



RESEARCH AND INNOVATION WITHIN MARINE BIOLOGY AT THE UNIVERSITY OF BERGEN 2010–2017. A TERRITORIAL EMBEDDING ASSESSMENT REPORT

REPORT 2020 // UNIVERSITY OF BERGEN

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BACKGROUND

This report is part of the Horizon2020 Research and Innovation programme “The European Marine Biological Research Infrastructure Cluster (EMBRIC)”, where The University of Bergen was a partner¹ Professor Anders Goksøyr, Department of Biological Sciences, has been the Project leader and Principal Investigator for the project. Vestlandets innovasjonsselskap AS (VIS) was a subcontractor in work package 5 of the project and the report has been authored by Randi E. Taxt. Also, Trygve Serck-Hansen, The Sars International Centre for Marine Molecular Biology, professor Arnt Fløysand, Department for Geography and professor Stig Erik Jakobsen from The Western Norwegian University of Applied Sciences were part of the project at UiB. The following persons have also been important contributors: Research Advisor Sjoukje Kuipers at The Department of Biological Sciences, UiB, Senior Advisor Anne Fjellbirkeland at The Division of Research and Innovation at UiB, Jarl Giske, Former Marine Dean at UiB, Amund Måge, Marine Director at UiB and Senior Advisor Kristin Bakken, Business Developer Anne Sophie Schillinger at VIS, Douglas Robinson and Antoine Schoen at EISEE. Finally, thanks to NIFU for providing data on the PhD candidates from their databases.

¹ Grant agreement No 654008, year 2017-2019

ABBREVIATIONS (MOST USED)

CorText	The CorText Platform is a research facility textual corpuses analysis
Cristin	Current Research Information System in Norway
EMBRIC	The European Marine Biological Research Infrastructure Cluster
ESIEE	École Supérieure d'Ingénieurs en Électrotechnique et Électronique
HVL	The Western Norwegian University of Applied Sciences
IFRIS	Institute Francilien Recherche Innovation Societé
IMR	Institute of Marine Research
INRAE	France's new National Research Institute for Agriculture
LISIS	Laboratoire Interdisciplinaire Sciences Innovations Sociétés
NHH	NHH Norwegian School of Economics
NIFES	Norsk institutt for ernæring og sjømatforskning
NIFU	Nordisk institutt for studier av innovasjon, forskning og utdanning
OSB	Ocean Sustainability Bergen
SDG	Sustainable Development Goal
UiB	University of Bergen
UiO	University of Oslo
VIS	Vestlandets innovasjonsselskap AS

HIGHLIGHTS FROM THE REPORT

Vestland County provides the right mixture for a vibrant Blue Bio research and innovation ecosystem, and the University of Bergen (UiB) is a key player in this system. Marine research and innovation activities touch all faculties. However, the Faculty of Mathematics and Natural Sciences, and especially the Department of Biological Sciences, are the most prominent players. UiB is ranked highly in the marine field in various global university rankings. UiB is also a very important provider of knowledge to the local community in terms of courses, master- and PhD candidates. In addition, the University has a high number of various economic links with private and public sector companies and organisations in the region. In Hordaland there are many marine-related research and innovation infrastructures which play a strong role in the local innovation ecosystem. UiB is involved, to a greater or lesser extent, in all of them. The University and its faculty have various social and policy links, both globally and locally, thus contributing to a general dissemination of research as well as research-based policy making. UiB has a strong emphasis on being an international visible change agent to e.g. global challenges for the oceans (with references to the actions taken to support UNs SDG 14, Life below Water).



SECTION 1: INTRODUCTION

There is a growing pressure to provide indicators of activities and success factors along a number of fronts, although it is not always clear what information is needed for such assessments. For the Horizon 2020 Infrastructure Project EMBRIC², this translates into a requirement for assessment tools that can capture the existing impact profiles of the different marine biology research institutions and centres in terms of scientific excellence and socio-economic impact.

Several EMBRIC partners have been gathering data to allow for multi-criteria assessment to profile the research centres' links with the knowledge sphere, the sphere of human resource capacity building, the economic sphere, the policy sphere and with society in the broadest sense (see Figure 1 below). This we have labelled ACTIVITY PROFILING and is made up of seven systematised databases.

An additional activity, drawing on this activity profiling, but focusing on the regional impact of EMBRIC research centres, has been labelled Territorial Embedding Analysis (TEA). The TEA is a report drawing out and emphasising the key characteristics of the individual research centres, following the same five dimensions shown in Figure 1, but also adding a 6th dimension of involvement in building Regional Infrastructures.

The analysis will cover Blue Bio, an umbrella term that we define as marine biology, including aquaculture and marine biotechnology in addition to research and innovation within stock-management and fisheries.

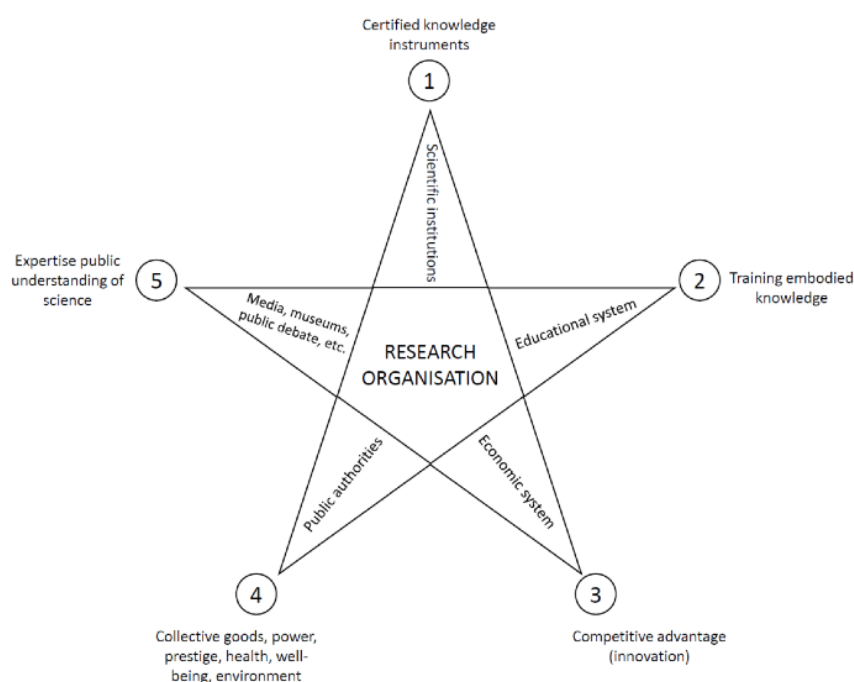


Figure 1: Five forms of impact to be described in the ACTIVITY PROFILING

² EMBRIC project: Mobilizing marine research Infrastructure to foster blue biotechnology ecosystems in marine regions

SECTION 2: THE UNIVERSITY OF BERGEN AND ITS LOCAL CONTEXT

2.1 THE UNIVERSITY OF BERGEN

The University of Bergen (UiB) was established in 1948 and is an internationally recognised research university. Academic diversity and excellence are key elements of the University's mission. UiB packs a strong punch in international research with the highest average citations per researcher in the country³. The UiB is built around seven faculties with a total of 18 500 students and it employs 4000 staff members (2020).

Whilst there is no regional Smart Specialization Strategy⁴ (S3) for the region, the University of Bergen has in its Strategic Plan, *Ocean, Life and Society*⁵, three particularly relevant strategic areas for blue biotechnology research and innovation: *Marine research*, *Climate and energy transitions* and *Global challenges*. The Faculty of Mathematics and Natural Sciences is the main marine actor at UiB; however, all seven faculties and the University Museum are involved to some extent in marine activities, making blue biotechnology particularly important for the university. In addition, marine research and education are taking place in close co-operation with external actors from both the private and public sector, leading to a rich research and innovation ecosystem.

Marine research at UiB is diverse, with strong groups in life sciences, geology, geophysics, and climate. In the 2018 university ranking by QS⁶, UiB was ranked #38 globally in the subject "Earth and Marine Sciences". In the CWRU ranking, which is solely based on publications and citations, UiB performs even better, and is ranked in top-10 in "Marine and Freshwater Biology" and #2 in Fisheries (see footnote 14).

UiB also emphasises science diplomacy and has recently been selected to take a leading role in global efforts towards Sustainable Development Goal (SDG) 14, *Life under water*, in the Agenda 2030 of the United Nations, both by United Nations Academic Impact (UNAI) and International Association of Universities (IAU). Ocean Sustainability Bergen⁷ (OSB) is UiB's virtual centre for taking care of the day to day activities and operations in conjunction with these appointments.



Photo: Sandra Ječmenica

3 www.uib.no/en/about

4 ec.europa.eu/regional_policy/sources/docgener/informat/2014/smart_specialisation_en.pdf

5 www.uib.no/en/strategy

6 www.topuniversities.com/university-rankings/world-university-rankings/2018

7 www.uib.no/en/ocean

2.2 BERGEN – A WORLD MARINE CAPITAL

Norway is characterised by breadth and strength with regards to marine research and has the highest share in the world with 364 marine researchers per million inhabitants⁸. For Bergen, this ratio is 60 times higher than for the rest of the country, with more than 1200 employees working within marine R&D activities in 2016 (see footnote 6). This cluster has a size, span and quality making it a European hub in marine research, education and innovation. Among the education and research institutes are Institute of Marine Research (IMR)⁹, NORCE¹⁰, Nofima¹¹, Nansen Environmental and Remote Sensing Center¹², NHH Norwegian School of Economics¹³, and The Western Norway University of Applied Sciences¹⁴, all contributing to maintaining the region's dominant position. Moreover, the University of Bergen is Norway's most prominent university in terms of marine disciplines and activity¹⁵, and the total number of marine publications in the period 2005-2014 was almost 25,000, with extensive collaboration between the institutions.

Hordaland county covers all actors in the value chain from production of fry and fish, through processing and export, as well as equipment suppliers. The region is also the base for Norway's largest ocean-going fishing fleet. About 35,000 jobs are linked to marine industries in Western Norway¹⁶. The greatest revenue in the marine sector is derived from businesses working with sales and farming, however, both aquaculture and fisheries are also important for the employment and value creation in the region¹⁷.

Hordaland, and especially Bergen, is further home to several of Norway's most innovative and internationally leading seafood companies, amongst others Lerøy Seafood Group, Mowi¹⁸ (former Marine Harvest), Grieg Seafood¹⁹, The Salmon Group²⁰, Austevoll Seafood²¹, Liegruppen²² and The Steinsvik Group²³. Lerøy Seafood Group and Mowi have been especially vital and played a key role in developing market opportunities for fresh Norwegian fish, making Norwegian seafood sought-after globally and a huge export success. Many important vendors within aquaculture, fish health and marine technology are also situated in this area.

8 www.regjeringen.no/contentassets/cd949726c03e4ad290540a2efaa2ab2e/kvu-marin-fou-sluttrapport.pdf

9 www.imr.no

10 NORCE, www.norceresearch.no/en, A 2018 merger of Agderforskning AS, Christian Michelsen Research AS, International Research Institute of Stavanger AS, Teknova AS og Uni Research AS and from 2019 NORUT

11 nofima.no/en

12 www.nersc.no

13 www.nhh.no/en

14 www.hvl.no/en

15 [cwur.org/2017/subjects.php#Marine & Freshwater Biology](http://cwur.org/2017/subjects.php#Marine%20&Freshwater%20Biology)

16 www.havbyenbergen.no

17 www.regionbergen.com/page/395/the-marine-sector

18 mowi.com

19 www.griegseafood.no/nb

20 salmongroup.no

21 www.auss.no

22 liegruppen.no

23 steinsvik.no/en



Photo: Endre knutsen/Visit Bergen

The Marineholmen Innovation Park, which is located adjacent to UiB's marine biology facilities, is designed for collaboration and innovation²⁴. The technology transfer office VIS²⁵ is one of the driving forces in this innovation hub. The aim of the innovation park is to promote innovation culture and facilitate the creation of start-ups, i.e. by creating good links between innovators and the business and research community and thus ensuring that the entrepreneurs are able to survive past the incubation period. One of VIS's offshoots is the Ocean Industries Accelerator (OIA); an accelerator that helps marine-industry companies grow and develop. NCE Seafood Innovation Cluster, GCE Ocean Technology and NCE Maritime CleanTech are, alongside VIS, some of the cluster organisations behind the accelerator (see also section 3.4).

2.3 REGIONAL INNOVATION STRATEGY FOR THE MARINE SECTOR IN HORDALAND

The University of Bergen is situated in Vestland county, which is a 2020 merger of the former counties Hordaland and Sogn and Fjordane (see map, Figure 2). Vestland has the marine sector as one of six specially prioritised areas. According to the *Plan for industry and community development*²⁶, for the former Hordaland County, the following three objectives will be important measures within the marine sector:

24 www.marineholmen.com/english/about-us/innovation-district/innovation/

25 www.visinnovasjon.no

26 www.hordaland.no/globalassets/for-hfk/naringsutvikling/filer/hnh/hnh-2017-2803.pdf

- Encouraging the development of the blue bioeconomy and a sustainable marine sector throughout the value chain
- Ensuring enough areas for sustainable growth and development within the industry
- Stimulating cooperation within the sector for development of the marine industry in Western Norway

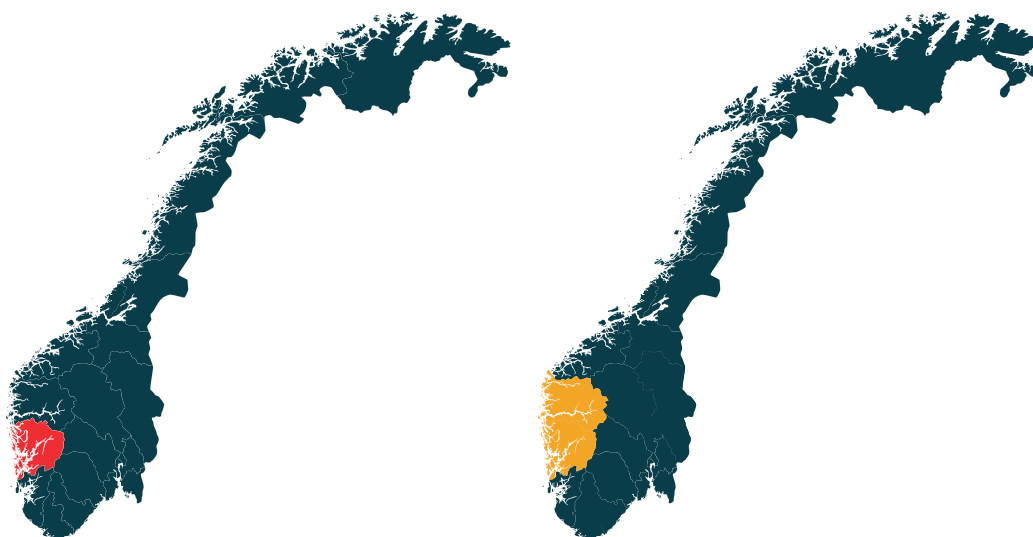


Figure 2: Map showing the Hordaland County (left). From 2020 Hordaland and Sogn and Fjordane counties merged and became Vestland County (right).

