

What is fish-carbon?



Image credit: Our Fish

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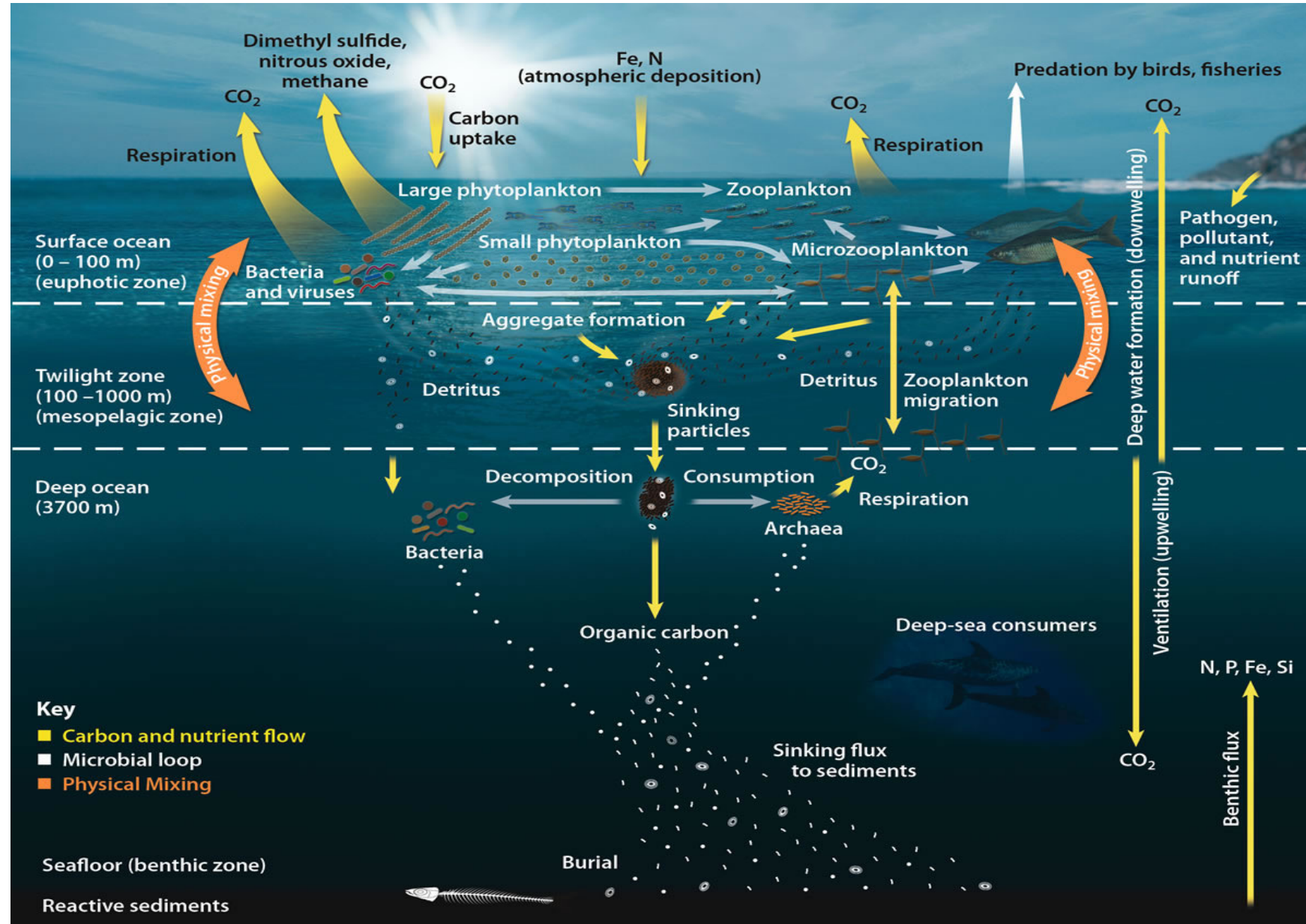


Poo!



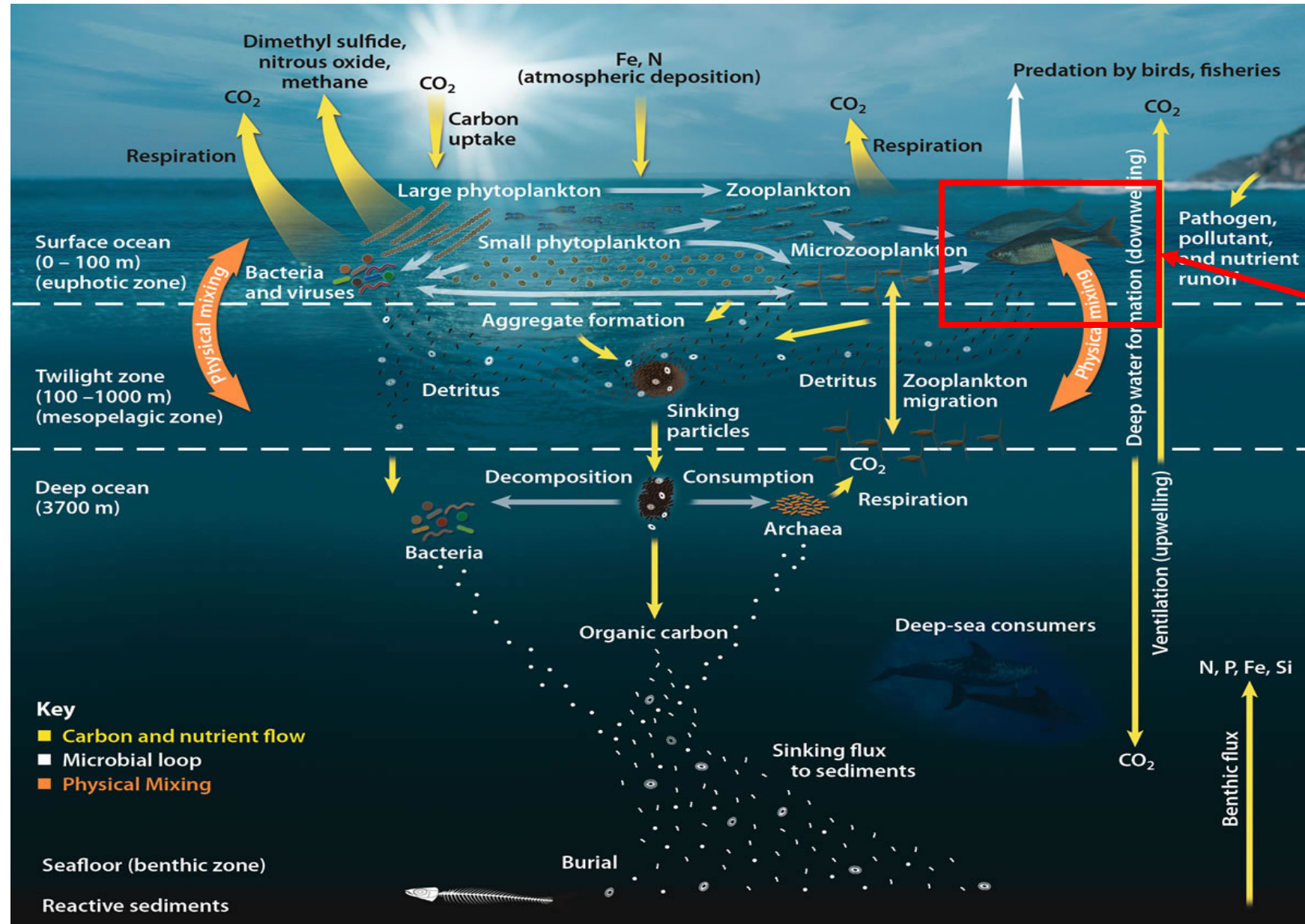
(image source: aquapona.co.uk)

