FORCOAST

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

PROJECT DELIVERABLE REPORT

Deliverable Number: 2.1

Deliverable Title: Stakeholders Interests and Needs by Sector and Pilot Site

Author(s): Anna Rubio, Luis Rodríguez, Vicente Fernandez, Arthur Capet, Nuno Ferreira, Ainhoa Caballero, Alec Reid, Ghada El Serafy

Work Package Number: 2

Work Package Title: User Engagement and Requirements

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Contributor(s)	Francisco Campuzano, Joana Staneva, Elisaveta Peneva, Genevieve Lacroix, Tomasz Dabrowski, Jun She, Marie Maar, Federico Falcini, Cosimo Solidoro
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Coordinator	Ghada El Serafy	Deltares	28/05/2020	GES
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Executive Summary

The general objectives of WP2 are to identify stakeholders needs, requirements and concerns in terms of specific information on any aspect of the marine environmental status to support decision-making in the framework of business activities in three target economic sectors: wild fisheries, bivalve mariculture and oysterground restoration. The main objective of this first deliverable of WP2 is to provide an early analysis of identified stakeholders, their interests and needs and to promote synergies between the main users within and across the different pilot areas and sectors.

In a first step, we identified internal and external (to the consortium) users in the three target FORCOAST sectors: wild fisheries, bivalve mariculture and oysterground restoration. In a second step, exchange of information among users has enabled a better understanding of their needs in terms of specific information requirements.

The sector of bivalve mariculture is the most widely represented by a significant number of intermediate and final users within several pilots inside FORCOAST. To find commonalities between the requirements gathered for the different users and regions was challenging and special efforts will be needed to ensure to converge towards services/products useful for different areas and activities. In the case of wild fisheries and osyterground restoration, the convergence towards defining common requirements was more straightforward since they are only present in 3 of the eight pilots. Special care should be taken in both cases to ensure contacts with the identified final user in the pilots and outside to ensure the uptake of the services and products and their applicability to areas with similar activities.

The main information requirements for the wild fisheries sectors were mostly to be produced an used in the short-term time scale (a few days), while oysterground restoration activities require information mostly at mid-term (weeks or months) and long-term time scales (seasons and climatologies). The requirements for the bivalve mariculture span the three time-scale categories. The details of the information needed in terms of variables, and spatiotemporal resolution and needs of specific technical solutions or considerations have also been gathered, as well as the specific requirements for some the different pilots (to feed into WP3, 4 and 5 plans).

This analysis will be updated, if needed, during the project lifetime to ensure the connection between the project developments and users' needs and eventually documented in the next deliverables of WP2 (D2.2 and D2.3).

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1 Introduction

A better understanding of the coastal environment and an integrated monitoring and forecasting of the coastal environment by the use of data from different sources (including Earth Observation from satellites) is key to minimize the potential impacts of human activities on the coastal area. This activity can also be crucial in the development of added-value operational products that will clearly represent a new market uptake and facilitate the deployment of those sectors in Europe.

The *FORCOAST* project aims to foster market development exploiting the added value of integration of Copernicus Products (remote, local data and model forecasts) and other data sources (local, regional or global) with Information and Communication Technologies - ICT (enhancing new frontiers opened by web and cloud computing) across different market segments through the delivery of tailored co-designed products and services encouraging their uptake by three specific economic sectors: fisheries, oysterground restoration efforts, and bivalve mariculture.

To guarantee the uptake of the products and services FORCOAST must ensure they are co-designed, from the beginning of the project, by the collaboration between academic and research organisations working together with SMEs which are partners in the consortium and also with a wide range of stakeholders (i.e. parties with a stake or interest on the project results), including users, scientists, decision makers, investors, etc.) and also with shareholders (parties investing money in the development of products). For this reason, FORCOAST is organized in eight pilot service uptake sites, which cover the three FORCOAST target sectors and five different regional waters (North Sea, Baltic Sea, Mediterranean Sea, Black Sea and the coastal Atlantic Ocean, see Figure 1 and Table 1). Through these pilots, FORCOAST will ensure an effective co-design of tailored products to meet user needs, which must be developed and demonstrated in hand with partner-clients and identified stakeholders in these areas.

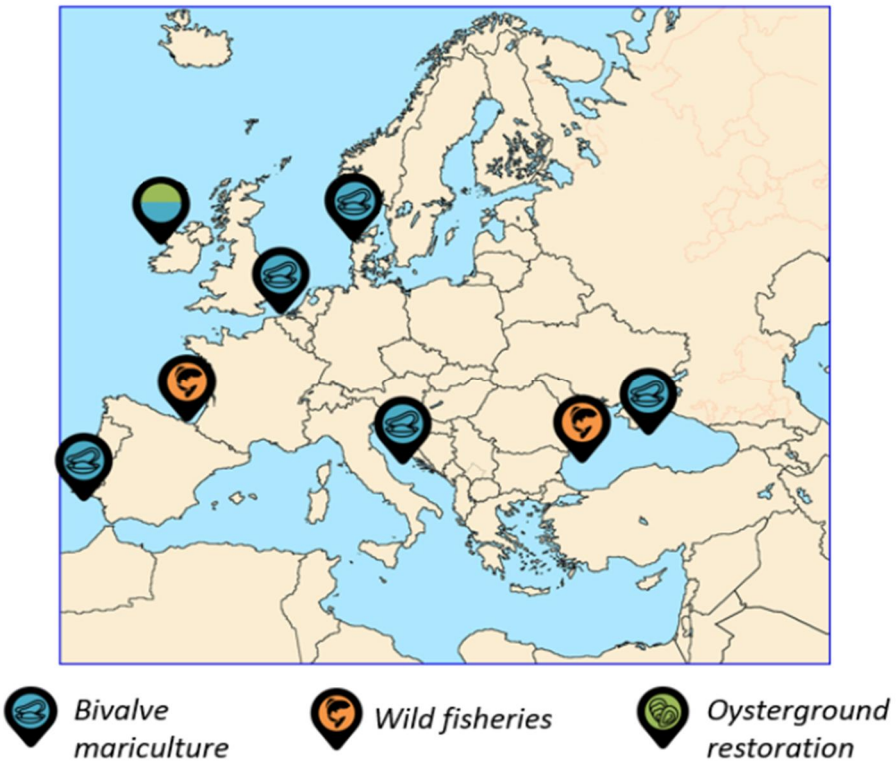

Figure 1: Map of FORCOAST pilot areas and their respective activity sectors

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Pilot	Wild Fisheries	Aquaculture		Oysterground Restoration
		Mussels	Oysters	
1. Sado Estuary - Portugal			X	
2. Bay of Biscay - Spain	X			
3. Black Sea - Bulgaria	X			
4. Southern North Sea - Belgium	Planned	X	X	Planned
5. Galway Bay - Ireland			X	X
6. Limfjorden - Denmark			X	
7. Black Sea - Romania		X		
8. Northern Adriatic Sea - Italy		X		

Table 1: Table showing FORCOAST pilots and their respective activity sectors

The engagement of different users in each of the pilot areas and for the three FORCOAST activity sectors, the identification of user needs, requirements and concerns in terms of specific information that is needed on any aspect of the state of the marine environment, to support decision-making in the framework of their business activity are the main objectives of FORCOAST WP2.

The first progress in WP2 is provided in this deliverable and the result of the foreseen actions in T2.1 and the following milestones:

- (MS3) Establishment of the Stakeholder Advisory Board (SAB)
- (MS18) Pilot sites workshops with stakeholders, where most of the information on user requirements and needs used in this document was gathered.

Thus, the needed information for the completion of this deliverable was gathered through two main mechanisms:

- The organization of Pilot Kick off (PKOs - MS18) meetings with the main aim of: (i) assign tasks to the partners and establish a 6-month working plan, (ii) Identify additional partners or collaborators and (iii) Identify end-users for WP2 and (iv) analyse the state of the art of the modelling activities for WP3. The participation of stakeholders or their representatives to the PKOs was encouraged. Details on the PKOs meetings organization can be found in Annex I. Their specific technical outcomes are summarized in the subsection devoted to the Specific regional requirements for each Pilot (subsections 3.x.4.x).

- The conception and distribution of a questionnaire to undertake a user analysis for each pilot and identify users needs. The “Feed-in User_requirements_template” was sent to the partners before the PKOs, and completed during and after the meetings. The template can be found in Annex II.

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A joint analysis of the information has been performed to promote synergies between the main actors and users within and across the different pilots and sectors and also to identify other economic sectors that could also benefit from the project outcomes. For this analysis, we are considering both stakeholders and shareholders jointly for the user's identification and requirement analysis. Three levels of users are considered in this report:

- Internal users: final and/or intermediate users inside the FORCOAST consortium (i.e. FORCOAST partners)
- External users: users interested in the three FORCOAST target sectors (wild fisheries, bivalve mariculture, and oysterground restoration) and in each pilot site but which are not partners in the consortium
- Other final users whit activities in other marine sectors that could also benefit from the project outcomes

We differentiate between intermediate users, those organizations who use the data to produce tailored services/products and end users as the ones who are the final users of the products/services for their specific activities.

The information on users and stakeholders collected in the different pilot workshops allowed to perform an analysis of the cross-pilot sectorial integration presented in this report. Moreover, the specific requirements of each pilot are also documented.

