BIM Ireland's Seafood Development Agency

Carbon Footprint report of the Irish Seafood Sector Summary

Bord Iascaigh Mhara
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Rialtas na hÉireann
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Background

In early 2023, BIM produced a Carbon Footprint report[1] of the Irish Seafood Sector.

This document summarises the main findings from this report and highlights the need to decarbonise the seafood sector to the greatest extent possible.

The Carbon Footprint report published in early 2023.

1: bim.ie/wp-content/uploads/2023/02/BIM-Carbon-footprint-report-of-the-Irish-Seafood- Sector-1.pdf

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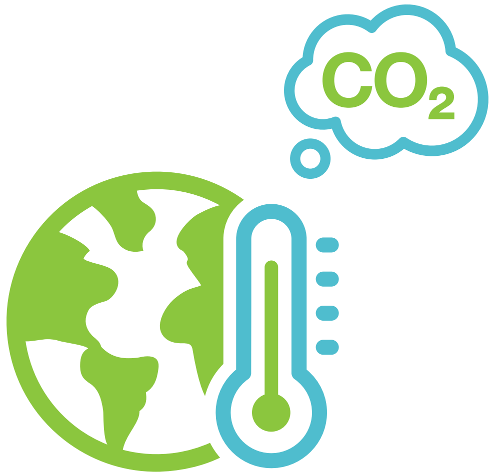
Climate Change and the Irish Seafood Industry

- Fish stocks will be altered by warmer waters, ocean acidification, changes in ocean currents, and a higher frequency of severe storm events.
- Greenhouse gas (GHG) emissions from human activities are the primary cause of climate change.
- The Irish Government plans to decarbonise Ireland with a Net Zero goal by 2050.



All sectors are seeking to adhere to the United Nations (2015) Sustainable Development Goals (SDGs) to achieve Net Zero carbon emissions by 2050 as agreed by 194 countries. Achieving sustainability and implementing climate action are essential to ensuring our planet can support a growing population of >8 billion people.

In 2020, the Department of the Environment, Climate and Communications (DECC) committed to move to a climate-resilient and climate neutral economy by 2050, through Ireland's Climate Action and Low Carbon Development (Amendment) Bill. Ireland's Climate Action Plan 2023 sets out steps to reduce overall national emissions in Ireland by 51% by 2030 and reach net zero emissions no later than 2050.

To limit the rise of average global temperatures to less than 1.5°C, all sectors of society are seeking to reduce GHGs emissions. Human and ecosystem health are inherently connected; thus, food production is a key component. Aquaculture and sea fishing, like all human activities, contribute to, and will be highly impacted by, climate change. A key challenge is to continue to produce healthy, nutritious food in a way that does not harm the planet.

> Decarbonising the seafood sector is an enormous task, with enormous benefits.

Irish Seafood Industry

The facts

The seafood sector is a relatively low GHG emitting sector

Global food production accounts for approximately 30% of total carbon emissions from human activities. However, the global seafood sector only accounts for a small portion of this overall figure (circa 4%).

Industry diversity means a varying carbon footprint

Fishing vessels target and land varied species - from Atlantic mackerel and Dublin Bay prawns to shellfish such as lobster and crab from various locations, with different techniques, and unique emission profiles. The Irish aquaculture sector is equally diverse, including shellfish (primarily oysters and mussels) and seaweed aquaculture production as well as larger scale production for finfish, primarily salmon.

Seafood supply chain has emission hotspots

Key targets for carbon footprint reduction:

- Fleet marine diesel use accounts for ~90% of all GHG emissions from wild capture supply chains.
- Imported feed for salmon farming accounts for 60% of emissions.
- A high export focus means that transport mode is especially important in terms of emissions.

Consumer awareness

Consumers see a low carbon footprint as a positive that influences their food purchasing decisions (Bord Bia, 2023). The sector will need to demonstrate their carbon credentials to these buyers. This can only be achieved by **establishing and monitoring a carbon baseline** as well as implementing **decarbonisation plans**.

