUTRITIONAL CONTENT OF FISH DUE TO CLIMATE CHANGE

Scientists are predicting more than 10 percent of the world's population, a whopping 845 million people, will experience deficiencies in critically important micronutrients including zinc, iron, vitamin A, vitamin B12, and fatty-acids in the coming decades if global fish catches continue to decline.

1 In 10 People May Face Malnutrition As Fish Catches Decline : The Salt : NPR

ALTERED NUTRITIONAL CONTENT OF FISH DUE TO CLIMATE CHANGE

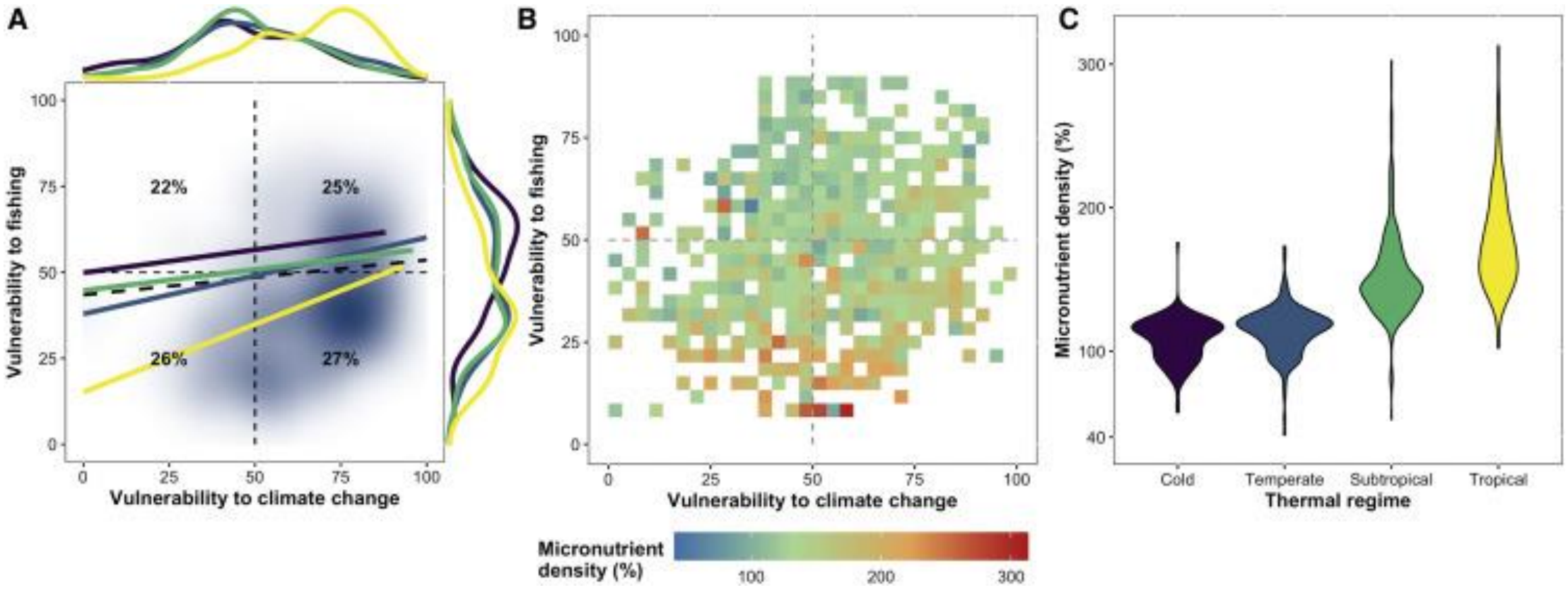


https://x.com/FAOKnowledge/status/886027713265508352?s=20

A study, published in Current Biology, looked at five key micronutrients: calcium, iron, zinc, selenium and vitamin A.

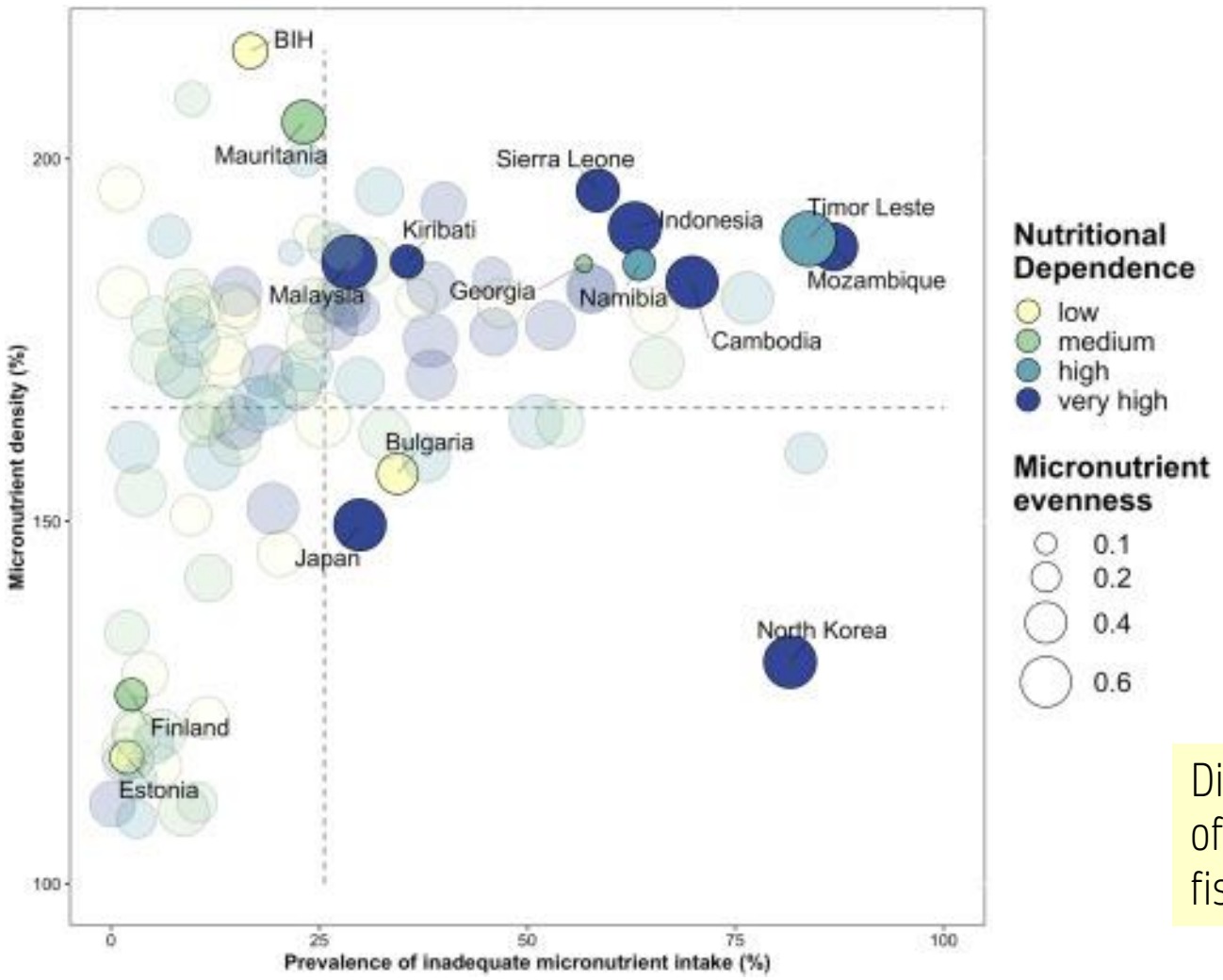
Micronutrient supply from global marine fisheries under climate change and overfishing: Current Biology (cell.com)

ALTERED NUTRITIONAL CONTENT OF FISH DUE TO CLIMATE CHANGE



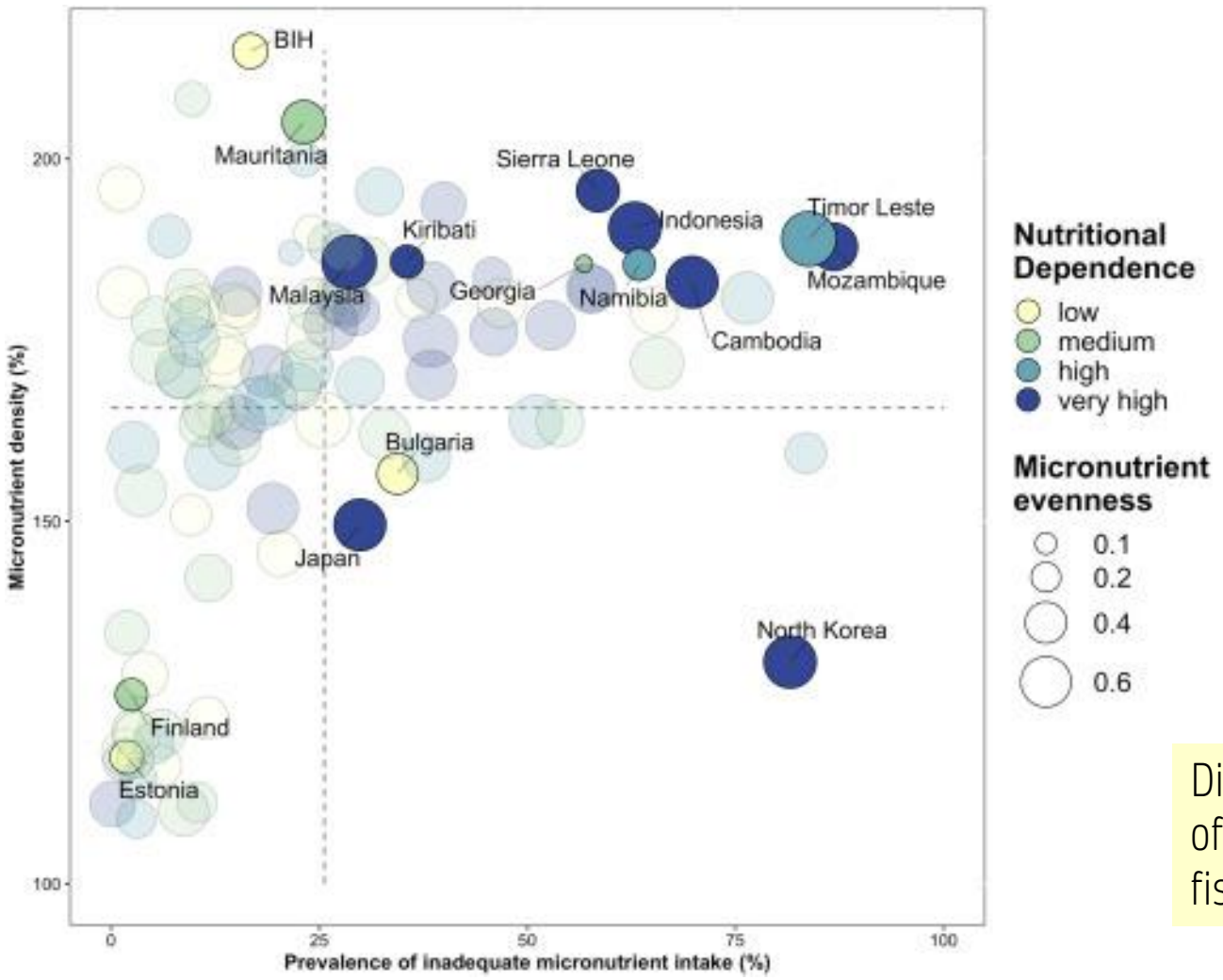
Relationships among global marine fish species' vulnerability to fishing, climate change, and micronutrient density

ALTERED NUTRITIONAL CONTENT OF FISH DUE TO CLIMATE CHANGE



Dietary micronutrient dependence on fish, prevalence of inadequate intake, and micronutrient density in fishery-dependent countries

ALTERED NUTRITIONAL CONTENT OF FISH DUE TO CLIMATE CHANGE

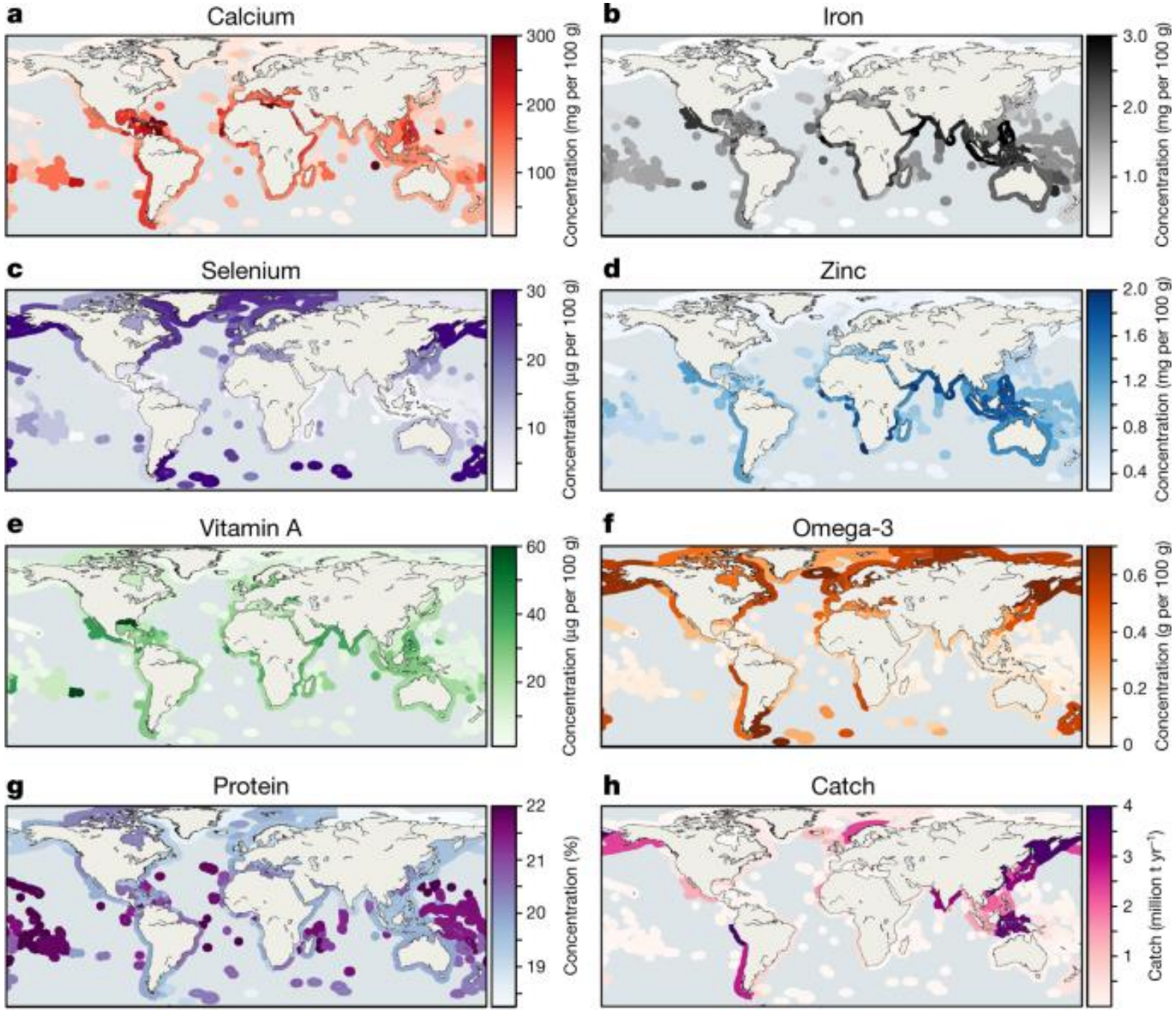


- Micronutrient-dense catches are more vulnerable to climate change than fishing
- Climate change threatens micronutrient fisheries yields in 40% of countries
- Catches are nutrient dense but vulnerable where dietary intakes are most inadequate
- Fisheries management can be optimized toward resilient and nutrient-dense species

Dietary micronutrient dependence on fish, prevalence of inadequate intake, and micronutrient density in fishery-dependent countries

ALTERED NUTRITIONAL CONTENT OF FISH DUE TO CLIMATE CHANGE

Data are based on annual catch composition between 2010 and 2014. Data are plotted at the scale of EEZ areas.



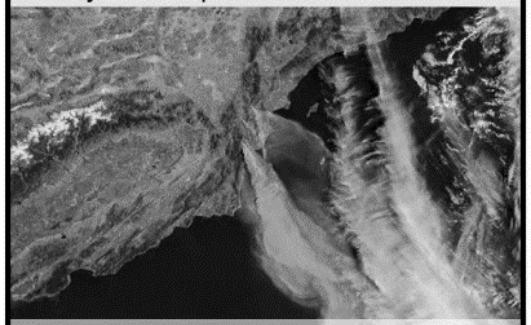
[Harnessing global fisheries to tackle micronutrient deficiencies | Nature]

TIME FOR A BREAK – 5 MINS

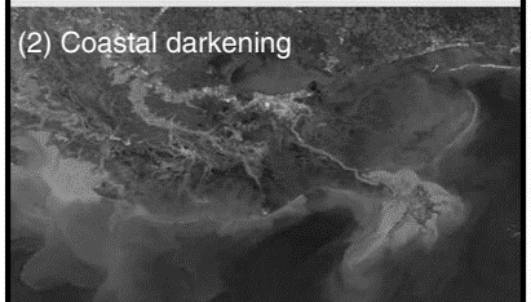
RESOURCE EXPLOITATION

RESOURCE EXPLOITATION

Ecosystem impacts



(1) Wildfire impacts on coastal and marine ecosystems



(2) Coastal darkening

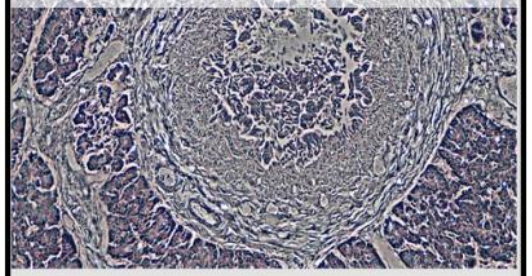
(3) Increased toxicity of metal pollution due to ocean acidification

(4) Equatorial marine communities are becoming depauperate due to climate migration

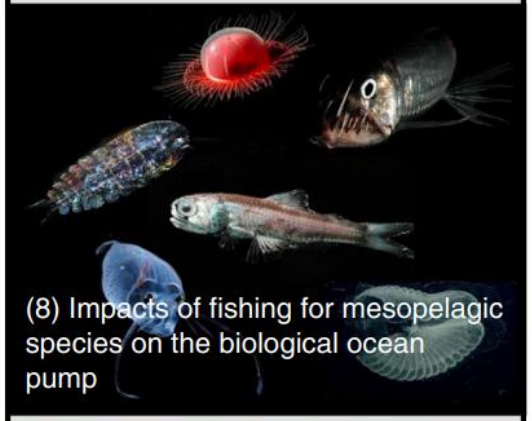
(5) Effects of altered nutritional content of fish due to climate change

Resource exploitation

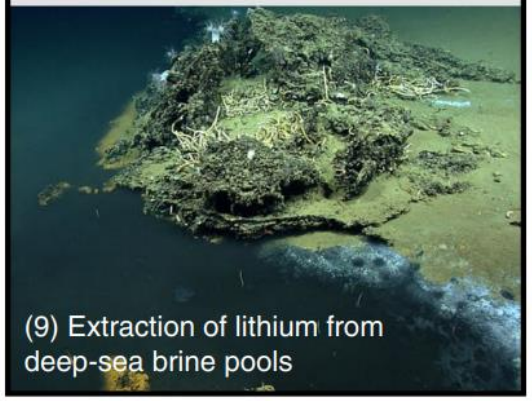
(6) The untapped potential of marine collagens and their impacts on marine ecosystems



(7) Impacts of expanding trade for fish swim bladders on target and non-target species



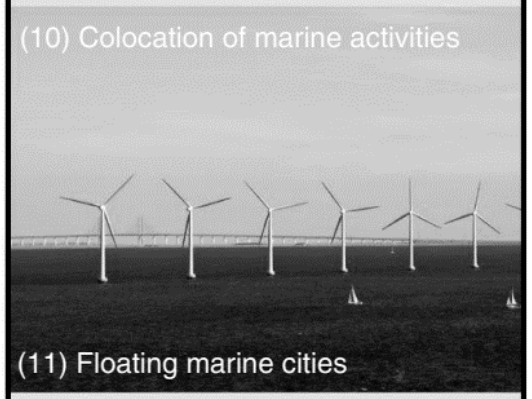
(8) Impacts of fishing for mesopelagic species on the biological ocean pump



(9) Extraction of lithium from deep-sea brine pools

New technologies

(10) Colocation of marine activities



(11) Floating marine cities

(12) Trace-element contamination compounded by the global transition to green technologies

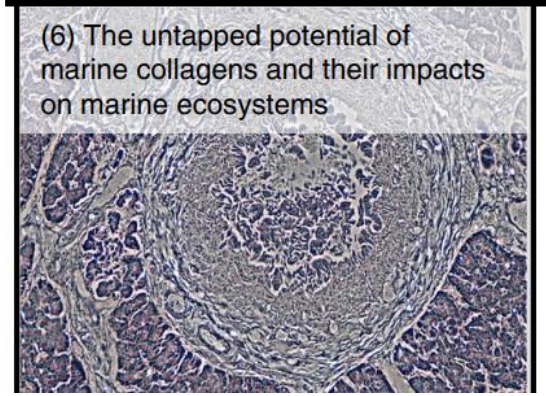
(13) New underwater tracking systems to study non-surfacing marine animals

(14) Soft robotics for marine research

(15) The effects of new biodegradable materials in the marine environment

[A global horizon scan of issues impacting marine and coastal biodiversity conservation | Nature Ecology & Evolution]

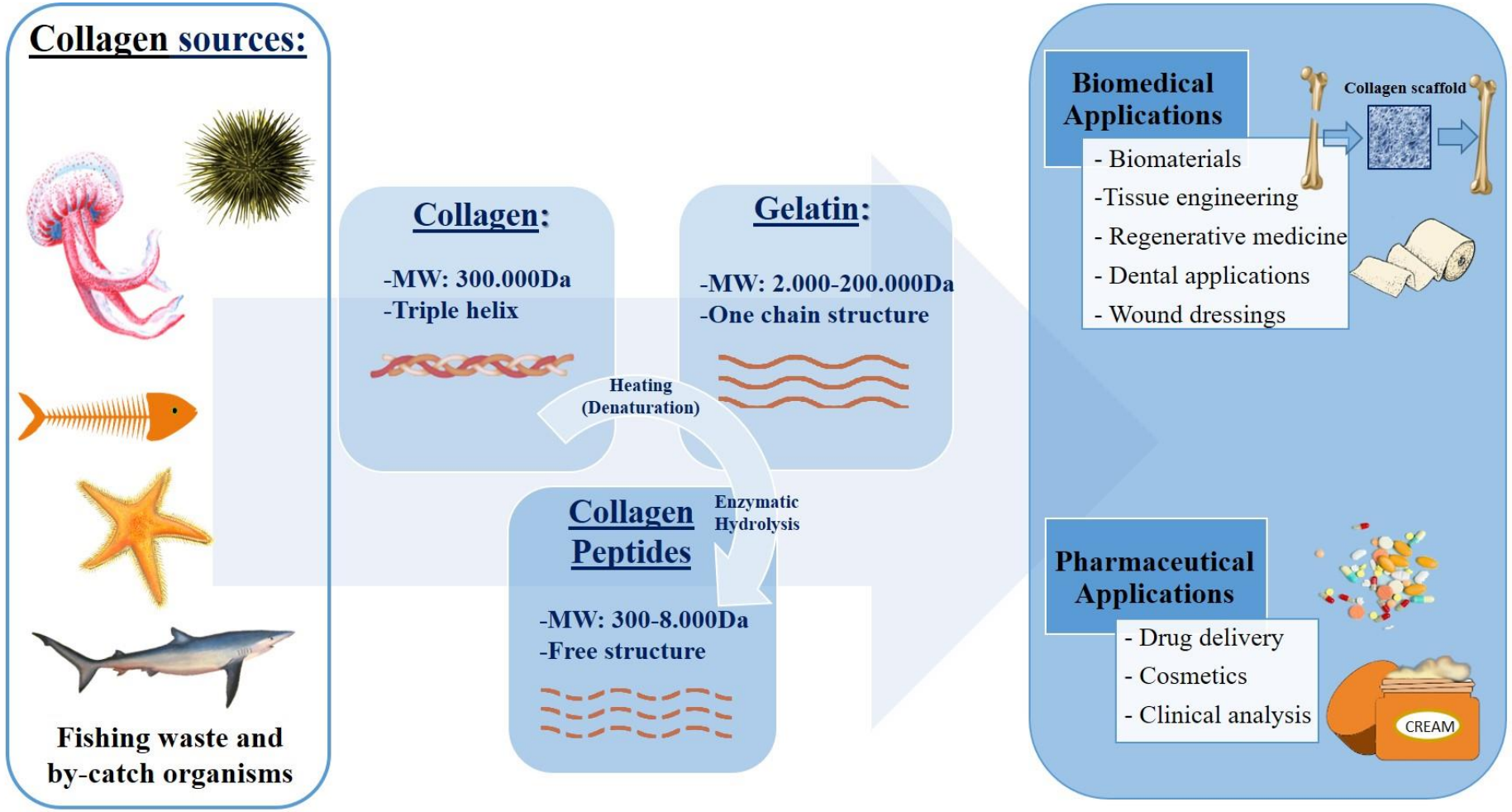
UNTAPPED POTENTIAL OF MARINE COLLAGENS AND THEIR IMPACT ON MARINE ECOSYSTEMS



Collagen is a general term to define a group of structural proteins of the extracellular matrix, organized in a fibrillar arrangement. Collagens display a palette of unique and numerous features, largely and advantageously exploited in the food, medical devices and pharma industries.

