TITLE

Composition, spatial distribution and sources of macro-marine litter on the Gulf of Alicante seafloor (Spanish Mediterranean).

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ABSTRACT

The composition, spatial distribution and source of marine litter in the Spanish Southeast Mediterranean were assessed. The data proceed from a marine litter retention programme implemented by commercial trawlers and were analysed by GIS. By weight, 75.9% was plastic, metal and glass. Glass and plastics were mainly found close to the coast. A high concentration of metal was observed in some isolated zones of both open and coastal waters. Fishing activity was the source of 29.16% of the macro-marine litter, almost 68.1% of the plastics, and 25.1% of the metal. The source of the other 60.84% could not be directly identified, revealing the high degree of uncertainty regarding its specific origin. Indirectly however, a qualitative analysis of marine traffic shows that the likely sources were merchant ships mainly in open waters and recreational and fishing vessels in coastal waters.

HIGHLIGHTS

1. 75.9% of marine litter (by weight) was composed of plastics, metal and glass.
2. Glass and plastics were mainly found close to the coast.
3. There were metal accumulation zones in both open and coastal waters.
4. Fishing activity was the source of 29.16% of marine litter.
5. Recreational vessels and shipping were the other main likely sources.

KEYWORDS

GIS; Macroplastics; Fishing vessels; Recreational vessels; Shipping; Debris retention.

1. INTRODUCTION

Marine litter is a consequence of human action and behaviour, whether deliberate or accidental. It is also the result of deficient waste management and a lack of public awareness of the potential consequences of inappropriate waste disposal (UNEP, 2009).

Marine litter is defined as any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment (Galgani et al., 2013). It includes any item made or used by people and deliberately discarded or unintentionally lost in the sea and along the coastline, or transported into the marine environment by rivers, drainage, sewage systems or winds. This definition does not include semi-solid remains of for example vegetable and mineral oils, and chemicals that often pollute sea and shores. The Technical Subgroup on Marine Litter under the Marine Strategy Framework Directive suggested a Master List of Categories to differentiate marine litter by size (macro, meso and micro) and by material (8 materials with 217 categories) (Galgani et al., 2013).

Around 6.4 million tonnes of litter ends up in the oceans each year, which is distributed among all the oceans in both densely populated and remote areas far from human contact (UNEP, 2009). The increase in marine litter is closely linked to the development of plastics worldwide (Bergmann et al., 2015). Since the 1950s, the total amount of plastic produced (and thus its waste) has increased continuously at about 4 % per year, to an estimated 288 million tonnes in 2012 (Ramirez-Llodra et al., 2013; Bergmann et al., 2015). As a consequence, the abundance of plastics at sea has significantly increased over time (Thomson et al., 2004). In the meantime, a large amount of other marine litter categories has also proliferated, such as metal, glass, rubber, wood, paper, textile or fishing items (Serrano et al., 2012; Ramirez-Llodra et al., 2013; CIESM, 2014; Ioakeimidis et al., 2014; Neves et al., 2015a; Strafella et al., 2015). Marine litter is present on beaches, floating, on the seafloor, inside and on biota and as micro-litter in the environment (Galgani et al., 2013). At sea, an estimation of the marine litter distribution shows 15% floating on the sea surface, another 15% remains in the water column and 70% lies on the sea floor (UNEP, 2005).

Marine litter is certainly a problem due to its causing detrimental effects on the environment, whether social, economic or ecological damage (Nash, 1992; Barnes, 2002; Katsanevakis et al., 2007; Baeta et al., 2009; Gregory, 2009; UNEP, 2009; Mouat et al., 2010; Andrady et al., 2011; Cole et al., 2011; Ramirez-Llodra et al., 2011; Serrano et al., 2012; Neves et al., 2015b).

The Mediterranean Sea is the most affected area in the world with the highest amounts of municipal solid waste generated annually per person (208-760 kg/year (D-waste, 2014). Considering already existing data, this sea may be the most affected in Europe, with densities higher than 100,000 items/km^2 on the seafloor close to metropolitan areas (Galgani et al., 2013). It also has the fourth highest concentration of floating marine litter in the world with 22,000 tonnes, representing 9% of the total (Eriksen et al., 2014; Suaria et al., 2016). The quantity of marine litter shows spatial variability across the Mediterranean Sea (Galgani et al., 2013), but on the seafloor in some areas it is equal to or greater than the biomass of megafauna (Ramirez-Llodra et al., 2013).

Two main categories of litter sources can be distinguished: land-based and ocean-based. Land-based sources include urban areas, industry, tourism, harbours, unprotected landfills, sewage outflows and accidental losses carried to the sea by local winds, rivers and runoffs. Ocean-based sources comprise shipping, ferries, fishing vessels, recreational boats and offshore installations, including aquaculture farms (Galgani et al., 2013; CIESM, 2014; Strafella et al., 2015; Pasquini et al., 2016; Melli et al., 2017).

On examining every item of marine litter individually, some can be attributed to sources such as fishing activities, sewage, tourism (Galgani et al., 2011) or shipping (Ramirez-Llodra et al., 2013), with a high level of confidence. These findings provide valuable information to set up marine litter reduction measures (Galgani et al., 2011). However, total identification of sources is generally very difficult, since some items may have several possible sources (Strafella et al., 2015; Pasquini et al., 2016; Melli et al., 2017).

The wide distribution, impact and persistence of marine litter are of particular concern regarding human and environmental health (Engler, 2012). Consequently, in recent years marine litter is now subject to increased interest from both researchers and policy makers, due to the need to reduce it significantly (Mouat et al., 2010). In fact, it is specifically addressed by EU legislation in the Marine Strategy Framework Directive (MSFD 2008/56/EC). Identifying the sources of marine litter is the first step in establishing measures to reduce marine litter, in order to prioritise the effort and focus on the most important culprits.

Through the MSFD, the European Commission lays down the framework for Member States (MS) to reach a Good Environmental Status (GES) for EU marine waters by 2020, setting 11 descriptors (Directive 2008/56/EC). Among them, descriptor number 10 focusses on litter, defining the GES when *properties and quantities of marine litter do not cause harm to the coastal and marine environment* (Directive 2008/56/EC).

According to the Commission Decision 2010/477/EU, descriptor 10 has indicators pertaining to the *Characteristics of litter in the marine and coastal environment (10.1)* and *Impacts of litter on marine life (10.2)*. The former includes *the trends in the amounts of litter […] deposited on the* seafloor*, with analysis of its composition, spatial distribution and, where possible, source* (10.1.2).

In 2012, Spain developed a Marine Strategy for its territory, establishing five marine areas. One of them is the Levantine-Balearic area in the Western Mediterranean Sea, comprising the Mediterranean waters between Gata Cape the French border and the Balearic Islands. The Marine Strategy report for this area shows marine litter reference levels based on the 2006, 2007 and 2010 data. However, it also shows information gaps and research was and is still required regarding the composition, distribution and possible sources of litter (Serrano et al., 2012).

The main objective of this work is therefore to determine the composition, spatial distribution and when possible source, of macro-litter deposited on or over the continental shelf. To achieve this goal, a litter retention programme was established with the cooperation of two trawling fleets, according to the protocols issued by the

European Commission in the Guidance on Monitoring of Marine Litter in European Seas (Galgani et al., 2013). The information provided by this study will aid in improving marine governance, awareness and ecosystem health.

2. MATERIAL AND METHODS

2.1. Study Area

The study area is the Gulf of Alicante in the Western Mediterranean Sea (Fig. 1), which belongs to FAO Geographical Sub-Area 6. This zone has several important harbours and about 11,683 km^2 of continental shelf and slope, where diverse commercial and recreational activities are carried out (Fig. 1). The whole fishing fleet in the Gulf of Alicante comprises 33 trawlers, 231 small-scale boats, 1 surface longline and 8 purse-seiners. All of them fish from harbours such as Campello, Alicante, Santa Pola, Guardamar, Torrevieja and San Pedro del Pinatar. However, many purse seiners and longliners from other Spanish Mediterranean ports are present seasonally in the study area and in many cases they land their catches at some of these ports. This roaming fishing traffic increases the presence of vessels in the study area.

The coast of the study area is a tourist place with areas of more than 100000 habitants in summer and a notable afluence to the beachs the whole year. The area also has a well-developed coastal tourist industry along the whole coast and an important port in Alicante. There is notable maritime passenger traffic connecting the Spanish mainland with the Balearic Islands and also the nearby island of Tabarca. Merchant ships also transit the Mediterranean around here, with dense maritime traffic between North Africa, the French and Italian coasts, and also Atlantic ports (Autoridad Portuaria de Alicante, 2014).

The harbours in the study area offer 11,875 moorings for recreational vessels (Fig. 1) with a high rate of occupation (CARM and Comunitat Valenciana) Recreational boats from other areas also cross the study area (www.fleetmon.com).

There are several aquaculture fish farms in the study area in two main areas, one located off San Pedro del Pinatar, which was set up in 2002 with 3.05 km^2 and produces 10,500 Tm/year as a maximum. The other was established at Guardamar del Segura in 1998 with 1.22 km*2*, producing 4,750 Tm/year maximum (Generalitat Valenciana, 2001; Generalitat Valenciana, 2009; Comunidad Autónoma de la Región de Murcia, 2015). Aquaculture activities in the study area are targeting gilthead sea-bream (*Sparus aurata*) and sea-bass (*Dicentrarchus labrax*).

