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Individual transferable quotas, does one size fit all? Sustainability analysis of an alternative model for quota allocation in a small-scale coastal fishery

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ABSTRACT

The introduction of vessel-based Individual Transferable Quotas (ITQs) in Danish demersal fisheries in 2007 caused significant structural changes in the fleet, towards fewer and larger vessels deploying otter trawls. Mainly smaller coastal vessels deploying Danish seines and gillnets reduced in numbers. The ecosystem effects of this structural change were investigated by comparing the sustainability of a local, small-scale, coastal fishery (Thorupstrand) using Danish seines and gillnets with that of demersal trawling by larger vessels using the same fishing grounds. The fisheries were compared using six ecological and socio-economic indicators: 1), discards (food web), 2), by-catch incidences (food web/biodiversity), 3), seabed impacts, 4), fuel use efficiency, 5), quality of fish landed (food provision), and 6), social and cultural gains and drawbacks (social and cultural features). Except for by-catch of vulnerable species, the fisheries using Danish seines and gillnets scored better in all indicators when compared to otter trawls. Additional commercial and cultural benefits of establishing a local fishery guild with share-owned quotas and land-based facilities were investigated. The results and lessons learned are discussed in the context of an ecosystem approach to fisheries management and the current reform of the common fisheries policy of the European Union.

1. Introduction

Vessel-based Individual Transferable Quotas (ITQs) have been introduced into the management of all Danish fisheries with the aim of constraining the fishing fleet capacity to a sustainable level by improving the control of the sustainability indicators, fishing mortality (*F*) and spawning stock biomass (SSB) [1]. The vessel-based ITQ system was first implemented in the pelagic fisheries in 2003 and has been introduced subsequently to the demersal fisheries for human consumption in 2007 [2]. ITQ systems are expected to cause structural changes in the fishing fleets by reducing the number of active vessels, when the less profitable leave the industry, and more efficient (i.e. larger vessel with new technology) are introduced [3,4] with the aim of improving the management of fishing mortalities and increasing the economic gain for the fewer remaining stakeholders [5]. Following the vessel-based ITQ implementation (i.e. with quota shares attached to individual vessel), the Danish fishing fleet restructured and the shift in management regime is now considered a success for the pelagic sector. ITQ systems, however, also have known drawbacks. For instance, the capitalization of fishing rights could prevent new fishermen from entering the business because quota prices are high and substantial capital is required to buy in [6], especially in Denmark where acquiring extra fishing rights are attached to buying vessels. In Denmark, moreover, the ITQ system has become a disadvantage to coastal, small-scale, fisheries because most quota shares have been sold outside these artisanal fishing communities. This shift in quota ownership has resulted in an increased proportion of large vessels in all Danish fishing fleets at the expense of more local ones comprising a greater number of small vessels, many of which have disappeared [3,4]. The change in fleet structure has also caused changes in fishing behaviour from the near-coastal deployment of gillnets and Danish seines towards the inshore and offshore usage of larger demersal trawls and Scottish seines (fly shooting) [4], which will eventually impact the ecosystem and marine environment differently [7; 8, 9, 10]. These latter ITQ effects barely comply with the European Common Fisheries Policy (CFP) goals to develop an Ecosystem Based Fisheries Management (EBFM) system and

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to safeguard and stimulate the sustainable growth of coastal, small-scale, fishing communities [11].

The aim of the present study was to assess the effects of ITQ-related changes in the Danish fishing industry on ecosystem sustainability, social equity and economic efficiency. The findings may aid in identifying either adjustments to or viable alternative management solutions that will enhance overall sustainability at the local and regional scales.

Following nine years of ITQ based management one of few remaining small coastal landing places for fish in Denmark is Thorupstrand. This small-scale fishing community is located on the Danish Skagerrak coast in Jammer Bay. The fishermen here have formed a local co-operative, the Thorupstrand Coastal Fishermen's Guild ('Thorupstrand Guild' hereafter). Within the guild, the fishermen have also established a management system of shared quotas and fishing structure that have proven efficient in protecting the local fisheries, and has made it possible for young fishermen to venture into the business. The initiative was made in order to prevent anticipated negative consequences to this community of the vessel-based ITQ system. Thorupstrand may thus serve as an inspiration for the development of new management initiatives and facilitate the re-establishment and sustainable growth of other coastal fishing communities. Before suggesting the above model for political action to secure national small-scale fishing, however, it is important to analyse the overall sustainability of this fishery based on an *ad hoc* quota pool system and compare this with the conventional trawl fishing methods, which has increased relative to the small-scale coastal fishery since the introduction of ITQs.

By analysing the socio-economic fisheries data collected around Thorupstrand, a set of indicators for the three pillars of sustainability (ecological sustainability, economic efficiency and social equity) was defined to evaluate this fishery in relation to others where the ITQ system has been implemented, and discuss the outcomes of this analysis in relation to the principles of EBFM, as the new European Union (EU) paradigm to follow. This case study, therefore, compared the sustainability of a local, small-scale, coastal fishery using Danish seines and gillnets with that of demersal otter trawling by larger vessels for the same target species in the case study area.