[Marine Origin Collagens and Its Potential Applications - PMC (nih.gov)]

UNTAPPED POTENTIAL OF MARINE COLLAGENS AND THEIR IMPACT ON MARINE ECOSYSTEMS



Marine Drugs | Free Full-Text | Marine Collagen from Alternative and Sustainable Sources: Extraction, Processing and Applications (mdpi.com)

IMPACTS OF EXPANDING TRADE FOR FISH SWIM BLADDERS ON TARGET AND NON-TARGET SPECIES

Fish swim bladders (or Fish Maw once processed), are among the most popular seafood delicacies in East Asian markets and are a valuable import commodity in Hong Kong and China (Wen et al., 2015).

Used in Chinese cuisine and traditional medicine for immune boosting and as a recovery tonic (Jing Wen et al., 2015).

fish-maw-trade-web.pdf (traffic.org)

IMPACTS OF EXPANDING TRADE FOR FISH SWIM BLADDERS ON TARGET AND NON-TARGET SPECIES

‘Gold in the sea’: Brazil’s booming fish bladder trade

Amazon fishers are cashing in on a booming maw industry fuelled by Chinese demand, but the threat of overfishing looms.

Fishers unload yellow croaker in the fishing town of Vigia in the northeast of Para state, Brazil [Sarita Reed]

‘Gold in the sea’: Brazil’s booming fish bladder trade | Food | Al Jazeera

IMPACTS OF EXPANDING TRADE FOR FISH SWIM BLADDERS ON TARGET AND NON-TARGET SPECIES

They are considered one of the big four traditional delicacies in market destinations along with sea cucumber, shark fin and abalone (Jing Wen et al., 2015), all of whose wild source populations have suffered declines due to unsustainable levels of harvestin.

Fish maw is increasingly used as a substitute for shark fins as the shark fin trade declines (WWF, 2018; Shea and Ho, 2014; Sadovy de Mitcheson et al., 2018). High demand and high value of the product may lead to unsustainable harvesting in source countries.

EIA_report_0208.qxd (eia-international.org)

Marine 'gold rush': demand for shark fin soup drives decimation of fish

Finning is still rampant in many countries due to diners' appetite for the delicacy, despite attempts to shut down the trade

IMPACTS OF EXPANDING TRADE FOR FISH SWIM BLADDERS ON TARGET AND NON-TARGET SPECIES

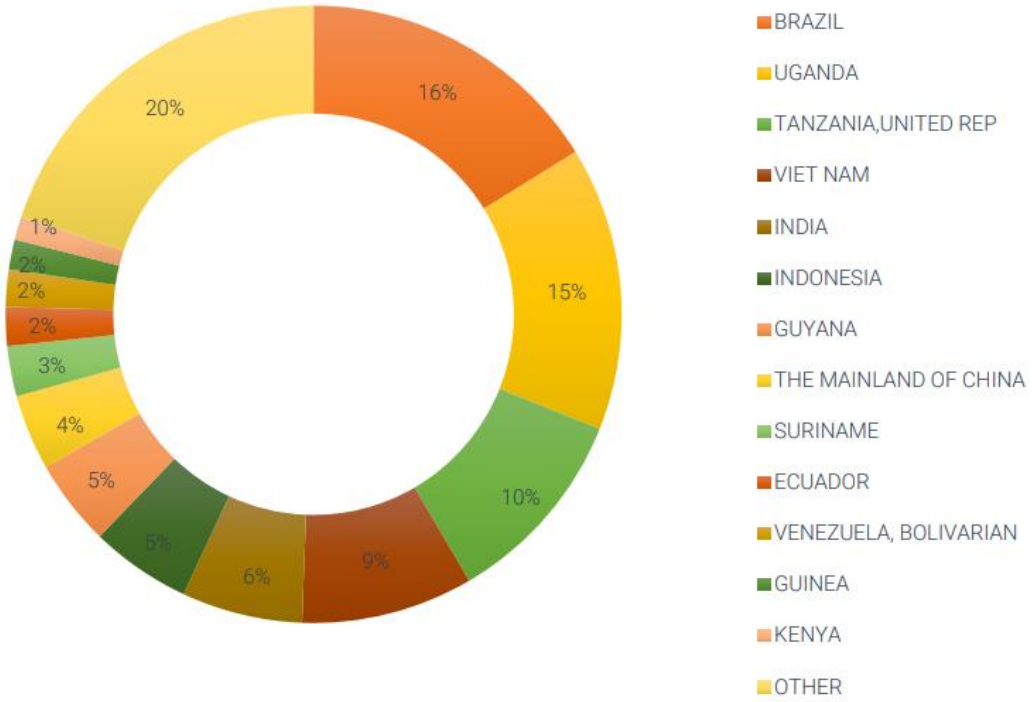


FIGURE 4

The countries of origin accounting for 80% of Hong Kong imports of dried fish maw (HS code 03057210) over the 2015–2019 period combined.
Source: Hong Kong Census and Statistics Department

[China's fish maw demand and its implications for fisheries in source countries - ScienceDirect]

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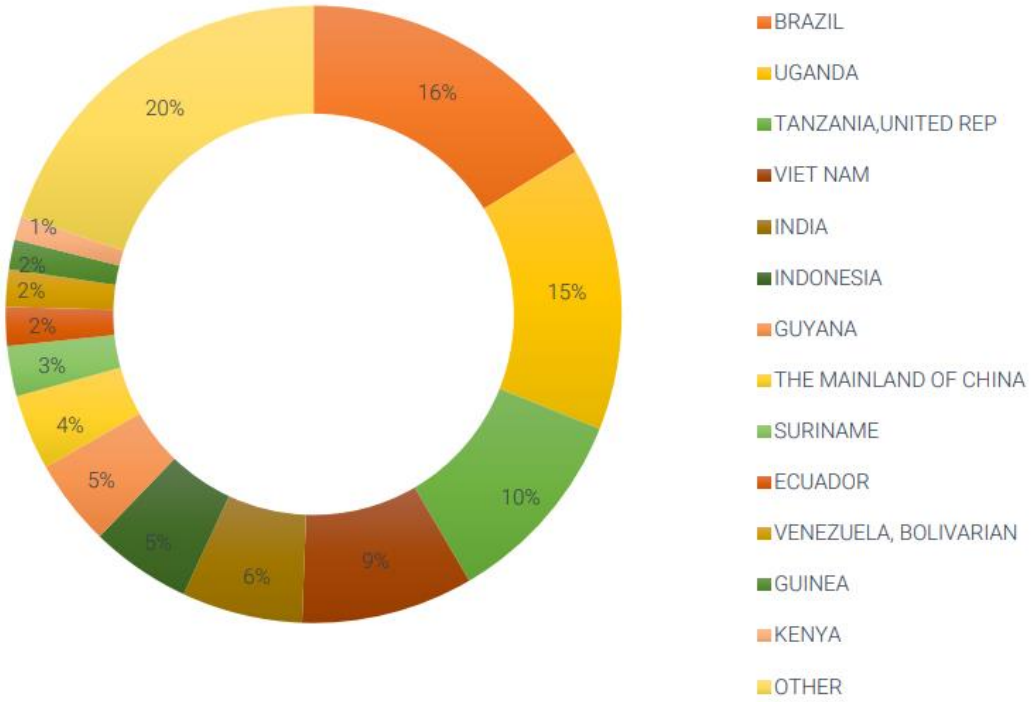

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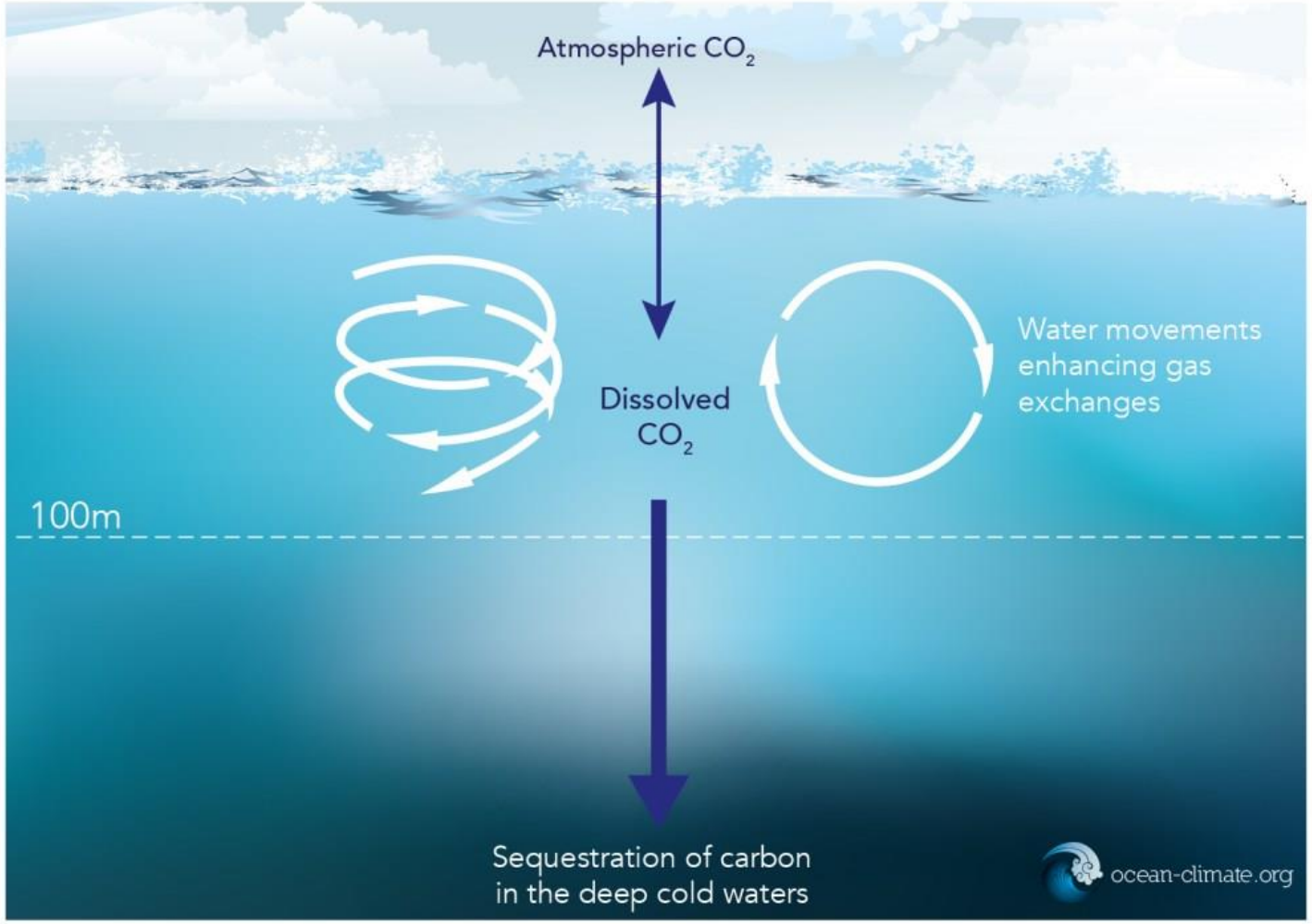
https://time.com/6097312/lab-grown-fish-maw-avant-meats/

[China's fish maw demand and its implications for fisheries in source countries - ScienceDirect]

[How Lab-Grown Fish Maw Could Help Save Our Oceans | Time]

IMPACTS OF FISHING FOR MESOPELAGIC SPECIES ON THE BIOLOGICAL OCEAN PUMP

Recap: The physical carbon pump and the biological carbon pump



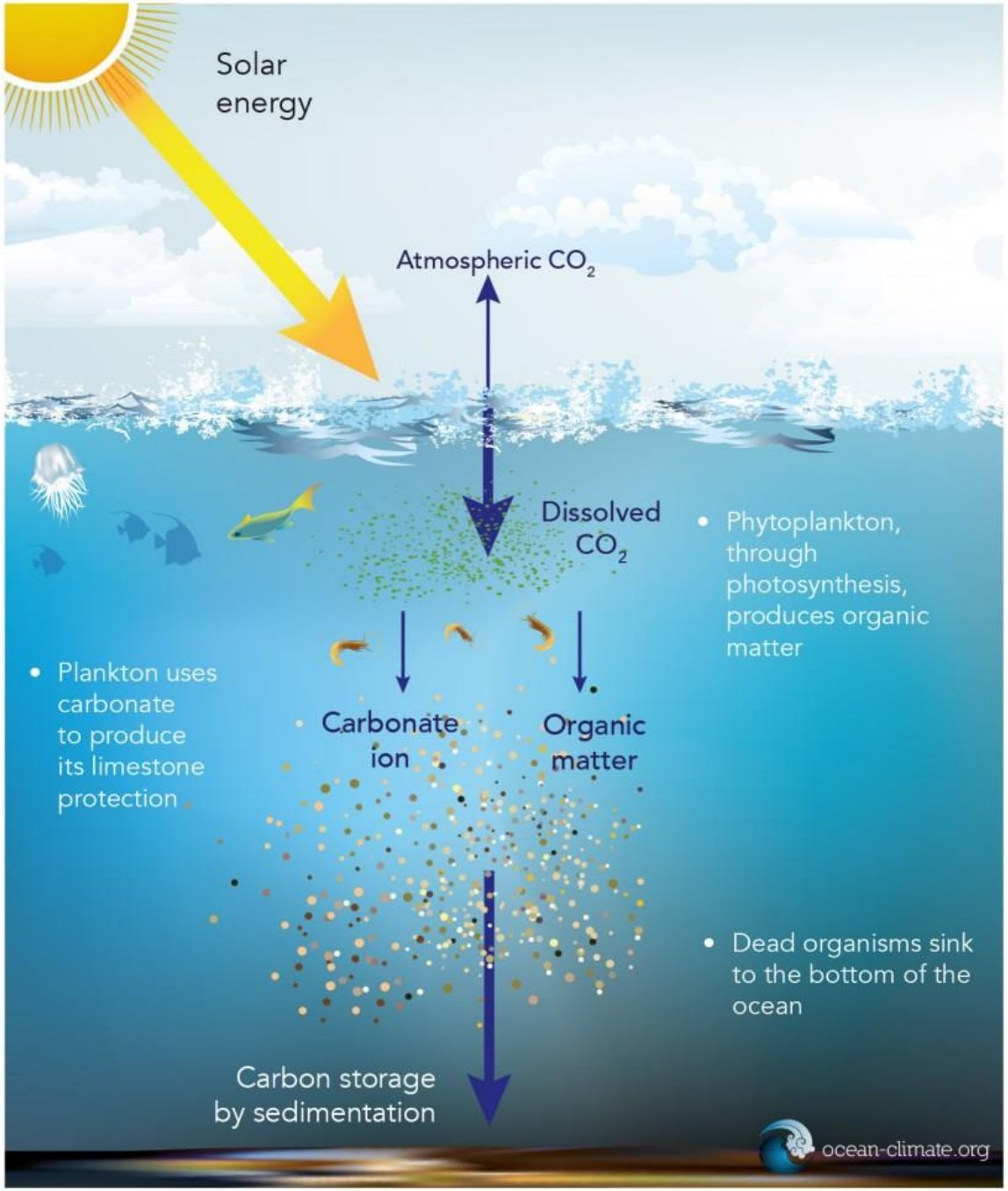
Physical carbon pump

[The Ocean, a carbon sink - Ocean & Climate Platform (ocean-climate.org)]

IMPACTS OF FISHING FOR MESOPELAGIC SPECIES ON THE BIOLOGICAL OCEAN PUMP

The ocean biological carbon sink, hereafter **'carbon sink',** is predominantly driven by phyto- and zooplankton at the base of ocean food webs (Turner, 2015).

The faecal pellets and carcasses of current and potential fishery species, including anchovy, krill and mesopelagic fish are also important in sinking carbon and fish are responsible for up to 16% of organic carbon export (Saba et al., 2021).

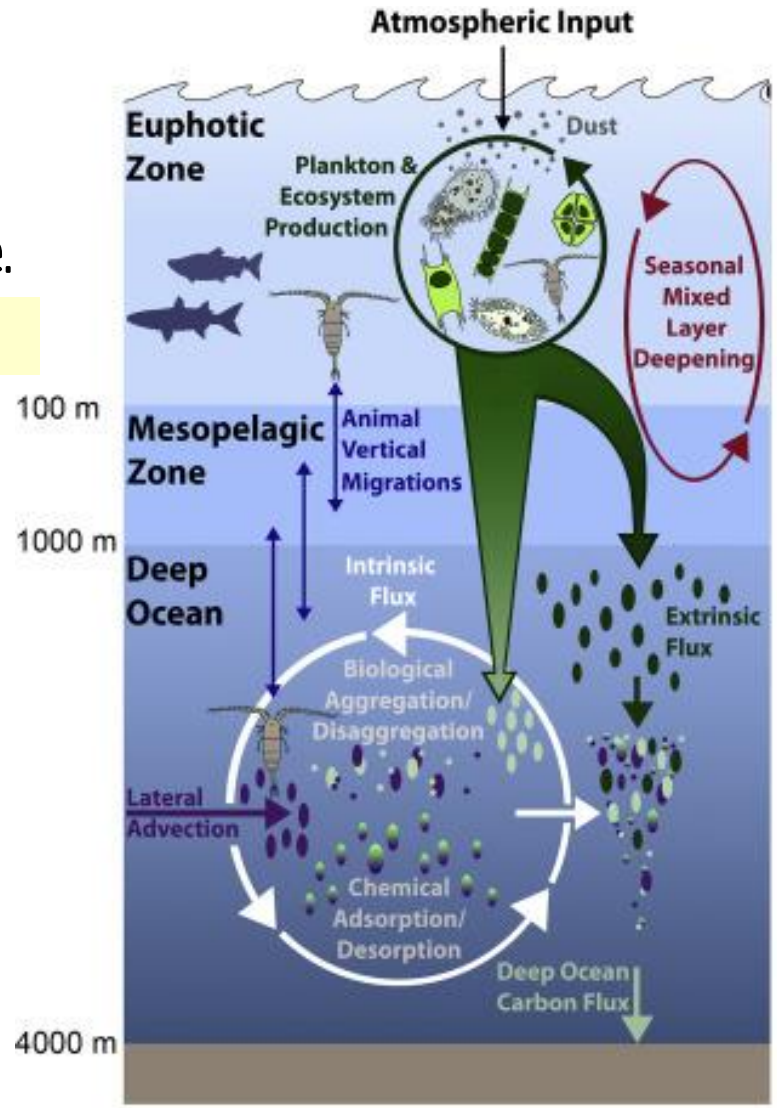


Biological carbon pump

IMPACTS OF FISHING FOR MESOPELAGIC SPECIES ON THE BIOLOGICAL OCEAN PUMP

The mesopelagic zone is the realm of the diurnally (daily) migrating organisms and extends from 200 to 2000m depth. Large gaps in **knowledge on mesopelagic ecological processes affecting carbon cycle.**

Biological ocean pump(!)



