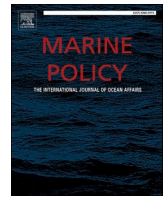




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A B S T R A C T

Marine litter harms marine life, human wellbeing and the provision of clean seafood. In the Barents Sea, a high portion of this source of pollution derives from fisheries. However, there remains a knowledge gap between fishers' attitudes towards litter and their practices when it comes to marine litter onboard their vessels and in harbors. By applying the conceptual lenses of social institutions, this study aims to explore the institutionalization of new practices among fishers to handle marine waste, as well as possible measures to reduce it. Empirical data derives from 21 qualitative interviews with fishers from Northern Norway. The data indicate that there has been a shift in fishers' attitude, partly because of media focus on this environmental issue and awareness campaigns from fishers' organizations. However, increased sensitivity to the problem has not completely translated into effective practices to address it. The institutionalization of desirable values and practices is hindered by the lack of infrastructure, institutional support and appropriate practical arrangements in harbors. We conclude that increased awareness has limited impact (and can potentially be invalidated), if not accompanied by a system designed to support environmentally adequate choices. Progress on addressing the problem of marine litter depends on the institutionalization of environmental practices, and these are contingent upon an integrated approach between operations at sea and on land.

Author contributions

Julia Olsen: Conceptualization, Methodology, Formal analysis, Project administration, Funding acquisition, Writing - original draft, Writing - review & editing. Leticia Antunes Nogueira: Conceptualization, Methodology, Formal analysis, Writing - original draft, Writing - review & editing. Anne Katrine Normann: Conceptualization, Writing - original draft, Writing - review & editing. Bjørn Vidar Vangelsten: Conceptualization, Methodology, Formal analysis, Project administration, Funding acquisition, Writing - original draft, Writing - review & editing. Ingrid Bay-Larsen: Conceptualization, Methodology, Writing - original draft, Writing - review & editing.

1. Introduction

In recent years, attention to marine litter and pollution has increased globally, not only in the media, but also among local government authorities, industries and organizations whose activities depend on the

sea. Although the global threat and consequences of marine litter to the marine environment, coastal societies and livelihoods are broadly documented (e.g. Ref. [1]), there are still many unanswered questions, particularly in regard to how to prevent plastics from entering the ocean in the first place [2]. This article is based on a study of perceptions of marine litter and waste management practices of fishers operating in the Barents Sea, and approaches possible solutions to the obstacles preventing better management and mitigation of litter and waste.

Marine litter pollutes pristine Arctic marine and terrestrial environments. The presence of plastic particles is ubiquitous, reaching even the most remote locations [3]. This pollution comes with a number of costs to human wellbeing, particularly in relation to sustainable and safe fisheries and aquaculture, recreation, and heritage values. Negative impacts extend to marine life, including fish, birdlife, mammals, invertebrates and plankton [4]. It is estimated that about 20% of marine debris comes from human activity at sea [5], to which fishers contribute substantially [6] through loss of gear—such as nets, lines, and traps—and waste discharge. Some types of lost gear can cause 'ghost

[☆] This is a translated version of an interview guide that is co-developed in Norwegian by researchers at Nordland Research Institute, NORCE and Salt, Norway.

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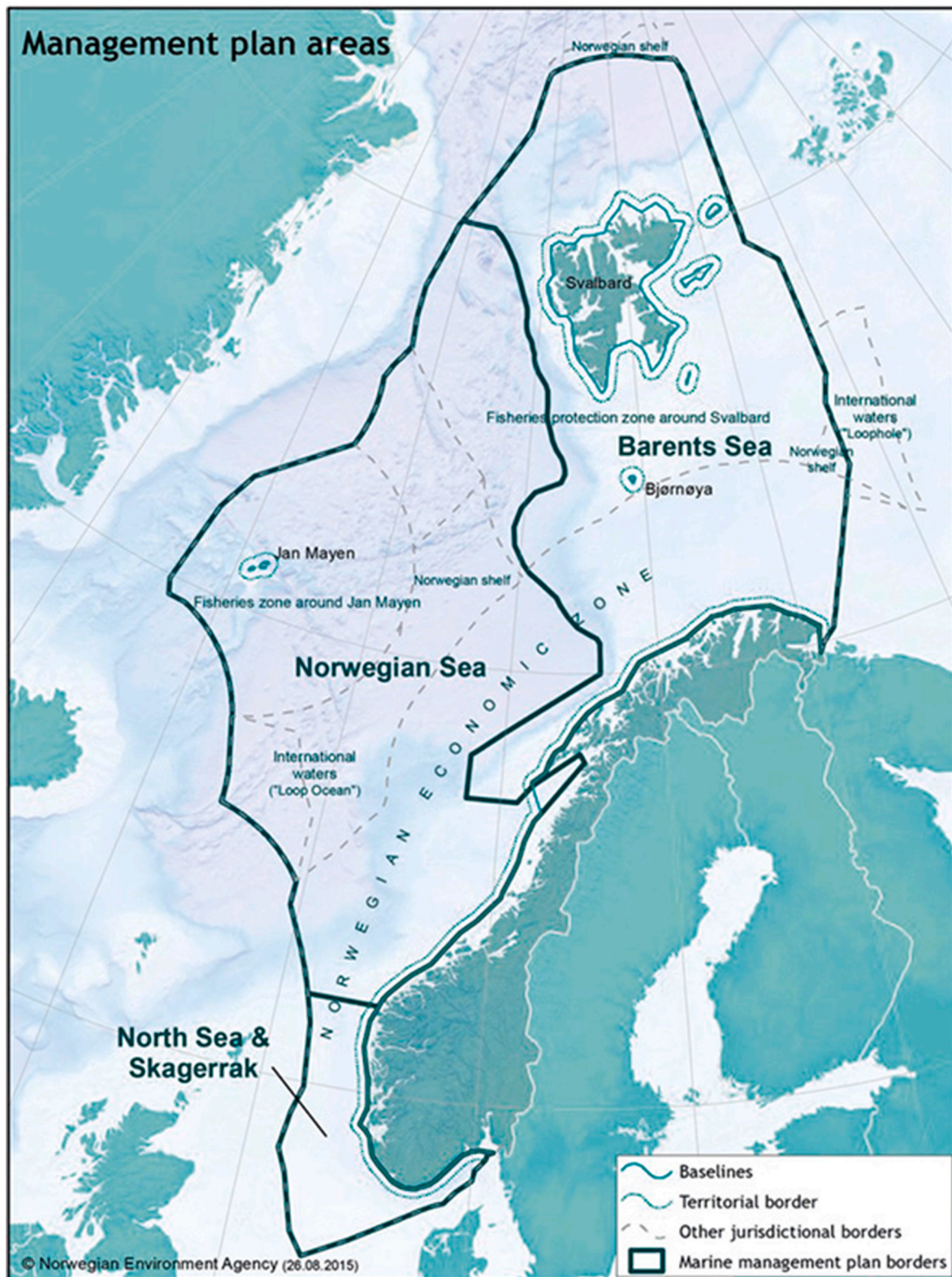


