FORCOAST

Earth Observation Services For Wild Fisheries, Oystergrounds Restoration And Bivalve Mariculture Along European Coasts

PROJECT DELIVERABLE REPORT

Deliverable Number: 6.3
Deliverable Title: Initial Business Plan
Author(s): Daan Delbare, Daniel Twigt, Luis Rodriguez Galvez
Work Package Number: WP6
Work Package Title: Innovation Management, Exploitation & Business Planning

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

FORCOAST Project Information	
Project full title	Earth Observation Services For Wild Fisheries, Oystergrounds Restoration And Bivalve Mariculture Along European Coasts
Project acronym	FORCOAST
Grant agreement number	870465
Project coordinator	Ghada El Serafy, Deltares
Project start date and duration	1st November 2019, 30 months
Project website	https://forcoast.eu/

Deliverable Information	
Work package number	WP6
Work package title	Innovation Management, Exploitation & Business Planning
Deliverable number	D6.3
Deliverable title	Initial Business Planning
Description	This initial deliverable explores the potential for the project results and the FORCOAST services beyond the duration of the project (task 6.2).
Lead beneficiary	Deltares
Lead Author(s)	Daan Delbare, Daniel Twigt, Luis Rodriguez Galvez
Contributor(s)	Service Module Leaders, Ghada El Serafy
Revision number	4
Revision Date	31/05/2022
Status (Final (F), Draft (D), Revised Draft (RV))	F
Dissemination level (Public (PU), Restricted to other program participants (PP), Restricted to a group specified by the consortium (RE), Confidential for	PU

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

consortium members only (CO))	

Document History			
Revision	**Date**	**Modification**	**Author**
Structure	07/05/2021	Draft structure	Luis Rodriguez
1st Draft	12/05/2021	Draft structure	Luis Rodriguez
Review	12/05/2021	Comments	Ghada El Serafy
1st Draft Review	12/05/2021	Refine structure content, addressing comments	Luis Rodriguez
2nd Draft v1	15/05/2021	Adding SM A4-Assistance for spat capture	Daan Delbare
2nd Draft v2	09/07/2021	Adding SM F2 – Front detection	Ainhoa Caballero & Daan Delbare
2nd Draft v3	12/07/2021	Adding draft SM F1 – Fishing Suitability Index & Upwelling	Elisaveta Peneva & Daan Delbare
2nd Draft v3	13/07/2021	Additions to SM F1 – Fishing Suitability Index & Upwelling	Sorin Constantin
2nd Draft v4	14/07/2021	Adding draft SM A3 – Prospections for new sites	Laurits Bernitt & Daan Delbare
2nd Draft v5	14/07/2021	Adding draft SM A2 – Harmful land discharges	Arthur Capet & Daan Delbare
2nd Draft v6	14/07/2021	Additions to SM A3 – Prospections for new sites	Jun She
2nd Draft v7	15/07/2021	Additions to SM-A2 – Harmful land discharges	Arthur Capet
Final draft v2	15/07/2021	Adding Executive summary, Introduction + Lay-out	Daan Delbare
Final draft v3	11/08/2021	Adding SM-R1 - Retrieve Sources of Contaminants	Alec Reid

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Revised draft	29/05/2022	Update of the document attending to the reviewers' comments	Daniel Twigt and Luis Rodriguez

Approvals				
	Name	**Organisation**	**Date**	**Signature (initials)**
Coordinator	Ghada El Serafy	Deltares	31/05/2022	GES
WP Leaders	Daan Delbare	ILVO	31/05/2022	DD

Feedback by reviewers		
Date	**Comment**	**Response**
11/02/2022	Overall the document describes the proposed business in a very qualitative manner, and does not provide key implementation cost information, requested during previous reviews.	Indicative quantitative cost estimates have been included in Section 2.5 of this deliverable, based on input obtained and experience gained in developing and deploying the services thus far. Note that the process to refine these estimates is ongoing, with several key activities presently taking place: • Further refinement by all project partners involved of the cost estimates which serve as the basis for the indicative estimates provided. This included an assessment of which OPEX costs should be covered as part of the FORCOAST exploitation, and which OPEX costs are already covered by other means. • Further refinement based on hands-on experience gained with running both the models and services (Service Modules) in production, related to the effort required in support and maintenance.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

		• Further refinement based on hands-on experience gained when transferring services (Service Modules) to other pilot sites within the FORCOAST project. Based on this, the estimates for "D6.4 - Final business plan" (to be submitted in October 2022) will be updated. Furthermore, further CAPEX costs required to improve the FORCOAST platform prototype and services to TRL9 will be incorporated in "D5.7 - Report on applications of the platform including Roadmap for achieving TRL 9".
11/02/2022	In the absence of information about the cost to deploy/transfer, calibrate, validate a model in a new location, the business plan cannot be considered complete, as a business plan should support quantitatively the evaluation of a return on investment, which is not feasible here.	See response to previous point. Indicative quantitative cost estimates have been included in Section 2.5. This includes estimates to deploy/transfer both services (Service Modules) and models (the local hydrodynamic and/or water quality models which provide input to the services) to new areas. Note that the process to refine these estimates is ongoing, and updated figures will be incorporated in "D6.4 - Final business plan".
11/02/2022	While this document is not the final version, it is a revised version, and contains insufficient information that could be linked to the cost to deploy, per site, especially for operational pilot sites deployed during the project.	See response to previous point. Indicative quantitative cost estimates have been included in Section 2.5. This includes estimates to deploy/transfer both services (Service Modules) and models (the local hydrodynamic and/or water quality models which provide input to the services) to new areas. Note that the process to refine these estimates is ongoing, and updated figures will be incorporated in "D6.4 - Final business plan".
11/02/2022	The following elements, for instance, although likely accurate, cannot be considered as sufficiently precise to assess threshold(s) of profitability for a commercial service, as the amortization of R&D and deployments cannot be calculated from this:	See response to previous point. Indicative quantitative cost estimates have been included in Section 2.5. Although not mentioned explicitly in the deliverable text, the maintenance costs foreseen are relatively low compared to

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

	• "Because it is still under development, it is for the moment not yet possible to give estimations on the costs for maintainance." • "Setting up the operational architecture and dissemination means from the modelling results to the service also requires some effort. However, these efforts are only needed once. The maintenance cost are relatively low compare with the implementation cost." • "During the FORCOAST period, the most expensive Key Activities are the model development, calibration and validation."	the implementation costs (below 10% of the implementation costs). Although not discussed explicitly in the deliverable text, the model expensive activity as listed in Section 2.5 is the development, calibration and validation of local hydrodynamic and/or water quality models.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

PROPRIETARY RIGHTS STATEMENT

This document contains information, which is proprietary to the FORCOAST consortium. Neither this document, or the information contained within may be duplicated, used or communicated except with the prior written permission of the FORCOAST coordinator.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Executive Summary

FORCOAST aims to offer information services, with the emphasis on the use of novel Copernicus-based data, co-designed with end users, which provide high-resolution data of water quality and met-ocean variables at coastal zone and nearshore that are used to give focused answers to specific questions from the targeted wild fisheries, bivalve mariculture, and oysterground restoration sectors. FORCOAST is developing, testing and demonstrating, in operational mode information services that will incorporate Copernicus Marine, Land and Climate Services Products, local monitoring data and advanced modelling in the service. This allows improving operation, planning and management of different marine activities in these sectors. Such information service includes among others: early warning service, real time crisis management, key performance indicators, and information for planning operations. FORCOAST's target market will be focusing on three different sectors, namely the fisheries, bivalve mariculture and oysterground restoration. All markets have been emerging over the last few decades.

Within the proposal of project FORCOAST it was decided to use the Business Model Canvas in order to set up a business plan for each of the Service Modules.

With the input from the end user groups per Pilot and the information from the stakeholders present at the General Assembly meeting in February 2021, a first exercise was performed, with the initial make up of three building blocks of the Business Model Canvas: Value proposition, Customer segments and Revenue streams.

Afterwards the exercise was extended to the nine building blocks of the Business Model Canvas for each of the Service Modules.

None of the proposed business plans are final, as each of the business cases (per Service Moduel) are built following an iteration process, in which the input of the end users (D2.1 & D2.2) and information from the other work packages are incorporated and presented back to the end users. The feedback from the end users is then fed into the business cases and again presented to the end user and to the work packages for for further refinement. As most of the Service Modules are still at a primordial state, this is an ongoing process.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Table of Contents

Executive Summary vii
1. Introduction 1
2. Business Case 2
2.1. Business case proposed in the DoA 2
2.2. State and development of the business potential within the target sectors 3
2.3. Updating the business case through an iteration process 3
2.4. SWOT analysis 4
2.5. Cost estimates 4
2.5.1 CAPEX and OPEX costs 4
2.5.2 Cost estimation process 5
2.5.3 Initial Operating expenses (OPEX) estimates 6
2.5.4 Initial Capital expenses (CAPEX) estimates 7
2.5.5 Refining CAPEX and OPEX costs 9
3. FORCOAST Services 10
4. Initial Business Plan 11
4.1. Business plan canvas 11
4.2. Preliminary exercise 11
4.3. Cross Service Module analysis 17
4.4. Detailed Initial Business Plan for each of the Service Modules 18
4.4.1. Service Module F1 - Suitable Fishing Areas 18
4.4.2 Service Module F2 – Fronts Detection 27
4.4.3. Service Module A1 – Marine Conditions 38
4.4.4. Service Module A2 – Land Pollution 45
4.4.5. Service Module A3 – Site Prospection 55
4.4.6. Service Module A4 – Spat Capture Assistance 64
5. Further Steps 100
6. Conclusion 100
Annex 1 – Cost estimation 101

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

1. Introduction

FORCOAST aims to offer information services, with the emphasis on the use of novel Copernicus-based data, co-designed with end users, which provide high-resolution data of water quality and met-ocean variables at coastal zone and nearshore that are used to give focused answers to specific questions from the targeted wild fisheries, bivalve mariculture, and oysterground restoration sectors. FORCOAST is developing, testing and demonstrating, in operational mode information services that will incorporate Copernicus Marine, Land and Climate Services Products, local monitoring data and advanced modelling in the service. This allows improving operation, planning and management of different marine activities in these sectors. Such information service includes among others: early warning service, real time crisis management, key performance indicators, and information for planning operations.

The demand for such services is increasing as the marine related business has been observed to be growing in economic value. This value depends on the efficiency and effectiveness in the operations and productivity while decreasing the pressures on the marine and coastal environment. The increasing availability of data and technological advancements will contribute to a better and deeper understanding of the surrounding environment. Europe in particular, through programs such as Copernicus, has been making significant investments to make data publicly available that can make important contributions to the operations productivity in different sectors.

The purpose of FORCOAST is to make data available for the end user in a understandable manner and, even more important, in an applicable way in the form of Service Modules.

This project has received funding from the European Union´s Horizon 2020 research and innovation programme under grant agreement No 870465.

2. Business Case

2.1. Business case proposed in the DoA

Based on the current market and economic figures, three possible scenarios have been developed in the Description of Action (DoA) once the FORCOAST project is finished (i.e. after public funding of the project). It is very difficult at this stage to give estimates of real turnover; a percentage has been used instead. For all scenarios, an inflation rate of 1.5% is considered. The total costs are the sum of indirect and direct costs. Fixed costs are equal to the maintenance of the service and exploitation activities, whereas variable costs are those related to setting up new customized FORCOAST services. For all scenarios, fixed costs are adjusted only by the inflation rate:

1. Scenario 1: Low market penetration expressed as 400,000 € annual turnover with an annual increase of 5%. 8 PM (Person Months) are assumed for this scenario.
2. Scenario 2: Moderate market penetration expressed as 800,000 € annual turnover with an annual increase of 10%. 10 PM are assumed for this scenario.
3. Scenario 3: High market penetration expressed as 1,200,000 € annual turnover with an annual increase of 15%. 12 PM are assumed for this scenario.

Table 1 indicates the estimated costs, some of which are attached to the maintenance of the service after the duration of the project and others are related to new requests for setting up such service. In order to break even, the first commercial year must generate a turnover of more than 50,000 €.

Year	Fixed cost	Scenario 1: Low market penetration			Scenario 2: Moderate market penetration			Scenario 3: High market penetration		
		Cost	Turnover	Revenue	Cost	Turnover	Revenue	Cost	Turnover	Revenue
	(A)	(B)	(C)	(C-B-A)	(B)	(C)	(C-B-A)	(B)	(C)	(C-B-A)
2021	41.000	170.000	400.000	189.000	210.000	800.000	549.000	250.000	1.200.000	909.000
2022	41.615	178.500	420.000	199.885	220.500	880.000	617.885	262.500	1.380.000	1.075.885
2023	42.239	187.425	441.000	211.336	231.525	924.000	650.236	275.625	1.449.000	1.131.136

Table 1. Turnover and cost forecast (amount in K€)

Three major pricing strategies, namely cost-based pricing, competition-based pricing and value-based pricing can be distinguished. As implied by the name, each pricing strategy has its particular focus, which will be discussed in more detail below. During the execution of WP6, FORCOAST will decide which pricing strategy will fit the provided services best.

Cost-based pricing: A pricing method in which a fixed sum or a percentage of the total cost is added (as income or profit) to the cost of the product to arrive at its selling price.

Competition-based pricing: A pricing method in which a seller uses prices of competing products as a benchmark instead of considering their own costs or the customer demand.

Value-based pricing: Pricing method based on the perceived worth of good or service to its intended customers.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

2.2. State and development of the business potential within the target sectors

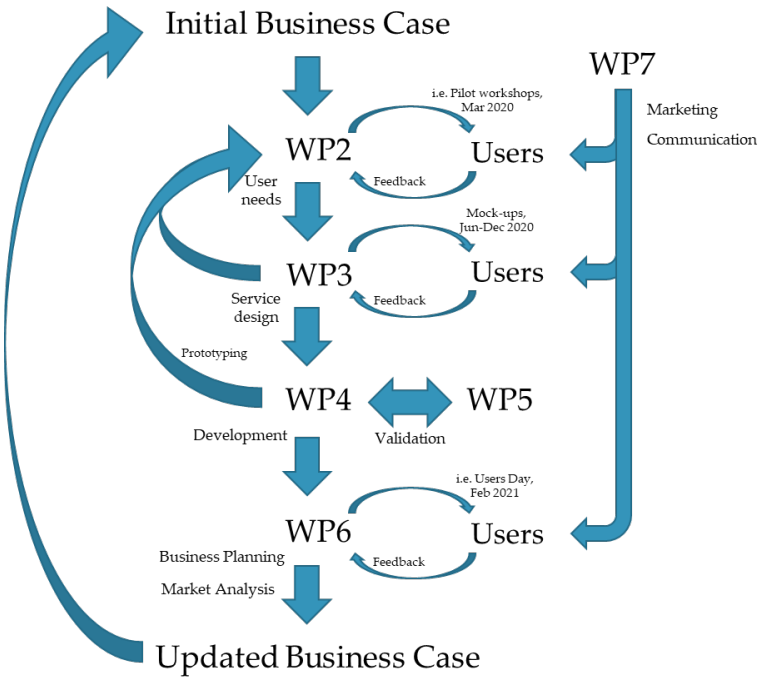
FORCOAST's target market will be focusing on three different sectors, namely the fisheries, bivalve mariculture and oysterground restoration. All markets have been emerging over the last few decades.

- Fisheries still dominate the EU seafood market, accounting for 76% of the total per capita consumption; fish prices grew significantly in the recent years (+ 10% between 2013 and 2017) (European Market Observatory for Fisheries and Aquaculture Products, 2018). Future growth will require continued progress in strengthening fisheries management regimes, reducing loss and waste, and tackling problems like illegal fishing, pollution of aquatic environments, and climate change, the report adds. But also more efficient fishing operations. Here FORCOAST reaches out with two Service Modules to help the fisherman
- The bivalve mariculture aquaculture sector will need to support increases in European demand for seafood products, as the wild fishery sector is not expected to make any dramatic shifts in the coming period, but rather to remain at fairly consistent levels. Bivalve mariculture is considered extractive and therefore sustainable up to certain levels/intensity. Aquaculture is highly specialised at regional and country levels and is strongly influenced by geography and the natural habitat of species. France was in 2017 the main producer of oysters (86% of total EU oyster production), while the leading EU producers of mussels were France (32% of total EU mussel production) and Spain (31%). FORCOAST reaches out with four services for the bivalve aquaculture sector to make their activities safer and more efficient.
- Oyster Reef Restoration is a new sector as natural oyster reefs are nearly totally extinct. Therefore, oyster reef restoration is needed, not only for the oysters themselves but also due to the fact that oystergrounds support a large number of natural services including sediment stabilization, water filtration, and provisioning of food for animals and society, among many others. Therefore, restoration activities not only benefit the landings of oysters, but also the associated species utilizing the habitats and therefore contributes to national economic growth. A 2019 review of oyster restoration case studies shows a growing global application of the process as construction and restoration of oyster grounds results in massive economic results: 100 miles of oyster restoration can create 380 jobs per year for 10 years or 3800 jobs during one decade of construction, boost regional household income by $9.7 million a year during a 10-year construction period, increase direct harvesting revenues by $7.87 million annually, noting investment and the number of oyster restoration activities globally is has been increasing since the turn of the century(Wight and Nichols, 2019). FORCOAST presents two services that can help the oyster reef restorators in their activities and make them more cost-effective.

2.3. Updating the business case through an iteration process

Each of the business cases (per Service Module) were produced following an iteration process, in which the input of the end users (D2.1 & D2.2), but also form the other work packages were incorporated and presented back to the end users. The feedback from the end users was then fed into the business case and again presented to the end user and to the work packages for enhancement (see figure below).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.



2.4. SWOT analysis

The following initial SWOT analysis for FORCOAST services was done.

Strengthens	**Opportunities**
- High resolution information; - Integration of existing knowledge by using Copernicus Marine Services; - Sustainable data provision; - Cost effectiveness of data provision; - Targeting the demand of the market; - Highly motivated and skilled consortium.	- Creating sustainable business and job opportunities; - Provide value to existing EU programs and projects; - Use and dissemination of Copernicus Marine services; - Contribute to sustainable fishery and oyster restoration activities.
Weaknesses	**Threats**
- FORCOAST service is partially dependent on satellite data availability and its continuity.	- Entities perform similar service; - Sustainability of existing services used in the supply chain platform; - Trust in new services by the end-users.

2.5. Cost estimates

2.5.1 CAPEX and OPEX costs

To quantify the expenses required for the upkeep of the FORCOAST platform and services after the completion of the FORCOAST project, we distinguish between capital expenses (CAPEX) and operating expenses (OPEX). Within the context of FORCOAST these are distinguished as follows:

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Capital expenses (CAPEX):

- Expenses associated with expanding the service portfolio offered from FORCOAST. Either:
  - By introducing (transferring) existing services to other areas or,
  - By introducing new services.
- Expenses associated with improving the services offered from FORCOAST. For example:
  - By improving the quality of the underlying hydrodynamic and/or water quality models as run at the FORCOAST pilot areas, through additional calibration and validation.
  - By collecting additional measurement data to support additional calibration and validation of the models.
  - By continued development of the services offered (improvements to algorithms, visualizations, etc), to improve them from prototype to TRL9.
- Expenses associated with improving the central FORCOAST platform from prototype to TRL9.

Operational expenses (OPEX):

- Day-to-day expenses required to keep the FORCOAST platform and services up-and-running with the service levels and support required by users. (Excluding the improvements and changes mentioned under CAPEX costs.)

To quantify the OPEX costs, the following key categories are relevant:

- OPEX costs related to the maintenance of hydrodynamic and/or water quality models running at the FORCOAST pilot areas
- OPEX costs related to the FORCOAST services (Service Modules) which use the results from the hydrodynamic and/or water quality models as input. This includes any one-off efforts to activate the automated service delivery upon user request and with user specified input.
- OPEX costs related to the maintenance of central platform from which these FORCOAST services are offered
- Other OPEX costs linked to day-to-day exploitation of the FORCOAST services (marketing, administration, etc)

2.5.2 Cost estimation process

The process to quantify the CAPEX and OPEX costs as listed in the previous section is ongoing. In this report, we will provide a breakdown and an initial estimation of key OPEX costs. Noting that these are in the process of being refined in preparation of “D6.4 - Final business plan” (to be submitted in October 2022). Estimates of CAPEX costs are only covered in the present deliverable in part, since the key initial CAPEX costs are already covered by the FORCOAST project funding during its development, and hence don’t need to be recovered by revenues created post-FORCOAST project. Furthermore, CAPEX costs associated with improving or expanding the services offered will largely be incorporated in “D5.7 - Report on applications of the platform including Roadmap for achieving TRL 9” (to be submitted in September 2022). Furthermore, based on further end-of-project user feedback, we will be able to identify those areas where FORCOAST has room for growth, and thus the highest potential for CAPEX investment to generate additional revenue based on end-user demand. Estimating the costs of the obtained list of potential improvements will be part of the activities carried out to evaluate the CAPEX costs, alongside the cost estimation of other points identified by the consortium.

This project has received funding from the European Union´s Horizon 2020 research and innovation programme under grant agreement No 870465.

For reference, Annex 1 contains the forms which are being used to collect the relevant cost estimates from the relevant project partners. Among others, input gathered in this way thus far served as the basis for the initial cost estimated in the subsequent sections.

2.5.3 Initial Operating expenses (OPEX) estimates

The continued exploitation of the FORCOAST services post-FORCOAST project relies on the partners and stakeholders involved in the exploitation strategy (Deliverable D6.5 – Initial Exploitation Strategy). Hence, to quantify these costs accurately, estimates from all relevant partners are required. The list of roles expressed per partner in the FORCOAST exploitation can be found in the 'Key Partners' points of the different Service Modules in Section 4. Noting that this process is ongoing, initial, indicative OPEX estimates have been derived based on input provided by partners and experience thus far with the various FORCOAST activities. These have been extrapolated to overall estimates in the below table.

OPEX costs FORCOAST				
Hydrodynamic and/or water quality models at pilot sites				
Pilot area	**Category**	**Estimate (Euros/year)**		**Note**
1.1 Western Black Sea	Support and maintenance	5000		
	Infrastructure costs	1000		
1.2 Bay of Biscay	Support and maintenance	5000		
	Infrastructure costs	1000		
1.3 Galway Bay	Support and maintenance	5000		
	Infrastructure costs	1000		
1.4 Sado Estuary	Support and maintenance	5000		
	Infrastructure costs	1000		
1.5 Southern North Sea	Support and maintenance	5000		
	Infrastructure costs	1000		
1.6 Limfjord	Support and maintenance	5000		
	Infrastructure costs	1000		
1.7 Western Black Sea	Support and maintenance	5000		
	Infrastructure costs	1000		
1.8 Northern Adriatic Sea	Support and maintenance	5000		
	Infrastructure costs	1000		
Service Modules				
Service	**Category**	**Estimate (Euros/year)**	**Estimate (Euros/user)**	**Note**
2.1 Suitable fishing areas	Support and maintenance	4000		
	Infrastructure costs	0		Infrastructure costs covered by "Central Platform"
	Setup scheduled bulletin with user input		500	
2.2 Front detection	Support and maintenance	4000		
	Infrastructure costs	0		Infrastructure costs covered by "Central Platform"
	Setup scheduled bulletin with user input		500	
2.3 Land polution	Support and maintenance	4000		
	Infrastructure costs	0		Infrastructure costs covered by "Central Platform"
	Setup scheduled bulletin with user input		500	
2.4 Contaminant source retrieval	Support and maintenance	4000		
	Infrastructure costs	0		Infrastructure costs covered by "Central Platform"
	Setup scheduled bulletin with user input		500	
2.5 Marine conditions	Support and maintenance	4000		
	Infrastructure costs	0		Infrastructure costs covered by "Central Platform"
	Setup scheduled bulletin with user input		500	
2.6 Assistance for spat capture	Support and maintenance	4000		
	Infrastructure costs	0		Infrastructure costs covered by "Central Platform"
	Setup scheduled bulletin with user input		500	
2.7 Site prospection	Support and maintenance	4000		
	Infrastructure costs	0		Infrastructure costs covered by "Central Platform"
	Setup scheduled bulletin with user input		N.A.	
Central Platform				
Central Platform	Support and maintenance	15000		
	Infrastructure costs	12000		DIAS hosting costs
TOTAL		**103000**		

The following considerations apply:

- For the hydrodynamic and/or water quality models at the pilot sites, it holds that these are often utilizing infrastructure which is also used for other (non-FORCOAST) activities by the associated partners. The same holds for the support, maintenance, organization and processes required to ensure that these models stay up-and-running continuously. Although this has already been considered in the present estimates to some extent, these cost estimates will be further refined based on agreement on which part of these costs should be charged to the FORCOAST exploiters.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

- The support and maintenance costs required for the Service Modules and the Central Platform are based on hands-on experience thus far. However, as we move from development to production, the effort required to ensure that the Service Modules are running continuously will decrease since initial start-up problems will have been resolved by that time. Also, economy of scale might lead to a reduction of costs, which has not been considered in these estimates yet.
- The "per user" effort to set up scheduled jobs per user may decrease as the number of users increases. Economy of scale has not been considered in these estimates yet.
- Operational expenses related to service exploitation (marketing costs, administration costs, …) are not incorporated. These will be incorporated in "D6.6 - Final exploitation strategy".