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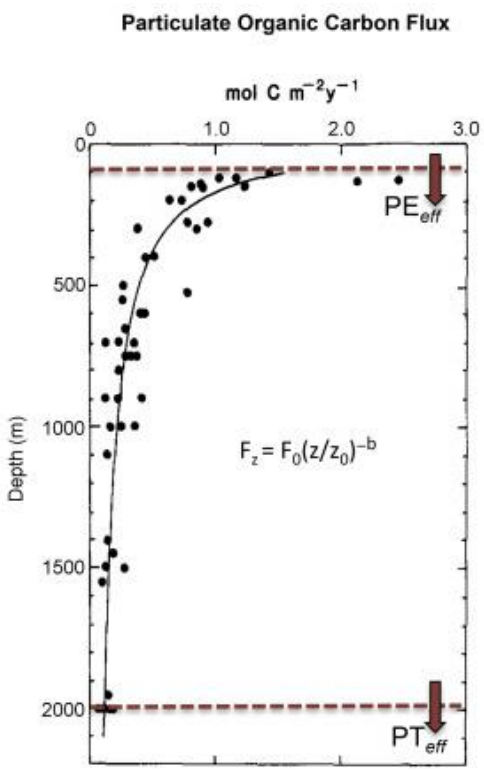
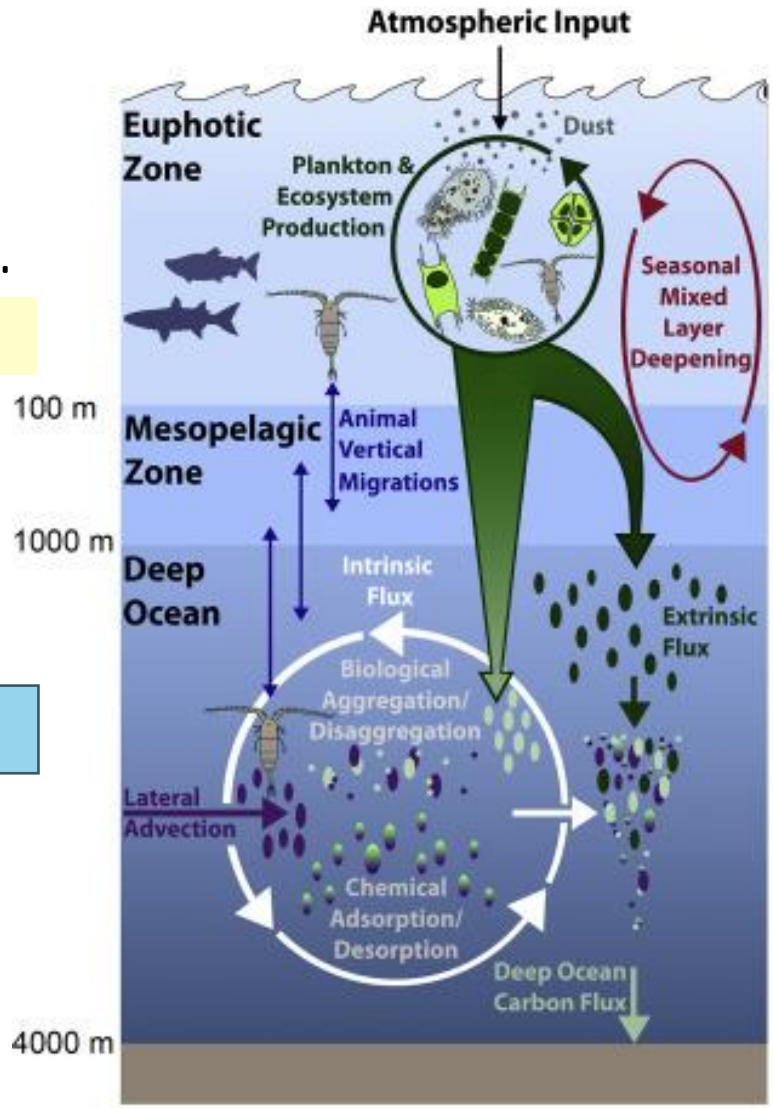


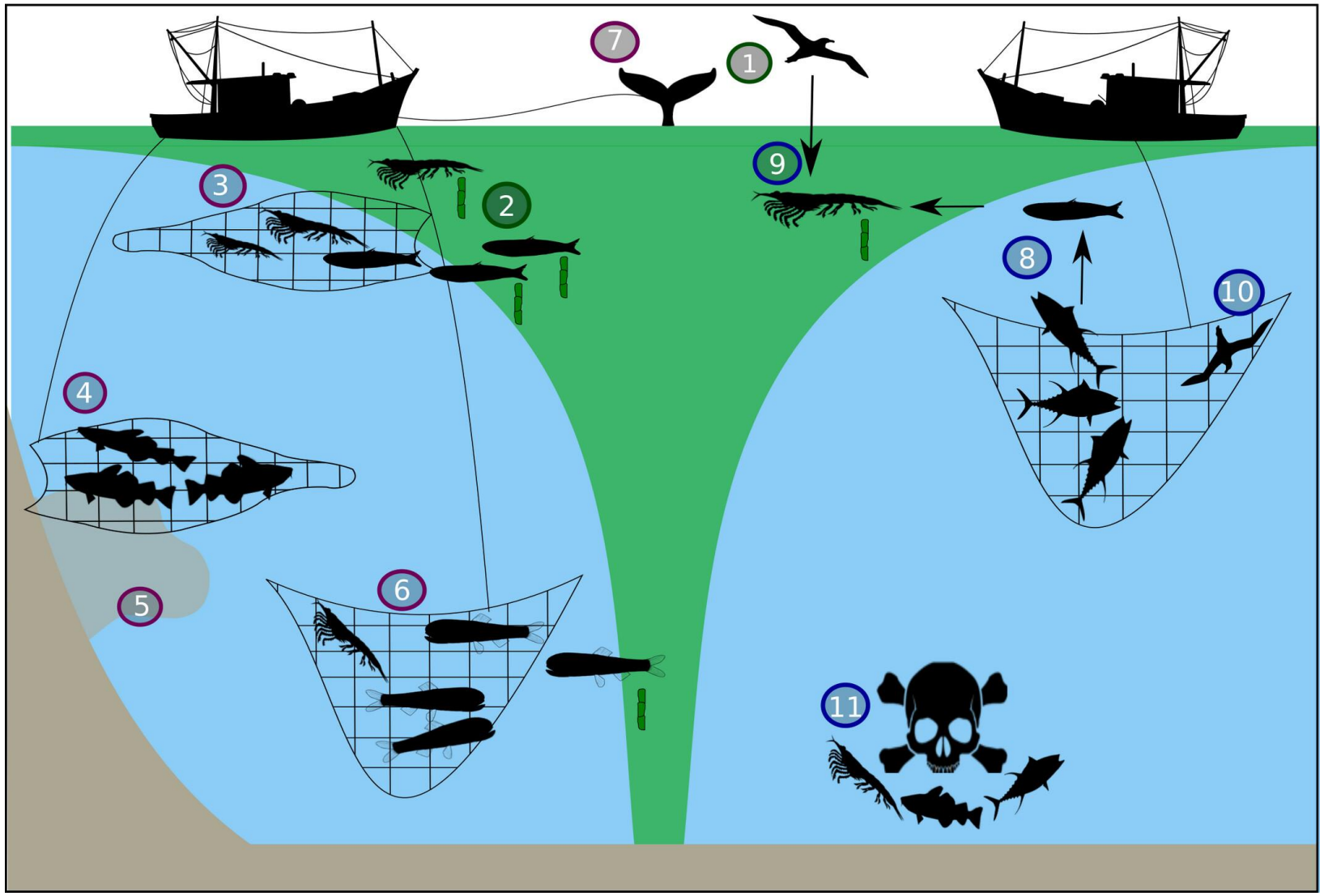


IMPACTS OF FISHING FOR MESOPELAGIC SPECIES ON THE BIOLOGICAL OCEAN PUMP

Removing **resident or migratory** mesopelagic species that contribute to the carbon sink (number 6 in this diagram).

Small pelagics are the most commonly fished group, and amongst the most important fish for sinking carbon as **faecal pellets.**

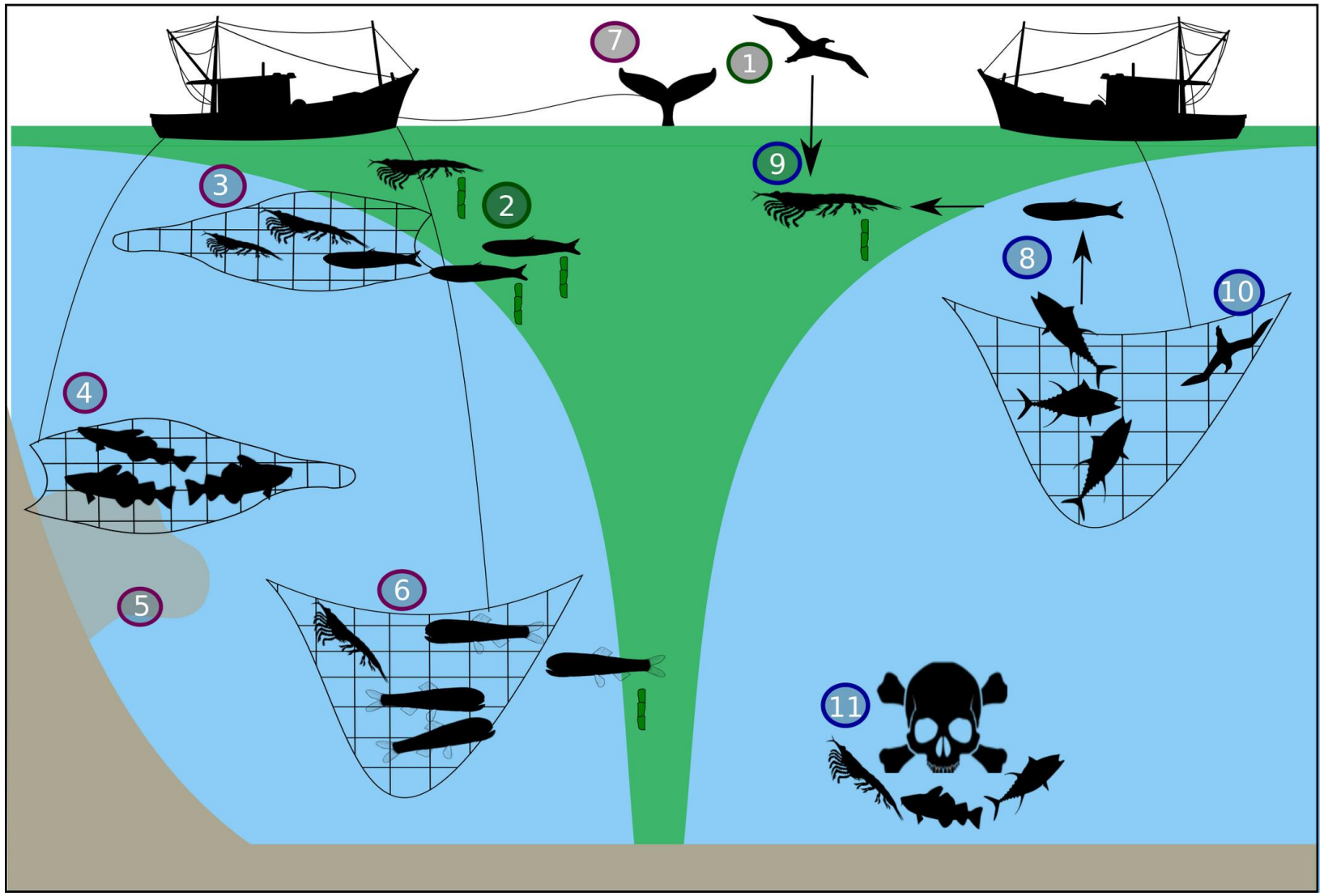
[Commercial fishery disturbance of the global ocean biological carbon sink - PMC (nih.gov)]



IMPACTS OF FISHING FOR MESOPELAGIC SPECIES ON THE BIOLOGICAL OCEAN PUMP

[Commercial fishery disturbance of the global ocean biological carbon sink - PMC (nih.gov)]

We have demonstrated a clear spatial overlap between the **carbon sink** and **commercial fishing**. Biomass and ecosystem changes caused by fishing could negatively impact carbon sinking and storage throughout the water column and seabed, and therefore atmospheric CO2 levels.



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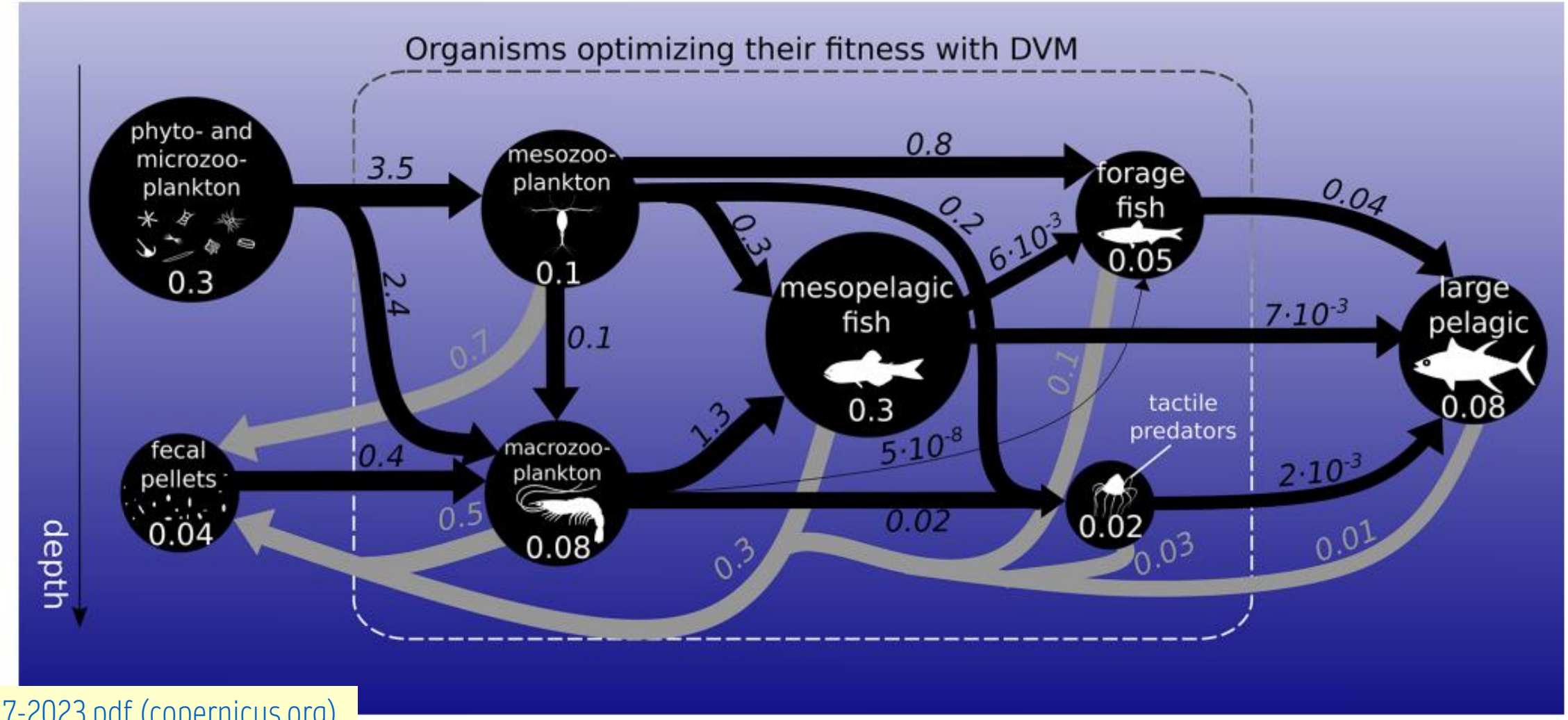
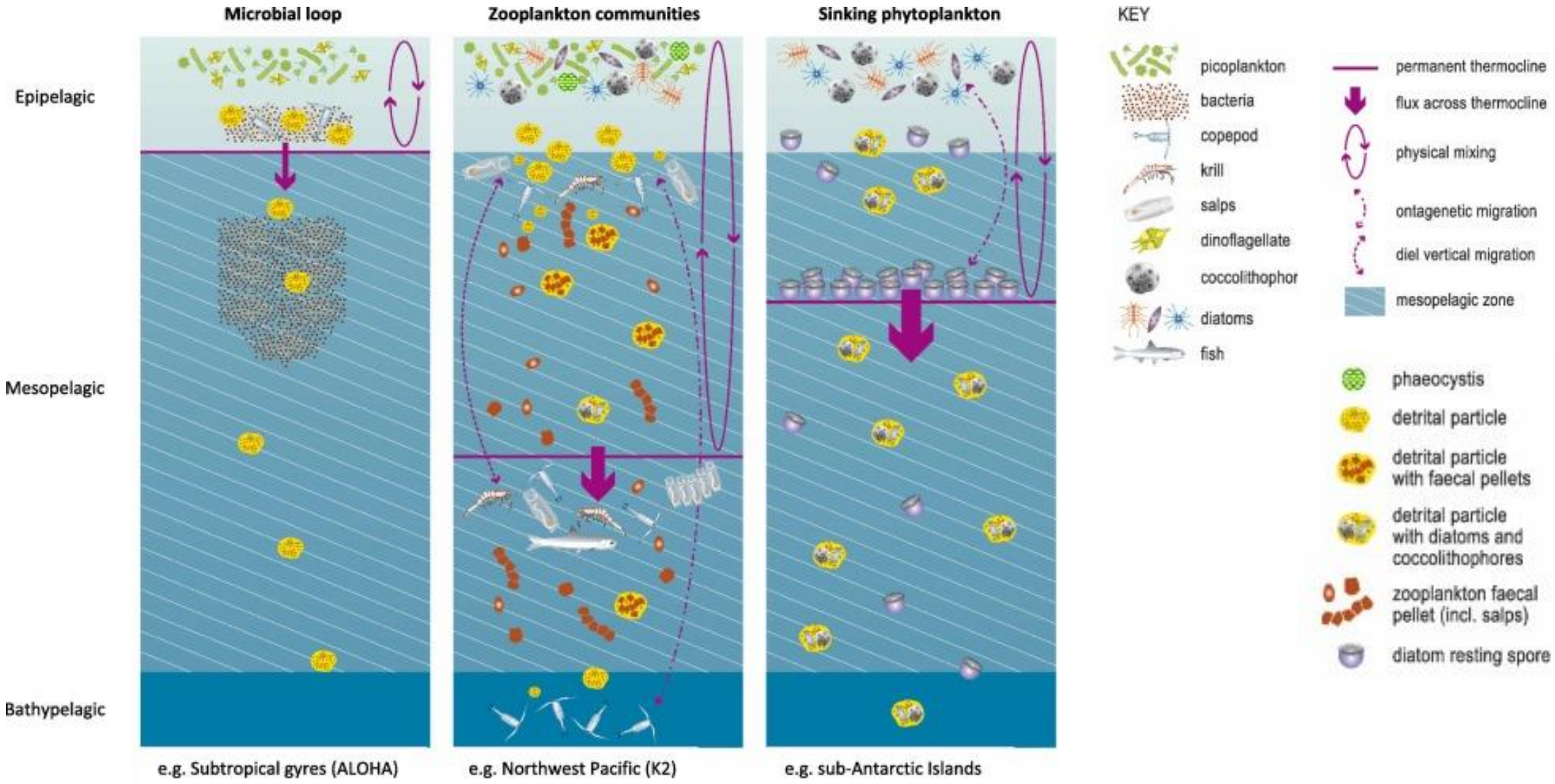


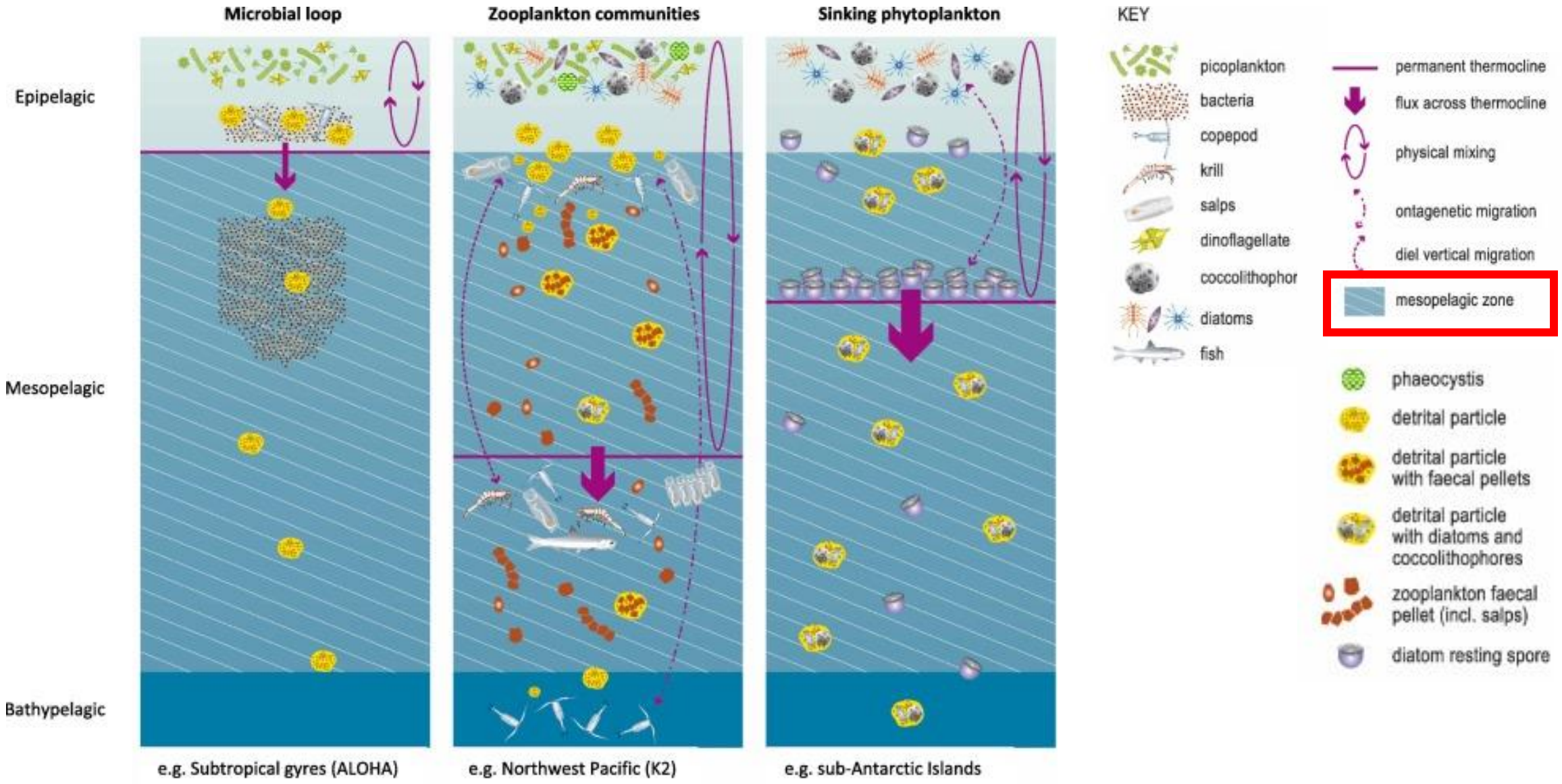
bg-20-997-2023.pdf (copernicus.org)

FISHING FOR MESOPELAGIC SPECIES



[Exploring the ecology of the mesopelagic biological pump - ScienceDirect]