Fig. 1. The fishing areas. (Credit: Norwegian Environmental Agency).

fishing' for decades [7–11].

It is unclear what percentage of marine litter relates to fishing activities, but in a recent study, Deshpande et al. [12] estimate that Norwegian commercial fisheries alone generate 380 t/year of plastic litter from fishing gear [13,14]. Several cleaning initiatives have been implemented in the Barents area to reduce marine litter, in which fishers

themselves are actively engaged [9,15,16]. One initiative is Fishing for Litter, which receives and disposes of litter collected in nets both during regular fishing activities and during targeted missions [7]. Fishers are obliged to search for and attempt to retrieve lost fishing gear and, if unsuccessful, report losses to the authorities. Lost gear is also collected during annual expeditions carried out by relevant authorities. An

estimated 70% of gear reported lost by fishers is returned to its owners [17].

Coastal cleaning activities involve both individuals, public authorities, R&D institutions, the fishing and aquaculture industry, and voluntary organizations in the Barents area. Along the Norwegian and Svalbard coasts, the public has been encouraged to clean beaches via initiatives established by NGOs, such as “Keep Norway Beautiful” [18], and by the public sector, such as Clean Up Svalbard. There are also initiatives coordinated by the Association for Expedition Cruise Operators (e.g. Ref. [19]) and by individuals. The municipality of Tromsø in Northern Norway has taken part in coastal cleaning activities since 2010, engaging local denizens and collecting a total of 1600 cubic meters of marine litter [20].

Cleaning is, however, simply a form of mitigation, and these initiatives cannot keep up with the pace at which litter enters marine systems. Thus, it is imperative that stakeholders in regions such as the Barents Sea area implement measures to prevent waste from entering the marine environment in the first place.

Commercial fishers are an under-researched group of stakeholders when it comes to marine plastic pollution [6]. While NGOs and authorities have consistently documented that fishing gear ends up as beach litter, their awareness of this issue appears to do little to remediate the problem itself. Unless clear understanding is attained and measures put in place towards halting this practice, the negative impacts of littering will continue to harm marine ecosystems.

To increase knowledge on the causes of pollution among fishers, we adopted an exploratory approach to study fishers’ attitudes and practices towards marine litter. We understand attitudes as the ways in which actors position themselves in relation to a specific issue, in our context, how fishers perceive the problem of marine litter and how their perceptions, in turn, influence their behavior and practices. This is in line with other studies related to attitudes and behavioral changes in the fishing industry, such as a recent study on the Fishing for litter scheme in the UK [6]. Thus, we are guided by the following question: *What characterizes fishers’ attitudes and practices toward marine litter?*

To examine possible gaps between attitudes and practices, our data are analyzed through the lens of institutional theory, with a focus on how social structures influence the ways people engage with environmental problems. Institutions are “a cluster of rights, rules, and decision-making procedures that gives rise to a social practice, assigns roles to participants in the practice, and guides interactions among occupants of these roles,” ([21]; xiii). That is, they present a set of social norms and practices that provide stability and thereby safeguard key tasks of society (e.g. Refs. [22]). At the same time, institutions are also subject to changes, as transformations in society give rise to new values, practices and roles [23], a process known as institutionalization. Environmental threats represent a context for observing how tensions between old and new institutional setups interact with the implementation of environmentally-conscious behaviors.