Ocean biological carbon cycle



(U.S. Department of Energy Office of Science)

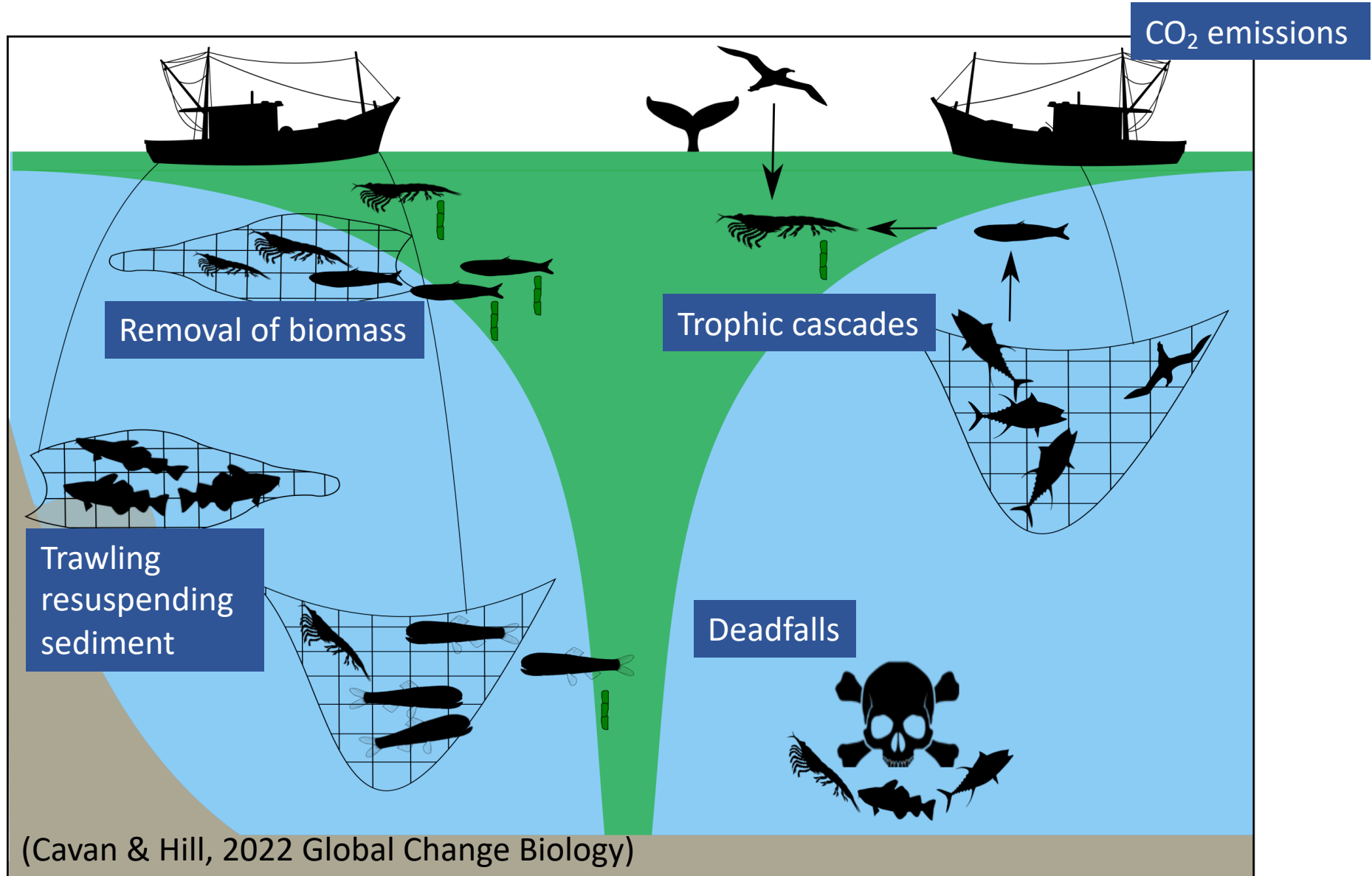
Ocean biological carbon cycle



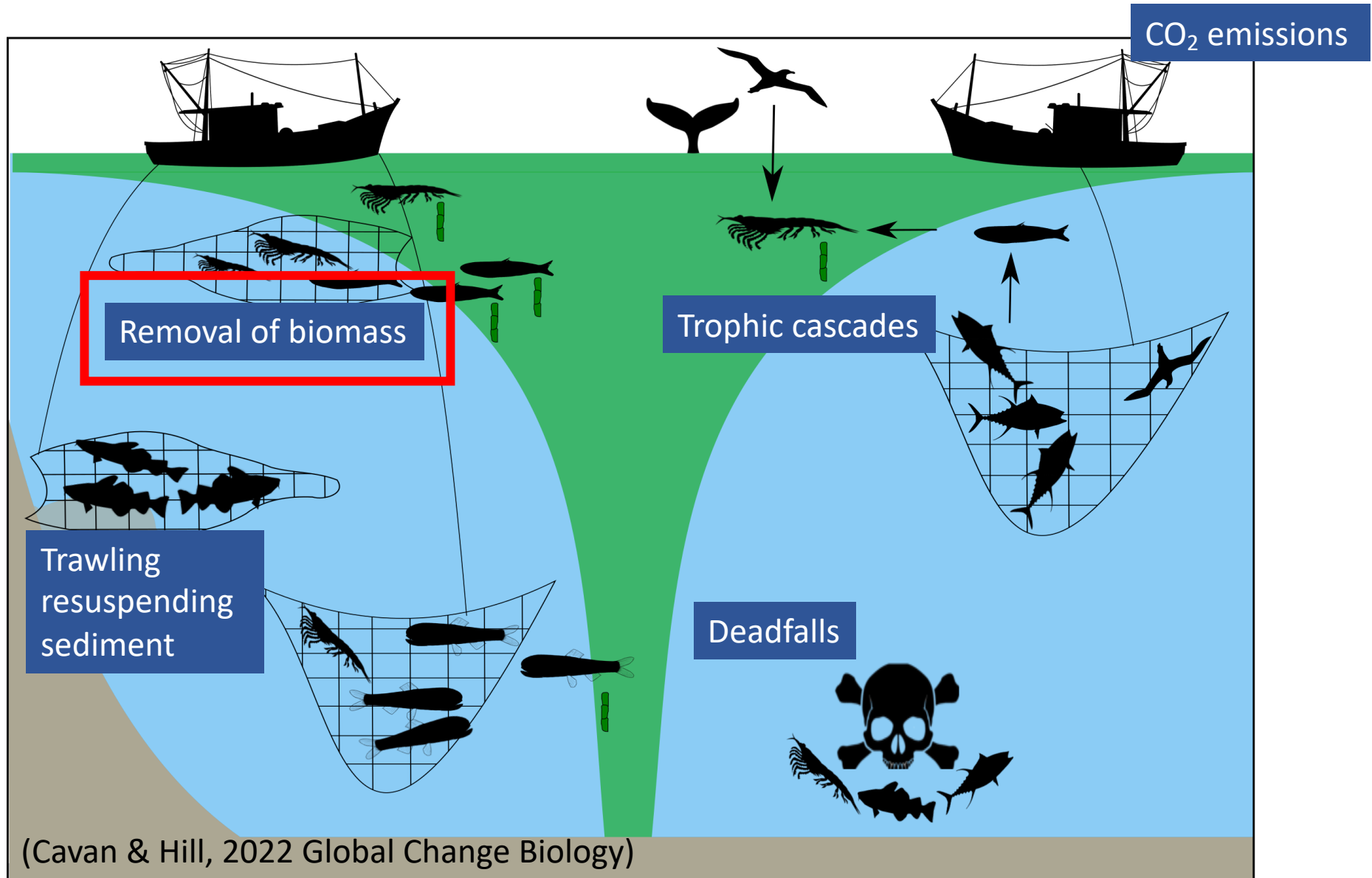
Fish!

