Dsolve

Centre for Research-based Innovation

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Biodegradable plastics for marine applications

Annual Report 2024

Photo: Anja Alvestad - UiT/SINTEF Ocean AS

Norwegian Centre for Research-based Innovation

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Content

Summary

The Centre for Research-based Innovation (CRI) Dsolve is aware of increasing focus on the challenges and negative environmental effects produced by marine plastic littering and ghost fishing from fisheries and aquaculture. As a response, during 2024 we made changes in the consortium to increase efforts towards our aim of replacing ordinary plastics with biodegradable materials in fisheries and aquaculture industries. We keep a high focus on our vision and goals of the Dsolve consortium to develop technologies and new products, improve the existing governance framework and foster innovations that enable plastic value chains to become more circular and resource efficient. A gradual change in fisheries and aquaculture towards the uptake of new biodegradable materials is expected to reduce the impacts of fishing and aquaculture on marine ecosystems due to long-term macro- and micro plastic pollution and ghost fishing caused by lost fishing gear. This is in line with the UN sustainable development goals (SDGs) 12 (responsible consumption and production) and 14 (life below water). The climate change challenge is not simple when using biodegradable materials. In order to ensure that the value chains developed address SDG 13 (climate action), a value-chain perspective is an important part of the research work. Dsolve is designed to address the challenges described above. Our scientific coordinator Valentina Pauna has organized meetings with Research Area leaders (RA1-RA6) every second month to present and discuss the results from laboratories and field trials. The partner meetings, organized by RA 6 leader Hilde Rødås Johnsen, have started with a presentation from one of the RA's followed by a discussion on results achieved. Our international partners have participated in several of these meetings. RA-leader and partner meetings are essential for further communication within Dsolve and the common goals for the development of biodegradable plastics.

The annual meeting during April 16th-18th was hosted by research partner NORSUS AS and arranged in Oslo. We started the meeting with a workshop about protection of innovation, IP rights and patents. The full-day session was organized by Morten Elde from Norinnova Technology Transfer AS. In total 31 Dsolve members, including national and international partners, participated during the meeting with relevant contributions. The discussions were related to input from research area leaders, PhD candidates, the Innovation Committee and the National and International Advisory Boards addressing all research areas of the Centre. An often-repeated key question raised was: What does it take to see uptake and practical use of biodegradable materials in fisheries and aquaculture? Fishers wish that new products hold properties similar to conventional plastics like nylon, polyester, polyethylene. However, this may not be the future solution for solving the negative impact intensive fisheries have on the environment.

Partner SalMar ASA hosted the board meeting at the Salmon House in Alta during September 24th-25th. In this meeting, we focused on status prior to the midterm-evaluation and further development with respect to the focus on education and research in the last part of the Dsolve (2025-2028). The meeting participants agreed that more attention on aquaculture and longline fisheries would be needed.

Three new candidates from aquaculture and fisheries were presented as new industry partners in Dsolve and formally incorporated in Dsolve at the Extraordinary General Assembly November 5th. Company BR Karlsen is a traditional fishing company with headquarter at Husøya (Troms County) specializing in whitefish and salmon, and is also co-owner of several coastal fishing vessels, including partner Tustern AS and their vessel MV "Fortuna". Further, two longline vessels from Vardø (Finnmark county), i.e., MV "Østkapp" (10.99m) and MV "Vardøyfisk II" (13m) owned by Brynjar Bangsund ENK and Øystein Enoksen ENK, respectively, were added to the consortium. During the board meeting (TEAMS) November 27th, plans for the six RA's for 2025 were discussed and agreed upon.

Our PhD candidates have participated in various activities during 2024, including courses and scientific production. Four of them (Huu-Luat Do, Waranya Wataniyakun, Kristine Cerbule, Dorian Vodopia) participated in mobility programs for longer periods in, Canada (University of Alberta, University of Northern British Columbia, Memorial University of Newfoundland and Labrador), France (IFREMER) and Croatia (University of Pula, University of Primorska and University of Split). Anja Alvestad started her PhD education in January, unlike other Dsolve PhD candidates, in a three-year position and has already collected data from several experiments at sea (gillnet and longline fisheries). One candidate within RA 4 (governance incentives to increase the use of biodegradable materials) decided to leave after six months and the position is since the end of the year in the hands of PhD candidate Erik Johannesen Bakke. PhD candidate Kristine Cerbule attached to RA 3 (field tests with biodegradable materials) presented her trial lecture and defended the thesis at UiT the Arctic University of Norway May 22nd. Dr. Cerbule started immediately in a permanent position as assistant professor at Heriot-Watt University, Scotland. By the end of the year, we managed to select the first post.doc., Dr. Ngan Le Thi Thanh, who is now attached to RA 4.

On June 14th, MSc student Simon Eliseussen and Dag Støme defended their co-authored thesis about ecofriendly capture of the invasive pink salmon (Oncorhynchus gorbuscha). Both are currently in permanent jobs within aquaculture. Nora Løvdal Gamnes has started a master thesis focusing on additives in plastic relevant for fishing gears. She is under supervision of Dr. Cecilia Askham at NORSUS (RA 5) in collaboration with the Institute of Industrial Ecology at NTNU-Norwegian Institute of Sustainability research. In August 2024, we opened a new MSc course FSK-3624 Marine litter and Arctic fisheries; Challenges and Solutions at UiT, and 14 (out of 18) students followed the full study program and took the exam. Teaching was primarily provided by our RA leader team and partners. We got assistance from Tromsø Municipality during beach cleaning. The students got presentations during seminars from Helene Svendsen (Grid Arendal), Haraldur A. Einarsson (FAO Fisheries division) and Kristian L. Skaar (the Directorate of Fisheries). Several of these students are now attached to Dsolve for their theses work. We will continue this course in coming years to enhance recruitment to research linked to Dsolve.

Summary

Our industry partners in South Korea (LG Chem and S-EnPol) and Mørenot Fishery AS have produced new types of biodegradable polymers for fiber production based on PBSA (polybutylene succinate-co-adipate) and DPET (biodegradable polyester). The new materials are closer to important properties of nylon regarding elasticity and tensile strength than the former PBSAT material. While tests in Croatia last year showed that there are considerable challenges regarding use of PBSA in gillnets built from very thin monofilaments, experiments in Norwegian gillnet fisheries show promising results. In longlining, the initial DPET multifilament branch lines (snoods) did not meet the required tensile strength. New batches of multifilament and monofilament branch-lines were produced by Mørenot Fishery and S-EnPol at the end of the year, and the testing of these products will be starting at the beginning of 2025. Provided the new products show comparable properties to nylon and polyester regarding fishing efficiency and service time, we believe an important barrier in polymer development has been overcome.

With help from UiT regarding use of RV "Helmer Hanssen", we took part in the annual retrieval ("clean-up") operation for abandoned, lost, or otherwise discarded fishing gear (ALDFG) with our partner the Directorate of Fisheries during October 6th - 11th. Several of our PhD candidates and MSc students, the scientific coordinator and partners joined the clean-up expedition and joined in cleaning collected fishing gears and registering the ghost-fishing effect from ALDFG. During this operation, we retrieved many lost gillnets and king crab pots, which contributed to a learning experience for all the participants involved.

UiT received funding for a two-year project "Networking for increasing sustainability in snow crab fisheries in the Arctic" from UArctic Networking Activities on Arctic Research and Education to develop co-operation on snow crab (*Chionoecetes opilio*) fisheries between Norway, Denmark, Greenland and Canada. The first workshop took place in St. John's, Newfoundland Canada during May 30th - 31st, and the second workshop was held on board RV "Helmer Hanssen" in the period December 14th- 20th. During this workshop in the northeast Barents Sea, several UiT students and partners from Dsolve participated and examined catches from a new pot-design using biodegradable materials. A commercial fishing vessel will be using this new pot design in the snow crab season 2025.

By the end of the year, UiT the Arctic University of Norway was granted a new research project funded by the Norwegian Seafood Research Fund (FHF) with the aim to develop environmentally friendly materials for use in longline fisheries. The research will be carried out in partnership with SINTEF Ocean, SINTEF Industry and several industry partners in Dsolve. Modified longlines will be operated from one deep sea mechanized vessel (51 m), one inshore (coastal) mechanized vessel (11 m) and one inshore vessel (13 m) with traditional hand-baited hooks. The results from this two-year project will be included in the doctoral education of PhD candidate Anja Alvestad and several master's degree students.

We are pleased that our new website (developed by SALT Lofoten AS in collaboration with Webium AS) has become more user-friendly, intuitive and frequently visited. Our primary objective has been to enhance the accessibility and relevance of the Centre's research and activities to our target audience. During 2024, the Dsolve team has produced several news articles, presentations about the Centre at national and international events like Håp i Havet (Tromsø), Havklynga (Alta), Skreikonferansen (Myre), SETAC Europe (Seville, Spain), Norfishing (Trondheim), FAO-ICES meeting (St. John's Canada), ICYMARE (Bremen, Germany), The Arctic Congress (Bodø), NAERE Wokshop (Bergen), The 15th Fall Rubber Colloquium (Hanover, Germany), and seminar for marine students at the University of Split (Croatia). The Centre administration continues to participate in various arrangements giving presentations on the progress of Dsolve. The published results and news are consecutively uploaded on the Dsolve webpage and communicated on social media.

Tromsø, 31. March 2025

Roger B. Larsen

Centre Director

Vision and Ambitions

Vision:

Reduce plastic litter and associated problems (macro-, microplastics and ghost fishing) caused by the fishery and aquaculture industries.

Ambition:

Place Norway at the forefront of research, development, and use of smart biodegradable materials to reduce the global problem of marine litter from fisheries and aquaculture.

SFI Dsolve timeline

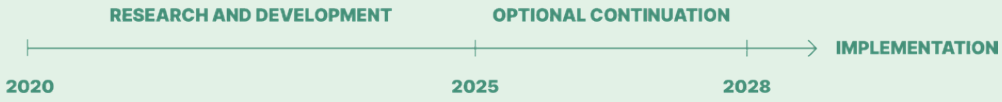


Illustration: SALT

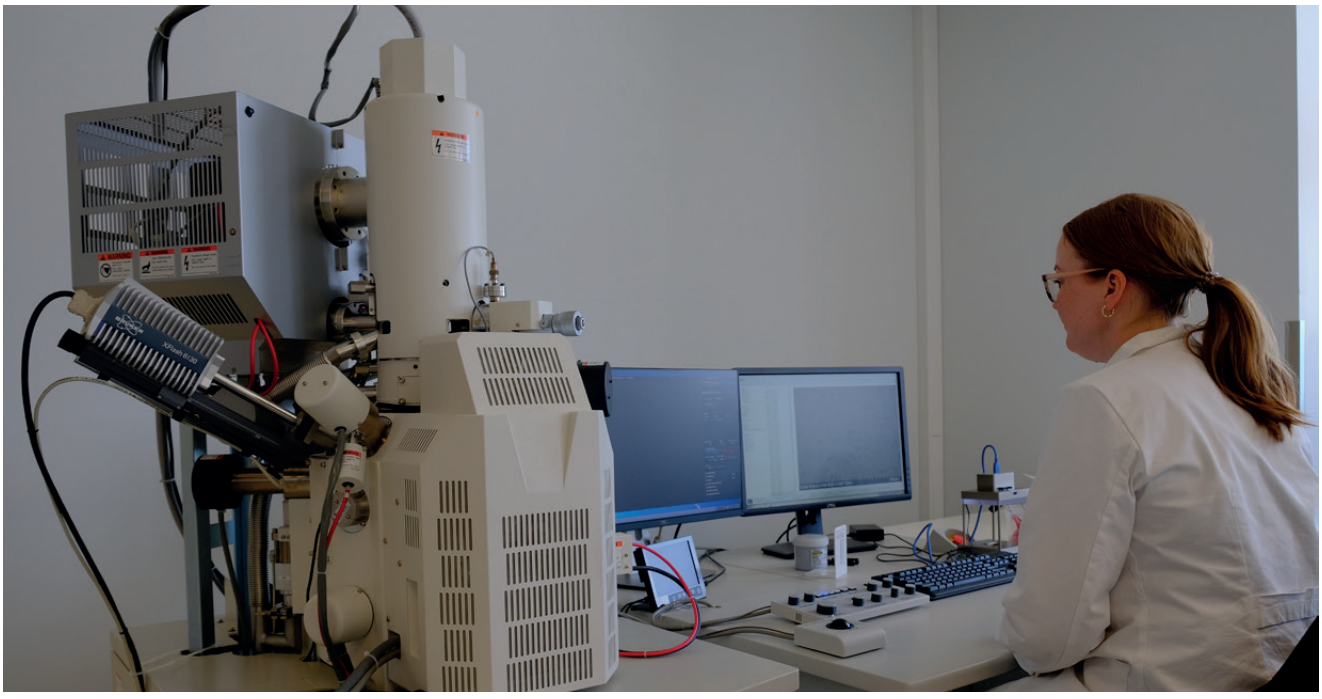
Jørgen Vollstad from SINTEF Ocean measuring the catch caught with biodegradable materials and conventional snoods on board MV "Loran".
Photo: Anja Alvestad, SINTEF Ocean

Objectives

The main objective of CRI Dsolve is to reduce plastic litter and its associated problems such as macro- and microplastics and ghost fishing in the marine environment caused by fishing and aquaculture industries, by replacing the traditional plastics used in gears and gear components with new biodegradable materials. This primary objective will be achieved by accomplishing the following objectives.

Secondary objectives:

- Develop new smart biodegradable polymers with controllable (non-linear degradation in the marine environment.
- Develop biodegradable filaments, twines, ropes, and netting for fisheries and aquaculture purposes.
- Create governmental incentives and restrictions to incorporate biodegradable plastics in an ecosystem-based management approach.
- Help to establish a supplier industry that can deliver biodegradable gears and services to the end-user sectors (fisheries and aquaculture).
- Develop sustainable downstream solutions and LCA for biodegradable fishing gear.
- Optimize and validate waste sorting technologies and circular waste processing options for biodegradable materials.
- Educate at least 8 PhD candidates, 4 post docs, and 30 MSc candidates.



Microscope Electron Scanning.

