Maximizing seafood by-product utilization towards eliminating waste

A Namibia pilot study

March 2022

FRIENDS of OCEAN ACTION

WORLD ECONOMIC FORUM

Contents

Overview

Reducing food loss and waste has a critical part to play in addressing nutrition security for a growing population within planetary boundaries. It is a topic being addressed by numerous initiatives at policy and private sector levels, with a view to achieving UN Sustainable Development Goal (SDG) 12.3 – however, seafood is rarely addressed. This is despite the fact that between 30% and 35% of fish caught is either lost or wasted post-harvest, according to the UN Food and Agriculture Organization (FAO).

This project addresses the ethical imperative to use 100% of all fish caught or farmed. It explores how to ensure all nutrition is efficiently and effectively captured and repurposed in economically viable and market-appropriate ways; or, where nutrition is not possible, to explore other appropriate uses for seafood by-products such as for medical benefit. Capturing and repurposing these by-products can support a number of the SDGs, not least Zero Hunger (SDG 2), and Life Under Water (SDG 14).

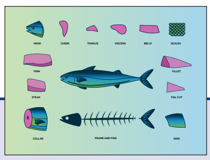
Friends of Ocean Action is currently working with Namibian stakeholders on an initial case study that brings together policymakers, business leaders, academics and civil society organisations. The project aims to learn from the stakeholders and encourage continued efforts to create an aligned approach to maximising by-product utilisation, thereby capturing more nutrition and reducing seafood waste.

The current work focuses on reframing the narrative from one of 'loss and waste' to one of 'by- or co-products', thus reframing these by-products as opportunities. The project seeks to create replicable model(s) that can be used by seafood businesses around the world to enable maximum utilisation of by-products, by adopting whole fish approaches from harvest through to processing on land.

The models laid out in the following pages have been compiled from working extensively, over six months, with stakeholders in the Namibian fishing and processing industry (engaging 90% of Namibia's onshore processing sector and 100% of its fishmeal sector), government representatives, local academics and NGOs, as well as expert stakeholders in other countries. The models are still in development pending further stakeholder consultation and further testing both in Namibia and elsewhere.

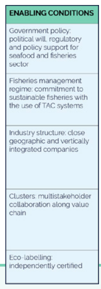
The models aim to demonstrate an approach to support a transition to whole fish use based on the key findings from Phase 1 of the project, as outlined in the diagram below.

Component parts to support a move to whole fish usage



WHOLE FISH PARADIGM

In order to ensure all nutrition is effeciently and effectively captured and repurposed from fish, it is importants to understand what are the component parts of the fish (ie by-products)

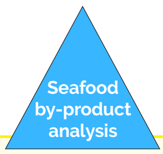


ENABLING CONDITIONS

A number of enabling conditions have been identified that can accelerate progress toward whole fish use and minimising waste

CREATING CLUSTERS

Public-private sector collaboration has long been recognised as an efficient and successful way to tackle major enviromental, social and economic issues



MEASURE *RESEARCH* MARKETS

This model seeks to help the seafood producer carry out that analysis to assess viability and includes three critical aspects

