Seafood and Climate Change

Insights from Life Cycle Assessments

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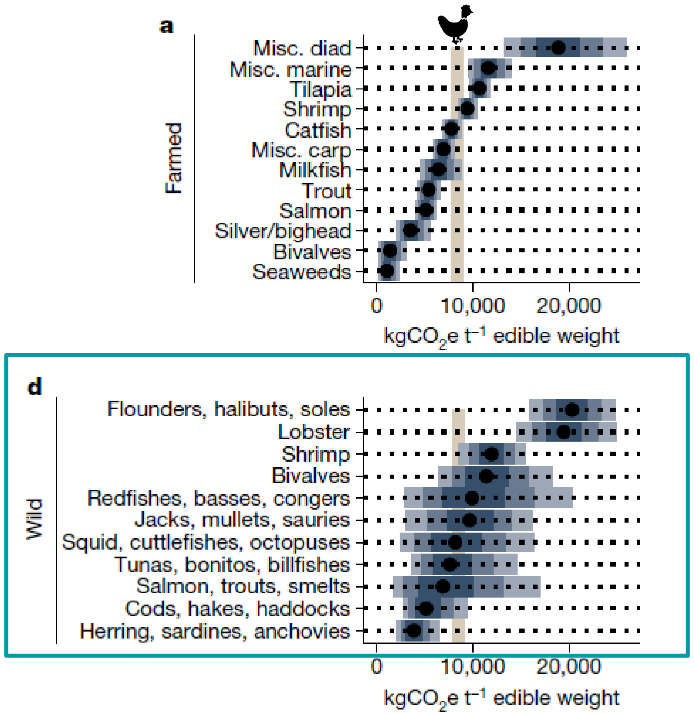
Nordic Climate Change Forum for Fisheries and Aquaculture, Dec 9 – 10 2021, Helsingør

Today's talk

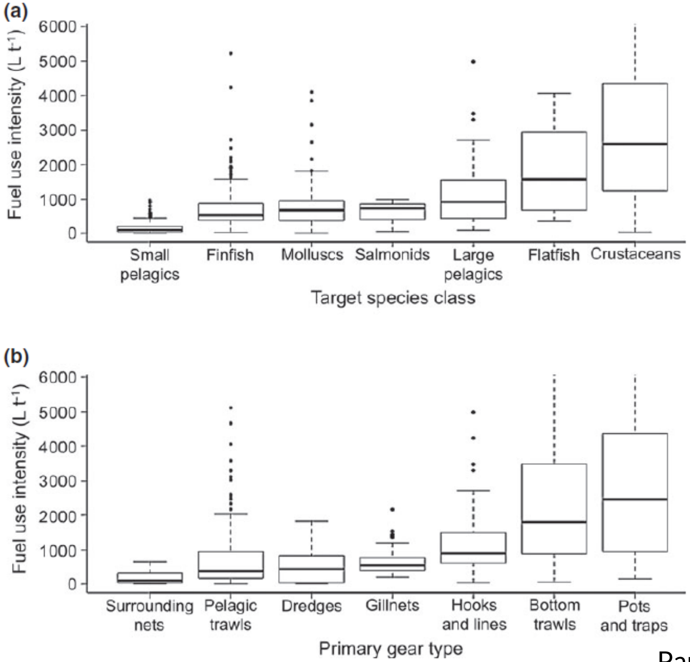
- Greenhouse gas emissions (GHG) of seafoods
  - Variability
  - Drivers
  - Reduction potentials
- Opportunities and challenges for industry and policy

