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Beyond métiers: social factors influence fisher behaviour

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Fisheries management is usually supported by technical and financial measurements (i.e. logbooks and market data), which are helpful for ecological or economic assessments. Yet this information is not able to address social heterogeneity and fisher motivations, which are key to understanding fisher behaviour. This case study of the demersal segment in the Netherlands shows that combining quantitative analysis of logbooks with qualitative data collected by engaging with fishers can capture both fishing activity and its motivations, generating a more social understanding of fisher behaviour. A métier analysis of logbook data describes five dominant fishing practices among the selected segment. Twenty-five in-depth interviews with fishers along with focus groups including other experts identify three social factors that influence fisher behaviour in the Dutch demersal fleet: business structure, working rhythm, and polyvalence. The results show that motivations for fisher behaviour are more complex than complying with regulations or seeking profit: social factors also influence fishing activity. Furthermore, these social factors have real implications for the impacts of management measures on both the fishing communities and the environment, especially in times of change. These results are useful for management strategy development or evaluation because they are feasibly observable through existing data collection protocols.

Keywords: Dutch demersal fishery, fisher behaviour, fisheries management, métier, mixed methods, social factors, social heterogeneity

Introduction

Managing fisheries requires managing people, which calls for understanding fisher behaviour (Larkin, 1988; Hilborn, 2007). Important advances have been made in understanding fisheries via a technique known as métier analysis, which uses logbook data to analyse what a fleet of fishers does at sea (where, when, and with what gear they have fished, with what landings; Ulrich *et al.*, 2012). These métiers (i.e. categorizations of fishing activity based on the characteristics above) are proxies for fisher behaviour as input for management strategy evaluations and ecological sustainability monitoring (Biseau and Gondeaux, 1988; Ulrich *et al.*, 2012). The limitation of using métiers for describing differences in fisher behaviour is that they cannot (nor do they claim to) understand the habitual, normative, and contextual aspects that are known to influence fisher behaviour (Ulrich *et al.*, 2012; Lade *et al.*, 2015; Boonstra and Hentati-Sundberg, 2016). This shortcoming can be problematic when making predictions about how fishers will respond to management interventions (Ulrich and Andersen, 2004).

To capture the changes in behaviour that lead to changes in fishing patterns, individual fishers (not vessels) need to be considered as the operating entity. Fishers have much in common with one another due to their occupation, but there are quantifiable and potentially generalizable distinctions that can help understand the differences among fishers operating within the same métier (Miller and Van Maanen, 1979). These distinctions are

useful for managers interested in anticipating changes in activities and designing more effective interventions. Incorporating these social distinctions to analyses based on métiers will help scientists and managers gain a better understanding of what motivates fishers to do what they do, what perceptions they hold, what habits they have, and which changes they might be willing to make, when they will make them, and how the changes might look (Fulton *et al.*, 2011). Without this understanding, trade-offs and interconnections between environmental goals and social and economic impacts are not clear. Therefore, the inclusion of social factors in ecosystem-based fisheries management reduces the chances of unintended and inequitable outcomes (Hornborg *et al.*, 2019). This so-called human dimension of fisheries management is increasingly being recognized as relevant (Wilen, 1979; Salas and Gaertner, 2004; Branch *et al.*, 2006; Hilborn, 2007; Link *et al.*, 2017; Stefansson *et al.*, 2019).

Understanding fisher behaviour is especially needed in a context of change as managers and fishers adapt to changing circumstances (Hanna and Smith, 1993; Wilen *et al.*, 2002; Salas and Gaertner, 2004; Fulton *et al.*, 2011). This is the case for North Sea fisheries as they face complex political changes in the coming years (Haasnoot *et al.*, 2016; Quirijns *et al.*, 2019). A landing obligation will be implemented in full to prevent discarding, which is particularly challenging for mixed fisheries fleets (Batsleer *et al.*, 2015; Guillen *et al.*, 2018). Furthermore, the withdrawal of the United Kingdom from the European Union is a significant governance change, which will impact fishers both directly (fishing ground access, renegotiation of quota shares, and trade), and indirectly (displacement; Phillipson and Symes, 2018). At the same time, space for fishing in many North Sea exclusive economic zones will likely shrink due to offshore wind farming, Blue Growth ambitions, and the designation of nature conservation areas following the Marine Strategy Framework Directive and the N2000 Habitats Directive (Janßen *et al.*, 2018). Furthermore, fish distributions will change as a result of climate change (Queirós *et al.*, 2016). These environmental, social, and political changes will impact fishers in different ways depending on their capacity to adapt, which is in turn dependent on social factors. Therefore, scholars who wish to understand changes in fishing behaviour must consider fishers as complex social actors, rather than a homogenous fleet switching between métiers.

This article uses the demersal flatfish fishery in the Netherlands as a case study to ask what meaningful (to fishers) and useful (for management and fisheries scientists) social factors can be identified to bring a richer understanding of motivations for fisher behaviour. The Dutch demersal flatfish fishery is an interesting case for this research question because these fishers are expected to respond to a recent ban on electric fishing (van Hoof *et al.*, 2020) as well as the various changes listed in the previous paragraph by either innovating, leaving the fishery, conducting business as usual, investing, relocating their fishing efforts, or a combination of these strategies. While it is certain that they will have to adapt, it is uncertain how exactly they will do so. In times of change, fisheries modelling can be employed to predict possible outcomes, but for this activity to be successful, a solid understanding of what motivates fishers is needed. An understanding of the heterogeneity of the demersal sub-sector may be useful to the Dutch government, which is preparing a restructuring of the fleet to accommodate the many incoming changes (Quirijns *et al.*, 2019). Furthermore, earlier periods of change in Dutch fisheries have demonstrated that there is a close relation between government policy development and fleet development (van Hoof *et al.*, 2020). This study thus responds to a call for fisheries classification that is quantifiable using existing data, relevant for management, and supported by stakeholders (Ulrich *et al.*, 2012). The aim is to identify distinguishing social factors that are (i) relevant for understanding the response of fishers to social and political changes and (ii) qualitatively generalizable. The discussion section includes reflections on the implications of the findings for management.