Hordaland has a longstanding tradition of trading fish, producing, and harvesting seafood, as well as playing a dominant position on the global seafood market for fishing, production, processing and sale.

The new Vestland County does not have any Smart Specialisation Strategy, but former Hordaland County did formulate its strategy in a *Plan for industry and community development in addition to its Regional Research and Development Strategy*²⁷.

²⁷ www.hordaland.no/globalassets/for-hfk/rapportar-og-statistikk/andre-rapportar---pdf/regional-forskningsstrategi-2015-2019_mai2017.pdf

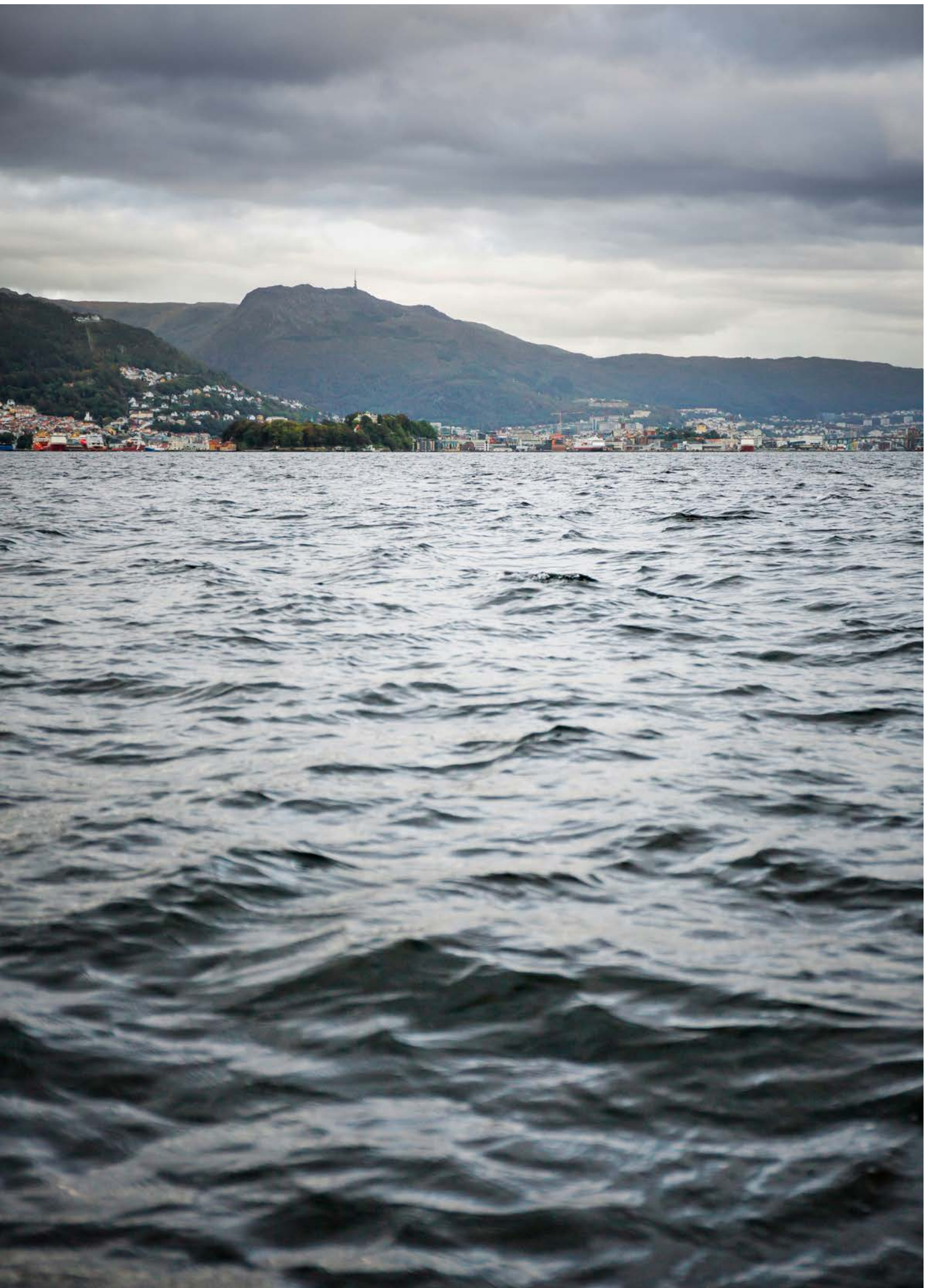


Photo: Eivind Senneset

**SECTION 3:
DATA SHOWING
THE ROLE AND
TERRITORIAL LINKAGES**

3.1 ROLE AS A RESEARCH POWERHOUSE

Universities and research centres can be seen as scientific powerhouses which provide world class research (global excellence) with researchers as ambassadors of their institutions. UiB has been recognised internationally for excellence across a diverse range of marine science and research, and for excellence in selected areas of teaching of marine disciplines²⁸.

3.1.1 SCIENTIFIC COLLABORATION AND PRODUCTION

Publication data collected from the Norwegian publication database Cristin²⁹ shows an average of 187 articles annually from UiB within marine biology in the period from 2011-2017³⁰ published in more than 390 scientific journals. The publications are relatively widespread throughout the university departments, but the former Department of Biology (The Department of Biology and the Department of Molecular Biology were merged to the Department of Biological Sciences from 2018) and The Sars Centre are by the far the most prominent contributors within the field of marine biology. The number of scientific articles corresponds very well to the bibliometric analysis carried out in the Evaluation Report from 2014 (footnote 27). The numbers are quite constant throughout the period (Table 1). CorText³¹ analysis reveals that marine scientists from UiB have a large amount of international collaboration within marine biology. However, the universities and research institutions within Norway are still the most frequent collaborators (Figure 3a and b and Figure 10 and 11 in Appendix). USA, UK, Germany and Norway are the most frequent collaborative countries, followed by Sweden, Denmark, France, Australia, Belgium and The Netherlands. Again, this is quite consistent with the results from the bibliometric analysis of the field from 2014.

28 www.uib.no/sites/w3.uib.no/files/attachments/marine_report_141203_final_1.pdf

29 www.uib.no/en/ub/79539/cristin

30 Data from 2010 has also been part of the analysis, see appendix for an explanation of the data sources and methods used in the EMBRIC project.

31 The CorText platform is the digital platform of LISIS Laboratory (Laboratoire Interdisciplinaire Sciences Innovations Sociétés) and a project launched and sustained by IFRIS and INRAE. www.cortext.net

TABLE 1: NUMBER OF MARINE BIOLOGICAL PUBLICATIONS FROM UiB IN 2011-2017, BY DEPARTMENTS (DETERMINED BY AUTHORS IN CRISTIN)*.

YEAR	2011	2012	2013	2014	2015	2016	2017
Centre for the studies ... (SVT)					2	4	
Geophysical Institute	2		1		2	1	
Dept. of Archaeology ... (AHKR)				1	1		
Dept. of Biology	160	173	174	166	145	158	170
Dept. of Biomedicine			1	1			
Dept. of Chemistry	3	2		2	3	1	4
Dept. of Clinical Medicine (K1)					1		2
Dept of Clinical Sciences (K2)				1	3	2	2
Dept. of Mathematics	1	1	1	1	2	1	1
Dept. of Molecular Biology	2	7	1				4
Dept. of Physics and Technology			2				
Sars Centre	5	12	13	14	18	20	17
University Museum	4		1	2	1	2	4
TOTAL	177	195	174	188	180	194	204

*Source: Cristin, UiB. The Department of Biology and the Department of Molecular Biology were merged to the Department of Biological Sciences from 2018.



Figure 3a: Location of co-authoring institutions appearing in publications within marine biology produced by UiB between 2010 and 2014. Data source: The Department of Biological Sciences, the Sars Centre, Cristin, Web of Science.

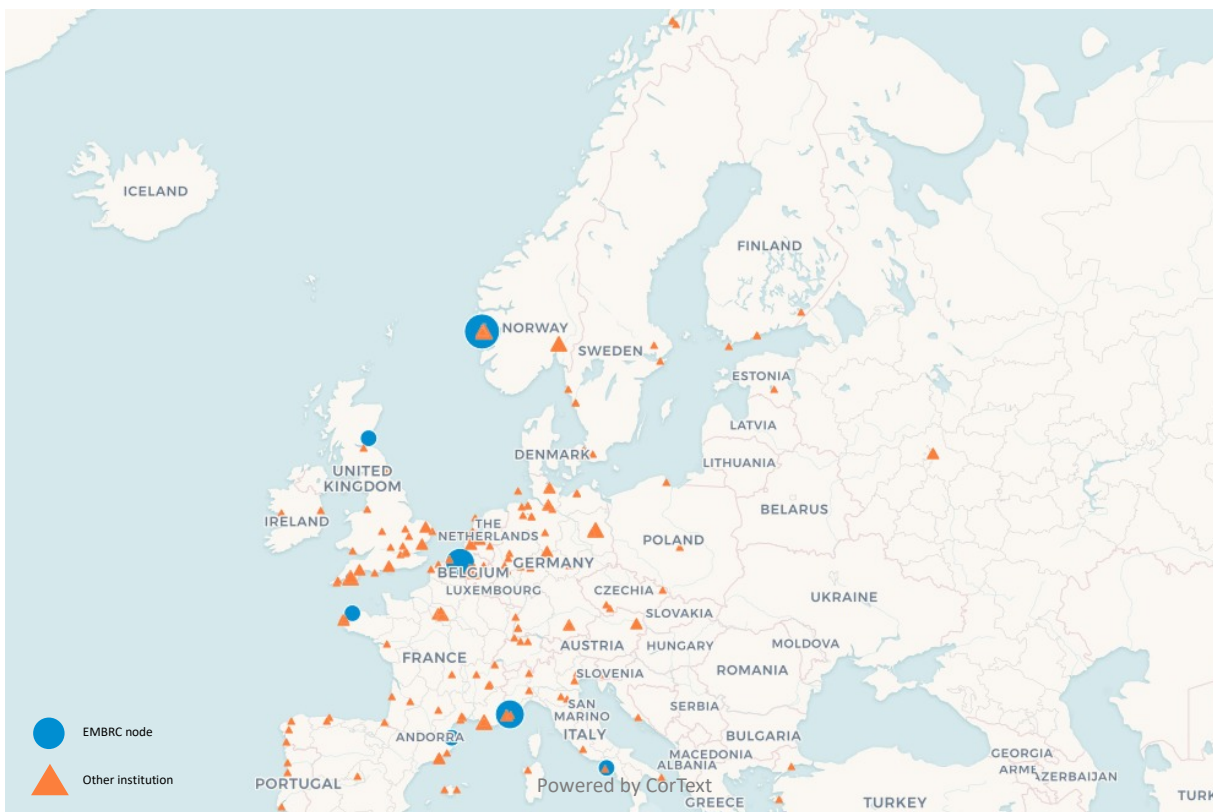


Figure 3b: Location of co-authoring institutions appearing in publications within marine biology produced by UiB between 2010 and 2014. Zoom on Europe. Treatment: EMBRC and UPEM (Cor-Text). Data source: The Department of Biological Sciences, the Sars Centre, Cristin, Web of Science.

Mapping of thematic fields and keywords in CorText shows that UiB is present in almost all the thematic fields within the EMBRIC and EMBC consortia (Figure 4).

