frontiers | Frontiers in Ocean Sustainability

TYPE Systematic Review
PUBLISHED 07 January 2025
DOI 10.3389/focsu.2024.1474477

OPEN ACCESS

EDITED BY
Ashley Deevesh Hemraj,
Aarhus University, Denmark

REVIEWED BY
João Frias,
Atlantic Technological University, Ireland
Harry Gorfine,
Victorian Fisheries Authority, Australia

*CORRESPONDENCE
Nicole R. Guerrato
nicole.guerrato@unifesp.br

RECEIVED 01 August 2024
ACCEPTED 13 December 2024
PUBLISHED 07 January 2025

CITATION
Guerrato NR and Gonçalves LR (2025) Netting the problem: a comprehensive analysis of marine litter on artisanal fishers.
Front. Ocean Sustain. 2:1474477.
doi: 10.3389/focsu.2024.1474477

Netting the problem: a comprehensive analysis of marine litter on artisanal fishers

Nicole R. Guerrato* and Leandra R. Gonçalves

Institute of Marine Sciences, Federal University of São Paulo (UNIFESP), Santos, Brazil

Marine litter, a critical global challenge, has gained prominence in international discourse, particularly during the United Nations Decade of Ocean Science for Sustainable Development. While extensive scientific literature on the distribution, origin, and ecological impacts of marine litter, research focusing on its socioeconomic impacts, especially on artisanal fishing communities, is markedly sparse. This study aims to address the gap in the impact of marine litter on small scale fishery through a systematic analysis of global research trends, patterns, and impacts of marine litter on fishing activities. Utilizing databases such as Scopus, SciELO, and repositories of theses and dissertations, the study analyzed scientific publications from 2011 to 2021, with keywords including "small-scale fishery," "artisanal fishery," "fisheries," and "marine litter." The analysis identified 14 articles that specifically address the impact of marine litter on the small-scale fisheries. These findings highlight a critical research gap: while the literature often portrays fishermen as sources of marine litter, notably through fishing gear, it seldom focuses on them as victims impacted by these environmental challenges. The study reveals the necessity for a more balanced research approach that integrates both environmental and social dimensions of marine litter, particularly in underrepresented regions. The increasing global focus on marine litter in recent academic research indicates a promising trajectory toward addressing these challenges comprehensively. This article underscores the urgency of broadening the scope of marine litter research to include the socioeconomic impacts on coastal communities, particularly artisanal fishermen. Such an approach is essential for developing effective, holistic solutions that address the intricate challenges posed by marine litter, balancing environmental protection with the livelihoods of coastal communities.

KEYWORDS

small-scale fishermen, marine litter, socioeconomic impacts, systematic literature review, Sustainable Development Goal 14

1 Introduction

Marine litter is a worldwide problem and is currently observed throughout the ocean, from the most remote areas, within the biota, sea ice, the surface, and even the deep ocean (Barnes et al., 2009; Ryan, 2015; Law, 2017; Waller et al., 2017). However, the coastal areas, which are constantly expanding due to urbanization, bear the greatest impacts due to their proximity to different waste sources (Hartley et al., 2018).

The negative impacts of marine litter in the ocean span various sectors and scales, reducing the provision of ecosystem services (Newman et al., 2015), affecting the economy (Mouat et al., 2010), human health and wellbeing (Wyles et al., 2016), and causing biodiversity loss (Bergmann et al., 2015). The damages caused by marine litter

are numerous and range from entanglement and ingestion affecting biodiversity (Gall and Thompson, 2015; Tekman et al., 2017); decline in tourism due to coastal and beach litter (McIlgorm et al., 2011; Keswani et al., 2016); destruction of deep-sea corals (Kühn et al., 2015); spread of invasive species (Kiessling et al., 2015); ship accidents (Cho, 2005); accumulation of contaminants along the food chain (Li et al., 2016); and the socioeconomic impacts of litter on artisanal fishermen dealing with this issue daily in their profession (Nash, 1992).

The influence of marine litter on artisanal fishing is noteworthy. It can occur directly or indirectly, affecting fishing gear, vessels, family economies, and food security (Ivar Do Sul, 2005; Nash, 1992; Takehama, 1989; Pinheiro et al., 2021). Specifically, the capture of litter in fishing nets can damage materials, increase repair costs, and reduce fishing time (Ivar Do Sul, 2005), obstruct equipment, reducing its capture potential, resulting in higher demand for vessel traction to pull the nets aboard, requiring more fuel (Graça-Lopes et al., 2002).

The impact of marine litter on biodiversity, the marine environment, and human health is increasingly addressed in scientific literature (Bettencourt et al., 2021). However, when analyzed from a socio-environmental perspective, the issue of litter generated by artisanal fishing activities remains underexplored in the scientific literature. Although Nash's (1992) research made initial contributions to this field, the topic has not received sufficient attention, leading to environmental conflicts that negatively impact the livelihoods of artisanal fishermen.

Globally, close to 40 million people are employed in capture fisheries, and ~90% of them are small-scale fishers (Bené et al., 2007). Overfishing, competition with industrial fleets, habitat destruction, and unsustainable urban and industrial development are common challenges faced by small-scale fisheries (FAO, 2020) in addition to the overarching issue of marine litter. Artisanal fisheries can be defined as: "Traditional fisheries involving fishing households (as opposed to commercial companies), using relatively small amounts of capital and energy, relatively small fishing vessels (if any), making short fishing trips, operating close to shore, mainly for local consumption.

In practice, definition varies between countries, e.g., from gleaning or a one-man canoe in poor developing countries, to more than 20 m. trawlers, seiners, or long-liners in developed ones. Artisanal fisheries can be subsistence or commercial fisheries, providing for local consumption or export. They are sometimes referred to as small-scale fisheries (FAO, 2012).

Despite the significance of artisanal fisheries, the subject is still underexplored, but there is a noticeable increase in publications on the topic in the last decade (Nash, 1992; Wyles et al., 2019). In the period from 1989 to 2016, it was possible to observe that, starting in 2012, there was an increase in scientific publications related to the theme of marine litter and fishing (Schneider et al., 2018).

Although there are frequent data collections regarding the presence of marine litter, this information is not quantitatively consolidated in publications that comprehensively describe the results of these collection efforts (Law, 2017; Keswani et al., 2016).

It is important to note that, so far, analyses and reviews often focus on reducing inputs and the impact of marine litter on the oceanic environment, neglecting an in-depth evaluation of activities associated with the management of collected waste (Iñiguez et al., 2016). In this context, this paper aims to understand the impact of marine litter on artisanal fishers within scientific literature, from a marine science perspective.

This paper will discuss not only the environmental implications but also aspects related to the sustainability of fishing and the management of marine waste.

2 Methods

A systematic literature review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009) to ensure methodological rigor and transparency (Figure 1). The review focused on assessing the impact of marine litter on artisanal fisheries, incorporating all types of scientific publications from the last decade (2011–2021).

2.1 Data sources and search strategy

Primary academic databases, including Web of Science, Scopus, and SciELO, were used due to their comprehensive coverage of journals relevant to the study's themes. Additionally, the CAPES[1] theses and dissertations database was consulted to ensure adequate representation of Brazilian academic contributions.

The search process was iterative and employed a series of keyword combinations in both English and Portuguese, such as "marine litter," "artisanal fishing," and "small-scale fishing," connected by logical operators ("AND" and "OR"). Initial searches yielded 3,249,090 articles, many of which were unrelated to the central theme. To refine the results, searches were narrowed using "AND" to ensure relevance, and duplicate records were removed. Studies that addressed marine litter or fishing separately, without exploring their interrelation, were excluded.

The final dataset consisted of 414 articles compiled and organized using Mendeley. These articles were descriptively analyzed and classified based on:

1. Type of publication (e.g., scientific article, thesis, dissertation, monograph, report, book, or book chapter);
2. Year of publication;
3. Presence of information on fishing and interactions with marine litter.

2.2 Thematic categorization

Publications were further categorized into three thematic groups:

1. **Socioeconomic impacts and perceptions of marine litter**: Studies addressing the social and economic consequences

1 CAPES—Coordination for the Improvement of Higher Level Personnel, Government foundation that, among its responsibilities, allows access and dissemination of scientific production.