- Sink carbon through their dead bodies and faeces
- Top-down controls on lower trophic levels important in sinking carbon

Fishery impacts to ocean carbon pump



Fishery impacts to ocean carbon pump



Removal of biomass

- Harvesting fish or other animals potentially reduces:
 - Carbon flux to seafloor from faeces, carcasses and moults (crustaceans)
 - Transfer of CO₂ to deep as part of active migrations (fish, squid, crustaceans)
 - Living biomass storing carbon for short timescales



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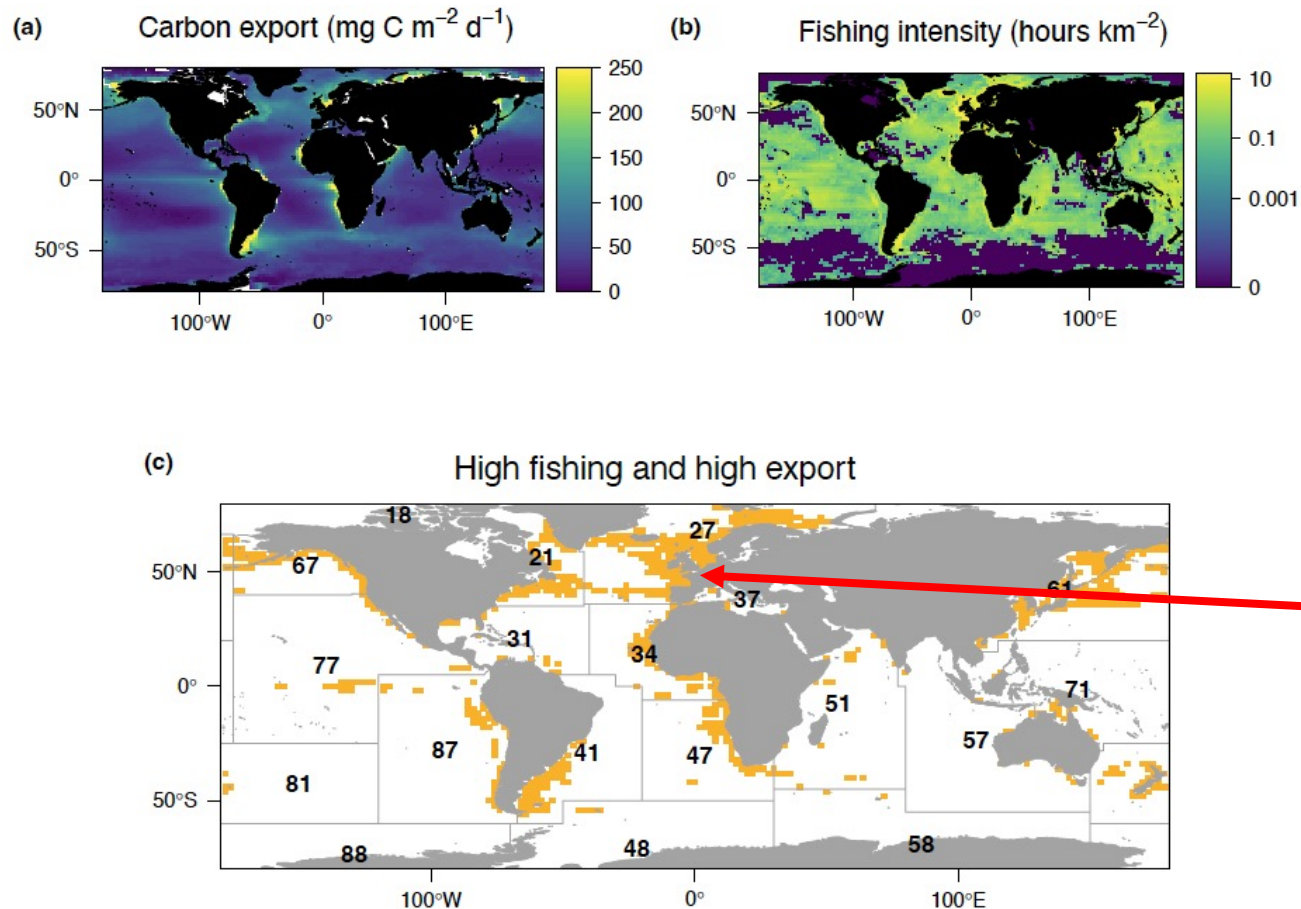
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- Evidence for fish contribution from the poo
 - Sink quickly at 100's meters per day to deep ocean
 - Contributes to ~ 16 % of total organic carbon sink from surface ocean (Saba et al 2021)



