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Fisheries

Assessing the effect of seafloor plastic litter on fishing economic performance and commercially important Mediterranean species

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Results demonstrate that seafloor plastic hotspots in the study area overlap with the fishing grounds, thus impacting it economic productivity

Study assessed the effect of seafloor plastic litter on fishing economic performance and commercially important species in the central Tyrrhenian Sea, Western Mediterranean Sea. Photo by SMR (https://creativecommons.org/publicdomain/zero/1.0/)

Seafloor biodiversity provides essential ecosystem services, including seafood production through fishing activities, and plays a **crucial role** (https://doi.org/10.3354/meps14270) in maintaining the health and functioning of marine ecosystems and providing valuable resources for human well-being. However, various human activities, such as fishing, pollution, and climate change, directly or indirectly threaten seafloor biodiversity.

Bottom trawling is considered one of the fishing industry's most widespread and destructive practices. This method involves dragging heavy nets or gears along the seafloor, which scrapes and ploughs the sediment, causing **damage** (https://doi.org/10.1073/pnas.1405454111) to benthic organisms and habitats. Bottom trawling reduces the biomass and diversity of seafloor communities and alters the sediment's physical and chemical properties, affecting the biogeochemical cycles and the sequestration of carbon and nutrients. Moreover, bottom trawling contributes to the **accumulation of litter** (https://doi.org/10.1088/1748-9326/abc6d4) on the seafloor, as fishing gears often lose or discard plastic and metal items, such as nets, ropes, hooks, cans, and bottles.

Seafloor litter pollution, determined by different human activities, including waste dispersal and fishing, has been observed to harm marine fisheries worldwide, directly and indirectly affecting them. The **combined effects (https://doi.org/10.1016/J.MARPOLBUL.2019.03.022)** of overfishing and seafloor litter could therefore have negative impacts on the productivity, sustainability, profitability and safety of the fishing and aquaculture industries.

Despite growing awareness and concern about the effects of trawling and litter on the seabed, there are no studies on the combined effects of these two pressures and filling this knowledge gap would be a crucial task. It is essential to elucidate the sources, distribution, and environmental impacts from a systems perspective, to **understand the risks** (https://doi.org/10.1039/C6AY02934E) posed by marine

debris. A functional approach to developing a risk assessment at sea could include the integration of fishing data, which can give us much information on the distribution of species of commercial interest and aggregation areas, which very often overlap with the species' feeding habits.

(https://link.chtbl.com/aquapod)

This article – **summarized** (https://doi.org/10.1016/j.fishres.2025.107346) from the **original publication** (https://creativecommons.org/licenses/by/4.0/) (Sbrana, A. et al. 2025. The effect of marine litter on fishery economic performance. *Fisheries Research* Volume 285, May 2026, 107346) – discusses the findings of a study that analyzed the effect of seafloor plastic on fishing economic performance (as revenues) and commercially important species by mapping trawl areas and identifying litter hotspots on the seafloor in the central Tyrrhenian Sea (FAO Geographical Sub Area 9 – Western Mediterranean Sea).

Study setup

The area for this study is in the central Tyrrhenian Sea (FAO Geographical Sub Area 9 – Western Mediterranean Sea) along the coast of the Lazio region. This area has a narrow continental shelf, characterized by fine sands and muddy bottoms. The coastal area is heavily populated with large urban centers, industrial settlements, and essential ports close to Rome. The Tiber River run-off significantly affects the chemical-physical traits of the area and trophic characteristics are primarily determined by the river supply.

For this study, a model of seabed litter distribution was used in conjunction with fishing metrics, including fishing effort, landings per unit effort, and revenues. The study area was divided into 3785 individual spatial units using a grid of 1-square-kilometer cells and these used to analyze the spatial distribution of seafloor plastic and trawling fleet activities. Fishing productivity was then overlapped with the plastic accumulation zone to identify any spatial relationship and bio-economic impacts.

These are crucial metrics for fisheries policy and decision-makers, as they demonstrate the economic return of fishing vessel operations. A spatial risk assessment analysis was conducted to inform fishers, managers and researchers about the demersal resources mainly affected by the accumulation of plastic litter and to indicate possible future field investigations.

For detailed information on the experimental design, sample collection and analyses, refer to the original publication.

Evaluating the catch efficiency for common sole with the mandatory trawl gear used in the Kattegat Sea

Regulation outside of gear specifications is needed for this common sole fishery with no additional selective device that will increase retention.