Conceptual framework

Since the beginning of 2000s, the concept of métiers has been used in Europe to classify fishing activity based on a combination of target species, gear, area fished, and seasonality (Ulrich and Andersen, 2004; Ulrich *et al.*, 2012). Métier analyses capture some diversity in fisher behaviour because they aim to understand how fishers combine their technology (gear) with their environment (target species, area, season). This understanding can be useful for achieving environmental sustainability because it can show which gears are being used to catch particular species, where, and in which seasons, thereby helping to understand fleet dynamics. However, métier classification captures only the results of fishing behaviour, doing so in a technical and short-term way. It does not serve or intend to explain why these patterns emerge. That requires a social understanding of who the fishers are and what their motivations or constraints might be.

In the traditional understanding of behaviour, fishers are influenced by three key factors: the natural environment (the sea, weather, seasons, fish stocks), rules and regulations, and economics (van Putten *et al.*, 2012; Girardin *et al.*, 2017). Tools such as bioeconomic fisheries models operationalize this traditional conceptualization of behaviour (Clark, 1990; Nielsen *et al.*, 2018). However, these models call for simplified assumptions about fisher behaviour and classify them according to technical indicators. In reality, in addition to being distinguished by the technology they use, fishers define appropriate behaviour based on their own social and occupational distinctions, and their conduct in response to regulations largely follows these distinctions (Miller and Van Maanen, 1979). The difficulty of incorporating these distinctions into models leaves fisher behaviour as the key source of uncertainty for fisheries management (Fulton *et al.*, 2011).

When studying fisher behaviour, it is useful to differentiate between two time scales: tactical and strategic (Christensen and Raakjær, 2006). Tactical behaviour refers to how fishers make decisions at sea during a fishing trip. Examples of tactical behaviour include how long each haul is, whether and how the fisher changes location when they see what they have caught, and how they react to changing weather (Pfeiffer, 2020). Strategic behaviour, on the contrary, refers to the long-term decisions that fishers make. Examples of strategic decisions include how and when to maintain or upgrade a vessel, the hiring of crew, the purchase or sale of quota, investments in gear, and the selection of fishing grounds. This article uses the distinction between strategic and tactical behaviour to structure its interpretation of the data.

One of the concepts used to identify patterns of behaviour is fishing styles. Building on rural sociology work that has looked at farming styles (e.g. Van der Ploeg, 1994; Schmitzberger *et al.*, 2005), fishing styles are patterns of behaviour that "create congruence between normative notions about how fishing should be practiced, and fishers' dependence on different social and ecological contexts" (Boonstra and Hentati-Sundberg, 2016). This

concept is a useful point of departure when trying to understand behaviour because it sees fisher choices as coming about by an interplay between two types of motivations: conscious, intended, or means-end, and the habitual, value-rational, or culturally determined (Boonstra and Hentati-Sundberg, 2016).

This article uses the concept of fishing styles to identify the most meaningful and useful social factors that motivate strategic and tactical behaviour. Social factors can be defined as social circumstances or influences that contribute to a result, in this case, fisher choices. In other words, a fishing styles lens takes the traditional model of fisher behaviour (environment, regulation, economics), and creates space for additional social factors that characterize the fisher in the model and allow for variability depending on their values, habits, and norms.

Methods

The study consisted of three phases: First, an iterative métier analysis to define relevant métiers, then a qualitative data collection and coding phase to understand fishers' own social distinctions and motivations for behaviour, and finally the identification and validation of social factors that influence fisher behaviour.

Phase 1—iterative métier analysis

We first analysed fishing activity in terms of choices fishers made about how, where, when, and what to fish. To synthesize these choices into métiers, we made a typology of the Dutch fishing activities using ordination and classification methods (as in Pelletier and Ferraris, 2000; Hentati-Sundberg *et al.*, 2015). First, we identified landings profiles (i.e. groups with similar landing composition) of the 320,000 trips in the 2001–2016 logbook data of Dutch fishers. For this, we transformed landing weights per species into a percentage of total landings for the trip, keeping the top 25 species (98% of total landings). We performed a principal component analysis (PCA, see Mardia *et al.*, 1979; Venables and Ripley, 2002) and a clustering (CLARA, see Kaufman and Rousseeuw, 1990) on these landing profiles. To improve the quality of the interpretation of the data, we presented these landing profiles, along with summary statistics of the data set, to a focus group of Dutch fisheries researchers and to a focus group of industry stakeholders, ministry representatives, and scientists, eliciting feedback on the validity of the analysis. These two focus groups validated the data analysis that produced the landing profiles and helped identify which segments might benefit from a more in-depth qualitative understanding. The demersal fleet (excluding shrimp) was chosen because it is a significant fleet by the number of trips recorded and volume of catch, and because the complex political changes mentioned in the introduction made it an interesting case for fisheries management. The métiers were defined using multiple correspondence analysis (MCA, see Husson *et al.*, 2010) and a second clustering procedure (CLARA). The landing profiles were used as a categorical variable together with the main gear and number of gears used in the trip, the main mesh size and number of mesh sizes used, the number of rectangles fished, total landings in kilograms, season, and days at sea. For both the landing profiles and métier definition, we used the average silhouette width technique (Rousseeuw, 1987) to determine a suitable number of clusters.

Phase 2—qualitative data collection and coding

For the qualitative data collection, we sampled 25 fishers, purposively selecting for representativeness of location, main gear, and business structure. We conducted in-depth structured interviews either in their vessels as they returned to the harbour after a fishing trip, in their harbourside warehouses, or in their homes, depending on the convenience of the respondent. The transcriptions were coded using the open-source software RQDA. Summary tables of each interview (fisher profiles) were created, combining information on social variables based on the qualitative coding with the interviewee's main fishing practice from the quantitative analysis in Phase 1.

