Journal of Sea Research 100 (2015) 91–98

Contents lists available at ScienceDirect

Journal of Sea Research

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

Lost fishing gear and litter at Gorringe Bank (NE Atlantic)

Rui P. Vieira [a,b,*], Isabel P. Raposo [c], Paula Sobral [c], Jorge M.S. Gonçalves [d], Katherine L.C. Bell [e], Marina R. Cunha [a,*]

[a] Departamento de Biologia & CESAM, Universidade de Aveiro, Campus de Santiago, 3810-193 Aveiro, Portugal
[b] Graduate School of the National Oceanography Centre Southampton, University of Southampton, Waterfront Campus, European Way, Southampton SO14 3ZH, UK
[c] IMAR — Instituto do Mar, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, Campus de Caparica, 2829-516 Caparica, Portugal
[d] CCMAR — Centre of Marine Sciences, Universidade do Algarve, Campus de Gambelas, 8005-139 Faro, Portugal
[e] Ocean Exploration Trust, URI Narragansett Bay Campus, South Ferry Road, Narragansett, RI 02882, USA

ARTICLE INFO

Article history:
Received 15 March 2014
Received in revised form 11 August 2014
Accepted 1 October 2014
Available online 13 October 2014

Keywords:
Marine Litter
Fisheries
Impacts
Gorringe Bank
NE Atlantic
Seamounts

ABSTRACT

Studies concerning marine litter have received great attention over the last several years by the scientific community mainly due to their ecological and economic impacts in marine ecosystems, from coastal waters to the deep ocean seafloor. The distribution, type and abundance of marine litter in Ormonde and Gettysburg, the two seamounts of Gorringe Bank, were analyzed from photo and video imagery obtained during ROV-based surveys carried out at 60–3015 m depths during the E/V *Nautilus* cruise NA017. Located approximately 125 nm southwest of Portugal, Gorringe Bank lays at the crossroad between the Atlantic and the Mediterranean and is therefore characterized by an intense maritime traffic and fishing activities. The high frequency of lost or discarded fishing gear, such as cables, longlines and nets, observed on Gorringe Bank suggests an origin mostly from fishing activities, with a clear turnover in the type of litter (mostly metal, glass and to a much lesser extent, plastic) with increasing depth. Litter was more abundant at the summit of Gorringe Bank (ca. 4 items·km^{-1}), decreasing to less than 1 item·km^{-1} at the flanks and to ca. 2 items·km^{-1} at greater depths. Nevertheless, litter abundance appeared to be lower than in continental margin areas. The results presented herein are a contribution to support further actions for the conservation of vulnerable habitats on Gorringe Bank so that they can continue contributing to fishery productivity in the surrounding region.

1. Introduction

Seamounts are prominent structures globally distributed across the ocean basins rising from bathyal depths to a few tens of meters below the sea surface (Clark et al., 2010; Wessel et al., 2010). In the northeastern Atlantic, several seamounts are irregularly spread over 700 km from the SW Iberia to the Madeira archipelago (Abecasis et al., 2009; Morato et al., 2013). The Gettysburg and Ormonde seamounts, forming Gorringe Bank, are the most outstanding of these features at a close distance from Portuguese mainland (Karson et al., 2012).

Gorringe Bank harbors large areas with rocky outcrops that support vulnerable habitats such as coral gardens and sponge aggregations (Karson et al., 2012; Xavier and van Soest, 2007), and at shallower depths also coralligenous algae and kelp beds (OCEANA, 2005). Earlier surveys on Gorringe Bank, conducted by SCUBA divers and with ROVs in photic zone, provided a comprehensive study of the fish communities in shallower depths (e.g. Abecasis et al., 2009; Gonçalves et al., 2004; OCEANA, 2005) but very little is known on the benthic biodiversity at greater depths.

Seamounts are particularly exposed to human activities owing to their role for world fisheries (Pitcher et al., 2010). Threats, such as overfishing, habitat loss, and litter disposal have been already documented on some seamounts (Clark et al., 2010; Pitcher et al., 2010; Wienberg et al., 2013). Recently, Pham et al. (2013) provided the first study on marine litter on seamounts, and reported a significant amount of lost fishing gear on the summit and slopes of Condor Seamount suggesting a fishery-related origin of lost or dumped materials.

