



Marine litter on Mediterranean shores: Analysis of composition, spatial distribution and sources in north-western Adriatic beaches



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ABSTRACT

Marine litter is one descriptor in the EU Marine Strategy Framework Directive (MSFD). This study provides the first account of an MSFD indicator (Trends in the amount of litter deposited on coastlines) for the north-western Adriatic. Five beaches were sampled in 2015. Plastic dominated in terms of abundance, followed by paper and other groups. The average density was 0.2 litter items m^{-2} , but at one beach it raised to 0.57 items m^{-2} . The major categories were cigarette butts, unrecognizable plastic pieces, bottle caps, and others. The majority of marine litter came from land-based sources: shoreline and recreational activities, smoke-related activities and dumping. Sea-based sources contributed for less. The abundance and distribution of litter seemed to be particularly influenced by beach users, reflecting inadequate disposal practices. The solution to these problems involves implementation and enforcement of local educational and management policies.

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1. Introduction

The Marine Strategy Framework Directive, MSFD (2008/56/EC; European Commission, 2008) establishes a framework for each Member State to take action to achieve or maintain Good Environmental Status (GES) for the marine environment by 2020. The MSFD follows a holistic functional approach identifying a set of 11 Descriptors, which collectively represent the state and functioning of the whole system (Borja et al., 2010). Descriptor 10 (D10) is identified as “Properties and quantities of marine litter do not cause harm to the coastal and marine environment” (European Commission, 2008). Marine litter is any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment; it consists of items that have been made or used by people and deliberately discarded or unintentionally lost into the sea or coastline including such materials transported into the marine environment (UNEP, 2009). Marine litter can be broadly categorized according to its source into land (land-borne sources) and marine-based (sea-borne sources) items: the former mainly originates from domestic, agricultural and industrial activities, while the latter originates from fisheries, recreational boats, and shipping (UNEP, 2009). UNEP (2009) estimated that approximately 6.4 million tonnes of litter are dumped

in the oceans each year. So, marine litter accumulation and dispersal is a growing problem at a global scale, affecting all marine environments (Gregory, 2009).

According to its weight and shape, marine litter can be divided into two categories: floating litter and sinking litter. Sandy shores are important sinks for floating litter, which after stranding generally becomes trapped in/under sand or might be blown farther inland (Kusui and Noda, 2003; Jayasiri et al., 2013). Litter stranded on the coastline is a serious affront to the visual and other aesthetic sensitivities of tourists and local visitors to beaches, as it curtails beach enjoyment: destinations where no beach cleanup is regularly conducted acquire a bad reputation and are avoided by tourists, with important consequences on the local economy. As a matter of fact, one indicator (10.1.1) for D10 in MSFD is “Trends in the amount of litter washed ashore and/or deposited on coastlines, including analysis of its composition, spatial distribution and, where possible, source” (Commission Decision 2010/477/EU). Surveys of litter stranded on the coastline are a primary tool for monitoring the load of litter in the marine environment and have been used to describe marine litter pollution. They can be used to measure the effectiveness of management or mitigation measures, the sources and activities leading to litter pollution and threats to marine biota and ecosystems (Cheshire et al., 2009).

Even though marine litter is a worldwide problem, it has been little studied in the Mediterranean area (PNUE/PAM/MEDPOL, 2009), and particularly in Italy. Surfing WoS, Scopus and Google

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Scholar databases, we found only three studies dealing with the assessment of marine litter in Italy: two concerning marine litter on Adriatic (Strafella et al., 2015) and Tyrrhenian (Angiolillo et al., 2015) deep seabed, and one concerning litter in coastal dunes from the central Tyrrhenian coast (Poeta et al., 2014). The north-western Adriatic coast, possessing the longest beaches in Europe, is home of a thriving tourism industry. Emilia Romagna and Veneto regions hold the record of tourist arrivals, with, respectively, over 5 and 3 million arrivals in 2013 (www.istat.it). The beach, which is State property, is given in concession to entrepreneurs, and is structured in “lidos” (Fig. 1a) with restaurants and leisure options, where tourists, to access and use the beach, should rent sunbeds and beach umbrellas from the beach management. Other stretches of beach (free access beaches) are kept free from lidos, and tourists are not obliged to rent beach equipment (Fig. 1b). The north-western Adriatic coast is vulnerable to litter accumulation on beaches from land sources due to river discharges and population concentration along the coast, marine sources due to aquaculture, fishing and recreational maritime activities. In lidos, beach cleanup is made daily by lido’s personnel; in free access beaches, beach cleanup is made occasionally by volunteers. Although north-western Adriatic coast is vast and of huge commercial importance, no studies have made a space inventory litter survey of beaches.

