2020
Annual report

SFI HARVEST

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SINTEF Ocean

Content

Summary

The ocean hosts a large number of species that could improve food security but that are currently either not harvested or only marginally utilised. In 2020, the Harvest Centre for research-based innovation- SFI Harvest- was funded through the Research Council of Norway's SFI scheme. The main objective of SFI Harvest is to develop knowledge and technologies for responsible harvesting and processing of lower trophic marine resources, allowing sustainable growth of Norway's biomarine industries.

SFI Harvest will draw upon Norway's leading position in the ocean and offshore sectors, bringing together pioneering shipowners, key technology providers, large producers of raw materials and feed for the aquaculture sector, stake-holders, SINTEF, Nofima and other excellent research groups at NMBU, UiT and NTNU, including SFF AMOS. The innovations will enable precise and efficient capture and processing of mesopelagic species, zooplankton and phytoplankton. The centre's industry partners will form an innovation board to speed up the time-to-market of innovations based on the centre's activities.

The centre integrates six research areas: Survey technology, Ecosystem dynamics, Decision support, Harvesting technology, Product development, and Fisheries management and business models. The main outcomes of the centre's activities will be sensor technology for cost-efficient mapping and monitoring of marine species, a model predicting good fishing grounds and variability in the ecosystem, decision support allowing fishermen to save fuel and time while predicting catch potential, selective and energy-efficient fishing gears, on-board processing lines for separating the catch by species while preserving quality, rapid catch quality measurement, new land-based feed and food ingredient processes, guidelines for resource allocation and vertical value chain coordination, and a sustainability assessment tool for value chains. They will enable the sustainable harvesting of new marine species and the establishment of a new biomarine value chain.

Further, the centre will enable Norway to lead the technological development for the mesopelagic and low-trophic fisheries, creating new global market opportunities for the centre's industrial partners. The technologies developed will also support cross-over solutions for today's commercial fisheries and for challenges like removing plastic from the oceans.

Centre for Research-based Innovation

Vision and objectives

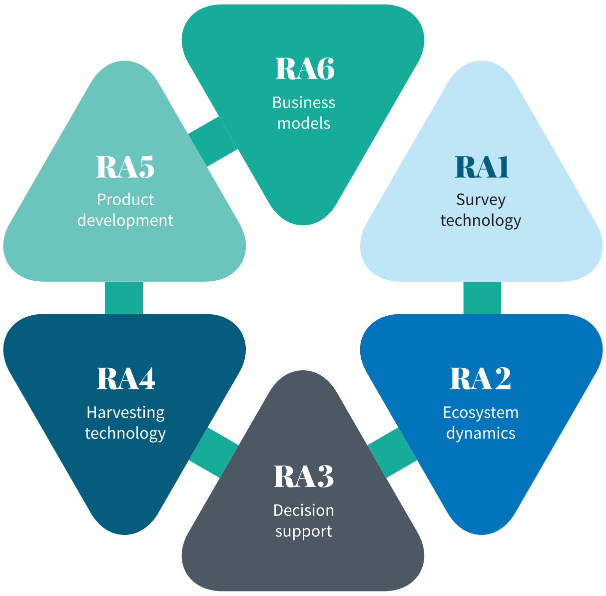
Vision:
Technologies for sustainable biomarine value creation

The **main objective of SFI Harvest** is to develop knowledge and technologies for responsible harvesting and processing of lower trophic marine resources, allowing sustainable growth of Norway's biomarine industries.

The centre will have the following secondary objectives:

- Conduct fundamental and applied research to close key knowledge gaps and enable responsible commercial utilisation of underexploited marine resources.
- Develop new competitive technologies to strengthen Norway's global leading position in fisheries and marine knowledge, expertise, and technology.
- Establish profitable biomarine value chains and business models which are evaluated according to social, biological, and economical sustainability requirements.
- Explore cross-over applications to enable detection and collection of plastic and other polluting materials in the oceans.
- Build knowledge and competence capacity through educating at least 10 PhD candidates, 3 post docs and 20 MSc candidates.

Research plan/strategy



Technologies for sustainable biomarine value creation

SFI HARVEST

SFI Harvest targets technological innovations for the development of responsible fisheries and sustainable business models.

To establish sustainable value chains for exploiting the abundant resources of mesopelagic fish, zooplankton and phytoplankton, new knowledge is needed within six research areas (RA).

Specific objectives for the research areas (RA):

RA1 Develop technology for autonomous vehicles and sensor systems to support mapping and monitoring of underexploited marine resources.

RA2 Understand and predict ecosystem dynamics to provide information and knowledge needed for sustainable fisheries management and harvesting.