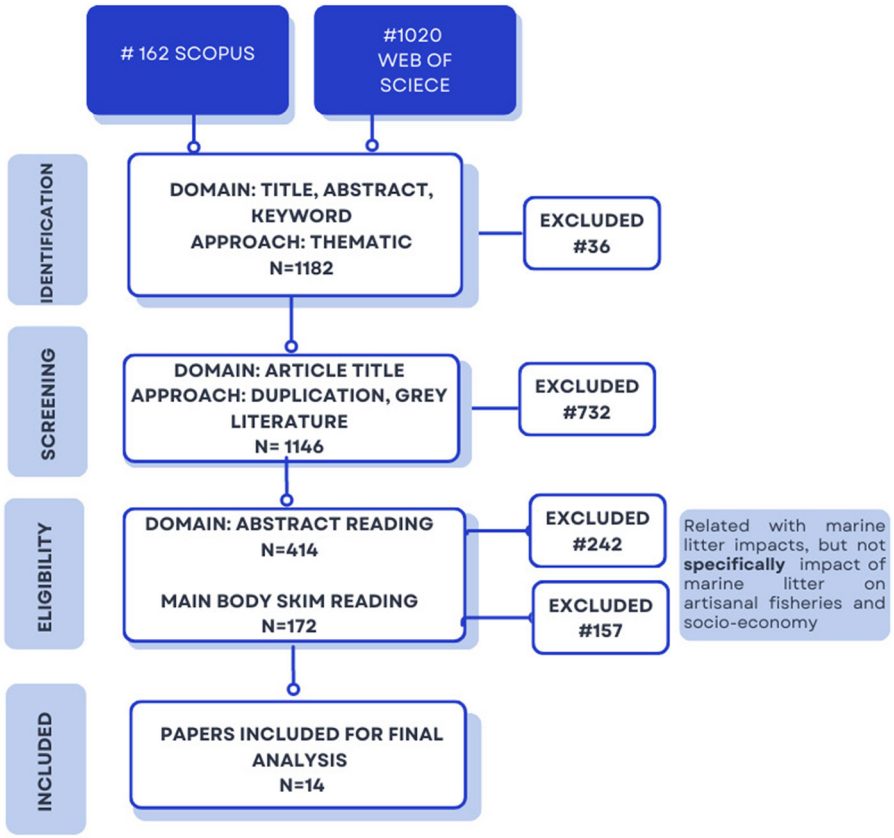

FIGURE 1
The flow diagram (PRISMA) for the database search of publications for systematic reviews. Adapted from Moher et al. (2009).

of marine litter on artisanal fishing communities, including livelihoods, health, wellbeing, and economic outcomes ($N = 14$).
2. **Diagnosis and monitoring of marine litter**: Research focused on identifying, quantifying, and tracking marine litter in coastal and marine environments, including the development of monitoring systems ($N = 227$).
3. **Marine litter and other environmental impacts**: Investigations into the ecological impacts of marine litter, such as effects on wildlife, habitats, and ecosystems, as well as interactions with other environmental stressors ($N = 172$).

For this study, only publications within the **Socioeconomic impacts and perceptions of marine litter** category were analyzed ($n = 14$), as they were within the scope of this research.

2.3 Analytical approach

The analysis followed three main steps (Figure 2):

1. **PRISMA systematic review**: Identification and refinement of relevant studies using predefined keywords.
2. **Bibliometric analysis**: Compilation and classification of publications.
3. **Content analysis**: Qualitative analysis of the selected studies to extract insights on the socioeconomic dimensions of marine litter impacts on artisanal fisheries.

3 Results

3.1 Bibliometric analysis

The Scielo and Scopus search engines provide the highest returns (Table 1), from which 13 were articles and 1 was a scientific note, totalizing in 14 publications.

Based on the results of these searches, it was possible to observe that the publications found in group 1 ($n = 14$) are predominantly associated with the distribution of marine litter in the coastal zone, quantitative assessments of waste through beach cleaning activities, and the origin of solid waste. Only five publications address the socioeconomic impact of marine litter on coastal communities, especially artisanal fishermen (e.g., Basurko et al., 2015; Andres et al., 2021; Abalansa et al., 2020; Navarro and Araque, 2021).

Regarding the 14 articles analyzed, there was a predominance of publications in European Union countries ($n = 6$: Spain, Germany, Norway and Croatia), highlighting Europe's leading role in studying topics related to the socioeconomic impact of

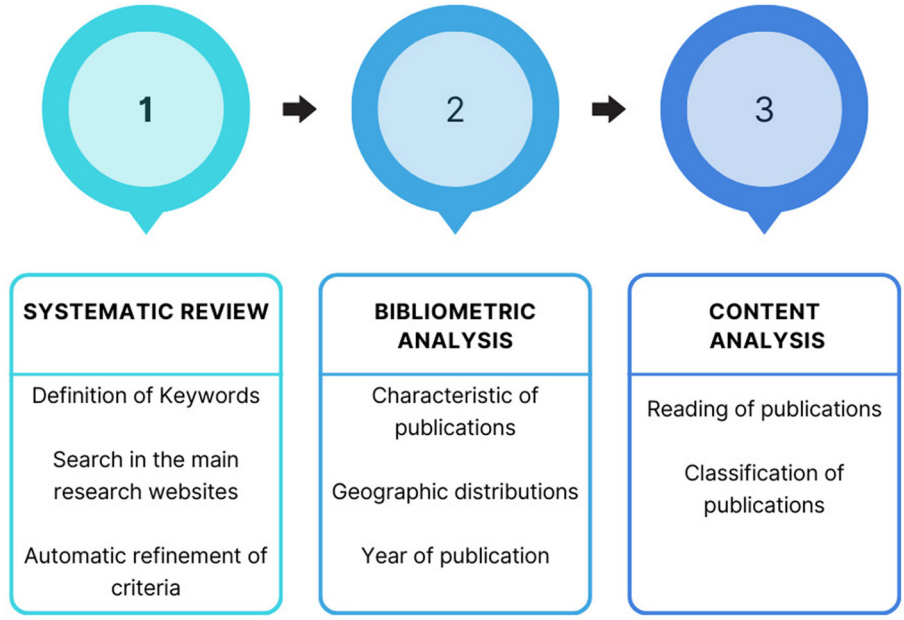

FIGURE 2
Step by step for carrying out the systematic literature review. Adapted from Bettencourt et al. (2021).

TABLE 1 Results of articles found with keyword combinations for each search base.

Bases	Key words	Returns	Excludents	Final
Scopus	Marine litter and artisanal fisheries	2	1	1
	Marine litter and fisheries	152	3	149
	Marine litter and Small Scale Fisheries	10	5	5
SciELO	Marine litter and artisanal fisheries	0	0	0
	Marine litter and fisheries	0	0	0
	Marine litter and Small Scale Fisheries	0	0	0
Web of Science	Marine litter and artisanal fisheries	30	28	2
	Marine litter and fisheries	1012	758	254
	Marine litter and Small Scale Fisheries	39	36	3
Total				
Final articles: 414				
Filtered and analysis articles: 14				

marine litter (Penca, 2018). The European Union also stands out in publications related to the circular economy and plastics (Domenech and Bahn-Walkowiak, 2019). Based on the selection criteria, only two publications from Brazil in the past decade have been included (Figure 3). While numerous other publications were produced in Brazil during this period, only these two meet the specified criteria. This indicates that this topic has triggered interest primarily in countries in the Global North and subsequently in the Global South. These countries served as the primary locations where the sampling was conducted for the publications.

The number of publications between the years 2011 and 2021 was also analyzed. Starting from 2020, there was a significant increase in publications related to the topic of marine litter and fisheries (Figure 4). This increase may have been stimulated by the agenda 2030, which, under Sustainable Development Goal 14, includes specific metrics for marine litter pollution. It is likely to continue to grow or even expand due to the visibility of the "United Nations Decade of Ocean Science for Sustainable Development," also known as the Ocean Decade, declared by the United Nations in 2017 as part of the UN's 2021–2030 agenda. The Ocean Decade aims to raise greater awareness and support for issues related to this

FIGURE 3
Publications found for each country in the systematic literature review, represented by the pins ($n = 14$).

