Marine Environmental Research 111 (2015) 27–33

Contents lists available at ScienceDirect

Marine Environmental Research

journal homepage: www.elsevier.com/locate/marenvrev

First observation on neustonic plastics in waters off NW Spain (spring 2013 and 2014)

Jesus Gago [a,*], Maryvonne Henry [b], François Galgani [c]

[a] Instituto Español de Oceanografía (IEO), Subida a Radio Faro, 50-52, 36390 Vigo, Spain
[b] Institut Français de recherche pour l'exploitation de la Mer (IFREMER), LER/PAC, ZI Bregaillon, 83507 La Seyne/mer, France
[c] Institut Français de recherche pour l'exploitation de la Mer (IFREMER), ZI Furiani, 20600 Bastia, France

ARTICLE INFO

Article history:
Received 26 January 2015
Received in revised form
1 July 2015
Accepted 21 July 2015
Available online 26 July 2015

Keywords:
Marine litter
Floating plastics
Microplastics
European MSFD
NW Spain

ABSTRACT

This paper examines the presence and distribution of plastic particles in waters off the NW Spanish Atlantic coast. A pilot sampling program was initiated in 2013 to study the presence of plastic particles in surface waters. A total of 41 neuston samples were collected using a manta trawl fitted with a 333 µm mesh (21 samples in 2013 and 20 samples in 2014). Several types of plastic particles were observed in 95% of the stations. A total of 1463 plastic microparticles (<5 mm; *mps*) and 208 mesoparticles (>5 mm and <20 mm; *MPS*) were counted. Average concentrations recorded were 0.034 ± 0.032 and 0.176 ± 0.278 *mps* m^{-2} and 0.005 ± 0.005 and 0.028 ± 0.043 *MPS* m^{-2}, respectively for 2013 and 2014.

Results on this emerging topic are discussed as a preliminary step towards implementation of the Marine Strategy Framework Directive in the region. Harmonization of protocols for determination of plastic particles is urgently needed in order to compare results between regions and to ensure coherence in the implementation of the MSFD. This aspect is also important at a worldwide scale.

1. Introduction

The ubiquity of plastics in the marine environment and biota from across the globe has highlighted the prevalence of this type of pollution within our oceans. Ever since the mid-1990s, the global production of plastics has been accompanied by an accumulation of plastic litter in the marine environment (Derraik, 2002). The massive accumulation of plastics in the marine environment has recently been recognised as a major problem worldwide by scientists, national authorities and other stakeholders (see e.g. Rochman et al., 2013; Eriksen et al., 2014).

Plastic particles can enter the marine environment either directly (e.g. pre-production pellets and/or granules used as abrasives in cleaning products) or indirectly due to fragmentation of larger plastic litter (Andrady, 2011). They disintegrate in the environment and are possibly transported as pellets (<5 mm) and powders (<1 mm) used to manufacture everyday items (Andrady, 2003). The relative importance of the primary and secondary sources of microplastics in the marine environment is still unknown (Andrady, 2011). Moreover, the rate of formation of secondary microplastics is difficult to predict because there are no systematic studies available of the disintegration processes of plastics under realistic conditions (Arthur et al., 2009; Andrady, 2011).

Plastic particles are not only widely dispersed in the marine environment but are also present in the water column, on beaches and on the seabed (Barnes et al., 2009; Browne et al., 2011; Claessens et al., 2011; Collignon et al., 2012; Colton et al., 1974; Goldstein et al., 2012; Law et al., 2010; Martins and Sobral, 2011). The presence and distribution of plastic debris are strongly influenced by hydrodynamics and show high spatial variability in the open ocean and in shoreline waters (Barnes et al., 2009; Browne et al., 2010).

Europe's Marine Strategy Framework Directive (Directive 2008/56/EC, hereafter MSFD) is a key element in Europe for addressing marine litter. Many challenges arise when implementing the MSFD (Borja et al., 2011; Gago et al., 2014) and therefore a study of the impact of plastics in the marine environment becomes quite relevant (Depledge et al., 2013). In a joint effort to implement the monitoring requirements of the MSFD, the IEO (Instituto Español de Oceanografia) and the IFREMER (Institut Français de recherche pour l'exploitation de la Mer) have begun a common monitoring programme for plastics (and specifically microplastics) in surface

* Corresponding author.
E-mail address: jesus.gago@vi.ieo.es (J. Gago).

http://dx.doi.org/10.1016/j.marenvres.2015.07.009
0141-1136/

waters of along the NW Spanish Atlantic coast.

The main goal of this pilot program was to study the distribution of plastics for the first time in surface waters of the NW Spanish Atlantic coast. Two different periods (spring 2013 and 2014) and two size ranges (<5 mm, microplastics and >5 mm and <20 mm, mesoplastics) were considered, in order to comply with the MSFD requirements. The study was carried out during a regular fish stock survey conducted in spring (PELACUS). Data on weight of plastic particles were also collected. The present study provides an overview of microplastic pollution (concentration and spatial distribution) in waters off the NW Spanish Atlantic coast.