Irish Seafood Industry

Decarbonising efforts are necessary for safeguarding sustainability and biodiversity of global marine ecosystems.

Decarbonising Plan

There is an urgent need for a detailed seafood sector decarbonising (Climate Action) plan, to reduce emissions by 7% per annum until 2030. There is also a strong need for business level climate action advisory services, so that seafood businesses are clear on what to do.

Direct and Indirect Emissions Accountability

Direct Emissions relate to fuel use and feed inputs. Indirect Emissions are generated by suppliers in upstream and downstream supply chains (e.g., transport). A partnership mindset across the entire seafood supply chain is essential to reduce emissions in the sector.

Monitoring and Reporting Emissions

Detailed fuel, energy, landings, and production data should be stored and managed in a standardised way across the seafood sector. Proof of successful target attainment can only be demonstrated using solid data. Insight into the latest research, industry and consumer trends internationally should be accessible to the Irish seafood sector.

The Drive to Decarbonise Will Increase

Pressure to reduce carbon in the food supply chain will continue due to:

- Environmental changes, ecosystem disruption and knock-on effects, and general supply chain issues.
- Government Policy and international agreements such as the UN Agreement 2015 Climate Action Plan.
- Fuel costs and risks associated with fuel price volatility.
- Retailers' wish to reduce seafood supplier related emissions
- Consumer demand to purchase low carbon food and to support environmental sustainability and biodiversity.

> By acting now, the seafood sector will be future proofed and more resilient.

Climate Action - Short, Medium and Long Term

Efficiencies in growing and capturing fish and shellfish are already visible in the seafood sector today; for example, lighter fishing gear with less drag, use of shore power at quay side, increased fuel consumption monitoring, and a general move towards circularity to 'reduce, reuse and recycle'. In the short term, 'plug and play' fuels such as bio-diesel including Hydrogenated Vegetable Oil (HVO) may help transition away from fossil fuel. In the long term, Irish fishing fleets may move away from using fossil fuels towards low or no carbon alternatives. For finfish aquaculture, life cycle assessments show that feed is the key carbon emitting hotspot and continued performance improvements are needed in this area.

Fishing and Aquaculture Sectors will be Net Zero Emissions by 2050

To support this transition, further research is needed to understand the Irish seafood sector carbon footprint. The costs and feasibility of adopting different fuels will need to be assessed, and continuous monitoring of technologies used in other sectors such as farming and transport, as well as innovations in other countries, will be of increasing importance.

> All steps in the seafood supply chain need to play their part in reducing emissions.

> Climate change is impacting our world and our planet. A global effort is underway to tackle this and ensure sustainability is at the centre of all human activity.

The production of wild-caught and farmed seafood contributes to and will be highly impacted by climate change. A key challenge is to continue to produce healthy, nutritious seafood in a way that does not harm the planet.

Section 1:
Seafood Carbon Footprint

The Irish Seafood sector has a low carbon emission profile, relative to other food production, energy production, transport, and other sectors.

The seafood sector is conscious of sustainability and the decarbonising agenda. The challenge is to continuously improve how we grow and catch, while sustaining a healthy seafood offering and a prosperous sector that employs over 16,000 people in Ireland. The main drivers for emission reduction are (i) national obligations to achieve Net Zero emissions by 2050, (ii) maintaining ecosystem biodiversity and sustainability, (iii) consumer demand for low-carbon products, and (iv) increasing fuel costs.

> Emissions are measured in carbon dioxide equivalents (CO_2 eq.)

The Irish seafood sector is diverse; the carbon footprint of different seafood products varies with the species and the methods used to cultivate or catch them. Total carbon emissions for the Irish seafood sector are 396,207 tonnes CO_2 eq. (both catch fisheries & aquaculture).

Climate Change and the Seafood Sector

Ireland's seafood GHG emissions reduced in absolute terms by 3% from 2017-2018 and by 13% from 2018- 2019, and this is considered to be mostly due to reduced seafood landings in 2019 and a significant reduction in farmed salmon production in 2018 and 2019 compared to 2017.