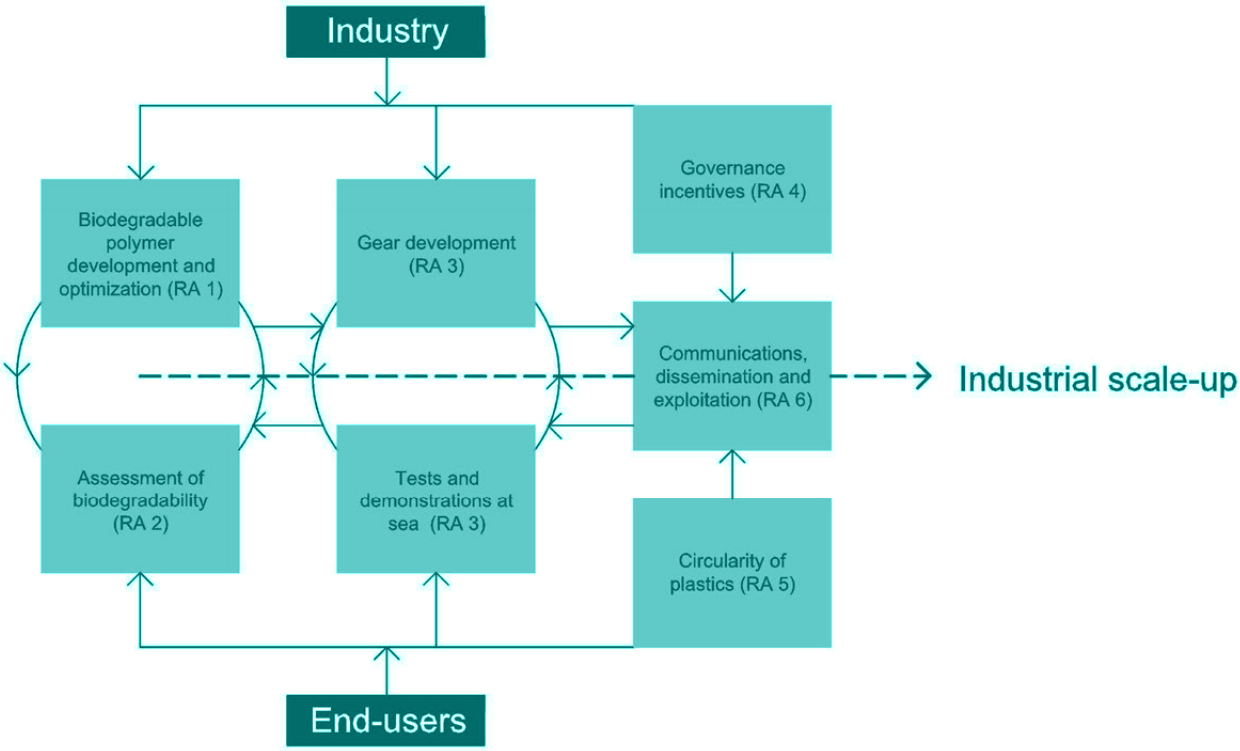
Photo: Norner Research AS

Research strategy

Our main research hypotheses are:

- By replacing traditional non-degradable plastics with smart biodegradable and controllable ones, we can reduce marine litter caused by the fishing and aquaculture industries.
- By reducing ghost fishing and macro- and microplastic pollution, value creation will increase in the fishing and aquaculture industries.
- By introducing effective incentives, the fisheries management can facilitate the use of biodegradable plastics, to enhance the ecosystem-based management approach.
- LCA and new sustainable downstream solutions can facilitate the circularity and sustainability of existing fossil-based non-degradable and biodegradable plastics.

Dsolve focus on six Research Areas (RAs) that jointly address these hypotheses:



Specific objectives for the Research Areas (RAs) are:

RA 1

Dr. Ravindra R. Chowreddy
Norner Research AS

Develop a range of biodegradable plastic materials with controlled biodegradability and the properties needed for products used in the fishing and aquaculture industries

RA 2

Dr. Christian W. Karl
SINTEF Industry

Create a sustainable framework for testing biodegradability and environmental impact. Lab and field testing will be carried out in conditions representing different marine environmental factors, and marine biodegradation tested in different marine habitats and climate zones. Biodegradable and conventional tools will be compared.

RA 3

Jørgen Vollstad
SINTEF Ocean/UiT

Sea trials in the Norwegian, Northsea, Baltic and Adriatic Seas including performance, catch pattern, and efficiency analyses of existing and new technology. Obtain data about the performance of biodegradable twines and ropes, the catch efficiency of nets, and how degradation varies in relation to different environmental conditions.

RA 4

Prof. Claire Armstrong
UiT Arctic Univ. of Norway

Assess the economic effects of non-biodegradable materials used in fisheries and aquaculture and evaluate costs and benefits on ecosystem services from introducing biodegradable materials in the marine industries. Further analyse institutional incentive mechanisms and assess public support systems to reduce risk and promote implementation of biodegradable innovations.

RA 5

Dr. Cecilia Askham
NORSUS AS

Develop sustainable circular solutions for existing non-degradable and future biodegradable fishing gear. The goal is to develop environmentally sustainable value chains which also take the level of circularity into account.

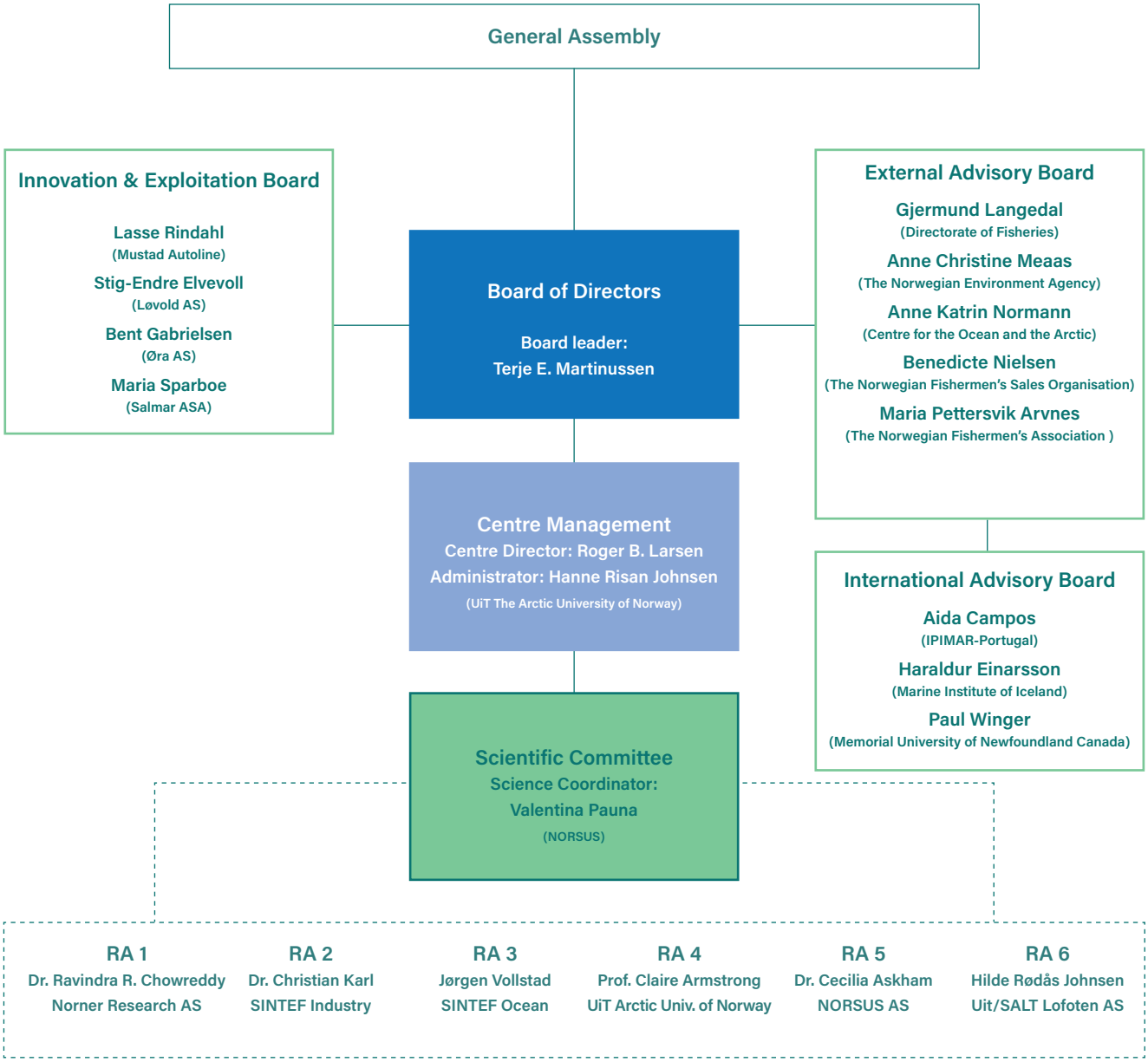
RA 6

Hilde Rødås Johnsen
UiT/SALT Lofoten AS

Develop and carry out a dynamic plan for outreach through communication, dissemination and exploitation of results in order to maximize the impact of the project results.

Organisation

The figure below describes the Centre's organisation. The General Assembly consists of representatives from each partner and has the uppermost decision-making power in the Centre. As from 2022 all partners have permanent representation in the Centre's board, including research partners and the host institution (UiT). The Centre Board is advised by the Innovation and Exploitation Board (IEB), the External Advisory Board (EAB) and the International Advisory Board (IAB), which members are selected amongst experts within industry, policy and bioeconomy, governance institutions, public organisations`, NGO`s and marine research. The IAB members have comprehensive networks and expertise as members of ICES (the International Council for the Exploration of the Sea) and the FAO (Food and Agriculture Organisation of the United Nations).



As from 2023 Terje E. Martinussen has been the leader of the board, while Dr. Valentina Pauna from NORSUS has had the role as Scientific Coordinator of CRI Dsolve. Martinussen has long experience from the seafood industry and research from previous executive positions within amongst other, the Norwegian Seafood Council, UiT and Nofima (former Fiskeriforskning).

The CRI partners are presented at pages 18 and 19, and includes several industry partners from both fishery and aquaculture sector. Three new partners have joined the consortium during 2024, the vertically integrated seafood company BR Karlsen, and the two coastal longline vessels "Østkapp" (10,99m) owned by Brynjar Bangsund ENK and "Vardøyfisk II" (13 m) owned by Øystein Enoksen ENK. BR Karlsen is a traditional fishing company specializing in whitefish and salmon who also is a co-owner of several coastal fishing vessels. The company has been located on Husøy in Senja since 1932 and is now run by the third generation. In 2001, the company was

The coastal longline vessel MV «Østkapp" is one of two new partner vessels in 2024

Photo: Avisa Østhavet

the first in Norway to start the production of organic salmon, and today it produces both organic salmon and smolt, in addition to traditional whitefish production such as salted fish, fresh fish, and by-products.
The inclusion of a production and sales company in the consortium, which is vertically integrated with fisheries and aquaculture, will further add competence to several research areas on issues related to e.g. promotion of more eco-friendly produced fish products and consumer preferences. The inclusion of two new coastal vessels in the CRI strengthens the Centre`s resources for further testing of biodegradable materials in coastal line fishing within Research Area 3.

Members of the Centre Board 2024

ROLE	MEMBER OF CENTRE BOARD	AFFILIATION
Leader of the Board	Terje E. Martinussen	Private
Host Institution	Terje Aspen	UiT-BFE
Research Partners	Thor Kamfjord	Norner Research AS
	Bård Wathne Tveiten	SINTEF Ocean
	Einar Hinrichsen	SINTEF Industry
	Ellen-Marie Forsberg	NORSUS AS
Industry and organisations	Bent Gabrielsen	Øra AS
	Sigve Drønen	Opilio AS
	Lasse Rindahl	Mustad Autoline AS
	Terje Lindal	Mørenot AS
	Håvard Olsen	Kvarøy Fiskeoppdrett AS
	Gunnar Kupen	Nofi AS
	Benedicte Nielsen	The Norwegian Fishermen's Sales Organisation
	Martin Solhaug	Martin Solhaug AS
	Rune Sand	Tustern AS
	Kristian Kalgraff	Legøy Rederi
	Signor Antonsen	Hermes AS
	Maria Pettersvik Arvnes	The Norwegian Fishermen's Association
	Stig-Endre Elvevoll	Løvold AS
	Brynjar Bangsund	Brynjar Bangsund ENK
	Øystein Enoksen	Øystein Enoksen ENK
Observer	Hilde Albech	The Research Council of Norway

Annual meeting and General assembly

The 2024 annual meeting and general assembly were held at the Radisson RED Hotell in Økern, Oslo on the 16th to 18th of April with 31 representatives and was opened with an innovation workshop led by Norinnova. The workshop on the 16th of April, set focus on the path from research idea to commercial success, and on experiences and perspectives regarding collaboration with industrial partners. All highly relevant topics for the CRI Dsolve. In addition, the annual meeting included a working group meeting led by NORSUS (RA5), on the topic of LCA methodology, including the functional units for the Dsolve case studies, presentation of Environmental LCA results and discussion, as well as a social LCA (S-LCA) questionnaire. The annual meeting included inputs from the International Advisory Board (IAB), the External Advisory Board (EAB), industry partners, LG Chem and S-Enpol about future plans. It provided an important arena for partners to connect, including with advisory board members, and to present views, status and plans for their respective research areas. The use of biodegradable materials in the aquaculture industry was especially set on the agenda, with Maria Sparboe, environmental team leader at CRI partner SalMar, contributing within the industry's perspectives.

An extraordinary general assembly was held on November 5th, 2024, welcoming the three new partners: BR Karlsen, Brynjar Bangsund ENK (MV "Østkapp") and Øystein Enoksen ENK (MV "Vardøyfisk II") into the consortium.

The annual meeting 2023 gathered participants from both industry and scientific partners to joint discussions.
Photo: Dsolve

International cooperation

CRI Dsolve participate and contribute in several international cooperations within amongst other fishery technology and environmental research. National and international scientists and students from Research Area 3 are members of the FAO-ICES working group on Fisheries Technology and Fish Behaviour (FTFB) and provide contributions to the annual meetings in the form of presentations, posters and topic group reports. In the thematic network on Arctic plastic pollution of UArctic several scientists and students have participated in meetings and research cruises. These activities are also presentet on the CRI website. Both fora lead to networking and teambuilding for extended mobility and research collaboration.

Research Area 4, as part of the Dsolve project, collaborates with the University of Wyoming and Appalachian State University, supported by their funding, to conduct a lab experiment with students at the University of Wyoming. The research focuses on enforcement mechanisms for adopting sustainable practices, particularly the use of biodegradable fishing gear. Additionally, through the North2North mobility grant, a collaboration has been established with the University of Alberta to study consumer preferences for seafood products caught using biodegradable fishing gear, employing choice experiments, funded by the Norwegian Retailer`s Environment Fund. These collaborations contribute to Dsolve's broader research agenda and are expected to result in scientific publications. Work Area 4 also works closely with environmental economists engaged in blue economy research, including the Environment for Development (EfD) Initiative, established by the University of Gothenburg, which connects over 15 research centers worldwide.

Research Area 5, through Dr. Cecilia Askham and Dr. Valentina Pauna, have close collaborations with the UNEP LC-Initiative, The MarILCA project (to include the impacts of marine littering into LCA methodology), the SETAC plastics interest group and the Plastic Footprint Network (PFN), specifically focussing on fishing and aquaculture littering. These collaborations include working on scientific papers relevant for Dsolve.