There are three protected areas in the study area. Two Marine Protected Areas (MPAs): Cabo de Palos-Islas Hormigas established in 1995 covering 19.31 km2 and Isla de Tabarca established in 1986 covering 14.54 km2. A Special Protected Area (SPA) for Birds was set up in 2000 in Isla Grosa with 0.18 km2 (MAPA, 1986; MAPA, 1995; Comunidad Autónoma de la Región de Murcia, 2010). These three protected areas attract a great number of recreational vessels.

Study area hosts several ravines. They are usually dry and eject water into the sea only a few times a year, mainly in autumn. There is a small river (Rio Segura) with a flow of 0.34 l/s/ km2 at the mouth of the river (Gil-Olcina, 2000).

2.2. Data Collection

Clean Fishing Grounds). Marine litter was caught by commercial trawlers (otter trawl) from Santa Pola and Torrevieja harbours between February 2014 and August 2014. The behaviour pattern of the crew was checked by a specific on board observer for 20 fishing days to chose the more reliable trawlers which carried to the dock all the marine litter caught. Twelve trawlers with 303 fishing days and 886 hauls were selected. The total amount of marine litter caught by each vessel per day was selected to make the analysis. Marine litter was weighed by an observer using a dynamometer Bsuper Mart, model WH-A08. Every fishing day, the observer landed and weighed the marine litter at dock. The main reason for using weight instead of number of items was that some litter categories can break into small pieces, impeding the quantification of single items without overestimating abundances (Ramirez-Llodra et al., 2013; Strafella et al., 2015; Pham et al., 2014). The trawler gear used was equipped with either 40 mm square mesh or 50 mm diamond mesh netting in the codend. The depth range was between 50 m and 700 m.

Bathymetry was provided by the Spanish Oceanography Institute. Position coordinates of fishing vessels were obtained from the Vessel Monitoring System (VMS) provided by the General Secretary of Fisheries which belongs to the Ministry of Agriculture, Food and Environment of Spain. The position coordinates of other vessels are taken from the Automatic Identification System (AIS) provided by www.fleetmon.com and www.marinetraffic.com. This information is complemented with the recreational moorings of the harbours.

2.3 Data Analysis

Composition of the macro-marine litter (size >25 mm) was classified as described by the specific protocol of the European Commission Guidance on Monitoring of Marine Litter in European Seas (Galgani et al., 2013) into 7 main categories according to material: *Artificial Polymers, Rubber, Cloth/Textiles, Paper/Cardboard, Processed/Worked Wood, Metal, and Glass/Ceramics* (Galgani et al., 2013). Materials outside or overlapping these categories were included as *Other* and *Mixture* respectively, making 9 categories in total.

The main 9 categories were broken down into other secondary subgroups as follows: *Artificial Polymers* into bags, bottles and fishing gear pieces (nets, longlines, pots etc.), *Metal* into cans, paint tins, gas bottles, oil drums and cables/hawsers, *Glass/Ceramics* into bottles, *Cloth/Textiles* into cloth, rags, gloves and shoes, *Rubber* into fishing gear pieces and boots, *Processed/Worked Wood* into fish crates, *Paper/Cardboard* into boxes/cartons and tetrapacks. *Other* refers to materials other than these and *Mixture* to litter composed of several different materials.

To assess spatial distribution, the study area was delimited by cells of one square nautical mile since this size is a good balance between data resolution, data confidentiality and study area size. Data were imported into a Geographic Information System (the open-source software QGIS Version 2.12.1-Lyon). The coordinate reference system used was ED50/TM 0 N. Marine litter weight was standardised for trawled area as quantity per area (kg/km2) using the gear width measured between the wings and the length of the haul.

An assumption was made in the standardization of marine litter. It was assumed that all the hauls of a vessel from the same fishing day had the same marine litter density. The marine litter caught by a vessel in a fishing day was divided equally into the number of hauls of the vessel. Using the VMS data, the distance and position of each haul was obtained. Employing the width of the gear of each vessel the the trawled area of each haul was determined. The marine litter density of each haul was obtained dividing the amount of the marine litter of each haul and the trawled area.

The track of each haul was cut into the segments that overlap the cells. The marine litter density of the haul was assigned to each segment. The cells have several segments from different hauls. The weighted average of the densities of the hauls that are within each cell were calculated by the segment distance. The weighted average density of each marine litter category, and total litter, were calculated for each cell.

The sources of ocean-based marine litter were classified when obvious, such as fishing activity. When this was not clear, marine traffic in the study area were mapped to establish cell by cell their relationship with the litter categories. As Ramirez-Llodra et al. (2013) argued, when heavy litter (glass, metal and clinker) is throw up to the sea sinks directly to the seafloor. Therefore, heavy litter can help to identify the vessel-based sources (Koutsodendris et al., 2008; Ramirez-Llodra et al., 2013; Ioakeimidis et al., 2014; Strafella et al., 2015). The marine traffic density was calculated in each cell for each vessel type as Merchant Ships, Fishing Vessels, Passenger Ships and Recreational Vessels. A total of 750,074 points were used for 4,470 vessels. Distance sailed (km) through each cell (km2) was calculated for 2015, thus the density units were km/km2 year (1/km*year).

3. RESULTS

3.1. Litter composition

A total amount of 5333.1 kg of marine litter was trawled from the study area. The proportion identified in detail was 50.71% (2709.7 kg) and the remaining 49.29% (2623.4 kg) was only weighed as *Mixture* of different materials. Table 1 shows the marine litter composition.

3.2. Spatial distribution of litter

It should be noted that the 237 km^2 of trawled area refers to places amenable to trawling, thus excluding incompatible rocky areas or areas shallower than 50 m where trawling is not allowed. Marine litter was found in all of the 886 hauls. The amount of 5333.1 kg was used to map the *All Materials* category in the study area (Fig. 2). Litter density in the study area varied among the cells and increased from north to south and from the sea to the coast (Fig. 2).

The amounts identified in each litter category were mapped (Figs. 3 to 7). *Artificial Polymers* were the most abundant (Table 1) with a density range of 0-11.6 kg/km^2. Overall, that density increases close to the coast but some isolated cells also had a high density of plastics (Fig. 3). *Metal* is the second most abundant category, with a heterogeneous density. Four areas stand out, with a high density of cans, paint tins, gas bottles, oil drums and cable (Fig. 4). The *Glass/Ceramics* distribution shows an overall trend increasing from northeast to southwest. A substantial accumulation area was situated in the southwest (Fig. 5). *Textile* density is heterogeneous since some areas have none and others have up to 6 kg/km^2 (Fig. 6). It must be noted that although the cloth was thoroughly drained it was weighed with some moisture. The distributions of the remaining categories: *Other, Rubber, Processed/Worked Wood* and *Paper/Cardboard* were not mapped because of their low densities and high dispersion over the study area.

3.3. Litter sources

The sources of 29.16% (790.1 kg) of the identified marine litter (2709.7 kg) were successfully determined. With a high level of confidence, this portion of marine litter came from fishing activity and accounted for: 68.1% of all *Artificial Polymers* (mainly nets, longlines and pots), 37.5% of all *Rubber* (gear parts and boots), 26.1% of all *Processed/Worked Wood* (e.g. fish boxes) and 25.1% of all *Metal* (gear parts).

This 29.16% can be disaggregated according to fishing gear as Trawling 12.40% (336.1 kg), Octopus pots 8.46% (229.2 kg), Gillnet 4.33% (117.3 kg), Longline 2.48% (67.1 kg), Shrimp traps 1.24% (33.6 kg) and Purse Seine 0.25% (6.8 kg). Overall, densities of fishing vessel traffic and marine litter with fishing as source had a similar distribution as one moves away from Santa Pola, the main fishing harbour in the area (Figs. 7 and 8). It must also be highlighted that during the marine-litter retention programme some fishers were seen throwing debris into the sea, mainly metal cans, glass bottles, rags and packing plastics. Thus, some fishing vessels taking part were themselves the source of an unquantified proportion of marine litter.

Figs. 8 to 11 show the traffic of Fishing Vessels, Merchant Ships, Passenger Ships and Recreational Vessels. Some of their routes overlap but traffic through certain areas consists of one or two kinds of vessel. The distribution of *Glass/Ceramics* in the study area was wide but highlights an accumulation zone in the south west (Fig. 5). Very low or no traffic of Merchant and Passenger Ships was observed in the *Glass/Ceramics* accumulation area (Figs. 9 and 10). However, recreational and particularly fishing vessels are active in that area (Figs. 8 and 11). Many of the recreational vessels have their mooring points close to the Glass/Ceramics accumulation zone (Fig. 1). That area hosted 48.2% of the moorings in the study area. It is noteworthy that the proportion of Recreational Vessels with AIS was low (Fig. 11), most do not have it (Fig. 1). We assume that the traffic of recreational vessels may be higher in coastal waters close to their mooring points and decrease with distance from the harbours. It may also be higher close to harbours with more recreational moorings.

