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Changes in fishing behaviour of two fleets under fully documented catch quota management: Same rules, different outcomes

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ABSTRACT

A Dutch pilot study of fully documented fisheries provided the opportunity to observe actual changes in fishing behaviour under catch quota management (CQM). Interviews with fishers in the pilot study aided in interpreting the results and giving insight in the decision making process and reasoning of fishers. The CQM pilot study entailed a fleet of small and large demersal vessels. For these vessels, all cod catches were counted against quota, including catches of individuals below minimum landings size. To obtain reliable catch data all vessels were equipped with electronic monitoring (EM) systems. These systems recorded videos of all fishing and processing activities on board. In return, fishers received a 30% quota bonus for cod and were compensated with more flexibility on effort regulations. It was hypothesized that vessels in the CQM will (i) increase their landings by 30% according to their quota bonus, (ii) increase the use of gear with large mesh size, and (iii) change effort towards fishing locations with high catch rates of large cod and avoid areas with high catch rates of undersized cod. The results showed that CQM had no effect on fishing behaviour of the small vessels. In contrast, large vessels significantly increased their cod landings (216%) and avoided undersized cod. This difference in response of different fleets suggested that implementation of CQM, for instance in the context of the European Common Fisheries Policy, should consider fleet characteristics. It seemed that larger vessels in this study more easily adapted their behaviour to new management regimes and that the quota bonus opened up new fishing strategies, that were not envisaged during the implementation.

1. Introduction

European fishery management traditionally attempts to control fishing mortality in commercial fisheries by setting annual quotas on landings [23,30]. However, constraining landings may not reduce total catches, and thus fishing mortality, because fishers may optimize the use of their quota by discarding low-valued fish (high-grading), or continue fishing and discard species after quotas have been reached [11,20,34,45]. Apart from the discarding of fish because of quota restrictions on landings, fishers also discard fish as a result of technical regulations and the economics of the fishery, e.g. fish that is caught but that is under the allowed minimum landing size, and fish that has no market value [7]. These aspects are particularly challenging in a mixed fishery context [29,3].

In general, discarding is considered to be a waste of natural resources. Indeed, the fish that does not survive after being discarded does not contribute to the future catch, as it would have if it had remained alive. Additionally, the discarded and unreported catch leads to unaccounted mortality and makes it difficult to appropriately monitor and manage the effects of fishing activities [10,35,47]. Recognizing these problems, the European Union (EU) has agreed to reform the Common Fisheries Policy (CFP) [18]. The reformed CFP includes a phased implementation of the obligation to land all catches [17].

If properly enforced, the obligation to land all catches prohibits discarding of commercial species and should serve as a driver for improved selectivity, and provides more reliable catch data [39,41,8]. Implementing a landing obligation requires that the complete catch is reported and deducted from the available quota. In such a catch quota management (CQM) regime fishers are held accountable for the total amount of fish caught, including the unwanted and unmarketable (previously discarded) part of the catch. Consequently, an incentive is created to change fishing behaviour, because every fish caught is deduced from the quota, including small and low-valued fish [30].

In order to gain insight in the potential effects of the landings obligation prior to its full implementation, the EU established provisions in the quota regulations to conduct pilot studies on fully documented catch-quota management schemes, or “fully

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documented fisheries". These provisions were established for cod in the North Sea, Skagerrak and Eastern Channel, under the condition that participating vessels use closed circuit television (CCTV) associated to a system of sensors, that record all fishing and processing activities on board. All cod catches are counted against the quota, including catches of individuals below minimum landings size. In order to create incentives for fishers to participate in the pilot studies, Member States are permitted to allow additional catches of participating vessels within an overall limit of 5% above the national cod quota. However, per vessel, additional quota is limited to 30% of the normal quota applicable to the vessel [16]. Within this context, a fully documented catch-quota pilot study for cod in Dutch demersal fisheries is initiated in 2012. The pilot study is a collaboration between the Dutch Ministry of Economic Affairs and the Dutch Federation of Fishermen's Organisations. In addition to the increase of individual cod quota, the Dutch government provides a derogation on national effort control regulations: vessels deploying a CCTV on board are not limited by the available number of days at sea for fisheries with mesh size $\geq$120 mm. The idea behind this derogation is to create extra flexibility for participants to be able to operate in a catch-quota system.

