# **Literature review**

## An overview of the seafood industry

- Examine current trends in the global seafood market.

- Discuss the challenges and opportunities faced by the seafood industry.

Scite AI:

The seafood industry is indeed a multifaceted sector that plays a crucial role in global food production and trade. It encompasses various aspects such as fisheries, aquaculture, processing, preservation, and distribution. The industry is characterized by a significant level of consolidation, with a few large companies controlling a substantial portion of the global catch and revenue (Blasiak et al., 2021). This consolidation has implications for market dynamics and sustainability efforts within the industry. Additionally, the seafood industry is a major source of employment, directly engaging millions of people and supporting the livelihoods of hundreds of millions more (Tveterås et al., 2012).

Traceability has emerged as a critical tool in addressing various challenges within the seafood industry, leading to initiatives by non-governmental organizations, companies, and government actors (Lewis & Boyle, 2017). These initiatives aim to improve the transparency and accountability of seafood supply chains, thereby enhancing sustainability and food safety. Furthermore, the emergence of Industry 4.0 technologies has led to advancements in seafood processing, preservation, and analytical techniques, contributing to improved efficiency and quality control in the industry (Hassoun et al., 2022).

The sustainability of the seafood industry is a growing concern, with efforts being made to address overexploitation of resources and unsustainable working conditions. As more capital flows into the industry, there is a need to ensure that investments prioritize sustainability and responsible practices (Jouffray et al., 2019). Moreover, the industry faces challenges related to the impact of the COVID-19 pandemic, including disruptions to supply chains and concerns about seafood safety and human health (Villasante et al., 2021; Rathod et al., 2022).

The seafood industry is also influenced by global trade dynamics, with key players such as China significantly shaping production, consumption, and trade patterns (Crona et al., 2020). Additionally, the industry is increasingly being scrutinized for its environmental footprint, with calls for a transition to more sustainable and plant-based dietary choices (Riverola et al., 2022). Overall, the seafood industry is at a crossroads, facing a range of challenges and opportunities that require concerted efforts from various stakeholders to ensure its long-term sustainability and resilience.

- Traditional seafood sources

- Provide an overview of commonly consumed seafood and their market status.

- Discuss the sustainability issues and concerns in traditional fisheries.

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The traditional sources of seafood have historically been fisheries, which have been the primary means of seafood production. However, due to the overexploitation of fish stocks, seafood production has progressively transitioned to aquaculture, which has experienced significant growth in recent decades (Schmidt et al., 2016). Aquaculture now accounts for nearly 50% of all seafood consumed globally, surpassing terrestrial livestock production and wild-capture fisheries (Bohnes & Laurent, 2018). This shift to aquaculture has been driven by the need for sustainable seafood production and the limitations posed by overfishing and unsustainable fish stocks (Schmidt et al., 2016).

Furthermore, the consumption of traditional fermented seafood products, such as jeotgal and sikhae in Korean cuisine, has been a longstanding practice for long-term storage and consumption (Kim et al., 2014). Additionally, the use of fishmeal as a traditional feed for farmed seafood, poultry, and pigs has been a historical practice in the industry (Fabris et al., 2020). Moreover, traditional dried seafood-based products are widely consumed in various cultures, such as in Thailand, due to their convenience and long shelf life (Soodsawaeng et al., 2023).

The coastal location of certain regions has provided ready access to seafood, making it one of the richest food sources for essential nutrients such as (n-3) fatty acids (Fialkowski et al., 2010). This has been particularly relevant for Pacific Northwest Tribal Nations, where seafood has been a significant part of the diet (Fialkowski et al., 2010).

In summary, the traditional sources of seafood have included fisheries, aquaculture, and the consumption of various traditional seafood products in different cultures. The shift towards aquaculture as a primary source of seafood production reflects the industry's response to the challenges of overfishing and the need for sustainable practices.

## Aquaculture’s contribution to seafood supply

(\*How big is the seafood industry?)

The increasing demand for seafood products, coupled with the diminishing productivity of wild-caught marine fish stocks, mostly due to the overexploitation and illegal exploitation of fish stock, positions the aquaculture industry as a significant contributor to the global seafood supply (Granada et al. 2016) (Figure 1). Aquaculture production significantly supplements capture fisheries production (Longo et al., 2019) contributing 49.2 % to the global production of aquatic animals in 2020, but despite the great diversity in farmed aquatic species, only a small number of “staple” species dominate aquaculture production (FAO, 2022). Further development of the aquaculture industry is necessary to meet growing demand for seafood products.

Aquaculture of fed aquatic animals continues to outpace that of non-fed aquatic animals making the aquaculture industry an important consumer of wild-caught marine fish stocks by using fishmeal in aquafeeds, raising concerns about the sustainability of the industry. Aquaculture effluent is another growing concern for the rapidly expanding industry. Both fresh- and saline water aquaculture require large amounts of water with good quality. Uneaten feed and waste products, result in the accumulation of suspended solids, otherwise known as particulate organic matter (POM) and dissolved organic substances (DOM), which contain compounds such as nitrogen and phosphorus, and possibly also other chemicals that are used to prevent diseases of aquatic species (Jegatheesan et al., 2011). This effluent water is discharged into the environment, which if untreated can be detrimental to the surrounding environmental and human health. Thus, intensive development of aquaculture has raised a range of environmental concerns such as effluent discharge, excessive use of resources and dependence on commercial feed (Granada et al., 2016) placing a spotlight on the need for research on sustainable aquaculture systems and practices.

