Fisheries Research 134–136 (2012) 52–63

Contents lists available at SciVerse ScienceDirect

Fisheries Research

journal homepage: www.elsevier.com/locate/fishres

Fishing tactics and fleet structure of the small-scale coastal scalefish fishery in Tasmania, Australia

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ARTICLE INFO

Article history:
Received 22 May 2012
Received in revised form 15 August 2012
Accepted 17 August 2012

Keywords:
Small-scale fishery
Fishing tactics
Metiers
Vessel groups
Multivariate analyses

ABSTRACT

The small-scale coastal scalefish fishery in Tasmania, south-eastern Australia, uses a large number of fishing gear types to target a range of fish, shark and cephalopod species. This study applied multivariate analyses of catch and effort logbook records to identify fishing tactics (characterised by fishing gear, target species, location and month) and vessel groups (characterised by their fishing activities) for the 17 gear types used in the fishery. A total of 35 fishing tactics were defined, with up to 10, mostly species-specific, fishing tactics per gear type. Subsequently, 20 vessel groups were characterised that were categorised according to three degrees of specialisation and a deepwater component. The analysis highlighted the strongly-interlinked fishing tactics and the high level of flexibility in selecting target species and fishing tactics. This flexibility should be taken into consideration in stock assessments and the management of this fishery that have traditionally focussed on single fish species and individual fishing methods.

1. Introduction

Single-species fisheries management approaches tend to perform poorly in mixed-species fisheries where a fish species is captured by a number of gear types or several species can be caught simultaneously in a haul. Since fish species and fish stocks are not exploited independently and fishing practices can be easily modified, it is important to understand the structure and dynamics of the fishing fleet in order to assess past and predict the impact of future fishing and management decisions on exploited fish stocks (ICES, 2003).

Complex fleet structure and dynamics are prevalent in small-scale fisheries. Small-scale fisheries are often characterised by (1) the use of small vessels; (2) labour intensive fishing methods with a relatively low level of capital investment, technical equipment and specialisation; (3) the dominance of traditional fishing gears such as gillnets, traps, lines, and seine, that are often used in combination; (4) short and decentralised fishing trips in inshore and coastal waters; and (5) great spatial and temporal variability in fishing activity, fishing gear used and target species (e.g. Berkes et al., 2001). Small-scale fisheries tend to be of great social significance for coastal communities due to the high number of people being directly or indirectly involved in the fishery. However, with small overall fishery production and revenue, these fisheries receive comparatively little attention by science and management (Mahon, 1997). Many small-scale fisheries are open access or are managed by limiting fishing effort that can be applied with particular gear types or directed towards a fish species, disregarding potentially strong interactions between different fishing practices (e.g. Salas et al., 2007).

Many of the typical characteristics of small-scale fisheries apply to the coastal scalefish fishery around Tasmania, Australia. Tasmanian fishers use a number of gear types such as nets, hooks and pots to harvest a diverse range of fish, shark and cephalopod species. Fishing vessels are deployed from many ports and launching sites, are typically small (3–20 m length) and owner-operated with less than three crew members. Catches and economic returns by individual fishers are often low. Between 1995/1996 and 2008/2009, 56% of all fishers reported on average less than 1 tonne/year landed, while only 18% of all active fishers caught on average more than 5 tonnes/year during the period. For full-time fishers, these low catches were reflected in an annual average profit from the fishery of just AU$ 37,000 (Bradshaw, 2005). Around 60% of the participants in Bradshaw's survey were full-time fishers, but two thirds of these were also active in other fisheries. The remaining 40% were part-time fishers and some of these had full-time employment outside commercial fisheries.

A low level of specialisation and technological equipment allows fishers to rapidly adapt and change their operations in response to changes in spatial and temporal species availability and market opportunities. However, assessment and management of the Tasmanian scalefish fishery have traditionally disregarded this flexibility and focussed on single fish species and individual fishing methods instead (Ziegler and Lyle, 2010).

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http://dx.doi.org/10.1016/j.fishres.2012.08.011

The Tasmanian fisheries management has recognised that it should be able to quantify and account for interactions brought about by effort shifts between different components of the fishery (A. Sullivan, Tasmanian Department of Primary Industries, Parks, Water and Environment, personal communication). The first step in this process is to analyse the fishing fleet structure and fishing tactics applied within the fishery (Tzanatos et al., 2006; Katsanevakis et al., 2010; Castro et al., 2011; Davie and Lordan, 2011). In this study, we use step-wise multivariate analyses to identify target species, fishing tactics and vessel groups from logbook data. The terms 'fishing tactic' (Laloë and Samba, 1991; Pelletier and Ferraris, 2000), 'métier' (Biseau and Gondeaux, 1988; Laurec et al., 1991; Marchal, 2008), or 'fishery' (Lewy and Vinther, 1994; Murawski et al., 1983; Ulrich and Andersen, 2004) describe the fishing intention in respect to species targeted, fishing area, and fishing gear. Similarly, the terms 'vessel groups' (Ulrich and Andersen, 2004) or 'fleets' (Laurec et al., 1991; Lewy and Vinther, 1994; Marchal, 2008) are used to describe vessels sharing similar characteristics in respect to technical features and fishing tactics. The analyses are based on compulsory logbook returns from commercial fishing operations, and are a combination of output-based methods (categorisation of fishing tactics by clustering catch profiles) and input-based methods (relating these clusters to fishing trip characteristics; Marchal, 2008).

