Plastic in the deep: an invisible problem

How the seafloor becomes a plastic trap

OCEANA

Contents

Credits

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Cover photo: Balloon and plastic bottle at a depth of more than 500 m in Sidon, Lebanon.

#breakfreefromplastic

1. Executive summary

Most marine debris remains hidden in the depths where, year after year, currents increase the concentration of waste, including macroplastics. Many estimates have been made of how long it takes for different plastic objects to degrade, but these approximations mainly relate to surface water.
They are not valid for the deep seas, as these environments are characterised by a lack of sunlight, low temperatures, and limited erosion. For this reason, marine debris can disrupt these ecosystems for centuries before it eventually degrades.

Much of Europe's waters are deep. Canyons, seamounts, escarpments, and reefs trap plastics, while simultaneously act as biodiversity hotspots. Observations made during Oceana's expeditions show accumulations of single-use plastics in areas of high biological value, abandoned fishing gear in the middle of the ocean, and half buried sheets of plastic hundreds of metres below the surface.

Very often, recovering this debris is technically and economically unfeasible, either because it is located at a great depth or because it is snagged on fragile biological structures. Therefore, to reduce the damage, it is essential to drastically reduce the everyday use of plastic and avoid its uncontrolled dumping. Oceana calls on all social agents to reduce the irrational use of plastic and implement an ambitious regulatory framework that responds decisively to one of the greatest challenges posed by debris and plastic in the marine environment: the pollution of the deep sea.

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The deep sea, an oasis for marine life

The deep seafloor has traditionally been described as an oasis for life or a biodiversity hotspot, due to the enormous abundance and richness of species that inhabit this area.[1,2]

This zone is of particular importance for marine biological diversity and, in fact, many species use deep sea environments as spawning, nursery, breeding, or feeding grounds. Canyons and seamounts house emblematic species, from corals to cetaceans and sharks.

Plastic in the deep:
an invisible problem

2. An invisible problem: Plastic traps

Most of what is known or assumed about plastic in the oceans comes from coastal observations. However, analysing the litter collected on beaches barely hints at the magnitude of what lies hidden at the bottom of the sea.

For fifteen years, Oceana has been using an underwater robot (ROV, *Remotely Operated Vehicle*) to document European and Mediterranean waters up to a thousand metres deep. Debris has been a constant on virtually every dive, excluding in certain areas where strong currents carry the litter far from the shore.

From an ecological point of view, **deep waters are considered to be 200 metres or more below sea level**, where the influence of light begins to disappear. This depth is reached very close to the coastline in some regions, but in this report, we also demonstrate that marine plastics have been found at great distances from inhabited areas.

The vast majority of these marine expanses have scarcely been studied, and often scientists find that the litter arrived before they did. In fact, it is estimated that only 1% of plastics are in surface waters, and the majority of the remaining 99% ends up in the deep sea[3].