These considerations aside, as an initial, indicative ballpark, the OPEX costs required to keep FORCOAST services running in the state as delivered by the end of the project are presently estimated in the order of 100k Euro/year. These estimates will be refined for "D6.4 - Final business plan".

2.5.4 Initial Capital expenses (CAPEX) estimates

The main Capital expenses (CAPEX) estimates to setup the FORCOAST platform prototype and services are incorporated into the FORCOAST project. Nonetheless, additional CAPEX costs might be required post-FORCOAST project, related to:

1. Expanding the service portfolio offered from FORCOAST
2. Improving the services offered from FORCOAST
3. Improving the central FORCOAST platform from prototype to TRL9.

Regarding these costs, indicative estimates for (3) will be derived as part of "D5.7 - Report on applications of the platform including Roadmap for achieving TRL 9". Costs associated with (2), in so far as these are not part of (3), cannot be determined at this stage, since the relevant improvements are not known at this stage. Initial estimates for (1) are provided below, to be refined for "D6.4 - Final business plan".

Expanding the service portfolio offered from FORCOAST can be done in several ways:

a. By introducing (transferring) existing services to other areas where the required hydrodynamic and/or water quality models required to provide input are already present,
b. By introducing (transferring) existing services to other areas where the required hydrodynamic and/or water quality models required to provide input are not present yet,
c. By introducing new services, not yet part of the FORCOAST service portfolio by the end of the FORCOAST project.

Again, costs associated with (c) cannot be estimated at this time, since the relevant services are not known at this stage.

<u>Transferring services (Service Modules) to areas where local hydrodynamic and/or water quality models are present</u>

For (a) the following table as included in "D3.10 Technical specifications for tailored products" indicates the potential transferability of the FORCOAST services (Service Modules) to other pilot areas presently included in FORCOAST (i.e. for which local hydrodynamic and/or water quality models are present).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

	Irrelevant	FORCOAST : Service Module transferability overview							
	Platform operational								
	Under development	Pilot 1	Pilot 2	Pilot 3	Pilot 4	Pilot 5	Pilot 6	Pilot 7	Pilot 8
	Feasible								
	Feasible for reduced functionality	Portugal	Spain	Bulgaria	Belgium	Ireland	Denmark	Romania	Italy
	Require additional data	THREDDS	THREDDS	/	ERRDAP	THREDDS	FTP	THREDDS	THREDDS
F1	Fish suitability index								
F2	Front detection								
A1	Marine conditions								
A2	Harmful Land Discharges								
A3	Prospection for new sites								
A4	Assistance for Spat Captures								
R1	Retrieve Source of pollution								

Indicative cost estimates to transfer these services to pilot areas for which they are not implemented yet by the end of the FORCOAST project (i.e. yellow and orange cells) are as follows:

		Estimate (Euros/pilot area)	Note
F1	Fish suitability index	3000	If parameter settings for the algorithm are available for this area
F2	Front detection	3000	
A1	Marine conditions	3000	
A2	Harmful land discharges	6000	
A3	Prospection for new sites	7500	
A4	Assistance for spat captures	6000	
R1	Retrieve source of pollution	3000	

These estimates cover the technical implementation in both the back- and front-end, as well as QA on the results.

Furthermore, these estimates are based on our hands-on experience transferring these Service Modules to other pilot areas thus far. As we are moving from development to production, and as we continue building experience transferring these services to other pilot areas, these estimates will be refined for “D6.4 - Final business plan”.

Note that the cost estimate provided for F1 is conditional to the availability of the parameter settings for the algorithm used. If these parameter settings are not available and need to be derived as part of the transferral process, additional measurement data is required. Cost estimates related to this have not been included yet.

Furthermore, note that although our experience thus far is with transferring services to other pilot areas within FORCOAST, services can also be transferred to other areas where local hydrodynamic and/or water quality models are already available. If the required hydrodynamic and/or water quality model data is accessible through OGC web services for those areas, at is expected that comparable costs as those provided in the above table apply.

This project has received funding from the European Union´s Horizon 2020 research and innovation programme under grant agreement No 870465.

Transferring services (Service Modules) to areas where local hydrodynamic and/or water quality models are not present yet

If no local hydrodynamic and/or water quality models are present for an area of interest yet, two options are available:

1. Rely on coarser resolution CMEMS data,
2. Develop a local, high resolution hydrodynamic and/or water quality model for this area

Option 1 is possible for several the services under development from a technical point of view at least, but at the cost of a local accuracy and a lower granularity (spatial and temporal) of the resulting service. In this case, cost estimates will be in a similar ballpark as those provided above for areas where local models are already available.

Option 2 is conditional to the effort invested in calibration and validation, and the necessity to collect in-situ data for model validation. Indicative estimates are provided below.

	Estimate (Euros/model)	Note
Development local hydrodynamic model	100000 - 200000	
Development local water quality model	100000 - 200000	

Note that these estimates are very coarse, in view of the uncertainty in the specifications for calibration and validation. For reference, note that some local or regional hydrodynamic or water quality models have been in continuous development for several years, with total investments exceeding 1M euro over time.

2.5.5 Refining CAPEX and OPEX costs

As described in previous sections, the initial, indicative cost estimates provided are being refined at present. The refined estimates will serve as the basis for "D6.4 - Final business plan" among others. The refinement process will rely on several key activities which are presently taking place:

- Further refinement by all project partners involved of the cost estimates which serve as the basis for the indicative estimates provided. This included an assessment of which OPEX costs should be covered as part of the FORCOAST exploitation, and which OPEX costs are already covered by other means.
- Further refinement based on hands-on experience gained with running both the models and services (Service Modules) in production, related to the effort required in support and maintenance.
- Further refinement based on hands-on experience gained when transferring services (Service Modules) to other pilot sites within the FORCOAST project.

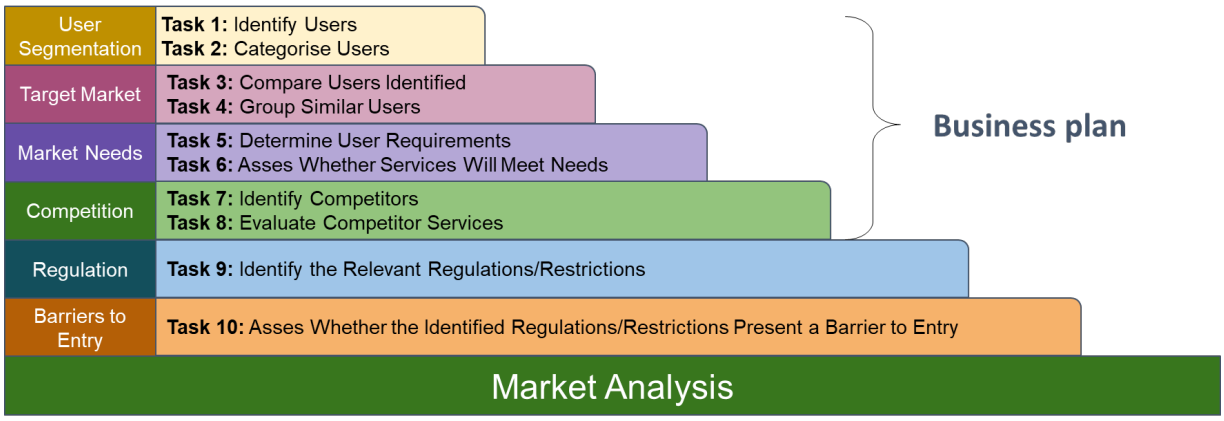
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

3. FORCOAST Services

This table represents the first initial catalogue of Service Modules (see D3.9. Sector-specific decision workflow synthesis), which were based on the list of FORCOAST services (D2.1 Stakeholders Interests and Needs by Sector and Pilot Site) which are the information services the users will get.

N°	Service module	Description of service provided	Leading country
F1	Suitable fishing area	Dynamic maps for commercial fish habitats	Bulgaria
F2	Front detection	Dynamic maps of frontal zones	Spain
A1	Operation scheduler	Met-Ocean conditions on site	Portugal
A2	Land pollution	Influence off harmful influence on-site	Romania
A3	Prospection for new sites	Scope for growth maps for oysters	Denmark
A4	Assistance for Spat Captures	Provides date of spat arrival to help on-site collection	Belgium
A5	Marine conditions at farming site/alarm system	Met-Ocean conditions on site	Denmark
R1	Retrieve sources of contamination	Influence off harmful influence on-site	Ireland

Hence, in order to make up the initial business plan for each of the Service Modules, a general initial market analysis was made for the different sectors (D.6.1 Initial Market Analysis).



The first four blocks of this Market Analysis feeds into several of building blocks of the Business Plan Canvas (see below) for each of the Service Modules.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

4. Initial Business Plan

4.1. Business plan canvas

As mentioned in the project proposal FORCOAST hasd chosen to use the simple and well defined canvas approach, which enables to focus on the key elements, such as available sources, activities, customers as well as strategic management and marketing plan (see figure below).

<table>
<tr>
<td rowspan="2">Key Partners
• Deltares
• Exporsado
• Marine Instruments
• Terrasigna
• Jailoo
• Brevisco
• Oyster Boat

Key Products and services
• Hydrological and water quality forecasts
• Real-time management and integration of in-situ, EO, modelled data and CMEMS
• Early warning services
• User friendly ICT</td>
<td>Key Activities
• Promotion of services/Marketing
• Organizing workshops
• Continues development of services and website
• Capacity building and training exercises</td>
<td rowspan="2">Value Proposition
• Information fitted to the user's needs
• High level information based on the data analysis
• Integration into client's workflow
• Sustainable information chain
• Key performance indicators able to
- Optimizing farming and planning activities</td>
<td>Customer Relationships
• Newsletters
• On-Site visits/trainings
• Technical support
• Validation report
• Knowledge Transfer</td>
<td rowspan="2">Customer Segments
1st row
• Mariculture bivalve sector
• Fishery sector
• Oyster restoration sector

2nd Other sectors
• Marine Spatial Planning
• Marine and Maritime Sector
• National Environmental Agencies
• Universities
• R&D institutes
• Insurance Agencies
• Tourism Industry</td>
</tr>
<tr>
<td>Key Resources
• Web portal
• Cloud computing (DIAS
• Copernicus Services
• Decision Support System
• Integrated ICT and data management network
• Expert knowledge
• Operational Pilot Sites</td>
<td>Channels
• Webpage
• Webinars
• Conferences and exhibitions
• Partners network
• Industry network
• Social media, press release
• Publications</td>
</tr>
<tr>
<td colspan="3">Cost Structure
• Marketing
• Develop operational systems
• Maintenance of supply chain
• Providing technical support
• Licenses</td>
<td colspan="3">Revenue Streams
• Develop of new operational systems
• Maintenance fee for supporting existing operational systems
• New users for an existing operational system
• Potential new business developments</td>
</tr>
</table>

User segmentation, target market, market needs and competition were identified within the Initial Market Anlysis (D6.1).

4.2. Preliminary exercise

In order to get familiar with the Business Plan Canvas, a first exercise was performed where all the Service Module leader and the partners of the Pilot, especially the end users from each Pilot and additionalpotential end users (not Pilot related), worked on three blocks of the business canvas:

- Value proposition: This is without any doubt the most important block, because this block will show you why they should do business with you rather than with your competitors, and makes the benefits of your products or services crystal clear from the outset.
- Customer segments: This block identifies the exact end user group. Which specific clients can be interested in your product according to their requirements. This can be sectorial, but can also be across sectors. End users can be grouped into into segments distinguished by common needs, common behaviors, or other attributes. In this way it is possible to make a conscious decision as to which segments to serve and shich segments to ignore, thus allowing to focus on matters that vitally affect the business.
- Revenue streams: Are the various sources from which a business earns money from, in our case, the provision of services. The types of revenue depend on the types of activities carried out by the business. In the case of FORCOAST serveral forms of revenues can be identified:
    - → Service revenue, which are generated by providing service to customers and are calculated based on time. For example, the number of hours of consulting services provided.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

- → Project revenue, which are earned through one-time projects with existing or new customers.
- → Recurring revenue, which are earnings from ongoing payments for continuing services or after-sale services to customers. The recurring revenue model is the model most commonly used by businesses because it is predictable and it assures the company's source of revenue as ongoing. These include:
- → Subscription fees
- → Renting, leasing, or lending assets
- → Licensing content to third parties
- → Brokerage fees
- → Advertising fees

The table below is the results of this first exercise.

	Value Propositions	**Customer Segments**	**Revenue Streams**
F1 - Fish Suitability Index	Main problem: lack of information regarding suitability of specific species.Need to have access to ocean variables. Components of the service: Global suitability index for species in the Black Sea, upwelling events assessment, improved wave products.	Customer segment:1. individual fishermen, small to large fishing vessels. 2. Institutions that can provide to final users Other segments: Researchers and Education purposes 3. Regulators	Hard to answer in the area. These are emerging industries. Further work needed to identify an answer. In principle they do not pay for anything at the moment. The service generates interest and the market is there, but there is a market wall since it is an incipient industry.
F2 - Front Detection	Sometimes is difficult for the fishing fleet to find fishing grounds, if is only considered historical fishing areas. Any information that could reduce the searching time and areas, will benefit the sector and the environment.	Fishing fleets	Some fleets pay for integrated solutions, other are reticent to pay these services and others take the advantage of free of charge services

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

A1 - Operational Scheduler	Access to environmental conditions to plan activities; and alerts. Problem to solve: maximize working time, and avoid risks SST, salinity, Chl, water level	Main customers: fishermen operating at the sea. Probably insurance companies too Market: ~10% of the Blue Economy market, which are fisherment. Producers, harvesters... but the focus is on professional aquaculture. Approach of targetting the main group first. After that is settled, expand to other ones. Willing to pay: to be tested. If we prove that money can be saved, the potential willingness is there. This service would be an extra that users are not used to pay for. Continuity of the service and 'commitment' of the users to stick with the product could be an issue based on past experiences. 'Free to pay' transition Few competition for this service, since it is not something being actively looked for by them. The market has to be generated in this case. Key aspect: customisation of the service especifically to the user, thus covering the main sector, narrowing the target is key.	They do not pay for such services. Only for particular analysis, but no operational services. Possibilities have to be explored once the product is in place. First assessment can be done once participation in the Portuguese Aquaculture Association, and feedback gathered (key event).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

A2 - Bacterial/harmful substances outbreak	Problem : Customers have no or low means to assess the risk of exposure to harmful land discharges. Along with the lack of information regarding the oceanographic variables, the main problem is the lack of information regarding the outflows from the on-shore wastewater treatment plants. The emerging aquaculture farms are placed somehow close to the Constanta city wastewater treatment plants, which sometimes, during summer - touristic periods - may outflow untreated water, containing possibly some bacterial inputs, such as *E. coli.* So the main need is to have timely information on the movements of the water bodies coming from the treatment plants, and the dispersal and direction of the particules. This knowledge could trigger actions from the farm managers, such as early harvest (if the model predicts sufficient time period until potential contamination), or delayed harvest (allowing the mussels to	Customers : Owners/managers of aquaculture. The emerging Romanian marine aquaculture farms (at this moment, in Romania there is only one emerging mussel farm). Also, the Institutions regulating marine aquaculture products and activities in Romania might use the service. To some extent, research institutes can use some data, for specific case studies or actions. Considering the novelty of marine aquaculture in the area no services of this type have been developed so far, consequently the FORCOAST SM is an ice-breaking offer. The willingness to pay is impossible to assess at the moment.	The only marine aquaculture farm (the emerging mussel farm) in Romania is not operational yet (we expect it to become operational by this summer). So, at the moment, we have no information on the revenues nor about the willingness to pay / amount to be payed by the sector.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

	self-purify, after the the contaminated water has passed the farm area), in order not to threaten public health.		
A3 - Prospection for new sites	Lack of knowledge of best locations for oyster culturing. We deliver maps of environmental variables (means and SD) and oyster growth potential. Optimise planning for new sites. (*Pilot#8 - Spatial and temporal patterns of biogeochemical tracers for monitoring and assessing conditions and risks of aquaculture sites and potential shellfish growth rates; the main problem of customers is understanding, monitoring and predicting physical (e.g., SST) and biogeochemical properties over the potential new sites. We offer modelling and satellite products which can tackle both physical and biogeochemical issues, also including river inputs.*)	oyster fishermen and farmers, mussel fishermen and farmers, (*Pilot#8 - Customers are biologists and environmental scientists working on management and coordination of aquaculture/mussel farmers for the Italian and Mediterranean market. They might be willing to pay for the service since there are no competitors.*)	They may pay a monthly fee or one-time fee to get access to the service. They don't pay now for any products now. Don't know anything about revenue. (*Pilot#8 - One of the values for which they might be willng to pay is the prediction and the assessment of any biogeochemical and/or physical issues that might stop the production.*)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

A4 - Assistance for Spat Captures	Lack of knowledge to identify the best period to install collector and maximise capture of spat	Shelfish farmer	Farmer have to buy young spat and go often at sea to check the collector. Services allow to reduce internvention at farm and decrease the need to buy spat
R1 - Retrieve source of contaminants	We deliver a forecasting and mapping service of environmental conditions and larval dispersion with high level of detail (i.e. high resolution) that is not otherwise available for the Inner Galway Bay. We are aiming at helping to solve the following problems: - What is the geographic distribution of suitable seabed habitats for native oyster?, - What is the distribution of oyster larvae spawned from the main oyster beds in the bay?, -What is the exposure to suboptimal temperatue and salinity and how this expsosure impacts on mortality and growth? Products and services addressing the above are expected to be bundled under one service module supporting native oyster restoration. We are staisfying the needs of environmentalists and oyster growers in the region by supporting them with identifying	- Oyster Restoration - There are 8 oyster restoration/fisheries groups in Ireland who could be potential customers, furthermore the Native Oyster Network UK and Ireland (NON) have a number of groups across UK and Ireland who could be potential customers and the Native Oyster Restoration Alliance (NORA) have a number of members across Europe who could potentially be interested in the service. Outside of Europe there are a number of large scale restoration groups operating in America, Canada Australia and New Zealand. - Oyster Producers - There are 126 active pacific gigas oyster farmers in Ireland who could potential be customers for the oyster service modules. - Galway Bay - There are a number of potential users in Galway Bay including recreational, state and scientific who could be	Oyster Restoration Groups often receive funding to provide citizen science or community science within local communities, within this funding there is scope to provide an analysis of water quality and marine habitat analysis. Ireland has a State Seafood Development Agency (Bord Iascaigh na Mhara) who provide water quality monitoring services to Aquaculutre Producers, they currently use remote sensors to do this, they could potentially be interested in the service. Other State Institutions who provide monitoring services include the Office of Public Works, National Parks and Wild Life Service,

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

	suitable habitats for native oyster (comobined sedimentation and temperature and salinity) and identifying target areas for spat collection.	potential customers for the service.	Department of Agriculture, Food and Marine, Irish Water and Department of Housing, Local Government and Development.

4.3. Cross Service Module analysis

After a cross analysis (similarities, synergies, differences, etc.) of these three canvas blocks together wioth the transferability analysis in WP4, it was decided that their were some similarities between different Service Modules, and others could be split up into parts, which could be incorporated into other Service Modules. For example, the original Service Module R1 included contamination by land discharges. This part was successfully incorporated in the Service Module A2 – Harmful land discharge.

After revision, the FORCOAST consortium came to the following new catalogue of Service Modules:

N°	Service Module	Description of service provided	Leading country
F1	Suitable Fishing Areas	Dynamic maps for commercial fish habitats	Bulgaria
F2	Fronts detection	Dynamic maps of frontal zones	Spain
A1	Marine Conditions	Met-Ocean conditions on site and schedule for operations	Portugal-Denmark
A2	Land Pollution	Risk of harmful influence on-site	Romania
A3	Site Prospection	Scope for growth suitability maps for oysters	Denmark
A4	Spat Capture Assistance	Provides date of spat arrival to help on-site collection	Belgium
R1	Contaminant Source Retrieval	Backward retrieval of pollution sources	Ireland

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

4.4. Detailed Initial Business Plan for each of the Service Modules

In the following section detailed Initial Business Plans are given for each of the Service Modules.

4.4.1. Service Module F1 - Suitable Fishing Areas

Value Proposition

Service Module identification

The main objective of this Service Module is to offer information about the most favourable conditions for fishing. In order to achieve this, the following information will be provided:

- Fishing Suitability Index – optimal habitat conditions for specific species
- Upwelling information – upwelling events are known to generate the most fertile marine ecosystems.
- Information on waves coming from nested wave model for the Northern Black Sea

Service Module purpose

The service is developed as a decision support tool for the fisheries engaged stakeholders in the north-western part of the Black Sea. It will provide access to valuable information, such as upwelling events and favourable areas for specific species, in order to help fishermen to maximize the economic efficiency of their activities. The service directly addresses multiple categories of stakeholders, from individual fishermen, to mid-size and industrial fishing companies in Bulgaria and Romania.

The idea behind the Service Module is to identify the favourable conditions for fishing. Fishing Suitability Index is implemented to reflect the optimal conditions for specific species. It is similar to the already developed Habitat suitability Index (HSI) for whiting (*Merlangius merlangus euxinus*) within the SkyFISH project (http://skyfish.terrasigna.com/). Optimal conditions were identified based on literature references and with the help of National Institute for Marine Research and Development "Grigore Antipa" (NIMRD) experts. Fishing Suitability Index is determined from multiple oceanographic variables (with values ranging from 0.1 – less suitable to 1 – best conditions). Survey and fishery data was used to tune the parameters .

The upwelling events are identified by a strong decrease in a day-to-day tendency of the SST, as well as offshore integral Ekman transport calculated from the 3D field of the velocity in the area of interest. The input data are taken from satellite and model products available through Copernicus Marine Service.

The information on waves is coming from a nested downscaled wave model, developed for this purpose, in the NW part of the Black Sea. The existing wave models do not provide sufficient spatial resolution, thus represent the significant wave height and period in more detail. NWS wave model is downscaled in the Copernicus configuration (CMEMS data at the open boundary).

Cross-sectorial

The information from the Service Module will be mainly of use for the industrial and private fishermen in the area of interest. The marine transport and recreational marine sports, including tourism could

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

also benefit from the data on waves and upwelling areas. Since the area of the Service Module covers also the coast, the Fishing Suitability Index and upwelling areas information can be used by the mussel farmers and rapana/sea-shell pickers.

Customers segments

Customers

Customers Segments

The potential customers of the Service Module could be separated in two big categories: 1) wild fishery industry operating in the open sea and 2) customers with activity in the coastal area or near shore. The first category could be further splitted to large fishing companies, mid-size fishing firms and individual fishermen. The second category includes merchants of sea food, fishing stationary nets operators, catchers of bottom organisms, dragging vessels, trawlers. There is also a third category, not directly related to fishing activities: these are customers with interest in the SCUBA diving and underwater photography, marine sports and maintenance of tourist attractions.

Bulgarian Pilot site

The Service Module is designed to work for the western part of the Black Sea and can not be directly applied/transfered in other areas of the world ocean or even in the Black Sea. Thus the main customers to take advantage of this Service Module would be the inhabitants of Bulgarian and Romanian Black Sea coast. The service offers information on typical marine species in the area, as well the events like upwelling, which is strongly dependent on local conditions. The table below summarizes the potential customers, following the categories described in the segmentation.

