ICES CM 2015/F:04

Monitoring fishing effort of a data-limited artisanal fishery. The case of common octopus small-scale fleet operating in the Galician coast (southeastern Atlantic shelf)

Rafael Bañón Díaz[1], Jaime Otero[2], Alexandre Alonso Fernández[2,], José Manuel Campelos Álvarez[1], and Fernando Quintero Fernández[1]*

[1]*Servizo de Planificación, Consellería do Mar e Medio Rural, Xunta de Galicia, Rúa dos Irmandiños s/n, 15701 Santiago de Compostela (A Coruña), Spain*
[2]*Instituto de Investigaciones Marinas (IIM-CSIC), Eduardo Cabello 6, 36208 Vigo (Pontevedra), Spain*
*alex@iim.csic.es

Small-Scale Fisheries (SSFs) are large contributors to global catches, and of relevance for local economies and society. However, due to their intrinsic characteristics and a paucity of appropriate information, accurate assessment of fishing effort performed by SSFs is often problematic. This work presents a detailed analysis of effort and yield for a specialized artisanal trap fleet targeting common octopus along the Galician coast (NW Spain) during 1999–2013. Information was compiled from official reported statistics and compared with data gathered by on board observers. A total of 1283 vessels had permission in 2015 to deploy creels, however, effective license usage is considerably lower and has steadily decreased since 2005-06 fishing season. The fraction of the fleet sampled by the observers were characterized by an average size of 6.1±3.6 GRT and had 1 to 6 fishermen deploying 66.7±34.5 creels per haul. The fishery yielded 0.8±1 kg per 50 deployed creels per hour at an average depth of 24.9±19.7 m and after an average displacement of 4.1±2.9 nm. Operation depth and distance to fishing locations showed spatio-temporal variability and depended on vessel size. On average, depth increased by 0.7% per year, whereas distance decreased by 1.1% per year.

Introduction

Global fishing pressure has steadily risen since 1970s leading to an increase in fish production and posing multiple questions such as which impact this raise in effort has on marine ecosystems or which would be the level of effort underestimation given the countries misreporting (Anticamara *et al*., 2011). SSFs are large contributors to worldwide fish catches, food supplies and security, and they provide employment to the largest number of fishermen (Chuenpagdee and Pauly, 2008). However, SSFs have been traditionally under-attended and marginalized in national and international policies including the European Union (Macfadyen *et al*., 2011). Fishing effort is a crucial metric for resource management, thus reliable statistics are desirable in order to improve our knowledge of SSF fleets capacity, identify areas of intense fishing activity, and evaluate the sustainability and impacts of coastal fisheries (Stewart *et al*., 2010). A SSF is inherently complex due to its multi-gear and multi-species nature, so as due to socioeconomic and cultural factors. Thus, it is often difficult to assess fishing effort despite widespread governmental attempts to provide reliable official statistics. To complete this information, contributions from other fields have been put forward (e.g. Ota and Just, 2008), however, more remains to be done. We here, analyzed detailed information on fishing effort and fleet dynamics for the common octopus creel fishery along the Galician coast (NW Spain) during 1999–2013. A combination of official information and data gathered by on board observers was used to shed some light on the capacity of this fleet.

Material and Methods

Fishery information: Official statistics on catch (landings per port) and effort (licensed vessels authorized to use creels) were obtained from published records produced by the Xunta de Galicia (Galician autonomous government). Furthermore, catch and operational data were collected by observers working on the artisanal fishing sampling program run by the Unidade Técnica de Pesca de Baixura (UTPB, Technical Unit of Artisanal Fisheries) of the regional government. The sampling program monitors fishing vessels randomly selected from within the artisanal fishing fleet covering the full set of multiple gears used in Galician waters. For each haul, observers recorded the number, weight and total length of the specimens caught. Observers also recorded a suite of operational variables that could affect catch rates: gear type and size, average gear depth, soak time, and gross registered tonnage (Alonso-Fernández *et al*., 2014).

Statistical analyses: Official statistics were analyzed using linear models. In addition, data from the observers monitoring were modeled using generalized additive models (GAMs; Wood, 2006).

Results and Discussion

A total of 1283 vessels had permission to deploy creels in 2015, however, both the registered vessels and the effective license usage decreased since 2005-06 fishing season at a rate of ~27 vessels and ~20 licenses per season. Official catches during the period 1997 to 2014 averaged a value of ~2500 tons, and the per port distribution of average landings and registered vessels were correlated. However, some deviations from model predictions were observed suggesting that, for some authorized vessels, creel was not the main gear, and/or vessels with a given homeport disembarked their catches in neighboring harbors. Moreover, boats might have changed their registration port along the time series (Ota and Just, 2008). The registered fleet mean size was ~8 m of overall boat length, 41.5 Hp, and 4.4 GRT. These values were below the common ranges considered for a small-scale fishery (see Macfadyen *et al*., 2011). Regarding the fraction of the creel fleet monitored by the observers, vessels' size was on average 6.1±3.6 GRT, and the crew was composed by 1 to 6 fishermen who deployed 66.7±34.5 creels per haul. Gear setting occurred mostly at 10 h local time and average soak time was 23.7±27.9 h. The fishery yielded 0.8±1 kg per 50 deployed creels per hour at an average depth of 24.9±19.7 m and after an average displacement of 4.1±2.9 nm. The GAMs showed that operation depth and distance to fishing locations showed spatio-temporal variability and depended on vessel's size. In spite of the narrow fishing ground, we found that, on average, fishing depth increased by 0.7% per year, whereas distance decreased by 1.1% per year. This suggests subtle operational shifts in a SSF. In other regions, common octopus is usually fished by different methods and estimation of effort has proven to be difficult. For instance, in neighboring Portuguese waters Lourenço and Pereira (2006) described a methodology to calculate landings per unit of effort for the multi-gear octopus fishery independently of the mode of operation (or *métier*). In Galician waters, however, octopus catches other than those landed by the trap fishery are negligible, thus the creel could be considered the unique *métier*. Our results should serve as a starting point to develop models to study the capacity of the fleet (e.g. Madau *et al*. 2009), and analyze "optimal economic fishing efforts" as done in other areas (Kim *et al*., 2008), in order to set up more complete management plans.

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