Phase 3—social factor identification and validation

The interview guide elicited responses from fishers about 78 themes (listed in Table A in Supplementary Material). For our purposes, key social factors were those that (i) were important to fishers during interviews and/or (ii) could realistically be observed across the whole fleet using logbook or other quantitative data. From the themes, 20 fit these criteria (Table B in Supplementary Material). An MCA biplot showed that, of these 20 factors, 2 were most important for differentiating fisher behaviour: business structure and polyvalence (the ability to change function or activity). The working rhythm factor was excluded from the MCA analysis because all but one respondent fished with a weekday rhythm and the imbalance of the categories (one occurrence for continuous against 24 for weekday fishing) gives disproportionate weight to that one occurrence. However, 18 of the 25 respondents cited the change to a continuous working rhythm as a driver of behaviour in the fleet. Thus working rhythm was included because it is a prominent "normative notion of how fishing should be practiced," a key component of the fishing styles concept (Boonstra and Hentati-Sundberg, 2016). Its inclusion was confirmed during the final focus group, detailed below.

The final step of this mixed-methods process was to validate the social factors with the key stakeholders. We assembled a diverse group of experts including fishers, ministry representatives, fishing industry representatives, and scientists. We presented the methodology and findings and elicited feedback using a world café methodology (Tan and Brown, 2005). The experts evaluated whether the factors we had selected based on our mixed methods analysis were justified based on their experience. They also made suggestions about whether and how the factors might be useful for management. Finally, we used a sorting game to elicit specific definitions of the factors. A more detailed explanation of the methodology can be found in Supplementary Material.

Results

Métier analysis

The quantitative analysis identified 16 métiers in the whole Dutch fishing fleet. Of those métiers, five clearly captured the activities of the demersal fishing fleet (see Table 1). The other métiers (three pelagic, four shrimp, three small scales, and one razor clam) will not be further commented on in this article, but a description of those métiers is available in Table C in Supplementary Material. Table 1 shows the five demersal métiers, as defined by MCA analysis of multiple trip characteristics (see "Phase 1—iterative métier analysis" section). To aid

Table 1. Description of the demersal métiers of the Dutch fleet.

Métier code	Métier	Landings per trip (mean kg)	Main Gears (% trips)	Mesh Size (mean mm)	Vessel length (mean m)	Trip length (mean days)	Peak season
1	Flyshoot	5,000	SSC (43) OTB (34) PTB (11)	87	27	3	Summer
2	Coastal sole	4,000	TBB (98)	77	29	4	Spring
3	80mm mesh flatfish	10,000	TBB (100)	80	41	5	Autumn/winter
4	Wide range flatfish	8,000	TBB (86) OTB (10)	82	37	5	No peak
5	Mixed gears plaice	13,000	TBB (44) OTB (24) SSC (19) OTT (11)	90	34	6	No peak

SSC: Scottish seine; OTB: otter trawl; OTT: twin trawl; PTB: pair trawl; TBB: beam trawl (incl. adaptations to traditional beam trawls such as pulse trawl and sumwing).

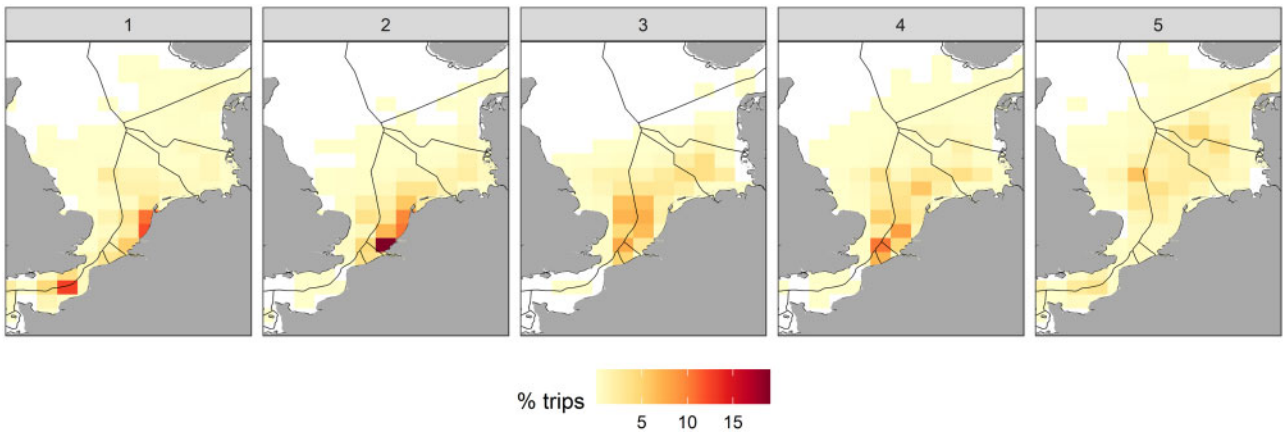

Figure 1. Maps showing concentrations of fishing activity in the North Sea (by ICES rectangle) per demersal métier between 2001 and 2016. The numbers in the top of the panels indicate métier code (see Table 1).

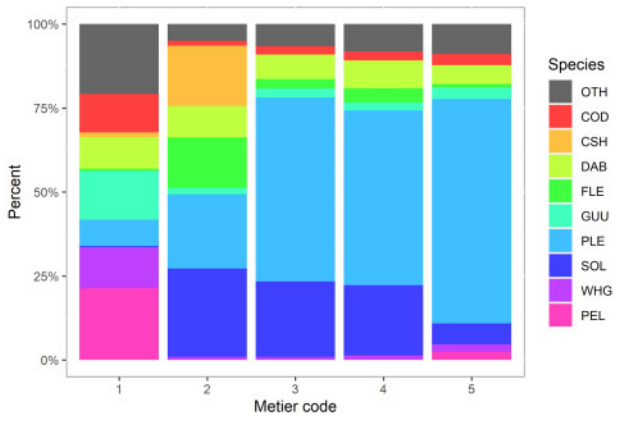

Figure 2. Average composition of species landed by the demersal métiers between 2001 and 2016. OTH: all other species, COD: cod, CSH: shrimp, DAB: dab, FLE: flounder, GUU: gurnard, PLE: plaice, SOL: sole, WHG: whiting, PEL: grouping of pelagic species (mackerel herring and horse mackerel). Latin species names supplied in Table D in Supplementary Material.

interpretation, the métiers were given shorthand names based on the elements that differentiate them most from one another.

