Marine Pollution Bulletin xxx (2013) xxx–xxx

Contents lists available at SciVerse ScienceDirect

Marine Pollution Bulletin

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

Note

As main meal for sperm whales: Plastics debris

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ARTICLE INFO

Keywords:
Marine debris
Greenhouse
Plastics
Sperm whale
Spatial modelling
Mediterranean Sea

ABSTRACT

Marine debris has been found in marine animals since the early 20th century, but little is known about the impacts of the ingestion of debris in large marine mammals. In this study we describe a case of mortality of a sperm whale related to the ingestion of large amounts of marine debris in the Mediterranean Sea (4th published case worldwide to our knowledge), and discuss it within the context of the spatial distribution of the species and the presence of anthropogenic activities in the area that could be the source of the plastic debris found inside the sperm whale. The spatial distribution modelled for the species in the region shows that these animals can be seen in two distinct areas: near the waters of Almería, Granada and Murcia and in waters near the Strait of Gibraltar. The results shows how these animals feed in waters near an area completely flooded by the greenhouse industry, making them vulnerable to its waste products if adequate treatment of this industry's debris is not in place. Most types of these plastic materials have been found in the individual examined and cause of death was presumed to be gastric rupture following impaction with debris, which added to a previous problem of starvation. The problem of plastics arising from greenhouse agriculture should have a relevant section in the conservation plans and should be a recommendation from ACCOBAMS due to these plastics' and sperm whales' high mobility in the Mediterranean Sea.

1. Introduction

Until the late 1970s little attention was paid to non-degradable waste that was discarded in the ocean. Today the fragmentation and accumulation of plastic debris in the marine environment is proposed as one of its major problems (Prouter, 1987; Stefatos et al., 1999) or as the "most ubiquitous and long-lasting recent changes to the surface of our planet" (Barnes et al., 2009). A recent review on the topic (Gregory, 2009), has brought to light how over the past five or six decades, contamination and pollution of the world's enclosed seas, coastal waters and wider open oceans by plastics and other synthetic, non-biodegradable materials has become an increasing phenomenon (Gregory et al., 1984; Derraik, 2002; Eriksson and Burton, 2003; Barnes and Milner, 2005; Barnes et al., 2009; Ryan et al., 2009). Marine plastic pollution is becoming an issue also in remote areas of the world previously thought to be unaffected so we are facing a worldwide problem that is affecting the marine fauna (Auman et al., 2004; Provencher et al., 2010). The consequences of marine debris are varied, as are its sources (land- or marine-based), and origins (local or distant). In the same way, the more widely recognised problems in marine animals can be varied (entanglement, ingestion, suffocation, general debilitation, etc.). Over 250 marine species (including crustaceans, fish, sea-turtles, sea-birds, sea-otters, pinnipeds, sirenians and cetaceans) are known to be impacted by entanglement and ingestion (Laist, 1997). The literature on ingestion and entanglement of plastic debris is wide. The main problems identified are wounds (internal and external), suppurating skin lesions and ulcerating sores; blockage of the digestive tract followed by satiation, starvation and general debilitation often leading to death; reduced life quality and reproductive capacity; drowning and limited predator avoidance capabilities; impairment of feeding ability, etc. (e.g. Gregory, 1978, 1991; Laist, 1997). Until now, most of the existing information regarding interactions between large marine mammals and marine debris is related to entanglement, but not ingestion. Pinnipeds have been reported to die from strangulation or starvation due to entanglement (Croxall et al., 1990; Boren et al., 2006; Dau et al., 2009). In cetaceans the usual problems are related to injuries to fins (pectoral or caudal) or mouth (Northridge, 1991; Moore et al., 2009; Neilson et al., 2009). In the case of sperm whales, gill net entanglements have been reported in Ecuador (Haase and Félix, 1994) and in the Mediterranean Sea (Pace et al., 2008). Ingestion of marine debris is well documented in marine birds (Moser and Lee, 1992; Spear et al., 1995; Rodríguez et al., 2012) and sea-turtles (Tomas et al., 2002), but less so in cetaceans, although several cases have been reported worldwide (Walker et al., 1989; Laist, 1997; Baird and Hooker, 2000; De Meirelles and De Barros, 2007;

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0025-326X/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.marpolbul.2013.01.033

Jacobsen et al., 2010). Even small quantities of debris have the potential to exert a large effect on the animal – for instance, through occlusion of the intestinal tract (Tarpley and Marwitz, 1993; Gorzelany, 1998; Stamper et al., 2006; Gomerčić et al., 2009; Levy et al., 2009). One interesting example is the case of two stranded sperm whales in the coast of northern California. During necropsy, a total of 24.20 kg and 73.63 kg of marine debris including ropes, plastics and different types of nets made of floating material were extracted from their stomachs. In the first case, gastric rupture following impaction with debris was presumed to be the cause of death, whereas in the case of the second whale, the emaciated body condition the animal was found in suggested starvation following gastric blockage (Jacobsen et al., 2010). More recently, a case of a young sperm whale (5.3 m) individual has been described, in the Mykonos Island in Greece Sea with more than 100 plastic in its stomach that caused its death in Katsanevakis (2008) and Notarbartolo-di-Sciara et al. (2012).