Based on a combination of empirical findings and secondary sources, we also present possible remediation measures for the environmental issue of marine litter. We presuppose that awareness of environmental challenges is an important precondition for changing attitudes. However, research on household management of waste shows that simply increasing awareness about environmental problems does not necessarily lead to effective practices [22]. Infrastructure enablers must be in place in order to motivate people to adopt an environmentally-conscious mentality and shift their waste management practices and attitudes towards sorting and discarding waste appropriately. Facilities that handle large volumes and types of waste must be accompanied by information, instructions, and education about new practices. It is also valuable to explicitly provide these facilities with the rationale that supports new practices [24–27].

Table 1

Vessel size and type of gear of interviewed fishers.

Vessel size (feet)	Number of interviews	Interviewees and type of gear
40 or fewer	6	F8: Jigging, longline, crab cages F11: Net, longline, jigging F13: Net, jigging F14: Net, seine, longline F17: Net, longline F20: Seine
41–50	6	F5: Longline, net, seine F9: Net, crab cages, longline F10: Net, crab cages, longline F12: Net, longline F15: Net, seine F21: Longline, net, jigging, seine
51–100	4	F1: Trawl F2: Trawl net F3: Net, longline F16: Net
More than 100	5	F4: Trawl net, seine F6: Trawl net F7: Seine, trawl net F18: Trawl net, seine F19: Seine

2. Methods

We apply a qualitative approach with a case study design. The study can be classified as a typical descriptive case study [28]. As such, our sample includes fishers from various ports in the counties of Nordland, Troms and Finnmark, whose geographic fishing regions comprise mostly coastal areas of Northern Norway and the Barents Sea, while some interviewees also fish in the Norwegian Sea (Fig. 1). The Norwegian fleet comprises approximately 3000 vessels and is the largest of the 12 nations that practice commercial fishing in this region [29]. Norway manages some of the world’s richest fishing grounds [30]. The Barents Sea is home to more than 200 species of fish and numerous marine mammals. This accounts for abundant, albeit seasonal productivity in the region [31]. Given the diversity of marine resources and fish stocks, fishers use vessels of different sizes and employ various types of fishing gear.

To say that our cases are typical does not imply that they are representative of a larger sample size. This study does not offer possibilities for a statistical generalization that describes the greater population of fisheries, nor was it intended to do so in the design phase. Rather, the study’s sample of fishers provides exemplary cases of attitudes and practices in the fisheries sector. As a result, we emphasize that the purpose of this case study’s selection is not to be representative of all fishers. Our findings should be read as issues, attitudes and challenges that do exist in the sector, and not as issues or values that apply to all fishers. By applying a qualitative approach with a limited number of cases, we were able to do in-depth interviews which lend high internal validity to our results, though external validity would require further investigation. Our approach upholds the standards of contextualized explanations and transferability, not to be confused with the contrasting prediction and generalizability of extensive research designs [32]. We expect that the knowledge obtained in this study can be extended to fishers in different geographical locations, and, to some extent, to others whose livelihoods depend on operations at sea, provided that the specificities of each context are respected and accounted for.

For data collection, we adopted a semi-structured protocol, typical for qualitative approaches and case studies, with the intention of documenting waste management practices onboard and in harbors, which were elicited voluntarily from the interviewed fishers. Open-ended questions covered the following topics: interviewees’ backgrounds, attitudes toward marine litter, waste management practices onboard and in harbors, cooperation and marine litter reduction measures. (See also Appendix 1: Interview guide).

The interviewees were recruited by suggestion from three organizations: the Norwegian Fishermen's Association, the Norwegian Coastal Fishermen's Association, and the Norwegian Fishing Vessel Owners Association. These organizations provided a list of 45 fishers with home harbors in Northern Norway, whom we invited to participate in the interviews. Our sample secures a diversity of viewpoints: fishing experience, area of fishing operation, home harbor for the fishing vessels they worked on, type of catch, and size of fishing vessels. In total, 21 fishers agreed to participate and were interviewed in 2017 and 2018 by telephone or face-to-face. Most of our interviewees are skippers and/or boatowners (F7 is a chief engineer, F18 was no longer a fisher), including coastal fishers and fishers from trawlers, and have between six and 30 years of experience. They catch a variety of species, including herring, haddock, cod, mackerel, crab, and whale, and use different types of fishing gear to do so. Table 1 indicates the distribution of interviewees according to the size of their vessels and type of gear used. A coding system (F1–F21) was used to cite interviewees in this study and ensure anonymity.

The research was conducted in accordance with the Norwegian National Research Ethics Committees (NESH, 2016). Prior to each interview, fishers received an informational letter, approved by the Norwegian Centre for Research Data, which included an orientation to data protection. The interviews were conducted in Norwegian and were audio recorded. The interviewers took extensive and detailed notes during the interviews and assured their quality by comparing them with the audio records. These detailed notes were subsequently coded according to themes,¹ with the assistance of Qualitative Data Analysis (QDA) software [33]. Thematic analysis is useful for identifying patterns in qualitative data [34]. In this approach, the coder attributes labels that synthesize descriptions and meanings in chunks of data, and subsequently organizes and groups these labels according to their emergent patterns [35]. This is an iterative process in which codes are created and reconfigured as the analysis progresses. While broad themes were derived from the way the interview guide was set up (top-down, listed above), the subordinate codes arose from the text (bottom-up). At this stage, the coding process intended to capture the essence of the empirical material, and relationships with theory were not of concern.

