Marine Pollution Bulletin 81 (2014) 80–84

Contents lists available at ScienceDirect

Marine Pollution Bulletin

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

Marine debris in bottom trawl catches and their effects on the selectivity grids in the north eastern Mediterranean

Ahmet Raif Eryaşar [a,*], Hüseyin Özbilgin [a], Ali Cemal Gücü [b], Serdar Sakınan [b]

[a] Mersin University, Fisheries Faculty, Yenişehir Campus, 33169 Mersin, Turkey
[b] Middle East Technical University, Institute of Marine Sciences, 33791 Erdemli, Mersin, Turkey

ARTICLE INFO

Keywords:
Bottom trawl
Marine debris
Selectivity grid
Plastic
Mersin Bay

ABSTRACT

In this study composition of marine debris and their blocking potential on the selectivity grid systems deployed on demersal trawls were investigated in the north eastern Mediterranean. For this, a total of 132 hauls were examined in two fishing season between 20 September 2010 and 19 February 2012. Results showed that plastic items were the most abundant debris (73% in terms of weight) and they were followed by metals (10%). Because of plastics and packing debris, it is highly probable that grids may have been blocked in 85% of trawl hauls. The bathymetric and geographical variability in the quantity of debris were evaluated, and concluded that particularly in some areas where direction of currents and bottom topography favor deposition, such devices may easily be rendered ineffective by the plastics and packing debris in particular. To solve this problem, several solution proposals are submitted.

1. Introduction

Marine debris consist 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 from land by rivers, drainage or sewage systems or wind (Galgani et al., 2010). The pollution of the Mediterranean has been recognized internationally as a serious problem, and collective measures were planned to control an increasingly broad range of pollutions (Galil et al., 1995). Despite efforts made internationally, regionally and nationally, there are indications that the marine litter problem continues to worsen (UNEP/MAP, 2011).

Sources of marine debris are classified as land based or ocean based depending on how the debris enters the water (UNEP, 2008). At the global scale, estimates indicate that nearly 80 percent of marine litter originates from land-based sources (OSPAR, 2009). As a result of this, the abundance of marine debris is generally much greater in shallow coastal areas rather than deeper waters, with the exception of some accumulation zones in the open sea (Lee et al., 2006; Koutsodendris et al., 2008; Katsanevakis, 2008). These accumulation zones in Atlantic Ocean and the Mediterranean have very high debris concentration despite being far from coasts due to large-scale residual ocean circulation patterns or local water movements (Galgani et al., 2010).

The studies of marine debris in the Mediterranean have focused on beaches, floating debris and the seabed of the continental shelf or the deep sea (Katsanevakis and Katsarou, 2004). In most of these studies that investigated debris on seabed, sampling was conducted by using demersal trawls (Bingel et al., 1987; Galil et al., 1995; Galgani et al., 1996; Stefatos et al., 1999; Galgani et al., 2000; Yılmaz et al., 2002; Katsanevakis and Katsarou, 2004; Koutsodendris et al., 2008; Topçu and Öztürk, 2010; Güven et al., 2013). These studies clearly show that plastics comprise the largest source of marine debris. Due to resistance of plastic to degradation and its continuing discard into the sea, it is the largest polluting found in the marine environment (Derraik, 2002; Topçu and Öztürk, 2010). The most significant effects of plastics on the marine animals are entanglement in or ingestion that they kill more than a million seabirds and 100.000 marine mammals and turtles every year (UNEP/MAP, 2012).

Selectivity grids are proven to be effective tools to increase selectivity of trawl nets. They are vastly used for conservation of species (turtle excluder devices, TEDs, e.g. super shooter) or to reduce discard rate of juvenile fishes in particular (bycatch reduction devices, BRDs, e.g. nordmore grid). Although, they have been found very effective, there is a clogging or blocking risk in highly polluted marine areas.

There are two primary aims of this study. First is to determine debris composition according to material and use, and second is to evaluate the blocking possibility of selectivity grids to see whether grids will work because of debris in Mersin Bay.

* Corresponding author. Tel.: +90 545 4710488.
E-mail address: raiferyasar@gmail.com (A.R. Eryaşar).

http://dx.doi.org/10.1016/j.marpolbul.2014.02.017
0025-326X/

2. Materials and methods

This study was carried out in conjunction with a project titled "investigations to improve species and size selectivity in Mersin Bay trawl fisheries". A total of 132 hauls were carried out onboard commercial trawler 'Azim' (18 LOA, 350 HP/261 kW engine power) in two fishing season between 20 September 2010 and 19 February 2012. Hauls were performed between 19 and 178 m depth, and lasted 80–271 min. Towing speed varied between 2.3 and 2.8 knots.