The sperm whale (*Physeter macrocephalus*, Linneus 1758), the largest of the toothed whales, has a cosmopolitan distribution, with a large latitudinal range (Whitehead, 2003). Genetic analyses suggest that the Mediterranean sperm whales constitute a separate population (Drouot et al., 2004; Engelhaupt et al., 2009). At the moment there are no overall abundance estimates for the Mediterranean subpopulation. Even though recent bioacoustic data indicate a more consistent and frequent presence of sperm whales than previously thought in some areas of the Mediterranean Sea, like in Sicily (Pavan et al., 2008), but the Mediterranean population appears to have declined over the last 20 years, mainly due to bycatch in driftnets targeting swordfish (Reeves et al., 2006), in addition to ship strikes (Panigada et al., 2006). The species is distributed throughout the Alboran Sea and Strait of Gibraltar (Cañadas et al., 2002, 2005; De Stephanis et al., 2008; Carpinelli et al., 2011, 2012), Balearic Islands (Gannier et al., 2002; Pirotta et al., 2011), Ligurian Sea (Gannier et al., 2002) and Greece (Frantzis et al., 2003, 2011), and can travel long distances between different areas (Carpinelli et al., 2011, 2012; Frantzis et al., 2011). Little is known about the species in the Alboran Sea (Cañadas et al., 2002, 2005), in particular regarding anthropogenic interactions in this area, and, as far as we are aware, the ingestion of plastic debris has not been described as a key issue for the conservation of the species in the Mediterranean Sea.

In this study we describe the second reported case of mortality of a sperm whale related to the ingestion of large amounts of marine debris in the Mediterranean Sea (4th reported case worldwide to our knowledge), and discuss it within the context of the spatial distribution of the species and the presence of anthropogenic activities in the area that could be the source of the plastic debris found inside the sperm whale.

2. Materials and methods

2.1. Sperm whale stranding

On March 28th 2012, a sperm whale (Fig. 3) was found dead on a beach near Castell de Ferro (Granada, SE Spain). The animal was weighed, measured, and the abdominal cavity opened. All the stomach contents (Fig. 7) were recovered and transported to the Estación Biológica de Doñana-CSIC (Spain) where they were washed and dried for subsequent labelling, weighing and measuring. Type of material, diameter, colour, and putative origin of the anthropogenic remains of more than 4 cm^2 were determined when possible. All of these characteristics were used to categorize each piece of plastic into a distinct type. All the items of less than 4 cm^2 were weighted together and labelled as small plastics. The fluke of the sperm whale was compared with the catalogue created by Carpinelli et al. (2011, 2012). The catalogue includes identifications of 47 sperm whales from the Strait of Gibraltar (collected between 1999 and 2011), 57 from the Balearic Islands (1994–2004), 35 from the Corso-provençal basin (1994–2011), 33 from the Hellenic Trench (1998–2009), 105 from the Ligurian Sea (1990–2010) and from the 5511 pictures of 34 contributors included in the NAMSC (North Atlantic Ocean and Mediterranean Sea) catalogue.

2.2. Spatial distribution

Data were collected during surveys carried out throughout several research projects under the umbrella of the NGO Alnitak from 1992 to 2009 (Cañadas et al., 2005; Cañadas and Hammond, 2006, 2008; Hooker et al., 2011; Druon et al., 2012). A total of 74.187 km were sailed. There were 34 groups of sperm whale recorded involving 55 individuals during these surveys. The study area (the entire Alboran Sea, reaching from the Strait of Gibraltar to Cabo de Palos-Spain) was characterized according to several spatial and environmental variables (depth, slope, distance to 200 m and 1000 m isobaths, sea surface temperature (SST), chlorophyll a concentration (Chla), primary production, and altimetry (Cañadas and Hammond, 2006, 2008), and model-based density estimation based on spatial modelling was applied following the general methodology described in Cañadas and Hammond (2006, 2008).

3. Results

3.1. Sperm whale stranding findings

On March 28th 2012, a 10.0 m long male sperm whale (Fig. 3) was found dead on a beach near Castell de Ferro (Granada, Spain). The whale weighed around 4500 kg, and seemed to be in a state of advanced emaciation. There was no evidence of entanglement scars or other injuries. The animal was opened on April 2nd 2012. During inspection of the abdominal cavity, squid beaks were found on the exterior portion of the small intestine, and inside the stomach compartments. A large mass of compacted plastics could be seen protruding through a rupture in the first stomach compartment (Fig. 4). No fresh remains of squids were recovered. The intestines were empty. Cause of death was presumed to be gastric rupture following impaction with debris, which added to a previous problem of starvation. All of the plastic pieces and other debris were recovered. A description of the contents can be found in Table 2, and Figs. 5 and 6. The matching of the sperm whale's fluke revealed that the animal had not been photographically matched before in the Mediterranean Sea.

3.2. Density surface models: Alboran Sea

The final model for group abundance included two covariates: depth and longitude (as a proxy to distance from the Strait of Gibraltar), both highly significant, and explaining 18% of the deviance. Group density increased very steeply with depth from 0 to 500 m, slightly towards deeper waters, and showed a bimodal distribution with respect to longitude, with the highest densities towards the Strait of Gibraltar and a second smaller peak around the south of Almería (see Fig. 1). The final model for group sizes included distance from the 200 m depth contour as the only but highly significant co-variable, explaining 34.2% of the deviance. Group sizes tended to increase towards shallower waters (closer to the 200 m depth contour (see Fig. 2).

Please cite this article in press as: de Stephanis, R., et al. As main meal for sperm whales: Plastics debris. Mar. Pollut. Bull. (2013), http://dx.doi.org/10.1016/j.marpolbul.2013.01.033