The whole fish paradigm

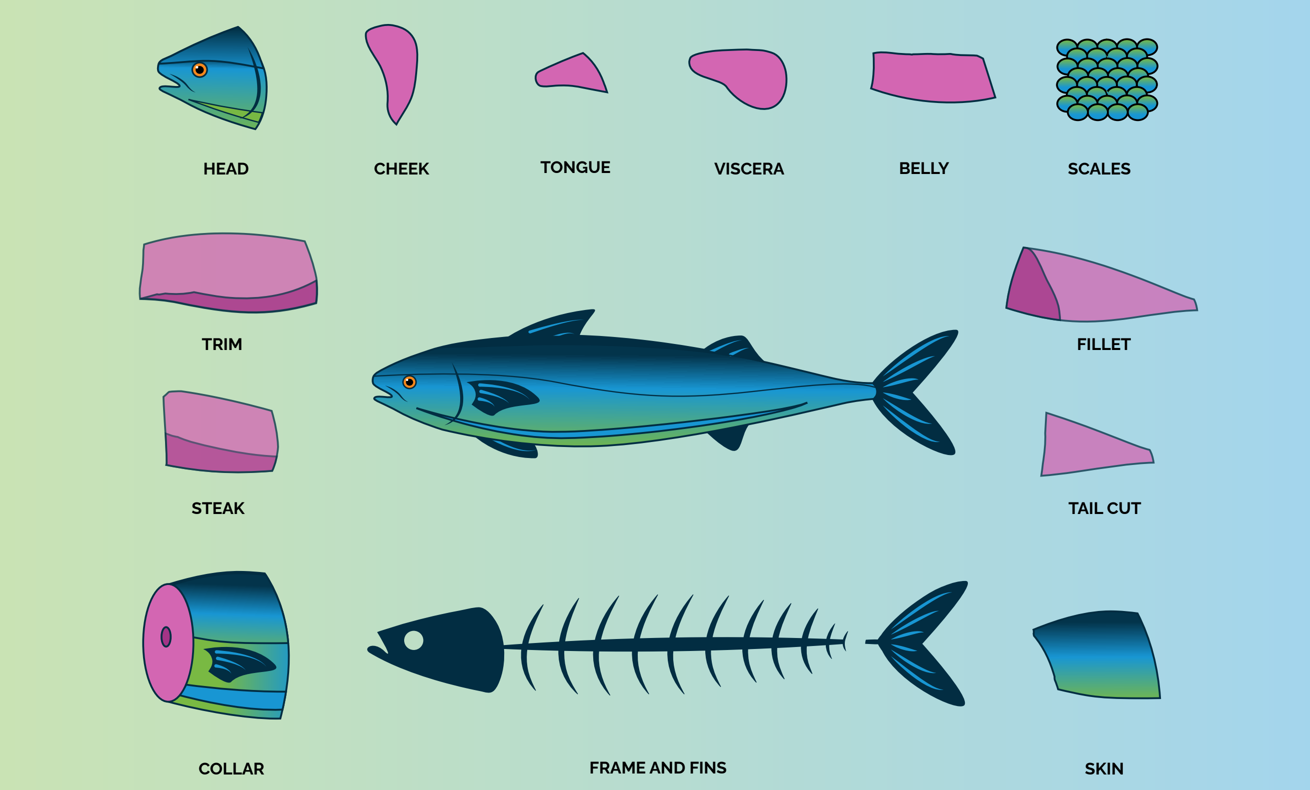


Fig 1. The component parts of a fish

In order to ensure all nutrition is efficiently and effectively captured and repurposed from fish, it is important to understand what the component parts of the fish (i.e. by-products) actually are.

This model illustrates the different components of a generic fish. Everything that comes from a fish is encompassed in this infographic – so, for example, roe and liver would come under 'viscera'. The terminology may vary across the globe, but the components are ubiquitous.

Initial conversations with a number of stakeholders have indicated that the infographic does adequately represent all the components, and helps illustrate what we mean by the 'Whole Fish Paradigm'. However, the diagram is indicative only and we continue to test it with stakeholders. Further work is required to develop an illustrative example with which to build industry consensus around the Whole Fish Paradigm.

There are a number of reasons why it is important to understand what all the components of a fish are:

- There is an ethical imperative to use the whole fish given the strain on marine resources, which is likely to increase with the impacts of climate change, changing demographics and changing consumption patterns. Currently 30 to 35% of fish is wasted (FAO) yet 768 million people are malnourished. Blue (aquatic) foods are the most highly traded food products in the world. They are critical to global food and nutrition security and provide millions of livelihoods. Three billion people rely on blue foods for nearly 20% of their animal protein, and 10 to 12% of the world's population rely on fish for their livelihoods.
- In order to understand the opportunities we need to understand what components are available, both in terms of type (by- or co-product) and volume, as well as the chemical/nutritional qualities of the components.

Observations

Research

This Whole Fish Paradigm is currently being researched in a number of different ways and places, including but not limited to:

- Scientists at the Namibian Ministry of Fisheries and Marine Resources (MFMR), together with the University of Namibia (UNAM), working with Stony Brook University, USA, wrote a scientific paper on assessment and quantification of Namibian seafood waste production (Erasmus, V.N. *et. al.*, 2021). Separately, MFMR, with supervising support from the University of Iceland, wrote a paper on assessment of the full utilisation of hake rest raw material in Namibia (Haimbili, E., 2019).
- Scientists at the University of Stirling led by Professor David Little are looking at the component parts of a fish to understand the potential nutritional value that they provide, and have run a series of 'Big fish seminars' exploring 'Eat the whole fish'.
- The Icelandic Ocean Cluster continues to research new innovations for by-products which are either not currently used or for which the value is not being maximised.
- Government departments such as the Norwegian Ministry of Fisheries are exploring the socio-economic benefits of maximising the use of by-products and recently published a report on the subject.
- Further down the value chain, chefs are encouraging consumers in some regions to use more of the fish, for example through cookbooks such as The Whole Fish Cookbook by Josh Niland.