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2 Cross-pilot sectorial stakeholder analysis

To guarantee the uptake of *FORCOAST* products, the project aims to co-develop its services and products via an end-user centred approach involving, from inception, the various user communities across the three target sectors (wild fisheries, bivalve mariculture, oysterground restoration). Some actors from these communities are already partners in the FORCOAST consortium, but also key external users, which are not partners in the consortium, have been identified in order to establish a tight collaboration for the improvement of the services.

In this section, we aim, first, to identify and categorise the internal and external users (both final and intermediate) for each target sector, so they can be involved in the analysis of the requirements and existing gaps for the three economic sectors considered (see Section 3). This is considered as a first step in the co-design and implementation of services and products to be undertaken in WPs 3, 4 and 5.

FORCOAST products and services will provide water quality and environmental parameters (i.e. meteorology, waves, currents, chlorophyll, marine pollution, etc.), which can be relevant for other maritime activities and be potentially interesting for a wider range of communities, an analysis of the stakeholders and shareholders of other sectors is also provided (Section 2.2). This analysis will be a basis for the WP6 (Innovation Management, Exploitation and Business Planning) and WP7 (Marketing and Communication). Based on this list of identified stakeholders, *FORCOAST* will adapt its communication strategy to communicate project results and achievements and demonstrate its capability of serving other users in the three FORCOAST target sectors and also its potential interest in a wider range of maritime activities.

2.1. External and internal users in the FORCOAST target sectors

Figure 2 provides a general overview of the number of users by sector represented in the consortium and those identified by the pilots during the workshops. Both final and intermediate users were identified for the three sectors. Note that the Mariculture sector is the one with the highest number of users identified (13 within the Consortium, being three of them final users).

In the case of oysterground restoration and bivalve mariculture sectors, both intermediate and final users are already included as partners in the consortium. This is not the case of the Wild fisheries sector, where final users are all external to the consortium. Special care will be needed to maintain continuous communication with the users through all the product and services co-design process to ensure their engagement and the uptake of the outcomes.

Additional details on the users by sector are provided in the following subsections.

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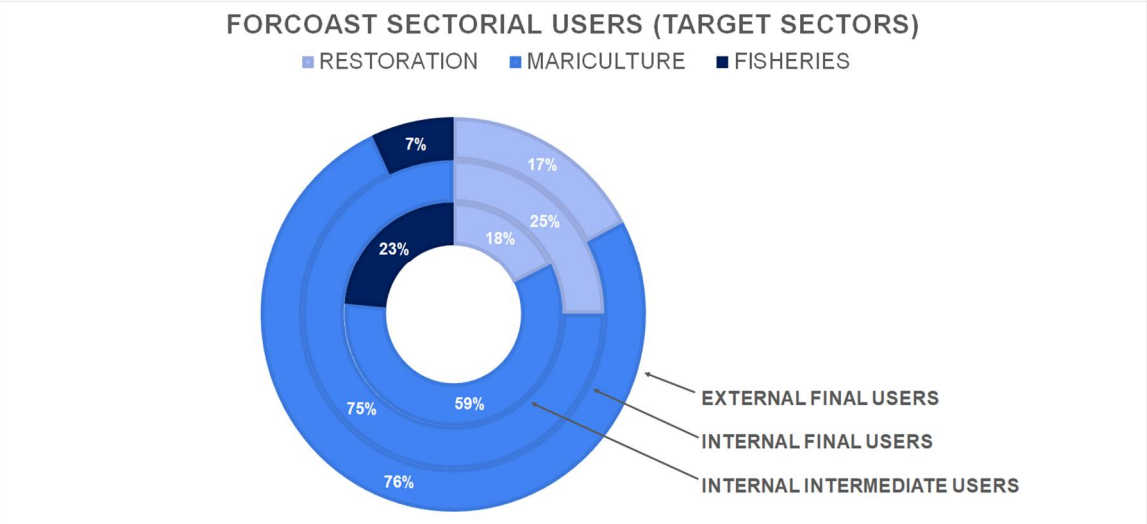

Figure 2: Percentage of identified users by sectors represented by the partners inside the Consortium (intermediate in the inner circe, final in the middle circle) and by the external users (outer circle).

2.1.1. Wild fisheries

The sector of wild fisheries is present in Pilots 2 and 3. In these two pilots four intermediate users are active, two of them are research/technological centres working in applied research and two of them SMEs experts in the development of products and services for the wild fishery sectors (and aquaculture in the case of TERRASIGNA). The final users for this case are all external: the Purse Seine fleet in the Bay of Biscay, which has already collaborated with AZTI in the framework of different regional/national projects, and the Bulgarian Fisheries companies.

P	Location	INTERNAL USERS		EXTERNAL USERS
		Intermediate	Final	
2	Bay of Biscay	AZTI (Research) Marine Instruments (SME)	-	Purse Seine fleet
3	Black Sea	Terrasigna (SME) USOF (Research)	-	Bulgarian Fisheries companies

Table 2: Detail on users inside the consortium (intermediate or final) and external users for the Wild Fisheries sector

2.1.2. Bivalve mariculture

The sector of bivalve mariculture is represented in Pilots 1, 4, 6, 7, 8 and 5. In these pilots, 11 intermediate users are active, being a combination of research/technological centres working in applied research and SMEs experts in the development of products and services for the aquaculture and mariculture sectors. Three final users are also part of the consortium: two oyster farmers and one specialist on nearshore aquaculture of blue mussels (BREVISCO). Then, among the external users, an extensive list of aquaculture, mariculture of oysters and mussels SMEs and NGOs have

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been identified (*Table 3: Detail on users inside the consortium (intermediate or final) and sectorial final users for the Bivalve mariculture sector*Table 3).

P	Location	INTERNAL USERS		EXTERNAL USERS
		Intermediate	Final	
1	Atlantic	IST (Research)	ExporSado (SME, Oyster farmer)	APA (Portuguese Association of Aquaculture, https://www.facebook.com/Associação-Portuguesa-de-Aquacultores-673407849366733/)
4	Southern North Sea	ILVO , RBINS (Research)	Brevisco (SME, Nearshore aquaculture and fishing)	Colruyt group (https://www.colruytgroup.com) UGENT (https://www.ugent.be/en) Jan de Nul Group - Offshore Renewables (www.jandenul.com) DEME (www.deme-group.com) + Dutch, UK and North of France equivalent At sea nova
6	Limfjorden	DMI, AU (Research)	Oyster boat (SME, Oyster production)	Jeka Group, Havnen (https://jeka-group.com/contact/) Vilsund Blue (Blue mussel fishing) https://vilsund.com/en/
7	Black Sea	ULiege, NIMRD (Research) Jailoo (SME)	-	SC MARICULTURA SRL
8	Adriatic Sea	CNR, OGS (Research)	-	AMA - Associazione Mediterranea Acquacoltori (www.a-m-a.it)
5	Galway Bay	Marine Institute (Research)	Cuan Beo (SME, Restoration)	Irish Native Oyster Fisheries Forum (INOFF) (No Website - organization coordinated by Bord Iascaigh na Mhara) Irish Packer's Group (No Website - organization coordinated by Bord Iascaigh na Mhara) Irish Farmers Association Aquaculture https://www.ifa.ie/sectors/aquaculture/ Marine Spatial Planning Unit (Dept of Housing) https://www.housing.gov.ie/planning/maritime-spatial-planning/maritime-spatial-planning-directive/maritime-spatial-planning Bord Iascaigh na Mhara http://www.bim.ie/about-us/contact-us/galway/ Sea Fisheries Protection Authority https://www.sfpa.ie/ Inland Fisheries Ireland https://www.fisheriesireland.ie/ National University of Ireland Galway

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				http://www.nuigalway.ie/ Galway Mayo Institute of Technology https://www.gmit.ie/

Table 3: Detail on users inside the consortium (intermediate or final) and sectorial final users for the Bivalve mariculture sector

2.1.3. Oystergrounds restoration

The sector of oystergrounds restoration is only represented in Pilot 5, where one intermediate and one final user are working closely with other external organizations for the restoration of Galway Bay natural habitats and oyster fisheries (Table 4).

P	Location	INTERNAL USERS		EXTERNAL USERS
		Intermediate	Final	
5	Galway Bay	Marine Institute (Research)	Cuan Beo – SME (Restoration)	Irish native Oyster Fisheries Forum (INOFF) Native Oyster network https://nativeoysternetwork.org/ Native Oyster Restoration Alliance (NORA) https://noraeurope.eu/

Table 4: Detail on users inside the consortium (intermediate or final) and sectorial final users for the Oysterground restoration sector

2.2. Potential external users from other sectors

In this section, we provide the information gathered on potential users from other economic sectors that could also benefit from the project outcomes. The main objective of this analysis is to provide a basis for the strategy of WP6 (Innovation Management, Exploitation and Business Planning) and WP7 (Marketing and Communication). In this report we don't elaborate a detailed evaluation of data and information requirements for each of the stakeholders but rather we want to ensure that contact information is gathered for all the identified users, to be further exploited by WP6 and 7.

