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METHOD

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State of the evidence on the impacts of fishing plastic waste to coastal communities: protocol for a Systematic Evidence Map

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ABSTRACT

Background: Fishing plastic waste (FPW) is known to cause multidimensional impacts to coastal communities globally. Detailed information on the environmental, socioeconomic and technical dimensions of effects to coastal communities caused by FPW has yet to be collated and considered in one place.
Methods: The main aim of this study is to identify, organise and group existing primary evidence of the environmental, social, economic, political, and technical impacts of FPW on coastal communities and identify gaps in our knowledge about which types of FPW are most problematic.
Search Strategy: We will search several databases across four electronic academic indexes (Web of Science, Scopus, PubMed and EBSCOhost [Business Source Complete, CINAHL Plus, EconLit, GreenFile, and Humanities International Index]).
Eligibility Criteria: Eligible studies must contain primary research investigating an environmental, social, economic, political, or technical impact of fragments of any size of plastic polymers (macro-, micro-, or nano-) originating from fishing equipment (i.e., capture and ancillary) that has been abandoned, lost, or otherwise discarded in the marine environment, affecting any defined human or non-human (vertebrates, invertebrates, micro-organisms) individual, group or assemblage of individuals, relying on coastal and ocean resources. Environmental impacts include physical and physiological effects to biotic and abiotic elements of marine ecosystems. Social impacts include impacts to community health and wellbeing. Economic impacts include impacts to livelihood and trade. Political impacts include responses from local or regional governments to address FPW. Technical impacts include effects to techniques employed by fisherfolk or to the management of FPW at the local level.
Screening & Extraction: Our search was optimised on Cadima. Articles will be screened at title and abstract, before a full-text review. All articles will be screened by a single reviewer, with two additional reviewers assessing articles for consistency. One out of ten articles will be screened by two additional reviewers in duplicate as a quality control. Data extraction will be performed on all articles included at full text, and articles that do not meet the eligibility criteria will be excluded. All articles excluded at full text will be confirmed by the two additional reviewers.
Study Mapping & Reporting: Results will be published in a narrative summary and visualised in a publicly available, user-friendly, interactive and interrogable evidence map on Tableau.

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Fishing plastic waste; coastal communities; impacts; evidence map

1. Introduction

1.1. Background and Rationale

Plastics are synthetic or semi-synthetic organic polymers that have become entrenched in modern-day society due to their beneficial characteristics, such as their affordability, durability, lightweightness,

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mouldability and insulating capabilities (Derraik 2002; Thompson et al. 2009). A consequence of these characteristics is that plastics are now undervalued, often being mass-produced for products with a short lifespan, resulting in a rapid accumulation of plastic waste. This, coupled with inadequate waste management systems that fail to capture the various plastic wastes and their embedded values, has led to plastic waste becoming a ubiquitous pollutant in our environment.

Geyer estimates that between 1950 and 2017, only 10% of all plastics ever made had been recycled, 14% had been incinerated, and 76% had been discarded into landfills (Geyer 2020). This issue is more dire in low- to middle-income countries, which tend to have poorer waste management infrastructure, resulting in a higher prevalence of mismanaged waste. Meijer et al. estimated that globally, 67.5 trillion metric tonnes (t) of mismanaged plastic waste are produced annually, with 1.5% of this leaking into the ocean (Meijer et al. 2021). It is now acknowledged that plastics make up the majority of waste present in the marine environment (Barnes et al. 2009; Galgani, Hanke, and Maes 2015; Gregory and Ryan 1997).

Although only 20% of plastics entering the ocean are thought to originate from marine-based activities, fishing gear accounts for 10% of marine plastic waste and represents the highest proportion of macroplastics floating on the ocean's surface (Morales-Caselles et al. 2021; Thomas, Dorey, and Obaidullah 2019). In some regions, fishing plastic waste (FPW) makes up the majority of litter present. Specifically, it accounted for 100% of litter found in the North and Northeast Faroe-Shetland Channels and >85% of litter found in the Condor Seamount, Hatton Bank and Wyville-Thomson Ridge (Pham et al. 2014). Moreover, 52% of the plastics found in the Great Pacific Garbage Patch originate from fishing activities, of which fishing nets formed 86% of the 42 kt of megaplastics (>50cm) present (Lebreton et al. 2018; Thomas, Dorey, and Obaidullah 2019). Despite this, current research focuses predominantly on land-based sources of plastics.

FPW has been shown to have physical and physiological impacts on marine biota and coastal environments and, consequently, human populations (Dau et al., 2009; Jones 1995; Link, Segal, and Casarini 2019; Macfadyen, Huntington, and Cappell 2009; Watson et al. 2022). Coastal communities in low-middle-income countries are heavily reliant on marine ecosystems for their livelihoods, including sustenance, trade, tourism, and cultural value (Rao et al. 2016; Robertson and Midway 2019; Wei, Xu, and Wall 2024); and are vulnerable to changes in the marine environment (Aswani et al. 2019). Furthermore, with most the world's capture fisheries being based in these regions, coastal communities here may be at greater risk from the effects of this pollution (Apete, Martin, and Iacovidou 2024). Understanding how FPW impact them is necessary to devise solutions with these communities and for governments to design effective policy interventions.