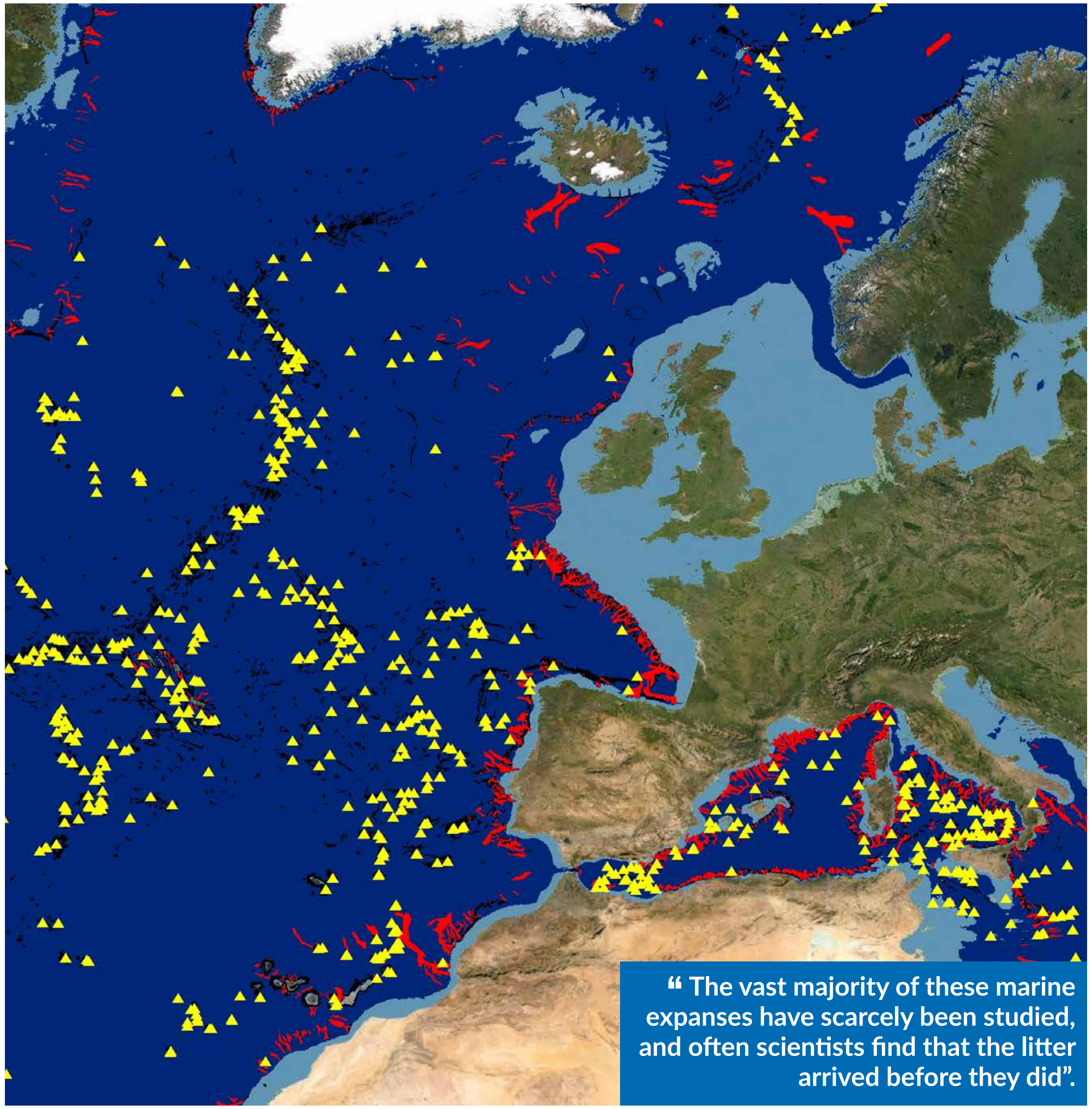
Due to their morphology, some geological formations concentrate marine debris. As can be seen on the map on this page, these are widely distributed habitats.

Below, we detail some of these cases that are transforming from biodiversity hotspots to underwater landfills.

Abundance of certain geohabitats in the Northeast Atlantic and Mediterranean.

Source:
Esri, Digital Globe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Seamounts
Submarine canyons
Escarpments
The deep sea



“ The vast majority of these marine expanses have scarcely been studied, and often scientists find that the litter arrived before they did”.

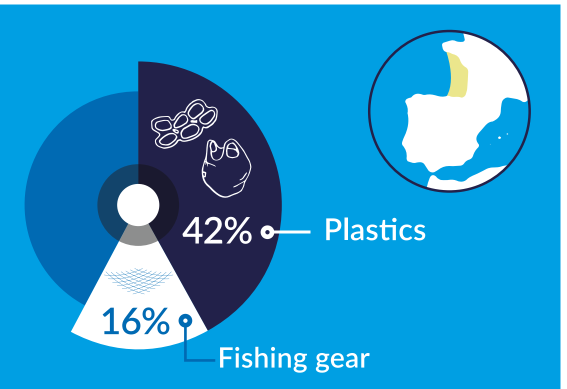
Submarine canyons

Some submarine canyons, such as the Capbreton Canyon (France), are the extension of rivers. This makes it easier for waste to reach the open sea and great depths.
Source: National Geographic, Esri. HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GERCO, NOAA, INCREMENT P.CORP.

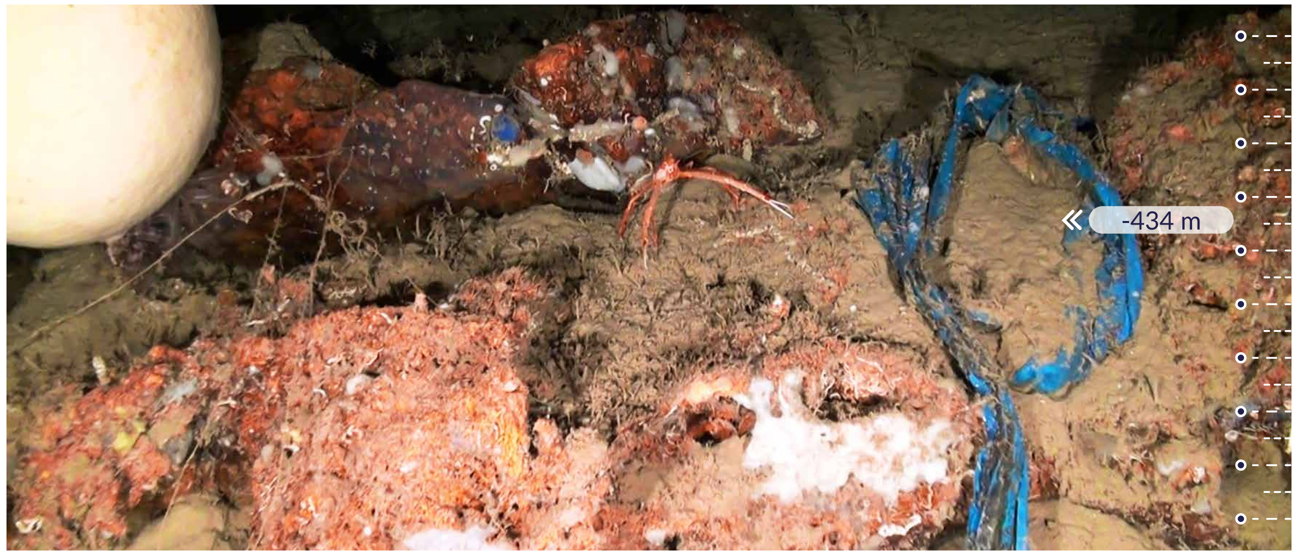
These underwater structures are, in some cases, associated with existing or former terrestrial rivers, and represent their continuation onto the seafloor.
In general, canyons tend to originate as a result of erosion by water and transported sediments, which generate valleys of varying depths. In other cases, they have been attributed to factors such as mud flows, landslides, subsidence, or glacial activity, among others.[4,5,6]

