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Spatial pattern and weight of seabed marine litter in the northern and central Adriatic Sea

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ABSTRACT

The present study analyzes spatial distribution and typology of marine litter on the seabed in the FAO Geographical Sub-Area 17 (northern and central Adriatic Sea). Two surveys were conducted during fall 2011 and 2012 and 67 stations were sampled each year. Litter items were collected using the "rapido" trawl, a modified beam trawl commonly used by the Italian fishermen to catch flat fish and other benthic species. Marine litter in the catches was sorted and classified in 6 major categories (plastic, metal, glass, rubber, wood, other). Plastic litter was further subdivided in 3 sub-categories based on its source: fishing nets, aquaculture nets and other. Plastic was dominant in terms of weight followed by metal and other categories. The highest concentration of litter was found close to the coast likely as a consequence of high coastal urbanization, river inflow and extensive navigation associated with the morphological and hydrological features of the basin.

1. Introduction

Human activities are responsible for a major decline of the world's biological diversity and environmental degradation. In the oceans, a particular form of human impact is litter, which started to be documented as a major form of pollution in the 1970s (Derraik, 2002; Mifsud et al., 2013).

Litter in the sea is a greatly underestimated component of marine pollution due to the limited geographic extensions of the study areas that make difficult to have a comprehensive understanding of the problem. Although some data on marine litter have been reported in the past, only recently this issue has received serious attention (Katsanevakis et al., 2007; Pham et al., 2014) and marine litter investigation has become an interesting issue for many scientists who focused on its impact on marine life and human activities (Koutsodendris et al., 2008).

Marine litter represents an issue of concern both at global and regional level since the 1970s (UNEP, 2009) and it is one of the descriptors of the Marine Strategy Framework Directive (MSFD) launched by the European Commission (Directive 2008/56/EC).

Marine litter has been defined as any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment (UNEP 2009) and may be categorized according to the material type.

The methodologies commonly used in litter investigation on the seafloor are visual investigation and trawl sampling (both on continental shelves and in deep sea) with fishing or research vessels (Galil et al., 1995; Hess et al., 1999; Stefatos et al., 1999; Galgani et al., 2000; Moore and Allen, 2000; Lattin et al., 2004; Pham et al., 2014). Visual investigations may be carried out by divers in shallow water (e.g., Katsanevakis and Katsarou, 2004), through submersibles (e.g., Donohue et al., 2001; Nagelkerken et al., 2001) and remotely operated vehicles (ROVs) in deep water (e.g., Galgani et al., 2000).

Marine litter can be broadly categorized according to its source into land (land-borne sources) and marine-based (sea-borne sources) items. Land-based litter mainly originates from domestic, agricultural and industrial activities and includes items washed out from land during storms and entering the marine environment through rivers, ephemeral streams and sewage inputs, as well as

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from wave action on the coast (Stefatos et al., 1999; Galgani et al., 2000; Moore and Allen, 2000; Katsanevakis and Katsarou, 2004).

Marine-based litter originates from fisheries, recreational boats, shipping, energy production, and science, and includes a large number of different materials of various sizes (Dixon and Dixon, 1981, 1983; Horsman, 1982; Ribic et al., 1992; Galil et al., 1995; Hess et al., 1999; Stefatos et al., 1999; Galgani et al., 2000; Moore and Allen, 2000; Somerville et al., 2003; Ryan et al., 2009; Ramirez-Llodra et al., 2011, 2013). High concentrations of litter are found near shipping lanes, around fishing areas and in oceanic current convergence zones (Galgani et al., 1995a). Early attempts to assess the amount of waste disposed by vessels at sea provided crude estimates of the amount dumped (Pruter, 1987; Dixon and Dixon, 1983; Galgani et al., 1995b; Rees and Pond, 1995). Official data have been reported by UNEP (2009) that estimated approximately 6.4 million tonnes of litter dumped in the oceans each year, 635,000 tonnes of which dumped illegally from ships.

Furthermore, according to its weight and shape marine litter can be divided into two categories: floating litter and sinking litter (Dae-In Lee et al., 2006). There are great differences in the distances that litter can reach from its source, depending on the buoyancy and longevity of the different types of items. For instance, while some plastics may float on the surface travelling great distances before sinking, glass and metal will sink rapidly close to sites where they were initially released (Pham et al., 2014). Floating objects eventually settle down along the shore or sink down to the seafloor due either to the increase of their weight for water filling and/or for the settlement of living organisms on them (Dae-In Lee et al., 2006).

Many studies on benthic litter describe its composition (e.g. plastic, metal, fishing gear, etc.) and origin, calculate its concentrations for each category and estimate its density on the seabed (Stefatos et al., 1999; Galgani et al., 2000; Lee et al., 2006; Pham et al., 2014). Among the various types of litter, plastics make up most of the marine litter worldwide, either on the sea surface, the seafloor and on the beaches (Derraik, 2002; Ryan et al., 2009; Pham et al., 2014). Some plastic debris are transported by wind. However, most land-based litter is carried by water via rivers and storm-water or comes from shipping traffic (Ryan et al., 2009) and it tends to aggregate in response to local sources, hydrography, prevailing winds and bottom topography (Galgani et al., 2000; Moore and Allen, 2000). However, determining the exact source of the litter found on the seafloor is very complex since several factors influence source identification.