Perceptions on distribution and abundance of marine litter have increased over the last few years (Ramirez-Llodra et al., 2011). Although some studies have been conducted from shores to deeper regions of continental margins, the effects of debris on marine communities and its habitats remain poorly known (Keller et al., 2010; Miyake et al., 2011; Mordecai et al., 2011; Ramirez-Llodra et al., 2011; Wei et al., 2012). Marine debris may enter directly into the oceans through a wide variety of maritime human activities including disposal (e.g. clinker, sewage, chemical products or radioactive materials) and exploitation of natural resources (e.g. lost fishing gears, oil and gas, mining, pipelines) (Kidd and Huggett, 1981; Ramirez-Llodra et al., 2011; UNEP, 2009). Moreover, any debris discarded, disposed, or abandoned at the coast or even far inland can potentially become marine debris. In fact, terrestrial human activities are the main source of marine

* Corresponding authors. Tel.: +351 234 370969.
E-mail addresses: rpvieira@ua.pt (R.P. Vieira), marina.cunha@ua.pt (M.R. Cunha).

http://dx.doi.org/10.1016/j.seares.2014.10.005
1385-1101/

debris worldwide and are responsible for 70–80% of all debris that end up in the ocean (Bowmer and Kershaw, 2010) dragged by the wind, rain, and tides or transported by rivers (Barnes et al., 2009).

Anthropogenic debris has been accumulating in marine environments from heavily populated coastlines to remote shorelines in high latitudes, floating on the surface or sunk at the bottom of the ocean (Barnes and Milner, 2005). Factors such as coastline morphology and hydrodynamics determine the extremely irregular distribution of marine debris throughout the oceans. However, it is recognized that marine debris distribution patterns along the seabed are influenced by human activities such as fishing activities, urban development, tourism, and maritime traffic (Micheli et al., 2013; Ramirez-Llodra et al., 2013).

Here we provide an analysis of the abundance, type and distribution of litter on Gettysburg and Ormonde seamounts documented during ROV video transects conducted at bathyal depths on Gorringe Bank.

2. Material and methods

2.1. Survey area — Gorringe Bank

Gorringe Bank is a ridge with a northeast–southwest direction that extends from southern Portugal, approximately 125 nautical miles off Cape St. Vicente (Fig. 1). It is formed by Gettysburg and Ormonde seamounts and covers an area of about 9500 km^2. Gettysburg (36°33′ N, 11°34′W) and Ormonde (36°42′N, 11°09′W) peaks rise up to less than 50 m below the sea surface, while the bases of these seamounts are rooted in the Horseshoe Abyssal Plain at depths of more than 5000 m. Gorringe Bank sits on the Eurasian–African plate boundary and has been the site of intense geologic activity (Tortella et al., 1997).

2.2. Video survey

From 8 to 19 October 2011, E/V *Nautilus* revisited the Gorringe Bank. The main objective of the cruise was to document unexplored geological features of the Gorringe Bank (Karson et al., 2012), but the ROV surveys also provided relevant information on the benthic assemblages and human impacts on the seafloor. Three dives were conducted on the Gettysburg Seamount, one on the SE flank (H1201) and two on the NW flank (H1202 and H1203); and a fourth dive was conducted on the southern flank of the Ormonde Seamount (H1204) (Table 1; Fig. 2).

The dives were performed by the ROVs *Hercules* and *Argus*, a two-body vehicle system, that uses a state-of-the-art navigation system in tandem with ultra-short baseline positioning and its equipped with a high-definition video system, a high-resolution stereo still camera system and a Seabird Fastcat conductivity-temperature-depth (CTD). *Hercules* was always deployed with the deep-towed system *Argus* that floats several meters above the seafloor providing a bird's-eye view of *Hercules* on the seafloor (Bell et al., 2012).