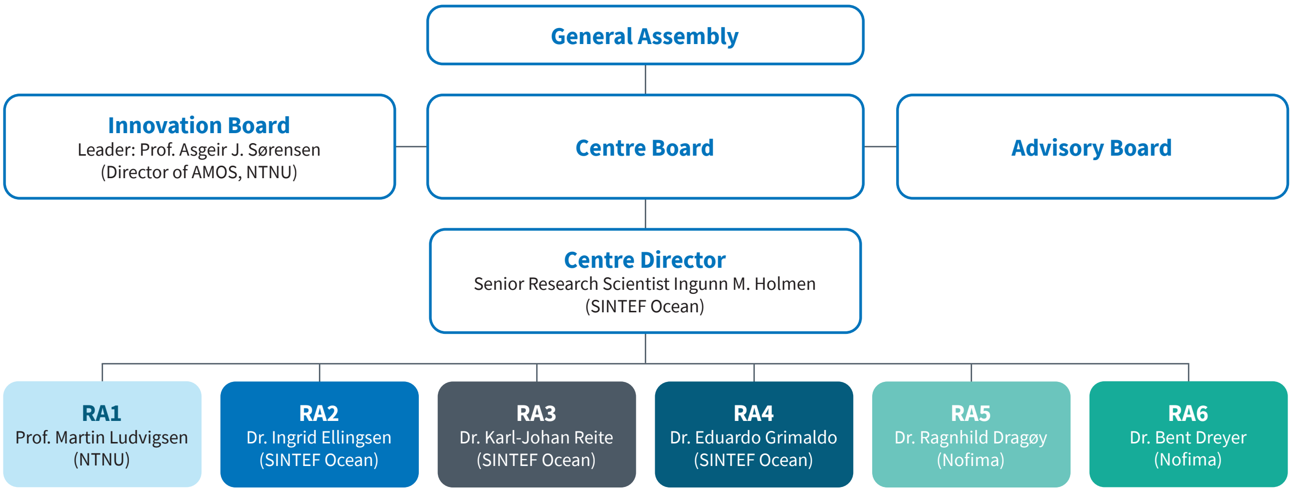
RA3 Develop decision support systems combining ecosystem models and collected data on the marine resources, enabling energy efficient precision fishing.

RA4 Develop cost-efficient and environmentally friendly harvesting and onboard processing technologies.

RA5 Develop sustainable products through cost and energy-efficient processes for on-land processing followed by market introduction.

RA6 Design guidelines for responsible management regimes and construct sustainable business models.

Organisation



Centre organisation.

The centre will be organized as shown in the figure above. The General Assembly, consisting of a representative from each partner, will have the uppermost decision-making power in the centre.

The Centre Board consists of nine members among the centre partners. The Centre Board will decide on organisation, budget, activities and working plans and have the responsibility for the progress and scientific quality of the centre research activities.

The members of the Centre Board (2020–2022)

MEMBER OF CENTRE BOARD	AFFILIATION
SIGVE NORDRUM (chairman)	Aker Biomarine AS
SIGVE DRØNEN	Br. Birkeland AS
FRANK TICHY	Kongsberg Maritime AS
EINAR NIELSEN	PGS Geophysical AS
MADS MARTINSEN	Skretting AS
MONIKA KOPCZYK	ScanBio Marine Group AS
ROAR BJÅNESØY	Norge Sildesalgslag SA
GUNVOR ØIE	SINTEF Ocean AS
DINA ASPEN	NTNU
ANDERS KARLSSON-DRANGSHOLT (observer)	The Research Council of Norway

The Centre Board will be advised by the Innovation Board and the Advisory Board. The Innovation Board is led by Professor Asgeir J. Sørensen, Director of AMOS, NTNU. The Advisory Board will give advice on issues related to ethics, governance, regulations and characteristics of the biomarine value chains.

Senior research scientist Ingunn M. Holmen (SINTEF Ocean) is the Centre Director. The centre management group consists of the Centre Director, Research Area Managers for each of the six RAs and two coordinators:

INGUNN M. HOLMEN
Centre director
SINTEF Ocean

KAJA HAUG
Adm. coordinator
SINTEF Ocean

MARTIN LUDVIGSEN
Manager RA1
NTNU

INGRID ELLINGSEN
Manager RA2
SINTEF Ocean

KARL-JOHAN REITE
Manager RA3
SINTEF Ocean

EDUARDO GRIMALDO
Manager RA4
SINTEF Ocean

RAGNHILD DRAGØY
Manager RA5
Nofima

BENT DREYER
Manager RA6
Nofima

LARS T. KYLLINGSTAD
Coordinator RA1, 2 and 3
SINTEF Ocean

Partners

The centre involves active cooperation between research partners and the Norwegian fishing sector, including fishing companies, technology developers and equipment suppliers, the main governmental body (Directorate of Fisheries) and relevant interest organisations. Addressing the research and innovation challenges in SFI Harvest requires a collaborative effort, sharing and integrating knowledge to develop technology for increased exploitation of low-trophic marine resources. The centre partners represent key user groups, technology providers, and internationally leading research institutes within the relevant fields.
The industry partners have had a leading role in developing the current state-of-the-art concepts. Their collective experience and competence from the fishing and processing industry and marine and maritime sectors cover the identified key research areas.