- Illustrations with similar aims to our infographic above have been created by a number of researchers, including this photo below:

Source: Guardian, How to eat a whole fish, nose to tail, 25 September 2021. © Eco-Chef Tom Hunt, Author of Eating for Pleasure, People & Planet

The whole fish paradigm

However, more research and data collection and analysis is needed in a number of areas. This includes:

- to understand what is processed at sea, how much and how, and what is jettisoned over the side of the vessel;
- the nutritional and pharmaceutical potential of individual species and their respective components; and
- the impact on marine ecosystems of discarding by-products at sea.

At-sea processing versus onshore processing

The scope of this project was initially limited to on-shore processing, but consultations with stakeholders on the ground in Namibia quickly highlighted that processing at sea was strongly linked to processing on shore, so to fully understand the potential for greater utilisation of seafood by-products both had to be looked at together.

The project therefore commissioned a report on at-sea processing to try to better understand its global context. A number of the findings from this report, conducted by RS Standards Ltd, are outlined in the box below.

Numerous species of fish and shellfish will undergo some form of processing (product transformation) at sea. This can be undertaken by different sizes and types of fishing vessel, using an array of fishing gears. There are variations on all these practices within countries, regions and globally. Data on all these areas are limited and it is only possible to provide general indications.

The lack of data means it is challenging to provide exact figures…to show types of on-board processing facilities, extent of processing, exact weight of capture etc.

Published data on the global production of by-products produced at sea is not available, therefore estimates, based on global catch and by-product yields are provided. Applying a series of assumptions and ranges provides a very broad estimate of by-products at sea. This is calculated as 1.5 to 25 million tonnes, globally. This huge range in quantities takes into account the lack of data and evidence, the fact that not all species are processed at sea, that the extent of processing at sea varies within a species, in a country, between countries and globally.

The extent and type of processing is driven by several factors. Quality and hygiene requires guts (viscera) to be removed from demersal fish, to maximise shelf life. Market requirements for products are key drivers, for example frozen at sea products such as headed and gutted fish, fillets are produced to satisfy specific on-shore market requirements.

There are numerous reasons why all or more by-products are not retained on-board. They include lack of space/capacity on board the vessels, lack of time to process, no/low demand, low market value, amongst others. It will take a significant shift in the market and value of by-products to change this current situation.

There are major vessels, types of vessels and nations that have become very successful at maximising the use of the catch. In these examples, vessels processing and freezing at sea retain a considerable quantity of by-products for different uses. Iceland has spent thirty years investing and innovating in by-products and, through collaboration, is able to maximise the use of a valuable species (cod).

Whilst there would be advantages to accessing and utilising at-sea by-products, for both direct consumption and indirect consumption, this cannot be looked at in isolation. Other factors that should be taken into consideration include the impact on marine habitats and the ecosystem, implications for the crew (work, earnings, safety), catch handling/safety/storage, vessel infrastructure etc. This is before consideration of access to sustained outlets or markets that will suitably recompense fishers.

There are data and knowledge gaps to address in considering the potential for increased utilisation of global at-sea by-products. It is evident there are differences between species, vessels and flag states and this is not a 'one size fits all' challenge. However, with collaboration and investment in technology, infrastructure and markets, access to at-sea by-products could provide a way to maximise the use of the valuable global catch of fish and shellfish.

Source: RS Standards Ltd, Global at-sea fish processing, 2022

Uses of by-products

There are a number of uses for the by-products, ranging in value both economically and nutritionally, with some going to indirect human consumption (e.g. to fishmeal as animal feed ingredients) or directly to human consumption (e.g. heads). There are increasingly high-value markets for by-products, such as for bio-medical (e.g. wound dressings) and nutraceutical (collagen) uses. Some final products will require greater technology and therefore investment. There are 'low-hanging fruits', however, that do not require sophisticated technology but can obtain reasonable returns (e.g. omega-3 from squeezing livers). The diagram below illustrates some of these potential end uses.

