



NORLANDSFORSKNING  
NORLAND RESEARCH INSTITUTE

# New knowledge for reduction and utilization of marine waste from fisheries (RE-D-USE)

Final report

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-

## **Final report**

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## REPORT

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<p><b>SUMMARY:</b> This is the final report of the RE-D-USE-project (New knowledge for reduction and utilization of marine waste from fisheries). The project has worked with fishers to identify causes and solutions related to marine waste from fisheries. It has developed and tested an educational program for fishers to reduce waste and gear loss. RE-D-USE also investigated the potential for circular economy ventures based on marine waste as a resource.</p>	<p><b>KEYWORDS:</b> Marine waste, fisheries, circular economy, Barents region</p>	
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## PREFACE

The RE-D-USE project (“New knowledge for reduction and utilization of marine waste from fisheries”) was financed by the Norwegian Ministry for Climate and Environment through the Arctic 2030 programme. The project period was June 2017 – March 2019. The project has been a collaboration between Norwegian, Russian and Canadian researchers, fishers’ organizations, maritime schools and recycling businesses. The RE-D-USE consortium has been:

Organization type	Partner	Country
Research institution	Nordland Research Institute (co-ordinator)	Norway
	SALT Lofoten AS (SALT)	
	NORUT (NORCE from 1 April 2019)	
	Luzin Institute for Economic Studies, Kola Science Centre	Russia
	Ocean Safety - Fisheries and Marine Institute of Memorial University of Newfoundland	Canada
Fishers’ organization	The Norwegian Fishermen's Association including the Nordland County Branch	Norway
	The Norwegian Coastal Fishermen’s Association	
	The Norwegian Fishing Vessel Owners Association	
	Fishing Industry Union of the North	Russia
Maritime school	Bodin Secondary School and Maritime College	Norway
	Lofoten Secondary School and Maritime College	
	North Cape Secondary School and Maritime College	
Recycling business network	The Marine Recycling Network	Norway

# SUMMARY

The RE-D-USE project (“New knowledge for reduction and utilization of marine waste from fisheries”) was financed by the Norwegian Ministry for Climate and Environment through the Arctic 2030 programme and led by Nordland Research Institute. The project period was June 2017 – March 2019. The project has been a collaboration between Norwegian, Russian and Canadian researchers, fishers’ organizations, maritime schools and recycling businesses.

A high portion of the marine litter in the Barents part of the Arctic relates to fisheries activities that threatens marine life, food safety and food security. The RE-D-USE-project has worked with fishers to identify causes and solutions related to marine waste from fisheries and has developed and tested an educational program for fishers to reduce waste and gear loss. RE-D-USE also investigated the potential for circular economy ventures based on marine waste as a resource. The project’s geographical focus has been the three northernmost counties of Norway and the Murmansk region in North-West Russia. RE-D-USE has had three work packages.

The first work package “Data collection through dialogue with fishers” has collected data both through interviews of fishers and a survey among fishers.

A total of 21 fishers from Northern-Norway have been interviewed by Nordland Research Institute to improve knowledge on fishers’ attitudes toward marine litter, waste management and how to reduce marine litter. Both coastal fishers and fishers from ocean-going vessels (size varying from 32-230 feet) have been interviewed. The fishers emphasize that attitudes towards the problem have been changing. Whereas most of the waste ended up in the sea some decades ago, more is now brought to port, although some waste still ends up in the ocean. Many of the Norwegian fishers emphasize that marine litter threatens to destroy the positive image of their product as something originating from clean Arctic seas. Waste management on board varies with the size of the vessel and to some degree is linked to the waste management system in harbours and fish landing facilities.

Many fishers report full containers in the harbours as the locals use facilities that are intended for tourists and fishers. The Norwegian “Fishing for litter”-programme, allowing fishers to deliver for free litter that they have caught in their fishing gear, was viewed positively. A key message is that there is a need to standardize waste management independent of geographical region and size of the harbour. Predictability will help fishers use less time for waste delivery, which can positively influence both practices onboard as well as the willingness to pay for harbour services.

In collaboration with the NORCE-led MARP-project (Marine Plastic Pollution in the Arctic: Origin, status, costs and incentives for prevention), a questionnaire was distributed to fishing industry actors in Norway and the North-Western part of Russia. Overall, the survey provided a better understanding of fishers’ activities and attitudes, and their impacts and interactions with waste management systems and regulations. The questionnaire for the survey was developed as a collaboration between the research partners and the fishers’ organizations. As of January 2018, there are 9200 registered full-time fishers and 1621 part-time fishers in Norway, of whom about 6400 are organised in the three Norwegian fishers’ organizations. In Russia, the Fishing Industry Union of the North in the North-Western part of Russia organizes 62 fishing companies. The survey was done electronically, by phone interviews in Russia, and

by handing out paper versions of the questionnaire in harbours in Norway resulting in 197 responses in Norway, and 30 responses in Russia. The relatively modest sample reflects the difficulties of getting fishers to reply to surveys. The survey confirms many of the observations from the interviews. The survey results were used as input to the work package developing an education module for workers in the blue sector. Details of the survey results will be published as part of MARP deliverables.

The second work package “Education as a preventive measure for further littering of the marine environment” focused both on students entering the blue sector and workers already in the blue sector. For students entering the blue sector, a comprehensive 3-5 day course has been tested with students in high schools and vocational schools taking marine and maritime courses. The course includes six teaching modules and a coastal clean-up action. The aim is to provide students with a solid foundation to approach the challenge of marine litter within their respective fields – where they can actively contribute to reducing the blue sector’s contribution in the future. The program was developed by SALT in collaboration with Vest-Lofoten High School, and was used by three schools in Northern Norway in 2017-2018.