Our research question was formulated in a descriptive and contextually-grounded way to keep an open stance in relation to theories of practices and behaviors. That is, our findings do not aim to be an exhaustive survey of attitudes and practices, but an exploration of these aspects. In line with many traditions in qualitative research, we adopted an agnostic position in regard to a possible hypothesis, which is also consistent with the nature of the study's objectives. Once the attitudes, practices and challenges of fishers in relation to waste management and marine litter were grounded in the data, their significance toward theoretical constructs began to emerge through abduction [36]. Insights from abductive reasoning are not logical necessities. As such, other theoretical insights might be of relevance, and our findings are to be understood as propositions.

Among the limitations of our study, we highlight that the attitudes and behavior of fishers are self-reported, and our research design cannot control for longitudinal changes in actual or reported attitudes and behaviors. Moreover, there are 12 nations with fleets represented in the area, while our sample comprises only fishers from Northern Norway.

¹ The first author was responsible for the coding, and an inter-coder reliability check was performed by the second author, who had not been involved in the data collection. In this check, two interviews (I1 and I11, about 10% of the coded data) had their coding reviewed for consistency and agreement. We found that although the actual labels differed between the coders, their essence was the same (e.g. "what is waste" vs. "definitions"; "willingness to pay" vs. "fees"; "beach cleaning" vs. "voluntary actions"). Overall, the two coders were in agreement with the classification and organization of the data in the thematic analysis.

In the following section, we present our findings on fishers' attitudes and waste management practices. Subsequently, we will also discuss possible remediation measures, consider which institutional aspects could facilitate and lead to the reduction of marine litter in the sector, and analyze how social institutions are reconfigured in this process.

3. Results

Below, we present fishers' experiences and practices concerning waste management and marine litter. We differentiate between the waste generated by fishers and waste they encounter at sea. Two essential categories for the former, as addressed during the interviews, are fishing gear and other waste. Fishing gear comprises discarded and unintentional loss of full nets during fishing activities. Other waste refers to other operational waste (such as organic waste, oil and batteries), as well as common household waste produced onboard. The following sections are divided according to these two categories. Waste that fishers come across in marine environments is referred to as litter.

We begin with fishers' perceptions and attitudes towards litter, as well as insight into the circumstances under which marine littering occurs. Next, we present fishers' waste management practices, challenges onboard vessels and, later, challenges on land.

3.1. Perception and attitudes concerning litter

Put simply, fishers understand marine waste as anything in the ocean that does not naturally belong there. They recognize that lost and discarded fishing gear and other debris are harmful to the marine environment and to fishing activities. They reported that marine litter causes several problems for their operation: nets can be caught up in boat propellers; plastic bags can clog water intake systems; fishing gear can be damaged if it attaches to old, lost gear; waste on hooks and in gears are a hassle. Moreover, fishers' reputations are threatened by litter, as plastic found in fish stomachs can harm consumer perceptions that seafood is healthy and clean: "A picture of fish with plastic will destroy this image," (F8).

At the same time, fishers, especially those with more than 10–15 years of experience, believe that waste management practices in the sector have improved in recent years, but they also concede that some waste still ends up in the ocean. One fisher reported changes in attitudes in the following way: "It has gotten much better. Huge difference. Before, it was normal to throw garbage in the sea ... It was a completely different attitude. No one thought about littering in the 1990s. Now, we take everything ashore, even litter we catch at sea, but there are some insufficient practices to get rid of all of this on land," (F5).

Fishing gear. Fishers reported that losing complete gear is rare due to the prohibitively high cost of replacing it. Interviewed fishers have either never lost their gear (or parts) or have experienced gear loss only a few times in their careers. Some interviewees described the possibility of accidental loss of fishing gear, especially from coastal vessels (e.g. longline, crab cages, nets), if the gear is not adequately attached to the boat. Trawls use thicker, heavier gear that is attached to the boat, which is very hard to lose. An owner of a trawler said: "It is rare for such types of vessels to lose gear. We use powerful gear that is almost impossible to lose. It is strongly attached to the boat, not like the nets that are released," (F7). Among the possible reasons for losing or damaging gear, fishers highlighted: (i) another boat cutting their longline; (ii) insufficient information about the fishing area (e.g. poor charts of the seabed); (iii) changes in ocean currents that lead to gear being stuck to the seabed or attached to other ships' previously lost gear.

Fishers describe the following practices they enact to avoid losing gear: (i) investing in higher-quality gear that is less likely to separate from their vessel; (ii) learning and exchanging information about fishing fields to avoid the most challenging areas; (iii) constantly checking gear for damage and, if damage is found, repairing it immediately; and (iv) improving operation routines to limit the possibility of future damage, e.

g. taking gear onboard during bad weather.

Other waste. Fishers acknowledged that, in the past, it was common to throw waste away in the ocean, but they also reported that this behavior has changed: *“Ten years ago, it was common, because things disappeared. It was more like ‘out of sight, out of mind.’ But now we have routines for dealing with waste on land. We take everything we produce ashore,”* (F9). Another fisher, in reference to collected marine litter, stated that: *“We always take care of everything we find,”* (F15). Fishers view much of today’s marine litter as the result of past littering.