Seafood – carbon footprint overview



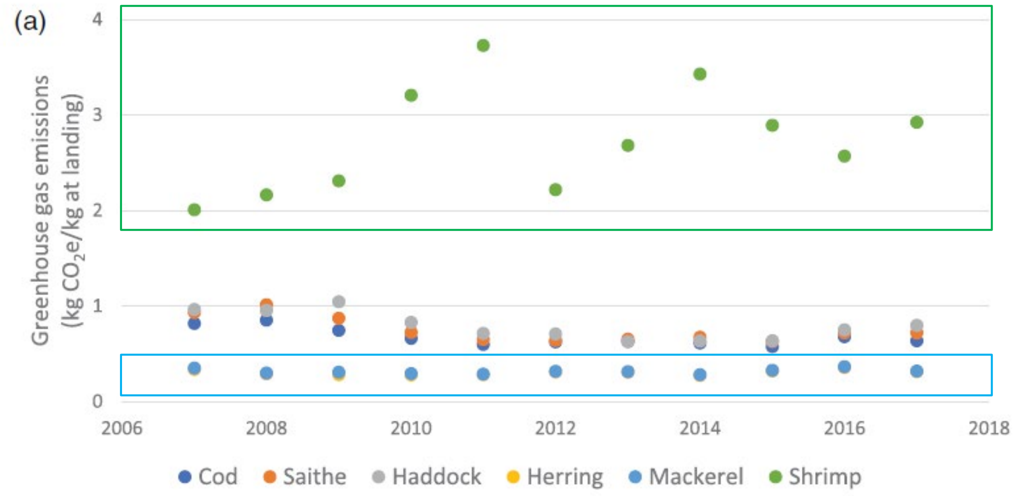
Gephart et al. (2021) Environmental performance of blue foods. Nature 597; 360-366

Capture fisheries: drivers and variability



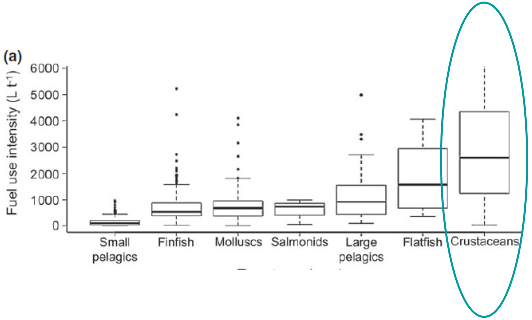
Parker & Tyedmers (2014) Fuel consumption of global fishing fleets: current understanding and knowledge gaps. Fish and Fisheries 16, 684-696

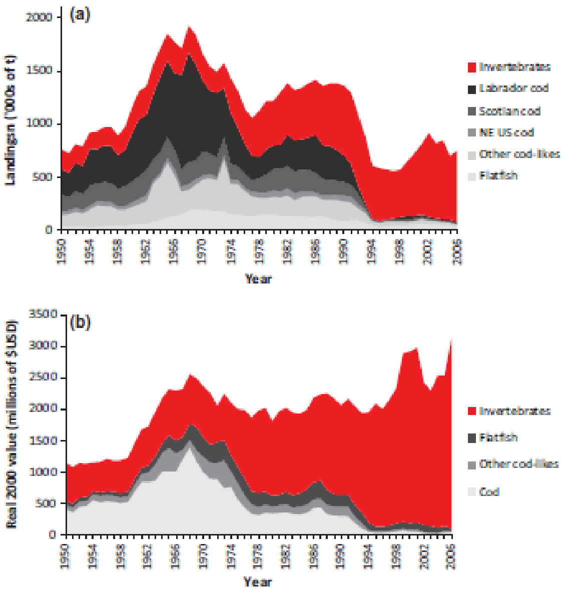
Example: Norwegian fisheries



Ziegler et al. (2021) Greenhouse gas emissions of Norwegian seafoods. From comprehensive to simplified assessment. J Ind Ecol 1-12

Ecosystem changes
"Simplifying the Sea"