Recent literature that explores the impacts of marine debris on coastal communities largely overlooks FPW (UN 2016b, p. 8). While reviews have been carried out on the impacts of abandoned fishing gear, none focus specifically on gear made from plastics, despite the consensus that plastics are the dominant material for this equipment (Jones 1995; Link, Segal, and Casarini 2019; Macfadyen, Huntington, and Cappell 2009; Watson et al. 2022). These reviews typically analyse items such as lines, nets and ropes but omit the impacts of associated equipment, such as polystyrene storage boxes and plastic ice bags used for storage and preservation (Do and Armstrong 2023). Furthermore, most studies emphasise environmental impacts, with limited attention to the broader impacts on coastal ecosystems, particularly in developing countries. Although existing research has identified negative impacts on provisioning, supporting and cultural services, none addressed regulating services. In addition, there is limited recent literature on the socioeconomic impacts of FPW in coastal communities (Jones 1995; Macfadyen, Huntington, and Cappell 2009). In many of these communities, there is a heavy reliance on the marine environment for service provision, yet they face increasing pressure from inadequate solid waste management systems (Arifin et al. 2023; Daniel and Thomas 2023). This underlines the urgent need for addressing both the environmental and socioeconomic dimensions of FPW, particularly in regions with high dependency on marine ecosystems and limited waste infrastructure.

The growing prevalence of FPW in the marine environment highlights the crucial need for a systematic approach to understanding its systemic impacts on coastal communities. Systematic evidence maps (SEM) provide an effective method for amassing and assessing the existing evidence base, identifying knowledge gaps, and guiding future research priorities (Miake-Lye et al. 2016). Such analyses can reveal critical blind spots in our understanding of systemic failures related to FPW pollution and inform targeted interventions to tackle these issues. For coastal communities, this approach is particularly valuable

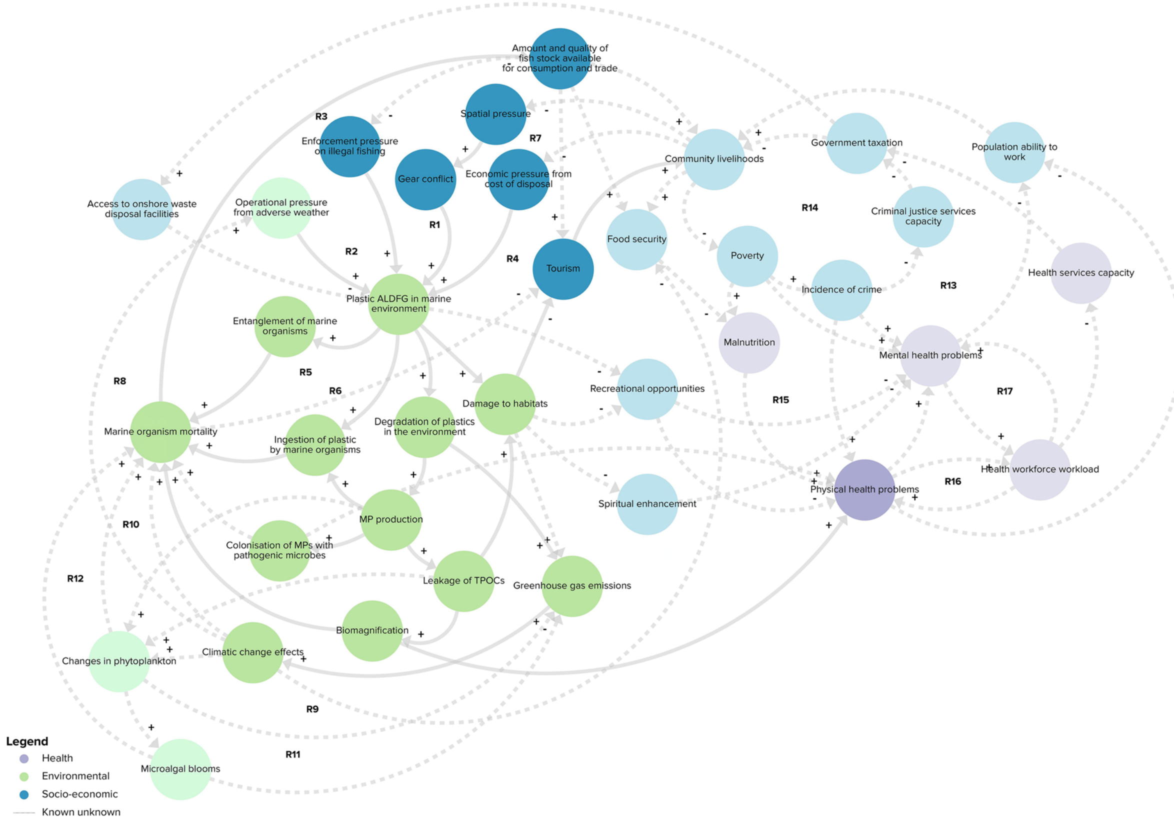

Figure 1. Causal loop diagram of the known and the known unknown environmental (green), health (purple) and socio-economic (blue) effects of fishing plastic pollution in the marine environment. Known-unknown causal links are joined by a dashed line. Paler nodes represent effects where all causal links are known unknowns. ALDFG = abandoned, lost, or otherwise discarded fishing gear; TPOCs = toxic persistent organic pollutants.; MP = microplastics. This is found here: https://kumu.io/larisha1/interconnections-between-socio-ecological-impacts-of-fishing-plastic-waste#untitled-map.

in tackling pollution challenges holistically. SEM also serves as a key step in employing a systems-based approach, helping to unpack the drivers of FPW pollution and generate useful evidence to support effective interventions. This SEM aims to provide a comprehensive, multi-dimensional perspective on the impacts of FPW on coastal communities. Our preliminary understanding and a priori assumptions of this system were informed by a narrative review used to produce a causal loop diagram (CLD; Figure 1) (Apete, Martin, and Iacovidou 2024). This has informed the development of the SEM protocol.