In addition, the Danish quota systems and their effects on the different fisheries in the study area have been investigated and are described. Furthermore, six descriptors and their indicators (in brackets) were applied in a sustainability assessment: Ecological impact: 1) *food web* (discards), 2) *food web/biodiversity* (by-catch incidences), 3) *seabed integrity* (seabed impacts); Economic impacts: 4) *energy use efficiency* (fuel efficiency), 5) *quality of fish landed*; and Social impacts: 6) *social and cultural features*. Indicators were compared between the case study fisheries, and their sustainability performances are discussed in relation to the ITQ management system and achievements of EBFM.

2. Case study background and sustainability indicators

2.1. Case study definition

In this study, the case study area was defined as the ICES statistical rectangles 43F8 and 43F9 [1]. Within this study area, and following the introduction of ITQs, two different types of fisheries were analysed and compared with respect to sustainability: i), a small-scale coastal fishery defined as that operating small vessels (a maximum length of 15 m) within 25 nautical miles (nm) from the shore and fishing and landing catches within 24 h using Danish seines (anchor seining) and gillnets (Fig. 1) and ii), a conventional demersal trawl fishery defined as vessels longer than 12 m fishing with otter trawls for the same species in the same study area.

2.2. Coastal fishing in the case study area

Bordering the northern North Sea and Skagerrak, Thorupstrand and its beach faces north towards Jammer Bay and, as such, is sheltered from the westerly wind by a hill, Bulbjerg, making it an ideal landing-place for coastal fishing vessels. This fishing community works 11 active fishing vessels (in 2016) and comprises a number of land-based buildings for fish processing. The vessels in Thorupstrand are all capable of being hauled up directly onto the beach after every fishing trip with a land-based winch, as there is no harbour. Fishing takes place in the Skagerrak at maximal distances of 20–25 nm from Thorupstrand within 24 h, and with daily landings of the catch [6,12,13].

The Thorupstrand fishermen use two different fishing methods: Danish seines and bottom set gillnets (Fig. 1). The Danish seine fishery is carried out over sandy sea beds whereas the gillnet fishery takes place on more heterogeneous hard-bottom areas. The Danish seine is somewhat similar to a demersal trawl, only simpler in construction with longer warps ($\leq$3 km long) and no otter-boards (Fig. 1). From a buoy/anchor point, the fishing vessel lets out long ropes and the seine in a roughly triangular pattern. When approaching the anchor, the ropes are winched in. As the two ropes slowly come together, the encircling ropes and net trap fish inside it. Only at the terminal point in this process does the main part of the catch enter the seine [9,14].

As the Thorupstrand vessels all have to be hauled onto the beach, they have to be light, which excludes large engines. Further, the propeller is placed higher than on most other vessels, which reduces and destabilizes the vessel's bollard pull. The size of the engines varies between 82 and 175 kW (today 120–130 HK) [15]. With these characteristics, the vessels are not suitable for conventional bottom trawling (Interview 6/8–2016, Supplementary Material (Appendix A, Table 1)) and use a Danish seine instead. From March/April/May to October the Danish seiners and gillnetters from Thorupstrand mainly target plaice (*Pleuronectes platessa*) whereas from October-April/May the fishery targets mainly cod (*Gadus morhua*) with gillnets. Depending on the occurrence of migrating and spawning Dover sole (*Solea solea*) and market prices, there is also a small-scale gillnetting fishery for this species from April-May and for lumpfish (*Cyclopterus lumpus*) in February-March (Interview 19/9–2016; Supplementary Material (Appendix A, Table 1)). In other periods, hake (*Merluccius merluccius*), turbot (*Scophthalmus maximus*), monkfish (*Lophius piscatorius*) and wolf fish (*Anarhichas lupus*) are targeted to a minor extent using gillnets (Interview 12/9–2016, Supplementary Material (Appendix A, Table 1)).

In the case study area (i.e. the ICES statistical rectangles 43F8-F9) in 2012, the total gillnet fisheries landed 197 t of plaice and 459 t cod, whereas the total Danish seine landings were 1014 t of plaice and 130 t of cod, respectively. In the same year, the logbook-based total landings of gillnets and Danish seines from the Thorupstrand (including 9 of 11 vessels, as two of them were too small to have a registered e-logbook) were 622 t of plaice and 265 t of cod. This equates around half of the fisheries with these gear types in the case study area.

2.3. Demersal trawl fisheries in the case study area

Demersal otter trawls are used for most bottom living fish and shellfish of commercial interest. In the case study area, the demersal trawlers mainly target cod and plaice and land their catches in the larger harbours on either the western or northern coasts of Jutland. In 2012, demersal trawlers targeting fish for human consumption landed 851 t of plaice and 203 t of cod in the case study area. Their engine power averaged 291 kW with a maximum of 737 kW and a minimum of 71 kW. Vessel length was 18.9 m on average. Beam trawlers landed 546 t of plaice and 31 t of cod in 2012 in the case study area and had an average length of 38.0 m and an average engine power of 1200 kW. In addition to plaice and cod, demersal trawlers land a significant amount of dab (*Limanda limanda*), haddock (*Melanogrammus aeglefinus*), lemon sole (*Microstomus kitt*), monkfish, saithe (*Pollachius virens*), sole and turbot.