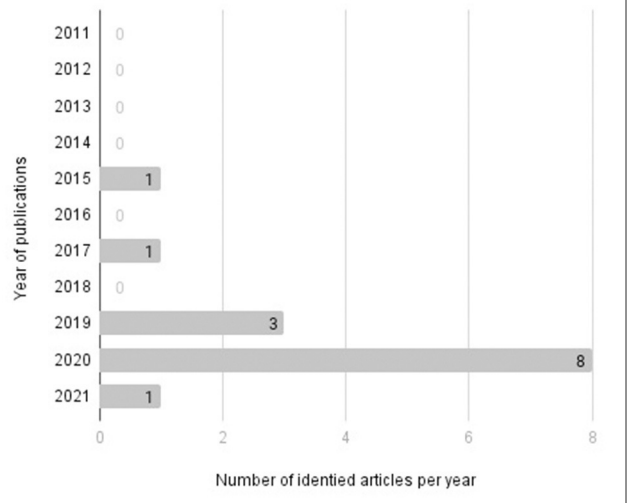

FIGURE 4
Number of articles published per year of publication.

theme, with one of its objectives being a clean and healthy ocean (UN Environment Program, 2017).

The analysis was also refined using VOSviewer software, which allows simulating various scenarios. Below, some of the different combinations that were used in the preparation of the study will be presented (Figure 5).

The above image represents the analysis of keyword co-occurrence in these 14 articles that composed the group on "socioeconomic impact of marine litter on artisanal fishermen." Despite conducting searches between 2011 and 2021, the findings were limited to the timeframe from 2018 to 2021. This timeframe discrepancy indicates that only in 2021 did keywords like "marine environment" and "marine impacts" begin to show associations with other previously mentioned keywords, such as "fisheries" and "perceptions." It's noteworthy that the correlation between "marine pollution" and "fisheries/fishery" has consistently persisted across these analyses.

The journals (Figure 6) in which the articles were published and the areas of expertise of the authors of the 14 selected articles are diverse, ranging from marine ecology, coastal biodiversity, environmental management, economic and environmental sustainability, marine governance, environmental education, and resource economics, highlighting the interdisciplinary, cross-cutting, and transdisciplinary nature of the subject.

The primary journal identified was the Marine Pollution Bulletin, suggesting that this topic is predominantly approached from a pollution perspective rather than focusing extensively on socioeconomics, governance, and management aspects.

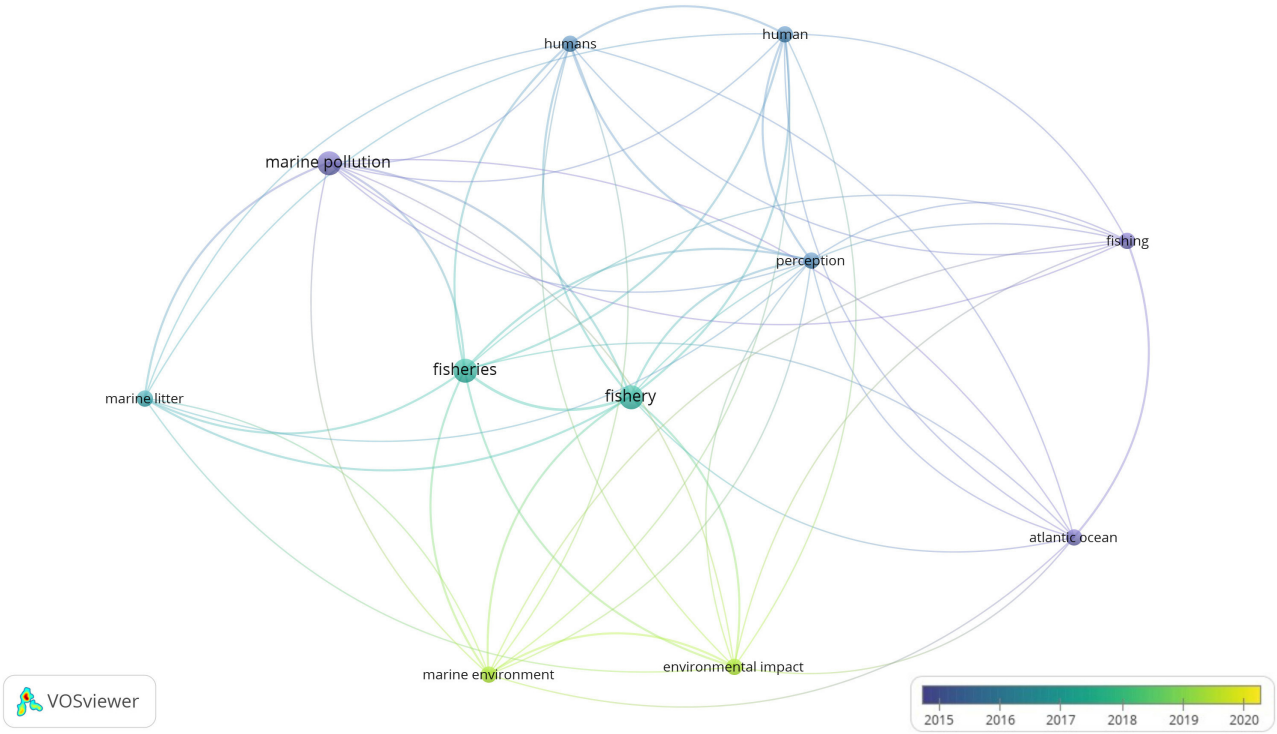

FIGURE 5
Co-occurrence analysis of keywords in the filtered articles, performed by VOSviewer software.

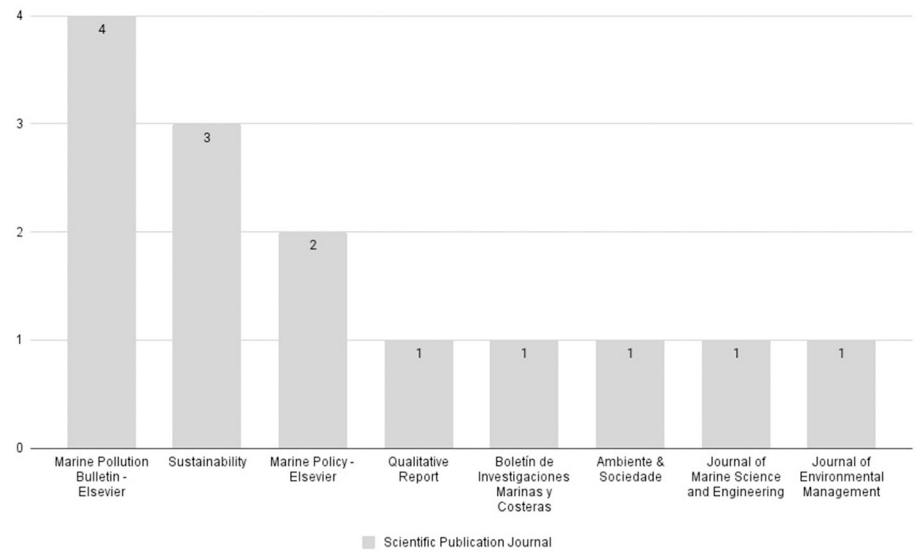

FIGURE 6
Number of identified papers published separated by journals of publications.

3.2 Content analysis

The qualitative content analysis approach was conducted when examining the selected articles (Saunders et al., 2009). The publications were initially read in their entirely to distinguish those that addressed marine litter and fishing from those that merely mentioned them. The publications in which the impact of marine litter on the fishing sector was identified as effectively explored were reread, and 14 relevant articles and 1 scientific note were extracted and grouped into different categories (Table 2).

TABLE 2 Systematized articles categorized by authors/year/article title/location and publication type and thematic groups.

