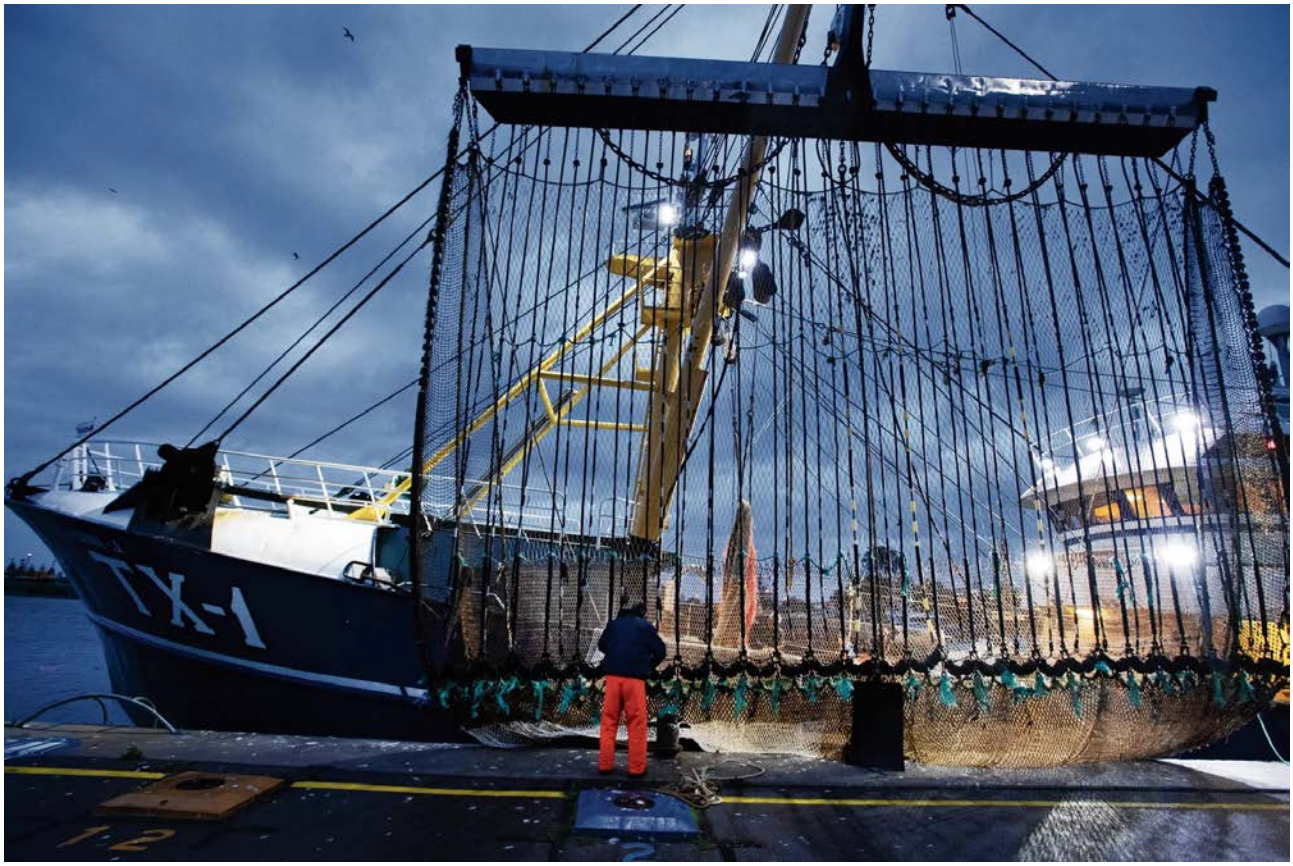
Technological Innovation System Analysis of the Dutch cutter fishery regarding fishing techniques



Writing Assignment

MSC BIO-INSPIRED INNOVATION

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ABSTRACT

This literature review comprises a technological innovation system analysis of the innovation system surrounding fishing techniques in the Dutch cutter fishery. The sector is in need of support, as currently the business case for landing fish turns out negatively, while innovations are needed that offer perspective for the future. In general, the method of Hekkert. et al is followed, adjusted for use in a literature review of limited size (M. P. Hekkert et al., 2007).

An innovation system consists of a structure, that fulfills system functions to varying degrees. For the part of the innovation system that is in the (pre)-development phase, guidance of the search, mobilization of resources, and resistance in the sector are hampering the innovation trajectory. For the system that handles mature technologies, it is the continuity of current technologies and mobilization of resources due to the high fuel costs that hamper entrepreneurial activities.

Improvements in the system are to i) offer perspective to the cutter fishery sector, ii) enable entrepreneurial activities in innovation, iii) stimulate the market for sustainable fish, iv) focus on multidisciplinary research for future fisheries, v) enhance international cooperation, and vi) stimulate knowledge development and sharing. An essential factor is that fishers that want to innovate are financially supported to stay in business during this trajectory. Theoretically, this literature research further develops an understanding of the workings of innovation systems by applying the method of innovation system analysis to a traditional sector. Practically, it offers handles to intervene in the current innovation system around fishing techniques in the Dutch cutter fishery, which may help them find a grip in the current crisis.

Keywords: *Technological Innovation System Analysis, Dutch cutter fishery, fishing techniques*

LAYMAN SUMMARY

The Dutch cutter fishery faces a set of challenges, which makes profitable business difficult. Space on the North sea is increasingly limited, as space is reserved for offshore wind farms, shipping lanes, and nature reserves amongst other things. On top of that come tedious regulations, a ban on the successful electric pulse fishing technique, and increasingly high fuel costs. The Dutch cutter fishery is deeply rooted in Dutch culture (Sweco, 2021). Also, sea food can be part of a healthy diet (Hoekstra, 2022; OFL, 2020). Due to the developments sketched above, innovation is needed to keep the Dutch cutter fishery functioning properly. A large challenge is to innovate fishing gears in order to gain better (selectivity of) catches, that are less harmful to vulnerable sea floors and use less energy.

Innovations develop not merely on their own, but are developed in a network. The network around innovations is called an innovation system. It consists of actors (people, organizations, parties), institutions (that determine the rules of the game), collaboration between actors, and physical infrastructure (M. Hekkert & Ossebaard, 2010). The success of an innovation is depended on the functioning of the innovation system. In this literature research, an innovation system analysis is done on the innovation system around the fishing gears of the Dutch cutter fishery. The structure and functioning of the innovation system are analyzed, and it is determined whether the system is just starting or mature, using the method by Hekkert et al (M. P. Hekkert et al., 2007). For the part of the innovation system that is in the (pre)-development phase, factors that limit the buildup of innovations are: guidance of the search, mobilization of resources and resistance in the sector.

For the system that handles mature technologies, the future prospects of existing technology are bad due its high energy consumption and impact on the environment. In combination with a lack of compensation for the high fuel prices, this limits entrepreneurial activities. Improvements in the system are to i) offer a vision for a way forward to the cutter fishery sector, ii) enable entrepreneurial activities in innovation, iii) stimulate market for sustainable fish, iv) focus on multidisciplinary research for future fisheries, v) enhance international cooperation, and vi) stimulate knowledge development and knowledge sharing. For the fishers to be able to innovate, it is essential that fishers have an income to stay in business.

INTRODUCTION

The Dutch cutter fishery are operating under pressure of several developments impacting their sector (IDON, 2022; RVO, 2022b; van Hoof et al., 2020). These are for instance spatial developments such as claimed space for wind farms, shipping and nature reserves, which leave less available space for the Dutch cutter fishery, as well as legislation such as the landing obligation and the ban on electric pulse fishing. Migrating fish populations and increased fuel prices are further limiting the sector's ability to sustain itself (van Hoof et al., 2020). The Dutch cutter fishery sector is economically of small importance, but the sector is deeply rooted in Dutch culture (Sweco, 2021). Also, sea food can be part of a healthy diet (Hoekstra, 2022; OFL, 2020). Due to the developments sketched above, innovation is needed to keep the Dutch cutter fishery functioning properly.

The Dutch cutter fishery sector reacts by reducing fuel costs by limiting boat movements, and utilizing more economical fishing techniques (Lagerberg, 2022; Wageningen University & Research, 2021). A large challenge for the sector is to innovate fishing gears in order to gain better (selectivity of) catches, relieve pressure on benthic habitats, and use less energy. In this report the definition of "Innovative gear", as provided by the Workshop on Innovative Fishing Gear (WKING), is adopted into: *'a gear or significant component of the gear that has not been used commercially and/or that is sufficiently different from the baseline in the current European Regulations, or in the absence of them, different from the commonly used gear in the specific sea basin (area) in EU waters'* (ICES, 2020, p. 1). The innovation process of the pulse fishing technique showed that social factors surrounding the innovation rather than technical factors contributed to the ban on pulse fishing (Delaney et al., 2022). Therefore, it is of added value to focus on the system around fishing gear innovations. In this way next innovations can be developed successfully.