Recent studies have shown the important role rivers play in transporting plastics from the land to the sea.[7] Like land-based valleys, submarine canyons collect, channel, and accumulate, meaning a great deal of waste ends up reaching the canyons and building up in large quantities. From these areas this debris is then transported to the deep sea.[8,9,10] This high concentration of waste is also influenced by the strong currents that can occur in the upper zone of these geological formations.[11]

Around 15% of the world's submarine canyons start close to the coast, increasing the amount of sediments and anthropogenic waste they receive, and facilitate the transport of plastics and other waste to the seafloor.[12]



A study of fifteen canyons in the Bay of Biscay found litter in all of them, with plastics (42%) and fishing gear (16%) being the most commonly encountered objects. Much of this fishing gear was also plastic, including gill nets, trawl nets, and longlines.[13]



St. Vincent Canyon, Portugal
Sampling in the St. Vincent Canyon (Portugal)[14] estimated an average of 1.67 objects per hectare, with concentrations exceeding 300 objects in some locations.

In Europe, the case of the Mediterranean is particularly worrying, as in some submarine canyons the concentrations of waste reach staggering figures. In certain canyons along the coast of Catalonia, concentrations of marine litter have been estimated as being between 1,500 and 15,000 objects per square kilometre, with a maximum of 167,540 in one particular location. Of the items found, the majority (72%) were plastics.[8]

The Mediterranean holds the submarine canyons with the highest concentration of plastics in Europe.

Batrun, Lebanon
In other canyons, such as those in Lebanon (Jounieh, Batrun, Beirut, and Sidon) the concentrations of domestic waste far exceed the densities found in the St. Vincent Canyon. It is not known how long it takes for plastic to degrade at great depth.

Escarpments

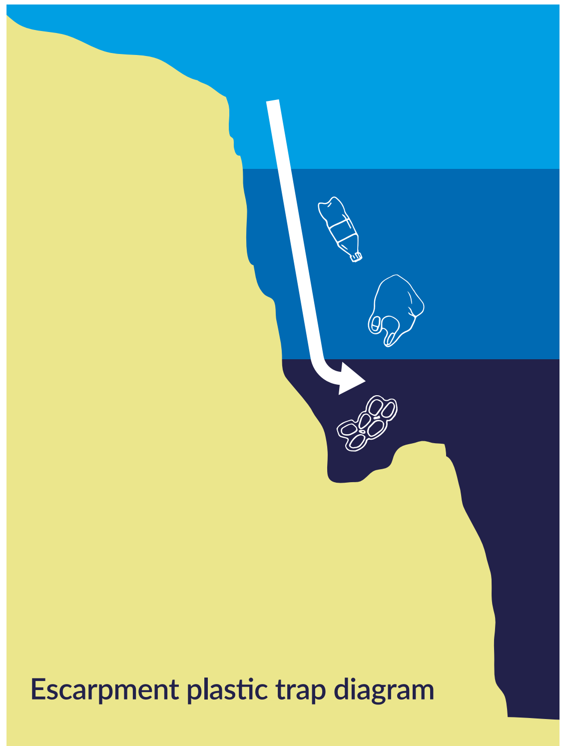
Where there are no submarine canyons to transport the waste, it reaches the deep sea via escarpments[15,16], in the same way as coastal runoff.

These underwater cliffs result from various tectonic, geological, and erosional processes. They can be interrupted by valleys and canyons, which increase their complexity.[15,17,18]

Many of these cliffs may have small platforms or terraces[19] at different depths that retain some of the sediment and debris that would otherwise end up in the deeps.