Thematic group	References	Article title	Publication location
Coastal stakeholders' perceptions and citizen science	Haarr et al., 2020	Citizen science data indicate a reduction in beach litter in the Lofoten archipelago in the Norwegian Sea	Norway
Coastal stakeholders perceptions and citizen science	Herdiansyah et al., 2021	Coastal community perspective, waste density, and spatial area toward sustainable waste management (case study: Ambon Bay, Indonesia)	Indonesia
Coastal stakeholders ' perceptions and citizen science*	Habibi et al., 2021	Madurese fishing community cultural perception of coastal litter	Indonesia
Coastal stakeholders ' perceptions and citizen science	Bezerra and Iared, 2019	Diferentes atores sociais e a relação com o lixo marinho no município de Cananéia - SP.	Brazil
Coastal stakeholders' perceptions and citizen science	Funduk et al., 2021	Marine litter in croatian adriatic: sources, quantities and stakeholders perspectives	Croatia
Coastal stakeholders' perceptions and citizen science	Ferreira et al., 2021	Perception of citizens regarding marine litter impacts: collaborative methodologies in island fishing communities of Cape Verde	Cape Verde
Coastal stakeholders' perceptions and citizen science**	Lewin et al., 2020	Recreational anglers' perceptions, attitudes and estimated contribution to angling related marine litter in the German Baltic Sea	Germany
Coastal stakeholders' perceptions and citizen science	Brennan and Portman, 2017	Situating Arab-Israeli artisanal fishermen's perceptions of marine litter in a socio-institutional and socio-cultural context	Arabia
Fishing as a measure to assess marine litter	Song et al., 2021	First observation and effect of fishery of seabed litter on sea bed by trawl survey Korea waters	Korea
Fishing as a measure to assess marine litter	Iraia et al., 2015	Fishing plastics: a high occurrence of marine litter in surf-zone trammel nets of Southern Brazil	Brazil
Economic impacts on the fishing sector	Iraia et al., 2015	Fishing for floating marine litter in SE Bay of Biscay: review and feasibility study	Spain
Economic impacts on the fishing sector	Andres et al., 2021	Measuring and comparing solutions for floating marine litter removal: lessons learned in the south-east coast of the Bay of Biscay from an economic perspective	Spain
Economic impacts on the fishing sector	Navarro and Araque, 2021	Esquema de pago por servicios ambientales como estrategia de gestión para regular la pesca artesanal del Distrito de Manejo Integrado Cispata, Colômbia	Colombia
Economic impacts on the fishing sector	Abalansa et al., 2020	The marine plastic litter issue: a social-economic analysis	Union European

Thematic group 1, stakeholders perceptions and citizen science; 1*, Artisanal fishing; 1**, recreational fishing; thematic group 2, fishing as a measure to assess marine litter; thematic group 3, economic impacts on the fishing sector.

Of the 14 selected articles on the socioeconomic impacts and perceptions of marine litter, eight focused on the perception of coastal stakeholders regarding marine litter (Thematic Group 1), and among these stakeholders were artisanal fishermen. Only the articles by Brennan and Portman (2017), conducted in Saudi Arabia, and the article by Habibi et al. (2021), conducted in Indonesia, exclusively focused on the perception of artisanal fishermen regarding the impact of marine litter. In both articles, fishermen recognized that marine litter is a complex problem that negatively impacts fishing activities. Furthermore, the authors concluded that mitigating the impacts and reducing marine litter are a shared responsibility and require interdisciplinary collaboration between scientists, public officials, and environmentalists.

Additionally, the research conducted by Lewin et al. (2020) indicated that fishermen can positively influence environmental conservation if engaged in the management process. In the articles by Brennan and Portman (2017) and Habibi et al. (2021), it is evident that long-term coastal litter management is difficult without a transformation in the relationships between local communities and government institutions.

Regarding the other articles in Thematic Group 1 (Perception of coastal stakeholders and citizen science), only the article by Haarr et al. (2020), conducted in Indonesia, used citizen science data to diagnose marine litter in coastal areas. The rest of the articles in this thematic group ($n = 5$) addressed the perceptions of coastal stakeholders (not just fishermen) regarding marine litter, using semi-structured interview methodology. In all the analyzed

articles, coastal stakeholders noted the presence of marine litter and regarded it as a complex problem that negatively impacts their respective activities and recreational spaces. The perception of artisanal fishermen regarding the impacts related to equipment damage and financial impact on fishing, as abandoned nets in the sea can become entangled in the vessel's propeller and cause damage, resulting in economic losses for repairs and disruption of artisanal fishing (Ferreira et al., 2021). Articles in Thematic Group 2 (Fishing as a measure to assess marine litter) report on two articles that used fishing as a method to diagnose marine litter. In the article by Song et al. (2021), a shrimp trawl vessel was used in South Korea to measure ocean waste. In this research, the authors concluded that 69.4% of all collected waste was of plastic origin, and it was revealed that 95% of deep-sea waste in the Korea region comes from fishing. In the study conducted by Pinheiro et al. (2021), artisanal beach seine fishermen played a central role in the scientific research, and the methodology involved sorting the waste captured during the seine fishing activity. In both cases, it was observed that the highest proportion (<60%) of deep-sea waste by density was plastic, followed by fishing-related items (fishing gear, pieces of net, rope, buoys, and hooks). In both articles, fishing activities were utilized as a potential tool for measuring and diagnosing solid waste in the ocean, either using only the vessel (Song et al., 2021) or the vessel and fishing activity itself as a tool for capturing solid waste (Pinheiro et al., 2021).

Finally, Thematic Group 3 (Economic Impacts on the Fishing Sector) encompasses four articles addressing the economic impacts of litter on various coastal segments, including fishing. Of these articles, three aimed to assess the technical, economic, and environmental feasibility of using artisanal fishing vessels to collect floating marine litter (Andres et al., 2021; Basurko et al., 2015; Navarro and Araque, 2021).

The article by Andres et al. (2021) addresses the challenges of implementing effective actions for monitoring and assessing floating marine litter (FML). It proposes mitigating measures, one of which is the collection of FML using adapted fishing vessels dedicated to actively fishing for litter. According to the authors, this approach can enhance the efficiency of both activities, but improvement depends on the fishermen's knowledge of vessel management, the accuracy of surface sea circulation models, and local litter density. The results demonstrate the possibility of having vessels engaged in active and passive litter fishing when the scopes of each activity are well-defined and do not overlap.

Additionally, the authors propose payment for this active fishing, estimated at 1–8 euros per kilogram. This objective is like that described by Basurko et al. (2015), which also aimed to determine the technical, economic, and environmental feasibility of an artisanal fishing vessel for collecting floating marine litter (FML).

The scientific note by Navarro and Araque (2021), although not specifically addressing marine litter, discusses the feasibility of a payment-for-environmental-services scheme as an alternative to incentivize compliance with fishing agreements, which would consequently reduce bycatch (accidental fishing) and resource overexploitation.

The other articles in this thematic group ($n = 2$) discuss marine litter from an economic perspective. In both articles, it is evident that the fishing sector experiences economic pressure when dealing with marine litter daily, resulting mainly in potential job and income loss for fishermen, directly related to the unsustainability of maintaining fishing activities due to financial losses associated with encountering marine litter (Abalansa et al., 2020).

These articles are related as they seek alternatives for ocean sustainability and solid waste mitigation, using the empirical knowledge of fishermen, scientific knowledge, and new approaches for litter removal and encouragement of marine litter collection.

4 Discussion

Marine litter was first mentioned in scientific literature in the 1960s when Kenyon and Kridler (1969) reported plastic ingestion and entanglement by Laysan albatrosses in the Hawaii. Despite growing research and warnings, plastic production increased by 625% between 1975 and 2012, reaching 348 million tons globally in 2017 (Plastics Europe, 2018). It is expected that plastic waste will double in the coming decades (Geyer et al., 2017; Jambeck et al., 2015). However, research on the socio-economic and environmental impacts on coastal stakeholders, particularly artisanal fishermen, remains limited, with most studies focusing on quantitative data from NGO-led cleanups (e.g., Addamo et al., 2017; Campbell et al., 2019). The analysis of the 14 selected publications on marine litter reveals a strong focus on its distribution in coastal zones, quantitative assessments through beach cleaning, and the origins of solid waste. Notably, only a third of these studies delve into the socioeconomic impacts on coastal communities, particularly artisanal fishermen. This distribution underscores a critical gap in understanding the broader implications of marine litter beyond its environmental footprint, as has already been pointed out by Nash (1992).

The geographical distribution of these studies, predominantly in European Union countries, points to a region-specific emphasis in marine litter research. This concentration aligns with Europe's proactive stance in environmental issues, especially those pertaining to the circular economy and plastics (Leone et al., 2023). The limited representation of studies from the Global South and Small Island Developing States (SMDI) suggests a disparity in research focus and resources between the Global North and South. This geographic skew could potentially overlook unique challenges faced by coastal communities in less-represented regions.