For this analysis, we used a set of categories previously established by the EuroGOOS Coastal WG (http://eurogoos.eu/coastal-wg/), which were used to build groups of users sharing common information needs, similarly to what has been done in other initiatives (e.g. CMEMS user market analysis https://marine.copernicus.eu/markets/ or in in Helsop *et al.*, 2019).

The user categories considered are:

- Maritime safety (e.g.: SAR operators, coastguard, oil spill response managers, maritime emergency managers, Navy, national and local security agencies, etc.)
- Water pollution management (e.g.: Local authorities; European Marine Strategy Framework Directive - MSFD)
- Offshore energy (e.g: energy company managers; Environmental Impact Assessments…)
- Tourism & recreational activities (e.g: recreational sailing, sports sailing/regattas, surfing, diving, citizens, NGOs)

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- Coastal protection management (e.g. government environmental agencies, beach and coastal planners, etc.)
- Ports & shipping (e.g: port managers, port pilots, ferry companies/captains, shipping companies/captains, cruise companies/captains …)
- Sustainable Marine living Resources (e.g: fisheries managers, fisheries scientists, commercial fishermen, recreational fishermen, sustainability managers, HABs)
- Weather & climate (e.g.: weather Forecast Centers)
- Basic and applied research in coastal oceanography (e.g: Academia, private research organizations, NGOs)
- Legislative entities (Governments and their departments, national and international Organizations)

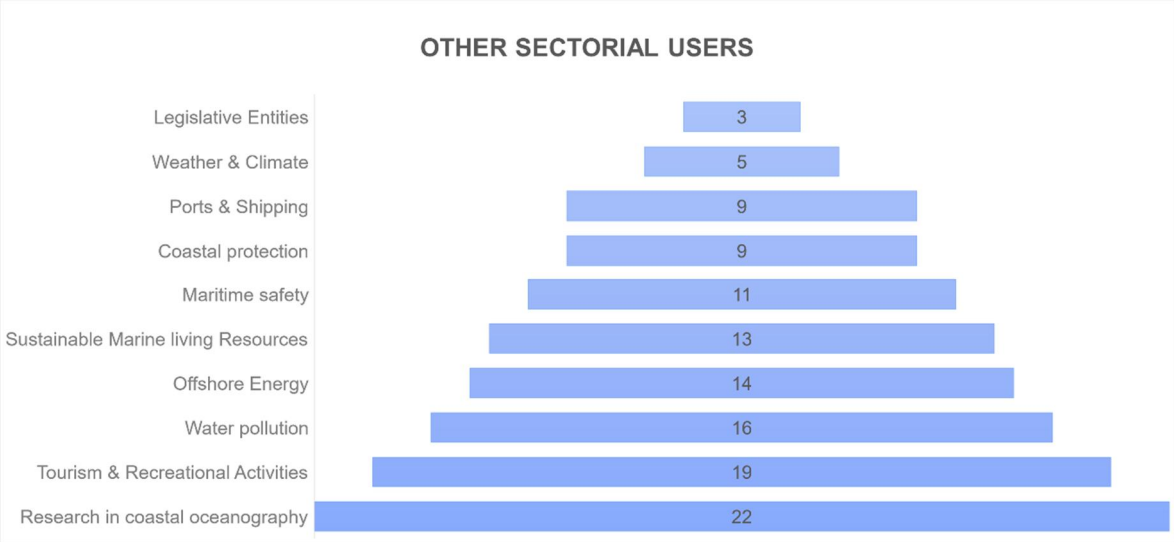

Figure 3: Figure showing the number of users identified in each category of other sectors outside FORCOAST.

The categories with the highest number of identified users are “Research in Coastal Oceanography”, “Water pollution”, “Sustainable Marine Living Resources” and “Tourism and Recreational Activities”. It must be said that further analysis of the requirements of the explored sectors is necessary before extracting any conclusion regarding the uptake of the FORCOAST services and products by these sectors. The details of the stakeholders identified can be found in the following tables.

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Basic and applied research in coastal oceanography sector			
P	Stakeholder / Shareholder	Short Description	URL/more info
1	Faculdade de Ciências e Tecnologia da Universidade NOVA de Lisboa	Academy	www.fct.unl.pt
	Politécnico de Setúbal	Academy	http://www.si.ips.pt/ips_si/web_page.inicial
	LPN, PONG-Pesca	NGOs	www.lpn.pt; https://pongpesca.wordpress.com
2	UPV	Academy	www.ehu.eus
	UPPA	Academy	www.univ-pau.fr
	Surfrider Foundation	NGO, Activities related to sensibilization, environmental projects and research	www.surfrider.eu/protection/ocean
3	Institute of Oceanology, Bulgaria	Academy	www.io-bas.bg
	Geoecomar, Romania		www.geoecomar.ro
	NIMRD, Romania		http://www.rmri.ro
	Marine Scientific Research Infrastructure, Bulgaria,		masri.io-bas.bg
	Black Sea Universities Network		https://www.bsun.org
4	Flemish Research Institute for Agriculture, Fisheries and Food - ILVO	Academy	https://www.ilvo.vlaanderen.be/default.aspx?tabid=6469&language=en-US
	Flanders Marine Institute VLIZ	Academy	www.vliz.be
	Royal Belgian Institute for Natural Science - RBINS	Academy	https://www.naturalsciences.be
5	NUIG	Academy	http://www.nuigalway.ie/science/earth-ocean-sciences.html
	GMIT	Academy	https://www.gmit.ie/natural-sciences/bachelor-science-applied-freshwater-and-marine-biology
6	Denmarks Meteorological Institut (DMI)	Academy	https://www.dmi.dk/ and http://ocean.dmi.dk
	DHI group	Engineering company	https://www.dhigroup.com/areas-of-expertise/coast-and-marine
	SWECO	Engineering company	https://www.sweco.dk/en
	COWI	Engineering company	https://www.cowi.com
	Ramboll	Engineering company	https://ramboll.com/water
7	GEOECOMAR	National Institute for Research and Development on Marine Geology and Geo-ecology, Constanta Branch	www.geoecomar.ro

Table 5: Details on identified potential users in the Basic and applied research in coastal oceanography sector

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Water pollution management			
P	Stakeholder / Shareholder	Short Description	URL/more info
1	Polícia Marítima	National Maritime Authority	https://www.amn.pt
	APA	Portuguese Environmental Agency	https://apambiente.pt/
	ICNF	Portuguese Institute for Nature Conservation and Forests	https://www.icnf.pt/
	DGRM	Directorate-General for Natural Resources, Safety and Maritime Services	https://www.dgrm.mm.gov.pt/
2	URA - Basque water agency	Responsible for the Water Framework Directive	https://www.uragentzia.euskadi.eus
	SUEZ Environement	Bathing water quality and services (private company)	www.suez.com
3	Black Sea Basin Directorate		https://www.bsbd.org
	Black Sea Commission		http://www.blacksea-commission.org
5	Sea Fisheries Protection Authority	Ireland's competant authority for seafood safety and sea-fisheries protection	www.sfpa.ie
	HSE - Bathing Waters	National/local authority	https://www.beaches.ie
	The Local Authority Waters Programme	National/local authority	http://watersandcommunities.ie/about
	Inland Fisheries Ireland	National/local authority	https://www.fisheriesireland.ie
6	Danish Environmental Protection Agency (EPA)	National/local authority	https://eng.mst.dk
	Geological Survey for Denmark and Greenland,	National/local authority	https://eng.geus.dk/water-resources/water-quality
7	Constanta Environmental Protection Agency	National authority	-
	Constanta Water Supply And Waste Water Treatment Directorate (RAJA SA)	National authority	-

Table 6: Details on identified potential users in the Water pollution management sector

Sustainable Marine living Resources			
P	Stakeholder / Shareholder	Short Description	URL/more info
1	Sustainable Marine living Resources	fisheries managers and scientists, commercial and recreational fishermen, sustainability managers; Aquaculture; HABs	-
	APA	Portuguese Environmental Agency	https://apambiente.pt
	Local fisheries associations	-	-
2	Departamento PESCA GV	National/local authority	https://www.euskadi.eus/gobierno-vasco/pesca-acuicultura/inicio

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3	Institute of fishery resources, Bulgaria	National/local authority	www.ifrvarna.com
	Electa Sea Products	Private company	www.electa.bg
4	Royal Meteorolgical Institute - KMI		https://www.meteo.be/nl/weer/verwachtingen/weer-voor-de-komende-dagen
5	Inshore Fisheries Forum	National/local authority	http://inshoreforums.ie/west-overview/membership
	HABS Marine Institute	Academy	https://webapps.marine.ie/HABs
6	DTU-Aqua, Dansk Skaldyr Center	-	http://www.skaldyrcenter.aqua.dtu.dk/en
	Foreningen Muslingeerhvervet,	-	http://www.muslingeerhvervet.dk
7	National Agency For Fisheries And Aquaculture/Maritime Directorate	National/local authority	-
	Black Sea Advisory Council	National/local authority	www.blsaceu.eu

Table 7: Details on identified potential users in the Sustainable Marine living Resources sector