Customers in Europe and the rest of the world

Other potential customers are the passing in the area fishing vessels from the other Black Sea countries (Turkey, Ukraine, Russia, Georgia) who could take advantage of the distributed information. In general the developed know-how in the Service Module could be applied to support the wild fishery in other regions in the European seas and the world ocean, but the local specific is to be taken into account and the algoritm should be tested and tuned to work in other areas.

Table 1. is a list of potential customers of the Service Module per county (this list can be longer than the end users described in the text above).

Table 1. List with potential customers of Service Module per country.

	End user	**Activity**
Bulgaria		
	"Black Sea Sunrise" Marine Fishery Association	organization of professionals in the field of sea fishing in the Black Sea
	BG-Fish	Bulgarian Association of Fish products producers

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

	Morski ribolov Nesebar Ltd	trade in fish and seafood, fish and seafood processing, commercial fishing
	Elekta Sea products	SME for processing of sea food and rapana
	Dalboka mussel farm	cultivation of ecologically clean Black Sea mussels
	Department of Meteorology and Geophysics – Sofia University St. Kliment Ohridski	Research and numerical modelling of oceanographic processes
	Institute of fish resources - Agricultural Academy	fish stocks studies and monitoring of the dynamics and structure of the food base of industrial marine fish species.
	Institute of oceanology, Bulgarian Academy of Science	Research and statisticks of biodiversity in the Black Sea
Romania		
	National Agency for Fisheries and Aquaculture	Governmental/regulatory agency
	Terrasigna	Business of Earth Observation data processing.
	Interfrig Fish	Fishing company
	Sea Sharks	Fishing company
	Rompescador ltd	Fishing company
Outside the European Union		
Georgia		
		Fishing operators in the western part of the Black Sea
Russia		
		Fishing operators in the western part of the Black Sea
Turkey		
		Fishing operators in the western part of the Black Sea
Ukraine		
		Fishing operators in the western part of the Black Sea

Market

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

European market

According to The State of Mediterranean and Black Sea Fisheries, 2020, the fish resources in the Black Sea are in thread due to the overfishing, climate change, alien species. The total direct fishery revenue in the Black Sea countries is estimated to USD 3.6 billion. The wider economic contribution of fisheries in the region, including both direct revenue and indirect impacts, is estimated at USD 9.4 billion. The top 3 commercial species by value are: European anchovy (USD 275 784 853); Whiting (USD 19 658 866) and Horse mackerel (USD 19 578 874). The report indicates the fishery is evolving in the right direction, but many challenges remain: catches are lower than in the 1980s, exploitation rates are mostly still too high, management plans need to be extended, discards and bycatch must be reduced, and an ageing fleet and workforce require renovation and new flow. In Bulgaria, the total domestic catch is about 8,600 metric tons (MT) since 2017.

According to Fish and Seafood Market Brief – Bulgaria, 2020, (Report Number: BU2020-0021), Bulgaria's Black Sea fishing industry is fragmented along its 300 km of coastline. In 2018, the Black Sea catch increased by 9.9 percent. It consisted of European sprat, red mullet, blue fish, Black Sea horse mackerel, and turbot. Conch accounts for the highest percentage of the Black Sea catch at about 41 percent. In 2018, the conch catch reached 3,515 MT, a 2.8 percent decrease over 2017. The soft-shell clam catch reached 600.5 MT, a 27 percent decrease. The blue mussel catch slightly increased by 11 percent, reaching 12.5 MT. Traditionally, the European sprat catch accounts for big percent of Bulgaria's total Black Sea catch. In 2018 it reached 3,188 MT, a 3.2 MT increase over 2017. Bulgaria's 2018 red mullet catch increased by 59 percent to 595 MT. The other Black Sea species caught by Bulgarian anglers included bluefish (261 MT), Black Sea horse mackerel (197 MT), turbot (56 MT), and other species. The Bulgarian fishing fleet is small, with about 2,000 vessels.

In 2018 the total catch from marine fisheries in Bulgaria reached almost 8600 tonnes, slightly decreasing from previous catch production around 10000 tonnes. Marine fisheries in Bulgaria originate from the Black Sea. According to the report of Fishery Division of the Food and Agricultural Organization to the United Nations in 2017, the Bulgarian fishing fleet consisted of 1 880 registered vessels, of which 1 295 were active. The active fleet had a combined gross tonnage (GT) of 5 thousand tonnes, engine power of 41.2 thousand kilowatts (kW) and an average age of 25 years. The Bulgarian fishing fleet consists mainly of small fishing vessels: the majority of the fleet was less than 12 m length and used passive gears. The segmentation according to Vessel Length (VL) is as follows (the numbers refer to 2016): VL <6 m - 415; 6m<VL<12m - 703; 12m<VL<18m - 61; 18m<VL<24m - 15; 24m<VL<40m - 12.

In Romania, in recent years there has been a considerable decline in marine catches, from 14000 tonnes in 1989 to 6200 tonnes in 1990 and 1200 tonnes in 1991, 2 122 tonnes in 2002. In 2002, 21 private companies were authorized to carry out commercial fishery. A number of more than 4 500 fishermen operated in this type of fishery and used 880 boats, 40 pound nets, 1260 turbot gillnets/trammel nets, 11 beach seines and 9030 rodlines.

In summary the fishing sector is composed mostly by SMEs and individual fisherman, who could benefit the Service Module at affordable price. An approximate estimation of the potential end-users would be the total number of vessels with VL>6 m, e.g. ~1500. Another important category of potential users is represented by national regulatory agencies, which could use the service as a working tool for issuing fishing licenses, for example. This could generate a shift in the initial busines model approach, from a one time (possible renewable) subscription to a monthly/annual one.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

EU market for the Service Module

The Service Module gives information of the areas suitable for fishing, taking into account the conditions favourable for specific fish species; the upwelling areas are known as favourable zones for fish catchment. The wave height is an essential oceanographic parameter for the adequate planning of the operations at sea.

In order to scale the service to European level, an adaptation of regional models would be required. Thus, since this is not a foreseen activity in the frame of the project, the service model will be marketed only regional, with a focus on the Bulgarian and Romanian potential clients. The potential end-users are estimated as ~1500.

Other potential users refer to the rest of the Black Sea fishing fleet that might have the rights to fish in the area of interest of the service. To this regard, the Turkish vessels would represent a priority for marketing strategies. According to the "State of Mediterranean and Black Sea fisheries" report, published by FAO (Food and Agricultural Organization of the United Nations), Turkey had, by far, the largest overall catch in the 2016-2018 period, of almost 274000 tonnes (23.3 % of the total catch in the Mediterranean and Black Sea basin). This amount was possible due to the 15352 fishing vessels, thanks to which Turkey leads the list in the region. Also, Turkey represents 82.1 % of the total fleet in the Black Sea.

Profitability per Customer Segment

The Black Sea fishermen in general are not accustomed to use digital services in their routine work, and furthermore to pay for it. Profit could be expected by the large industrial fishing companies operating in the open sea, as they are more dependent on the marine conditions. Other sources of revenue could be generated by national regulatory agencies, provind that they adopt the service and have allocated funding to guarantee the subscription. A good strategy to attract users would be to offer for free the product over 3 months under the condition that the user sends regularly feedback on the use and result of the Service Module.

Revenue Streams

Value of the Service Module

To estimate the Value of the Service Module, it was estimated that approximately 10% of the 1500 potential users would subscribe to the service, with an annual subscription of 30 euros. This would come to a revenue of 4500 euros per year. Of course, much more would be at stake if national/regional agencies would use the service in their daily routine.

Competition and current services

An application like the foreseen Service Module does not exist at the moment. Within the project Skyfish the partners acquire some experience in provision of services in support to fishery. In general it will be costly to maintain operational services with the present human resources, that is why it is designed as a demonstration service.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Form of Revenues

The most plausible form of revenue is the abonament rate to the service and activation on demand.

Contribution of the Revenue Streams

Bulgaria and Romania are countries with relatively low income comparing to the other countries in the European Union. It can not be expected that the small and medium enterprises as well as individual fishermen could affort to pay large sums for the service. It is more profitable to rely on small abonament rate and thus increase the number of customers.

Key partners

Key Partners and their activities

Give a description of the Key Partners and their activities that are needed to develop and maintain the Service Module.

- Sofia University will develop the nested wave model with high resolution for the Western Black Sea and implement the upwelling identification algorithm
- **TerraSigna** will develop the algoritm for calculation of Fish Suitability Index. It has been identified as a suitable candidate to exploit and maintain the FORCOAST central platform during and after the FORCOAST project. The FORCOAST Central Platform is the central access point to the FORCOAST information services.
- **FORCOAST partners** will provide several services during and after the project (Table 2).

Table 2. FORCOAST partner and their role in the exploitation of the Service Modules (D6.5 Initial Exploitation Strategy).

Role -------- Partner	Final User	Data Provision	Service Exploiting	Platform Exploiting	Advise/Support	Others (please specify)	Comments
Deltares					X	project base expertise	Deltares cannot be part of the exploitation after the project completion as a non-profit organisation.
EuroGOOS					X	Communication and link to the European Operational Oceanography Community	EuroGOOS as a non-profit organization cannot be part of the exploitation
Instituto Superior Tecnico		x	x	x	X		Exploitation probably through other Instituto Superior Tecnico linked institutions and spin-offs

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Exporsado							
AZTI		x	x	x	X	Horizontal expertise and links towards different sectors of the blue economy and stakeholders managing marine and coastal resources.	AZTI is mainly a technological and research centre focused on transferring solutions and advising managers and service providers. But we can also provide ourselves services to administrations or companies.
Marine Instruments	x	x	x				MI will be both a final user and can exploit the service modules as well as providing data.
University of Sofia		x			X	Communications to Fisheries Sector	
TERRASIGNA		x	x	x	X		
Marine Institute		x			X	Can act as the first point of contact for Irish users	Marine Institute being a state agency will not be involved in exploitation
Cuan Beo	x					Communication to Oyster Restoration Groups	
University of Liege		x			X		Restrictions applies on the possibility to get involved in non-research activity.
NIMRD					X	Communication to emerging aquaculture sector	NIMRD is a public research institute, 100% project-based financed, so we can't commit to provide data after the end of the project without any convention/financial support
Jailoo							Jailoo is a private entity specializing in research and operational services, hence continuation after the project end strongly depends on financial conditions
RBINS	x	x			X		
ILVO	x	x			X	Additional biological parameters on spat	
Brevisco							

Key Suppliers

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

The Key Suppliers are

- Copernicus services: Copernicus Marine Service, Copernicus Climate Service
- EMODNET analysis on fish stock and catchment in the Black Sea

Key Activities

Required Key activities for the Value Proposition

Further development of the model

The nested wave model with high resolution in the western Black Sea is fully developed and will not require further efforts. The algorithms for calculation of Fishing Suitability Index and the upwelling areas require additional tuning. Validation of the developed services is difficult as specific information on fish availability and catch is needed and is general difficult to achieve.

Gathering biological data

Data on fish stock, habitats and migration.

Gathering physico-chemical data

Essential physical and biogeochemical parameters: temperature, salinity, currents, Chrorophyl A, primary production.

Gathering meteorological data

At the moment meteorological data will be needed as an input to the wave model, future developments forsee to integrate the information on extreme meteorological events and alert in the service.

Gathering earth observation data

Copernicus Marine Service: data from the satellite observations and models of essential oceanographic variables , such as of Sea Surface Temperature, Salinity or Chlorophyll A.

Key Resources

Key Resources

In order to implement adequately functioning Service Module for Fishing suitability the main key resources are:

- Copernicus Marine Service products: Black Sea Physics Analysis and Forecast, Black Sea Monthly and 8-days Reprocessed Surface Chlorophyll Concentration from Multi Satellite Observations + SeaWiFS Daily Climatology, Black Sea High Resolution and Ultra High

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Resolution Sea Surface Temperature, Black Sea Monthly, 8-Days and Daily Interpolated Surface Chlorophyll Concentration from Multi Satellite and Sentinel-3 OLCI observations
- adequate computer resources in order to execute the codes and store the data
- human man power to ensure the smooth execution of the project

Revenue Streams

As explained above, it can not be expected that the small and medium enterprises as well as individual fishermen could affort to pay large sums for the service. It is more profitable to rely on small abonament rate and thus increase the number of customers. In addition it is suggested to grant a free of charge period in order to convince the user of the benefit of the Service Module.

Customer relationships

Keeping contact with the target groups

It is suggested that the Service Module will be made available to end users via mobile or desktop apps. The personal contact by sending mais and chat messages is also productive. A target group meeting will be organized (it was delayed due to the COVID-19 restrictions).

Keeping the target groups interested

An initial period free of charge is suggested. In addition the abonament plan could be offered in three alternative variants – common, silver and gold, offering various bonuses to the subscription.

Channels

Channels to reach the Customer Segments

Communication via app interface, personal e-mails and chat messages.

Integration of channels

Describe the possibilities of integrating these channels into ongoing FORCOAST work, e.g. webpages of projects, etc. and which ones work best and are most cost-efficient.

A Q&A sectin in the website will summarize the main problems and solution the users encounter.

Cost Structures

Most important costs

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

The most important cost is the cost of the human power as well as the computer processor time and storage, necessary to maintain the service alive. The communication events with the target groups are also consuming money and man efforts.

As this service module was designed as a demonstration case study, further work will be required in order to make it fully operational service. Because it is still under development, it is for the moment not yet possible to give estimations on the costs for maintainance.

Most expensive Key Resources

Significant resourcecs will be needed to maintain the service and to relate to other interested working groups in other European and world ocean regions.

Most expensive Key Activities

Significant resources will require the organization of target users events and development of user friendly interface. The validation of the proposed service will require interaction with the end users and it is suggested that a discount is offered if the users agrees to take part in the validation efforts.

4.4.2 Service Module F2 – Fronts Detection

Value Proposition

Service Module identification

This service module will daily locate the main temperature and chlorophyll fronts within the sea surface. This information could help small pelagic fishing fleet to have more relevant information in their search for rich fishing grounds. Any information that could reduce the searching time and locate more efficient the areas, will benefit the sector and the environment.

Sea fronts can be identified from remote sensing and/or model imagery. But since the fishing sector needs more processed data to take fast decisions, this Service Module has been designed for a fast identification of frontal areas.

Service Module purpose

Ocean fronts are narrow areas at the sea surface, where a sharp gradient between two water masses with different hydrodynamic properties occur. Across frontal areas there is a strong gradient in a short horizontal distance in the physical and biochemical properties of the sea water. There are different types of fronts depending on their location, persistence and size. Frontal areas play an important role in the ecosystems and in different human activities, including fisheries as there is usually a higher concentration of commercial fisheries along fronts. In this service module we will focus on the following fronts: shelf, shelf-break, coastal-upwelling and estuarine fronts; as well as, on frontal areas in the deep ocean. Ocean front information together with other ocean information is useful in fisheries to search for suitable habitat for small pelagic and avoid other species. This Service Module will therefore reduce the costs associated with days at sea (person-work, fuel, fungible...) and thus, optimizing the resources in sea operations. In short, the Front Detection service module is addressed to the fisheries sector by providing it with another source of information about the ocean conditions

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

to reduce the time at sea and the distance travelled, with the final purpose of contributing to a more efficient activity.

Cross-sectorial

This Service Module can be applied to the other wild fisheries pilots within the FORCOAST consortium, *i.e.*, the Bulgarian Pilot. This service is applied to global remote sensing data provided by Copernicus and could, therefore, be useful to other areas outside both pilot areas (Bay of Biscay and Black Sea).

The spatial resolution of the resulting output is not relevant for the remainder sectors: Bivalve Aquaculture and Oyster ground Restoration (see also Deliverable 3.10 on Transferability). Nevertheless, in the future and based on the experience of the FORCOAST experts in these sectors, this Service Module could potentially help also these end users, if a higher resolution could be provided.

Customers segments

Customers

Customers Segments

The main customer segment identified for this Service Module is the wild capture fisheries sector, more specifically those focusing on small pelagic species.

At Pilot site

As stated before, this Service Module has been developed to answer some needs identified in pilot 2 (Deliverable 2.1 Stakeholders Interests and Needs) focused on giving service to the wild fisheries sector. Small pelagic species in the pilot area are the following ones: Atlantic horse mackerel (*Trachurus trachurus*), European pilchard (*Sardina pilchardus*), Mackerel (*Scomber scombrus*) and European anchovy (*Engraulis encrasicolus*), with the latter being the most appreciated due to its economic value. According to the Working Group on Stock Assessment of Small Pelagic Species (WGSASP) 2019 report (http://www.fao.org/gfcm/technical-meetings/detail/en/c/1274635/), the Northern Spain fleet operating on small pelagics during 2019 was composed of 104 vessels of different sizes (<12 m, 12-24 m and >24 m length). These target customers are listed in the first rows (Spain) of Table 1.

The French fleet also operates partially at the pilot site, and as such two POs fishing on small pelagics have been included in the table.

Finally, since this Service Module is mainly addressed for the fisheries sector and the main inputs to this Service Module are global remote sensing data, partners within the consortium, especially Pilot 3 (Bulgaria and Romania) and its end users (Raykov, 2020) could also benefit from this Service Module.

Customers in Europe

In other to look for more end users at the European level, DG-MARE published a "List of recognised producer organisations and associations of producer organisations" (https://ec.europa.eu/oceans-and-fisheries/fisheries/markets-and-trade/seafood-markets_en). Among them, it would be necessary

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

to search for each producer organizations focusing on small pelagics and with enough technology on board to support this type of applications.

Customers in the rest of the world

Finfishes is the main group of marine species fished worldwide (85% of the total marine catches that supposes about 7.9 million tonnes). Among them, the most fished ones are the small pelagics (FAO, 2020). The most fished species worldwide is the Peruvian anchoveta (*Engraulis ringens*), whose production represented the 10% of the finfish production in 2018 (7045 thousand tonnes). Among other species in the top list of the species worldwide there is the Atlantic herring (*Clupea harengus*) that supposes the 3% of the total finfish production (fourth position in the ranking) in 2018 (1820 thousand tonnes) followed by the European pilchard (*Sardina pilchardus*), which accounted for the 2% (1608 thousand tonnes), Pacific chub mackerel (*Scomber japonicus*), with 1557 thousand tonnes catched contributing to a 2% of the global production and Atlantic mackerel (*Scomber scombrus*), Japanese anchovy (*Engraulis japonicus*) and Sardinellas nei (*Sardinella spp.*) accounting each of them with 1% of the total production with catches of 1047, 957 and 887, respectively. These geographically widespread species can be classified into two groups depending on their final production. The biggest species (*e.g.* mackerel, horse mackerel) are utilized for human consumption and the smaller ones (*e.g.* Peruvian anchoveta) are more typically converted into fishmeal or fish oil for use as feed (for aquaculture and livestock).

Table 1. List with potential customers of Service Module per country.

	End user	**Activity**
Spain		
	OPEGUI	Fisheries producer organizations
	OPESCAYA	Fisheries producer organizations
	ARVI	Fisheries producer organizations
	OPROMAR	Fisheries producer organizations
	Organización de productores Puerto de Celeiro, S.A.	Fisheries producer organizations
	OPLUGO	Fisheries producer organizations
	OPACAN	Fisheries producer organizations
	Future fisheries producer organization from Asturias	Fisheries producer organizations
France		
	Coopérative des artisans pêcheurs d'Aquitaine	Fisheries producer organizations
	Les Pêcheurs de Bretagne	Fisheries producer organizations
Bulgaria		
	Black Sea Sunrise	Fishery associations

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

	BG Fish	Fishery associations
Rumania		
	Terrasigna	Business of Earth Observation data processing.
	Interfrig Fish	Fishing company
	Sea Sharks	Fishing company
	Rompescador ltd	Fishing company
Outside the European Union		
Chile		
	Asociación de Industriales Pesqueros del Norte (ASIPNOR)	Industrial fishing association
	Agrupación de Industrias Pesqueras del Sur Austral (FIPES)	Industrial fishing association
	Asociación de Industriales Pesqueros A.G. (ASIPES)	Industrial fishing association
	Sociedad Nacional de Pesca (SONAPESCA).	Industrial fishing association
Peru		
	Federación de Integración y Unificación de los Pescadores Artesanales del Perú (FIUPAP)	Artisanal fishermen organizations
	Asociación Nacional de Empresas Pesqueras Artesanales del Perú (ANEPAP)	Artisanal fishermen organizations

Market

European market of small pelagics

Between 2000 and 2013, small pelagic fisheries represented over 50% of the landings in the Mediterranean and Black Sea; these species accounted for 17% of the E.U. catches in 2015 (Schickele et al, 2020). The EU market contains a large number of vessels and fisheries. Understanding each fishery or metier is fundamental for the growth. Even though there are different types of metiers for targeting these species, the main metier used is the purse seine. In addition, these vessels are usually equipped with computers and receive satellite communications when they are far from the coast and as such, they do not obtain 4G signal. On the other hand, artisanal fleet that also catch small pelagics operates very close to the coast where this service module is less accurate and usually, they are not enough equipped for supporting this type of technologies. Therefore, we will focus herein on purse seiners fishing small pelagics.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

The Spanish fishing fleet is composed by 8839 vessels operating in 4 different fishing grounds: national (95% of the fishing vessels), European (1%), international (1%) and unified census of surface longline (2%). Within the national group there are 4 fishing grounds: Canary Islands, Cantabrian and NW Spain, Bay of Cadiz and Mediterranean. The Pilot 2 is focused on the Cantabrian Sea (see in Table 1 the main PO of this fishing ground within the Spanish coast) and the NW Iberian Peninsula fishing ground. There are 4643 fishing vessels registered operating in this fishing ground, among them the main fleet is the artisanal fleet that accounts for the 91% of the total fleet. The 88% of the total fleet belongs to the Galician autonomous community, while the 12% are from Asturias, Euskadi, and Cantabria communities. Even though the number of purse seiners contribute only to the 6% of the total fleet, these vessels reach the 39% of the gross tonnage within this fishing ground and the 30% of the total engine power.

Summarizing (Table 2), the potential users of this Service Module are 253 vessels where the Pilot 2 is focused (coverage of the oceanographic model). If the Service Module is applied to other models' outputs covering the rest of the Spanish coast the potential users could be 540 vessels.

Table 2. Number of purse seiners per autonomous community fishing in the Cantabrian Sea and NW Iberian Peninsula and total purse seiner fleet in Spain

Galicia	Euskadi	Asturias	Cantabria	Total Cantabrian Sea and NW Iberian Peninsula	Total Spain
152	58	6	37	253	540

With regard to the European fleet, in 2018 it was composed by 63 593 active vessels, being Greece, Italy and Spain the countries with the highest number of boats and Spain with the highest gross tonnage (Prellezo et al., 2020). The European Union large-scale fleet comprises 15 344 vessels and cover the 75% if the total gross tonnage, among these vessels there are vessels fishing large and small pelagics and a country-by-country analysis should be done to clarify the percentage of these vessels fishing on small pelagics. But these data can provide us an estimate of the potential users at the European level.

Profitability per Customer Segment

Fisheries have different profitability, since the commercial value and final end income depends on regions and type of fish. This makes it difficult to charge the same cost to each fishery. In the case of the different targeting species, as an example incomes of tuna fisheries are notably higher than those focusing on small pelagics such as sardines. Another difference is that the Tuna vessels are more far out in sea, so the conditions (time at sea, fuel cost, etc.) and time frames vary to those of sardine vessels. In both examples the front detection benefits the fleet reducing costs in a different manner and being able to plan the route more efficiently.

Revenue Streams

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Value of the Service Module

This type of service should be adapted to each fleet. Since their technical resources and general characteristics depends on the region and type of fish. This makes it difficult to charge the same cost to each fishery. Therefore, the value should be aligned with the result of the Profitability per Customer Segment. As an estimation for small pelagics, a Sardine vessel could be paying 100 euro or even less monthly for this type of service.

Competition and current services

The current competition is the data provided by satellite services and or other companies involved in the analysis and distribution of the information. Currently the data received and/or provided by the satellite's services are not easy to access and/or interpret by some end-users. On the other hand, the data provided can vary on sizes and frequency depending on the type of data. But taking into account the usual communications onboard of a great part of this fleet, data access is costly and therefore limited. Other companies, which provide similar information after analysis, are companies like Orbimap.

Form of Revenues

Revenues can be received either on a monthly or annually basis or even for specific single campaigns. In the case of Pilot 2, the duration of such sea campaigns take weeks or even months during different periods of the year, as they can change the target species according to the season. So this tool could be useful for this Customer Segment for multi-species and it would therefore be preferable to program revenues at the end of each campaign.