Saba and Steinberg, 2012

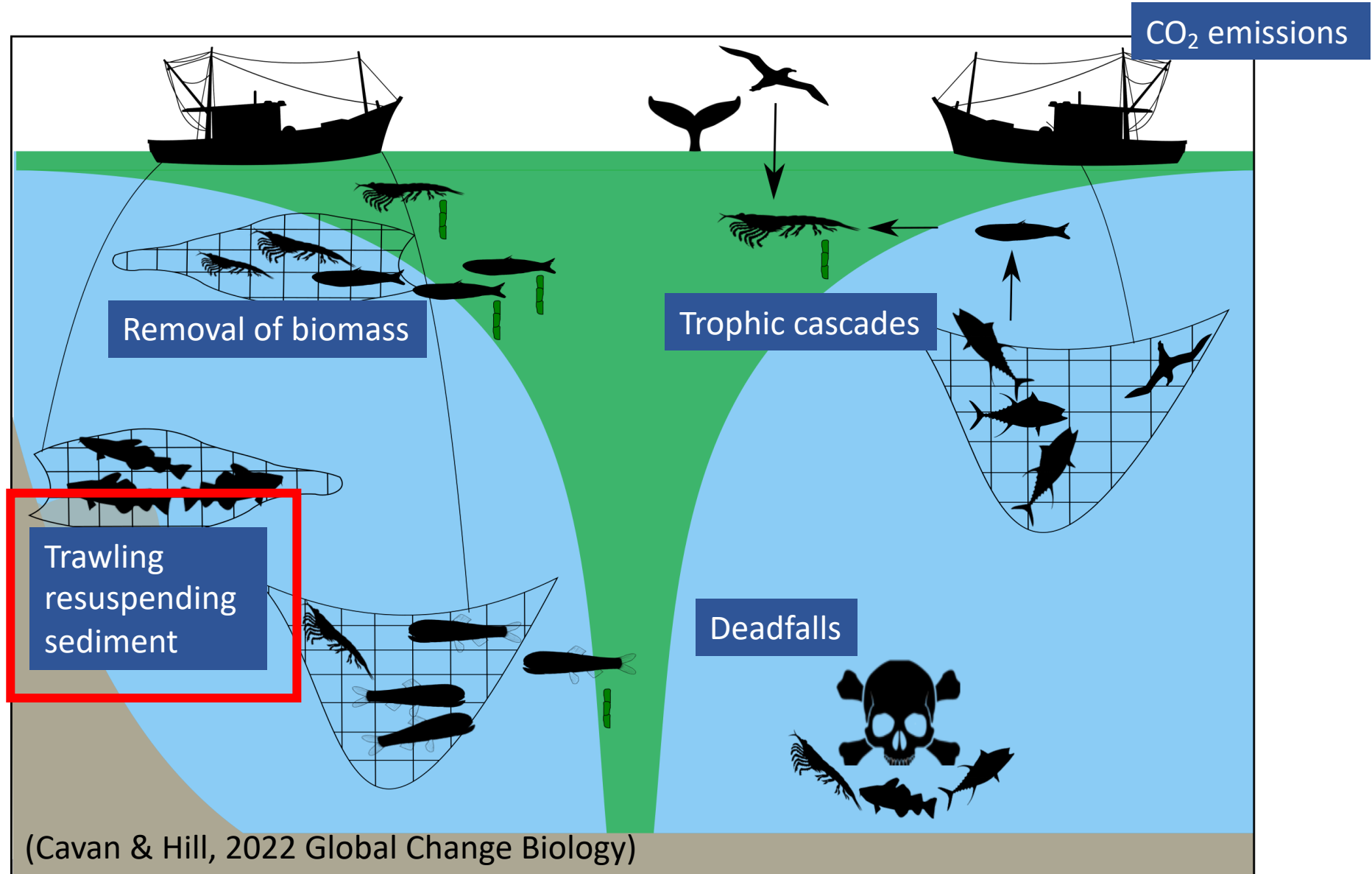
Removal of biomass

- Quantifying fish contribution to biological pump stimulated estimates on fisheries on carbon and nutrient cycling



- Fishing and carbon export driven by primary production
- High overlap of fishing intensity and upper ocean carbon sink around coasts and in some open-ocean areas
- European seas potentially have big impact from fishing on carbon sinks

Fishery impacts to ocean carbon pump



Benthic trawling resuspended sediment

- Headlines from work by Enric Sala et al 2021 stimulated large new area of research

The New York Times

Trawling for Fish May Unleash as Much Carbon as Air Travel, Study Says

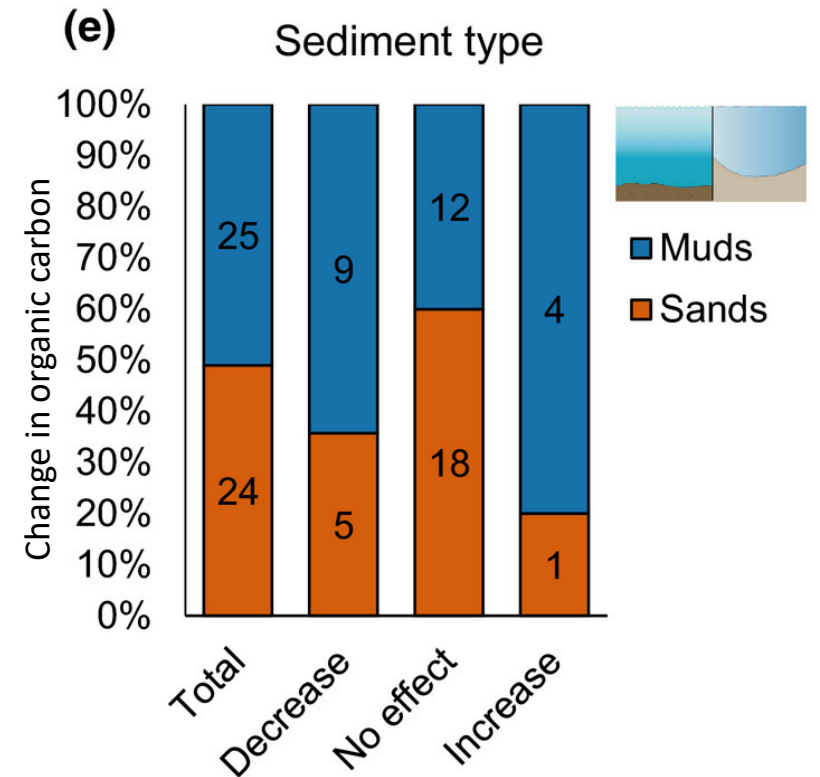
The report also found that strategically conserving some marine areas would not only safeguard imperiled species but sequester vast amounts planet-warming carbon dioxide, too.



- Many scientists believe this is probably an over-estimate, but... still potentially a big problem

Benthic trawling resuspended sediment

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Most studies show trawling no affect on organic carbon, some showing there is decrease, and some increasing even
(Epstein et al 2022)

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Biogeosciences, 18, 2539–2557, 2021
<https://doi.org/10.5194/bg-18-2539-2021>
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De Borger et al 2021