Some *Metal* accumulation zones are below Merchant Ship routes or where the traffic is mainly that of coastal Fishing and Recreational vessels (Figs. 4 and 9). The *Artificial Polymers* distribution is broad, and concentrated mostly in coastal waters along Fishing Vessel routes, where there is very little or no traffic of Merchant, Passenger, and Recreational Vessels (Figs. 3 and 8 to 11). *Textiles* are linked to the routes of Fishing and Recreational Vessels in coastal waters and to those of Fishing Vessels and Merchant Ships in deep waters (Figs. 6 and 8 to 11).

4. DISCUSSION

4.1. Litter composition

The highest proportions (75.9%) of marine litter by weight were *Artificial Polymers, Metal,* and *Glass/Ceramics*. This trend is similar to those observed in other studies (Koutsodendris et al., 2008; Neves et al., 2015a; Strafella et al., 2015; Ioakeimidis et al., 2014; Galgani et al., 2010).

The proportion by weight of *Artificial Polymers* (36.53%) in the study area is notably lower than other places along the Mediterranean continental shelf, such as Greece (Koutsodendris et al., 2008), Turkey (Güven et al., 2013; Eryasar et. al., 2014), France (CIESM, 2014; Galgani et al., 2000) or the Adriatic Sea (Pasquini et al., 2016). In fact, the environment in the study area may has a lower exposure to plastics effects than other Mediterranean fishing grounds, although that effects may be prolonged for years (NOAA et al., 2008).

The *Metal* and *Glass/Ceramics* proportions in this study (20.68% and 18.70%, respectively) are similar to those observed in Greece (Koutsodendris et al., 2008) or higher than some Mediterranean areas such as Turkey (Güven et al., 2013; Eryasar et. al., 2014) or the Adriatic Sea in the 50-100 m depth range (Strafella et al., 2015). However, the effects of glass are of less concern than plastic or metal (Islam and Tanaka, 2004; Palomar and Llorente, 2016). *Textile, Processed/Worked Wood* and *Paper/Cardboard* represent 10.7%, with decomposition rates of a few years (NOAA et al., 2008).

4.2. Litter distribution

Marine litter is present in the whole study area since it was found in all of 886 hauls. The distribution detected in this work showed an overall increase from open sea to the coast, where many cells have more than 10 kg/km^2. This trend was also observed by Serrano et al. (2012) in the study area and by other authors in other Mediterranean localities (CIESM, 2014; Strafella et al., 2015). Higher densities of users in coastal areas and the influence of land-based sources may explain this distribution.

The geographical distribution of litter on the seafloor is strongly influenced by hydrodynamics, geomorphology and human factors (Galgani et al., 2013). For this reason, Ramirez-Llodra et al. (2013) grouped the marine litter into light litter (soft and hard plastic) and heavy (glass, metal and clinker). While some plastics float great distances before sinking, heavy litter sinks almost directly to the seafloor (Carlson et al. 2017). Therefore, metal cans and glass bottles can point to the vessel-based sources (Koutsodendris et al., 2008; Ramirez-Llodra et al., 2013; Ioakeimidis et al., 2014; Strafella et al., 2015; Pasquini et al. 2016). In the study area, Glass/Ceramics are widely distributed, with a high accumulation area to the southwest in coastal waters. However, the *Metal* distribution shows some isolated zones with a high level of *Metal* under both coastal and open waters. Both the *Glass/Ceramics* and *Metal* distributions suggest that the users of these zones may have caused the littering of those seafloor areas.

A wide distribution of *Artificial Polymers* occurs in the study area, although their proportion is lower than other Mediterranean areas. It has to be considered that we only studied macro-litter whereas microplastics, which may be an important pollution source, were not sampled. The presence of *Textiles* near the shore is low although a higher accumulation was observed far from the coast.

4.3. Litter sources

Some items can be attributed to fishing activities with a high level of confidence, (Galgani et al., 2011). The present work attributes 29.16% by weight of marine litter to fishing. Also is the source of more than two-thirds of the plastics and a quarter of the metals in the study area. Two reasons explain the presence of such litter. One of them is the easily avoidable inappropriate behaviour of throwing away old or damaged gear and tackle into the sea. The other is the less avoidable accidental involuntary loss of often expensive or essential gear overboard that occurs during fishing operations requiring prompt costly replacement.

Marine litter from trawlers makes the greatest contribution due to their covering the whole study area. Their active gear is also a factor with its high risk of becoming snagged on rocky grounds, leaving pieces of gear at sea. Although the purse-seiner is also active gear, its lesser contribution to marine litter could be because of operating higher in the water column with a lower risk of losing gear parts through snagging. Fixed gear may also easily be lost at sea if it become trapped in rocky grounds. Unsurprisingly, comparing Fishing Vessel traffic with the fishing litter there is a direct relationship. The accumulation zone close to the coast may be because of the rocky ground of this area increasing the risk of losing gear.

At the same time, this study reveals the high degree of uncertainty since 60.84% could not be attributed directly to its source. To infer the sources we compared the litter distribution with marine traffic to identify the possible sources.

The distribution of *Glass/Ceramics* and the traffic through the west and southwest both point to the main polluters of those zones being Recreational and Fishing Vessels due to the low or zero presence of Passenger and Merchant Ships there. Merchant Ship routes and the largest *Metal* accumulation zone appear to be correlated. This area is shared with some fishing vessels, however the presence of paint pots and oil drums support the Merchant Ships source. On the other hand, *Metal* in coastal waters may come from fishing and recreational vessels because they are the main users of that zone.

Other studies in Turkey (Güven et al., 2013), the Adriatic (Strafella et al., 2015) or the Northeastern Spanish Mediterranean (Ramirez-Llodra et al., 2013) report that half the plastics found had fishing activity as source. Although *Artificial Polymers* have a wide distribution in the study area and 68 % were identified as a result of the fishing activity, an important source for the rest may be Recreational Vessels and fishing activity due to their coastal distribution. However, it has to be considered that plastics can float for miles from their source previous to sinking (Carlson et al. 2017). Cloths/Textile distribution can be divided into three zones. In the coastal area, it can be attributed to Fishing and Recreational Vessels. *Cloths/Textile* in the accumulation areas both north and south of the study area are most probably linked with Fishing and Merchant Ships.

5.CONCLUSIONS

This work was possible thanks to trawling, which has a double role in marine litter. The paper has showed both roles as polluter and as marine litter reducer. Fishing activity is a notable pollution source on the whole Gulf of Alicante. Pollution of merchant ships take place on open waters and recreational vessels on coastal waters. Marine Litter is present in the whole Gulf of Alicante increasing from open sea to the coast. Marine retention programs should be encouraged on trawlers to reduce marine litter. The participation of fishers would be decisive in achieving success in litter reduction measures. It will be important also to develop initiatives aimed at raising general awareness for all types of vessels to keep the sea clean.

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Table List

Table 1. Composition and proportion of marine litter by categories

Category/subcategory	Weigh (kg)	% of the total amount
Mixture	2623,4	49,19
Artificial polymer materials	989,8	18,56
Other Plastics	278,8	5,23
Octopus Pots Rope	218,2	4,09
Trawler Rope	99,8	1,87
Trammel Net	89,8	1,68
Nylon	67,1	1,26
Trawler Net	66,7	1,25
Water Cloths	27,2	0,51
Trammel Net Rope	25,6	0,48
Trawler Buoy	24,4	0,46
Traps	18,6	0,35
Food Plastics	18,2	0,34
Trap Rope	15,0	0,28
No Food Plastics	14,5	0,27
Octopus Pots Rope	11,0	0,21
Buoy	9,5	0,18
Poliester	2,5	0,05
Trawler Plastic box	1,2	0,02
Purse Seiner Net	1,0	0,02
Purse Seiner Poliespan box	0,4	0,01
Trammel Net Buoy	0,2	0,00
Metal	560,5	10,51
Other Metal	211,5	3,97
Trawler Warps	93,9	1,76
Food Metal	67,5	1,27
Paint Drums	55,3	1,04
No Food Metal	52,9	0,99
Trawler Sweeps	48,4	0,91
Battery	29,0	0,54
Trammel Net Plummet	1,7	0,03
Trawler Plummet	0,4	0,01
Glass/ceramics	506,7	9,50
Other	261,7	4,91
Other	189,1	3,55

Paint tins	67,8	1,27
Slack/Coal	4,8	0,09
Cloth/textile	146,9	2,75
Textile	131,7	2,47
Shoes	15,2	0,29
Processed/Worked Wood	129,9	2,44
Processed/Worked Wood	124,5	2,33
Wood box	5,4	0,10
Rubber	101,5	1,90
Rubber	68,2	1,28
Boot	26,2	0,49
Trawler Rubber Element	7,1	0,13
Paper/Cardboard	12,7	0,24
Total	5333,1	100,00

Fig. List

Fig. 1. Location of the study area and its activities. The number next to city/area and blue circles show the number of recreational vessels mooring points. MPA is Marine Protected Area.

Fig. 2. Density of all marine litter (kg/km^2). MPA is Marine Protected Area.

Fig. 3. Density of artificial polymers (kg/km^2). MPA is Marine Protected Area.

Fig. 4. Density of metal (kg/km^2). MPA is Marine Protected Area.

Fig. 5. Density of glass/ceramics (kg/km^2). MPA is Marine Protected Area.

