

# The hidden role of market-making in the rise of farmed salmon

## Abstract

Aquaculture is expected to play an important role in transitioning towards healthy and sustainable diets, requiring dietary changes towards products with lower environmental footprints, in ways that address dietary needs. Farmed Atlantic salmon accounts for 2% of global aquaculture, with productivity-growth factors, such as research investment, credited with creating a high-value, globalized food commodity. However, its contribution to sustainability and nutrition goals remains unclear, and factors underlying consumer demand, such as marketing, have been overlooked. We inspect the rise of farmed salmon in the UK, using key stakeholder interviews to understand the role of various actors (e.g., industry, retailers) in ‘making’ farmed salmon markets. Our analyses reveal market-making efforts by industry and retail actors have co-created consumer demand by promoting perceptions of accessible, nutritious, and sustainable products. Using data on UK seafood markets, we challenge these perceptions, finding that farmed salmon is the most consumed aquatic food, but is less popular than other animal-source foods and primarily consumed by affluent households. Increasing farmed salmon consumption led to decreases in consumption of other species, while population-level aquatic food consumption remained below UK health guidelines. We discuss use of accreditation and labelling in market making to shape messaging around health and sustainability, despite farmed salmon being comparable in nutrient profile to other aquatic foods, and having long-standing environmental impacts (e.g. feeds). Market-making insights could be used to enhance demand for other aquatic foods, in ways that target dietary gaps by supplying affordable and sustainable products, such as mussels.

## Introduction

Sustainable transitions towards affordable, healthy diets will require dietary shifts that disadopt unsustainable foods in favour of existing but more sustainable products (Cottrell *et al* 2021), or emerging future foods (Parodi *et al* 2018). Aquatic foods are often positioned as ways to enhance global food and nutrition security (Golden *et al* 2021, Garlock *et al* 2022) while reducing environmental footprints (Willett *et al* 2019), with farmed aquatic foods expected to play a significant role in sustainable dietary transitions (Gephart *et al* 2020). Global aquaculture produces over 100 million tons of marine algae, invertebrates, and finfish annually, accounting for ~50% of aquatic foods, and will soon exceed wild fisheries supply (FAO 2022, Naylor *et al* 2021). Much aquaculture supply is traded globally, with rising demand linked to rapid expansion in farming of few marine species, such as Atlantic salmon and whiteleg shrimp (Gephart *et al* 2024). These species characterise an increasingly globalized aquatic food system, directed by a small number of corporate actors (Österblom *et al* 2015), with unclear contributions to sustainable development goals (Barton *et al* 2023) and food and nutrition security (Belton *et al* 2020).

Farmed Atlantic salmon (*Salmo salar*) is the world's most valuable mariculture (i.e. farmed at sea) commodity (ISFA, 2018) and accounts for 2% of global aquaculture production (Naylor *et al* 2021). Commercial salmon farming started in the 1960s (Ellis *et al* 2016), expanding into a large-scale, intensive production system that now supplies over 2.7 million tons of fish

globally (Pandey *et al* 2023). Multiple factors have been credited with the rise of farmed salmon as a global commodity, particularly those relating to ‘productivity growth’ (Asche *et al* 2011) such as the species’ suitability for large-scale intensive farming (e.g. fast growth), investment in technology and innovation (Regan *et al* 2021), and industry consolidation (Asche *et al* 2013). Consumer demand is often cited as a key driver of farmed salmon production, but aspects underlying such ‘demand growth’ are less well understood (Asche *et al* 2011), particularly in how market characteristics co-drive demand and consumption of products. Such ‘market making’ requires the felicitous and purposeful coalescing of multiple elements, including market actors (e.g., producers, retailers, consumers), devices (e.g., pricing mechanisms, packaging), practices (e.g., farming, transporting, categorising) that, combined, generate a market (infra)structure that facilitates and encourages consumption (Araujo 2007, Katy Mason and Hagberg 2015). These elements are characteristic of farmed salmon retail, which has undergone substantial product categorisation (Asche *et al* 2021) and creation of new markets (Straume *et al* 2024), with use of diverse labelling schemes to convey messages around food quality, dietary value, and sustainability (Global Salmon Initiative, 2019, Salmon Scotland, n.d.).

In market making for farmed salmon, producers and retailers thus develop widely-available, convenient products (e.g., salmon fillets, ready meals), and amplify characteristics that are desirable to consumers (e.g. sustainability, health properties) in order to create demand. While these actions can have positive outcomes, such as creating new markets for sustainable products, market making has also been criticized for perpetuating false narratives. Seafood labelling schemes, for example, can promote environmentally-damaging fisheries (Jacquet *et al* 2010), while marketing and lobbying for ultra-processed foods is expected to significantly raise health risks for middle-income countries (Moodie *et al* 2021). For farmed salmon, large-scale, intensive practices have long-standing sustainability issues around feeds, disease, and animal welfare (Kuempel *et al* 2023), while the potential for high-value mariculture products to contribute to global food and nutrition security has been questioned (Belton *et al* 2020). Even within the UK, a high-income salmon-producing country, seafood consumption remains below recommended levels (Lofstedt *et al* 2021), suggesting farmed salmon production has not addressed dietary gaps. While the global trade (Gephart *et al* 2024) and environmental pressures (Kuempel *et al* 2023) of salmon industry are well-documented, effects of salmon market-making on aquatic food markets and consumer diets remain unclear.

Here, we examine perspectives of farmed salmon in the UK to develop insights into ‘market-making’ of aquatic foods. We interview expert actors involved with industry, government, research, and policy in Scotland to gather multi-sided views on farmed salmon, and examine productivity and demand factors underlying the rise of salmon industry. We use interviews to identify demand-growth factors that relate to ‘market making’, and test these perspectives against data on industry supply and composition, retail and marketing, and food consumption. Finally, we discuss how aquatic food markets could be shaped to better prioritise public health and environmental sustainability, focusing on existing aquatic food markets in the UK.

## Methods

Our ‘marketography’ of UK farmed salmon used “*interviews, observation, documentary work, [and] historical record*” to trace the market-making efforts of actors across space and time (Roscoe and Loza 2019).

### *Interviews with expert stakeholders*

Initial participants were recruited following the identification of main players in the market through publicly available data, and contacted via online channels. From this, a process of snowballing (Thorpe *et al* 2008) allowed for further potential participants to be selected. Sampling through snowballing poses the risk of distorting bias (Hammersley and Atkinson 2019) (e.g., only meeting colleagues), however, the multi-sided nature of our approach to recruitment ensured accounting for diverse perspectives. We contacted eight activists, aquaculture researchers, industry leaders, and policymakers who were identifiably involved with salmon farming (e.g., published research on salmon aquaculture). One of the authors also attended one of the largest industry events in Scotland in 2023 to network and identify potential participants, which resulted in one of the expert interviews.

Interviews followed a semi-structured guide which allowed adaptation and exploration during conversations (Supplementary Methods). Thus, the authors made decisions about “which line of questioning [...] to explore further” (Thorpe *et al* 2008) depending on which points were raised by the interviewees. Interviews were conducted either in person in Scotland or online, and both authors were present at all but two interviews. In this case, the non-present co-author listened to the recording of the interview. All interviews, in person and online, were recorded and transcribed by an independent transcriber and subsequently cross-checked by the authors. Transcriptions formed the dataset of the thematic analysis to identify key themes raised by the participants. Analysis was performed through open, axial and selective coding in which every “pass-through” involved identifying and refining themes (Neuman 2012). Both authors conducted an independent analysis of the texts to identify key themes, which was followed by a process of contrasting, discussion and agreement.

### *UK farmed salmon production*

We extracted data on the global production of farmed salmon (tonnes) from the FAO Fishery and Aquaculture Statistics databases (FAO Fisheries Division, Statistics and Information Branch 2020), and examined relative contributions of the top three producing countries (Norway, Chile, Scotland) from 1980 - 2021. We gathered additional data on Scotland’s farmed salmon production, trade and industry. We extracted trade quantity and value of major aquatic foods over 2010-2022, using EUMOFA data provided by Seafish (Seafish 2019). From the Scottish Fish Farm Production Survey (Scotland 2021), we extracted data on industry composition (the number of companies from 1993-2022), and farm system productivity (the number of sites, smolt size, and cage capacity from 1990-2022).

## *UK aquatic food consumption*

We used public food consumption databases to understand contributions of farmed salmon to UK diets relative to other terrestrial and aquatic animal-source foods. We assessed demand for animal-source foods using family food datasets collected by the UK government (Department for Environment, Food & Rural Affairs 2012). These datasets estimate the average quantity of food products purchased per person per week, from 1974 to 2022, providing a standardised metric of long-term demand for major UK animal-source foods. We extracted all animal-source foods recorded in this dataset, and further categorised aquatic foods into groups of similar species (e.g. blue fish, white fish). We complemented these household consumption estimates with data from individual diet recall surveys, collected by the National Diet and Nutrition Survey (Office for Health Improvement and Disparities 2016). These surveys allowed us to understand relative consumption of aquatic food products at greater resolution than the household consumption dataset, containing information on portion sizes and consumption frequency of 43 aquatic food products, from 2008-2018. We examined annual changes in aquatic food consumption by adults, aggregating products to common species names (e.g. salmon, cod, tuna) and estimating the relative proportion (i.e. frequency \* portion size) of each product, for individuals who consumed aquatic foods. We visualized all species that had  $\geq 5\%$  of diets (cod, haddock, prawn, salmon, tuna, mackerel), and grouped the remaining species as 'Other'.