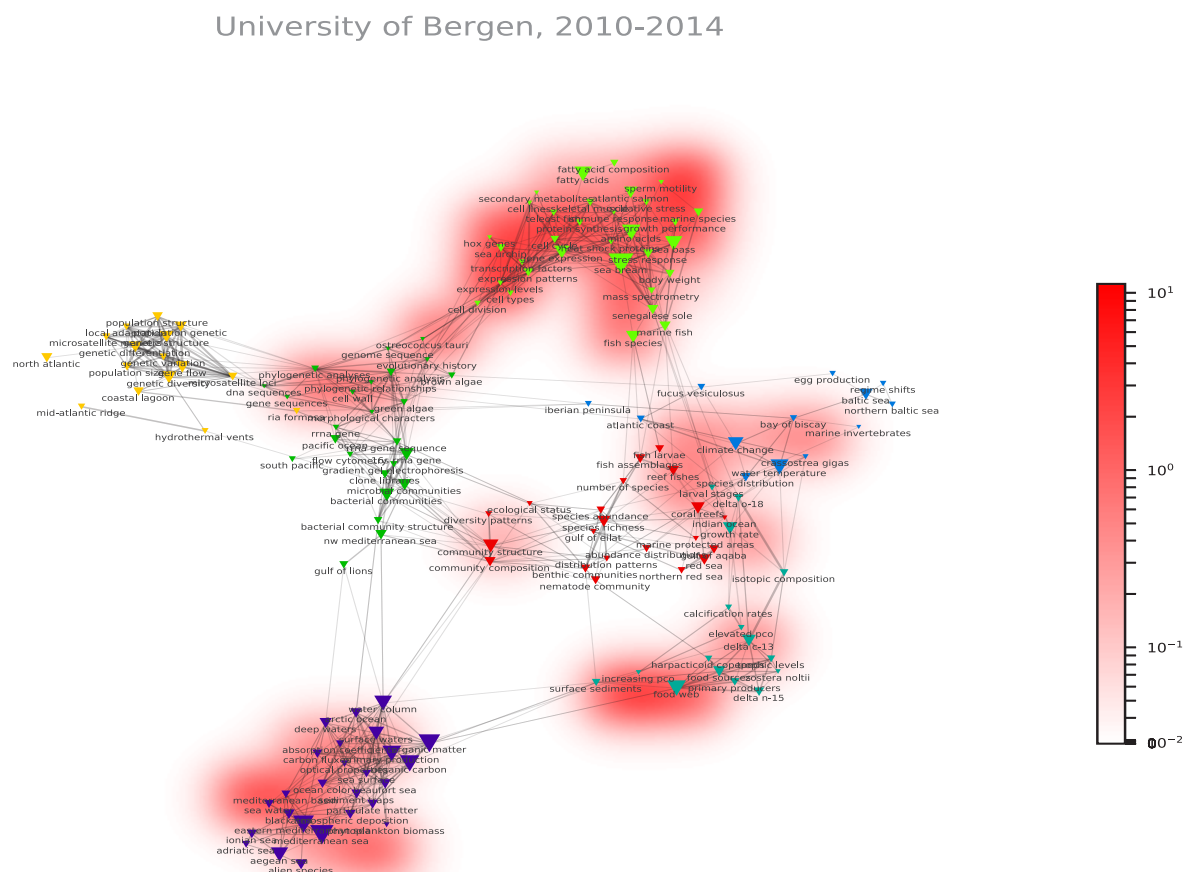


Figure 4: Thematic HEAT Map where Bergen (red shadows) has been overlaid over EMBRC master map (triangles). Publications are from a list provided by the The Department of Biological Sciences and the Sars Centre and cover the years 2010-2014. By the use of DOI retrieved from Cristin, more detailed data about key-terms are extracted from Web of Sciences, grouped in CorText and harmonised.

3.1.2 AN OVERVIEW OF THE EXTERNAL PROJECT PORTFOLIO WITHIN MARINE BIOLOGY AT UiB

Competitive public funded research projects are awarded based on expert reviews. They can be financed locally, regionally, nationally or through international funds (like the European Commission's H2020) and thus the source of finance, as well as the size and form of finance, can provide useful insights into the research centres/institutions profile.

Based on the data material collected from UiB, a total of 390 marine biological research projects were ongoing and funded at UiB in the period 2010-2016. Not surprisingly, a high amount of the projects (82%) comes from national funding sources, 12.1% of the projects are funded internation-

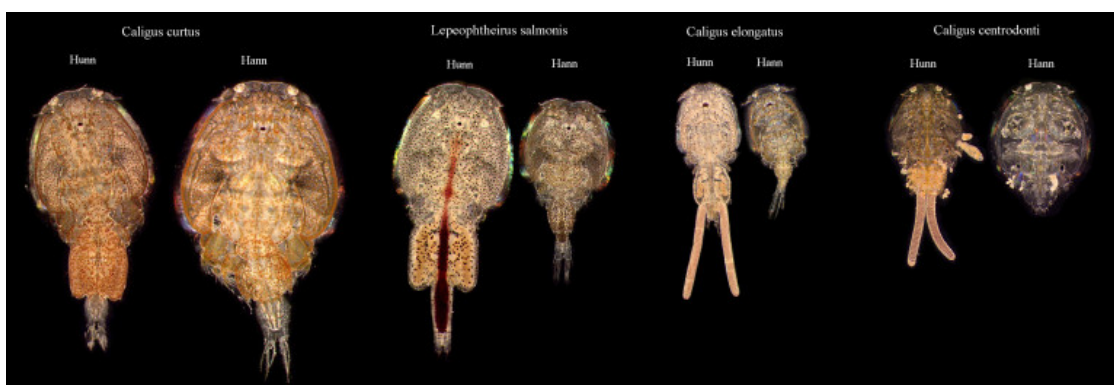
ally and only 5.9% from regional funding sources. Figure 5 below shows the distribution by the different funding sources. The Research Council of Norway is the major external funding source of marine research projects at UiB (63.3%). Different kinds of contributions³² come in second place with 14.6% of the projects. EU is number three (10.8%), followed by project funding from different kinds of foundations with the aim of supporting research³³. Although the data is not directly comparable to the data from the Evaluation Report in 2014, the findings are very coherent and the story about the funding landscape is basically the same.

Collaborative partners were only possible to track in 230 of the 390 projects and 770 different partners were identified. These partners were again divided between 443 unique organisations and companies. 81.4% of the partners are public (Typical universities, intermediates, governmental and funding organisations), 15.3% are private companies. 3.3% are labelled as NGOs³⁴.

The Sea Lice Research Centre

The Sea Lice Research Centre (slrc.w.uib.no) was a Centre for Research-based Innovation appointed by the Research Council Norway (RCN) in 2011, with secured funding until 2019. It has also been part of UiB's EMBRC node. The Centre has been hosted by the University of Bergen. It entered a new phase in September 2019 with industry sponsors and UiB partly replacing the RCN funding. The Centre has been led by Professor Frank Nilsen and is a collaboration between UiB, IMR, NMBU and industrial companies within the field.

The Sea Lice Research Centre has grown to be world leading on research on salmon louse and related parasites. The Centre has done both basic research on sea lice and facilitated development of new methods for lice control. UiB is presently still working on funding alternatives for its continuation.



32 Contributions means funding without any "ties", including contribution from private sources.

33 www.uib.no/en/node/125404 , www.mohnfoundation.no/?lang=en , <https://stiftkgj.no/?lang=en>

34 en.wikipedia.org/wiki/Non-governmental_organization

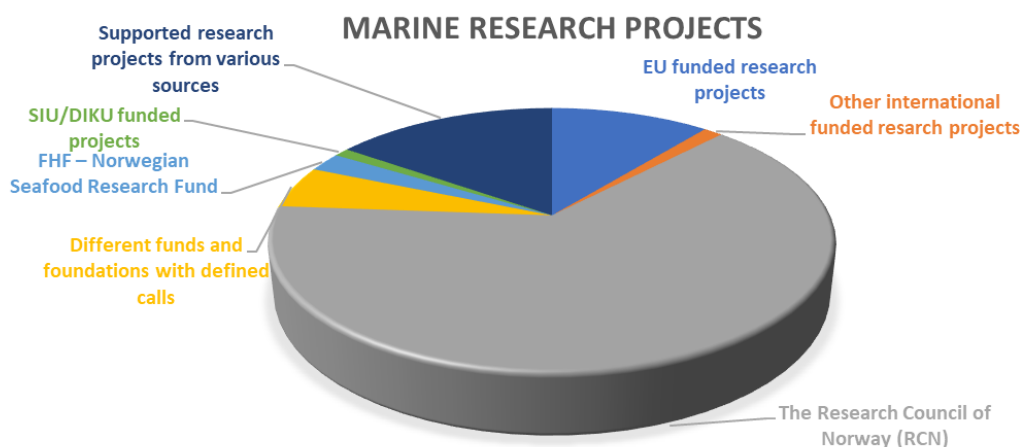


Figure 5: Number of marine biological research projects at UiB in the period 2010-2016 (sources: RCN, EU Cordis, UiB Project Accounting System (PA), The Faculty of Mathematics and Natural Sciences, The Department of Biological Sciences). Both coordinated and partnering projects are listed for UiB.

Of the top 20 collaborative partners in Research Projects, regional and national institutions are very dominant, with The Institute of Marine Research and Uni Research AS (now NORCE) on top and VIS in third place (Table 3). University of Oslo (UiO), Nofima AS and NIFES³⁵ are also quite frequent partners. International research collaborators and private companies are more sporadic partners, as shown in Table 3 below.

Active participation in the European Union framework programme for research, Horizon 2020, is stated as an important strategic goal for the University of Bergen. UiB has the highest success rate among Norwegian universities, with more than one in five proposals funded³⁶. Projects that receive funding from Horizon 2020 also receive additional funding from the Research Council of Norway and the University of Bergen. In the period 2010-2016 UiB has participated in 42 EU projects within marine biology.

Focusing only on EU, Figure 6 shows the location and strength of collaboration with other European institutions on a geographical map. Figure 6 shows that the major UiB collaborators in EU projects with relevance to marine biology and biotechnology are situated around the coast. However, still quite many partners are not situated by the sea. This will typically be large EU projects with many partners where some of the partners are larger, and more general institutions like Centre National de la Recherche Scientifique – CNRS, Max Planck and Helmholtz-Gemeinschaft (HHG), and public bodies like UNESCO and Royal Netherlands Academy of Arts & Sciences. In addition, some of the EU projects are not purely related to marine biology, but rather large networks like AtlantOS

35 NIFES, The National Institute of Nutrition and Seafood Research, has from 2018 become an integrated part of the Institute of Marine Research

36 www.uib.no/en/news/117611/uib-still-lead-eu-research-funding

and EPOCA. Some of the projects are, although covering a lot of marine biological themes, more focused on modelling and/or computing, like ELIXIR and GROOM. This also means that not all the project partners necessarily are situated by the sea.

TABLE 2. COLLABORATIVE PARTNERS IN MARINE BIOLOGICAL RESEARCH PROJECTS FROM UiB (2010-2016)

INSTITUTION	# PROJECTS
Institute of Marine Research (including NIFES)	49
NORCE (former Uni Research)	36
VIS AS (former BTO AS)	15
University of Oslo	13
Norwegian University of Science and Technology NTNU	12
Nofima AS	11
The Norwegian Seafood Research Fund	8
Consejo Superior de Investigaciones Científicas (CSIC), Spain	7
Norwegian Biodiversity Information Centre	7
Stichting Dienst Landbouwkundig Onderzoek, Netherland	7
Centre national de La recherche scientifique (CNRS), France	5
Hellenic Centre For Marine Research, Greece	5
L'Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER), France	5
Lerøy Seafood Group Asa	5
Norwegian Centre for International Cooperation in Education	5
University of Helsinki, Finland	5
Wageningen University and Research Centre; Netherland	5
Technical University of Denmark (DTU)	4
Natural Environment Research Council, UK	4
Norwegian University of Life Sciences (NMBU)	4

NIFES is merged into Institute of Marine Research, and Uni Research AS has become part of a bigger research organisation, NORCE, from 2018. The old names are kept because the table is based on historical data.

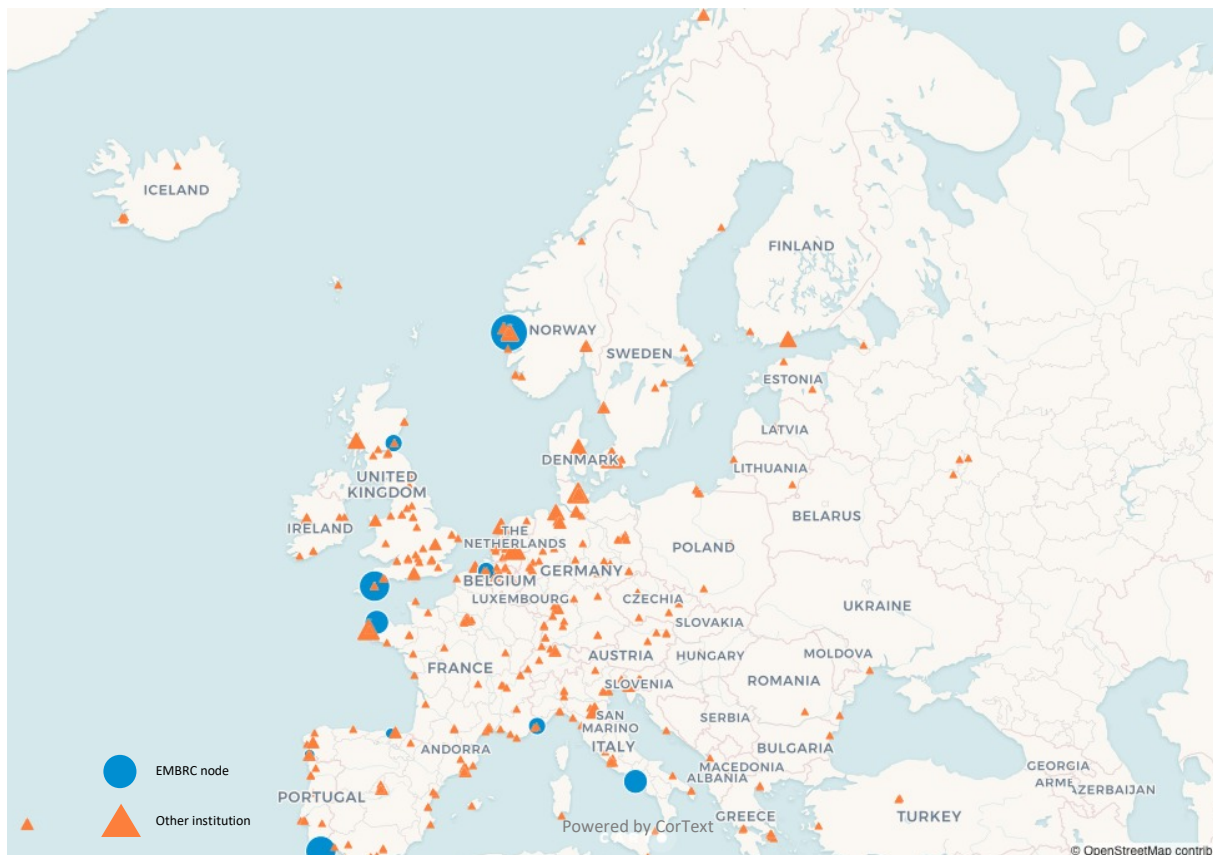


Figure 6: Location of institutions appearing in the same EU projects as BERGEN between 2010 and 2016. Data source: EUPRO, Cordis, project webpages. Treatment: EMBRC and UPEM (CorText).