2. Material and methods

2.1. Data

The commercial Tasmanian scalefish fishery is defined through the requirement that participants hold Tasmanian fishing licences and report their fishing activity in Tasmanian logbooks. These reporting requirements have changed over the years and with them which fishers have been part of the Tasmanian scalefish fishery. Prior to 1998, the Tasmanian logbooks included dually endorsed Tasmanian and Commonwealth fishers with a significant amount of fishing activity in offshore waters of Australia's economic exclusion zone (EEZ) targeting pelagic and deepwater species. Since then, most of the fishing activity of these vessels has been stepwise reclassified and these vessels are now part of the Commonwealth Southern and Eastern Scalefish and Shark Fisheries (SESSF) and the Southern Squid Jig Fisheries (SSJF). Nowadays, Tasmanian fishing licences generally restrict fishing to waters within 3 nautical miles of the coast. These changes have resulted in the sharp decline of total Tasmanian catches from around 3000 to 1500 tonnes between 1999/2000 and 2001/2002, while catches before and after this decline have remained relatively stable (Fig. 1a). In contrast, the number of Tasmanian scalefish vessels and fishers (skippers only) has continuously declined from around 400 to 200 between 1995/1996 and 2008/2009 (Fig. 1b). Similar numbers of vessel and fishers, particularly in recent years, indicate that most fishers use only one vessel during the course of a fishing year.

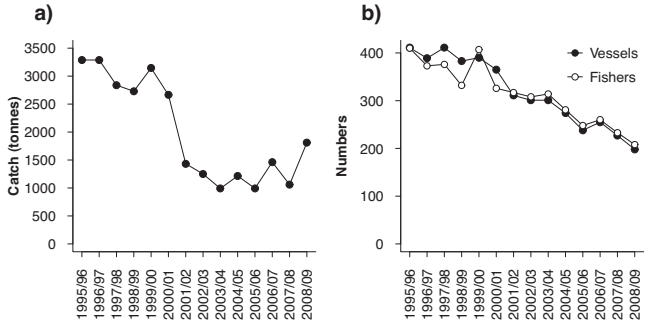

Fig. 1. (a) Total catch (tonnes) and (b) number of vessels and fishers (skippers only) in the Tasmanian scalefish fishery. The Tasmanian scalefish fishing year lasts from 1st July to 30th of June of the subsequent year.

Tasmanian commercial logbook entries between July 1995 and June 2009 were used for the analyses, following the Tasmanian fishing year from 1st July to 30th of June of the subsequent year. Logbook data provided daily summaries of fishing operations, including vessel mark, fisher identification mark, fishing gear, location based on 30×30 nautical mile fishing units, minimum and maximum fishing depth, fishing effort, and catch weights of individual species.

The logbook entries did not specify whether the daily fishing records would represent a whole trip or part of a multi-day trip. To reduce the noise in daily data and the potential for misclassification of records for which the target species was not caught on a particular day, daily fishing records were pooled monthly, summarising fishing effort and catch weights for all fish species caught while retaining unique information by vessel, fisher, fishing gear, spatial fishing unit, month and year (i.e. catches by a fisher using the same fishing gear in two separate fishing units during a particular month resulted in two logbook records). This procedure assumed that a fisher did not change target species for a particular gear during a month and in a spatial fishing unit. Erroneous records and records without catch information were excluded from all analyses. These procedures resulted in 55,242 monthly records.

Due to the large number of individual fish species (over 80), larger functional species groups were set up, with a total of 36 species or species groups defined for the analysis. The most common species or species groups were anchovy (Engraulidae), Australian salmon (*Arripis* spp.), banded morwong (*Cheilodactylus spectabilis*) and other morwong (*Nemodactylus* spp.), barracouta (*Thyrsites atun*) and pike (*Dinolestes lewini* and *Sphyraena novaehollandiae*), bastard trumpeter (*Latridopsis forsteri*) and striped trumpeter (*Latris lineata*), blue warehou (*Seriolella brama*), blue-eye trevalla (*Hyperoglyphe antarctica*), southern calamari (*Sepioteuthis australis*) and Gould's squid (*Nototodarus gouldi*), flathead (Platycephalidae), garfish (*Hyporhamphus melanochir*), jack mackerel (*Trachurus declivis*), mullet (Mugilidae), octopus (*Octopus* spp.), whiting (Sillaginidae), and wrasse (*Notolabrus* spp.).

The reported 24 gear types were reduced to 17 gear types by pooling similar gear types, e.g. dip and push net, and bottom and shark line.

2.2. Methods

The general sequence of analyses followed that of Pelletier and Ferraris (2000) and ICES (2003) and was applied to each fishing gear. Firstly, catch profiles or target species were defined based on catch composition data. Secondly, fishing tactics were described based on the relationship between catch profiles and effort variables such as fishing location and month. Lastly, vessels groups with similar fishing tactics were identified. All analyses were conducted with the statistical package R (R Development Core Team, 2011).

2.2.1. Identification of target species

The analysis for target species was approximated from catch profiles and conducted separately for each gear type. Catch weights per species for individual monthly records were transformed into catch profiles with relative species composition (i.e. the catch per species was divided by the total catch of that record). The matrix was not normalised, since fishing tactics were expected to depend primarily on the target species rather than the bycatch species. A principal component analysis (PCA) on the Euclidian distances allowed for a visual examination of the data, however all factorial dimensions were retained for the subsequent hierarchical cluster analysis (HAC). Clusters were identified based on the minimum