



GHG production of different sources of protein

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Where do the GHG come from

- Energy and fuel use
 - Direct consumption (fishing boats, tractors, factories)
 - In the inputs (feed, fertilizer, packaging)
- Land conversion for agriculture
- Methane from ruminants

Where is carbon produced

- Production – on the farm or the boat
- Processing
- Transport
- Retail
- Consumption

Energy Intensity of Agriculture and Food Systems

Nathan Pelletier,¹ Eric Audsley,² Sonja Brodt,³
Tara Garnett,⁵ Patrik Henriksson,⁶ Alissa Kendall,⁴
Klass-Jan Kramer,⁷ David Murphy,⁸
Thomas Nemecek,⁹ and Max Troell¹⁰

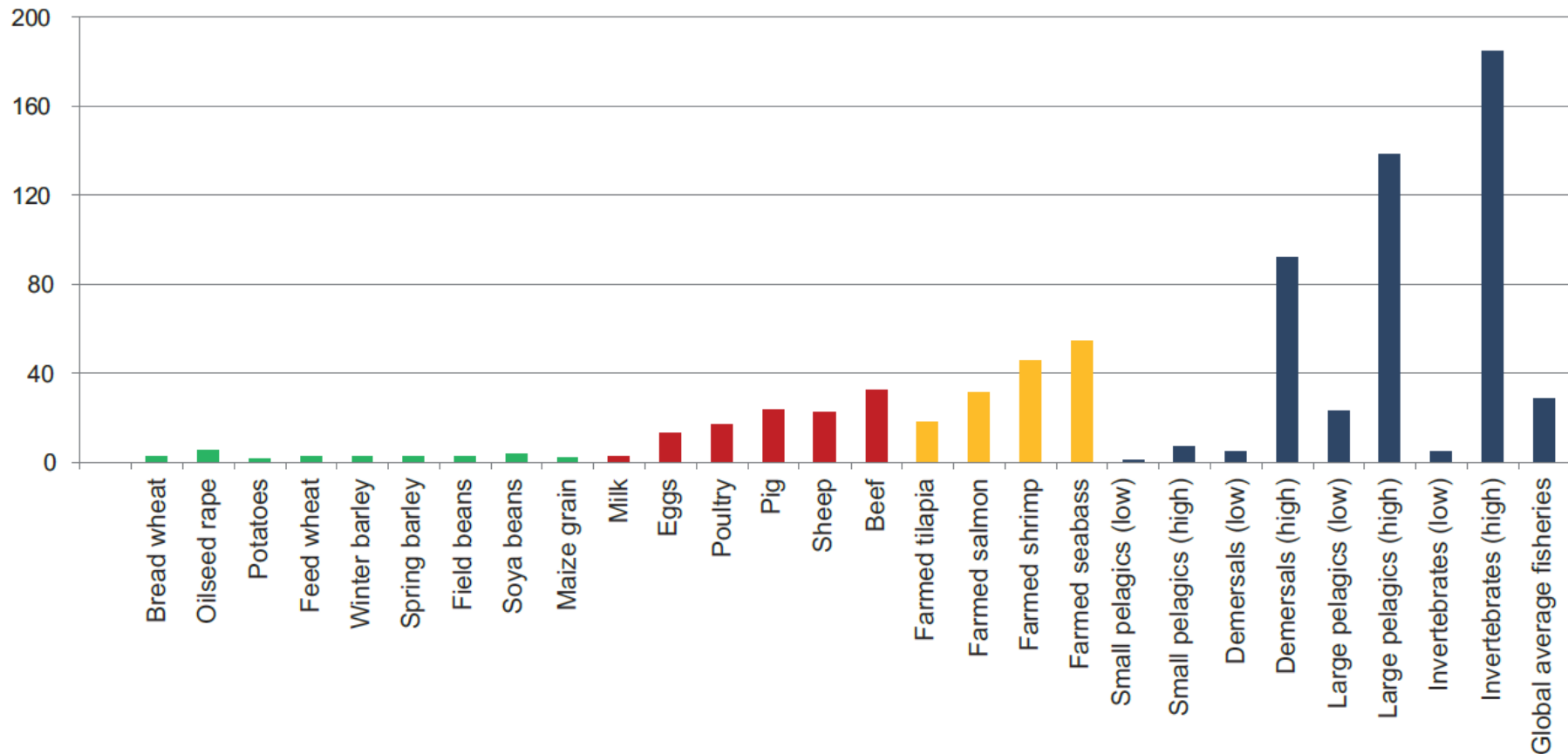
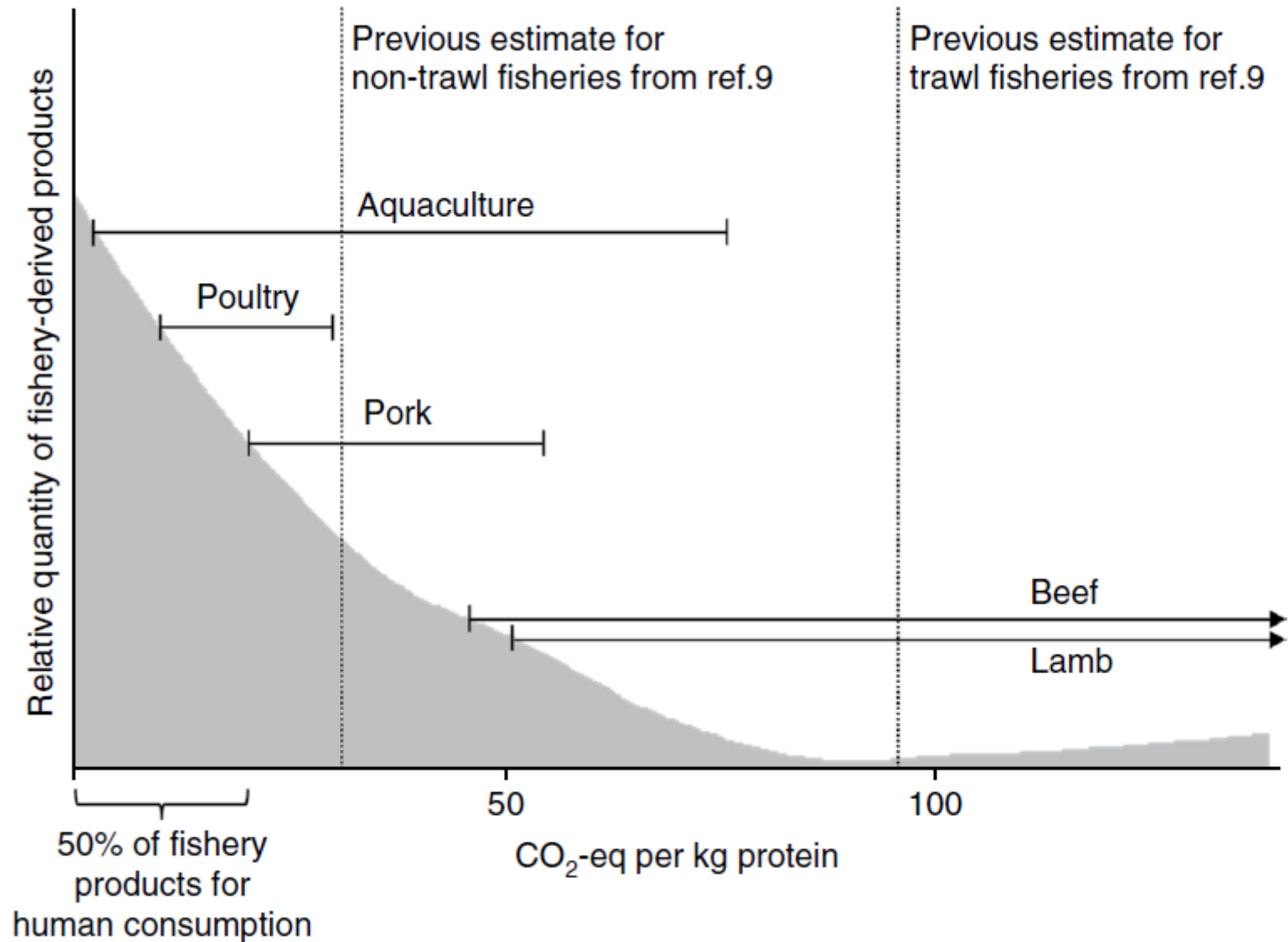