To reach workers already in the blue sector, a 1-hour long mini-module has been developed to be incorporated into mandatory marine safety training. This mini-module was developed by SALT in collaboration with the Ocean Safety Research group at the Marine Institute of the Memorial University of Newfoundland (Canada) and the Lofoten Maritime Safety Centre (Norway). The module consists of a short (10-15 min) introduction to marine litter focusing on the extent of the marine litter problem, and consequences to ecosystems, fisheries and other blue industries. The introduction is followed by an examination of litter samples from different sources (both related to fisheries and other non-related items) and an active discussion around the questions (1) what is it?, (2) how may it have ended up in the ocean?, and (3) how can we prevent such littering in the future?. The objective is to create engagement around solutions to reduce the contributions of the blue sector. The long-term goal is for the module to be adopted as part of standardised marine safety courses nationally and internationally.

The third work package “From waste to business – implementation of a Circular economy in the arctic” was led by NORCE and has analyzed the potential for transforming marine debris into business ventures. The international legal framework and conventions implemented into Norwegian law reflect the principle of preventing plastic entering the ocean. The legal framework spurs intensified innovation and facilitation for recycling plastic from the fisheries and aquaculture. The bottleneck seems to be the enforcement and implementation of the legal framework. When the ability to enforce laws is lacking, the incentives for the industry to make changes in their processes are also reduced. The recycling of plastic materials is also hindered by technical and economic issues.

However, central waste management actors see the potential in reuse and recycling of used gear from fisheries and aquaculture. They acknowledge that much more can be done, if the change is facilitated by Norwegian authorities to a greater extent. Currently, the necessary support is lacking. For instance, as the cost of depositing used gear into landfills is much lower than the transportation costs of recycling, sending used materials to landfills is the most economically attractive downstream solution. Currently, there are no large-scale recycling systems in the Norwegian Arctic. However, the pressures for upscaling recycling possibilities by, inter alia, the European Commission and Norwegian waste management actors, may

counteract this paradoxical situation. Also, industry actors are pressured to take more responsibility as producers and consumers of plastic products and to demand that a larger share of material input is of recycled materials.

Information and results from the project have been disseminated through the following channels:

- Selected results from two first work-packages are summarized in the final report from the Nordland Research Institute led project *Redusere marint avfall fra fiskeflåten* (REMAFISK).
- Presentation during the OSPAR work session *Handling (plastic) garbage in the fishing industry*, November 2017m Rotterdam
- Selected results from the third work package are summarized in the SALT report *From waste to business – implementation of a circular economy in the Arctic*.
- Presentations during the annual general assembly of the Nordland County branch of The Norwegian Fishermen's Association, both in 2017 and 2018.
- Presentations during the Norwegian National Research Days event in Bodø, 2017 and 2018
- Poster and presentation during the *Norwegian-Russian Seminar on Marine Pollution in Moscow*, November 2018
- Presentation during the Arctic Frontiers conference in Tromsø, January 2019
- Presentation during the *2nd High North Dialogue Research Workshop: Business in the Arctic*, Bodø, April 2019.



# 1 INTRODUCTION AND BACKGROUND

Marine plastic pollution has become a major and increasing global problem with grave consequences for the marine environment, as well as society, given our dependence on the former for resources and livelihoods. Globally, 20% of marine debris is estimated to originate from human activity at sea (Eunomia 2016), although in areas with high fishing activity and lower population densities, such as Northern Norway and parts of the Arctic, the proportion is several times higher (KLIF and DN, 2011; Falk-Andersson et al. 2019). Lost and discarded fishing gear constitutes a major part of this debris; and nets, lines and traps can continue to 'ghost fish' for decades as the gear rarely decays. Poor waste management onboard also contributes to the problem.

To address these issues, the RE-D-USE project ("New knowledge for reduction and utilization of marine waste from fisheries") has aimed to (1) engage the fishing industry in dialogue regarding prevention of marine litter, (2) identify challenges and solutions for managing waste and securing equipment from diverse fishing fleets in different regional contexts, (3) begin the inclusion of a week-long interactive program to raise awareness of marine litter into lesson plans of secondary and vocational schools within the maritime and seafood sectors, (4) develop an intensive education module to be incorporated into obligatory marine safety training and refresher courses, (5) provide improved understanding of opportunities of re-use, recycling and circular economy ventures in Arctic regions, and (6) identify knowledge gaps for achieving the latter and opportunities for basic and applied science.

The project has been structured in three interlinked work packages:

1. WP-1 (Data collection through dialogue with fishers) has used a combination of a questionnaire and qualitative interviews to gain broad, systematic in-depth insights on practices of waste management onboard different fishing fleets and in harbours, fishers' strategies in securing gear, and their perceptions of challenges and solutions to marine litter and the reduction of fisheries related debris.
2. WP-2 (Education as a preventive measure for further littering of the marine environment by the maritime and seafood sectors) has focused on preventing further marine pollution originating from human activities at sea through education regarding best practices and preventative measures on board. The "Blue Charge" education module for secondary school programs within the maritime and seafood sectors, has been launched in Northern Norway. In addition, a new educational program to be integrated into existing compulsory safety training for active fishers has been developed based on the results of WP-1.
3. WP-3 (From waste to business – implementation of a circular economy in the Arctic) has analyzed the potential for transforming marine debris into business ventures. The WP investigated the potential for applying different levels of the waste hierarchy in Arctic regions, including the status of knowledge, market potential and technology for re-use, recycling, and heat recovery with special focus on fisheries related plastics.

This report summarizes the main findings from the project. In addition to this report, information and results from the project have been disseminated through the following channels:

- Selected results from two first work-packages are summarized in the final report from the Nordland Research Institute led project *Redusere marint avfall fra fiskeflåten* (REMAFISK).