FISHING FOR MESOPELAGIC SPECIES



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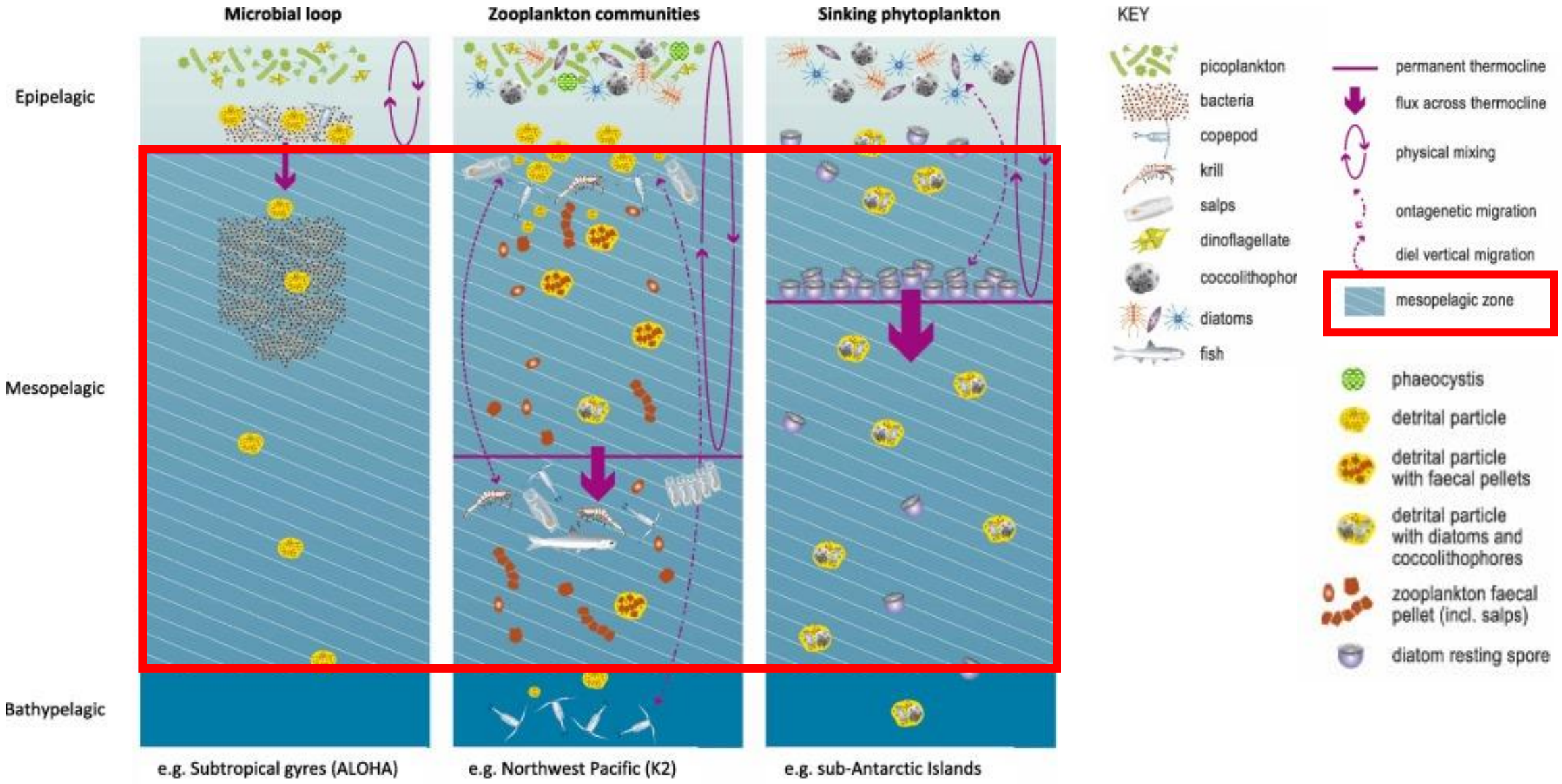

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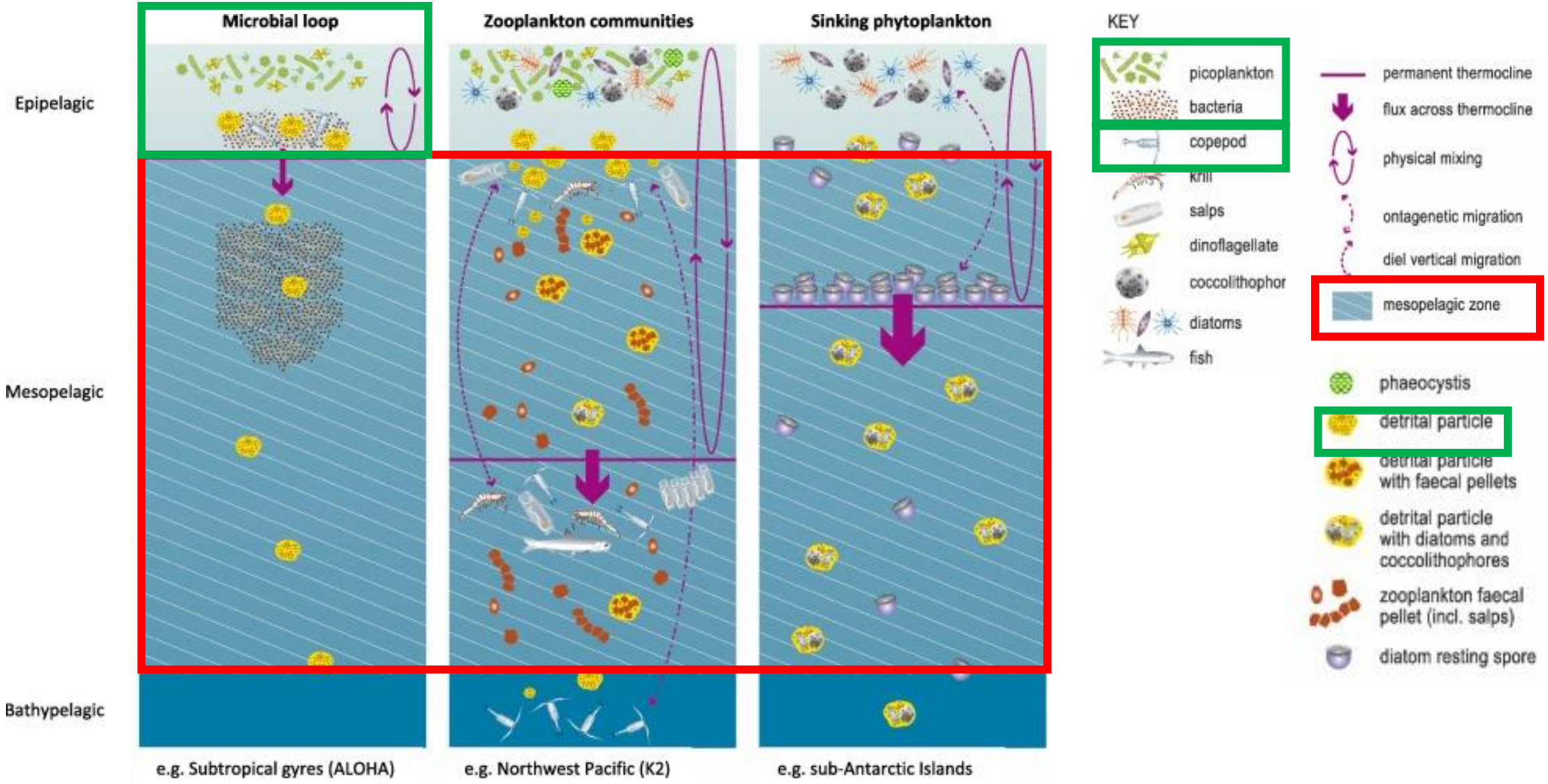

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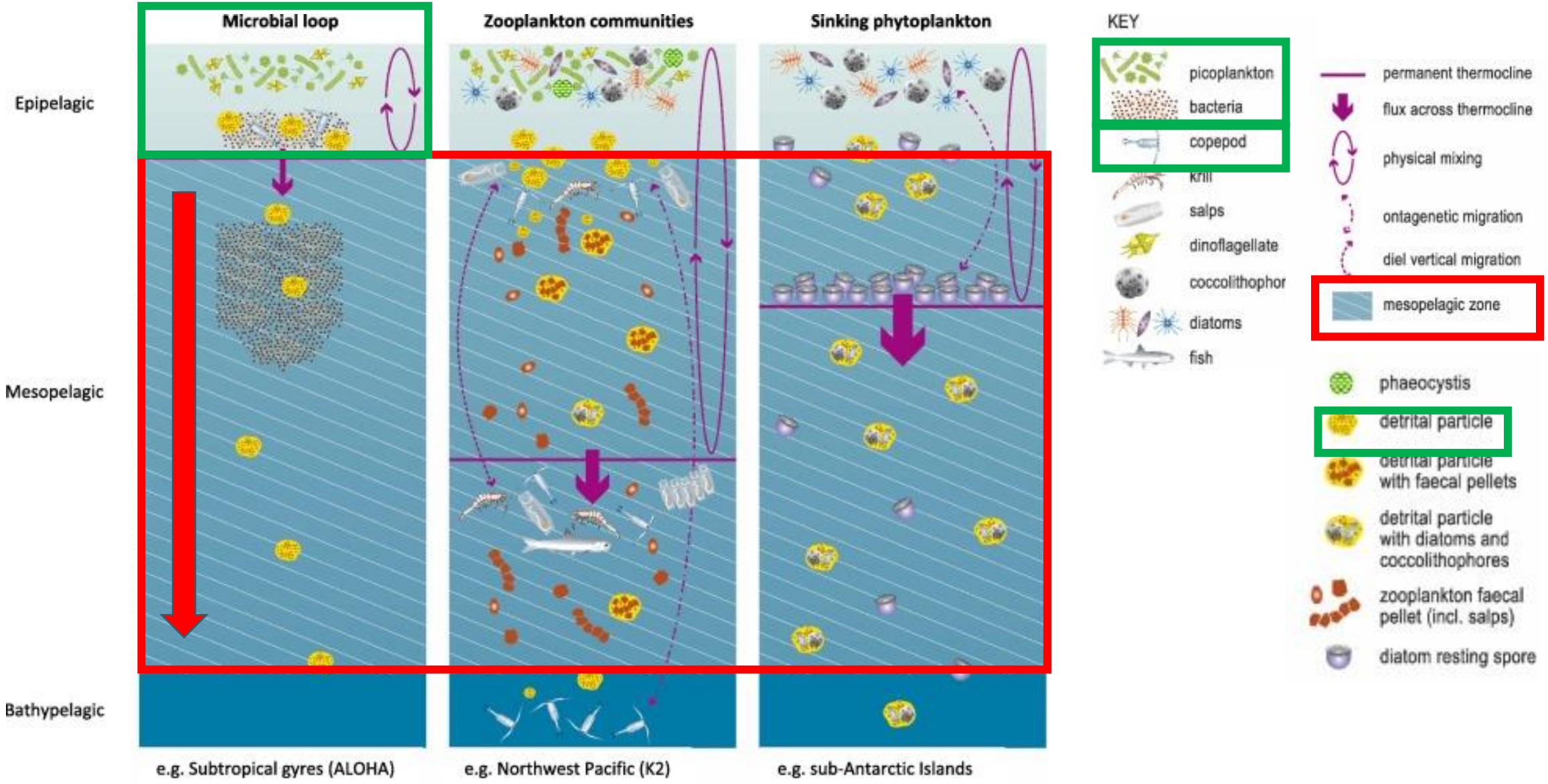

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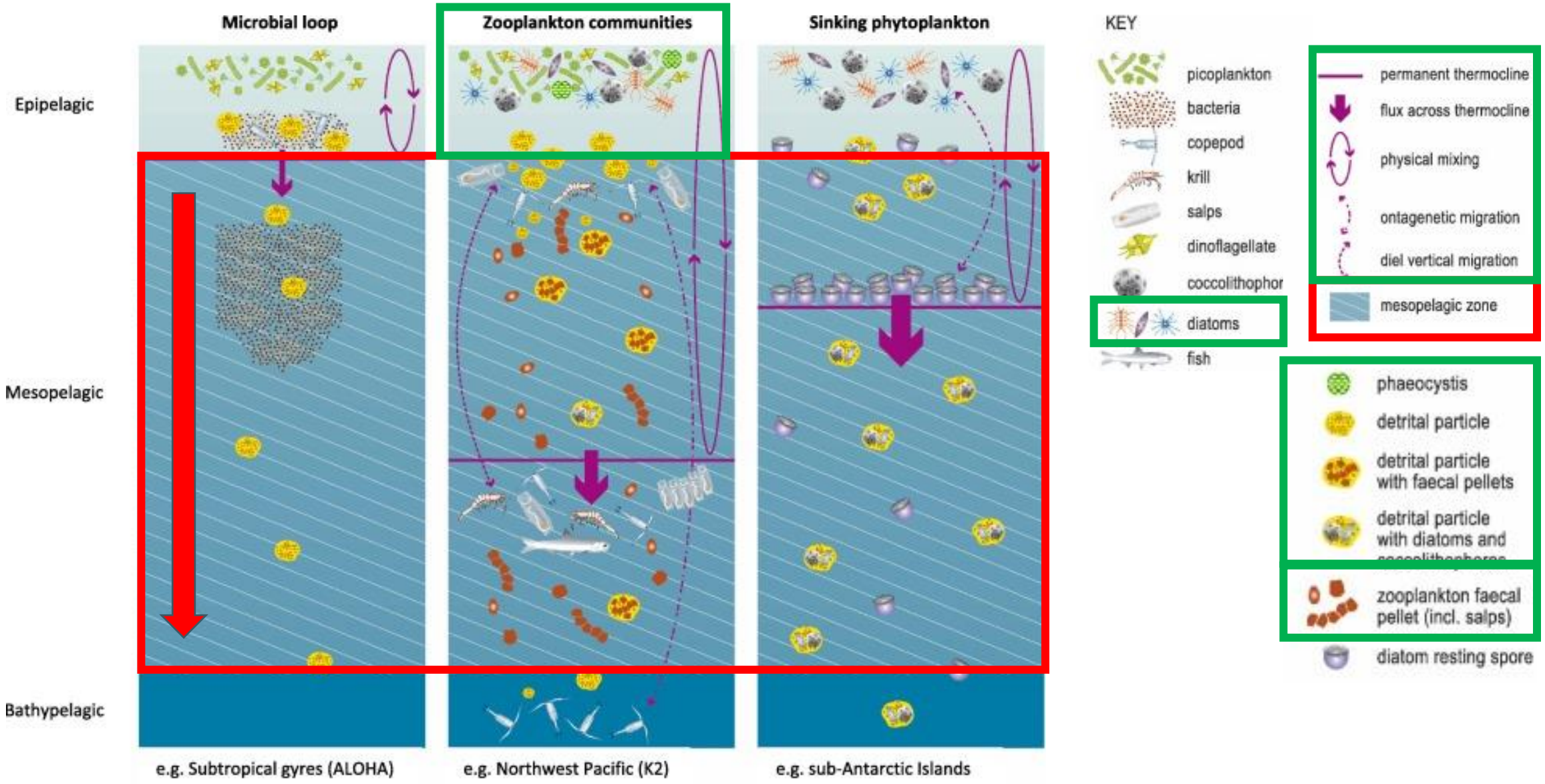

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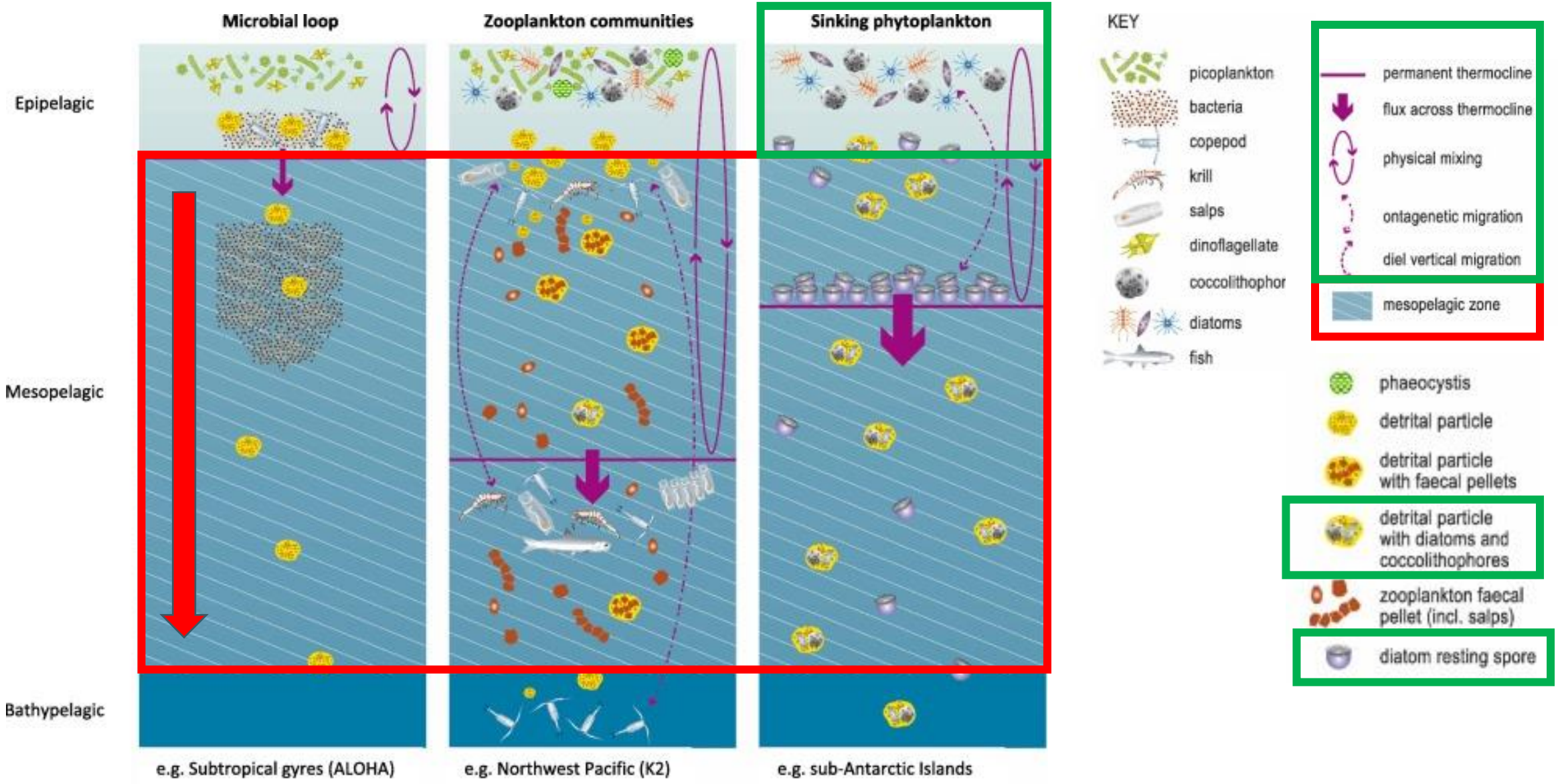
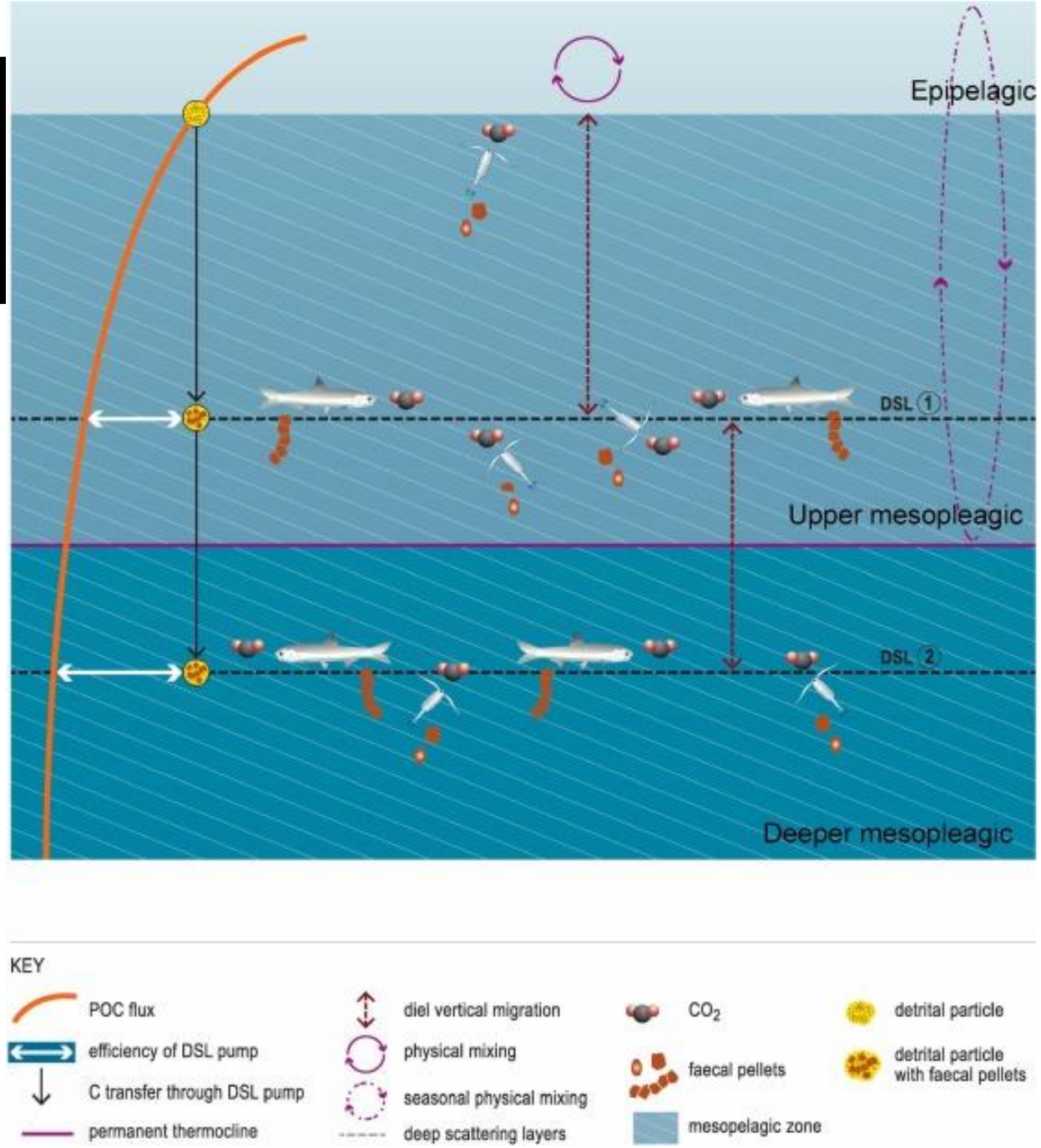


[Exploring the ecology of the mesopelagic biological pump - ScienceDirect]

IMPACTS OF FISHING FOR MESOPELAGIC SPECIES ON THE BIOLOGICAL OCEAN PUMP

Zooplankton and mesopelagic fish such as myctophids migrating between the upper ocean and deep scattering layers (DLSs) transfer carbon as faecal pellets or CO2 (released during respiration) to deeper within the mesopelagic zone

This carbon escapes remineralisation from upper ocean zooplankton and bacteria, so a greater proportion of it reaches the deep ocean