Industry partners

AKER BIOMARINE	**Aker BioMarine Antarctic AS** Experience and knowledge from many years of harvesting and processing krill. Vessel time for field studies, onboard lab use, metrics and data storage.	(RA1–3, 6)
Br. Birkeland AS	**Br. Birkeland AS** Experience and knowledge on pelagic and mesopelagic fisheries. Vessel time and fishing gear for mesopelagic fish.	(RA1–4, 6)
NORDNES	**Nordnes AS** Knowledge on harvesting mesopelagic species. Vessels time for field studies and validation of new technologies	(RA1, 3, 4, 6)
ScanBio	**ScanBio Marine Group AS** Knowledge on how to ensile, store and transport fish silage, and share experience on production of silage made from mesopelagic fish, as well as three industry-scale productions of fish oil and fish protein concentrates.	(RA4–6)
SKRETTING a Nutreco company	**Skretting AS** Knowledge of feed raw material and nutritional value.	(RA4–6)
KONGSBERG	**Kongsberg Maritime AS** Expertise and systems for communication, control, navigation, decision support and AUVs.	(RA1–4)
PGS	**PGS Geophysical AS** Competence on seismic exploration. Access to marine data and equipment relevant for use in the centre.	(RA1, 3, 4)
NCMC	**Norwegian Centre of Maritime Communication AS (NCMC)** Competence on internal and external communication, including interface between internal equipment over IP with secure remote support.	(RA3)

	Optimar AS Competence and equipment for the development of new processing equipment for mesopelagic fish and Calanus.	(RA3–6)
	Energy Valley Offering access to nearly 200 member companies of the cluster. These are also potential suppliers to the other partners.	(RA1–6)

Advisory Board Partners

	Norges Sildesalgslag SA (Norwegian Fishermen's Sales Organization for Pelagic Fish) Knowledge and data from current pelagic fisheries.	(RA3, 4, 6)
	IFFO The Marine Ingredients Organisation Frontier knowledge on the marine ingredient industries.	(RA4–6)
	Norges Fiskarlag (The Norwegian Fishermen's Association) Advice on technological innovations and governance issues in fisheries.	(RA4, 6)
	Directorate of Fisheries Advice on innovative development, industrial and scientific progress.	(RA2–4, 6)
	REV Ocean AS REV Ocean will contribute with expert knowledge on the potential risks of targeting new fisheries resources and potential solutions to these risks. Furthermore, joint research cruises on the research vessel "REV Ocean" (in operation from 2022) will be enabled.	(RA1, 2, 6)
	WWF (associated partner) The SFI Harvest consortium will have a dialog with WWF (World Wide Fund for Nature) in Norway about the sustainability of underexploited fisheries including low trophic species. WWF has strongly highlighted that there is a significant lack of knowledge on species-to-species interactions and species-to-habitat interactions.	

Research partners

SINTEF	**SINTEF Ocean AS (host institution)** Centre administration, research and infrastructure within all research areas.	(RA1–6)
SINTEF	**SINTEF Digital** Knowledge and competence in robotics and data analytics, in the areas of autonomy, adaptive sampling and machine learning.	(RA1, 3)
Nofima	**Nofima AS** Research on processing and value creation from the harvested biomass and industrial economics in marine industries. Access to unique infrastructure.	(RA4–6)
NMBU Norwegian University of Life Sciences	**NMBU** Competence on toxicology, fish health and -nutrition. Provides well-equipped laboratories.	(RA5)
NTNU	**NTNU Department of Marine Technology (IMT)** World-class fundamental research within the field of marine technology. Hosts the Centre for Autonomous Marine Operations and Systems (AMOS), a Norwegian Centre of Excellence.	(RA1, 3)
NTNU	**NTNU Department of Engineering Cybernetics (ITK)** Research in various fields associated with control theory, including mathematical modelling and simulation, autonomy, optimisation, and automatic control. Plays a major role in AMOS.	(RA2–4)
NTNU	**NTNU Department of International Business (IIF)** A dedicated research team focusing on environmental sustainability analysis.	(RA6)
UiT The Arctic University of Norway	**UiT – The Arctic University of Norway** Research within the modelling of productivity and fishing gear technology. Ship time on their research vessel.	(RA2, 4)

Associated research partners

matís	**Matis** Research within harvesting, preserving, processing and value addition of key seafood resources.	(RA4, 5)
U.PORTO FEUP FACULDADE DE ENGENHARIA UNIVERSIDADE DO PORTO	**University of Porto** Knowledge on networked vehicle systems as well as state-of-art software toolchain for multi-domain vehicle systems. PU will make their fleet of over 16 autonomous underwater, surface and air vehicles available for experimentation and testing and will share data from experiments at sea.	(RA1, 2)
AZTI MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE	**AZTI** Competence on oceanographic information and big data technologies for improvement of fishing efficiency, and competence on new marine resources such as mesopelagic fish.	(RA3, 4)

Scientific activities and expected results

The centre activities in the fall of 2020 focused on consolidation of the centre with its partners and their contributions, establishing administrative routines and finalising the consortium agreement. This section therefore describes the scientific basis for the future projects. For each of the six research areas, we present a summary for state-of-the-art, research and innovation challenges, and important research questions which need to be addressed to reach the goals of SFI Harvest.

RA1 Survey technology – autonomous systems and sensor technology for data collection

State of the art: Currently, autonomous vehicles such as AUVs, gliders and ASVs are being used for environmental assessment, geophysical surveys, and ecosystem assessment, but they are rarely used in marine resource research and hardly at all by fisheries. Autonomous surveys are usually pre-programmed and monitored by an expert user. The acquisition of biomarine data is almost exclusively carried out by dedicated research vessels, making the surveys costly. There is a huge unmet need for cost-efficient acquisition of marine data, highlighting the need for both improved sensors and new data acquisition strategies for combining ships and autonomous vehicles. Satellites provide better geospatial coverage but have limitations in spatial resolution and availability due to weather [1, 2]. *Ships of opportunity* refers to vessels that volunteer to perform data acquisition while carrying out their primary purpose, such as ferries and merchant ships. For these vessels, the major challenges are their non-optimal collection patterns, the problem of how to establish a sufficiently large fleet, and cost-efficient, automated sensor systems [3]. In-situ measurements using autonomous vehicles and ships of opportunity are sought to complement and calibrate remote sensing data [4, 5], but no adequate systems currently exist for detection and identification of lower trophic species.