Large concentrations of plastics can be seen in these places.

Émile Baudot Escarpment, Balearic Islands
It is increasingly common to see commercial species like this forkbeard (*Phycis* sp.) among agglomerations of urban debris. Recycled or not, plastic invades the depths.


Escarpment plastic trap diagram

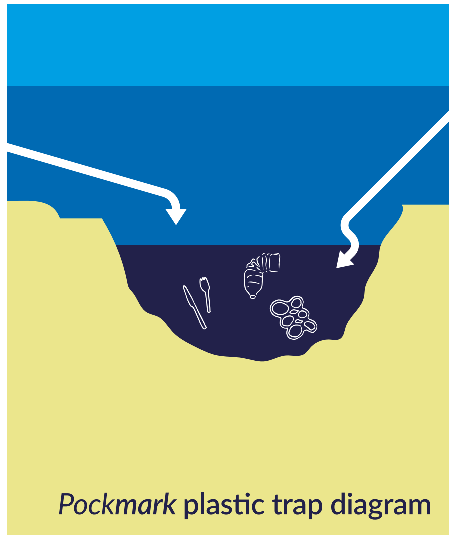
Pockmarks

Pockmarks are crater-shaped formations formed by gases escaping through the submarine crust.[20,21,22]

Their concave shape means they become traps for waste carried by marine currents which, once deposited, is difficult to remove.

Mallorca Channel, Balearic Islands
Forkbeard (*Phycis* sp.) next to plastics between the Ausias March and Ses Olives seamounts.

Scanner, United Kingdom.
Plastics in the Scanner marine conservation area (North Sea).


Pockmark plastic trap diagram

Seamounts and reefs

Sa Creu Cape, Balearic Islands

The Single-Use Plastics Directive requires fishing gear manufacturers to defray the costs of awareness-raising activities relating to the damage caused by abandoned gear, as well as the separate collection of this waste.

Seamounts and other seafloor rises impede the free circulation of ocean currents.[23,24] Waste can be trapped by these formations, similarly to the way islands and bays trap and accumulate floating debris that travels on the surface of the sea or is carried by currents.[25,26]

These places concentrate fauna, making them very attractive for fishing, observing marine life, and water sports. This frequent use increases the dumping of waste in addition to the loss of fishing gear and other objects.[27,28]

Pollution generated by boats means that waste can reach pristine, remote locations.

In sampling carried out by Oceana on seamounts very far from the coast, such as Triton and Dacia (130 km and 215 km north of Lanzarote) and Echo (295 km southwest of El Hierro), anthropogenic debris was also present.

The three-dimensional structure of reefs makes them behave in a similar way to seamounts. Debris is trapped in them, affecting the fauna that lives attached to the reef.[29] This is the case with nets, which break corals and gorgonian branches and prevent the growth of these organisms, as well as others that are trapped underneath.

Abubacer Ridge, Alboran Sea

Submarine rises are oases of life. Lost or discarded fishing gear may be responsible for "ghost fishing" for hundreds of years before it becomes degraded.

Triton Seamount, to the north of the Canary Islands

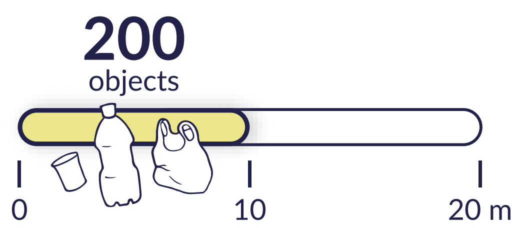
Located between the Canary Islands and Madeira, Triton Seamount was first documented in 2014. At that time, Oceana already found abandoned fishing gear there.

Depressions

Erosion by marine currents around structures and objects on the seafloor often generates depressions that, in addition to channelling and collecting litter, act as traps for debris that is heavier or which may become entangled.[30]

These elements can be natural, such as rocks, reefs or rises, but also artificial, including oil wells, wind turbines, and even the waste itself.

Submarine valleys and "gorges" that form between marine rises, islands, and continental areas also act as bottlenecks for the transport of submarine sediments and waste, meaning these may concentrate a large quantity of debris.



In the channels between Sicily and Calabria (Tremesteri, Sant'Agata and San Gregorio), up to 200 objects have been recorded for every 10 linear metres,[31] which are transported to the deep seas.

The same is true of large oceanic trenches, which can also channel and concentrate litter and plastics. In Japanese oceanic trenches, these accumulations were regularly found to coincide with places where marine species aggregate,[32] thus increasing the interactions between debris and biodiversity.