- Presentation during the OSPAR work session *Handling (plastic) garbage in the fishing industry*, November 2017m Rotterdam
- Selected results from the third work package are summarized in the SALT report *From waste to business – implementation of a circular economy in the Arctic*.
- Presentations during the annual general assembly of the Nordland County branch of The Norwegian Fishermen's Association, both in 2017 and 2018.
- Presentations during the Norwegian National Research Days event in Bodø, 2017 and 2018
- Poster and presentation during the *Norwegian-Russian Seminar on Marine Pollution in Moscow*, November 2018
- Presentation during the Arctic Frontiers conference in Tromsø, January 2019
- Presentation during the *2nd High North Dialogue Research Workshop: Business in the Arctic*, Bodø, April 2019.

A scientific article giving more detailed findings from the interviews and survey is planned to be submitted to an academic journal in 2019.

This report is structured as follows: Chapter 2 presents new knowledge obtained in WP-1 from a series of interviews with fishers in Northern Norway and from a survey launched among fishers in Norway and Russia. Chapter 3 describes WP-2 and the implementation of the Blue Charge education module for students in the blue sector and the development of a new education module to be used in marine safety training. Chapter 4 presents findings from WP-3, including literature review and interviews with value chain actors involved in re-using marine plastic waste.

## 2 DIALOGUE WITH FISHERS

### 2.1 INTERVIEWS AMONG NORWEGIAN FISHERS

A total of 21 fishers from Northern-Norway have been interviewed to improve knowledge on fishers' attitudes toward marine litter, waste management and how to reduce marine litter.

The interviewees were recruited by suggestion from the three fishers' organizations the Norwegian Fishermen's Association, the Norwegian Coastal Fishermen's Association and the Norwegian Fishing Vessel Owners Association. Both coastal fishers and fishers from ocean-going vessels (size varying from 32-230 feet) have been interviewed. The vessel size is given in Table 1.

*Table 1: Vessel size of interviewed fishers*

Vessel size (feet)	Number of vessels
40 and less	6
41 - 50	6
51 – 100	5
More than 100	4
TOTAL	21

An overview of the fishing equipment used by the different vessels is given in Table 2.

*Table 2: Number of vessels using different types of fishing equipment*

Type of equipment	Number of vessels
Net	12
Longline	9
Seine	8
Trawl	5
Jigging	4
Cages	3
Danish seine	2
Harpoon cannon	1

The interview guide included questions on the following topics:

- Short information about the interviewee.
- Attitude toward marine litter and marine plastic pollution
- Waste management on board (storage and sorting)
- Waste management in the ports
- Cooperation and circular (recycling) economy
- Marine litter reduction measures

The fishers state that attitudes towards the problem have been changing. Whereas most of the waste ended up in the sea some decades ago, more is now brought to port, although some waste still ends up in the ocean. Many of the fishers emphasize that marine litter threatens to destroy the positive image of their product as something originating from clean arctic seas. In addition, marine waste cause problems with operations and lead to economic loss if they lose

fishing equipment. When they do, the loss and its location is to be reported allowing the Norwegian Directorate of Fisheries annual clean-up mission to recover the equipment.

Waste management on board varies with the size of the vessel and is linked to the quality of the waste management facilities in harbours and fish landing facilities. Many fishers report full containers in the harbours as the locals use facilities that are intended for tourists and fishers. In particular, it can be difficult to dispose of discharged fishing equipment as many harbours do not offer services for collecting old fishing equipment. The Norwegian “Fishing for litter”-programme, allowing fishers to deliver for free litter that they have caught in their fishing gear, was viewed positively and should be expanded.

There is a need to standardize waste management, so that fishers can expect to find similar system independent of geographical region and size of the harbour. Predictability will help fishers use less time for waste delivery, which can positively influence both practices onboard as well as the willingness to pay for harbour services. When asked for examples of best practice, the fishers highlighted the waste management facilities in the following Northern-Norwegian harbours: Svolvær, Røst, Dønna, Senjahopen, Tromsø and Tromvik.

In general, the fishers ask that new regulations and laws should be limited. Rather the focus should be on introducing easy-to-use and reasonable solutions in parallel with building knowledge and awareness among fishers. In this way the fishers are encouraged to be part of the solution.

A scientific article presenting more findings from the interviews is planned to be submitted to the academic journal “Barents Studies: Peoples, Economies and Politics” in 2019.

## **2.2 SURVEY AMONG NORWEGIAN AND RUSSIAN FISHERS**

RE-D-USE cooperated with the three-year long, international and transdisciplinary MARP project (Marine Plastic Pollution in the Arctic: Origin, status, costs and incentives for prevention), funded by the Polar Programme of the Research Council of Norway (2016-2019). The MARP project is led by NORCE, collaborating with UiT the Arctic University of Norway, the Norwegian Polar Institute, Akvaplan-Niva, SALT, Plymouth Marine Laboratory in the UK and Kola Science Center in Apatity, Russia, and with Norwegian and Russian fisher organizations. A central part of the MARP project was a survey questionnaire targeting fishing industry actors in Norway and Russia operating in the Barents Sea. Russia and Norway are significantly different in aspects such as law, policy, management, culture, behavior, and fishery related factors such as fleet structure and fishing gear. Knowing this, we did not aspire, nor would it have been possible, to carry out a comparative study, but rather to map a bigger geographical area.