Low edible yield

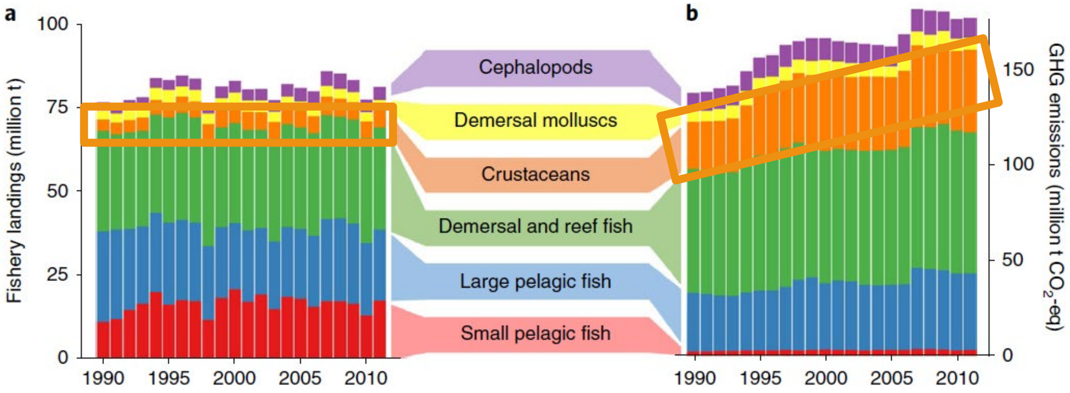
Higher risks

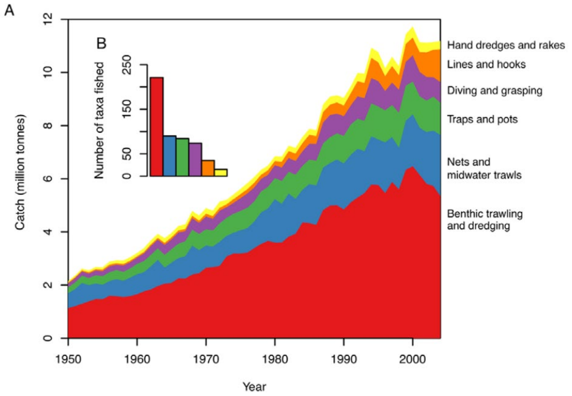
Climate change

Howarth et al. (2014) The unintended consequences of simplifying the sea: making the case for complexity. Fish and Fisheries 15, 690-711.

Capture fisheries - trends

Global GHG development





Parker et al. (2018) *Nature climate change* 8; 333-337
Anderson et al. (2011) *PloS ONE* 6, e14735

Stock status

Detail no. 1

- **Iceland** (1997-2018): CO_2 emissions from *ITQ regulated fishing* fleet fell per unit catch (~40%) – overall catches and abundance by far the most important factors[1]
- **Norway** (2003-2012): increasing energy efficiency correlated with catch per days at sea, *fish stock biomass*, quota, and fuel price (little evidence of reductions from technological improvements)[2]
- **Australia**: many fisheries have decreased in fuel consumption, particularly in response to *increases in biomass and decreases in overcapacity*[3]
- **Theoretical:** l/kg rises hyperbolically with fishing effort— relatively flat at low levels of effort but rises steeply as effort increases and biomass and catch decline

[1]Kristofersson et al. (2021) *ICES Journal of Marine Science* 78, 2385-2394.
[2]Jafarzadeh et al. (2016) *Journal of Cleaner Production* 112, 3616-3630.
[3]Parker et al. (2015) *Journal of Cleaner Production*, 87, 78-86.
[4]Hornborg & Smith (2020) *ICES J Mar Sci* 77, 1666-1671.

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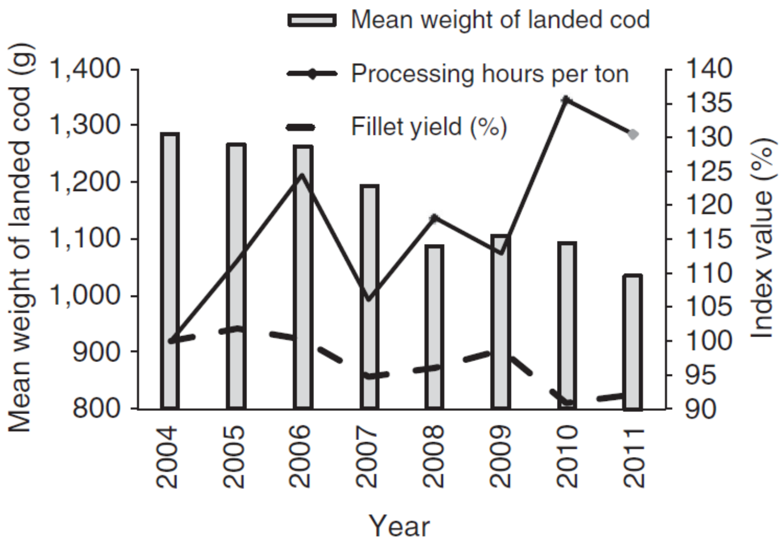
Size matters

Detail no. 2



Svedäng & Hornborg (2014) Selective fishing induces density-dependent growth. Nature communications 5, 1-6.

