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Marine litter in south Bay of Biscay: Local differences in beach littering are associated with citizen perception and awareness

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ABSTRACT

Marine litter is often left by beachgoers. Thus, understanding beachgoers' perception and awareness is important. In this study, the amount and type of litter was measured from nine beaches of central south Bay of Biscay (Spain), and a survey about perception and awareness of the beach littering was conducted among beachgoers. The region could be considered moderately littered compared with other studies, with significant differences among beaches for litter amount and types. Plastic was the most abundant item, followed by fishing gear. Differences among beaches for awareness and litter perception correlated significantly with differences in litter amount. Perception was positively correlated with beach frequentation. Significant gender differences were found, males taking more actions against litter than females regardless how much litter they perceived. These results could be employed for designing campaigns of beach litter treatment and awareness raising, by taking into account local differences detected in this study.

1. Introduction

Marine litter is defined as all solid materials of anthropogenic origin that are discarded at the sea or reach the sea. This contamination is considered, after the habitat loss, one of the biggest threats to marine biodiversity (Goldberg, 1995; Santos et al., 2005). It has diverse origins: recreational and tourism-related litter, abandoned fishing gear, sewage-related debris and shipping waste are the main sources (Somerville et al., 2003), as well as ship discharges (Ryan et al., 2009; Dias and Lovejoy, 2012). Also, other important factor that affects litter abundance is the river proximity (Rech et al., 2014), especially taking into account tides and currents.

Plastic is the main component of marine litter, probably because it is an abundant, cheap material with many uses (Ribic et al., 1992; Derraik, 2002; Gregory, 2009; Dias and Lovejoy, 2012; Ryan et al., 2009; Pham et al., 2014). In 2014 > 250.000 tons of plastic were reported in sampling from seas all over the world (Eriksen et al., 2014). Its prevalence at sea is enormous. For example, in 2010 between 4.8 and 12.7 million metric tons (MT) reached the oceans all over the world (Jambeck et al., 2015). Plastic objects do not decompose as natural polymers do, but degrade into smaller pieces (microplastics) that are dangerous for the environment and could enter the food chain (Martins and Sobral, 2011; Browne, 2015; Jambeck et al., 2015). Other type of

litter frequently found at sea is abandoned, lost or otherwise discarded fishing gear (ALDFG), which abundance has much increased over the last decades and is expected to be associated with ports and aquaculture areas (Moore and Allen, 2000; Lee et al., 2006; Macfadyen et al., 2009; Hong et al., 2014). Rivers are other potent vehicle of litter that ends at sea and is deposited on the coast depending on tides and currents (Rech et al., 2014; Löhr et al., 2017).

Marine litter is harmful for wildlife. There are many examples of animals suffocated, smothered, entangled, immobilized due to plastics and other litter floating in the sea (Gregory, 2009; Williams et al., 2011; Paleczny et al., 2015; Sarafraz et al., 2016). Many of them die after eating plastics (Laist, 1987; Somerville et al., 2003; Gregory, 2009), and even when it is not lethal, plastic ingestion reduces food intake capability, jeopardizing animal development, and its partial digestion can be toxic (Derraik, 2002; Gregory, 2009; Williams et al., 2011; Browne, 2015). Regarding the ecosystem diversity, floating litter is a potential vector for the introduction of invasive species attached to it (Barnes, 2002; Barnes and Milner, 2004; Gregory, 2009; Dias and Lovejoy, 2012; Gil and Pfaller, 2016; Rech et al., 2016). From the human point of view, there are also many problems with marine debris. Landscape degradation due to litter accumulation is aesthetically unpleasant, driving to a decrease of tourism and subsequent income fall (Somerville et al., 2003; Nijkamp et al., 2008; Roca and Villares, 2008; Sarafraz et al.,