2. Material and methods

2.1. Study area: An overview of the oceanography of the region

The study area lies in one of the five sub-regions or "marine demarcations" defined by Spain (Bellas, 2014) for implementing the MSFD. General oceanographic data for the area were also studied to verify some of the hypotheses put forward on plastic distribution.

Fig. 1 shows mean patterns of surface ocean circulation, river basins, the big coastal cities and bathymetry in the study area. Only names of the three big rivers in the region are shown: Miño, Duero and Adour. The river Duero estuary is located to the south of the study area but waters are transported northwards and therefore affect the study area.

The seasonal large scale climatology interplay between the Azores high pressure cell (strengthened and displaced northward during the summer) and the Icelandic low pressure cell (weakened cell at the time) give rise to winds (northerlies) that favour upwelling off the NW Iberian coast between April and October (Wooster et al., 1976). The oceanographic patterns in the NW Iberian upwelling system reveal a conspicuous succession of mesoscale structures such as jets, meanders, ubiquitous eddies, upwelling filaments and counter-currents, superimposed on the more stable seasonal variations (see e.g. Relvas et al., 2007). The shelf in the Cantabrian Sea (southern Bay of Biscay) is narrow and the hydrography of the region is highly influenced by climatic factors among others. Warm saline waters are transported along the shelf break from autumn to early spring. Changes in wind patterns during spring trigger upwelling of central water and this effect is associated with the appearance of mesoscale structures along the NW Spanish Atlantic coast and in the Cantabrian Sea. Complex dynamics of fronts and eddies have been described for the area in spring and summer (Sánchez and Gil, 2000). These large scale climatological patterns in the ecosystem of the region are partly obscured by mesoscale activity. The oceanography of the region is largely dominated by medium sized structures that represent variability of ocean "*weather*" (Álvarez-Salgado et al., 2003). For a complete review of the physical oceanography in the region kindly see Relvas et al. (2007).

Based on the described oceanographic scenario, the study area is divided into two different zones. The NW Iberian upwelling system (from the River Miño to Cape Estaca de Bares) and the Cantabrian Sea (from Cape Estaca de Bares to the frontier between Spain and France) as shown in Fig. 1.

2.2. Microplastics in the marine environment: The MSFD approach

The MSFD calls for all the EU's marine regions and sub-regions to reach 'Good Environmental Status' (GES) by 2020. GES is defined by means of eleven qualitative 'descriptors'. The relevant criteria and indicators applicable to these eleven descriptors are defined in Commission Decision 2010/477/EU. The descriptors are very diverse, closely linked to each other and cover all aspects of marine environmental conservation and protection, including issues ranging from biodiversity to marine noise.

The MSFD's marine litter descriptor is descriptor 10 ("*Properties and quantities of marine litter do not cause harm to the coastal and marine environment*") and it is the first time ever that marine litter is addressed comprehensively in a European Directive, to protect the marine environment (see Galgani et al., 2013 for more info on marine litter in the MSFD).

Microparticles of a range of common materials including glass, metal, plastic and paper litter are undoubtedly present in the marine environment. However, the most comprehensive data available is for microscopic plastic particles (Hidalgo-Ruz et al., 2012). In the marine environment, the term microplastics was first used in 2004 (Thompson et al., 2004) and is associated with a classification based on size. Microplastics are specifically considered in the

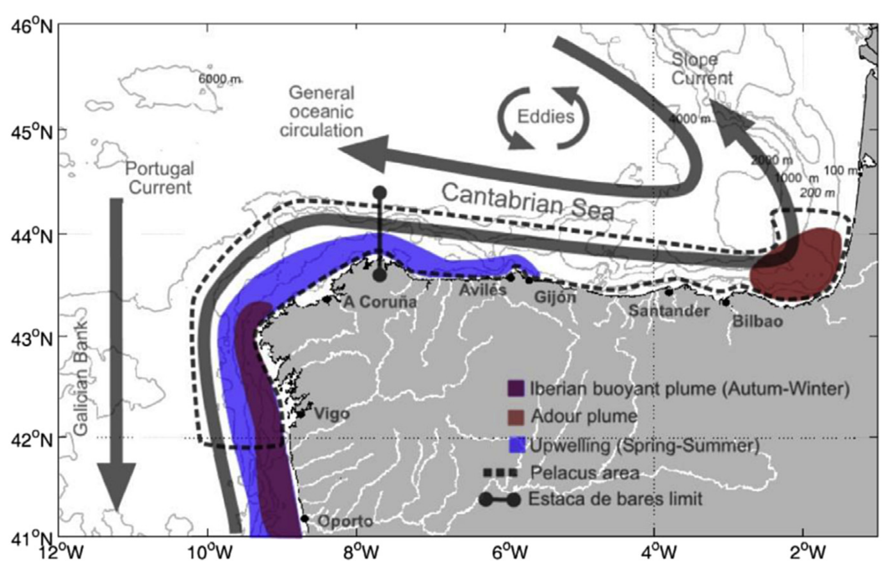

Fig. 1. Map showing the study area and the main hydrographic features. The arrows indicate surface predominant currents during spring with the slope current dominating the study area. Other relevant coastal phenomena (upwelling and plumes) are shown as shadowed areas.