The five métiers capture the activities of the demersal fishing fleet and show the heterogeneity of the demersal fishing activities in terms of how (gears used), where (location), when (seasonality and trip length), and what (species composition) is fished. The gears used in the five métiers include beam trawls, otter trawls, twin trawls, Scottish seines (flyshoot), and pair trawls. Four demersal métiers employ predominantly beam trawl gears (Table 1). The fishing grounds are mainly located in the North Sea, only the "flyshoot" métier is also active in the eastern Channel (Figure 1). The "coastal sole" and "80mm mesh flatfish" métiers are more often located in the southern part of the North Sea, while the "wide range flatfish" and "mixed gears plaice" métiers frequent more areas and spread further North. The trips vary in length from an average of 3–6 days absent from port. The vessels return with average landings of 4–13 tonnes per trip (Table 1). The species composition of the Dutch demersal métiers is dominated by flatfish species, particularly plaice (*Pleuronectes platessa*) and sole (*Solea solea*; Figure 2). For three of the métiers, these two species amount for more than 75% of the volume of landings. For the "coastal sole target" métier, the proportion decreases to 50%, showing a more mixed catch. The "flyshoot" métier shows the most diversity in the species landed, including pelagic species such as mackerel, horse-mackerel, and herring.

Social factors

The qualitative analysis identified three social factors that were both important to fishers during interviews and could realistically be observed across the whole fleet using logbook or other quantitative data: business structure, working rhythm, and polyvalence.

Business structure

The interviews and focus groups identified business structure as a factor that is important for understanding differences in fishing behaviour in the Dutch demersal fleet. The majority of fishers operate in an owner–operator construction, while a smaller number are employees in incorporated fishing companies. While these two business structures may have much in common, the stakeholder focus group identified several characteristics to define two main business structures in the demersal fleet (see Table 2).

Owner–operator businesses

Dutch demersal fishing companies have traditionally been family businesses, where extended families co-invest in the vessel and share skills and labour, with the profession passed down in a patrilineal manner. In owner–operator businesses, the skipper (who makes tactical choices about when, where, and how to fish) is either the owner of the company or related to the owner. In a system evolved from informal employment, skippers and the fishing crew are paid in a *maatschap* (shared remuneration system), which means that they all take a pre-determined share of the profits (and the losses) of each fishing trip. According to fishers, this helps motivate the crews to work hard and ensures that everyone shares the risk of seafaring together. In these businesses, crews may also influence tactical decisions. In addition, familial links between the crew and skipper can lead to greater loyalty than with contractually hired crew. Because of personal relationships, crew members may stay with a struggling fishing business for longer than would appear rational to an outsider, or a vessel with hired crew may operate at a loss for weeks just to retain their workers:

> *It [the business] was always good in the summers and very bad in the winters. Then we would actually not earn anything for those four, five months. But back then we had our brothers on board and we could manage that. We could just say, "There's no fishery at the moment, we'll just leave the ship in the harbour". But yeah, with a hired crew you can't really do that, because then your men just walk away [to another vessel] and in the spring you can't get a crew.*
> *[Interview 13, owner-operator skipper]*

In addition, an owner–operator business is rarely the sole property or enterprise of one individual, but is shared (financially and in-kind) across multiple people and generations of the same family, increasing the resilience of the business. The economic logic and social importance of these family structures have been extensively researched in the Dutch context by van Ginkel (2009, 2014). Our data show that, in the case of the Netherlands, many women are connected to running fishing businesses, despite the vast majority of owner–operator skippers being men. Similar research in other contexts has shown that this connection strengthens fishing businesses in a number of ways (Davis and Nadel-Klein, 1992; Neis, 1993; Neis *et al.*, 2013). During the interviews with Dutch demersal fishers, many owner–operator skippers explained how their wives and mothers engaged in unpaid or informal work related to the business, such as bookkeeping. This, combined with the shared remuneration system, means that both tactical and strategic decisions are rarely taken by a single individual, but that a vessel may be under the direction of several fishers (or fisher family members), some of whom have ownership rights. The quote below demonstrates how multiple family members can be involved in the business at once, meaning that strategic decision-making is not actually located with one individual:

> *Interviewer: Did you take the business over from your father?*
> *Fisher: No, I didn't take it over [. . .]. My brother and I went into business together with my father. My father and his brother started in 1960 together, and we came into the business in 1981.*
> *[Interview 15, owner–operator skipper]*

Thus, in owner–operator business, personal, and professional matters are often closely entangled. Traditionally, ownership of fishing businesses is passed to the first-born son (known as succession), and the pressure for the new skipper to remain in the business is high because the "job" is linked to the family identity itself. Many fishers who run owner–operator businesses do not want to be the last of several generations:

> *But stopping is not so easy because it is actually my father's and my uncle's pension.[. . .] And your family business is completely ruined all at once, something that five generations have worked towards. It's all gone at once [. . .] And in the end you are the one who has helped bring that family business into ruin. It is also due to the circumstances, but you're the one who's put the nail in the coffin. That's the pressure that's all behind it [. . .] It's mostly about the idea that the family business stops, you know. You can't just walk away from it. It is not so easy to just say, "I'm stopping here and...". That is*

Table 2. Differentiating owner-operated and fishing company business structures.