Innovations develop not merely on their own, but are developed in a network of actors and institutions. This network around innovations is called an innovation system and can be defined as *'a system consisting of elements (organizations and institutions) between which relations exist that affect the development, application and diffusion of innovations'* (Boschma et al., 2002). It consists of actors (people, organizations, parties), institutions (that determine the rules of the game), networks of interaction between actors, and physical infrastructure (M. Hekkert & Ossebaard, 2010). The development of innovations is thus depended on the functioning of the innovation system. The innovation system is different for each innovation, and develops in conjunction with the specific innovation. The functioning of the innovation system surrounding the Dutch cutter fishery is important for the maturing of innovations. In this thesis, it is analyzed how the innovation system around the Dutch cutter fishery regarding fishing techniques can be enhanced.

In order to develop an answer, it is important to dissect the workings of this particular innovation system. A method that uses empirically verified system functions that make visible the underlying structure and functioning between the actors and institutions in an innovation system, has been developed by Ossebaard & Hekkert (M. Hekkert & Ossebaard, 2010). The method forms the backbone of this literature research. The system functions, explained in the methods, guide the search strategy in scientific journals and government documents. In the results section, insight in the processes around fishing gear innovation in the Dutch cutter fishery sector is created, by mapping the most important factors that influence the sector's ability to innovate. In the discussion, first recommendations for interventions in the innovation system are given, that may improve the creation of new fishing techniques in the Dutch cutter fishery.

METHODS

The Innovation system analysis for the Dutch cutter fishery consisted of a structure and a function analysis. Several elements of the structure of an innovation system could be distinguished. Actors in the fisheries sector are knowledge institutes, educational organizations, industry, market actors, government bodies and supportive organizations. Institutions are regulations on fisheries imposed by and on the actors. Networks are important pathways of interaction between actors, while technological factors are existing technologies and physical infrastructure, such as cutters and fishing equipment.

Ossebaard & Hekkert identify seven empirically verified system functions (M. Hekkert & Ossebaard, 2010). These can be analyzed by mapping different indicators, of which examples are given in table 1.

Table 1. System functions of innovation systems and how they can be analyzed (Hekkert et al, (2007).

#	System function	Analyze by mapping..
1	**Entrepreneurial activities**	The number of entrepreneurs, mapping the scope of their actions and the amount of experiments they do with the new technologies.
2	**Knowledge development**	R&D projects, R&D investments and patents.
3	**Knowledge diffusion**	The size and intensity of knowledge exchange of the system.
4	**Guidance of the search**	Specific targets of governments and industries about the new technologies and by counting the numbers of positive and negative articles written about these.
5	**Market formation**	Niche markets, tax conditions and new environmental standards that improve the chances for the new technologies.
6	**Resources mobilization**	Key actors perceive access to these resources as problematic or not.
7	**Counteract resistance to change**	The growth of interest groups around these technologies.

Besides the structure and function analysis, in order to accurately describe the functioning of an innovation system, the phase of the system needed to be defined. In each phase of the innovation system, different sets of factors are important for the functioning of the system. There are five possible phases in the life cycle of an innovation system. These phases can be identified as exploration- , take-off- , acceleration- , stabilization- and decline phase (M. Hekkert & Ossebaard, 2010; Markard, 2020).

As the scope of this thesis is relatively limited, the structure and function analysis were taken together. The first subsections of the results section discuss the structure and the phase of the innovation system. The phase was determined by placing it placing it on an S-curve, using diagnostic questions. Then, segments follow that elucidate the different system functions – using literature. Within each system function, information is given about the relevant organizational structures. In the discussion, interactions between the system functions are handled, which form positive feedback loops for developing the innovation system (M. Hekkert & Ossebaard, 2010). These can be generative or degenerative for the innovation system. Finally, possible interventions are given, based on the system problems that block the well-functioning of the innovation system.

For the data acquisition, scientific literature and policy papers were used. To give a more complete overview, a general internet research was done, which includes news articles from within the sector. The main sources which were used to find information on this topic were: *Scopus, Rijksoverheid, VIN, visserij in cijfers, Visned, Vistikhetmaar, visserijnieuws, Noordzeeoverleg, Nederlandse vissersbond,* and *ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB).* Both policy papers and peer reviewed articles were searched for, focusing on keywords such as: *Kottervisserij, Dutch cutter fishery, Innovation, Innovation system, fishing technique,* and *fishing gear.*

The research is a first inventory of the innovation system surrounding the Dutch cutter fishery, and does not give a complete insight in all factors. A limitation to the approach outlined by Ossebaard & Hekkert is that in this research no expert interviews were taken to map systems functions. The added information these interviews provide, would strengthen the accuracy of the analysis that is provided in the results. Also, it would strengthen its argumentation. However, interviews were out of scope of this literature review.

INNOVATION SYSTEM ANALYSIS

Overview structure innovation system

The structure of the innovation system surrounding fishing techniques of the Dutch cutter fishery is outlined in figure 1. The parts that the scheme consists of, are further elucidated in the structure and function analysis.

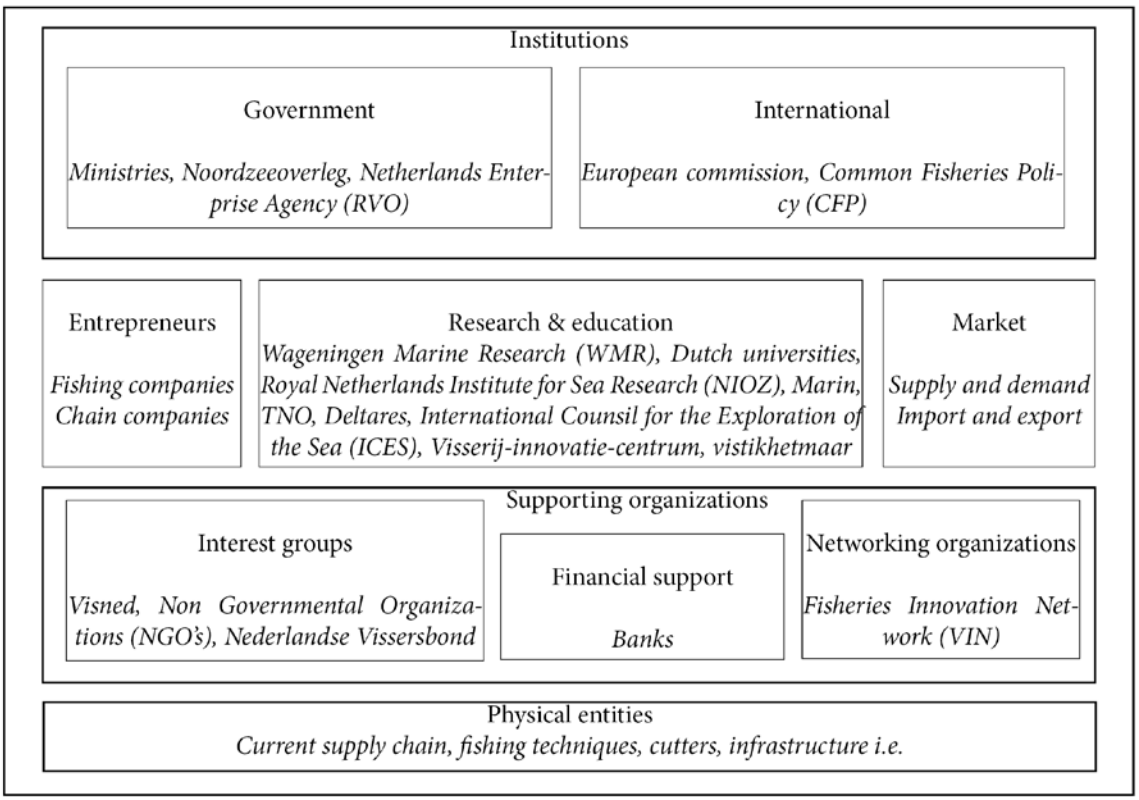

Figure 1: Overview structure of the innovation system of the Dutch cutter fishery regarding fishing techniques (Adapted from Hekkert et al, 2011). The structure of an innovation system comprises: actors, institutions, physical entities and the networks of interaction between them. The functioning and interaction between actors (not displayed here) is worked out in the function analysis.

Phase of the innovation system

The innovation system of the Dutch cutter fishery is on the one hand likely to be in the decline phase, a continuation of the downward spiral that occurred around the millennium change (Salz, 2022; Wageningen University & Research, 2022d). Due to the developments sketched in the introduction, the high fuel prices and the decommissioning scheme of the Dutch government – it is expected that more than half of the large >24m cutters will stop operating in 2023 (Salz, 2022). When this happens, this may cut the annual fish harvests of the Dutch cutter fishery in half. The innovative pulse fishing technique, with which the Dutch cutter fishery innovated itself out the crisis around the millennium change, was banned by the European Union (Delaney et al., 2022). Now, the sector is using the conventional beam trawling technique again, which was first planned to be phased out because of its energy use and environmental impact (Task Force Duurzame Noordzeevisserij, 2006).

