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ScienceDirect
Fisheries Research 90 (2008) 128–137
FISHERIES RESEARCH
www.elsevier.com/locate/fishres

Trawl catch composition in relation to Norway lobster (*Nephrops norvegicus* L.) abundance on the Farn Deeps grounds, NE England

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Received 21 March 2007; received in revised form 22 September 2007; accepted 5 October 2007

Abstract

Management of fisheries directed at a particular species (the target) is often complicated by the capture of other species (the bycatch), each of which may be subject to competing management objectives. Optimal management depends upon a good understanding of how catches of the target species vary in relation to bycatch of other species of commercial and conservation concern. This paper considers the composition of trawl catches taken on a Norway lobster (*Nephrops norvegicus*) ground off the NE coast of England, examining the factors that determine catch rates of *Nephrops* and various commercial finfish species taken as bycatch. We describe the results of a trawl survey undertaken using four commercial vessels deploying standard commercial gear. Only about 19% of the variance in *Nephrops* catch rates could be accounted for by variations in local density, as measured independently by underwater television survey of *Nephrops* burrows. Variations in *Nephrops* catch rates were dominated by changes over time, particularly in relation to tidal state. Five commercial bycatch species were taken alongside *Nephrops* in significant quantities. Catch rates of haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangus*) and lemon sole (*Microstomus kitt*) varied independently of *Nephrops*, whereas catches of cod (*Gadus morhua*) and plaice (*Pleuronectes platessa*) were inversely related to *Nephrops*. We conclude that it is possible for the commercial *Nephrops* fishery to use spatial and temporal targeting to maximise catches of *N. norvegicus* whilst minimising the bycatch of some fish species. If catch statistics are used to identify *Nephrops*-directed fishing métiers for fishery management purposes it is vital that data are examined at the level of individual hauls or fishing trips. Aggregation of data at a higher level risks obscuring the effectiveness with which the fishery is targeted at *Nephrops*.

Keywords: *Nephrops norvegicus*; Trawl survey; Bycatch; Catch composition; Fishery management; Monitoring

1. Introduction

The success of single species fishery management depends on the extent to which catches of one species can be separated from those of others. It is rarely possible to take one species without a bycatch of others, particularly in fisheries prosecuted using mobile gear such as trawls or dredges. This has implications for fisheries monitoring because calculation of catch per unit effort and effort statistics is complicated by difficulties in defining directed fishing effort; and for fisheries management because different species taken by mixed fisheries are likely to have different and potentially competing management objectives.

Fisheries for the Norway lobster, *Nephrops norvegicus* (hereafter referred to as *Nephrops*), are among the most valuable of all demersal fisheries in the northeast Atlantic and Mediterranean. The bulk of the landings are taken by trawling, but the nature of the gear and of the fisheries varies widely across the range (Graham and Ferro, 2004). Similarly, bycatch species vary widely across the range (ICES, 2003). Around the Iberian peninsula and in the Mediterranean, *Nephrops* is often taken as a valuable bycatch alongside other target species (ICES, 2003; Maynou et al., 2003), so that the fishing mortality of *Nephrops* is determined by management objectives for species such as hake (*Merluccius merluccius*). In waters around the UK *Nephrops*-directed fisheries potentially take a significant

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doi:10.1016/j.fishres.2007.10.003