The survey was launched in September 2017 and closed in May 2018. The purpose of the survey was to bring forward the voices, knowledge and opinions of groups of people strongly affected by marine littering, to understand how it affects their work, and to get their suggestions for solving the problem. To reach as many respondents as possible, we developed an online questionnaire. The questionnaire addressed fishing industry actors in Norway and in the North-Western part of Russia, asking about fishers’ knowledge, preferences and attitudes related to waste handling. Furthermore, we asked about fishers’ perception of obstacles and incentives to bring ashore wastes generated on board and marine litter that end up on board during fishing trips.

In Norway, we cooperated with three national organizations; the Norwegian Fishermen's Association, the Norwegian Fishing Vessel Owners Association, and the Norwegian Coastal Fishermen's Union. As per January 2018, there were 9200 registered full-time fishers and 1621 part-time fishers in Norway (Fiskeridirektoratets statistikk, [www.fiskeridir.no/yrkesfiske](http://www.fiskeridir.no/yrkesfiske)), of whom about 6400 are organized in the three organizations. The Norwegian fishers' organizations encouraged their members to participate in the survey, pinpointing the importance of having their voices heard. They distributed the questionnaire by e-mail to their members. The survey was promoted on the fisher organizations' web pages, as well as on social media, with links to the questionnaire. In total 197 Norwegian fishers answered the questionnaire. In addition to the online survey, we approached fishers in person. Thirty-one of the Norwegian respondents were reached at the annual meeting of the Norwegian Fishermen Association in the county of Nordland in September 2017, where they were given paper versions of the questionnaire in connection with presentation of the RE-D-USE project. 126 answered the questionnaire online, and 40 paper versions were handed out and collected by approaching the fishers in fishing harbours in Tromsø and Lofoten. In our opinion, the latter approach turned out to be most efficient.

In Russia, we did not have access to fishers as we had in Norway. Fishing boat companies that were members of the Fishing Industry Union of the North in Murmansk participated in the survey. The Russian research team and the Fishing Industry Union of the North had modest expectations that Russian fishing boat companies would respond to the online survey and approached the fishing boat companies' administrations by e-mail or phone to encourage them to participate in the survey.

In Russia, we cooperated with the Fishing Industry Union of the North in Murmansk in the North-Western part of Russia (<http://srps.ru/>), which organizes 62 fishing companies. The Fishing Industry Union of the North frequently interacts with and knows the fishing boat owners and their crew and knows the issues of concern in the fishing sector, including members' attitudes and awareness, as well as perceptions of options for solutions. Being our gatekeeper (Bryman, 2004), the Fishing Industry Union of the North enabled contact with Russian respondents by e-mail or phone, inviting them to take part in the survey. The largest fishing boat companies were approached and invited to participate in the survey, either via the online link, by e-mail in which the electronic version of the questionnaire was attached, or to fill out the paper version of the questionnaire. In general, interest in participating in the survey was low, and only one of the fishing boat companies used the link to answer the questions. After the initial contact with the fishing boat companies were made, there was no feedback for a while, spurring the research team to call and remind them to answer the questions. After the reminder, thirty-one fishing boat companies answered the questionnaire, most of them the paper version, which was punched into the Survey Xact system by the Russian researchers.

In the introduction to the questionnaire, we explained to the respondents that their answers would be kept anonymous and we would assure their confidentiality. We did not ask for names, gender, age, residence, e-mail addresses, name of vessel or other identification. This is valid for the Norwegian sample. As it turned out, in Russia, we could not claim anonymity, as the respondents were contacted by e-mail or phone. Although the researchers assured that they would be kept anonymous and their information confidential, it might have impacted on respondents' willingness to participate, and to their answers. For several of the questions in

the questionnaire, up to half of the Russian respondents opted for neutral or middle grounds answers, avoiding the extreme ends of the scales where they applied.

The questionnaire asked about respondent's role on the vessel, type / age / season of operation of vessel, type of fishing gear used, and frequently visited fishing fields. One section of the questionnaire sought information about the respondents' observations of litter in their catches: type of litter, how often, how it impacts on their work, how much time they use to separate the litter from the fishing gear, whether the litter causes technical problems, and the costs accruing to litter occurrences. Another section sought information about waste generation and waste handling on board, and about potential solutions, including questions relating to how waste could end up in the ocean. Then the questionnaire poses some claims that the respondents must agree or not agree with on a five-point scale, for the researchers to be able to analyze attitudes and knowledge related to marine litter. This includes respondents' perception of the harbours' facilities for relieving them of the litter and waste they bring ashore.

Results from the survey has been used to develop the educational mini-module to be incorporated into mandatory marine safety training (see Section 3.2). Details of the questionnaire results will be presented as part of MARP project deliverables: articles, reports, presentations and conference talks. Some articles have been submitted to journals, awaiting peer reviews, while other articles are still in progress. Results are made official when the respective articles are approved for publication. A preliminary analysis shows that there is a large degree of compliance with the answers from the interviews with Norwegian fishers (Section 2.1). While some respondents report that the plastic littering problem has increased the past years, they also indicate that more is brought to shore. Even more could have been brought to shore had the harbour facilities been more accommodating to the fishers' needs for depositing their waste and litter. An overall impression is that while the larger harbours have satisfactory waste management facilities, overall, much is to be wanted. Fishers want for more coverage of waste management facilities in harbours, and point to that this would make it easier to reduce the amount of plastic litter found at sea, as they will know that they will be able to easily dispose of the litter they pick up from sea once they reach the destined harbour.

## 3 EDUCATION TO REDUCE MARINE LITTERING

### 3.1 “BLUE CHARGE” – STUDENTS ENTERING THE BLUE SECTOR

In 2016, SALT developed the educational module “Blue Charge” in collaboration with West-Lofoten High School, with funding from the Norwegian Environment Agency. In RE-D-USE, we have put this module to use at three high schools targeting students in the blue sector.