> Ireland's climate has changed over the past 100 years with higher temperatures and intense rainfall.

Climate impacts are predicted to increase, but the greatest uncertainty is how effective global actions will be. Indicators of climate change in Ireland:

- Satellites indicate a sea level rise around Ireland of ~2-3 mm per year since the early 1990s.
- The average sea surface temperature measured at Malin Head was 0.47°C higher over the last 10 years compared with 1981-2010.
- Surface waters measurements in the west of Ireland between 1991 and 2013 indicate increased ocean acidity comparable to the rate of other global seas.
- Expansion of the growth of some potentially harmful phytoplankton species has been observed in almost all winter months since 2010.

The Department of Agriculture Fisheries and the Marine's Agriculture, Forestry and Seafood Climate Change Sectoral Adaptation Plan (DAFM, 2019) establishes the projected changes in climate, focussing on what is most likely to impact the agriculture, forestry, and seafood sectors.

Predicted negative changes for Ireland[2] include:

- Increased pace of sea-level rise.
- More intense storms and rainfall events.
- Increased likelihood/magnitude of river and coastal flooding; storm surges.
- Changes in sea temperatures beyond species tolerance.
- Changes to shellfish seed recruitment, altered disease parasites.
- Changes in freshwater temperatures, dissolved oxygen impacting fish growth and survival.
- Increased ocean acidity in Irish waters (with implications for shell-forming organisms).
- Increased harmful algal species in Irish waters.
- Potential lack of access to freshwater and other resources.

Section 2: Irish Fishing Fleet Emissions

Key points

- The Irish fishing fleet is a relatively low GHG emission sector contributing 83.5% of total seafood GHG emissions.
- Over 90% of GHG emissions are from diesel combustion aboard fishing vessels.
- (RWS) caught Atlantic mackerel, the main species caught by these vessels, are 0.23 tCO_2 eq. landings.
- GHG emissions of bottom trawl fisheries are higher than pelagic fisheries (on a per tonne of landing basis) primarily due to increased load on engines.
- Innovations in net design and fish finding technologies will reduce carbon footprints through more targeted and selective fishing.

An absolute average GHG value (330,888 tCO_2 eq.) was calculated for Irish fishing vessels from 2017-2019 by scaling up the emissions data obtained from a sample of the fishing fleet.

Average tCO_2 eq./tonnes of fish landed

For comparison, the average number of registered Irish fishing vessels (active and inactive) by segment (2017-2019) and their emissions are shown below.

Table 1: Registered Irish fishing vessels (active and inactive) by segment (2017-2019) and their emissions.

Vessel Segment Type	Number of Vessels	tCO_2 eq./t
Beamer 24-28m	14	4.20
Freezer 22-27m	59	5.17
Hake Gillnetters 12-27m	10	3.17
Potter 0-12m	836	1.33
Prawns and Whitefish 12-18m	42	2.94
Prawns and Whitefish 18-24m	33	2.06
Prawns and Whitefish 24-40m	25	1.54
Seiners 16-27m	9	1.57
Refrigerated seawater vessels (RSW) 24-70m	23	0.23
Other (26 small segments)	931	3.07

2: The Environmental Protection Agency Climate Change Research Programme.

Section 3:
Irish Fishing Fleet Fuel Use

Key points

- Irish fishing vessel sample data shows average emissions of 1.03 tCO_2 eq./tonnes fish landed, well below the global seafood average of 1.7 tCO_2 eq./tonnes fish landed.
- The average of 1.03 tCO_2 eq./t fish landed is **lower than emissions from other food production** (equivalent quantities).
- Fuel usage per tonne of landing is similar to other European fishery fleets.

Patterns in international fleets are also seen in the Irish fleet, e.g. the Irish refrigerated seawater (RSW) pelagic fleet is the most efficient in terms of carbon emissions per tonne of landings.

> 1.03kg CO_2 eq. are emitted to land 1kg of fish.