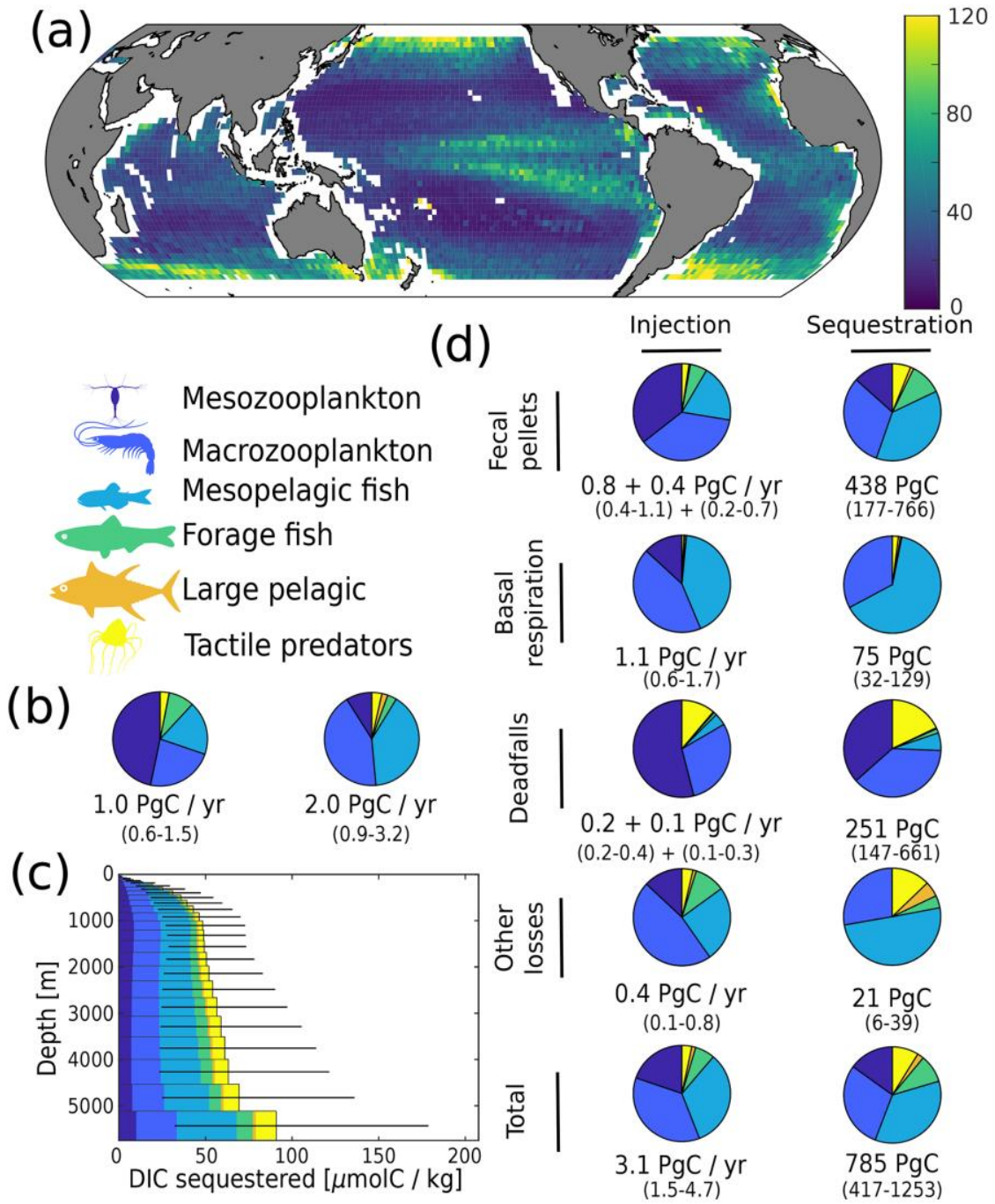


Exploring the ecology of the mesopelagic biological pump - ScienceDirect

IMPACTS OF FISHING FOR MESOPELAGIC SPECIES ON THE BIOLOGICAL OCEAN PUMP

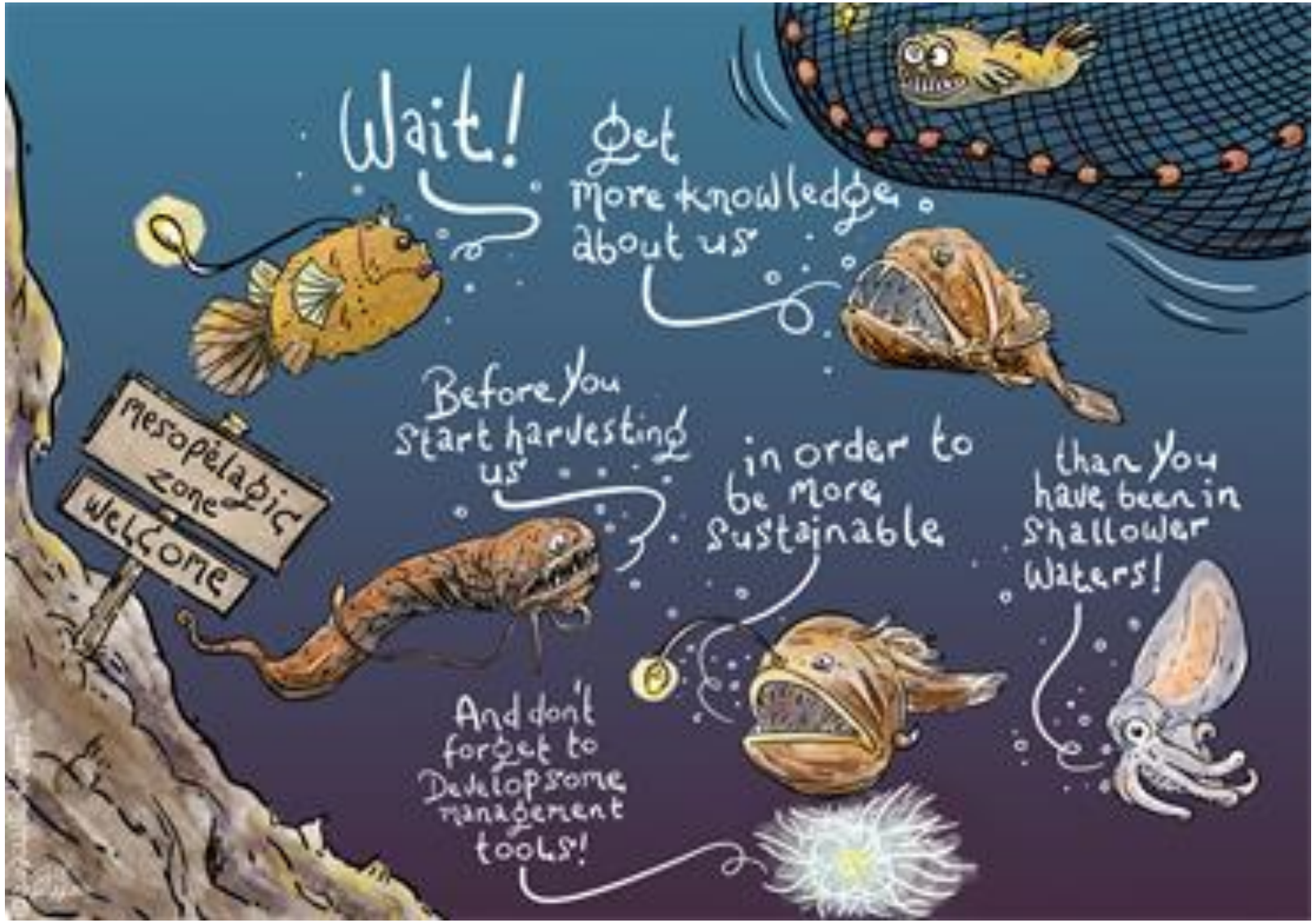
Simulated carbon injection and sequestration by metazoans.

Relative contribution of the simulated functional groups to injection below the euphotic zone. Left pie chart corresponds to the degradation of organic carbon that was produced in the euphotic zone and subsequently sank below the euphotic zone; right pie chart corresponds to the degradation of organic carbon that was injected by metazoans directly below the euphotic zone



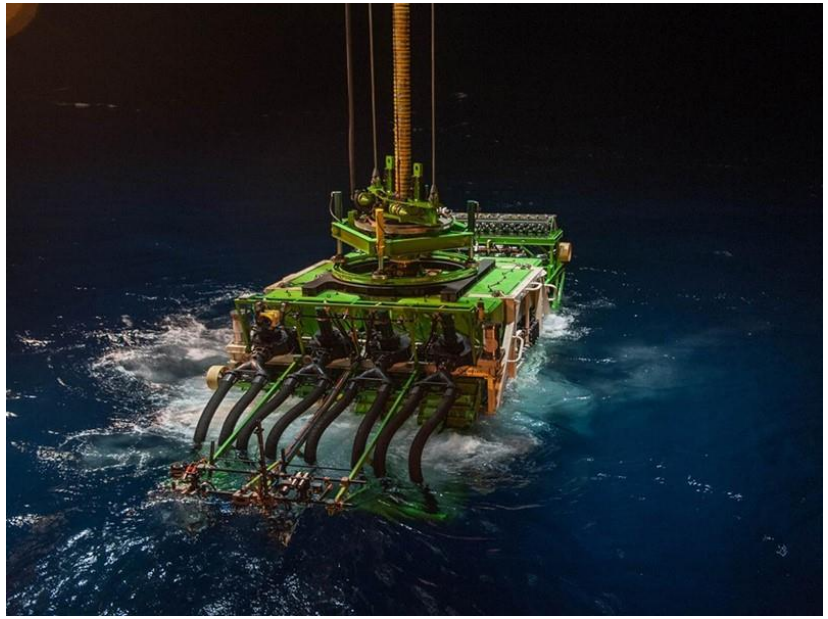
bg-20-997-2023.pdf (copernicus.org)

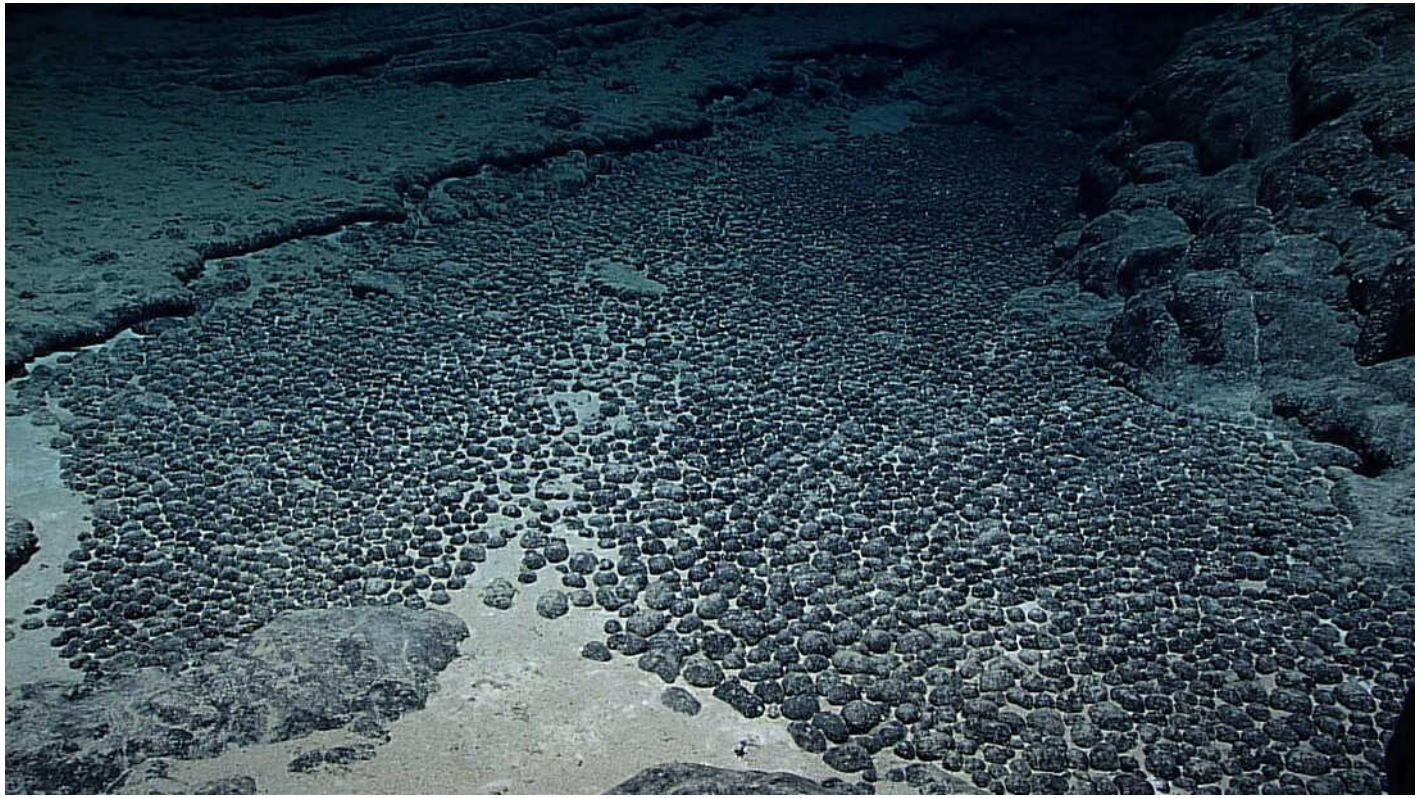
Any marine ecosystem change resulting in deviations in abundance or community composition of species responsible for sinking and storing carbon could result in a positive feedback increasing atmospheric CO_2 levels (DeVries et al., 2019).



Opportunities and risks in the mesopelagic zone (ices.dk)

EXTRACTION OF LITHIUM FROM DEEP-SEA BRINE POOLS





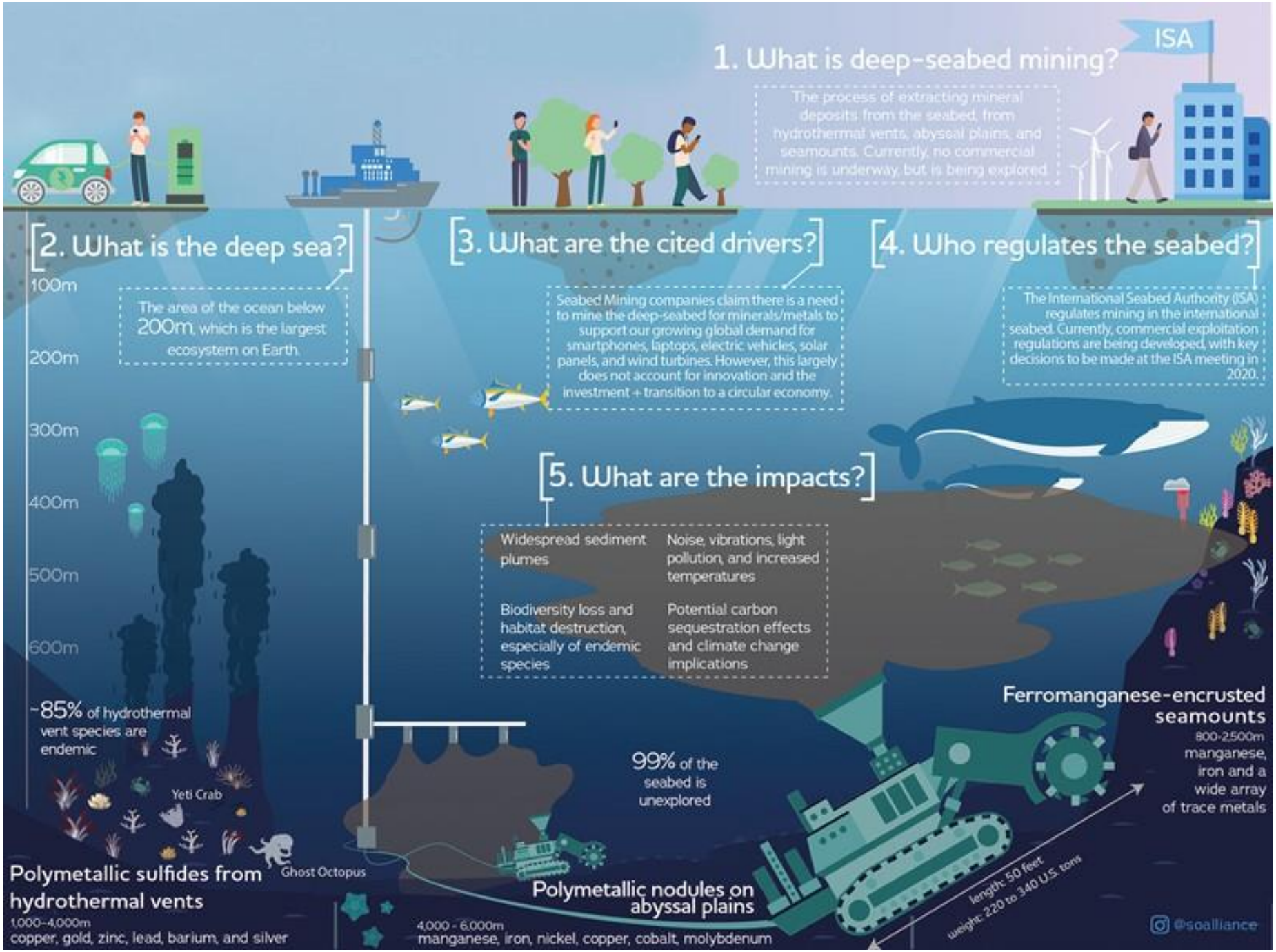
Polymetallic nodules coat fields of the ocean floor and are rich in critical minerals needed to make batteries for electric vehicles.

[Environmental impact of direct lithium extraction from brines | Nature Reviews Earth & Environment]

DEEP SEA MINING

[The environmental impact of deep-sea mining | E&T Magazine (theiet.org)]

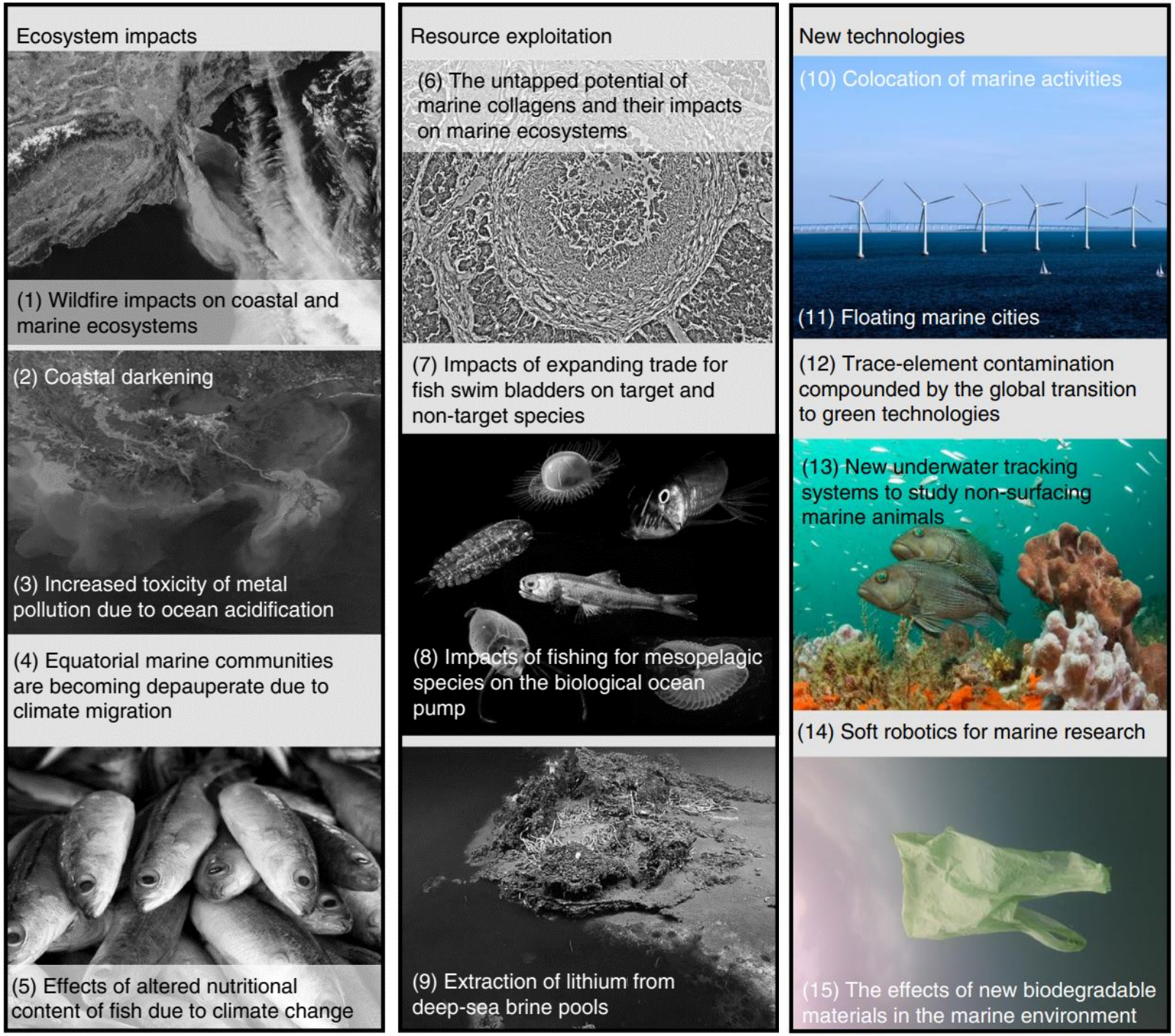
EXTRACTION OF LITHIUM FROM DEEP-SEA BRINE POOLS



TIME FOR A BREAK – 5 MINS

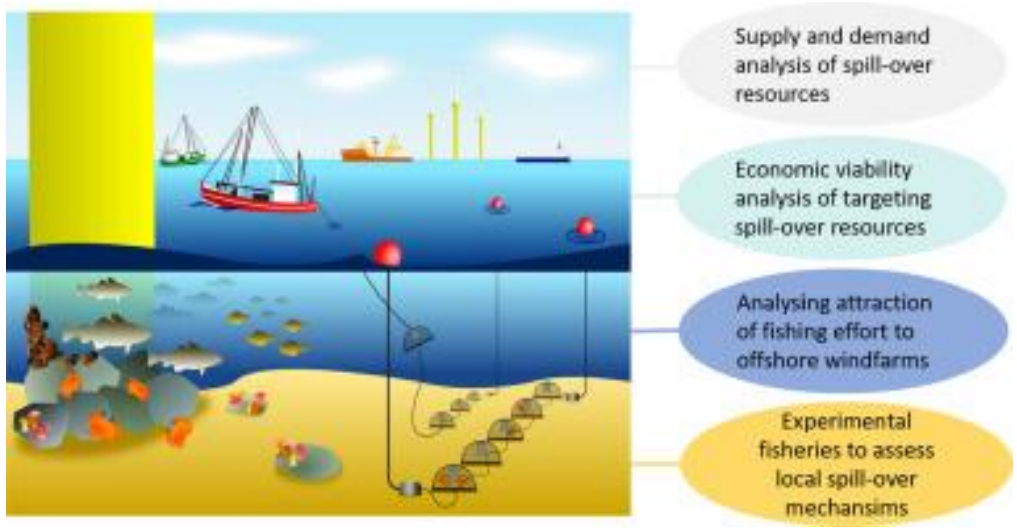
NEW TECHNOLOGIES

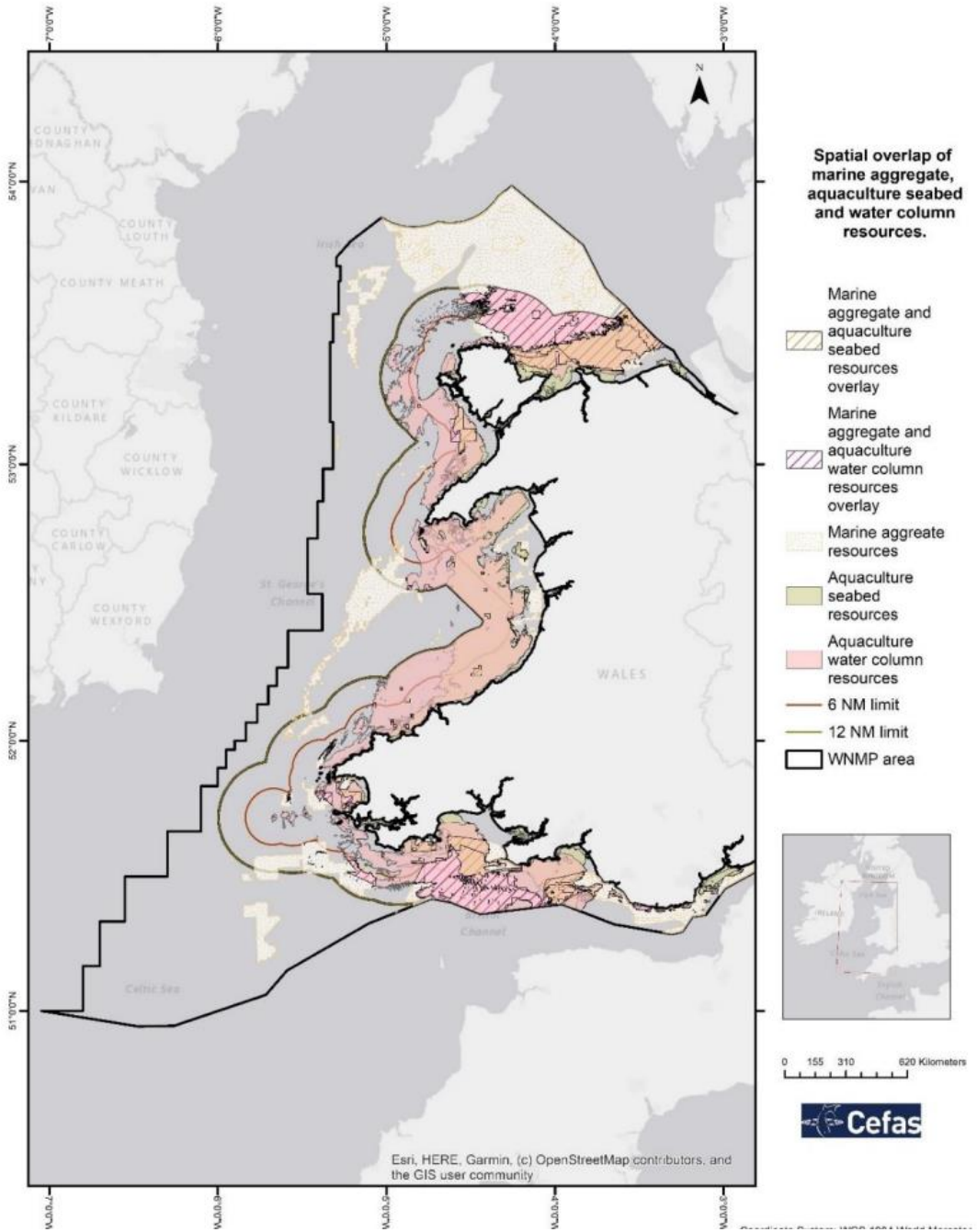
NEW TECHNOLOGIES



[A global horizon scan of issues impacting marine and coastal biodiversity conservation | Nature Ecology & Evolution]