Interviewees described several reasons for the reduction in littering, mainly revolving around changing awareness and attitudes, as well as better routines for waste management onboard vessels and in harbors (described in the following sections). Increased awareness is partly related to an increase in media coverage. One fisher stated that the news of a whale found dead in 2017 with its stomach full of plastic bags was a turning point: *“News about the whale was a wake-up call,”* (F8). Another interviewee also highlighted this pivotal event: *“The image of that whale belly is a good example and had good effect,”* (F19). According to our interviewees, younger fishers are especially sensitive to the problem. *“Young people ... have completely different attitudes towards taking care of litter,”* (F3). Fishers also suggested that marine litter comes from non-fishing activities, including terrestrially-derived litter blown from land, and from regions connected to the Barents area via ocean currents. Interviewees have observed industrial waste on beaches and claimed that waste from fish farming is becoming increasingly prominent.

3.2. Waste and litter during fishing operations

Fishers reported that the waste management routines onboard vessels have improved in general. Nowadays, most of the operational and household waste produced onboard, as well as litter caught from the sea, is stored and brought to shore. One of the interviewees thinks that fishers take care of both their operational and household waste: *“It goes without saying that we take care of our own trash,”* (F6). In addition to their own operational waste, fishers might collect marine litter: *“If we have a chance to collect litter that can pose a risk to vessels or operations, we do it,”* (F3). One fisher explained that metal pieces and wires were caught by his longline and added: *“We take such litter ashore, as it can cause problems next time,”* (F17). However, the size of vessels and the availability of waste management facilities in harbors are described as two important factors that influence waste management and storage onboard. Another interviewee described improvements in the following way: *“Since I started as a fisher, there has been an improvement in taking garbage to shore,”* and then underlined that, *“It is a mix of attitude change and how easy it is to throw away waste onshore,”* (F19).

Fishing gear. If the unintentional loss of full gear during operation occurs, fishers immediately search and retrieve it. If they fail, they report the loss of gear on *Barentswatch* (an internet-based platform). One of the interviewees explained that such practices are done for *“their own and others’ sake,”* (F10). The same interviewee added that, when a longline is damaged, *“It can become fastened to the bottom [of the seabed]. You can search for it, but it is not certain that you will find it,”* (F10). Voluntary initiatives and Fishing for Litter are also mentioned as important responses: *“When the season is over, we go out in several boats to pick up old gear. So, when we come next [season] it will not cause us problems. The Norwegian Directorate of Fisheries is involved in the cleaning of gear and we continuously report where we lose gear ...”* (F3). The interviewees are aware of such campaigns and underlined that *“...It is positive to collect, but it is important that it [the loss of gear] is reported,”* (F6). The owner of a smaller boat also emphasized that because of limited capacity, *“Fishing for litter is not an initiative for smaller boats,”* (F20).

When it comes to litter caught at sea, fishers expressed differing viewpoints about the possibilities of collecting and storing it. That is, not all litter is taken onboard when fishers encounter it. In the case of lost gear, some fishers lack experience in how to collect it, and are also limited by their onboard storage capacity. For smaller boats, it can be

challenging to pick up and store large pieces of fishing gear not only because of capacity but also due to the lack of time and personnel on the vessel’s voyage. One fisher said that: *“It can be challenging on some occasions. But I think that it relates to attitudes. We are talking about a large coastal fleet. Whether [litter] is taken ashore is much about attitudes,”* (F19).

Other waste. Interviewees underlined that, apart from biological waste, the operational and household waste generated onboard is stored and taken to harbors. This also applies to oil waste, filters, and old batteries.

However, there are slight differences in delivery routines depending on the type and size of vessels. Smaller coastal boats take all household waste to land each day, while some of the newer and larger boats, which are offshore for several days at a time, have waste compressors and storage facilities. Moreover, all skippers for boats over 400 gross tonnage must report the amount of waste produced and delivered to shore. Skippers also provide instructions for waste management routines onboard.

Fishers do not identify bad weather as a primary cause of marine litter. Smaller coastal boats that fish one day at a time do not go out when the weather is bad. Larger boats, whose operations span several days, tend to store and secure waste inside, thus avoiding many of the problems experienced by smaller boats, whose waste is often kept onboard in bins or sacks, which can also become malodorous and attract seagulls.

Fishers reported varied practices when it came to sorting waste onboard. While space is indeed an issue, the main reason fishers forego sorting is the inadequate facilities in harbors and at fish landings to receive sorted waste. *“Everything is thrown into residual waste,”* (F2). Only a few fishers mentioned that they roughly sort plastic. Oil and filter waste are also delivered to separate, specialized containers. As it was noted by one interviewee: *“Everyone has a waste bin onboard, the question is what happens with it after,”* (F20).

3.3. Waste management in harbors

Our interviewees reported that, in general, waste that is produced onboard or collected from the sea is delivered by fishers to harbors and fish landing facilities. According to fishers, the quality of waste facilities varies substantially not only across counties but also in harbors within the same county. One of fishers noted that, though the waste management facilities in the harbors are improving: *“... there are still places without containers,”* (F10). Fishers have little motivation to store waste onboard if it cannot be delivered in the harbor, and they have no incentive to sort waste if everything will eventually be thrown into the same container. According to F1: *“Not much sorting in the harbor. They usually have large containers that collect everything.”* In some harbors that offer waste facilities, waste management can be time-consuming, as sometimes fishers have to spend time finding containers for waste.