Figure 2



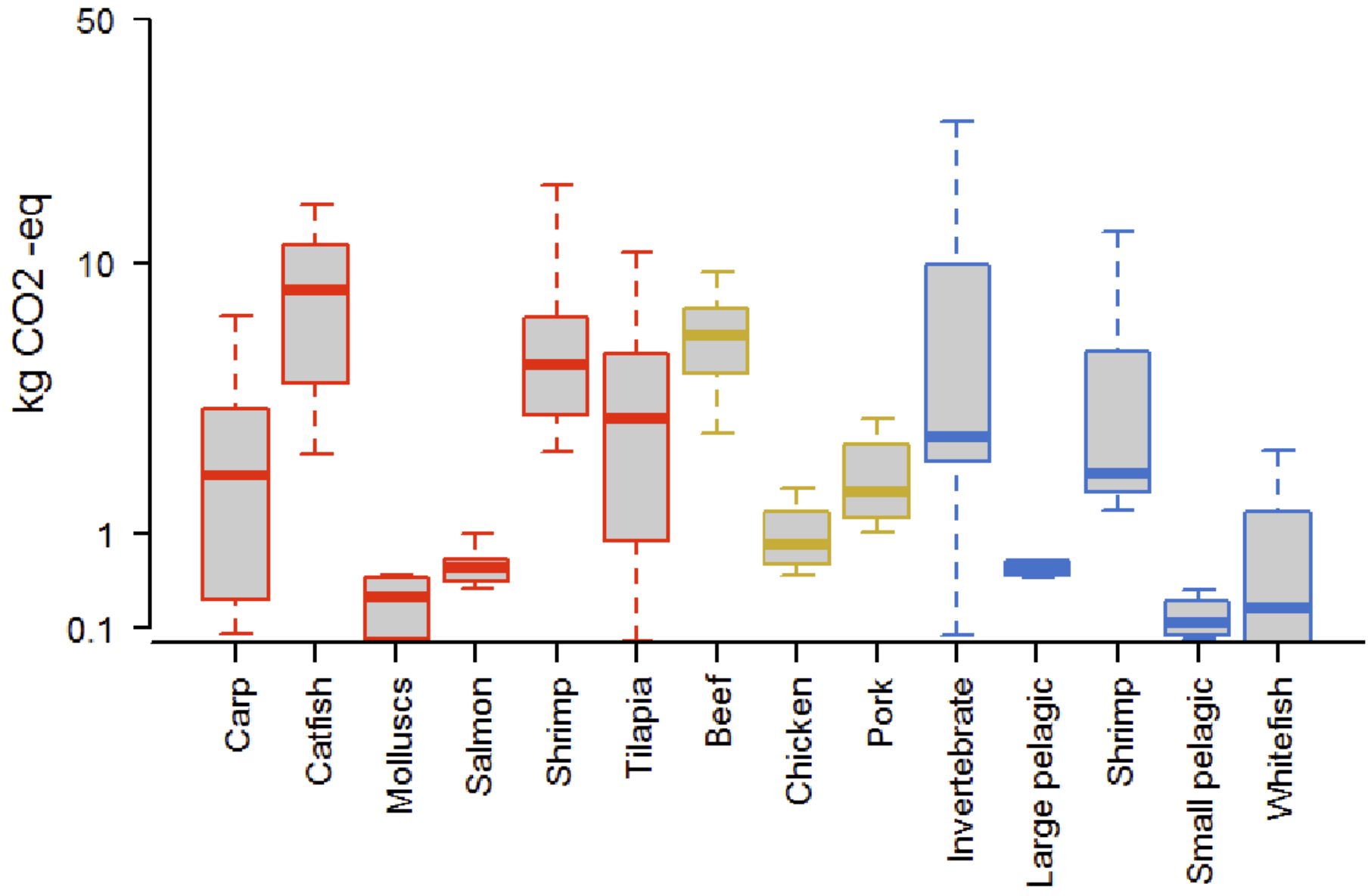
Parker and Tyedmers 2018

The environmental cost of animal source foods

Ray Hilborn^{1*}, Jeannette Banobi¹, Stephen J Hall², Teresa Pucylowski³, and Timothy E Walsworth¹