Research and innovation challenges: 1) Continuous, unattended sampling of the concentrations of zooplankton, mesopelagic fish species and marine plastic litter/micro-plastic. 2) Surveying and monitoring of biomass and plastic concentrations using data-driven data collection strategies.

Research questions: 1) How can machine vision be used for characterising the contents of seawater *in situ*? 2) Can shipborne hydroacoustic equipment measure mesopelagic resources? 3) How can surface-based observations take into account the dynamics of the vertical distribution of phytoplankton and zooplankton? 4) How can multiple data collection platforms cooperate to efficiently survey a marine biomass?

Impact: The knowledge generated will result in novel sensor technology and innovations that will enable cost efficient mapping and monitoring of concentrations of low trophic marine species, as well as marine waste.

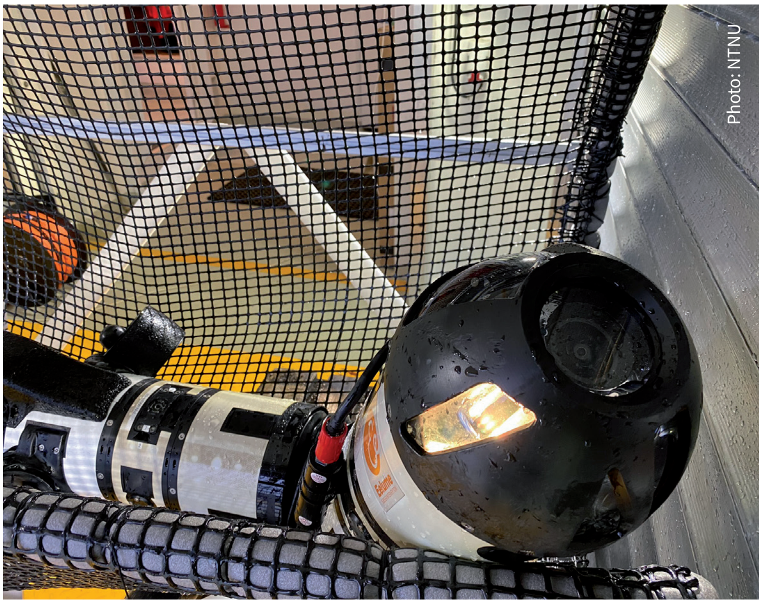


Photo: NTNU

RA2 Ecosystem dynamics

State of the art: Knowledge and predictability of ocean ecosystem dynamics and harvest potential are fundamental to the development of sustainable fisheries. Model systems are needed to quantify biomasses and to assess how populations and food web dynamics are impacted by fisheries and other stressors such as climate change and pollution [6, 7]. Models that represent ecosystem dynamics on lower trophic levels exist [8], but the effects of fisheries on e.g. zooplankton have not been fully implemented [9]. Biological hot spots are usually associated with dynamic physical features in the ocean such as fronts and eddies [10]. The combination of ocean modelling, statistics and artificial intelligence for autonomous sampling of dynamic fronts and eddies by gliders [11] and AUVs [12] enables the development of advanced model and forecast systems.

Research and innovation challenges: 1) Short-term prediction of ecosystem characteristics for efficient and sustainable harvesting. 2) Long-term prediction of ecosystem dynamics for sustainable management of low trophic species.

Research questions: 1) How are the spatial-temporal distributions of species in the lower part of the food chain linked to particular ocean features? 2) How can this knowledge be used for mapping and prediction? 3) Which factors impact the variability in ecosystem services? 4) What is the potential for sustainable harvesting of under-developed fisheries?

Impact: Reliable prediction of potential hot spots for fishing that uses knowledge of important foraging areas for other mammals, birds or fish. Predictability in spatiotemporal variability in ecosystem services are important for long term planning and sustainable management of undeveloped fisheries.

RA3 Digital decision support for fisheries

State of the art: Predicting future fisheries based on biomarine modelling and historic catches is in its infancy, but promising results have been reported [13, 14]. Based on AIS data and artificial intelligence, detection accuracies of 83-97% have been achieved to identify potential fisheries activity [15]. The most relevant digital decision support services available to fisheries are AIS services that report the position and speed of other vessels (Marine Traffic, Fish-Facts), fisheries activity maps (Global Fishing Watch) and positions of fixed fishing gear (BarentsWatch – FishInfo). We are not aware of any decision support service for fisheries based on the combination of in-situ measurements, earth observations and environmental simulations, and the selection of when and where to go fishing for certain species are today governed by the individual captains' own experience and expertise.

Research and innovation challenges: 1) The combination of biomarine models and gathered data to generate information of value, such as predictions of future fishing areas. 2) Business models which encourage data sharing and the development of commercial decision support services in the fishing industry.