“Blue Charge” is a comprehensive 3-5 day course, which targets students in high schools and vocational schools taking marine and maritime courses. The course includes 6 teaching modules and a coastal cleanup action (Table 3). The classroom modules include numerous discussion topics and other exercises to create engagement. The course is in the form of a complete package ready to be used directly and independently by teachers with PowerPoint presentations, various practical and discussion exercises, additional reading material, and other relevant resources. The goal is to provide students with a solid foundation to approach the challenge of marine litter within their respective fields – where they can actively contribute to reducing the blue sector’s contribution to the problem in the future.

*Table 3: Overview of the teaching modules in “Blue Charge”.*

Module	Content
Module 1: The blue planet	<ul style="list-style-type: none"> <li>• The ocean and marine ecosystems</li> <li>• The importance of the ocean for the planet as a whole</li> <li>• Our ecosystem</li> </ul>
Module 2: The global challenge	<ul style="list-style-type: none"> <li>• What is marine litter?</li> <li>• Sources of marine litter</li> <li>• Consequences of marine litter</li> </ul>
Module 3: Legal aspects	<ul style="list-style-type: none"> <li>• International laws and regulations</li> <li>• National laws and regulations</li> </ul>
Module 4: Coastal cleanup action	<ul style="list-style-type: none"> <li>• The coast as a classroom</li> <li>• Beach cleanup and sorting of collected litter</li> <li>• Reflections</li> </ul>
Module 5: Lessons learned from the cleanup action	<ul style="list-style-type: none"> <li>• Litter items found</li> <li>• Sources of litter found</li> <li>• Ties to fisheries and shipping</li> </ul>
Module 6: Those who live off the sea	<ul style="list-style-type: none"> <li>• Proportion of marine litter originating from the blue sector</li> <li>• Why and how does the blue sector contribute to marine litter?</li> </ul>
Module 7: The goal – and YOUR contribution	<ul style="list-style-type: none"> <li>• The big picture</li> <li>• Our coast and your home port</li> <li>• The blue sector and possible solutions</li> </ul>

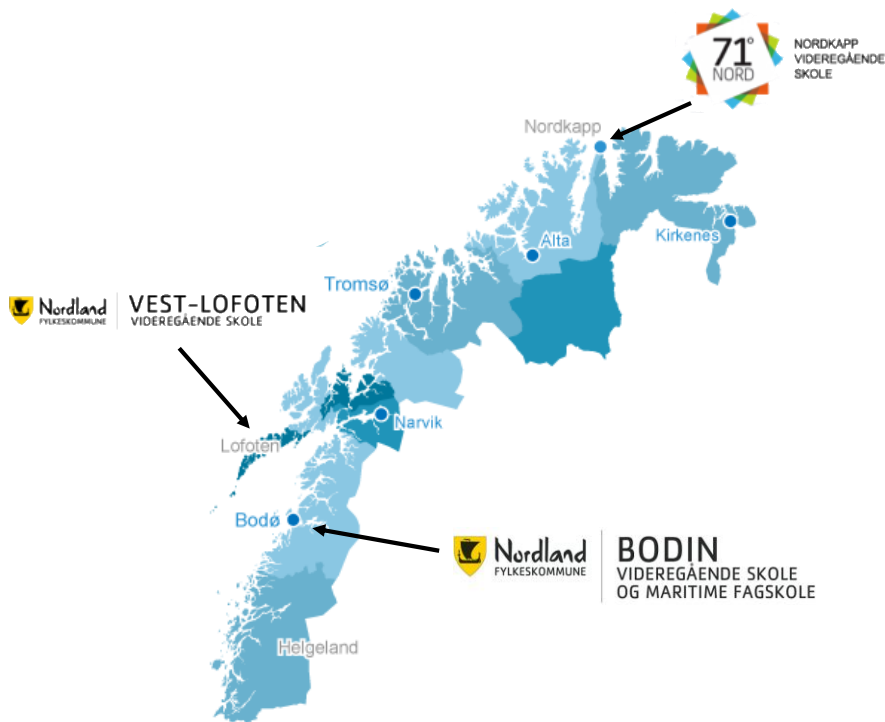


Figure 1: Map showing participating high schools. The "Blue Charge" module was run with 1-3 classes of students studying within the blue sector.



Figure 2: "Blue Charge" coastal cleanup action with students from Nordkapp High School May, 2018. Approx. 7.5 tonnes of marine litter was collected (photo by SALT/Anne Dupont Andersen).

Through RE-D-USE the "Blue Charge" module was used at three different school in northern Norway during the spring of 2018: West-Lofoten High School (Gravdal, Nordland), Bodin High School (Bodø, Nordland) and Nordkapp High School (Honningsvåg, Finnmark) (Figure 1). "Blue Charge" was run with 1-3 classes of students studying within the blue sector at each school (Figure 2).



The module was received very favourably by the schools, and feedback from students and teachers alike were highly positive. Comments from teachers included a well researched and well put together module made with clear educational targets and methods in mind. Students reported increased awareness of the marine litter problem, and particularly the contributions (and solutions) by local activities and the blue sector. One example highlighted by several students were rope segments and the increased awareness from seeing firsthand how frequently these wash up on shore and how large a proportion were clearly cut-offs rather than accidental wear and tear. Teachers will continue using the module with incoming classes.

### 3.2 AWARENESS BUILDING THROUGH SAFETY TRAINING COURSES

The “Blue Charge” module only targets students entering the blue sector, and does not reach people already employed. To address this, we also developed a 1-hour long mini-module to be incorporated into mandatory marine safety training. This mini-module was developed by SALT in collaboration with Ocean Safety Research at the Marine Institute of the Memorial University of Newfoundland (Canada) and the Lofoten Maritime Safety Centre.