Contribution of the Revenue Streams

It is expected that the revenue streams will increase, once the end users see the advantages/value of this Service Module and got used to the way of using the service as part of their daily work processes. Mouth to mouth will increment the widely use of this Service Module. The final product can be purchased monthly, per semester or yearly. Depending on the need of each end user. The method of payment can be via bank transfer prior to the use of the data.

Key partners

Key Partners and their activities

- **AZTI** is the model developer in Pilot 2 and within this institute the Marine Technologies department is in charge of the development and operationalization of this hydrodynamic model. About the Service Module developer, it has been designed by Marine Instruments enterprise in collaboration with Azti. Both teams will continue maintaining and further developing these tools.
- **TerraSigna** has been identified as a suitable candidate to exploit and maintain the FORCOAST central platform during and after the FORCOAST project. The FORCOAST Central Platform is the central access point to the FORCOAST information services.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

- **FORCOAST partners** will provide several services during and after the project (Table 3).

Table 3. FORCOAST partner and their role in the exploitation of the Service Modules (D6.5 Initial Exploitation Strategy).

Role -------- Partner	Final User	Data Provision	Service Exploiting	Platform Exploiting	Advise/Support	Others (please specify)	Comments
Deltares					X	project base expertise	Deltares cannot be part of the exploitation after the project completion as a non-profit organisation.
EuroGOOS					X	Communication and link to the European Operational Oceanography Community	EuroGOOS as a non-profit organization cannot be part of the exploitation
Instituto Superior Tecnico		x	X	X	X		Exploitation probably through other Instituto Superior Tecnico linked institutions and spin-offs
Exporsado							
AZTI		x	x	X	X	Horizontal expertise and links towards different sectors of the blue economy and stakeholders managing marine and coastal resources.	AZTI is mainly a technological and research centre focused on transferring solutions and advising managers and service providers. But we can also provide ourselves services to administrations or companies.
Marine Instruments	X	x	x				MI will be both a final user and can exploit the service modules as well as providing data.
University of Sofia		x			X	Communications to Fisheries Sector	
TERRASIGNA		x	x	X	X		
Marine Institute		x			X	Can act as the first point of contact for Irish users	Marine Institute being a state agency will not be involved in exploitation
Cuan Beo	X					Communication to Oyster Restoration Groups	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

University of Liege		x			X		Restrictions applies on the possibility to get involved in non-research activity.
NIMRD					X	Communication to emerging aquaculture sector	NIMRD is a public research institute, 100% project-based financed, so we can't commit to provide data after the end of the project without any convention/financial support
Jailoo							Jailoo is a private entity specializing in research and operational services, hence continuation after the project end strongly depends on financial conditions
RBINS	X	x			X		
ILVO	X	x			X	Additional biological parameters on spat	
Brevisco							

Key Suppliers

The main key supplier is the Copernicus Marine Environmental Service, which provides remote sensing data necessary for the computation of the fronts. In addition, it also provides input data (e.g. boundary conditions) necessary for forcing the hydrodynamical model. Other suppliers are meteorological agencies that distribute also datasets (e.g. wind forcing) to feed the model.

Key Activities

Required Key activities for the Value Proposition

Further development of the model

To make this service module a workable service module across various sections, further knowledge and analysis is required of other fisheries and time experience of the knowledge put to use. For example, service module it is applied both to hydrodynamic model outputs and to remote sensing imagery. In the first case, it would be necessary to search for regional or coastal models covering the new areas and adapt the code the corresponding spatial resolution. In addition, a validation of the results in each area would be advisable.

Gathering biological data

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Since this Service Module is applied on remote sensing imageries or model outputs, there is no need of gathering biological data.

Gathering physico-chemical data

Since this Service Module is applied on remote sensing imageries or model outputs, there is no need of gathering physico-chemical data.

Gathering meteorological data

Since this Service Module is applied on remote sensing imageries or model outputs, there is no need of gathering meteorological data.

Gathering earth observation data

The front detection algorithm is applied usually to sea surface temperature and sea surface chlorophyll concentration maps (remote sensing or model data), but it could be applied to other variables (e.g., salinity). It has been designed to be applied to the following Copernicus products:

- CMEMS OCEANCOLOUR_GLO_CHL_L4_NRT_OBSERVATIONS_009_033
- CMEMS SST_GLO_SST_L4_NRT_OBSERVATIONS_010_001

Key Resources

Key Resources

- Key resources required for the development and maintenance of this Service Module, are the daily images received and analysed. In order to keep up with the continuous data stream, the received information must be under constant analysis and study.

Revenue Streams

Revenue streams can be other programmes, associations, groups and even individual vessels and companies.

Customer relationships

Keeping contact with the target groups

Keeping in contact with the target groups is via constant communication, conferences and fair. Market updates and analysis is essential.

Keeping the target groups interested

In order to keep the target groups interested in the serve module added value must be shown and counted for. Incrementing the added value with constant knowledge is key.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Channels

Channels to reach the Customer Segments

Channels to be used to reach the customer segments are those targeting associations via conferences and fairs. Magazine articles and advertisements should also be correctly used. Word of mouth in these sectors are of the most importance.

Integration of channels

FORCOAST work can be integrated into all the channels mentioned above.

Cost Structures

Most important costs

Most important costs are those produced by the satellites taking images in real time. This is not supported by the FORCOAST Consortium but highlight the importance of this EO missions to keep this type of services. In addition, other important costs are the maintenance of the data servers and computational systems, as well as the analysis time.

Most expensive Key Resources

Most Expensive Key Resources are the information provided by the satellites.

Most expensive Key Activities

Most Expensive Key Activities are based on incrementing user knowledge and type of fishery knowledge. Gaining knowledge on a vast number of fisheries takes time, effort and money for research and understanding analysis.

References

Marçalo, A., Breen, M., Tenningen, M., Onandia, I., Arregi, L., & Gonçalves, J. M. (2019). Mitigating slipping-related mortality from purse seine fisheries for small pelagic fish: case studies from European Atlantic waters. The European Landing Obligation, 297.

Prellezo Raul, Carvahlo Natacha, Guillen Jordi (eds) (2020). Scientific, Technical and Economic Committee for Fisheries (STECF): The 2020 Annual Economic Report on the EU Fishing Fleet (STECF 20-06). EUR 28359 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-27164-2, ISSN 2467-0715, JRC123089. https://doi.org/10.2760/500525

Raykov, V. S. (2020). Characteristics of the Bulgarian Small-Scale Fisheries. In Small-Scale Fisheries in Europe: Status, Resilience and Governance (pp. 69-81). Springer, Cham.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Schickele, A., Goberville, E., Leroy, B., Beaugrand, G., Hattab, T., Francour, P., & Raybaud, V. (2021). European small pelagic fish distribution under global change scenarios. Fish and Fisheries.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

4.4.3. Service Module A1 – Marine Conditions

Value Proposition

Service Module identification

The Service Module provides forecast on meteo-oceanographic conditions and near real time data that is distributed to the end user in a friendly way using mobile phone existing applications. The main objective is to plan the activities by having updated local information of the limiting environmental conditions. In addition, recent operational observations of environmental variables (meteorological, hydrodynamic, biogeochemical, river discharges,..) will be distributed by the same channel.

IST has started developing this service taking into considerations the requirements by ExporSado to develop a diagram that include the most limiting factors for planning their activities:

- Tide
  - Time and heigh of high and low tide
  - Optimum tide level for their activities
- Daylight hours (sunrise and sunset)
- Wind conditions
- Rain conditions

The service is distributed on a daily (including next two days forecast) and weekly basis (including next week best forecasts). The service was presented in the Portuguese Aquaculture Association (APA, on its portuguese acronym) and was well received but still we have to demonstrate this concept with more end-users. Our next step is to approach directly other Sado estuaries aquaculture producers and to gather their interest. In addition, the tool will be exported to other pilots to evaluate the response of other aquaculture areas to this product.

Service Module purpose

This service module aims to contribute for a better and safer management of the production areas. Since producers receive daily updated metocean environmental conditions for their area. This information allow them to better decide which activities they will be performing according to the environmental conditions.

Cross-sectorial

This information is relevant for other sectors that operate in the same area such as fishermen, ports administration and tourist operators including dolphin watching activities. This service module can be also of interest to local authorities and other industry present in the area.

Customers segments

Customers

Customers Segments

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

This Service Module focused on bivalve aquaculture producers to validate the concept. It also focuses in areas where tide is a relevant limiting factor. However, it can be exported to other aquaculture producers areas and add other variables as desired, i.e. in open areas replacing tide levels with waves. Recent data, from 2019, listed 3619[1] and 1265[2] active fisheries and aquaculture enterprises respectively in Portugal .

At Pilot site

The pilot site is one of the major areas of bivalve production in Portugal with 14 firms producing oysters. In addition to ExporSado, other aquaculture companies in the Sado estuary includes are Neptunpearl, Bivalsado, Oysterworld and Aquanostra.

Customers in Europe

List the most important end users that could benefit from the Service Module in Europe and explain how the Service Module could be of benefit for them.

Other end users in Europe could start by exporting the SM to the other FORCOAST pilots and trying to reach the market through the European Aquaculture Association (EAS).

Customers in the rest of the world

At this level of development, it is complicated to explore the world end users. But in theory it can be exported to any other location in the world if the requirements are met.

Market

European market

The oyster production in Portugal had always been very volatile and fragile. The production was mainly of the "Pacific oyster" species but in recent years, there was an increase in the farming of the "flat oyster" and in the so-called "Portuguese oyster". Although the oysters were a Portuguese heritage, they were not traditionally consumed on a regular basis and its introduction was a long process as most people associated it to a luxury consumption good[3]

EU catches, which were above 10.000 tonnes at the end of the 1960s, followed then a decreasing trend to less than 1.000 tonnes in 2018. In 2018, EU catches represented only 0,4% of global oyster

catches. The European flat oyster (*Ostrea edulis*) is the main caught species within the EU (FAO). Wholesale prices show an increasing trend (EUMOFA)[4].

1 https://www.pordata.pt/Portugal/Empresas+da+Pesca+e+Aquicultura+total+e+por+escal%c3%a3o+de+pessoal+ao+servi%c3%a7o-3444

2 https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_publicacoes&PUBLICACOESpub_boui=506923022&PUBLICACOESmodo=2

3 2020 Palhas, SLC. Neptunpearl : the search for growth. MSc dissertation in Management with Specialization in Strategy and Entrepreneurship, at the Universidade Católica Portuguesa

4 https://www.eumofa.eu/documents/20178/137160/Oyster_31-1.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

PRICES ALONG THE SUPPLY CHAIN (EUR/kg)

First-sale (live/fresh)

First-sale prices are presented for European flat oyster (the main caught oysters' species), for which Denmark is the main producer, and Pacific cupped oyster (the main famred oysters' species), for which France is the main producer.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Source
France (European flat oyster)	2,54	3,26	3,59	2,89	3,22	3,43	3,76	3,17	2,00	1,54	EUMOFA
France (Pacific cupped oyster)	2,16	3,30	4,14	4,23	n.a.	n.a.	n.a.	3,26	2,42	2,23	EUMOFA
Denmark (European flat oyster)	2,60	3,62	5,69	7,37	7,57	6,75	6,47	6,77	5,95	5,51	EUMOFA

Wholesale (live/fresh)

Wholesale prices are presented for Spain (wholesale market of Barcelona).

Average price	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Source
Spain	8,72	9,94	10,92	11,03	11,55	12,37	12,43	11,79	11,83	12,8	Mercabarna

EU market for Service Module

No information available.

Profitability per Customer Segment

No data available.

Revenue Streams

Value of the Service Module

During the co-development of the tool with ExporSado, we estimated that arriving 15 minutes late for the adequate tides could cost around 1500€ and this situation can happen more that 6 times per month.

Competition and current services

The competition is low in the Pilot 1 since the aquaculture producers are using tidal tables or other online services for nearby areas to their production sites.

Form of Revenues

The revenues of this service are yet to be investigated but having all the information in one place and easy to access may be interesting for them. It could be each producer to sustain the service or it could be presented to associations or administration for providing the service to the aquaculture community.

Contribution of the Revenue Streams

The model of revenue has to be tested during the project and the willingness to pay has to be evaluated.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Key partners

Key Partners and their activities

- **CoLAB +ATLANTIC** for future capitalisation and exploitation activities in Portugal.
- **TerraSigna** has been identified as a suitable candidate to exploit and maintain the FORCOAST central platform during and after the FORCOAST project. The FORCOAST Central Platform is the central access point to the FORCOAST information services.
- **FORCOAST partners** will provide several services during and after the project (Table 1).

Table 1. FORCOAST partner and their role in the exploitation of the Service Modules (D6.5 Initial Exploitation Strategy).

Role -------- Partner	**Final User**	**Data Provision**	**Service Exploiting**	**Platform Exploiting**	**Advise/Support**	**Others (please specify)**	**Comments**
Deltares					X	project base expertise	Deltares cannot be part of the exploitation after the project completion as a non-profit organisation.
EuroGOOS					X	Communication and link to the European Operational Oceanography Community	EuroGOOS as a non-profit organization cannot be part of the exploitation
Instituto Superior Tecnico		X	x	x	X		Exploitation probably through Instituto Superior Tecnico linked institutions such as CoLAB +ATLANTIC
Exporsado							
AZTI		X	x	x	X	Horizontal expertise and links towards different sectors of the blue economy and stakeholders managing marine and coastal resources.	AZTI is mainly a technological and research centre focused on transferring solutions and advising managers and service providers. But we can also provide ourselves services to administrations or companies.
Marine Instruments	x	X	x				MI will be both a final user and can exploit the service modules as well as providing data.
University of Sofia		X			X	Communications to Fisheries Sector	
TERRASIGNA		X	x	x	X		

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Marine Institute		X			X	Can act as the first point of contact for Irish users	Marine Institute being a state agency will not be involved in exploitation
Cuan Beo	x					Communication to Oyster Restoration Groups	
University of Liege		X			X		Restrictions applies on the possibility to get involved in non-research activity.
NIMRD					X	Communication to emerging aquaculture sector	NIMRD is a public research institute, 100% project-based financed, so we can't commit to provide data after the end of the project without any convention/financial support
Jailoo							Jailoo is a private entity specializing in research and operational services, hence continuation after the project end strongly depends on financial conditions
RBINS	x	X			X		
ILVO	x	X			X	Additional biological parameters on spat	
DMI		X			x		
Brevisco							

Key Suppliers

Provision of meteorological forcing from IPMA and river flow from the Portuguese Environmental Agency are key for this high resolution model.

UNDERSEE has been subcontracted in the framework of this project to provide near real time observation in the production area.

Key Activities

Required Key activities for the Value Proposition

Further development of the model

There still a need to collect other sector requirements and to set up graphic templates for them.

Gathering biological data

HAB information has been identified very relevant for many aquaculture producers.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Gathering physico-chemical data

The physical and chemical data need include: water level, Chlorophyll *a*, temperature, salinity and nutrients.

Gathering meteorological data

Wind and rain data are seen as key components of this Service Module. Also atmospheric pressure. Currently using a 2.5 km resolution meteorological model from IPMA.

Gathering earth observation data

Satellite SST, chl-a, SPM and optical data are needed with high resolution and accuracy in intertidal areas.

Key Resources

Key Resources

- Access and automatic download of high resolution meteorological forcing from IPMA for short forecast (next 48h) and from the NCEP Global Forecasting System for longer forecasts (up to 14 days)
- Access to near real time river flow from EMODnet and operational simulations of other properties from MOHID LAND applications
- Access and storage of ocean boundary conditions from CMEMS
- Data servers to store and distribute the information through ftp and thredds services
- MOHID Water model to simulate the estuarine dynamics
- Scripts to convert the modelling results into the service and the graphic design that can be apelative and easy to understand by the end user.

Revenue Streams

The revenue streams for this service are not fully validated. If producers accept to pay a value for the Sado estuary around 500 €/month and 10 units buying the service would be acceptable to maintain the service. A similar overall value could be offered to a single payer or an association.

Customer relationships

Keeping contact with the target groups

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

A questionnaire was developed for the APA presentation with low feedback. Next step is to adapt the questionnaire locally and to distribute it within the Sado aquaculture producers with the support of ExporSado.

Keeping the target groups interested

New features could be develop in the future to include other relevant information collected in the area becoming a one-stop-shop.

Channels

Channels to reach the Customer Segments

We'll setup a landing page with a full description of the Service Module.

Integration of channels

The landing page and description could also be integrated in the FORCOAST webpage and other project defined channels.

Cost Structures

Most important costs

The cost for this service consist on developing the pipeline of information and to implement the high resolution model with enough boundary conditions options so it's not limited by those conditions. The effort in model configurations, validation and calibration is very time consuming. Setting up the operational architecture and dissemination means from the modelling results to the service also requires some effort. However, these efforts are only needed once. The maintenance cost are relatively low compare with the implementation cost. But other costs, such as user support, marketing and communication/dissemination costs that we are not fully aware can also result in a increase of the SM cost.

Currently, our costs are in maintaining the operational system working, continuous calibration and validation of the numerical models. However, the marketing costs and customer service may increase in the future.

Most expensive Key Resources

The most expensive resource is the implementation of the model for a particular area and the monitoring station when necessary. After the implementation phase, the customer service and marketing can be the most expensive resources.

Most expensive Key Activities

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Gathering information with end-users and customisation of the service can be expensive until reaching a high level of development.

4.4.4. Service Module A2 – Land Pollution

Value Proposition

Service Module identification

Aquaculture farmers have no or low means to assess the risk of exposure to harmful land discharges. Along with the lack of information regarding the oceanographic variables, the main problem is the lack of information regarding the outflows from the on-shore wastewater treatment plants. For instance, in Pilot 7, the emerging aquaculture farms are placed somehow close to the Constanta city wastewater treatment plants, which sometimes, during summer - touristic periods - may outflow untreated water, containing possibly some bacterial inputs, such as *E. coli.*

SM-A2 targets aquaculture farmers as main users. It is built on the flexible assumption that users only have limited means to characterize the source of pollutants. A thorough description of these sources would include location of the source, nature of the discharge and temporal variations in the outflow. As a first approach we consider that users won't be able to gather sufficient knowledge regarding nature, and temporal variations, but should have the means to characterize at least the location.

Also, SM-A2 uses surface circulation hindcast and forecast model data to provide an estimate of the potential risk of being affected by user-identified sources of pollution, i.e. to assess if the local marine conditions are such that an effective release at the pollution source has significant probability to reach the farm. A constant watch is set, updated daily to consider the most recent circulation conditions. As the best proxies attainable within this context, alarms are raised on the basis of relative concentration and age of released substance. That is, users are notified if a substantial fraction (1) of release may reach the farm in a relatively short time (2). (1) and (2) respectively correspond to "Fraction" and "Age" thresholds, that the user may modify to parameterize notification.

Service Module purpose

The knowledge that marine conditions are such that releases from pre-identified sources have large chances to reach the farming area (and notification of when this risk arises for at least three days in advance) could trigger actions from the farm managers. This includes early harvest (if the model predicts sufficient time period until potential contamination), delayed harvest (allowing the mussels to self-purify, after the contaminated water has passed the farm area), or extra/enforced quality control procedures in order not to threaten public health.

Cross-sectorial

SM-A2 may actually match with some requirements of the Oyster Ground Restoration sector in the cases where 1) fixed sources are known in advance, 2) a regular watch may be beneficial concerning the potential influence over a predetermined area. However, it seems unsure that the short forecast timescales required for the Aquaculture sector is of relevance for the Oyster Ground Restoration sector.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Customers segments

Customers

Customers Segments

The main identified customer segment is represented by the owners/managers of aquaculture farms(s). Additionally, the institutions regulating marine aquaculture products and activities might use the service (for instance, the National Agencies for Fisheries and Aquaculture, the National Sanitary-Veterinary and Food Safety Authorities, the Waters National Administrations). To some extent, research institutes can use some data, for specific case studies or actions.

At Pilot site

- Maricultura Ltd. / Pescaria lui Matei Ltd.
- Authorities: National Agency for Fisheries and Aquaculture, the National Sanitary-Veterinary and Food Safety Authority, the Romanian Waters National Administration
- Research institutions: NIMRD for future research purposes

Customers in Europe

Maricultura Ltd. / Pescaria lui Matei Ltd. (Romania), Smart Farm AS, Bulgaria (Bulgaria), Musholm farm (Denmark) are all mussel farms that may trigger management actions as a follow-up of early warning of potentially microbiologically contaminated waters reaching the farm site.

Customers in the rest of the world

Smart Farm AS, Norway is a mussel farm that may trigger management actions as a follow-up of early warning of potentially microbiologically contaminated waters reaching the farm site.

Table 1. is a list of potential customers of the Service Module per county (this list can be longer than the end users described in the text above).

Table 1. List with potential customers of Service Module per country.

	End user	Activity
Romania		
	Maricultura Ltd. / Pescaria lui Matei Ltd.	Mussel farming. Trigger management actions as a follow-up of early warning of potentially microbiologically contaminated waters reaching the farm site
	National Agency for Fisheries and Aquaculture, the National Sanitary-Veterinary	Policy and decision-making

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

and Food Safety Authority, the Romanian Waters National Administration	
NIMRD	Future research activities
Bulgaria	
Smart Farm AS, Bulgaria	Mussel farming
Denmark	
Musholm farm	Mussel farming
Outside the European Union	
Norway	
Smart Farm AS, Norway	Mussel farming

Market

European market

The target species the Pilot 7 SM focuses on is the black mussel (*Mytilus galloprovincialis* Lamarck, 1819). The European market for mussels is estimated to be slightly below 600,000 tonnes in equivalent live animal weight. The popularity of mussels differs from country to country, where per capita consumption varies from less than 200 g to nearly 4 kg per year (FAO statistics). The overall production of mussels in Europe peaked at nearly 750,000 tonnes in the late 1990s and has since declined to about 550,000 tonnes in the past few years. On a global scale, Europe is a major contributor of mussels, supplying over a third of the total production. Aquaculture is by far the main source of mussels and is responsible for over 90 percent of total landings. Three countries are responsible for two thirds of all European mussel production. Spain is very clearly the largest producer, with over 200,000 tonnes per year, followed by France, with a stable production of around 80,000 tonnes. Italy is the third main producing country, with 65,000 tonnes. Most of the supplies from all three countries come from aquaculture. At the production level, a number of external risks may alter the overall output on sales, in particular unreliable seed resources and poor water quality, pollution, biotoxins, and finding spaces for future sites. At the market level, challenges exist relating to the low price of imports, which could pose a threat to local production, expensive transport and logistics and consumer reluctance to eat mollusks (http://www.fao.org/in-action/globefish/fishery-information/resource-detail/en/c/338588/).

EU market for Service Module

This Service Module can be of great importance to any shellfish farmer, especially for those with shellfish production areas that are nearshore of in estuary, with high risk to land discharge exposure. It is estimated that the number of otential end users may exceed 1,000, *e.g.* in 2015, there were in France alone more than 3,000 shellfish farmers producing oyster (EUFOMA, 2017).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Profitability per Customer Segment

The willingness to pay for the identified Customer Segments is impossible to assess at the moment, thus profitability cannot be estimated.

Revenue Streams

Value of the Service Module

Considering the novelty of marine aquaculture in the area no services of this type have been developed so far, consequently the FORCOAST SM is an ice-breaking offer. The willingness to pay is impossible to assess at the moment.

Competition and current services

There is no similar service available, thus no competition.

Form of Revenues

No information available.

Contribution of the Revenue Streams

No information available.

Key partners

Key Partners and their activities

- **University of Liege** is the responsible for developing the model and is developed in collaboration with **Jailoo**. It benefits from expertise of both in the maintenance of the CMEMS BS-MFC-BIO product.
- **TerraSigna** has been identified as a suitable candidate to exploit and maintain the FORCOAST central platform during and after the FORCOAST project. The FORCOAST Central Platform is the central access point to the FORCOAST information services.
- **FORCOAST partners** will provide several services during and after the project (Table 2).

Table 2. FORCOAST partner and their role in the exploitation of the Service Modules (D6.5 Initial Exploitation Strategy).