There is already a drive to utilise seafood by-products in fishmeal or oil that can be used for animal feed. IFFO – The Marine Ingredients Organisation, which is the international body for fishmeal and fish oil, is encouraging the use of by-products as marine ingredients, thereby reducing reliance on forage fish for the purpose. IFFO is currently exploring new ways in which to measure feed ingredients based on life cycle analysis (LCA) and lower forage feed dependency.

Another consideration for the use of by-products is the quality (the fresher the product, the more valuable and versatile it is) and quantity available. This highlights the need to measure the volume of component parts available – something that is addressed in our model for seafood by-product analysis later in this report.

Fig 2. Circular economy of by-products

Enabling conditions

During the course of this project, it was noted that there were five aspects of the cases in Namibia and Iceland that were very similar and that may constitute enabling conditions to accelerate success. These five enabling conditions are outlined below.

ENABLING CONDITIONS	NAMIBIA	ICELAND
Government policy: political will, regulatory and policy support for seafood and fisheries sector	• Increase value addition and maximise economic returns, promoting employment through onshore fish processing, and environmentally sustainable fisheries	• Maximise utilisation of the catch 'including fish by-products', promoting stable employment and environmentally sustainable fisheries
Fisheries management regime: commitment to sustainable fisheries with the use of TAC systems	• Subject to annual total allowable catch (TAC) • Exploitation rights allocated through non-transferable individual quotas (IQs)	• Subject to annual TAC • Exploitation right allocated through tradeable individual transferable quotas (ITQs)
Industry structure: close geographic and vertically integrated companies	• Vertically integrated companies, smaller firms entering into operational agreements with larger firms • Low automation processing • Limited fish stocks promote maximum catch utilisation	• Vertically integrated companies, with fish auction market allowing smaller specialised firms • Highly automated processing • Limited fish stocks promote maximum catch utilisation
Clusters: multistakeholder collaboration along value chain	• Only two ports where all fishing operations are based • Have fishing associations by sector, and an umbrella association, centred on communicating with government.	• Small country with multiple fishing ports, the main ones centred around Reykjavik • Iceland Ocean Cluster promoting broad collaboration on by- product research and innovation
Eco-labelling: independently certified	• Marine Stewardship Council (MSC) recently certified hake fishery	• MSC certified cod fishery –enforced catch reductions promoted by-product utilisation, increasing overall fishery value

In 2018, Iceland produced 1.3 million tonnes of fish (including molluscs and crustaceans), with a value of USD 1,327.4 million. Nine per cent of this value came from aquaculture and 91% from wild capture fisheries. Direct fisheries sector employment provided 4,528 jobs (OECD, 2021). By comparison, in 2017, Namibia landed around 550,000 tonnes of wild caught fish and crustaceans worth about EUR 625 million (approximately USD 697 million). Some 16,000 people are directly employed in the Namibian fisheries sector (Haimbala, T., 2021).

There are direct similarities between the Namibian and Icelandic fishing industries. Both are commercially sophisticated with significant export markets, and both countries have opted for species-specific quota management systems, which go up or down based on annual total allowable catches (TACs). The TACs are set based on annual stock assessment research undertaken by government fisheries institutions. The key difference is that while Iceland settled on individual transferable quotas (ITQs) which are owned by the fishing companies in perpetuity and can be bought and sold, the Namibian government opted for individual quotas (IQs) which remain the property of the government. ITQs encourage fishing industry consolidation into fewer and larger commercial companies, while IQs allow the Namibian government to issue fishing concessions that encourage black economic empowerment. Government monitors these Namibian companies through annual quota applications, fishing rights being 7 to 20 years based on performance, and potential renewal beyond 20 years. To achieve economies of scale, new Namibian concession holders form joint ventures with large established vertically integrated fishing/processing companies who recognise the value of the IQs, there being enough large players to create natural competition and fair deals. ITQs, meanwhile, can be used as direct security for bank loans.