Impact of bottom trawling on sediment biogeochemistry: a modelling approach

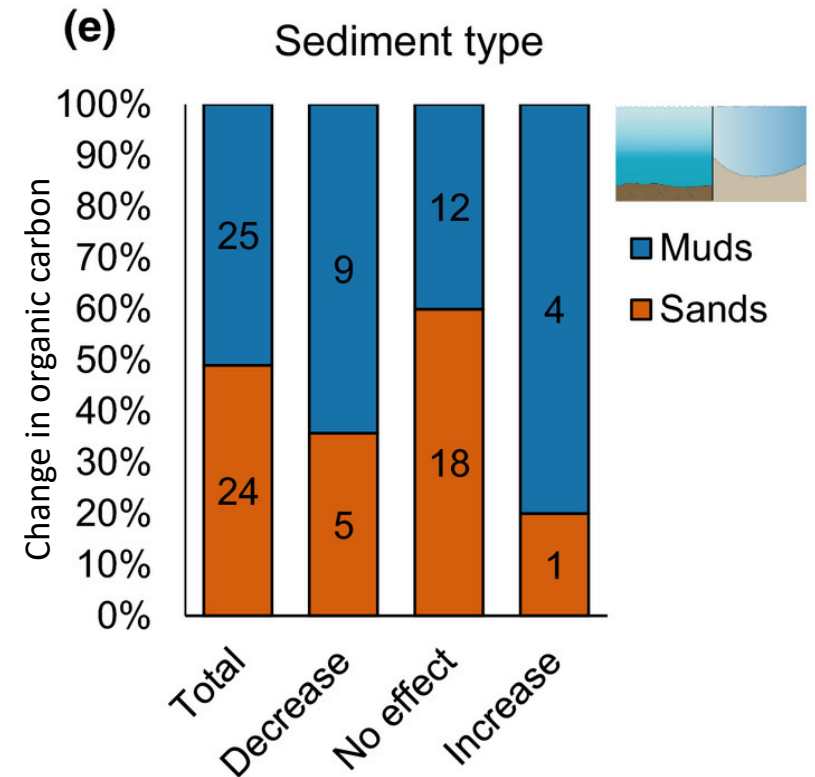
Emil De Borger^{1,2}, Justin Tiano^{2,1}, Ulrike Braeckman¹, Adriaan D. Rijnsdorp³, and Karline Soetaert^{2,1}

manuscript submitted to *Geophysical Research Letters*

Preprint – Zhang et al

Impact of bottom trawling on long-term carbon sequestration in shelf sea sediments

W. Zhang¹, L. Porz¹, R. Yilmaz¹, J. Kuhlmann², A. Neumann³, B. Liu⁴, D. Müller⁴, T. Spiegel⁵, M. Holtappels^{4,8}, N. Ziebarth², B. Taylor², K. Wallmann⁵, S. Kasten^{4,7,8}, U. Daewel¹ and C. Schrum^{1,6}



Most studies show trawling no affect on organic carbon, some showing there is decrease, and some increasing even (Epstein et al 2022)

Geophysical Research Letters
 Geophysical Research Letters homepage

Research Letter | Open Access Paradis et al 2021

Persistence of Biogeochemical Alterations of Deep-Sea Sediments by Bottom Trawling

S. Paradis[✉], M. Gofii, P. Masqué, R. Durán, M. Arjona-Camas, A. Palanques, P. Puig



Continental Shelf Research
 Volume 233, 15 January 2022, 104628

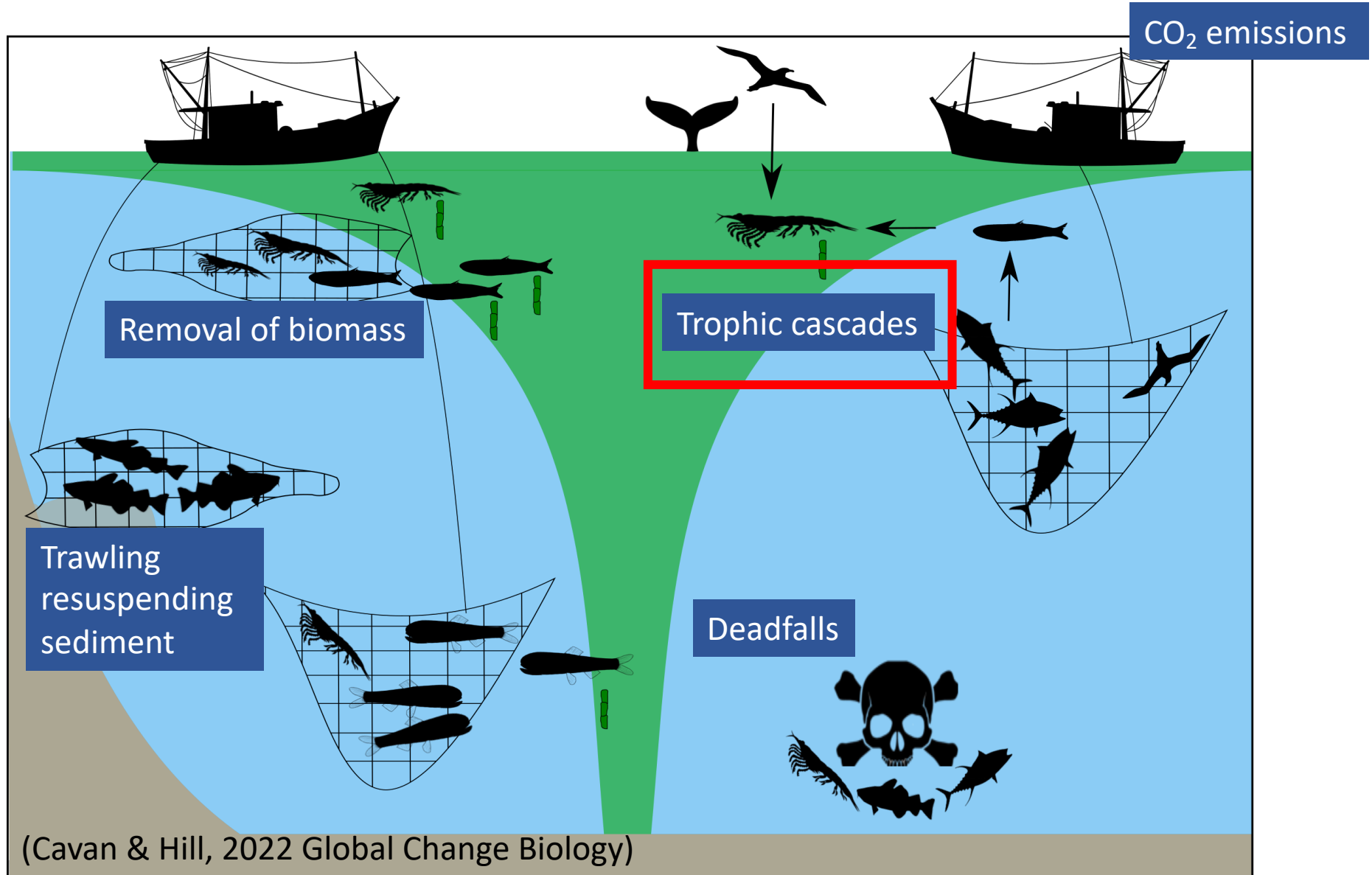


Breimann et al 2022

Quantifying the resuspension of nutrients and sediment by demersal trawling

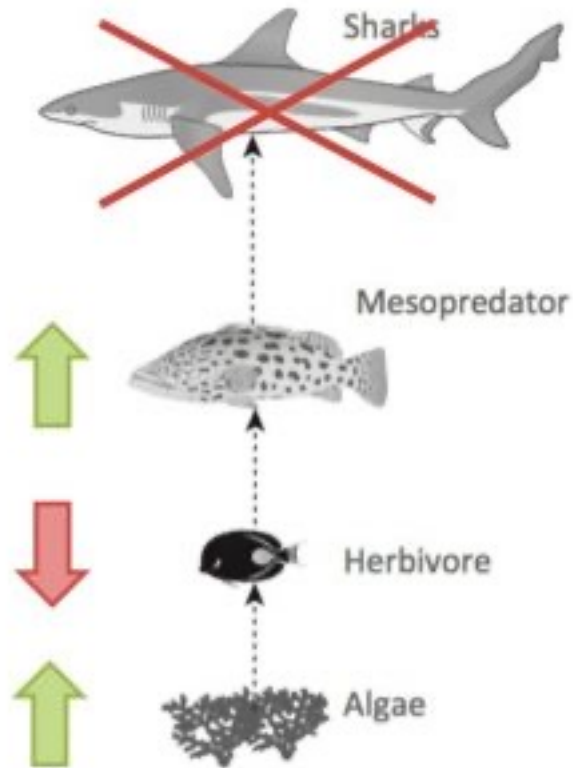
Sarah A. Breimann^{a b c}, Finbarr G. O'Neill^{b d}, Keith Summerbell^b, Daniel J. Mayor^a