Role -------- Partner	Final User	Data Provision	Service Exploiting	Platform Exploiting	Advise/Support	Others (please specify)	Comments

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Deltares					X	project base expertise	Deltares cannot be part of the exploitation after the project completion as a non-profit organisation.
EuroGOOS					X	Communication and link to the European Operational Oceanography Community	EuroGOOS as a non-profit organization cannot be part of the exploitation
Instituto Superior Tecnico		X	x	x	X		Exploitation probably through other Instituto Superior Tecnico linked institutions and spin-offs
Exporsado							
AZTI		X	x	x	X	Horizontal expertise and links towards different sectors of the blue economy and stakeholders managing marine and coastal resources.	AZTI is mainly a technological and research centre focused on transferring solutions and advising managers and service providers. But we can also provide ourselves services to administrations or companies.
Marine Instruments	x	X	x				MI will be both a final user and can exploit the service modules as well as providing data.
University of Sofia		X			X	Communications to Fisheries Sector	
TERRASIGNA		X	x	x	X		
Marine Institute		X			X	Can act as the first point of contact for Irish users	Marine Institute being a state agency will not be involved in exploitation
Cuan Beo	x					Communication to Oyster Restoration Groups	
University of Liege		X			X		Restrictions applies on the possibility to get involved in non-research activity.
NIMRD					X	Communication to emerging aquaculture sector	NIMRD is a public research institute, 100% project-based financed, so we can't commit to provide data after the end of the project without any

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

							convention/financial support
Jailoo					X		Jailoo is a private entity specializing in research and operational services, hence continuation after the project end strongly depends on financial conditions
RBINS	x	X			X		
ILVO	x	X			X	Additional biological parameters on spat	
Brevisco							

Key Suppliers

Copernicus services: Copernicus Marine Service, Copernicus Land Monitoring Service (CLMS), Copernicus Climate Service; Regional data collectors; Internet providers etc

Key Activities

Required Key activities for the Value Proposition

Further development of the model

The Service Module has been tested for two pilot sites (Romania, Pilot 7 and Ireland Pilot 5) and is used as a test case for the development of the cloud-based deployment (ie. scheduled execution from the centralized FORCOAST platform). As such it counts among the most developed SM of the catalogue.

Further improvements are strongly dependent on user capacity to constrain sources, and on pilot models to characterize marine conditions.

For instance, an extended version of SM-A2 could implement a transformation model along particle advection, ie. released substances would be evolved from a passive tracer to an evolutive tracer which may represent the growth of bacteria, or the decay of a pollutant. At this point, there is no point in providing such development without evidence that user or external sources can be used to precise the nature of harmful substances. Another example would be to ingest temporal variations in the release. Again this requires the user's capacity to provide such information, or the identification of an external source able to provide this information in real time, or at least on a climatological basis.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Specific validation could be based on drifter experiment : drifters (or dyes) could be released from the user source locations and the real trajectory compared with the simulated one.

Gathering biological data

In the cases where users require to develop SM-A2 for the specific aim of *E. coli* bacterial outbreak, an intensive protocol would need to be deployed to validate bacterial growth along advection trajectory.

According to EU Regulation No. 629/2019, the risk of contamination of shellfish is evaluated by reference to the sources and types of fecal contamination (human and animal) in the vicinity of the shellfish production areas (shoreline survey), on the one hand, and the results obtained based on the indicator bacteria *Escherichia coli,* from samples taken in these areas, on the other hand. Areas are classified following a full assessment of this risk and the classification given to an area determines whether shellfish harvested in that area require post-processing treatment and, where appropriate, the level of such treatment.

Criteria for the classification of bivalve mollusk harvesting/culture areas (Table 3).

Table 3. Classification of bivalve mollusc harvesting/culture areas according to EU law Regulation (EC) 629/2019.

Class	Criteria for the classification of bivalve mollusk harvesting areas	Post-harvest treatment required to reduce microbiological contamination
A	Samples of live bivalve mollusks from these areas must not exceed, in 80% of samples collected during the review period, 230 *E. coli* per 100 g of flesh and intravalvular liquid. The remaining 20% of samples must not exceed 700 E. coli per 100 g of flesh and intravalvular liquid.	none
B	Live bivalve mollusks from these areas must not exceed, in 90% of samples, 4,600 MPN *E. coli* per 100 g of flesh and intra-valvular liquid. In the remaining 10% of samples, live bivalve mollusks must not exceed 46,000 MPN *E. coli* per 100 g of flesh and intra-valvular liquid	purification, relaying or cooking by an approved method
C	Live bivalve mollusks from these areas must not exceed the limits of a five-tube, three dilution MPN test of 46,000 *E. coli* per 100 g of flesh and intravalvular liquid	relaying or cooking by an approved method

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

In September 2020, the microbiological survey as per EU Regulation No. 629/2019 was completed in Romanian marine waters. After analyzing the results of the samples collected and corroborating them with the shoreline survey carried out by NIMRD, the National Sanitary-Veterinary and Food Safety Authority performed the microbiological classification of all three production and relaying areas of live bivalve mollusks in the Romanian sector (namely Chituc - Perișor, Mamaia Bay and Agigea - Mangalia) in class A. As such, shellfish harvested or reared in these areas can be marketed for human consumption without further purification required. It must be underlined that classification is not permanent and, once regular monitoring indicates non-compliance with the set-parameters, classification shall be suspended and the entire process must be re-run, in order to allow safe marketing on the local and European market.

Gathering physico-chemical data

The data gathering for drifter-based validation of SM-A2 was designed within certain experiments in adjacent areas of the Eforie mussel farm. The new instrument, Spotter, will deliver high-fidelity, real-time waves in AOI, but also will be used as a wave-enabled Lagrangian drifter to measure both waves and track surface currents. Two Coastal Nomad drifters will provide the same surface current data in the vicinity of Constanta maritime port and Eforie South.

Gathering meteorological data

The Pilot model is dependent on operational atmospheric forcing data, currently obtained through the ECMWF data servers.

Gathering earth observation data

Remote sensing data is required only sporadically, in the course of validation exercise. Those are thus required upon evolution of the pilot model, but not for daily operational production.

Key Resources

Key Resources

Running the service module requires operational provision of modelled currents. Human intervention is required only in case of operational chain failures or in case of (upstream) model upgrades with changes to the forecast files. Furthermore, on the contrary of the operational hydrodynamic forecasting model itself, a hypothetical failure of the service module on a given day does not compromise the following cycles. Thus, the operational maintenance cost of the service module should be quite limited.

Updates to the service module may consist mainly of (1) upgrading the Ocean Parcels code to the newest version, (2) adding capabilities to consider different (new) hydrodynamic model forecast files.

Without considering these updates, and assuming no cost for the hydrodynamic forecasts, the key resources required by the service module can be summarized as follows:

- a platform able to automatically download all required forecasting files (from various Thredds or FTP servers corresponding to different geographical sites), both for hydrodynamics and

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

waves. The platform should have sufficient computing resources in order to perform the lagrangian simulations,

- relatively limited human supervision in order to detect operational chain failures, and rectify them ; and potentially periodically perform updates and/or upgrades.

Revenue Streams

No information available.

Customer relationships

Keeping contact with the target groups

As there are no registered aquaculture associations in the region, contact with the Target Group(s) of Pilot 7 shall be kept directly and via e-mail/social media.

Keeping the target groups interested

The Service Module will function as an app. Taking into consideration the unsheltered specificity of the North-Western Black Sea coast and potential disruptions in activity caused by severe weather, an integration within the SM-A2 of an access point to meteorological forecast (4-5 days), with reliable data (maybe directly from ECMWF), would increase the interest level and willingness to pay of Target Group(s).

Channels

Channels to reach the Customer Segments

The Service Module will be made available to end users via an app, that can be consulted by smart phone and/or desktop. As mentioned, direct communication, as well as e-mail/social media shall be used for providing updates and news.

Integration of channels

It would largely benefit the SM-A2 user uptake to be channelled and shared beyond the Romanian pilot to reach European areas where the Aquaculture sectors is more developed. Besides, this may also benefits the development of the sector in the Romanian area.

Cost structures

Most important costs

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

The most important cost lies in the personnel costs associated with maintenance and update of the pilot model, required to provide met-ocean data at a local scale, and the development and maintenance of the post-processing modules. In addition, the cost of computational resources for operational data provision remains significant.

Most expensive Key Resources

A spatial extension of the service availability, across Europe or beyond, is probably the best strategy to enlarge the potential user base. This potential is already covered by the transferability principles adopted in the FORCOAST Service Design. A larger enlargement would require to secure the access to high-resolution local met-ocean forecast data, in particular concerning ocean circulations. We advice that this can be secured by incorporating local operational met-ocean data providers, external to the projects, in the data stream.

To extend the service finality (eg. addressing the nature of harmful substances explicitly) would demand significant research and development efforts, while the transferability of the produced knowledge may suffer from a lack of transferability.

Most expensive Key Activities

Key upstream activities to support the viability of SM-A2 are :

- Development and maintenance of operation met-ocean data provision. This includes the development of complex 3D hydrodynamic circulation models, which need to be coupled with atmospheric and marine conditions data at their boundary.
- Development and maintenance of the post-processing units, in particular, this involves the Python-based OceanParcels modules to compute Lagrangian tracks, and specific post-processing code to generate FORCOAST specific diagnostics and user-dedicated information.
- Regular local met-ocean in-situ data acquisition. Constant update of the local models requires a strong observational basis to support validation, and characterization of the uncertainty to be associated with the service.
- Advection specific data acquisition. Local drifters experiments would fulfill the need of specific validation of the advection module (ie. the post-processing unit). Such experiments are strictly relevant at local scales, and mostly benefits the validation of the module at each implementation site.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

4.4.5. Service Module A3 – Site Prospection

Value Proposition

Service Module identification

The Service Module provides forecast and historic information on hydrography and marine biological information as well as user specific compilations of these data.

OysterBoat conducted a phone survey with the 5 top primary producers and whole sale dealers in Denmark, 9 key Forcast parameters are identified, which are listed below in descending priority:

1 – Water temperature over the water column

2 – Advance icing information

3 – Oxygene over the water column

4 – Hypoxia, release of H2S

5 – Algy, shellfish nutrition

6 – Venomous algy leading to shell closure and non feeding

7 – *E. coli*

8 – Marteilia and Bonamia

9 – Spatfall of blue mussels and oysters

Especially for Limfjorden, the shellfish primary producers need to know about icing and hypoxia. Ice formation is governed by hydrography and meteorological condition while hypoxia additionally includes oxygene, phytoplankton and detritus deposits. The primary producers cannot abandon locations but may lower or hoist their cultures to avoid havoc or mortality.

Service Module purpose

In addition to provide high accurate environmental forecast on water level, water temperature, salinity and currents, the Service Module is also able to forecast icing and probably hypoxia in the future, the two largest risks in Danish shellfish farming.

Cross-sectorial

Environmental studies of hydrography and marine biology may benefit greatly from accurate and detailed models. Authorities, consultants, academia, nature conservation organisations and philanthropic investors may commission specialised studies.

Customers segments

Customers

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Customers Segments

The Service Module is primarily relevant to the shellfish primary producers and the processing industry. Secondarily authorities, consultants, academia, nature conservation organisations and philanthropic investors may be interested. Authorities regulate the shellfish business and may impose environmental restrictions depending on environmental impact or public health issues.

Most of the fishing and aquaculture companies may be potential for using the environmental information service. A list of 51 Danish fishing and aquacuture companies is given in Table 1.

At Pilot site

For Limfjorden Pilot Site, the Service Module is primarily relevant to the shellfish primary producers. OysterBoat is the project partner which uses hydrography and biogeochemical information for its oyster cultivation business. Other aquaculture companies in Limfjorden includes Blå Biomasse A/S, Seafood Limfjord ApS, Shellfish Limfjord ApS, MytiLine ApS, Vilsund Blue A/S and Muslingeriet

Table 1. 51 Danish Fisheries and Aquaculture companies and their net profit.

#	Company	Net profit (×1000) DKK	#	Company	Net profit (×1000) DKK
1	Rederiet Ruth A/S	185 098	27	Royal Danish Fish A/S	225
2	Gitte Henning A/S	94 633	28	Shellfish Limfjord ApS	87
3	Astrid Fiskeri A/S	77 986	29	Britta Brock E443 A/S	85
4	Asbjørn A/S	31 530	30	Sten Kjær ApS	52
5	Cattleya A/S	19 375	31	Vestjydske Dambrug ApS	18
6	Jette Kristine E 727 ApS	17 930	32	BRØDRENE OLSEN. RØDVIG FISKERI ApS	9
7	Frea A/S	13 034	33	SEA ApS	- 20
8	Aquapri A/S	12 220	34	Funderholme Dambrug A/S	- 77
9	Kjærsgaard Hirtshals A/S	8 121	35	HM 120 Astoria ApS	- 89
10	Aquapri Denmark A/S	7 232	36	John Hansen. Glyngøre ApS	- 112
11	HJ FISKERI HARBOØRE ApS	6 420	37	Karen Nielsen ApS	- 115
12	Fiskeriselskabet Pondus ApS	5 476	38	Sejbæk Dambrug ApS	- 148

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Table 1. 51 Danish Fisheries and Aquaculture companies and their net profit.					
#	Company	Net profit (×1000) DKK	#	Company	Net profit (×1000) DKK
13	Seafood Limfjord ApS	4 836	39	Fonden Danmarks Center For Vildlaks	- 327
14	Partsrederiet Albatros ApS	2 548	40	BORNØ ApS	- 616
15	Lingbank Fiskeri ApS	2 493	41	Credo Fish ApS	- 698
16	Fiskeriselskabet Borkumrif ApS	2 090	42	Løvlund Dambrug ApS	- 1 076
17	FISKERISELSKABET HOUNISEN ApS	1 692	43	Fn 234 Canopus Aps	- 1 156
18	Brejnholm Dambrug ApS	1 554	44	HG 352 Polaris ApS	- 2 149
19	Ny Kingfisher A/S	1 353	45	Volstrup ApS	- 2 773
20	T 138 Poseidon A/S	1 290	46	Danaqua ApS	- 3 026
21	Kærhede Dambrug ApS	878	47	Danish Salmon A/S	- 3 269
22	Smidt Nissen Jøker & Co., A/S	436	48	Maximus A/S	- 6 055
23	Hanstholm Samlecentral A/S	391	49	Amy ApS	- 6 276
24	Løjstrup Dambrug A/S	312	50	Hjarnø Havbrug A/S	- 11 187
25	SSO ApS	271	51	Atlantic Sapphire Denmark A/S	- 46 398
26	Pedersen Aqua ApS	229			

Customers in Europe and the rest of the world

This is the Danish Pilot and there is no knowledge available on other European Primary Producer needs, nor in countries outside Europe. LTA, Lower Trophic Aquaculture is poorly developed in Europe. Reliable Service Module information may boost the development of LTA in Europe.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Market

European market

The European market for flat oysters has dwindled to a fraction of its original volume due to failing supplies and with a consequent persistent rise in unit prices (see also Service Module A4 – Assistance for spat capture). The current market deficit is estimated at 3000 t annually.

Blue mussels may provide an alternative to agricultural proteins and with a much lower carbon footprint. Additionally Blue Mussels may remove vast amounts of nutrients from the water column. The industry is picking up momentum and the Danish industry muster an annual production above 10000 t.

EU & world market for Service Module

As this a Danish pilot, there no data available for the European market.

Profitability per Customer Segment

No data available at this moment.

Revenue Streams

Value of the Service Module

Icing and hypoxia are “life and death” matters to shellfish primary producers and the processing industry. Consequently, they carry commercial insurance against these perils. Insurance premiums in well kept aquaculture business amounts to 1-2 % of the biomass value. Assuming that half of the peril is taken out by the Danish Service Module, annual fees up to 50 k€ seems to be justified.

Competition and current services

Several advanced consultants run advance hydrographic/biological models. However, currently nobody has been able to model shallow water temperature with an accuracy below 0.5 °C. In this respect the Service Module is second to none.

Form of Revenues

Advanced ice and hypoxia information as an alert information service, is the primary interest of the shellfish aquaculture and processing business.

Contribution of the Revenue Streams

No information available.

Key partners

Key Partners and their activities

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

- **DMI** is developing the Service Module and generate multi-year hydrodynamic hindcast in Limfjord
- Aarhus University develops a hydrodynamic Limfjord hindcast model to generate long-term forcing for BGC model Flexsem and a biogeochemical model for Limfjord
-
- **TerraSigna** has been identified as a suitable candidate to exploit and maintain the FORCOAST central platform during and after the FORCOAST project. The FORCOAST Central Platform is the central access point to the FORCOAST information services.
- **FORCOAST partners** will provide several services during and after the project (Table 1).

Table 1. FORCOAST partner and their role in the exploitation of the Service Modules (D6.5 Initial Exploitation Strategy).

Role -------- Partner	Final User	Data Provision	Service Exploiting	Platform Exploiting	Advise/Support	Others (please specify)	Comments
Deltares					X	project base expertise	Deltares cannot be part of the exploitation after the project completion as a non-profit organisation.
EuroGOOS					X	Communication and link to the European Operational Oceanography Community	EuroGOOS as a non-profit organization cannot be part of the exploitation
Instituto Superior Tecnico		x	x	x	X		Exploitation probably through other Instituto Superior Tecnico linked institutions and spin-offs
Exporsado							
AZTI		x	x	x	X	Horizontal expertise and links towards different sectors of the blue economy and stakeholders managing marine and coastal resources.	AZTI is mainly a technological and research centre focused on transferring solutions and advising managers and service providers. But we can also provide ourselves services to administrations or companies.
Marine Instruments	x	x	x				MI will be both a final user and can exploit the service modules as well as providing data.
University of Sofia		x			X	Communications to Fisheries Sector	
TERRASIGNA		x	x	x	X		

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Marine Institute		x			X	Can act as the first point of contact for Irish users	Marine Institute being a state agency will not be involved in exploitation
Cuan Beo	x					Communication to Oyster Restoration Groups	
University of Liege		x			X		Restrictions applies on the possibility to get involved in non-research activity.
NIMRD					X	Communication to emerging aquaculture sector	NIMRD is a public research institute, 100% project-based financed, so we can't commit to provide data after the end of the project without any convention/financial support
Jailoo							Jailoo is a private entity specializing in research and operational services, hence continuation after the project end strongly depends on financial conditions
RBINS	x	x			X		
ILVO	x	x			X	Additional biological parameters on spat	
Brevisco							

Key Suppliers

No information available.

Key Activities

Required Key activities for the Value Proposition

Further development of the model

Ice and hypoxia forecast service have been identified by the stakeholders. However this has not been planned in the FORCOAST project. Although current Limfjord forecasting system can provide ice forecast, however there are no activities planned in FORCOAST to improve the product. A biogeochemical modelling system has been developed by AU and used to produce hindcast. However, no activities have been planned in FORCOAST to provide forecast, including hypoxia. These issues may be further improved after the project end.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Gathering biological data

Following biological data are needed according the user survey in Limfjord: venomous algae leading to shell closure and non feeding, *E. coli*, Marteilia and Bonamia, spatfall of blue mussels and oysters.

Gathering physico-chemical data

The physical and chemical data need include: hourly SST, T/S profiles, dissolved oxygen, secchi depth or light attenuation, H_2S and nutrients.

Gathering meteorological data

Winds and precipitation are needed. High resolutio NWP forecast data are needed.

Gathering earth observation data

Satellite Sea Surface Temperature, Chlorophyll a, Suspende Particular Matter and optical data are needed.

Key Resources

Key Resources

Key resources used for developing this Service Module includes:

- Forecast system development: a new high resolution Limfjord forecasting system with improved shallow water temperature forecast, using CMEMS forecast as boundary condition, has been developed by DMI (supported by FORCOAST)
- Forecast pre-operational production: DMI is running the model twice a day, and provides 5day forecast and provides data with sftp (supported by DMI and FORCOAST)
- Hindcast data production: a 11-year model dataset on hydrography conditions has been producted and validated (supported by FORCOAST)
- Platform development: Deltares is developing a information platform which can display the forecast products (supported by FORCOAST)
- Tailored product development: DMI has proposed a few products for the forecasting service, which may be improved in the future
- Maintanance of data production and dissemination flow: DMI and Deltares

Revenue Streams

The Service Module is primarily relevant to the shellfish primary producers and the processing industry. Secondarily authorities, consultants, academia, nature conservation organisations and philanthropic investors may be interested. An annual fee in the order of 50 k€ is estimated from the primary and processing sector,

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Customer relationships

Keeping contact with the target groups

Service Module A3 will answer following 3 end user scenarios:

- Aqua-farming related information (statistics) for a given potential site: the service scenario is that a user has a potential site already, but the user would like to know relevant physical-biogeochemical conditions at that position.
- An end user has two potential sites, he wants to compare the environmental conditions in the two sites to decide which one is better.
- Within an user-defined area, user would like to choose one or more sites suitable for aqua-farming.

Keeping the target groups interested

As long as the SM is run at a second to none level with respect to accuracy of forecasts there will be very little competitive pressure.

Channels

Channels to reach the Customer Segments

No information available.

Integration of channels

No information available.

Cost Structures

Most important costs

The cost for developing the forecast Service Module includes costs used in and after FORCOAST project. During the FOROCAST, costs have been used in forecasting model development, model calibration and validation, pre-operational forecast production and data provision, user consultation, service definition, tailored product development, information platform design, development, implementation, testing and maintainance.

After FORCOAST, the most important cost to provide a market-oriented service includes:

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

- Operational forecast data production: the cost covers maintainance of running the forecast system
- Operational data provision: maintanance cost to ensure an operational data provision
- R&D on forecast models: e.g. calibrating and improving ice forecast; establish hypoxia forecast
- Maintanance of platforms
- Maintance of the real-time service: customer service

Most expensive Key Resources

During the FORCOAST period, the most expensive Key Resources are used to support the model development, calibration and validation. To extend the Service Module for a large group of users, the most expensive Key Resources will still be forecasting system development.

Most expensive Key Activities

During the FORCOAST period, the most expensive Key Activities are the model development, calibration and validation. To extend the Service Module for a large group of users, the most expensive Key Activities will still be forecasting system development too meet the user requirements, as we have found that user needs on the forecast products can be quite different. A forecast model with high quality, flexible grids which can cover coastal waters in a large area (*e.g.* regional sea or pan-European seas) and with high resolution is needed for this service. In addition, collecting and use satellite and in-situ observations for pan-European Sea coastal waters is also an important activity.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

4.4.6. Service Module A4 – Spat Capture Assistance

Value Proposition

Service Module identification

This Service Module will estimates the period of blue mussel/flat oyster spat settlement and their distribution in a given area and will enable mussel/oyster farmer or flat oyster reef restoration operator:

- → to employ their bivalve spat collectors at the best period of the year, in order to enable the highest efficiency of the spat collectors
- → to employ their oyster spat collectors at the areas with the highest densities of oyster spat in a given period and area, in order to collect highest yield of spat

According to the requirements of the Customers of this the Service Module, it must generate output on two levels:

- Forecast of the time window with the highest probability of spat settlement at a specific location (farm or oyster reef)
- Forecast with distribution and density map within a specific area (Belgian part of the North, Galway Bay, Limfjorden, Black Sea, etc.)

Service Module purpose

The majority of marine bivalves reproduce by releasing large amounts of gametes into the water column where the fertilisation takes place. The fertilized egg cells and the consecutive larval stages float in the water column (pelagic phase) and are transferred to other areas by currents. The reproduction is mainly driven by temperature, while the development of the larvae are mainly driven by temperature and feed availability. The higher the temperature (within the optimal range) and/or the higher density in phytoplankton, the shorter the larval development period. The growth of the shell of the larva causes the larva to sink to the bottom and start its benthic phase. This is the period that the larva needs to find a suitable substrate. In some cases, like for the blue mussel (*Mytilus edulis*), the spat can still detach itself and uses its byssal threads as a parachute in the water current to attain a better place. In case of the flat oyster this is otherwise (see below).

This means that the shellfish farmer must have an idea when the spawning takes place (when the temperature threshold is reached) and how long the larval development will take (amount of temperature x hours/days) before the spat settlement will take place, in order to deploy the spat collectors (*e.g.* dropper lines, empty shells,).