Research questions: 1) How to predict catch potential, catch quality and bycatch for a given species, area and time? 2) How to estimate the accuracy of such predictions, and how this is affected by e.g. the sampling pattern of a fleet of ships of opportunity? 3) How to correct, rank and combine data collected from *in situ* sensors?

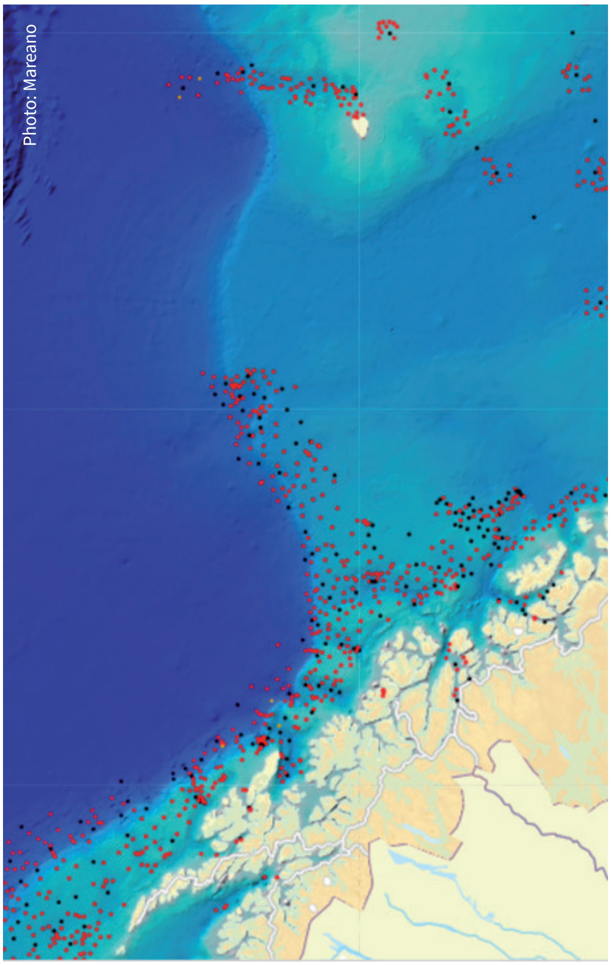


Photo: Mareano

Photo: NTNU

Impact: This will form the basis for new commercial fisheries decision support services allowing fishing vessels to save fuel and time, while improving the monitoring and understanding of the marine environment. This will contribute to fisheries sustainability and further innovation and business development.

RA4 Harvest technology and onboard processing

State of the art: Capture of Calanus and mesopelagic fish species is in its infancy, with a severe lack of methods and equipment for both harvesting and onboard processing. New trawls for harvesting mesopelagic species are currently being developed, but their energy efficiency needs improvement [16]. Other emerging methods include bubble-driven upwelling with the potential of concentrating zooplankton at the sea surface [17]. Although fishing gear has traditionally been developed iteratively using trial and error, research efforts have approached this challenge with more technological methods that combine modelling and control theory [18]. Including fish behaviour into such design processes may lead to new and energy efficient fishing gear using light and sound for concentrating and/or repelling specific species; see e.g. [19] and refs. therein. Although fish modelling for fishery purposes has not been extensively researched, some work has been done on simulating salmon behaviour [20, 21].

Mesopelagic fish and Calanus are perishable commodities which enter a series of degradation processes upon death. The speed of these processes depends on species composition and fish properties, handling, storage conditions and processing. The catches are today preserved mainly by cooling, but new methods are needed to delay the breakdown and increase the value of the biomass.

Research and innovation challenges: 1) Modelling the interaction between fish and harvesting equipment. 2) Cost-effective monitoring of harvest species while trawling. 3) Species and size selection during fishing. 4) Fractionation of the catch before onboard handling. 5) Cost-and energy-effective onboard preservation of mesopelagic species. 6) Cost-effective removal of plastics in the open ocean.

Research questions: 1) Can mesopelagic fish species be herded (concentrated) to improve fishing efficiency? 2) Can mesopelagic fish species be selectively caught by size and species? 3) Which tools and technologies are best suited for onboard fractioning and handling of catches to preserve and maintain quality? 4) How can the harvesting technologies be designed to also be applicable for removing plastics at sea?

Impact: Novel technology for effective and selective fishing, fractioning and onboard processing will improve efficiency and profit, as well as reduce waste. Selecting the right onboard handling and preservation methods will ensure high quality raw materials, further refined products and ingredients. New harvesting technologies may also form a basis for novel tools for removing plastics from the ocean.

RA5 Land-based processing and product development

State of the art: The commercial fishing of mesopelagic species is still in its infancy and the biomass is unexplored as a food or feed source. Recently, minor mesopelagic catches have been processed to fishmeal and oil based on conventional technology, but other options must be developed [22]. Some of this development has recently been started in the EU H2020 MEESO project and the developments being done will be taken into account in SFI Harvest. Commercial Calanus fishing was opened in 2019, and fishing licenses are currently being applied for [23]. Today, there is one company selling products from Calanus in Norway, and with increased catch the utilization of this biomass needs to be diversified [24, 25]. Krill is a more established industry involving three Norwegian companies, with Aker Biomarine being the largest. Presently, krill shells and part of the soluble phase are discarded due to the lack of economically viable processing technology on board the fishing vessels. Development of more cost-effective process technology and novel product applications are required in order to obtain maximal value creation and total utilization of the biomass.