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Results and discussion

This study investigated the impact of seafloor plastic litter on trawl productivity (measured in terms of revenues) in the central Tyrrhenian Sea and identified the commercial species at risk of exposure to plastic litter. The findings suggested that litter density above a certain threshold negatively affects revenues.

The spatial distribution map of seafloor litter by season highlighted the presence of plastic accumulation hotspots on the seabed, with mean values of 16,392 objects per square kilometer and did not change among seasons. These are located mainly in the coastal area and have the highest values in the north of the Tiber River while decreasing offshore (Fig. 1). Revenues had seasonal variations, with maximum peaks in the winter season, mainly in the northern portion of the study area and offshore, while lower revenue values were recorded for coastal cells in summer.

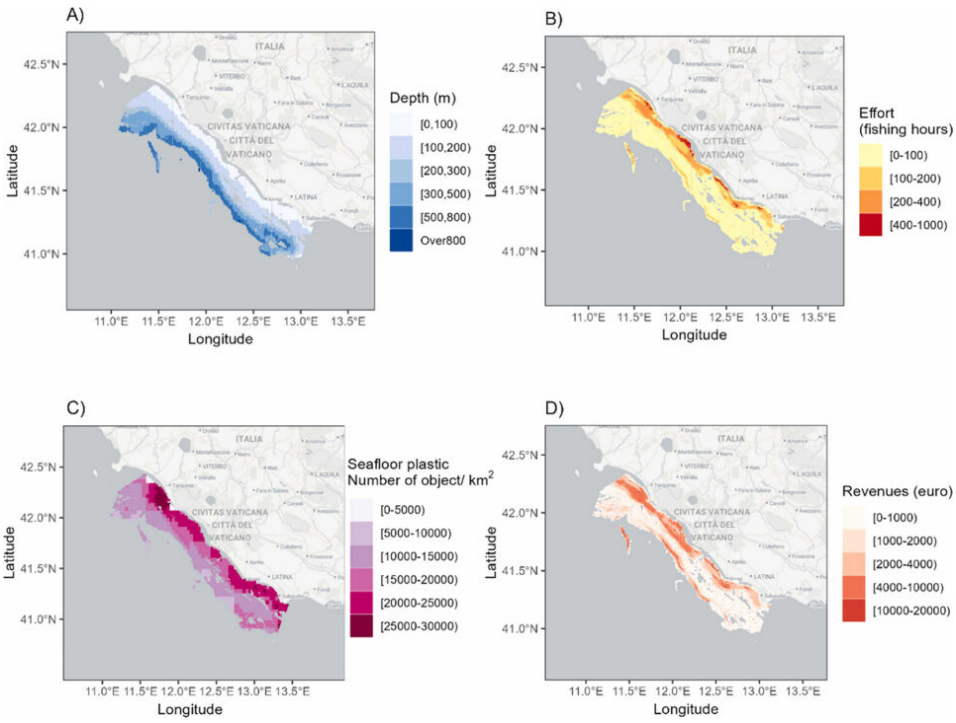

Fig. 1: Map of depth (A), fishing effort (B), seafloor litter (C) and revenues (D) of the studied area – central Tyrrhenian Sea (GSA 9).

The distribution of plastic litter on the seafloor in our study was consistent with predicted patterns of litter accumulation along the Italian coast. Indeed, high-impact zones were found to be mainly concentrated in coastal areas and decreased. Sources of marine litter are **primarily derived** (https://doi.org/10.1021/es201811s) from the mainland, depending on population density, river inputs, industries and harbors. This is particularly evident in our study, where a densely populated area (Rome) with significant river run-off due to the presence of the Tiber River was found to deliver the majority of plastic litter to the study.

The analysis of landing data has revealed that 16 species are fished in this area. Of these, nine are considered **key species in commercial fisheries** (https://doi.org/10.4060/cc0461en) in terms of landings and economic values. The catch distribution identified in this study follows the general pattern of Lazio fishing activities; indeed, in this region the trawling effort is evenly distributed on the platform and the continental slope. Smaller boats typically operate on the platform and target hake (HKE), red mullet (MUT), shortfin squid (SQM), and curled octopus (EOI), while larger boats mainly operate on the slope, with an activity aimed at pink shrimp (DPS), red shrimp (ARS), blue shrimp (ARA) and Norway lobster (NEP).