Iceland's main fish species include cod, herring, golden redfish, haddock and saithe, and on average 90% of the fish is utilised. Namibia's main fish species are hake, horse mackerel and monkfish. Hake and monk are both demersal whitefish, sold mostly into Europe, primarily processed at sea into headed and gutted product for further onshore processing. The by-products are currently mostly being jettisoned at sea as waste due to limited space in the vessel fish-holds, where the prime product is prioritised. With hake, around 30% is jettisoned, and with monkfish, with the head being so large, up to 65.5% goes to waste (Erasmus, V. et. al., 2021). Horse mackerel, by comparison, is mostly sold into the African market, whole frozen. Once onshore waste is significantly reduced, being monitored very closely in order to maximise every kilo of landed quota, with any waste such as skins and bones being sold on a profit-share basis to fishmeal producers.

Observations

Namibian fisheries development policy is primarily based around ensuring fisheries resource sustainability and encouraging ongoing development of value-added products. The latter involves onshore processing factories employing a large workforce skilled in maximising fish product yield. Recently, the Ministry of Fisheries and Marine Resources has been undertaking research into minimising fish waste, but to date this has not been incorporated into fisheries policy. Iceland, on the other hand, has a much more automated processing sectorand in recent years has emphasised utilisation of the whole fish as a means of achieving greater value and minimising waste. Iceland includes regulations on landing ratios of selected by-products both from vessels bringing in fish products on ice and from at-sea factory vessels landing frozen products. The Icelandic government works with the fishing industry to make sure rules and decisions make economic sense and are in line with progress in the fishing industry before they are introduced. This could be a useful approach for Namibia to adopt.

Namibian companies, working on by-product development utilising items such as heads, skins, roe and livers, tend to do it individually. This used also to be the case in Iceland, with the sector competing over a limited resource. However, when the Iceland Ocean Cluster was set up in 2012 it prompted collaboration involving industry, the university and start-up companies: this accelerated research and development, increased knowledge and funding, and resulted in significant value creation from by-products.

Supporting evidence

The Namibian Ministry of Fisheries and Marine Resources (MFMR), together with the University of Namibia (UNAM), working with Stony Brook University, USA, wrote a scientific paper on assessment and quantification of Namibian seafood waste production (Erasmus, V.N. *et. al.*, 2021). Separately, MFMR, with supervising support of the University of Iceland, wrote a paper on assessment of the full utilisation of hake rest raw material in Namibia (Haimbili, E., 2019).

The Namibian whitefish industry is limited in that fishing vessels generally only have space for headed and gutted product, which onshore is converted into prime marketable products such as fillets and loins. Due to limited space and high fuel costs, sacrificing prime products to bring ashore lower-value by-products does not make economic sense. However, industry is open to bringing lower value by-products ashore when, for example, catches slow down in winter. Industry also currently identifies fish scales as waste as they interfere with fishmeal processing equipment and are mostly sent to landfill. However, if the scales could be utilised for a collagen/chitosan product, the fishing companies would receive income instead. Fish skins from onshore processing facilities currently go into low-value fishmeal despite being known to have collagen/gelatine qualities. Finding economically viable markets for by-products has held back their development to date, as it can involve significant research and is generally beyond the capacity of individual fishing companies.

Over 90% of the Namibian onshore processing fishing industry, at which this project is aimed, were represented at the Friends of Ocean Action (FOA) workshop in March 2022, showing their interest in assessing means of processing a greater percentage of fish by-products. Also in attendance were Namibia's two main fishmeal producers, along with senior international representatives from the University of Stirling, UK – Whole Fish Project, the Iceland Ocean Cluster, and IFFO – the Marine Ingredients Organisation. In a separate FOA workshop involving the Namibian government, UNAM and NGOs, a senior MFMR official observed that this initiative comes at a good time as the Namibia Blue Economy Policy is being finalised. UNAM also saw the initiative as positive, offering it the opportunity to provide industry research support through its different departments, with potential international funding. The Namibia Fish Consumption Promotion Trust (NFCPT) saw greater production of fish heads as a human food security opportunity – there is high demand in Namibia for fish heads – and expressed interest in working with industry to acquire products and formulate a distribution strategy.