Annotations from video footage and photos provided the data on the type and distribution of marine litter. The observations were checked thoroughly to avoid double counting (video and photo) and each fragment was counted as one item; long but continuous fishing lines were counted as one item. Litter items were categorized as fishing gear (e.g. longlines, nets and cables), glass, metal, plastic. The category "Others" includes pottery, rubber, wood and unidentified or complex items.

For the estimates on litter abundance (number of items per linear km) the following bathymetric ranges were considered: 0–125 m, 125–500 m, 500–1000 m, 1000–2000 m, and 2000–4000 m (see Supplementary material). The area of the seafloor covered by each dive varied, but was often greater at shallower depths. Therefore, in order to obtain more accurate estimates on the density of litter, the bathymetric ranges considered here were progressively wider at greater depths.

3. Results

A collection of 4832 photographs of the seafloor was taken and 124 h of video was recorded. The bathymetric range of dives was between 60 and 3015 m along a distance totalling 80.6 km (Table 1).

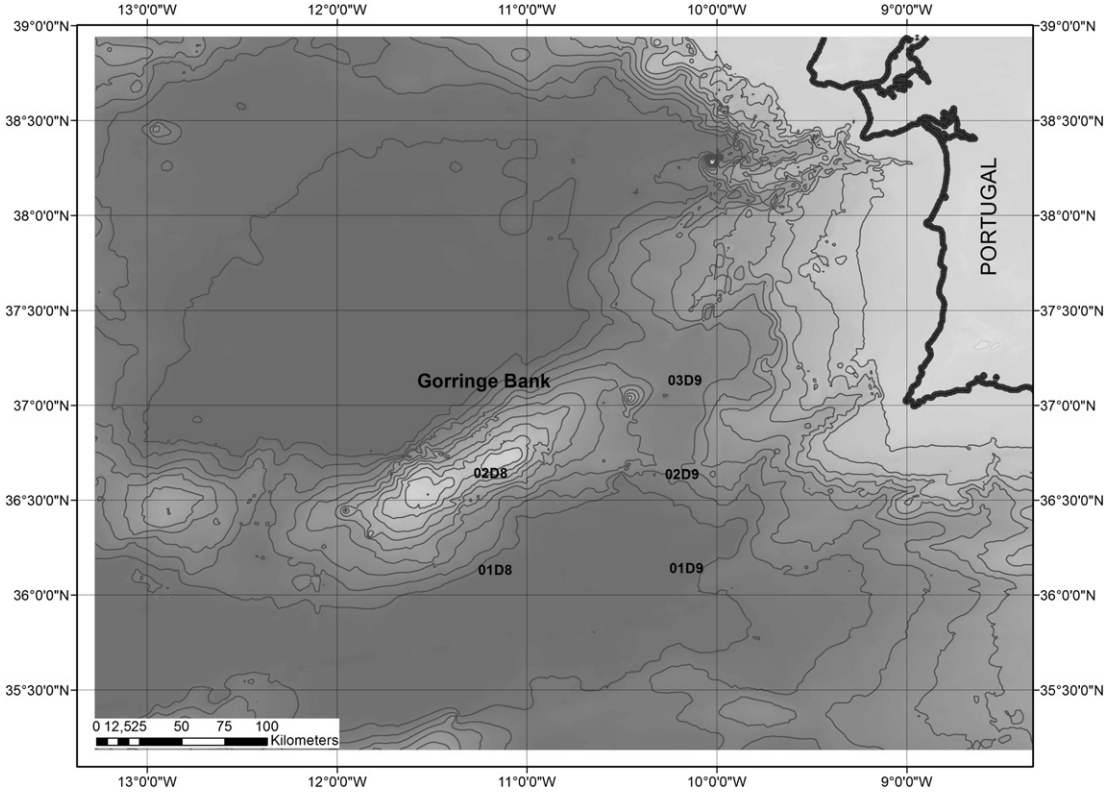

Fig. 1. Location of Gorringe Bank. Rectangles mark different subdivision areas for assessment of fishing effort in the region (see also Table 3). Background bathymetric contour lines from http://www.gebco.net (The GEBCO_08 Grid, version 20100927) (IOC et al., 2003).