COLOCATION OF MARINE ACTIVITIES





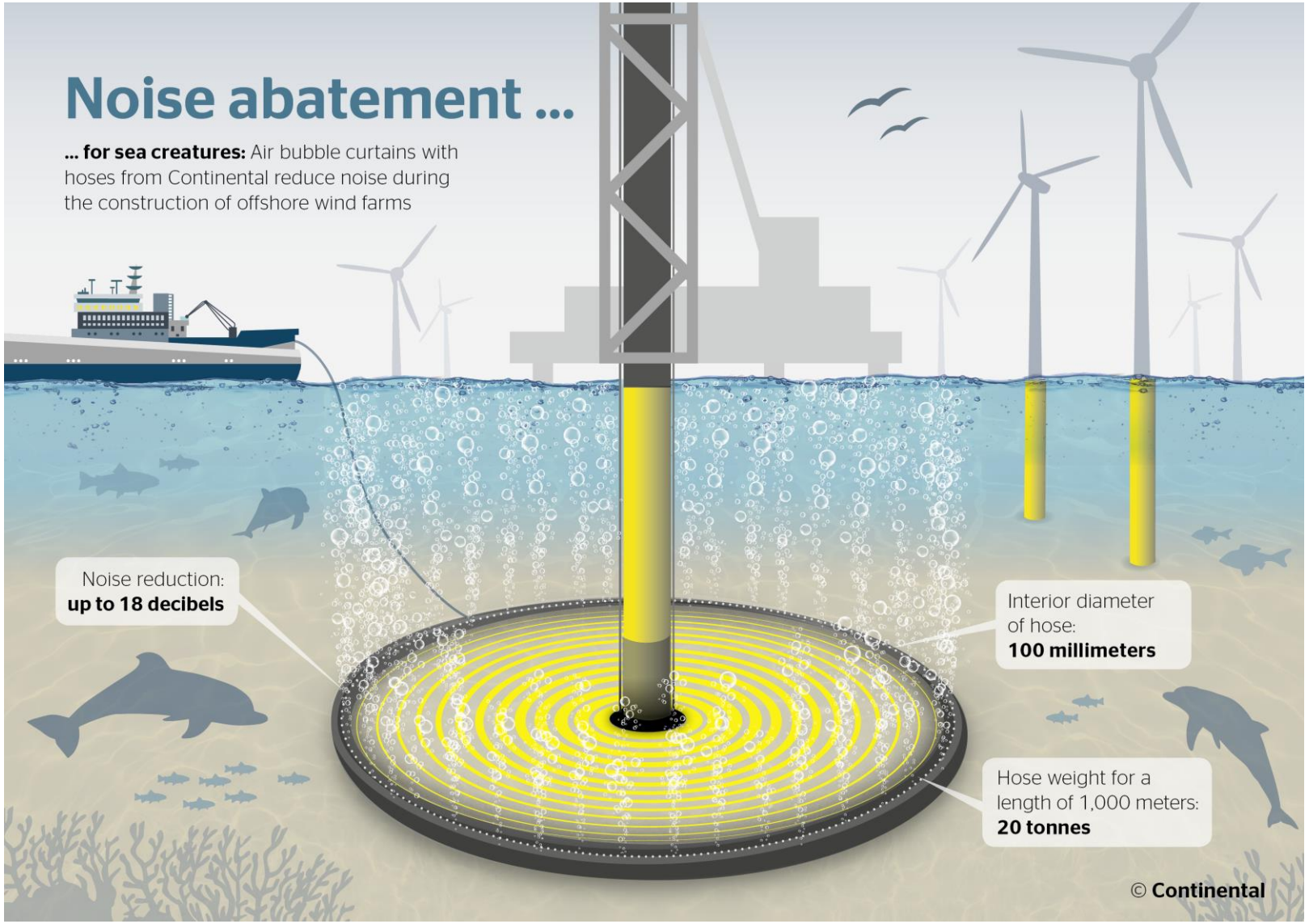
[A review of the potential for co-existence of different sectors in the Welsh Marine Plan Area (gov.wales)]

[Sustainable co-location solutions for offshore wind farms and fisheries need to account for socio-ecological trade-offs - ScienceDirect]

[Co-location of activities and designations: A means of solving or creating problems in marine spatial planning? - ScienceDirect]

COLOCATION OF MARINE ACTIVITIES

[Offshore wind power: Continental develops sound insulation for marine life - Continental AG]



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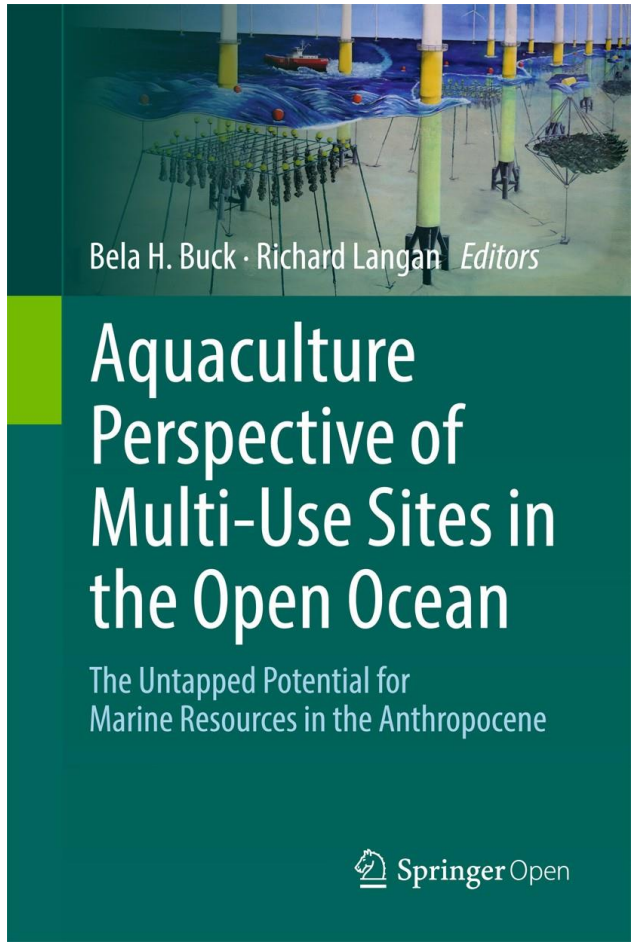
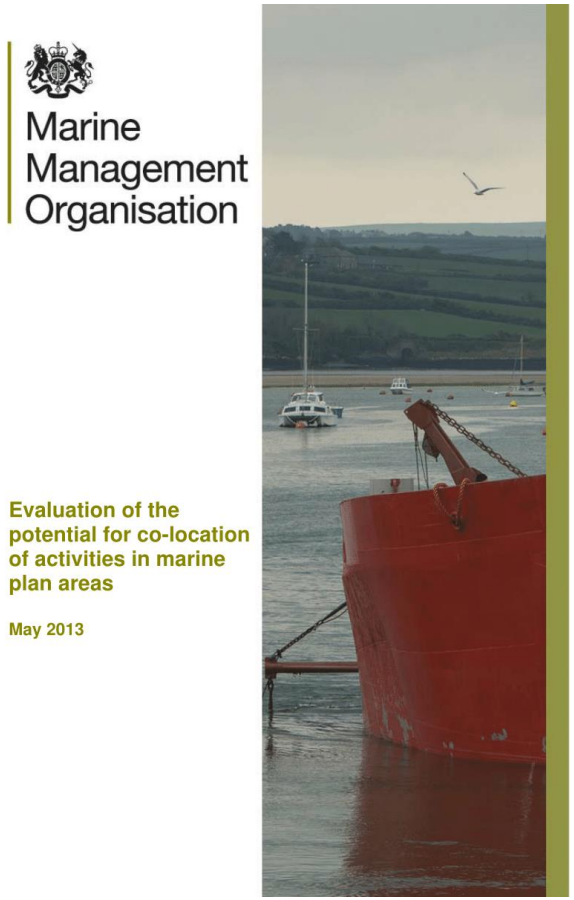
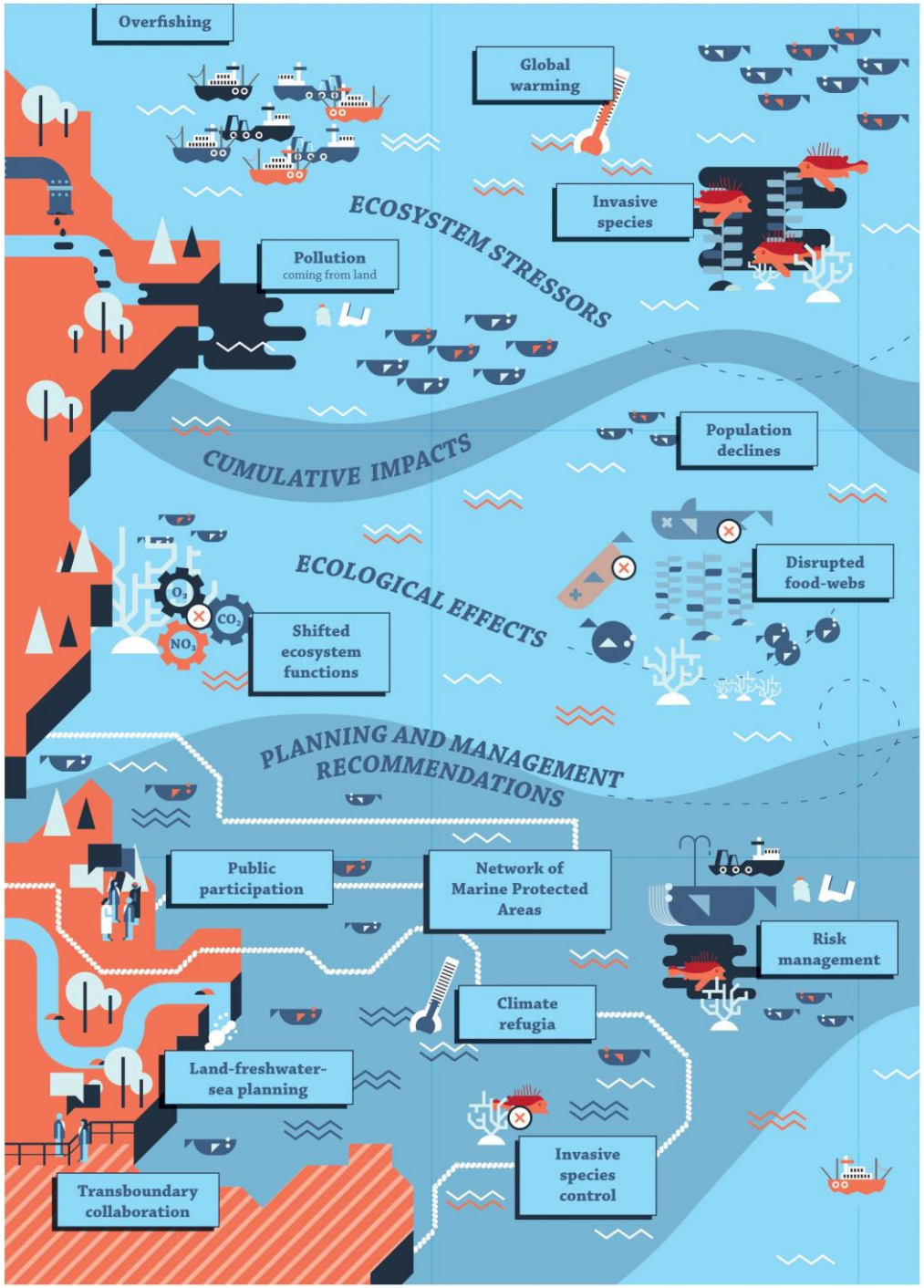
COLOCATION OF MARINE ACTIVITIES

[Frontiers | Twelve Recommendations for Advancing Marine Conservation in European and Contiguous Seas (frontiersin.org)]



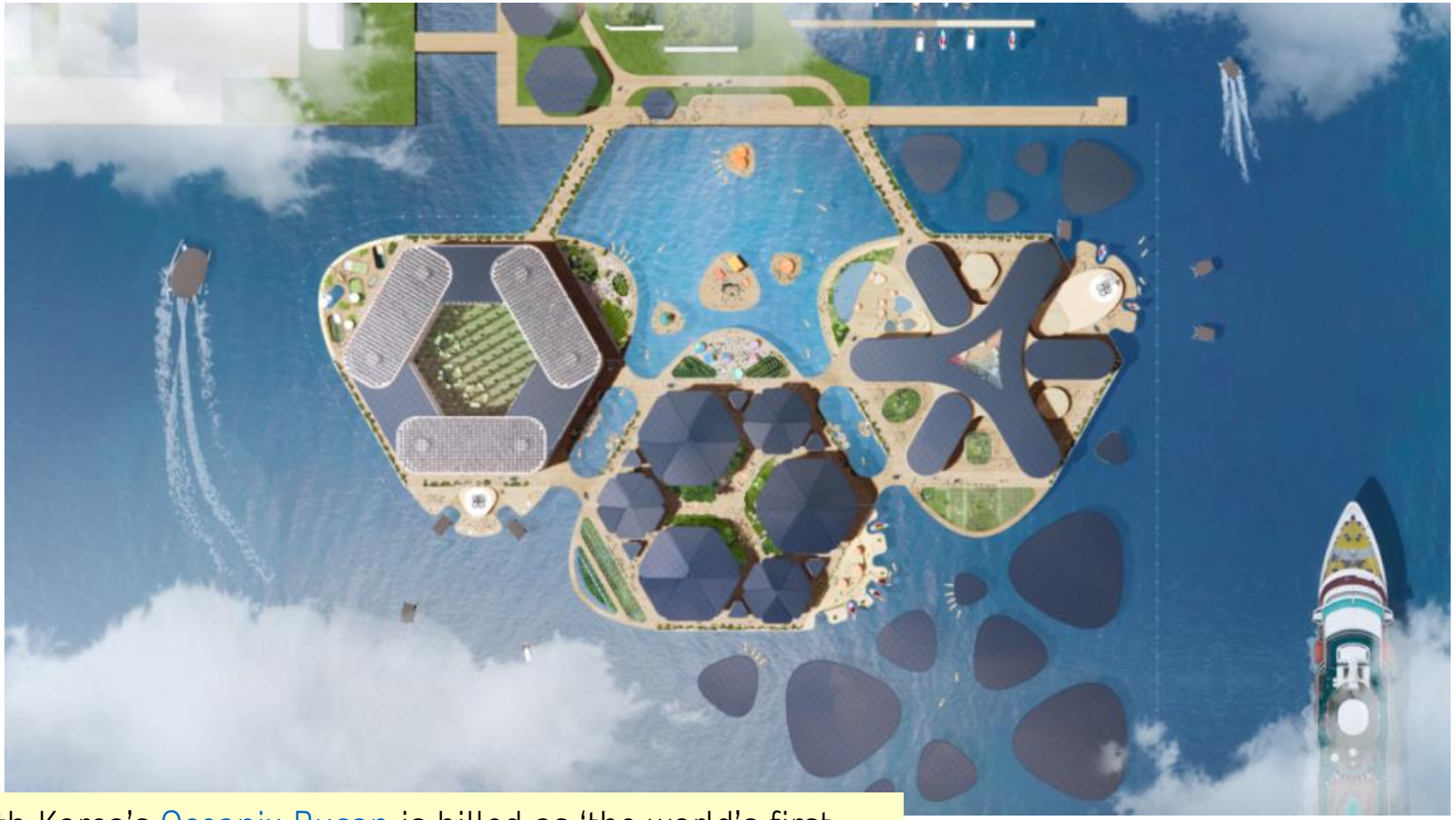




FLOATING MARINE CITIES

Why the Dutch embrace floating homes - BBC Future

FLOATING MARINE CITIES



South Korea's Oceanix Busan is billed as 'the world's first prototype of a resilient and sustainable floating community'.

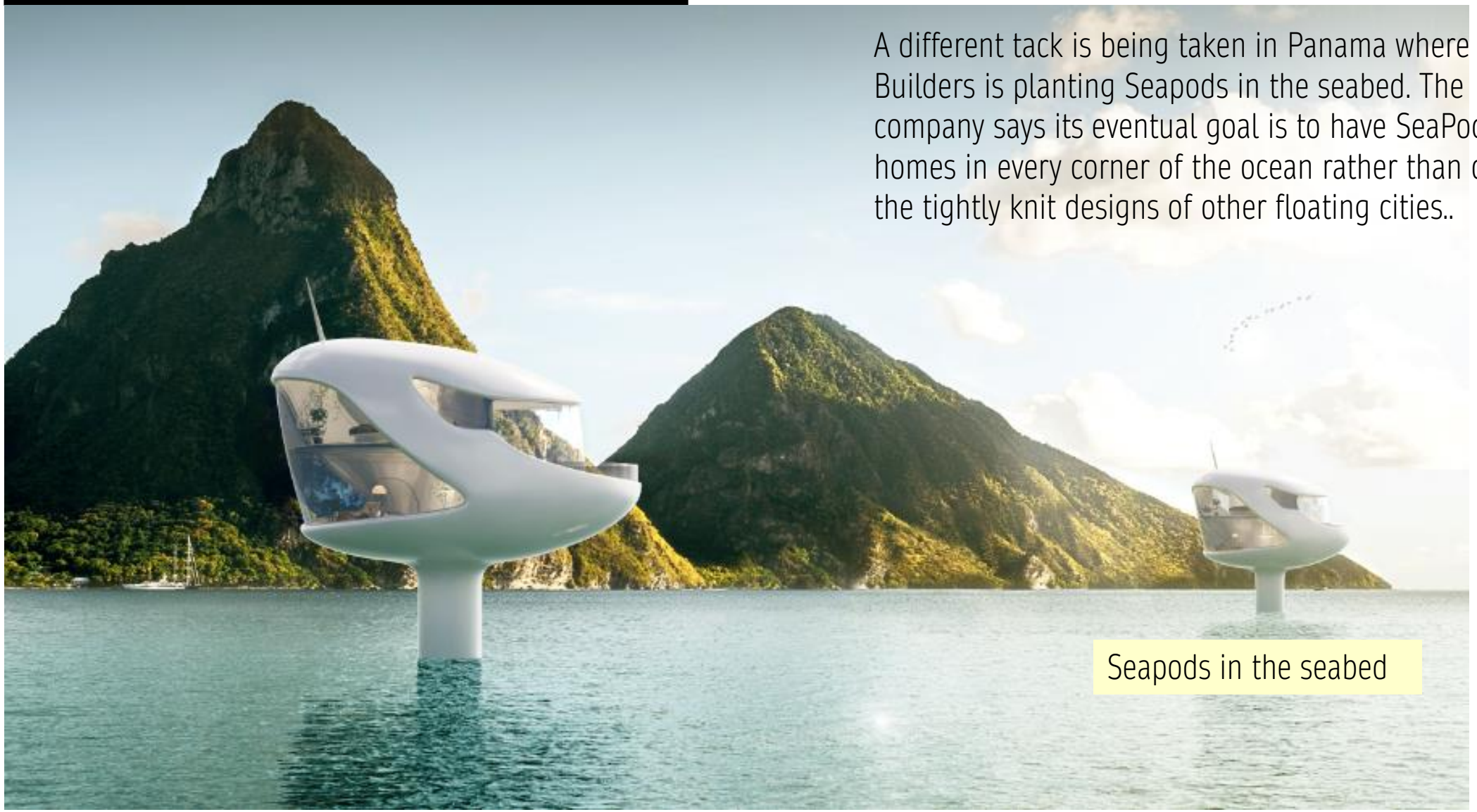
The prototype – which aims be finished by 2025 – has been backed by the United Nations Habitat project. It'll be flood resistant and will be made up of a series of islands which rise with the sea.

FLOATING MARINE CITIES

5,000 housing units, tethered to the lagoon floor and linked together.

In June 2022, Dutch Docklands Maldives acquired the last necessary signatures in order to start Maldives Floating City.

FLOATING MARINE CITIES



A different tack is being taken in Panama where Ocean Builders is planting Seapods in the seabed. The company says its eventual goal is to have SeaPod homes in every corner of the ocean rather than one of the tightly knit designs of other floating cities..

Seapods in the seabed

FLOATING MARINE CITIES

The architecture community was fascinated with marine utopias between the 1950s and '70s. The technological optimism of this period led architects to consider whether we could build settlements in inhospitable places like the polar regions, the deserts and on the sea.