Understanding the causal connections between these impacts is beyond the scope of this SEM. Instead, the body of evidence retrieved will inform systems-based analyses where it is triangulated and integrated with contextual data from case study sites collected through semi-structured interviews. By mapping the available evidence, we will widen and improve our understanding of the complex interrelationships within these environmental, technological, political, economic and social sub-systems. The findings will enable practitioners to identify knowledge gaps and potential positive and negative feedback loops, reducing the risk of adopting a siloed approach to problem-solving, thereby fostering integrated, sustainable solutions.

1.2. Definitions and Disambiguation of Terms

1.2.1. Coastal Communities

There are many definitions of coastal communities in the literature, specifically referring to human settlements (Table 1). A commonly used definition incorporates a 100-kilometre (km) inland boundary based on analyses of human population distribution, which revealed a steep population density gradient over this distance (Small and Cohen 2004; Small and Nicholls 2003). However, for our systematic evidence mapping, our focus is not on geographic proximity but rather on populations and communities

Table 1. Definitions of coastal communities found in the literature.

Definition	Source
Populations within 100 horizontal km of the coastline and 100 vertical meters of sea level.	(Small and Nicholls 2003)
Any coastal settlement within a(n English) local authority area whose boundaries include (English) foreshore, including local authorities whose boundaries only include estuarine foreshore. Coastal settlements include seaside towns, ports and other areas which have a clear connection to the coastal economy.	(Coastal Communities Alliance 2024)
Coastal populations are those living within 100 km of the coast, and excluding countries without territory within 100 km of a coastline measured using an Azimuthal Equidistant (world) projection.	(Barbier 2015)
Percentage of total population living within 100 km of the coastline.	(UN 2017; UNEP 2017)
Residents living within 100 km of the shore.	(Maul and Duedall 2021)
One that lives near the coast and/or utilizes coastal resources and the ocean for its livelihood in a manner shaped by cultural heritage or economic needs.	(Green 2.0 2022) – environmental racial diversity NGO
People living within 100 km from the coast.	(Barros et al. 2023)

whose livelihoods are directly dependent on coastal and marine resources. While populations and communities beyond the 100 km threshold are often bound to inland activities and may not be linked to the coast socio-economically (e.g., through fishing or cultural identity), others may depend on coastal systems/infrastructure (e.g., inland agricultural communities dependent on estuaries). Therefore, it is important to consider populations and communities reliance on surrounding natural resources as emphasised in definitions by Green 2.0 (2022) the Coastal Communities Alliance (2024), particularly when investigating the socioeconomic, political, and technical impacts. These natural resources include the biotic and abiotic elements of marine and coastal ecosystems, which directly influence the ecosystem services available to coastal communities.

Further for this study, our understanding of "coastal communities" will be defined as *"individuals or groups of individuals living near the coast and/or relying on coastal and ocean resources for their livelihoods, in ways influenced by cultural heritage or economic need, and interconnected with the ecosystems that support them."* This definition accounts for both the geographical proximity and the socioeconomic, cultural and ecological interconnections on which the livelihoods and well-being of coastal communities rely.

1.2.2. Fishing Plastic Waste

Currently, there is no universally accepted definition for "fishing plastic waste." To address this gap, we developed a definition by analysing existing definitions of fishing plastic equipment, referred to here as "fishing plastics" or "fishing gear," and reviewing how FPW is characterised in the literature.

The definitions of fishing gear (Table 2) vary in the specificity of the components included. However, they consistently agree that *fishing gear refers to any equipment or combination of components used or capable of being used to capture, control for subsequent capture, or harvest marine or freshwater organisms and biological resources*. Most descriptions of fishing gear are derived from the International Standard Statistical Classification of Fishing Gear (ISSCFG) (He, et al. 2021), which was designed to support fisheries and marine conservation research. The ISSCFG classifies fishing gear based on physical characteristics, operational methods, and fish capture mechanisms. The major types of fishing gear and their material compositions are summarised in Supplemental Table S1 (*Annex 1)*.

Defining fishing plastic becomes more complicated when looking at how FPW is characterised in the literature. Fishing plastics also encompass ancillary items used in fishing activities, such as buoys, gloves, fish storage boxes, strapping bands, plastic bottles carrying stroke oil, and plastic ice bags for fish preservation that become waste (Supplemental Table S2 in *Annex 2*).

In the literature, FPW is characterised as materials, components and products that have been abandoned, lost, or discarded in the environment and are associated with the act of fishing (Claereboudt 2004; Consoli et al. 2019; Edyvane et al. 2004; European Commission 2019; GESAMP 2021; ICES 2022; Moriarty et al. 2016; Nguyen et al. 2022; Pinheiro et al. 2021, 2023; Simeonova and Chuturkova 2020; UNEP 2016; Watson et al. 2022). These ancillary items are necessary for the handling, storage, and preservation of captured or harvested marine organisms but are often made from polymers also commonly found in marine debris of terrestrial origin (e.g., polystyrene being used for fish storage boxes, as well as food containers). In some fisheries, particularly small-scale and artisanal activities, marine resources are

Table 2. Definitions of fishing gear found in the literature.