On the other hand, there are also signs that the innovation system of the Dutch cutter fishery is in the pre-development phase, in an effort to innovate itself out of the crisis. The innovation trajectory of the pulse fishing technique, although it was halted, was successful in many ways and contained valuable lessons and expertise (Delaney et al., 2022; Haasnoot et al., 2016). Furthermore, to develop a positive and energetic innovation climate, the Dutch government established the Fisheries Innovation Network (VIN) (RVO, 2022b). However, the perspective for further innovation is yet unclear. New fishing techniques still need considerable time to develop as most of these innovations are in the pre-development and development phase (M. Hekkert & Ossebaard, 2010).

Structure & function analysis

The following subsections will discuss the structure & function analysis. This chapter is organized using the 7 system functions. Within each section, relevant subjects of the structure analysis are embedded.

1 Entrepreneurial activities

Entrepreneurs play an important part in the innovation system by experimenting with new technologies and knowledge to create commercial opportunities. In this paragraph it is explored to what extent this system function is fulfilled.

Structure

The cutter fishery sector focuses on two main species. These are plaice and sole (figure 2). Of these species, sole is most lucrative to fish (Sweco, 2021). Both species are important sources of income for the sector. Other (non-quota) species are of less importance, but their importance might grow with policy changes and fish- and fuel prices (Rijksoverheid, 2022a; RVO, 2022b; Sweco, 2021; VisNed, 2020).

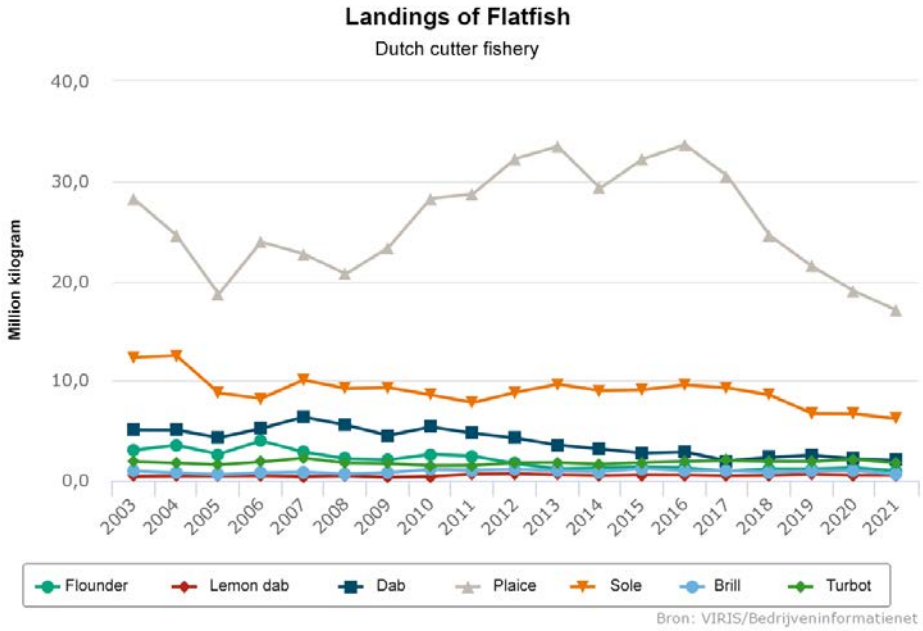

Figure 2: Landing of demersal fish in the cutter fishery sector per year in million kilos per year Source: visserij in cijfers. From the figure it can be seen that Plaice and Sole are the most important species for the Dutch cutter fisheries.

The cutters of the Dutch cutter fishery fleet are aging. Since 2008 the percentage of ships older than 20 years has risen. As a reaction to the successful pulse fishery, the fleet acquired some (6) new ships in 2018 after a long period of no acquisition (Wageningen University & Research, 2020). In 2021 7% of ships was younger than 10 years, while more than 80% was older than 20 years.

After pulse fishing was banned, fishers started using the less efficient and environmentally damaging beam trawling fishing techniques again (figure 3) (Wageningen University & Research, 2021). This method needs more fuel and is known to damaging vulnerable sea floors (Haasnoot et al., 2016; Koning et al., 2021).

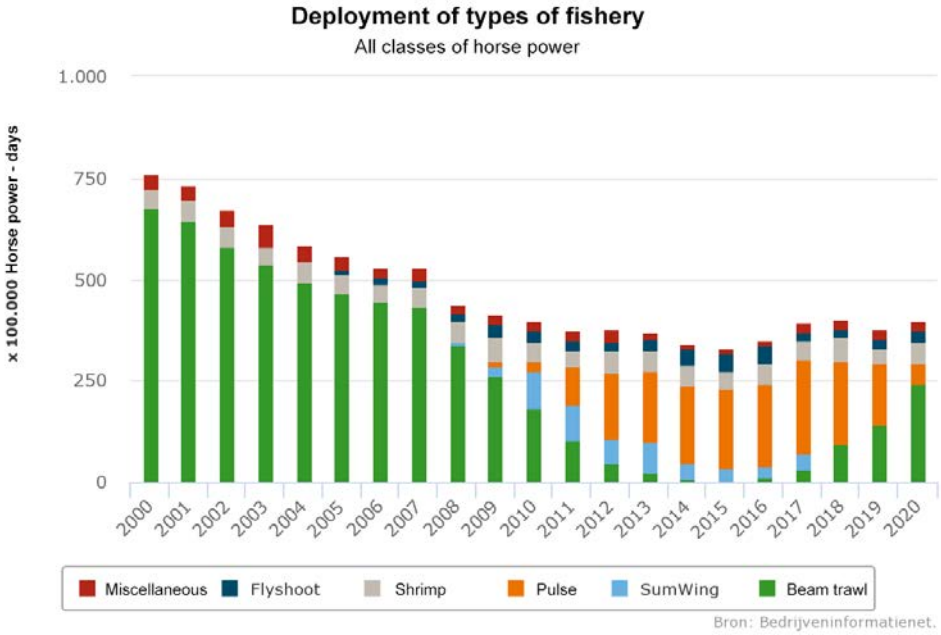

Figure 3: Application of fishing techniques in the cutter fishery in x 1000,000 Horse power x days per year Source: visserij in cijfers. The beam trawling technique was the most used technique till 2009, after which the pulse fishing technique and the sumwing technique gained importance. The pulse fishing technique was very successful in the years 2009 till 2018, after the technique got banned by the European Union. Fishers are now using the conventional beam trawl technique again.

Functioning

Within the Dutch cutter fishery, a limited amount of fishers is actively involved in developing innovations (RVO, 2022b). A majority, however, is hesitant in organizing innovation. While it is common that a sector is divided into different adopter-categories, of which the majority is hesitant in adopting innovations, the fisheries sector as a whole lacks financial security, which hampers the sector's uptake of innovations (RVO, 2022b; Salz, 2022). Besides factors related to the ability to innovate, - social, policy and science-related factors associated with willingness play a role in the voluntary uptake of selective fishing techniques (N. A. Steins et al., 2022).

The sector has recent experience in innovation trajectories. The process of developing the pulse fishing technique did take a multitude of years, but was seen as positive and very promising. As the pulse fishing technique was banned in 2019, other technologies are needed to take its place. In the report for the Workshop on Innovative Fishing Gear (WKING), examples of state-of-the-art technologies and innovations are given that are relevant to the European fisheries (ICES, 2020). Innovative fishing techniques are the helix- and twister fishing techniques. It is likely, however, that these technologies take years before they are developed into profitable innovations. According to Hekkert et al, innovation is a process in which both success and failure occur, which results in innovation trajectories of decades rather than years (M. Hekkert & Ossebaard, 2010).

In the short term, gains can be made by incremental innovations. Adjusting the mesh size of fishing nets and/or using escape panels may limit discards (Quirijns et al., 2019; Vist ik het maar, 2021). However, these adjustments often result in other undesirable effects, that need innovation in their turn (Quirijns et al., 2019). Working with different mesh sizes costs time, and experimenting with these adjustments means smaller catches or less time to fish. This impacts the income of personnel at the ship, that take a share in the profit of the fish catches. In the end, time spend on testing modifications or innovations uses time that cannot be spend on reliably generating income.

Energy efficiency is important. Innovations on the hull and on the powertrain of the cutters, are therefore instrumental to lessen the sectors reliance on fossil fuels. For this collaboration is sought with the maritime sector (Visser, 2020).

2 Knowledge development

In this paragraph, the knowledge production that takes place in the sector is described.

Structure

Academic knowledge on cutter fishery is built up by different academic knowledge organizations in the Netherlands. Between 2012 and 2022 Wageningen UR was the most productive with over 400 documents on cutter fishery. The publications of Wageningen Marine Research (a research institute dedicated to marine research and fisheries) fall under this number. Wageningen is followed by Utrecht University (72 documents) and the University of Amsterdam (66 documents). Other national research institutions that work on marine science and fisheries are TNO, Deltares, NIOZ, Delft University of Technology, Marin and the 'visserij-innovatiecentrum'.

Practical knowledge of fishers is developed when experimenting with new fishing techniques (F1). Several subsidies require actors to work together in order to create innovations. An example of this is the IPC subsidy (Staghouwer, 2021). This subsidy is aimed at entrepreneurs that are willing to work together in order to transition to a more sustainable fisheries. Also other subsidies such as the SDVA and NWO subsidies stimulate developing and sharing knowledge, for example by working together with knowledge institutions (NWO, 2019, 2021; RVO, 2022e).