Fig. 6. Density of cloth/textile (kg/km^2). MPA is Marine Protected Area.

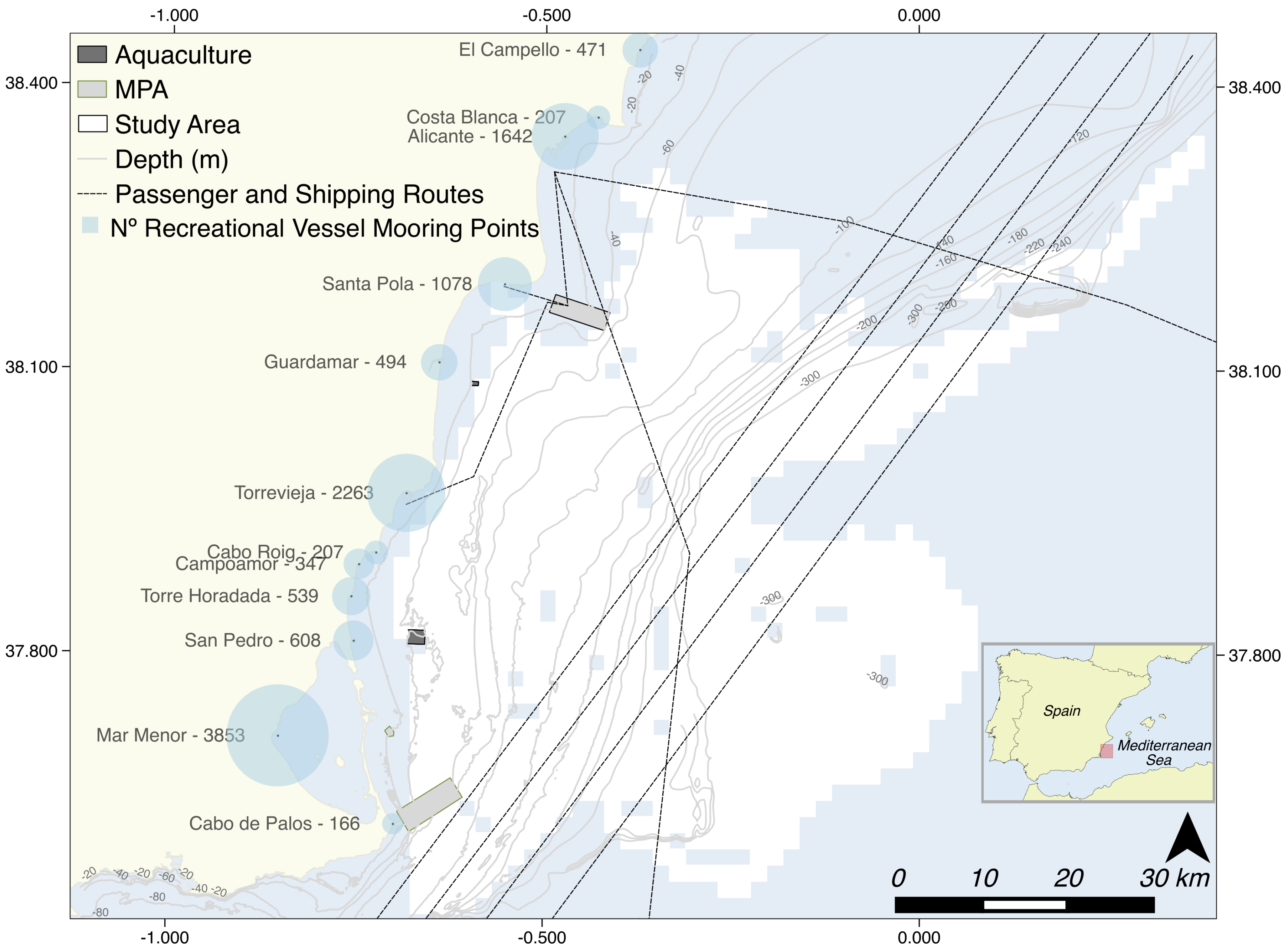
Fig. 7. Density of marine litter with fishing activity as source (kg/km^2). MPA is Marine Protected Area.

Fig. 8. Density of fishing vessel traffic (km/km^2*year). MPA is Marine Protected Area.

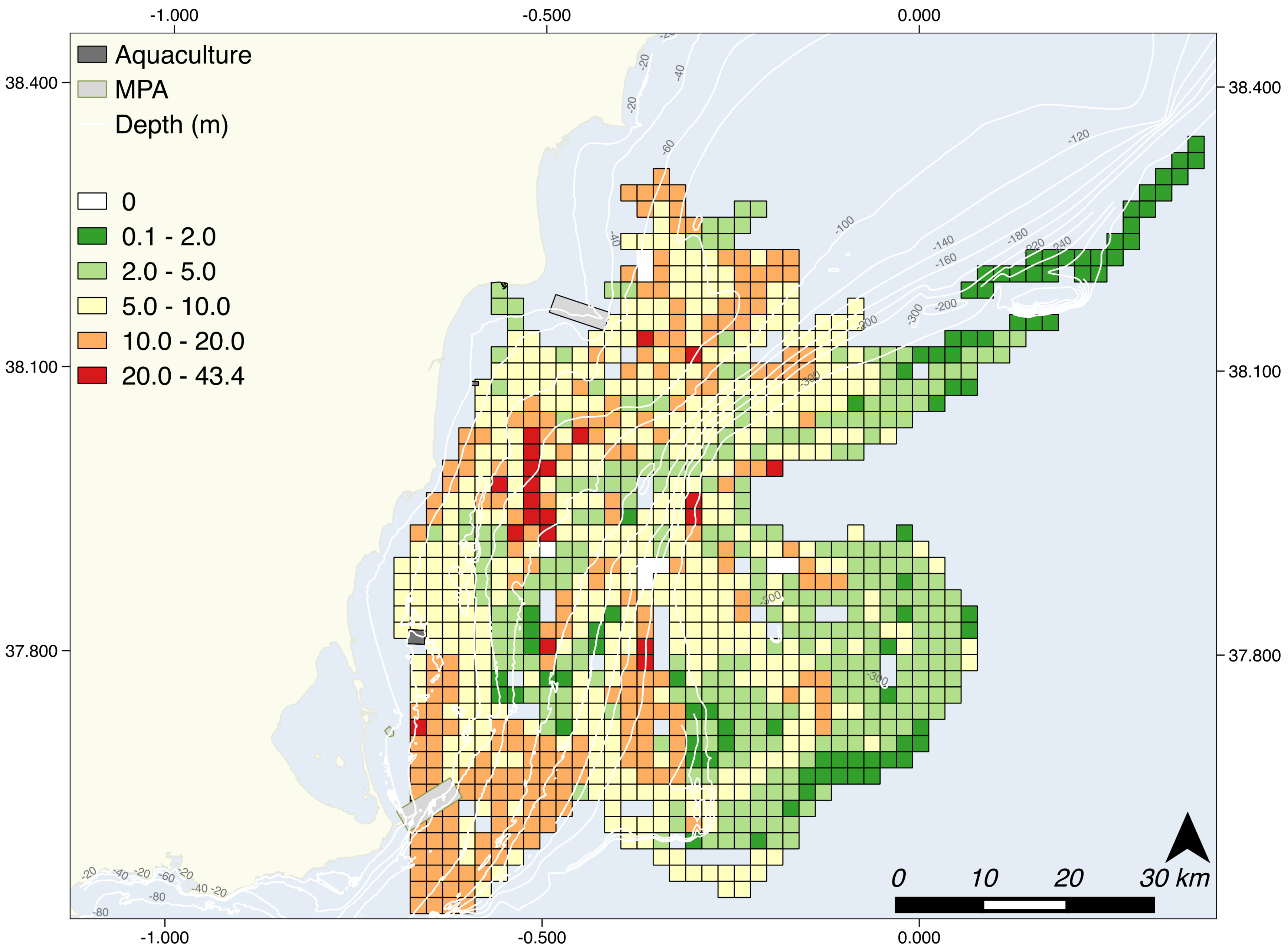
Fig. 9. Density of merchant ship traffic (km/km^2*year). MPA is Marine Protected Area.

Fig. 10. Density of passenger ship traffic (km/km^2*year). MPA is Marine Protected Area.