SponGES: Deep-sea Sponge Grounds Ecosystems of the North Atlantic

From March 2016 to August 2020, the University of Bergen coordinated a Horizon 2020 research project on mapping sponge grounds in the North Atlantic. The project ran was granted 10 mill Euro and was led by the late professor Hans Tore Rapp from the Department of Biological Sciences. The main objective of SponGES is to map and investigate the sponge ecosystems in the North Atlantic, creating a solid knowledge base to better preserve and sustainably use the vulnerable sponge ecosystems. Sponge grounds are among the most diverse, ecologically, and biologically important and vulnerable marine ecosystems of the deep sea. The project promoted an interdisciplinary approach, involving researchers from marine biology, biosystematics, genomics, geobiology, and resource management. Further, the project has been ground-breaking for the exploration of unknown deep sea habitats, with possible environmental and medicinal gains (www.deepseasponges.org).



3.2 ROLE AS CAPACITY BUILDING THROUGH TRAINING OF ACADEMICS AND PROFESSIONALS

Training is seen as capacity building for the local innovation ecosystem, providing a skilled workforce to build socio-economic value. Research centres involved in training can also be attractors of talent to the region and thus build regional socio-economic capacity.

3.2.1 TRAINING PORTFOLIO

In terms of formalised training, BSc, MSc and PhD level education in marine biological subjects at UiB take place mainly at the Faculty of Mathematics and Natural Sciences. Here we characterise training activities into four different categories (see Table 3). Of the eight master programmes offered at The Department of Biological Sciences, four are marine: Aquaculture Biology, Environmental Toxicology, Fisheries Biology and Management, and Marine Biology. In addition, UiB offers integrated master programmes in Aquaculture and Seafood, in Aqua medicine (Fish health), and an integrated master programme in Ocean Technology together with HVL. Of the 42 training activities/events reported in total in this TEA, 29 are graduate courses (BSc, MSc and PhD). These courses typically attract students who already are working in the public sector, industry, etc. (fractions or numbers of such students has not been possible to acquire). 25 of the activities reported were regular programmes or courses, while 17 were special courses or events. Nine of the activities were directed towards employees from the public sector (mostly for teachers by The Centre for Science Education, UiB), one activity was directed towards the industry, three activities for researchers and two for post-graduate students. The rest of the activities were typically directed towards students, including doctoral students (Table 4). The Department of Biological Sciences has a Centre for Excellence in Biology Education: BioCeed³⁷. The centre is also directed towards public organisations, innovation and private companies.

The data in this section was collected from The Department of Biological Sciences and from the Faculty of Mathematics and Natural Sciences. In addition, about 50 interviews have been conducted with researchers within the field in order to extract information about non-recorded training activities. The data is not exhaustive but considered indicative of the variety and share of training activities at UiB.

TABLE 3. TYPE OF TRAINING ACTIVITIES AIMED TOWARDS PROFESSIONALS WITHIN MARINE BIOLOGY AT UiB IN THE PERIOD 2010-2016

TYPE OF TRAINING	#	%
BSc courses and events	7	16.7
MSc courses and events	21	50.0
PhD courses and events	2	4.8
Traning of professionals	12	28.6
TOTAL	42	100.0

³⁷ bioceed.w.uib.no

TABLE 4. ORIGIN OF ATTENDEES AT THE TRAINING COURSES/EVENTS AIMED TOWARDS PROFESSIONALS WITHIN MARINE BIOLOGY AT UiB IN THE PERIOD 2010-2016

PROFESSIONAL STATUS OF ATTENDEES	#	%
Employees from industry	1	2.4
Employees from public agencies	9	21.5
Graduate	27	64.3
Researcher	2	4.8
Total	42	100.0

The Centre for Science Education

The Centre for Science Education at UiB (www.uib.no/en/skolelab) provides courses for teachers in science and mathematics, in both in-service training and supplementary training. The centre offers yearly courses within marine biological subjects and also runs projects for schools, where one of the main projects is called The Norwegian Environmental Education Network.



3.2.2 PRODUCTION, GEOGRAPHICAL ORIGIN AND TRACKING OF PHDS

About one in three graduating PhDs at UiB are non-Norwegian Citizens, while the number is about 2 out of 3 at the Faculty of Mathematics and Natural Sciences. At the Department of Biology, 141 candidates defended their thesis in the period from 2010-2017. 111 (79%) of these candidates defended a thesis within a marine field. The geographical origin (nationality) of the PhDs has been identified in NIFUs PhD database, and we have been able to track the first job for 102 of these marine PhDs (90%). 58% of the PhDs we were able to track are from Norway, while 88% are from Europe. Most of the PhDs get their first job in Norway (92%) and 84 of them at a research institution in Bergen (82%). The Institute of Marine research and UiB are by far the two most dominant employers for the graduated PhDs. We assume that more employees with PhDs will move out of Bergen and Norway 1-3 years after graduation, but the data material strongly indicate that PhDs within marine sciences graduated from UiB tend to stay in Bergen. 17 of the 102 PhDs got their first job within the private sector, the rest within the public sector.

TABLE 5. THE NATIONALITY OF PHDs WITHIN MARINE SCIENCES GRADUATED IN THE PERIOD 2010-2017 FROM THE DEPARTMENT OF BIOLOGY, FROM WHICH WE HAVE BEEN ABLE TO TRACK THEIR FIRST JOB.

COUNTRY	NATIONALITY OF PHDs	COUNTRY, FIRST JOB
Norway	59	94
Germany	8	1
France	4	
Sweden	3	1
Other Europe	16	3
Asia	5	1
Africa	2	
South America	4	
USA/Canada	1	2
TOTAL	102	102

The Institute of Marine Research

The Institute of Marine Research (IMR) is one of the biggest marine research institutes in Europe, with about 1,000 employees. The main activities of IMR are research, advisory work and monitoring. In January 2018, the IMR was merged with NIFES – the National Institute of Nutrition and Seafood Research. The new institute is a leading supplier of knowledge relating to the sustainable management of the resources in our marine ecosystems and the whole food chain from the sea to the table. The head office is in Bergen, but IMR also has an office in Tromsø and research stations in Matre, Austevoll and Flødevigen. In addition, the Research Vessel Department has ownership responsibility for the research vessels, which are its most important tools for collecting marine data. The IMR also has several laboratories that analyse the samples taken by its monitoring and research programmes. Through its research and advice activities, IMR seeks to help society to continue exploiting the valuable assets in the sea sustainably. IMR is affiliated to the Ministry of Trade, Industry and Fisheries, which also provides around half of the funding. The rest of IMR's funding comes from external research grants. For more information see: www.imr.no/en.

IMR is the most prominent collaborating partner to UiB, and of the 100 marine PhDs tracked from 2010-2017, 28 got their first job at IMR/NIFES. This is exactly the same number as the 28 PhDs getting their first job at UiB.



3.3 THE ROLE OF THE RESEARCH INSTITUTION AS AN ECONOMIC ACTOR

The Activity Profiling work already done in EMBRIC reveals a large diversity of economic links of research institutions and centres with industry, public sector and the rest of the society. In this report, however, the focus is on regional economic linkages. These linkages may be a challenge to disentangle if connected to a multi-national organization that happens to be in the region. An economic link is defined as a transaction that is traceable somewhere between the parties. In other words, collaboration links without any formal trace somewhere in a system are not included in this report.

3.3.1 CONTRACTS AND OTHER FORMS OF ECONOMIC LINKS

Of the 192 economic links and contracts with companies and organisations traceable for UiB, 168 are with private companies and 24 are with public organisations. They have been categorised in seven different economic linkages (see Table 6 and Figure 7 below), where Consultation and Contract Research by far is the most common form of economic link. Product development and Commercialisation links come second.

TABLE 6. CONTRACTS (ECONOMIC LINKS) WITHIN THE AREA OF MARINE BIOLOGY FROM OR WITH UiB FROM 2010-2016. SOURCES: UiB's PROJECT MODULE (PA), VIS, THE RESEARCH DEPARTMENT (FA) AND THE FACULTY OF MATHEMATICS AND NATURAL SCIENCES.

TYPE OF CONTRACTUAL RELATION	# OF CONTRACTS	%
Consultation / Contract Research	98	51.0
Product Dev / Commercialisation	55	28.6
Licence agreements	17	8.9
Other	11	5.7
Start Up / Spin	6	3.1
Services	4	2.1
Collaborative groups	1	0.5
TOTAL	192	100.0

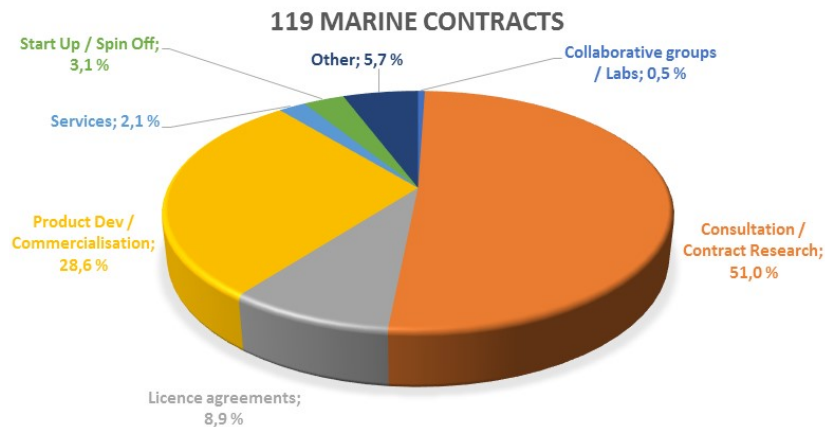


Figure 7: Contracts (economic links) within the area of marine biology from or with UiB in % from 2010-2016. Sources: UiBs Economic system, VIS databases, and information from The Faculty of Mathematics and Natural Sciences. And Department of Biology.

Below we see two figures showing the geographic spread of the economic linkages to and from UiB (Figure 8a and b). 164 (87.5%) of the links are from Norway (Figure 8b) and 28 are from other countries (Figure 8a). Only six contracts are from outside Europe (Canada 4, Australia 1 and Vietnam 1). The Canadian links are mostly within the field of animal health, while both the Australian and the Vietnamese economic links are direct results of long-term research collaboration. The 22 European links are diverse, but larger, multinational companies dominate, many within pharma and biotechnology. More than half of the national links (98) are with local companies and public organisations from former Hordaland County. Another 14 are from nearby counties (former Sogn og Fjordane and Rogaland), while 52 of the contracts are from other parts of the country (See also Appendix, Figure 12). Figure 8b also clearly shows how these national companies typically are situated by the sea, while the situation is not the same for the international links.

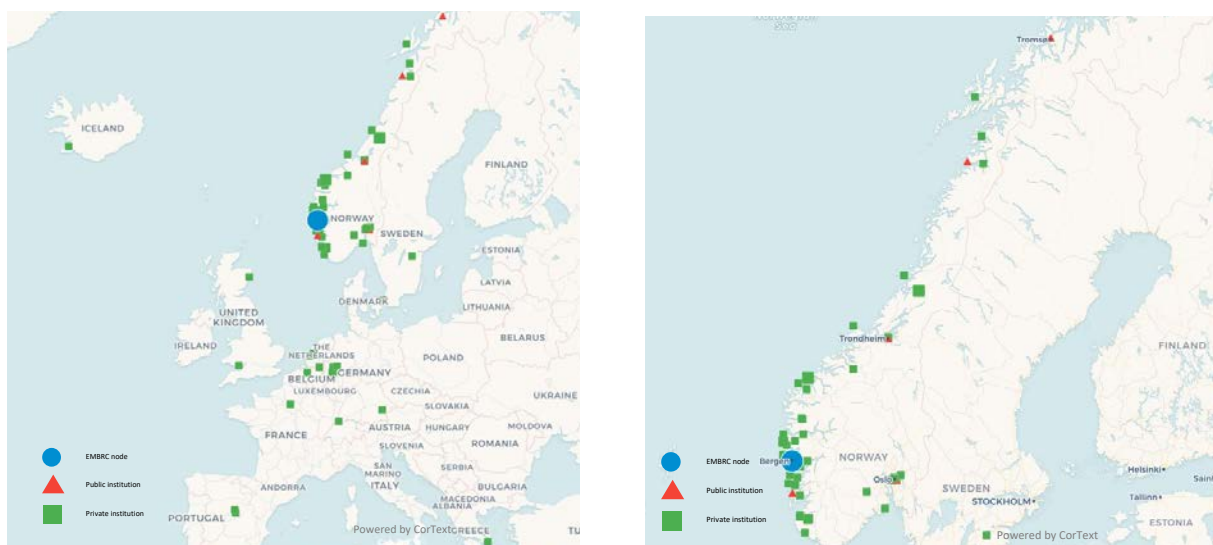


Figure 8a and 8b: Geographical map showing location of partners with economic linkages to UiB in the period 2010-2016. Figure 8b is a Zoom on Norway. Sources: UiB databases, VIS databases supplemented with information from The Faculty of Mathematics and Natural Sciences and The Department of Biological Sciences. Treatment: EMBRC and UPEM (CorText).

Sustainable use of marine resources – Ocean Bergen AS and TuniChor AS

Located in Bergen Norway, Ocean Bergen AS carries out research and develops technology solutions for sustainable production of food, material and energy from the ocean. Experimental systems involve laboratory and pilot scale facilities at the Espegrend Marine Biological Station of the University of Bergen as well as the Scalpro facility in Rong, Øygarden municipality. Ocean Bergen AS works in close collaboration with University of Bergen and NORCE.

