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The traditional small-scale octopus trap fishery off the Galician coast (Northeastern Atlantic): Historical notes and current fishery dynamics

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ABSTRACT

Common octopus is a worldwide important cephalopod resource fished by both industrial and small-scale fleets which has gained market value in recent decades. In Galicia (NW Iberian Peninsula), common octopus (*Octopus vulgaris sensu stricto*) has been exploited since ancient times in intertidal and subtidal areas using multiple methods and fishing gears. A vast artisanal fleet using traps has been exclusively dedicated to catching this species since the 1970s. However, a comprehensive description of current fishery dynamics and production is lacking. A total of 1255 vessels had permission to deploy traps in 2016, though effective license usage was considerably lower and has steadily decreased since 2004. The fleet, in recent years, was largely composed of vessels of ~4.5 t of average gross tonnage (GRT) although the proportion of vessels per GRT segment has changed showing a decrease in vessels of lower and greater segments of GRT, whereas intermediate and more polyvalent segments, mainly between 2.5 and 4.99 GRT, increased notably. On average, the fleet deploys ~66 traps per haul usually set on a given day and hauled the next one yielding from 0.13 kg trap^{-1} in the south to 0.25 kg trap^{-1} in the north. Fishing operations (i.e. number of traps deployed, soak time, fishing depth, and trip length) varied seasonally and along the coast and depended on vessels' size. Similarly, fishing strategies (i.e. alternation of traps with other gears) also differed along the coastline and during the year. Fishing effort estimated as the number of deployed traps has decreased slightly since mid 2000s and so has expected catches though more pronounced in the northern coast as compared to the south. Furthermore, estimated catches were notably higher than official reported values regardless of the zone. This article provides new insights into the current fishery dynamics of an important small-scale fishery that should be useful for the development and implementation of new assessment and management plans for common octopus in the north-west coast of Spain.

1. Introduction

Cephalopods are a group of organisms that have a particular combination of life history traits including short lifespans, rapid growth to maturity, high fecundity and strong plasticity. These characteristics make them very versatile and opportunistic taxa with a high capacity for adapting to changing environmental conditions and being a key component of worldwide marine food webs (Boyle and Rodhouse, 2005). In recent decades, a global increase has been observed in cephalopod landings, increasing the economic importance of these organisms in worldwide marine fisheries (Hunsicker et al., 2010). Much has been speculated regarding the proliferation of cephalopod populations, for instance, as a consequence of the overfishing of predators and competitors (Caddy and Rodhouse, 1998), or in response to changing environmental conditions (Rodhouse et al., 2014). Whatever the reason, recent analyses show that populations of cephalopods have increased globally, suggesting that shared mechanisms across different marine environments might have caused the proliferation of these organisms (Doubleday et al., 2016). Three groups of species constitute the bulk of cephalopod fisheries, namely, cuttlefish, squid and octopus, supporting in some cases large industrial-scale fisheries (e.g. *Loligo gahi* in the Patagonian shelf), but also numerous small-scale fisheries (SSF) (e.g. *Octopus mimus* in the Chilean Coast). However, cephalopod catches are typically composed of both landings from industrial and artisanal

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fleets being the latter less well documented or unreported (e.g. local consumption in developing countries).

In European waters, cephalopod species tend to be a by-catch in multi-species demersal fisheries, but also, they are target species for specialised coastal SSFs. This is especially true for southern European countries where trawling would be generally the most important gear type in terms of landings, though numerous inshore fisheries would be the main contributors for a given cephalopod species in particular regions (Pierce et al., 2010). However, despite its notable socio-economic importance, the contribution of the artisanal fisheries is probably underestimated in the official statistics, mainly because not all catches tend to pass through monitored markets and other misreported issues, and fleets are not under strict control as compared to their industrial counterparts. These deficiencies are usually accompanied by a lack of fundamental data such as effort which, in conjunction with the particular biological traits of these species, hampers the application of traditional population dynamics models for assessment and management purposes (Rodhouse et al., 2014). This fact is even more prevalent in SSFs.

Spain has been traditionally one of the main contributors to European landings of cephalopods caught in territorial and international waters reaching 48,344 t in 2015 (MAPAMA, 2017). National catches have been dominated by octopus (basically *Octopus vulgaris* s. s.) followed by long-finned squid (mostly *Loligo vulgaris*) and cuttlefish (mainly *Sepia officinalis*) (Pierce et al., 2010). Within Spain, Galicia is the most important region in terms of cephalopod fisheries, and the artisanal component of the fleet is remarkable (Bañón et al., 2007). Currently the Galician fleet, with 4534 vessels registered in 2016 represents 48.8% and 43.1% of the Spanish fleet in terms of number of boats and gross tonnage, respectively (MAPAMA, 2017). Within the fleet, the small-scale coastal component has the largest number comprising about 88% of the Galician vessels. This small-scale coastal fishery usually develops a multi-specific and multi-gear fishing activity that includes an important shellfishing sector (Surís-Regueiro and Santiago, 2014). Regarding cephalopods, official catches in Galician waters by the artisanal fleet were mostly dominated by *O. vulgaris* s. s., with a mean of 2404 ± 581 t y^{-1} during the period 2002–2016, and to a lesser extent by *S. officinalis* (420 ± 134 t y^{-1}) and squid *L. vulgaris* (19 ± 9 t y^{-1}) (Servizo de Análise e Rexistros, SIPDBM, Consellería do Mar, Xunta de Galicia).