Due to the transboundary nature of marine plastic pollution, the difference in capacity between States (Global South and Global North) in implementing "internationally agreed rules, procedures and practices" has the potential to make preventive activities ineffective (Raubenheimer et al., 2018). Waste management laws in the Global South are generally weak, creating a pattern of uncontrolled plastic production and consumption that ultimately leads to unmanaged plastic garbage. This equal distribution of responsibility ignores the fact that Global North's contribution to global plastic production and the export of plastic waste increase environmental risks in the Global South (Owens and Conlen, 2021).

The increasing trend in publications from 2020 onward, possibly influenced by the Agenda 2030 and the United

Nations Decade of Ocean Science for Sustainable Development, indicates a growing global awareness and commitment to addressing marine litter issues. This trend is promising, as it could lead to a more holistic understanding of marine litter, encompassing both environmental and social aspects, that pathway could end up contributing to the current Plastic treaty negotiations.

The keyword co-occurrence analysis, as shown in Figure 5, reveals a recent shift in research focus. The association of terms like "marine environment" and "marine impacts" with "fisheries" and "perceptions" since 2021 suggests an evolving discourse that integrates ecological concerns with human dimensions. However, the persistent correlation between "marine pollution" and "fisheries" across these analyses indicates that the pollution aspect remains a dominant theme in marine litter research. The predominance of publications in the Marine Pollution Bulletin suggests a skewed focus toward pollution aspects, revealing an opportunity for future research to explore more thoroughly socioeconomic, governance, and management aspects of marine litter. Such an expansion is essential for devising effective, holistic solutions that address the intricate challenges posed by marine litter, particularly for vulnerable coastal communities and artisanal fisheries.

The interdisciplinary nature of the journals and authors' expertise—spanning marine ecology, coastal biodiversity, environmental management, and economics—highlights the multifaceted nature of marine litter research. This diversity is crucial for developing comprehensive strategies that address not only the ecological but also the social and economic dimensions of marine litter. To make better contributions, social scientists are welcome in this debate, and could offer a broader perspective (Olsson and Ness, 2019).

This discussion underscores the necessity for a more balanced research approach that considers both environmental and social dimensions of marine litter, especially in underrepresented regions and communities. The increasing global focus on marine litter, as indicated by recent trends in academic research, provides a hopeful trajectory toward addressing these challenges comprehensively.

Cleanup efforts worldwide, including in Brazil, help mitigate environmental damage but are not a solution to the complex problem of marine litter. These actions raise awareness about consumption habits and waste production while contributing to global initiatives (Grechinski, 2020). However, from beach cleanups are often discontinuous, random, and lack standardization (Ryan et al., 2009), creating a gap in scientific literature and limiting their use in public management and effective marine litter control.

Regarding the publications targeted in this article (Impacts of marine litter on artisanal fishing), there is a noticeable low number of publications related to the topic when analyzing the impact of marine litter from a social and economic perspective, especially for coastal users, primarily artisanal fishermen. Among the few articles found on the impact of litter on fishing communities ($n = 14$), it was possible to conclude that marine litter directly and indirectly impacts artisanal fishing since it can interfere with the quantity and quality of fish (Batista, 2018) and cause damage to fishing gear and vessels, resulting in social and economic impacts and threats to the traditional way of life of coastal communities (Nash, 1992; Pinheiro et al., 2021). A study conducted in Scotland, outside the sample period of this research, showed that 86% of Scottish boats reported problems due to the amount of litter caught in fishing nets (Mouat et al., 2010) and estimated that litter caused an impact between 11.7 and 13 million on average each year, equivalent to 5% of the total fishing revenue.

Other articles that mentioned fishing and marine litter often portrayed fishermen as polluters, especially when they lost fishing gear at sea, and not as negatively impacted by this issue (e.g., Topçu et al., 2013; Thiel et al., 2013; Ramirez-Llodra et al., 2013). The lack of political representation and social marginalization of artisanal fishermen is an old problem (Acheson, 1981), and this factor may be a strong contributor to the historical lack of analysis of the impact of pollution, specifically solid waste pollution, on their way of life. Considering environmental issues such as climate change, marine pollution, increasing resource degradation, and low financial returns, the fishing sector is undergoing changes that will continue to intensify (FAO, 2016). All the characteristics mentioned above, along with the challenges of the present, emphasize the relevance of social studies with fishing communities.

Most publications on this topic were from European Union countries, highlighting the emphasis of this subject in academic circles among European countries. It's worth noting that since 2011, a total of 80 NGOs in 43 countries have signed the Global Declaration for Marine Litter Solutions and more than 900 independent scientists that have signed the Scientists' Declaration for the Global Plastics Treaty. According to the progress report from Plastics Europe, ~395 projects related to marine litter were planned, ongoing, or completed worldwide (Plastics Europe, 2018).

Additionally, the Organization for Economic Cooperation and Development (OECD), along with the European Environment Agency (EEA) and the United Nations Environment Programme (UNEP), used the Driver-Pressure-State-Impact-Response (DPSIR) framework as a tool for analyzing complex socio-economic-environmental issues like marine litter. This framework has been widely used in marine and coastal contexts (Gari et al., 2015; Lewison et al., 2016) because it is an interdisciplinary and adaptive management framework that considers ecological and social systems.

In Brazil, regarding publications on marine litter in general, it stands out in academic circles that out of the 17 coastal states, eight of them (Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Rio de Janeiro, Bahia, Pernambuco, and Paraíba) have at least one publication in international journals, forums, and conferences for each coastal city (do Sul and Costa, 2007).

The topic of marine litter is complex, and its intersection with other subjects (e.g., economics, ethno-biology, governance) from different perspectives is essential to overcome knowledge fragmentation and achieve a critical and transformative understanding of the issue. Without a systemic approach that considers the relationship between nature and society, we cannot effectively address modern environmental problems. Landon-Lane (2018) underscores the importance of a multi-level and inclusive approach to address marine plastic pollution. Oceanic plastic pollution is intricate, and the approach to addressing this issue is equally complex. However, most significantly, a multilevel

approach is deemed necessary but not sufficient in responding to complex multiscale and multi-sector issues (Fidelman et al., 2013).

The studies by Brennan and Portman (2017) in Saudi Arabia and Habibi et al. (2021) in Indonesia, which specifically focus on artisanal fishermen, highlight a crucial finding: fishermen recognize marine litter as a complex issue with negative affecting in their livelihood. These articles emphasize the need for an interdisciplinary approach involving scientists, public officials, and environmentalists to mitigate impacts and reduce marine litter. This viewpoint aligns with Lewin et al. (2020), suggesting that engaging fishermen in management processes can have positive environmental conservation outcomes.

The issue of marine litter, particularly its impact on artisanal fishing, requires integrated strategies that address both ecological and socio-economic dimensions. Some recommendations provided by FAO (2017) report and GESAMP (2021) report suggest several solutions to mitigate the marine plastic pollution. These include investing in the development of biodegradable materials for fishing gear and creating incentives for the proper return and disposal of used equipment are essential steps. Additionally, implementing circular economy or similar principles throughout the lifecycle of gear, from the design stage to the end of the life stage, throughout, policy needs to ensure provision of adequate disposal facilities, address the economic barriers to recycling, and encourage or establish extended producer responsibility schemes for gear.

The difficulty of managing coastal litter without transforming relationships between locals communities and government institutions are a significant insight from these studies. Furthermore, the comparison between artisanal and commercial fisheries also points to the need for differentiated policy approaches. While large-scale commercial fisheries may benefit from global governance frameworks and technological innovations, artisanal fisheries require localized, community-driven interventions that address their unique vulnerabilities. This includes strengthening local waste management systems, improving access to resources and training, and fostering collaborations between scientists, policymakers, and fishing communities. Such efforts can help mitigate the socio-economic impacts of marine litter while promoting sustainable practices and enhancing community resilience.

The use of citizen science data in the study by Haarr et al. (2020) illustrates an innovative approach to diagnosing marine litter issues, demonstrating the potential of community involvement in scientific research. The predominance of semi-structured interviews in the remaining articles of Thematic Group 1 indicates a reliance on qualitative methods to capture the perceptions of coastal stakeholders. This approach reveals a consistent concern among these stakeholders about the complex problems posed by marine litter, affecting both their activities and recreational spaces.