Other platforms, that focus more on knowledge sharing than on knowledge development, are the Fisheries Innovation Network (VIN), the Community Of Practice (COP) of the North Sea and vistikhetmaar (see section 3: knowledge diffusion through networks).

Functioning

Research regarding alternative fishing techniques in the Netherlands is mainly focused on the 'bodemberoerende visserij' (demersal fishery). The current use of the beam trawling technique requires high energy input, causes substantial mortality of all species caught, and is damaging the sea floor (Haasnoot et al., 2016; RVO, 2022b). A long-term solution for the fisheries industry to avoid damage to the sea floor is still to be developed (RVO, 2022b). The same goes for fishing techniques that have a large precision for the target species and CO_2 neutral means of transport (RVO, 2022b). Academic research can take a long time, while in practice it turns out that the fisheries sector needs to make informed decisions in a relatively short timeframe. This means that the priorities of academic research and practice differ, which compromises both innovation power and the practical use of academic knowledge.

The Dutch government is being advised by knowledge institutions, Non-Governmental Organizations (NGOs), and parties that have interest in the fisheries sector. It is important that knowledge is built up within the government, in order to maintain the directive power of the government and the quality of policies that maintain the stability and viability of the sector (Schilder, 2022). Regular change of government officials and policy officers increase this necessity. The buildup of knowledge within the Ministry of Agriculture, Nature and Food Quality is deemed under pressure and may need improvement (Knabben & van den Berg, 2020; Schilder, 2022).

3 Knowledge diffusion through networks

Knowledge diffusion to different actors through networks is important for the functioning of an innovation system. In this paragraph it is explored to what extent this system function is fulfilled.

Structure

The Fisheries Innovation Network (VIN) is a platform leading the transition of the Dutch cutter fishery (RVO, 2022f). It is set up by the government and consists of parties within the sector driven to make a change. The goal of VIN is to create a positive innovation climate, that leads to innovations for profitable fisheries and less impact on the environment.

Several platforms exist that translate scientific information into an easily accessible format. An example is the website Vistikhetmaar, that translates knowledge in an easy understandable format for education purposes (Vistikhetmaar, 2021a). Sector specific news platforms that diffuse knowledge are: visserijnieuws, visserij.nl and the news letters of 'de Nederlandse Vissersbond' and VisNed.

The Community Of Practice (COP) of the North Sea is a network of entrepreneurs, knowledge institutions, societal organizations and government organizations and top-sectors (RVO, 2022a). It has the goal to stimulate innovations regarding the use of the North Sea. This is done by balancing between energy, nature and food production and stimulating a sustainable blue economy. For example, by investigating shared-use of different areas in the North Sea.

Functioning

Collaboration to develop innovative fishing gears is not always profitable for entrepreneurs in the short term, as they often need to co-finance the research projects (NWO, 2021). Subsidies may flow mainly to the knowledge institutions, while fishers share the financial risks of partnering in the innovation trajectory. Furthermore, the financial situation of many companies in the fisheries sector is limiting the possibilities for innovation (Taal, 2022). Still – the IPC subsidy attracts ten proposals for innovation (Visserijnieuws, 2022e), showing the ambition of fishers to innovate.

In the Netherlands, knowledge is sufficiently shared between knowledge institutions and the fisheries sector. For over twenty years, fishers and researchers have been working together (N. Steins, 2022). This collaboration has formed trust between the institutions and the cutter fishery. Internationally, there is interest in the high standard of collaboration in the Netherlands. The sharing of knowledge and development of trust between fishers and science on the one side and NGOs on the other side, is less developed (N. A. Steins et al., 2020).

The sharing of knowledge between the Dutch government and the fisheries sector used to be good. There is a mode of cooperation, joint decision-making, and vision-building (van Hoof et al., 2020). However, in past years, the challenges for the fisheries sector grew to be comprehensive, and the fisheries sector did not see their interests translated into a sufficient perspective. This has led the fisheries sector to not sign agreement with the 'Noordzeeakkoord', an official agreement between the government and stakeholders of the North Sea for the upcoming decennium (Koning et al., 2021; OFL, 2020). Recently, the relationship has been restored, and representatives of the sector are now joining the North Sea Dialogue (Visserijnieuws, 2022b). Besides this, the Ministry of Agriculture, Nature and Food Quality established the Fisheries Innovation Network (VIN). The platform still needs to take on a leading role in the innovation process in order to make a change (Visserijnieuws, 2022g). At the moment, finance and subsidy possibilities for the sector are worked upon by the Ministry. These form the basis for the VIN for offering a guiding role in the innovation process.

Besides this, Nationally, the Community of Practice (COP) of the North Sea creates a positive learning environment, in which practice is decoupled from policy (N. A. Steins et al., 2021). Here cooperation between stakeholders in an informal setting is facilitated in an informal setting. The practice aspect of the COP North Sea has however not yet fully blossomed, due to its relatively short existence (the COP is organized since 2018).

Internationally, knowledge is insufficiently shared. In the case of the ban on pulse fishing, it became clear that other European countries were not involved in the innovation process at the right time. This led to resistance based on remaining uncertainties about the technology and notions of protectionism (Haasnoot et al., 2016). In the case of the landing obligation, knowledge diffusion about adjustments of fishing nets to decrease discards was insufficient. *'Possible solutions were not universally known and available'* (Visserijnieuws, 2019). Apart from market actors, scientific knowledge is sufficiently shared among researchers in the international scientific community through for instance the knowledge development organization ICES (ICES, 2022).

4 Guidance of the search

In this paragraph is described to what extent the sector is guided in its search for innovations. A shared or common goal for the future is important to direct the efforts of the different actors in the same direction.

Structure

Guidance by the Dutch government is provided via the VIN network (See F3, p10). On a system level, with the formation of the VIN, the framework to support the cutter fishery sector in innovation is created. The content that identifies specific levels of change to reach the set goals still needs to be formed. Offering perspective to the cutter fishery sector is a priority in the upcoming months and years.

A considerable part of the legislation for the Dutch cutter fishery is determined by the European Union, in the Common Fisheries Policy (CFP). This is a set of rules for managing European fishing fleets sustainably and for conserving fish stocks (European Commission, 2022). These rules relate to the total allowable catches, specific places where fishing is (dis)allowed, and the period or intensity that specific areas can be fished in (Rijksoverheid, 2022b). Moreover, there are rules for the maximum allowed engine power of vessels and the used fishing techniques. The goal of the policy is to ensure that fish resources can be used sustainably while providing healthy food at reasonable prices (European Council, 2022).

Important regulations imposed by the European Union are the landing obligation and the ban on pulse fishing. The landing obligation entails that fishers need to bring bycatch to the shore, to stimulate innovation to diminish bycatch, and to acquire more accurate data on real catches (European Commission, 2022). The pulse fishing technique is a Dutch innovation that was halted by the European Union in 2019 (Delaney et al., 2022). Furthermore, European regulations on handling the Brexit are influential for the quota and fishing areas of the Dutch cutter fishery (Rijksoverheid, 2022b). Currently, European fisheries are striving to continue using bottom trawling techniques, as the European Union advances to propose banning bottom trawling fishing techniques (The Fishing Daily, 2021; van Tuinen, 2022).

Important Dutch laws and regulations for the cutter fishery are the North Sea agreement and the 'Vision on cutter fishery'. In the North Sea agreement, there are regulations that allocate space for different activities on the North Sea (figure 4) (OFL, 2020). Offshore wind farms, nature areas, transport routes and other reserved spaces limit the available space for fisheries (Rijksoverheid, 2022a). In the Vision on cutter fishery, a proposal

is done to distribute governmental resources to the cutter fishery sector to be transformed to fit the current situation, encompassing a decommissioning scheme and a restructuring of the sector (Burger, 2019). These resources are closely tied to the North Sea Agreement.

