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Size selectivity of trammel nets in southern European small-scale fisheries

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Abstract

Trammel net size selectivity was studied for the most important métiers in four southern European areas: the Cantabrian Sea (Atlantic, Basque Country, Spain), the Algarve (Atlantic, southern Portugal), the Gulf of Cádiz (Atlantic, Spain) and the Cyclades Islands (Mediterranean, Aegean Sea, Greece). These métiers were: cuttlefish (*Sepia officinalis*) and soles (*Solea senegalensis*, *Microchirus azevia*, *Synaptura lusitanica*) in the Algarve and the Gulf of Cádiz, sole (*Solea solea*) in the Cantabrian Sea and mixed fin-fish in the Cyclades. In each area, experimental trammel nets of six different types (combinations of two large outer panel mesh sizes and three small inner panel meshes) were constructed. Fishing trials were carried out on a seasonal basis (four seasons in the Cantabrian Sea, Algarve and Cyclades and two seasons in the Gulf of Cádiz) with chartered commercial fishing vessels. Overall, size selectivity was estimated for 17 out of 28 species for which sufficient data were available. Trammel nets generally caught a wide size range of the most important species, with length frequency distributions that were skewed to the right and/or bi-modal. In many cases the length frequency distributions of the different nets were highly overlapped. The Kolmogorov–Smirnov test also showed that the large outer panel meshes generally had no effect in terms of size selectivity, while the opposite was true for the small inner panel ones. Six different selectivity models (normal scale, normal location, gamma, log-normal, bi-modal and gamma semi-Wileman) were fitted to data for the most abundant species in the four areas. For fish, the bi-modal model provided the best fits for the majority of the data sets, with the uni-modal models giving poor fits in most cases. For *Sepia officinalis*, where trammelling or pocketing was the method of capture in 100% of the cases, the logistic model fitted by maximum likelihood was judged to be more appropriate for describing the size selective properties of the trammel nets. Our results, which are among the first ones on trammel net selectivity in European waters, will be useful for evaluating the impacts of competing gear for the socio-economically important small-scale static gear fisheries.

Keywords: Trammel nets; Size selectivity; Cantabrian Sea; Algarve; Gulf of Cádiz; Cyclades Islands

1. Introduction

Trammel nets are widely used throughout the world in artisanal or small-scale fisheries to catch a variety of demersal species such as soles, sea breams, red mullets, skates, shrimps, lobsters and cuttlefish. In southern European countries trammel nets are among the most important gears, with different combinations of gear characteristics (mesh sizes, hanging ratios, net height, flotation), target species, fishing areas, depths, seasons and fishing strategy defining different trammel net métiers (Laurec et al., 1991; Ulrich et al., 2001; Salas and Gaertner, 2004). In the Algarve (southern Portugal), trammel nets were second in importance after longlines

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with 611 (18%) of a total of 3343 licences attributed to 1241 vessels in 2002 (Seruca, personal communication, DRPAS). In a study based on a fraction of the Basque Country's artisanal fisheries (boats with a total length less than 15 m), 56 out of a total number of 96 boats (58%) used trammel nets during part or all of the year (Puente et al., 2002).

Trammel nets consist of three walls of multifilament or monofilament netting, with a loosely hung, small mesh inner net between larger mesh netting. Hanging ratios for the inner net generally range between 0.3 and 0.5, while hanging ratios of the larger mesh outer panels are typically greater. Vertical slack, the ratio of the depth of the small-meshed inner panel to that of the large-meshed outer panels (Losanes et al., 1992a), is commonly between 1.5 and 2.0.

In addition to wedging, gilling and entangling (i.e., held by teeth, spines or other protrusions), trammel nets also catch fish and invertebrates in the pocket formed by the inner smaller mesh wall of netting being pushed through one of the larger mesh outer walls. This is known as trammelling or pocketing (Losanes et al., 1992b; Fabi et al., 2002). The catches of trammel nets depend primarily on the mesh size and vertical slack of the inner net (Purbayanto et al., 2000) with several studies reporting wider selection ranges with increasing inner net slackness (Kitahara, 1968; Koike and Takeuchi, 1985; Koike and Matuda, 1988; Salvanes, 1991; Losanes et al., 1992a,b). Trammel nets with a slackness of more than 1.5 are expected to be more effective in catching larger sized fish than gillnets of the same mesh size (Koike and Matuda, 1988).