In Thematic Group 2, the innovative use of fishing activities to assess marine litter, as seen in the studies by Song et al. (2021) and Pinheiro et al. (2021), provide a unique perspective on the composition and source of marine litter. The finding that a significant portion of deep-sea waste is plastic, often originating from fishing activities, suggests that the fishing industry itself is both a victim and a contributor to the marine litter problem. This duality underscores the need for sustainable fishing practices and greater awareness within the fishing community.

Thematic Group 3/s focus on the economic impacts of marine litter on the fishing sector reveals a critical aspect of the marine litter issue. The proposed strategies in the studies by Andres et al. (2021) and Basurko et al. (2015), involving the use of fishing vessels for collecting floating marine litter, offer innovative solutions to mitigate litter while potentially providing economic benefits to fishermen. The suggested payment-for-environmental-services scheme in Navarro and Araque (2021) further highlights alternative approaches to incentivize sustainable fishing practices.

Besides the fact that representation of socio-economic impacts remains limited in scientific literature, the literature reveals that marine litter impacts artisanal fishermen not only when it reduces the quantity of target species and damages fishing gear (in the case of direct impacts), but also when it increases fishing effort, since it increases the frequency of casting the net and the time spent fishing at sea (Batista, 2018; Nash, 1992; Pinheiro et al., 2021), this added to the other impacts that coastal communities face (Prado et al., 2022), directly affect the traditional culture of the coastal community. This gap highlights the necessity for more research that integrates environmental and socio-economic aspects for traditional coastal communities.

5 Conclusion

The studies revealed the multifaceted nature of the marine litter problem, encompassing environmental, social, and economic dimensions. The recognition of marine litter as a daily economic pressure for the fishing sector, leading to job and income losses, calls for a comprehensive approach that combines empirical knowledge from fishermen, scientific insights, and innovative litter removal strategies. The emphasis on ocean sustainability and solid waste mitigation across these articles underscores the urgency of finding viable solutions that balance environmental protection with the livelihoods of coastal communities.

In all the analyzed articles, there were similarities in their conclusions, indicating that marine litter is a global and transboundary problem with impacts that extend beyond marine fauna, affecting human wellbeing and posing a threat to the preservation of traditional ways of life, such as fishing.

Moreover, they all suggest the need for better listening to artisanal fishermen and emphasize awareness actions, such as environmental education, as a crucial factor in mitigating the problem of marine litter.

The scarcity of information on the socioeconomic impacts of marine litter on artisanal fishermen highlights a significant gap in existing literature. Addressing this gap is crucial for crafting effective public policies that align with the Ocean Decade's goals of a cleaner and healthier ocean. The role of NGOs in raising public awareness about marine litter is undeniable, yet achieving holistic progress necessitates that scientific institutions intensify their research into this complex issue. Collaborative efforts between these institutions and governments are essential for developing comprehensive strategies and legal frameworks that address the multifaceted nature of marine litter. The predominance

of marine litter research in developed regions, particularly in European Union countries, compared to the Global South and Small Island Developing States (SIDS), highlights a geographical imbalance in the understanding of this issue. This disparity suggests a potential oversight of unique challenges faced by less-represented coastal communities, such as those in Brazil. A more balanced research approach, integrating environmental, social, and economic dimensions, is imperative, especially in these underrepresented regions. Marine litter, a structural issue intensified by modern consumption patterns, demands a multi-level governance approach to effectively tackle its impacts.

Embracing a multi-level governance framework facilitates the alignment of policies, distribution of responsibilities, and efficient resource utilization. Such an approach fosters collaboration among diverse stakeholders, leading to more comprehensive solutions and advocating for economic decolonization. This problem extends beyond the realms of law enforcement and technical solutions; it requires a coordinated effort across various stakeholders and policy frameworks, with an emphasis on education, cultural change, and active stakeholder participation.

The studies reviewed reveal marine litter's extensive impacts on human wellbeing and traditional livelihoods, such as fishing. The urgent need for more research and publications focusing on the social and economic impacts of marine litter, particularly on artisanal fishing, is evident. This research is vital for understanding the complex social dimensions associated with marine litter and for developing potential resolutions to this environmental challenge.

Effectively addressing the marine litter problem requires a systemic approach that considers both nature and society. Future research should focus on how different stakeholders and institutions can organize to tackle marine litter from a governance perspective, integrating ecological, economic, social, and cultural dimensions. This comprehensive approach is essential to ensure the sustainability of coastal communities and the marine environment, ultimately contributing to the global efforts against marine litter and enhancing ocean sustainability.

Therefore, the significance of our findings is underscored by the scarcity of relevant studies. By shedding light on the socioeconomic impacts of marine litter on artisanal fishermen this study provides a critical foundation for future investigations. Addressing these gaps is essential not only for academic but also for informing policy-making processes that aim to protect vulnerable coastal communities, such as the artisanal fishermen, and ensure sustainable marine environments. Recommendations for policymakers and decision-makers include better listening and addressing artisanal fishermen's knowledge to mitigate marine litter. Also, collaboration between scientific organizations and NGOs, should be encouraged to target more interdisciplinary research and effective public awareness campaigns. Additionally, proactive measures, such as implementing economic incentives to reward artisanal fishermen for collecting litter and support sustainable fishing practices, can provide tangible solutions to combat marine pollution.

Data availability statement

The original contributions presented in the study are publicly available. This data can be found here: GitHub, https://github.com/nicoleguerrato/FRONTIERS.

Author contributions

NG: Conceptualization, Data curation, Investigation, Writing – original draft, Writing – review & editing, Methodology, Validation. LG: Conceptualization, Formal analysis, Funding acquisition, Resources, Supervision, Validation, Writing – review & editing.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. This work was supported by grants nos. 2021/10951-9, 2022/12013-9, and 2019/24416-8 from the São Paulo Research Foundation (FAPESP).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

Abalansa, S., El Mahrad, B., Vondolia, G. K., Icely, J., and Newton, A. (2020). The marine plastic litter issue: a social-economic analysis. *Sustainability* 12:8677. doi: 10.3390/su12208677

Acheson, J. M. (1981). Anthropology of fishing. *Annu. Rev. Anthropol.* 10, 275–316. doi: 10.1146/annurev.an.10.100181.001423

Addamo, A. M, Laroche, P., and Hanke, G. (2017). "Top marine beach litter items in Europe," in *A review and synthesis based on beach litter data. MSFD technical group on marine litter. Report no. EUR29249* (Luxembourg: Publications Office of the European Union), 148335. doi: 10.2760/496717

Andres, M., Delpey, M., Ruiz, I., Declerck, A., Sarrade, C., Bergeron, P., et al. (2021). Measuring and comparing solutions for floating marine litter removal: lessons learned

in the south-east coast of the Bay of Biscay from an economic perspective. *Mar. Policy* 127:104450. doi: 10.1016/j.marpol.2021.104450

Barnes, D. K. A., Galgani, F., Thompson, R. C., and Barlaz, M. (2009). Accumulation and fragmentation of plastic debris in global environments. *Phil. Trans. R. Soc. B* 364, 1985–1998. doi: 10.1098/rstb.2008.0205

Basurko, O. C., Gabiña, G., Andrés, M., Rubio, A., Uriarte, A., and Krug, I. (2015). Fishing for floating marine litter in SE Bay of Biscay: review and feasibility study. *Mar. Policy* 61, 103–112. doi: 10.1016/j.marpol.2015.07.010

Batista, J. S. C. (2018). *Lixo marinho e práticas piscatórias: o estudo de caso do Estuário do Sado* (PhD thesis). Available at: https://www.iscte-iul.pt/tese/8177 (accessed July 23, 2022).

Bené, C., Macfadyen, G., and Allison, E. H. (2007). *Increasing the Contribution of Small-Scale Fisheries to Poverty Alleviation and Food Security.* Rome: FAO Fisheries Technical Paper, No. 481.

