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# A cost–benefit analysis of improving trawl selectivity in the case of discards: The *Nephrops norvegicus* fishery in the Bay of Biscay

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**Abstract**

The *Nephrops* trawl fishery is one of the most important fisheries in the Bay of Biscay. The fishery management essentially relies on conservation measures, a total allowed catch (TAC) for *Nephrops* together with a minimum landing size (MLS) and minimum trawl mesh size (70 mm stretched mesh). These measures have failed to prevent high discard levels of many species that characterize the fishery. *Nephrops* trawlers thus discard about half of their *Nephrops* catches in numbers (a third in weight) of which only 30% survive. *Nephrops* discards mainly occur in younger *Nephrops* age groups below the MLS. This is a waste for the already overexploited *Nephrops* stock as well as for the fleet. Based on a bio-economic simulation model, the paper analyses the consequences of several scenarios of improving *Nephrops* selectivity. The potential impacts of these scenarios on *Nephrops* biomass, landings, discards and economic indicators (e.g. rent) are examined and a cost–benefit analysis of each scenario is carried out. We show that a better exploitation pattern would benefit fisheries that have high level of discards. Reducing non-commercial *Nephrops* discards leads to positive net present values of rent with better value realized from the production potential and limited short-term losses for the fishing units. By taking account of the economic dynamics of increasing effort however, we show that selectivity measures are insufficient. Regulating access to the fishery is also required to ensure the sustainability of the fishery and a better exploitation of the production potential.


*Keywords:* *Nephrops norvegicus*; Bio-economic simulations; Cost–benefit analysis; Selectivity; Discards; Fisheries management

## 1. Introduction

Bottom trawls are known to be poor selective gears. Their use in a multi-species and multi-size ecosystem induces catches of non-targeted fishes or unwanted length grades of the targeted species. Much of this catch is often discarded with high mortality rates (Alverson et al., 1994). The French bottom trawler fleet targeting *Nephrops* in the bay of Biscay (ICES Divisions VIIIa,b) is characteristic in this context.

Based on a total allowed catch (TAC) together with minimum landing sizes (MLS) and a rather small minimum mesh size (70 mm stretched mesh), present management rules have failed to prevent high levels of by-catches and discards of many species. Especially Norway Lobster (*Nephrops norvegicus*), Hake (*Merluccius merluccius*), Anglerfish (*Lophius piscatorius* and *Lophius budegassa*) and Megrim (*Lepidorhombus whiffiagonis*) are discarded. The poor gear selectivity and a MLS on *Nephrops* (8.5 cm and 9 cm since 2005) are the main reasons for high discard levels of younger age groups of *Nephrops* observed in this fishery. In 2004, *Nephrops* discards represented 60% of the *Nephrops* caught in number of individuals (30% in weight) (ICES, 2006) of which 70% die (Guéguen and Charuau, 1975). This leads to wasteful high fishing mortality on young *Nephrops* and, therefore, contributes to mis-exploitation (by growth over-fishing) of the *Nephrops* stock production potential. ICES thus reports the *Nephrops* stock is over-exploited compared to the maximum sustainable fishing mortality. To

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date, no quantitative assessment of potential benefits, from an improved exploitation pattern for the stock and the fleets, is available. This is, however, a key issue for fisheries management.

The benefits of size-selectivity measures, aimed at improving the exploitation pattern, appear evident in fisheries characterized by high level of by-catches and discards (Beverton and Holt, 1957; Ward, 1994; Suuronen and Sardà, 2007; Pascoe and Revill, 2004). Selectivity measures, such as increasing mesh-size or adopting more selective gear or devices (like *Nephrops* grids), avoid catches and discards of the youngest individuals. This increases the age at first capture, the catch per unit effort and the sustainable total yield (MacLennan, 1995; Stergiou et al., 1997; VanMarlen, 2000; Kvamme and Fröysa, 2004; Salini et al., 2000). Improving selectivity leads to a more efficient exploitation of the stock's growth potential. More *Nephrops* thereby reach mature size and spawn. Furthermore, this smoothes fluctuation in recruitment and thus guarantees more even yields for the fishery. From an economic perspective, the catches contain larger individuals, which generally receive better prices per weight. Some studies, assessing impacts of selectivity measures, highlight likely high short-term losses for the fleet (Griffin et al., 1993; Ferro and Graham, 2000; Heikinheimo et al., 2006; Tschernij et al., 2004). In view of the uncertain long-term gains, the problem of high short-term losses is often used as an argument against the use of more selective gears. However, reducing discards does not necessarily mean a reduction in landings. When selectivity only affects the discarded fraction of the catches, landings can be unchanged at first and then increased.

The objective of this paper is to provide a cost–benefit analysis of improving selectivity measures in the case of the *Nephrops* fishery. We analyze transition phases and compare potential short-term losses to long-term gains. Few papers are available in the literature on this subject (see OECD, 1997, 2000; Halliday and Pinhorn, 2002; Freese et al., 1995; Lucena and O'Brien, 2005; Boncoeur et al., 2000). A bio-economic deterministic simulation model of the *Nephrops* fishery in the Bay of Biscay is developed for this purpose. The model is based on an age-structured model for the *Nephrops* stock, with several fleets targeting *Nephrops*. The model produces different indicators over the simulation period, both at equilibrium and during the transition phases. *Nephrops* biomass, catch, landings, discards, gross revenue and producer surplus (rent), used for the cost–benefit analysis, are thus studied for six theoretical selectivity scenarios. The model assumes that effort is either constant or adjusted to profitability of the vessels. In this case, the endogenous effort model is based on similar approaches developed in other contexts (Lleonart et al., 2003; Guillen et al., 2004). This assumption implies that selectivity measures do not prevent "the race for fish".

After a description of the *Nephrops* fishery, we present the framework of the bio-economic model. Results of cost–benefit analyses of selectivity scenarios are then discussed, assuming static or endogenous effort. The concluding section discusses limitations of selectivity measures for fisheries management.

## 2. Material and methods

Bio-economic modeling requires a good analysis of the conditions of exploitation in this fishery in order to assess the impacts of management measures, especially selectivity scenarios. This includes a description of the management rules, a characterization of the fleets involved in the fishery and of their exploitation pattern as well as an analysis of the status of the stock.

### 2.1. The Nephrops fishery in the Bay of Biscay

#### 2.1.1. Management rules

*Nephrops* are targeted by bottom trawlers on a sand-muddy area called the "Grande Vasière" (ICES Divisions VIIIa,b). Nearly all the *Nephrops* landings from VIIIa,b are taken by French trawlers. The *Nephrops* trawler fleet is one of the most important segments of the French fleet in the Bay of Biscay. The fleet indeed represents about one quarter of the French trawlers in this area (Berthou et al., 2004). In 2003, 234 bottom trawlers were involved in the *Nephrops* fishery (Fig. 1).

The management of the *Nephrops* Fishery in the Bay of Biscay essentially relies on conservation measures. For a long-time, an MLS of 26 mm Cephalothoracic Length, i.e. 8.5 cm total length, was fixed by French Producers' Organizations. Because of the market, this MLS was chosen larger than the European MLS (20 mm CL i.e. 7 cm total length). Since December 2005, a new French MLS regulation (9 cm total length) has been adopted.

Several regulations regarding mesh size were adopted successively these last few years. In 2000, minimum codend mesh size in the Bay of Biscay became 70 mm instead of the former 55 mm for *Nephrops* (Council Regulation (EC) No 850/98,


Fig. 1. *Nephrops* fishery in the Bay of Biscay (ICES Divisions VIIIa,b), Source: IFREMER.