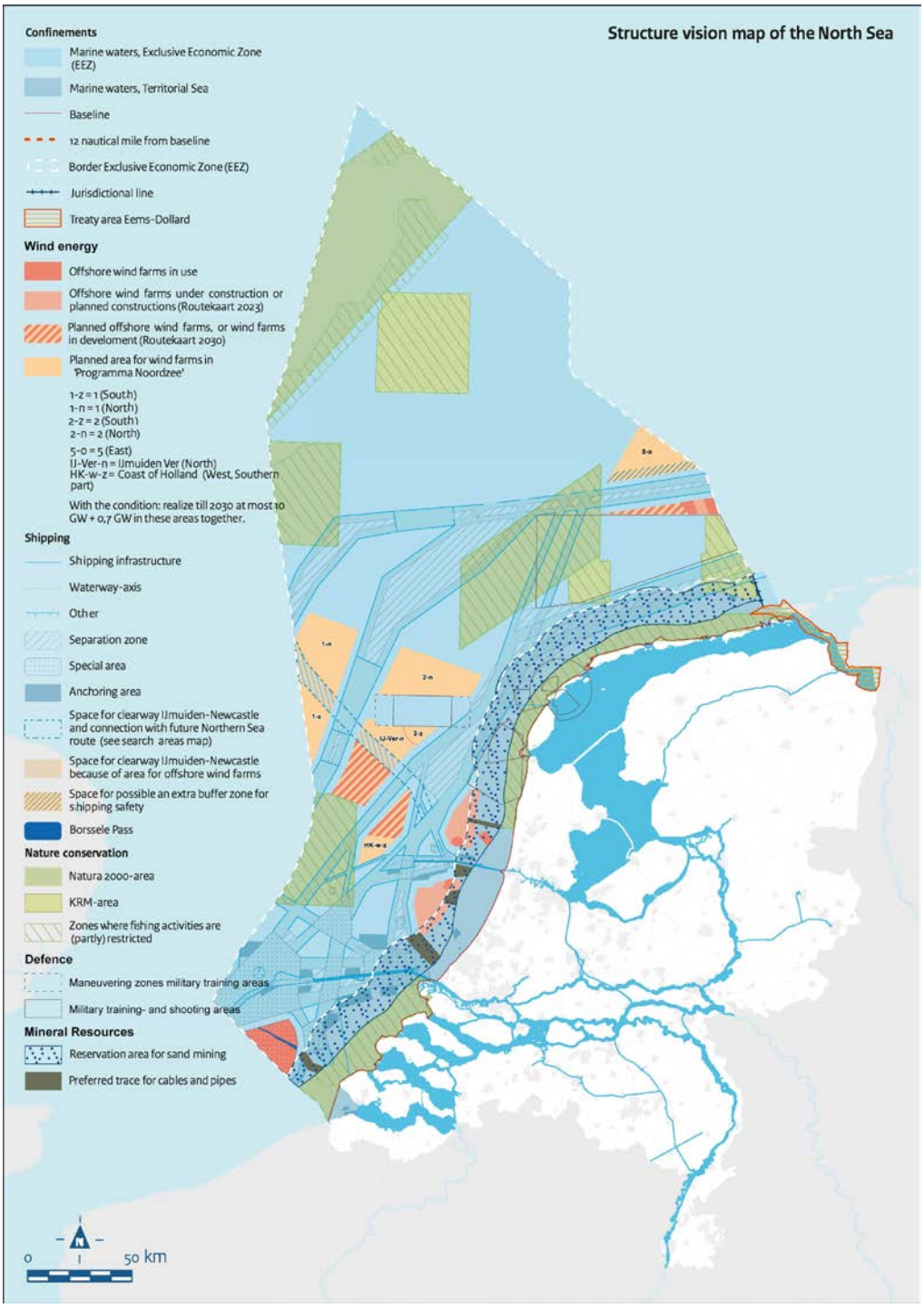

Figure 4: Vision map of the North Sea area (Programma voor de Noordzee 2022-2027). Space on the North Sea is increasingly limited. For several developments space is reserved, while fishers are dependent on the remaining space for their activities.

Functioning

There is insufficient perspective for the Dutch cutter fishery, especially for the demersal fishery. The cutter fishers feel that they lose control over the future, as the challenges ahead are impressive (Knabben & van den Berg, 2020). The need for a transition in the cutter fishery sector never was this dire (RVO, 2022c). What makes it more difficult to offer perspective to the sector, is that the sector is dependent both on Dutch as on EU regulations (Staghouwer, 2022).

The insufficient perspective leads to fewer investments in innovations. This is partly inability to invest in new technologies, as the financial risks are considerable (RVO, 2022c). While existing technologies have proven to be effective, current new technologies are often not in a phase where they are competitive with existing technologies.

Furthermore, it may be that the Dutch government fulfills its guiding role for the fisheries sector insufficiently. It can be argued that the Ministry of Agriculture, Nature and Food Quality is guided by expert opinions that besides their role as advisors, also have interests in the sector (such as knowledge institutions and NGOs) (Schilder, 2022). Together with a lack of knowledge development within the Ministry, this leads to responsive actions of the government rather than proactive actions (Knabben & van den Berg, 2020; Schilder, 2022). Distance from the sector, inside knowledge and directive power are needed to provide counterbalance against advising parties.

5 Market formation

Market formation is important for the profitability for the sector. Here import and export are described, and the state of sales-market for fish and the profitability of the business case to land fish.

Structure

The net-result of the Dutch cutter fishery was positive in the years 2012-2018 (figure 5), mainly due to the adoption of pulse fishing. After the ban on pulse fishing, the Brexit, the landing obligation and the rise of fuel-costs, the sectors net results decline below zero in 2021. In 2022 the result is expected to be more than minus twenty million euros (Wageningen University & Research, 2022d).

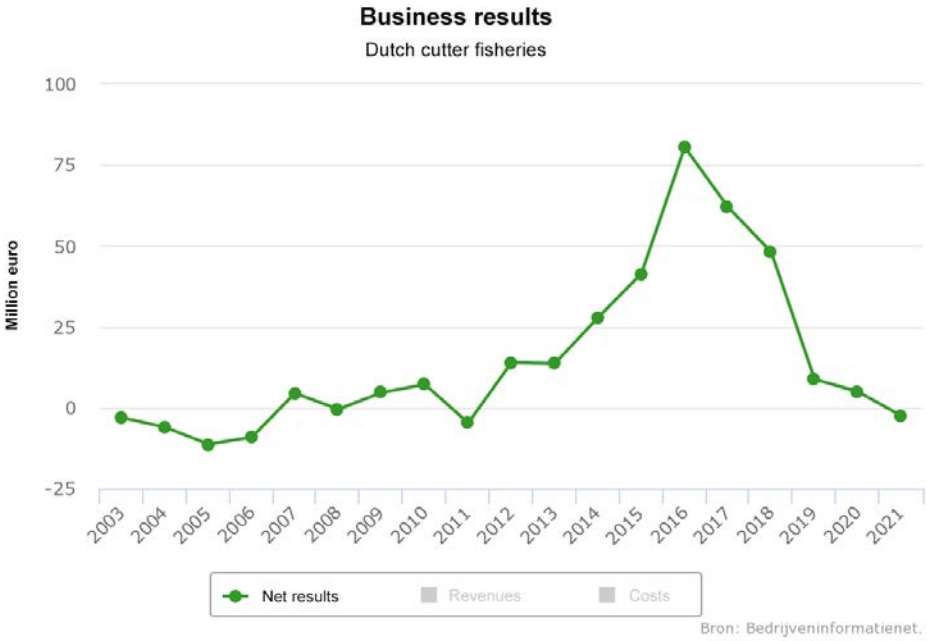

Figure 5: Net economic results of the Dutch cutter fishery. (Visserij in cijfers 2022). The net results of the cutter fisheries fall below zero in 2021 and are likely to turn out very negative for 2022.

The value of export of fish caught by Dutch fishers has risen to a record high of 4.4 billion euros in 2021 (figure 6) (Wageningen University & Research, 2022b). While 1.1 million tons of fish were exported, 872,000 tons of fish were imported (figure 7) (Wageningen University & Research, 2022c). The demand for fish in the Netherlands exceeds the volume of fish provided by the Dutch fisheries. The prices of North Sea fish are high (Wageningen University & Research, 2022b), but due to lower purchasing power of Dutch households, this may lead to lower sales.

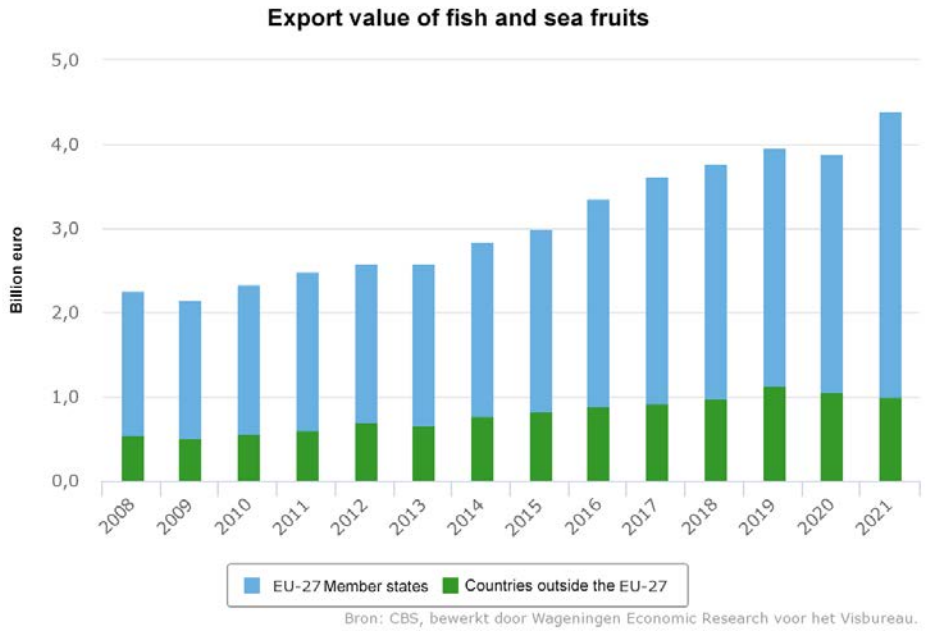

Figure 6: Export value of fish and sea fruits (Visserij in cijfers 2022). The export value of fish is increasingly high (+13% in the last year), mainly due to the higher price that is paid for fish. In weight the export increased +3% to 1,100 tons.