Safety training courses are required for all people who work at sea, including regular refresher courses. This is therefore an excellent opportunity to reach the majority of workers in the sector on a regular basis. A challenge with utilising the safety training framework, however, is limited time. A module to be incorporated into such a framework must therefore be very compact. In consultation with safety training centers, it was decided that one hour was a realistic time frame.

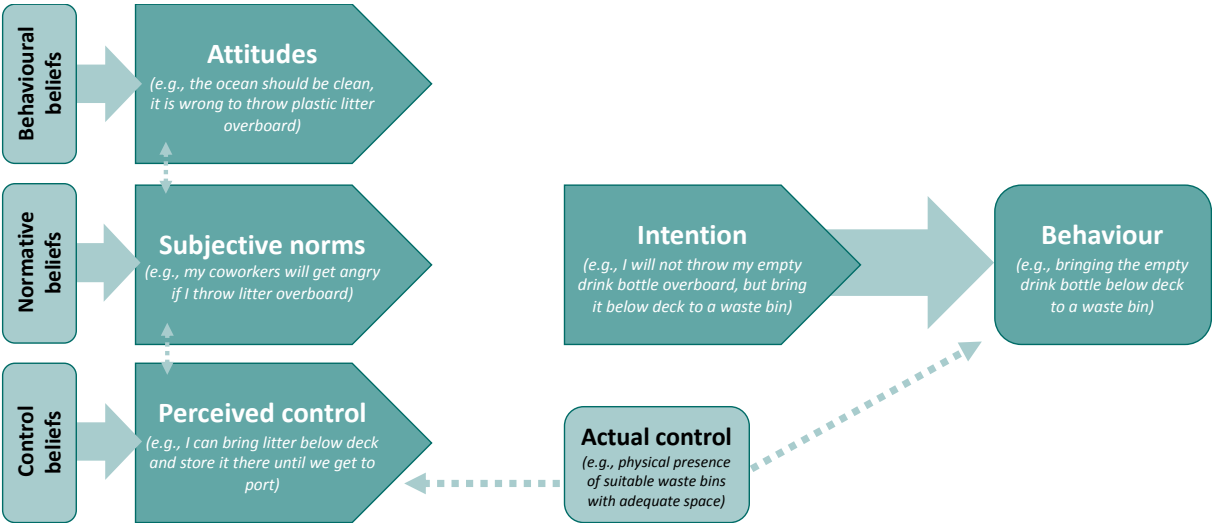


Figure 3: An overview of the Theory of Planned Behaviour. Adapted from Ajzen (1991).

To ensure maximum impact of such a short module, we analysed the responses from interviews and questionnaires with fishermen in Workpackage 1 in a Theory of Planned Behaviour (TPB) framework, and applied the findings to tailor a highly targeted mini module. TPB is a model for behavioural interventions with substantial empirical support behind it (e.g., Steinmetz *et al.* 2016). TPB states that one’s beliefs about the world and our situation will dictate our attitudes, subjective norms (our beliefs about the expectations of others) and our perceived control of the situation, all of which combined drive our intentions to act, and thus our behaviour (Ajzen 1991) (Figure 3).

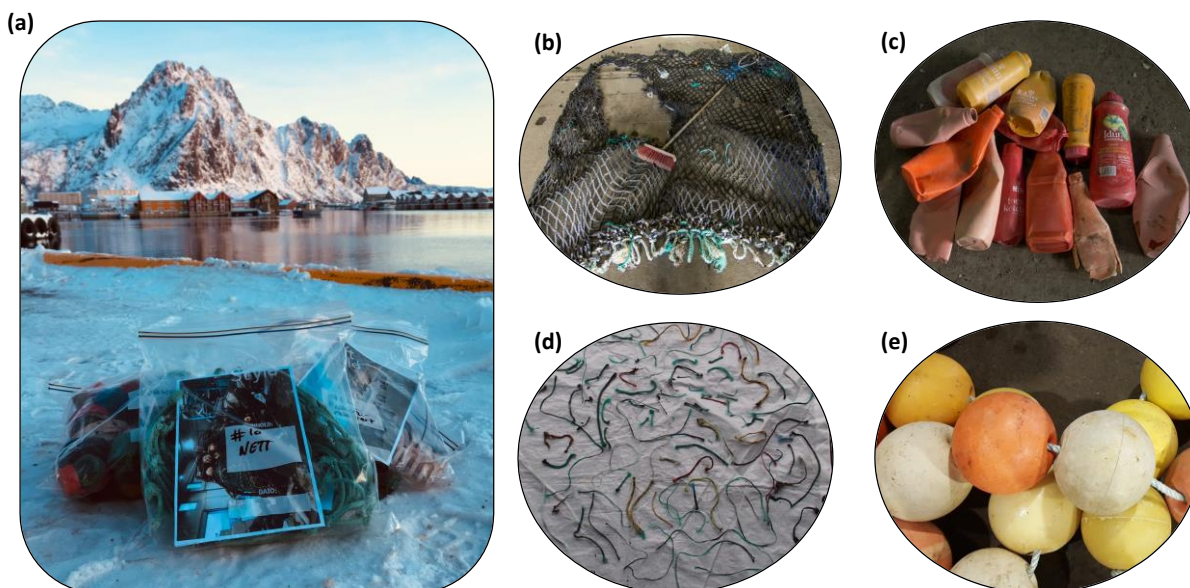
To design effective interventions and change behaviour, we can target changes in one or all of attitudes, subjective norms and perceived control. To do this, we categorised questions in the Workpackage 1 surveys according to which of the three each question targeted. Next, we identified the questions with the most diverse responses, and questions to which a considerable portion of responses did not match known facts. Both cases indicate potential focus areas where interventions may be successful.