## *Market-making datasets*

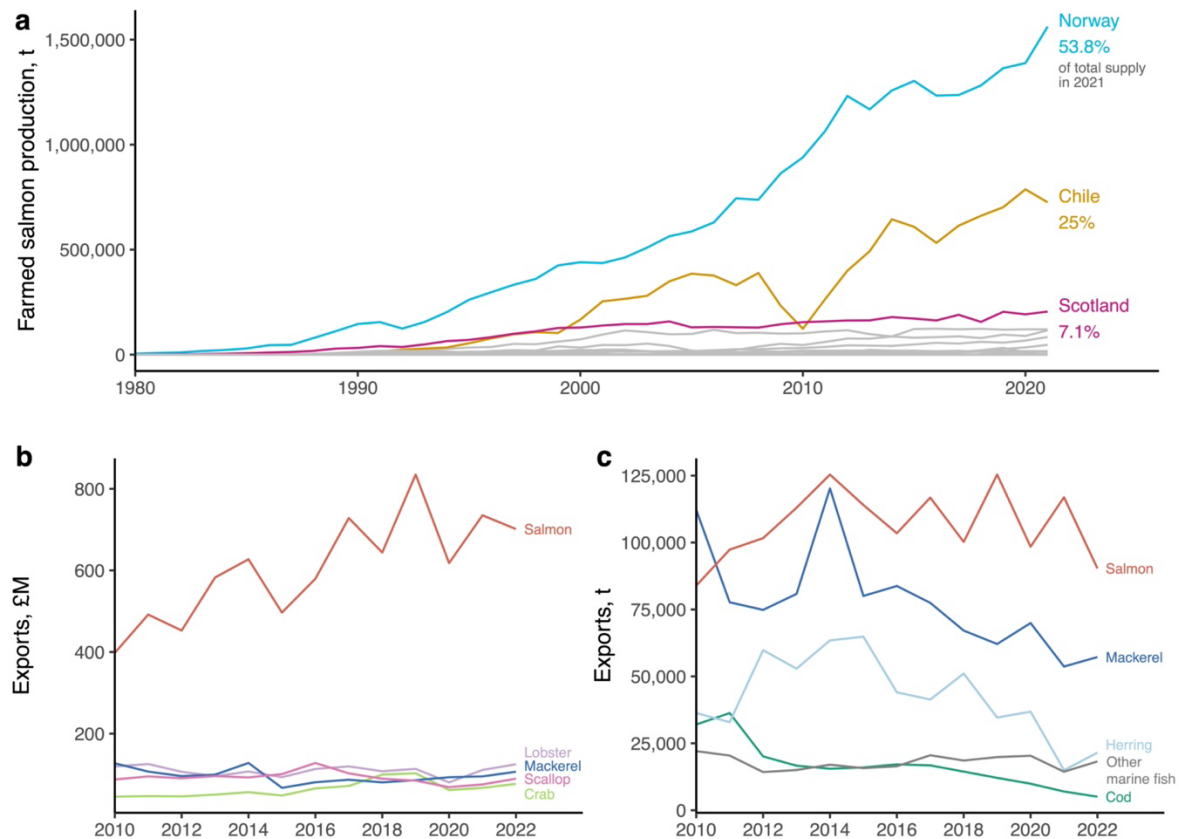
We examined aspects of market making in farmed salmon using data on the average price of animal-source foods, and omega-3 fatty acid content in aquatic foods. Price estimates were extracted from the Office for National Statistics dataset on inflation-corrected prices of commonly consumed foods by UK households (Office for National Statistics 2023). This dataset tracks the monthly price of a food basket of popular items, corrected for inflation, including farmed salmon, four other aquatic foods, and five terrestrial animal-source foods. We estimated the average price per kg of these foods from 2018-2023. We next extracted omega-3 fatty acid estimates from (Widdowson n.d.) and identified all foods with EPA and DHA concentrations above 250 mg per 100 g. The UK does not have specific health guidelines on EPA and DHA intakes, so we assessed these food values relative to guidelines for adult women (1.1 g per 100 g) (WHO and FAO 2010).

## **Results**

### *Scottish salmon context*

Norway, Chile, and Scotland dominate global Atlantic salmon mariculture, with Scotland contributing 205,000 t (in 2021), accounting for 7.1% of total annual supply (Fig. 1a). From initial experimental farms in the 1970s, growth in production was achieved through registering more marine farm sites around Scotland's coastline, reaching 203 active sites between 2018-2021 (Fig. 2b), alongside increases in farm size, productivity, and fish growth and survival (Ellis *et al* 2016). Farmed salmon production in Scotland has also increasingly oriented towards export markets. In 2022, 90,351 t of salmon was exported (£701 million, or

41% of total seafood export value), making farmed salmon the UK's most valuable and high-volume aquatic food export (Fig. 1b,c). Salmon is also popular in domestic retail markets, where salmon, cod, haddock, tuna, and prawns ('the big 5') account for most UK fish consumption (Harrison *et al* 2023).



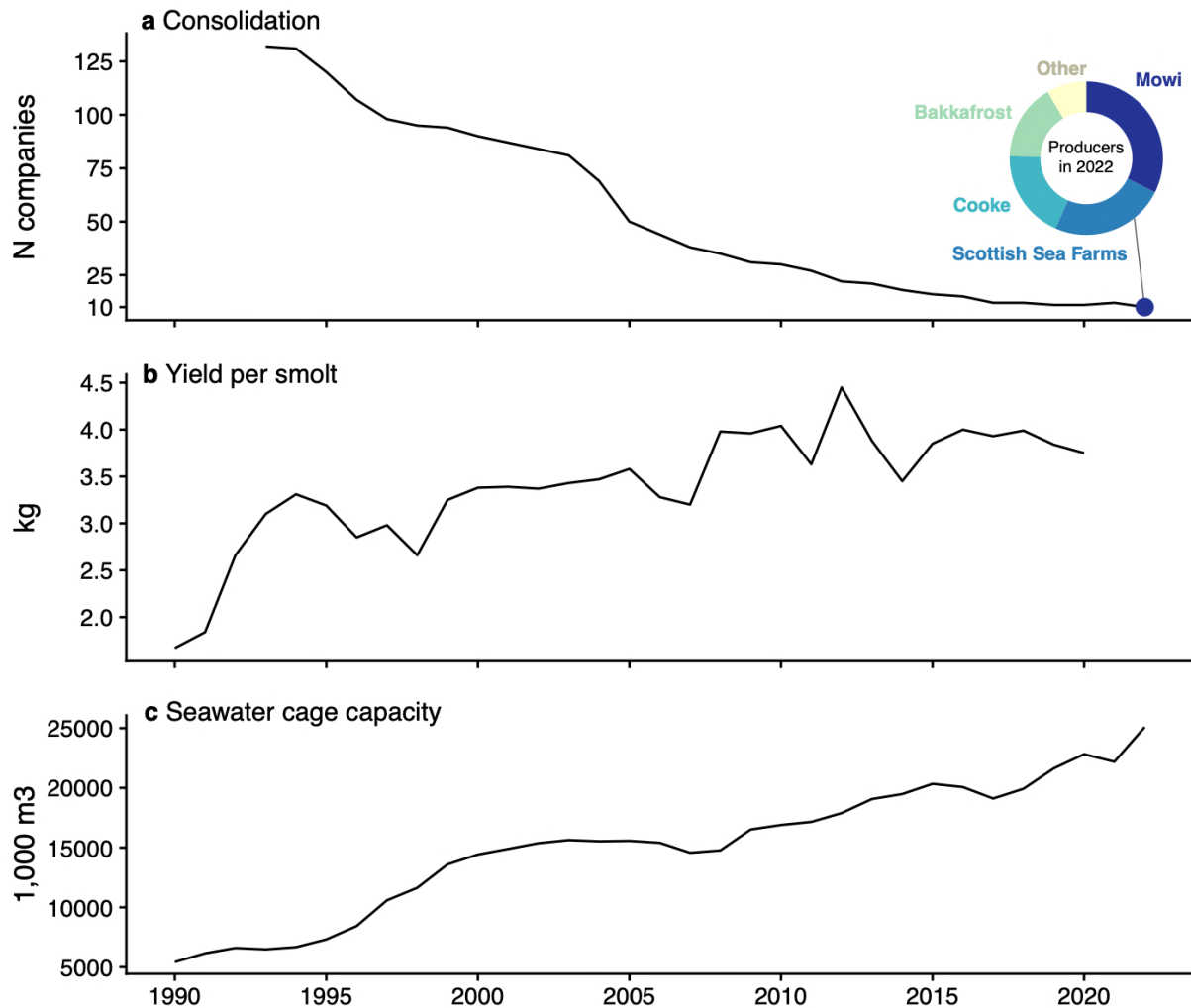
**Figure 1 | The global rise of farmed salmon.** **a)** Global farmed salmon production from 1980-2022 in 22 countries (tonnes per year). Top three producers are highlighted (Norway, Chile, Scotland), with labels showing relative contribution (%) to global supply in 2022. In Scotland, export statistics show farmed salmon dominated UK exports of aquatic foods by **b)** total value (million £ GBP) and **c)** total volume (tonnes) between 2010-2022. Lines show the top five exported aquatic food species.

### Stakeholder perspectives on salmon markets

Our interviewees linked multiple productivity and demand factors with growth in global and UK farmed salmon production (Table 1). Most interviewees identified the significance of market consolidation and technological innovation (e.g. efficiency of feed, disease treatments) in supporting industry growth. Market consolidation was perceived to have enabled 'vertical integration' of farmed salmon production, increasing production through economies of scale. Indeed, farmed salmon markets have consolidated over the last three decades, with the number of salmon producer companies in the UK decreasing from 132 in 1993 to 10 in 2022, when four companies accounted for 92% of UK production (Fig. 2a). Farm productivity has also steadily increased, owing to technological innovations in genetic selection (e.g. faster fish growth, shorter life cycles, disease resistance) and vaccines (less mortality), and regulatory changes that permit larger and higher numbers of cages and sites,

199 and a higher stocking density (in freshwater systems/stages) (Ellis *et al* 2016). This  
200 intensive, large-scale model of salmon production has been referred to as 'precision  
201 aquaculture' (Føre *et al* 2018) and presented as an example of 'sustainable intensification',  
202 where yields are increased without causing additional environmental impacts (e.g. land  
203 conversion) (Ellis *et al* 2016).