Definition of Fishing Gear	Source
A fishing gear is any physical device or part thereof, or combination of items that may be placed on or in the water or on the seabed with the intended purpose of capturing or controlling for subsequent capture or harvesting marine or freshwater organisms.	The International Convention for the Prevention of Pollution from Ships (MARPOL), Annex V (MEPC. 2011)
"Fishing gear" means any net or other implement or means used or capable of being used for the harvesting of marine resources.	Namibia's Marine Resources Act, 27 of 2000 (Republic of Namibia, 2000)
Fishing gear means any equipment, implement or other thing that can be used in the act of fishing, and includes any fishing net, rope, line, float, trap, hook, winch, or associated boat or aircraft.	Fisheries Act No. 10 of 2014 (Republic of Vanuatu 2014)
"Sea fishing equipment" means (a) fishing nets or any other equipment used during sea fishing (including, for example, equipment used to navigate, or to deter animals that are not intended to be caught), or (b) equipment used to monitor sea fishing.	Fisheries Act 2020 (UK Government 2020)
"Fishing gear" means any item or piece of equipment that is used in fishing or aquaculture to target, capture or rear marine biological resources or that is floating on the sea surface, and is deployed with the objective of attracting and capturing or of rearing such marine biological resources.	Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment (European Parliament, Council of the European Union, 2019)
Fishing gear includes any net, line, pot, bob, trap, dredge, apparatus, device, or other thing that is used or is capable of being used for the purposes of taking fish.	Fisheries (Amateur Fishing) Regulations 2013 New Zealand (Governor-General 2013)
Facilities and equipment or other objects that are used for fishing.	Ministerial Regulation 33/PERMEN-KP/2021 (Minister of Marine Affairs and Fisheries of the Republic of Indonesia 2021)

brought directly to shore for sale, often using the same plastic materials used during fishing (e.g., fish boxes, gloves) (Cunha et al. 2023; Pardie and Campion 2022; UN 2016a, p. 4). As this study focuses on the global impacts of FPW on coastal communities, particularly those dependent on small-scale, artisanal fisheries, our definition includes plastics used for storing and preserving the catch during direct sales on shore. Excluding this aspect risks overlooking a critical component, potentially leading to an incomplete understanding of what encompasses FPW and, subsequently, their environmental and socio-economic impacts, leading to partial or ineffective solutions.

Considering these definitions and conditions, we developed the following working definition of FPW as *"a piece, part or combination of equipment made from plastic polymers that are used or capable of being used to capture, control for subsequent capture, or harvest, marine or freshwater organisms, including ancillary plastic items that support these activities or are used for the storage and preservation of these organisms until sold or allocated for personal consumption by the fisher, that has been abandoned, lost or otherwise discarded in the marine or coastal environment."* This definition includes only ancillary items explicitly linked to fishing practices (e.g., gloves, storage boxes, ice bags). It includes plastic items used to store gear during fishing activities, as well as repurposed consumer plastics used in fishing activities (e.g., plastic bottles repurposed as bailing containers). This definition excludes plastics associated with fish farming equipment and aquaculture. The broad definition is intended to ensure that variation in how FPW is described in literature does not hinder the extraction of relevant data.

1.2.3. Multidimensional Impacts

This SEM will explore five key dimensions of impact: (i) environmental; (ii) social; (iii) economic; (iv) technical; and (v) political impacts. These dimensions align with the five interacting sub-systems of the "five levels of information," or "5LoI" framework of the Complex Value Optimisation for Resource Recovery (CVORR) systems-based tool (Iacovidou et al. 2020; Figure 2).

This facilitates a holistic understanding of the complex interrelationships within these systems.

Environmental impacts fall within the 1st level of information, the "Natural environment and provisioning services." The SEM will explore the impacts of FPW on ecosystem health (i.e., marine organisms and their habitats), biodiversity and ecosystem services that coastal communities depend on for their well-being (via ecosystem services; Millennium Ecosystem Assessment 2005).

Technical impacts fall within the 2nd level of information, "Technologies, infrastructure and innovation level." Technical impacts relate to a "technique," i.e., a specialised method or procedure, and challenges related to fishing gear functionality, fishing activities or operations and waste management systems. Therefore, technical effects to coastal communities once plastic fishing gear becomes waste/they are exposed to FPW in the environment include changes in the way communities conduct fishing activities