Taking into account the very scarce information available on marine litter, and that the marine litter is one of the descriptors of the MSFD, with the present study we wanted to assess, for the first time in the north-western Adriatic coast, the quality and quantity of marine litter occurring in selected free access beaches to address the gap in knowledge and to serve as a baseline for future comparisons. Knowledge of the abundances and types of stranded marine litter is important to identify possible sources,

thereby facilitating the search for solutions. The ultimate goal is to provide insights into possible approaches to manage marine litter deposition. Selected beaches do not host lidos because they are included into the two Regional Parks of the Po Delta (Veneto and Emilia Romagna), and are part of the system of the protected areas within the Natura 2000 Italian network. The study focused principally on the following questions: (i) what is the quantity, composition and distribution of marine litter in north-western Adriatic beaches, (ii) are there differences in the types of litter at different locations, and finally (iii) which are the sources of litter. We also assessed the cleanliness of selected beaches using an appropriate indicator. The ultimate purpose of this study was to provide the first assessment of marine litter (MSFD indicator 10.1.1) at the beaches in the Po Delta area.

2. Methods

2.1. Study area

Along the north-western Adriatic coast a large number of rivers discharge into the sea, being the Po River the most relevant, followed by the Adige. The area is subjected to intense marine traffic from supplier vessels for offshore activities (gas platforms), trawling vessels, and recreational boats. It is also an area of intense aquaculture, with offshore mussel farms, and coastal clam cultivations. Beaches vary in breadth from a few meters to over 200 m. Five free access beaches, included in the Po River Delta Parks and in the Natura 2000 Italian network, were chosen (Fig. 2): Rosolina (IT3270004) in the Veneto Regional Park, Volano (IT4060007), Bellocchio (IT4060003), Casalborsetti (IT4070005), and Bevano (IT4070009) in the Emilia Romagna Regional Park. Beach characteristics are summarized in Table 1.



Fig. 1. (a) A beach structured as a “lido”; (b) a free access beach.

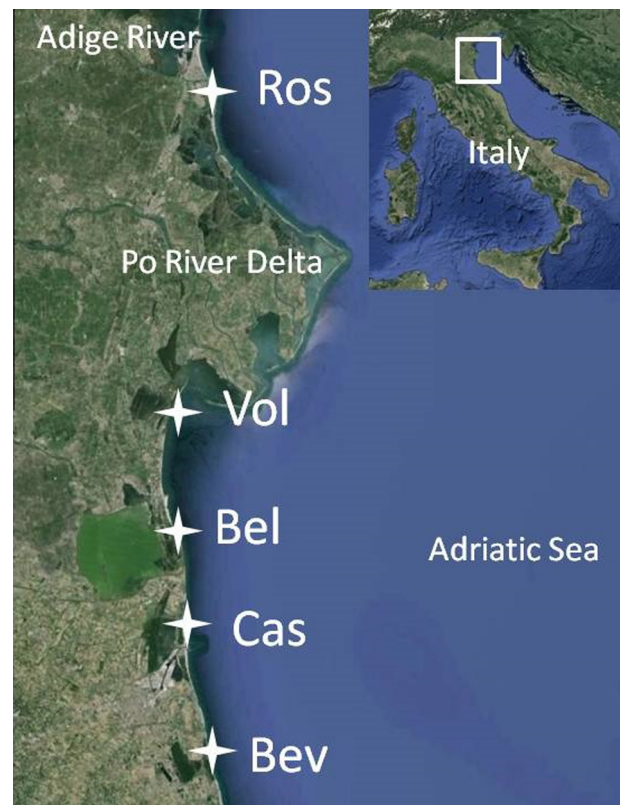


Fig. 2. Location of the study beaches (Ros: Rosolina; Vol: Volano; Bel: Bellocchio; Cas: Casalborsetti; Bev: Bevano).

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