Tourism and recreational activities sector			
P	Stakeholder / Shareholder	Short Description	URL/more info
1	CMS (camara setubal)	Local Authority	www.mun-setubal.pt
	Associação Regional de Vela do Centro	NGO / Association	www.arvc.pt
	Clube Naval Setubalense	NGO / Association	http://clubenavalsetubalense.pt
	Clube de Vela do Sado	NGO / Association	https://www.facebook.com/CVSado
	Clube Naval de Sesimbra	NGO / Association	https://www.naval-sesimbra.pt
2	Beach watchers and beach managers	Use of operational data from videometry and others	-
3	Black Sea NGO network	NGO / Association	http://www.bsnn.org
4	Information and services of the Belgian government	Tourism agency	https://www.belgium.be/en/about_belgium/tourism/the_coast
	Tourist offices of the Belgian coast	Tourism agency	https://www.belgiancoast.co.uk/en/practical-info/tourist-offices
	Vlaamse Yachthaven Nieuwpoort	NGO / Association	https://www.vynieuwpoort.be/en/home
	Royal Yacht Club Belgium - RYCB	NGO / Association	https://www.rycb.be
	Royal Belgian Sailing Club - RBSC	NGO / Association	https://www.rbsc.be/nl/clubs/jachthaven-zeebrugge
	Surf-Forecast.com	NGO / Association	https://nl.surf-forecast.com
5	Galway Bay Sailing Club	NGO / Association	www.gbsc.ie
	Galway Hookers Association	NGO / Association	https://www.galwayhookers.ie
	Galway Bay Boat Tours	NGO / Association	https://www.galwaybaytours.com
	EBB + FLOW	NGO / Association	https://swimbuddies.ie/ebb-flow
6	Havneguide	Tourism agency	https://havneguide.dk/da/limfjorden
	Visit Alborg	Tourism agency	https://www.visitaalborg.dk/aalborg/planlaeg-din-tur/ms-kysten-gdk596375

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Table 8: Details on identified potential users in the Tourism & Recreational Activities sector

Maritime safety			
P	Stakeholder / Shareholder	Short Description	URL/more info
1	Instituto Hidrográfico		https://www.hidrografico.pt
	APA	Portuguese Environmental Agency	https://apambiente.pt
	Porto Setúbal	National/local authority	https://www.portodesetubal.pt
	Polícia Marítima	National Maritime Authority	https://www.amn.pt
2	SASEMAR	Spanish SAR operator	http://www.salvamentomaritimo.es/
	DAEM Directorate of Emergencies and Meteorology Basque Goverment	Basque littoral emergency managers	https://www.euskadi.eus/gobierno-vasco/-/emergencias-quienes-somos
3	Marine Cluster, Bulgaria	-	www.marinecluster.com
5	RNLI Galway	-	https://rnli.org/find-my-nearest/lifeboat-stations/galway-lifeboat-station
	Oranmore Maree Coastal Search Unit	-	Facebook:@oranmoreMareeCoastalSerchUnit
6	Danish Maritime Authorities	National/local authority	https://www.soefartsstyrelsen.dk
	The Danish Navy, Søværnets Operative Kommando,	National/local authority	https://www2.forsvaret.dk/omos/organisation/sovarnet/Pages/forside.aspx

Table 9: Details on identified potential users in the Maritime Safety sector

Ports and shipping sector			
P	Stakeholder / Shareholder	Short Description	URL/more info
1	Porto Setúbal	National/local authority	https://www.portodesetubal.pt
	Atlantic ferries(setubal-troia)	Private company	http://www.atlanticferries.pt
3	Bulgarian Executive Agency - Marine administration	National/local authority	www.marad.bg
4	Port of Oostende	National/local authority	https://www.portofoostende.be
	Port of Zeebrugge	National/local authority	https://portofzeebrugge.be/nl
5	Port of Galway	National/local authority	https://theportofgalway.ie
6	Port of Aalborg	National/local authority	https://portofaalborg.dk
	Port of Thyborøn	National/local authority	http://www.thyboronport.com/thyboroen-port.html
7	CONSTANTA HARBOUR ADMINISTRATION - NATIONAL COMPANY	National/local authority	

Table 10: Details on identified potential users in the Ports & Shipping sector

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Coastal protection sector			
P	Stakeholder / Shareholder	Short Description	URL/more info
1	APA	Portuguese Environmental Agency	https://apambiente.pt
2	DAEM - Directorate of Emergencies and Meteorology	Basque littoral emergency managers - Basque Government	www.euskalmet.euskadi.eus
4	Consortium Coastbusters	Coastbusters investigates the possibility to protect the Belgian coast with biogenic reefs	www.blauwecluster.be
5	Redercentrale	-	www.rederscentrale.be
	Galway County Council Marine	National/local authority	http://www.galway.ie/en/services/roads/marine
	Department of Housing Planning and Local Government	-	https://www.housing.gov.ie/planning/marine-planning/marine-planning
	National Parks and Wildlife	NGO / Association	https://www.npws.ie/marine
6	Danish Coastal Authorities	National/local authority	https://kyst.dk/publikationer/om-kystdirektoratet/welcome-to-the-danish-coastal-authority-kystdirektoratet
7	DOBROGEA Littoral Water Basin Administration	National/local authority	-

Table 11: Details on identified potential users in the Coastal protection sector

Weather & Climate			
P	Stakeholder / Shareholder	Short Description	URL/more info
2	EUSKALMET - Regional weather forecast center	Weather Agency/ Institute	www.euskalmet.euskadi.eus
3	Bulgarian National Institute or Meteorology and Hydrology - Varna Section	Weather Agency/ Institute	www.meteo.bg
5	Irish Meteorological Service	Weather Agency/ Institute	www.met.ie
7	Dobrogea Regional Weather Forecast Center	Weather Agency/ Institute	-
6	Denmark's Meteorological Institut (DMI)	Weather Agency/ Institute	https://www.dmi.dk and http://ocean.dmi.dk

Table 12: Details on identified potential users in the Weather & Climate sector

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Legislative Entities			
P	*Stakeholder / Shareholder*	*Short Description*	*URL/more info*
7	CONSTANTA SANITARY-VETERINARY AND FOOD SAFETY DIRECTORATE,	Laboratory for Veterinary and Food Safety	-
	CONSTANTA PUBLIC HEALTH DIRECTORATE	-	-
	Black Sea Economic Organization		http://www.bsec-organization.org

Table 13: Details on identified potential users belonging to Legislative Entities sector

Offshore energy sector			
P	*Stakeholder / Shareholder*	*Short Description*	*URL/more info*
2	*Biscay Marine Energy platform (Bimep)*	*Research infrastruture*	*https://bimep.com*
4	*Belgian Offshore Platform - BOP*	*NGOs of investors and owners of windfarms in the Belgian part of the North Sea*	*www.belgianoffshoreplatform.be*
	Belwind– Belgian Offshore Platform	*Private company*	*www.belgianoffshoreplatform.be*
	Northwind	*Private company*	*https://northwindenergy.en*
	Nobelwind	*Private company*	*www.nobelwind.eu*
	Rentel	*Private company*	*https://www.otary.be/en*
	Norther	*Private company*	*https://www.norther.be*
	Northwester	*Private company*	*https://www.power-technology.com*
	Seamade - Mermaid	*Private company*	*https://www.otary.be/en*
	Seamade - Seastar	*Private company*	*https://www.otary.be/en*
	Parkwind Northern	*Private company*	*(info@parkwind.eu)*
	Cpower	*Private company*	*www.c-power.be*
6	*Rønland Offshore Windfarm*	*Private company*	*https://www.4coffshore.com/windfarms/denmark/r%C3%B8nland-denmark-dk04.html*
	Rønland II, Nissum Brednings Vindmøllelaug I/S,Jysk Energi A/S	*Private company*	*https://www.4coffshore.com/windfarms/denmark/nissum-bredning-vind-denmark-dk44.html*

Table 14: Details on identified potential users in the Offshore Energy sector

2.3. Role and composition of the Stakeholder Advisory Board (SAB)

The SAB is composed of a group of experts which provides guidance and inputs to the optimization and monitoring of the project activities and goals, taking into account innovation in both academia and industry.

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In FORCOAST, the SAB is composed of managers and cross-sectoral professionals whose task is to ensure improved decision-making capacity and the tailored uptake of project resulting methodologies. The advisory board is chaired by Glenn Nolan (EuroGOOS), being the members Adelio Silva (Hidromod), Alexandra Neyts (European Aquaculture Technology and Innovation Platform EATIP) and Angelique Melet (Mercator Ocean).

Overall, the purpose of the SAB is to ensure that project goals are consistent with the needs of beneficiaries, suggesting, where feasible, additional work to help realise social, environmental and economic benefits for the broadest possible range of stakeholders; to review and provide feedback on project progress towards stated goals, reflecting on the progress of the FORCOAST project and bringing on strategically relevant knowledge and experience. It is expected from the SAB to provide expertise and feedback on the project case studies and on scenarios developed in the research, and when available to take part in workshops to generate new ideas. Lastly, from the market expansion approach of the FORCOAST platform and product to be delivered, the SAB will contribute towards the development of options for upscaling project findings across the EU and internationally in the fields relevant for the FORCOAST Project.

2.4. Conclusions of the stakeholder analysis

A cross-pilot and cross-sector analysis of the stakeholders relevant to FORCOAST project objectives has been performed. The base of the analysis has been the information gathered in the pilots during their setup and the first exchanges with the stakeholders in different workshops. Further efforts will be needed to update or enlarge the list of users and stakeholders during the whole lifetime of the project.