Section 4:
Mitigation Measures

Key points

- Better data and knowledge sharing is crucial to keep the sector up to date on environmental and carbon performance. This is an active research area and networks can be established to **improve the environmental credentials of Irish seafood**.
- All fishing vessels should **understand their fuel consumption and emissions**, and how to reduce their carbon footprint by monitoring fuel consumption, carrying out regular maintenance and monitoring speeds when steaming to and from fishing grounds.
- **Innovations in gear and technology**, such as better sonar, hydrodynamic nets and doors, and catch sensors, are already leading to lower fuel consumption. Such work should continue along with efforts to incentivise uptake of such innovations that will lead to reductions in emissions.
- **Alternative fuels** like hydrogen and Liquified Natural Gas are possible longer-term options, but in the short-term the use of biodiesel such as HVO will aid this transition, so hybrid engines will be part of carbon mitigation plans.
- **Innovations in vessel design** are mainly applicable to new builds and therefore will take time to have an impact on overall carbon emissions. Currently the cost of such vessels is a limiting factor, while retrofitting of existing vessels in many cases is not an option given their design and age.
- **Governance and fisheries management impact fishing patterns** and therefore fuel use. Improved fisheries management response to change will be key in terms of reducing food waste which needs a collaborative effort from fishers, processors, retailer and food service sectors for more efficient fishing.

> Fuel use is the biggest GHG contributor.

Potential Alternative Fuels

Shore to Ship Power connecting to shore power while docked uses electrical power, rather than engines.

Full Electric, but relying on battery packs limits the trip range of fishing vessels.

Hybrid Electric has potential and is currently in use as it is a clean energy and ensures optimal diesel engine performance.

Liquified Natural Gas (LNG) burns with fewer GHG emissions than diesel, and is beginning to be regulated.

Biofuels (biodiesel and treated vegetable oil) can be added directly to existing engines with minimal modifications and are sustainable. These fuels are currently being trialled by some Irish vessels.

Hydrogen burns with zero carbon emissions, but its generation requires significant energy.

Ammonia is used in some vessel refrigeration systems and has potential for powering, but infrastructural and safety aspects still need to be addressed.

Section 5:
Aquaculture Carbon Footprint

Ireland's aquaculture output is mainly export-driven, marine-based, with a smaller land-based, freshwater aquaculture sector. Fluctuation is due to production variations for salmon sea-farms, and the volume of bottom grown mussels produced. Overall, production was €100 million (2009) to €173 million (2019).

> The average carbon footprint for Irish aquaculture between 2017-2019 was 65,319 tCO_2 eq., which includes farmed salmon and the shellfish sector.

Key points

- 97% of Irish aquaculture is from four main species group/production systems (salmon, rope mussel, farmed oyster and bottom mussel). Smaller aquaculture segments include inland trout farming (2%) land-based tank shellfish (c 1%) and sea-grown seaweed (<1%).
- The Irish aquaculture sector has low GHG emissions, contributing 16.5% of total seafood GHG emissions.
- Shellfish and seaweed aquaculture have very low GHG emissions - rope grown mussel 107kg CO_2 eq.t., oyster 235kg CO_2 eq.t. and bottom grown mussel 824kg CO_2 eq.t. - as these species absorb more carbon than they release and may even be considered to have a negative carbon footprint.
- Ireland is the largest producer of organic salmon in the world and Irish farmed salmon emits 3.88 kg tCO_2 eq./kg, which is low. Salmon feed is the main contributor accounting for 58% of emissions to farm gate.
- Molluscs are one of the lowest GHG emitters and ecosystems. They can sequester carbon by producing geologically stable calcium carbonate shells. Seaweed sequesters carbon and can absorb nutrients. This can be used for remediation by co-locating seaweed farming with mussel and salmon farming, thus it is being viewed as a nature-based solution.

> Global warming potential varies across countries and is impacted to the greatest extent by feed production and transport, farm energy use, smolt production and operational waste.