204  
205 However, most interviewees also associated intensive salmon production with environmental  
206 impacts, suggesting that farmed salmon is, at best, a disputed example of sustainable  
207 intensification. Negative perceptions included declines in wild salmon populations, feed  
208 supply chain issues, environmental run-off, and impacts to local community economies  
209 (Table S1). However, several interviewees also identified sustainability and environmental  
210 accreditation as positive attributes of farmed salmon, with "*farming in the*  
211 *sea...intrinsically...more sustainable than farming on land*" (Table S1). Such a disconnect in  
212 perspectives may arise because environmental impacts can be diffuse and lagged, making it  
213 difficult to robustly link farm practices with environmental declines. For example, life cycle  
214 analysis shows that over 90% of salmon's environmental impacts are generated from fish  
215 feeds for which, in the UK, over 75% are sourced from countries distant from salmon farms  
216 (Newton and Little 2018). Positive environmental assessments may also reflect recent  
217 improvements in salmon practices (Naylor *et al.* 2021), such as decreasing dependence on  
218 marine ingredients (marine oil use in Norway declined from 31% to 10% from 2000-16, Aas  
219 *et al.* 2019), phasing out of antibiotics (Bondad-Reantaso *et al* 2023), and (comparatively)  
220 low carbon footprints of net pen systems (Ziegler *et al* 2013).



**Figure 2 | Consolidation and intensification in Scotland's farmed salmon industry from 1990 - 2022.** a) Number of companies producing salmon, inset with top producers in 2022, b) system productivity measured by yield per smolt age class, and c) total seawater cage capacity. Data from the Scottish Fish Farm Production Survey (Scotland 2021).

All interviewees viewed retailers as key players in the farmed salmon industry, and noted 'demand-growth' factors underlying salmon industry market-making. Retailers mentioned in interviews were primarily supermarkets, which were associated with the growing convenience of salmon products, and popularity of foods labelled with images associated with Scotland and healthy ecosystems (e.g. '*Scottish environment pristine, great animal health and welfare*', Table S1). Accreditation labels were also associated with efforts to promote supply of sustainable food, which are widely used by seafood producers. For example, many Scottish salmon products are associated with eco- or sustainability labels, such as the Aquatic Stewardship Council (ASC) which has certified 57 farm sites in Scotland (26% of farms) (Aquaculture Stewardship Council 2024). Retail messaging was also raised by interviewees who see health benefits of farmed salmon as important for consumers (e.g. omega-3 fatty acids, '*salmon is a regular health message out there*'). However, consumer demand for farmed salmon was less clearly communicated by interviewees, with farmed salmon considered both more expensive than other animal-source foods ('*premium price*') and "*one of the most purchased fish products in supermarkets*" (Table S1).

Topic	Interview code	Stakeholder perspectives	Example
Industry	Global commodity	Farmed salmon is now a global seafood commodity, enabling efficiencies of scale and industry power.	<i>"dramatic improvements in productivity and efficiency of production"</i>
	Consolidation	Salmon industry has consolidated into fewer, large companies	<i>"there's only really three or four producers...in Scotland now"</i>
Retailers	<b>Labelling and certification</b>	Scottish brand has positive connotations for consumers	<i>"...clear premium to be associated with the Scottish one, because it's seen as better"</i>
	<b>Retail power</b>	Retailers have strong influence on industry success and consumer perceptions	<i>"salmon...is the biggest single product within the seafood category"</i>
Diets	<b>Health benefits</b>	Farmed salmon contributes to healthy diets	<i>"it's at the pinnacle of nutritional value"</i>
	<b>Convenience</b>	Categorisation of farmed salmon products has made it easier for consumers (e.g. ready-to-eat)	<i>"accessible format is key"</i>
	<b>Consumer perceptions</b>		<i>"I think it's one of the most purchased fish products in supermarkets"</i>
		Accessible and popular seafood available in supermarkets	<i>"we can only encourage consumers to eat [what they want] to eat"</i>
Environment	Fish welfare	Scotland's farm production is associated with good fish welfare, but also fish welfare issues in global salmon industry	<i>"...if you ask them would turn to issues like sea lice, or use of antibiotics or polluting local waters"</i>
	Sustainability	Farmed salmon have impacts on marine ecosystems, but farmed salmon are also sustainable food choices	<i>"a really positive story, the space of water use [...] lower carbon footprint, because I know it's got a sort of similar footprint to chicken, for example."</i>
	Future challenges	Barriers to further growth in Scottish farmed salmon, such as marine spatial planning and climate change	<i>"challenges that you have around disease, and particularly sea lice"</i>

**Table 1.** Stakeholder perceptions of Scottish farmed salmon. Themes were identified by coding interviews for repeated or important topics raised by interviews. Codes in bold are associated with demand-growth or market-making factors.

#### *Testing stakeholder perspectives against data from UK aquatic food systems*

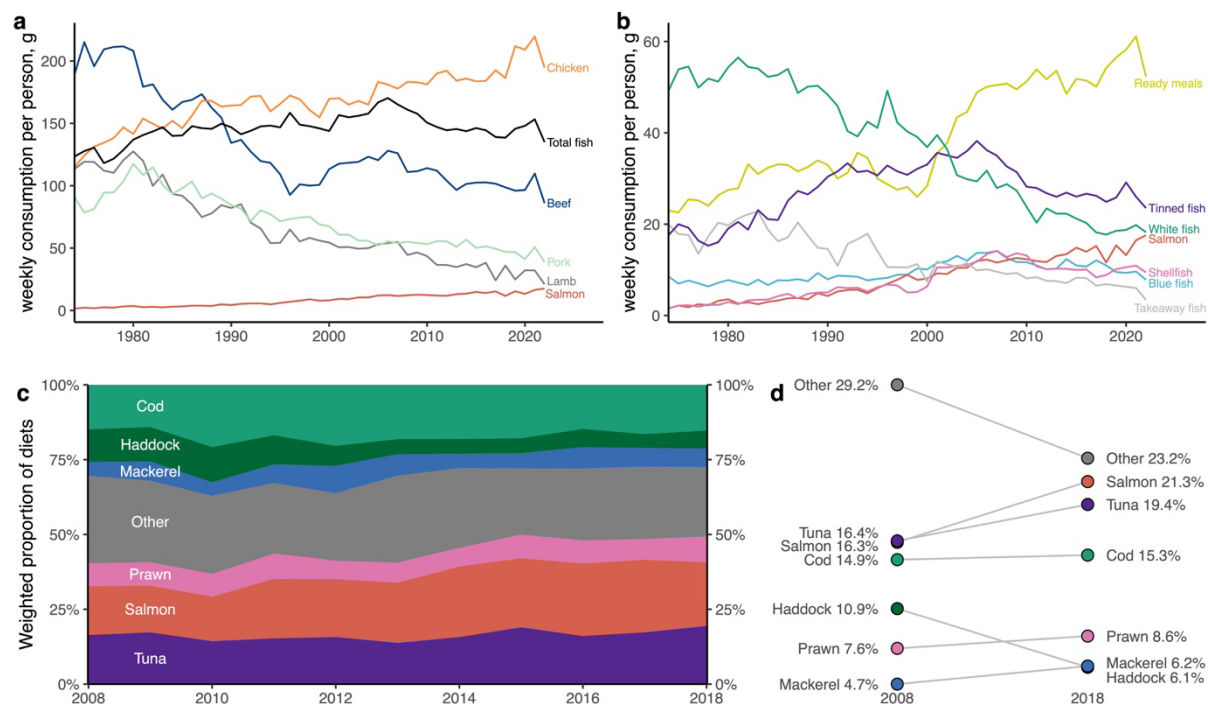
We next used diet surveys, food composition tables, and market price data to test three key 'demand-growth' factors raised by consumers: that farmed salmon is 1) a popular and accessible animal-source protein, 2) a nutritious food, with 3) accreditation and labelling used to highlight aspects of sustainability. First, we extracted household food consumption data to examine long-term trends in animal-meat consumption in the UK, examining



consumer demand for farmed salmon. Since 1990, chicken has been the most consumed animal-source protein in the UK (195 g per person per week), followed by aquatic foods (135 g) and beef (86 g) (Fig 3a). Total fish consumption has remained relatively stable since 1980, while salmon consumption steadily increased from ~2 g per week in the 1970s to 18 g by 2022. Households have increasingly consumed fish in ready meals (40% of weekly diet in 2022), and these products are substituting for long-term declines in white fish (fresh or frozen) and takeaway fish (16% of diet, combined) (Fig. 3b). While these surveys quantified consumption of fresh or frozen salmon separately from convenience forms (e.g. ready meals), our analysis shows that salmon has always been consumed less than other terrestrial meats. We next examine the retail price of farmed salmon, using estimates for animal-source products tracked by the UK's Office of National Statistics (Office for National Statistics 2023). Between 2018-24, farmed salmon was the most expensive animal-source food, and over three times more expensive than the cheapest products (canned tuna, pork sausages) (Fig. 4a). These price differences are reflected in household consumption data showing that white fish is more popular than salmon in all but the three highest wealth deciles (excluding ready meals, Fig. S1).

