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Assessing the fishing footprint using data integrated from different tracking devices: Issues and opportunities

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ABSTRACT

Different tracking devices are currently used to record the activity of fishing vessels in space and time and to analyse the pattern of fishing effort with respect to sea substrates, resources, or socio-economics factors. Among these devices, the Vessel Monitoring System (VMS) and the Automatic Identification System (AIS) represent the most interesting and fertile data sources for fisheries investigations but an integration of these two sources was never explored. Two large VMS and AIS datasets, covering the activity of the Italian fishing vessels with length-over-all ≥15 m for the whole year 2012, were used to perform the first assessment of the features characterizing each data source, and ultimately the properties of the estimators of ecological indicators of fishing pressure obtained using these data. In this way, a dataset related to five vessels equipped by a third high frequency device (the Fishing Observing System) was used as reference for a comparative analysis of fishing activity as reconstructed by VMS and/or AIS. Moreover, the ecological indicator 5 of fishing pressure as spatial extent of fishing activity (defined within the Data Collection Framework for Fisheries—DCF) was used as a reference to test the separate and integrated usage of VMS and AIS data. Results evidenced important differences in spatial, temporal and fleet coverage between VMS and AIS. Namely, VMS is affected by a lower frequency with respect to AIS but covers a larger portion of the fleet. Furthermore, AIS mainly operates near the harbours, so that offshore activity is underrepresented. The integration of VMS and AIS data, however, allows valorising the strengths and minimizing the limits of each source. In fact, the assessment of the total spatial extent of fishing activities (as captured by the DCF indicator 5) is significantly improved by the integrated usage of VMS and AIS data.

1. Introduction

The general awareness of the spatial and temporal dimensions of fishing activity is, without any doubt, one of the main aspects in modern fisheries science. Thus, since the appearance of the Vessel Monitoring System (EC, 2003), different geo-positioning devices have been used to track and analyse the allocation of fishing effort with respect to the spatial and temporal patterns of sea substrates, resources, or socio-economics factors. A considerable number of papers describing applications of VMS in fisheries science have been published in the last decade. After the pioneering work of Witt and Godley (2007), VMS data have been used to investigate the strategic behaviour of fishing vessels (Bertrand et al., 2005, 2014; Russo et al., 2015, 2016), the spatial distribution of catches (Gerritsen and Lordan, 2011; Scarcella et al., 2014), and the impact of fishing gears on the environment (Gerritsen et al., 2013; Russo et al., 2013) and on sensitive species (Lucchetti et al., 2016). Moreover, VMS data can be used as a proxy of fishing effort in space within complex bio-economic models for predictive and management purposes (Bastardie et al., 2010, 2013; Russo et al., 2014a). In parallel with these applications, methods for handling and validat-