Fishing activities are strongly affected by marine debris. Indeed, waste can remain entrapped in the propellers of the fishing vessels and fishermen may experience problems with accumulated debris in nets, they may see their catch contaminated by debris and risk to snag their nets on debris on the seabed. Debris can also reduce set net catch efficiency making them more easily detectable by fish. Moreover, cleaning the nets requires additional costs making the fishing activities less profitable and often forcing the fishermen to change location due to the high concentration of debris (Nash, 1992). The waste caught by fishing nets includes wooden crates, glass bottles, tin cans, cardboard, pieces of netting, plastic bags, bottles and other plastic objects, and food. Conversely, hooks and lines mainly catch plastic bags (Nash, 1992). As most of these materials tend not to be decomposed or destroyed easily, it is not surprising that the 70%, 57%, and 41% of benthic trawls, respectively in the Eastern Mediterranean Sea, the Gulf of Alaska and the Bering Sea, contained litter (Jewett, 1976; Feder et al., 1978; Galil et al., 1995).

On the other hand, fishing also contributes to increase the amount of litter in the oceans. In fact, as fishing nets and other items lost during fishing activities are not easily degradable, they can obstacle bottom trawling and dragnet fisheries causing a decrease of catches and of the overall efficiency of these gears (An et al., 2001; Dae-In Lee et al., 2006). Furthermore, abandoned fishing gears may have numerous negative impacts on marine resources, including ghost fishing and the entanglement of invertebrates (Balazs, 1985; Jones and Ferrero, 1985; Carr, 1987; Laist, 1987; Duguy et al., 1998; Gregory, 1999; Ramirez-Llodra et al., 2011). The impacts of marine litter on marine species, caused by entrapment and ingestion are well documented in the literature

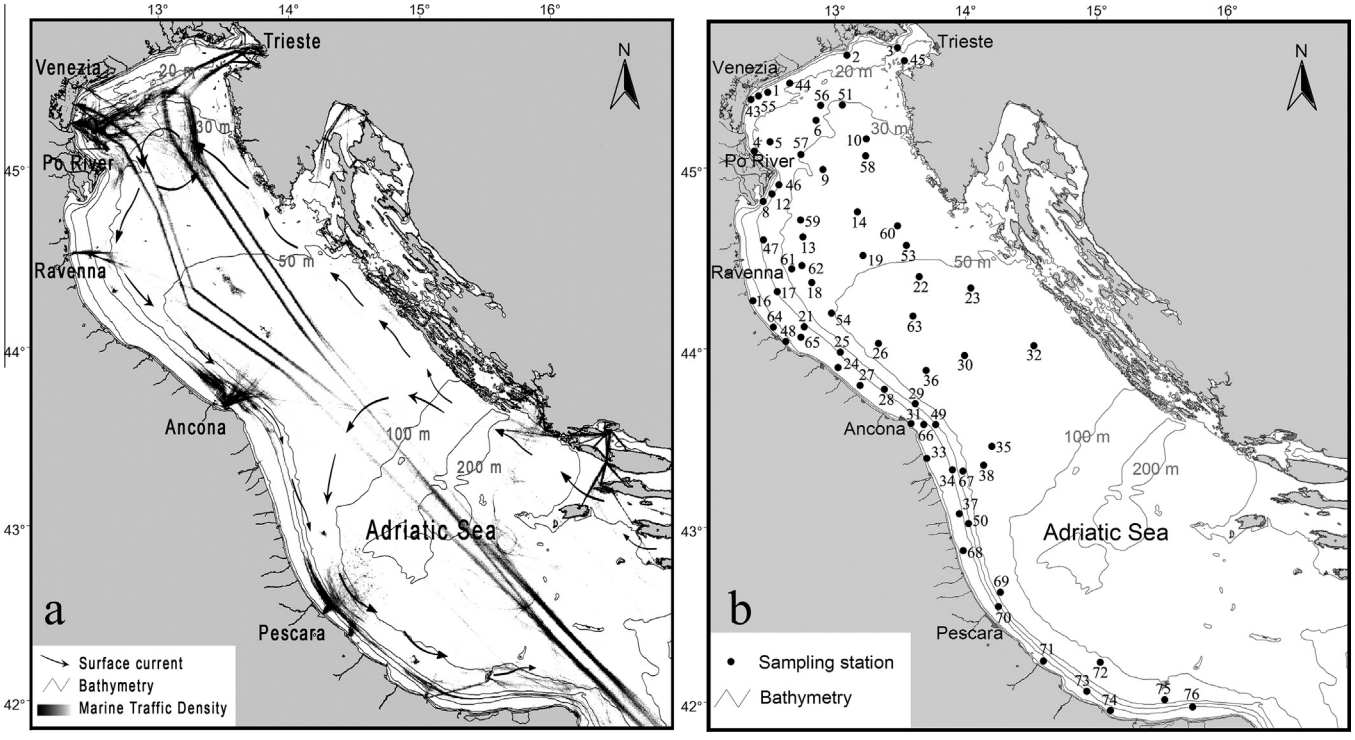

Fig. 1. Map of the northern and central Adriatic Sea (GSA 17) with the two main surface currents and ship routes (a) and stations sampled in the two survey years (b).

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