A graph showing the growth of the company's sales

Description automatically generated

Figure 4. World capture fisheries and aquaculture production excluding aquatic mammals, crocodiles, alligators, caimans, and algae. Data expressed in live weight equivalent. (FAO,2022)

South Africa is endowed with good infrastructure, business institutions, and supply chains, however, the potential for aquaculture production is limited by the high energy coastline combined with water scarcity in inland areas thus, South Africa, through trial and error, has successfully developed shore-based marine aquaculture (Britz &) Venter, 2016). (Discuss aquaculture farm distribution).

## Diversification of the aquaculture industry

Why is diversification important?

IMTA: Integrated multi-trophic aquaculture (IMTA) is an advanced form of aquaculture considered a suitable approach to limit aquaculture nutrients and organic matter outputs through biomitigation (Granada et al., 2016). In IMTA systems, nutrients from uneaten feed and excreted waste from fed species become food for extractive species (FAO, 2022). Converting the waste products from one species into a valuable resource for another reduces the amount of nutrients released into the environment while enhancing overall productivity. The extractive species in IMTA systems are both traded as a commodity and used as a biofiltration system, which increases their value to the farm, this is especially important for extractive species with low commercial value or species which are new entrants to the market. The implementation of IMTA systems can increase the efficiency of aquaculture systems and contribute to the development of a sustainable aquaculture industry, particularly when species that are ecologically compatible are co-cultured (Kang et al. 2003; Kim et al. 2015). IMTA has the potential to reduce environmental impacts, increase profitability and diversify commercial production in a sustainable way.

For IMTA systems to succeed, both species being co-cultured should have commercial potential. However, the feasibility of the Cape sea urchin as an additional value-added product has not been investigated as yet. This project is exploring the feasibility of the Cape sea urchin, *Parechinus angulosus*, as a new market product for South Africa which has the potential to be co-cultured with South African abalone, *Haliotis midae*, through an IMTA system. Through the improvement of the culturing protocols for this urchin species, further value could be added to the co-culturing of sea urchins and juvenile abalone, increasing the sustainability of the abalone aquaculture industry and potentially, the Cape sea urchin may diversify the South African aquaculture market.

IMTA in SA abalone industry: \*\*\*

SA Tripneustes research (what is the urchin product exactly, how does it compare?)

Tripneutes/Ulva potential

WW urchins work but most of SA coast is cold



Figure 3: Image of Cape urchin, *P. angulosus*, harvested by Veld and Sea for consumption

## Echinoculture research and practices

- Summarize existing studies or observations regarding the taste, texture, and culinary potential of Parechinus angulosus.

- Discuss any unique nutritional benefits it might offer compared to traditional seafood.

Sea urchin gametes, embryos and larvae have also been used for fast, low-cost and reliable screening of toxic substances, and for detailed studies of their mechanism of action (Micael et al., 2009).

Live sea urchin products are in the highest demand. Japan imported ~ 11 000 tonnes of live sea urchin in 2016 valued at 183 million US dollars, a six-fold increase in volume and nine-fold increase in value since 1975 (Sonu, 2017). (processed) Sea urchin product (live and processed) prices are dependent on a number of factors including appearance (color, quality), origin (species, region of harvest), palatability (flavour, texture), demand, distribution, form and processing

(Why?) What are the factors influencing this? Supply? Quality? Processing?

The primary driver of sea urchin market value is gonad quality (Teck et al., 2018). Gonad quality is determined by a number of factors including colour, texture, taste and gonad somatic index (GSI) (Cyrus et al., 2015). Quality of the sea urchin fishery is highly variable and dependent on the reproductive state of the organism (Teck et al., 2018). The price differential paid for sea urchin roe across varying reproductive stages can be substantial, with early stages (prior to spawning) being preferred what stage is preferred and why? (Teck et al., 2018). (What other factors affect reproductive state and gonad quality?)

bright yellow or orange, firm, unbroken,

Although quality of roe is the most important factor in determining prices, total supply (domestic and imported roe) is also significant (Sonu, 2017).

* Sea urchin market analysis/summary
* Areas of controversy or need for improvement
* Does this project relate to any gaps within the industry?

Expectations/Previous work

* Has anyone done anything similar? What did they find?
* What are factors that have affected gonad quality/growth rate/feeding rate for other species?

The sea urchin industry is also associated with aquaculture, with efforts being made to sustainably cultivate sea urchins for commercial purposes (Rubilar & Cardozo, 2021). In the USA, sea urchin aquaculture is being considered in several states, including California, Oregon, Washington, Maine, Massachusetts, and New Hampshire (Nelson et al., 2010).

- Do they have other uses, besides for human consumption?

In addition to their culinary value, sea urchins are commercially exploited for their gonads, which are used for quality roe production, naphthoquinone pigments, and drug discovery (Rubilar & Cardozo, 2021). Furthermore, sea urchins are used as a feed supplement or total replacement for a commercial shrimp diet, and their feces have been evaluated as a food source for small sea cucumbers in integrated multi-trophic aquaculture systems (Jensen et al., 2018; Yu et al., 2023).

## Challenges and considerations

- Address potential challenges associated with harvesting, processing, and marketing Parechinus angulosus.

- Discuss any environmental or ethical considerations related to its exploitation.

## Project expectations

This project

* Motivation for the factors I am considering & methodology followed:
  + Feeds chosen: is it what they naturally eat? (e.g., *Ecklonia maxima* characterizes the environments usually populated by *P. angulosus*)
  + Temperatures chosen
  + How does my methodology compare with other studies?
* Project hypotheses