Our most abundant biomass resources are generated through the process of primary production. Using solar energy (photosynthesis), or alternatively, oxidation or reduction of inorganic compounds (chemosynthesis), nutrients constitute the bottom of the food chain. This is a renewable biomass resource forming the very basis for sustaining life on the planet. The amount of primary production is roughly equivalent between land and oceans; however, only 2% of our food comes from the ocean. This is because we harvest resources throughout the food chain on land, whereas harvesting in the ocean occurs predominantly at the top, less energetically efficient, levels. Developing sustainable technical solutions to harvest low trophic resources from the ocean is therefore key to solving the global challenge of increased human population. Filter-feeders are efficient organisms in aquatic environments that are able to feed on low trophic levels. Ocean Bergen is particularly interested in the benthic tunicate *Ciona intestinalis*. Tunicates are the only animal group able to synthesize cellulose. This is due to a lateral gene transfer of cellulose synthase genes from prokaryotes at the very base of this tunicate lineage. In benthic tunicates, this cellulose is located in the mantle of the organism. The inner animal fraction contains very little cellulose but is rich in both proteins and marine lipids containing high levels of omega 3.

Ocean Bergen AS is a start-up company originated from a research idea developed from UiB and NORCE. The original technology is licenced through TuniChor AS, which also is a major owner in Ocean Bergen. The other owner is Ocean IPR AB, located at Fårö, Gotland, Sweden. Ocean IPR has several projects on sustainable production of food, material and energy from the ocean.

Ocean Bergen has the goal to commercialise new products in the market and has explored the use of tunicates as a new resource for both animal feed and biopolymers. Ocean Bergen also works on other technologies related to primary production and algae.

For more information see: www.oceanbergen.no



3.3.2 PATENTS

In the period 2010–2016, 29 marine biology patents were registered in the VIS patent database.³⁸ Seven of these are priority patents (first filings, see Table 7). Four of the three priority patents are considered borderline to the marine biological field and are patents within the process, chemical or medical fields. However, all of them are linked to marine biological applications and projects.

TABLE 7. PRIORITY PATENTS FROM UiB IN THE PERIOD 2010-2016. SOURCE: VIS PATENT DATABASE

PATENT TITLE	APPLICATION DATE	APPLICATION NUMBER	STATUS	COMMENT
Natural lipids containing non-oxidizable fatty acids	10.03.2014	14741365,2	Filed	Marine applications
Improved olefin metathesis catalysts	10.07.2015	15 176 276.2	Filed	Marine applications
Process (Production of Neosaxitoxin)	12.02.2016	1602576.9	Lapsed	Marine
Detection of saxitoxin-producing dinoflagellates	16.05.2012	PCT/AU2012/000541	Withdrawn	Marine
Use of triazolylpiperidine derivatives	11.01.2012	EP12150762.8	Withdrawn	Marine applications
Tunicates as biofuel and cultivation	17.06.2010	GB1010176.4	Withdrawn	Marine
Marine Biomass for use as Feedstuff	16.12.2011	GB1121722.1	Withdrawn	Marine

Patents on use of Tunicates (*Ciona intestinalis*)

Two of the patents within marine sciences are on the use of the Tunicate as use of feedstuff, on cultivation and as biofuel. The patents were filed in 2010 and 2011 and were an important base for the technological development in the academic start up TuniChor AS and later in Ocean Bergen and TuniCell AS. The patents are administered by VIS, the technology transfer office in Bergen, on behalf of NORCE and UiB and licensed to TuniChor AS.

For more information see the Fact box above and at: www.oceanbergen.no



³⁸ VIS is the Technology Transfer Office for UiB and is managing the patents on behalf of UiB.

The willingness to patent within aquaculture, marine biology and blue biotechnology is not very high compared to e.g. life sciences in general, probably because exploitation of marine resources is considered as a new frontier. This is especially the case within marine genetic resources (MGR)³⁹. In addition, funding of marine research from FHF – Norwegian Seafood Research Fund⁴⁰, require that all the results are open and accessible, and the industry is not very interested in research collaboration if research organisations want to patent their results themselves. Exploring the marine related patents from UiB shows that the inventors are strictly local from the Bergen region, except in one case. This is a patent within natural lipids containing non-oxidizable fatty acids, where there is a co-inventor in Ålesund. This is, however, a result of a long-term research collaboration.

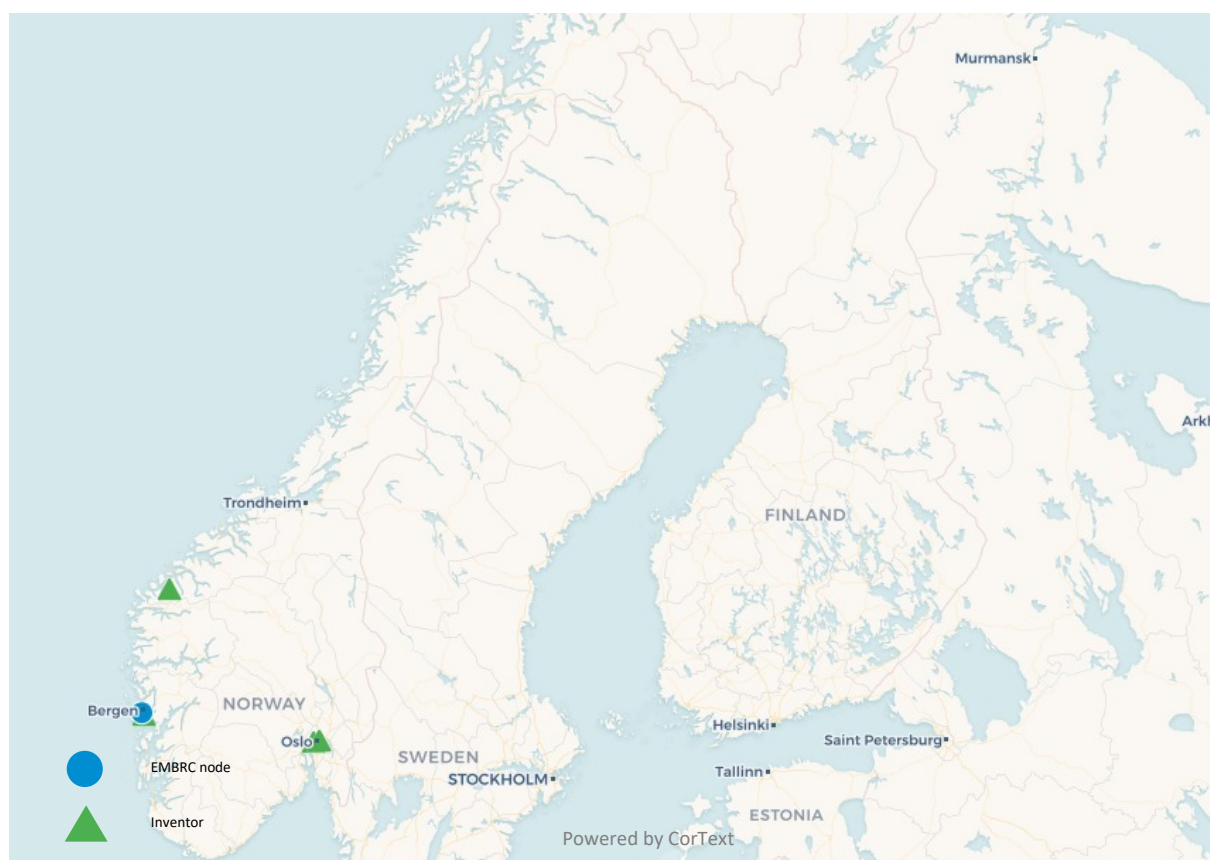


Figure 9: Location of inventors appearing in patents applied for by UiB. Data source: VIS patent database and Patstat⁴¹. Treatment EMBRC and UPEM (CorText)

39 https://books.google.no/books?hl=no&lr=&id=QB2KDwAAQBAJ&oi=fnd&pg=PA404&dq=patenting+and+IPR+within+marine+field&ots=RDa81ySIGI&sig=WmCsPS9PoBqrMcbTnNjdyw91Xs&redir_esc=y#v=onepage&q=patenting%20and%20IPR%20within%20marine%20field&f=false

40 www.fhf.no/fhf/about-fhf-english

41 www.epo.org/searching-for-patents/business/patstat.html

3.4 UiB AND ITS ROLE IN DEVELOPING AND MAINTAINING REGIONAL INFRASTRUCTURES

Universities, governments, and companies have increasingly moved beyond traditional forms of research collaboration projects and training needs, to ensure optimal connectivity between universities, public sector, and business innovation. They have concentrated their innovation strategies on setting up new networks, services, or organisations that aim to connect researchers and innovators from different regional institutions — universities, research institutes, businesses, and governmental or non-governmental organisations — in order to develop and implement a common innovation agenda (Reichert, S., 2019). Infrastructures are mediators and drivers of regions. For example, in the field of nanotechnology, regional infrastructures configure regional innovation systems (Robinson et al. 2007⁴²). Infrastructures provide sustained connections with various “spheres” (see the five elements in Figure 1) and provide real anchoring of the research institute in the region.

UiB collaborates in a number of important networks and infrastructures within the blue bio area, both regionally, nationally and internationally. The most important ones are listed and briefly described in the sections below. Also, the following chapters about the social and the policy links are important for the understanding of the overall contribution of the UiB organisation as a participating actor in society. These listings are not exhaustive but illustrate the wide range of marine networks and infrastructure around UiB and the other actors in the region, both within research and public and private sectors.

3.4.1 COLLABORATIVE STRUCTURES/SPACES

ILAB (Industry & Aquaculture Lab)

This organisation of the wet lab facility for aquaculture and other tank-based research was set up as a foundation between the University of Bergen and Marineholmen Research Park in 1989 (www.ilab.no). The lab, with about 20 employees, is certified for working with fish pathogens. It has recently introduced RAS (Recirculating Aquaculture Systems) and is further expanding in this direction through the establishment of Marineholmen RASlab. ILAB has over 200 trials annually in basic research, applied research, product development and product approval for the industry and for governmental research institutions on a commercial basis. ILAB offers self-produced test fish (salmon) with thoroughly documented health status, quality assured operation (ISO 9001) and monitoring of approx. 240 fish tanks with a flexible supply of water qualities from fresh to sea water and between 4 and 30 °C in a flow-through system.

For Marineholmen, UiB has built a seawater system that collects fjord water at a depth of 100 meters, and supplies the seawater laboratories via a height pool. It was upgraded in 2018 with a new intake line, pump station and partly new pipeline. The private seawater supply to Marineholmen by Indre Puddefjorden Energiverk AS is used as a back-up if needed. In addition, a separate chlorine-free raw fresh water supply has been established from Lake Svartediket outside the municipal

42 Robinson, D. K.R., Rip, A., & Mangematin, V. (2007). Technological agglomeration and the emergence of clusters and networks in nanotechnology. *Research policy*, 36(6), 871-879.

water treatment system. In total, these investments have an estimated present value of between EUR 15 and 20 million.

Espeland Marine Biological Station

This facility is run by the UiB Department of Biological Sciences and is located at the Raunefjord, 20 km south of downtown Bergen and close to Bergen Airport. Espeland has a number of specialized facilities. It is internationally well known for its mesocosm facility which is in active use in EU projects. Espeland has very good access to diverse and well-described marine habitats and model environments. The station comprises a boarding house, lecture room, boats, laboratories and basic equipment for marine research.

Norwegian Ocean Observation Laboratory (Havobservasjonslaboratoriet)

This is an open infrastructure on Marineholmen in Bergen established by the University of Bergen, the Institute of Marine Research and Norwegian Defence Research Establishment. In 2018 it was extended towards NORCE, HVL and Nansen Environmental and Remote Sensing Centre (NERSC). It comprises a collection of different national infrastructure projects mainly financed by the Research Council of Norway. It includes observation technology facilities, including the ROV Ægir 6000, which operates down to 6,000 meters depth. It further holds AUVs and other advanced observation technologies for underwater research.

Marineholmen, including VIS

This includes the physical area (owned by Marineholmen Research Park) and is a cluster containing several companies with a strong innovative edge including VIS itself. VIS is the central innovation hub for the University of Bergen, the Institute of Marine Research and the Health Research Institutions in Western Norway. It comprises several facilities for start-ups and innovation and holds industrial clusters such as GCE Global Ocean Technology and NCE Seafood Innovation, SINTEF, The Veterinary Institute, the Norwegian Food Safety Authority, and DNV-GL among many others.

Ocean Industries Accelerator

Ocean Industries Accelerator (OIA) is a community, run by VIS and the marine industrial clusters in Bergen for companies from the ocean industries, providing offices and an open-space office, surrounded by other entrepreneurs. The the accelerator's ambition is to provide actors from the ocean industries like shipping, seafood, oil and gas with the possibility to cooperate closer and more efficiently. The new accelerator is primarily a place where one can share knowledge and participate in a network that helps produce better products, to get new projects started and to help new ideas to flourish.

Austevoll and Matre Research Stations

These are two research stations owned by the Institute of Marine Research but with close links to the University in Bergen in teaching and student projects. The station in Matre is specialized on salmonid research while the station in Austevoll is specialized in research of marine species, especially for aquaculture, and used for scientific research by (both) IMR and the University of Bergen. The stations are open for other users on commercial basis when there is capacity.

The Norwegian Research Vessel Fleet

A Shipping Unit (Research Vessel Department) at the Institute of Marine Research runs the research vessel fleet. This unit runs research vessels owned by IMR, UiB, NORAD, UiT, and the Norwegian Polar Institute, in total seven ships including the new icebreaking research vessel, RV Kronprins Haakon. IMR and UiB has a joint committee prioritizing tasks for some of the research vessels, including use in courses, student projects and research. The research from vessels are the basis for the fisheries regulations in Norway and other marine research.

KG Jebsen Centre for Deep Sea Research

JC-DeepSea was established as a result of a generous contribution from the Kristian Gerhard Jebsen Foundation. It aims to be a leading international centre for deep ocean research. It is a joint centre between the departments of earth science and biological sciences at UiB.

CBU Computational Biology Unit

CBU is a joint research centre for the Faculty of Medicine and the Faculty of Mathematics and Natural Sciences, located at Department of Informatics at UiB. It has an open service unit assisting other departments and researchers as well as the Haukeland University Hospital in their work on bioinformatics as well as performing their own research and education.