Bergmann, M., Gutow, L., and Klages, M. (2015). *Marine Anthropogenic Litter*. Cham: Springer Nature, 447. doi: 10.1007/978-3-319-16510-3

Bettencourt, S., Costa, S., and Caeiro, S. (2021). Marine litter: a review of educative interventions. *Mar. Pollut. Bull.* 168:112446. doi: 10.1016/j.marpolbul.2021.112446

Bezerra, D. P., and Iared, V. G. (2019). Diferentes atores sociais e a relação com o lixo marinho no município de Cananeia, SP. *Ambiente Soc.* 22:e01322. doi: 10.1590/1809-4422asoc0132r2vu19L4TD

Brennan, R. E., and Portman, M. E. (2017). Situating Arab-Israeli artisanal fishermen's perceptions of marine litter in a socio-institutional and socio-cultural context. *Mar. Pollut. Bull.* 115, 240–251. doi: 10.1016/j.marpolbul.2016.12.001

Campbell, J., Bowser, A., Fraisl, D., and Meloche, M. (2019). *Citizen Science and Data Integration for Understanding Marine Litter*. Available at https://pure.iiasa.ac.at/id/eprint/16095/ (accessed January 15, 2022).

Cho, D. O. (2005). Challenges to marine debris management in Korea. *Coast. Manag.* 33, 389–409. doi: 10.1080/08920750500217559

do Sul, J. A. I., and Costa, M. F. (2007). Marine debris review for Latin America and the wider Caribbean region: from the 1970s until now, and where do we go from here? *Mar. Pollut. Bull.* 54, 1087–1104. doi: 10.1016/j.marpolbul.2007.05.004

Domenech, T., and Bahn-Walkowiak, B. (2019). Transition towards a resource efficient circular economy in Europe: policy lessons from the EU and the member states. *Ecol. Econ.* 155, 7–19. doi: 10.1016/j.ecolecon.2017.11.001

FAO (2012). *Small-Scale and Artisanal fisheries*. Food and Agriculture Organization. Available at: http://www.fao.org/fishery/topic/14753/en (accessed August 14, 2024).

FAO (2020). *The State of World Fisheries and Aquaculture. Sustainability in Action*. Rome: Food and Agriculture Organization.

FAO (Food and Agriculture Organization of the United Nations) (2017). *Microplastics in fisheries and aquaculture: status and knowledge on their occurrence and implications for aquatic organisms and food safety*. FAO Fisheries and Aquaculture Tech. Paper No. 615. Rome: FAO.

FAO (Food and Agriculture Organization) (2016). *Report of the Expert consultation on the Marking of Fishing Gear, Rome, Italy, 4-7 April 2016*. FAO Fisheries and Aquaculture Report No. 1157. Rome: FAO.

Ferreira, J. C., Monteiro, R., Vasconcelos, L., Duarte, C. M., Ferreira, F., and Santos, E. (2021). Perception of citizens regarding marine litter impacts: collaborative methodologies in island fishing communities of Cape Verde. *J. Mar. Sci. Eng.* 9:306. doi: 10.3390/jmse9030306

Fidelman, P. I., Leitch, A. M., and Nelson, D. R. (2013).Unpacking multilevel adaptation to climate change in the Great Barrier Reef, Australia. *Glob. Environ. Change* 23:800812. doi: 10.1016/j.gloenvcha.2013.02.016

Funduk, M., Tutman, P., Farkaš, A., Tišma, S., and Boromisa, A. M. (2021). Marine litter in Croatian Adriatic: sources, quantities and stakeholders' perspectives. *Sustainability* 13:4691. doi: 10.3390/su13094691

Gall, S. C., and Thompson, R. C. (2015). The impact of debris on marine life. *Mar. Pollut. Bull.* 92, 170–179. doi: 10.1016/j.marpolbul.2014.12.041

Gari, S. R., Newton, A., and Icely, J. D. (2015). A review of the application and evolution of the DPSIR framework with an emphasis on coastal social-ecological systems. *Ocean Coast. Manag.* 103, 63–77. doi: 10.1016/j.ocecoaman.2014.11.013

GESAMP (2021). *Sea-Based Sources of Marine Litter*. (IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP/ISA Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). Rep. Stud. GESAMP No. 108, 109. Available at: http://www.gesamp.org (accessed September 15, 2024).

Geyer, R., Jambeck, J. R., and Law, K. L. (2017). Production, use, and fate of all plastics ever made. *Sci. Adv.* 3:e1700782. doi: 10.1126/sciadv.1700782

Graça-Lopes, R., Puzzi, A., Severino-Rodrigues, E., Bartolotto, A. S., Dsf Guerra, K. T. B., and Figueiredo, B. (2002). Comparação entre a Produção de Camarão-Sete-Barbas e de Fauna Acompanhante pela Frota-de-Pequeno-Porte Sediada na Praia de Perequê, Estado De São Paulo, Brasil. *Bol. Inst. Pesca* 28, 189–194.

Grechinski, P. (2020). Lixo no Mar, um problema social. Revista Mosaicos Estudos em Governança, Sustentabilidade e Inovação. *Curitiba* 2, 30–43.

Haarr, M. L., Pantalos, M., Hartviksen, M. K., and Gressetvold, M. (2020). Citizen science data indicate a reduction in beach litter in the Lofoten archipelago in the Norwegian Sea. *Mar. Pollut. Bull.* 153:111000. doi: 10.1016/j.marpolbul.2020.111000

Habibi, H., Suryadarma, I., and Wilujeng, I. (2021). Madurese fishing community cultural perception of coastal litter. *Qual. Rep.* 26, 125–139. doi: 10.46743/2160-3715/2021.4539

Hartley, B. L., Pahl, S., Veiga, J., Vlachogianni, T., Vasconcelos, L., Maes, T., et al. (2018). Exploring public views on marine litter in Europe: perceived causes, consequences and pathways to change. *Mar. Pollut. Bull.* 133, 945–955. doi: 10.1016/j.marpolbul.2018.05.061

Herdiansyah, H., Saiya, H. G., Afkarina, K. I. I., and Indra, T. L. (2021). Coastal community perspective, waste density, and spatial area toward sustainable waste management (case study: Ambon Bay, Indonesia). *Sustainability* 13:10947. doi: 10.3390/su131910947

Iñiguez, M. E., Conesa, J. A., and Fullana, A. (2016). Marine debris occurrence and treatment: a review. *Renew. Sustain. Energy Rev.* 64, 394–402. doi: 10.1016/j.rser.2016.06.031

Iraia, O. G., Oihane, K. E., Cristina, M., Ana, M. M. A., and Ainhoa, A. V. (2015). Identification of municipal characteristics regarding household waste generation and their forecasting ability in Biscay. *Waste Manag.* 39, 26–34. doi: 10.1016/j.wasman.2015.02.017

Ivar Do Sul, J. (2005). *Lixo Marinho na Area de Desova de Tartarugas Marinhas do Litoral Norte da Bahia: conseqüencias para o meio ambiente e moradores locais* (Undergraduate Thesis in Oceanology). Federal University of Rio Grande Foundation, Rio Grande. Available at: https://ri.ufs.br/jspui/handle/riufs/6903 (accessed July 23, 2022).

Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., et al. (2015). Plastic waste inputs from land into the ocean. *Science* 347, 768–771. doi: 10.1126/science.1260352

Kenyon, K. W., and Kridler, E. (1969). Laysan albatrosses swallow indigestible matter. *Auk* 86, 339–343. doi: 10.2307/4083505

Keswani, A., Oliver, D. M., Gutierrez, T., and Quilliam, R. S. (2016). Microbial hitchhikers on marine plastic debris: human exposure risks at bathing waters and beach environments. *Mar. Environ. Res.* 118, 10–19. doi: 10.1016/j.marenvres.2016.04.006

Kiessling, T., Gutow, L., and Thiel, M. (2015). "Marine litter as habitat and dispersal vector," in *Marine Anthropogenic Litter*, eds M. Bergmann, L. Gutow, and M. Klages (Berlin: Springer Nature), 141–181.

Kühn, S., Bravo Rebolledo, E. L., and van Franeker, J. A. (2015). "Deleterious effects of litter on marine life," in *Marine Anthropogenic Litter*, eds. M. Bergmann, L. Gutow, and M. Klages (Berlin: Springer), 75–116.