Recruitment

During 2024 we have recruited one post.doc (RA4) and announced one PhD candidate position in RA2 which received 46 applicants. This position is expected to start in early 2025. A new UiT course "Marine litter and Arctic fisheries: Challenges and Solutions" attracted 18 MSc students. Three of them have decided to continue their MSc education based on Dsolve topics and will receive supervision from Dsolve RA-leaders and PhD canidates.

Partners

Host Institution

UiT – The Arctic University of Norway As hosts institution, UiT contributes to the CRI with expertise in Arctic and marine biosciences, economy, and subjects relevant to the fisheries and the aquaculture industry, as well as infrastructure for lab testing and fishing gear trials. UiT is leading Research Area 4 Governance incentives, Research Area 6 Communication, Dissemination and Exploitation, and is involved in Research Area 3 Tests and demonstrations at sea.

National Research Partners

Norner Research AS contributes to the CRI with expertise in Polymer R&D services, material and analytical testing, evaluation of physical and chemical properties, environmental influence on material properties, and plastic processing techniques. Norner is leading Research Area 1 Biodegradable polymer development and optimalization.

SINTEF Ocean contributes to the CRI with expertise in ocean-based industries, including fishery and aquaculture, and with R&D infrastructure. Sintef Ocean is leading Research Area 3 Tests and demonstrations at sea, and has been head of the Scientific Committee of CRI Dsolve.

SINTEF Industry contributes to the CRI with expertise in the entire value chain from manufacturing to finished product, for all types of plastics, including thermoplastics, plastics composites, elastomers, and gels. Sintef Industry is leading Research Area 2 Assessment of biodegradability.

NORSUS AS contributes to the CRI with expertise in LCA for analysis of environmental and resource efficiency for products and services. NORSUS is leading Research Area 5 Circularity of plastics and has also the role as Science Coordinator of the CRI.

International Research Partners

DTU-Aqua (Denmark) Research, advice, education and innovation in sustainable exploitation and management of aquatic resources. Contributes to Research Area 3 Tests and demonstrations at sea.

Thünen Institute of Baltic Sea Fisheries (Germany) Research, advice, and monitoring on fisheries and environment in the Baltic Sea. Contributes to Research Area 3 Tests and demonstrations at sea.

University of Split (Croatia) Research, science, and innovation within oceanography and fishing, nautical science, and a range of other specific disciplines. Contributes to Research Area 3 Tests and demonstrations at sea.

International Industry Partners

LG Chem (South Korea) Supplier of biodegradable polymers and fishing gear. Contributes to the CRI with materials for testing and expertise on biodegradable plastics.

S-EnPol (South Korea) Supplier of biodegradable polymers and fishing gear. Contributes to the CRI with materials for testing and expertise on biodegradable plastics.

National Industry partners - suppliers

	Nofi Tromsø AS Supplier of fishing gear. Contributes to the CRI with expertise on fishing gear, and in particular nets.
	Mørenot Fishery AS Supplier of applications to the fisheries and aquaculture industry. Contributes to the CRI with expertise on fishing gear and aquaculture equipment.
	Løvold AS Supplier of applications to the fisheries and aquaculture industry. Contributes to the CRI with expertise on fishing gear and aquaculture equipment, and in particular ropes.
	Supplier of fishing gear. Contributes to the CRI with expertise on fishing gear, and in particular longlines.

National Industry partners - users

Øra AS (coastal gillnetting)	Contributes to the CRI through full-scale tests of biodegradable fishing gear at the 11 m coastal gillnet-vessel "Karoline".
Tustern AS (demersal seining)	Contributes to the CRI through full-scale tests of biodegradable fishing gear at the 30 m seine-vessel "Fortuna".
Hermes AS (demersal trawling)	Contributes to the CRI through full-scale tests of biodegradable fishing gear at the 62 m trawler "Hermes".
Legøy Rederi AS (gillnetting)	Contributes to the CRI through full-scale tests of biodegradable fishing gear at a 15 m coastal gillnet-vessel.
Martin Solhaug (longlining)	Contributes to the CRI through full-scale tests of biodegradable fishing gear at the 15 m coastal longliner "MS Vibeke Cathrin".
Opilio AS (snowcrab potting)	Contributes to the CRI through full-scale tests of biodegradable fishing gear at the snowcrab vessel "Northeastern".
Loran AS (mechanical longlining)	Contributes to the CRI through full-scale tests of biodegradable fishing gear at the mechanized longliner "Loran".
Kvarøy Fiskeoppdrett AS	Contributes to the CRI as end user within salmon farming. Owns and operates two ordinary salmon farming licenses and one R&D license.
SalMar ASA	Contributes to the CRI as end user within salmon farming. SalMar ASA is the world's second largest breeder of salmon, and produces in Norway, Shetland, Orkney Islands, Iceland and Scotland.
BR Karlsen	Contributes to the CRI as a vertically integrated end-user within traditional whitefish production and aquaculture.
Brynjar Bangsund ENK (longlining)	Contributes to the CRI through full-scale tests of biodegradable fishing gear at the coastal longliner "Østkapp".
Øystein Enoksen ENK (mechanical longlining)	Contributes to the CRI through full-scale tests of biodegradable fishing gear at the mechanized longliner "Vardøyfisk II".

Organisations

Norges Fiskarlag	(The Norwegian Fishermen's Association) Contributes to the CRI as representative for Norwegian fishers. Participate in Research Area 6 Communication, dissemination, and Exploitation.
Norges Råfisklag	(The Norwegian Fishermen's Sales Organisation) Contributes to the CRI as representative for Norwegian fishers. Participate in Research Area 6 Communication, dissemination, and Exploitation.

External Advisory Board

Senter for Hav og Arktis	Contributes to the CRI with expertise on blue sustainability in the arctic and partnerships for sustainable blue business.
Miljødirektoratet	Contributes to the CRI as representative for Norwegian authorities with authority on environmental management and legislation.
Fiskeridirektoratet	Contributes to the CRI as representative for Norwegian authorities with authority on fishery and aquaculture management and legislation, and expertise on retrieval of lost fishing gear.

International Scientific Advisory Board

Institute for the Ocean and the Atmosphere, Portugal	Contributes to the CRI with expertise in ocean science and technology research.
Marine and Freshwater Research Institute, Iceland	Contributes to the CRI with expertise in marine and freshwater research.
Memorial University of Newfoundland	Contributes to the CRI with expertise in fishery research.

Scientific activities and results

RA 1 Biodegradable Polymer Development and Optimization

Objectives and motivation

The main objective of Research Area 1 (RA 1) is to develop a range of biodegradable plastic materials with the properties needed for products used in the fishing and aquaculture industries (e.g., twines and netting, ropes, gillnets, coatings, pots and traps, foils and boxes, pipes, and connectors). The developed materials should meet a range of processing and performance requirements, including biodegradability.

The motivation behind RA1 is that conventional plastic materials used in the construction of fishing gear and aquaculture equipment are not biodegradable and remain in the aquatic environment when lost during operation. This leads to plastic pollution, microplastic formation, and ghost fishing issues. Utilizing biodegradable plastic materials in fishing gear and aquaculture equipment would reduce plastic pollution and ghost fishing due to their shorter lifespan. None of the commercial biodegradable plastics meet both the performance and marine biodegradability requirements needed for fishing gear and aquaculture equipment. Therefore, RA1 in the Dsolve project intends to develop a range of biodegradable alternative materials that will meet the requirements of both performance and marine biodegradability for the fabrication of fishing gear and aquaculture equipment.

Key research tasks

The overall key research tasks of RA 1:

- Selection, identification, sourcing, and suitable modification of biodegradable plastic materials for marine fishing and aquaculture applications.
- Development of biodegradable materials with optimal processability and performance for various applications, such as fibres (twines, netting, ropes, etc.), injection moulding (pots, traps, boxes, etc.), and coatings (steel rope coatings).
- Investigation of potential microplastic formation from the biodegradable plastics and prediction of the degradation products.
- Establish collaborations with material suppliers to ensure the availability of biodegradable plastics for the project.
- Development of new material and design concepts to meet the requirements of marine biodegradability, processability, and performance for marine fishing and aquaculture applications.

The key research tasks prioritised in 2024:

- Conducting desktop study to evaluate commercial bioplastics, providing recommendations for material development tailored to various applications within the Dsolve project.
- Scouting and sourcing of alternative commercial bioplastics for further materials development in fibre, moulding, and coating applications within the Dsolve.
- Identification, selection, and utilization of modification strategies for the development of modified bioplastics for fibre applications.
- Processing and performance evaluation of monofilaments from developed biodegradable plastic formulations.
- Development of optimal biodegradable materials for fibre applications.
- Identification, selection, and utilization of modification strategies for the development of modified bioplastics for moulding applications.
- Processing and performance evaluation of moulded/extruded biodegradable plastic products.
- Development of optimal biodegradable materials for moulded/extruded applications.
- Conduct desk-top study to screen various metallic wire coating processes and identify material needs and equipment.

Achievements for 2024

- As none of the commercial biodegradable plastics meet all the processability, performance, and marine biodegradability requirements needed for fishing gear and aquaculture equipment, RA1 aimed to develop a range of biodegradable blend formulations from commercial materials. A variety of biodegradable plastic blend formulations for fibre applications were developed and characterized for their rheological, mechanical, and morphological properties in 2023. This blend development and characterization work was further continued in 2024 which resulted in approximately 80 different formulations. The findings from this development work are detailed in technical report D2.3 (NR240859).
- The processability of selected newly developed biodegradable plastic blends was investigated through monofilament extrusion and stretching. The monofilaments produced were subsequently characterized for their mechanical properties and biodegradability. Additionally, the suitability of the produced monofilaments for fishing gear (twines, netting, ropes, etc.) was evaluated in the Dsolve project. The monofilaments processed from the biodegradable blends meets the requirements with respect to processability, performance and biodegradability that are needed in the Dsolve project. The outcomes of the monofilament processing trials-, and mechanical testing are summarized in technical report D2.4 (NR240860). Some selected formulations will be produced on a pilot scale, converted into fishing gear, and evaluated in field trials.
- Highly biodegradable plastic blend formulations and compounds with cellulose fibers were developed for moulding/extrusion applications in the Dsolve project. The blends and compounds were characterized by their rheological,

morphological, mechanical properties, and biodegradability. The outcomes of the development study are summarized in technical report D3.1 (NR250119). Some of the selected bioplastic compounds will be produced on a pilot scale, converted into fishing gear (e.g., escape gates for pots), and evaluated in field trials.

- The bioplastic materials sourced in 2024 were extensively characterized by their thermal and rheological properties. The results of this characterization are summarized in deliverable report D6.3 (NR250118).
- A manuscript was drafted in collaboration with other research area leaders of the Dsolve project and will soon be submitted for publication. Some of the desktop study findings from RA 1 were incorporated into the manuscript. Additionally, another manuscript is under development.

Monofilaments testing.

Photo: Norner Research AS

Tensile strenght testing.

Photo: Norner Research AS

Technical reports:

Chowreddy, R., Intermediate technical report with summary of modifications evaluated to meet the requirements of Fibres, Norner Research AS, Report#NR240859, Deliverable D2.312.12.24

Chowreddy, R., and Cao,V., Summary of 2nd round of fibre spinning trials on modified bioplastics and the results of mechanical testing, Norner Research AS, Report#NR240860, Deliverable D2.4, 12.12.24

Chowreddy, R., Intermediate technical report with summary of 1st round of materials development for moulding applications, Norner Research AS, Report#NR250119, Deliverable D3.1, 13.02.25

Chowreddy, R., Summary of characterization results of bioplastics sourced in 2024, Norner Research AS, Report#NR250118, Deliverable D6.3, 13.02.25

Guest Lectures:

Chowreddy. R, Guest lecture on topic "Biodegradable plastics as an alternative materials for fishing applications" for the course FSK-8010: Marine litter and Arctic Fisheries: Challenges and Solutions (25.09.24)

Chowreddy. R, Guest lecture on topic "Biodegradable plastics" for the course FSK-8010: Marine litter and Arctic Fisheries: Challenges and Solutions (26.09.24)

RA 2 Assessment of Biodegradability

Objectives and motivation

In the second Research Area (RA2), assessment of biodegradability, the degradation behavior of fishing gear or other equipment for marine applications made of biodegradable polymers will be investigated in more detail. These fishing gears should have the same or better mechanical properties and fishing efficiency as the non-biodegradable plastics. These common polymers currently used in the fishing and aquaculture industries include primarily polyamide (PA). Gillnets made from synthetic materials are durable and have high tensile strength, which becomes problematic when lost at sea as they contribute to ghost fishing. Issues such as ghost fishing, marine plastic pollution, shipping risks, and the introduction of synthetic materials into the marine food chain have become much more acute with the increase in fishing activity. In recent years, biodegradable gillnets (e.g. made of PBSAT) that can be degraded by naturally occurring microorganisms in seawater have been increasingly discussed and researched as a replacement for conventional PA gillnets. The catch efficiency of these nets made of biodegradable polymers is in some cases comparable to nets made of PA. However, significant research is still needed to improve the mechanical properties, catch efficiency and biodegradability of these gillnets and other devices of interest for future applications. In addition, the degradation of biodegradable polymers with controllable and nonlinear degradation profiles that exhibit stable mechanical properties during their lifetime and degrade rapidly thereafter will be investigated. Additional suitable materials are currently being investigated.

The Dsolve project consortium will work closely with academic and industrial partners to make biodegradable plastics commercially available and economically accessible to end users.

Key research tasks

One main focus of this RA is to investigate modified and un-modified biodegradable polymers for fishing gear that have the same or better mechanical properties and catch efficiency than the non-degradable plastics currently used by the fishing and aquaculture industry. The physical and chemical integrity and degradation of biodegradable and conventional nets and twine will be evaluated in laboratory and field tests over an extended test period (5 years or complete degradation). Accelerated weathering tests in the laboratory, especially the influence of UV radiation and temperature, will be compared with field tests and experiments conducted under controlled laboratory conditions. The work plan describes in more detail the activities planned to achieve these objectives. The following main tasks are relevant (Task 2.1 – 2.3):

- Investigation of the marine biodegradation of gillnets and twines with PBSAT as test and PA6 as control material in situ in different marine habitats and in different climate zones (Skagerrak Sea, North Sea, Baltic Sea, Adriatic Sea, and Norwegian Sea) to cover a wide temperature range from 4 to 27°C and analyse the samples.
- Investigation of the biodegradation in laboratory systems (controlled conditions) consisting of natural seawater. Analysis includes monitoring microbial biodegradation, performing microbiome analyses, and analyzing the materials (chemical and physical properties) during and after degradation.
- Evaluation of the effects of UV radiation with simultaneous changes in temperature, humidity, and pollutants (and the combination of these factors) on the physical properties of PBSAT and PBSA nets and yarns and PA6 as control.