Digital Life Norway

Centre for Digital Life Norway (DLN) is a unique transdisciplinary research centre creating the biotechnology for tomorrow. The aim of this virtual Centre is to evolve new knowledge and methods to create value and address societal challenges. UiB is an active partner in this centre and is the host of the Competence and infrastructure network, which contributes to the effort of keeping DLN at the forefront of data management and analysis, both for the experimental and the computational aspects of the research.

Probe – The Proteomics Unit at the University of Bergen

Probe is a national core facility for large-scale protein analysis using mass spectrometry, and is the leading node of the NorProteomics Consortium, which includes groups at several universities in Norway. PROBE offers service, support and collaborations to those interested in doing mass spectrometry-based protein analysis on any type of sample, and is located at the department of Biomedicine, UiB

The K.G. Jebsen Centre for Deep Sea Research

The K.G. Jebsen Centre for Deep Sea Research (JC-DeepSea) at UiB aims to be a leading international Centre for research on the deep oceans. Its goal is to pioneer discoveries, thereby expanding our knowledge of the deep sea and its potential resources. The work extends across several disciplines that work closely together to achieve these research goals, and is a continuation of the research carried out at the former Centre for Geobiology.

IMR operates a range of ocean-going research vessels, on behalf of itself, UiB, The Polar Institute, and UiT. The two top vessels in this fleet as *Kronprins Haakon* and *G.O. Sars*, both with high value for JC-DeepSea:

RV *G.O. Sars* has state-of-the-art sonar systems, multibeam mapping capabilities and dynamic position systems ideal for deep sea exploration. As part of the proposed Centre program, there will be yearly international expeditions to the Arctic Mid-Ocean Ridge (AMOR) with this vessel.

RV *Kronprins Haakon*, a new Norwegian polar research vessel with ice breaking capabilities, was launched in 2018. This opens new opportunities for research along some of the ice-covered segments of the AMOR.

Through funding from the Research Council of Norway, UiB has acquired a 6,000m-rated ROV system, the *Ægir6000*. It is a cornerstone of the marine infrastructure, the Norwegian Marine Robotics Facility (NORMAR). This new ROV-system will be our primary tool for exploring, sampling and deploying instruments and experiments at deep sea study areas - including the ice covered parts of the Arctic Ocean.

For more information see: www.uib.no/en/kgj-deepsea



Molecular Imaging Centre (MIC)

MIC was started in 2003 and is an open access core facility in advanced subcellular, cellular and small animal imaging, located at the Department of Biomedicine, UiB. Research and development of imaging methodology is an integrated part of their activities. MIC arranges on average 2-3 national imaging courses and workshops per year and accommodate a large user-group at the instrumentation. National and international researchers can use the facilities.

ELMI Electron Microscopy Lab

ELMI is part of the open research infrastructure located at the Department of Earth Science, UiB. The instrumentation is also in use for biological sciences.

The Genomics Core Facility

The Genomics Core Facility (GCF) is hosted by the Department of Clinical Science, UiB, in collaboration with Haukeland University Hospital. The activities are supported by a grant from Trond Mohn Stiftelse/Trond Mohn Foundation (www.mohnfoundation.no). The Trond Mohn Foundation has also founded a six-year position as service bioinformatician. GCF is a partner of the Norwegian consortium for sequencing and personalized medicine (NorSeq), supported by an infrastructure grant from the Research Council of Norway.

The Sequencing Facility

This is a separate unit under the Department of Biological Sciences, UiB, running automated Sanger sequencing. It is open for all users to buy services from the facility.

Ocean Sustainability Bergen

Ocean Sustainability Bergen (OSB) is a virtual centre at UiB working with partner institutions worldwide in ocean science and education. The aim is to engage with the Sustainable Development Goals (SDGs) and the centre is part of the university's strategic initiative, SDG Bergen, which presents scientific advice to governments and international bodies to aid them in decision-making processes. OSB takes care of day to day activities in relation to UiB's status as the Hub for SDG 14: Life below water, as appointed by the United Nations Academic Impact (UNAI) and is also the SDG 14 representative in the International Association of Universities (IAU) SDG Cluster.

3.4.2 EMBRC NODES

Norwegian membership of EMBRC has been made possible thanks to a grant from the Research Council of Norway in 2017, which was a "quality stamp" required to become a member of this prestigious research infrastructure network. The Norwegian node consists of five research institutions offering seven different research facilities to the EMBRC network. The University of Bergen, which is the national EMBRC coordinator for Norway, offers two research facilities (nodes) into the EMBRC network:

1. Sars International Centre for Marine Molecular Biology

The Sars Centre is a basic research facility under the University of Bergen. It is a member of the European Molecular Biology Laboratories (EMBL) where it serves as the marine hub. Today it has 6-7 research groups with internationally recruited non-tenured group leaders. The group has their own wet lab facilities at Marineholmen and will through the EMBRC network open some of the facilities for cooperation.

2. Sea Lice Research Centre

The Sea Lice Research Centre is a SFI Centre for Research-based Innovation⁴³ focusing on salmon lice, which is a major problem for further development and growth of the Norwegian Aquacul-

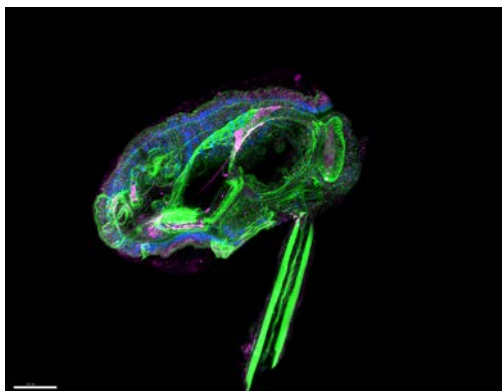
43 www.forskningsradet.no/en/call-for-proposals/2019/centre-for-research-based-innovation/

ture industry. In its second phase, beginning in 2019, it is a cooperation between UiB, IMR and several private companies. It has special facilities for maintaining sea lice stocks. The research is collected in Lice Base, an open digital storage of the research data. Part of the facilities in the Sea Lice Research Centre will be open for EMBRC cooperation.

The Sars International Centre for Marine Molecular Biology

The Sars International Centre for Marine Molecular Biology (The Sars Centre), created in 1997, studies the basic biological processes in marine organisms using functional and comparative molecular methods. It has since 2003 been a partner of the European Molecular Biology Laboratory (EMBL), and since 2018 an EMBRC node. Using molecular techniques, the Sars Centre aims to use marine animals as model systems to study development, most often in an evolutionary context. Major model species are the tunicates *Oikopleura* and *Ciona*, the sea anemone *Nematostella* and various invertebrate protostomes mostly in the group of Lophotrochozoans. Methods include molecular biology, cell biology and genome-wide analyses. The Sars Centre is also occasionally involved, mostly through external collaborations, in projects on species having direct relevance to aquaculture, fisheries and other industries. UiB is now in the process of establishing a sister centre in China, The Sars-Fang Centre, in collaboration with Ocean University of China in Qingdao (www.uib.no/en/news/117177/new-ocean-research-initiative-china).

For more information see: www.uib.no/en/sarscenteret



3.4.3 NETWORKS AND INDUSTRY CLUSTERS

Bergen has Europe's greatest concentration of marine research centres, and more than half of Norway's research into the sea, fish and the coast happens in Western Norway. Bergen's unique mix of internationally leading marine research and management competence is totally unique in Norway and represents great potential for important synergy effects. UiB is a member of the industry innovation clusters NCE Seafood Innovation Cluster, NCE Maritime CleanTech and GCE Ocean Technology, which then with other institutions and organizations have formed the loose umbrella organization "Ocean City Bergen".

Seafood Innovation Cluster

The NCE Seafood Innovation Cluster is a world-leading cluster, where the headquarter is situated in Bergen. The 57 members with more than 18,000 employees represent the whole seafood value

chain, as well as the research institutions. Enabling sustainable seafood to the global community is the overall vision of the cluster, and the mission is to build an ecosystem for growth and competitiveness in Norwegian seafood.

Global Ocean Technology

GCE Ocean Technology is an industry-driven initiative within ocean technology with more than 120 partners and members. The cluster develops and supplies innovative ocean technology within a wide range of applications, including: Subsea oil and gas production, Marine renewable energy production, Marine food production and Exploration of marine mineral resources.

NCE Maritime CleanTech (NCE MCT) represents one of the world's most complete maritime commercial hubs. The cluster organisation uses the Norwegian maritime expertise, built up over generations, as a springboard for the development of new energy-efficient and environmentally friendly technologies, also within the aquaculture sector. NCE MCT focuses on establishing sustainable innovation projects with commercial potential and works together with its partners and stakeholders for new clean maritime solutions.

Ocean Innovation Catapult Center (OINC) at Marineholmen is a national test, simulation and visualization centre for effective prototype development, and verification of new solutions for blue growth and green conversion in the marine industries. A central investment is a recirculating aquaculture system, (RAS) in close partnership with ILAB and UiB.

Sustainable Energy

Sustainable Energy is a Norwegian Catapult Center which covers various levels of completion of technological solutions, from development and testing of prototypes in laboratory environments to finished products that need testing in operational facilities on land, on ships and in the ocean space, including fish farms. The Catapult Center will provide expertise in prototyping, testing and market introduction.

Norwegian Marine University Consortium (NMU) is a cooperation between 11 Norwegian universities (among them universities in Oslo and Tromsø, NMBU, NTNU, NHH and Western Norway University of Applied Sciences), initiated by and administered from UiB. NMU holds the membership in the European Marine Board on behalf of the member universities, and facilitates cooperation with a similar university cluster under establishment in China.

Bergen Marine Research Cluster is a cooperation between research institutions in Bergen: UiB, Institute of Marine Research, NORCE, NERSC, Nofima and Haukeland University Hospital. Its administration is at the Faculty of Mathematics and Natural Sciences at UiB. One of its major activities is the Ocean Outlook workshop series which alternates annually between Bergen and Woods Hole (USA).

Ocean Innovation Catapult Center (OINC)

Ocean Innovation Catapult Center (OINC) is a national testing center for effective prototyping and verification of new technologies. The target group is entrepreneurs and SMBs with new solutions targeted towards the marine industry. OINC will invest in new and immature technologies such as metal 3D printing and RAS (Recirculating Aquaculture Systems) facilities and at the same time make available residual capacity on existing laboratory and testing facilities in Norway. OINC is one of five national catapult centers supported by the public through SIVA. Behind the company OINC AS is VIS (on behalf of UiB and HVL), GCE Ocean Technology, NCE Seafood, ILAB, CMR Prototech (NORCE) and the Marineholmen Research Park.

For more information see: oceaninnovation.no



3.5 ROLE IN POLICY SHAPING

Universities and research centres do not operate in isolation, they are linked to the overall research and innovation ecosystem, both locally and nationally, where representatives of the research centre are proactive or are invited to participate in political and economic forums as experts and advisors. Examples include the engagement activities of key persons from the research centre participating in setting the agenda for research and innovation goals of the region (by participating in dedicated committees) or participating in the operational part of regional/national research and innovation policies.

From the University of Bergen 77 activities were collected from different sources and divided into four categories: *Building markets*, *Participation in politics of a domain*, *producing data for policy and Research and innovation agenda setting* (See Table 6 below).

Very few of these activities are formally recorded by the institution and are usually a personalised matter for the individual scientist. Most of the activities (49) are ongoing and occur regularly. Typical examples of policy activities are regional, national and international advisory committees (i.e.

for the government, the Research Council of Norway and EU committees), executive committees, board membership in different types of associations, NGOs and companies. The rest of the activities collected were not regular and mostly focused on production of white papers and working groups around specific themes.

Advisory and scientific committees seem to be the most common types of policy links for the marine biological researchers from UiB. The work in the advisory committees seems to be typical on an advisory or expert level and not dependent on the participating researcher's specific marine biological field. The participation in scientific committees, on the other hand, seems to be more connected to the researchers' own scientific field. It must be specified that the scientific committees listed in this report are connected to policy and agenda setting of research and innovation.

TABLE 8. DIFFERENT TYPES OF POLICY LINKS FROM UiB WITHIN MARINE BIOLOGICAL ACTIVITIES. SOURCES: THE DEPARTMENT OF BIOLOGY, THE FACULTY OF MATHEMATICS AND NATURAL SCIENCES, INTERVIEWS WITH INDIVIDUAL SCIENTISTS.

TYPE OF POLICY LINK	# OF LINKS COLLECTED	%
Building Markets	6	7.8
Participation in politics of a domain	13	16.9
Producing data for policy	13	16.9
Research and innovation agenda setting	45	58.4
TOTAL	77	100.0

The data collected for this is not exhaustive for the period in question, but the material is considered sufficient to get an overview of the activities within the policy area. The University does not systematically collect information about these kinds of engagement from their leaders and researchers.

3.5.1 PARTICIPATION IN RESEARCH AND/OR INNOVATION AGENDA SETTING

The participation in research and/or innovation agenda setting in activities related to marine biological sciences can roughly be divided into two different categories: participation as a scientific leader (rector, dean, head of department, etc) and participation as a scientist contributing with specific scientific or innovation knowledge. Typically, examples of the first are the UiB rector's membership in the Board of The Seafood Innovation Cluster and the Vice Dean for Mathematics and Natural Sciences leading The Marine Research Cluster in Bergen. Typical examples of the latter are participation of scientists at UNESCO's Intergovernmental Oceanographic Commission and The Regional FUGE Board (A Board appointed by the Norwegian Research Council).