In a first step, we identified internal and external (to the consortium) users in the three target FORCOAST sectors: wild fisheries, bivalve mariculture and oysterground restoration. In a second step, the exchange of information among users has enabled a better understanding of their needs in terms of specific information requirements (see Section 3).

The sector of bivalve mariculture is the most represented, since is active in six of the eight pilots and both intermediate and final users are represented in the consortium, while they have also been identified among the external stakeholders. In the case of wild fisheries, while it is present in two pilots, only intermediate users are inside the consortium, therefore, special care should be taken to ensure contacts with the identified final users. In the case of oysterground restoration, although both intermediate and final users are inside the consortium, only one pilot is active, so special attention should be given to ensure the applicability of the requirement analysis performed here to other geographical areas with similar activities.

Two additional mechanisms for ensuring the cross-pilot and cross-sector fertilization and uptake of the project outcomes are the constitution of the Stakeholder Advisory Board and the identification of an extensive list of potential users in other economic sectors as a basis for the strategy of FORCOAST Business (WP6) and Marketing and Communication (WP7) plans.

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3 Sectorial user requirements

Starting from the list of internal final, internal intermediate and external final users in the three FORCOAST target sectors (wild fisheries, bivalve mariculture, oysterground restoration), an analysis of their needs in terms of information and specific requirements has been performed. Again, the gathering of the information has been performed at the level of the different pilots, while here the analysis of the needs and requirements is integrated by sector. Thus, a common/integrated section describing the requirements per sector is developed, and then specificities for the pilots working actively on each of the sectors are provided.

Four main aspects have been covered:

- Information needs and implications: What information is needed? What are the main uses/ reasons behind the need of information? How are the decisions taken now? What are the costs/consequences of the lack of information? What could be improved? How could it be improved?
- Sectorial user requirements: what are the needs in terms of parameters, spatio-temporal coverage and resolution? Needed response time?
- Readiness level of the sectors: are the users in the pilot able/ready to use a computer-based tool? Unable to receive big amounts of data and or to connect to the internet in a regular basis? Need instead mobile or tablet applications? Open to the use of new technologies? Are there any special difficulties for the technical uptake of FORCOAST services/products by the users in the pilot?
- Pilot specificities: Are there specific regional requirements to be considered?

The requirements have been classified in terms of the temporal scales needed for an effective action using the following three categories:

- Short-term time scale (within the next hours, days or weeks), including operation planning at short temporal scales to improve production or captures and protection or mitigation measures (warning system) needed to avoid major losses/damage.
- Mid-term time scale (within the next months or season), including operation planning at mid-term temporal scales to optimize production and installations and/or plan marketing options.
- Long-term time scale (within next years), including determination of habitat suitability for new locations, environmental impact assessment, etc ...

3.1. Wild Fisheries

3.1.1. Information needs and implications

For the wild fisheries sector these are the main drivers that should be considered for the development of services and products:

> i - To determine the distribution of suitable habitat for small pelagic fisheries and avoid other non-target species. Information on the environment (synoptic maps of salinity, temperature, chlorophyll (Chl-a), Sea Surface Temperature (SST), Sea Surface Salinity (SSS), Mixed Layer Depth (MLD), Sea Surface Height (SSH), O_2, Primary Productivity (PP), Euphotic

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Zone Depth (ZEU) is key to provide an overview of the potential habitat of the target species. Together with the information on the ocean conditions (next point), the environmental information will support the decision for defining the next fishing grounds. With the final purpose of reducing the costs associated with days at sea (person-work, fuel, fungible...); thus, optimizing the operations in the sea and port cost. Nowadays this decision (fishing grounds) are taking based on their historical experience (previous fishing campaigns) and on the climate background and weather forecast. The marine weather forecast services give frequent information but, it is mostly for the atmosphere, i.e. there is a lack of data for the sea. There are also onboard met-ocean tools (e.g. MarineView) that give operational daily information on the met-ocean conditions. In the framework of FORCOAST, to integrate this high priority information as proxys for the fishing suitability in the area of interest will be a priority, by means of a single platform, easy to use and hourly or daily updated with 3 days forecast.

ii - To inform about the ocean conditions (currents, stokes drift, maximum crest height, maximum wave height, momentum and energy fluxes, atmosphere state variables...) for planning operational activities (where/when to target fishing effort). This information about the met-ocean conditions will support the decision on where/when to target fishing effort and to plan routine operations for the following days. The economical cost associated with the decision are those related with days at sea, on the other hand, it will also impact on the safety and working comfort on board. Nowadays, in order to make this decision they look for online information on met-ocean forecast services for the next 1 to 3 days. In the framework of FORCOAST, we foresee to cover this high priority information for this sector in an easy to use single platform updated hourly or daily and with 3 days forecast.

3.1.2. Sectorial user requirements

The specific requirements for the fisheries sector to meet previous two needs must be provided in a short time scale (between the next hour to 3 days). Regarding the frequency, it will be daily for the first need (fishing grounds) and hourly for the second (met-ocean conditions) to inform about the ocean conditions. The information of the ocean surface and atmosphere should be provided in colour scaled maps or vector fields in the case of the currents and winds, with a desirable resolution of 1-2 km. The provision of time series of environmental conditions at a chosen location is also considered interesting information.

The chosen platforms are website or API. The service should be available and contain up-to-date information during regular office hours at least and considering the local time of the end users. Also, alerts when there are exceedances of defined thresholds would be valuable for the second need (met-ocean conditions).

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			Short-term	
			i	ii
Type of Service / frequency	Operational			
	One-time			
	On demand			
Parameters	Tides			
	Wind			
	Storms			
	Waves			
	Currents			
	Geostrophic currents			
	Temperature			
	Salinity			
	SSH			
	DO			
	ZEU[1]			
	chl-a			
	MLD[2]			
	PP[3]			
Temporal coverage		Historical		
		Nowcast		
		Forecast	1-3d	1-3d
Temporal resolution			Daily	Hourly
Spatial coverage		Station		
		maps		
		vertical	Surface	Surface
Spatial resolution			1-4 km	1-4 km

Table 15 - Detail of specific requirements for the fisheries sector related to the needs detailed in the previous section: i- distribution of suitable habitat for small pelagic fisheries, ii - planning operational activities. The requirements are classified in terms of the temporal scales needed for an effective action, in the case of Wild fisheries, these requirements are needed in the short-term time scale (within the next hours or next weeks). [1] Euphotic Zone Depth; [2]Mixed layer depth; [3]Primary Productivity.

3.1.3. Technical readiness level of the sector

The key users in the wild fishery sector have experience with met-ocean tools and weather forecast services and are familiar with computer systems, web and table applications. The computer systems, mainly due to onboard data connexion costs, do not allow them to receive onboard big amounts of data. Therefore, we envisage systems to be easily accessible in the ports (anchovy fleet come back frequently to ports) from computer or tablet applications. The stakeholders within the wild fisheries sector tackled in FORCOAST are thus open to new technologies, but they need to receive formation and support and the respective training.

3.1.4. Specific regional requirements

3.1.4.1. Pilot 2

Pilot 2 is located in the south-eastern Bay of Biscay, in an area where commercial fisheries activities take place seasonally. Although this sector focuses his activities on different species (sardine, mackerel, horse mackerel, tuna), we will focus here on one of the most important pelagic species

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cached in this area: the anchovy. The spawning of this species takes place in the south-eastern Bay of Biscay during spring. Then, they migrate to the southwest occupying a great part of the southern Bay of Biscay (i.e. the Cantabrian coast). During autumn, the recruitment takes place in coastal areas along the French coast where they probably spend winter in areas influenced by the river discharge. These areas are located during the next spring. The seasonality of the fishing activity is related to the inner variability of the environment. In fact, the maturation of the juveniles is related to the water temperature, reaching it during summer.

The topo-bathymetry of this area (change of the orientation of the coast, narrow shelf, and presence of canyons) south-eastern Bay of Biscay is characterized by the presence of canyons (e.g. Capbreton canyon) gives rise to a complex dynamic. During winter, the circulation is mainly cyclonic, and the main flow is dominated by the Iberian Poleward Current. The flow is reversed, and it weakens during summer, in part due to the wind influence that is the main driver of the surface circulation. Besides the seasonal variability of the circulation, there are (sub)mesoscale processes that contribute to the mixing and enrichment of the water masses, such as the input of fresh waters from rivers and mesoscale eddies. The temperature of the water starts to rise from late April, reaching maximum values in July-August and begins to decrease in October-November. The development of the seasonal mixed layer evolves in sync with temperature. During summer, it is located between 30 m and 50 m depth.

In this pilot we will focus on the area covered by the Basque Operational Observing System (EuskOOS; http://www.euskoos.eus), belonging to the Basque Government. The main purposes of the EusKOOS system are i) providing an accurate description of current sea conditions along the Basque coastline, ii) offering ongoing forecasts of future sea conditions; and iii) supplying met-ocean products to Basque coastal users. It monitors the area daily (depending on the observing system), allowing an overview of the waves, currents, temperature, salinity and of the other physical parameters in the study area. It is composed of coastal met-ocean stations, a network of coastal cameras, one long-range HF radar, two ADCPs located in two slope moorings along the Spanish coast. In addition, the area is also simulated by means of ROMS model, providing hindcast and forecast simulations also daily. The area covered by this simulations extends from 43.24º N to 44º N and from 3.4º W to 1.3º W, The ROMS simulation includes the last daily averaged freshwater discharges (real-time data) from the following rivers: Adour, Bidasoa, Oria and Nervión.