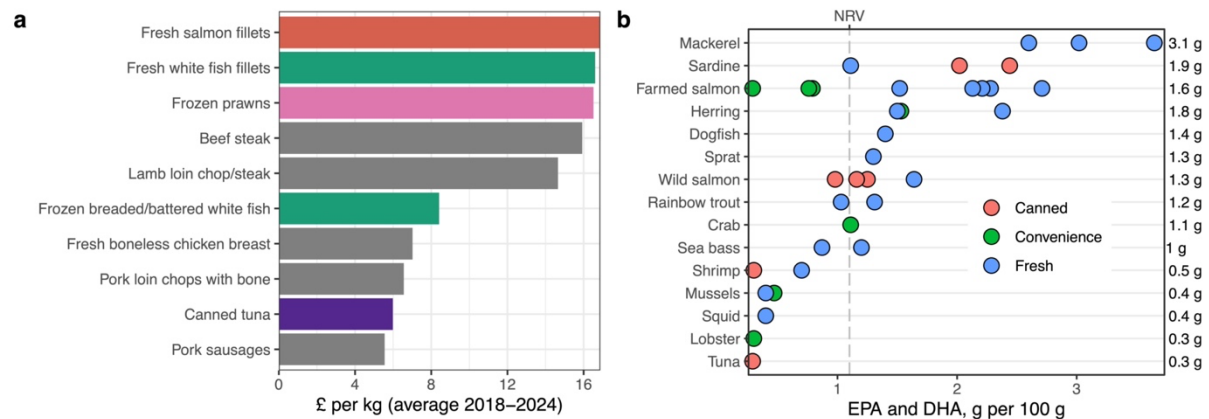
We next examined farmed salmon consumption relative to other aquatic foods, using more highly-resolved diet surveys of UK adults (Office for Health Improvement and Disparities 2016). Between 2008-2018, 60% of adults consumed aquatic foods (average daily intake = 40 g), with the 'big five' of salmon, tuna, cod, prawns, and haddock accounting for approximately two-thirds of the average seafood diet. Steady increase in farmed salmon demand (16% to 21%) has placed salmon as one of the top two consumed aquatic foods (for people who eat aquatic foods), displacing haddock (-4.8%) and 'other' species (-6%) (Fig. 3d). Together with household food consumption data (Fig. 3b), these trends suggest that increases in ready meal consumption is primarily of convenient forms of farmed salmon and tuna, consistent with evidence of growing categorisation and commodification of farmed salmon products (Asche *et al* 2021).

284  
285



**Figure 3 | Animal-source food consumption in the UK from 1974-2022. a)** weekly household consumption of major animal-source foods and farmed salmon (dark blue), and **b)** major aquatic food products. Individual diet surveys from 2008-2018 show **c)** the average composition of diets for people eating aquatic foods, accounting for quantity and frequency of consumption. **d)** Absolute change in diet composition from 2008 to 2018. Aquatic foods contributing < 5% of diet (by weight) were grouped as 'Other'. See Fig. S1 for household aquatic food consumption by wealth decile.

Second, we test interview claims about salmon consumption providing health benefits, particularly through omega-3 fatty acid intakes. UK dietary guidelines recommend that adults eat two portions (2 x 140 g) of aquatic foods every week, with one of those being an oily fish, such as salmon (NHS 2024). Food composition tables confirm that a 140 g portion contains over 100% of an adult's recommended intake of omega-3 fatty acids, vitamins B12 and D, and thus can be a significant contributor to dietary nutrient intakes (Willer et al. 2023). However, 'convenience' farmed salmon products, such as smoked salmon or fishcakes, had less EPA and DHA than fresh salmon, with levels that were below the recommended daily intake for omega-3 fatty acids (Fig. 4b). Such prepared products account for 39% of the UK farmed salmon market (Straume et al 2024), suggesting contributions to omega-3 fatty acid intakes may be overstated. Indeed, focus on omega-3 fatty acid content also belies other health benefits of consuming a diverse set of aquatic foods (Beal et al 2024). For example, seafood products available in the UK are sources of several nutrients, including iodine (e.g. cod), iron (e.g. farmed mussels), or zinc (e.g. shrimp / prawns), that have relatively lower concentrations in farmed salmon (Robinson et al 2022). Other oily fish such as herring, mackerel, and sardine also contain comparable or higher omega-3 fatty acid levels to farmed salmon (Fig. 4b).



**Figure 4 | Price and nutrient content of UK animal food products.** **a)** Average price (£ GBP per kg) of animal-source foods in national food surveys that included salmon products (2018–24) and **b)** omega-3 fatty acid (EPA and DHA) content in UK aquatic food products (those >0.25 g per 100 g). Products were aggregated by common species name, and coloured by processing type (convenience products were pre-cooked, e.g. smoked fish or fish cakes). Terrestrial animal products contained negligible amounts of EPA and DHA (median = 0.03 g per 100 g). Dashed line shows the Nutrient Reference Value for adult women, indicating recommended daily intake of EPA and DHA (1.1 g) (WHO and FAO 2010). Secondary y-axis shows the mean EPA and DHA concentration for each species.

Third, we examine the prevalence of sustainability accreditation in farmed salmon products, arising from interviewees who noted retailer labelling associated with positive perceptions of farmed salmon (e.g., ‘local’, ‘wild’, and ‘organic’). Multiple accreditation schemes and ecolabels have been introduced to promote sustainability standards for aquatic foods, introducing confusion for markets and consumers, with variable success in improving sustainability (Roheim *et al* 2018). Labelling schemes used for farmed salmon have been considered indicators of environmental or social responsibility, rather than sustainability standards (Gulbrandsen *et al* 2022). Indeed, accreditation movements may help larger companies to exert market influence by re-defining sustainability (Aarset *et al* 2020), while environmental footprints remain large, due to longstanding impacts associated with aquafeeds (e.g. emissions and land use) (Newton and Little 2018, Kuempel *et al* 2023). ASC and other aquatic food ecolabels have been criticised for failing to capture these broader system impacts of salmon production (Gulbrandsen *et al* 2022), having weak certification criteria, and even for misleading consumers (Jacquet *et al* 2010). Labelling thus appears to serve as a powerful demand-growth factor. Industry influence in this area remains strong, with, for example, the UK government approving legislation in 2024 to market farmed products as ‘Scottish Salmon’, a labelling protection previously reserved for wild-caught products (Scotland 2024).

## Discussion

Favourable regulation, market consolidation, and technological innovation have supported farmed salmon producers in developing a model of intensive large-scale production (Ellis *et al* 2016, Asche *et al* 2013, Graziano *et al* 2018), transforming salmon into one of the most valuable global food commodities. One of our interviewees said “we can only encourage consumers to eat [what they want] to eat” (E1, Table 1). However, our study suggests that the rise of farmed salmon demand in the UK was a process that included several purposeful

actions from market actors, such as the processing and creation of convenience food products, wide availability, and health and sustainability labelling, leading to positive framing of the industry from almost all interviewees. Our analyses show that consumers responded to this increase in supply by changing aquatic food preferences towards farmed salmon, positioning salmon as the most popular aquatic food product in the UK.

Market-making by industry (e.g. farmers, processors and retailers) has thus played a significant role in creating demand and popularity for farmed salmon. Interviewees suggested that salmon's market appeal is linked to its accessibility, nutrient value, and sustainability credentials, yet our analysis suggests these messages can be misleading. UK food consumption datasets showed that farmed salmon is less widely consumed than other animal-source proteins, while recent increases in salmon consumption (the most popular aquatic food in 2018) have displaced other aquatic foods from diets, primarily through popularity of convenience products. While farmed salmon products can be a rich source of omega-3 fatty acids (EPA and DHA), they are also among the most expensive animal-source foods, and consumed primarily by affluent households. These trends thus suggest that retailers have steadily prioritised farmed salmon products over other aquatic foods, shaping seafood markets to favour more affluent consumers. Indeed, in the UK between 2006-18, salmon demand increased while total seafood consumption remained stable (Fig. 3a). These dietary shifts occurred during a period when UK diets remain below recommended levels of seafood intake (Harrison *et al* 2023) and deficiencies of nutrients concentrated in aquatic foods, such as iron and selenium (Derbyshire 2018), remain prevalent. Finally, despite having lower carbon emissions than most livestock products (Robinson *et al* 2022, Bianchi *et al* 2022), environmental impacts of large-scale salmon farming (e.g. feed supply chains) remain substantial (Kuempel *et al* 2023). Continued supply-growth in farmed salmon (Froehlich *et al* 2021), and associated demand-growth through market-making, will therefore lead to mariculture accounting for an increasing share of the UK food system environmental footprint.

The role of retail commodification in market-making can have strong influences on food system composition with, for example, consumption of 'Other' aquatic foods partly substituted by farmed salmon (and tuna) (Fig. 3d). While such food substitutions are historically rare, aquatic food markets are highly diverse, encompassing many species, production methods, and sources (Ferraro *et al* 2022). This sector may therefore be more suited to market making efforts to reshape consumer demand. Indeed, UK consumers have already transitioned from primarily consuming wild-caught species from UK waters (cod, haddock) in the 20th century, to retail dominated by imported and farmed products (Harrison *et al* 2023). Characteristics of farmed salmon market-making could thus be used to promote consumption of more sustainable and nutritious aquatic foods that reach people with greater dietary needs. For example, the UK also produces other farmed aquatic foods at smaller quantities (mussels, seaweed), and large quantities of wild-caught species such as herring and mackerel (Robinson *et al* 2022, Harrison *et al* 2023) destined for export markets (Graziano *et al* 2018). Creating demand for such low-impact species would help to reduce environmental footprints from aquatic foods (Jones *et al* 2022), while addressing deficiencies in nutrients that are concentrated in aquatic foods (Vogliano *et al* 2024, Willer *et al* 2021). Such diversification (i.e. reducing farmed salmon dominance) would add resilience to food supply (e.g. from trade disruption) (Graziano *et al* 2018) and reduce food system

contributions to emissions targets (Stewart *et al* 2023). Market-making efforts towards other products could engender new markets through, for example, product categorisation (Gawel *et al* 2023). Upscaling production and demand for these markets will require further analysis on market dynamics between farmed salmon and other animal foods (terrestrial and aquatic), engagement with industry and retailers (Ruel *et al* 2018), and investment and regulatory support (Vogliano *et al* 2024).