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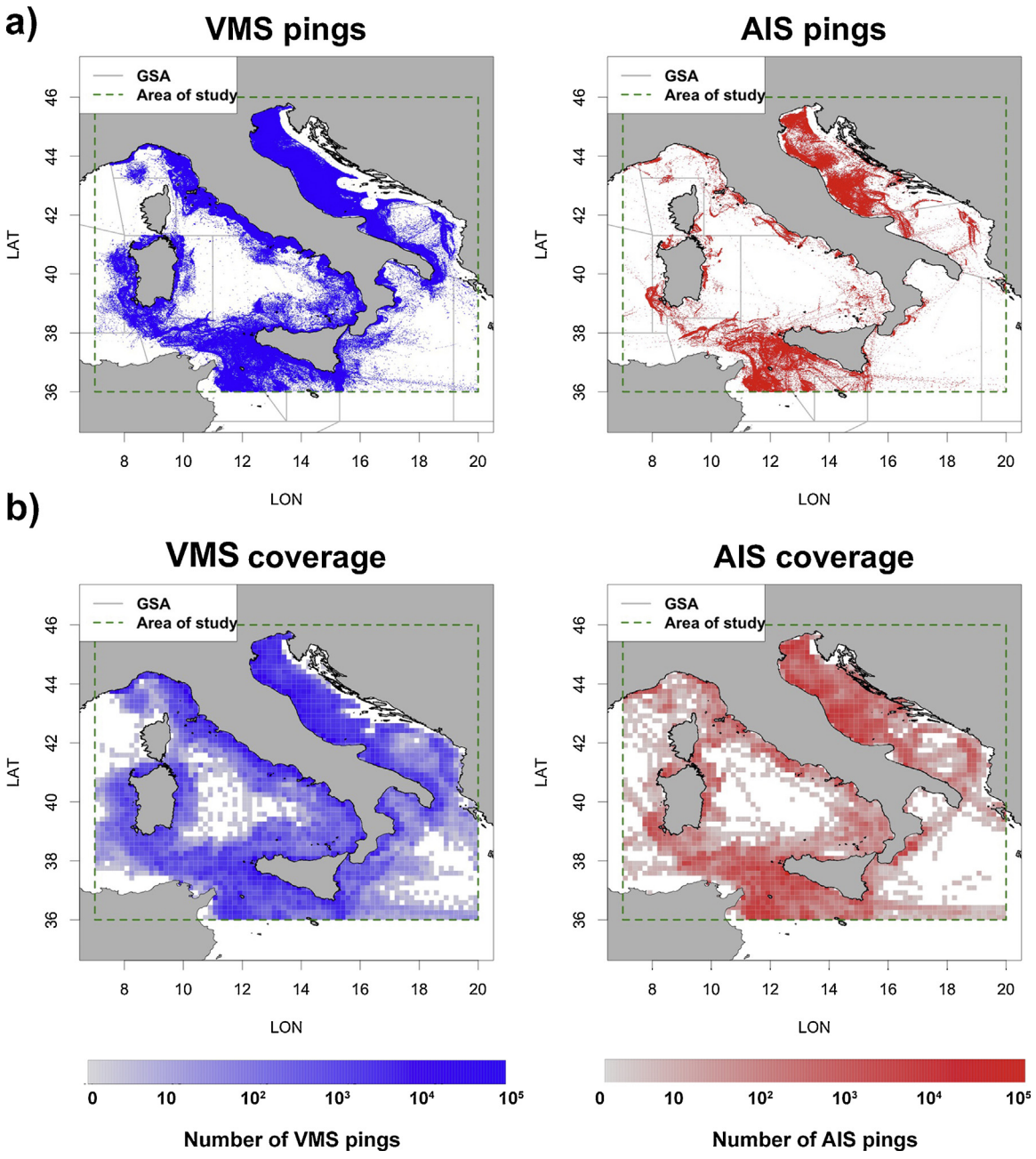

Fig. 1. (a) Geographical representation of the AIS and VMS pings for the year 2012 in the Italian seas; (b) Representation of the spatial coverage of the VMS (on the left) and AIS (on the right) devices, with respect to a 10 min grid.

ing VMS data were developed and steadily improved (Hintzen et al., 2012; Joo et al., 2011; Lambert et al., 2012; Russo et al., 2014b). Within the framework of ecological indicators, it is important to stress that VMS data were used, and are still used, as the main input for the computation of fishing pressure indicators 5–7 within the EU Data Collection Framework (DCF) for Fisheries (EC, 2008). These three indicators are devised to monitor the impact of fisheries on the eco-system and to describe the spatial extent of fishing activities (Acom, 2009). Specifically, the DCF Indicator 5 measures the spatial extent of fishing activity and allows analysing the trend of sea space use by fisheries, ultimately providing an assessment of fishing pressure with respect to sea bed communities, stocks, or management areas (Piet et al., 2007; Russo et al., 2013; Eigaard et al., 2015). Hence, the availability of VMS data definitively supported and stimulated theoretical and applied researches since, for instance, VMS data allow evaluating of the effect of spatial measures of fishery management such as Marine Protected Areas (Campbell et al., 2013; Russo et al., 2014a).

Since 2005, the VMS is mandatory for all the fishing vessels with length-over-all (LOA) ≥ 15 m (EC, 2003). Although this threshold has been generally downscaled to 12 m from 1 January 2012 (EC, 2009), a specific provision contained in the same Council Regulation (Art. 9.5) allowed almost all the Italian fishing vessels with 12 m <= LOA < 15 m to be exempted from this rule, and then we will refer to the still applied threshold of 15 m as a reference for fleet analyses. Moreover, in recent years, an increasing number of vessels were progressively equipped with other tracking devices. Among these, the Automatic Identification System (AIS) is probably the best alternative option to VMS. The AIS is an automatic tracking system used by vessel traffic services for identifying and locating