Achievements for 2024

- As outlined in task 2.1, samples were collected on an annual basis between June and July (2022-2024) following a 12–36-month period from all testing sites in Norway, Denmark, Germany and Croatia. Initial analyses were conducted after a maximum of 36 months with all testing sites. The finalization of the RA 2.1 report, which provides a comprehensive description of the samples at the testing sites following sample collection, has been completed. Fig. 1 shows a temperature logger and monofilament samples fixed in a pot from the Norwegian testing site in the vicinity of Trondheim.

- Accelerated weathering experiments of the monofilaments (PA6 as a reference and PBSAT and PBSA as biodegradable polymers) were carried out in task 2.3. The methods (chemical, physical, surface characterisation) selected for this purpose are important for the entire work package in the future (especially for the field experiments in task 2.1 and the laboratory experiments in task 2.2). A test report has been finalized, which summarizes the results of the analyses from the field and lab-based degradation studies in task 2.1 and task 2.3.

- Waranya Wataniyakun (PhD candidate) affiliated to the Research Area 2 (assessment of biodegradability) has carried out characterization studies of biodegradable polymers and PA as a reference in collaboration with Ifremer, RDT Research and Technological Development Unit (France).

It was found that the rate of degradation could be predicted at other temperatures, like 2 ˚C, 10 ˚C, 15 ˚C, 20 ˚C and 30 ˚C. This study figured that by just using pure hydrolysis and biodegradable monofilaments instead of PA, the time it takes to reach the end-of-life criteria drops significantly. Still, it's longer than expected. For example, if you use PBSAT, PBSA and PA at 2 ˚C, it will take about 10, 20 and 1000 years for them to lose half of their initial stress at break, in that order.

Link to the published work: https://www.sciencedirect.com/science/article/pii/S0025326X25000827?via%3Dihub

Fig. 1: Temperature logger and monofilament samples fixed in a pot.

Photo: SINTEF Ocean

Dissemination and public outreach RA 2

Popular science:

A popular science article in Norwegian https://gemini.no/2024/12/slik-vil-forskere-hindre-plastforurensing-fra-fiskeri-og-havbruk/ has been published in December 2024 (RA2 and RA 3), with an English version https://norwegianscitechnews.com/2025/02/how-scientists-will-prevent-plastic-pollution-in-the-ocean/ to be published in February 2025.

Conference contributors:

C. W. Karl, Utfordringer og mulige løsninger ved biologisk nedbrytbare alternativer til plast, Bølger på land, Alta, Norway, February 2024 (see photo below).

S. Hakvåg, C. W. Karl, J. Brčić, J. Santos, L. Sørensen, R. P. Frandsen, S. Kubowicz, K. Olafsen, Investigations into Ageing of Monofilaments Under Various Test Conditions in the Sea, SETAC Europe 34th Annual Meeting, Sevilla, Spain, May 2024.

C. W. Karl, The future of marine plastic technology: Challenges and possible solutions, Arctic Congress, Bodø, Norway, May - June 2024.

W. Wataniyakun, M. Le Gall, M. El Rawke, C. W. Karl, S. Hakvåg, R. B. Larsen, Hydrolytic Degradation of Monofilaments Used for Fishing Gear –A Comparison Between PA 6 (nylon) and Biodegradable Materials (PBSAT and PBSA), Saint Valery en Caux/ France, June 2024.

C. W. Karl, Plasma polymerized coatings on elastomers, 15th Fall Rubber Colloquium, Hanover/Germany, September 2024.

Guest Lectures:

C. W. Karl, Conventional fishing gear, marine littering and recycling aspects, 90 min guest lecture in the course FSK-3624 and FSK-8010 Marine litter and Arctic Fisheries: Challenges and Solutions (02.09.24)

C. W. Karl, Fishing gears from biodegradable plastics, 90 min guest lecture in the course FSK-3624 and FSK-8010 Marine litter and Arctic Fisheries: Challenges and Solutions (03.09.24)

Presentation "Challenges and possible solutions for biodegradable alternatives to plastic" at conference "Bølger på land" in Alta, Norway (Christian W. Karl from the Polymer and Composite Materials Group, SINTEF Industry).
Photo: Andreas Markussen, Kreativ Industri AS.

Publications

One scientific article has been published in April 2024 in co-operation with external partners (Nordlandsforskning, NTNU). Enabling transition thinking on complex issues (wicked problems): A framework for future circular economic transitions of plastic management in the Norwegian fisheries and aquaculture sectors: https://www.sciencedirect.com/science/article/pii/S0959652624008680?via%3Dihub

Two articles under preparation will be published in January and February 2025 in cooperation with IFREMER and UiT:
(1): Biodegradable fishing gears: A potential solution to ghost fishing and marine plastic pollution: https://www.sciencedirect.com/science/article/pii/S0025326X25000827?via%3Dihub
(2): Degradation Behavior of Biodegradable and Conventional Polymers for Gill Nets, Exposed to Accelerated Aging:
https://pubs.acs.org/doi/10.1021/acsapm.4c03333

Figure 2 below, shows SEM and light microscopy pictures of PBSAT and PA6 monofilament specimens which were subjected to artificial aging that replicates outdoor conditions. Exposure to this condition for 1000 hours resulted in the development of a network of small cracks in the PA6 samples, extending both longitudinally and transversely to the fibre axis on one side of the fibre (refer to Fig. 3 1c). In addition to this, a progression of longitudinal cracks was observed, initially detected after 600 hours. After 1000 h, the PBSAT sample exhibited fine longitudinal cracks along the fibre axis and slight surface changes on one side. However, these changes were not visible as fine cracks but rather as a textural change (see Figures 1f, Karl et al, ACS Applied Polymer Materials, 2025). The findings demonstrated that the ageing process exerts a negligible influence on the tensile modulus of both PA6 and PBSAT, with an enhancement in tensile modulus observed after one thousand hours of ageing, reaching 21% and 5% for PA6 and PBSAT, respectively. However, a discernible influence on the elongation at break was evident, with a reduction of approximately 67% and 91% observed for PA6 and PBSAT, respectively. Furthermore, tribological tests of the monofilaments demonstrated that the PBSAT monofilament exhibited higher levels of wear and abrasion under dry conditions when compared to PA6; however, under seawater lubrication, the wear and friction force of both PBSAT and PA6 monofilaments were comparable. The findings of this study demonstrate that biodegradable PBSAT materials have the potential to substitute for non-degradable PA6 in gillnets.

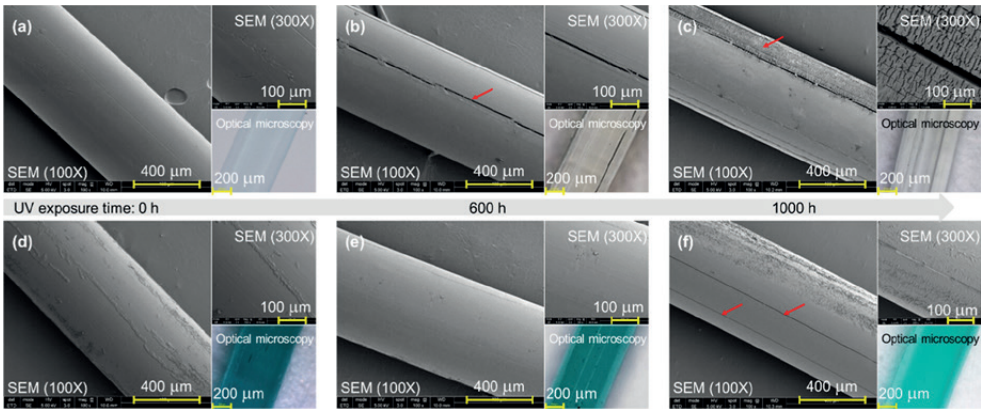


Fig. 2 Scanning electron microscopy (SEM) and optical microscopy were employed to analyse the samples (PA6 and PBSAT) before and after UV exposure. The arrows in Figures b and f denote longitudinal cracks, while the arrow in Figure c indicates extensive surface cracks. The ageing times for these samples were 0 hours (a,d), 600 hours (b,e), and 1000 hours (c,f). No discernible discoloration was observed in any of the samples, as evidenced by the insets in the optical microscopy images (Karl et al., ACS Applied Polymer Materials, 2025).

Fig. 3 exhibits demersal seine ropes before and after being used. Further details and the latest results of studies on demersal ropes and possible biodegradable alternatives can be found in the following publication: https://www.sciencedirect.com/science/article/pii/S0025326X2301069X?via%3Dihub

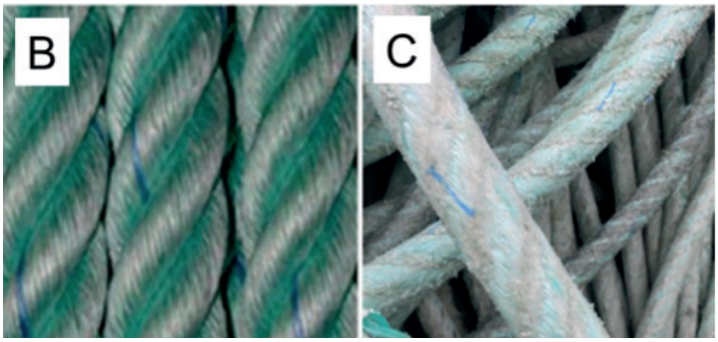


Fig. 3 (B) 50 mm demersal seine ropes when they are new, and (C) the same ropes after being used for one season. Source: Grimaldo et al., 2003 (in Marine Pollution Bulletin).

Related projects:

POCOplast KSP: Pathways to sustainable post-consumer plastics in aquaculture

SHIFT-PLASTICS (KSP): Shifting to sustainable circular values chains for handling plastics in the fisheries and aquaculture sector.

PLASTICENE (KSP): Development of tools for increased resource utilization, circularity and regulatory support of plastic use in Norway

In-No-Plastic (EU): Innovative approaches towards prevention, removal and reuse of marine plastic litter

Development of environmentally friendly materials in line/autoline fishing (FHF)

RA 3 Tests and Demonstrations at Sea

Objectives and motivation

This Research Area (RA3) is dedicated to developing, testing, validating, and optimizing biodegradable fishing and aquaculture gear for specific applications. Before large-scale production, commercialization, and practical implementation can take place, the industry requires solid, evidence-based results. Identifying specific needs, developing suitable products, and conducting extensive testing and documentation are crucial.

The shift from traditional petro-based materials to biodegradable alternatives must account for key factors such as performance (including catch patterns), durability, handling and maintenance costs, and efficiency assessments of both existing and emerging technologies. To evaluate these aspects, sea trials will be conducted in Norway, providing crucial data on the performance of biodegradable twines and ropes, the catch efficiency of nets, and how material degradation varies under different environmental conditions. These insights will help extend findings to other fisheries and contribute to the broader adoption of biodegradable fishing gear worldwide.

Key research tasks

- For gillnets (inshore and deep-sea gillnetting), find a combination of strength/elasticity and capture efficiency comparable to or better than existing PA twines during multiple trials conducted on board commercial gillnetters.
- Develop biodegradable materials (cage-netting and escape mechanisms) to be used in pots and traps-based targeting brown crab, snow crab, red king crab, and lobster, including recreational pot fisheries.
- Develop biodegradable ropes and components for coastal and deep sea longlines to replace nylons and polyester as material for snoods (branch lines) and ropes connecting line sections.
- Identify several possibilities for replacing PE, PA, PP and PES fibers with biodegradable fibers for use in twines, ropes, and netting for all fishing gears and aquaculture.
- Full-scale tests of dolly-ropes and other types of chafing mats for use in demersal (bottom) trawling.
- Develop an alternative to combination ropes (30–60 mm thick steel wire ropes coated with PE/PP fibers) for demersal seining.

Organisation

Research Area 3 (RA 3) is pleased to welcome BR Karlsen and fishing vessel companies ENK's Brynjar Bangsund and Øystein Enoksen in 2024. BR Karlsen is a traditional fishing company specializing in whitefish and salmon and is also a co-owner of several coastal fishing vessels. The company has been based in Husøy, Senja, since 1932 and is now run by the third generation. In 2001, it became the first company in Norway to start producing organic salmon. Today, it produces both organic salmon and smolt, in addition to traditional whitefish production, including salted fish, fresh fish, and by-products. This year, the company was unanimously

approved by the extraordinary general meeting as a new industrial partner in SFI Dsolve. In addition to BR Karlsen, two coastal fishing vessels, Øysten Enoksen ENK ("Vardøyfisk II", 12,99m) and Brynjar Bangsund ENK ("Østkapp", 10,99m), were also accepted as new partners. The vessels, owned by Øystein Enoksen and Brynjar Bangsund, respectively, both operate out of Vardø, using traditional hand-baited coastal longline and autoline fishing. Their inclusion in Dsolve strengthens the project's foundation for further testing of biodegradable materials in coastal longline fishing within Research Area 3.

Captain Øystein Enoksen on board MV "Vardøyfisk II", ready for departure. Pictured together with Dag Støme from SINTEF Ocean. *Photo: Anja Alvestad, SINTEF Ocean*

Our partners in RA 3, especially those who operate fishing vessels, require close collaboration to conduct experiments at sea. These experiments take place on several small and some larger vessels, where tasks are integrated into existing fishing activities. This demands thorough planning and close cooperation between the vessel operators and our researchers on-board to achieve the best possible results. Our partners at sea have demonstrated outstanding teamwork in this regard and without this close and effective collaboration, progress in the project would have been difficult to achieve.

Publications

"Comparison of fishing performance of biodegradable and nylon gillnets with different twine diameter"

The aims of this study were to compare the effectiveness of biodegradable nets from our partner in South-Korea, LG Chem, with traditional nylon nets used by Norwegian fishermen. Based on experience from previous years' experiments, we know that biodegradable nets have weaker monofilaments and knots than traditional nylon nets. Therefore, two different thicknesses of biodegradable nets were tested to see if the increased thickness could compensate for the slightly weaker threads of the biodegradable nets compared to regular nylon nets.

Cerbule, K., Larsen, R., Vollstad, J., Alvestad, A. (under review). Comparison of fishing performance of biodegradable and nylon gillnets with different twine diameter. Regional Studies in Marine Science.

"Use of biodegradable plastic materials in gillnet and longline fisheries"

The doctoral thesis of the PhD-student associated with RA3, Kristine Cerbule. The aim of this study is to evaluate the performance of recently developed biodegradable PBSAT plastic materials in gillnet and longline fisheries. By assessing their fishing efficiency and durability, the study explores their potential to reduce marine plastic pollution and ghost fishing while maintaining the profitability and practicality required for commercial adoption.