Floating cities: the future or a washed-up idea? (theconversation.com)

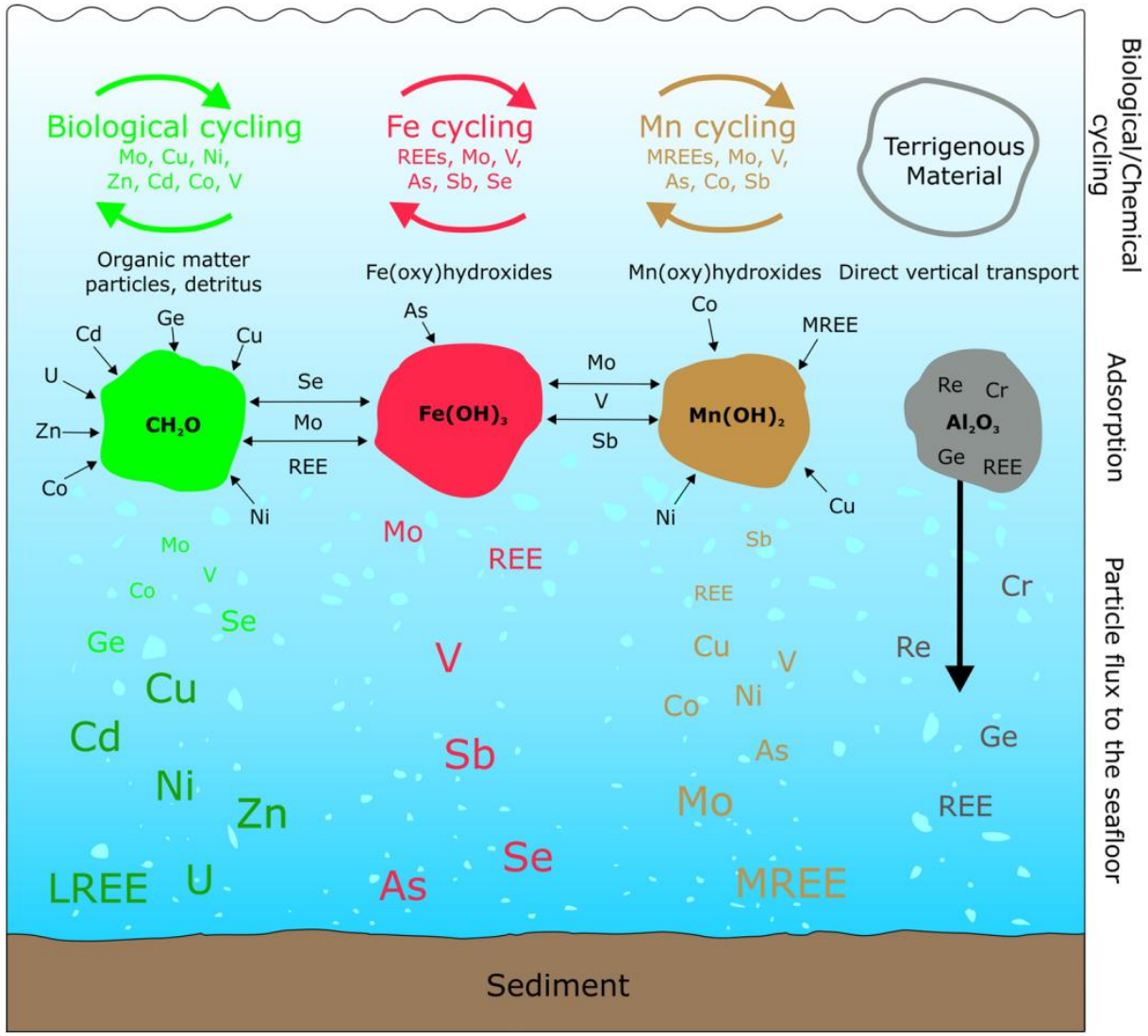
There are calls for the standardisation of these types of floating building. Virginie Segura, project manager for Vicastel Project Management, says: "There is a lack of building regs in this area. We need a roadmap, a standardised set of rules, for projects incorporating a floating building or structure." The confusion around the issue is underpinned by a June 2022 ruling in Miami regarding a floating mansion. As reported in Marine Industry News, it will evade a tax bill of nearly $120,000 because its owners have proven it's a boat.

TRACE ELEMENT CONTAMINATION COMPOUNDED BY THE GLOBAL TRANSITION TO GREEN TECHNOLOGIES

Trace elements (TEs)

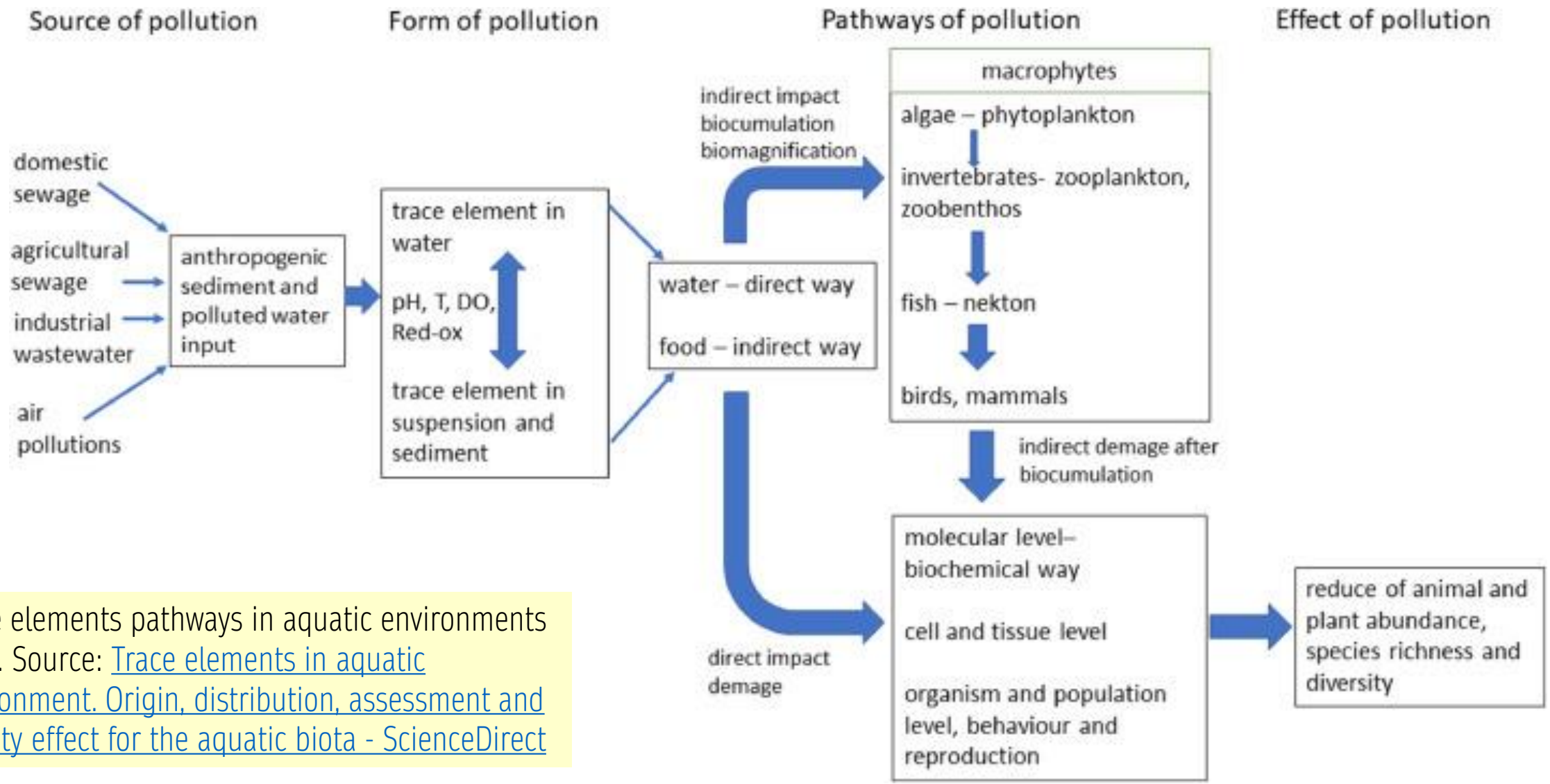
Trace elements (TEs) frequently contaminate coastal marine sediments with many included in priority chemical lists or control legislation. These, improved waste treatment and increased recycling have fostered the belief that TE pollution is declining.

[Three decades of trace element sediment contamination: The mining of governmental databases and the need to address hidden sources for clean and healthy seas - ScienceDirect]



Schematic illustration of trace element cycling, sorption, and transport in the water column to the seafoor. From Smrzka et al (2019).

TRACE ELEMENT CONTAMINATION COMPOUNDED BY THE GLOBAL TRANSITION TO GREEN TECHNOLOGIES



Trace elements pathways in aquatic environments (TEs). Source: [Trace elements in aquatic environment. Origin, distribution, assessment and toxicity effect for the aquatic biota - ScienceDirect]

TRACE ELEMENT CONTAMINATION COMPOUNDED BY THE GLOBAL TRANSITION TO GREEN TECHNOLOGIES

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Geospatial data

1 of 2

TRACE ELEMENT CONTAMINATION COMPOUNDED BY THE GLOBAL TRANSITION TO GREEN TECHNOLOGIES

Table 1. Percentage of sites (all sites together, coastal sites or open sea sites) monitored on a yearly basis, integrated over the full 31-year monitoring time series, distributed among the seven pollution levels of the Geoaccumulation Index scale, for each studied TE. Digestion techniques: strong acid digestion (sad) or total digestion (td) are specified and considered separately for Cr and Fe.

All sites together

Pollution Level	I_{geo}	Colour scale	CF	As (796)	Cd (1,210)	Cr (sad) (842)	Cr (td) (201)	Cu (1,070)	Fe (sad) (676)	Fe (td) (198)	Pb (1,064)	Hg (1,126)	Ni (1,066)	Zn (1,073)
Unpolluted	0		<1.5	53.9	14.6	43.9	76.1	28.7	58.9	82.3	36.2	25.7	38.5	33.6
Unpolluted - moderate pollution	0-1		1.5-3	27.9	18.0	49.2	20.4	25.8	39.6	17.7	34.4	15.0	51.3	39.1
Moderate pollution	1-2		3-6	6.8	22.6	6.9	3.5	22.6	1.3	0	20.8	23.0	9.3	19.2
Moderate - strong pollution	2-3		6-12	5.9	25.0	0	0	11.6	0.1	0	6.8	23.5	0.9	5.1
Strong pollution	3-4		12-24	2.8	14.4	0	0	6.4	0	0	1.7	9.9	0	1.3
Strong - very strong pollution	4-5		24-48	0.8	2.9	0	0	3.1	0	0	0.2	1.9	0	0.9
Very strong pollution	>5		>48	2.0	2.5	0	0	1.9	0	0	0	1.1	0	0.7

Coastal sites

Pollution Level	I_{geo}	Colour scale	CF	As (706)	Cd (1,121)	Cr (sad) (842)	Cr (td) (112)	Cu (980)	Fe (sad) (676)	Fe (td) (112)	Pb (974)	Hg (1,037)	Ni (976)	Zn (981)
Unpolluted	0		<1.5	52.3	12.6	43.9	65.2	28.5	58.9	74.1	36.0	21.2	41.1	33.8
Unpolluted - moderate pollution	0-1		1.5-3	27.8	17.0	49.2	28.6	23.0	39.6	25.9	32.2	14.7	48.2	36.8
Moderate pollution	1-2		3-6	7.1	22.3	6.9	6.2	24.0	1.3	0	22.5	24.9	9.7	20.6
Moderate - strong pollution	2-3		6-12	6.7	26.8	0	0	12.4	0.1	0	7.3	25.4	1.0	5.5
Strong pollution	3-4		12-24	3.1	15.5	0	0	6.7	0	0	1.7	10.7	0	1.4
Strong - very strong pollution	4-5		24-48	0.8	3.1	0	0	3.4	0	0	0.2	2.0	0	1.0
Very strong pollution	>5		>48	2.3	2.7	0	0	2.0	0	0	0	1.2	0	0.8

Open sea sites

Pollution Level	I_{geo}	Colour scale	CF	As (90)	Cd (89)	Cr (sad) (0)	Cr (td) (89)	Cu (90)	Fe (sad) (0)	Fe (td) (86)	Pb (90)	Hg (89)	Ni (90)	Zn (92)
Unpolluted	0		<1.5	66.7	40.4	-	89.9	31.1	-	93	37.8	77.5	10	30.4
Unpolluted - moderate pollution	0-1		1.5-3	28.9	30.3	-	10.1	56.7	-	7	57.8	19.1	85.6	64.1
Moderate pollution	1-2		3-6	4.4	25.8	-	0	7.8	-	0	2.2	1.1	4.4	4.3
Moderate - strong pollution	2-3		6-12	0	3.4	-	0	2.2	-	0	1.1	2.2	0	1.1
Strong pollution	3-4		12-24	0	0	-	0	2.2	-	0	1.1	0	0	0
Strong - very strong pollution	4-5		24-48	0	0	-	0	0	-	0	0	0	0	0
Very strong pollution	>5		>48	0	0	-	0	0	-	0	0	0	0	0

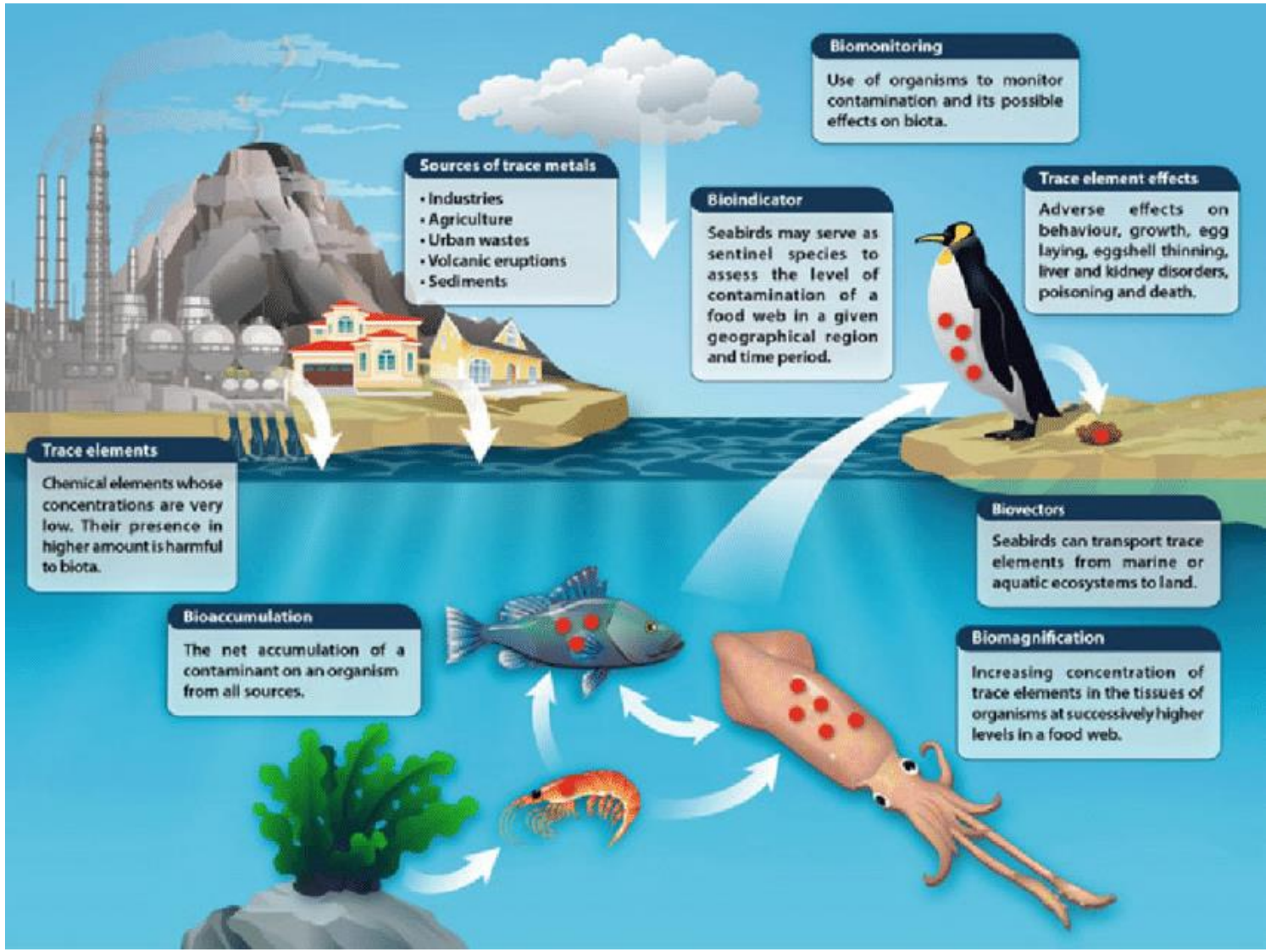
I_{geo}=Geoaccumulation Index.

CF=Contamination Factor.

Number in brackets=number of sites monitored, on a yearly basis, over the 31-year time series.

[Three decades of trace element sediment contamination: The mining of governmental databases and the need to address hidden sources for clean and healthy seas - ScienceDirect]

TRACE ELEMENT CONTAMINATION COMPOUNDED BY THE GLOBAL TRANSITION TO GREEN TECHNOLOGIES

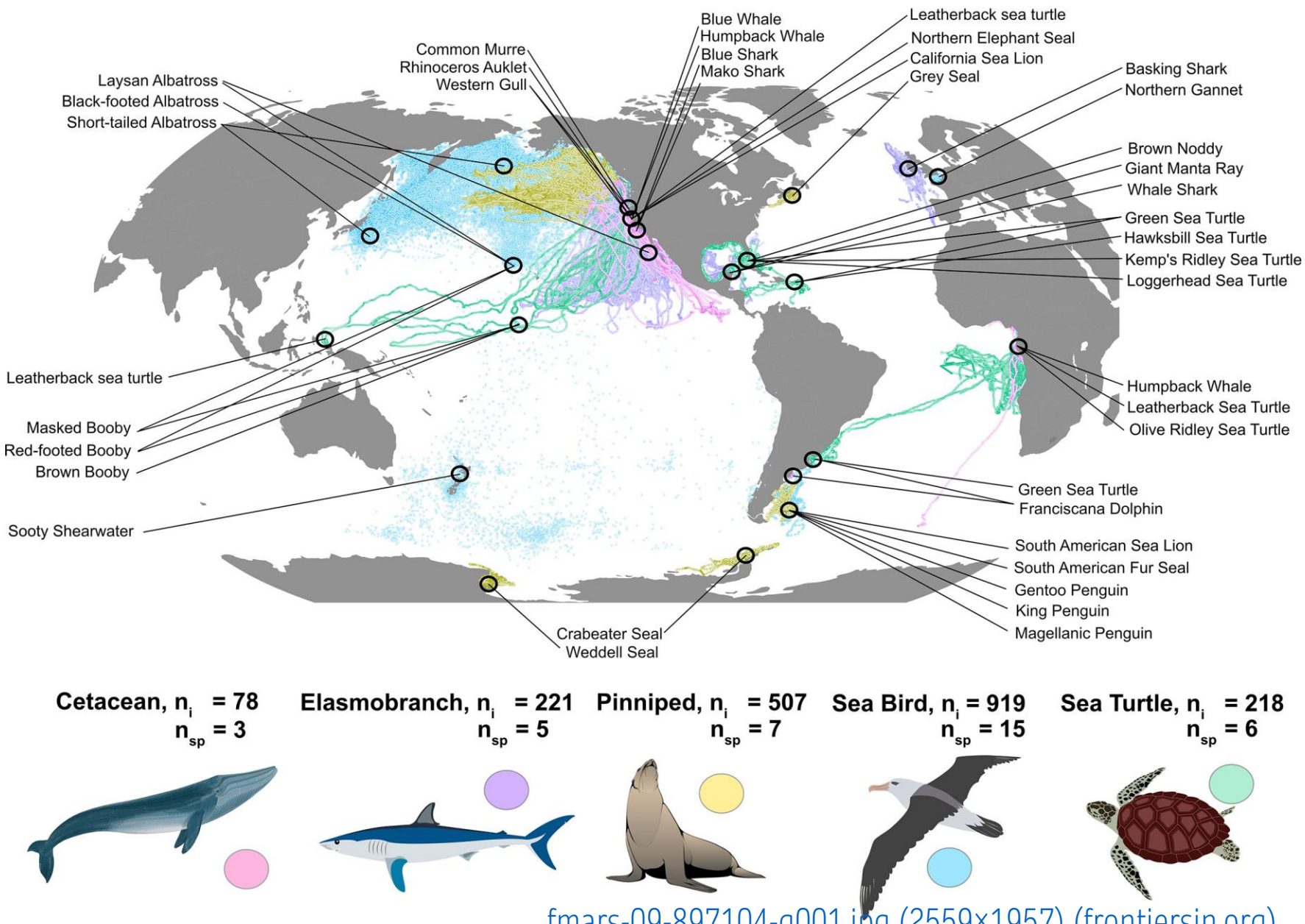


[A Global Overview of Exposure Levels and Biological Effects of Trace Elements in Penguins | SpringerLink]

NEW UNDERWATER TRACKING SYSTEMS TO STUDY NON-SURFACING MARINE ANIMALS

Most trajectory data collected on marine species to date, however, has been restricted to large and near-surface species, limited by the size of the devices and reliance on radio signals that do not propagate well underwater.