We reviewed 148 assessments of animal source food (ASF) production for livestock, aquaculture, and capture fisheries that measured four metrics of environmental impact (energy use, greenhouse-gas emissions, release of nutrients, and acidifying compounds) and standardized these per unit of protein production. We also examined additional literature on freshwater demand, pesticide use, and antibiotic use. There are up to 100-fold differences in impacts between specific products and, in some cases, for the same product, depending on the production method being used. The lowest impact production methods were small pelagic fisheries and mollusk aquaculture, whereas the highest impact production methods were beef production and catfish aquaculture. Many production methods have not been evaluated, limiting our analysis to the range of studies that have been published. Regulatory restrictions on ASF production methods, as well as consumer guidance, should consider the relative environmental impact of these systems, since, currently, there appears to be little relationship between regulatory restrictions and impact in most developed countries.

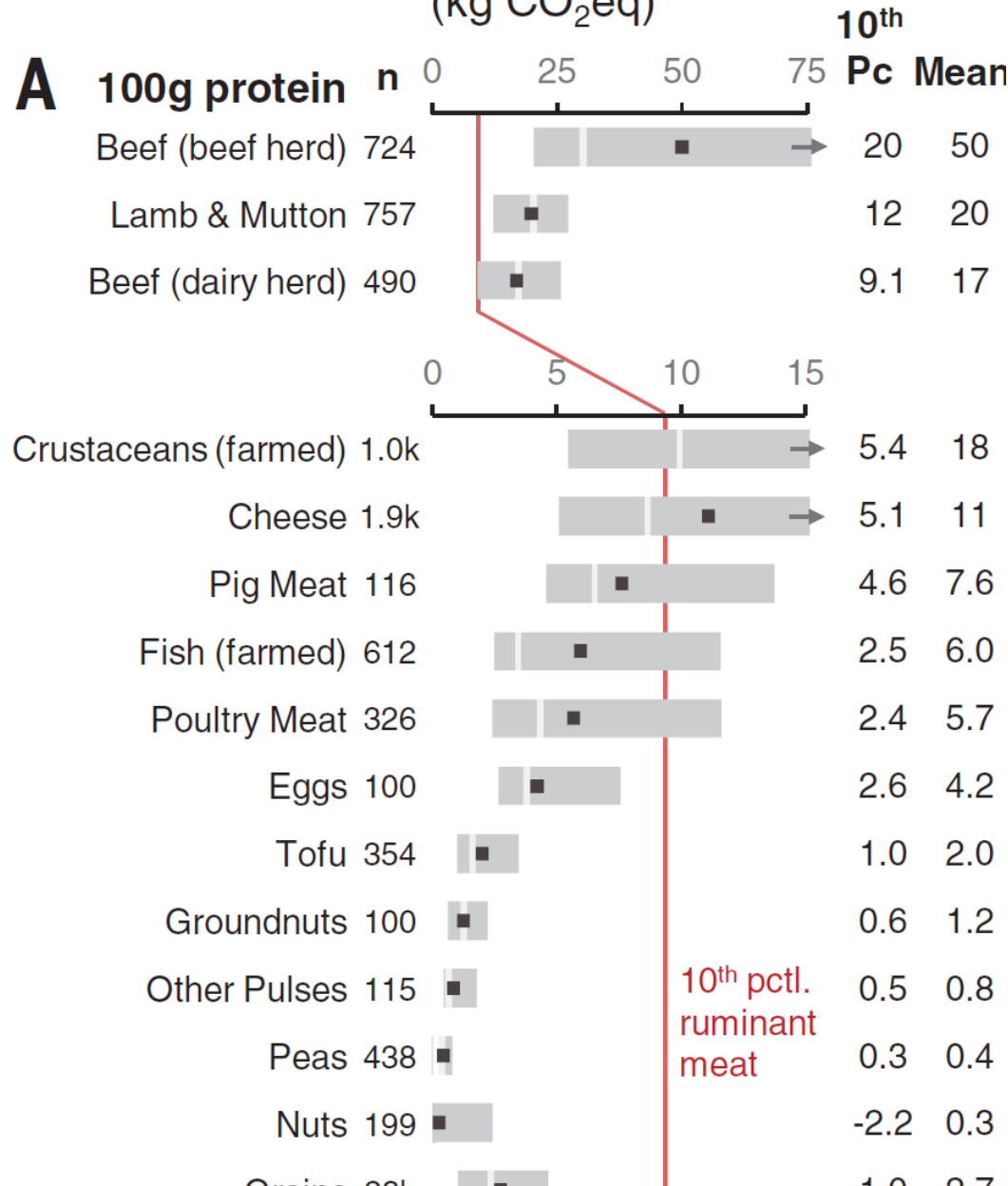
Greenhouse gas produced by one serving



Reducing food's environmental impacts through producers and consumers

J. Poore^{1,2*} and T. Nemecek³

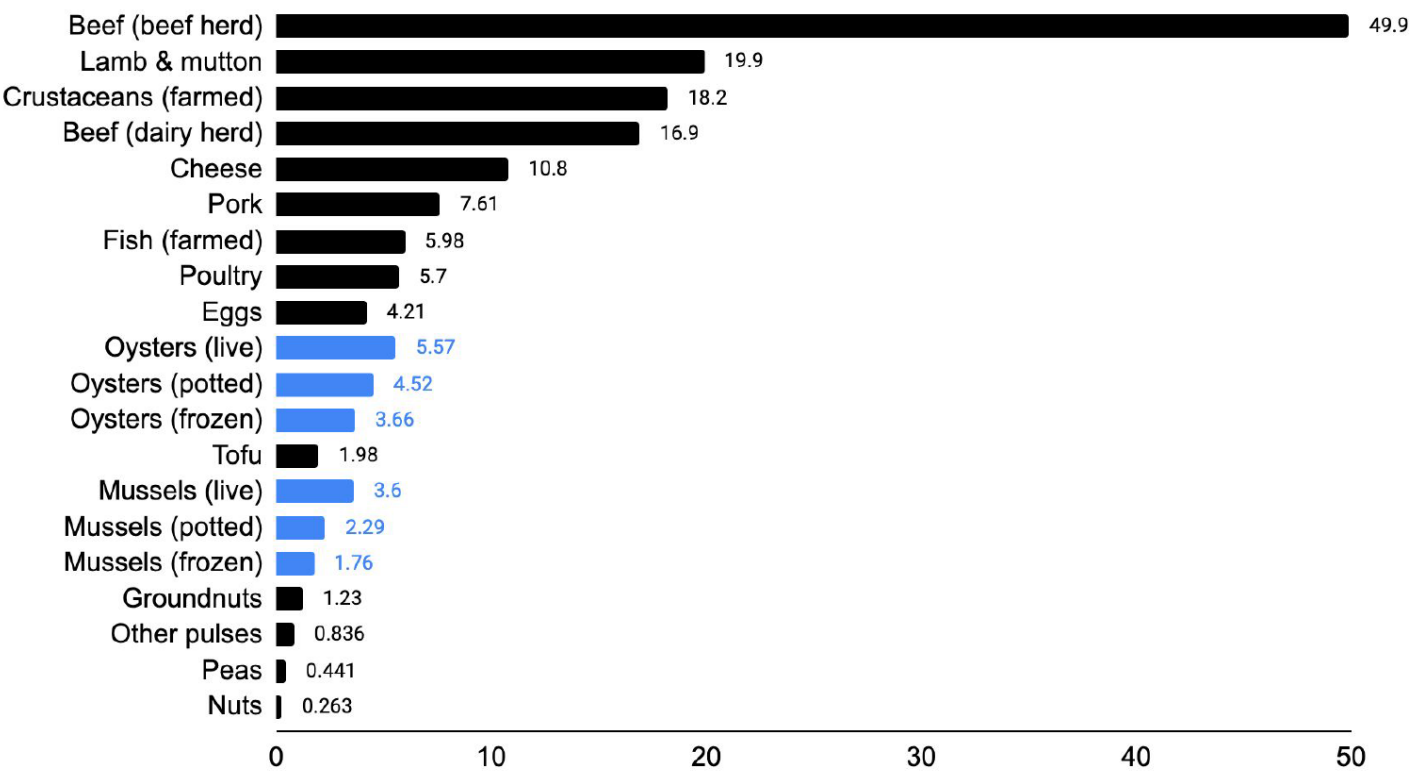
GHG Emissions (kg CO₂eq)