Research and innovation challenges: 1) For mesopelagic fish, the high level of autolytic activity and variable raw material quality causes increased energy consumption and reduced product quality. 2) For Calanus and krill, processing methods must be improved in terms of energy use, sustainability and total utilization. 3) Diversification of product portfolio and maximum value creation from harvested biomass. 4) In the development of new products from new species or through new processes, data on the nutritional quality, toxicological and microbial safety of novel food and feed products are needed.

Photo: SINTEF Ocean

Photo: SINTEF Ocean

Research questions: 1) How can raw material and intermediate products delivered to land-based processing plants meet quality criteria for food and feed applications? 2) Is it possible to develop cost-efficient processing methods for the manufacturing of novel products from the biomasses targeting aquaculture, food and the health food/nutraceutical markets? 3) Are the new products and processes sustainable and marketable?

Impact: The outcomes of RA5 will form a solid foundation for commercial fishery and total utilisation of low trophic species. The work will identify the most promising land-based processing methods and products for realisation of the commercial potential of new bio-marine resources.

RA6 Fisheries management and sustainable business models

State of the art: For new mesopelagic and lower trophic fisheries in the North-Atlantic, the knowledge about biology and biomass is insufficient for determining sustainable quotas and technical rules for harvesting. The knowledge basis for choosing efficient business models is therefore missing. Although different models for vertical integration exists in Norwegian fisheries, the dominant business model constitutes separate ownership to vessels and processing plants, as independent transaction partners of fish in the first-hand markets. This is, however, predicted to be inefficient if applied to new lower-trophic fisheries [26, 27]. Here, vessels with integrated catching and processing capabilities may represent the most relevant technical approach and the lowest transaction costs in a value-chain perspective.

The demand for food products with documented sustainability is increasing. Life Cycle Assessment (LCA) has been implemented in other industries to quantify the environmental impacts generated by the production of products and services (ISO 14040; ISO 14044). The Life Cycle Sustainability Assessment (LCSA) extends the basic LCA methodology by combining the three pillars of sustainability, measuring environmental (E-LCA), economical (LCC) and Social (S-LCA) impacts in a single, comprehensive framework [28, 29]. There is a need for integrated fishery-specific life cycle impact categories to develop an accurate LCSA model for the new biomarine value chains and business models.

Photo: NTNU

Research and innovation challenges: 1) A sustainable governance regime. 2) Efficient value chains. 3) Sustainable governance and business models.

Research questions: 1) To what extent can the principles of modern fisheries management contribute to the development of sustainable lower trophic fisheries? 2) What business models are suited to address vertical coordination, capacity adaptations and product development for a biomarine industry based on the lower trophic fisheries? 3) How can LCSA form a decision-support tool for choices of technology and business models emerging from the new fisheries?

Impact: RA6 will provide input to management regimes for sustainable harvesting of lower trophic species. For the commercialisation in a value chain perspective, analysis of different options for vertical coordination will provide input to the most viable and sustainable business models. A quantitative LCSA evaluation tool will be tailored for use during technology development and for the emerging biomarine value chains developed under SFI Harvest, as well as for evaluating alternative governance regimes.

International cooperation

International partners will be associated participants in the centre's research and innovation activities. In RA1, the University of Porto will contribute with competence in underwater vehicles, autonomy and sensor technology complementary to that of NTNU and SINTEF. This will ensure that the challenges encountered in these fields are addressed with a more complete competancy profile, increasing the chance of scientific success. Furthermore, AZTI will contribute to the work in RA2, 3 and 4 with world-leading competence in low trophic biology and ecology and methods for data collection from fishing vessels. Matis will also contribute actively with their competence in processing technology in RA4 and 5. Aside from inviting the international partners to all annual meetings, the collaboration will be realised through active exchange of personnel through short to medium length visits where visiting researchers will be actively included in concrete activities. This can include personnel from international partners visiting Norway to participate in research cruises or data collection campaigns, or by Norwegian researchers, post docs or PhD students visiting international partners to participate in laboratory experiments, data analyses or being supervised by international experts. The international cooperation will give the Norwegian industry partners access to scientific knowledge in important areas for the innovation activities in the centre: AUV, autonomy, sensor technology, oceanography, ecology, harvesting and processing technology. This will ensure that the research and technology development is beyond state-of-the-art internationally. REV Ocean will also facilitate international participation through global partnerships.

Recruitment

The public and business sector will need expertise in all the scientific disciplines within SFI Harvest to address managerial and technological challenges related to the increased exploitation of lower trophic marine species: Innovations and new knowledge are needed within autonomous sensor and data collection systems in the ocean space, real-time decision support in marine operations, advanced harvesting and processing technologies, and guidelines for responsible resource management and sustainable business models. As one of the centre's research objectives, knowledge and competence capacity will be built through educating a minimum of 10 PhDs, 3 post docs, 20 master students, and supporting their subsequent employment in academia and industry. These candidates will have a unique opportunity to collaborate closely with leading industry and research groups, and work on highly relevant challenges and applications. NTNU will have the educational responsibilities for the majority of PhD, post doc and MSc candidates. In addition, PhD, post docs and MSc candidates will be educated at NMBU and UiT. The centre will encourage exchange of PhD and post doc candidates with its international partners.