Salmon

Key points

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- Irish farmed salmon is grown to organic standards and is a low carbon food source.
- Salmon feed accounts for 58% of GHG emissions to farm gate depending on its composition (e.g., terrestrial animal protein, oils, mammalian meal).
- Feed ingredients now use reduced quantities of marine-sourced proteins and replaced with EU sourced plant proteins.
- Slightly higher emissions from organic compared to non-organic is due to the lower scale of production in Ireland.
- Global Warming Potential (GWP) varies across countries and is impacted to the greatest extent by feed production and transport, farm energy use, smolt production and operational waste.

Mitigation Options

- Increase vertical integration and sector scale (subject to licensing); The low volume and decentralised nature limits opportunities to reduce emissions.
- Develop **domestic aquafeed** to reduce emissions related to transporting supplies.
- Further investigate **energy and nutrient recovery** in salmon production (e.g., usage of fish wastes) through anaerobic digestion and the added value of the resultant digestate as a fertiliser.
- Investigate **local feed sourcing**, increased use of renewable energy and interim use of natural water bodies (i.e., lakes) to improve the efficiency of Recirculatory Aquaculture System (RAS) production of smolts and reduce GHG emissions.
- Develop and increase **advanced environmental modelling capabilities** (i.e., Life Cycle Assessment (LCA), carbon foot printing, circular economy modelling) to explore strategic scenarios, (e.g., raising post-smolts on land, transport/logistics and local feed production).
- Promote and increase the **use of clean energy** across the production and supply chains, especially for heating and pumping water in land-based production facilities.
- **Genetic improvements** in stock to improve feed conversion ratio and disease resistance to reduce the amount of feed required to grow fish.
- Consideration for **developing domestic markets** to reduce post-harvest supply chain emissions. More than 95% of Irish grown organic salmon is currently exported.
- Investigate the potential of **Integrated Multi-Trophic Aquaculture** (IMTA) as a way of reducing GHG emissions (nutrient offset or nutrient balancing) given that lower trophic organisms could be used solely for mitigation purposes or for increasing product offering.

Oysters

Key points

- The oyster growing sector contributes <1% of GHGs (235kg CO_2 eq.t) towards Irish seafood GHG emissions.
- Most Irish grown oysters are exported to Europe and Asia, so transport is significant for post-harvest emissions.
- Tractor diesel is a key driver accounting for ~60% of emissions to farm gate.
- Oyster production can offer a carbon sequestration potential, which can offset the carbon footprint. Currently, carbon sequestration is not considered, but this may change in the future.
- A significant portion of oyster seed sourcing is from outside the state (France), but this accounts for only 6% of GHG emissions.

Mitigation Options

- Increased **use of biofuels and Liquefied petroleum gas** (LPG) for tractors and site vehicles could reduce GHG emissions compared to diesel.
- **Newer machinery** is required to use emission control technologies such as Diesel Particulate Filters (DPF), Selective Catalytic Reduction (SCR), and Exhaust Gas Recirculation (EGR).
- Improvements in **energy efficiency for depuration** can be achieved using Variable Speed Drives (VSD) on pumps to reduce electrical consumption.
- Installation of **on-site renewables**, notably solar Photo Voltaic (PV), and wind turbines to replace grid electricity with renewable electricity.
- **LED lighting** upgrades have significant potential to be realised. LED bulbs require less than half the electricity of fluorescent T8 tubes.
- Enhanced **protections for shellfish waters** to improve local water quality sufficiently for regrading as Class A waters that would not require depuration.
- Prioritise use of **clean transport modes** in post-harvest supply chains.

Bottom Grown Mussels

Key points

- Emissions from this sector are relatively small, contributing 1.2% of Irish seafood total GHG emissions.
- Emissions per tonne are 823.9 kg CO_2 eq.t of bottom grown mussels are considered low but significantly higher than rope grown mussels and oysters.
- Vessel fuel, for seed collection and site husbandry, is a key driver of GHG emissions.
- No physical structures or feed inputs are used in the culture phase thus contributing to a low emission profile for this sector.