Owner–operator business		**Fishing companies**	
Necessary characteristics	**Additional**	**Necessary characteristics**	**Additional**
The owner of the ship is or was the skipper (in the case of a son skippering for a father who has not yet retired) or the skipper has a large ownership stake in the business There is the expectation of succession (son or other relative coming in as skipper) if possible in the family	Usually one vessel per family, but it can be multiple vessels if operated by sons, brothers, cousins who have an ownership stake (current or future)	Skipper(s) are employees, not owners, The company operates two or more vessels, and One or more of the additional criteria	Fleet manager (not related directly to owner) makes many long-term decisions Any form of vertical integration (within the company) Large investment capabilities and/or a financial buffer Use of salaries (in place of traditional *maatschap* payment)

really a sentimental matter. It is really a sense of failing, so to say. If it ends up stopping then you've failed, and that's what most people think.
[Interview 21, owner–operator skipper]

Fishing companies

In recent decades, a new model has arisen in which the skipper of the vessel is not the owner. Some owner–operated family businesses have become larger than others by acquiring more vessels, joining with other families, and sometimes by vertically integrating their operation to include processing and trading. These multi-vessel businesses come to be regarded as fishing companies when the skippers making tactical decisions at sea are not (at least partial) owners of the business, but are instead hired as employees. Skippers for fishing companies make valuable contributions to tactical decision-making and are frequently raised in fishing families, bringing their own knowledge and experience about fishing grounds and techniques to their role in the fishing company. However, in fishing companies, the administration, investment, quota acquisition, long-term strategizing, and even negotiating with governments are undertaken by someone other than the skipper of the vessel. In addition, fishing companies often employ a fleet manager (who does not go to sea) to make decisions about when to fish, how, and where. When a fleet manager is present, tactical decision-making is no longer solely the responsibility of the skipper, but is shared with the fleet manager. The fleet manager can determine the target species and the gear to be used, based on the portfolio and market position of the fishing company.

The ability of a fishing company to absorb costs may give skippers more room to innovate or make them more willing to risk trying new fishing grounds even though they may damage their gear. Good quota availability and even vertical integration of the business can also relieve some stress and responsibility from the fisher.

Fisher: I know for sure that 90% of people, they're all thinking, "I wish that it was still good fishing, the free livelihood of yesteryear." But it's just not like that anymore. There is just, yeah – there are so many pressures and that is the big advantage of what we, for example how we work for a fishing company. They take so many things out of our hands.
Interviewer: Worries?
Fisher: Worries, stressful moments about logbooks, certificates and paperwork, quota. We don't need [to do] any of that anymore.
[Interview 28, company skipper]

This security comes at a compromise in how lucrative fishing as a profession can be. Unlike the *maatschap* payment in owner–operator businesses, skippers for fishing companies can be paid with a base salary and a smaller additional percentage of the total profit of the vessel.

Working rhythm

The interviews and focus groups identified working rhythm as another factor that is important for understanding differences in fishing behaviour in the Dutch demersal fleet. The majority of demersal fishers operate with a "weekday" fishing rhythm, while a smaller number fish in a way fishers refer to as "continuous." According to the stakeholder focus group, this factor can be defined via several characteristics (see Table 3).

Weekday fishing

Most Dutch demersal fishers travel to fishing grounds a few hours away from their harbours, whereby multi-day trips compensate the fuel used to travel to the grounds. Thanks to refrigeration, ice machines, and storage capacity of large vessels, the norm in the Dutch demersal sector has been to fish from very early on Monday morning (a few minutes past midnight), returning to auction their fresh catch on Thursday, Friday, or even early Saturday. The data show that, despite economic motivations to fish with a continuous rhythm, local social norms have a large role to play in the perpetuation of weekday fishing. According to the interviewees, many vessels in Denmark and Germany fish in the continuous rhythm, yet the practice remains uncommon in the Netherlands.

Most people are religious in Urk [a fishing village], they're Christian. They don't fish on the weekend or on Sundays. I also don't do it. I have never fished on a Sunday. Of course there are people who choose to go for seven days in the week. Yes, it earns more money, but. . .
[Interview 13, weekday skipper]

Historical texts (van Ginkel, 2009; Bergsma *et al.*, 2019) and other interviews corroborated that one of the main motivations for fishing with a weekday rhythm is the Christian belief that Sunday should be spent as a day of rest. Another motivation is that fishers want to spend time with their families, who are free to socialise on weekends. Because of these values, demersal fish auctions are busiest on Thursdays and Fridays, when the vessels return with their catch.

Table 3. Differentiating weekday and continuous fishing rhythms.

Weekday fishing		**Continuous fishing**	
Necessary characteristics	**Additional characteristics**	**Necessary characteristics**	**Additional characteristics**
The vessel leaves the harbour at midnight on Sunday or on Monday morning and returns before Saturday midday, lying still in the harbour over the weekend	Some are what fishers refer to as a "good weather fisher": they do not go out if the weather is very bad, or if there is a holiday period, even though it might be lucrative financially	The vessel spends less than 24 h in the harbour at a time There are alternating crews	Fishing trips are longer than a week

Continuous fishing

Some fishers have begun operating their business so that the vessel does not spend more than one night in the harbour. This often involves employing a rotating crew so that the vessel can operate continuously, returning to harbour only to unload the catch, refuel, and conduct any necessary maintenance before returning to fishing as soon as possible with a fresh crew. Although the traditional weekday fishing rhythm is still dominant due to religious and social norms, there are several emerging motivations for this increase in continuous fishing: economic rationale, available quota, changed regulations, and changing social norms on land (e.g. secularization). For example, continuous fishing aligns with global economic changes such as more globalized trade, longer opening hours in the land-based economy, and shift work. Fishers are adapting:

> *There are fishermen who don't understand that you need to adapt to the new norms of fishing continuously. They want the old ways but those days are over. They live in another reality. Of course I want to have my three days with my wife and kids. But your ship has to go to sea and your business works when your ship is at sea... You have to go along. The world is changing. If you stand still, you will be gone in five years.*
> *[Interview 1, continuous skipper]*

The increased acceptance of a continuous rhythm is also evident in the logbook data, which show changing departure and arrival patterns for the five demersal métiers. Particularly the "coastal sole target" and "mixed gears plaice target" métiers (plates 2 and 5 in Figure 3) have shown a change in working rhythm: a comparison between 2001 and 2016 shows that many vessels still return on Thursday or Friday, but more are leaving on Wednesdays and Thursdays. The "80mm mesh flatfish" and "wide range flatfish" métiers (plates 3 and 4 in Figure 3) also show a shift in norms. The changing departure times in these métiers suggest that, although the weekday fishing rhythm is stable, the Christian social norm of waiting until the early hours of Monday morning to depart (so as not to work on Sunday) has been replaced with a rush of departures on Sunday evening. According to the interviewees, this change meant fishers could spend time with their families, but still not miss out on time in the fishing grounds.