Banco del Bagno, Aeolian Islands

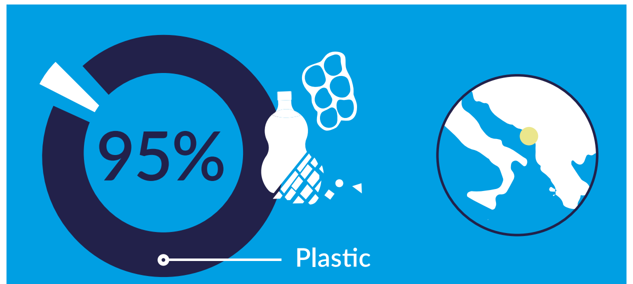
Located to the north of Sicily, the Aeolian Islands are a biodiversity hotspot, but also hide accumulations of single-use plastics.

Submarine caves and other structures

Gozo, Malta

Plastic waste inside a submarine cave

Submarine caves also act as plastic traps, as currents can introduce a large amount of floating debris into these. This waste cannot then escape and continues to build up over the years.



In Papuca Cave in Montenegro, 95% of the rubbish found was plastic[33].

There are other submarine geological formations that produce depressions and concave forms similar to *pockmarks*. This is the case of *brine pools* or hypersaline lakes.[34] These deep lakes often support dense concentrations of sessile filtering organisms, such as polychaete worms and molluscs. These generate reef structures in which debris can become entangled. The anoxic conditions (lack of oxygen) and high salinity limit the degradation of any dead organisms that reach these zones and this is possibly true for anthropogenic waste, too.[35,36]

Finally, we should mention chimney formations, caused by the gas seepages, which can also trap plastic debris and other litter. These include hydrothermal vents, which are abundant along the mid-Atlantic ridge, and *bubbling reefs*, such as those found in Kattegat.

The deep sea

As explained above, the various geological formations can act as channels that transport waste, whether carried by currents or simply by the effect of gravity, to the deepest areas of our oceans.[27, 37]

As has happened for millions of years with sediments or biological remains, recent studies indicate that the depths are the destination of a large proportion of macro- and microplastics (fragments smaller than 5 mm) whose location was unknown.[38] This explains why we see only a small proportion of this on the surface, approximately only one hundredth of the plastic waste.

There is increasing evidence that the world's seafloor is severely affected by the accumulation of litter.[31,39,40,41]

The plastic traps mentioned in previous sections represent only one stage in the journey of this rubbish, as part ends up dropping into the deeps when it becomes disentangled or carried away by the currents.[29]

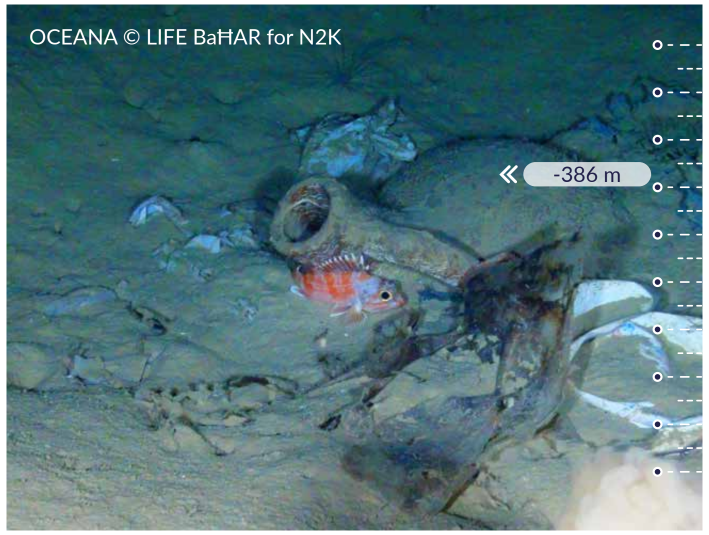
In fact, microplastics have been found at depths of more than 5,000 metres in the Kuril-Kamchatka[42] Trench and macroplastics at more than 10,000 metres in the Marianas Trench.[43]

The tragedy of the deep: plastics that do not degrade

Low temperatures and lack of UV light are two important factors that slow down the degradation of plastic waste in the deep sea.[44,45] For this reason, the impact of plastic waste is much longer-lasting in these ecosystems than in surface and coastal waters.

Most plastic fragmentation is caused by photodegradation (i.e., the effect of sunlight) and marine dynamics (waves),[46,47,48] neither of which occurs when the waste is at great depth or buried in the substrate.

Microorganisms such as bacteria and fungi also contribute to the degradation, but the deep sea is not the ideal habitat for this microbiological activity.[49]



Malta
The excessive use of plastic and its uncontrolled dumping has become one of the ocean's biggest problems.

In enclosed or semi-enclosed seas, waste is particularly abundant. In some deep areas of the Black Sea and Mediterranean, it has been estimated that the densities of debris on the seafloor may be as high as 100,000 objects per square kilometre.[27]
In fact, in some deep areas of the Mediterranean, the weight of marine litter already exceeds the megafaunal biomass.[50]

In some areas of the Mediterranean there is more rubbish than wildlife .