After the trawl codend was dumped on deck, marine debris was sorted from the catch. Then, the bulk of debris was kept on deck for a while to remove the seawater. The plastic materials were wringed out by hand to filtrate the water. Subsequent to this process, all marine debris items caught in a haul were classified, and then weighed in groups. Although quantification methods vary, marine debris is mostly calculated as the number of items, by weight or size (Galil et al., 1995; Lee et al., 2006) and the choice of unit to quantify the debris is very important because variance of materials may cause distortion to the results (Galil et al., 1995; Spengler and Costa, 2008). Lastly, to determine the blocking possibility of selectivity grids, all items were brought together and surface area of plastic bags and packing debris was estimated in each haul, under three categories: less than 0.1 m^2, between 0.1 m^2 and 1 m^2, and larger than 1 m^2. Dimensions of super shooter (120×80 cm) and nordmore grids (80×60 cm) used in selectivity studies and tested in project mentioned above was taken into account to assess the blocking possibility. Debris components were initially classified according to their material in the following seven categories: plastic, wood, metal, glass, combined (consisting of more than one material) and others. They were also grouped into the following four categories according to usage: packaging, clothing, fishing gear, and others.

The concentration of debris on the seafloor was calculated with debris per unit effort (DPUE). DPUE was estimated using the following equation:

$$DPUE = D/f$$

where D is weight of debris (kg) caught during the trawl operation and only those accumulated in the codend were taken in account and the others entangled on the wires, brindles etc. were disregarded. f denotes for effort and given that the trawling speed did not change remarkably during the operation the haul duration (hour) was assumed to be a good indicator to standardize the quantity of the debris.

The standardized quantities were statistically analyzed to explain the variability in the debris accumulation. Two explanatory variables, namely "depth" and "longitude" were chosen on the basis of their capacity, to examine the accumulation pattern of debris. Generalized additive models (GAMs) were applied to explain the variability in the debris accumulation. The "depth" was the average depth of the tracked line during the trawl haul, and "longitude" was the longitude of the midpoint of the haul track. Such approach was chosen due to non-linear relationships between predictor and response variables. In addition GAM allowed examining the relative influence of each parameter. Analyses were done using *mgcv* in R version 3.0.1 (R Development Core Team, 2013). The GAM was fitted assuming a quasi-Poisson error distribution in order to account for the overdispersion in the DPUE data (variance was greater than mean). All predictors in the model were included as smoothed terms. Thin plate regression splines were used as penalized regression smoothers. The smoothing level of the model, in other words balance between the model flexibility and generalization ability was determined based on the scoring as suggested by Wood (2006) available in the "*mgcv*" library (Wood, 2013). As the scale of the overdispersion of the data has not been known prior to analysis the "generalized cross validation" scoring method was selected (Wood, 2013). The goodness-of-fit was analyzed with regards to the percentage of explained deviance.

3. Results

Study area and middle points of each haul are shown in Fig. 1. In a total of 132 hauls conducted in Mersin Bay, total weight of marine debris entered the trawl codend was 227.34 kg. Debris density

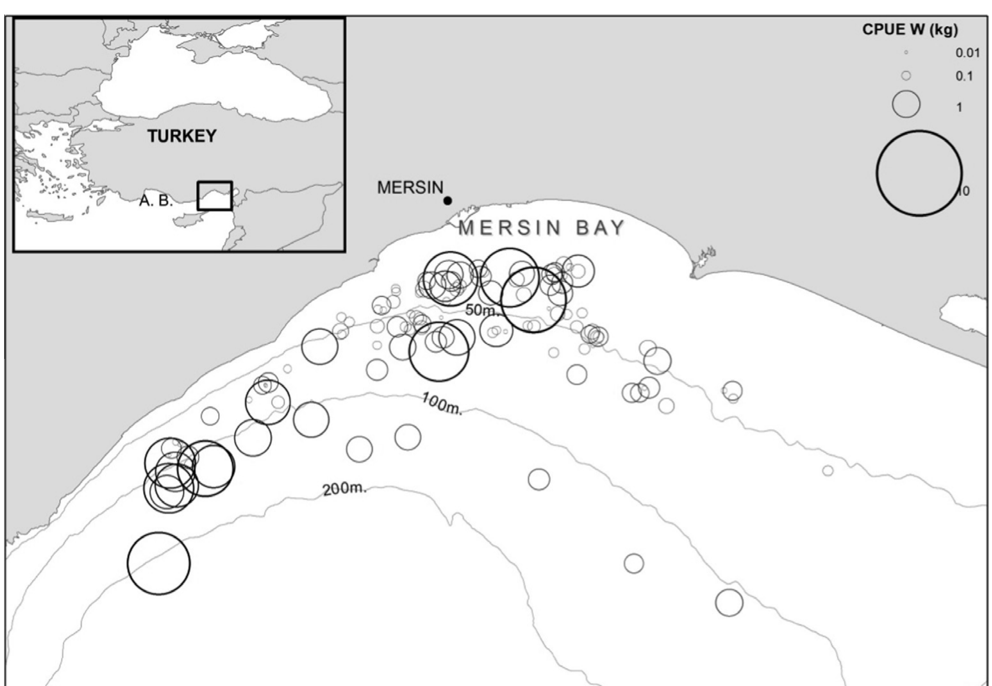

Fig. 1. Study area and middle points (each circle represents weight of debris pear hour) of hauls for two fishing season, 20 September 2010 – 19 February 2012 (A.B. shows Antalya Bay).