Mitigation Options

- Fuel use for vessels is the obvious target for emission reduction. Consideration should be given to the **use of electric and/or hybrid propulsion systems** given that this fleet operate within the inshore or near shore environment. Biofuel may offer potential to reduce emissions in the short term.
- **Reduced effort for finding seed**. Continued seed mussel surveys and increased use of high-resolution side scan sonar technologies, coupling search efforts with improved seed settlement modelling capabilities (seed dispersal/hydrodynamic modelling).
- Continued **research into the rope growing of seed for transplanting** to the seabed. This would help alleviate fluctuations in supply and would be a potential strategy for carbon reduction.
- General measures such as **moving to clean technologies** for powering refrigeration and transport.
- Champion the **use of sequestered carbon** and positive biodiversity impacts into carbon calculation methodologies.
- Prioritise use of **clean modes of transport** in post-harvest supply chain.

Rope Grown Mussels

Key points

- Emissions from this sector are small and are estimated to be 1,023 CO_2 eq.t on average across 2017-2019.
- Emissions per tonne of mussels are the lowest in the Irish seafood sector at 107.4 kg CO_2 eq.t.
- Diesel use for workboats is a key driver of GHG emissions in mussels, accounting for close to 90% of emissions for this sector.
- Consumables account for less than 10% of total emissions.
- Carbon sequestration is not considered in current carbon emission and LCA calculation methodologies. Some studies suggest that the inclusion of sequestration could lead to negative emissions for this sector (i.e., mussels act as a carbon sink).

Mitigation Options

- As 90% of GWP impact for mussels arise from the **use of fuel**, so mitigation options should be focused in this area.
- Good **maintenance and optimisation of equipment** for the weight and size of the ropes could result in significant reductions in the energy required to operate them.
- Careful planning can yield significant improvements in operational efficiency. **Selection of sites** with close shore access, appropriate mooring, bathymetry and seabed type, and appropriate use of support craft can reduce fuel use and improve the emissions rate without compromising efficacy.
- Van fuel use could be mitigated through use of a **hybrid or electric vehicle lease** or purchase in future. Alternative fuels for the van fleet could be considered, e.g., Biodiesel.
- Ensure reuse of **Flexible Intermediary Bulk Containers** (FIBCs) (1-tonne bags). These currently have a lifespan of one trip; an obvious opportunity is to reuse these highly-durable bags for multiple trips. A system on the part of the processor to record, store and return bags could result in these being used many times (following circular economy principles).
- The ecosystem services that shellfish aquaculture requires additional research to assess the benefits to human wellbeing from healthy ecosystems, supported by the sequestration potential of shellfish aquaculture.

Section 6: Transport and Processing

The Irish seafood sector exports most of its produce to various destinations around the world. The Route to Market and the means transport are important from an emissions perspective.

Key points

- Most Irish seafood is exported, so mode of transport is key for carbon footprint calculations. Air transport significantly increases carbon footprint when compared to sea and road transport.
- Live seafood or cooked fish transport by air will have a higher emission profile than fresh or frozen product transport by sea or road.
- The degree of food processing is proportional to the level of GHG emissions. In general, seafood does not undergo high levels of processing and is rarely considered an ultra-processed food, so the carbon footprint is generally less than other food types.
- For finfish, gutting and refrigeration contributes to GHG emissions but to a much smaller scale than sea fishing (fleet) or feed for fish (aquaculture).

Transport to Main Markets

An analysis of the size and contribution to the overall impact of selected species and travel to their main market originating in Ireland shows that oysters sent to the Middle and Far East by air are the largest emitters at 2.3 tonnes of CO_2 eq for a typical journey compared to transportation of seafood by road and sea.