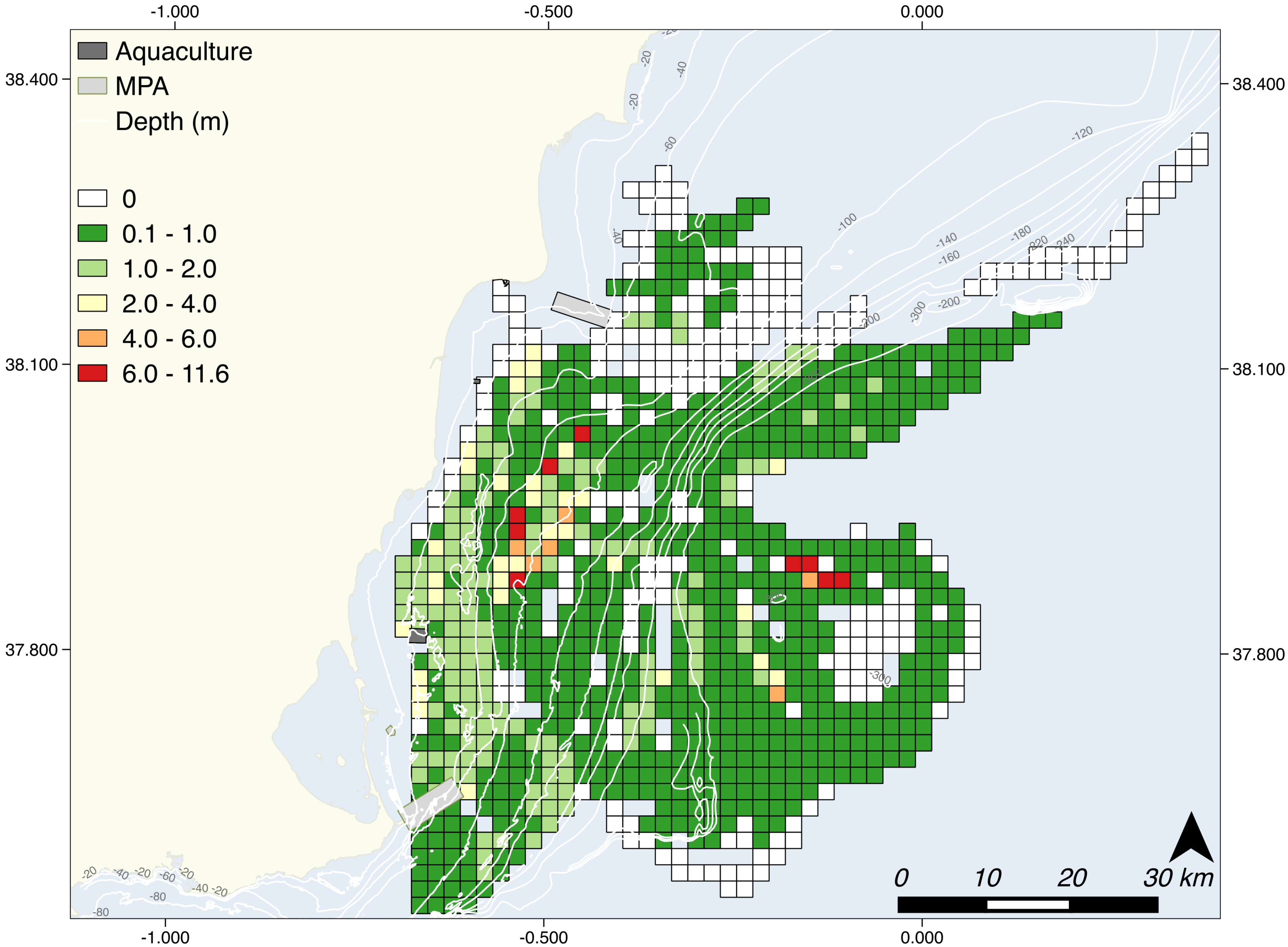
Fig. 11. Density of recreational vessel traffic (km/km^2*year). MPA is Marine Protected Area.



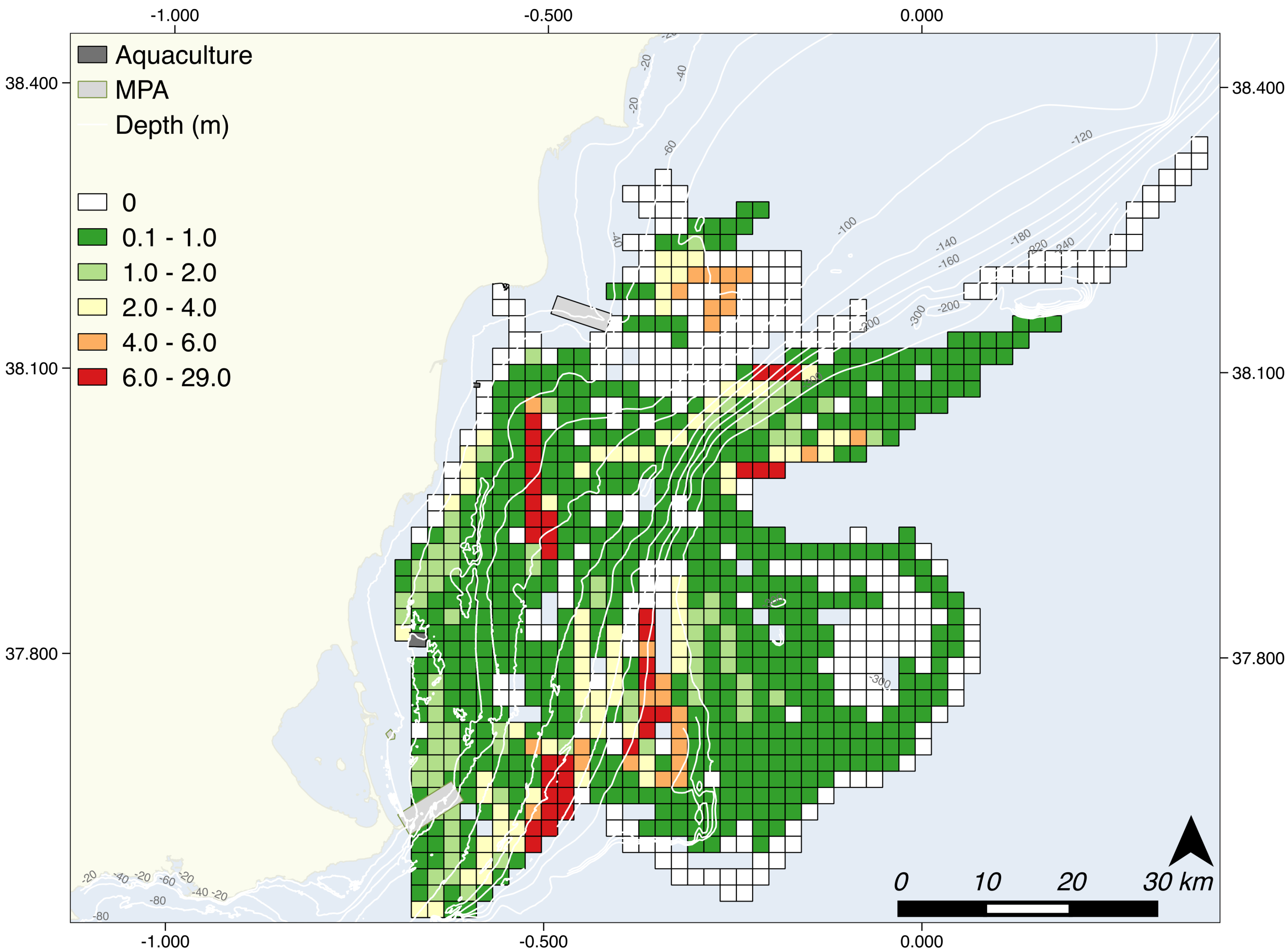
Aquaculture
MPA
Study Area
Depth (m)
Passenger and Shipping Routes
Nº Recreational Vessel Mooring Points
El Campello - 471
Costa Blanca - 207
Alicante - 1642
Santa Pola - 1078
Guardamar - 494
Torrevieja - 2263
Cabo Roig - 207
Campoamor - 347
Torre Horadada - 539
San Pedro - 608
Mar Menor - 3853
Cabo de Palos - 166
-1.000
-0.500
0.000
38.400
38.100
37.800
Spain
Mediterranean Sea
0
10
20
30 km