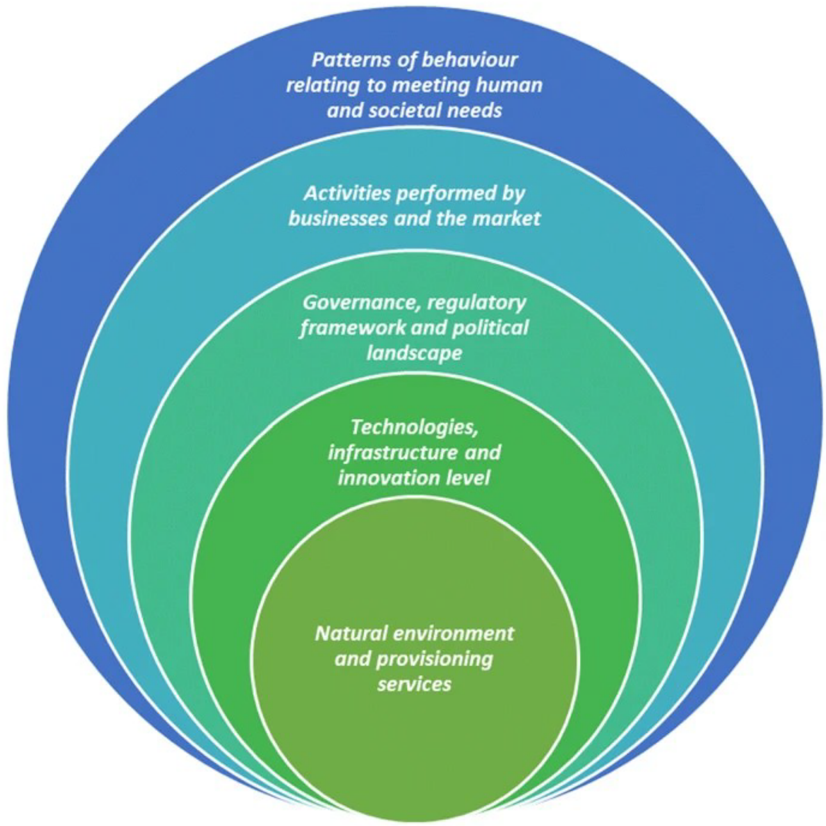

Figure 2. The "5LoI" (five levels of information), a conceptual framework that enables the understanding of the dynamics, drivers and barriers of resource recovery systems. Source: Iacovidou et al. (2020).

(e.g., reduced functionality of gear, altered fishing techniques) or methods of dealing with this waste at end-of-use/end-of-life (e.g., repair, repurposing, recycling, collection for disposal, energy recovery). This may also relate to what indigenous knowledge and technical skills may have been lost at the end of the use/life stage due to replacing traditional fishing gear with plastic fishing gear.

Political impacts support the 3rd level of information: "Governance, regulatory framework and political landscape." This refers to policy responses from the government in coastal regions to address FPW. Ultimately, any policy proposed in response to FPW will have consequences for the region's inhabitants.

Economic impacts support the 4th level of information, "Activities performed by businesses and the market." The SEM will include the impacts of FPW on livelihoods, including financial implications from the presence of FPW on individuals and the broader coastal communities.

Social impacts support the 5th level of information, "Patterns of behaviour related to meeting human and societal needs." The SEM will focus on the impacts of FPW on human well-being and community dynamics, including cultural aspects and perspectives on FPW. Social outcomes explored are supported by social life cycle assessment impact catergories (UNEP 2009).

1.3. Objectives

Well-formulated research statements are critical for ensuring the accuracy and coherence of other review components, including the literature search strategy, data extraction, synthesis, and presentation of findings. The PEO (Population, Exposure, Outcome) framework (Moola et al. 2015) is a widely used tool for exploring associations between specific exposures and outcomes, particularly in qualitative research.

1.3.1. Our Research Question is Articulated as Follows

What are the environmental, social, technical, economic and political impacts of FPW-associated pollution on coastal communities?

Table 3. PEO framework developed for this protocol - Population, Exposure, Outcome.

Element of PEO framework	Description of the PEO element developed for this protocol
Population	Individuals or groups of individuals living near the coast and/or relying on coastal and ocean resources for their livelihoods, in ways influenced by cultural heritage or economic need, and interconnected with the ecosystems that support them.
Exposure	A piece, part or combination of equipment made from plastic polymers that are used or capable of being used to capture, control for subsequent capture, or harvest, marine or freshwater organisms, including ancillary plastic items that support these activities or are used for the storage and preservation of these organisms until sold or allocated for personal consumption by the fisher, that has been abandoned, lost or otherwise discarded in the marine or coastal environment.
Outcomes	Environmental impacts caused by the presence and exposure of human and non-human populations or communities to FPW in the marine and coastal environments. This includes physical harm to marine life (e.g., entanglement and ingestion, habitat damage), toxicological impacts (e.g., chemicals leaching, microplastics), disruption of ecosystem services (e.g., impact on marine food web and flora), contribution to climatic change (e.g., greenhouse gases emissions).
	Social impacts of the presence or interaction of FPW with human and non-human populations or communities in the marine and coastal environments. This includes impacts on health and well-being or coastal communities.
	Technical impacts arising from the presence or interaction of FPW in the marine and coastal environments. These include technical challenge such as damage to fishing equipment (e.g., gear entanglement, gear loss and equipment degradation due to wear and tear), repair and recycling.
	Economic impacts to individuals, groups of individuals or economies caused by the presence or interaction of FPW in the marine and coastal environments. These include impacts on livelihoods, fisheries, tourism, and economic activities dependent on healthy marine and coastal ecosystems.
	Political impacts resulting from the presence of FPW in the marine and coastal environments, particularly on local policy and governance. This may include the influence on local government activities, regulations and initiatives aimed at managing the impacts of FPW on ecosystems or managing and reducing FPW.

Using the PEO framework (Table 3), the specific objectives of this SEM are to:

1. Identify, group and organise existing primary evidence on the multidimensional (environmental, social, economic, political, technical) impacts (outcomes) of FPW (exposure) on coastal communities, inclusive of the ecosystems these communities rely on (population).
2. Present the evidence in a user-friendly format, including an interactive online cause-effect diagram and dashboard that will be made publicly accessible to facilitate knowledge sharing.
3. Identify knowledge gaps and evidence clusters across taxa (population), FPW types (exposure), and multidimensional effects (outcomes) to inform future research needs and/or analysis.

2. Methods

This protocol was drafted following the updated 2015 PRISMA-P guidelines (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols; *Annex 3*) (Moher et al. 2015; Page et al. 2021) and giving due consideration to the recommendations for the Conduct of Systematic Reviews in Toxicology and Environmental Health Research (COSTER) (Whaley et al. 2020).