Cerbule, K. (2024). Use of biodegradable plastic materials in gillnet and longline fisheries. [Doctoral Thesis, The Arctic University of Norway]. https://hdl.handle.net/10037/33443

A publication in Gemini (RA 3 and RA 2) titled "How scientists will prevent plastic pollution in the ocean".

This publication highlights how fishing and aquaculture gear contribute to microplastic pollution and coastal littering. The article presents a plan developed by an interdisciplinary and international research team to reduce this pollution.

How scientists will prevent plastic pollution in the ocean

Experiments

Longline

Throughout 2024, fishing trials were conducted to compare the use of biodegradable and conventional materials in longline fisheries. The experiments focused on assessing the fishing performance of both materials in snoods (branch lines) and exploring the feasibility of using biomaterials in ropes for both coastal and autoline commercial fisheries.

MV Vardøyfisk II

Experiments were carried out aboard the coastal longliner "Vardøyfisk II" in January and February 2024. The study aimed to evaluate the effects of long-term storage on biodegradable materials (PBSAT) used in 2021, which had been kept at room temperature since then. The experiments focused on assessing fishing performance and snood loss for both biodegradable materials and conventional nylon snoods.
There is still a considerable amount of work to be done before concluding whether this biodegradable material is suitable for use in coastal longline fisheries. However, preliminary results, along with findings from previous studies, appear promising. The trials will continue in 2025 and 2026 to gather more data and further assess the material's suitability.

Biodegradable snoods to be used on board MV "Vardøyfisk II". *Photo: Anja Alvestad, SINTEF Ocean*

Longlines with biodegradable snoods ready to be used on board MV "Vardøyfisk II". *Photo: Anja Alvestad, SINTEF Ocean*

Work on board MV "Vardøyfisk II". Dag Støme from SINTEF Ocean measuring the catch caught with biodegradable and conventional nylon snoods. *Photo: Jørgen Vollstad, SINTEF Ocean.*

MV Loran

In April 2024, experiments were conducted aboard the autoliner "Loran" to assess fishing performance and snood loss for both biodegradable materials (Bio-PES multifilament) and conventional snoods (PES multifilament). Additionally, the study evaluated the performance of wood fiber and cotton for ropes to connect line sections. The results from the fieldwork show promising potential for the use of biodegradable materials in longline fisheries, demonstrating their effectiveness in reducing environmental impact. However, the trials also revealed certain challenges that must be addressed before commercialization. These valuable insights have been shared with the gear manufacturers, who have incorporated the findings into the development of improved snoods. The next generation of biodegradable snoods is set to be tested in new trials planned for 2025.

Experimental set-up on board the autoliner MV "Loran" – biodegradable snoods in white, and conventional snoods in blue.
Photo: Anja Alvestad, SINTEF Ocean.

Testing of 6mm wood fiber ropes to connect the line sections on board MV "Loran".
Photo: Anja Alvestad, SINTEF Ocean.

Grillnets

Onboard the (full-electric) fishing vessel MV "Karoline", experiments were conducted in February and March 2024 using biodegradable nets from our partner in South-Korea, LG Chem. Two different thread thicknesses were used for the biodegradable nets, as previous experience indicates that biodegradable nets are somewhat weaker than traditional nylon nets, which were used for comparison.

The trials showed that the biodegradable gillnets perform just as well as nylon nets in terms of catch numbers, though not in fish size. It remains uncertain whether this is influenced by color, as previous trials have shown lower catches with biodegradable nets. These findings will be detailed in a paper by Cerbule et al., which is currently under review.

Work on board MV "Karoline". Fish caught with traditional nylon gillnets (green, left) and biodegradable gillnets (blue, right).
Photo: Jørgen Vollstad, SINTEF Ocean

Demersal seine Ropes

The Demersal seine vessel MV "Fortuna" has documented the wear and tear of standard seine ropes in 2024 and will continue this work in 2025. The purpose of these measurements is to determine the expected level of wear on a typical seine rope. This documentation is crucial, as we hope that the first prototype of a biodegradable seine rope will be produced in 2025. By understanding the durability of a standard seine rope throughout its lifespan, we can also establish expectations for the performance of a biodegradable alternative.
The results are not yet available, as the trials will continue throughout 2025.

Demersal seine ropes onboard the vessel "Fortuna".
Photo: Jørgen Vollstad, SINTEF Ocean

Snow Crab

During 2024, we carried out experiments in snow crab pot fishery. Pots are commonly used fishing gear for capturing snow crab. In this fishery, optimal snow crab size selection is important for reducing unintended mortality of undersized individuals aiming at conserving fisheries resources. We investigated whether an additional size selection mechanism can have a potential to improve selectivity compared to 140 mm mesh size of the "jackets" (i.e., the net covering the pot-frame). Use of biodegradable twine as escape mechanism has been compulsory since 2024. However, to reduce the capture of snow crabs below the minimum landing size of 95 mm carapace width the industry has voiced interest in fixed escape gaps to improve size selectivity. Our aim is to produce escape plates of biodegradable material to reduce continuous capture of undersized snow crabs by derelict pots (so-called "ghost fishing") and plastic pollution if the gear is lost.

Communication and Dissemination Activities

Representatives from SINTEF Ocean and UiT participated at the ICES/FAO Working Group on Fishing Technology and Fish Behavior meeting in June 2024 in St. John's, Newfoundland, Canada, as a part of the topic group "Abandoned, lost or otherwise discarded fishing gear" (ALDFG). The aim of this topic group was to review, discuss and investigate gear modifications and designs that aim to prevent and reduce ghost fishing from ALDFG, enable gear stewardship through the inclusion of gear marking and tracking technologies, and support the responsible discard of recovered ALDFG and other end-of-life fishing gear.

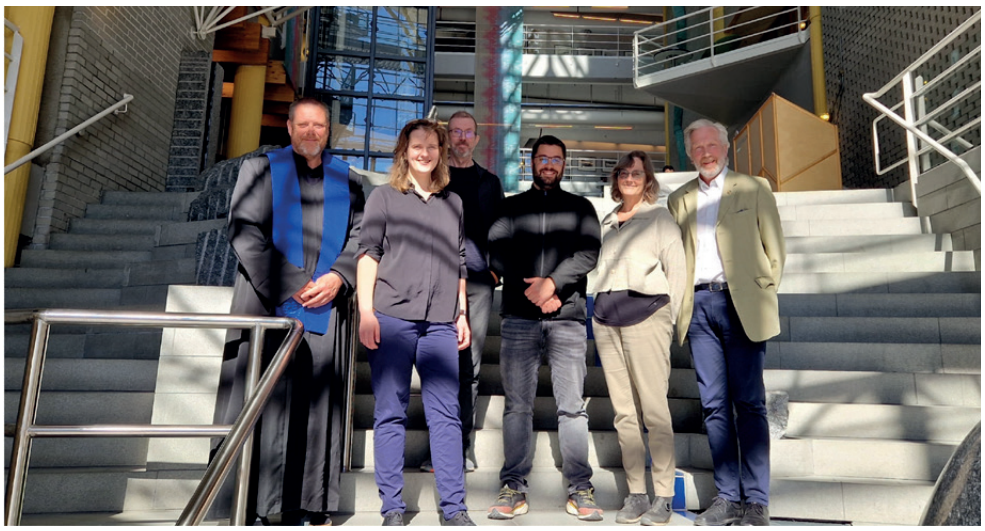
Annual meeting participants of ICES/FAO Working Group on Fishing Technology and Fish behaviour, 2024.
Photo: ICES/FAO

The project "Networking for increasing sustainability in snow crab fisheries in the Arctic" was funded by UArctic Project Grants. The networking project between Norway (lead), Greenland, Denmark and Canada aim to address sustainability challenges in snow crab fisheries, specifically focusing on challenges caused by lost fishing gear and plastic materials used in snow crab pots. The aim of this project links with objectives of SFI Dsolve by specifically focusing on challenges caused by lost fishing gear and plastic materials used in snow crab pots. The meeting in St. John's, with a large number of FTFB participants and Canadian fishermen and scientists participating, was the first out of two workshops in the project. The second workshop was arranged during a research cruise with RV "Helmer Hanssen" (UiT) during snow crab fishing trials in the period 6th- 20th December.

The research area 3 leader, Jørgen Vollstad, gave a lecture focusing on results from fishing gear trials related to Dsolve in the UiT master's course FSK Marine Littering and Arctic fisheries; Challenges and Solutions, contributing to discussions on the topic of possible use of biodegradable materials in fisheries and sharing insights from ongoing project activities.

The Dsolve project was prominently showcased at the bi-annual Nor-Fishing exhibition in Trondheim, Norway, in August 2024—one of the world's largest fisheries technology events. Field trial results were presented on stage during a debate panel hosted by the Norwegian Fishermen's Sales Organization, under the title "Status on Testing and Work with New Biodegradable Fishing Gear." Additionally, both new and used biodegradable fishing gear were featured at the SINTEF stand, attracting significant interest and engagement from attendees.

Presentation of materials and results from field testing at SINTEF stand at Nor-fishing 2024. Photo: Aleksander Lillienskiold, SINTEF Ocean.
Photo: Dsolve



Kristine Cerbule became the first PhD candidate within CRI Dsolve to complete her defense.
Photo: Dsolve

In May 2024, RA3 PhD candidate Kristine Cerbule successfully defended her thesis at UiT, titled "Use of Biodegradable Plastic Materials in Gillnets and Longline Fisheries." Her work received highly positive evaluations.

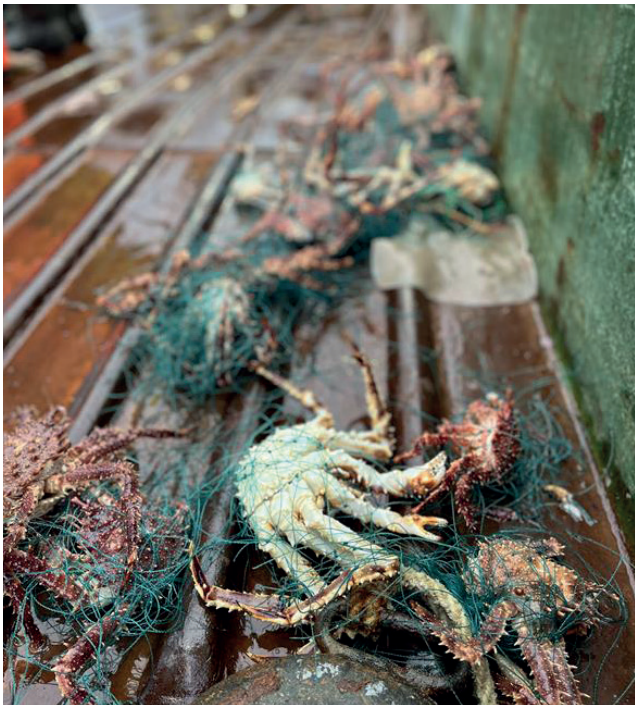
The Directorate of Fisheries has conducted annual operations for over 40 years to clear the seabed of lost and abandoned fishing gear. For many years, ghost fishing was the primary focus of this work, but over the past decade, marine litter has become an increasingly important part of the effort. With this, Norway has the world's longest continuous time series on gear retrieval, and the knowledge held by the Directorate of Fisheries will be highly valuable in developing materials and methods to reduce gear loss.
During the period 6th-11th October 2024, partners from Dsolve and UiT students joined the Directorate of Fisheries on an expedition along the coast of Troms and Finnmark to map and investigate ghost fishing. We examined locations where fishers had reported lost gear and then conducted systematic measurements of the retrieved gear and catch. The catches included both new and old fishing gear—131 king crab pots and several gillnets in total, containing both live animals and remains of dead and decayed catches.
To develop new materials, it is crucial to understand how ghost fishing occurs. In this way, we will be able to convince fishers to adopt the knowledge we gain and to use gear made from new biodegradable materials once they become available on the commercial market.

PhD Candidates

Anja Helene Alvestad – The Faculty of Biosciences, Fisheries and Economics (BFE), Norwegian College of Fishery Science, UiT. Project period: 2024-2026.
This PhD research focuses on evaluating the performance of fishing gear made from biodegradable plastic materials in comparison to those made from traditional plastics. Additionally, it examines the mechanical properties of these materials, including tensile strength and degradation rate.

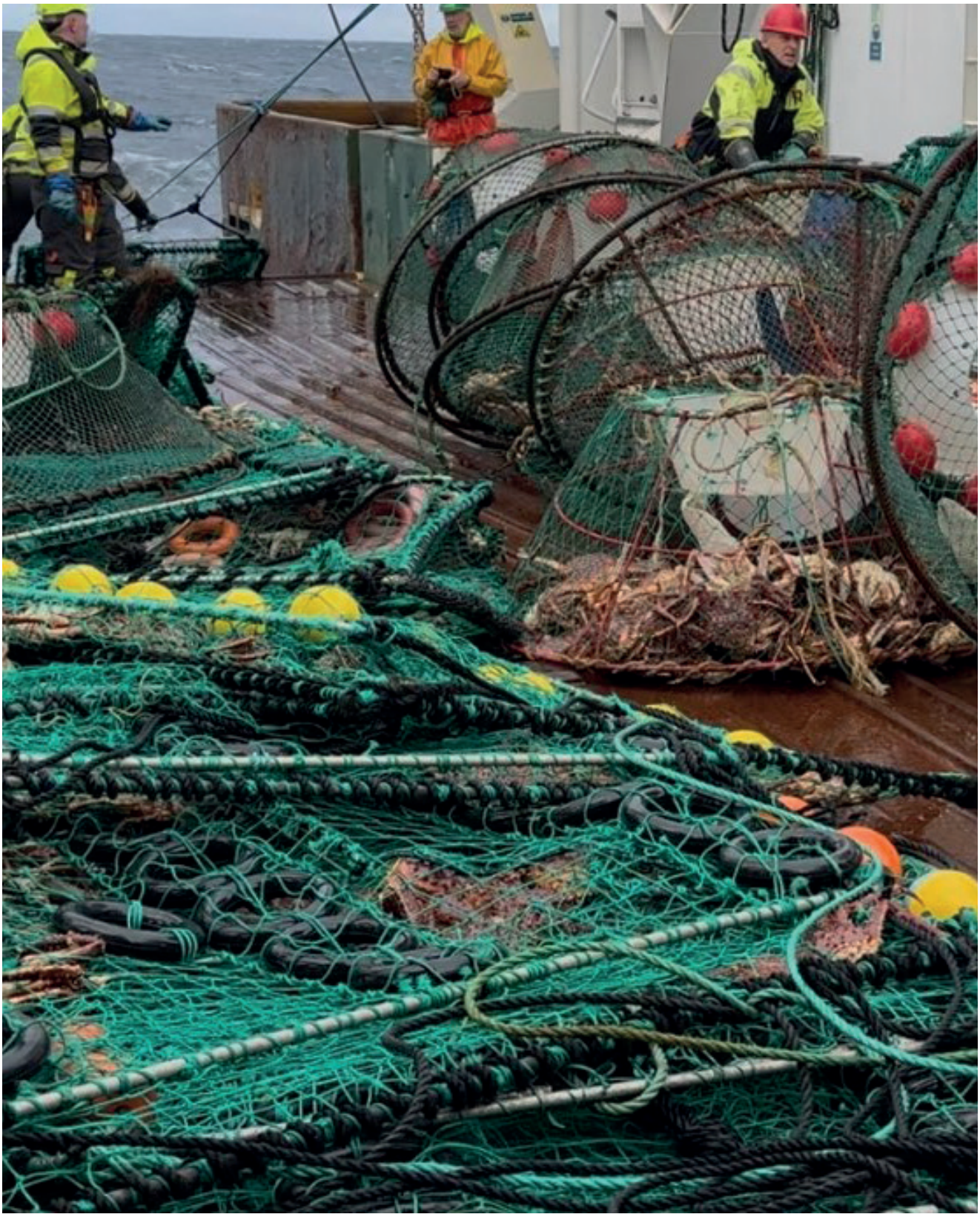
Looking towards a better future.