Fishery impacts to ocean carbon pump



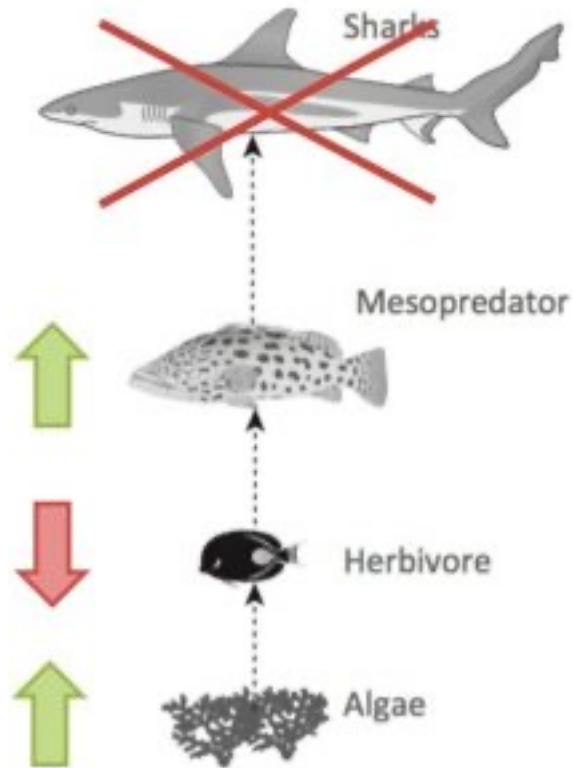
Trophic cascades

- Removal of mid-high trophic levels, may change lower trophic level community structure, where a lot of carbon export and flux occurs

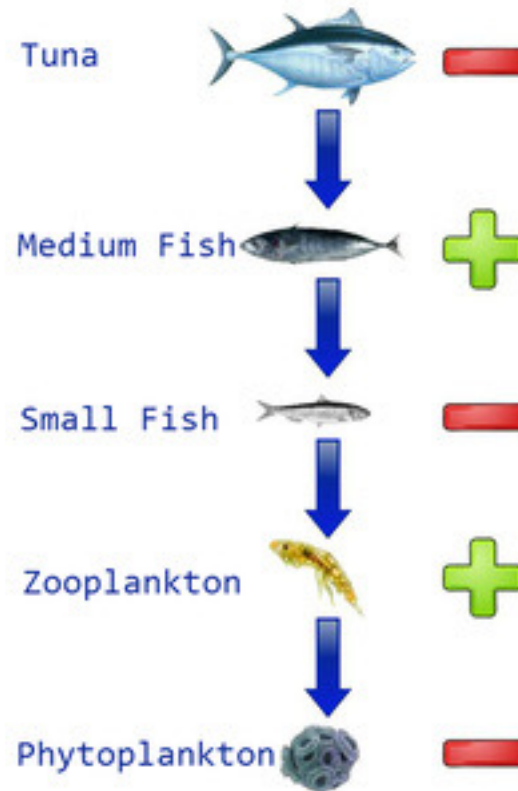


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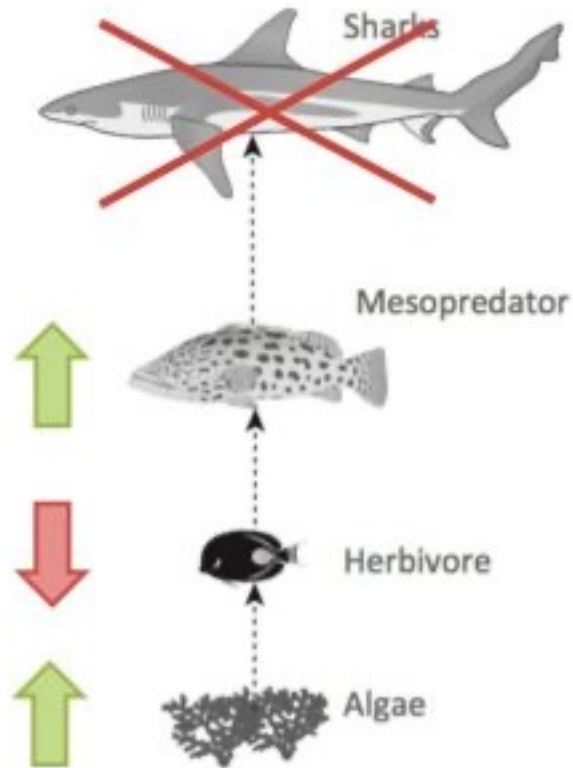
(www.blogs.cofc.edu)



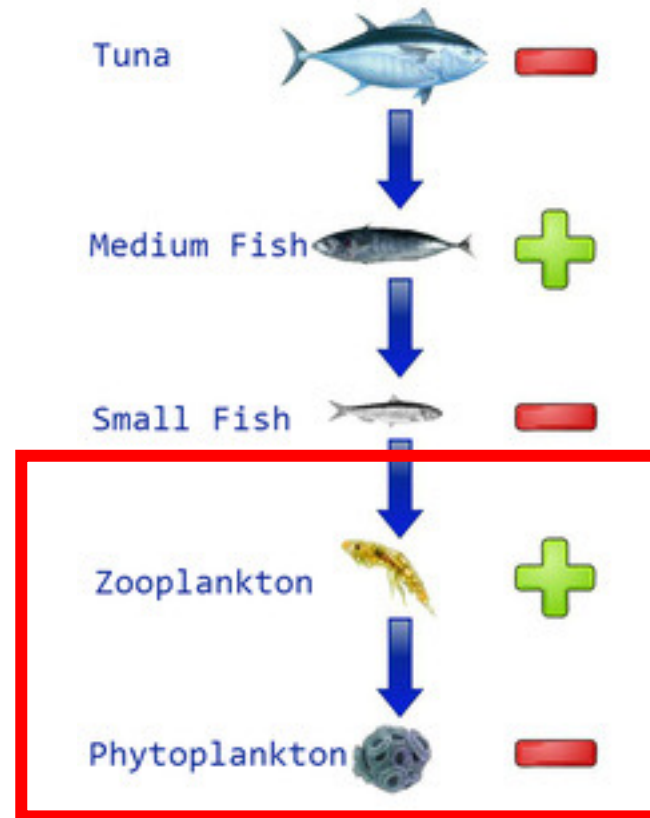
(notenoughfishes.weebly.com)