3.5.2 PARTICIPATING IN POLITICS OF A PARTICULAR DOMAIN

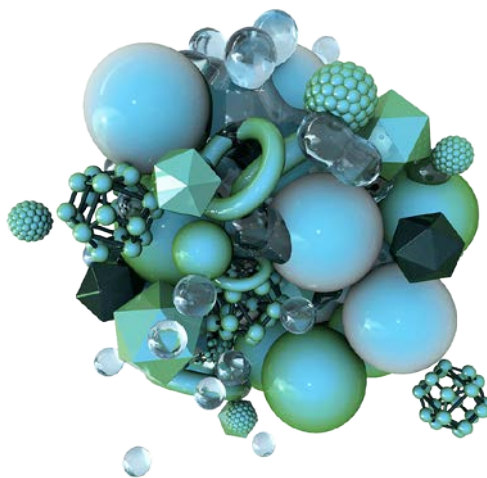
The participating in politics of a particular domain typically takes place in different advisory or scientific committees like the Scientific Committee on Food Safety and the Cod Development Norwegian Knowledge Platform

National centre for biotechnology research and innovation

The Centre for Digital Life Norway is a unique transdisciplinary research centre creating tomorrow's biotechnology. It is a national centre for biotechnology education, research, and innovation, with the aim of evolving new knowledge and methods to create value and address societal challenges. It is run as a collaborative project by the University of Oslo, University of Bergen, and the Norwegian University of Science and Technology, supported by the Research Council of Norway. The activities at the centre are organised in a governance and networking project, which includes a research school for PhDs and postdocs and several research projects. The centre facilitates transdisciplinary cooperation across institutions and fields of research, and between projects. The host institutions of the research projects at the centre constitute the hub- and node-structure of the network. The University of Bergen is responsible for the working group of competence and infrastructure (Professor Inge Jonassen). In addition, UiB has a large research project on decoding the systems of toxicology of Atlantic cod, dCod 1.0, where professor Anders Goksøyr is the project leader.

UiB has also appointed a board member of the Centre (at present it is Deputy Dean Marit Bakke at the Faculty of Medicine) and this activity is reported as a link under the *Research and Innovation agenda setting*.

For more information see: digitallifenorway.org/gb/



3.5.3 BUILDING MARKETS

Typically, Board membership in industrial companies, including academic start-ups.

3.5.4 PRODUCING DATA FOR POLICY BEYOND THE MARINE FOCUS

Typically, regional, national, and international advisory committees producing data for policy making.

3.6 ROLE IN CONNECTING WITH SOCIETY

Another way research centres can be embedded in their regions is through strong relationships with civil society (specific and general publics). Controversies linked to scientific research have led to an expectation of transparency and closer ties to civil society. This pressure to interact can be positioned as an opportunity. In areas such as biodiversity, citizen science can mobilise the public for joint data collection. It can also create broader enthusiasm for the scientific domain which both convinces research funding agencies of the relative importance of the research domain and inspires young aspiring students to embark on scientific careers.

From the University of Bergen, 61 different kinds of societal links relevant for the blue bio economy were collected, mostly from Department of Biological Sciences. Data from other departments at UiB were also reported (Table 8). The different kinds of links were quite diverse, and despite being highly dominated by regional events (92% of the links were regional), it is difficult to find any trends or pattern in the engagement from the University and its employees in this realm. However, the public outreach category (typically open seminars, conferences, fairs, meetings etc.) is most prominent. The other visible category is participation in debates.

The data in this section were collected from The Department of Biological Sciences and from the Faculty of Mathematics and Natural Sciences. In addition, about 50 interviews have been conducted with researchers within the marine field in order to extract information about non-recorded society links. The data is not exhaustive but considered sufficient in order to see a pattern in the data collected.

TABLE 9. TYPES OF SOCIETY LINKS RELEVANT FOR MARINE BIOLOGY FROM UiB BY NUMBER. SOURCES: THE DEPARTMENT OF BIOLOGY, THE FACULTY OF MATHEMATICS AND NATURAL SCIENCES, INTERVIEWS WITH INDIVIDUAL SCIENTISTS.

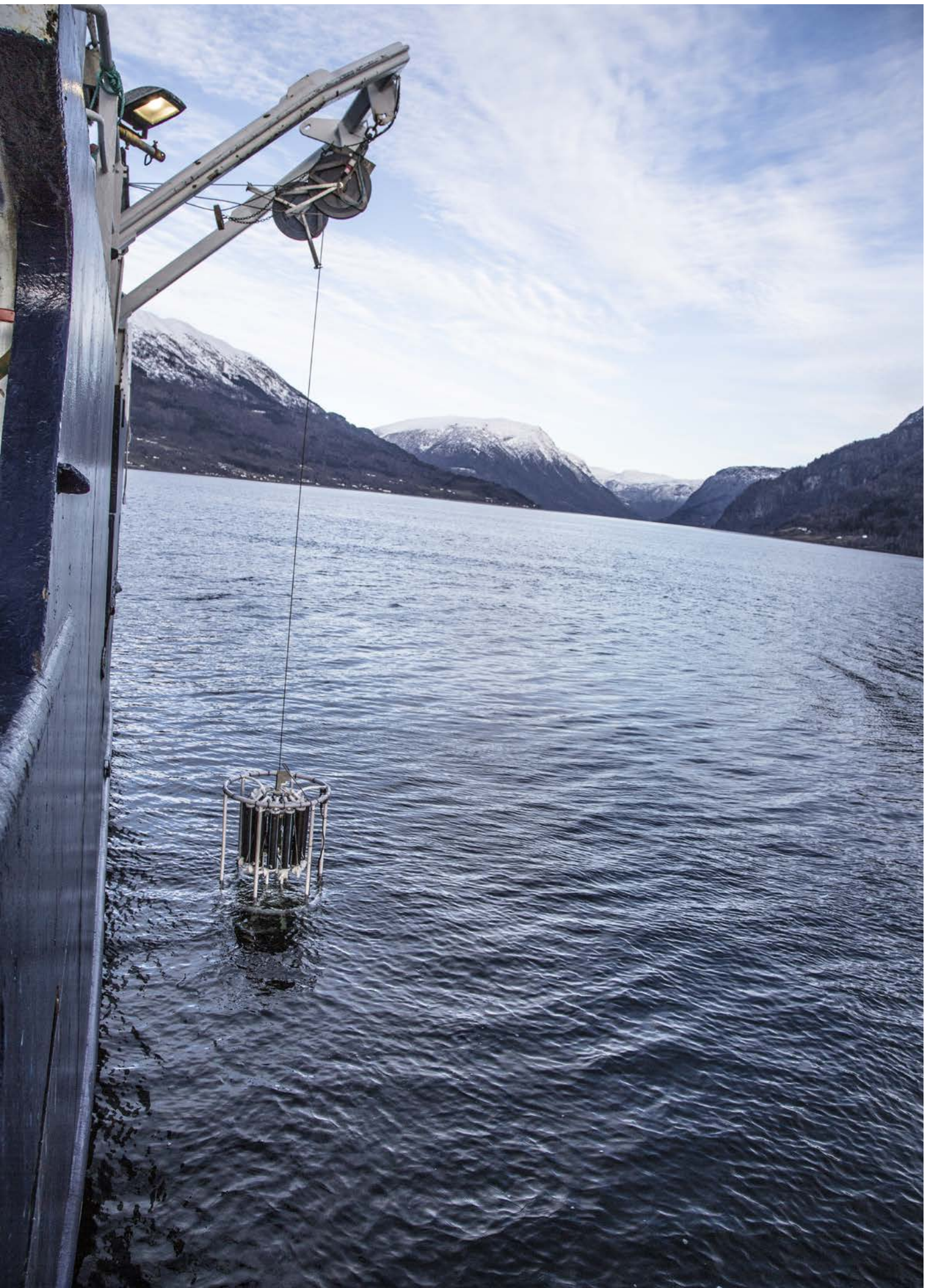
TYPE OF POLICY LINK	# OF LINKS COLLECTED	%
Building Markets	6	7.8
Participation in politics of a domain	13	16.9
Producing data for policy	13	16.9
Research and innovation agenda setting	45	58.4
TOTAL	77	100.0

Fish to Mars – a metal science opera

When real science makes you wanna scream like an opera. Fish to Mars combines two of Bergen's most international products, marine science and metal music. Professor Karin Pittman and composer Arild Brakstad worked with dramaturg Ivar Tindberg and director AnnTerese Aasen to build the scenic concert version of the original story by Peter Watts with the cast of artists and scientists from a multitude of international institutions, and website developer Dr. Jonathan Soule fish2mars.w.uib.no. In 2017, 2018, 2019 and 2020, the expanding and improved versions of an original multidisciplinary 1-hour opera, Fish to Mars, were performed to live audiences, winning the People's Choice Award at Fringe Festival 2019 and opening the SDG Conference at UiBergen in 2020. Fish to Mars was invited to several international science-music festivals prior to the pandemic.

Fish to Mars is a multi-disciplinary meeting place for dramatization and debate about climate change and our place on this planet, first performed at The Aquarium of Bergen, Norway. The prime mover behind this innovative communication exercise is Prof. Pittman, Dept of Biosciences, building on graduate student feedback over several decades. Her scientific field is within biological oceanography and fish biology, and she is also the founder and chief scientific officer of the biotech start-up QuantiDoc AS.





Seafloor mapping in Sognefjorden by research vessel "Håkon Mosby". Photo: Håvard Nesbo

SECTION 4: MAIN FINDINGS AND SOME CONCLUDING REMARKS

This report displays a strong marine regional innovation ecosystem in Bergen and Vestland, and the University of Bergen (UiB) is a key player in this system. The marine research and innovation activities can be seen within all faculties. However, the Faculty of Mathematics and Natural Sciences, and especially the Department of Biological Sciences, are the most prominent players from the UiB. The University is ranked highly scientifically within the marine field in various global university rankings. Further, the collaboration between UiB and IMR and other regional and national research institutes is very visible within the various dimensions of data collected. UiB has a high amount of various economic links with private and public sector companies and organisations in the region and is a provider of knowledge and competence in various forms of training courses, and educated candidates to the local community. These candidates are important for collaboration and development within science and innovation in the region. However, the specific offer from UiB in terms of specialised training courses etc. toward professionals seems to be a mostly missed opportunity. One striking exception is, however, the training of teachers from schools in Bergen and Vestland county.

Many marine-related research and innovation infrastructures are listed in the region, and they have a strong role in the local innovation ecosystem. UiB is involved, to a greater or lesser extent, in all of them. The University and its faculty have various social and policy links, both globally and locally, thus contributing to a general dissemination of research as well as research-based policy making. The development of new technologies and the patent situation within marine aquaculture, marine biology, and biotechnology, should be subject to a deeper investigation in order to unlock some possible bottlenecks to meet the changing and challenging conditions within the industry.

UiB has a strong emphasis on being an internationally visible change agent to e.g. global challenges for the oceans (with references to the actions taken to support UNs SDG 14, *Life below Water*). In the society and policy links collected in this study, a lot of activities relevant for such a strategy is identified. However, UiB lacks a system for collecting and maintaining such information, suggesting another underutilised opportunity.

APPENDIX: SUMMARY OF DATA ACQUISITION, METHODS AND ADDITIONAL FIGURES

TABLE A1. A LIST OF THE DATA SETS COLLECTED ALONG THE FIVE DIMENSIONS OF THE RESEARCH COMPASS (NUMBER 1-5). SEVEN DATASETS WERE COLLECTED

DATA SET LINKED TO COMPASS	DESCRIPTION	DATA REQUIREMENT
1a. Publications	Peer-Reviewed scientific publications identified as broadly linked to Marine Biotechnology and/or Marine Biological Resource Management	List of references for each publication from the institute between the period 2010 – 2015, Authors, Year, Title, Journal, Doi
1b. Competitive Funded projects	Public funded projects, most often from public funding organisations (European Commission, national research councils), but can also include regional funds, foundations.	Acronym, Funder, Funding Source, Funding Instrument, Project Title, Department/ Unit in Insitute, Start Date, End date, Total amount, Partners, Project abstract
2. Training	Professional and academic training activities broadly linked to Marine Biotechnology and/or Marine Biological Resource Management	Type, Name of Training activity, Professional status of attendees, Number of sessions between 2010 - 2017, Average number of participants. PhDs, nationality and first job after graduation
3a. Contracts with private sector	Economic relations between the research centre and the private sector. This includes contract research, consultancy, service provision, provision of a PhD student, commercial use of infrastructure, etc.).	Name of private partner (when disclosable), Location Town/City, Country, Type of contractual relation, Frequency of activity, Budget
3b. Patents	Patents as broadly linked to Marine Biotechnology and/or Marine Biological Resource Management	Application number, Name of co-applicant(s), Address(es) of co-applicants, Application date
4. Connections with policy for market creation	Participation in standards organisation, in regional committees, etc.	Policy Link Type, Frequency, Last meeting date, Approximate No. people involved
5. Connections with civil society	Links between the research centre (and individual researchers) with civil society.	Name of activity, Type of Societal Link, Frequency, Date of last activity

Below is outlined the seven types of data needed to be able to characterise the different elements of the star in figure 1. It must be added that, along with the seven datasets, other contextual information is drawn upon, for example details on the history of the institute, the local economy, the mission of the institute, key facilities and infrastructures.

1. PUBLICATIONS

The core activity of public funded research organisations is to produce verified scientific knowledge that is both peer-reviewed and placed into circulation for use by others. The successful production and use of such knowledge increase the status of the institute, as well as the individual scientists involved, and thus the production and use of such knowledge provides an indicator of the success of the institute. In contrast, those results of research which are kept local or secret cannot be tested by peers and thus do not add to the status of the institute compared with other institutes or national standards.

Therefore, because of this organised process, a good site for tracing the production and use of scientific knowledge is in peer-reviewed journals, where knowledge is codified into articles, is quality controlled through the mechanism of peer-review and referred to in other articles and journals.

Data gathered

For UiB, the Cristin database (Current Information System in Norway)⁴⁴ was used to collect the data.

A list of publications related to marine biotechnology from UiB between 2010 and 2014 was collected. The data includes author(s), year, title, journal, and (doi when available). An additional list of publications collected on the same criteria from 2015-2017 was also collected. In addition a separate list from the Sars Centre was provided by them.

The CorTexT platform is the digital platform of LISIS Unit and a project launched and sustained by IFRIS and INRA. This tool was used to analyse the publication data both for the whole EMBRIC consortium and for UiB.

2. COMPETITIVE PUBLIC FUNDED PROJECTS

Another approach to assessing the type of scientific knowledge production and the status of the research organisation, is through analysing the forms and frequency of research acquisition for research. Competitive public funded projects is a measure of this, since they are awarded based on expert review and comparison amongst a number of project proposals. Competitive public (and private) funded projects can be financed locally, regionally, nationally or through international funds (like the European Commission's H2020), and thus the source of finance, as well as the size and form of finance, can provide useful insights on the research centre's profile.