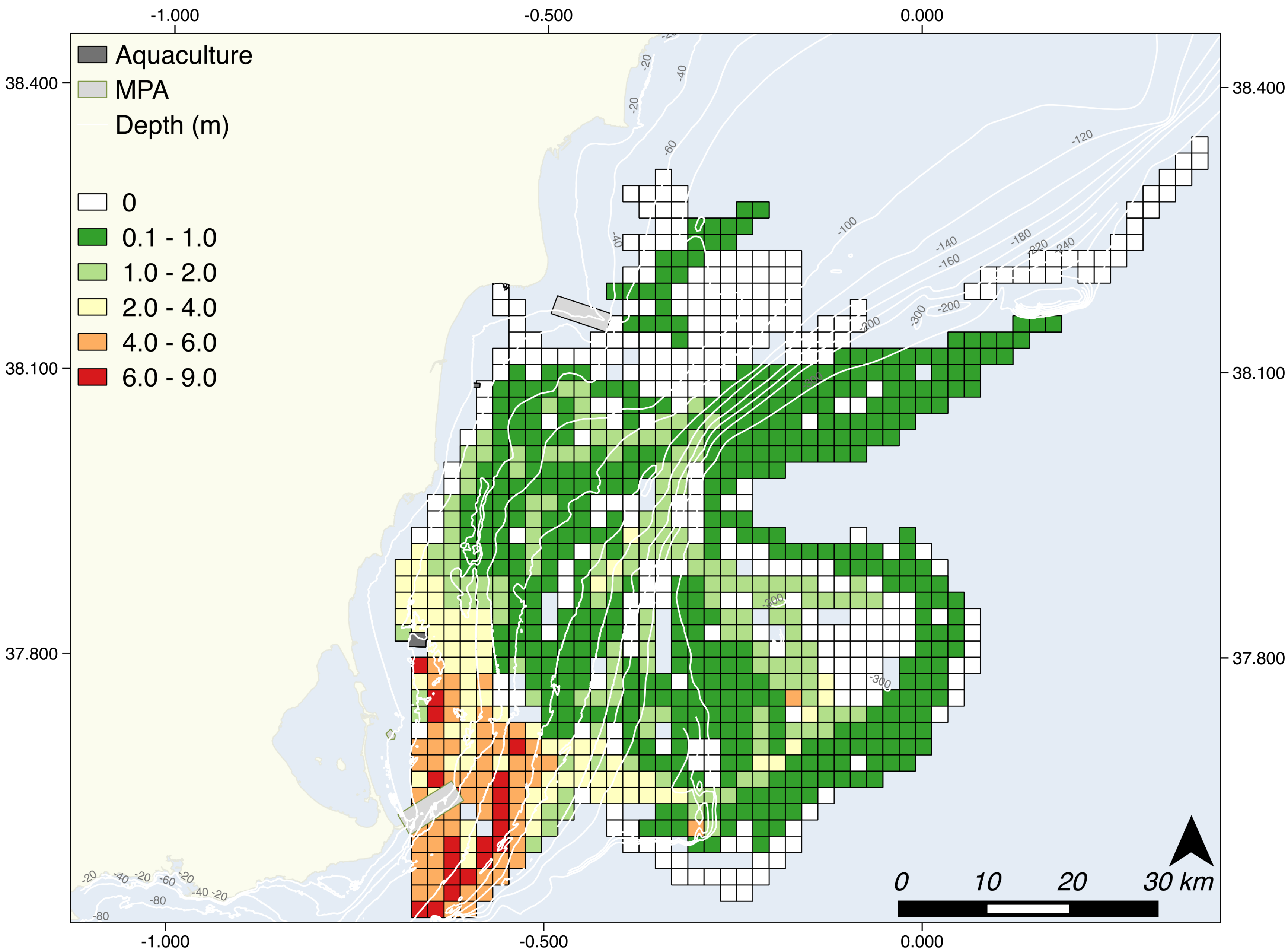
Aquaculture
MPA
Depth (m)
0
0.1 - 2.0
2.0 - 5.0
5.0 - 10.0
10.0 - 20.0
20.0 - 43.4
-1.000
-0.500
0.000
38.400
38.100
37.800
0
10
20
30 km

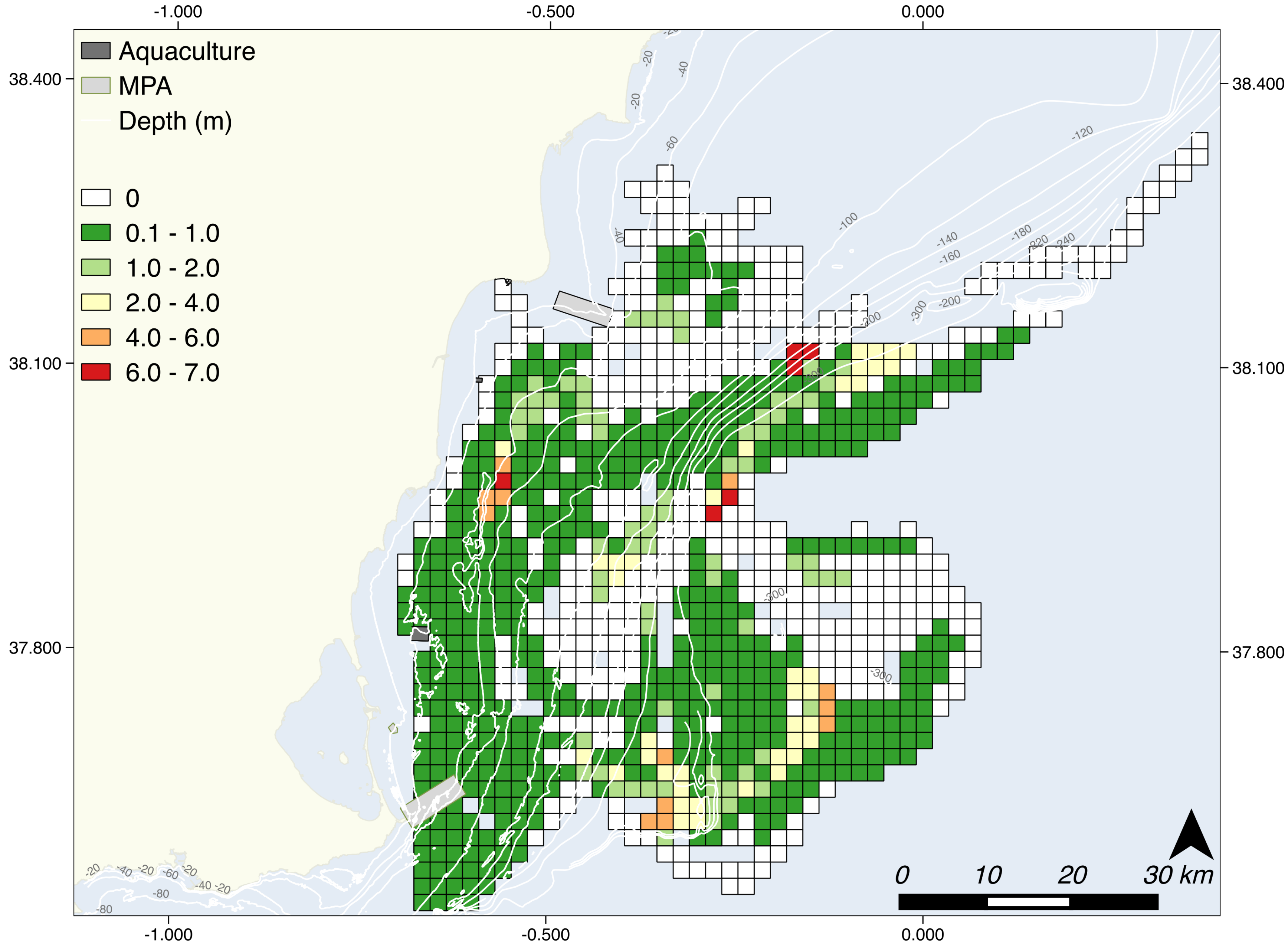


Aquaculture
MPA
Depth (m)
0
0.1 - 1.0
1.0 - 2.0
2.0 - 4.0
4.0 - 6.0
6.0 - 11.6
-1.000
-0.500
0.000
38.400
38.100
37.800
0
10
20
30 km