Local management actions/fleets

Detail no. 3

- Lobster fishing in NW Atlantic: fishing in the US requires 3 times as much bait than in Canada (3 kg herring/kilo lobster) – but the same fuel use[1]
- Different fleets fishing on the same stock (*Pandalus borealis*) exhibit different fuel use per kg, affected by fleet structure and fishing pattern[2]
- Rock lobster Australia: possibly 80% reduction of emissions from fishing at MEY instead of MSY, but 23% increase from introduction of MPA[3]

[1]Driscoll et al. (2015) *Fish Res* 172, 385-400
[2]Ziegler et al. (2016) *ICES J Mar Sci 73*, 1806-1814
[3]Farmery et el. (2013) *J Clean Prod* 64, 368-376

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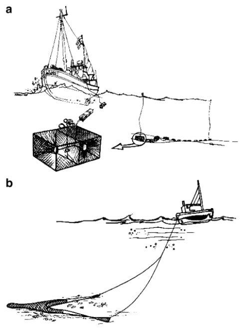
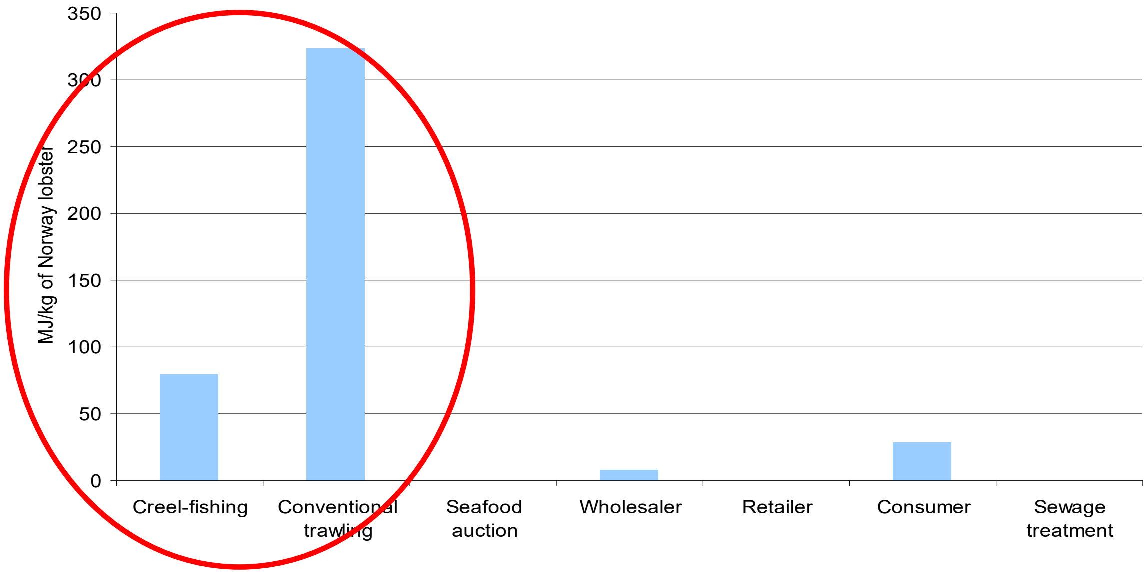
The role of fishery management

a Swedish case study





Nephrops norvegicus

Ziegler & Valentinsson (2008) *International Journal of Life Cycle Assessment 13*, 487-497