2.1. Information sources

Peer-reviewed academic literature will be found by searching on Web of Science (WoS), Scopus and Pubmed electronic indexes, as well as Business Source Complete, CINAHL Plus, EconLit, GreenFile, and Humanities International Index via the EBSCOHost Platform. All databases will be accessed using the University College London subscription (as of December 2024). Pilot searches demonstrated that this combination of databases provides adequate coverage for the diverse range of outcomes to be explored. Details of each database's disciplinary coverage can be found in the supplementary material (*Annex 4)*. The searches will be complemented by direct citation searching (i.e., snowballing), conducted using the TARCiS checklist developed by Hirst and colleagues (Hirt et al. 2024). Springer was considered; however, it yielded an unmanageable number of results (>500,000). Conversely, Anthropology Plus, SocIndex, and Child Development and Adolescent Studies via the EBSCOHost Platform, and JSTOR were also considered, but all yielded an insufficient number of relevant results (<3%).

All indexes will be searched using title, abstract and keyword fields. This will be achieved on WoS by searching by Topic in the core collection and all databases subscribed to by University College London (as of December 2024). If a search update is required, the search will be repeated, however, limited to studies published since the date of the last search.

Grey literature searches will be manually conducted on repositories of The World Bank Group, the United Nations (UN), the Organization for Economic Co-Operation and Development (OECD), as well as Non-Governmental Organization (NGO) reports and published research available via the Google search engine.

Literature screening will be managed and coordinated with the support of the freely available online tool CADIMA, established in a close collaboration between the Julius Kühn-Institut and the Collaboration for Environmental Evidence (Kohl et al., 2018). The reference manager, Citavi (Swiss Academic Software, 2023), will be used to support the retrieval of full texts of studies. Data will be collected and presented using Microsoft Excel.

2.2. Search strategy

We developed search strings for each database to reflect our PEO framework in collaboration with a librarian specialist (JMP). Population terms were developed relating to aspects of the study subject (i.e., community, coastal, environment, organism) and species group (i.e., human, animal, plant, bacteria, fungi). As plastic is the standard material used in fishing gear, it is common for titles and abstracts not to reference plastic materials in papers related to the effects of fishing plastic waste. Titles and abstracts either describe the effects of (1) specific items of gear, with no explicit mention of fishing or material, (2) "fishing-related" pollution, or (3) marine debris, with no mention of fishing or material. Therefore, it was important for exposure terms to sufficiently capture this variation by including general terms for fishing plastics (e.g., fishing gear, fishing nets, rope), terms related to the source of the item (e.g., fisher* related, originating from fishing, derived from fishing), the material (e.g., fishing *plastic, plastic polymer names), and waste terms (e.g., pollut*, derelict). Proximity operators (e.g., fisher* NEAR origin) were employed here to capture these items.

Pilot searches revealed a need to group microplastic terms with waste terms, as due to these intrinsically being waste abstracts, they did not tend to use waste terms (e.g., litter, pollution) to describe them. To capture relevant literature where fishing plastic waste is described as marine debris in the abstract, we also searched for fishing-related terms in the keywords field. No search limitation (i.e., NOT terms) were used to prevent excluding studies reporting on more than one population/exposure/outcome. The search was not restricted by language; however, as the search was conducted in English, a title and abstract in English were required to assess the relevance of the study.

A comprehensive list of outcome terms was devised related to health effects (e.g., inflammation, oxidative stress, genotoxicity, apoptosis, necrosis), ecologically relevant effects (e.g., survival, reproduction, growth, development, behaviour, invasive species, greenhouse gas emissions), social effects (e.g., culture, recreation, education), economic effects (e.g., econom*, livelihood, income), political (e.g., govern*, poli*, legislation), and technical effects (e.g., technique, dispose, reuse, repurpose). Terms related to known methods of estimating these outcomes were also used (e.g., LCA, cost*benefit). Outcome terms were included as they effectively refined the results without compromising a significant number of relevant papers (2% relevant papers missed). Terms were searched for individually on each database to confirm their relevance, then combined with Boolean and proximity operators to devise a sufficiently sensitive whilst selective strategy (Supplemental Table S4 *in Annex 5*).

Details of the performance-piloted search terms and strings and the agreed final search strings can be found in *Annex 6*. As it is not possible for any search string to capture all existing literature or to be completely free of bias, we undertook a validation exercise using a subset of articles (n = 30) identified as relevant to the objectives of this study (*Annex 7*). These articles were selected during the initial scoping search using expert knowledge or due to their inclusion in prior articles reviewing the evidence of environmental, economic, social, and/or technical/technological effects of marine plastic pollution (Agamuthu et al. 2019; Agarwala 2023; Angiolillo and Fortibuoni 2020; Browne et al. 2015; Costa et al. 2022; Gilman et al. 2023; Hernandez et al. 2022; Kibria 2024; Kumar et al. 2021; Li, Tse, and Fok 2016; Nama et al. 2023;

Stelfox, Hudgins, and Sweet 2016; Watson et al. 2022). They include papers related to each outcome category and contain varying levels of detail in the title/abstract describing the type of fishing plastic waste. Comparing the list of relevant articles to articles retrieved using our search string on WoS, we achieved a retrieval rate of 87%. This increased to 93% when searching in Scopus, PubMed or EBSCOHost for missed articles. Thus, we are confident that our search strategy is robust enough to identify the body of evidence relevant to our research aims.