The specific requirements and key activities for PILOT 2 are:

- Provide multi-year hindcast (forecast) products of T, S, currents, mixing
- Introduce river flow in the regional models
- Develop indicators of mesoscale processes and location of fronts

3.1.4.2. Pilot 3

Pilot 3 is in the western Black Sea, in an area where commercial fishery activities take place. For the Black Sea Bulgarian economic zone, the recruitment takes place in coastal areas along the Bulgarian coast. The seasonality of the fishing activity is related to the inner variability of the environment, e.g. the upwelling, water temperature, wave conditions.

At the moment, there is no information system dedicated specifically to the fisheries/aquaculture sector USOF is involved in CMEMS BS-MFC at basin-scale analyses and forecasts. TERASSIGNA prepares and distributes high resolution ocean colour data met-ocean data. Based on those, the TRL

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for fisheries target marine product distribution platform for the Bulgaria pilot case is estimated at a level of 3.

The most significant gaps identified for the Bulgaria pilot (pilot 3) are:

• Lack of in-situ observational data

• Impact of environmental conditions on the biological cycle of target species must be assessed.

The most relevant data for fisheries focus on ocean currents, significant wave height, temperature, upwelling events, extremes analyses (e.g. high waves). A downscaling of the existing CMEMS BS-MFC-WAV products to 1 km resolution will be developed and validated, focusing on the western Black Sea. A particular emphasis will be set in providing to the end users of additional downscaled parameters related to the extreme statistics of coastal upwelling.

The selection of suitable thresholds for these variables is also key in the effectiveness of the warning systems. For instance, some of the thresholds can be set to detect a rapid drop of temperature due to upwelling, high wave height and wave crests and strong currents.

Tailored information products combining model and earth observation will be proposed, matching user requirements to be identified in consultation with the fisheries industry in the Bulgarian Black Sea. The demonstration data and cases will be provided on the project common platform.

Different Copernicus products are used in the area as well as the following models: NEMO (5 km) and WAM (5 km) models used in the production of the CMEMS BS-MFC PHYS and WAV forecast and reanalyses. For the western Black Sea, the WAM model has a resolution of 1 km.

The specific requirements and key activities for PILOT 3 are:

- downscaling of the existing CMEMS BS-MFC-WAV products to 1 km resolution
- providing additional downscaled parameters related to the extreme statistics and coastal upwelling

3.2. Bivalve mariculture

3.2.1. Information needs and implications

The bivalve mariculture sector is represented by a significant number of intermediate and final users within several pilots inside FORCOAST. In this case to find communalities between the requirements gathered for the different users and regions was challenging and special efforts will be needed to ensure to converge towards services/products useful for different areas and activities.

The main common drivers for the development tailored of services and products are summarized in the following.

i- Operation planning at short temporal scales for the operational design of the work plan for the following day, or next days. To have accurate forecast of currents/wave height/meteorological conditions (wind)/tides (surface elevation)/temperature), for 1 to 5 following day (and for in the recent past days) is key for deciding whether to go out to the field or not due to the met-ocean conditions, planning or adapting short-term or daily operations in the farm or site, deciding on

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harvesting and localizing lost gears. The main cost of inaction or wrong action related to lack of the needed information is in general coupled to increased farming costs. These can be directly related to costs associated with workers workday, when conditions are not appropriate for on-site work (for instance work hours lost due to low/high tide under/over estimations due to the lack of reliable information), potential losses related to field safety, potential cost to losses in the production due to abnormal conditions (e.g. abnormal temperature). In the case of the lost gears the cost should be computed as a trade-off between gear lost and searching cost, so an accurate forecast on gear location is key to decide on gear recovering.

Today, a decision is based on available daily forecasts of marine and/or meteorological conditions (e.g. wind guru or national weather forecast services, DMI weather and SL forecasts) or empirical estimations based on available data. The available forecasts usually lack spatio-temporal resolution of precision (e.g. bias on SST or errors in locating a lost gear) and of key variables for the operation and harvesting (like good prediction of currents, SST and river loads). The estimations obtained from available data for some cases are not able to reflect the conditions at the farm/site of exploitation (e.g. tide gauge in the Sado Estuary does not reflect what happens deep inside the estuary, which can lead to errors on high and low tides up to 30 min) or at much lower temporal resolution (e.g. in-situ temperature measurements only available several times a year). Thus the main gaps to be filled by FORCOAST products and services are: more accurate and high-resolution met ocean conditions, namely on surface elevation, temperature, currents (drift of potential lost gears), wind conditions, solar radiation (to determine the possible working hours) time series in a window of 1-5 days around the operation day.

ii-planning of special protection or mitigation measures in case of special events. A special case for operational planning and short time scales has been raised in several of the pilots; this is the building of an operational warning or alert system which could help planning measures in case of special events in order to minimize the risk of loss of production and ensure the growth rates and the quality and homogeneity of the harvest.

The list of key information and variables for bivalve aquaculture is extended and includes: monitoring/forecasting storms, waves, sea surface TS conditions and chlorophyll concentration, dissolved oxygen (DO, mg O_2/L) and hypoxia, total suspended matter, water quality, eutrophication, contaminants including chemicals and oil spill, toxic algae or faecal bacterial contamination (wastewater discharges and spatial extension).

The selection of suitable thresholds for these variables is also key to the effectiveness of the warning systems. For instance, for preventing mussel death some of the thresholds can be set to detect:

- High temperature (>30 ºC)
- Very low salinity (below 6 PSU), which can occur because of a massive freshwater input
- DO concentrations below 2 mg O2/L, which cause the closing of valves and the subsequent impossibility of feeding and ultimately death of mussels.
- High probability of wastewater discharge reaching the mussel farm
- High wave height

Today, the decisions are based on data from local monitoring and weather forecasts (sometimes not validated) and experience or the combination of all of these. Usually, the absence of a coherent alert system leads to a delay in obtaining usable information from data holding institutions. While with a coherent alert system special protection or mitigation measures could be planned like: preventive fast harvesting, the submersion of long-lines for protection (e.g. in case of high wave

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heights it could be needed to submerge the installations from 2 m depth to 4-7 m depths) or perform *E. coli*/other bacterial contaminants analyses. Even in the occurrence of this special events is low for most of the cases (from few times in a decade or a year), the main benefits of an accurate alert system can be key to reduce: (a) Production losses (for instance in conditions causing death of mussels, to recover and market at least some of the harvest can be more cost effective than to leave the entire harvest to die, since the costs of harvesting live/dead mussels from the installations are the same) and (b) incomes loss and risks for human health and the sustainability of the exploitation in case of contaminated mussels.

iii- Operation planning at mid-term temporal scales. To have accurate mid-term to long-term forecasts or climatological information on Chlorophyll surface and vertical distribution, temperature and nutrients are key to ensure/monitor food availability and optimize mussels/oysters grow rates and health conditions, though actions required at monthly to seasonal timescales to, for instance, decide long-term harvesting plans or adapt the depth of mussel bags. Again, these actions have direct consequences in the production costs and benefits, and presently decisions are taken mostly based on experience since for some cases there is no data or for others, the climatology or forecasts available are not accurate enough. Thus the main gap to be filled by FORCOAST in terms of services is to use and, where needed, to produce ocean and biogeochemical hindcast data to build climatologies of these variables, as a basis for decision or to feed Dynamic Energy Budget (DEB) models in order to determine and improve if possible the production yield.

iv- Determine habitat suitability and planning of new locations or to determine the distribution of suitable habitat for oysters. The availability of long-term hindcast or climatologies of the following variables: temperature, salinity, currents, Chl-a, turbidity, and nutrients is again key for decisions on whether the habitat is sufficiently healthy for oysters, find suitable locations for cultivating oysters and in general optimal siting for aquafarming. Thus, again the production of ocean and biogeochemical hindcast data to build reliable climatologies of these variables would be a main gap to be filled by FORCOAST.

v- Other specific requirements have been identified for some of the pilots:

- (Pilot 1) Determination of cause for oyster green colouration
- (Pilot 4) Additional requirements on available information is related with their co-production of seaweeds, like light availability or nutrients, and to the prediction the arrival of oyster spat (i.e. a decision tool to maximize the collection of spat and lowers production cost related to the purchasing of seeds). FORCOAST services can be likewise designed in a way that allows adaptations for different type of productions (mussels, oysters, seaweeds, fishes).

These, along with other specificities of the different pilots are presented in subsection 3.1.4.

3.2.2. Sectorial user requirements

The specific requirements for each of the needs detailed in the previous sections and in terms of type of service, variables/parameters, spatio-temporal resolution and coverage are summarized in table 14.