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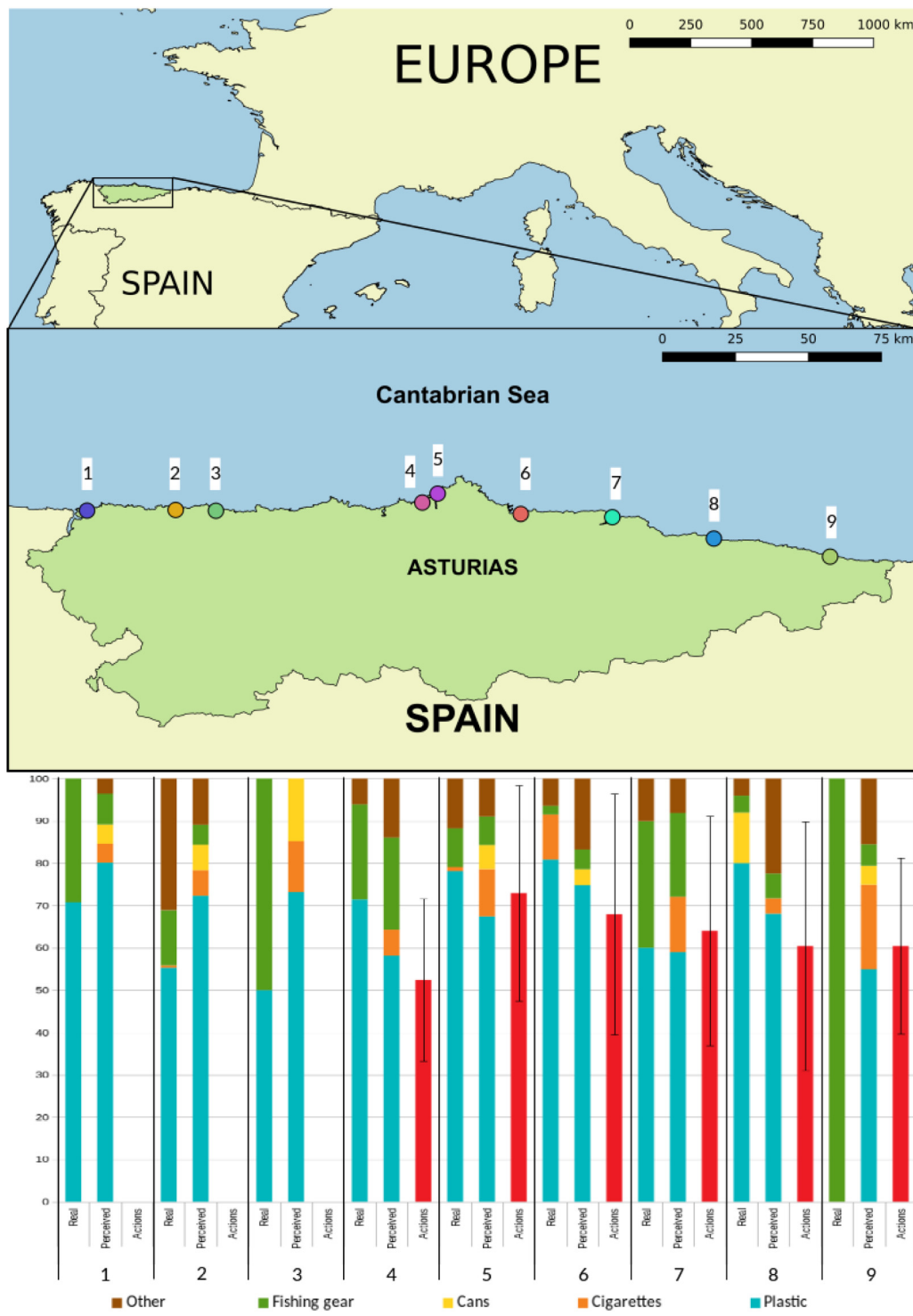


Fig. 1. Above: Location of the sampling beaches (1, Peñarronda; 2, Otur; 3, Navia; 4, Salinas; 5, Xagó; 6, San Lorenzo; 7, Rodiles; 8, Santa Marina; 9, Andrín) in Asturias region. Below: Graph showing the proportion of different types of litter (Real), their perception by beachgoers (Perceived), and mean score ($\times 50$), with standard deviation as vertical bars, of declared actions taken by the beachgoers (Actions), by beach.

2016). Off-coast litter often gets entangled with fishing gears, negatively affecting the fisheries sector, in addition to the direct effect on the fishing target species (Newman et al., 2015; Rochman et al., 2015). Last but not least, some authors have related coastal debris with human security and health problems (Thompson, 2015; Keswani et al., 2016).

All litter (including marine litter) is of anthropogenic origin (Galgani et al., 2015). Thus, humans are the main agents that can stop the problem. In the case of the coastal debris, for example, beachgoers

may generate marine litter and at the same time are affected by it (Santos et al., 2005). It is well known that an increment of public awareness drives to a reduction of littering (Rees and Pond, 1995), and involving all the actors is sought to efficiently address this problem (Löhr et al., 2017). Beachgoers and other users of the coast have a role in decision making, because their opinions and demands will be taken into account by politicians, managers and the public administration (Hastings and Potts, 2013). For managers, knowing public perceptions

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