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Collection and validation of self-sampled e-logbook data in a Mediterranean demersal trawl fishery

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HIGHLIGHTS

- Fishers' self-sampled electronic logbook data showed agreement with observer's data.
- Self-sampled data allowed describing the spatio-temporal pattern of target species.
- Seasonal patterns detected through logbooks agreed with literature data and EBK.
- The direct involvement of fishers fosters the collection of reliable data.

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ABSTRACT

Over the last several years, a great deal of emphasis has been given to the use of participatory research to enhance knowledge co-production between fisheries stakeholders, involving fishers in the sampling of their catches both for scientific and control purposes. Indeed, this approach could complement data collection through trawl surveys and onboard observers, which is usually expensive and thus, does not allow much spatio-temporal coverage. Within the EU participatory research project, GAP2, electronic logbooks were installed on board otter-trawlers to collect haul-by-haul geo-referenced catch data in the Adriatic Sea (NW Mediterranean Sea). Between September 2012 and December 2013, catches of some of the most important otter-trawl target species (8 species including teleosts, cephalopods, and crustaceans) were recorded in 3588 self-sampled hauls. Because a major concern for the use of these data is related to their quality, self-sampling was run concurrently with a scientific observers' program, which allowed the detailed monitoring of catches from 249 hauls. The latter dataset was used to test the reliability of fishers' self-sampled data and for their validation. In all species, no significant disagreement between the two datasets was observed. The full self-sampled dataset was thus used to describe the spatio-temporal changes in catches, as derived by observers' data, allowing important insights into species' life cycles. Results agreed with available literature information and fishers' experience-based knowledge, which was thus embedded in the process of data validation and results interpretation. The collaboration between scientists and fishermen was demonstrated to be a valuable approach for generating reliable fisheries data, allowing a better understanding and quantitative descriptions of species' life cycles and the attainment of a common base of knowledge for the enforcement of spatially explicit fisheries management.

1. Introduction

The potential availability of high spatio-temporal resolution fishing effort and catch data at a large spatial scale is one of the most important novelties in fisheries science (Gerritsen and Lordan, 2011). Methods for gathering information about marine resources are traditionally divided into fishery-independent

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and fishery-dependent methods (Hoggarth et al., 2006). Fishery-independent methods are based on data collected during scientific surveys and provide estimates of stock abundance and demography (Sparre and Venema, 1998). However, this type of sampling is expensive and thus is characterized by significant limitations in terms of temporal intensity (often limited to an annual survey) and spatial resolution (the number of sampling stations for a given area). Indeed, whilst fishery-independent data have a prominent role in stock assessment and the estimation of standardized abundance/biomass indices, they present severe limits if the phenomenon under investigation is the finer scale spatio-temporal distribution of species or the assessment of catches for a given fishery métier.

Conversely, fishery-dependent methods are based on the collection of commercial fishery data obtained from logbooks, markets, questionnaires, and scientific observers on board fishing vessels, and provide information that may allow quantifying catch per unit of effort (CPUE). These data may for instance allow the estimation of fishing mortality exerted on various stocks (Hilborn and Walters, 1992) although they may embed various levels of accuracy according to their methods of collection.

The collection of fishery-dependent data through observers' programs is an expensive approach that, consequently, usually results in a small sample size (Feekings et al., 2012; Kraan et al., 2013). This is the case of monitoring programs carried out in the European Union under EC Regulation No 199/2008, which were shown to provide variable estimates of commercial catches and discards (Uhlmann and Van Helmond, 2013; Rochet et al., 2014).

The rapid advances in electronic and satellite monitoring (e.g., Vessels Monitoring System [VMS]) and data acquisition systems, being used primarily for control and enforcement purposes (EU, 2011), allow monitoring of the spatial distribution of fisheries and help estimate CPUEs. These data also allow assessment of fisheries' interactions with target stocks and the environment (Fonseca et al., 2008; Lee et al., 2010; Mullowney and Dawe, 2009; Rijnsdorp et al., 1998). Accordingly, the integration of the VMS with landing data (collected through mandatory logbooks) has received considerable attention in the last few years (Bastardie et al., 2010; Gerritsen and Lordan, 2011; Hintzen et al., 2012; Martín et al., 2014; Russo et al., 2014). Usually, VMS data are available at frequencies of thirty minutes to two hours, while logbook catch data are available at a daily frequency. This implies that an interpolation procedure is necessary to infer the fishing areas exploited each day, and that daily catches are averaged over estimated fishing positions, with the underlying assumption that catches are uniformly distributed within a daily trip (Gerritsen and Lordan, 2011). However, a vessel can cover a relatively large area in one day, depending on the skipper's fishing strategy (Russo et al., 2015), and catches may vary even at small distances as a result of several factors, including alternation in swept habitats, night–day cycle, distance from the coast, depth, etc. All this could result in a loss of fine-scale details about catches. Moreover, the quality of logbook data, for example those obtained by the official EU Electronic Recording and Reporting System (ERS; EU, 2011), is most often not verified, and could potentially be biased.