Photo: Anja Alvestad, SINTEF Ocean



Ghost nets containing live and dead marine life.

Photo: Anja Alvestad, SINTEF Ocean



Ghost king crab pots hauled during the retrieval operation with RV "Helmer Hanssen". October 2024.

Photo: Gjermund Langedal, Directorate of Fisheries

RA 4 Governance Incentives

Objectives and motivation

The central objectives of Research Area 4 (RA4) are to:

- Assess the economic effects of non-biodegradable materials used in fisheries and aquaculture.
- Determine costs and benefits related to ecosystem services from introducing biodegradable materials in the fisheries and aquaculture industries.
- Investigate institutional incentives to increase the use of biodegradable applications used in marine industries and help in supporting the public support systems to reduce risk and promote the implementation of biodegradable innovations.

The motivation for these objectives is to broaden our understanding of the consequences of non-biodegradables materials in fisheries and aquaculture to also include economic aspects. Furthermore, this work will provide input into how these consequences could be lessened by governance actions.

Key research tasks

RA 4's research tasks are closely linked to the objectives. Early tasks have therefore focused on ghost fishing, as a central consequence of non-biodegradables in fisheries, specifically involving gathering relevant knowledge and data, especially to determine the costs of non-biodegradable fishing gear. Though some research regarding fisheries remains, with new personnel hired (a post doc and a PhD), much of the focus of RA 4 will shift over to plastics related to aquaculture:

- Publish and develop papers on fisheries and plastics.
- Develop surveys for the general public and consumers related to biodegradable fishing gear in fisheries (funded by Handelens Miljøfond) on the willingness to accept compensation by fishers for using biodegradable fishing gear.
- Develop popular science articles based on output from fisher surveys.

Achievements

Published and accepted papers

- Standal, D. and Hersoug, B.: Walking sideways? Management of the Norwegian snow crab fishery Marine Policy Vol 165, 2024.

Presentations:

- Huu-Luat Do: Competitive pressure and the adoption of biodegradable fishing gear. Nordic Annual Environmental and Resource Economics (NAERE) workshop in Bergen, 2024
- Huu-Luat Do: A bio-economic model of ghost fishing with an application to the Norwegian snow crab fishery. International Institute of Fisheries Economics & Trade (IIFET) Conference, Malaysia, 2024.

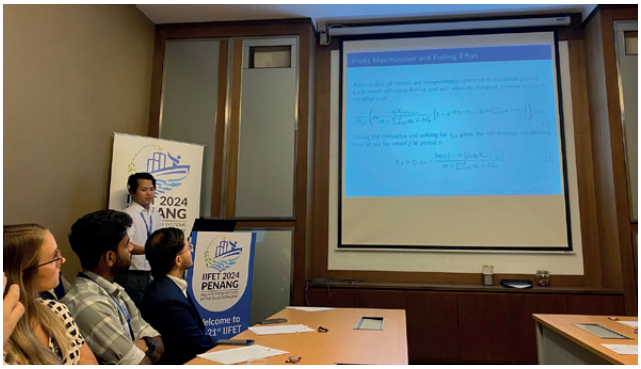


Photo: Dsolve

Newspaper articles:

Tapt redskap - hva mener fiskere? Armstrong, Do, Larsen, Fiskeribladet, January 2024 Tapt fiskeredskap – hva mener fiskere? | Fiskeribladet

Opinion:

Lost fishing gear – what do fishers think? Armstrong, Do, Larsen, World Fishing, February 2024. Opinion: Lost fishing gear – what do fishers think? | News | World Fishing

Some results from the fisher survey regarding fishing gear losses

From the survey of Norwegian fishers Figure 1 illustrates the primary reasons for fishing gear losses. Accidents and the type of bottom environment were the top causes of gear loss reported by fishers, followed by poor equipment and weather. These causes also reflect the specific characteristics of Norwegian fisheries and ocean areas, in which challenging weather conditions and complex underwater terrain are prevalent. Therefore, potential governance measures to decrease abandoned, lost and otherwise discarded fishing gear (ALDFG) may involve limiting the possibilities for fishing in adverse weather conditions and areas prone to gear entanglement, as well as improving the quality of fishing gear. High density of vessels is rarely seen to contribute to fishing gear losses, which may reflect management and the declining number of fishing vessels in Norwegian fisheries.

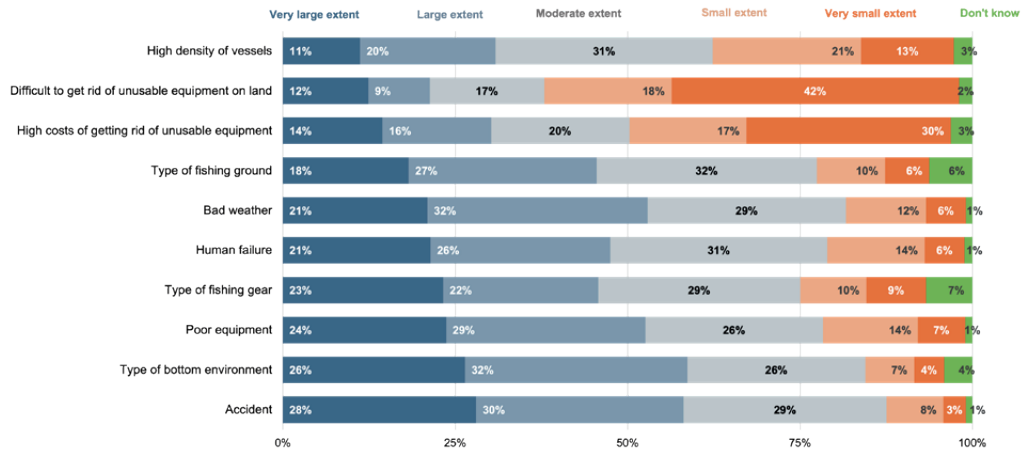


Figure 1. Causes of fishing gear losses

In Figure 2 Norwegian fishers express the most concern about ghost fishing, marine plastic pollution, and damage to marine animals and environment as consequences of fishing gear losses. ALDFG was seen to have a lesser impact on fishing activity and safety at sea.

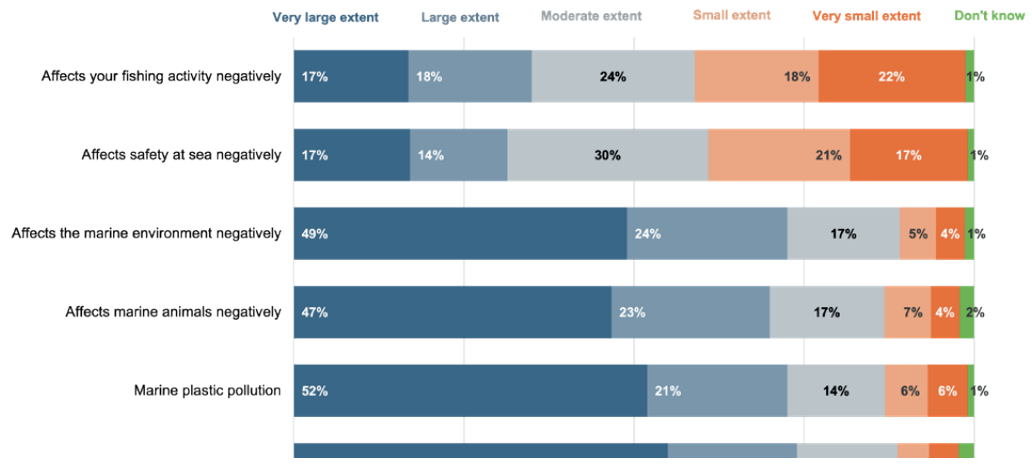


Figure 2. Consequences of fishing gear losses

Fishers were also asked why they thought their colleagues may not report lost gear, with the most frequently mentioned reason being laziness and fear of consequences. Fishers expressed concerns about the financial burden of gear retrieval and time-consuming paperwork and communication connected to official reporting, which could interrupt their fishing activities. Time spent reporting gear loss may therefore lead to economic losses. Fear of penalties or consequences may be assumed associated with lack of awareness, as there are no fees and punishment for reporting lost fishing gear, while not reporting gear losses is illegal. This points to the importance of raising fishers' awareness of ALDFG reporting regulations.

More interestingly, some respondents stated that fishermen might refrain from reporting to avoid embarrassment or damage to their reputation, as lost fishing gear is seen as a sign of incompetence or negligence. Furthermore, inadequate training or outreach related to the ALDFG reporting system was mentioned.

As a potential remedy, fishers were asked about their awareness of biodegradable fishing gear. The result revealed that over 65% of fishers have noted the existence biodegradable fishing gear, while about 35% of the fishers surveyed were not aware of biodegradable fishing gear.

Publications
Brief overview of published or accepted papers in 2024:

Standal, D. and Hersoug, B.: Walking sideways? Management of the Norwegian snow crab fishery Marine Policy Vol 165, 2024.

The Norwegian snow crab fishery in the Barents Sea is a novel fishery. As the snow crab was first observed in the Barents Sea at the end of the 1990's, the commercial fishery started in 2012. In the beginning, only a few vessels participated. However, the numbers of vessels rapidly increased and the Fisheries Directorate allocated more than 60 licenses in the following years, and management rules were implemented. Amongst others, a regime for annual total allowable catch (TAC) was introduced in 2017. The fishery was organized as an Olympic fishery or free fishing within the framework of the annual TAC. This status created a race among the vessels to harvest as large part of the TAC as possible. As the snow crab fishery occurs in very rough conditions along the ice-edge south-east of Bear Island during dark winter months, the stiff competition and weather conditions have contributed to significant environmental problems. Losses of large amounts of crab pots, which contribute to ghost fishing and plastic pollution, have become a hallmark of the snow crab fleet.

In order to solve the problems and increase the sustainability of the snow crab fishery, a further closure of the fishery has thus been high on the fisheries political agenda for the last years.
The article "Walking sideways? Management of the Norwegian snow crab fishery" (Standal and Hersoug, 2024), suggests that the closing of the fishery and the introduction of vessel quotas will be paramount to reduce the harsh competition and hence contribute to reduce losses of crab pots, ghost fishing and plastic pollution. In this article, different models for how the closing process may occur are outlined, including activity demands for further participation and an overall framework for the future quota system to achieve a more sustainable snow crab fishery.

Key researchers
Dag Standal (SINTEF)
Claire Armstrong (UiT The Arctic University of Norway)

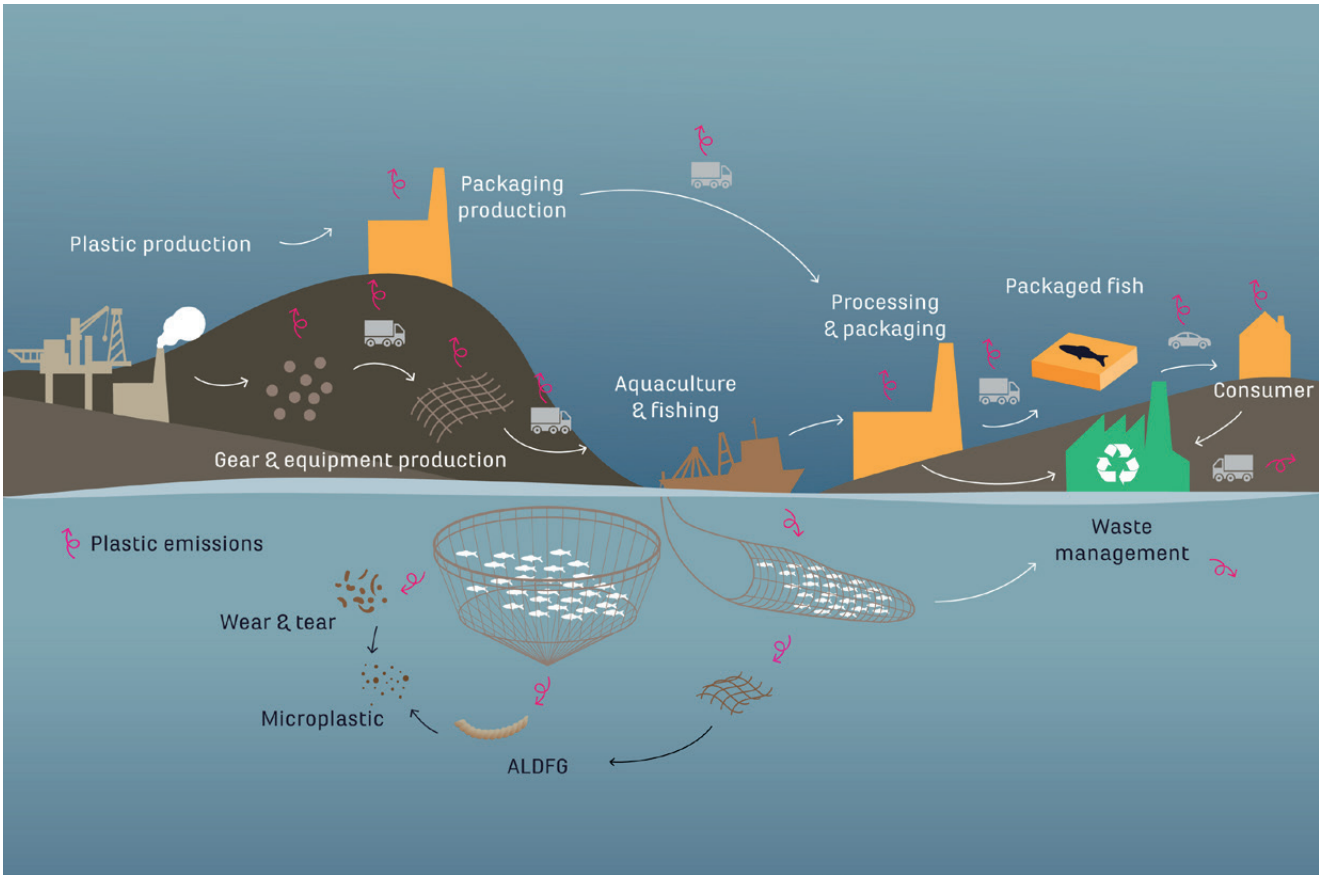
PhD candidates and Master students at UiT
PhD candidate Huu-Luat Do
PhD candidate Lorenzo Mucciarelli (quit August 2024)

Objectives and motivation

Ghost fishing and plastic littering caused by losses of gear from fishing and aquaculture are environmental problems causing impacts on marine ecosystems. These impacts are only partially understood and due to the longevity and strength of this gear, these problems accumulate over time, meaning that the impacts from these losses are occurduring the long lives of the durable materials they are made from.