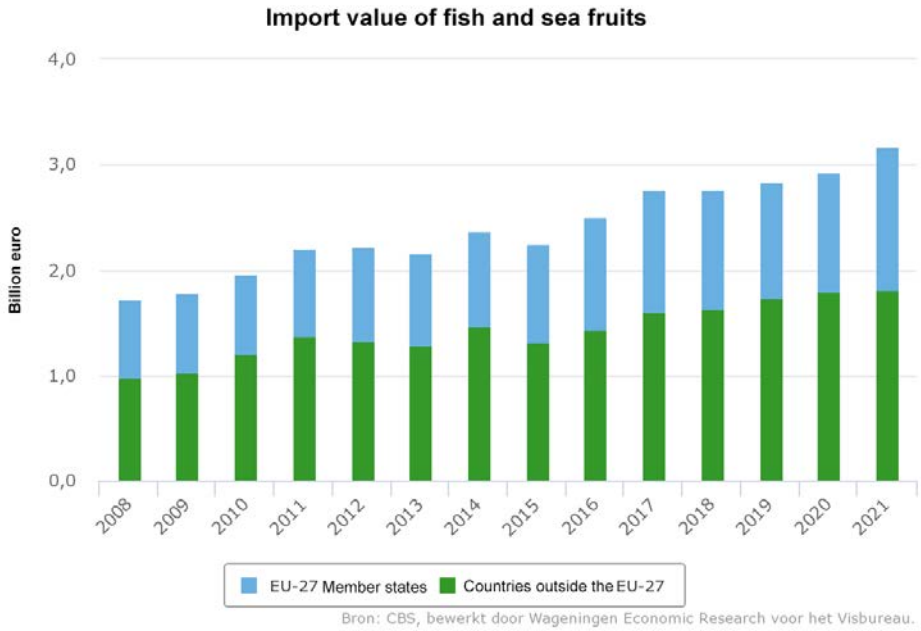

Figure 7: Import value of fish and sea fruits (Visserij in cijfers 2022). The import value of fish is increasingly high as well, with an increase of 8% in the last year. In weight there was an increase of 5% to 872,000 tons of fish.

Since the war in Ukraine fuel prices in European Union have exploded. In the first 8 months of 2022 the fuel prices for the cutter fishery have risen to 0.89 euros per liter, which is double the price of 0.45 euros per liter in 2021 (Taal, 2022). Increasing inflation (more than 10%) comes on top of that. Because of these reasons, 25% to 30% less ship movements were made - a lot of cutters have not been out of operation to wait for profitable times. The last decennia, the sector was using less fuel (figure 8) (Wageningen University & Research, 2022g). This was due to shrinkage of the Dutch cutter fishery sector, a ban on using engines larger than 2,000 pk, using new and innovating fishing techniques (pulse), and fishing increasingly energy conscious.

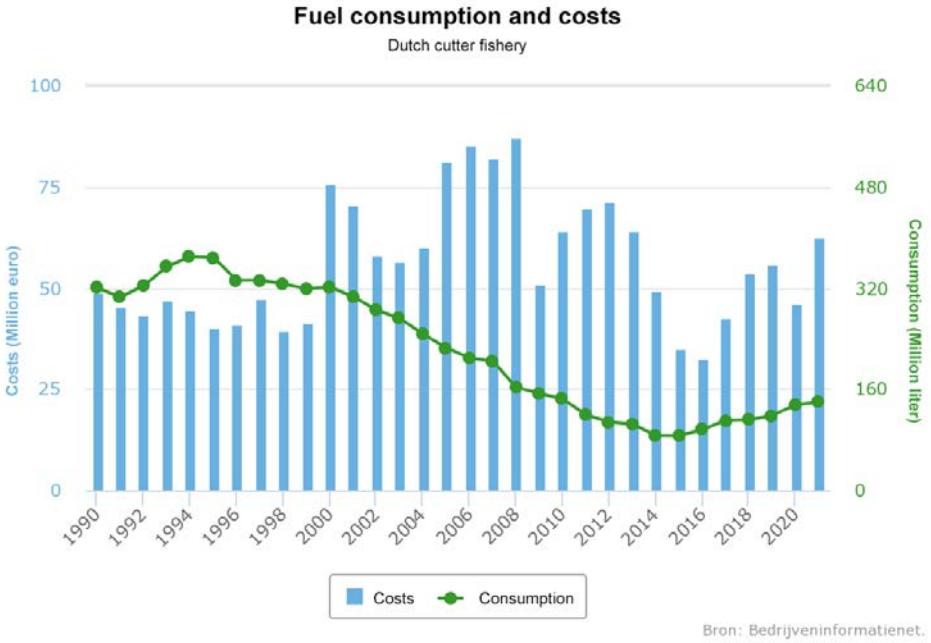

Figure 8: Fuel consumption (in green) and expenses (in blue) of the Dutch cutter fishery. (Visserij in cijfers 2022). The last decennia the sector was using less fuel. From 2014 onwards, an increase of activities increased fuel consumption. After the ban on pulse fishing the fuel consumption increased due to increased use of the beam trawling technique.. The high fuel price (double the amount of 2021) will create a trend break for 2022. Likely, less fuel will be consumed (Lagerberg, 2022).

Functioning

The Dutch demand for fish and seafood exceeds the supply of fish by the Dutch fisheries, and the fish prices have risen again after a dip in 2021 (Wageningen University & Research, 2022a, 2022b). The sales market surrounding fish production, despite the fluctuating fish prices, is therefore in good condition (Visbureau, 2022; Wageningen University & Research, 2022a). However, the costs to deliver fish to the shore haven risen to spectacular heights, due to the fuel costs (more than double the number presented for 2021 in figure 8). Therefore, ultimately, the business case for fishing companies is negative for 2022 (Taal, 2022).

Although illegal, there remain possibilities to catch more fish by also catching more undersized fish, and selling both for direct human consumption. According to a report by the Netherlands Food and Consumer Product Safety Authority (NVWA), the demersal- and shrimp fisheries are often unwilling to live by the rules (NVWA, 2022). Although the landing obligation leads to practices that are unworkable for the fishermen (Visned, n.d.), not catching and selling undersized fish and discards for direct human consumption is in the interest of the fisheries themselves to guarantee healthy populations (NVWA, 2022). However, when using nets with mesh sizes that reduce undersized fish and discards, less fish of the target species is caught, leading to loss of income.

Branding sustainable fish to consumers is a point of attention. Several developments show that 'sustainability through the market' which was executed for example by the successful implementation of the MSC label (van Hoof et al., 2020), is lacking in progression. The acquired MSC certificate for demersal fishery is controversial, due to its impact on sea floors (pointer kro-ncrv, 2022). Furthermore, fish monger shops fall short to mention information related to sustainability of their merchandise (Consumentenbond, 2021). Dutch consumers are therefore less able to make balanced choices in their consumer behavior. Most consumers do favor a reasonable price, quality and shelf life of fish at fish stores over sustainability. Only one fifth of consumers tend to look at sustainability measures while buying fish (Consumentenbond, 2021).

Dutch consumers eat only a limited portion of fish per year in comparison with other European countries (9,5 kg – 25kg) (Vistikhetmaar, 2021b). Moreover, imported fish species are popular, while various local North Sea species are less known (Hoekstra, 2022). The relationship between Dutch consumers and local fish is therefore underdeveloped.

6 Resources mobilization

For the development of an innovation system, it is essential that there are enough financial and human resources. The upcoming paragraph it is explored to what extent this system function is fulfilled.

Structure

In total, the Dutch government provides € 444 million transform the Dutch fisheries in such a way that it is fit for the changes around the North Sea (Visserijnieuws, 2022d). € 200 million of this amount is provided by the BAR fund, and is meant for decommissioning, loss of income and prolonged mooring of vessels (Nederlandse Vissersbond, 2022c; RVO, 2022d). From the North Sea agreement € 45 million is made available for

innovation for sustainable fisheries. On top of that, € 199 million was added from the Climate Fund that will be spent on innovation, new ships, and shared use of Offshore Wind Farms. Besides these figures, there are a few smaller subsidies that the fisheries sector can use. These are the IPC, MIT and SDVA subsidies (RVO, 2022e).

The personnel costs within the cutter fishery declined to € 63 million in the last few years (Wageningen University & Research, 2022f). Most employees are self-employed and work in a partnership. This means that every employee is able to claim a fair share of the net profit of the fishing activities. However, the net-profit of the cutter fishery sector fell below zero in the last year (figure 6). Companies help their personnel by giving guaranteed income although this results in losses for the company. Profitable innovations, subsidies, and financially strong companies are needed to support employees and provide perspective for the future.

Functioning

Financial mobilization is urgent for the Dutch cutter fishery sector, due to the large uncertainties and the financial condition of the sector. More than half of the large >24m cutters will likely stop operating in 2023 (Salz, 2022). The Dutch government provides a bridging arrangement for fuel costs to the cutter fishery (Visserijnieuws, 2022f). However, this arrangement comes late for many cutter fishery companies in financial distress. Moreover, the € 30.000 provided by the arrangement can support companies only for a short amount of time.