Dominance of individual species within seafood sectors has been historically rare (Ferraro *et al* 2022), and yet the intensive production, investments in infrastructure of processing and distribution, technology, labelling and categorisation, and other market-making practices of farmed salmon are similar to those in the poultry sector (i.e. ‘aquatic chicken’) (Gephart *et al* 2020). Our analysis suggests that farmed salmon demand has been co-created through purposeful market-making by producers and retailers, underpinned by narratives of widespread appeal, nutrient value, and sustainability. We find that farmed salmon dominance of UK aquatic food consumption is primarily due to affluent households and, through categorisation, labelling, and differentiation, may have led to reduced demand for other aquatic foods. The knock-on impacts for other aquatic food sectors remain unclear, requiring further research on how producers and retailers act to influence consumer behaviour. Uncovering market-making in food systems can reveal ways of promoting consumption of new or alternative products, providing means to address consumer barriers for more affordable, nutritious and sustainable aquatic foods (Gawel *et al* 2023).

## Acknowledgements

We thank all interviewees for their time and insights on this project.

## References

- Aarset B, Carson S G, Wiig H, Måren I E and Marks J 2020 Lost in translation? Multiple discursive strategies and the interpretation of sustainability in the Norwegian salmon farming industry *Food Ethics* **5** Online: <https://link.springer.com/article/10.1007/s41055-020-00068-3>
- Aquaculture Stewardship Council 2024 Aquaculture Stewardship Council Online: <https://asc-aqua.org/our-impact/>
- Araujo L 2007 Markets, market-making and marketing *Mark. Theory* **7** 211–26
- Asche F, Dahl R E, Gordon D V, Trollvik T and Aandahl P 2011 Demand Growth for Atlantic Salmon: The EU and French Markets *Mar. Resour. Econ.* **26** 255–65
- Asche F, Roll K H, Sandvold H N, Sørvig A and Zhang D 2013 SALMON AQUACULTURE: LARGER COMPANIES AND INCREASED PRODUCTION *Aquacult. Econ. Manage.* **17** 322–39
- Asche F, Sogn-Grundvåg G, Zhang D, Cojocaru A L and Young J A 2021 Brands, Labels, and Product Longevity: The Case of Salmon in UK Grocery Retailing *Journal of International Food & Agribusiness Marketing* **33** 53–68
- Barton J R, Baeza-González S and Román Á 2023 Unravelling sustainable salmon aquaculture: an historical political ecology of a business responsibility discourse,

439 1970–2020 *Marit. Stud.* **22** 10

440 Beal T, Manohar S, Miachon L and Fanzo J 2024 Nutrient-dense foods and diverse diets are  
 441 important for ensuring adequate nutrition across the life course *Proc. Natl. Acad. Sci.*  
 442 *U. S. A.* **121** e2319007121

443 Belton B, Little D C, Zhang W, Edwards P, Skladany M and Thilsted S H 2020 Farming fish  
 444 in the sea will not nourish the world *Nat. Commun.* **11** 5804

445 Bianchi M, Hallström E, Parker R W R, Mifflin K, Tydemers P and Ziegler F 2022 Accounting  
 446 for nutritional diversity in seafood climate impact assessment – A global perspective  
 447 *Communications Earth and Environment*

448 Bondad-Reantaso M G, MacKinnon B, Karunasagar I, Fridman S, Alday-Sanz V, Brun E, Le  
 449 Groumellec M, Li A, Surachetpong W, Karunasagar I, Hao B, Dall'Occo A, Urbani R  
 450 and Caputo A 2023 Review of alternatives to antibiotic use in aquaculture *Rev.*  
 451 *Aquac.* Online: <https://onlinelibrary.wiley.com/doi/abs/10.1111/raq.12786>

452 Cottrell R S, Maier J, Ferraro D M, Blasco G D, Geyer R, Froehlich H E and Halpern B S  
 453 2021 The overlooked importance of food disadoption for the environmental  
 454 sustainability of new foods *Environ. Res. Lett.* **16** 104022

455 Department for Environment, Food & Rural Affairs 2012 Family food datasets Online:  
 456 <https://www.gov.uk/government/statistical-data-sets/family-food-datasets>

457 Derbyshire E 2018 Micronutrient Intakes of British Adults Across Mid-Life: A Secondary  
 458 Analysis of the UK National Diet and Nutrition Survey *Front Nutr* **5** 55

459 Ellis T, Turnbull J F, Knowles T G, Lines J A and Auchterlonie N A 2016 Trends during  
 460 development of Scottish salmon farming: An example of sustainable intensification?  
 461 *Aquaculture* **458** 82–99

462 FAO 2022 *The State of World Fisheries and Aquaculture 2022. Towards Blue*  
 463 *Transformation* (Rome, FAO) Online: <http://dx.doi.org/10.4060/cc0461en>

464 FAO Fisheries Division, Statistics and Information Branch 2020 FishStatJ: Universal  
 465 software for fishery statistical time series

466 Ferraro D M, Cottrell R S, Blasco G D, Froehlich H E and Halpern B S 2022 Historical food  
 467 consumption declines and the role of alternative foods *Environ. Res. Lett.* **17** 014020

468 Føre M, Frank K, Norton T, Svendsen E, Alfredsen J A, Dempster T, Eguiraun H, Watson W,  
 469 Stahl A, Sunde L M, Schellewald C, Skøien K R, Alver M O and Berckmans D 2018  
 470 Precision fish farming: A new framework to improve production in aquaculture  
 471 *Biosystems Eng.* **173** 176–93

472 Froehlich H E, Couture J and Falconer L 2021 Mind the gap between ICES nations' future  
 473 seafood consumption and aquaculture production *ICES J. Mar. Sci.* Online:  
 474 <https://academic.oup.com/icesjms/article-abstract/78/1/468/5828449>

475 Garlock T, Asche F, Anderson J, Ceballos-Concha A, Love D C, Osmundsen T C and  
 476 Pincinato R B M 2022 Aquaculture: The missing contributor in the food security  
 477 agenda *Global Food Security* **32** 100620

478 Gawel J P F, Aldridge D C and Willer D F 2023 Barriers and drivers to increasing  
 479 sustainable bivalve seafood consumption in a mass market economy *Food Front.* **4**

480 1257–69

481 Gephart J A, Agrawal Bejarano R, Gorospe K, Godwin A, Golden C D, Naylor R L, Nash K L,  
 482 Pace M L and Troell M 2024 Globalization of wild capture and farmed aquatic foods  
 483 *Nat. Commun.* **15** 8026

484 Gephart J A, Golden C D, Asche F, Belton B, Brugere C, Froehlich H E, Fry J P, Halpern B  
 485 S, Hicks C C, Jones R C, Klinger D H, Little D C, McCauley D J, Thilsted S H, Troell  
 486 M and Allison E H 2020 Scenarios for Global Aquaculture and Its Role in Human  
 487 *Nutrition Reviews in Fisheries Science & Aquaculture* 1–17

488 Golden C D, Koehn J Z, Shepon A, Passarelli S, Free C M, Viana D F, Matthey H, Eurich J  
 489 G, Gephart J A, Fluet-Chouinard E, Nyboer E A, Lynch A J, Kjelleevold M, Bromage S,  
 490 Charlebois P, Barange M, Vannuccini S, Cao L, Kleisner K M, Rimm E B, Danaei G,  
 491 DeSisto C, Kelahan H, Fiorella K J, Little D C, Allison E H, Fanzo J and Thilsted S H  
 492 2021 Aquatic foods to nourish nations *Nature* **598** 315–20

493 Graziano M, Fox C J, Alexander K, Pita C, Heymans J J, Crumlish M, Hughes A, Ghanawi J  
 494 and Cannella L 2018 Environmental and socio-political shocks to the seafood sector:  
 495 What does this mean for resilience? Lessons from two UK case studies, 1945–2016  
 496 *Mar. Policy* **87** 301–13

497 Gulbrandsen L H, Vormedal I and Larsen M L 2022 No logo? The failure of ASC salmon  
 498 labeling in Norway and the UK *Mar. Policy* **138** 104987

499 Hammersley M and Atkinson P 2019 *Ethnography: Principles in practice* (London:  
 500 Routledge)

501 Harrison L O J, Engelhard G H, Thurstan R H and Sturrock A M 2023 Widening mismatch  
 502 between UK seafood production and consumer demand: a 120-year perspective  
 503 *Rev. Fish Biol. Fish.* Online: <https://doi.org/10.1007/s11160-023-09776-5>

504 Jacquet J, Pauly D, Ainley D, Holt S, Dayton P and Jackson J 2010 Seafood stewardship in  
 505 crisis *Nature* **467** 28–9

506 Jones A R, Alleway H K, McAfee D, Reis-Santos P, Theuerkauf S J and Jones R C 2022  
 507 Climate-friendly seafood: The potential for emissions reduction and carbon capture in  
 508 marine aquaculture *Bioscience* **72** 123–43

509 Katy Mason H K and Hagberg J 2015 Exploring the performativity of marketing: theories,  
 510 practices and devices *Journal of Marketing Management* **31** 1–15