So far, publications on fully documented fisheries (FDF) have been concentrating on the efficacy of catch documentation technology [25,31,37,46,48,49]. The efficacy of catch documentation by video gives promising results, particularly when fish are processed in such a manner that it is easy to detect individual fish in video footage, e.g hook-and-line fisheries [1,49]. However, few studies have investigated changes in fishing behaviour under a fully documented catch-quota management regime and little is known about the effectiveness of the landings obligation in changing fishing behaviour. Kindt-Larsen et al. [25] and Ulrich et al. [48] observe that fishers participating in catch-quota trials reduced discarding of legal sized cod of low value. When asked, the participating fishers confirm that they are more aware of catch compositions than before the start of FDF, and more often change fishing grounds to avoid small cod [25]. Avoiding discarding of small cod can be achieved by fishing with larger mesh sizes and fishing effort reallocation towards fishing grounds with high densities of larger cod [49].

Changes in fishing behaviour in two mixed bottom trawl fleets on catch quota management have been studied in this pilot study. The results are used to indicate whether the changes of behaviour comply with the purpose of the regulation, i.e. avoiding undersized cod. A before-after control-impact (BACI) study of catch and effort data is applied, contrasting vessels within the two fleets with their peers who are not under CQM. In addition, interviews with participating fishers about changes in behaviour under CQM are conducted. It is hypothesized that vessels in the CQM will (i) increase their landings by 30% according to their quota bonus, (ii) increase the use of gear with large mesh size, and (iii) change effort towards fishing locations with high catch rates of large cod and avoid areas with high catch rates of undersized cod.

Improved understanding of fishers behaviour, eventually, allows for a better understanding of fisheries dynamics, which in turn is essential for effective fisheries management [32,38,6]. In the context of the CFP, with the implementation of catch quotas and the obligation to land all catches, this study gives an important insight in what the significant factors are in the decision making process of individual fishers in a mixed bottom-trawl fisheries under such management systems.

2. Methods

2.1. Implementation of CQM in the pilot study

The full documentation of cod catches was done by the participating fishers in the study. Catch weights (kg) per haul were recorded in a logbook for each fishing trip. All catches were landed and subtracted from the quota. Undersized individuals that were landed were not allowed to be sold, and were therefore collected by the control authorities.

In order to attract vessels, a 30% extra individual cod quota was handed out to the participants of the pilot study. This 30% quota increase was based on the total quota (owned and leased) in the previous year. In addition to the increase of individual cod quota, the Dutch government provided a derogation on national effort control regulations: vessels deploying a CCTV on board were not limited by the available number of days at sea for fisheries with mesh size $\geq$120 mm. The idea behind this derogation was to create extra flexibility for participants to be able to operate in a catch-quota system.

To verify if logbooks were filled out correctly, video observations on the catch were obtained with electronic monitoring (EM) systems. A random selection of hauls (ca. 10% of the total number of hauls) was used to compare catch recordings in the logbooks with catch estimates from video analysis, see van Helmond et al. [49].

The EM system consisted of a GPS unit, up to four closed circuit television (cctv) cameras, and sensors for measuring force on the tow cables and net drum rotation. All sensors and cameras were connected to a control box with exchangeable hard drives for data storage [25,28]. The sensors were used to trigger the control box to start video recording during fishing operations. The cameras recorded overhead views of the working deck and catch-handling areas, while fishing, hauling, and processing the catches. Sensor and GPS data were recorded continuously whilst at sea. See also van Helmond et al. [49] for a detailed description of the EM system set up on board of the vessels.

2.2. Study fleet

The pilot study was applied to a bottom-trawl fishery that targets multiple species using various bottom trawl gears (e.g. otter trawl, Scottish seine, or beam trawl), and mesh sizes depending on target species. Within this fishery cod is targeted during short periods of the year, typically $<$2 months, using a mesh size $\geq$120 mm, or as valuable by-catch in fisheries with mesh size $\leq$100 mm, by a small part of the fleet. Vessels within this fleet were identified based on their possession of individual cod quotas and fishing effort track records. The identification of vessels in the fleet was done by the Dutch Federation of Fishermen's Organisations. In total, 40 vessels were identified as cod fishers and all were contacted by the Dutch Federation of Fishermen's Organisations.

Vessels were divided in two groups based on their engine power, since Dutch demersal fleet vessels with different engine powers exhibit different spatial fishing patterns due to (amongst others) regulations [33,36]: vessels with engine power $\leq$221 kW have access to fishing grounds within the 12 nautical mile zone and within a protected nursery area; the "plaice box" [4]. Vessels with engine power exceeding 221 kW are forbidden in this zone. In the $\leq$221 kW engine power group, 24 vessels were contacted, of which 6 vessels participated in the study (Table 1). These vessels used otter trawls and beams trawls with a wide range of different mesh sizes, from 20 to 130 mm, depending on season and target species. Of the group in the second category (with engine powers between 677 and 1471 kW), 16 vessels were contacted, and