Polyvalence

The interviews and focus groups identified polyvalence (the ability to change function or activity) as the third factor that is important for understanding differences in fishing behaviour in the Dutch demersal fleet. The majority of demersal fishers have specialized their fishing patterns to one or two key target species using only one or two gears and/or mesh sizes. These fishers are also conservative in their selection of grounds, preferring familiar fishing areas, or even those they have learned to fish from their fathers. A smaller number of fishers are more polyvalent, strategically switching gears and mesh sizes throughout the year in order to target different species. In addition, they may be more adventurous with selecting new fishing grounds. While these specialists and switchers have much in common we use the criteria in Table 4 to define what differentiates them.

Specialist strategy

While all fishers must specialize their knowledge of their gear and preferred target species to some degree, some fishers have strategically specialized their entire operation. The risk they take in doing so is that they are less flexible to escape adverse conditions if they arise. The reward is that, at least in theory, a more specialized fisher will be able to make a profit more efficiently than those who are always switching tactics (Krugman, 1979; Romer, 1987; Becker and Murphy, 1992; Ward *et al.*, 2018). A skipper who has specialized has made investments in gear, quota, and/or knowledge and will exploit them to get a return:

> *You specialise yourself somewhere and that grows over the years. We have bought quota for sole, so you're also going to specialise your nets for the fishing grounds where you can catch sole. And yeah, you become more and more specialised for just one species, actually.*
> *[Interview 5, specialist skipper]*

One reason for specializing could be that the fisher learned how to make a satisfactory living using the knowledge passed down from his father about their fishing gear and grounds, and is happy to continue in the same manner. Other fishers have specialized in certain gear-ground combinations in order to continue fishing close to home. One example of this is the chain mat fishers

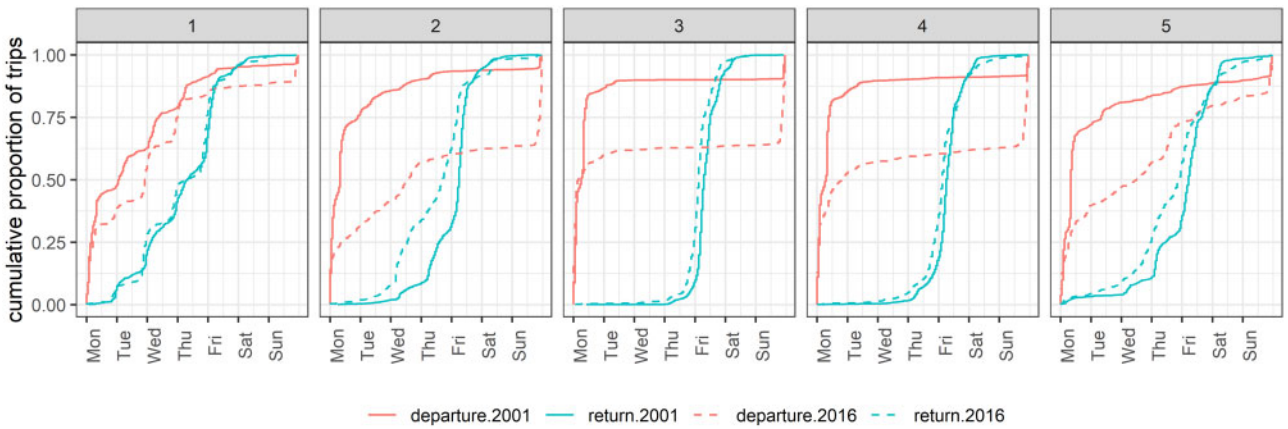

Figure 3. Cumulative proportion of trip departure and return times over the week per demersal practice in 2001 and 2016. The numbers in the top of the panels indicate métier code (see Table 1).

Table 4. Differentiating specialist and switching strategies.

Specialist strategy		Switching strategy	
Necessary characteristics	**Additional characteristics**	**Necessary characteristics**	**Additional characteristics**
1–3 key target species throughout the year 1–2 gear and mesh size combination(s) throughout the year Consistent annual fishing pattern year to year	Returning to the same area each season Returning to the same fishing lines (not just areas)	4+ target species in a year 3+ gears or mesh sizes used in a year	Non-quota species as target species Visiting unfamiliar fishing grounds

(*mattenvissers*) from the south of the Netherlands, who have adapted their gear for the stonier sea floor of their historic fishing grounds. One respondent from a different region said "we prefer to fish in our own grounds" [interview 5, specialist skipper], when explaining his choice to adapt his gear to his grounds, rather than move on to easier places to fish. Other respondents repeated a similar sense of ownership over or connection to particular fishing areas.

Switcher strategy

Switching fishing techniques allows some fishers to monitor the quality, availability, and market value of a particular species and determine week to week whether they will target it.

> *I can give you a really nice example: Shrimp catches in recent years have been very good, so we do that as well [as flatfish]. We are a multifunctional vessel; we can fish for langoustines, we use twin rig, we use a quad rig, we can fish for shrimp, we can fish for sole. We have five different ways of fishing. [Interview 23, switcher skipper]*

At the strategic level, this wider range of fishing patterns and techniques can be motivated by a combination of seasonal availability, quota portfolio, market conditions, and/or simply a sense of daring and adventure. According to the respondents, being able to switch fishing techniques week to week requires means, such as investment capital for new gear, connections with other markets, or even extra harbourside warehouse space to store the other gears when not in use.

Some fishers developed a switching fishing strategy due to the circumstances, such as quota limitations or pushes from regulations. They choose to fish for species that are not subject to quota because they cannot afford to invest in or rent quota for species that are restricted. Thus at the tactical level, several respondents spoke of calculating their catch and quota after every haul so they could maximize their profits, for example, by targeting non-quota species. If they catch a lot of one species, they can go elsewhere to try to change the catch composition.