The Generalized Additive Model (GAM) model used effectively detected changes in fishing productivity caused by plastic accumulations on the seabed. It indicated that litter on the seabed could reduce the revenues of commercial fishing activities. Indeed, a significant decline in revenue was observed as the quantity of plastic on the seafloor increased.

Fig. 2: Summary of the Generalized Additive Model (GAM) results used to identify the correlation between trawling revenues (response variable) and seafloor litter hotspots (Litter – explanatory variable), and incorporating fishing hours, species-specific LPUE (Landings Per Unit of Effort), and seasons as significant factors affecting economic productivity. Adapted from the original.

Further investigation is required to fully understand the non-linear effect of plastic litter abundance on revenues. Notably, trawling practices may contribute significantly to the **redistribution of plastic waste** (https://doi.org/10.1016/j.marpolbul.2019.110580), often displacing plastic hotspots on the seabed and intensifying the problem. It is reasonable to expect a certain level of litter abundance in areas with high trawling intensity, given that the activity itself may inadvertently increase seafloor litter. Conversely, it is less likely to observe high values of LPUE (Landings Per Unit of Effort, kg of landing/m of vessel length X hours of fishing) in areas without litter, especially in historically overexploited regions. This dynamic suggests a reciprocal influence between fishing intensity and the quantity of seafloor litter, where increased fishing activity contributes to plastic pollution. In turn, the presence of plastic negatively affects fish populations and, subsequently, fishing productivity.

Within the scope of this research, seafloor plastic data and LPUE (as a proxy of habitat suitability for each species examined) were used for the first time to map fishing grounds according to levels of anthropogenic contamination. This approach provides a novel framework for evaluating the spatial overlap between marine litter and fishing activities, highlighting areas where plastic pollution could pose significant threats to marine biodiversity and commercial fisheries. Previous studies have attempted to identify plastic exposure hotspots using numerical models of floating plastic, species distribution maps, and literature reviews of plastic ingestion.

Fig. 3: Map of landing per unit effort (LPUE, kg of landing/m of vessel length/hours of fishing) for 9 important commercial trawling species in the central Tyrrhenian Sea (GSA 9). Adapted from the original.

While these studies have contributed valuable insights, they mainly focus on surface and water-column plastics, which exhibit higher mobility due to ocean currents, winds, and other environmental factors, potentially leading to less localized impacts. A key innovation of our research lies in using a spatial distribution model for plastic on the seafloor. Unlike floating plastic, which is subject to wide dispersal, seafloor plastic has limited mobility, remaining closely tied to its deposition sites. This characteristic allows for a stronger and more stable connection between plastic pollution and its impact on benthic habitats. It enables a more precise predictive model of its ecological and economic consequences. By incorporating high-resolution spatial data on plastic accumulation on the seabed, this research offers a more accurate representation of the intersection between anthropogenic contamination and fisheries productivity, contributing to the development of targeted management strategies.

Additionally, this novel approach addresses the knowledge gap in understanding the long-term accumulation of plastic in benthic environments, which is often overlooked in studies focusing on surface plastics. Since seafloor plastic may interact with fishing gear, damage essential habitats, and alter benthic community structures, this methodology opens new pathways for assessing the localized effects of marine litter and designing mitigation measures tailored to high-contamination fishing grounds.

Perspectives

A distinct separation between plastic debris and fishing activities was identified in the study area. Such categorization simplifies the recognition of areas characterized by different levels of accumulation and serves as a primary reference for understanding the spatial distribution of marine debris and fishing activities. The proposed mapping of litter hotspots provided valuable tools for ongoing monitoring efforts, in line with European directives, and highlighted the need for adapted approaches based on

habitat type and spatial distribution. Seafloor litter was found to seriously endanger the sustainability and profitability of commercial fishing, along with the health and well-being of the species, and this study identified areas and species that are at high risk of exposure and impact.

Future research could investigate whether these species are directly or indirectly contaminated, which is important for assessing and monitoring the impact of marine litter. The implications of these findings extended beyond scientific inquiry and reached into the field of resource management in the Lazio region. Recognizing waste as a potential threat to economic productivity may encourage fishing community participation in waste monitoring and removal efforts.

Additionally, the study recommended establishing a threshold level of seafloor litter density as a practical approach to ensuring the sustainability and profitability of commercial fishing operations in the face of evolving environmental challenges. This research provided practical insights for policymakers, stakeholders, and the fishing community providing a framework for further research, collaboration and innovation to protect the delicate balance of the central Tyrrhenian Sea's marine environment.

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