Cluster model

Cluster properties	
Purpose	• Increase value of what is being used already • Find ways to use other products not being used
Characteristics	• Pre-competitive • Cross-sectoral • High degree of networking/knowledge-sharing/brainstorming
Benefits	• Enhanced collaboration across sectors – bridging the gap between the traditional fisheries sector and value adding technologies across different sectors • Incubation and acceleration of solutions • Spin-off technology and businesses • Increased value despite decrease in availability of resource • Match-making role has led to successful projects

Public-private sector collaboration has long been recognised as an effective way to tackle major environmental, social and economic issues. The Iceland Ocean Cluster has illustrated that this applies equally to the Whole Fish Paradigm. Established in 2012 with 10 companies, the cluster now hosts 70 companies in the blue bio-economy, including a number of start-ups, as well as key supporting companies and connected companies (e.g. PR, legal, investment and also university presence). A number of high-value products have been created from cod by-products through collaboration within the cluster.

One of the characteristics of a cluster is that it is pre-competitive, allowing industry to come together to tackle joint problems, sharing knowledge and experience among themselves and other stakeholders that benefits all involved.

By bringing together experts in different areas, innovations are better incubated and, in some cases, accelerated through collaboration within the cluster. Such collaboration has, in the case of the Iceland Ocean Cluster, led to an increase in export value despite a decrease in availability of the resource itself (Icelandic cod).

Observations

Namibia is well suited to explore a similar model given the geographically consolidated nature of its fisheries industry. The vertically integrated nature of the fishing industry means that key stakeholders are concentrated in a few companies, making collaboration easier in logistical terms.

There also appears to be an appetite for it, both from industry and from members of the academic community who want to see practical applications for their research.

Figure 4, courtesy of the Iceland Ocean Cluster, outlines some of the spin-off industries that have developed since the cluster was established. These spin-offs have increased value realised from the ocean and its resources.

Through the Cluster, 90% of the whole fish now appears to be utilised. This means that despite a decrease in catch quotas and total catch in Iceland, the actual export value of cod has remained high. This level of utilisation has been realised through a wide array of by-products including heads, frames, guts and gonads etc. To put this into perspective, many other countries use on average only 54% of whitefish, with the rest going to waste.

Fig. 3 5-step process from idea to realisation of by-products

Source: Iceland Ocean Cluster

The Iceland Ocean Cluster has developed a '5-step process' to outline how to go from an idea to the realisation of innovative by-products – see Figure 3. Steps include creating a business plan and a working group, and establishing a dedicated team to implement the business plan.

Following this 5-step process has led to the production of high-value by-products such as collagen and wound dressings. Such products would not have been developed without the collaboration of researchers/academia and business/innovation groups brought together by the Iceland Ocean Cluster.

Clusters working on by-product utilisation also exist in other parts of the world and demonstrate similar successes, particularly in North America.

From a Namibian perspective, there is already evidence that collaboration within the fishing industry is possible and effective. This was demonstrated on a couple of occasions in a recent workshop. One example was through collaboration between one of the fishing companies and one of the fishmeal companies to determine the quantity of scales that accumulate on a monthly basis from processing of longline-caught hake on land in Walvis Bay (1.6 tonnes). Despite potentially having pharmaceutical/nutraceutical properties, scales are currently not utilised and so go to landfill – the disposal of scales is undertaken by the fishmeal company since fishing/processing companies are not allowed to dispose of scales into water systems. The other example was the result of a discussion around the challenges of drying scales (the humidity in Walvis Bay prevents the natural drying of scales and the cost of energy makes it prohibitively expense to dry scales mechanically). When these challenges were raised by the processors, there was an immediate response from one of the fishmeal companies, suggesting that the large amounts of spare heat from its fishmeal boiler could be utilised to dry the scales. It would just involve some research on how much heat should be applied.