The role of fishery management

quick fixes rather than best available technology

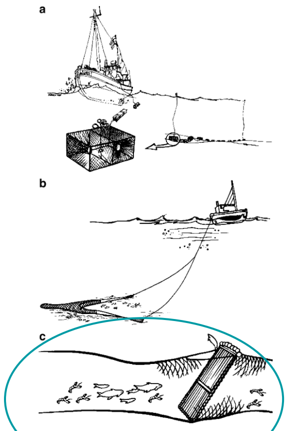
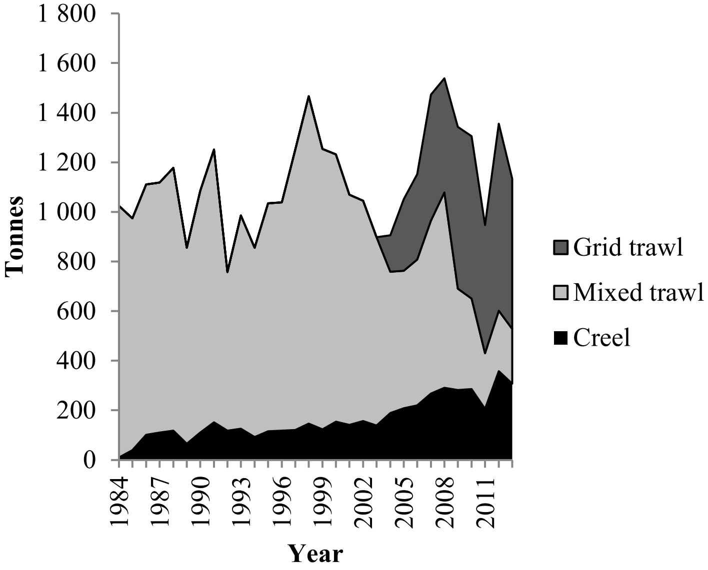
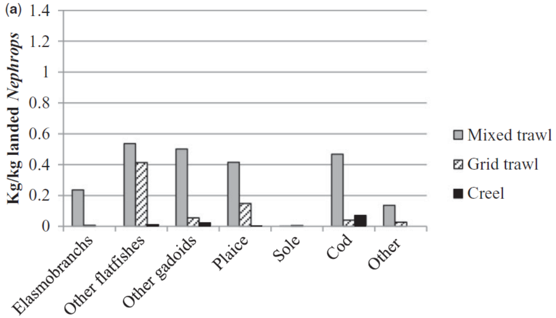
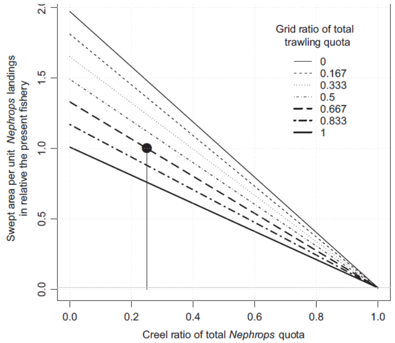


Fig. 1 Fishing gear used along the Swedish west coast to target Norway lobster a creel, b conventional single trawl, and c species-selective grid trawl (illustrations by Jürgen Asp)



Quick fix: Making a fuel-intense practice less effective





Hornborg et al. (2016)
ICES J Mar Sci 74, 134-145

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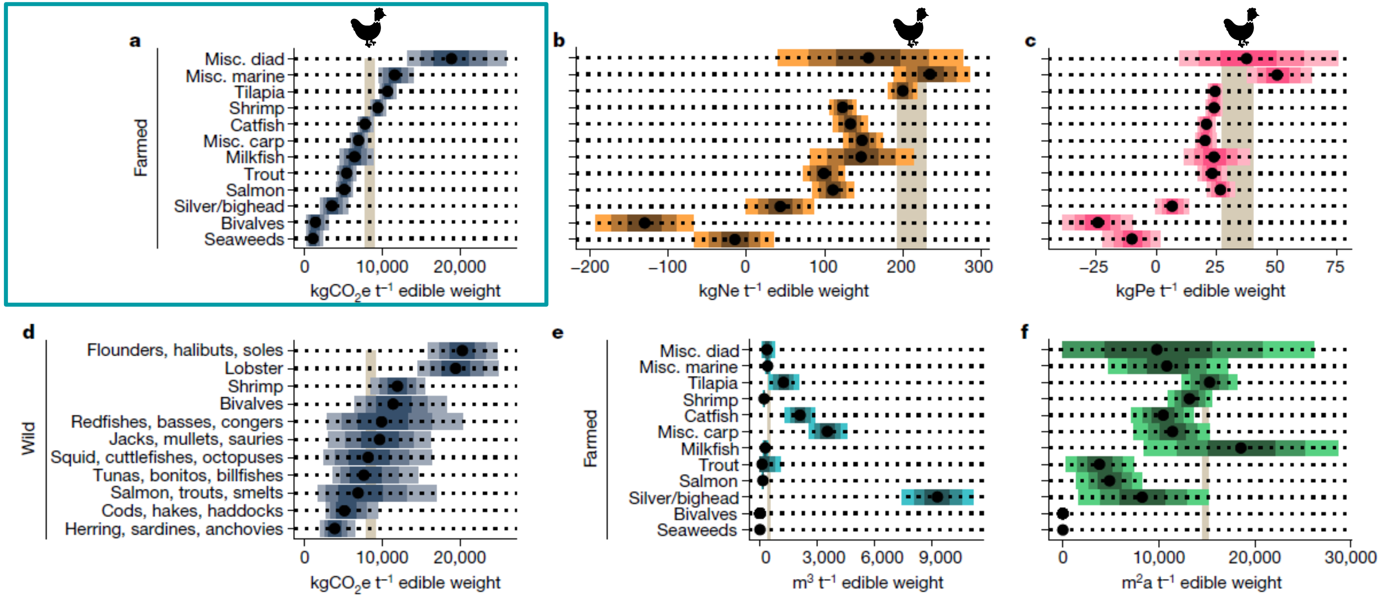
Seafood – an overview again