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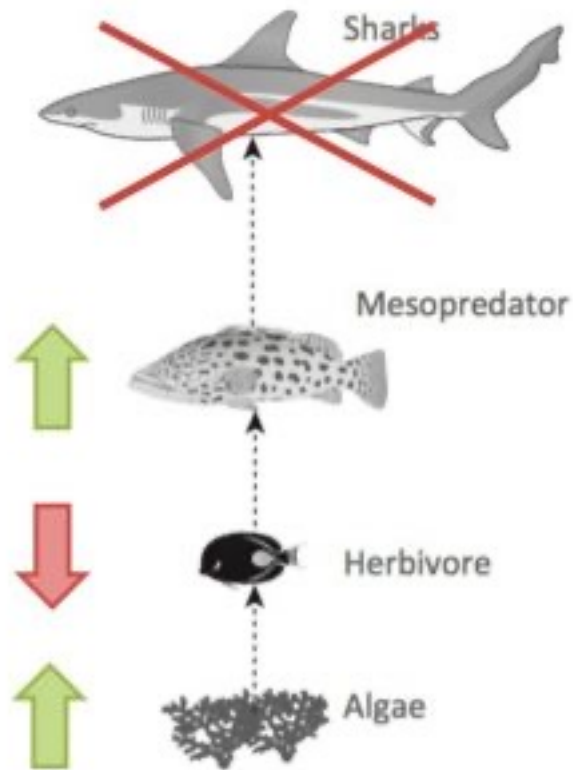


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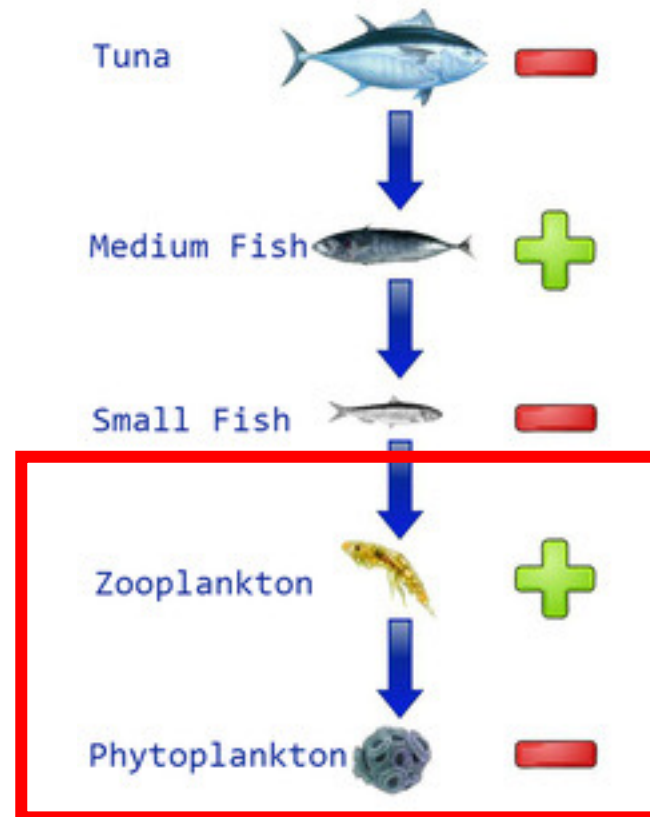
Big carbon sinkers

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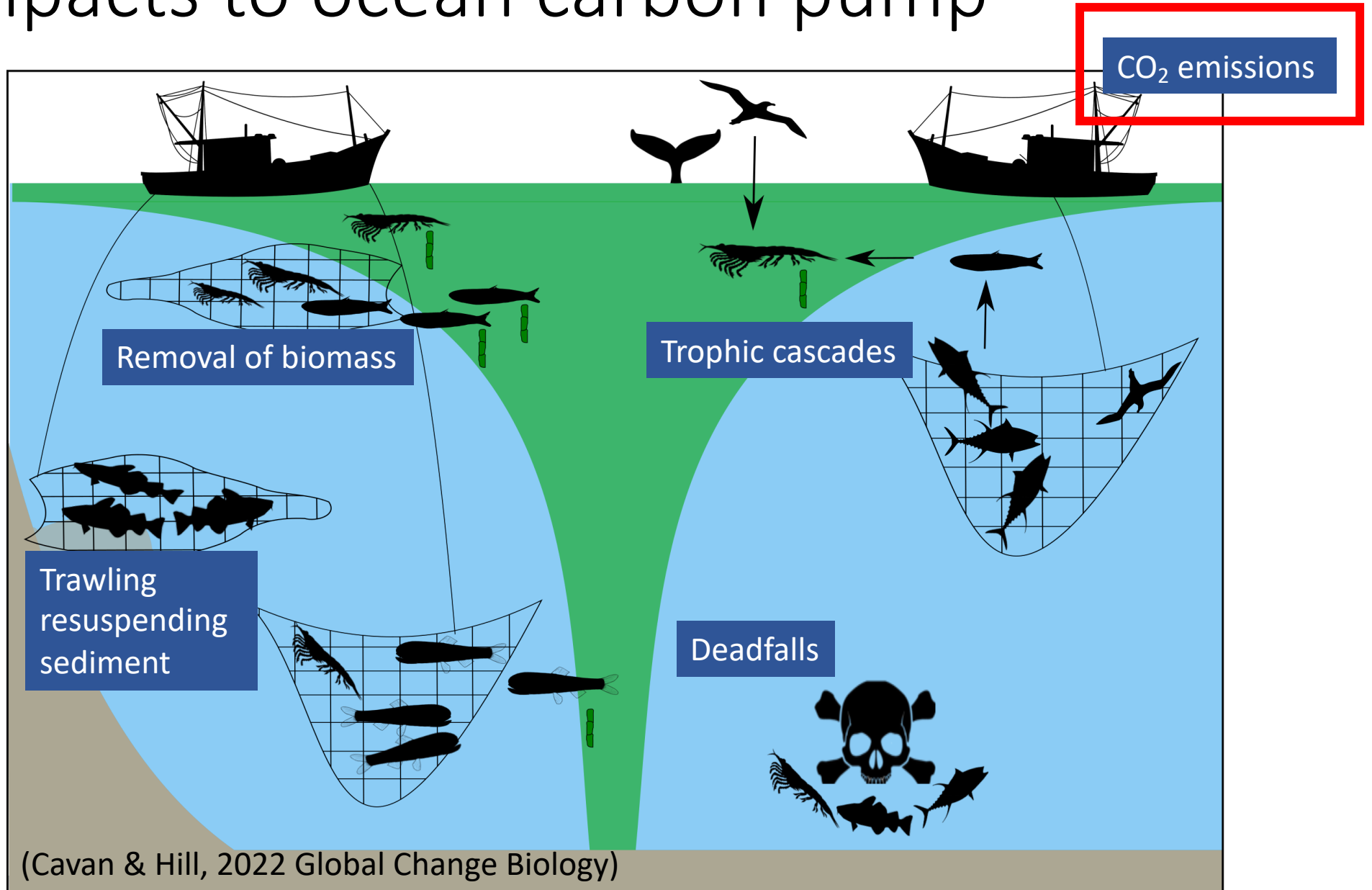