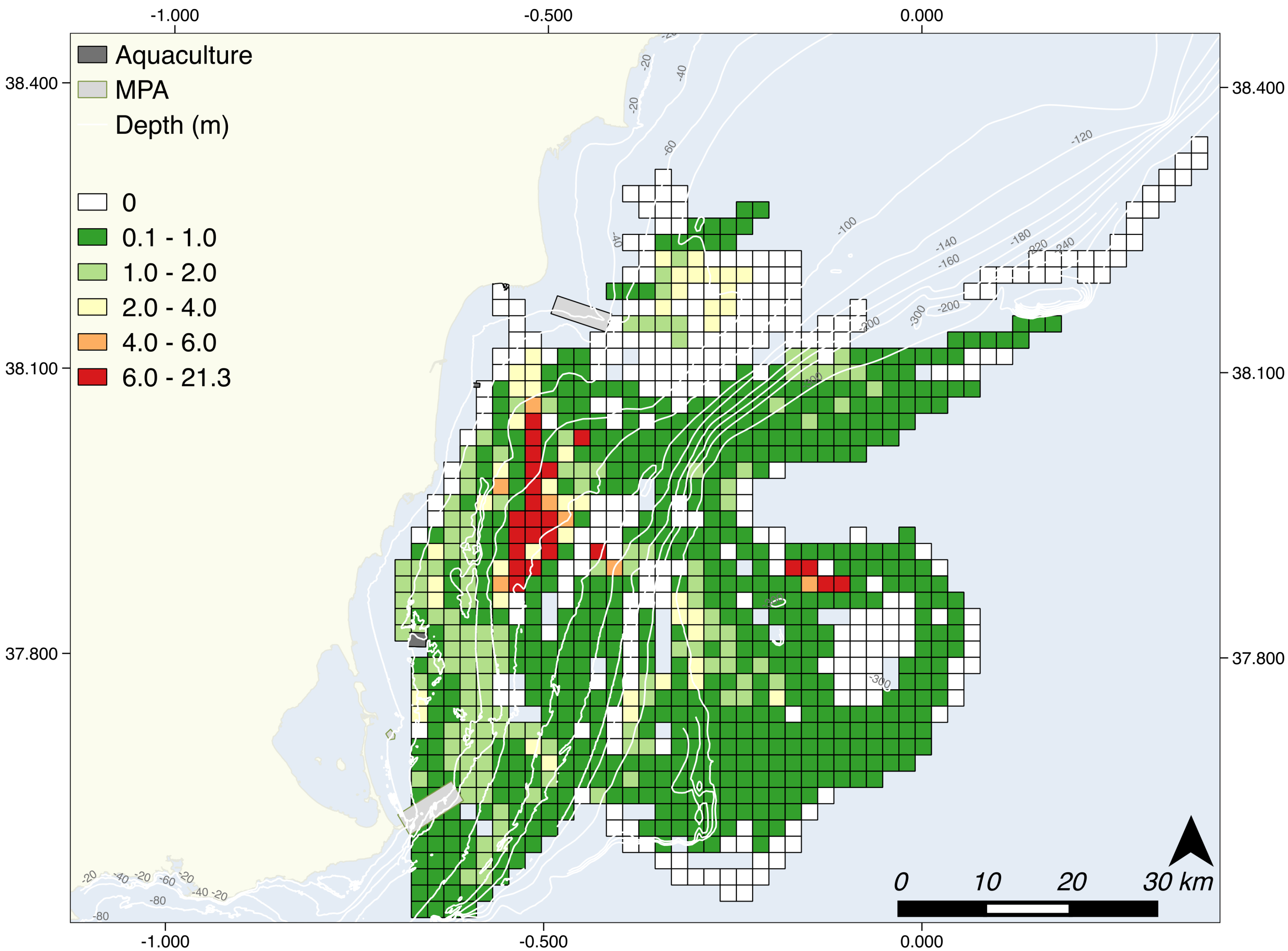


Aquaculture
MPA
Depth (m)
0
0.1 - 1.0
1.0 - 2.0
2.0 - 4.0
4.0 - 6.0
6.0 - 29.0
0
10
20
30 km
-1.000
-0.500
0.000
38.400
38.100
37.800

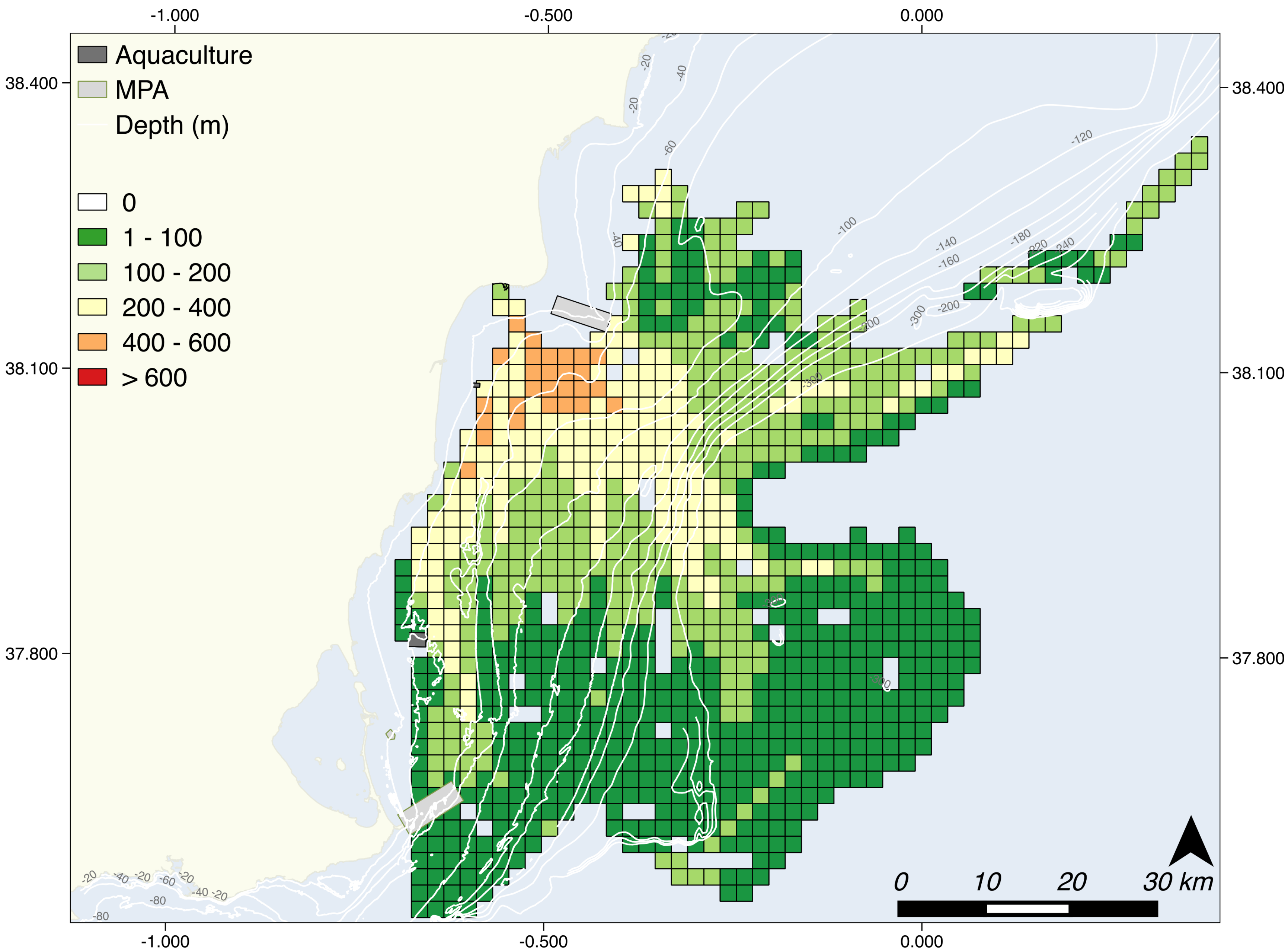

Aquaculture
MPA
Depth (m)
0
0.1 - 1.0
1.0 - 2.0
2.0 - 4.0
4.0 - 6.0
6.0 - 9.0
-1.000
-0.500
0.000
38.400
38.100
37.800
0
10
20
30 km



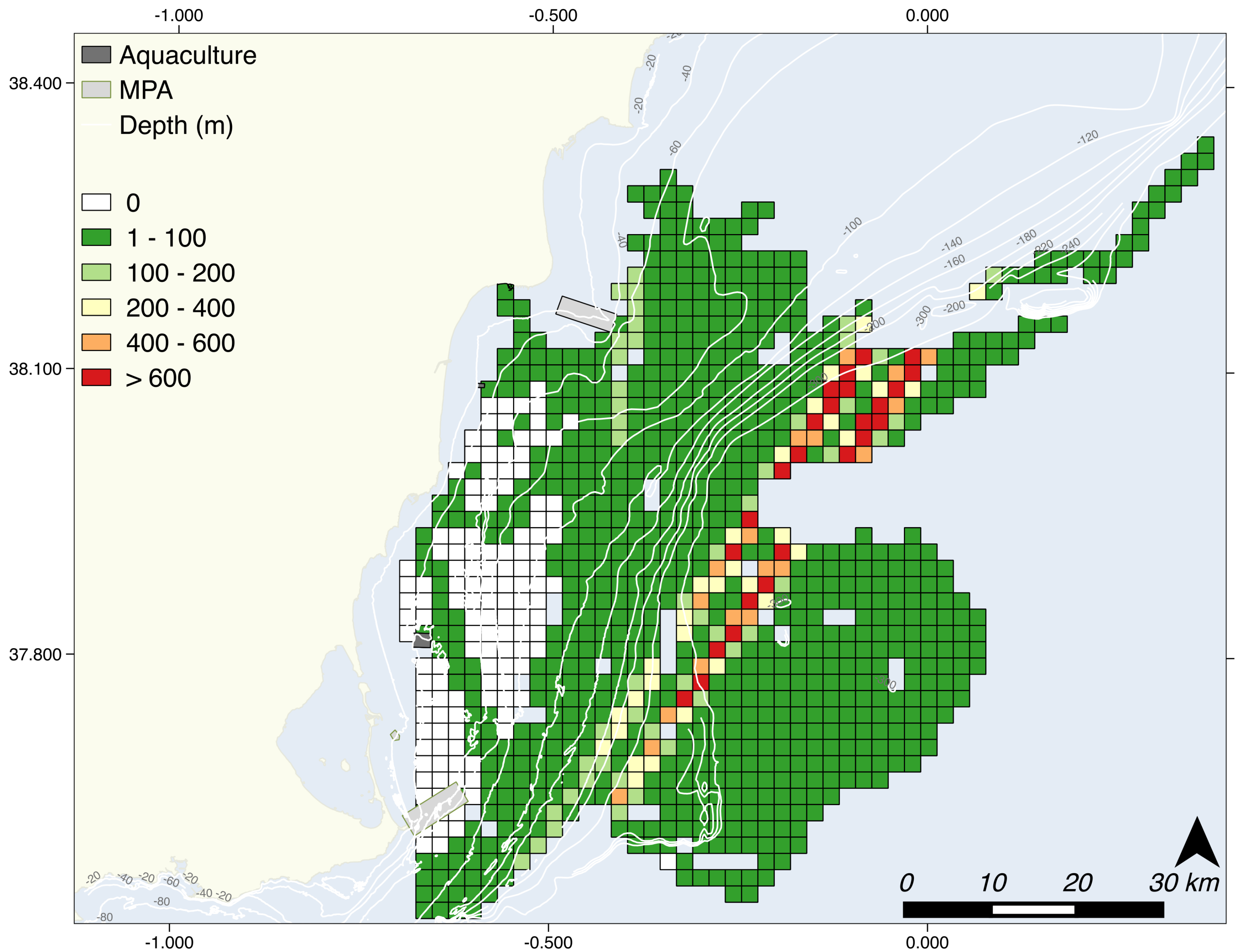
Aquaculture
MPA
Depth (m)
0
0.1 - 1.0
1.0 - 2.0
2.0 - 4.0
4.0 - 6.0
6.0 - 7.0
-1.000
-0.500
0.000
38.400
38.100
37.800
0
10
20
30 km