While the proposals and perspective that the VIN works are still awaited on, current subsidies are not always of help for the fisheries sector. Fishers have problems to find and apply for subsidies, and encounter complexity in the procedures (Knabben & van den Berg, 2020). Good ideas for innovation are something different than worked out project plans that meet the requirements to apply for a subsidy. On top of that, the IPC Vis subsidy that can be applied for, is not sufficient for the submitted innovation proposals (Visserijnieuws, 2022e). Requirements around other subsidies and arrangements are strict as well and negotiations and payouts take long (Nederlandse Vissersbond, 2022d; van den Berg, 2022). Individual companies often have too few financial resources to develop innovations and scientific evidence for these (Knabben & van den Berg, 2020). When all effort is done on ‘surviving’, there is less attention to innovations to fish more sustainably (Quirijns et al., 2019).

Young motivated personnel that wants to work in the fisheries sector is scarce (Vedder, 2021). This has the following reasons. First and foremost, the fisheries sector is characterized by family businesses, and is highly localized (Quirijns et al., 2019; RVO, 2022b). Youngsters outside this specific environment are often not engaged with the fisheries (Provincie Zeeland, 2018; Schilder, 2022). Education related to the marine and fisheries sector are struggling for several years to attract enough students (Nederlandse Vissersbond, 2022b). Furthermore, given the enormous challenges, tedious regulations, and little perspective for the future, the fisheries sector is struggling to keep personnel (Lagerberg, 2022; Vedder, 2021). Advantageously, the upcoming decommissioning scheme might elevate the problems by redistributing the personnel to the remaining ships (Salz, 2022).

7 Counteract resistance to change

New developments often lead to resistance to change. Managing this resistance is important for the successful implementation of innovations. In the next paragraph, it is analyzed to what extent this is the case.

Structure

Interest groups of the fisheries sector are sector organizations such as ‘visned’, ‘de Nederlandse vissersbond’, and other individual initiatives (Nederlandse Vissersbond, 2022a; VisNed, 2022). ‘Visned’ is an advocate for the Dutch cutter fishery, while the advocacy of ‘de Nederlandse visserbond’ encompasses the whole Dutch fisheries sector – the entrepreneurs, owners, and crew members in all sectors of the Dutch fisheries. Both parties act in the interests of the Dutch cutter fishery. In 2021 VisNed split up after the five organizations that VisNed consists of, could not find common ground (Visserijnieuws, 2021). In 2022 only the Producer Organization (PO) Urk is a member of VisNed.

Furthermore, The VIN (worked out in section 3) improves contact between the fisheries industry and the government and counteracts resistance to change by offering cooperation and developing perspective for the cutter fishery sector.

Functioning

Within the sector, there is resistance to change. First, there is a lot of uncertainty and little hope for the future. Several political decisions have negatively impacted the sector, such as the Brexit and the ban on pulse fishing. The pulse fishing technique was an innovation that led to less damage to the sea floor and less fuel costs (Delaney et al., 2022). These are exactly the goals that are needed for a more sustainable fishery. That the technology was banned, mostly for social reasons related to inequality between international stakeholders, is hard to digest. The scientific evidence for the technology is proving its success (Haasnoot et al., 2016). The ban on this technology does not improve trust in innovation within the sector.

Second, the rewards for innovating are unclear. The fisheries sector is hesitant in adopting new fishing techniques because it is unclear what the financial benefits of the investments will be (RVO, 2022b). Taking up and innovation leads to catching less fish, while the costs and inefficiency of handling a new gear are higher. Not only factors to ‘being able’ to innovate are hampering voluntary uptake of proven (selective) fishing gears. Steins et al. point out that social, policy- and science-related factors related to willingness are important as well (N. A. Steins et al., 2022). This is reflected in the intrinsic motivation and beliefs about sustainable fishing of the fishers, the legitimacy of policy goals and regulations, and normative beliefs about the presence (or absence) of a level playing field. Trust between parties is not guaranteed, and trust in innovation has fallen due to the ban on pulse fishing, which was thought to be a real and innovative change-maker (Knabben & van den Berg, 2020; RVO, 2022c). Also, there is too less enforcement of regulations, leading to a field where it is profitable to not live by the rules.

Third, the culture within the fisheries sector is limiting innovation power. Internationally, this was the case for France, which held more importance to tradition than to innovation in the pulse fishing project (Quirijns et al., 2019). In the Netherlands in 2020, 89% of the companies in the cutter fishery sector had only one cutter

(Wageningen University & Research, 2022e). This means that fishing companies are each other's competitors and that the uptake of innovations can be hampered by a lack of a level playing field (N. A. Steins et al., 2022).

Another reason that there is resistance in the sector, is that there are contextual differences in the fisheries sector and that fishers have different views. VisNed fell apart after disagreements between its members around the decision-making process of the North Sea agreement (Visserijnieuws, 2021). The playing field is multi-leveled (Hatenboer et al., 2023). Individual, local, national, and international levels exist where the stakeholders need to find compromises, consensus, and/or need to find their interests represented. Internationally, there is distrust of foreign fishers and NGOs, that try to influence the opinion around Dutch innovations in a negative way (Knabben & van den Berg, 2020).

Lastly, also in the government changes are needed to enhance cooperation. The minister and other officials change regularly, which is not conducive to the buildup of knowledge and the continuity of relations (Knabben & van den Berg, 2020; Visserijnieuws, 2022h). In addition, trust needs to be gained. In the past, the fishers needed to pay back subsidies, and this has damaged the level of trust of fishers in the government (Visserijnieuws, 2016).

DISCUSSION

Discussion

This literature review comprises an innovation system analysis of the innovation system surrounding new fishing techniques in the Dutch cutter fishery. In general, the method of Hekkert. et al is followed, adjusted for use in a literature review of limited size (M. P. Hekkert et al., 2007). First, the phase of the innovation system was determined, after which a structure and function analysis followed. By using seven empirically verified system functions (figure 9), the inner workings of the innovation were analyzed. A comprehensive picture of the interaction between the system functions is still lacking, but this can be built upon the carried-out structure and function analysis.

Hekkert distinguishes several stadia of innovation systems, in which different functions (functional patterns) are important for the development and continuation of the innovation system (Hekkert, Marko ; Heimeriks, Gaston; Harmsen, 2011). The current innovation system of the Dutch cutter fishery regarding fishing techniques is characterized by more than one functional pattern, because of the state of decline and the state of innovations. For the development of innovations, the pre-development and development pattern are applicable (figure 10). For the current situation, in which fishing techniques are insufficient for sustaining the sector in the future, continuation is needed to move into a new innovation system. The acceleration pattern of the innovation system may be a starting point to inhibit the developments that bring the innovation system into disarray (figure 11).

Figure 9: Legend of functions (Hekkert et al, 2011).

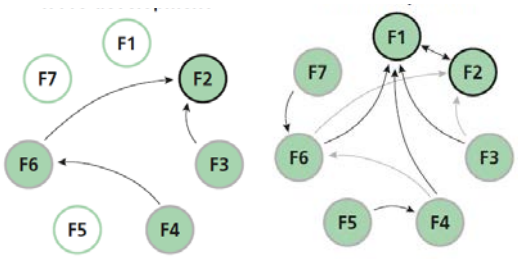

Figure 10: The pre-development and development functional pattern (Hekkert et al, 2011).

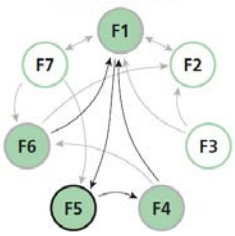

Figure 11: The acceleration functional pattern (Hekkert et al, 2011).

Positive interactions within the functional patterns of the innovation system

Within the pre-development functional pattern, knowledge exchange (F3) between fishers and science (especially WMR) is well developed (N. Steins, 2022), leading to the building up of knowledge (F2). Knowledge is shared via easily understandable platforms such as vistikhetmaar, and the COP of the North Sea, and other initiatives. A limited number of subsidies is available for collaborations of fishers (F6), and for developing knowledge (F2).

In the development functional pattern, the demand for fish is present (F5), which is a positive input for guiding the innovation trajectory. The VIN is in the early starting phase for offering perspective (F4). It is a step to improve the 'guidance of the search' for entrepreneurs that wish to continue and invest in their future. Entrepreneurs have applied a dozen innovation projects to the IPC vis subsidy (F1 and F6).

Within the acceleration functional pattern, market creation (F5) is the most important system function (Hekkert, Marko ; Heimeriks, Gaston; Harmsen, 2011). Existing technologies, such as fishing with the beam trawling technique are in this phase. Within the fisheries sector, close-knit communities and family businesses exist, that have a heart for the business, are willing to create markets, and are proud to do so. For the successful continuation and improvement of technologies in the acceleration phase, also relationships in the prior patterns need to be maintained. In the prior pattern counteracting resistance to change (F7) is an important function.