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		Short-term		Mid-term	Long-term	Mixed
		i	ii	iii	iv	v
Type of Service / frequency	Operational					
	One-time					
	On demand					
Parameters	SSH / tides					
	Wind					
	Storms					
	Waves					
	Currents					
	Temperature					
	Salinity					
	Drift[1]					
	DO					
	Toxic algae					
	Nutrients					
	chl-a[2]					
	Waste water[3]					
	contaminants[4]					
	growth rate[5]					
	light, TSM[6]					
Temporal coverage	Historical		For thresholds definition		3-10 y	
	Nowcast					
	Forecast	1-5 d	2-5 d	season		1- 5 d /season
Temporal resolution		5 min[7]- 1h	day	day-week	1h - 1 d	10 mn - 1-d
Spatial coverage	station					
	maps					
	vertical	surface	surface - 20m (every 5m)	surface - 20m (every 5m)	surface or 3D	surface
Spatial resolution		<50m		100m	100 m	<50m

Table 16 - Detail of specific requirements for the mariculture sector related to the needs detailed in the previous section: i- Operation planning at short temporal scales, ii-Planning of special protection or mitigation measures (warning system), iii- Operation planning at mid-term temporal scales, iv- Determination of habitat suitability and new locations, v- others. The requirements are classified in terms of the temporal scales needed for an effective action. [1]drfit trajectories of gears or seeds; [2] or plankton biomass; [3]waste water discharge or E. coli concentration; [4] oil spills and contaminants; [5] growth rate of considered species; [6] light, turbidity, Total Suspended Matter (TSM); [7] for the specific case of tides

3.2.3. Technical readiness level of the sector

Different readiness levels for the use of technology and information have been reported for the stakeholders in the pilots. Difficulties with the user uptake of the FORCOAST services and products are not foreseen as far as the observed limitations are considered in the design phase. For instance, the key user in the Limpfjord pilot 6: Oysterboat has experience with model data applications and is familiar with computer systems and the use of model data. The computer systems are not adequate for receiving big amounts of data and products need to be tailored to specific user requirements, to ensure the availability of the service. Regular data provision via the internet is not a problem. Mobile or tablet applications are of benefit for further development of the service. Oysterboat company is very open for the application of new technologies, if benefits for the oyster production can be demonstrated.

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The key user(s) in Pilot 7 has some experience with remote sensing and model data (e.g. http://iswim.rmri.ro/, http://skyfish.terrasigna.com/geoportal.html), as well as weather forecasting Apps. However, FORCOAST products need to be tailored to specific user requirements, to ensure the availability of the service and the provision of useful and timely information for a mussel farmer. The key user(s) will operate from a PC and/or Tablet and SmartPhone, connected to the internet on a regular basis, and will be able to manage a user-friendly downstream service/App.

Key user in Pilot 8 has experience with remote sensing and model data, although it might not be able to handle big amounts of data and, in particular, it might not be familiar with Climate and Forecast (CF) Metadata Conventions and thus manage CF-compliant formats. The key user will operate from a PC and/or Tablet and SmartPhone, connected to the internet on a regular basis, and will be able to manage a user-friendly downstream service, also in a form of App.

3.2.4. Specific regional requirements

3.2.4.1. Pilot 1

The Sado estuary consists of a large coastal bay connected by the Atlantic Ocean by a narrow channel on its northern shore (Figure *4*). The Sado estuary is a large estuary (about 150 km2) that presents a high ratio of intertidal areas (about 1/3 of its surface) and a complex bathymetry, with two channels in the lower estuary separated by a set of sand banks and 3 main basins in the upper part (Marateca, Alcácer Channel and Comporta<<).

The main oyster production areas are in the Marateca Channel. In this channel, ExporSado has 3 production areas: Longa, Pontal and Assolvo. The latter area is under development while Longa and Pontal are currently production units. Both production units are in intertidal areas and to determine accurately water levels is relevant for planning the working times. Depending on the activities to be performed on the Longa site, ExporSado operators need to reach the production area when the tide is at a specific height. They need forecasts that provide sea levels, with an error not greater than 15 minutes at least 24h in advance. Currently, Exporsado is estimating manually the water levels on the site using the low frequency data provided by the Portuguese Hydrographic Office from Setubal-Tróia tidal gauge which consist on daily water level maxima and minima

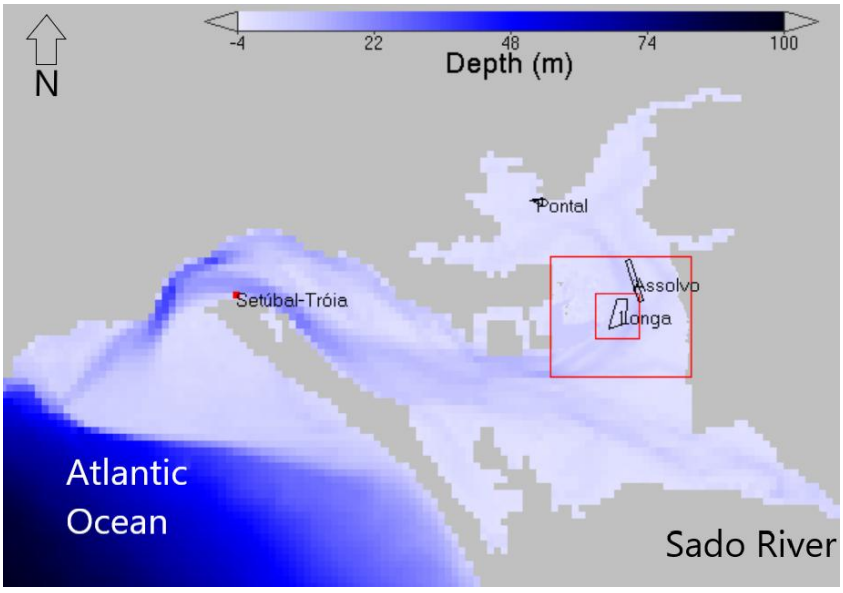

Figure 4 : Location of the ExporSado production units within the Sado Estuary.

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During the FORCOAST project, a high-resolution models (up to 8 m) will be developed for the production units that will be validated using continuous monitoring installed in the Longa production unit. The installed monitoring station will be equipped with water level sensors aiding to calibrate and validate accurately the modelled water levels. In addition, this monitoring station will cover the gap in data of other environmental variables such as temperature, salinity, pH, conductivity, suspended sediments and chlorophyll *a*.

The collected information will contribute to the second Pilot challenge: sometimes, oysters flesh presents a non-permanent green colouration. Though this issue is regarded as harmless to the consumer, the price of the final product can drop up to 70%. This is a common problem for all the producers in the Sado region. So, it is needed an explanation for this phenomenon including why it appears and to predict its occurrence. ExporSado will extend in-situ monitoring with oyster sampling that will go through laboratory analysis to evaluate the intensity of the oyster green colour.

IST will model and provide forecasts up to 5 days for the Sado estuary and its area of influence. The model will include inputs from the Sado River and other freshwater courses discharging in the Sado estuary. The modelling results will be completed and validated with the in-situ and remote sensing data made available during the FORCOAST project. IST will also apply the Dynamic Energy Budget to model the Portuguese oyster growth and the influence of surrounding environmental conditions.

The specific requirements and key activities for PILOT 1 are:

- Continuous in-situ observations collected during the lifetime of the project to evaluate the quality of modelling results, including water levels, and remotely observed products
- Forecasts of meteorological, oceanographic and watershed models to generate fit-for-purpose products and services. These products/services will aid in activity planning and increase the understanding of the impact of environmental conditions on oyster growth.
- Dynamic Energy Budget (DEB) models will be adapted to the Portuguese oyster and will allow monitoring the performance of this species to environmental changes.
- Explain and forecast the green colour observed in the oyster flesh of the Sado estuary.
- Remote sensing products and numerical modelling results will be compared with continuous in-situ observations and will provide high temporal and spatial information that can aid in decision making to environmental conditions.

3.2.4.2. Pilot 4

The Belgian pilot “Westdiep” is based on an aquaculture installation located in a high energy environment in the Belgian part of the North Sea. The current area is 700 x 500 m (3.5 ha) and located 5 km in front of the port Nieuwpoort. It is a small-scale prototype existing out of one seaweed minifarm, two longlines for different species of shellfish and seaweed, and one mussel longline. In Spring 2020, four more longlines will be placed to increase the test facilities. Next to aquaculture, the test location will be used for experimental passive fishing gears and oyster reef restoration. As “Smart farming” (referring to aquaculture farms that are run by an application of ICT, where the farmer has accurate, real-time knowledge of what is happening to the working environment and its animals) is a research line for the “Westdiep” location, it can serve in FORCOAST as a test case for the development of different prediction modules to be commercialized within this project.

The Belgian pilot site will focus on the existing site, but the products and services should be extended to the 5 zones foreseen for industrial and commercial activities in the revised Belgian Marine Spatial

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Plan. These are located in open sea (i.e. unsheltered areas) but still in the Belgian shallow territorial waters offshore the harbour cities of Nieuwpoort, Ostend and Zeebrugge. The bathymetry is less than 30 m depth. The hydrodynamic in this area is mainly tide dominated with peak currents up to 1.7 m/s in spring tide. Significant waves height is usually less than 2 m and rarely exceed 5 m in storm conditions. Zero-up crossing waves period are usually in the range 2-8 s. The Belgian territorial waters are very turbid areas with maximal turbidity off Zeebrugge port. The Belgian waters have a rich nutrients content leading to eutrophication issues and phaeocystis blooms.