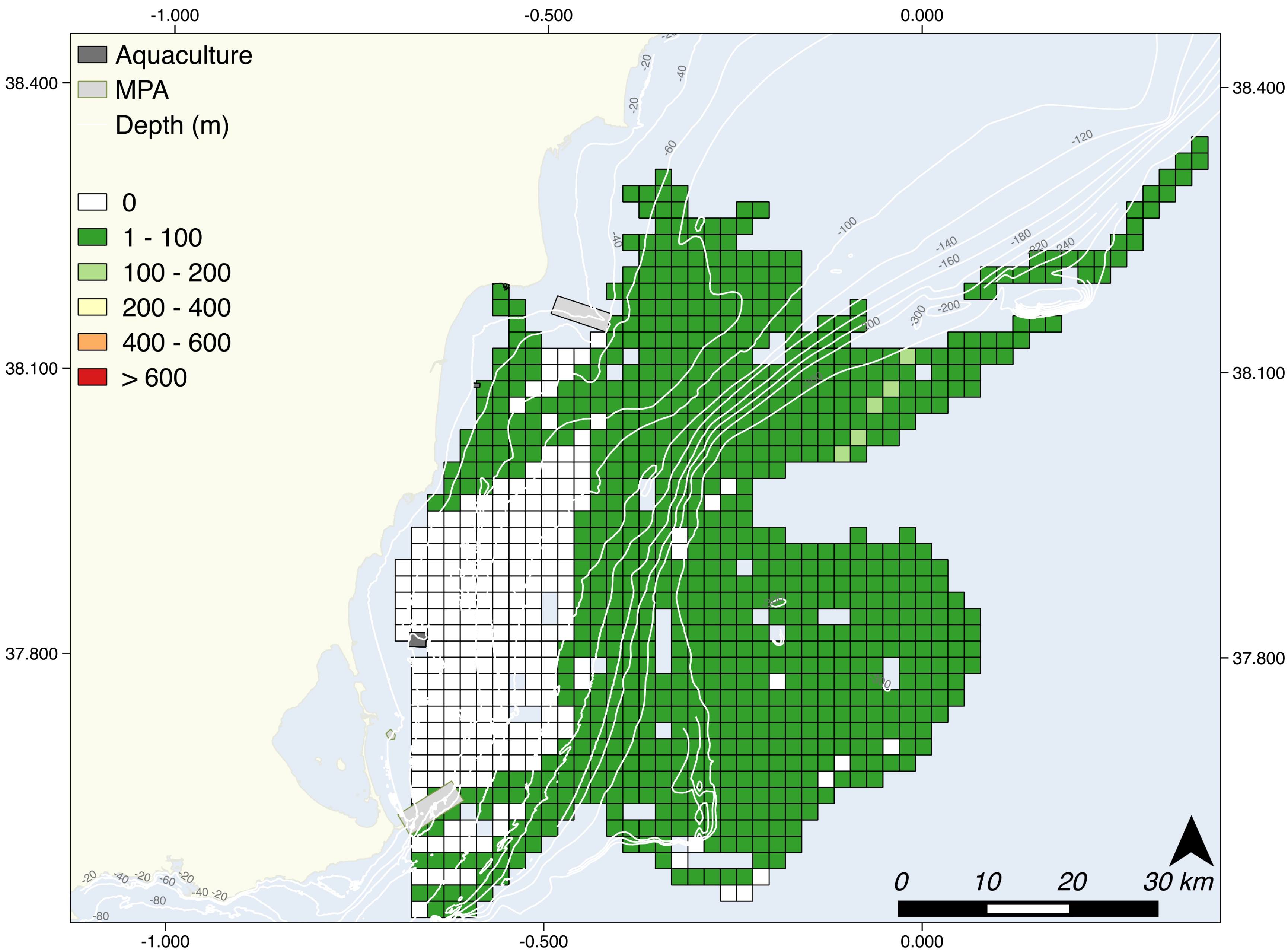


Aquaculture
MPA
Depth (m)
0
0.1 - 1.0
1.0 - 2.0
2.0 - 4.0
4.0 - 6.0
6.0 - 21.3
-1.000
-0.500
0.000
38.400
38.100
37.800
0
10
20
30 km

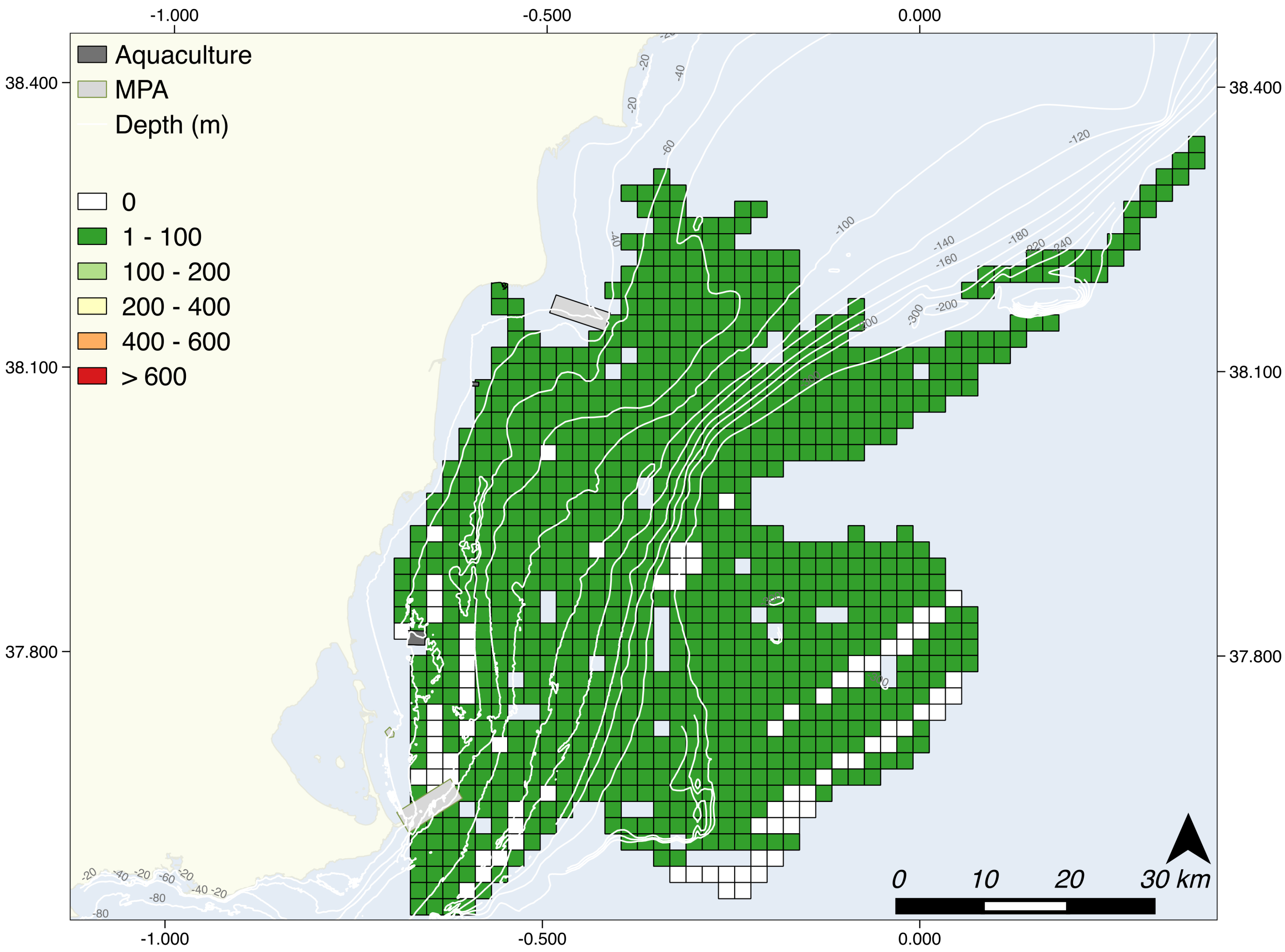


-1.000
-0.500
0.000
38.400
38.100
37.800
Aquaculture
MPA
Depth (m)
0
1 - 100
100 - 200
200 - 400
400 - 600
> 600
0
10
20
30 km


Aquaculture
MPA
Depth (m)
0
1 - 100
100 - 200
200 - 400
400 - 600
> 600
-1.000
-0.500
0.000
38.400
38.100
37.800
0
10
20
30 km



Aquaculture
MPA
Depth (m)
0
1 - 100
100 - 200
200 - 400
400 - 600
> 600
-1.000
-0.500
0.000
38.400
38.100
37.800
0
10
20
30 km



Aquaculture
MPA
Depth (m)
0
1 - 100
100 - 200
200 - 400
400 - 600
> 600
0 10 20 30 km
-1.000
-0.500
0.000
38.400
38.100
37.800