Extended Abstract: Theme Session C

Mixed fisheries management: Protecting the weakest link

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Abstract

North Sea cod (*Gadus morhua*) is outside safe biological limits and total allowable catch (TAC) management has proved ineffective to rebuild the stock. The European Commission is considering to impose a discard ban to preserve vulnerable and economically important fish stocks. We explore the potential effects of a discard ban in mixed fisheries management using the French mixed fisheries in the Eastern English Channel as a model system. We examine in particular the performance of two different management scenarios, (i) individual quota management with a tolerance for discarding and, (ii) individual quota management in combination with a discard ban, using a dynamic state variable model. The model evaluates a time series of decisions taken by fishers to maximize profits within management constraints. Compliance to management was tested by applying an in height varying fine for exceeding the quota. We then evaluate the consequences of individual cod quota in both scenarios, with respect to over-quota discarding, spatial and temporal effort allocation and switching between métiers. Individual quota management without a discard ban hardly influenced fishers' behaviour, as they could fully utilise cod quota and continue fishing other species while discarding cod. In contrast, a discard ban forced fishers to reallocate effort to areas and weeks where cod catch is low, at the expense of lower revenue. In general, a restrictive policy for individual quota for cod needs to be combined with a discard ban and a high fine (> 20 times the sale price) to reduce over-quota discarding.

Keywords: Eastern English Channel, discard ban, dynamic state variable modelling, effort allocation

Introduction

Throwing overboard dead fish that has been caught in the net ("discarding") is often considered a wasteful practice that has adverse effects on fish stocks while not contributing to the harvesting of food (Kelleher, 2005, Alverson et al., 1994). The European Commission is implementing a discard ban, starting in 2013. A discard ban in combination with individual, and possibly transferable, quota aims to prevent the waste of food, reduce fishing impacts on the ecosystem, preserve vulnerable and economically important fish stocks and improve scientific advice (Catchpole and Gray, 2010, Anon., 2011, Buisman et al., 2011). Under a discard ban, all catches of both target and by-catch species should be landed and will be deducted from the individual quotas.

This paper will study how a discard ban in combination with individual quota may improve the regulation of fishing mortality for a depleted stock that is exploited in a mixed fishery. Using a dynamic state variable model (DSVM (Clark and Mangel, 2000)), we study the over-quota discarding of cod (*Gadus morhua*) in the eastern English Channel and the southern North Sea. We will compare the performance of (i) TAC management that allows over-quota discarding and (ii) TAC management in combination with a discard ban, using the French otter trawl and net fisheries as a case study. The consequences of individual quota for cod in both management regimes will be studied based on a number of indicators of the fishery system such as the catch of cod, the spatial and temporal distribution of fishing effort, the changes in métiers and the economic performance of the fishery.

Material and Methods

Effort and landings data obtained from logbooks and sales slips were made available over the period 2001 – 2005. We selected the French otter trawlers and netters fishing in the eastern English Channel and most southern part of the North Sea between 49°N, 2°W and 52°N 4°E, for which most data is available.

We parameterized a simulation model by estimating the spatial and temporal distribution of landings per unit effort (LPUE) of five species: plaice (*Pleuronectes platessa*), sole (*Solea solea*), cod (*Gadus Morhua*), whiting (*Merlangius merlangus*) and Atlantic mackerel (*Scomber scombrus*). Generalized Additive Models (GAMs) combined with the negative binomial distribution with a logarithmic link function were applied to give a prediction of catch rates in time and space for each year in the dataset.

The simulation model is based on Dynamic State Variable Modelling (DSVM) (Houston and McNamara, 1999, Clark and Mangel, 2000) and is used to predict the behaviour of two fishing fleets, targeting a mix of five species, that are constrained by annual individual quota for one species; cod. Each individual vessel in the model has a set of choices, allowing it to respond to management regulations and economic opportunities. In each time-step a fisher can choose simultaneously: (1) to go out to fish or to stay in port, (2) a métier, (3) a fishing ground and (4) to discard.

A vessel evaluates its optimal annual strategy in terms of biweekly behavioural choices, based on a utility function, in this case net revenue. Net revenue is defined as the total quantity landed of each

species weighted by each species price; minus the variable fishing costs. Variable fishing costs consist of total fuel cost; i.e. total effort (days) times fuel costs per day (€/day); and a fine for overshooting the quota. Given the utility function at the end of the year, a Dynamic Programming Equation is used to calculate the optimal decision in each time step given the state of the individual. In our case, the state is determined by the uptake of the cod quota, landings of the 4 other species, and the fishing effort. The details for this procedure can be found in Poos et al. 2010.

The management scenarios considered in this study compare the performance of individual cod quota management combined with two discard scenarios for both fisheries. Individual cod quota gradually increase from zero to 27 tons for trawlers and zero to 20 tons for netters. In addition, compliance to management was tested by exploring the effect of different fine values. Fines increased from one to 200 times selling price of cod.

Results

Cod catches depend on the management scenario. When discarding is allowed, individual quota lower than 10 tons per year result in full utilization of quota by almost all vessels, while over-quota catches are being discarded. However, when a discard ban is introduced (in combination with a high fine; 200€/kg), individual cod quota may reduce catches considerably. In addition, fishers switch to other fishing grounds during periods when cod catches are highest, resulting in lower annual cod catches.

When constrained by a discard ban the spatial distribution of fishing effort shifts from the southern North Sea to the eastern English Channel. This shift is related to the spatial distribution of cod. Cod is more frequently caught in the southern North Sea fishing grounds compared to the Channel. When cod quota is high a fisher can continue to fish in the northern fishing grounds until the cod quota becomes depleted. Implementing low cod quota and a discard ban, however, make the Channel fishing grounds more attractive, because of the reduced risk of catching cod, while targeting other commercial fish species.

Furthermore, two indicators of fishery, i.e. effort and net revenue are weighted against cod catch. When permitting cod discarding, fishers will uphold effort and maintain their net revenue at the expense of cod conservation. In contrast, with a discard ban, at lower quota fishers avoid cod but maintain a reduced fishing effort targeting lower valued species such as mackerel to compensate the loss in revenue. As more quota is made available, effort increases leading to an increased cod catch, because gradually more cod fishing grounds are fished. In addition, landings of commercially valuable and co-occurring species such as whiting increase and contribute substantially to the revenue. We should note that in our model, the fine needs to be sufficiently high, e.g. 20 times the price of cod, to reduce discarding of over-quota cod below 6 tons.

Conclusion

Under a management regime that allows over-quota discarding, quota for by-catch species such as cod may have little effect on the effort allocation, and catch composition of fishing fleets. Fish that is caught without quota provision are discarded. IQ management with a discard ban can reduce over-

quota discarding of cod when properly enforced. In that case, fishers will reallocate effort to fishing grounds and weeks when the cod catch is low at the expense of lower revenue.

Mechanistic models are increasingly being used to analyse vessel fishing behaviour. These models have strong predictive power, making them ideal tools to analyse fisheries responses to new management regulations (Dowling et al., 2012). Our spatially explicit effort allocation model proves to be a useful tool to evaluate conservation and economic trade-offs and enables managers to visualize consequences of new management scenarios, such as a discard ban.

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