Some examples of particularly low GHG in production

- Seaweed
- Farmed shellfish
- Small pelagic fishes
- Salmon from Alaska
- Pollock from Alaska

Carbon Footprint

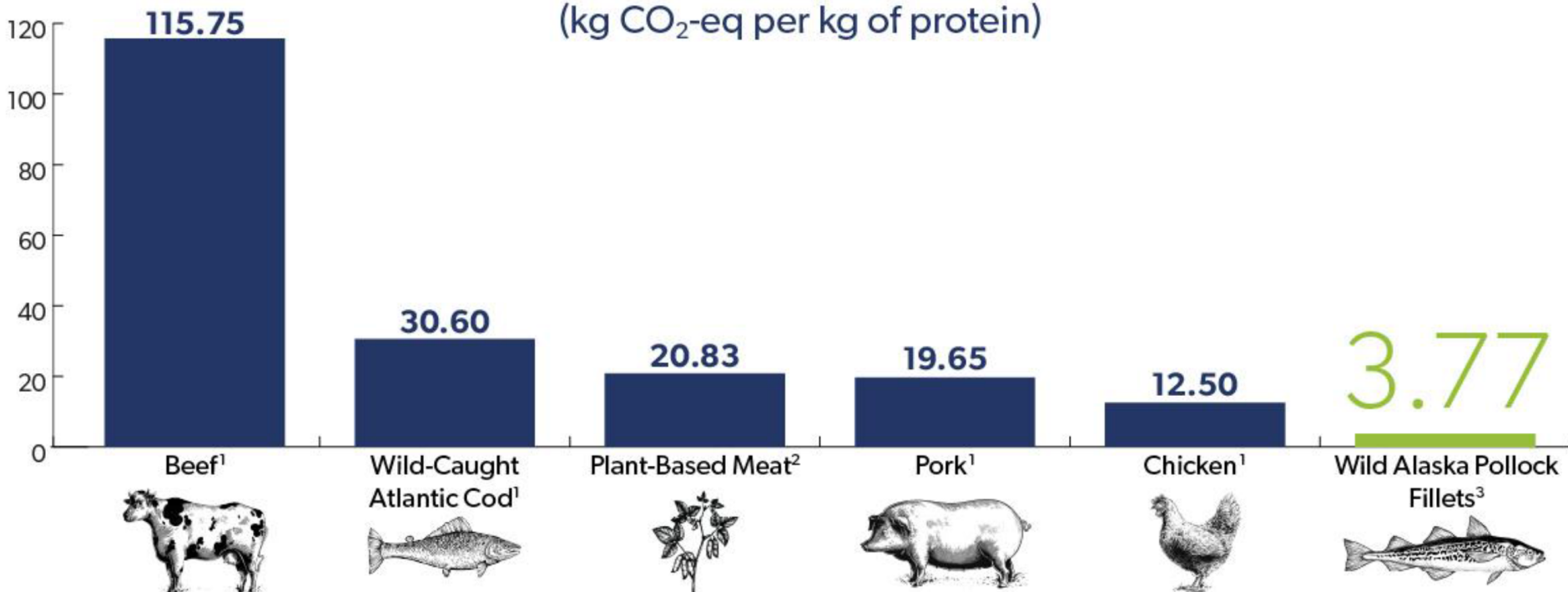


kg CO2 eq per 100g protein (cradle-to-retail)

Poore and Nemecek 2018
Warmerdam et al. 2021

Carbon Impacts of Wild Alaska Pollock as Compared to Other Proteins

(kg CO₂-eq per kg of protein)



¹ Monterey Bay Aquarium/Dalhousie University Seafood Carbon Emissions Tool; measured as kg CO₂-eq per kg of protein, midpoints for reported range (as of July 14, 2021)

² Comparative environmental LCA of the Impossible Burger® with conventional ground beef burger, Quantis International (2019)

³ Quantis International, Life Cycle Assessment of Wild Alaska Pollock: ISO LCA Report (2021)

Key factors in reducing GHG

- Unfed aquaculture
- Food conversion efficiency
- Efficient fishing fleets
- No air transport