Grey literature search strings will be adapted to fit the functionalities and filters available for retrieving results from these sources.

2.3. Eligibility criteria

The PEO statement (Table 4) informed the development of clear inclusion and exclusion criteria to ensure transparent and reproducible study eligibility screening. These criteria enable a systematic approach to study selection for the SEM.

This SEM is focused on evidence of real-world impacts on coastal communities and the natural environment they depend on. Thus, laboratory, in vitro, and silico studies were excluded, as they typically rely on controlled conditions, technical proxies, or sample types that may not reflect the complex, real-world socio-technical, and environmental contexts relevant to this evidence mapping. Including such studies could introduce context-specific biases and limit the generalisability of findings to field-based, observational settings.

2.3.1. Refinement via piloting of the screening process

A first consistency check was conducted to develop and refine the eligibility criteria. All search results were imported into Cadima, where duplicate records were removed, leaving a total of 9,581 unique references. Three reviewers piloted the Title and Abstract screening by applying the initial eligibility criteria to the titles and abstracts of 7.83% ($n = 750$) of the results, as this is the maximum allowed on Cadima. This resulted in 121 papers being progressed to full text screening; therefore, we estimated ~1400 papers may still be progressed for full text screening. This high number of eligible studies would be challenging to extract data from within the resources allocated to this project. It is common for literature exploring the impacts of marine plastics (especially microplastics and smaller) not to include the source of the plastic in the abstract. A permissive interpretation of the eligibility criteria would further introduce uncertainty and weaken our analysis of the evidence. To limit this, we sought to refine our eligibility criteria to reduce the 89 of 121 eligible rated unclear at the Title and Abstract screening stage.

The reviewers noted a high occurrence of microplastic papers that did not explicitly refer to FPW in the title or abstract, so needed to be progressed to full text screening to determine their relevance. To reduce this, microplastic papers will only progress to full text screening if they relate to direct impacts to marine biotic (i.e., impacts following ingestion/inhalation) and abiotic elements. In addition, many studies were identified that made inferences about potential impacts in the abstract after solely characterising or estimating the abundance of fishing plastic waste in the environment. It was decided that only studies that directly investigate impacts would be accepted.

Furthermore, studies on political impacts will only be progressed that impact on our defined “coastal communities” population (i.e., at the local level). Studies at the interface of local and national policy will be included if they provide empirical insights from cross-scale governance structures from local, national and global scales. Whilst those exclusively at the national and multilateral levels will be excluded. Studies reporting on the outcomes of governmental responses on FPW (e.g., government clean-up project), based on stakeholder perceptions will also be excluded.

Finally, only studies on technical impacts to fishing technique and management of FPW at end-of-use/end-of-life will be progressed. Studies on technological impacts will be excluded.

A second consistency check was conducted applying the new eligibility criteria to the 121 progressed studies using Microsoft Excel (*Annex 8*). This process reduced the number of progressed studies to 55. Further refinement of the search strings to reduce ambiguous studies produced 6,237 results. Applying the

Table 4. Eligibility criteria for inclusion and exclusion of the PEO framework.

PEO element	*Inclusion criteria*	*Exclusion criteria*
Population	All the following must be true: • Any **defined** individual, group or assemblage of individuals or species • human or non-human (Vertebrates including humans, Invertebrates, Micro-organisms) • Relying on coastal and ocean resources	If any of these is true, the study is excluded: • Undefined group(s) e.g. global, nationals or regional population
Exposure	All the following must be true: • Fragments of any size of plastic polymers (macro-, micro-, or nano-) • Polymer types: … • Waste (no longer in active use) • Origin attributed to previous use as fishing gear • Repurposed consumer plastics used in fishing activities • Plastic items used to store gear during fishing activities	If any of these is true, the study is excluded: • Biodegradable plastic or natural polymers • Still in active use • Waste of unspecified origin • Waste from activities other than fishing • Waste from fish farms and aquaculture • Waste or fragments from boats and ships regardless of whether they are used in fishing or other activities.
Outcomes	Any of the following is true for: **Environmental impacts**, Field, in situ or observational study measuring any of the following. • physical harm to marine life caused by macroplastic (e.g., entanglement and ingestion, ghost fishing, smothering and habitat damage). These do not need to describe a population-level impact to be accepted, as plastics of this size have inherent physiological effects (i.e., gastrointestinal tract function, motility, or presence of a foreign object attached to the body). • impacts to marine biotic and abiotic elements. • disruption of ecosystem services	If any of these is true, the study is excluded: • Conducted under controlled laboratory conditions • In vitro or in silico experiments If these are the only outcomes measured, the study is excluded: • Abundance of any type of plastic • Ingestion or inhalation on NMPs • Characteristics of nano- or microplastics ingested or inhaled by an organism
	OR **Social impacts,** objectively measured or perceived related to. • Health and well-being • Human rights, • Safety, • Justice, • Culture and recreation, • Education, • Access to services • Working life (e.g. labour rights, working conditions)	If these are the only outcomes, the study is excluded: • estimate(s) of future impacts • theoretical studies
	OR **Economic impacts**, objectively measured or perceived on. • Livelihoods, • Trade • Any financial costs/benefits	If these are the only outcomes, the study is excluded: • estimate(s) of future impacts • theoretical studies
	OR **Political impacts**, including. • Local or regional responses (e.g., initiatives/schemes, action plans, policies, legislation) • Responses at the interface of local and national policy that provide empirical insights from cross-scale governance structures from local, national and global scale. • Enforcement of new or existing responses	If these are the only outcomes measured, the study is excluded: • Exclusively national and multilateral governmental responses • Outcomes of governmental responses on FPW based on stakeholder perceptions
	OR **Technical impacts**, including. • Local techniques employed for fishing gear or active fishing • Local management at the end-of-use/end-of-life stage	If these are the only outcomes measured, the study is excluded: • Global, international, corporate or national techniques • Technological solutions

outcome of the consistency check (depicted in *Annex 9*) we estimate ~400 papers may still be progressed to full text screening. The logic underlying the application of the eligibility criteria is detailed in Table 4.