Fishing gear. Fishers reported that fishing gear with recycling potential is treated separately from other types of waste. Such fishing gear is delivered to special containers for recycling, where available. Fishers referred to the company Nofir,² which collects fishing nets for recycling purposes. However, Nofir sacks are not available in all harbors, and the volume of waste that would justify pickup by the company is much larger than what individual fishers collect. Another organization mentioned by fishers is Asvo, a Lofoten-based company that repairs damaged gear. For gear retrieved from the sea, the program, Fishing for Litter, provides an alternative to discarding materials by offering free harbor management of used/retrieved fishing gear. Though it imparts a valuable service, Fishing for Litter, according to our interviewees, is partnered with only a few harbors in the Barents area.

² Nofir is a commercial enterprise, although the majority of its shares are owned by the municipal waste companies, IRIS Salten (40, 45%, through IRIS Produksjon), and Lofoten Avfallsselskap (19%).

Fishers praise initiatives like Nofir's, but state that it is the duty of the public sector to arrange facilities for the delivery of fishing gear, and that authorities currently fall short of this responsibility. Fishers expressed frustration with the lack of adequate facilities for waste management in harbors, with some of them pointing out that this service is supposed to be included in the municipal harbor fees that boats already pay. Fees vary from harbor to harbor, as does the quality of the service and infrastructure they offer. In the words of one interviewee: "We pay for services that certain harbors do not deliver," (F5). Hence, many fishers expect services to improve without added costs, but others said they would be willing to pay extra if they knew that services would have consistent quality in harbors both small and large.

When it comes to litter retrieved from the sea, as opposed to waste generated onboard, the issue of waste delivery is sensitive. Fishers claim that the cost of adequately disposing of marine litter, in addition to the time and effort it takes to collect it, disincentivizes them from retrieving it at all.

Other waste. According to the interviewed fishers, harbors and fish landing facilities usually have a container for residual waste. In many harbors, one can also find facilities for waste oil and batteries. Nonetheless, fishers reported that it is not uncommon for these containers to be full, locked, or difficult to access. Fishers believe this problem exists because other users of harbor areas are disposing of waste in these receptacles. Increasing capacity by means of more containers is necessary. The problem of insufficient capacity worsens in seasons of high demand, when the tourism industry also makes use of such facilities.

Additionally, fishers observed that smaller harbors usually offer fewer options for delivering and managing waste, and many small harbors offer no waste facilities whatsoever. In these circumstances, fishers must either take all generated waste home, drive it to municipal waste facilities, take it to their personal storage rooms, leave it in the harbor area when there is no structured alternative (F10), or keep it onboard to be thrown away at a subsequent harbor. In Finnmark, where harbors are smaller and distances between waste facilities greater, this is an especially prominent problem. When reflecting on such limitations, one fisher asked: "Why should we take waste to land if no one there takes care of it?" (F6).

Harbors that emerge as examples of best practices in terms of waste facilities include Svolvær, Dønna, and Røst (Nordland), as well as Tromsø, Tromvik, and Senjahopen (Troms). In the words of one interviewee: "[The fish landing facility of] Tromvik is the only place where the waste management system functions very well, and that is one reason why I deliver my fish there," (F11). What makes Tromvik popular is the fact that containers are easily found and there are no charges for delivering waste. Tromsø, on the other hand, can be expensive but is well organized, as the waste management facilities are easy to find and use. Senjahopen and Røst were also mentioned as well-organized harbors. Svolvær and Dønna are considered easy to use and also offer several sorting options. Fishers emphasized the importance of being able to deliver waste and catch together, without extra expenses, noting that the waste management facilities of these harbors could inspire other harbors.

Fishers pointed to a strong need for improved harbor waste facilities, as well as cooperation between involved stakeholders. As one interviewee declared: "It should be easy for us. If not, it may end up in the ocean," (F6). In addition, they emphasized the need for universal standards of waste management in harbors. Standardization can facilitate effective waste management, information systems, availability, easy access, and the opportunity to handle different types and volumes of waste for arriving vessels.

We discuss those opportunities and other suggested measures in the following section.

4. Concluding discussion

We have built this study around the fact that marine litter has

become a significant global environmental challenge, where fisheries are not only among the culprits, but also, as illustrated in the results section, might suffer from its effects. As such, any measures addressing marine litter must involve fishers as part of the solution.

Our findings indicate that fishers themselves notice changing perceptions and attitudes toward marine litter, for fishers both report and are aware of numerous negative consequences of marine litter for marine life and also for their own operations. The emergence of changes in attitudes among fishers can be related to increasing media attention (with the news of a dead whale found with plastic in its stomach marking a significant turning point) and by a heightened awareness of the problem among younger fishers, since education and training have also contributed to attitude changes toward marine litter in the blue sector [37]. Other contributing factors towards fishers' reported changes in attitudes are the established initiatives that improve their ability to collect and deliver marine litter in harbors.