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- Particularly relevant to changes lower down food chain such as phytoplankton, zooplankton, krill and small pelagic fish
- Much more to do on this topic

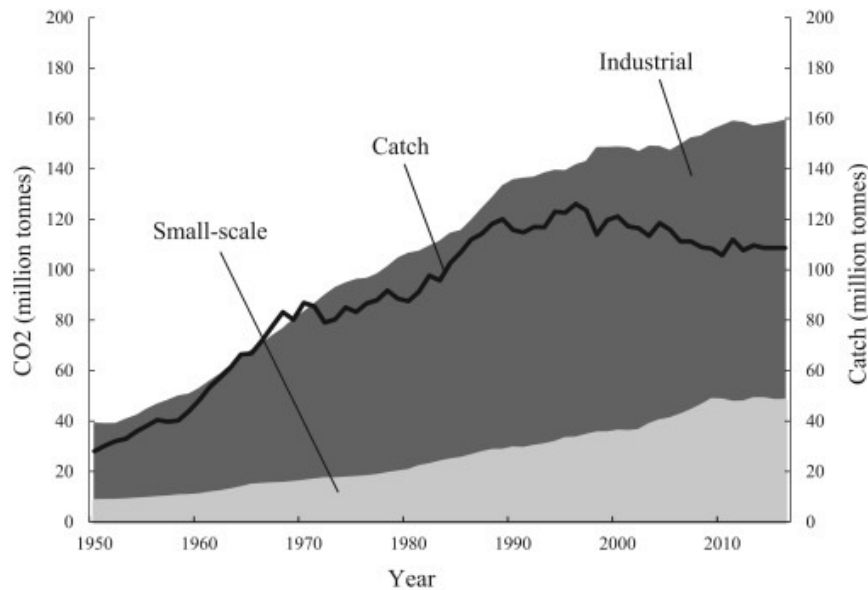
Big carbon sinkers

Fishery impacts to ocean carbon pump



Emissions for fishery vessels

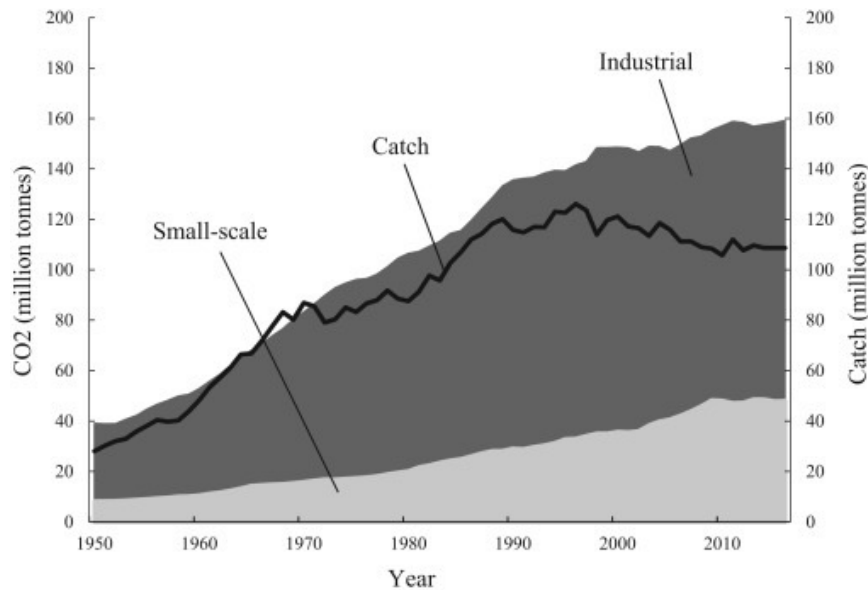
- Fishery vessels mostly fueled by fossil fuels
- Release ~ 180 million tonnes of CO₂-equivalent GHG, 4 % of food production (Parker et al 2018)
- Fishing is not cost efficient, and fuel subsidies support a large proportion of industrial fishery activities



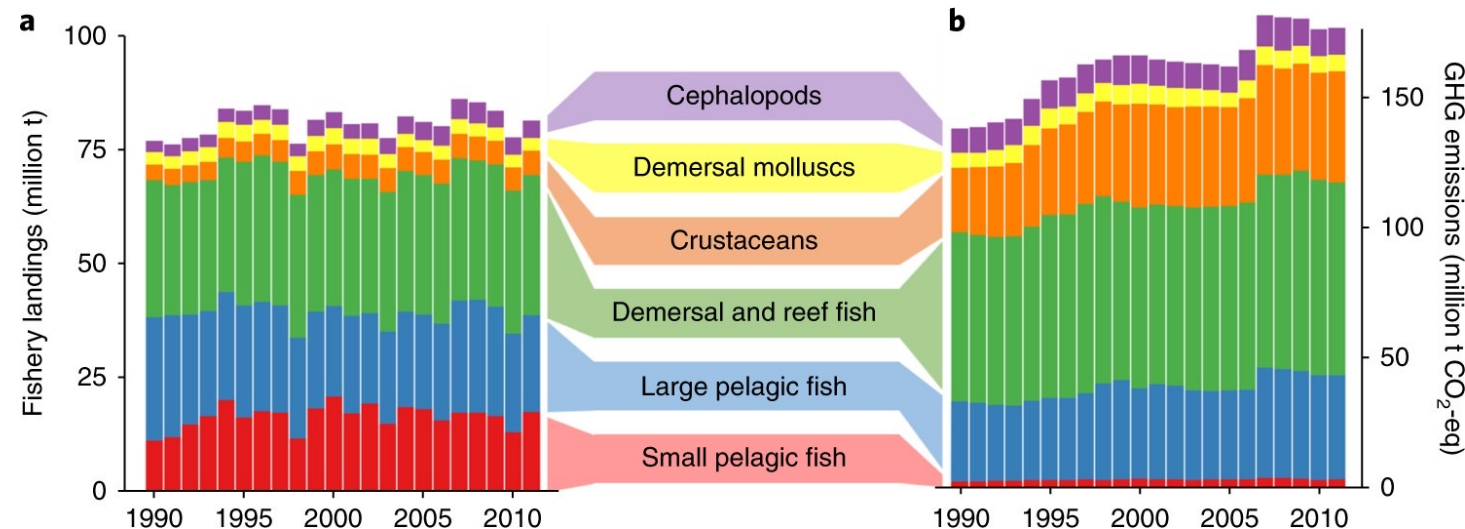
Greer et al 2019

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Greer et al 2019



Parker et al 2018



Summary

- Fish and other harvested marine life can be important in ocean carbon cycle
- Fisheries may disrupt sink by:
 - Removing key carbon sinkers
 - Releasing carbon stored in sediments via bottom trawling
 - Causing trophic cascades reducing key carbon sinkers
 - Contributing to greenhouse gas (CO₂) emissions
- Enough research to act now regarding emissions and subsidies, with more coming out now and over the next few years which will enable policy makers to act regarding biomass.