Knowledge about the recyclability of the plastics used in field trials and developed in RA 1, alongside LCA-based sustainability information, will contribute to developing sustainable circular downstream solutions. This knowledge will also benefit the development of future bio-based and biodegradable plastic fishing gear and aquaculture equipment, which will benefit the fishing and aquaculture industries and marine ecosystems.

Understanding key aspects of the value chains involved, using the life cycle assessment (LCA), will enable the value chain partners involved in Dsolve to understand the positive and negative impacts associated with different materials that can be used to develop innovative solutions to the ghost fishing challenge.



Plastic emissions included in the Dsolve project environmental LCA (E-LCA) model
(Concept and illustration a collaboration between Cecilia Askham, NORSUS and Natalie Borgersen Illustration & Design)

Key research tasks

- Define the status quo for the material flow of fishing gears on a national and regional level to document the proportion of used fishing gear delivered for further processing and depositing, loss of mass due to wear, and both documented and undocumented loss of gear.

- Perform LCA assessments of specific fishing gear systems and materials, taking into account the entire value chain from production to end-of-life in order to:

    - Develop circular value chains
    - Enable increased and environmentally beneficial recycling
    - Assess the potential leak of plastics in the sea from both non-degradable and degradable plastics, and their potential environmental effects.
    - Provide information and new knowledge in order to achieve interactive processes for developing sustainable systems.

- Identify research gaps.

- Contribute to development of the LCA methodology to include plastic losses and marine litter, in collaboration with MarILCA (https://marilca.org/), as well as contribute to the UNEP Life Cycle Initiative GLAM (Global Guidance for Life Cycle Impact Assessment Indicators and Methods).

Achievements for 2024

During Dsolve, RA 5 has mapped the amount of plastic fishing gear and aquaculture equipment that leaks from fisheries and aquaculture activities in Norway. We have developed LCA models for conventional and biodegradable plastic fishing gear, including downstream waste management solutions. We have also identified relevant aquaculture equipment for potential substitution with biodegradable materials. Data for two types of biodegradable plastic have been implemented into the model. The results from the first biodegradable plastic were shared with project partners in 2024. The results for the second type of biodegradable plastic will be shared in 2025. In 2024 NORSUS worked on the LCA study for conventional and biodegradable plastic aquaculture equipment, including data gathering for downstream waste management solutions. We collaborated with Norner and Sintef Ocean (RA 1 and RA 3) to plan recyclability trials for 2025. We also shared and increased knowledge, competence and capacity related to LCA-based sustainability assessments of biodegradable plastics for exploitation of marine resources with the project group and internationally.
Dorian Vodopia's PhD work has progressed well in 2024, resulting in one published paper and several others in the pipeline.

The scientific activities and results performed in 2024 are listed below:

- NORSUS collaborated with Salmar to ensure that daily lines were the relevant plastic ropes that could be replaced by biodegradable plastic.
- All of the gear producing partners were canvassed about their interest in developing environmental product declarations based on the LCA-model developed in Dsolve.
- Norner performed a literature review about the recyclability of biodegradable plastics.
- NORSUS/Norner and SINTEF Ocean planned recyclability trials for biodegradable materials pre- and post-field trials.
- Based on data gathering with waste management actors for fishing and aquaculture gear, the E-LCA model was refined and updated.
- A survey of stakeholders in the Dsolve project was developed and carried out at the annual meeting with all of the participants. These included project partners from academia, industry (both fishing and plastic), industry organisations and governmental organisations. This will contribute to the social-LCA paper to be submitted to a journal in 2025.
- NORSUS has identified potential other biobased and biodegradable material scenarios that the E-LCA model can be used to analyse, based on inputs from the research partners. This will enable the E-LCA model to be expanded in 2025 to include other bio-based materials for comparison with conventional plastic and the first biodegradable plastic case.
- NORSUS researchers Cecilia Askham, Mafalda Silva and Valentina Pauna are collaborating other researchers involved in the Marine Litter Impacts in LCA project under the United Nations environment programme's (UNEP's) life cycle initiative, with the working title: Expanding Life Cycle Impact Assessment to account for marine plastic emissions: a case study for the fishing industry
- Expanding Life Cycle Impact Assessment to account for marine plastic emissions: a case study for the fishing industry including a Peruvian anchoveta case and the Dsolve gillnets case was presented by Cecilia Askham at the scientific conference LCA Food in Barcelona in September 2024.
- Cecilia Askham presented Weighting Factors for LCA – A New Set from a Global Survey, work developed as part of her co-chair role for the Weighting subtask of the United Nations Environment Programme (UNEP) Life Cycle Initiative's Global Guidance for Life Cycle Impact Assessment Indicators and Methods (GLAM) at SETAC - Society of Environmental Toxicology and Chemistry Europe's annual conference in Seville in May 2024. This work will be important in the Dsolve project for weighting of different impacts calculated for the different types of gear analysed with the E-LCA models developed for Dsolve.
- Cecilia Askham has published the paper Weighting factors for LCA—a new set from a global survey, in The International Journals of Life Cycle Assessment. DOI: 10.1007/s11367-024-02330-w
- Nora Løvdal Gamnes (NTNU) started her Masters project in 2024. The working title of her thesis is: Mapping additives in plastic components of conventional fishing gear to learn how they affect the marine environment.

The PhD work in 2024

Dorian Vodopia has published a peer-reviewed paper with the title "Retrieval operations of derelict fishing gears give insight on the impact on marine life" in Marine Pollution Bulletin (DOI: 10.1016/j.marpolbul.2024.116268). He has also managed the data gathering work on a second retrieval mission in 2024, enabling master's students and other research partners (including NORSUS) to participate in the data gathering work aboard the research vessel Helmer Hanssen. Additionally, a paper with the working title "Ghost fishing characterization factors for gillnets in the Norwegian marine environment" will be submitted in 2025, as well as a paper related to fieldwork in Croatia. The working title of this paper is "Long-term in-situ assessment of "Ghost Fishing" impacts of gillnets and fish traps in the northern Adriatic Sea".

Dorian's further work in developing factors to quantify impacts on the marine ecosystem (characterisation factors in life cycle impact assessment) is of great interest to researchers internationally.

Dorian Vodopia attended the retrieval mission on the RV "Helmer Hanssen", December 2024.
Photo: Valentina Pauna, NORSUS

PhD student Anja Alvestad (RA 3) explaining the difference between male and female king crabs onboard the RV "Helmer Hansen". Photo: Valentina Pauna, NORSUS
Photo: Valentina Pauna, NORSUS

Master student Nora Løvdal Gamnes, NTNU is writing her master thesis on additives in plastic fishing gear components.
Photo: Nora Løvdal Gamnes

International Cooperation

Cecilia Askham continues her work as co-chair of the weighting subtask under the UNEP LC-Initiative GLAM project. Valentina Pauna continues her co-chair role in the SETAC plastics interest group and will continue to contribute to the Plastic Footprint Network (PFN) concerning fishing and aquaculture littering.

The MarILCA project collabaoration continues with work on the collaboration paper Expanding Life Cycle Impact Assessment to account for marine plastic emissions: a case study for the fishing industry, to be submitted for publication in 2025. There is also large interest from MarILCA about Dorian's PhD on the impacts of ghost fishing on the marine ecosystem.

Communication and Dissemination Activities

As shown in the previous scientific activities section, RA 5 work is being disseminated through peer-reviewed publications and conferences, as well as popular science articles on the Dsolve and NORSUS websites. The international collaboration arenas, such as the GLAM and MarILCA projects under the UN Life Cycle Initiative and SETAC plastic interest group, as well as the PFN, contribute to using the forefront of LCA methodology research within the Dsolve work and the Dsolve work contributing to moving the research forward internationally. The PhD work on including Ghost fishing in life cycle impact assessment is also of international interest and will be communicated as the work progresses.

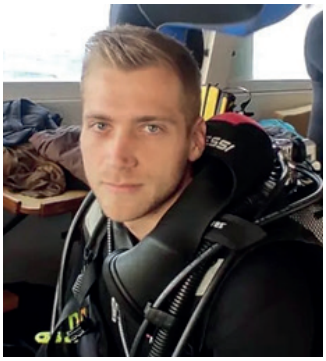
Dorian Vodopia communicated his research (popular science communication, public dissemination, and seminar activities at regional universities) in 2024; some of this communication activity took place in Croatia, as well as Norway.

Participants at the RV "Helmer Hansen" retrieval operation ready to register lost fishing gear. From the left: Gjermund Langedal (The Directorate of Fisheries) Dorian Vodopia (UiT), Valentina Pauna (NORSUS), Olav Lekve and Hilde Sofie Berg (The Directorate of Fisheries), Maria Pettersvik Arvnes (The Norwegian Fishermen's Association).

Photo: Dsolve

Key researchers






From the left: Cecilia Askham, Valentina Pauna, Dorian Vodopia and Mafalda Silva.

Photos: NORSUS

RA 6 Communication, Dissemination and Exploitation

Objectives and motivation

The results of CRI Dsolve will provide valuable scientific knowledge on biodegradable products necessary for the sustainable, circular economy. The work undertaken by Dsolve is essential for advancing the research, innovation, documentation and design of these novel products. The resulting innovations will be important to enhance Norway`s leading position in global fishery and aquaculture and reflect its ambition to be at the forefront of research and innovation on marine plastic pollution. Research Area 6 (RA6) will develop and carry out a dynamic plan for outreach through communication, dissemination and exploitation of results to maximize the impact of the CRI. Dialogue with affected industries and stakeholders through seminars, workshops, and networking is particularly emphasized. Further dissemination will be through a publicly accessible website https://dsolve-sfi.no/ and social media, as well as publications in specialized journals and magazines, presentations, press releases, popular science publications, video and other media productions. The Research Area is led by UiT and carried out in cooperation with Salt Lofoten AS (SALT).

Through the activities in RA6, the CRI has adopted a comprehensive communication approach, aimed at maximizing the visibility of the Centre, its goals, challenges and results. The communication agenda aims to make the results visible to stakeholders, including the industrial and the scientific community, authorities, policy makers, and the public. The concrete objectives of RA 6 can be described as:

- Develop and apply actions to maximize the impact of CRI research.
- Ensure a wide dissemination and uptake of results for the CRI.
- Ensure a close relationship between the academic community and industrial partners and facilitate the exploitation of results and the transfer of technology.

A dynamic dissemination and exploitation plan (DEP) was developed in a preliminary phase of the CRI and regularly updated throughout the Centre's life span. The main communication activities for each year are described in the respective annual plans and publication plans, including a) the participation in conferences, trade-fairs and in national and international exhibitions; b) specifications about the promotion channels to be used; c) timing for outreach activities and raising awareness of the results, and d) partners responsible for the various activities. The key research tasks for RA 6 and achievements in 2024 are presented below.

Key Research tasks

- Dissemination
- Communication
- Exploitation of results

Achievements for 2024

Dissemination Activities

- Communication & Dissemination Plan 2021-2028
- Social media strategy/publication plan, and Annual plan 2024
- Newsletters
- CRI Dsolve video (new)
- Web site and social media updates
- Nor-Fishing
- Popular Science publications

The new and improved CRI website that was launched in the late autumn 2023 has been continuously updated and developed throughout 2024, with news from the Centre and research results continuously published on the site, with both scientific and popular science articles. A total of five newsletters have been produced and distributed in both Norwegian and English language, with the possibility to sign up on the CRI website. The newsletters contain updates on the work and progress of the CRI. In addition, a new CRI promotion video has been produced with the contributions of all research partners. The video focuses on the research and development process of new biodegradable materials and fishing gear – from polymer development to gear production and testing. An interactive popular science article targeting end users in the fishery sector was produced and distributed in cooperation with industry partner Norges Råfisklag (The Norwegian Fishermen's Sales Organisation), focusing on the development of new material solutions, and the future implementation of biodegradable fishing gear in the Norwegian fisheries. Further, material samples and samples of biodegradable fishing gear and ropes, were introduced for end users at the Nor-Fishing 2025 fishery trade fair in cooperation with RA3 and industry partner Norges Fiskarlag (The Norwegian Fishermens Association), along with an interview presentation of test results and the development status. The presentation was held at the joint fishery stand hosted by two sales organizations in the fishery sector and Norges Fiskarlag, as part of the topic "What the fishery sector do to combat marine litter". In addition to the website production, the CRI social media have been continuously updated throughout 2024. Due to international circumstances and the development of this channel, the use of X for promoting CRI Dsolve have been gradually reduced and is to be dismissed from 2025.

Communication activities

- Social media (SoMe) and web production; Facebook, LinkedIn, X
- Social media templates for industry and research partners
- Partner workshops

Social media content, such as news reports from the project and videos etc, have been produced and published continuously throughout 2024. A set of social media templates have additionally been produced and distributed to all the CRI partners for the use of promoting Dsolve in their respective social media. Social media templates are produced in both a Norwegian and English version, consisting of 18 Norwegian and 13 English graphical illustrations describing the organization and objectives of Dsolve, as well as explaining biodegradable plastics and the impact of lost fishing gear.
Three partner-worhshops have been organized throughout the year and hosted by the respective research areas. A fourth workshop was planed but postponed to January 2025. These digital partner workshops invite everyone involved in the project nationally as well as internationally, to join for research updates and discussions.

Exploitation of results

- Annual Report 2023
- News articles
- Research Summaries (popular science)
- Conferences and events

CRI results have been presented at several national or international conferences, fairs, meeting, workshops and events in 2024 by research partners, where RA6 role has been to help facilitation the Centers contributions in cooperation with partners, and/or to disseminate the CRIs contributions on web page and social media. Activities include an interview presentation at Nor-Fishing 21st of August (RA3) as described above, as well as visibility of the Centre and biodegradable fishing gear at stand in cooperation with partners. Further amongst other, The Arctic Congress in Bodø 31.05.24 (RA2 and RA6), Håp i Havet, Tromsø 08.02.24, Skreikonferansen in Myre 6th of March where Dsolve hosted a seminar onboard the RV "Helmer Hansen" and SETAC Europe in Sevilla at the 5th – 9th of May (RA 5 and RA 2). Further events are described in the report summary. Dissemination also included the joint retrieval expedition in cooperation with The Norwegian Directorate of Fisheries that took place from the 6th -11th of October, and which was communicated in cooperation with the Directorate. Several news articles have been produced and published at the CRI website throughout the year, including research summaries of scientific articles published by Dsolve. Such summaries are made for popular science purposes. RA 6 has also been responsible for summarizing the Dsolve annual report.