Eutrophication



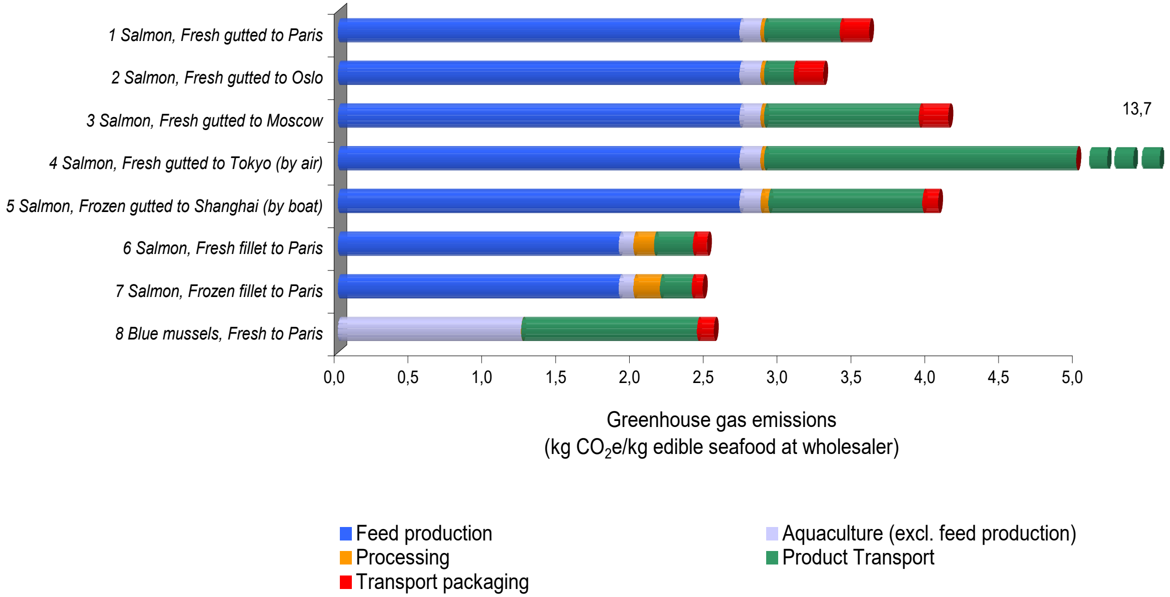
Freshwater use

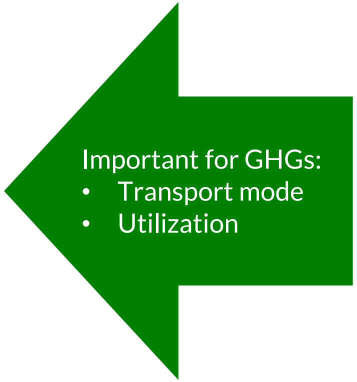
Land use

Gephart et al. (2021) Environmental performance of blue foods. Nature 597; 360-366