2.4. Study selection

Title-abstract and full-text screening will be conducted by LA in Cadima. Title-abstract screening will be set up with a 10% overlap (i.e., LA will screen 100% of the studies and 10% of the studies will be screened in duplicate by OM and EI) as a quality control step. The full text of studies included after title-abstract screening will be retrieved and screened in Cadima - again with a 10% overlap as a quality control check while one screener (LA) conducts most of the screening. Discrepancies between reviewers will be resolved through discussion between reviewers as soon as they arise to allow for the rectification of any systematic error or drift in the interpretation of eligibility criteria to be addressed as soon as detected. An unexplained high rate of discrepancies (> 5%, checked weekly) may trigger a second round of screening as a corrective step. We will report the recorded discrepancy rates. The reasons for the exclusion of studies after the assessment of the full text will be recorded.

Multiple reports of the same study (e.g. multiple publications, conference abstracts, etc.) will not be excluded, but instead, the methodological information from each of the reports will be collated as part of the data recording process as one unit of evidence.

2.5. Data extraction and data items

A data extraction template in Microsoft Excel was developed, piloted and revised following the piloting exercise. Three reviewers individually extracted data from a sample of papers (n = 3) identified as relevant during the second consistency check. The results of these individual data extraction exercises were compared to ensure parity (*Annex 10)*. This piloting exercise generated important discussions about what one unit of evidence should consist of and avoid the multiplication of rows. Following piloting, it was agreed that capturing detailed information under each outcome was neither necessary nor feasible to meet the aims of this systematic evidence map. We decided to capture broad categories and allow the selection multiple entries rather than triggering a separate entry (new row). Google Forms was tested to achieve this and rejected. We found using a Visual Basic for Applications (VBA) code in Excel (Annex 11) to allow the selection of multiple items in drop down lists to be most appropriate for the subsequent production of Tableau visualisations and dashboards. Full guidance on the cells in which multiple entries are permitted can be found in the "Instructions" sheet of the Data Extraction Template (Annex 10). One reviewer (LA) will extract data from the included records, and 1 in 10 will be extracted in duplicate in parallel by OVM or EI as a quality control step. The error rate will be checked weekly, with a focus on entries which have a material impact on further analyses of the database, specifically consistent categorisation and completeness of extraction. Here, estimating an error rate is more complex and will require qualitative judgement on when an error rate should trigger duplicate extraction of data from studies not included in the quality control check. We will report error rates, differentiating between incompleteness and miscategorisation errors for relevant columns.

2.6. Summary measures and synthesis of results

Results will be summarised narratively, and the characteristics and volume of evidence visualised in interactive Tableau (Salesforce, Inc., 2025) dashboards, allowing quick access to the title and abstract and link to included studies. Analyses may include publication and trends, geographical distribution of studies per type of FPW or outcome and analyses of categories of effects under each type of impact. This may include, where appropriate, reporting quantitative measures related to the volume or proportion of the body of literature addressing specific aspects (e.g. specific items, or outcomes) but quantitative synthesis of measure of effects are not envisaged. Dummy Tableau visualisations were generated from the results of the data extraction piloting exercise. These illustrate how Tableau can help visualise large amounts of data collected in a database and how interactivity can support reuse and access to the collated references. This can be accessed here: https://public.tableau.com/views/ADLFGSEMdummy/DashboardMap2?:language=en-GB&:sid=&:redirect=auth&:display_count=n&:origin=viz_share_link.

2.7. Data sharing

The interactive Tableau dashboards will be hosted on Tableau Public a free online platform to share interactive visualisations of public data. The underpinning database will also be made publicly available as supplementary material to an open access peer-reviewed scientific article as an Excel file.

2.8. Reporting

A comprehensive written report, formatted as a peer-reviewed scientific article, will be developed to accompany the systematic map visualizations. This report will ensure the study's results and database are publicly accessible, downloadable, and easily searchable. It will document all phases of the systematic mapping process, including the background and rationale for the study, details and justifications for any deviations from the outlined methods, a summary of the evidence base's volume and characteristics, and recommendations for future primary research to address identified knowledge gaps. Additionally, the report will outline priorities and opportunities for future systematic reviews. Significant priority will be given to adhering to established reporting standards for systematic maps, such as the Reporting Standards for Systematic Evidence Syntheses (ROSES) guidelines (Haddaway et al. 2018).

Authors Contributions

CRediT: **Larisha Apete**: Conceptualization, Data curation, Funding acquisition, Methodology, Validation, Writing – original draft, Writing – review & editing; **Eleni Iacovidou**: Conceptualization, Data curation, Funding acquisition, Project administration, Supervision, Validation, Writing – review & editing; **Joanne McPhie**: Methodology, Resources; **Olwenn Martin**: Conceptualization, Data curation, Funding acquisition, Methodology, Project administration, Software, Supervision, Validation, Writing – review & editing.

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