Through this method we identified the need to increase awareness of the scale of the marine litter problem, its potential consequences for marine ecosystems and fisheries, its perseverance in the marine environment, and the contributions of the blue sector to local plastic pollution. These are therefore the topics covered in the module's introductory presentation, which lasts approximately 15 minutes.

The remaining 45 minutes of the module are dedicated to a practical exercise in which participants actively examine and discuss various types of marine litter. Our experiences hosting beach litter analyses workshops with industry through the MARP project suggest that physical examination of litter is a powerful tool for raising awareness, changing attitudes and increasing a sense of stewardship. It has also been shown that engaging in beach cleanups positively changes perceptions and beliefs regarding the marine litter challenge (Rayon-Vina et al. 2019). This is why "Blue Charge" includes a beach cleanup day. Naturally, however, this is not possible within the confines of a safety training course, but a more limited examination of litter is.

We prepared a set of 14 litter samples, each containing a different category of litter (Figure 4; Table 4). The samples are given out to participants in sets of 1-2 depending on the size of the group. Participants then examine their litter samples in groups of 2-4 and discuss (1) what is it?, (2) where could it have come from/how could it have ended up in the marine environment?, and (3) how can we prevent this in the future? Participants are encouraged to discuss in their small groups for approximately 30 minutes, after which the final 15 minutes are dedicated to each small group presenting their conclusions to the class as a whole and a short general discussion.

This practical exercise is designed to facilitate attitude changes through raising awareness in combination with the introductory presentation, as well increase perceived control by discussing specific solutions to different types of litter. By discussing in varying sized groups, and by repeatedly running the module during safety training courses, we can also affect social norms. TPB interventions done in a group and also in public settings (e.g., at a safety training centre) are much more effective than those targeting individuals (as in e.g., a leaflet information campaign) (Steinmetz et al. 2016). We therefore expect this module to be impactful as it is an intervention in its most effective setting. It targets various determinants for intention and behaviour, it has a practical, highly visual and tactile component, and information provided was tailored to address identified problem areas.



*Figure 4: Overview of the practical exercise kit. (a) Examples of prepared sample bags, each containing different types of litter. b-e show examples of bag contents: (b) Discard from trawl net repairs. small items are included in samples bags, along with photographs of larger pieces as shown here. (c) Various household items and food containers, in this case ketchup bottles. (d) Rope cut-offs. (e) Other fisheries-related items, specifically trawl bobbins.*

The module was tested with a group of 8 participants during a basic safety training course at the Lofoten Maritime Training Centre in January, 2019. It was well received with exclusively positive feedback from both instructors and participants. Lofoten Maritime Training Centre will continue using the module during their safety training courses. Once more sets of litter samples can be prepared, the module will also be ready for adoption by other centres, several of whom have already voiced an interest in the module.

*Table 4: List of marine litter samples for the practical exercise. All litter was collected locally from a beach in Lofoten. Participants are given 1-2 samples in groups of 2-4 and given 30 min to discuss. The assignment is to suggest preventive measures for each sample item/category at a personal/sector level (before governmental/legislative measures).*

Sample	Contents	Category	Questions for discussion
#1 – Shotgun casings	Shotgun casings	Recreation	How do shotgun casings end up in the marine environment? Through recreational activities on land? Clay pigeon shooting onboard cruise ships?
#2 - Bottles	Assorted bottles (incl. drink bottles)	Single use plastics/ packaging	How are empty bottles handled onboard? What measures are in place to limit loss? How and why may bottles be lost/discarded both from vessels and on land?
#3 – Styro-foam	Fragments of Styrofoam	Packaging	Styrofoam can be extremely difficult to remove from the environment as it fragments. Why do we find so much along our beaches? Who uses it and where? When used onboard, how is it secured?
#4 – Single use items	Plastic cutlery, straws	Single use plastics	What types of single use items are used onboard? Can any be replaced with reusable items? If yes, will this impact routines onboard and how? What are the barriers (if any) to broadly adopting reusable items only?
#5 – Bottle caps	Assorted caps from drink	Packaging	Why do we find so many bottle caps in the marine environment? Are they easily lost? Discarded?.

Sample	Contents	Category	Questions for discussion
	bottles, jerry cans, etc.		
#6 – Construction related items	Assorted items, incl. explosives detonators, etc.	Construction	Large construction projects can contribute to marine litter. How? How effective are waste management routines on site? How is waste secured in event of e.g., strong winds? How well is waste sorted for recycling and optimal disposal? What about private home renovation projects? How do we secure and dispose of waste?
#7 – Food packaging	Food packaging, e.g., chip bags	Packaging	How is food packaging handled onboard? At home? Is it ever lost or discarded? How is food packaged when bringing onboard? Can packaging be reduced?
#8 – Soft plastics	Plastic bags, sheeting	Packaging	What are the potential sources of these types of litter? Note that soft plastics degrade and fragment fairly quickly, and are therefore unlikely to have traveled far.
#9 - Nets	Cut-offs from trawl and purse seine net repairs	Fisheries	Why do we find segments of net with clear knife marks? Cut-offs from net repair? How/why are they lost/discarded? What are the routines onboard for preventing these? Can anything be changed?
#10 – Rope cut-offs	Rope cut.off.s (<1 cm diameter)	Fisheries	Why do we find such staggering numbers of small rope cut-offs? How are these generated? How are they handled? Can routines be changed to prevent loss?
#11 – Various fisheries related	Assorted items, incl. packing bands, hydraulic components	Fisheries	How/why are such items lost/discarded? Where is relevant equipment (e.g., packing machines) stored onboard? Above or below deck? What are the routines for waste handling?
#12 – “The bathroom”	Toothbrushes, Q-tips, shampoo, tampon applicators	Sanitary waste	Are such litter items generated onboard? Or only at home? How/why is it lost/discarded? Can routines be changed onboard and at home to reduce the amount of sanitary waste generated?
#13 - Floaters	Various floaters from e.g., trawls	Fisheries	Where do these floaters come from? Are they still in use, or are all «old sins»? Are other items with similar function still lost/discarded today?
#14 – Rigid plastics	Various fragments of rigid plastics	Fisheries Construction Packaging	Where do all these fragments come from? What types of litter could fragment to pieces like these? Are they already fragments when lost? What types of waste are generated on board which may contribute to the fragments?