These results show improvements in relation to the findings described by the Nordic Council of Ministers in 2006, which stated that inadequate operational waste management onboard vessels occurred due to a lack of incentive for fishers to properly dispose of their waste. This, in turn, could be blamed on a lack of awareness of the harmful effects of littering [38]; p. 44–45). Since 2006, much public debate and media coverage have increased knowledge on and sensitivity to the problem, and fishers in our sample were adamant they were aware of the problem and their role in it. Yet, we find increased awareness alone does not necessarily lead to improvement in waste management practices. The Nordic Council of Ministers' report outlines how a waste management plan could be designed, taking into account the sources, amounts, and types of waste, and which routines and technologies can be used to manage waste onboard. Our findings illustrate that, while such procedures are essential, they are insufficient for realizing behavioral change.

We posit that what currently prevents many fishers from improving their waste management practices is the institutional setup that governs waste systems. The lack of motivation on fishers' parts appears to be associated more with frustration than with ignorance. Our findings show that waste management practices onboard depend not only on the design of routines and systems in the vessels, but also on the quality of the waste management facilities in harbors and at fish landings. More explicitly, our findings indicate that changes in attitudes and practices onboard will not promote reduction of marine litter unless these initiatives are combined with well-designed facilities for receiving waste onshore. Moreover, the quality of waste management facilities has a feedback loop effect, where the effectiveness of waste management in harbors continually influences the attitudes and practices of fishers' marine litter management.

Nonetheless, we have found that, today, the mindset of preventing and reducing marine litter is, to a large extent, integrated into fishers' activities. This is illustrated by implemented routines for collecting and sorting waste onboard vessels and for delivering waste in harbors, suggesting that less waste is thrown into the ocean by fishers than before. We must note, however that our findings are based upon self-reported indications of behavioral change, and further investigations with different designs are welcome in order to document the extent to which fishers' actual and perceived/reported behaviors differ.

4.1. Suggested institutional measures to address marine litter

Throughout analysis of our empirical data, we have identified three possible institutional measures that must accompany changes in fishers' attitudes and practices towards marine litter and waste. The table below indicates such measures, describes their meanings, elucidates how they lead to behavioral change, and lists the main limitations on their implementation.

Table 2
Suggested measures for marine litter reduction.

Suggested measures	Description	How suggested measures can facilitate change	Anticipated challenges and limitations
Standardize waste management systems and improve infrastructure in harbors	<ul style="list-style-type: none"> • Allow for delivery of fishing-related gear in all harbors; • Design facilities to be available and accessible with sufficient information and sorting opportunities; • Learn from best practices; e.g. Svolvær, Røst, Dønna, Tromsø, Senjahopen, Tromvik. 	<ul style="list-style-type: none"> • Motivation for fishers to collect discarded/lost fishing gear from the sea; • Motivation for small vessels to collect, sort, and deliver waste. • Possible reduction of time spent by fishers in harbors. 	<ul style="list-style-type: none"> • Associated economic cost: There are 4443 identified harbors in Norway and only 969 had approved a waste reception and handling plan in 2016 [39]; • Lack of public bodies involved in the collection of discharged fishing gear.
Improve cooperation between fleets, harbors, and waste management actors	<ul style="list-style-type: none"> • Promote close cooperation across stakeholders to improve waste facilities in harbors; • Foster a dialogue between foreign fishing organizations whose members operate in the Barents Sea. 	<ul style="list-style-type: none"> • Establishment of a shared understanding of challenges and solutions; • Implementation of recycling schemes (e.g. Nofir). 	<ul style="list-style-type: none"> • Different parties have distinct interests and approaches to marine litter; • The responsibilities and solutions should be shared across the nations that operate in those waters via the establishment of intergovernmental institutions; • Fragmented responsibility and lack of leadership to initiate and coordinate such cooperation.
Expansion of the Fishing for Litter program	<ul style="list-style-type: none"> • Allow fishers to deliver litter that they have caught in their fishing gear without expense • Deliver found/recovered fishing gear to its owners. 	<ul style="list-style-type: none"> • Greater incentivization for fishers to collect discharged fishing gear; • Engagement of fishers as agents of problem-solving. 	<ul style="list-style-type: none"> • The costs of running and expanding the program are high; • The problem of limited space on smaller vessels remains a challenge.

4.2. Coordinated institutionalization of attitudes and practices

As presented in the introduction and in line with North [23]; we approach institutionalization as the process by which new values, practices and social norms become crystallized in the pattern of established social structures. Because social institutions exist to confer stability, institutionalization can often be characterized by conflict, as new practices disrupt established ones. When it comes to environmental challenges, such as dealing with marine litter, institutionalization confronts the challenge of steering large-scale change in the values and practices of multiple stakeholders.

Our findings show that the institutionalization of practices to address marine litter among fishers depends on three interconnected mechanisms: i) new perceptions and attitudes concerning littering (i.e. values); ii) revised/adapted waste management during fishing operations (i.e. behaviors and practices); and iii) improved waste management in harbors (i.e. practices and infrastructure).