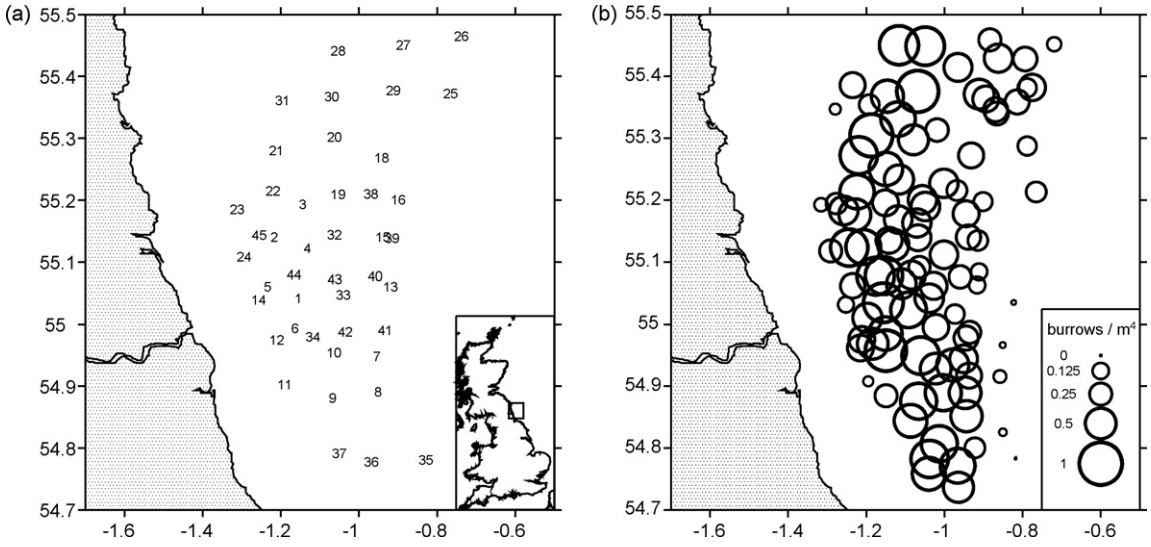

Fig. 1. Trawl and underwater television survey stations on the Farn Deeps ground, NE England: (a) positions of trawl stations sampled 8 November–1 December 2004; (b) burrow densities recorded during an underwater television survey, 12–18 October 2004. Circle areas in (b) are proportional to burrow densities.

bycatch of demersal fish species such as cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and whiting (*Merlangius merlangus*). In some areas one or more of these species, e.g. cod in the North Sea and Irish Sea, have been the subject of Recovery Plans. Effective management of mixed fisheries requires that the nature of targeting behaviour be understood and identified properly in monitoring data. This involves identifying 'métiers', being segments of the fishery characterized by gear and mode of fishing and by the assemblage of species targeted (e.g. Biseau, 1998). Work to identify *Nephrops*-directed and other métiers is ongoing (ICES, 2006a,b). On another front, gear developments are underway aimed at reducing or eliminating unwanted bycatch whilst fishing for *Nephrops* (e.g. Arkley and Dunlin, 2003; Dunlin and Reese, 2003; Graham and Ferro, 2004).

In this paper we describe the results of a trawl survey on the Farn Deeps *Nephrops* grounds off the coast of NE England (North Sea) (Fig. 1a). The survey was conducted using standard commercial gear deployed by commercial trawlers from the local fleet that targets *Nephrops* mainly during the winter months (October to March). The aim of the survey was to describe the variation in commercial catch rates of *Nephrops* and bycatch species in relation to location, vessel, time of day and tidal factors. The intention was to shed light on the ways in which the composition and quantity of catch depend on when and where the vessel is fishing, with a view to gaining an improved understanding of the effectiveness with which fishing effort may be targeted at *Nephrops*.

We also make use of data from a fishery independent assessment of the Farn Deeps *Nephrops* stock (Fig. 1b). Underwater television (UWTV) surveys are routinely used to measure the density of *Nephrops* burrows on the area of muddy sediment that defines the distribution of the Farn Deeps stock (e.g. ICES, 2006b). Burrow density is considered to correspond with the density of adult *Nephrops* on the ground (Tuck et al., 1997a,b). Bell et al. (2005) estimated local depletion by the fishery by undertaking UWTV surveys of the ground at the start and end of a winter fishing season, demonstrating that the method is effective in distinguishing variations in local burrow density, and that the fishery appears to target fishing effort at areas of highest density. In this paper we use UWTV survey data on local burrow density to determine the extent to which trawl catch rates of *Nephrops* are related to variations in local abundance.

2. Materials and methods

2.1. Trawl survey

A trawl survey of the Farn Deeps *N. norvegicus* grounds off the northeast coast of England (54°45′–55°35′N and 0°40′–1°30′W) was undertaken during 8 November to 1 December 2004 using four commercial fishing vessels. The wooden-hulled trawlers FV *Kristenborg* (16.3 m) and FV *Star Divine* (11.4 m) each made four 1-day trips over the period 8–12 November 2004 and the two steel-hulled trawlers FV *Gallant Venture* (11.0 m) and FV *Quo Vadis* (9.0 m) each made five 1-day trips over the periods 15–16 November and 29 November–1 December 2004. The gap of 2 weeks between sampling periods was due to poor weather conditions which precluded fishing.

The survey design consisted of 45 stations covering the main part of the *Nephrops* fishing ground (Fig. 1a). These were a subset of stations sampled by an underwater television (UWTV) survey undertaken in October 2004 (see below). The trawl stations were selected to cover the range of *Nephrops* burrow densities recorded in the UWTV survey whilst at the same time giving good spatial coverage of the ground. Trawling at each station was undertaken using standard 180 ft prawn trawls with 80 mm mesh cod-ends. Each vessel used its own set of gear, towed as a single rig. Tows were undertaken according to normal commercial practice, except that tow duration was limited to 0.5 h to allow maximum survey coverage within the time available. A total of 79 tows was undertaken during the survey, most stations being sampled by at least two vessels.

The catch from each trawl haul was separated by the fishing crew into *Nephrops*, commercial fish species and 'trash'