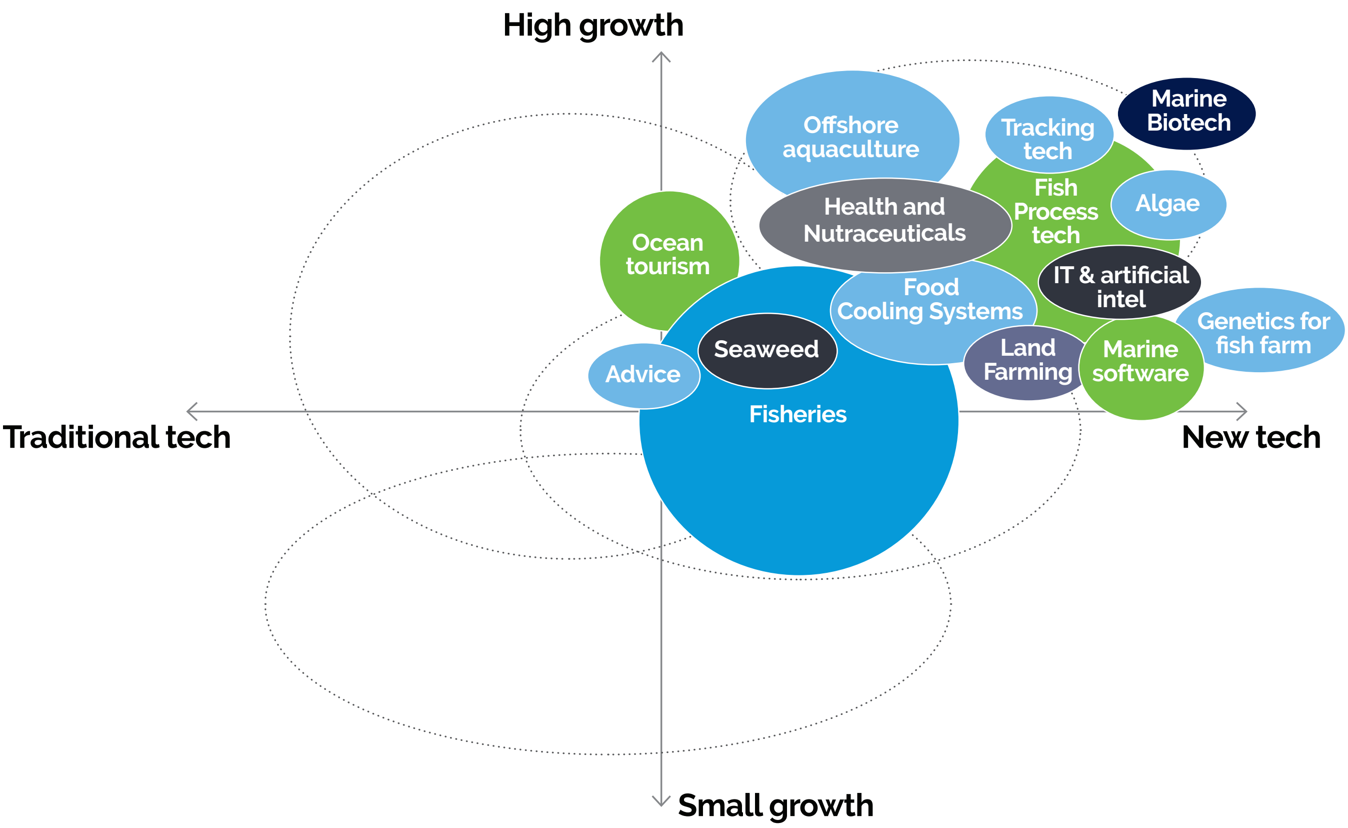


Fig 4. Spin-off industries devloped since cluster model was established

Source: Iceland Ocean Cluster

Model for seafood by-product analysis

We have created a model for seafood by-product analysis, which is illustrated above and outlined in more detail below.

Where a Whole Fish Paradigm has been adopted the seafood producer, at catching and processing level, will begin to identify by-product material. This is typically the non-target parts of the fish that may have been previously discarded as waste.

The question becomes how to turn that by-product material into a marketable ingredient or component with a more valuable outcome. That outcome may be something financially lucrative that uses the by-product in ways which increase its economic value, or it may be something that enables it to be used to nourish people, directly or indirectly. The intent is to use the whole fish. Any outcome should be economically viable, as well as socially and environmentally appropriate. In short, all components of the fish, beyond the target parts, should be analysed to explore their potential opportunity. This model seeks to help the seafood producer carry out that analysis to assess viability.

Measure

At the outset, it will be important for the producer to know how much of the by-product they have available and whether that availability is seasonal or consistent. The quantity of material available may influence whether it can be provided directly to a market or needs to be combined with other suppliers, for example. It might also be important to understand whether the by-product should be kept separate and species-specific, or if it can be mixed. If it must be kept separate, then measuring availability by species will be appropriate.

In Namibia, we learned that in the hake long-line fishery the fish are descaled at the processing plant, which consequently captures a quantity of hake scales. (It should be noted that trawled hake have considerably fewer scales, as they get rubbed off as the fish jostle in the net.) However, the processor in question did not know the quantity of scales that were captured in any given week. As part of the project process, the processor was asked to measure the quantity of scales directly captured. It transpired there are 1.6 tonnes of scales available each month. This could be increased by adding those captured from wastewater from the processing plants.