This polyvalence is also evident in the métier analysis of the logbook data, which show that some vessels switch between practices. Figure 4 shows the correlation between the number of trips in each métier per vessel-year. A high number indicates that the two métiers are likely to be employed by the same vessel within a calendar year. A negative number indicates that the two practices are unlikely to be employed by the same vessel within a calendar year. Figure 4 thus shows that some fishers regularly combine fly shooting with another métier to target plaice. It also shows that

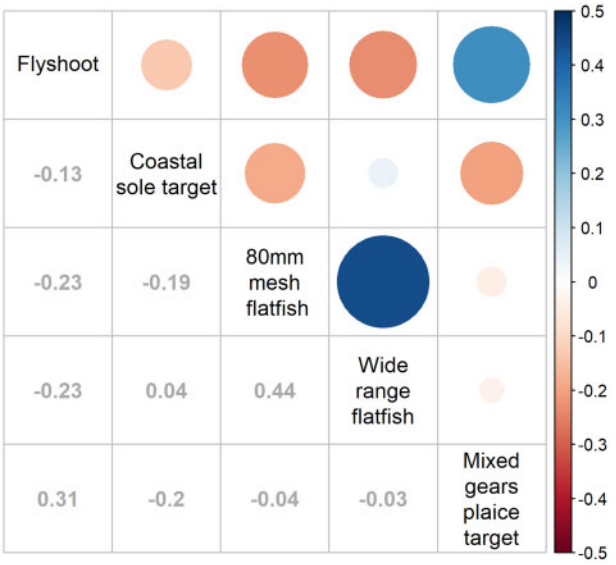

Figure 4. Correlation of fishing métiers used by the same vessel in a single year.

the "wide range flatfish" and "80mm mesh flatfish" métiers are employed by the same fishers in the same year. These correlations corroborate the findings of the interviews, where respondents explained that the majority of fishers are specialized into one métier, but some switch strategically (e.g. to make use of seasonal abundances).

Discussion

The identification of fishing métiers is a useful first step in understanding fishing activity at an aggregate level. Using logbook data, fisheries scientists and managers alike can use métiers to gain a synthesized understanding of what species fishers have caught, where, when, and with what gear. Métiers can therefore be a useful tool for mapping the spatial distribution of fishing effort or tracking changes in catch compositions. However, for understanding and modelling fisher behaviour, métiers are limited in the sense that they represent the *outcomes* of fisher decisions and do not account for the *motivations* fishers may have for their choices. The qualitative phase of the research revealed that fisher motivations are often more socially determined than the assumptions commonly used to model fisher behaviour.

The qualitative data show that fishers make decisions based on complex and often interacting contextual influences that are not

always directly related to the fishery or its management regime. Rather, the choices fishers make at sea are regularly prompted or constricted by their surroundings and these choices may appear irrational if that context is not taken into account. For example, one factor identified in this research, business structure, shows that the value placed on succession by owner–operator businesses may motivate them to keep fishing for longer than would appear rational in a profit maximization model of behaviour. At the strategic level, these fishers may display less economically rational behaviour in order to continue their livelihood because it is so closely entangled with their identity and personal relationships. At the tactical level, skipper–owners might be more risk-averse and driven by habit and traditional knowledge compared to skippers of company vessels. By contrast, skippers who are employed by companies are far less involved in strategic decision-making. At the tactical level, they may display more rational means-end behaviours than their owner–operator counterparts and be more willing to take risks because repairing or replacing gear is not at their own personal expense. When social context is properly considered, it becomes apparent that fishers working for a fishing company may be making a trade-off between more lucrative potential earnings and more formal and secure employment conditions.

For the second factor, working rhythm, fishers who maintain the weekday fishing rhythm remarked that they do this because they value tradition. For these fishers, compliance with social norms surrounding working on weekends, especially Sundays, is still more important than a rationally-economic approach to their fishing business. Their tactical behaviour at sea may be affected by their desire to return to harbour on time, rather than when the boat's storage is full. However, a gradual shift from leaving in the early hours of Monday morning to more vessels leaving on Sunday evening (as shown in Figure 3) signals a compromise in social norms. According to our interviews, this change meant fishers could still attend church and spend time with their families, but by leaving earlier they could maximize their time in the fishing grounds. By comparison, those who fish with a continuous rhythm have demonstrated that they are willing to contravene social norms in order to make their vessel fish for as long as possible. At the tactical level, their fishing trips may display more rational means-end behaviours than their weekday fisher counterparts.

For the third factor, polyvalence, specialized fishers have more stable fishing strategy in terms of gear, target species, and location. Their tactical behaviour at sea may be more habitual and risk-averse. The interviews show that fishers saw this specialization as an investment in terms of gear, but also of knowledge and technique. By contrast, fishers who employ a switching strategy will change gears, target species, and fishing grounds within and between years. At the tactical level, their fishing trips may involve more time spent relocating as they try new fishing grounds and their weekly catches will be more variable depending on how successful their changes in tactic have been. Thus these factors, which capture differences in behaviour, can be included in modelling to characterize the behaviour of fishing agents (fishers or fleets). They can be applied to develop behaviour scenarios where specific profiles are more performant (e.g. Wijermans *et al.*, 2020).

These insights allow for a more realistic *ex ante* assessment of social impacts of proposed management interventions as these factors are based on fishers' experiences and intentions. While much relevant social science research that could inspire applied researchers to better include important insights on human social behaviour exists (Smith, 1977; McCay, 1978; Acheson, 1981; Pollnac, 1988; Pálsson, 1989; McGoodwin, 1995; Jentoft *et al.*, 1998; Steins and Edwards, 1999; Flyvbjerg, 2001; Salas and Gaertner, 2004; Kooiman *et al.*, 2005; van Ginkel, 2009; Hind, 2015; Link *et al.*, 2017), uptake of social science techniques and outcomes has been patchy in fisheries science and management (Hind, 2015; Stephenson *et al.*, 2016; Stephenson *et al.*, 2017).