Especially for spat of the European flat oyster (*Ostrea edulis*) the condition of the substrate is important, as spat of this species will not settle on substrate which have already substantial fouling. This means that when the spat collectors are put into the water too long in advance of the spat settlement, biofouling organisms will have the change to colonize the substrate, preventing the flat oyster spat to settle on the substrates. Subsequently, with low yields of spat on the collectors. If the spat collectors are deployed too late, than the farmer will miss the window of spat settlement, with

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

subsequently low yields of spat. As the settlement of flat oysters takes place after the first settlement peak and before the second peak of settlement for blue mussels. This provides only a small window to deploy the spat collectors for European flat oysters.

Furthermore, it is also interesting for the shellfish farmer to have an idea about the distribution of the bivalve larvae in the water column. Because it is possible that the farming site is situated in an area with low bivalve recruitment due to low connectivity with natural bivalve grounds (*e.g.* mussel beds or oyster reefs). It is therefore necessary that the Service Modules can provide a forecast of spat distribution and density, in order to pinpoint the ideal settlement locations for spat of the target species next to the culture sites. In this way, spat collectors can be deployed at these locations and subsequently transfer the juveniles to the farming site(s).

Cross-sectorial

As this model could also provide valuable information on time and quantity of recruitment of flat oyster spat, this model can also be used in Oyster Reef Restoration project and is therefore also already used in the H2020 project UNITED, in order to find areas where spat settlement could take place naturally (with oyster larvae coming from outside the Belgian part of the North Sea, as it is believed that there are no flat oyster reefs within that area). This model can also simulate the effects of self-recruitment ones a flat oyster reef is initiated or a oyster farm is in place. It was therefore decided with the FORCOAST consortium that the Service Module could also include the Irish Pilot.

Customers segments

Customers

Customers Segments

In general two customer segments could be identified. On the one side there are the oyster reef restoration operators and on the other side the bivalve farmers that rely on natural spat settlement. According to the live cycle of the target species, however, the latter can be split further into two groups: *i.e.* the mussel farmer (the blue mussel has two reproduction/settlement peaks in a year) and the flat oyster farmer (the European flat oyster has one short window of reproduction/settlement once a year).

Relations between the three Customer Segments can be linked to eachother. But in some cases, the relation between the three Customers Segments is none existing, as some suspended mussel farmers rely on the fishing of young mussels from natural settling grounds (*e.g.* some suspended mussel farmers in the Easter Scheldt sock mussel spat from the Wadden Sea), while oyster reef restoration operators rely on juveniles and adult flat oysters from farmers.

Belgium Pilot

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

This Service Module - Assistance for spat capture was originally designed for the Belgium Pilot. This Pilot is located at Westdiep and investigates the possibilities of integrated aquaculture (blue mussels, flat oysters and sugar kelp) and passive fisheries (project SYMAPA). During the former project Value@Sea (at the same location), it became clear that finding of juvenile flat oysters of good quality and disease free was very difficult. Therefore, the possibilities of capturing flat oyster spat is investigated in the ongoing project SYMAPA. Mussel culture also relies on the availability of mussel spat from nature. Therefore a model was constructed by RBINS to aid the SME (**Brevisco**) involved in bivalve farming in the project.

As the interest of mariculture in Belgium is increasing, several other SME's are following. For example, at the end of 2020 the SME **CODEVCO V** has received an user and environmental permit to establish an integrated mariculture farm (105 ha), first with blue mussel and later onwards with European flat oyster and sugar kelp (MD of 23 December 2020). **Geo XYZ** is a company specialized in hydrographic and topographic services, provides services to local authorities dredging industry, marine & offshore industry engineering companies and research centers, and is also interested in mariculture.

But also the Belgian industrial partners within the project UNITED are potential customers of this Service Module: **Parkwind** (offshore windfarm operator) and **Jan De Nul** (dredging, offshore energy market & environmental works) (Table 1).

Customers in Europe

The end users that could benefit from the Service Module – Assistance in spat capture includes all bivalve farmers that are depending on spat collection from the wild with spat collectors, and end users that are involved in oyster reef restoration and rely on natural recruitment.

For the blue mussel farmers, these are all the farmers that uses the suspended mussel culture with seed collected from the water column (excluding all farmers that uses mussel seed that is fished on natural mussel beds), almost all mussel farmers in Norway and Denmark, and a part of the mussel farmers in The Netherlands and France.

The number of customers could however substantially be increased, when the Service Module would be adapted for two more species: the Mediterranean mussel (*Mytilus galloprovincialis*) and the Pacific oyster. It is believed that this Service Module can be easily adapted for these species, as the cue parameters for reproduction and spat settlement are already well known.

For the flat oyster farmers, the number of customers is limited, as most of the flat oyster culture rely on spat that is produced in hatcheries. It is however believed, that the number of flat oyster farmers that will collect oyster spat will spat collectors will increase in the future with the introduction and expansion of oyster reefs through restoration (more availability of natural spat) and the stricter regulations on the transfer of oysters between locations within and from outside the European Union to prevent the spreading of invasive species and diseases.

For the oyster reef restoration operators, it is believed that with the increase of initiatives and the EU funding for oyster reef restoration projects, the number of customers will grow in the near future. Deliverable 6.1 Initial Market Analysis identified 19 Oyster Reef Restoration (ORR) groups in Europe and 3 large ORR groups outside of Europe. The industrial partners, knowledge institutes, as well as environmental organisations that are involved in oyster reef restoration are potential customers.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Table 1 lists the potential customers for the Service Module - Assistance for spat capture.

Table 1. List with potential customers of Service Module A4 – Assistance for spat collection and distribution per country.

	End user	Activity
Belgium		
	Brevisco	Bivalve farmer
	Codevco V	Bivalve farmer
	DEME Dredging International	Mussel bed enhancement for coastal protection
	FOD Environment	Government involved in MRP & concessions for maritime activities
	Geo XYZ	Maintenance of mussel farming & oyster reef restoration projects
	ILVO	Knowledge institute involved in project on bivalve farming & bivalve reef restoration
	Jan De Nul	Partner in Belgian Pilot of project United: culture and oyster reef restoration on scour material in offshore windfarms
	OD Nature	Knowledge institute
	Parkwind	Partner in Belgian Pilot of project United: culture and oyster reef restoration on scour material in offshore windfarms
	University of Ghent	Knowledge institute
	Aquacultuur Oostende – De Oesterput	Oyster farmer
Bulgary		
	Smart Farm AS, Bulgary	Mussel farming
Croatia		
	University of Dubrovnik (Mali Stone Bay)	Main research body working in Mali Stone Bay which is the largest native oyster aquaculture production area in the Mediterranean
	Plasma Saal	Holistic medicine & Partner in Native Oyster Reef Restoration Ireland (NORRI)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Denmark		
	Musholm farm	Longline mussel farm
France		
	CRC Bretagne Nord	Partner in FOREVER – Flat Oyster REcoVERy
	CRC Bretagne Nord	Partner in FOREVER – Flat Oyster REcoVERy
	ESITIC Caen	Knowledge institute & Partner in Marineff project & Partner in FOREVER – Flat Oyster REcoVERy
	IFREMER	Knowledge institute & Partner in
	Ports de Normandie	Maritime Industry & Partner in Marineff project
	TPC	Civil engineering & Partner in Marineff project
	University of Caen - Normandy	Knowledge institute & Partner in Marineff project
	VINCI Construction Maritime and Fluvial	Civil engineering & Partner in Marineff project
Germany		
	AWI	Knowledge institute & Partner in Proceed - Seed Oyster Production for Ecological Restoration & RESTORE I
	Federal Agency for Nature Conservation	Government & Partner in Proceed - Seed Oyster Production for Ecological Restoration
	Kieler Meeresfarm	Longline mussel farm
Ireland		
	Achill Oyster Group	Oyster Fishery Management
	Clarinbridge Oyster Co-op Society Ltd	Oyster Fishery Management
	Comharchumann Sliogeisc Chonamara Teo	
	Galway Bay Oyster Restoration Project (Cuan Beo)	Restoration of native oyster habitats
	Lough Swilly Wild Oyster Society Ltd	Oyster Fishery Management

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

	Loughs Agency	Oyster Reef Restoration in Lough Foyle
	Marine Health Foods Ltd	Producer of marine products & Partner in Native Oyster Reef Restoration Ireland (NORRI)
	Native Oyster Reef Restoration Ireland	Training and educating local community about biomimetic restoration
	NexLoop	Partner in Native Oyster Reef Restoration Ireland (NORRI)
	North Mayo Oyster Development Co-op Society Ltd	Oyster Fishery Management
	Tralee Oyster Co-op Society Ltd	Oyster Fishery Management
Spain		
	Spanish Institute of Oceanography	Knowledge institute & Partner in the Mar Menor Oyster Project
	Smart Farm AS, Spain	Mussel farming
Sweden		
	East Sweden Aquaculture Centre (ERAC)	Longline mussel farm
	Bohus Havsbruk	Longline mussel farm
The Netherlands		
	Barbé Yerseke	Suspended mussel farmer & partner of 100% Zeeuws
	Firma NL. en L. de Keijser	Suspended mussel farmer & partner of 100% Zeeuws
	Hoogerheide Delimossel	Suspended mussel farmer & partner of 100% Zeeuws
	Marinecultuur Oosterschelde BV	Suspended mussel farmer & partner of 100% Zeeuws
	Mosselhangcultuur Landa	Suspended mussel farmer & partner of 100% Zeeuws
	Neeltje Jans Mosselen	Suspended mussel farmer & partner of 100% Zeeuws

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

	Shell	Partner in Blauwwind and The Rich North Sea Oyster Pilot
	Van Oord	Partner in Blauwwind and The Rich North Sea Oyster Pilot
	Eneco	Partner in Blauwwind and The Rich North Sea Oyster Pilot
	Diamond Generating Europe	Partner in Blauwwind and The Rich North Sea Oyster Pilot
	Partners Group	Partner in Blauwwind and The Rich North Sea Oyster Pilot
	Ark Natuurontwikkeling	Partner in Borkum stones, Voordelta & Wadden Sea
	WWF Netherlands	Partner in Borkum stones, Voordelta & Wadden Sea
	Wageningen Marine Research	Partner in Borkum stones, Voordelta & Wadden Sea
	Bureau Waardenburg	Partner in Borkum stones, Voordelta & Wadden Sea
	Sas Consultancy	Partner in Borkum stones, Voordelta & Wadden Sea
Outside the European Union		
Canada		
	ATLANTIC AQUA FARMS LTD	Blue mussel farmer
	BADGER BAY MUSSEL FARMS LTD.	Blue mussel farmer
	FANNY BAY OYSTERS	Pacific oyster farmer
	MAISON BEAUSOLEIL	Oyster farmer
	MAC'S OYSTERS LTD.	Pacific oyster farmer
	K'AWAT'SI SHELLFISH COMPANY	Pacific oyster farmer
United Kingdom		
	Ardfern Yacht Centre	Recreational sailing & Partner in Seawilding Restore the Native Oysters in Loch Craignish
	Blue Marine Foundation	Nature protection & Partner in Essex Native Oyster Restoration Initiative (ENORI) & Solent

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

		Oyster Restoration Project & Wild Oyster Project
	Bournemouth University	Knowledge institute & Partner in Marineff project
	British Marine	British Marine is the trade association for the UK leisure, superyacht and small commercial marine industry & Partner in Wild Oyster Project
	CEFAS	Knowledge institute & Partner in Essex Native Oyster Restoration Initiative (ENORI)
	Colchester Oyster Fisheries	Oyster Fishery Management & Partner in Essex Native Oyster Restoration Initiative (ENORI)
	CROMACH	Local volunteer association & Partner in Seawilding - Restore the Native Oysters in Loch Craignish
	Environmental Agency	Government & Partner in Essex Native Oyster Restoration Initiative (ENORI)
	Glenmorangie Compagny	Partner in the Dornoch Environmental Enhancement Project (DEEP)
	Heart of Argyll Wildlife Organisation	Nature Protection & Partner in Seawilding - Restore the Native Oysters in Loch Craignish
	Heriot Watt University	Knowledge institute & Partner in The Dornoch Environmental Enhancement Project (DEEP)
	IFCA	Government & Partner in Essex Native Oyster Restoration Initiative (ENORI)
	Institute of Aquaculture	Knowledge institute & Partner in Seawilding - Restore the Native Oysters in Loch Craignish
	Marine Conservation Society	Partner in the Dornoch Environmental Enhancement Project (DEEP)
	Native Oyster Network –UK & Ireland	Nature protection & Partner in Essex Native Oyster Restoration Initiative (ENORI)
	Natural England	Nature protection & Partner in Essex Native Oyster Restoration Initiative (ENORI)
	Nature Conservacy	Nature protection & Partner in Essex Native Oyster Restoration Initiative (ENORI)
	River Roach Oyster Company	Oyster farmer & Partner in Essex Native Oyster Restoration Initiative (ENORI)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

	Scottish Association of Marine Sciences	Knowledge institute & Partner in Seawilding - Restore the Native Oysters in Loch Craignish
	Stirling University	Knowledge institute & Partner in Seawilding - Restore the Native Oysters in Loch Craignish
	Tollesbury & Mersea Native Oyster Compagny LTD	Oyster Fisheries & Partner in Essex Native Oyster Restoration Initiative (ENORI)
	University of Ediburg	Knowledge institute & Partner in Essex Native Oyster Restoration Initiative (ENORI)
	University of Essex	Knowledge institute & Partner in Essex Native Oyster Restoration Initiative (ENORI)
	University of Exeter	Knowledge institute & Partner in Marineff project
	University of Southampton	Knowledge institute & Partner in Marineff project
	Wildlife trust	Nature protection & Partner in Essex Native Oyster Restoration Initiative (ENORI)
	Zoological Society of London (ZLS)	Partner in Essex Native Oyster Restoration Initiative (ENORI) & Wild Oyster Project
Norway		
	Smart Farm AS, Norway	Mussel farming
United States of America		
	Refanala - High Vibrational Living Solutions	Health & Beauty & Partner in Native Oyster Reef Restoration Ireland (NORRI)
	Biomimicry New England	Biomimicry & Partner in Native Oyster Reef Restoration Ireland (NORRI)
	Chesapeake Bay Foundation	Restoring the native oyster, Crassostrea virginica in Chesapeake Bay, Maryland, Virginia
	Duke University	Oyster reef restoration in Australia
	Georgia Department Of Natural Resources	Oyster Reef Restoration projects in Plantation Creek, Florida Passage, Oatland Island, Skidaway River, Altamaha River, Jekyll Island Boat Ramp, Oyster Creek, Jointer Creek, Turtle

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

		and South Brunswick, Bellville Boat Ramp & Overlook Park
	Institute for Applied Ecology (IAE)	Oyster Reef Restoration Projects in the Gulf of Mexico
	NOAA Restoration Center	has funded more than 70 oyster restoration projects in 15 states
	Norwegian University of Science and Technology – NTNU-Trondheim	Mussel farming technologies
	The Nature Conservancy (TNC)	Pensacola East Bay Oyster Habitat Restoration Project & South Carolina Oyster Reef Restoration
Australia		
	Flinders University, SA	
	The Centre for Tropical Water and Aquatic Ecosystem Research - TropWATER	

Market

European market of bivalves

Europe is responsible for 5.5% of the world production of marine bivalves, but is the major contributor of mussels, supplying over a third of the total production, *e.g.* 550 000 tons of blue mussels (*Mytilus edulis*) and Mediterranean mussels (*M. galloprovincialis*). Three countries are responsible for two thirds of the total European mussel production, *i.e.* Spain (200 000 tons per year), France (80 000 tons) and Italy (65 000 tons). In fourth place is The Netherlands with 65 000 tons, which are mainly exported to Belgium.

Oyster farming is the second next important bivalve aquaculture activity in Europe. From the 1950s, there has been a steady decline in flat oyster production in Europe from 30 000 tons in 1961 to just under 2000 tons in 2016 (Figure 1). This decrease is due to the import of diseases, including *Bonamia*, which has caused a strong decimation of the natural resources. Therefore, to keep the production of oysters going in Europe, the Pacific oyster (*Magellana gigas*, formerly *Crassostrea gigas*)was introduced, which was resistant to the *Bonamia* parasite. However, due to climate change (warming of the North Sea), the species has started to massively reproduce and went into competition with the native European flat oyster.

From 2008, the European oyster culture suffered great losses due to the infection with the herpes virus OsHV1 (Pacific Oyster Mortality Syndrome - POMS), which causes high mortality in young Pacific oysters. As from 2012, a new infection emerged, *i.e. Vibrio aestuarianus*, which mainly affects the

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

adult Pacific oysters. These infections weakened the economic profitability of many European oyster farms until 2015. Although production has not yet fully recovered, high sales prices saved the industry from collapsing. Today oyster farming in the Netherlands continues to struggle due to the occurrence of the herpes virus and a new parasite of the oysters, namely the Japanese oyster borer, a small predatory snail that drills holes in the young oysters and eats the meat (http://www.zeevruchtengids.org/nl/oester).

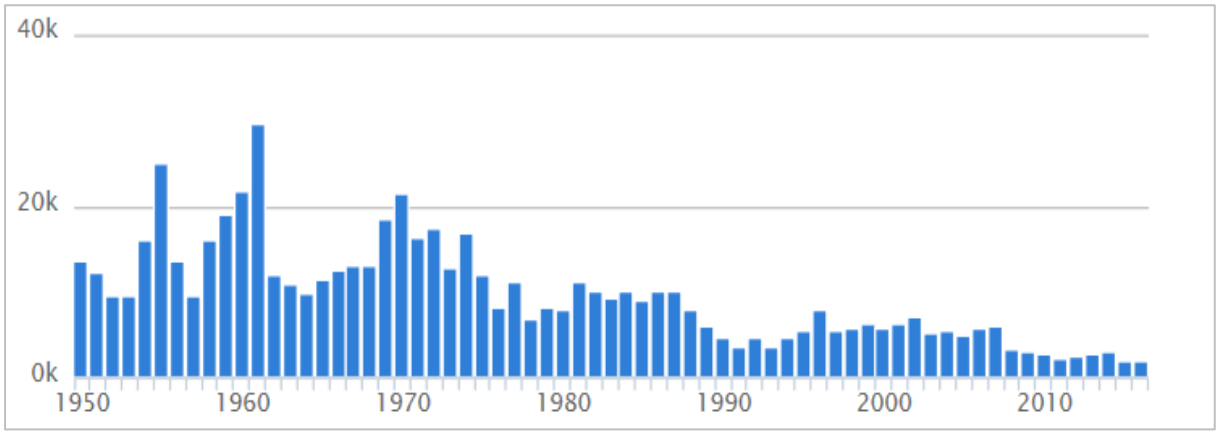


Figure 1. Evolution in production of the European flat oyster (*Ostrea edulis*) (www.fao.org/fishery/culturedspecies/Ostrea_edulis/en).

The top five countries for flat oyster production are France (40.5% - 1 612 tons), Ireland (15.7% - 627 tons), Croatia (14.2% - 566 tons), Spain (11.8% - 468 tons) and the Netherlands (8.8% - 350) (https://www.tridge.com/intelligences/oyster/production).

There is only one oyster farmer present in Belgium, which is located in Ostend and uses the water from the Spuikom for the cultivation of both hollow and flat oysters.

In 2016, 1940 tons of oysters were imported into Belgium, of which 60% came from Dutch and 40% from French oyster farms. 70% was imported live, including 162 tons of flat oyster and 1200 tons of Pacific oysters, a ratio of 1:7.4, but with a difference in price in favour of the flat oyster of 3-5x. The remainder was imported frozen, smoked and otherwise processed oysters. About half of the production of Dutch oyster farming (in the Oosterschelde and Grevelingenmeer in Zeeland) is destined for the Belgian market.

Furthermore, wild oyster populations became very rare due to overfishing of the natural oyster beds including the Hinderbanks of Belgium (Gercken and Schmidt, 2014; Houziaux et al., 2008), the introduction of beam trawling destroying the natural oyster beds, severe winter periods (i.e. 1962/1963). Nowadays, patches of wild European flat oysters are only found in estuaries around the North Sea, especially at locations that are protected from beam trawling, e.g. Limfjorden in Denmark, Lake Grevelingen and the Oosterschelde in the Netherlands, several inlets on the coast of the British Isles, Ireland and Norway. Some European flat oysters have been found recently in the BPNS (Kerckhof, 2018; Personnel observations in Westdiep).

There is therefore a strong need to restore native oyster populations, in order to increase the biodiversity and their function in coastal defence. These so-called eco-services are difficult to assess in value, but when looking into coastal defence, measures for coastal protection are increasingly

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

required as coastal zones are under duress of climate change (sea level rise, intensification of storms, increasing beach erosion, etc.) and under enhanced anthropogenic pressure (demographic evolution, loss of habitats, economic expansion, etc.). The combination threatens the ecosystem and significantly reduces the resilience of the coast. Current engineering approaches – both hard and soft measures – come short in efficiently and cost effectively protecting the coast. In Belgium alone the annual costs for coastal defence amounts to several millions of euros and that for only 67 km of coastline. In a study of Van der Biest et al. (2017) to quantify and estimate the value of ecosystem services of bivalve reefs in the Belgian Part of the North Sea (BPNS). The identified ecosystem services were identified as shrimp production, carbon retention, water quality regulation, coastal protection and recreational diving. The yearly added benefits (sum of five ecosystem services) of one hectare of a bivalve reef in comparison with one hectare of unstructured, sandy foreshore (typical for the Belgian coast) are estimated at 85.9 x 10^3 €, indicating an important potential added value in terms of ecosystem services.

EU market for Service Module

The Service Module gives an insight in the best period to employ the spat collectors and the distributions of the spat pinpointing the areas with the highest densities. This means that the Service Module can be used by bivalve farmers (for the moment only for blue mussel and European flat oyster, but it is believed that this Service Module can be easily adapted for the Mediterranean mussel, *Mytilus galloprovincialis* and the Pacific oyster) that are depending on spat collected from the wild with spat collectors, and end users that are involved in oyster reef restoration and rely on natural recruitment. Table 1 lists a few of the potential end users, but not all. It's expected that the number of potential end users exceeds the 150 within Europe.

Profitability per Customer Segment

It is clear that there is a significant difference in profitability between the Customer Segments involved in bivalve farming and the oyster reef restoration. Two Curstomer Segments (blue mussel farmer & flat oyster farmer) perform their activities to gain money, while Oyster Reef Restoration operators perform their activity to increase the biodiversity and other eco-services and incomes are mainly coming from fundings (NGO and governments) and in some cases could be generated by side activities (e.g. ecotourism, recreational diving and/or fishing, etc.).

Revenue Streams

Value of the Service Module

As there not yet a commercial bivalve farmer or oyster reef restoration established in the Belgian part of the North Sea, it is still an estimate for what value the end users would pay for this service.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Within the project Value@Sea a business plan was made for a 65 tons suspended flat oyster farm in the Belgian part of the North Sea. The annual cost for oyster seed to run this farm was 30 000 Euro. From the project SYMAPA it became clear that 86 tubes of 5m with a diameter of 20 cm filled with empty oyster shells are sufficient to capture the necessary spat of flat oyster at the Belgian Pilot site. As one longline can hold 98 spat collectors, it is enough to reserve one longline for spat capture. One longline (screw anchors, mooring lines, backbone and spat collectors) costs 14 000 Euro, with a depreciation period of 5 years and 5 700 Euro of (de-)commissioning costs. As the Service Module would enable the farmer to have an insight in what areas have the highest concentrations of larvae/spat at time of spat settlement and gives the best timeframe for commissioning the spat collectors. This service could therefore result in an annual saving of 30 000 Euro – 3 940 Euro (longline with spat collectors) = 26 060 Euro.

A value of 5 – 10% of this cost seems to be acceptable for the end users within the Belgian Pilot. This would set the value of the Service Module at **1 303 – 2 606 Euro/year**.

Depending on the requirements of the bivalve farmer, the service requested can be different. For example a mussel farmer has a concession on a specific location, and wants to capture spat at the farming site. For this Customer the Service Module should give him a forecast on the time window with the highest probability of spat settlement, in order to deploy his dropper lines timely. On the other hand, a flat oyster farmer has a plot very suitable for growing oysters, but with low recruitment rates. However he has a permit to collect oyster spat at 6 different locations in the Belgian part of the North Sea. This Customers wants to have a forecast where and when the oyster spat settlement will take place at the highest density, in order to deploy his spat collectors timely and at the best location for the highest efficiency. As the Service Module would resolve the high uncertainty in the last case, the Value of the Service Module would subsequently also be higher for this Customer.