511 Kuempel C D, Frazier M, Verstaen J, Rayner P-E, Blanchard J L, Cottrell R S, Froehlich H E,  
 512 Gephart J A, Jacobsen N S, McIntyre P B, Metian M, Moran D, Nash K L, Többen J,  
 513 Williams D R and Halpern B S 2023 Environmental footprints of farmed chicken and  
 514 salmon bridge the land and sea *Curr. Biol.* Online:  
 515 <http://dx.doi.org/10.1016/j.cub.2023.01.037>

516 Lofstedt A, de Roos B and Fernandes P G 2021 Less than half of the European dietary  
 517 recommendations for fish consumption are satisfied by national seafood supplies  
 518 *Eur. J. Nutr.* **60** 4219–28

519 Moodie R, Bennett E, Kwong E J L, Santos T M, Pratiwi L, Williams J and Baker P 2021  
 520 Ultra-processed profits: The political economy of countering the global spread of  
 521 Ultra-processed foods - A synthesis review on the market and political practices of  
 522 transnational food corporations and strategic public health responses *Int. J. Health*

- 523 *Policy Manag.* **10** 968–82
- 524 Naylor R L, Hardy R W, Buschmann A H, Bush S R, Cao L, Klinger D H, Little D C,  
525 Lubchenco J, Shumway S E and Troell M 2021 A 20-year retrospective review of  
526 global aquaculture *Nature* **591** 551–63
- 527 Neuman W L 2012 *Basics of social research* (New Jersey: Pearson)
- 528 Newton R W and Little D C 2018 Mapping the impacts of farmed Scottish salmon from a life  
529 cycle perspective *Int. J. Life Cycle Assess.* **23** 1018–29
- 530 NHS 2024 The Eatwell Guide Online: [https://www.nhs.uk/live-well/eat-well/food-guidelines-](https://www.nhs.uk/live-well/eat-well/food-guidelines-and-food-labels/the-eatwell-guide/)  
531 [and-food-labels/the-eatwell-guide/](https://www.nhs.uk/live-well/eat-well/food-guidelines-and-food-labels/the-eatwell-guide/)
- 532 Office for Health Improvement and Disparities 2016 National Diet and Nutrition Survey  
533 Online: <https://www.gov.uk/government/collections/national-diet-and-nutrition-survey>
- 534 Office for National Statistics 2023 Shopping Prices Comparison Tool Online:  
535 [https://www.ons.gov.uk/economy/inflationandpriceindices/articles/shoppingpricescom-](https://www.ons.gov.uk/economy/inflationandpriceindices/articles/shoppingpricescomparisonstool/2023-05-03)  
536 [parisonstool/2023-05-03](https://www.ons.gov.uk/economy/inflationandpriceindices/articles/shoppingpricescomparisonstool/2023-05-03)
- 537 Österblom H, Jouffray J-B, Folke C, Crona B, Troell M, Merrie A and Rockström J 2015  
538 Transnational corporations as “keystone actors” in marine ecosystems *PLoS One* **10**  
539 e0127533
- 540 Pandey R, Asche F, Misund B, Nygaard R, Adewumi O M, Straume H-M and Zhang D 2023  
541 Production growth, company size, and concentration: The case of salmon  
542 *Aquaculture* **577** 739972
- 543 Parodi A, Leip A, De Boer I J M, Slegers P M, Ziegler F, Temme E H M, Herrero M,  
544 Tuomisto H, Valin H, Van Middelaar C E, Van Loon J J A and Van Zanten H H E  
545 2018 The potential of future foods for sustainable and healthy diets *Nat Sustain* **1**  
546 782–9
- 547 Regan T, Bean T P, Ellis T, Davie A, Carboni S, Migaud H and Houston R D 2021 Genetic  
548 improvement technologies to support the sustainable growth of UK aquaculture *Rev.*  
549 *Aquac.* **13** 1958–85
- 550 Robinson J P W, Garrett A, Esclapez J C P, Maire E, Parker R and Graham N A 2022  
551 Navigating sustainability and health trade-offs in global seafood systems *Environ.*  
552 *Res. Lett.* **17** Online: <https://iopscience.iop.org/article/10.1088/1748-9326/aca490>
- 553 Roheim C A, Bush S R, Asche F, Sanchirico J N and Uchida H 2018 Evolution and future of  
554 the sustainable seafood market *Nature Sustainability* **1** 392–8
- 555 Roscoe P and Loza O 2019 The –ography of markets (or, the responsibilities of market  
556 studies) *J. Cult. Econ.* **12** 215–27
- 557 Ruel M T, Quisumbing A R and Balagamwala M 2018 Nutrition-sensitive agriculture: What  
558 have we learned so far? *Global Food Security* **17** 128–53
- 559 Scotland M 2021 Scottish Fish Farm Production Survey Data Online:  
560 <https://data.marine.gov.scot/dataset/scottish-fish-farm-production-survey-data>
- 561 Scotland S 2024 Salmon Scotland secures protected status update Online:  
562 <https://www.salmonscotland.co.uk/news/scottish-salmon-secures-new-legal->



563 protection

564 Seafish 2019 UK Seafood Trade and Tariff Tool Online:  
565 <https://public.tableau.com/views/SeafishTradeandTariffTool/>

566 Stewart K, Balmford A, Scheelbeek P, Doherty A and Garnett E E 2023 Changes in  
567 greenhouse gas emissions from food supply in the United Kingdom *J. Clean. Prod.*  
568 **410** 137273

569 Straume H-M, Asche F, Landazuri-Tveteraas U, Misund B, Pettersen I K and Zhang D 2024  
570 Product forms and price transmission in major European salmon markets  
571 *Aquaculture* **582** 740508

572 Thorpe R, Jackson P R, Easterby-Smith M and Lowe A 2008 *Management Research*  
573 (London, England: SAGE Publications) Online:  
574 [https://books.google.com/books/about/Management\\_Research.html?id=eilNkQOo6h](https://books.google.com/books/about/Management_Research.html?id=eilNkQOo6hEC)  
575 EC

576 Vogliano C, Kennedy G, Thilsted S, Mbuya M N N, Battista W, Sadoff C, White G, Kim J K,  
577 Pucher J, Koome K, D'Cruz G, Geagan K, Chang K, Sumaila U R, Palmer S and  
578 Alleway H 2024 Regenerative aquatic foods can be a win-win for human and  
579 planetary health *Nat. Food* **5** 718–9

580 WHO and FAO 2010 *Fats and fatty acids in human nutrition. Proceedings of the Joint*  
581 *FAO/WHO Expert Consultation*

582 Widdowson M A Composition of foods integrated dataset (CoFID) Online:  
583 [https://www.gov.uk/government/publications/composition-of-foods-integrated-](https://www.gov.uk/government/publications/composition-of-foods-integrated-dataset-cofid)  
584 [dataset-cofid](https://www.gov.uk/government/publications/composition-of-foods-integrated-dataset-cofid)

585 Willer D F, Nicholls R J and Aldridge D C 2021 Opportunities and challenges for upscaled  
586 global bivalve seafood production *Nat. Food* **2** 935–43

587 Willett W, Rockström J, Loken B, Springmann M, Lang T, Vermeulen S, Garnett T, Tilman D,  
588 DeClerck F, Wood A, Jonell M, Clark M, Gordon L J, Fanzo J, Hawkes C, Zurayk R,  
589 Rivera J A, De Vries W, Majele Sibanda L, Afshin A, Chaudhary A, Herrero M,  
590 Agustina R, Branca F, Lartey A, Fan S, Crona B, Fox E, Bignet V, Troell M, Lindahl  
591 T, Singh S, Cornell S E, Srinath Reddy K, Narain S, Nishtar S and Murray C J L 2019  
592 Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from  
593 sustainable food systems *Lancet* **393** 447–92

594 Ziegler F, Winther U, Hognes E S, Emanuelsson A, Sund V and Ellingsen H 2013 The  
595 carbon footprint of Norwegian seafood products on the global seafood market:  
596 Carbon footprint of Norwegian seafood on global market *J. Ind. Ecol.* **17** 103–16

## Supplementary Material

Theme	Examples from interviews
<p><b>Market consolidation</b></p>	<p>“[Salmon Scotland is] a key player in all of this. They're a focal point, and all producing companies are members, large number of supply chain members are members, [...] we are a member of that. [...] it's a key focal point, that's a key place for us to come together as a sector to face into challenges, but it's also about facing outwards and making sure that we've got unified voices, clear messaging, which might conflict, engagement, political, local, council level, etc. Just so that everyone -- there is a clear and consistent message about the sector being portrayed. And equally Salmon Scotland will face into, rather than one company coming out into media or facing into inquiries on their own and voicing on behalf of the industry. Salmon Scotland can do that.” (E1)</p> <p>“it's a very consolidated industry [...] there's only really three or four producers I would say in Scotland now. [...] So everyone's critical, really from a producer side in such a consolidated industry. [...] I think there will continue to be value chain consolidation. So I think more and more farmers will get into the value chain, adding value to the product, supplying direct to retailers, potentially direct to consumers at some point in the future. I think that's a trend that started and is inevitable in a way. (E2)</p> <p>“[...] there's an issue in terms of UK salmon consumption and supply in that there are only two UK retailers that exclusively stocked Scottish salmon [...]. Everybody else has a mixture. [...] there are four producers in Scotland that have scale, that's it. No more than four. Used to be 10, used to be 20 and so the producers and the buyers and the retailers because the retailers set a whole host of requirements on producers and those are around volume, price, quality, adherence to a whole range of either in-house retailer standards or externally certified standards, RSPCA Freedom Foods, welfare, stocking densities, use of antibiotics, different forms of husbandry treatments. The retailers certainly had collectively -- have agreed buying policies for their growers on fish feed.” (E9)</p>
<p><b>Global commodity</b></p>	<p>“[...] there has been funding mechanisms that has been platforms created via likes of UKRI to support the sector [...] more innovation funds, sourced funding bodies, like Innovate UK, or KTN, as it used to be, they put quite significant investments into collaborative projects. And that would then bring together the sector players, the relevant sector players who wanted to support it, as well as R&amp;D bases so Sterling, Aberdeen, Edinburgh, Rosalind, etc, whomever, Cefas, Weymouth, the list goes on and on. Those are sort of mechanisms that help really push forward research and development. [...] you get bigger jumps, when you've got collaborative projects [...] And it was quite a few significant scale projects, looking at feeds, development of raw materials, you know, sea lice control mechanisms, vaccine development, etc. It was those sort of platforms that really moved things along” (E1)</p>