Landon-Lane, M. (2018). Corporate social responsibility in marine plastic debris governance. *Mar. Pollut. Bull.* 127, 310–319. doi: 10.1016/j.marpolbul.2017.11.054

Law, K. L. (2017). Plastics in the marine environment. *Ann. Rev. Mar. Sci.* 9, 205–229. doi: 10.1146/annurev-marine-010816-060409

Leone, G., Moulaert, I., Devriese, L. I., Sandra, M., Pauwels, I., Goethals,., et al. (2023). A comprehensive assessment of plastic remediation technologies. *Environ. Int.* 173:107854. doi: 10.1016/j.envint.2023.107854

Lewin, W. C., Weltersbach, M. S., Denfeld, G., and Strehlow, H. V. (2020). Recreational anglers' perceptions, attitudes and estimated contribution to angling related marine litter in the German Baltic Sea. *J. Environ. Manage.* 272:111062. doi: 10.1016/j.jenvman.2020.111062

Lewison, R. L., Rudd, M. A., Al-Hayek, W., Baldwin, C., Beger, M., Lieske, S. N., et al. (2016). How the DPSIR framework can be used for structuring problems and facilitating empirical research in coastal systems. *Environ. Sci. Policy* 56, 110–119. doi: 10.1016/j.envsci.2015.11.001

Li, W. C., Tse, H. F., and Fok, L. (2016). Plastic waste in the marine environment: a review of sources, occurrence and effects. *Sci. Total Environ.* 566, 333–349. doi: 10.1007/s00128-020-02820-1

McIlgorm, A., Campbell, H. F., and Rule, M. J. (2011). The economic cost and control of marine debris damage in the Asia-Pacific region. *Ocean Coast. Manag.* 54, 643–651. doi: 10.1016/j.ocecoaman.2011.05.007

Moher, D., Liberati, A., Tetzlaff, J., and Altaman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med.* 6:e1000097. doi: 10.1371/journal.pmed.1000097

Mouat, J., Lozano, R. L., and Bateson, H. (2010). *Economic Impacts of Marine Litter*. Lerwick: KIMO International, 105.

Nash, A. D. (1992). Impacts of marine debris on subsistence fishermen: an exploratory study. *Mar. Pollut. Bull.* 24, 150–156. doi: 10.1016/0025-326X(92)90243-Y

Navarro, J. L. L., and Araque, A. C. (2021). Esquema de pago por servicios ambientales como estrategia de gestión para regular la pesca artesanal del Distrito de Manejo Integrado Cispata, Colombia. *Boletín de Investigaciones Marinas y Costeras* 50, 179–190.

Newman, S., Watkins, E., Farmer, A., and Brink, P. (2015). "The economics of marine litter," in *Marine Anthropogenic Litter*, eds. M. Bergmann, L. Gutow, M. Klages (Cham: Springer).

Olsson, L., and Ness, B. (2019). Better balancing the social and natural dimensions in sustainability research. *Ecol. Soc*. 24:7. doi: 10.5751/ES-11224-240407

Owens, K. A., and Conlen, K. (2021). Mopping up or turning off the tap? Environmental injustice and the ethics of plastic pollution. *Front. Mar. Sci.* 8:713385. doi: 10.3389/fmars.2021.713385

Penca, J. (2018). European plastics strategy: what promise for global marine litter? *Mar. Policy* 97:197201. doi: 10.1016/j.marpol.2018.06.004

Pinheiro, L. M., Junior, E. L., Denuncio, P., and Machado, R. (2021). Fishing plastics: a high occurrence of marine litter in surf-zone trammel nets of Southern Brazil. *Mar. Pollut. Bull.* 173, 112946. doi: 10.1016/j.marpolbul.2021.112946

Plastics Europe (2018). "Plastics – the facts 2018. An analysis of European plastics production, demand and waste data," in *Association of Plastics Manufacturers and EPRO* (Brussels: European Association of Plastics Recycling and Recovery Organisations, Association of Plastic Manufacturers and European Association of Plastics Recycling and Recovery Organizations), 18. Available at: https://plasticseurope.org/knowledge-hub/plastics-the-facts-2018/ (accessed May 03, 2023).

Prado, D. S., Martins, I. M., and Christofolett, I. R. A. (2022). *Pesca artesanal e conflitos costeiros e marinhos no litoral de Sao Paulo (SP)*. Santos, SP: Universidade Federal de Sao Paulo (UNIFESP).

Ramirez-Llodra, E., De Mol, B., Company, J. B., Coll, M., and Sardà, F. (2013). Effects of natural and anthropogenic processes in the distribution of marine litter in the deep Mediterranean Sea. *Prog. Oceanogr.* 118, 273–287. doi: 10.1016/j.pocean.2013.07.027

Raubenheimer, K., Mcilgorm, A., and Oral, N. (2018). Towards an improved international framework to govern the life cycle of plastics. *Rev. Eur. Comp. Int. Environ. Law* 27, 210–221. doi: 10.1111/reel.12267

Ryan, P. G. (2015). "A brief history of marine litter research," in *Marine Anthropogenic Litter*, eds. M. Bergmann, L. Gutow, and M. Klages (Berlin: Springer), 1–25.

Ryan, P. G., Moore, J. M., Van Franeker, J. A., and Moloney, C. L. (2009). Monitoring the abundance of plastic debris in the marine environment. *Philos. Transact. R. Soc. B* 364, 1999–2012. doi: 10.1098/rstb.2008.0207

Saunders, M., Lewis, P., and Thornhil, A. (2009). "Understanding research philosophies and approaches," in *Research Methods for Business Students* (Pearson), 106–135. Available at: http://catalogue.pearsoned.co.uk/educator/product/Research-Methods-for-Business~Students/9781292016627.page (accessed April 15, 2023).

Schneider, F., Parsons, S., Clift, S., Stolte, A., and Mcmanus, M. C. (2018). Collected marine litter—a growing waste challenge. *Mar. Pollut. Bull.* 128, 162–174. doi: 10.1016/j.marpolbul.2018.01.011

Song, S. H., Lee, H. W., Kim, J. N., Jeong, J. M., Ji, H. S., Jo, H. S., et al. (2021). First observation and effect of fishery of seabed litter on sea bed by trawl survey Korea waters. *Mar. Pollut. Bull.* 170:112228. doi: 10.1016/j.marpolbul.2021.112228

Takehama, S. (1989). "Estimation of damage to fishing vessels caused by marine debris, based on insurance statistics," in *Proceedings of the Second International Conference on Marine Debris*. Available at: https://repository.library.noaa.gov/view/noaa/6012 (accessed June 09, 2021).

Tekman, M. B., Krumpen, T., and Bergmann, M. (2017). Marine litter on deep Arctic seafloor continues to increase and spreads to the North at the HAUSGARTEN observatory. *Deep-Sea Res.* I120, 88–99. doi: 10.1016/j.dsr.2016.12.011

Thiel, M., Hinojosa, I. A., Miranda, L., Pantoja, J. F., Rivadeneira, M. M., and Vásquez, N. (2013). Anthropogenic marine debris in the coastal environment: a multi-year comparison between coastal waters and local shores. *Mar. Pollut. Bull.* 71, 307–316. doi: 10.1016/j.marpolbul.2013.01.005

Topçu, E. N., Tonay, A. M., Dede, A., Öztürk, A. A., and Öztürk, B. (2013). Origin and abundance of marine litter along sandy beaches of the Turkish Western Black Sea Coast. *Mar. Environ. Res.* 85, 21–28. doi: 10.1016/j.marenvres.2012.12.006

UN Environment Program (2017). *Sustainable Development Goals 17 Goals to Transform Our World*. Available at http://www.un.org/sustainabledevelopment/sustainabledevelopment-goals/ (accessed March, 2024.).

Waller, C. L., Griffiths, H. J., Waluda, C. M., Thorpe, S. E., Loaiza, I., Moreno, B., et al. (2017). Microplastics in the Antarctic marine system: an emerging area of research. *Sci. Total Environ.* 220–227. doi: 10.1016/j.scitotenv.2017.03.283

Wyles, K. J., Pahl, S., Carrol, L., and Thompson, R.C. (2019). An evaluation of the Fishing For Litter (FFL) scheme in the UK in terms of attitudes, behavior, barriers and opportunities. *Mar. Pollut. Bull.* 144, 48–60. doi: 10.1016/j.marpolbul.2019.04.035

Wyles, K. J., Pahl, S., Thomas, K., and Thompson, R. C. (2016). Factors that can undermine the psychological benefits of coastal environments: exploring the effect of tidal state, presence, and type of litter. *Environ. Behav*. 48, 1095–1126. doi: 10.1177/0013916515592177