Farmed seafood

Norwegian examples

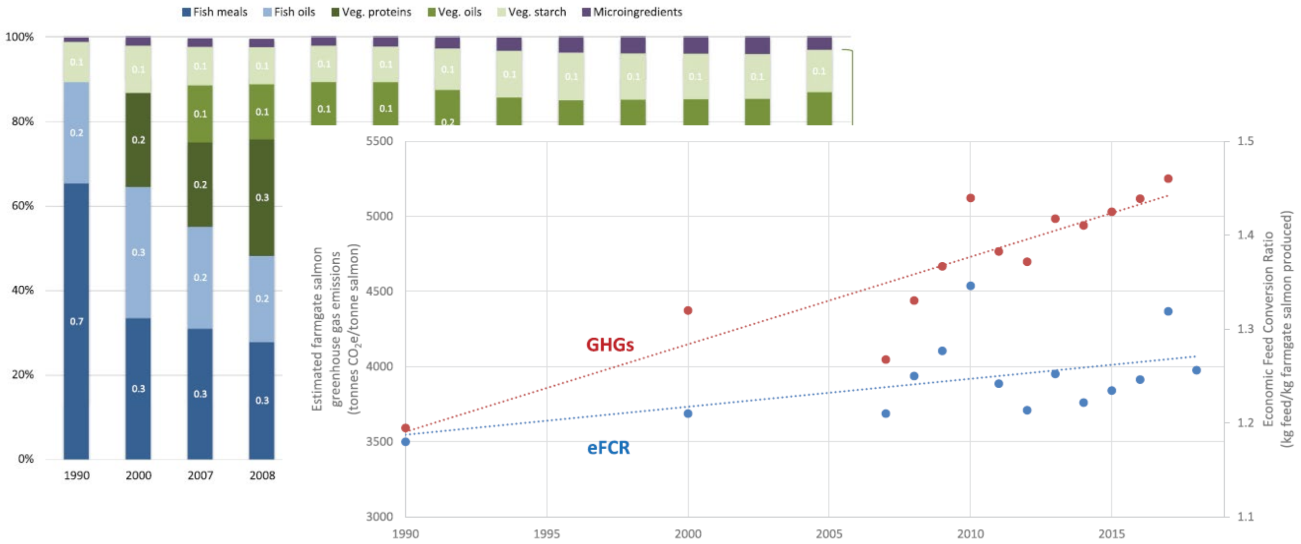




Ziegler et al. (2013) The carbon footprint of Norwegian seafood products on the global seafood market. J Ind Ecol 17, 103-116.

Feed: composition and amount

Norwegian salmon farming



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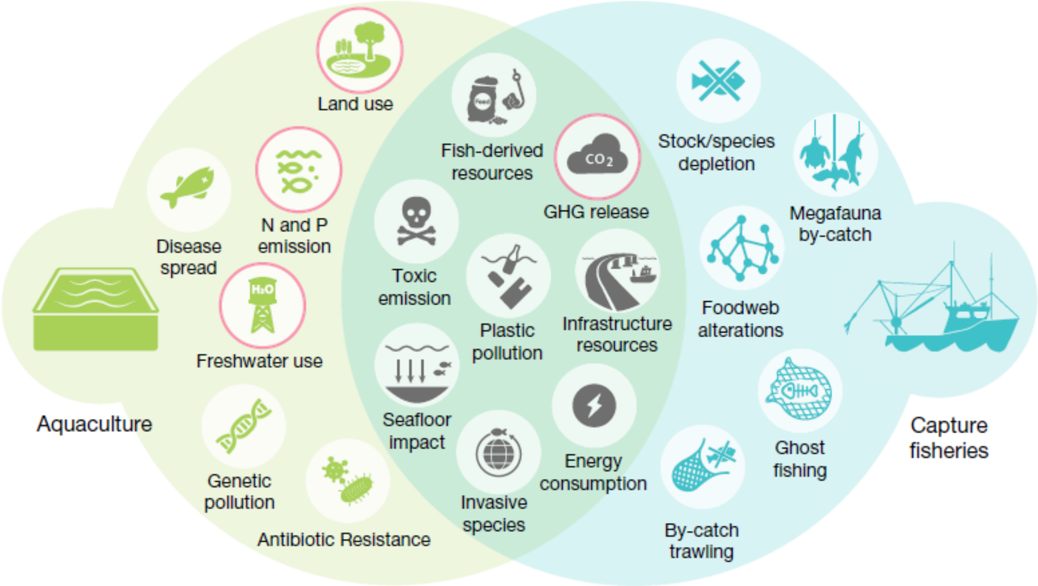
Common and unique pressures