But even in the polar areas, waste is increasing in the deep sea. At the Arctic Hausgarten Observatory, at a depth of 2,500 metres between Greenland and Svalbard, the density and impact of plastics have both been increasing and are now affecting several species.[51]

Given the scarcity of human populations in the area, researchers believe that currents have transported these concentrations of garbage from other parts of the planet.

A polluting country can have clean waters due to marine currents.

A study of marine debris data from the last 30 years in the Pacific, Atlantic and Indian Oceans provided revealing information on the accumulation and types of litter.[42]
34% of the waste found on the seafloor comprised macroplastics, of which 89% was single-use plastic. Moreover, the ratios of plastic waste and single-use plastics increased with depth, being 52% and 92%, respectively, in areas deeper than 6,000 metres.

Some scientists believe that certain objects, such as single-use plastic bags, are an important source of microplastics for deep habitats.[52]

South of Sicily
The price of plastic is negligible compared to its environmental cost.

A large proportion of microplastics comes from single-use plastic.

3. The ecological vulnerability of plastic traps

According to the FAO, almost all of the above structures —canyons, seamounts, reefs, submarine ridges, and seepage formations— house “vulnerable marine ecosystems” (e.g., coral reefs, sponge aggregations, gorgonian gardens, and black coral forests).[53,54]
These are habitats of great ecological importance and very susceptible to the impact of fishing activities, while at the same time they provide ideal conditions for the development of various commercial species.
Submarine canyons and seamounts are considered to be key parts of marine ecosystems because of their great diversity of habitats and species, and because endemic taxa are frequently found in these locations.
They are preferential sites for megafaunal recruitment, in other words, they are places where animals can complete their development and progress to their adult stage, as well as being crucial habitats for benthic and pelagic species.[55,56]

Canyons offer a constant “rain” or source of sediment and organic matter (nutrients, detritus and food). These are distributed according to *downwelling* and *upwelling* processes that put nutrients in suspension and result in large concentrations of animals, which take advantage of this “manna” from the currents.[57,58,59,60]

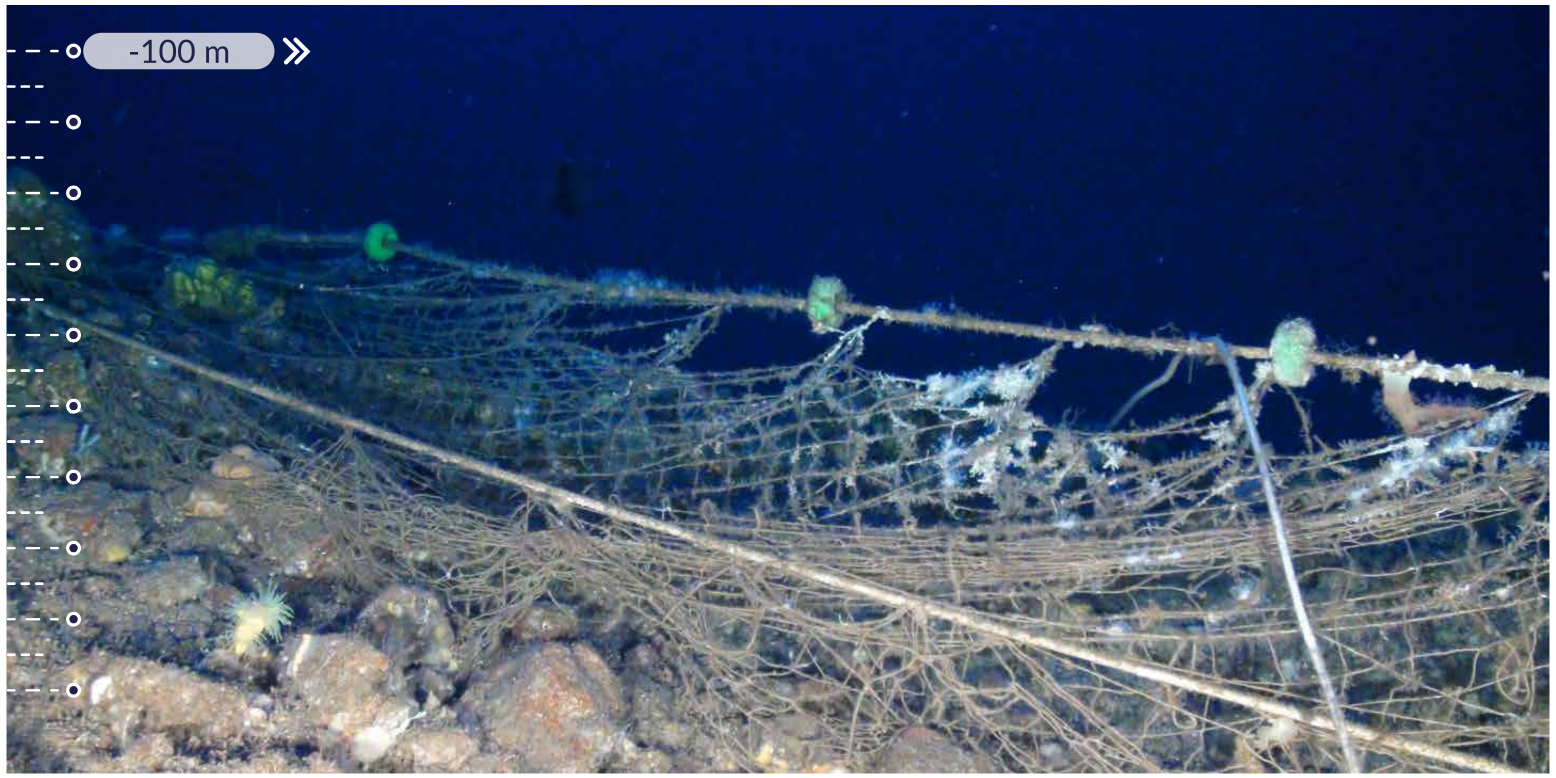
Thanks to these particular conditions, sperm whales, beaked whales, dolphins, and sharks often concentrate in the vicinity of canyons and seamounts to catch cephalopods and fish that feed there.[61,62,63,64,65,66,67]