Barriers for development

When looking at the innovation system in the phase of (pre)-development (figure 10), several functions form barriers. Knowledge exchange (F3), is well-developed between certain fishers and research institutions. However, a large part of the fishing companies is less involved in this relationship and is less enthusiastic about the uptake of innovations (F7). In the pre-development pattern, another barrier is that the process of mobilization of financial resources is tedious and slow, and the amount proves not to be sufficient for all innovation projects (F6). Fishers are not incentivized to do sustainable fishing practices and participate in innovation as this often costs money and time while the rewards are unclear. In the development pattern, the VIN can be a game-changer within the structure of the innovation system as a leader in generating perspective (F4). The VIN has large potential due to its integration within the sector and its mediating role with the government (RVO, 2022b). However, the VIN is in starting phase and its results are awaited. Until then, entrepreneurs and fishers are hampered by the lack of perspective, which contributes to a lack of unity within the sector and to disagreements on how to proceed (F7).

When looking at the existing technologies of the innovation system in the phase of acceleration (figure 10), other barriers occur. The external effect of high fuel prices has a large effect on the validity of the business case for the Dutch cutter fishery. Little influence can be exerted on external effects, thus external stimuli need to be accounted for within the current innovation system (M. Hekkert & Ossebaard, 2010). Mobilization of resources (F6) is urgent for entrepreneurs to continue their activities (F1). However, there is resistance to continuing the status quo of the demersal fishery (see next section).

Effects leading to innovation system decline

The national and European backing for the demersal fishery is waning due to shifting policy goals towards sustainability and environmental priorities (F4). Resistance of the national government, NGOs, and international actors (F7), and sluggish institutional procedures hamper the timely mobilization of resources for the Dutch cutter fishery that is needed due to the high fuel prices (Vissersbond, 2022). Furthermore, the innovation system of the Dutch cutter fishery was already weakened by the ban on pulse fishing, which led to the discontinuation of this technological innovation system. Finally, emerging innovation systems around new techniques are dependent on successful pilot projects for further development. An example is that the

innovation system surrounding the waterspray fishing technique has declined due to disappointing research results (Visserijnieuws, 2022a, 2022c).

Limitations and implications for future research

This innovation system analysis has theoretical and practical limitations. Ambiguity in the methodology was found when comparing different sources. Suurs (2009) describes innovation motors as reinforcing feedback loops within the innovation system, whereas in later versions of the methodology, in the functional patterns, incomplete feedback relationships are shown (Hekkert, Marko ; Heimeriks, Gaston; Harmsen, 2011; Suurs, 2009). For this analysis, the latest version of the methodology is used. Furthermore, in recent years the life cycle of innovation systems is studied, in which innovation system decline is handled, but the methodology is not yet updated incorporating this information (Markard, 2020). This limits the accuracy of handling innovation system decline.
Moreover, several fishing techniques fall in the scope of this innovation system analysis, while technological innovation systems usually study one technology. The added complexity of internal technology competition is not taken into account in this literature review. Better results can be obtained by conducting several analyses for each technology and aggregating these at the recommendations level.

The results obtained from this innovation system analysis are based on secondary sources of information. Written texts may contain political phrasing, which clouds their message. Also, indicators for measuring the amount and scope of the actions of actors differ widely. Some metrics are readily available, while others are less measurable. This leads to bias in the functioning of the innovation system. Primary sources of information such as conducting expert interviews would enhance the accuracy of the analysis.

CONCLUSION

This research is focused on the innovation system around the Dutch cutter fishery, specifically on how to enhance fishing techniques. The Dutch cutter fishery sector needs support, both financially as well as support in the innovative processes itself. Currently, the business case for landing fish turns out negatively, while innovations are needed that offer perspective for the future. The current fishing techniques that the sector uses, are not sufficient, as they impact vulnerable sea floors and need extensive fuel.
A starting point for generating recommendations for interventions in this innovation system can be offered by a technological innovation system analysis (Hekkert, Marko ; Heimeriks, Gaston; Harmsen, 2011). It uses seven empirically verified system functions that describe the functioning of an innovation system, while also dissecting the structure of the system and the phase it is in. Applying this to the Dutch cutter fishery sector regarding fishing techniques, one can say that the system can be characterized in more than one phase. For the part of the innovation system that is in the (pre)-development phase, guidance of the search, mobilization of resources, and resistance in the sector are hampering the innovation trajectory. For the part of the system that handles mature technologies, it is the continuity of current technologies and mobilization of resources due to the high fuel costs that hamper entrepreneurial activities.
How can we innovate fishing techniques? For the fishers to be able to innovate, fishers must be financially supported to stay in business. The next steps in the innovation process are to offer perspective to the cutter

fishery sector and to enable entrepreneurial activities in innovation. The market for sustainable fish can be enlarged to give a positive impulse for sustainable practices. For example, Dutch consumers can be educated by a made documentary and local sustainable fish may be marketed as higher-value products that enable fishers to fish more sustainably. Multidisciplinary research and cooperation on a sectoral, national, and international level may lead to the successful development and implementation of new fishing techniques. Applying the innovation system analysis method to innovation systems in sustainability transitions shows shortcomings in innovation system decline, which is a topic for further investigation.

RECOMMENDATIONS FOR THE DUTCH CUTTER FISHERY

Recommendation 1: Offer perspective to the cutter fishery sector

The fourth system function (guidance of the search) is insufficiently executed. This means that entrepreneurs and other actors are unsettled by the lack of perspective for the sector. This impacts the amount and scope of entrepreneurial activities negatively (F1) (figure 9) and creates resistance within the sector (F7). For the creation of perspective, innovation is needed, for which the VIN can play a driving role, together with financing from the Ministry of Agriculture, Nature, and Food Quality. The tasks of the VIN are to find answers on reducing the energy input of the sector, limiting damage to vulnerable sea floors, and reducing unwanted discards (RVO, 2022c). If the working groups can indeed translate these into profitable business cases within limited space, and point to realistic goals – perspective is developed. Fishers that want to innovate must be financially supported to stay in business during this trajectory. Besides this, it is essential that nationally and internationally an answer is developed on the continuity of demersal fishery. The government needs to play a leading role in these matters and make sure fish stocks and biodiversity are preserved and enhanced in the future.

Recommendation 2: Enable entrepreneurial activities in innovation

When entrepreneurs endeavor in innovation projects, this often implies making extra costs. If instead entrepreneurs would be rewarded (F6) (N. A. Steins et al., 2022), this strengthens the ability and willingness to innovate. This can be done by adapting regulations of subsidies for innovation projects, for example by guaranteeing income and by helping entrepreneurs with subsidy applications (N. A. Steins et al., 2022; Visserijnieuws, 2022d). Also, positive fishing behavior (reducing energy use, limiting damage to vulnerable sea floors, and reducing unwanted discards) can be stimulated and negative fishing behavior can be punished, by rewarding fishers in accordance (F6). A task for the government is to research which reward systems are most feasible.

Recommendation 3: Stimulate the market for sustainable fish

While the sales market for fish is in relatively good shape, export and import figures show a distorted relationship between Dutch consumers and local fish species (F5). Solutions can be to educate Dutch consumers by making a documentary or to market local sustainable fish as higher-value products that enable fishers to fish more sustainably (Hoekstra, 2022; Vistikhetmaar, 2021b). Besides this, the sales market for unsustainable fish can be diminished by prohibiting sales of under-sized fish at fish auctions. In this case, the government needs to find ways to enforce the regulations.

Recommendation 4: Focus on multidisciplinary research for future fisheries
The challenges for innovation in the cutter fishery sector are broader than the used fishing techniques. A vision in which there is space to redesign business models, as well as the cutters and fishing techniques, may lead to possibilities not thought of when focusing on parts of the challenge (F4) (Visserijnieuws, 2022d). In practice, it takes many years to develop successful innovations. As in the early phases of development, fewer resources are needed than in later phases, it is plausible to explore different solutions right away (F1 and F2). For instance, a roadmap towards alternative fuels, conceptual redesign of cutters, competitions, and pilot projects on new fishing techniques (Visserijnieuws, 2022g).

Recommendation 5: Enhance international cooperation
Both in the pulse fishery trajectory and the recent reactions to the raised fuel prices, international competition impacts the entrepreneurial success of the Dutch cutter fishery. An international consensus about fishing techniques, perspective for future fisheries, and cooperation would stimulate knowledge development (F2) and reduce international resistance in the upcoming innovation trajectory (F7).

Recommendation 6: Stimulate knowledge development and knowledge sharing
Lastly, it is important to stimulate knowledge development and knowledge sharing among different actors in the innovation system. This is important to stimulate innovations, as well as for getting the actors on the same page regarding new fishing technique innovations. Cooperation can be enhanced between fishers mutually, but also between fishers, research institutes, NGOs, and retailers. This can best be done by intervening in the innovation system structure. For example, by adjusting the roles of actors, such as involving NGOs in an innovation program, or by stimulating supermarkets to educate their customers through promotion stands. Finally, everyone willing to contribute to innovation can join the working groups of the just erected VIN. In a collective effort, the working groups of the VIN can play a central role in the knowledge development and knowledge exchange in the Dutch cutter fisheries sector.

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