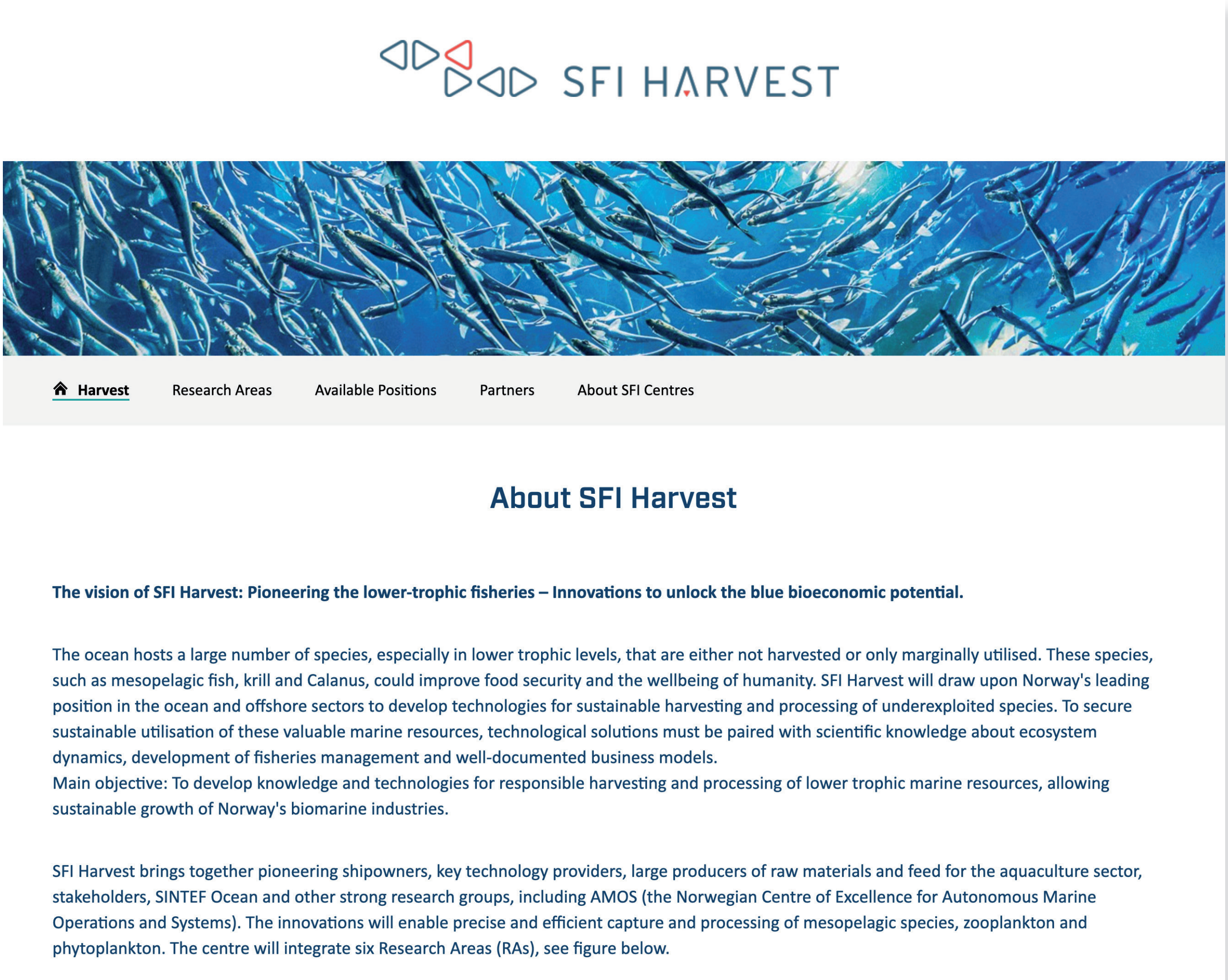
Two PhDs and one post doc position were announced in the fall of 2020 and the first candidates will start in 2021.

Photo: SINTEF Ocean

Communication and dissemination activities

The centre will actively **communicate** its activities and results to industry, the scientific community and the general public. Information flow, communication, and demonstration of development in the centre is an important administrative task for SFI Harvest, and media is an essential communication channel. Detailed communication activities will be announced each year based on the Centre's Communication and Dissemination Plan.

A project webpage (**www.sintef.no/projectweb/harvest**) has been established to present information about and news from the centre to both internal and external target groups. The SINTEF Ocean Facebook page (**www.facebook.com/sintefocean**) and LinkedIn profile (**www.linkedin.com/company/sintefocean**) is being used to further promote news from the centre. Both Facebook and LinkedIn pages link to new articles from the webpage, in addition to presenting other relevant information that is not available on the webpage.