The first mechanism requires establishing a shared understanding of the problem, as well as the necessity of addressing it. The media has been instrumental in creating this understanding and raising awareness. Fishery organizations have also undertaken awareness campaigns with the intention of provoking changes in attitudes. In August 2018, the Norwegian Fishermen’s Association kicked off the campaign, “Clean Oceans – Our Common Responsibility” [40]. The campaign focuses on influencing the intrinsic motives of fishers through their personal values and norms [25]. Achieving the desired result of cleaner oceans depends on clearly conveying the campaign’s message and appropriately delegating responsibility, while also avoiding antagonizing fishers by pointing fingers. This is a delicate balancing act that risks making fishers defensive and prompting them to deny their responsibility in the issue’s resolution [41]. A similar debate takes place in other industries, such as oil and gas, where some employees perceive stigma against themselves, rather than against the issue, itself. These same issues of blame, shame, and responsibility have spurred debate in the Norwegian media [42–44].

Increased awareness is expected to lead to the second mechanism—namely, revised practices and adapted systems for managing waste onboard. To a certain extent, this has already happened; fishers described how they have adjusted their practices to better contend with operational and household waste on vessels, thus demonstrating that they recognize a responsibility to avoid littering, as well as their role in finding solutions and mitigating negative impacts. However, when it comes to marine litter, the complete institutionalization of best practices is hampered by the lack of infrastructure, institutional support, and appropriate practical arrangements on land. This not only represents a gap in the process of behavioral change but can also nullify the benefits achieved through raised awareness. For, when waste facilities are poor, fishers become frustrated and demotivated to act, even when they do recognize marine litter as a problem.

As a result, in order to institutionalize the desired social norms and practices that sufficiently address marine litter, it is crucial to improve infrastructure on land. Progress on this third mechanism can be aided by the measures presented in Table 2, which include standardizing waste facilities in harbors, developing necessary supporting infrastructure, improving cooperation between local, national and international stakeholders, and extending existing cleaning initiatives. In other words, our findings suggest that measures that address the institutional landscape surrounding fishers, harbors, and waste management actors are essential to securing a well-arranged system that supports environmentally sustainable choices³.

Ultimately, the current waste management system is inherently

³ Source: the authors. The two columns on the left are based on interview data and the two on the right are the authors’ propositions, which result from analysis and validation from relevant stakeholders.

vulnerable to failure, as it is contingent upon each individual fisher making proper waste management choices. Regulated, standardized, and easy-to-implement solutions can positively impact and alter traditional ways of handling waste, which can, in turn, impact future norms [24]. We expect that regulations would pave the way for intentions to become actions.

Improving infrastructure and waste management in harbors is a crucial next step once progress has been made on awareness-raising and the creation of shared perceptions and attitudes towards marine litter. As is often the case with complex problems, bottlenecks come down to coordination and organization. This could explain why so much focus has been devoted to awareness campaigns, while amending supporting infrastructure has been neglected. Yet, we propose that only an integrated approach between operations at sea and on land can make salient progress in addressing the problem of marine litter.

Declaration of competing interest

The authors report no potential conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.marpol.2020.104211>.

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Interview guide*

1. Short information about the interviewee.
 - a. What is your current position on the vessel?
 - b. Type of the vessel, age and size, including size of the crew.
 - c. How many years of experience as a fisherman do you have?
 - d. What kind of gear is used?
 - e. Main fishing area
 - f. Seasonal or all year-around.
 - g. What port do you usually deliver fish (waste) to?
2. Attitude toward marine litter and marine plastic pollution
 - a. When I say "marine litter" what do you think of then?
 - b. How would you describe the marine litter situation?
 - c. Has it changed during last years?
 - d. Is it a topic for discussion among fishers?
 - e. What challenges does marine litter (marine plastic pollution) create in a fishing industry?

- f. How much time during an active fishing day do you use to clean fishing gear for litter?
- g. What is the estimated financial loss (during the last 5 years) caused by marine litter for a vessel you are working on?
- h. Who do you think are the main responsible for the marine litter found in this region?

3. Waste management on board (storage and sorting)

- a. Can you describe the waste produced onboard and how this is handled?
- b. What routines do you follow for waste management and sorting on board?
- c. What are the main challenges for waste management on board?
- d. Do you get marine litter in your catch? How do you handle it?
- e. Is loss of fishing gear a problem? Under what circumstances can gear be lost?
- f. How can fishing gear last longer, before it gets broken during fishing? For instance, is it possible to not trawl at the bottom, but to raise the trawl a bit from the sea floor (only relevant for bottom trawlers)? Other suggestions on how to make gear last longer?
- g. How can the routines be improved to avoid loss of fishing gear, or other equipment?
- h. What other type of items are lost overboard? Why?
- i. How is litter stored onboard? If on deck: does it get lost in storm weather? Are there solutions to this?

4. Waste management in the ports

- a. Can you describe what happens with the waste when you come to shore?
 - b. Can you deliver marine litter to ports? If yes, which ports? How does this work?
 - c. What are strengths and weaknesses of current waste management systems in the ports?
 - d. Do you have any thoughts on how waste management can be improved in the ports?
 - e. Are you willing to pay for a well-functioning, continuously available and convenient waste management system in ports? If yes, how much. If not, who do you think should be responsible for funding management of waste from fisheries?
 - f. Have you experienced that authorities follow up on waste management onboard and in port?
5. What measures should be implemented to reduce marine litter?
 6. Do you have any comments or questions to the project?
 7. Would it be possible to contact you for clarification, if necessary?

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