	<p>“the technology has evolved, which has allowed [...] bigger scale production. The industry's largely very well financed, and can invest to innovate and grow production technology and methodology and so on. I mean, [...] If you contrast salmon farming or producers in Scotland with sheep farming [...] there's a lot of them so any kind of evolution of the industry is kind of hampered by the scale of those farmers, their access to capital and innovation. So the industry is very, very innovative. And while we have challenges, no question there, what the industry has been really good at is finding solutions to the challenges that come up. And then and then investing in infrastructure to manage them. [...] technology has allowed us to move into higher energy environments and investment. (E2)</p> <p>“Another factor [in the rise of salmon] would be I'd say dramatic improvements in productivity and efficiency of production through state changes in two things. One, the genetics and the breeding of the animal so it grows faster and the way in which it's farmed takes less time. So that improves your profitability. That's been a very big change in increasing supply. [...] So the second thing would be improvements in Disease Control. So we can now vaccinate fish against diseases that they used to die from. [...] And it's difficult to vaccinate. You know, fish are different animals to us in terms of immune systems and so on and there's been big improvements in animal health, through medical and scientific technology developments. And then the third thing that would explain the dramatic increase in production is we've gotten better at farming at bigger and bigger scale and the equipment and the know-how and the technology of how you do that”(E9).</p>
<b>Labelling and certification</b>	<p>“there's a very strong association of it being a Scottish product, and certainly that works very strongly in its favour” (E6)</p> <p>“Scotland has a fantastic reputation to build on. In terms of the imagery that is associated with Scotland. It's very positive and he's very clean and it's wild and it's majestic and [...] you compare like Norwegian salmon with Scottish salmon, there's a clear premium to be associated with the Scottish one, because it's seen as better [...] and you will evoke those sorts of relations in the market.” (E6)</p> <p>“Scottish salmon is sold on a premium. It sold in a premium of Scottish environment pristine, great animal health and welfare.” (E8)</p> <p>“But there has been a lot of discussion about certification and labelling schemes. And both I know, from the point of view of how do you guarantee those schemes work as they should actually work. [...] And there's a problem that they're often paid by the industry to certify them as sustainable. And so [...] that's open to criticism. And then the other side of it is [...] the consumer take. We look at all these little marks [...] it's fair, it's fair trade, it's red tractor, it's sustainable fishery. When you need quite a lot of the consumer has to be well informed and have the time to think about it.” (E3)</p>
<b>Retail power</b>	<p>“the reality is, [consumers] don't like things with heads, eyes, gills, the UK consumers like easily accessible, quick and easy to use protein. And salmon offers that [...] Retailers stepping away from having counters. [...] And so availability of that</p>

	<p>traditional sourcing of fish is getting harder and harder for UK consumers. But what they're used to is spending on pack, you know, going up to the counter and there's all these packs presented to you and it's quick and easy grab it, there's a great portion size, everything's dealt with you and salmon lends itself very well to that. So you know that drive is primarily due to boneless portions, fillet portions, in some cases go even further being skinless or descale all the rest of it. [...]. I think accessible format is key. (E1)</p> <p>“Salmon, without question is the biggest single product within the seafood category. [...] And in many retailers was in the region of 30 to 40% of the total seafood category. So from a retailer's point of view, having appropriate salmon offering was critical to the whole of that category performance. So it was hugely important. [...] salmon for consumers was possibly seen along cloak more akin to other proteins, terrestrial proteins in a way. So if they were going to buy fish, they will choose between cod, haddock, sea bass, prawns potentially, so that was almost a purchase decision among those seafoods whereas salmon would be a case of ‘okay, we're gonna have chicken, beef, lamb, or salmon tonight’. Not absolute situation, but certainly more towards that kind of purchase decision” (E2)</p> <p>“30 to 40 different products. So it was a vast ingredients in other products. Now M&amp;S is different retailer because of the kind of the breadth of the portfolio of added value products compared to other retailers but that's probably an evolution that's happened over time. And I think then also, you know, you go to the sandwich, the lunch section of the retailer now and you will see much more salmon now than you would have done. So maybe going back 10-15 years, you would have seen a smoked salmon sandwich, but you wouldn't have seen salmon bites or sushi or so on and so on and so on. So I think salmon has made that move into different eating and consumption occasions.” (E2)</p> <p>“Well, I'm sure the retailers have a big part to play. You know, if they have their but a kind of, “Pick one of your proteins, one of your stir fry mixes one of your carbohydrates and a sauce and a sachet” (27:18). Then you can have noodles or rice, and you can have green vegetables or rainbow vegetables, and you can have a piece of chicken or a piece of salmon. So some of it will be literally physically that the salmon is in a fridge next to the chicken and the chicken and salmon fridge is not next to the beef and pork fridge. [...]there's elements about “What’s eye level?”, “What’s on promotion?” [...] They might not even tell you anyway, but you know the retailers will have strategies that optimize the profitability of their lines and so they will push or not push depending on, can they get the supply that they want and can they get the profit margin that they want [...] smoked salmon or ready meals [...] that's a huge part of the market as well because lots of people don't even cook a fillet at home. (E9)</p>
Health benefits	<p>“[there is ] a regular health message out there ‘make sure you omega 3 and make sure you eat an oily fish’ - Salmon delivers on that” (E1)</p> <p>"When we asked consumers why they have chosen salmon, nine times out of 10, there's two real drivers on purchase decision. The first one is because they like eating salmon. That's it, they really enjoy the bite because they like to eat it. The</p>

	<p>second one is from a health aspect. So they enjoy it and they know it's good for their health. [...] ultimately, it's a good -- because it's a good product, because it's healthy so it's, I mean, how many foods do we eat, that a) we enjoy, and b) are good for us?" (E2)</p> <p>"both Norway and Chile have much lower requirements on the fish feed ingredients, which means that the product quality that the Omega 3 in the fish that we eat is significantly less from those sources. Scottish salmon would have more Omega 3 than any of the well Pacific salmon that people think of as healthy [...] it's at the pinnacle of nutritional value [...] I think one of the drivers of people's consumption of [salmon, prawns] is they are perceived to be healthy, but they don't have a preparation hurdle associated with them." (E9)</p>
Convenience	<p>"...because it's quite versatile, it's got a nice size fillet. And it's got a nice colour to it generally, it's got a quite nice texture, I suppose it's easy to do different things with cooking different ways. It's perceived as being nutritious, omega three fatty acids. I still think that's why and it's a price which is affordable for most as not maybe as a staple every week for parents, but something that they can get on a reasonably regular basis." (E4)</p> <p>"But rushing into a supermarket after work to buy some tea, there's a nice packet of salmon with some instructions on how to cook it, you know, you can cook it in 15 minutes. And so that's why what you buy" (E3)</p> <p>"[...] it's not like you just buy salmon fillets, and that's all there is, in the same way that you might only by sea bass fillets. [...] But salmon, you can get as a smoked, as poached, [...] little trimming scraps, as a product, as a moose, as a spread, as you know, it comes in a lot of different forms. So, there's a lot of different value-added opportunities for the industry as well." (E5)</p> <p>"there's all these packs presented to you and it's quick and easy grab it, there's a great portion size, everything's dealt with you and salmon lends itself very well to that." (E1)</p>
Consumer perception	<p>"...the supermarket opened, and it was selling salmon, and [...] salmon on the shelf. So, I think that farmed salmon had become a part of the diet. And I guess the producers become big enough to come to agreements with the supermarket chains to supply them in the quantity that they needed." (E3)</p> <p>"I think it's one of the most purchased fish products in supermarkets, for people to buy and cook at home. I think that it has become a staple because the industry and the retail sector have found it to be a product that can be sold to customers as 'easy to cook', 'mild in flavour', 'easy to make into different recipes at home' 'doesn't require, you know, boning' or can be produced in a ways that the consumers find it easy to consume." (E5)</p>