In case of oyster reef restoration, the amount of flat oyster juveniles is even larger, with subsequently higher seeding costs. As Oyster Reef Restoration project are mostly funded by governments and wildlife foundation, natural capture of spat for oyster reef restoration would make the Value of the Service for this activity even more acceptable.

Competition and current services

A similar service is non-existent. Currently, hind- and a 5 days forecast information is freely available for any end user on sea surface elevation and due to astronomical tide, wind speed, mean waves period, peak wave period, significant wave height, surface & bottom current speed, sea surface & bottom temperature, and sea surface and bottom salinity for 42 locations in BPNS, 4 locations in the Dutch part NS, 5 locations in the German part NS 1 location in Danish part NS and 6 location in the UK part NS (https://odnature.naturalsciences.be/marine-forecasting-centre/en/graphs/sea_bottom_temperature/Ostend).

On the other hand, the LARVAE&CO model is not yet made available to the public and would be made available through the Service Module – Assistance for spat capture under the umbrella of FORCOAST.

Form of Revenues

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

In case of this Service Module several possible forms of revenues can be identified:

- As Service Revenue, which is generated by providing a service to the customers and are calculated based on time. For example, the number of hours of consulting services provided;
- As Project Revenue, which is generated through one-time projects with existing or new customers; and
- Recurring Revenue, which is generated from ongoing payments for continuing services or after-sale services to customers. The recurring revenue model is the model most commonly used by businesses, because it is predictable and it assures the company's source of revenue as ongoing. These include subscription fees and licensing content to third parties.

The end users from the Belgian Pilot prefer to pay a subscription fee for the use of the Service Module – Assistance for spat capture. The second choice was through a one-time payment, but with the insurance that the service would continue for several years and that updates would be included.

Contribution of the Revenue Streams

In case of the Belgian Pilot, it is for sure that in the very near future two bivalve farmers will initiate commercial activities. Depending on the incentives of the Belgian Government, it is also most likely that one ORR will start with the construction of an oyster reef. This would mean a contribution of 4500 – 9000 Euro per year for the maintenance of the service.

Key partners

Key Partners and their activities

- **RBINS** developed and maintains the larval transport model LARVAE&CO (Lacroix et al., 2013). This model was developed to assess flatfish larval dispersal, recruitment at nurseries and connectivity between spawning grounds and nurseries (Barbut et al., 2019) as well as the impact of climate change on sole recruitment and connectivity in the North Sea (Lacroix et al. 2018). This model has also been used, after some adaptations to other species such as blue mussels and flat oysters, to assess for instance the impact of artificial hard substrates on marine organism's dispersal (project UK-INSITE-UNDINE), or the possibility of oyster bed restoration (BE-Oyster restoration project). Model results of dispersal of mussels and oysters in the Belgian waters, obtained using a very simple parameterization, are available for the period 2000-2010.
- **EV-ILVO:** will keep on providing the necessary biological data to maintain the Service Module, but also provide and additional data to expand the Service Module.
- **TerraSigna** will exploit and maintain the FORCOAST central platform during and after the FORCOAST project, The FORCOAST central platform is the central access point to the FORCOAST information services.
- **FORCOAST partners** will provide several services during and after the project to (Table 2).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Table 2. FORCOAST partner and their role in the exploitation of the Service Modules (D3.5 Initial Market Strategy).

Role -------- Partner	Final User	Data Provision	Service Exploiting	Platform Exploiting	Advise/Support	Others (please specify)	Comments
Deltares					X	project base expertise	Deltares cannot be part of the exploitation after the project completion as a non-profit organisation.
EuroGOOS					X	Communication and link to the European Operational Oceanography Community	EuroGOOS as a non-profit organization cannot be part of the explotation
Instituto Superior Tecnico		x	x	x	X		Exploitation probably through other Instituto Superior Tecnico linked institutions and spin-offs
Exporsado							
AZTI		x	x	x	X	Horizontal expertise and links towards different sectors of the blue economy and stakeholders managing marine and costal resources.	AZTI is mainly a technological and research center focused on transfering solutions and advicing managers and service providers. But we can also provide ourselves services to administrations or companies.
Marine Instruments	x	x	x				MI will be both a final user and can exploit the service modules as well as providing data.
University of Sofia		x			X	Communications to Fisheries Sector	
TERRASIGNA		x	x	x	X		
Marine Institute		x			X	Can act as the first point of contact for Irish users	Marine Institute being a state agency will not be involved in exploitation
Cuan Beo	x					Communication to Oyster Restoration Groups	
University of Liege		x			X		Restrictions applies on the possibility to get involved in non-research activity.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

NIMRD					X	Communication to emerging aquaculture sector	NIMRD is a public research institute, 100% project-based financed, so we can't commit to provide data after the end of the project without any convention/financial support
Jailoo							Jailoo is a private entity specializing in research and operational services, hence continuation after the project end strongly depends on financial conditions
RBINS	x	x			X		
ILVO	x	x			X	Additional biological parameters on spat	
Brevisco							

Key Suppliers

- Copernicus services: Copernicus Marine Service, Copernicus Land Monitoring Service (CLMS), Copernicus Climate Service
- Regional data collectors
- Internet providers
- Other important key partners are organisations that can provide information on the distribution of natural oyster ground, e.g. oyster fisheries, knowledge institutes, environmental protection organisations, etc. (see Table 1). This is necessary information for the model in order to pinpoint the different sources of larvae/spat.

Key Activities

Required Key activities for the Value Proposition

Further development of the model

The model has not been validated yet due to lack of data (in 2020 a first attempt was undertaken to analyse the settlement window in situ, but no discrimination was made between spat of European flat oyster and Pacific oyster). It is the objective within the FORCOAST project to validate the model with data collected *in situ* (ongoing).The model will benefit from an improvement of the parameterization such as for instance the inclusion of vertical migration or prey availability. Moreover, this model will be coupled to the growth dynamics of organisms, in order to simulate several generations, and to the MIRO&CO model, which describes the biogeochemical and ecological dynamics in the English Channel and the southern North Sea, especially N, P, Si, chlorophyll a concentration and primary production.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

The more recent version of the 3D marine biogeochemical model MIRO&CO (Dulière et al., 2017) results from the coupling of the 3D hydrodynamic COHERENS v2 model (Luyten, 2011) with the biogeochemical MIRO model (Lancelot et al., 2005). MIRO is a biogeochemical model that has been designed for *Phaeocystis*-dominated ecosystems (Lancelot et al., 2005). The MIRO&CO model describes the biogeochemical and ecological dynamics in the English Channel and the southern North Sea. Model results of nutrients (N, P, Si), chlorophyll a concentration, primary production, etc. are available over the period 2000-2010 (grid resolution 5 km x 5 km). A model validation performed by Dulière et al., (2017) showed that the model is able to capture the geographical distribution of nutrients and in particular the strong coastal gradients (Figure 2), but it underestimates Chl a concentration in the Belgian waters (Dulière et al., 2017). To validate the seasonal dynamics of Chl a, phytoplankton species and nutrient concentrations, model results have been compared against in-situ observations at station 330 located in the center of the Belgian waters (51°26.00'N, 2°48.50'E). The nutrient seasonal dynamics is well reproduced by the model. Chl a is well estimated on average except during spring bloom, where the peak magnitude is underestimated in the model. From a comparison with remote sensing chlorophyll observations, it has been shown that the timing of the spring bloom is delayed in the model, in particular for the Belgian coastal and central stations (Dulière et al., 2017).

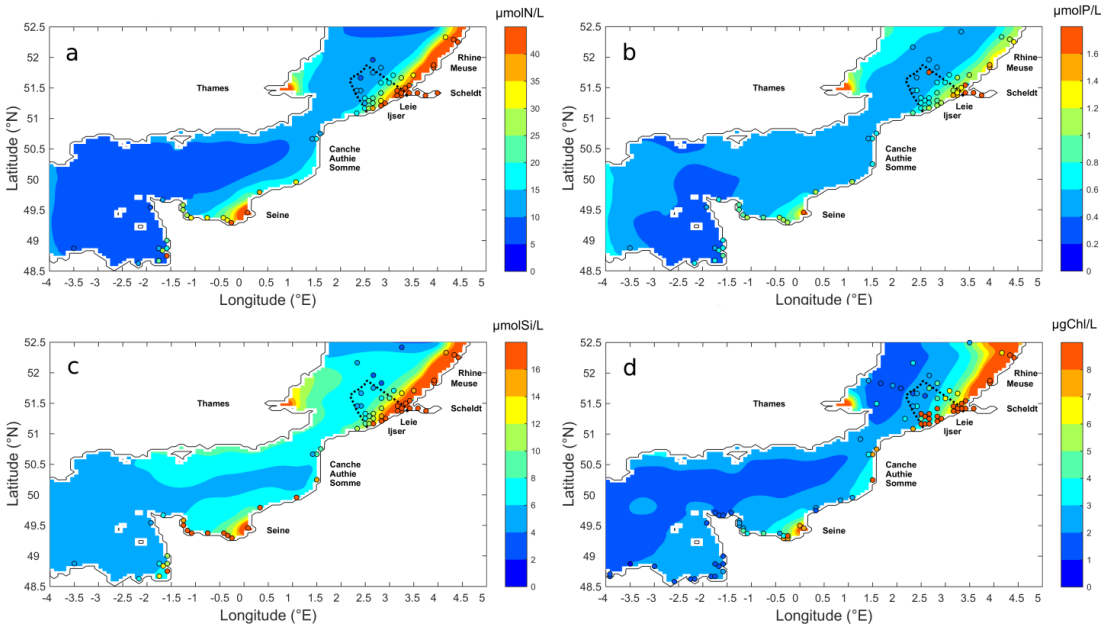


FIGURE 2. SPATIAL DISTRIBUTION OF DISSOLVED INORGANIC NITROGEN (DIN, A), DISSOLVED INORGANIC PHOSPHORUS (DIP, B), DISSOLVED SILICATE (DSI, C) AND CHLOROPHYLL A CONCENTRATIONS (D). VALUES ARE AVERAGED FROM MIRO&CO RESULTS OVER THE PERIOD 2000-2010 (DEC-FEB FOR NUTRIENTS, MAR-OCT FOR CHLOROPHYLL A). THE DOTTED LINE DELINEATES THE BELGIAN EEZ. SUPERIMPOSED DOTS REPRESENT IN SITU DATA (DULIÈRE ET AL., 2017).

Gathering biological data

The aim of the Service Module – Assistance for spat capture is to determine the period where spat of specific species is likely to arrive in the collecting location(s). That implies to have information on potential sources where the spat comes from, on cue(s) conditioning the release of larvae as well as

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

an estimation of the time lag between the larvae release and the arrival of spat at location. This information is given by local expertise:

- Cues for conditioning spawning events: Each species has a specific reproduction period, which can depend on the location. This information can be provided by knowledge institutes and from literature.
- Duration of release events: Knowledge about the spawning event duration is needed to determine the potential date of arrival. Usually this period is species specific and fixed. This information can be provided by knowledge institutes and from literature.
- Dispersal duration: The drift duration is also species specific. In addition, this value can also be dependent of environmental conditions and must be locally assessed. An interval of drift duration (Pelagic Larval Duration minimum - PLDmin and Pelagic Larval Duration maximum - PLDmax corresponding to the shorter and longer pelagic duration estimate respectively), could be provided by experts taking into account uncertainties, this interval could be reduced by local expertise and data obtained in the farm. This interval would represent uncertainties in the estimation of PLD coming from 3 main sources: uncertainties of the growth rate, uncertainties due to different environmental conditions met by larvae of the same cohort (as for example temperature or food availability which could affect the growth rate) and interannual variability. The time period of spat settlement for blue mussel and flat oyster is investigated by EV ILVO within the FORCOAST project.
- Source location(s): Service Module – Assistance for spat collection and distribution needs to consider potential source location(s) where the population of the considered species is present (either natural or farmed population) and can provide larvae to the collecting location(s). This information could come from different sources as for example, local expertise and/or from a drift model. In the case of the Belgian Pilot, this information will be provided by a larval transport model.

Key Resources

Key Resources

Key Resources for the development and maintenance of Service Module – Assistance for spat capture exist of:

- Input data from physical parameters, including current, wave direction and surface & bottom temperature. The parameters are measured in situ on several locations in the Belgian part of the North Sea. These data are collected by RBINS and is an ongoing mandated assignment.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

- Input data from biological parameters, including:
  - Chlorophyll a, SPM, turbidity are measured by RBINS and VLIZ (annual sampling campaigns)
  - Chlorophyll a can be supplied by the remote sensing data
  - Life cycle of target organisms are provided by ILVO, University of Ghent (this is mainly gathered on project base)
- Input data on the distribution of the target species: this is provided by ILVO and VLIZ by ongoing sampling campaigns, and from knowledge institutes from The Netherlands, France and the UK.
- The Service Module forecast is based on a hydrodynamic model (temperature, wave) and biogeochemical model (chlorophyll) developed by RBINS. The setup of the Service Module is estimated around 10-15 working days, providing that all the required input data is available. Otherwise, an additional time will be needed to gather all requested input (species/site dependent). The maintenance of this operational service, provided by RBINS, is estimated at 5 working days per year (at a cost of 627€/day according to the RBINS tariff applicable for services provided to for-profit organizations in Belgium and abroad in 2020). This will guarantee that the service will continuously be provided on time and, in case of issue (ex. No meteorological forecast delivered, HPC failure), that the users will be notified. Regarding the Belgian part of North Sea, this service will be maintained on the long-term beyond the FORCOAST project as other products provided by the Belgian Marine Forecasting center (https://odnature.naturalsciences.be/marine-forecasting-centre/). For other areas, a hydrodynamic model is needed, e.g. Marine Institute for Galway Bay (Ireland), Aarhus University for Limfjorden (Denmark). Chlorophyll a can be supplied by the remote sensing data.

Revenue Streams

As mentioned in Revenue Sreams, in case of the Belgian Pilot, it is for sure that in the very near future two bivalve farmers will initiate commercial activities. Depending on the incentives of the Belgian Government, it is also most likely that one ORR will start with the construction of an oyster reef. This would mean a contribution of 4500 – 9000 Euro per year for the maintenance of the service.

Customer relationships

Keeping contact with the target groups

It is suggested that the Service Module will be made available to end users via mobile or desktop apps and on the ODNature website free of charge in a first time to demonstrate its utility. The availability of such a free demo service would definitely foster the development of offshore mariculture in the area and would be a beneficial incentive for other potential investors, which on the long term might

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

be interesting for FORCOAST business plan as a demonstration of the service relevance, and as an incentive for further subscriptions. Further communication channels will be investigated in WP7.

Keeping the target groups interested

The Service Module will function as an app. The FORCOAST central platform can provide a link to the newsletter, which provides data on updates (new target species, new areas) and success stories of end users that use the Service Module – Assistance for spat capture. Further communication channels will be investigated in WP7.

Channels

Channels to reach the Customer Segments

The first idea for the Service Module – Assistance for spat capture is that the service will be made available to end users via an app that is can be consulted by smart phone desktop. Further communication channels will be investigated in WP7.

Integration of channels

The links to the FORCOAST central platform and thus to the Service Module – Assistance for spat capture will also be placed on the different websites, such as that from the Marien Living Lab webpage of ILVO, on the webpage for forecasts of ODNature, a webpage of VLIZ and the webpage of the Flemish Aquaculture Platform in order to increase the visibility of this Service Module. The same can be carried on webpages of other European knowledge institutes and sector groups, and beyond. Further communication channels and their integration will be investigated in WP7.

Cost Structures

Most important costs

The most import debit entry in our business plan is the incormporation of new areas, the coupling of hydrodynamic models of these areas and the incorporation of other bivalve species.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Another important cost is the maintenance of the Service Module, but as the FORCOAST central platform contains several Service Modules, this cost can be divided over the total cost of maintenance of the FORCOAST central platform.

Most expensive Key Resources

When the Service Module – Assistance for spat capture would be extended to other area, e.g. Galway Bay, Limfjorden, Black Sea, additional work will be needed to collate the different hydrodynamical models into the Service Module. For this extra Key Resources will be needed.

Most expensive Key Activities

As mentioned above, it is in our opinion that the further development of the Service Module with other areas than the Belgian of the North Sea, will be the most expensive Key Activity.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

4.4.7. Service Module R1 – Contaminant Source Retrieval

Value Proposition

Service Module identification

The Service Module - Retrieve sources of contaminants will show the trajectory particles move through the water, how long they remain in a particular area and where they are most likely to have originated from. This is a valuable service module for all coastal users who good water quality is a concern for, however it is particularly useful for coastal users who are located close to flood drainage plains, waste water treatment, storm water overflows, urban areas, areas of large scale agricultural production and other potential sources of harmful substance pollution.

The Service Module - Retrieve sources of contaminants will allow the end user to show how the above mentioned polluting activities effects their coastal activity and can allow them to take actions to;

- → Mitigate against these challenges,
- → Show policy makers how a polluting activity is effecting their coastal activity,
- → If possible eek compensation for losses.

Service Module purpose

The Service Module – Retrieve sources of contaminants will allow an end user to cast a hind-cast of the trajectory harmful particles traveled in the water to show where they likely originated from and determine whether or not they remained in a particular area for a significant period of time to cause damage to seafood production, marine life or human health.

- This service module is particularly useful to Oyster Reef Restoration groups for a number of reasons, these include;
- Understanding why a particular site is not performing well for oyster reef restoration.
- Showing regulators how a marine polluting activity can directly impact oyster health.
- Influence coastal planning decision by highlighting how a planned development could potentially lead to increased pollution of coastal waters.
- Showing the areas of the coast where the lowest level of contamination takes place and thus allowing Oyster Reef Restoration groups to select the best site for reef restoration.

Cross-sectorial

Wild Fisheries: The service module could potentially explain why a particular area of wild fishery is in decline owing to pollution from land based activities.

Aquaculture Production:-

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

- Understanding why a particular site is not performing well for seafood production.
- Showing regulators how a marine polluting activity can directly impact bivalve health.
- Influence coastal planning decision by highlighting how a planned development could potentially lead to increased pollution of coastal waters.
- Showing the areas off the coast where the lowest level of contamination takes place and thus allowing aquaculture producers to select the best site for reef restoration.

Customers segments

Customers

Customers Segments

Users vary from scientific institutions, state institutions, community groups, marine restoration groups and aquaculture producer groups. All these groups have a need for good water quality and a need to understand potential contamination pressures on coastal waters.

Irish Pilot

Sectorial Final Users

- Irish Native Oyster Fisheries Forum (INOFF)
- Native Oyster Network
- Tralee Oyster Co-op
- Lough Swilly Co-op
- Clew Bay Co-op
- Achill Co-op
- Cuan Beo Galway Oysters
- Kilkieran Co-op
- Clarin Bridge Co-op
- Native Oyster Restoration Alliance (NORA)
- Irish Oysters Packer Group
- IFA Aquaculutre
- Bord Iascaigh na Mhara
- Tralee Oyster Society
- BIM Clare
- BIM (Galway)
- Marine Spatial Planning Unit (Dept of Housing)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Maritime Safety Users

- Royal National Lifeboat Institution
- Irish Coast Guard
- Oranmore Maree Coastal Search Unit

Water Pollution Concerned Users

- Sea Fisheries Protection Authority
- Health Service Executive - Bathing Waters
- Marine Institute

Offshore Energy

- Marine Renewables Industry Association
- Department of Communications, Climate Action and Environment

Tourism and Recreation

- Galway Bay Sailing Club
- Galway Hookers Association
- Galway Bay Boat Tours
- Swim Buddies

Coastal Protection Users

- Galway County Council
- Clare County Council
- Inland Fisheries Ireland
- Marine Institute
- Office of Public Works
- National Parks and Wildlife Service
- Irish Whale and Dolphine Group
- Department of Planning Housing and Local Government

Port and Shipping

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

- Port of Galway

Sustainable Marine Living Resources

- Inshore Fisheries Forum
- HABS Marine Institute

Weather and Climate

- Met Eireann

Basic and Applied Ocenography

- National University of Ireland Galway
- Galway Mayo Institute of Technology

Customers in Europe

The end users that could benefit from the Service Module – Retrieve sources of contaminants includes all bivalve farmers, and end users that are involved in oyster reef restoration and rely on natural recruitment.

Table 1 lists the potential customers for the Service Module – Retrieve sources of contaminants.

Table 1. List with potential customers of Service Module R1 – Retrieve sources of contaminants per country.

	End user	**Activity**
Ireland (9 ORR groups)		
Galway Bay Oyster Restoration Project (Cuan Beo)	Galway Bay, Co. Galway, Ireland	Project aims to restore native oyster habitats through strategic cultch deployment to promote larval settlement, to identify distribution of critical habitat for native oyster including modelling of temperature and salinity, develop spatial management of fisheries that will include closed areas for oyster reef development, to gain a more indepth knowledge of native oyster habitat restoration through practical research, to monitor prevalence of Bonamia

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

		and to improve coastal water quality in Galway Bay.
Clarinbridge Oyster Co-op Society Ltd	Clarin Bridge, Co. Galway	Oyster Fishery Management
Clarinbridge Oyster Co-op Society Ltd	Clarin Bridge, Co. Galway	Oyster Fishery Management
Loughs Agency	Lough Foyle, Co. Derry	Oyster Reef Restoration in Lough Foyle.
Tralee Oyster Co-op Society Ltd	Fenit, Co. Kerry	Oyster Fishery Management
North Mayo Oyster Development Co-op Society Ltd	Belmullet, Co. Mayo	Oyster Fishery Management
Achill Oyster Group	Achill Island, Co. Mayo	Oyster Fishery Management
Lough Swilly Wild Oyster Society Ltd	Buncrana, Co. Donegal	Oyster Fishery Management
Comharchumann Sliogeisc Chonamara Teo	Kilkieran, Co. Galway	Oyster Fishery Management
Native Oyster Reef Restoration Ireland	Arklow, Co. Wicklow	Training and educating local community about biomimetic restoration.
Belgium (1 ORR group)		
Belgian pilot of UNITED	Belgium	Belgian United is combining the culture of flat oyster and sugar kelp, and compares the characteristics of sugar kelp grown nearshore and offshore.
Croatia (1 ORR group)		
University of Dubrovnik (Mali Stone Bay)	Mali Stone Bay, Croatia	The University of Dubrovnik is the main research body working in Mali Ston Bay which is the largest native oyster aquaculture

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

		production area in the Mediterranean.
Denmark		
France (1 ORR group)		
Flat Oyster Recruitment and Growth (FOREVER)	-Brest, France -Quiberon, France	The project consists in 3 complementary actions. The first action aims to inventory the main populations of wild flat oyster in Brittany and to describe their health and genetic characteristics. The second action focuses on the ecology and the dynamics of the two remarkable beds still remaining in the bays of Brest and Quiberon. The last action promotes restoration and management measures for these beds in partnership with local actors (fisheries and shellfish farming bodies, regional authorities, environmental management organizations such as Natura 2000).
Germany (2 ORR groups)		
Seed Oyster Production for Ecological Restoration (PROCEED)	Helgoland, Germany	PROCEED is engaged in implementing an oyster hatchery on the German offshore island Helgoland to establish a healthy broodstock and a sufficient seed oyster production for ecological restoration.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Ecological Restoration of the Native Oyster Species Ostrea edulis (Restore)	Borkum Reefground, Germany	Restore involves the construction of a pilot oyster reef in the Natura 2000 site Borkum Reefground.
Spain (1 ORP group)		
Knowledge and Tools for a Future Oyster Restoration Action (Mar Menor)	Mar Menor, Spain	The project aims to gain a knowledge about the feeding physiology of the oyster and its nutrient capability throughout a phytoplankton bloom and to develop the necessary tools for a future oyster restoration action.
Sweden		
The Bilvalve Project	Sweden	Identification of existing pressures on Swedish oyster populations, knowledge development for best management structures, initiate stock enhancement strategies.
The Netherlands (2 ORP groups)		
Blauwind and the Rich North Sea Oyster Pilot	Nederland	The Rich North Sea and Blauwwind have joined forces to expand this plan to gain more understanding of the influences of habitat conditions on biodiversity and how we to stimulate flat oyster reef development.
Voordelta, Wadden Sea, Brokum Stones Restoration Projects	- Voordelta - Wadden Sea - Brokum	3-D printing of reef structures and other hard substrate material and starting a Bonamia free ostrea edulis population.
Outside the European Union		
United Kingdom (7 ORR groups)		

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Essex Native Oyster Restoration Initiative (ENORI)	Blackwater, Essex, England	ENORI is a collaboration between the oystermen, scientists, conservationists and the UK governement to restore native oysters in Essex UK.
Marine Infrastructure Effects Initiative (Marineff)	English Channel, England	The MARINEFF project was selected under the European cross-border cooperation Programme INTERREG VA France (Channel) – England co-funded by the ERDF and involves 9 French and British partners. The project aims to demonstrate new biomimetic marine structures to improve the ecological status of inshore waters, as well as to involve professionals and stakeholders in the project.
Solent Oyster Restoration Project	Solent, England	The Solent Oyster Restoration Project, spearheaded by the Blue Marine Foundation (BLUE), is restoring native oyster populations on a large scale on England's south coast.
Wild Oyster Project (Self-sustaining populations of Native Oysters for the UK Seas)	- Conwy Bay, Wales - Firth of Clyde, Scotland - Tyne&Wear, England	The Wild Oyster Project is a new three-year restoration project that launched in June 2020, developed as part of a new collaboration between the Zoological Society of London (ZSL), Blue Marine Foundation (BLUE) and British Marine. The aim of the project is for the UK seas have self-sustaining populations of native oysters which provide clean water, healthy fisheries, plentiful biodiversity and on land there is a re-ignited national love of this iconic species.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

The Dornoch Environmental Enhancement Project (DEEP)	Dornoch Firth, Scotland	Oyster reef restoration in Dornoch Firth.
Ecological Restoration, Rewilding, Preservation (Kilchoan Estate)	Kilchan Estate, Scotland	Kilchoan Estate has been working with Seawildng to create a native oyster restoration project at the head of Loch Melfort.
Restore the Native Oysters in Loch Craignish (Seawilding)	Loch Craignish, Scotland	Oyster reef restoration in Loch Craignish.
United States of America		
Billion Oyster Project	New York, America	Restoring oyster reefs in new york harbor through public education initiatives
Cheasapeake Bay Foundation Cooks Point Sanctuary Reef, Maryland	Cooks Point Sanctuary Reef, Maryland, America	Restoring oyster reefs in Chesapeake Bay
Australia		
Australian Shellfish Reef Restoration Network	-Australia -New Zealand	The Australian Shellfish Reef Restoration Network is a community of practice that brings together organisations and individuals interested in shellfish reef education, conservation, restoration and management

Market

The market for understanding how land based actives can contaminant marine habitats is huge and wide ranging across a number of potential users including; (a) regulators, (b) seafood producers, (c) coastal recreational users, (d) marine habitat restoration groups, (e) research groups and (f) marine safety groups.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Profitability per Customer Segment

Water Management - High

Maritime Safety - High

Tourism and Recreation - Moderate

Scientific Institution - High

State Institution - High

Marine Habitat Restoration - Moderate

Fishing - Low

Aquaculture - Low

Revenue Streams

Value of the Service Module

Not possible to estimate exactly as service module is designed to increase knowledge of marine habitat as opposed to improving revenue streams. One possible estimation could be based on site selection for oyster reef restoration ground which involves deploying suitable substrate for oyster settlement. The deployment of this substrate can cost up to 6,000 euro for 200 tonnes. So possible if we knew the best location for substrate deployment which would not suffer contamination this would result in better value for cultch deployment.

