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Pulse trawling as an alternative for beam trawling: insights from a spatial-agent based model

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Summary

Changed socio-economic, ecological and institutional conditions increased the pressure on the beam trawler fishery using tickler chains. Pulse trawling, in which the tickler chains are replaced by electrodes, is seen as an alternative for the beam trawler fleet targeting sole (*Solea solea*). In this study, a spatial agent-based fleet dynamic model is developed to gain more insights in the socio-economic and ecological effects of the introduction of four pulse trawlers in the Belgian beam trawler fleet (>221 kW). This fleet practices different métiers whereby other fish species than sole have an important value in the total landed revenue. In the scenario without landing obligation, pulse trawlers have mainly ecological advantages. Fuel usage is lower and the discards of marketable plaice and undersized species are lower, however the difference in profitability is less pronounced due to lower landings of other target species. With landing obligation, pulse trawling is more profitable because the quota for the choke species are not as soon depleted as for beam trawlers. As such pulse trawlers are able to spend more days at sea.

Introduction

Pressure on the beam trawler fleet has strongly increased the last decade. First, high fuel prices resulted in high operational costs and a decline of the profit margins. Second, the beam trawler fleet, characterized by high by-catches of undersized species, is facing a major challenge with the implementation of the landing obligation. Third, traditional beam trawling with tickler chains has a high impact on the benthic ecosystem while ecological concerns are rising. Therefore, EU allowed the use of the pulse trawl fishing gear for a part of the beam trawler fleet active in the North Sea (EU, 2009). Uncertainty about the socio-economic impact obstructs the transition to pulse trawling in the Belgian fishery. This uncertainty caused by hidden disincentives may result in the so called implementation error and lead to unintended management outcomes (Fulton *et al.*, 2011). By gaining insights in different scenarios concerning pulse trawling, this study aims to address this uncertainty of both fishermen and policy makers.

Material and Methods

An agent-based model (ABM) is developed to simulate the dynamics of the Belgian fleet. In the ABM, each vessel is represented as an individual decision making unit which allows to represent the heterogeneity of the fleet. At each daily time-step, the state (harbor, steaming or fishing) of a vessel determines which simulation loop it follows.

In harbor state, vessels decide whether to go fishing or not. Therefore, the different fishing opportunities are evaluated dependent on the available quota and effort, the distance, fish - and fuel prices and season. If the quota are depleted or there are no profitable fishing opportunities, vessels stay in the harbor, in the other case, the most profitable fishing ground is stochastically selected as target and vessels change their state to steaming. When fishing, a stochastic amount of fish is caught according the patch specific catch per unit effort (CPUE). Based on logbook data, a generalized additive model (GAM) - including a vessels engine power, the ICES area and the month as covariates- was fitted to calculate CPUE of the four target species sole, plaice (*Pleuronectes platessa*), cod (*Gadus morhua*) and anglerfish (*Lophius piscatorius*). Since interference competition has a negative effect on sole catches, catches of sole decline with the number of vessels on a fishing ground (Rijnsdorp *et al.*, 2000). When the average trip length (10 days) is reached, vessels set the closest harbor as target and change their state to steaming. During steaming state, vessels follow the shortest path.

Catch and fuel efficiency of pulse trawlers are obtained from a comparative study of Dutch beam and pulse trawlers (van Marlen *et al.*, 2014). However, since Belgian beam trawlers fish at lower speeds compared to Dutch beam trawlers, the pulse-beam ratio for the catch efficiency of sole is estimated at one. Yet, no experimental studies the catch efficiency ratio of anglerfish are available and simulations were conducted with pulse/beam ratio 0.2, 0.4, 0.6 and 0.8. Vessels receive an individual, non-transferable quota proportional to their engine power. The remaining national quota are redistributed every three months among the vessels. The fuel price was set at €0.60 liter^{-1} and in each simulation run a virtual fleet was set up with 26 beam trawlers and 4 pulse trawlers.

Results and Discussion

Without landing obligation, the difference in profitability between pulse and beam trawlers depends on the catch efficiency ratio of pulse trawlers for anglerfish. With a ratio of 0.8, average profit of pulse trawlers is 22% higher which is mainly due to the lower fishing costs. However, when the catch efficiency ratio drops below 0.5, beam trawlers are more profitable (16%, ratio 0.2) because the losses of anglerfish in the landings are not balanced by the lower fishing costs. Pulse trawlers do not only have lower fishing costs due to the lighter gear, but steaming costs are 6 to 13% lower, because they allocate more effort on fishing grounds closer to harbors. Beam trawlers are able to spend the same number of days-at-sea (270) as pulse trawlers since discarding of over-quota fish species is possible which allows them to continue to fish. With landing obligation, pulse trawlers are in each scenario more profitable. First, beam trawlers have more discards and thus higher costs of processing the discards. Second, since more discards are landed, the quota are sooner depleted, resulting in the occurrence of choke species. Hence, they stop fishing after on average 193 days-at-sea.

The total amount of undersized plaice caught is 10% lower in the scenario with landing obligation. This is mainly due to the fact that beam trawlers are not able to fish throughout the year when discarding is not allowed. Since, the discard ratio is equal for each ICES area, vessels cannot adapt their strategy by moving to specific spots with lower discards. Additionally, Belgian fishermen share a common quota whereby the best strategy is to fish on the most profitable fishing ground. Cooperation among fishermen, to avoid discards, may be a better strategy to increase annual profits.

References

EU. 2009. No. 43/2009 of 16 January 2009 fixing for 2009 the fishing opportunities and associated conditions for certain fish stocks and groups of fish stocks, applicable in Community waters and, for Community vessels, in waters where catch limitations are required.

Fulton, E. a, Smith, A. D. M., Smith, D. C., and van Putten, I. E. 2011. Human behaviour: the key source of uncertainty in fisheries management. Fish and Fisheries, 12: 2–17.

Rijnsdorp, A., Dol, W., Hoyer, M., and Pastoors, M. A. 2000. Effects of fishing power and competitive interactions among vessels on the effort allocation on the trip level of the Dutch beam trawl fleet. ICES Journal of Marine Science, 57: 927–937.

Van Marlen, B., Wiegerinck, J. a. M., van Os-Koomen, E., and van Barneveld, E. 2014. Catch comparison of flatfish pulse trawls and a tickler chain beam trawl. Fisheries Research, 151: 57–69. Elsevier B.V.