Unfortunately, when searching for prey in these areas that contain concentrations of marine debris, large predators consume not only food, but also significant quantities of plastics and other objects. Similarly, plastic also enters the human food chain via the commercial species that live in these places.

Whales and sharks feed in deep zones, full of plastics.

Ormonde, Gorringe Bank, Portugal
On the Gorringe Bank, a group of seamounts more than 200 km southwest of Portugal, marine debris and the remains of fishing gear reach densities of up to 4 objects per kilometre.[73]

Seco de los Olivos, Alboran Sea
The single-use plastics directive requires that a minimum annual collection of fishing gear is established. It is vital to set ambitious targets to avoid images like this of the Seco de los Olivos, or Chella Bank (Alboran Sea), declared a Site of Community Importance because of its enormous biodiversity.



Pockmarks, generated by the formation of carbonate crusts due to bacterial activity[68,69] provide a suitable substrate for the settlement of many different species, thereby giving rise to complex biological communities of molluscs, crustaceans, polychaetes and anthozoans (such as sea anemones and sea pens),[70,71,72] which in turn provide habitats and shelter for other types of fauna. Alterations to this fragile ecosystem, including contamination by debris, could damage the food chain at several levels.

Like *pockmarks*, **reefs and caves** are included in the European Union Habitats Directive and therefore their conservation is a mandatory priority for Member States. For this reason, the impact that plastic waste can have on these habitats should be carefully analysed in order to comply with the obligations of the Directive.

It is also worth mentioning that in Sites of Community Importance (SCIs) declared under the Habitats Directive, abandoned fishing gear made of plastic has been documented, an issue that the new Single-Use Plastics Directive (‘SUP Directive’) is intended to resolve.

4. Oceana's recommendations

Plastic pollution in the sea is ubiquitous, but there are areas where the concentration is greater and its impact on the marine ecosystem is more severe, due to the morphological characteristics of those zones and the sensitivity of the species and habitats they host. This is the case of the deep seafloor, the forgotten reaches of the oceans.

The true extent of the damage caused by debris remains hidden from view, and this is also reflected in the legislation.

Within the European Union, the SUP Directive represents a major step forward in reducing plastic waste, but its wording is based on the objects most frequently found on beaches. For this reason, more ambitious measures are needed to address the problem of seafloor pollution.

Oceana proposes a series of recommendations with the ultimate goal of reducing the plastic pollution that reaches our seas:

1. **Generation of risk maps** that identify the areas most susceptible to the impact and accumulation of plastics and other marine debris. The current distribution maps are mainly based on data collected during expeditions focusing on other studies (geology, fisheries, biology, etc.) or on data provided by fishermen or other users.

2. Given the longevity of plastics in these deep habitats, and marine ecosystems in general, **development of a protocol for removing this waste**, including the cases where this is not appropriate due to the potential impact (for example, because of the vulnerability of the species affected).

3. **Replacement of disposable products with reusable ones.** A binding target should be set to reduce food containers and single-use cups by 50% by 2025, and 80% by 2030, compared to 2020 levels. To help achieve this, Oceana proposes banning these products in government buildings, as well as bars and restaurants, and promoting similar initiatives in environments involving an elevated use of single-use plastic, such as hotels, beach bars, festivals, and street parties, especially in coastal areas.