Competition and current services

Remote Sensors. See Initial Market Analysis for detailed description of current competition.

Form of Revenues

Once of payment for service with possible additional payments for improvements or technical support. This is the preferred method used by remote sensor service providers.

Contribution of the Revenue Streams

In case of the Belgian Pilot, it is for sure that in the very near future two bivalve farmers will initiate commercial activities. Depending on the incentives of the Belgian Government, it is also most likely

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

that one ORR will start with the construction of an oyster reef. This would mean a contribution of 4500 – 9000 Euro per year for the maintenance of the service.

Key partners

Key Partners and their activities

- The **Marine Institute** will develop the code for Service Module R1 – Retrieve Sources of Contaminants, and will ensure the transferability to other Pilot sites within the FORCOAST project where there exists an interest in the service provided. This code will be made available to **Deltares**, which will develop the central FORCOAST platform.
- **Cuan Beo** identified as the most important customer, representing the oysterground restoration sector, will provide feedback on the features that must be present in the Service Module and on the most convenient way of user interaction with the application.
- **FORCOAST partners**.
- **TerraSigna** will exploit and maintain the FORCOAST central platform during and after the FORCOAST project, The FORCOAST central platform is the central access point to the FORCOAST information services.
- Some **FORCOAST partners** will develop the hydrodynamic models needed to predict dispersion of contaminants at each Pilot site, while others will provide several services during and after the project to (Table 2).

Table 2. FORCOAST partner and their role in the exploitation of the Service Modules (D3.5 Initial Market Strategy).

Role -------- Partner	Final User	Data Provision	Service Exploiting	Platform Exploiting	Advise/Support	Others (please specify)	Comments
Deltares					X	project base expertise	Deltares cannot be part of the exploitation after the project completion as a non-profit organisation.
EuroGOOS					X	Communication and link to the European Operational Oceanography Community	EuroGOOS as a non-profit organization cannot be part of the explotation
Instituto Superior Tecnico		x	x	X	X		Exploitation probably through other Instituto Superior Tecnico linked institutions and spin-offs
Exporsado							

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

AZTI		x	x	X	X	Horizontal expertise and links towards different sectors of the blue economy and stakeholders managing marine and costal resources.	AZTI is mainly a technological and research center focused on transfering solutions and advicing managers and service providers. But we can also provide ourselves services to administrations or companies.
Marine Instruments	x	x	x				MI will be both a final user and can exploit the service modules as well as providing data.
University of Sofia		x			X	Communications to Fisheries Sector	
TERRASIGNA		x	x	X	X		
Marine Institute		x			X	Can act as the first point of contact for Irish users	Marine Institute being a state agency will not be involved in exploitation
Cuan Beo	x					Communication to Oyster Restoration Groups	
University of Liege		x			X		Restrictions applies on the possibility to get involved in non-research activity.
NIMRD					X	Communication to emerging aquaculture sector	NIMRD is a public research institute, 100% project-based financed, so we can't commit to provide data after the end of the project without any convention/financial support
Jailoo							Jailoo is a private entity specializing in research and operational services, hence continuation after the project end strongly depends on financial conditions
RBINS	x	x			X		
ILVO	x	x			X	Additional biological parameters on spat	
Brevisco							

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Key Suppliers

The Key Suppliers are

- Copernicus services: Copernicus Marine Service, Copernicus Climate Service
- The Norwegian Meteorological Institute, through the development of the OpenDrift particle-tracking model (Dagestad et al., 2018) used for tracking contaminants in the seawater.

Key Activities

Required Key activities for the Value Proposition

Further development of the model

Any model providing 3-D currents would be suitable for this Service Module and would not need any further development.

Gathering physico-chemical data

Any physico-chemical data (e.g. river freshwater flux) needed to force the operational models needs to be collected.

Gathering meteorological data

Any meteorological data needed to force the operational models needs to be collected.

Key Resources

Key Resources

Implementation of Service Module R1 – Retrieve Sources of Contaminants requires the following resources:

- Hydrodynamic currents from operational models.
  Computer resources to run the operational models and keep the service working.
  Human resources for maintenance of the service.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Revenue Streams

Revenue streams could be through an annual subscription with an initial free of charge period to attract potential users.

Customer relationships

Keeping contact with the target groups

Contact with the developers of this Service Module will be through email, so the contact information details should be properly displayed in the website.

Keeping the target groups interested

Proper communication of the capabilities of the service will enhance interest among stakeholders.

Channels

Channels to reach the Customer Segments

Communication with customers will be mostly through the user interface and emails.

Integration of channels

As suggested for other Service Modules, a Q&A section in the website will help to identify the problems the users may encounter when using the service.

Cost Structures

Most important costs

Most important costs are related to the computational effort of running the operational models producing the 3-D current fields for tracking contaminants.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Most expensive Key Resources

Similarly, most expensive key resources will be the computational ones.

Most expensive Key Activities

Once the models are fully operational, no particularly expensive key activities are foreseen.

References

Dagestad, K.-F., Röhrs, J., Breivik, Ø., and Ådlandsvik, B.: OpenDrift v1.0: a generic framework for trajectory modelling, Geosci. Model Dev., 11, 1405–1420, https://doi.org/10.5194/gmd-11-1405-2018, 2018.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

5. Further Steps

The following next steps are foreseen, in relation to “D6.4 – Final Business Plan”:

- Next iteration with the users via Service and Pilot Workshops and subsequent engagement. These interactions will provide us with feedback to ingest in the business plan.
- Ingest user feedback to define the list of CAPEX costs.
- The plan will be updated in D6.4 to be interlinked with the Final Market Analysis and feeding to the Final Exploitation Strategy.
- Refine the OPEX costs estimations based on the experience post service implementation in agreement with the parties involved in the FORCOAST exploitation.
- In collaboration with WP2 and as part of the WP6 activities, keep on with the activities to refine the revenue estimates, based on service value to the user and predisposition to pay. Also, this has a strong relation with the Market Analysis and the Exploitation Strategy.

6. Conclusion

This document serves as a midterm revisit of the proposed aspects in the DOA leading to the implementation of a business plan that can lead to the sustainability of the FORCOAST product after the funding period. Following the continuous ongoing process , the final version of the business plan will be reported at the end of the project in deliverable D6.4 – Final Business Plan.

This project has received funding from the European Union´s Horizon 2020 research and innovation programme under grant agreement No 870465.

Annex 1 – Cost estimation

Cost estimation template

Data collection and analysis:

1. Is your compagny/research center collecting, analyzing and/or processing data for a Service Module? If not, go to Tab 2

General

For which Service Modules is your compagny/research center collecting & analizing data:

1.	F1-Fisheries suitability index		Mark with capit
2.	F2-Front detection		Mark with capit
3.	A1-Operation scheduler		Mark with capit
4.	A2-Land pollution		Mark with capit
5.	A3-Prospection for new sites		Mark with capit
6.	A4-Assistance for spat collection		Mark with capit
7.	R1-Retrieve sources of pollution		Mark with capit

2. Costs in maintaining the Service Module(s)

IMPORTANT! These are the costs associated with those to keep the Service Module running established within FORCOAS

Personnel costs

Number of person months/year to collect the necessary data and cost/month

Administrative personnel			Euro/month	Euro/year
Scientific personnel			Euro/month	Euro/year
Technical personnel			Euro/month	Euro/year
Other (Specify)				
			Euro/month	Euro/year
			Euro/month	Euro/year
			Euro/month	Euro/year

Consumables

Specify consumables for collecting & analyzing data (e.g. software, maintenance of structures and sensors, monitoring,

	Euro/year
	Euro/year
	Euro/year

Equipment

Specify depreciation equipment (e.g. sensors, buoys, computer, monitoring, etc.)

	Euro/year
	Euro/year
	Euro/year

Subcontracting

Specify (e.g. use of boats, fishing gear, data resources, etc.)

	Number of units/year			
			Euro/unit	Euro/year
			Euro/unit	Euro/year
			Euro/unit	Euro/year

TOTAL 0 Euro/year

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

3. Costs for expanding the Service Module(s) (including new funcionalities)

IMPORTANT! These are the one of costs associated with those to expand the Service Module(s) (e.g. sample collection fo

Personnel costs

Number of person months/year to collect the necessary data and cost/month

Administrative personnel		MM		Euro/month		Euro
Scientific personnel		MM		Euro/month		Euro
Technical personnel		MM		Euro/month		Euro
Other (Specify)						
		MM		Euro/month		Euro
		MM		Euro/month		Euro
		MM		Euro/month		Euro

Consumables

Specify consumables for collecting & analyzing data (e.g. software, monitoring, etc.)

		Euro
		Euro
		Euro

Equipment

Specify new equipment (e.g. sensors, buoys, computer, monitoring, etc.)

		Euro
		Euro
		Euro

Subcontracting

Specify (e.g. use of boats, fishing gear, data resources, etc.)

	Number of units/year			
			Euro/unit	Euro
			Euro/unit	Euro
			Euro/unit	Euro

Total **0 Euro**

4. Costs in maintaining the expanded service (including new funcionalities)

IMPORTANT! These are the costs associated with those to keep the Service Module(s) running (including 2. Cost for mai

Personnel costs

Number of person months/year to collect the necessary data and cost/month

Administrative personnel		Euro/month	Euro/year
Scientific personnel		Euro/month	Euro/year
Technical personnel		Euro/month	Euro/year
Other (Specify)			
		Euro/month	Euro/year
		Euro/month	Euro/year
		Euro/month	Euro/year

Consumables

Specify consumables for collecting & analyzing data (e.g. software, maintenance of structures and sensors, monitoring,

		Euro/year
		Euro/year
		Euro/year

Equipment

Specify depreciation equipment (e.g. sensors, buoys, computer, monitoring, etc.)

		Euro/year
		Euro/year
		Euro/year

Subcontracting

Specify (e.g. use of boats, fishing gear, data resources, etc.)

	Number of units/year			
			Euro/unit	Euro/year
			Euro/unit	Euro/year
			Euro/unit	Euro/year

Total **0 Euro/year**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Modelling:

1. Is your compagny/research center involved in the making of models for a Service Module? If not, go to Tab3.

General

For which Service Modules is your compagny/research center collecting & analizing data:

1.	F1-Fisheries suitability index		Mark with capital X
2.	F2-Front detection		Mark with capital X
3.	A1-Operation scheduler		Mark with capital X
4.	A2-Land pollution		Mark with capital X
5.	A3-Prospection for new sites		Mark with capital X
6.	A4-Assistance for spat collection		Mark with capital X
7.	R1-Retrieve sources of pollution		Mark with capital X

2. Costs in maintaining the existing service

IMPORTANT! These are the costs associated with those to keep the Service Module running established within FORCOAST and

Personnel costs

Number of person months/year to maintain the model (including model validation) and cost/month

Administrative personnel		Euro/month	Euro/year
Scientific personnel		Euro/month	Euro/year
Technical personnel		Euro/month	Euro/year
Other (Specify)			
		Euro/month	Euro/year
		Euro/month	Euro/year
		Euro/month	Euro/year

Consumables

Specify the consumables needed to maintain and/or extend the model (including model validation, big data storage, etc.)

	Euro/year
	Euro/year
	Euro/year

Equipment

Specify new equipment to maintain and/or extend the model (including model validation, big data storage, etc.)

	Euro/year
	Euro/year
	Euro/year

Specify depreciation equipment to maintain and/or extend the model (including model validation, big data storage, etc.)

	Euro/year
	Euro/year
	Euro/year

Subcontracting

Specify subctractors to maintain and/or extend the model (including model validation, big data storage, etc.), e.g. use of sup

	Number of units/year		
		Euro/unit	Euro/year
		Euro/unit	Euro/year
		Euro/unit	Euro/year

TOTAL **0 Euro/year**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

3. Costs for expanding the service (including new funcionalities)

IMPORTANT! These are the one of costs associated with those to expand the Service Module and do not include costs that ar

Personnel costs

Number of person months/year to maintain and or extend the model (including model validation) and cost/month

Administrative personnel		MM		Euro/month		Euro
Scientific personnel		MM		Euro/month		Euro
Technical personnel		MM		Euro/month		Euro
Other (Specify)						
		MM		Euro/month		Euro
		MM		Euro/month		Euro
		MM		Euro/month		Euro

Consumables

Specify the consumables needed to expand the model (including model validation, etc.)

		Euro
		Euro
		Euro

Equipment

Specify new equipment to expand the model (including model validation, etc.)

		Euro
		Euro
		Euro

Subcontracting

Specify subctractors to maintain and/or extend the model (including model validation, big data storage, etc.), e.g. use of sup

	Number of units			
				Euro
				Euro
				Euro

TOTAL **0 Euro/year**

4. Costs in expanding the service (including new funcionalities)

IMPORTANT! These are the costs associated with those to keep the Service Module(s) running (including 2. Cost for maintain

Personnel costs

Number of person months/year to maintain and or extend the model (including model validation) and cost/month

Administrative personnel		MM		Euro/month		Euro/year
Scientific personnel		MM		Euro/month		Euro/year
Technical personnel		MM		Euro/month		Euro/year
Other (Specify)						
		MM		Euro/month		Euro/year
		MM		Euro/month		Euro/year
		MM		Euro/month		Euro/year

Consumables

Specify the consumables needed to maintain and/or extend the model (including model validation, big data storage, etc.)

		Euro/year
		Euro/year
		Euro/year

Equipment

Specify depreciation equipment to maintain and/or extend the model (including model validation, big data storage, etc.)

		Euro/year
		Euro/year
		Euro/year

Subcontracting

Specify subctractors to maintain and/or extend the model (including model validation, big data storage, etc.), e.g. use of sup

	Number of units/year			
				Euro/year
				Euro/year
				Euro/year

TOTAL **0 Euro/year**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Service Module Exploitation:

1. Is your compagny/research center interested in the exploitation of the data platform for one or more Service Modules after t

General

Which Service Modules would your compagny/research center like to exploit:

1.	F1-Fisheries suitability index		Mark with capital X
2.	F2-Front detection		Mark with capital X
3.	A1-Operation scheduler		Mark with capital X
4.	A2-Land pollution		Mark with capital X
5.	A3-Prospection for new sites		Mark with capital X
6.	A4-Assistance for spat collection		Mark with capital X
7.	R1-Retrieve sources of pollution		Mark with capital X

2. Costs in maintaining the services and data platform

IMPORTANT! These are the costs associated with those to keep the Service Module and infrastructure running established wi

Personnel costs

Number of person months/year to expoit the data platform for Service Module(s) and cost/month

Administrative personnel			Euro/month	Euro/year
Scientific personnel			Euro/month	Euro/year
Technical personnel			Euro/month	Euro/year
Other (Specify)				
			Euro/month	Euro/year
			Euro/month	Euro/year
			Euro/month	Euro/year

Consumables

Specify consumables for maintenance the data platform (e.g. infrastructure, software, big data storage, etc.)

	Euro/year
	Euro/year
	Euro/year

Equipment

Specify depreciation equipment for maintenance and upgrading data platform (e.g. infrastructure, software, big data storage

	Euro/year
	Euro/year
	Euro/year

Subcontracting

Specify (e.g. use of provider services, for maintenance of the data platform, etc.)

	Number of units/year			
			Euro/unit	Euro/year
			Euro/unit	Euro/year
			Euro/unit	Euro/year

Publicity and communication with the end user

Specify costs for publicity & communication with the en user

	Euro/year
	Euro/year
	Euro/year

Total **0 Euro/year**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

3. Costs for expanding the service (including new funcionalities)

IMPORTANT! These are the one of costs associated with those to expand the services and dataplatform, and do not include c

Personnel costs

Number of person months/year to expoit the data platform for Service Module(s) and cost/month

Administrative personnel		MM		Euro/month		Euro
Scientific personnel		MM		Euro/month		Euro
Technical personnel		MM		Euro/month		Euro
Other (Specify)						
		MM		Euro/month		Euro
		MM		Euro/month		Euro
		MM		Euro/month		Euro

Consumables

Specify consumables for upgrading the data platform (e.g. software, big data storage, etc.)

		Euro
		Euro
		Euro

Equipment

Specify new equipment for expanding the data platform (e.g. infrastructure, software, big data storage, etc.)

		Euro
		Euro
		Euro

Subcontracting

Specify subcontracting costs for upgrading data platform (e.g. software, big data storage, etc.)

	Number of units/year			
			Euro/unit	Euro
			Euro/unit	Euro
			Euro/unit	Euro

Publicity and communication with the end user

Specify costs for publicity & communication with the en user

		Euro
		Euro
		Euro

Total 0 Euro/year

4. Costs in maintaining the expanded Service Modules (including new funcionalities)

Personnel costs

IMPORTANT! These are the costs associated with those to keep the Service Module(s) and infrastructure running (including 2

Number of person months/year to expoit the data platform for Service Module(s) and cost/month

Administrative personnel		Euro/month		Euro/year
Scientific personnel		Euro/month		Euro/year
Technical personnel		Euro/month		Euro/year
Other (Specify)				
		Euro/month		Euro/year
		Euro/month		Euro/year
		Euro/month		Euro/year

Consumables

Specify consumables for maintenance the upgraded data platform (e.g. infrastructure, software, big data storage, etc.)

		Euro/year
		Euro/year
		Euro/year

Equipment

Specify the equipment for maintenance of the upgraded data platform (e.g. software, big data storage, etc.)

		Euro/year
		Euro/year
		Euro/year

Specify depreciation equipment for maintenance and upgrading data platform (e.g. software, big data storage, etc.)

		Euro/year
		Euro/year
		Euro/year

Subcontracting

Specify (e.g. use of provider services, for maintenance and upgrading data platform (e.g. software, big data storage, etc.)

	Number of units/year			
			Euro/unit	Euro/year
			Euro/unit	Euro/year
			Euro/unit	Euro/year

Publicity and communication with the end user

Specify costs for publicity & communication with the en user

		Euro/year
		Euro/year
		Euro/year

Total 0 Euro/year

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

Advice and support:

1. Is your compagny/research center involved in giving advise or support to one or serveral Service Modules and/or Data platfor

General

For which Service Modules is your compagny/research center collecting & analizing data:

1.	F1-Fisheries suitability index		Mark with capital X
2.	F2-Front detection		Mark with capital X
3.	A1-Operation scheduler		Mark with capital X
4.	A2-Land pollution		Mark with capital X
5.	A3-Prospection for new sites		Mark with capital X
6.	A4-Assistance for spat collection		Mark with capital X
7.	R1-Retrieve sources of pollution		Mark with capital X

2. Costs for maintaining the service

IMPORTANT! These are the costs associated with those to keep the services and infrastructure running established within FOR

Personnel costs

Number of person months/year to maintain the services and data platform, and cost/month

Administrative personnel			Euro/month	Euro/year
Scientific personnel			Euro/month	Euro/year
Technical personnel			Euro/month	Euro/year

Other (specify, including overheads)

			Euro/year
			Euro/year
			Euro/year

Consumables

Specify the consumables needed to maintain the services

	Euro/year
	Euro/year
	Euro/year

Equipment

Specify depreciation equipment to maintain the services

	Euro/year
	Euro/year
	Euro/year

Subcontracting

Specify subctractors to maintain and/or extend the model (including model validation), e.g. use of super computers, etc.

	Number of units/year			
			Euro/unit	Euro/year
			Euro/unit	Euro/year
			Euro/unit	Euro/year

Total **0 Euro/year**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.

3. Costs in expanding the service (including new funcionalities)

IMPORTANT! These are the one of costs associated with those to expand the services and dataplatform, and do not include cc

Personnel costs

Number of person months/year to maintain and or extend the model (including model validation) and cost/month

Administrative personnel		MM		Euro/month		Euro
Scientific personnel		MM		Euro/month		Euro
Technical personnel		MM		Euro/month		Euro
Other (Specify)						
						Euro
						Euro
						Euro

Consumables

Specify the consumables needed to maintain the services and infrastructure

		Euro
		Euro
		Euro

Equipment

Specify new equipment to expand services and infrastructure

		Euro
		Euro
		Euro

Subcontracting

Specify subctractor costs to expand the service and infrastructure, e.g. use of super computers, etc.

	Number of units/year			
			Euro/unit	Euro
			Euro/unit	Euro
			Euro/unit	Euro

Total 0 Euro/year

4. Costs in maintaining of the expanded services and infrastruction

IMPORTANT! These are the costs associated with those to keep the Service Module(s) and infrastructure running (including 2.

Personnel costs

Number of person months/year to maintain the expanded services and infrastructure, and cost/month

Administrative personnel			Euro/month	Euro/year
Scientific personnel			Euro/month	Euro/year
Technical personnel			Euro/month	Euro/year
Other (Specify)				
				Euro/year
				Euro/year
				Euro/year

Consumables

Specify the consumables needed to maintain the expanded services and infrastructure

	Euro/year
	Euro/year
	Euro/year

Equipment

Specify depreciation equipment to maintainthe expanded services and infrastructure

	Euro/year
	Euro/year
	Euro/year

Subcontracting

Specify subctractors to maintain the expanded services and infrastructure, e.g. use of super computers, etc.

	Number of units/year			
			Euro/unit	Euro/year
			Euro/unit	Euro/year
			Euro/unit	Euro/year

Total 0 Euro/year

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870465.