Data gathered

We aimed at exhaustivity; therefore a comprehensive list of competitive funded projects has been gathered. This list covers projects from 2010 until 2016 inclusive, which allows for a study of the diversity of sources of financing and amount of such funding as well as details of partner research organisations (name and location).

From UiB, the list of research projects within the Blue Bio were collected from The Research Council of Norway, Horizon 2020 database, UiBs project module (PA), supplemented with information from The department of Biology and the Sars Centre. Only projects where UiB is listed as a coordinator or partner are listed.

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3. ECONOMIC CONTRACTS AND RELATIONSHIPS WITH THE PRIVATE AND PUBLIC SECTOR

New knowledge can produce value in a variety of ways. In the previous two sections, new knowledge is added to a global reservoir, which can be tapped by those with access to peer-reviewed journals and exchange through project collaboration through publicly funded competitive projects.

For this data set, we shift the focus to private sector funded activities, or more broadly, relationships between the research centre and the private sector. This can also include contracts with the public sector, but here the public sector acts as a customer towards the research institute/organisation. This is a key element of the modern research lab: economic activity to create competitive advantage both regionally and nationally.

For clarification purposes, a prototype or demonstration project cannot be included in this section unless private resources have been mobilised to finance it. Likewise, if public funding has been mobilised through competitive funds, then it should be mentioned in section 2.

Data gathered

A list of links with the private (and public) sector between 2010 and 2016. We take the broadest view of private sector linkage here and include **seven types of contracts and relationships** (provided in the box below). More specifically, what is required for each private partner name (when disclosable), location, type of contractual relation (see box below), and frequency of activity (once, repeated or regular).

BOX 1. CONTRACT/RELATIONSHIP TYPE

(1) Consultation / Contract Research:

the production of new knowledge commissioned by a client

(2) Services: the provision of expertise in the form of a service to a client (not research) for example DNA analysis of a sample of fish provided by a supermarket for authenticity reasons.

(3) License agreements: licensing patents or know-how to a client

(4) Collaborative Research groups / labs: shared investment (public and private) in a research group or lab

(5) Hosting Companies (not spin offs): housing companies that were not created by the institute

(6) Start-ups / Spin Offs: the creation of a start-up or spin-off

(7) Product development / Commercialisation: the creation of a product or commercial service

The data from UiB was collected from UiB's project module (PA), VIS, The Research Department (FA) and The Faculty of Mathematics and Natural Sciences.

4. INTELLECTUAL PROPERTY (PATENTS)

The most widely acknowledged indicator of the creation of competitive advantage is the notion of invention. More often than not, invention is accompanied by patents, which can provide a metric for characterising the impact of a research centre. The study of patents, as an indicator of the creation of competitive advantage, is the subject of a whole community of researchers and analysts, and we can draw upon this community to provide insights into understanding patents and their contribution to the profile of the research lab.

Data gathered

Data gathered includes: the patent number (application or publication number), name of co-applicant(s), address(es) of co-applicant(s) and application date. All patents since 2006 should be included.

Data from UiB was collected from VIS' patent database.

5. TRAINING

The previous data sets provide an indication of the research organisations' activity via circulating knowledge through publishing, collaborating and through contract work. Another aspect of circulating knowledge relates to mobility of researchers and competence building, in other words: training. Training is an important activity for many labs and forms a key part of national research policies. Whilst codified knowledge (scientific publications and research projects) and codified economic impacts (patents and contracts with the private sector) can be systematised and turned into maps, understanding of the production of a qualified workforce is a more qualitative affair.

Data gathered

Two sets of data are required. The first focuses on the organised training activities led by the institute. This regards involvement in European/International training networks.

Training: list all the professional and academic training activities broadly linked to Marine Biotechnology and/or Marine Biological Resource Management from the period 2010 to 2016 inclusive. This includes type (MSc, PhD, professional), professional status of attendees (graduate, post graduate, researchers, employees from industry and employees from public agencies), number of training sessions over the past 6 years (2010-2016) and average number of participants.

European / International training programmes: A large part of the embedding of a research centre is its participation and shaping of pan-national training initiatives. Cataloguing such initiatives can be useful to assess the diversity and reach of the centre with regards to training the Marine Bio workforce.

Data from UiB was gathered from a variety of sources, through the Marine Evaluation Report, including self-evaluation material, BIO-info, Cristin (PopVit database) and interviews with scientific personnel and management (not exhaustive).

In addition to organised training activity, data on marine PhDs (defended thesis) from the Department of Biology from 2010–2017 was collected from NIFUs PhD database. The geographical origin of the candidates and their first jobs after graduation were identified.

6. CONNECTIONS WITH POLICY

Research centres do not operate in isolation, they are linked to the overall research and innovation system, both local and national, where representatives of the research centre are proactive or are invited to participate in political and economic forums as experts. Examples include the engagement activities of key persons from the research centre participating in the *agenda setting* of research and innovation goals of the region (by participating in dedicated committees) or participating in the *operational* part of regional/national research and innovation policies. It may be the involvement in new infrastructure, science or innovation districts, or regional development activities.

Other examples may be less geographical, but more based on the domain of expertise of the research lab, for example participation in technical standards committees. It is important to note that participation in technical standards committees represents “represents a strong power to shape the domain by those involved in such committees – they decide what is usual, what is not, and create definitions which include and exclude certain activities.

Data gathered

Below are the types of information needed for this indicator (understanding that not all will be covered by each institute).

- Participating in research and/or innovation agenda setting, for instance in setting the Smart Specialisation Strategy of the region or participating in regional innovation councils.
- Participating in politics of a particular domain (Parlement de la Mer)
- Market building, for example participation in technical standards setting committees. Another common example would be participation in the operational aspects of research and innovation policy, for example the development of a science and business park.
- Data production for policy (experts informing climate change policy)

Data from UiB was gathered from a variety of sources, through the Marine Evaluation Report, including self-evaluation material, BIO-info, Cristin (PopVit database). In addition, about 50 interviews have been conducted with researchers within the field in order to extract information about non-recorded policy links. The data is not exhaustive but considered sufficient to see a pattern in the data collected.

7. CONNECTIONS WITH CIVIL SOCIETY

Controversies linked to scientific research have led to an expectation of transparency and closer ties to civil society. Events such as mad cow disease, concerns and protests over genetically modified organisms and the increasing concerns around nuclear fission and fusion research, dictate that part of the work of research centres is to link with civil society.

This pressure to interact can be taken as an opportunity. In areas such as biodiversity, citizen science can mobilise the public for joint data collection. It can also create broader enthusiasm for the scientific domain, which both convinces research funding agencies of the relative importance of the research domain and convinces young aspiring students to embark on scientific careers.

Whilst quantitative analyses of connections with civil society may not yield useful data, a systematic listing, based on a typology, can provide an indication of the breadth and depth of links between the research centre and civil society. Below, we provide a typology of types of civil society engagement which will guide the data collection and ordering.

- Public outreach (and public open days) organised by the institute itself
- Participation of researchers from the research centre in externally organised debates (including debates on controversies)
- Public engagement and democratising science (user committees and focus groups that influence the direction of research or research related activities).⁴⁵
- Coordinating citizen science, where non-statutory researchers (the general public, fishermen, farmers etc.) contribute to the activities of research)⁴⁶
- The creation and dissemination of education tools and kits.

Data from UiB was gathered from a variety of sources, through the Marine Evaluation Report, including self-evaluation material, BIO-info, Cristin (PopVit database). In addition, about 50 interviews have been conducted with researchers within the field in order to extract information about non-recorded policy links. The data is not exhaustive but considered sufficient to see a pattern in the data collected.

⁴⁵ This type of civil society linkage must have a goal of using the output of the engagement to influence the way research and development is carried out. An example is the steering committee of the field trials of Genetically Modified grapevines, which ran for a 10-year period in France and included researchers, wine growers, NGOs etc. to assess and direct the research directions and practices in the field trials.

⁴⁶ For example, the COMBER citizen science biodiversity project led by EMBRIC node HCMR : Arvanitidis, C., Faulwetter, S., Chatzigeorgiou, G., Penev, L., Bánki, O., Dailianis, T., ... & Vasileiadou, A. (2011). Engaging the broader community in biodiversity research: the concept of the COMBER pilot project for divers in VIBRANT. *ZooKeys*, 150, 211.

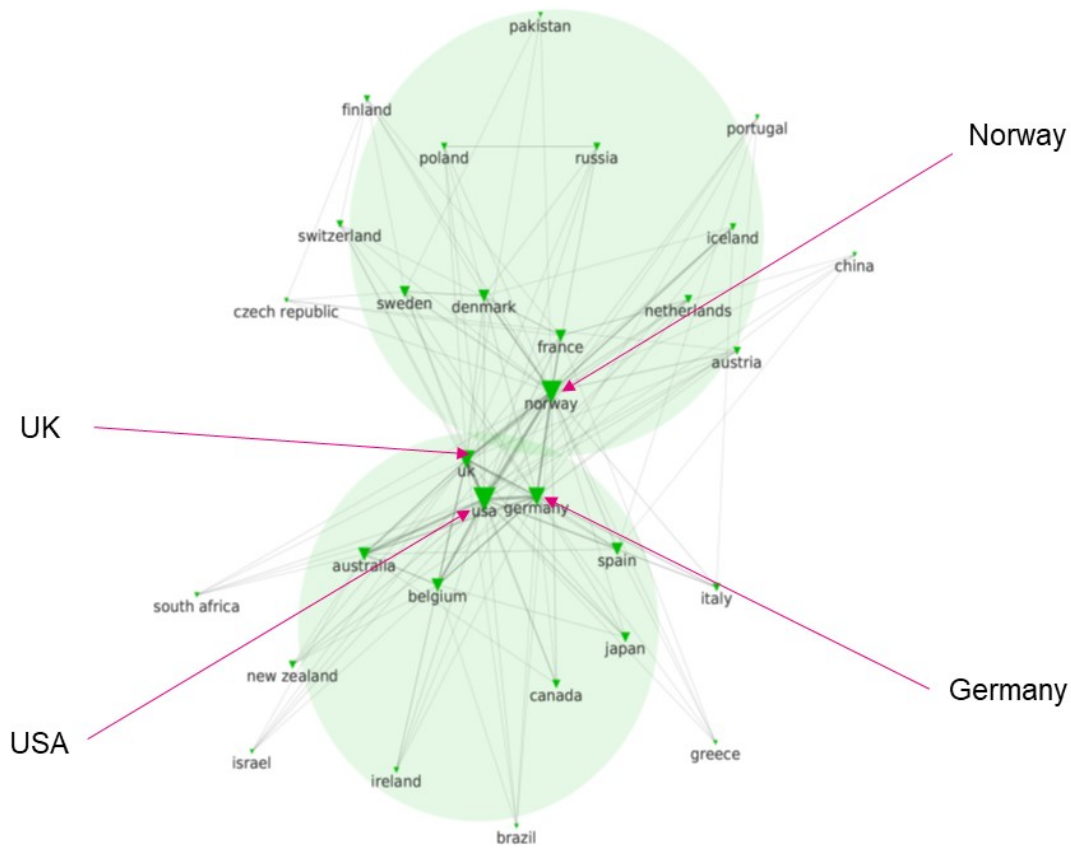


Figure 10: Scientific co-authorship with researchers within marine biology from UiB grouped by country. USA, UK, Germany and Norway are the most frequent collaborative countries, followed by Sweden, Denmark, France, Australia, Belgium and The Netherlands. Sources: Publications are from Cistin in the period 2011-2017. By the use of DOI, more detailed data about co-authors are (/is) extracted from Web of Sciences and grouped by CorText.

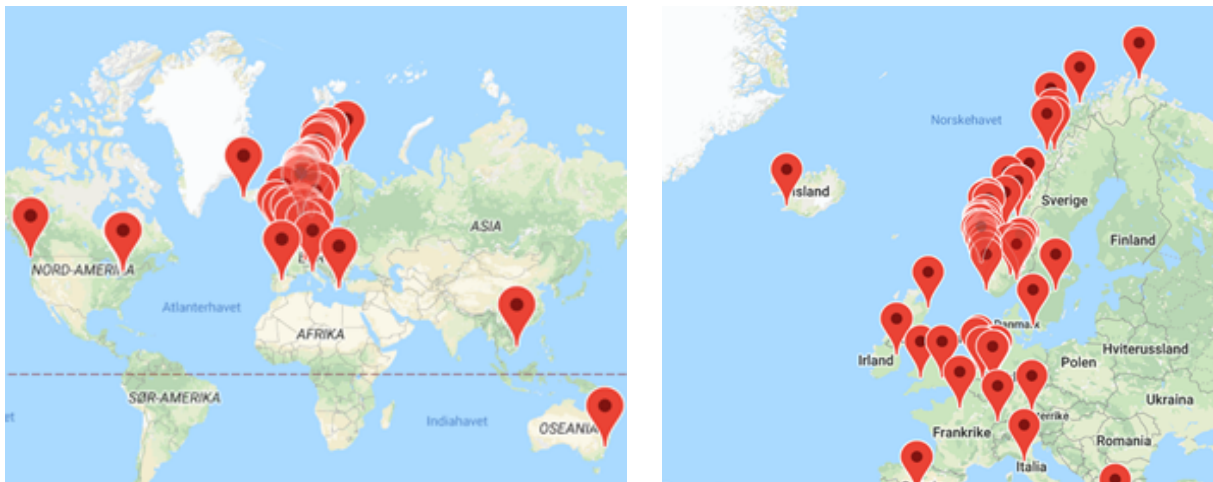


Figure 12: Geographical maps showing the location of partners in the contracts within marine biology to and from UiB. The map to the left shows all the locations of all contracts recorded. The map to the right is an enlargement of the European area from the same map. Sources: UiB databases, VIS databases supplemented with information from The Faculty of Mathematics and Natural Sciences and The Department of Biological Sciences. Treatment: EMBRC and UPEM (CorText).



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