4. **Reinforcing of measures** to prevent plastics from reaching the sea. To discourage consumers from improperly disposing of packaging, it is necessary to reintroduce deposit return schemes in the trade sector in those countries that have eliminated it. Current refillable systems have a loss rate (broken or unreturned bottles) of less than 5%[74]. There should be a minimum target of 70% of refillables for beverages by 2025, and these systems should be promoted at outdoor events.

5. **To levy a green tax on certain single-use plastics** such as cups, food containers, wrappers, bottles up to 3 litres, wet wipes, and balloons. To help curb marine pollution, this tax should be targeted and used to finance measures such as those listed above.

6. **To eliminate the plastic rings** on drink packs, because of the ensnaring risk they represent for marine fauna. To prohibit the release of balloons, as for many species these are the leading cause of death by plastic ingestion, due to suffocation and starvation.

7. **To declare effective fishing closures** that prevent the use of bottom fishing gear in vulnerable habitats, implement gear marking systems that make it possible to recover gear and identify the owner, and invest in research into alternative materials to plastic for nets.

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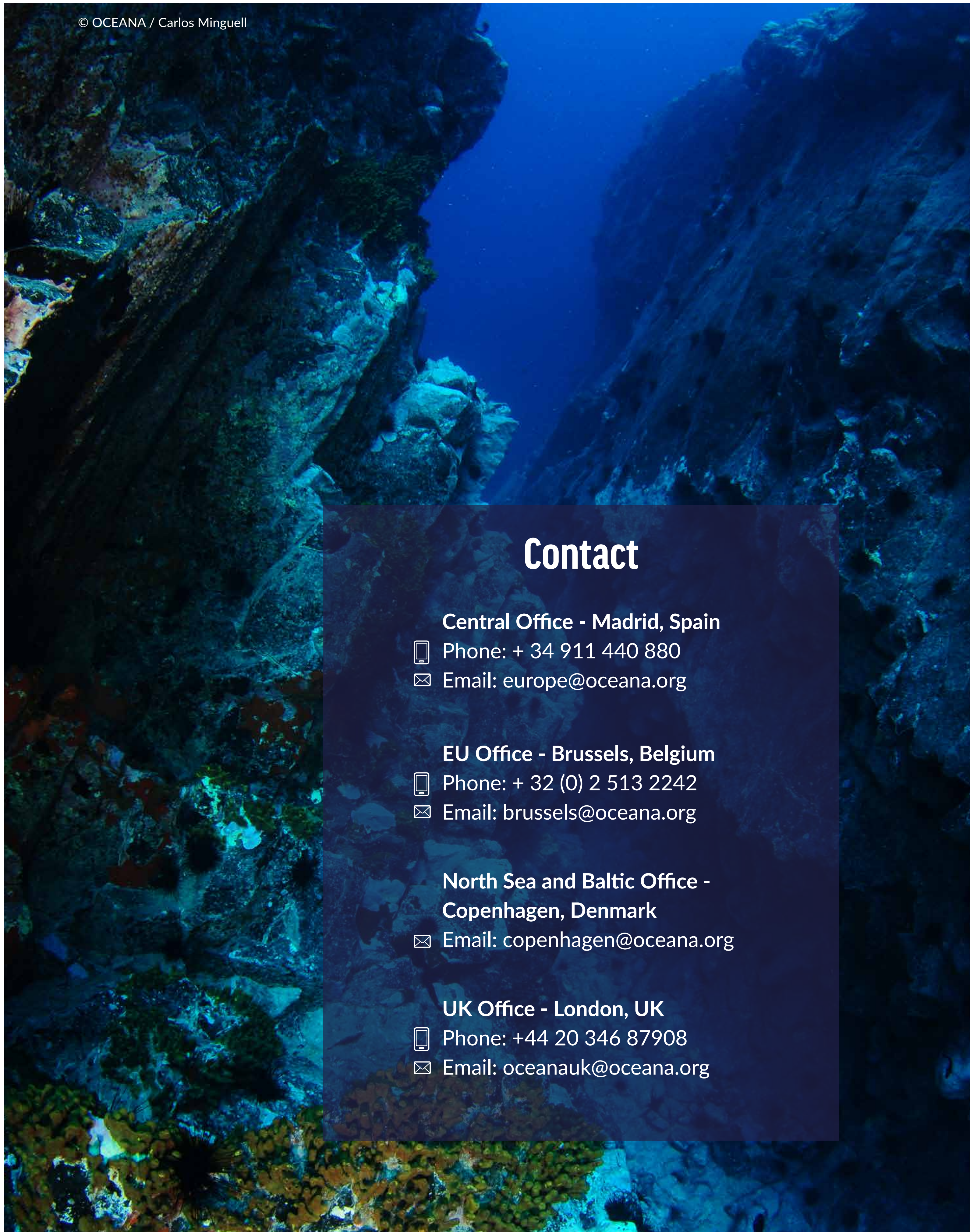

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