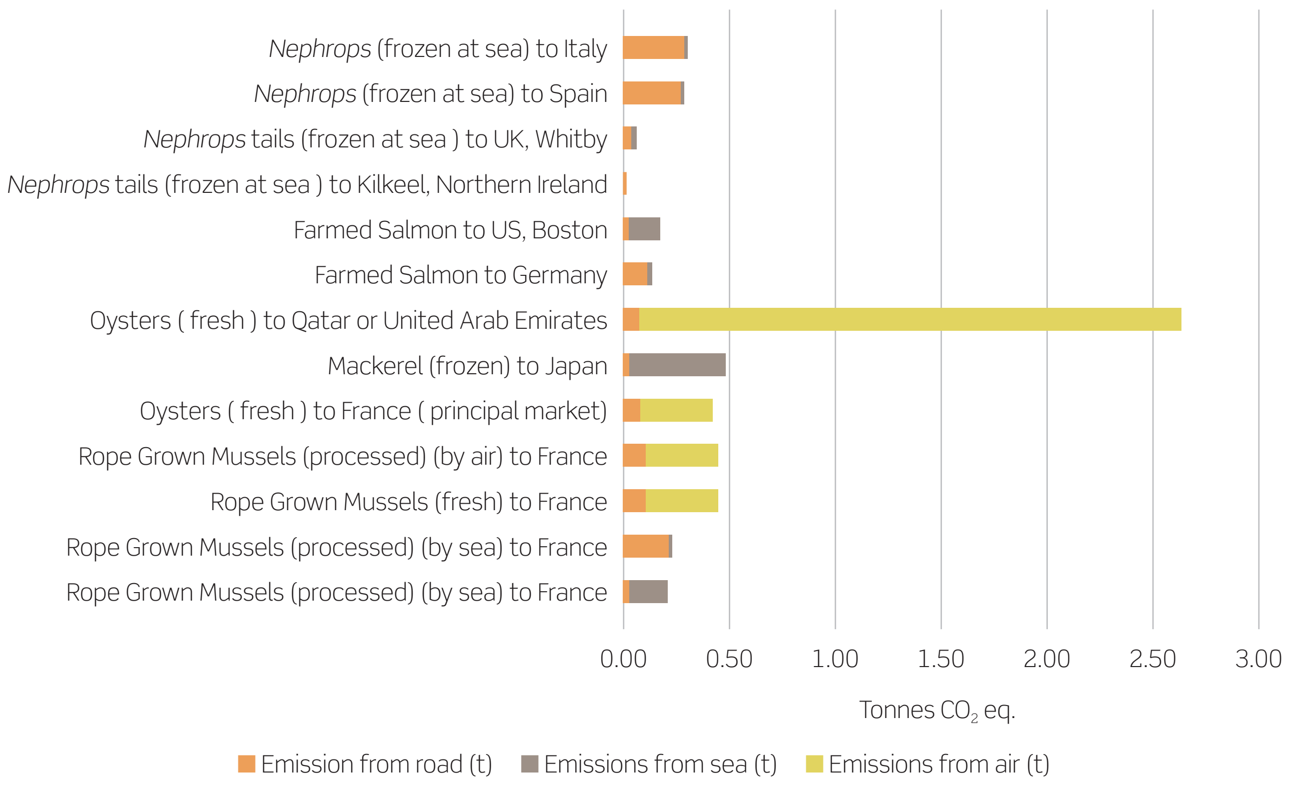

Figure 1: Tonnes CO_2 eq. of seafood species transported.

Section 7: Secondary Processing and Food Waste

Key points

Food waste is a global problem, with approximately one third of all food produced ending as waste, equivalent to 1.3 billion tonnes per year. The EU fares slightly better but still estimates ~20% of all food produced is wasted.

- Food wastage accounts for ~6% of total global GHG emissions, so it is a key area to target in terms of Climate Action (for all food types including seafood).
- Food waste equates to resource wastage (raw material, energy, water, fuel), therefore reducing food waste will reduce carbon emissions.
- ~66% of food waste is the result of poor storage and handling techniques, and spoilage in transport and processing.
- ~33% of waste comes from food thrown away by retailers and consumers.

If food waste were a country, it would be the third highest emitter of greenhouse gases in the world.

Food waste's carbon footprint (3.6million tonnes CO_2 eq) equals the average annual electricity consumption for 700,468 homes and would require planting 4.2 million acres of forest per year to offset.