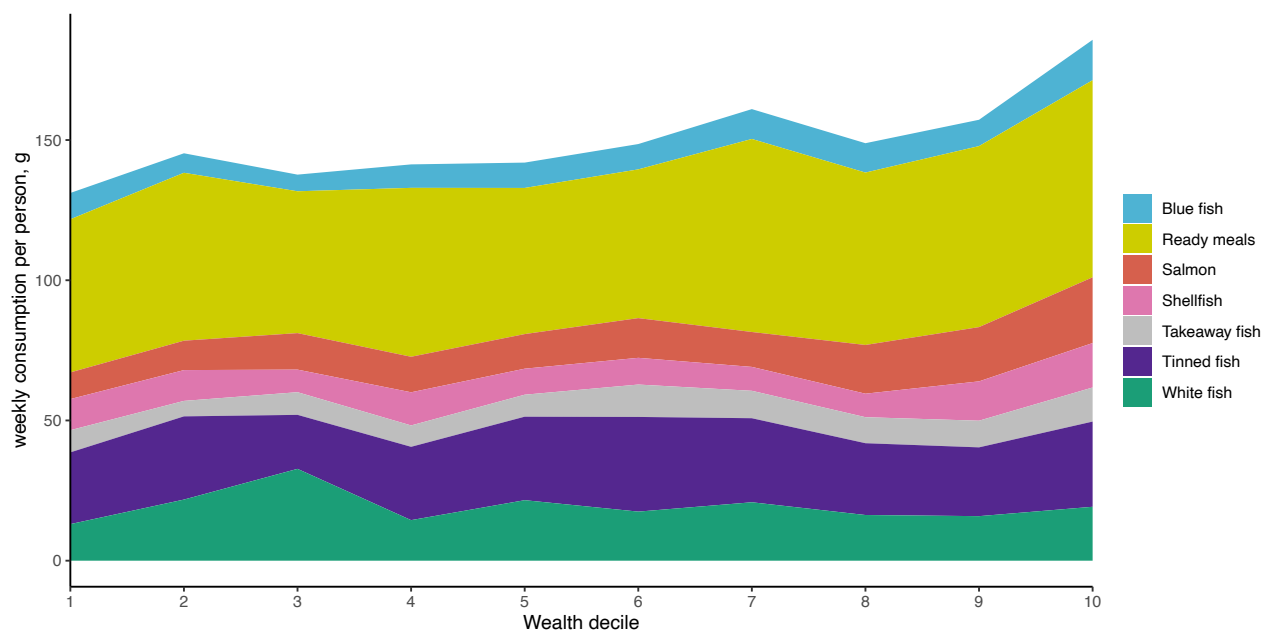
<p><b>Fish welfare</b></p>	<p>“What I've noticed is personal now, [...] the typical salmon supermarket [...] it tastes flabby and oily. And I put that down to the changes in the stock that are being bred for fast growth, they're being fed a largely vegetable diet. They don't get the exercise [...] I am still willing to eat animals, but I think they have to have a high welfare life before they're sorted.” (E3)</p> <p>“I think the public perception is still that salmon and farmed salmon is a sustainable product. I think the industry has cultivated that perception very strongly. And that's the reason that it exists. I think there's maybe a greater awareness than there was, say, like, three or four years ago, that there are some problems with salmon farming. And if people probably, if you ask them would turn to issues like sea lice, or use of antibiotics or polluting local waters [...] or maybe fish welfare” (E5)</p>
<p><b>Sustainability</b></p>	<p>“there was a feeling that UK consumers were starting to gravitate away from red meat with a sort of concern about impacts -- their impact of their basket on climate change, so on so forth, and it looked like there was a real opportunity there to try and capture elements of that consumer spend and it looked like it was gravitating towards fish, primarily salmon, as well as plant based products. [...] if you're sourcing from responsibly sourced fisheries, ie certified sustainable fisheries, you could argue that is potentially the lowest impact source that we should be using. If you were to flex across to terrestrial proteins or oils, they bring a very significant carbon footprint with them. So if you want to go with a low carbon footprint feed, actually, high marine inclusions is the way to head (E1)</p> <p>“[because a fishery lost its] MSC approval, we would no longer source fishmeal from those fisheries. So ‘No, it's not been independently certified as sustainable so we're out, we're not sourcing from there, we'll buy elsewhere’. And we will only be using a trimming, so a byproduct of those fish that were used for human consumption”. [...] through work with SEPA and Marine Scotland, each farm will look at the expected and modelled impact on the seabed. So we will do the research that says if we have 1500 tonnes of salmon on this site at peak biomass, it will have this impact on the seabed. And that impact would be recoverable over [...] so short number of years if that farm was removed, and then every year, that peak biomass and at the end of the crop, you go in, and you sample the seabed around the farm. [...] So it's all about the carrying capacity of the environment with a constant feedback loop. [...] [what] will influence how much salmon we produce will be what sites we're producing fish on, are those sites sustainable – environmentally and economically and sustainable, when should we stock them for the best outcome, again economically and welfare, and then what does that then do in terms of our harvest profile.”(E2)</p> <p>“the [...] issue that is the most fundamental is the diet of farmed salmon. Some of the carnivores, initially, were fed on a diet made from fish, small fish, anchovies, fish like that often collected off the coast of Peru, for example, or these big upwelling fisheries. From fisheries in the North Sea, at one time, there were fish like herring and sprat, fish for human consumption, and now it turned into fish meal and some of it goes to salmon, some of it goes to chicken. It's a general problem.” (E3)</p>

	<p>“Over the last couple of years, there has been more and more energy put into things like the ASC, developing sustainability standards and that's a sign that there's an industry that feels it might have a sustainability problem on its hands, and needs to hedge that bet, sooner rather than later.” (E5)</p> <p>“So that's a really positive story, the space of water use [...] lower carbon footprint, because I know it's got a sort of similar footprint to chicken, for example. But in a place where you need food, where the sector is already committed to like, Net Zero 2045. Those are all positive things.” (E8)</p> <p>“we have funded projects about waste capture, resource efficiency [...] We have conversations with the Sustainable Seafood Coalition [...] I think the people that are driving improvements in sustainability or environmental footprint are directly the retailers and the feed companies. [...] farming in the sea is intrinsically by a factor of about five, at least five more sustainable than farming on land. [...] And so that there are many, many ways in which farmed salmon is a highly sustainable product for those biological reasons (E9)</p>
Future challenges	<p>“...the total demand for fish feed for salmon could outstrip the world production of small fish. There's been a move to replace much of the fish protein with vegetable protein. [This] leaves the problem with the fish oils, the Omega-3 oils, which the salmon need, without which salmon doesn't taste like salmon. And also, it can't be sold on the health benefits. So, [there is] even more of a shortage of Omega-3 oils. I know that there's work being done to try and produce these either from algae or from genetically modified rapeseed crops, which has the problem of genetic modification” (E3)</p> <p>“There's also a lot of research going into more exposed sites going further away, because having more robust cages which allows us to produce more on both sides, having the other one which allows you to expand the industry in terms of volume. Then there are the challenges that you have around disease, and particularly sea lice. That's the major one-- that's there to be solved and these management ones, solutions have been the best so far. There's cleaner fish, but there's challenges around cleaner fish is you've got the welfare issues of the cleaner fish and the production of clean fish and that whole new species for sharing so incorporate into your salmon cages. It's been partially successful, but it's largely challenges around maintaining the health of the cleaner fish, the interaction of the theme of fish with the salmon, and then what to do with the cleaner fish once we have salmon.” (E4)</p> <p>“I think the industry is very aware that sustainability debates are going to be increasingly important, that they need to be absolutely on point in terms of any sort of environmental impact. [...] You already see that things like antibiotics they handled years ago, right, massive replacement on how they operated. You know, already in the past,</p>

	<p>what five or six years have a massive shift on how they feed the salmon to go again, go, move away from unsustainable things because it was a risky move for them from a financial standpoint to keep what they were doing. But it was also a perception risk. [...] So I think you'll just continue seeing the sort of move that you see now: open communication, try to address the issues, try to partner with retailers, with NGOs, kind of open doors as much as possible or create associations with other industries that could offset the impact of production." (E6)</p>
--	--

**Table S1.** Thematic structure of interviews with supporting quotes.





**Figure S1.** Average weekly consumption (g per person) of major aquatic food groups by wealth decile. Data on household purchases from Family Food Datasets (Methods).

## Supplementary Methods

### Interview Template

#### *A: Interviewee Background*

**1. Can you describe your interest and experience with farmed salmon?**

- How long has been working with it?
- In what capacity (past and current job)?

#### *B: Narrative around salmon industry*

*Perspectives on salmon as sustainable, healthy seafood*

**2. What is the current perception of the salmon industry globally?**

- Is salmon considered a healthy seafood? Where + why?
- Is salmon a profitable market? Where + why?
- Is salmon a sustainable seafood? Where + why?

**3. What is the current perception of the salmon industry in the UK?**

- Is salmon considered a healthy seafood in the UK?
- Is salmon a profitable market in the UK?
- Is salmon a sustainable seafood in the UK?

**4. How has the perception of salmon changed over time?**

- How would your previous answers change 20 years ago?

**5. Why do you think salmon has become a popular seafood?**

- Wild Scottish salmon was a luxury, upper class food, and farmed salmon is now one of the top 5 seafood consumed in the UK. What do you think is the main reason for this change?

#### *C: Key salmon interventions / state of industry*

*Key players, policies + technologies underlying salmon growth*

**6. Who do you think are the key players in the salmon industry?**

*Key player = companies with market influence: producers, farmers, sales, marketing*

**7. What key interventions supported the rise of farmed salmon globally?**

- What technologies have supported industrial salmon farming?
- How have improvements in disease and feeds supported salmon growth?
- What policies supported industrial salmon farming?
- How do policies make salmon farming economically profitable?
- Have any marketing strategies been particularly important for the growth of farmed salmon? In which countries?

52  
53  
54 **8. What key interventions supported the rise of farmed salmon in the UK?**

- 55
  - How has the farming process changed over time?
  - How has regulation changed the industry?
  - How do you promote the product/channels/target audience?
  - What would you say is the goal of the business/industry?
  - How would you say salmon figures in British diets?
  - Why is salmon popular in the UK?

61  
62 **D: Future salmon**

63 *Sustainability, food security, profit + growth*

64  
65 **9. In your opinion, what is the future of Scottish farmed salmon?**

- 66
  - Do consumers want to eat more salmon? Why?
  - How will the salmon industry tackle environmental issues?  
(disease, crowding, coastline space, feed, animal welfare)
  - Will salmon industry continue to be incentivised by government? Why?

70  
71  
72 **10. How will farmed salmon need to change in the future, if at all?**

- 73
  - Do you think farmed salmon will contribute to global food security? How?
  - Do you think salmon industry growth will lead to any sort of conflict? Which and why? (marine space: renewables, recreation, tourism, access)
  - Do you think that environmental concerns impact the profitability and growth of the farmed salmon industry?
  - Should salmon impacts be penalised with legislation? How?