Compared to gill nets, trammel net selectivity is relatively poorly studied. Trammel nets are generally considered to be less size selective than gill nets, with size frequency distributions frequently skewed to the right (Millner, 1985; Dickson, 1989; Fabi et al., 2002; Fitzhugh et al., 2002). The selectivity curve of trammel nets is domed but has a flatter shape than that for fin-fish caught with gill nets, as reported by authors who used the same methodology to fit the selectivity curve (Koike and Matuda, 1988; Losanes et al., 1992a). If a significant proportion of individuals, especially the larger ones, are pocketed or trammelled, then the selectivity curve may not fall to zero or even have a descending limb, implying that very few fish escape after coming into contact with the trammel net (Salvanes, 1991; Losanes et al., 1992b).

While there is a general consensus with regards to the form of gill net selectivity curves, this is not the case for trammel nets. Many authors have fitted uni-modal selectivity models to trammel net data. Thus, Fujimori et al. (1990, 1992) fit a skew-normal model, while Purbayanto et al. (2000) use Kitahara's (1968) method to fit a uni-modal model that was skewed to the right. Fujimori et al. (1996) also use Kitahara's (1968, 1971) method and report a dome-shaped selectivity curve that is flat on top. Losanes et al. (1992b) fit a bi-normal curve where the first component is assumed to correspond to fish that are essentially gilled or wedged, as in gill nets, and the second one to larger fish that are entangled or trammelled/pocketed. Matsuoka (1991) reports that trammel net selectivity for *Tilapia mossambica* is bi-modal, with wedging being a minor component compared to entangling. However, Matsuoka (1991) suggests that given the relatively poor fit of the bi-modal selectivity curve, trammel net selectivity may be tri-modal due to the capture of fish in the pocket.

Despite the importance of trammel nets for the small-scale fisheries in southern European waters, in terms of landings, commercial value, number of vessels and fishers, there have been few studies on the size selectivity this gear. Elsewhere we have examined the catch rates, catch species composition and métiers in southern European waters (Stergiou et al., 2006). In this paper our objectives were: (1) to study the size selectivity of the main métiers in four southern Europe areas: the Basque country (Atlantic, Spain), Algarve (Atlantic, southern Portugal), Gulf of Cádiz (Atlantic, Spain) and Cyclades (Mediterranean, Aegean Sea, Greece), (2) to evaluate the influence of outer panel mesh size on size selectivity, and (3) to investigate the effect(s) of catching mechanism(s) on size selectivity.

2. Materials and methods

2.1. Experimental fishing trials

In all four areas the most important trammel net métiers were identified on the basis of questionnaire surveys. In the Basque country and in the Algarve monofilament trammel net métiers were the most important while in the Gulf of Cádiz and in the Cyclades multifilament nets were the principal métiers. In the Basque country the *Solea solea* métier was chosen for the selectivity study while in the Algarve the *Sepia officinalis* and flatfish métier were the most important. The latter métier was also the most important in the nearby Gulf of Cádiz. Finally in the Cyclades, trammel nets for fin-fish, especially *Mullus surmuletus* and *Pagellus erythrinus,* were selected.

The trammel nets were constructed either by commercial enterprises or by the fishers contracted for the project according to design specifications appropriate for the selected métier. These design specifications were similar to those used by local fishers in terms of number of meshes deep, hanging ratios, lead line and floats. In all areas three inner panel mesh sizes and at least two outer panel mesh sizes were used, giving at least six combinations of outer and inner panel mesh size trammel nets. Inner panel stretched mesh sizes ranged from 40 to 48 mm in the Cyclades to 100–140 mm in the Algarve, while outer panel stretch mesh sizes ranged from 220 to 300 mm in the Cyclades to 600 and 800 mm in the Algarve (Table 1). Some differences between the gear parameters of the experimental trammel nets in each area were obtained due to constrictions in the mounting of the nets. The ranges of the main gear parameters are given in Table 1.

Normal fishing practices were followed in all four areas. In the Basque country the nets were generally fished for 24 h, except when bad weather did not allow gear retrieval. In