Self-sampling by fishermen, that according to Mangi et al. (2013) is related to different actions carried out to gather data/samples by their own including, among others, the collection of data and self-recording, could be a potentially attractive alternative or complement for data collection. This is because it may allow gathering haul-by-haul data and increasing the number of sampled trips at a lower cost compared to observers' programs (Kraan et al., 2013; Mangi et al., 2013). For these reasons, there is an ongoing worldwide effort to develop activities aimed at involving fishers in collecting data about their catches (ICES, 2008). The effective engagement of the fishing industry in data collection and management is an integral part of actual fisheries policies (Mackinson et al., 2011) in, for instance, the reform of the European Common Fisheries Policy (EC, 2002; Kraan et al., 2013).

A major problem in the use of self-sampled data for management purposes is related to the fact that fishermen self-sampling remains to be considered by some scientists and managers as lacking rigor, and potentially biased by misreporting (Hoare et al., 2011; Kraan et al., 2013). Fishermen are usually not keen on sharing their own data, because they fear it could be used as evidence for enforcing restrictions in their activities (Kraan et al., 2013). For these reasons, the potentiality of self-sampled data remains to be questioned, and there is the need for direct assessment and validation of its reliability and representativeness, along with a development of methodological standards and procedures for their collection and analysis. Such assessment could be achieved only when a fruitful collaboration between scientists and fishermen is enforced.

This study, relying on activities carried out in the context of the EU participatory research project GAP2 (Bridging the gap between science, stakeholders, and policy makers, www.gap2.eu), aims at assessing the strong points and drawbacks of using electronic logbooks for self-sampling in the Mediterranean Sea, with a case-study established in the Adriatic Sea demersal trawl fishery. In this context, self-sampling activities were related to the collection, assessment and self-recording of catch data at haul by haul level. The study benefited from the long term fruitful collaboration established between scientists and fishermen in the area. Specifically, the aims of this paper are: (i) to describe how we tested the potentiality/effectiveness of the use of electronic logbooks for self-sampling; (ii) to assess the quality of fishermen's haul-by-haul self-sampled data using a direct comparison with data collected by onboard scientific observers; and (iii) to assess the consistency in the spatio-temporal patterns of the most important target species by integrating self-sampled data and comparing results with available scientific knowledge and fishermen's experience-based knowledge (EBK).

2. Materials and methods

2.1. Study area and participatory setting

The Adriatic Sea (NW Mediterranean Sea) is an epi-continental basin whose depth increases from north to south and which is conventionally divided into three sub-basins: Northern, Central, and Southern. The study area was located in the Northern Adriatic Sea (18 900 km^2), in particular, in the area off the Veneto Region coast (Fig. 1). The oceanographic and biological characteristics of the Northern Adriatic Sea are mainly influenced by shallow waters (average depth, 33.5 m), moderate bathymetric gradient, and a considerable input of fresh water and nutrients from the Po river. In such geographical context, the meteorological and climatic forcings influence oceanographic parameters, determining intense annual fluctuations in temperature (5–28 °C at the surface and 12–17 °C at the bottom) that trigger seasonal migration of many target species from the western inshore areas to the eastern coasts (Abella et al., 1996; Belcari et al., 2002; Grati et al., 2013). The large nutrient load makes the Northern Adriatic Sea one of the most productive areas of the Mediterranean (Campanelli et al., 2011), and its wide trawlable muddy and sandy bottoms (Pérès and Gamulin-Brida, 1973), combined with large fishing fleets, lead to overexploitation of its biological resources (Pikitch et al., 2004; SIBM, 2010).

Research activities were based in Chioggia, the biggest fishing port of the Northern Adriatic Sea, and they focused on otter-trawlers. The port currently hosts ∼90 active bottom trawlers (about 50 otter-trawlers and 40 *rapido* trawlers; data from Chioggia Coastguard) representing about 25% of the Italian Northern