Gephart et al. (2021) Environmental performance of blue foods. Nature 597; 360-366

Uncertainties in GHG estimates
-a brief note on knowledge gaps-

- Current estimates are highly influenced by underpinning data (e.g. age, representative) and methodological choices of the LCA (e.g. system boundaries, allocation of burdens)
- Knowledge gaps:
  - Demersal trawling effect on carbon sequestration
  - Use of climate forcing coolants
  - Biogenic emissions from aquaculture
  - Small-scale fisheries (in particular inland fisheries)

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To summarize

What matters for seafood?
Take home messages

Capture fisheries

- *Fuel inputs* during fishing most often dominates total carbon footprint
- Influenced by target species (e.g., shoaling or not, gear used, stock status)
  - strongly linked to fishery management

Aquaculture

- *Feed inputs* most often dominates total carbon footprint
- Influenced by farmed species (e.g., feed conversion efficiency, feed composition)
  - requires both innovations in feed and grow-out

Overview provided in Ziegler et al. (2016) Expanding the concept of sustainable seafood using Life Cycle Assessment. *Fish and Fisheries* 17, 1073-1093.

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Oportunities and challenges

Capture fisheries policy-makers and managers

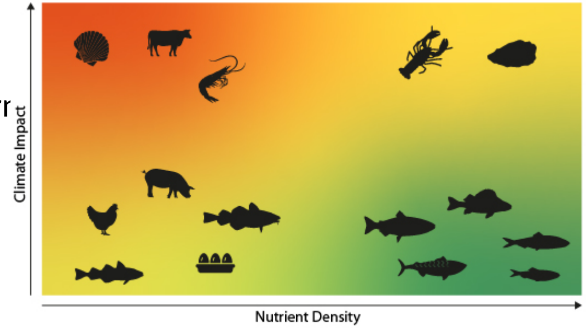
Challenge & potential

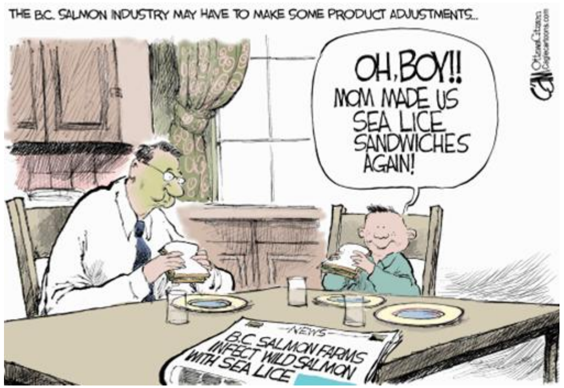
- **Short-term mitigation and adaptation**
  - from policy to action: quota allocation to certain gears [*in line with article 17 of CFP*]
  - mitigate unintended consequences of using different tools (effort restrictions – spatial measures – selectivity)
  - increasing fuel costs and changing ocean will affect fishing patterns, calls for pro-active management!
- **Long-term transformation** – change in path
  - target reference points: allow for higher fish abundance, including a size composition with more large fish *[=in line with MSFD descriptors*]
  - management allowing for improved carbon sequestration and biodiversity restoration

Opportunities and challenges

Seafood industry

- Easier path to cut emissions in capture fisheries!?
  - ***Opportunities:*** other energy sources, cut fuel use (gears, fishing pattern technology)
  - ***Challenges:*** how&what, investment costs, room for improvement
- Aquaculture:
  - ***Opportunities***: efficient feed converters
  - ***Challenges***: finding low-impact feed ingredients, feeding efficiencies (eFCR), suitable production location (coastal, offshore or on land)
- Seafood value chains
  - ***Opportunities:*** dietary advice, waste less (= less pressure per kg)
  - ***Challenges:*** product/process development to utilize new species and side streams while attracting consumers





Thank you for your attention!

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