Some of our Dissemination activities in 2024

CRI Video

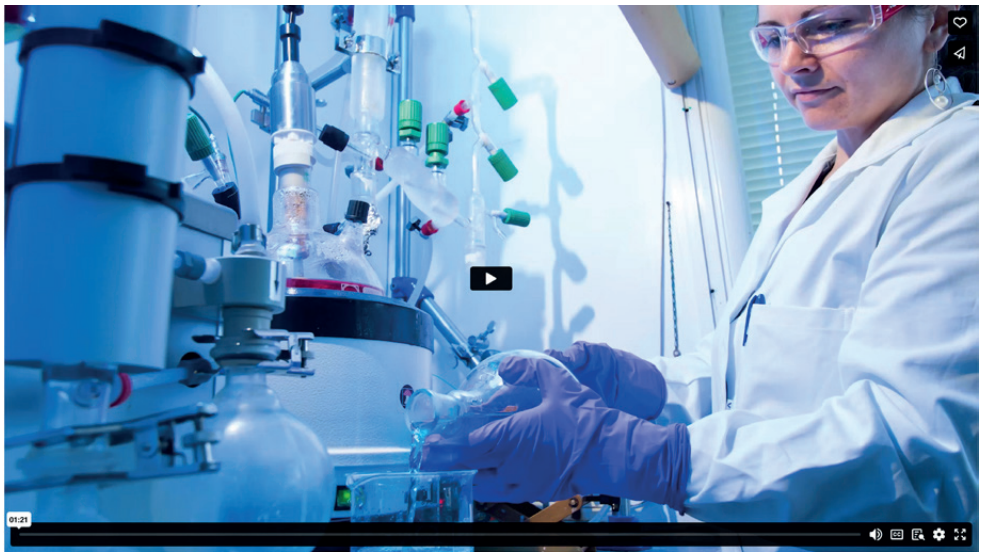


Photo: SINTEF, Werner Juvik

A new CRI Dsolve promotion video was produced in cooperation with both research and industry partners, to show the research and process of developing new biodegradable material solutions. The video is available in both Norwegian and English language and published on both CRI website and Vimeo. The video is also available for partners and is being used for presentation purposes as well as shared in conferences and events.

Social Media Templates

Illustration: SALT, Dsolve

Several graphical templates are made available for CRI partners to promote Dsolve in social media and web sites. The templates, both in Norwegian and English language, are focusing on the organization and objectives of Dsolve, as well as explaining biodegradable plastics and the impact of lost fishing gear.

Research Summaries

Research summaries of the scientific articles "Retrieval operations of derelict fishing gears give insight on the impact on marine life" (https://doi.org/10.1016/j.marpolbul.2024.116268), and "Effect of gillnet twine thickness on capture pattern and efficiency in the Northeast-Arctic" (https://doi.org/10.1016/j.marpolbul.2023.114927) have been produced and published at the Dsolve web site. Additional research summaries produced by Dsolve scientists, have also been published. These summaries aim at making scientific results more available for a broader audience, including the press.

Illustration: SALT, Dsolve

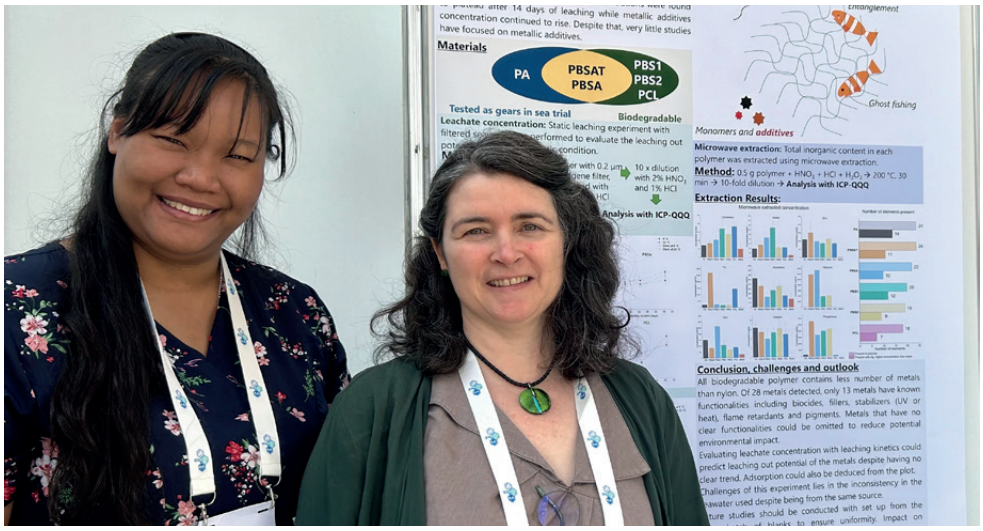


Photo: NORSUS

In cooperation with CRI partners NORSUS and SINTEF (RA 2 and RA 5), Dsolve presented four posters at the SETAC (Society of Environmental Toxicology and Chemistry) Europe annual meeting in Seville 5th – 9th of May. One poster also received Poster Spotlight.

The RV "Helmer Hanssen".
Photo: UiT

"Skrei" is the name of the North Atlantic cod wandering to the shore of Lofoten and Vesterålen to spawn each winter. During the annual Skrei Conference in Myre, CRI Dsolve at the 6th of March, in collaboration with FHF, DNB, the Institute of Marine Research, Indeks Nordland and UiT - The Arctic University of Norway, hosted a seminar onboard the RV "Helmer Hanssen". The seminar, among other things, offered presentations on the topics; "Plastic in the sea - why should we do something about it?", by Center leader Roger Larsen, and "Alternatives to plastic in danish seines", by RA 3 leader Jørgen Vollstad from SINTEF Ocean.

Personnel

Key Researchers

NAME	INSTITUTION	MAIN RESEARCH AREA
Roger B. Larsen	UiT	Centre leader
Claire Armstrong	UiT	Leader RA 4. Bioeconomic modelling
Hilde Rødås Johnsen	UiT	Leader RA 6
Valentina Pauna	UIT/NORSUS	Supervisor
Ravindra Reddy Chowreddy	Norner Research AS	Leader RA 1
Vihn Cao	Norner Research AS	Polymer rheology (RA1)
Siw Fredriksen	Norner Research AS	Sustainable feedstocks and bioplastics (RA1)
Hany Anwar	Norner Research AS	Polymer modifications, additives (RA1)
Christian Karl	SINTEF Industry	Leader RA 2. Materials and nanotechnology, polymer and composite materials (RA1)
Stephan Kubowicz	SINTEF Industry	Microplastics/polymer characterization
Anna-Maria Persson	SINTEF Industry	Polymer characterization (RA 2)
Bjørnar Arstad	SINTEF Industry	Polymer characterization (RA 2)
Szymon Bernat	SINTEF Industry	Polymer characterization (RA 2)
Lisbet Sørensen	SINTEF Ocean	Analytical chemistry (RA 2)
Amaia Igartua	SINTEF Ocean	Environmental chemistry (RA 2)
Sigrid Hakvåg	SINTEF Ocean	Microbial biodegradation and microbiome analyses (RA 2)
Heidi Moe Føre	SINTEF Ocean	Structural engineering (RA 2)
Dag Standal	SINTEF Ocean	Structural Engineering
Cecilia Askham	NORSUS	Leader RA 5
Mafalda Silva	NORSUS	RA 5
Ellen-Marie Forsberg	NORSUS	Board member
Francesca Verones	NTNU	Supervision RA 5
Jørgen Vollstad	SINTEF Ocean	Leader RA 3, Fishing gear
Ludvig Kraag	DTU Aqua	Fishing Gear
Esther Savina	DTU Aqua	Fishing Gear, Gillnets
Rikke P. Frandsen	DTU Aqua	Fishing Gear/Fisheries
Jure Brčić	University of Split	Fishing Gear/Fisheries
Mirela Petrić	University of Split	Fishing Gear/Fisheries
Željka Trumbić	University of Split	Fishing Gear/Fisheries
Svjetlana Krstulović Šifner	University of Split	Fishing Gear/Fisheries
Juan Santos	Thünen Institute	Fishing Gear Technology
Daniel Stepputtis	Thünen Institute	Fishing Gear Technology
Ulf Böttcher	Thünen Institute	Fishing Gear Technology

Key Personell

NAME	INSTITUTION	MAIN RESEARCH AREA
Hanne Risan Johnsen	UiT	Administration
Terje E. Martinussen		Leader of the board
Terje M. Aspen	UiT	Faculty BFE director, Board member
Ivan Tatone	UiT	Technician, RA 3
Ilmar Brinkhof	UiT	Technician, RA 3
Thor Kamfjord	Norner Research	Board member
Ole Jan Mhyre	Norner Research	Advisor, Technical support
Valeriya Føreland	Norner Research	Administration support
Sveinung Aasetre	Norner Research	Senior Engineer, Compounding and injection molding
Heidi Houghton	Norner Research	Senior Engineer, Mechanical testing
Ingeborg Paus Wik	Norner Research	Senior Engineer, Thermal analysis
Bård Wathne Tveiten	SINTEF Ocean	Board member
Einar Hinrichsen	SINTEF Industry	Board member
Niclas Risvoll	SALT (subcontractor)	Web and graphics RA 6
Anders Balteskard	SALT (subcontractor)	Web and graphics RA 6
Vilde Sørnes Solbakken	SALT (subcontractor)	Communication and outreach RA 6
Helene Skjeie Thorstensen	SALT (subcontractor)	Communication and outreach RA 6
Tomas Brage	SALT (subcontractor)	Communication and outreach RA 6
Malin Jacob	SALT (subcontractor)	Communication and outreach RA 6
Terje Lindal	Mørenot	Fishing gear supplier
Gunnar Kupen	NOFI	Fishing gear supplier
Olav Småbakk	NOFI	Fishing gear supplier
Stig-Endre Elvevoll	Løvold	Gear supplier. Innovation Board
Rune Sand	Tustern	Fisheries
Ståle Dyb	Loran	Fisheries
Sigve Drønen	Opilio	Fisheries
Arne Birkeland	Opilio	Fisheries
Mikal Solhaug	M. Solhaug	Fisheries
Kristian J. K. Kalgraff	Legøy Rederi	Fisheries
Signor Antonsen	Hermes	Fisheries
Jan Roger Lerbukt	Hermes	Fisheries
Åsmund Breivik	Hermes	Fisheries
Brynjar Bangsund	Østkapp	Fisheries
Øystein Enoksen	Vardøyfisk II	Fisheries
Rita Karlsen	BR Karlsen	Fisheries and aquaculture
Randi Karlsen	BR Karlsen	Fisheries and aquaculture
Håvard Olsen	Kvarøy Fiskeoppdrett	Aquaculture
Alf Jostein Skjærvik	SalMar ASA	Aquaculture
Maria Sparboe	SalMar ASA	Aquaculture

Key Personell

NAME	INSTITUTION	MAIN RESEARCH AREA
Maria Pettersvik Arvnes	The Norwegian Fishermen's Association	RA 6, End users
Benedicte Nielsen	The Norwegian Fishermen`s Sales Organisation	RA 6, End users
Thor Kalsaas	The Norwegian Fishermen's Sales Organisation	RA 6, End users
Gunn Norvik	The Norwegian Fishermen's Sales Organisation	RA 6, End users
Lisbeth Drotz	The Norwegian Fishermen's Sales Organisation	RA 6, End users
Aida Campos	IPMA	International Advisory Board
Haraldur Einarsson	Marine & Freshwater Research Institure	International Advisory Board
Paul Winger	Marine Institute	International Advisory Board
Gjermund Langedal	Fiskeridirektoratet	External Advisory Board
Anne Katrin Normann	Senter for Hav og Arktis	External Advisory Board
Bent Gabrielsen	Øra	Fisheries. Innovation Board
Lasse Rindahl	Mustad Autoline	Innovation Board
Jahn N. Hoel	Mustad Autoline	Innovation Board
Jake Chang	LG Chem	Bio-Business development
Ryan Yoon LG Chem Bio-Business development	LG Chem	Bio-Business development
Kim Sei-Hoon	S-EnPol Company	Biodegradable Polymer R&D

PhD candidates with financial support from the Centre budget

NAME	NATIONALITY	PERIOD	S E X M/F	TOPIC
Kristine Cerbule	Latvian	2021-2024	F	RA 3 Field experiments with gillnets, longlines, and crab pots in Norway (Arctic), Denmark and Croatia. The focus is on efficiency and catch patterns when changing from petro-based to biodegradable gears.
Huu-Luat Do	Vietnamese	2021-2025	M	RA4. Modeling social costs and optimal management of ghost fishing.
Dorian Vodopia	Croatian	2023-2027	M	RA5. Inclusion of ghost fishing and its effects on ecosystems and biodiversity in life cycle impact assessment (LCIA).
Waranya Wataniyakun	Thai	2022-2026	F	RA 2. Marine biodegradation of polymers used for fishing gear.
Anja Alvestad	Norwegian	2023-2027	F	RA3. Performance and mechanical properties of biodegradable fishing gear compared to traditional plastics.

Master degrees

Name	Period	Sex M/F	Topic
Nora Løvdal Gamnes	2024 – 2025	F	Mapping additives in plastic components of conventional fishing gear to learn how they affect the marine environment.
Dag Støme	2023-2024	M	Capture technology for humpback salmon
Simon Eliseussen	2023-2024	M	Capture technology for humpback salmon

Accounts

Funding (1000 NOK)	Amount
The Research Council	11 328
The host institution, UiT	11 589
Research partners*	615
Industry partners**	18 337
Organizational partners***	206
Total	**42075**

Costs (1000 NOK)	Amount
The host institution, UiT	15 586
Research partners	7878
Industry partners	18 475
Organizational partners	136
Equipment	8 500
Total	**42 075**

* SINTEF Ocean, SINTEF Industry, Norner Research AS, NORSUS, University of Split, Thünen Institute of Baltic Sea Fisheries, and DTU-Aqua

** Hermes, KvarøyFiskeoppdrettAS, LG Chem, Løvold AS, Mustad Autoline AS, Mørenot Fishery AS, NOFI, Tustern AS, Øra AS, and S-EnPol

*** The Norwegian Fishermen's Association, The Norwegian Fishermen's Sales Organisation

Photo: Erling Svensen

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Chowreddy, R., Intermediate technical report with summary of 1st round of materials development for moulding applications, Norner Research AS, 13.02.25, deliverable D3.1

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