Global Tracking Datasets From 36 Species of Marine Megafauna



fmars-09-897104-g001.jpg (2559×1957) (frontiersin.org)

NEW UNDERWATER TRACKING SYSTEMS TO STUDY NON-SURFACING MARINE ANIMALS

An underwater navigation system powered by sound | MIT News | Massachusetts Institute of Technology

For a video on this technology click here: https://youtu.be/zC3HaY6YJLY

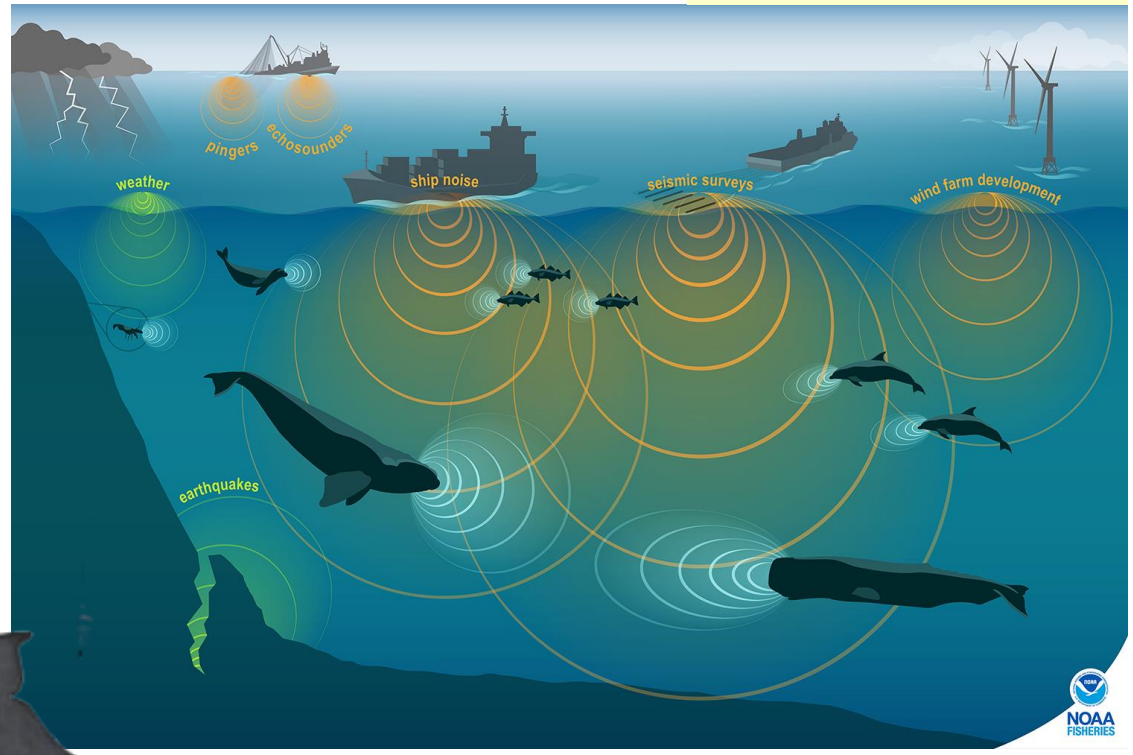
New battery-free technology based on acoustic telemetry, named 'underwater backscatter localization' (UBL), may allow high-accuracy (<1 m) tracking of animals travelling at any depth and over large distances.

NEW UNDERWATER TRACKING SYSTEMS TO STUDY NON-SURFACING MARINE ANIMALS

However, the potential negative impacts of this methodology on the behaviour of animals are still to be determined.

Ultimately, UBL may inform spatial management both in coastal and offshore regions, as well as in the high seas and address a currently biased perspective of how marine animals use ocean space, which is largely based on near-surface or aerial marine megafauna

Ocean Noise | NOAA Fisheries



SOFT ROBOTICS FOR MARINE RESEARCH

Advances in Deep-Sea Sampling with Soft Robotics: NOAA Ocean Exploration

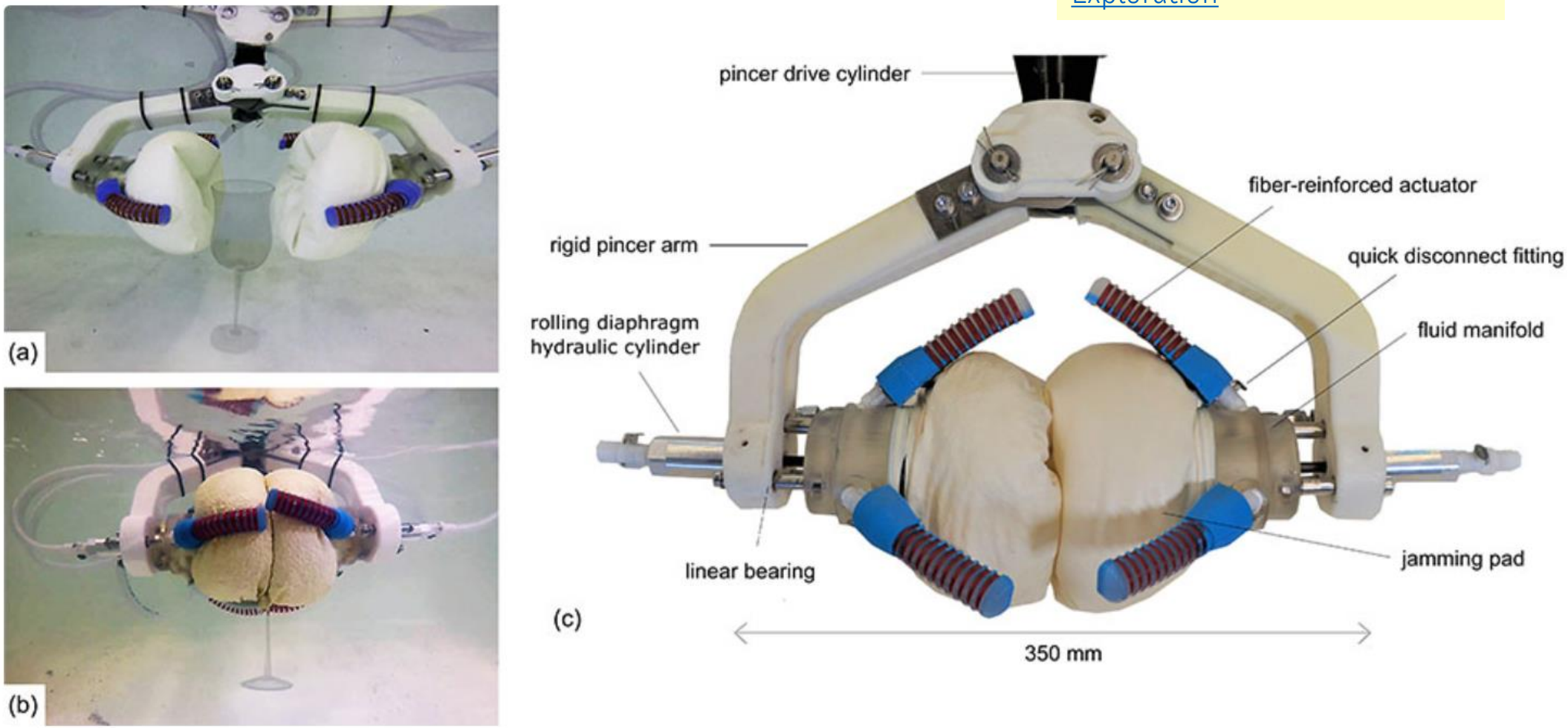
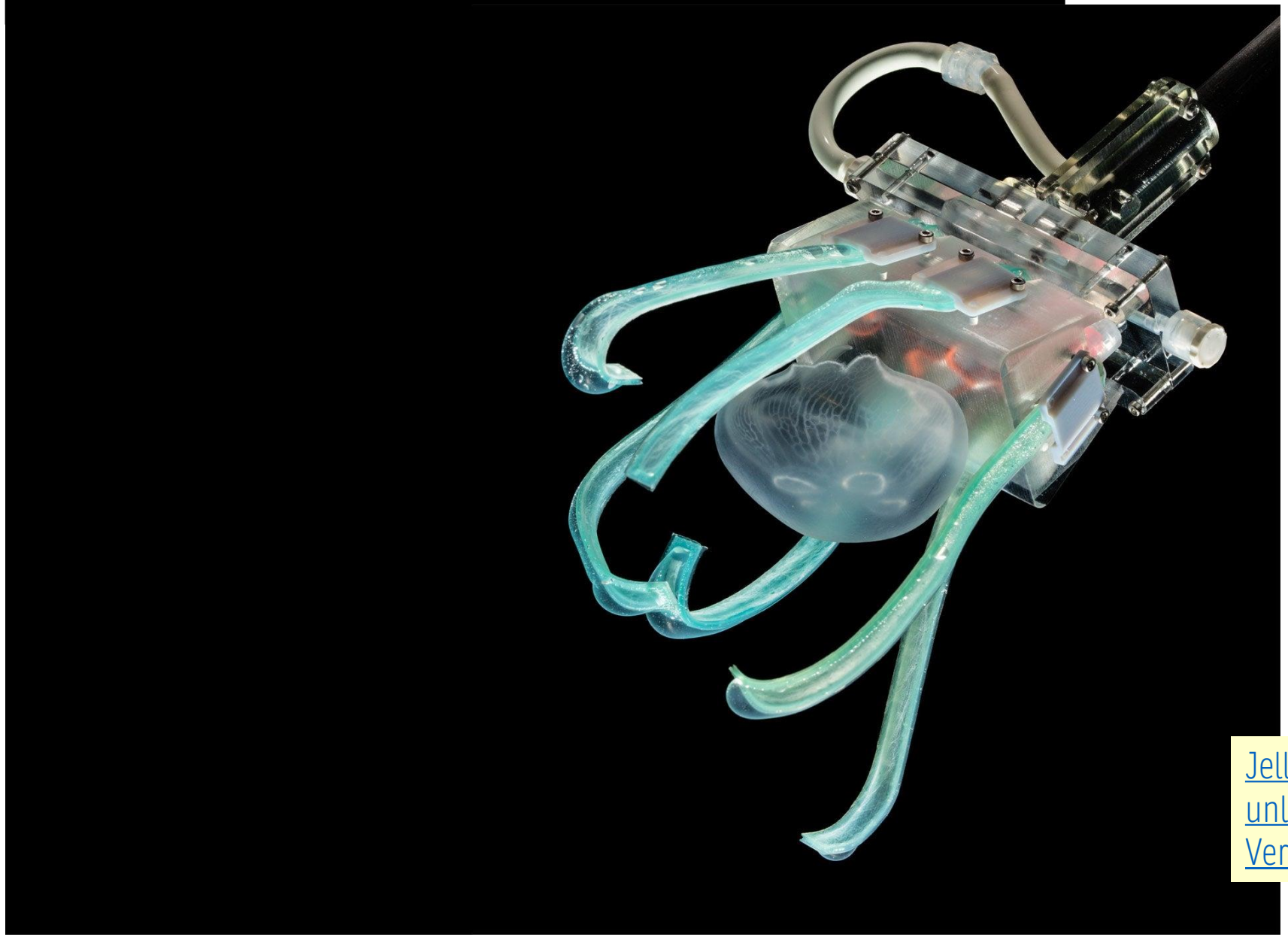


Illustration of hybrid design combining two universal jamming grippers to form a "clamshell" that allows the grippers to grab something not necessarily lying horizontally on the ground. *Image courtesy of Alexander Yin, Stephen Licht, and Brennan Phillips.*

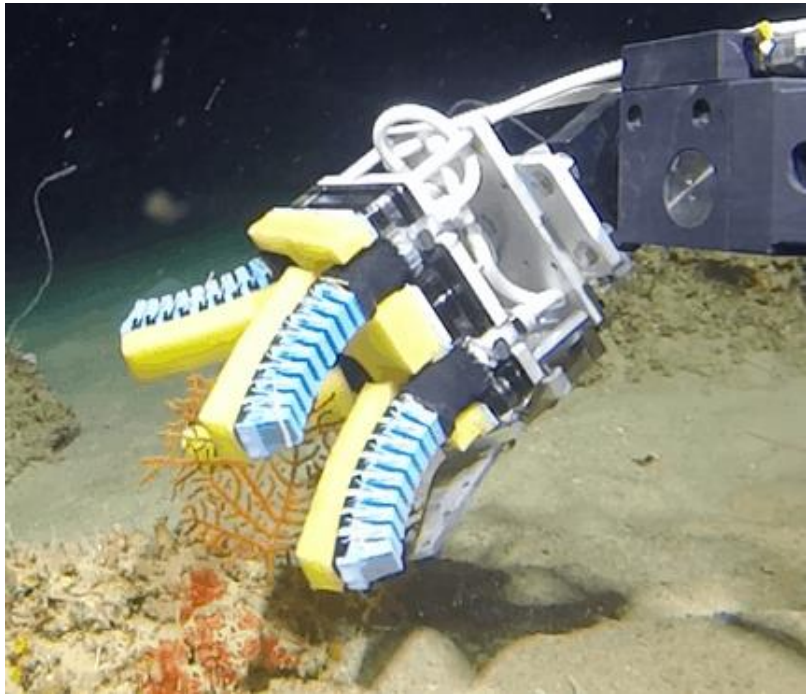
Download largest version (jpg, 1.3 MB).

SOFT ROBOTICS FOR MARINE RESEARCH



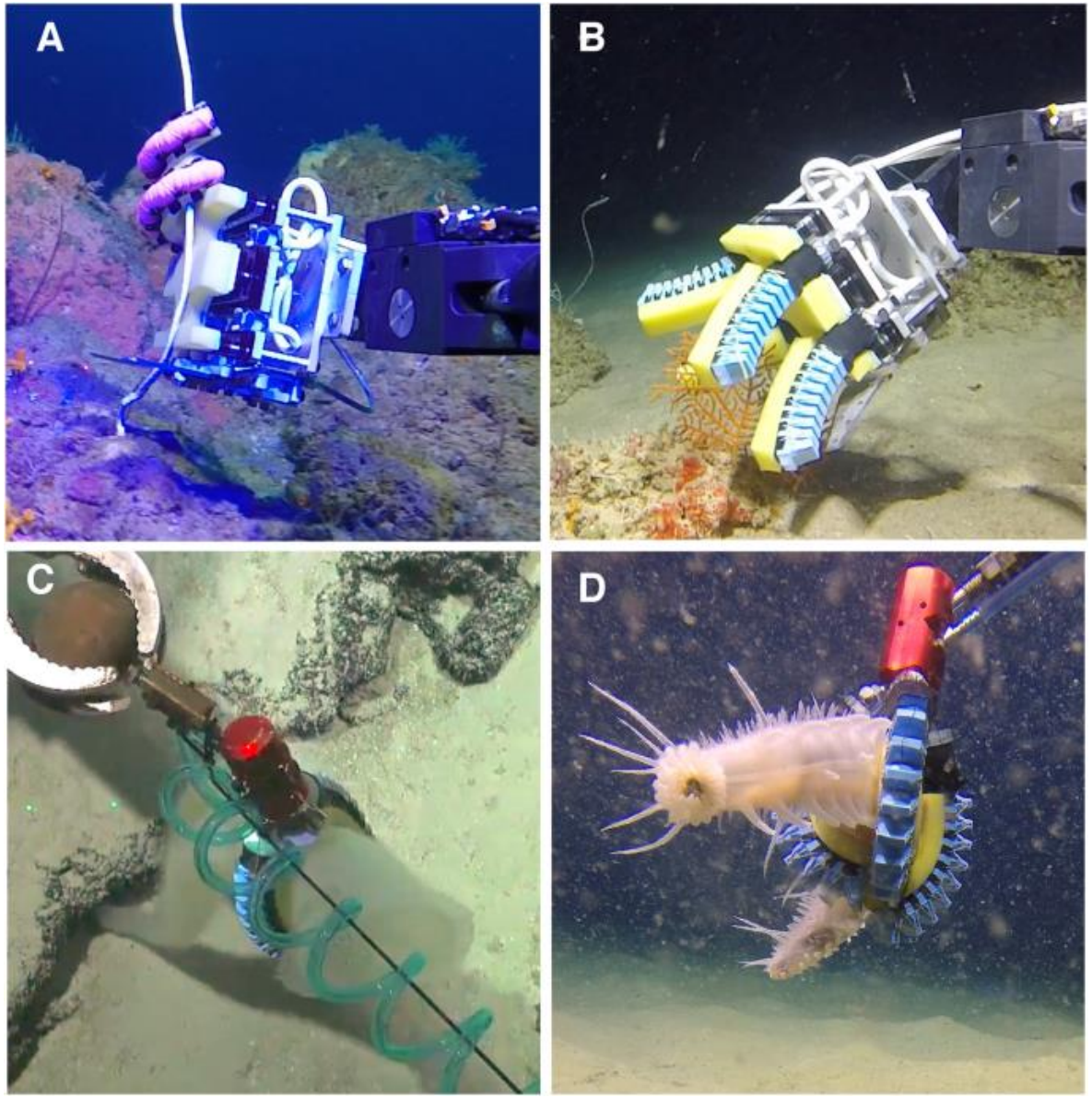
Jellyfish-catching soft robot to unlock vital marine research - Verdict

SOFT ROBOTICS FOR MARINE RESEARCH



[Soft robotic grabber for subs could enhance marine science (theengineer.co.uk)]

[A Dexterous, Glove-Based Teleoperable Low-Power Soft Robotic Arm for Delicate Deep-Sea Biological Exploration | Scientific Reports (nature.com)]



THE EFFECTS OF NEW BIODEGRADABLE MATERIALS IN THE MARINE ENVIRONMENT

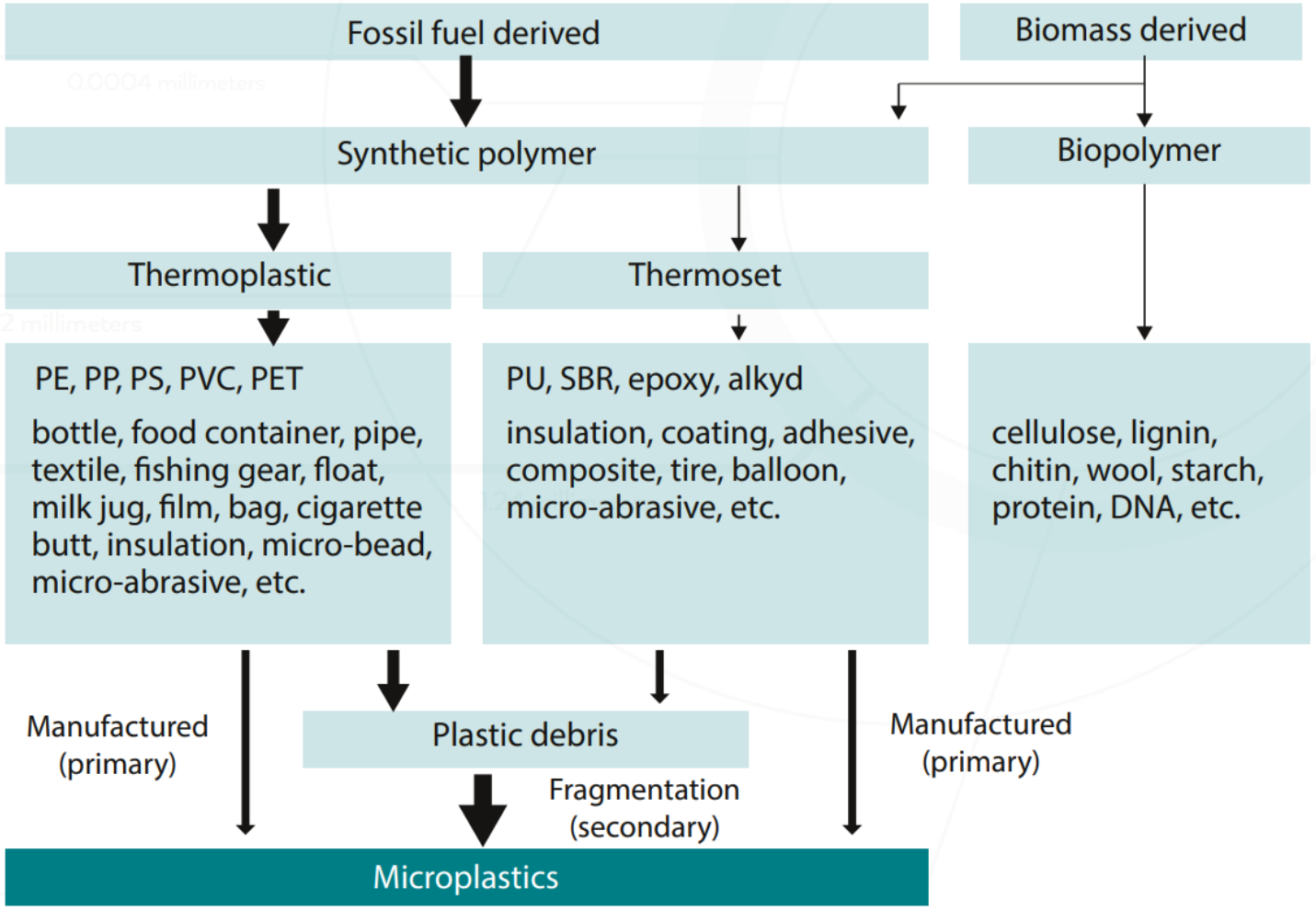
- Degradation processes: conditions required for rapid biodegradation are unlikely to occur.
- Experimental studies of biodegradation of polymers in seawater are limited.

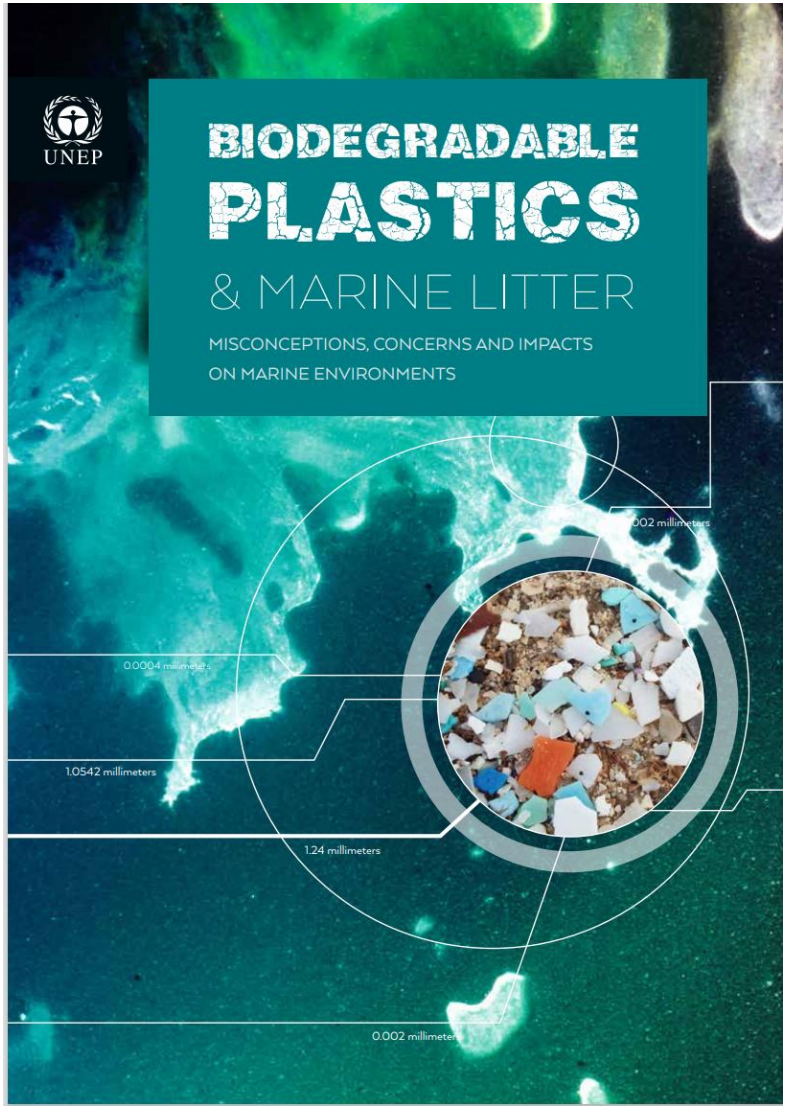
Biodegradable plastics and marine litter

PHOTO: © FOREST AND KIM STARR / CREATIVE COMMONS

[Biodegradable Plastics and Marine Litter: Misconceptions, concerns and impacts on marine environments | UNEP - UN Environment Programme]

THE EFFECTS OF NEW BIODEGRADABLE MATERIALS IN THE MARINE ENVIRONMENT





Schematic illustrating the relationship between primary materials source, synthetic and natural polymers, thermoplastic and thermoset plastics and their applications: from GESAMP, 2015