During the final stakeholder workshop, we asked whether the selected social factors were relevant for management. The three factors were all deemed relevant and the discussions during the workshop highlighted potential (unintended) consequences of upcoming management interventions. A first example is the relevance of working rhythm for the implementation of buyback schemes, which aim to reduce fishing pressure by removing capacity from the fleet by buying (and repurposing or scrapping) fishing vessels. According to the vessel utilization ratio indicator (STECF, 2020), there is unused capacity in the Dutch fleet. In this circumstance, if a fishing company has two vessels and fishes with a weekday working rhythm, they could make use of the buyback scheme for one vessel and subsequently concentrate their fishing activity on the remaining vessel by changing to a continuous working rhythm with two crews. In other words they can maintain their current fishing capacity despite the intention of the buy-back scheme, if they are willing to contravene the social norms. The interview data indicate an increasing prevalence of continuous fishing, therefore a buyback programme may be rendered ineffective as more fishers come to accept continuous fishing as a way to maximize their vessel's capacity. Ways to avoid this rebound effect would be to set individual limits on vessel utilization or to decrease the total fishing opportunities (either by effort or quota).

A second example is the relationship between the effectiveness of quota limits and polyvalence. Sudden changes to available quota due to shifts in management targets, fish stock abundance, or the quota distribution key (e.g., as a result of Brexit) can drastically reduce fishing opportunities from one year to the next for specialist fishers. However, fishers with a switching strategy tend to depend on a broader set of species, areas, and gears, allowing them to change métiers if one of their activities becomes limited by external factors.

Third, business structure was relevant for both vessel buy-back programmes and quota changes. In case of a buy-back programme, a company with several vessels could decide to concentrate their activity on fewer vessels, reducing their costs and taking compensation for the vessel(s) leaving the fishery, all while maintaining their profitability and catch by switching to the continuous rhythm. Reduced access to fisheries (through quota limits or reduced access to fishing grounds) may also be less of an issue for the larger companies that have the means to invest in a large portfolio of quota and alternative gears.

These are just some examples of the applicability of the social factors for management aims. Table 5 shows more relevant behaviours or outcomes that can be expected from the different social groups in the fleet.

Further research may wish to interrogate the complex interactions between these factors. For instance, the interview data suggest that fishing companies with skippers as employees are more likely to engage in continuous fishing due to their removal from the social and traditional norms of owner-operator fishers and

Table 5. Management implications of the results.

Factor		Implications
Working Rhythm	Weekday	These fishers might be more willing to comply with management interventions that use hours or days at sea (rather than quotas or motor power restrictions) as the mechanism to limit effort.
		Crew is able to maintain social connections within local community every weekend.
		Skippers of these vessels can potentially increase their fishing effort if they are willing to switch to continuous fishing.
	Continuous	These fishers might be more willing to comply with management interventions that use quotas or motor power restrictions (rather than hours or days at sea) as the mechanism.
		These fishers have fully leveraged their capital by utilizing their vessel to its full extent.
Business Structure	Owner–operator	These fishers might maintain the fishing business despite failing to satisfy profit-maximization expectations because of the cultural value of the work and its link to their identity, and/or thanks to the "invisible" contributions of non-fisher family members to the profitability of the business (e.g. wives conducting unpaid administration or bookkeeping work).
		The families of these fishers might be more vulnerable to economic hardship given how concentrated their dependence is on the vessel for income.
		These fishers might be less inclined to invest in innovations, given the involvement of the past generation of fishers, who might prefer traditional or familiar techniques.
		These fishers might have greater contributions to cultural heritage, and therefore might be supported more by their local communities.
	Skipper as employee	Working as an employee for a company makes it easier for someone who is not the child of a skipper-owner to become skipper of a vessel.
		These fishers are not concerned with the business strategy, and can remain focused on tactical decisions at sea.
		These fishers have less influence over the selection of crew, gear, fishing area, and even market orientation.
		These fishers are often directed by fleet managers, who may control or influence several vessels simultaneously in order to maximize the use of available quota within the company.
Polyvalence	Specialist	These fishers might flourish in single stock management regimes, where specialization is implicitly encouraged by single-species quotas.
		These fishers are likely to invest heavily in gear and quota in order to target specific species with specific techniques.
		These fishers might be less resilient to area closures due to conservation or other uses of the sea such as wind farming.
	Switcher	These fishers might flourish in multi-species management regimes, where they can fish for a more diverse range of species.
		These fishers are likely to have a more diversified portfolio of gears and target species in order to facilitate their switching throughout the year.
		These fishers might be more resilient to area closures due to conservation or other uses of the sea such as wind farming.

because they are encouraged to do so by the company. Another interaction could be that continuous fishers are more likely to adopt a switching strategy because they want to be agile to change while still maximizing their earning potential. In addition, while these results provide first empirical indications of management implications, there is scope for further research to clarify how these factors might relate to management measures. As for whether the factors identified in this research are emerging in response to fisheries management measures, more research would be needed to properly qualify these potential links.

Conclusion

This article has used the Dutch demersal fleet as a case study to ask what meaningful (to fishers) and useful (for management and fisheries scientists) social factors can be identified to bring a richer understanding of fisher behaviour. Business structure, working rhythm, and polyvalence all motivate fisher behaviour in the demersal fleet in the Netherlands. These social factors are generalizable to the entire study population and explain diversity in fishing behaviour. The results reveal heterogeneity among fishers who would be classified in the same métier. This work builds on the value of métier analysis to offer a more integrated understanding of not just what the fleet does, where, and when, but also who it comprises and why they behave the way they do. The addition of these social factors adds necessary complexity to the existing conceptual model of fisher behaviour, which is limited to compliance with regulations, economics, and technical interactions between gears and the marine environment. This added complexity is useful for fisheries scientists who want to better interpret different patterns in tactical and strategic behaviour and for managers who want to develop effective management. Due to social heterogeneity, certain policies can unintentionally favour one group of fishers over another. This work provides evidence that social factors influence the behaviour of fishers in different ways and demonstrates that these differences can be known and accounted for by managers.

Data availability

Limited data (in aggregate form) can be shared upon request, when in compliance with GDPR regulations and the protection of the anonymity of the participants in the study.

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Supplementary data

Supplementary material is available at the *ICESJMS* online version of the manuscript.

Authors' contributions

A.S. and K.H. analysed and interpreted the logbook data. K.H. generated the figures. A.S. analysed the interview data. A.S. and M.K. interpreted the interview data. A.S., M.K., and K.H. wrote the manuscript.

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