Personnel

KEY PERSONNEL	INSTITUTION	MAIN RESEARCH AREA
Ingunn M. Holmen	SINTEF Ocean	Research management, fisheries technology
Hilde Wanvik	SINTEF Ocean	Administration
Kaja Haug	SINTEF Ocean	Administration
Gunvor Øie	SINTEF Ocean	Administration, New Biomarine Industries
Kristin Holseth	SINTEF Ocean	Communication
Anne Berit Heieraas	SINTEF Ocean	Communication
Karl-Johan Reite	SINTEF Ocean	Digital decision support
Jarle Ladstein	SINTEF Ocean	Digital decision support
Joakim Haugen	SINTEF Ocean	Digital decision support
Martin Føre	NTNU IKT	Digital decision support
Lars T. Kyllingstad	SINTEF Ocean	Digital decision support, data acquisition
Ingrid Ellingsen	SINTEF Ocean	Ecosystem dynamics
Dag Slagstad	SINTEF Ocean	Ecosystem dynamics
Ragnhild Daae	SINTEF Ocean	Ecosystem dynamics
Øyvind Knutsen	SINTEF Ocean	Ecosystem dynamics
Ole Jacob Broch	SINTEF Ocean	Ecosystem dynamics
Morten Alver	NTNU IKT	Ecosystem dynamics
Paul Wassmann	UiT	Ecosystem dynamics
Sünnje Linnéa Basedow	UiT	Ecosystem dynamics
Dag Standal	SINTEF Ocean	Fisheries management and sustainable business models
Bent Dreyer	Nofima	Fisheries management and sustainable business models
Marianne Svorken	Nofima	Fisheries management and sustainable business models
Ingrid Kvalvik	Nofima	Fisheries management and sustainable business models
Annik Magerholm Fet	NTNU IIF	Fisheries management and sustainable business models
Roger B. Larsen	UiT	Harvesting technology
Eduardo Grimaldo	SINTEF Ocean	Harvesting technology
Bent Hermann	SINTEF Ocean	Harvesting technology
Kristine Cerbule	SINTEF Ocean	Harvesting technology
Kurt Hansen	SINTEF Ocean	Harvesting technology
Leif Grimsmo	SINTEF Ocean	Harvesting technology, On-board processing
Rasa Slizyte	SINTEF Ocean	Processing and product development
Ana Karina Carvajal	SINTEF Ocean	Processing and product development
Ragnhild Dragøy	Nofima	Processing and product development
Birthe Vang	Nofima	Processing and product development
Ingelinn Eskildsen Pleym	Nofima	Processing and product development
Jan Ludvig Lyche	NMBU	Processing and product development

KEY PERSONNEL	INSTITUTION	MAIN RESEARCH AREA
Trond Kortner	NMBU	Processing and product development
Øystein Evensen	NMBU	Processing and product development
Emlyn John Davies	SINTEF Ocean	Survey technology
David Williamson	SINTEF Ocean	Survey technology
William Naylor	SINTEF Ocean	Survey technology
Raymond Nepstad	SINTEF Ocean	Survey technology
Esten Ingar Grøtli	SINTEF Digital	Survey technology
Kristian Gaustad Hanssen	SINTEF Digital	Survey technology
Frederic Py	SINTEF Digital	Survey technology
Martin Ludvigsen	NTNU IMT, AMOS	Survey technology
Asgeir Sørensen	NTNU IMT, AMOS	Survey technology, Innovation Board
Dina Aspen	NTNU IIF	Sustainability analytics, Centre Board

Accounts

	FUNDING	COST
The Research Council	1 384 433	
The Host Institution (SINTEF Ocean)	375 522	1 496 405
Research Partners*	130 188	498 738
Enterprise partners**	230 100	125 100
Public partners		-
Equipment		-
TOTAL	**2 120 243**	**2 120 243**

* Nofima AS

** Aker Biomarine Antarctic AS, Kongsberg Maritime AS, Nordnes AS, Optimar AS, Skretting AS, Norges Sildesalgslag SA, Norges Fiskarlag

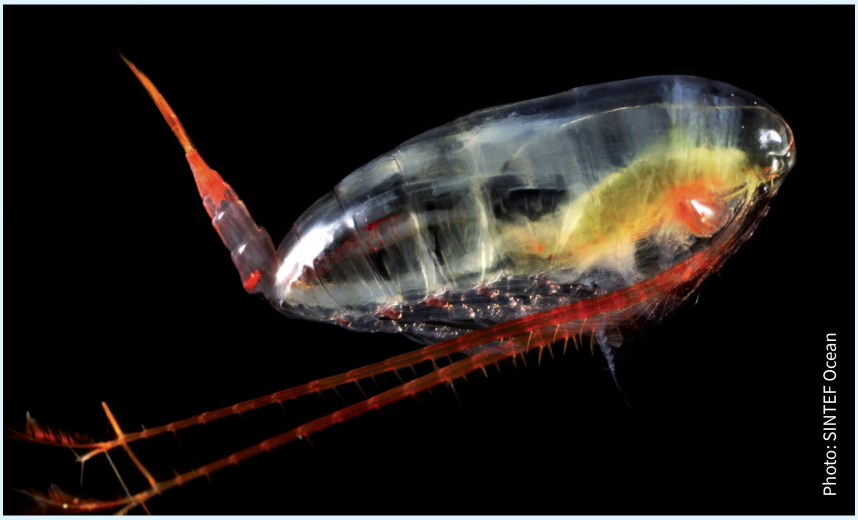


Photo: SINTEF Ocean

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