## 4 FROM WASTE TO BUSINESS

A main principle in circular economic thinking is that once a product is made, it is a goal to keep it in the economy for as long as possible for its original purpose, before repair, recycling or incineration (Nilsen, 2008, 2017; Korhonen et al., 2018). Circular economy principles are being implemented in countries like China, Japan, Canada, Norway, at the EU level and in single member states (European Commission, 2015; CIRAIG, 2015; Ellen MacArthur Foundation, 2013).

Marine litter is a symptom of ineffective use of resources. Due to the global concern over marine litter, the interest in finding solutions at all levels of the waste stream is increasing. Preventing the inflow of plastic litter into the oceans must be prioritized, as the most efficient way to combat marine litter (Havas, 2018). Much of the fishing gear found on beaches in the Arctic have a recycling potential (SALT, 2017).

While the concept of circular economy has not yet become household terminology in the fishing industry, it has become so in the waste management industry. Nofir is a Norwegian company specializing in collecting and cleaning used gear from the fishing and aquaculture industries but has no recycling facilities in Norway. Nofir has produced some animated films that demonstrate containers of gear being exported for recycling to Lithuania, Slovenia and Turkey<sup>1</sup>, to be used in the production of items such as clothes, carpets, garden furniture, baskets and hammocks (Ruud, 2017). The environmental benefits gained through Nofir's recycling system are a decrease in equipment going to landfills, incineration or ending up at sea, decrease in the use of non-renewable resources, and decrease in climate gas emissions. Cost is a recurring issue when it comes to using recycled plastic, as using raw material as input to production is often cheaper than using recycled materials. However, the cost of recycled materials can be lowered, for example by reducing transportation costs. Therefore, facilitating recycling of plastic materials in Norway can contribute to the competitiveness of recycled plastic materials. We interviewed representatives from two different waste management companies with activities in northern Norway. They held quite different views in regard to the feasibility of a circular plastic economy.

One company claimed that there is “no economy in the circular economy”. They developed and improved landfill system for used gear, and worked on encouraging and educating industry actors to deliver used gear to the waste management company instead of dumping it at sea. The other waste management company – located in northern Trøndelag - had extensive experience in collecting used gear from the fishing and aquaculture industries for recycling purposes. They are confident that there is a high economic potential in the circular economy, as well as high potential for increasing activities and expanding the use of recycled plastic materials from the fishing and aquaculture industries. The company representative emphasized circular economy's role in value and job creation, and not the least, its contribution to positive environmental impact; using plastics more efficiently reduces the greenhouse gas emissions caused by plastic production. With the right technology, a large share of gear from fisheries and the aquaculture can be recycled and used in the production of new materials.

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<sup>1</sup> <https://www.youtube.com/watch?v=EavkCOBzmrM>; [https://www.youtube.com/watch?v=C8leh\\_AFaKw](https://www.youtube.com/watch?v=C8leh_AFaKw)

However, according to the company representative, it is generally cheaper to send used gear to landfills, rather than transporting it to the recycling facilities in northern Trøndelag. There is therefore a need to develop economic incentives to increase the relative profitability of recycling further. One argument is that the fee for landfill deposits should be increased to match the cost of recycling. Another argument is that the actors within the fishing and aquaculture industries should take on more responsibility for gear being recycled, by demanding that recycled material is used as input in the production of new gear: “The aquaculture industry is in a good position. They can demand that recyclable material does not go into landfills” (Waste company representative, interview February 2019).

The opinion of the waste management company is that there is more than enough plastic in the world, and that we are not recirculating enough. *“We are dependent on large amounts, tons of used gear. Our problem is not our production capacity, it is how to get a hold of enough plastic materials. But we must compete with the alternative of sending materials to landfills, because it is cheaper”.*

This implies that there is a will for solving the problem at a local level, which must be seen in a larger international context. The importance of finding local solutions for plastic recycling has gotten a new momentum due to recent developments in the global trade of plastic waste. High income countries have exported their plastic waste to Asian countries, with China accounting for 45 % (Brooks et al. 2018, in Havas 2018). In the European Union, there are strong incentives to increase the pace of recycling (European Commission, 2015, 2016). The European Union has put forward an ambitious plastic strategy, where it is stated that by 2030 all plastic packaging in the EU shall either be reusable or recyclable. More than half of plastic waste generated in Europe is to be recycled and sorting and recycling capacities should be fourfold, as compared to 2015. In order to be able to reach these goals, all European countries must expand producer responsibility and develop local recycling systems (Havas, 2018).

To create a local, sustainable recycling system in the Norwegian Arctic, more information about the local conditions, such as stakeholders, availability of infrastructure, marine litter categories, and transportation alternatives is needed (Havas, 2018).

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This is the final report of the RE-D-USE-project (New knowledge for reduction and utilization of marine waste from fisheries). The project has worked with fishers to identify causes and solutions related to marine waste from fisheries. It has developed and tested an educational program for fishers to reduce waste and gear loss. RE-D-USE also investigated the potential for circular economy ventures based on marine waste as a resource.



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