On board the fishing vessels, hake and monkfish are routinely headed and gutted. These heads and guts are largely, but not entirely, jettisoned overboard. No attempt to measure the amount of viscera or heads jettisoned has been made. This may be important in terms of understanding the potential quantity of nutrition available and should not be difficult to assess, given the size of catch and an average head/viscera weight can be assumed based on official Namibian conversion factors by species. At this stage this is a measure-only assessment, to understand the potential availability, subject to other criteria.

Research

The second step in analysis of the by-product is to research any knowledge gaps that exist. This might involve the specific qualities of the by-product so as to better identify potential end markets, or it might be aimed at improving understanding of the consequences of capture and repurpose.

In the case of the scales, it is important to understand the specific qualities of hake scales, such as ease of handling in terms of size, or their level of collagen availability.

We learned that the viscera and heads of hake have been thrown overboard for many decades. This may mean that local ocean ecosystems have adapted and become dependent upon that nutritional availability. The impact on sea birds has been studied, but the impact on systems below the water has not been assessed. A proper study of the impact of stopping the provision of viscera and heads to the local marine ecosystems is important: it may be that the availability of fish and crustaceans would be reduced were the viscera nutrition no longer available. Such outcomes should not however be assumed, but properly tested in the field: more research on the subject is needed in Namibia.

The scientific literature shows a recurring theme of concern over the negative impact of fish offcuts being returned to the ocean. Internationally, the trend is towards limiting waste being jettisoned overboard – in order to promote environmentally, economically and socially sustainable fishing practices, the EU Common Fisheries Policy (CFP) has recently supported the drastic reduction/prohibition of discards and the most efficient possible use of the captured biomass (Caruso, G., 2015; Coppola, D. *et al*., 2021).

Markets

Having established the quantity of available material and undertaken the necessary research on, for example, its specific qualities, the consequences of its capture, or a change in current processes, the producer is then in a position to identify a potential market.

In Namibia, much of the by-product from land-based processing is currently used to produce fishmeal. This may be a very appropriate end use, for which there is considerable demand, but it may be worth producers exploring other options for specific by-products. For example, skins from Icelandic cod are being used to extract collagen, which considerably raises their value. Further value is gained if the skins are used in medical-grade wound dressings. Alternatively, some skins are finding their way to become pet treats or 'chips' for human consumption.

Consequently, for some by-products there will be a number of potential end uses, which may depend upon their availability (measure) and their specific qualities (research). A model for a database that could help identify that market and make connections is illustrated in the next section. Such a database may provide connections to markets, as well as expert advisors on connecting by-products to end markets.

Potential model for further development

Seafood co-product database

1. By-product item – i.e. viscera

2. Choose viscera item – liver, roe, other (named)

3. Choose liver – by-product options i.e.
- Whole vac packed
- Whole tinned
- Oil extraction
- Other (named)

4. Choose option i.e. oil extraction
- Market contacts
- Example products
- Contacts for expert advice

5. Market looking for products
- Companies with product available
- Market database
- Science and news

If the Whole Fish Paradigm has been adopted and the seafood producer has analysed the available by-product to understand how much material is available, its specific qualities and any consequences of capture and repurpose, they are now ready to confidently identify potential markets.

There does not appear to be a central, streamlined way by which to identify end markets for the by-products of seafood processing. It is therefore proposed that a database could be developed to meet this need.

1. By-product item: the database would begin by listing the core component parts.
2. It is likely that each part would have a number of sub parts. For example, viscera would include the liver, roe and other parts.
3. The producer would select the specific part, e.g. liver. At this point they would likely be required to provide details about the species of fish from which it can be derived, the availability of material and potentially details such as location and/or whether frozen, dried, etc.
4. The details provided in (3) would enable the database to identify end uses. It would suggest what typical requirements are needed and give contact details for companies who might be interested in such product, as well as experts who can further advise on progressing towards a market.
5. In a supplementary section, the market database area would act as a directory of companies who source by-product material, and of those with material available – i.e. it would be a resource for buyers and sellers alike. It could also capture relevant news and science.

Next steps

The intent is to move forward with a second phase that will develop the models outlined here, as well as exploring further the link between offshore and onshore processing.

Acknowledgments

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