Overall, common octopus is one of the best-known and most studied cephalopod in the world (see Amor et al., 2017 for an evaluation of the taxonomic status of this species complex). Like most cephalopods, it has a short life cycle of less than two years; it grows rapidly to maturity, spawns once, often seasonally, at the end of its life and is an ecological opportunist with labile populations (Jereb et al., 2015). The species complex is an important marine resource reaching between 30,000 and 50,000 t globally in recent decades with very important markets in Southern Europe (e.g. Spain, Portugal, Italy and Greece) and Asia (e.g. Japan) (FAO, 2016). It is caught by both industrial trawlers and artisanal vessels using trammel and fyke nets, hooks and lines and mostly pots and traps (e.g. Pita et al., 2015). Fishing strategies and gear usage usually vary among regions, and industrial and artisanal fleets tend to fish different components of the population (e.g. Tsangridis et al., 2002). Traps and pots are traditionally used along the Iberian Peninsula, with pots predominating in the Mediterranean coast (Sánchez and Obarti, 1993) and the Gulf of Cádiz (Sobrino et al., 2011), and traps dominating in the North and Northwest coast where pots are not allowed (Fernández-Rueda and García-Flórez, 2007). Although trawlers contribute to the overall catch, typically the artisanal fleet is responsible for the majority of the landings. For instance, in Portuguese waters more than 90% of the octopus landings result from the activities of the artisanal fishery (Pilar-Fonseca et al., 2014), especially in the southern coast where pots and traps are the main fishing methods (Sonderblohm et al., 2017). In Galician waters, *O. vulgaris* s. s. is the target species of a trap fishery developed in the shelf up to about 100 m depth. The reported catch of this fishery during 2016 was ~3000 t, representing 17% of the total artisanal landings in that year, and reached a market value of €18 million, representing 18% of the total first sale value. Other gears such as trammel nets and trawlers catch octopus in small quantities though their production is practically negligible in comparison with catches from traps, which tend to range between 80 and 90% in weight of the total catch per year (García-Tasende et al., 2009). The trap fishery is therefore the main artisanal métier with around 800 vessels involved in the fishery annually. However, despite its enormous socio-economic importance multiple aspects related to the fishery dynamics are poorly known or scarcely described in the literature (e.g. Pierce et al., 2010; Pita et al., 2016). In particular, changes in fleet dynamics, fishing strategies or reliable figures of effort and production are understudied as tend to happen in other SSFs elsewhere. Thus, parameters that characterise the trap fleet, and especially effort, would be of importance to improve our knowledge of the artisanal octopus fleet capacity, to identify areas of intense fishing activity, and to evaluate the sustainability and impacts of the fishery (Stewart et al., 2010). Furthermore, known effort metrics would be crucial in order to develop future assessment models and improve the current resource management measures.

Therefore, the objective of this study is to analyse the current fishery dynamics and production of the small-scale trap fleet targetting common octopus in Galician waters. Through a compilation of official information and an intensive monitoring of the small-scale fleet, we: i) contextualize the historical fishing of common octopus by Galician fishers providing data on reported landings and notes on the changes in fishing gears and operations; ii) characterize the modern trap fleet and depict the current legislation and management measures; iii) study the spatio-temporal changes in the composition of the fleet and its dynamics providing information on fishing effort fluctuations and drivers of fishing operations, and iv) estimate expected production.

2. Material and methods

2.1. Study area

Galicia is an autonomous region of Spain located in the northwestern corner of the Iberian Peninsula, between the river Eo (43° 32′N, 7° 01′W) and the river Miño (41° 50′N, 9° 40′W) comprising ICES Divisions 9.a and 8.c (Fig. 1). The Galician coast has a length of 1498 km, representing 19% of the Spanish coastline and is characterised by the presence of the rías that are tectonic estuaries penetrating the coast almost perpendicular to the coastline. These rías receive the main fresh water contribution at their heads, and the inner positive circulation and water exchange with the shelf are both affected by the continental runoff and coastal wind-driven upwelling. Galician waters are at the northern boundary of the Iberian-Canary Current upwelling system. Coastal winds at these latitudes (42° to 44° N) are seasonal; however, more that 70% of the total variability of coastal winds occurs during periods of less than 1 month (Álvarez-Salgado et al., 2002). The combination of the topographic features and coastal orientation with the oceanographic conditions divides the Galician coast into three domains (Fig. 1): the western coast (known as Rías Baixas), the central coast (known as Ártabro Gulf), and the northern coast (known as Cantabrian Sea). These oceanographic zones are characterized by differences in the upwelling strength and timing and primary productivity (Álvarez et al., 2011; Álvarez et al., 2012).

2.2. Concepts and definitions

In this study, small-scale fishing is defined as the fishing carried out by the registered vessels in the fleet called “artes menores” in the National Census of the Operating Fishing Fleet. According to current legislation, this fleet is composed of fishing vessels up to 15 m length between perpendiculars or 18 m total length, a maximum of 50 GRT or