Several parameters are measured on-site (e.g. temperature, salinity, turbidity and Chlorophyll a) in order to develop a growth model for sugar seaweed, mussel and flat oyster. These data can be used to validate the results of the data from remote sensing. The model, incorporating monitoring data from measuring buoys in the Belgian part of the North Sea and satellite data (for example chlorophyll-a and other pigments) would serve as an early warning system for seeding, maintenance, harvesting. Furthermore, data on currents and temperature could provide insight into the prevalence of oyster spat in Belgian part of the North Sea, to capture the spat for further growth.

The specific requirements and key activities for PILOT 4 are:

- Upgrade the river discharge forcing used by its forecast model OPTOS
- Using MIRO&CO results for estimating primary production and nutrients cycle
- Further developing the LARVAE&CO model to suit aquaculture needs
- To develop services to forecast the optimal timing, water quality, risk of a site to be affected by river plumes, etc.

3.2.4.3. Pilot 5

The Galway Bay pilot area is located on the west coast of Ireland and contains within it several of the few remaining Ostrea edulis (European native oyster) populations in Ireland as well as a multitude of bivalve mariculture production sites. The specificities of this pilot, covering both mariculture and oystergrounds restoration activities are provided in subsection 3.3.4.1.

3.2.4.4. Pilot 6

The Limfjorden pilot 6 area is the most important area for shellfish fishery and culturing in Denmark. The Limfjorden is a large, shallow body of water in northern Jutland, which is connected to the North Sea on the west coast, and the Baltic Sea on the east coast. Both connections are shallow channels and the Limfjorden consists of a network of narrow straits and smaller basins. The total volume of water in the Limfjorden amounts to 7.1 km3, and the average water depth is 4.5m. Throughout most of the year, the wind blows from a westerly direction, with the exception of the summer period, which is dominated by easterly winds that are usually low in energy. Water temperatures in the Limfjorden average around 2–3 °C in the winter period, and 15–17 °C in the summer period. The Limfjorden is a microtidal system with a tidal amplitude of 0.1–0.2 m. There is a constant intrusion of high saline water from the North Sea (32–34 psu) and an input from the Baltic Sea of lower saline water (19–25 psu). Furthermore, there is a freshwater input of 2.7 km3 per year from the catchment area.

The Limfjorden is a eutrophic water body affected by nutrient input from the surrounding watershed. This results in high primary production rates of up to 1000 mg C/m2/d in summer which supports a high level of biomass of benthic suspension-feeders. The Limfjorden contains a large

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shellfish fishery based primarily on wild populations with annual landings of 20,000–25,000 t of mussels and 150 t of flat oysters mainly for human consumption. In recent years, oyster cultivation practices designed for human consumption have also been tested in the Limfjorden although with mixed results. The SME OysterBoat is the primary producer of flat European oysters in Denmark and developed a prototype for oyster culturing. The aim is to increase production to be economically sustainable. However, they experience high mortality among the juvenile oysters and they need information about the best locations for potential culture sites. The focus of the project is to provide modelling products and services that can help to identify suitable sites and increase oyster production.

The specific requirements and key activities for PILOT 6 are:

- Provide multi-year hind-cast products of T, S, currents, mixing from HBM
- Provide multi-year run for ecological variables from FlexSem-ERGOM
- Make pre-operational forecasting for physical parameters using HBM
- Design model products and indicators for site selection to oyster farmer
- Indicators could be temperature, salinity, turbidity, food flux, chl a, oxygen, …
- Identify and map optimal locations for restoration and culturing

3.2.4.5. Pilot 7

Black Sea mariculture currently focusses on finfish species of high economic value. In recent years, other resources have gained interest, such as mussels and the rapa whelk. Shellfish aquaculture is not developed to its full potential in the Black Sea region due to environmental constraints and an unclear legislative framework (no applicable Water Law to allow concession). The promotion of scientific, technical and legislative bases for this activity is absolutely necessary. Engaging users of the FAO/GFCM Shellfish Aquaculture Demonstrative Center (S-ADC), coordinated by NIMRD Constanta, to redefine targeted products and how those should be delivered (services) to best support decision-taking in the aquaculture implementation (site selection and multi-use) and operation (support for management decision) is one of the main objectives of this pilot. Prototype products will be issued and their operational exploitation (i.e. the service) will be developed in the frame of the S-ADC.

At the moment, there is no information system dedicated specifically to the fisheries/aquaculture sector. MAST-ULiège provides CMEMS biogeochemical forecast and reanalyses for the whole Black Sea. Moreover, NIMRD regularly monitors Black Sea living resources and environmental variables and reports data to regional and international bodies. NIMRD also hosts the National Oceanographic and Environmental Data Center. Jailoo SRL prepares and distributes high resolution met-ocean data. Based on those, the TRL for an aquaculture-targeted operational marine product distribution platform is estimated at a level of 3.

The most significant gaps identified for the Romanian pilot are:

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• Detailed riverine flow and nutrient discharge data are needed, in particular to resolve the monthly distribution of those among the three main tributaries of the Danube.
• Mapping of existing shellfish beds will have to be re-evaluated from historical datasets gathered by the NIMRD-operated Romanian National data centre.
• Impact of environmental conditions on the biological cycle of target species must be assessed.

The most relevant data for mussel aquaculture focus on chlorophyll, temperature, salinity, currents, waves and discharges from land sources (primarily the Constanta Port and the wastewater treatment plant of Constanta City). A downscaling of the existing CMEMS BS-MFC-BIO forecast to 1 km resolution will be developed and validated, focusing on the northwestern and eventually western Bulgarian shelves (depending on user interests). A particular emphasis will be set in the downscaled as regards the spatial distribution of Danube tributaries and their share in water flow and nutrient loads. Tailored information products combining model and earth observation will be proposed, matching user requirements to be identified in consultation with S-ADC stakeholders. The target TRL for the service is 7, provided those products can be distributed on the project common platform. Different Copernicus products are used in the area as well as the following models: The GHER-BAMHBI (15 km) and NEMO-BAMHBI (5 km) models used in the production of the CMEMS BS-MFC-BIO forecast and reanalyses.

The specific requirements and key activities for PILOT 7 are:

- A downscaling of the existing CMEMS BS-MFC-BIO forecast to 1 km resolution (northwestern and eventually western Bulgarian shelves)
- Spatial distribution of Danube tributaries and their share in water flow and nutrient loads.
- Tailored information products combining model and earth observation

3.2.4.6. Pilot 8

The Northern Adriatic Sea is one of the most productive areas in the Mediterranean Sea, due to the nutrient input from the Po and other rivers debouching in this sector, whose drainage basins extend from the Central to the Eastern Arch of the Alps. This semi-enclosed basin is, indeed, characterized by a large number of rivers that discharge waters with different biogeochemical and optical properties. These river inputs act in a limited spatial extent and strongly influence the physical and biogeochemical properties of the basin itself. Between those watercourses, the Po, Adige, and Brenta rivers together provide most of the NAS freshwater, but also the effect of the rivers in the Northern part is relevant for the optical property dynamics (Brando et al., 2015; Solidoro et al., 2009). Moreover, the wind-driven forcing, especially from Bora and Scirocco, can influence the vertical and horizontal current fields, and, consequently, the sediment transport and the concentration of the water components (Bignami et al., 2007; Harris et al., 2008; Benincasa et al., 2019). On the contrary, there is no appreciable net effect of tides on sediment transport and resuspension (Malačič et al., 2000; Wang et al., 2007).

In this Pilot site, several mariculture activities (mostly Mediterranean mussel, Mytilus galloprovincialis) are spread along the coastline. These are placed in a range of bathymetric, hydrographic, sediment and nutrient conditions. In such a context, the presence of biotoxins follows a constant seasonal trend and, in recent years, some significant facts have been observed (Rubini et al., 2018): (i) yessotoxins group in mussels stays longer than past years even though below the legal threshold; (ii) spirolides (toxic macrocyclic imines), never previously reported in the area, appeared in mussels in 2003, following significant blooming of Alexandrium ostenfeldii. In 2017, tetrodotoxins

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were found northward of the study area and the Adriatic Sea currents direction could suggest that TTXs will soon reach the Po delta.
For this pilot site it is therefore crucial a water quality service that would encompass river discharge and load characteristics by the synergy of remote sensing and modelling. This would help shellfish aquaculture sector of this area to better manage operations and reduce risks.

The specific requirements and key activities for PILOT 8 are:

- provide statistical analysis and monitoring tool from ocean colour full resolution satellite products (e.g., chlorophyll-a, total suspended matter)
- integrating operational modelling and remote sensing data to develop maps of suitability conditions
- develop alerting system for hazardous conditions including heat waves and oxygen depleted conditions (i.e., eutrophication).

3.3. Oysterground restoration

3.3.1. Information needs and implications

The oysterground restoration sector is another sector highly dependent on water quality information as well as physical conditions of the water environment. Therefore, water quality prediction plays an important role in modern oysterground restoration activities, planning and management. In this case, the sectorial user requirements have been gathered mostly from the inputs of Pilot 5, in Galway Bay. Knowing that the gathered requirements are not so representative of the whole sector but mostly of the Galway Bay case, special interest should be put in update these requirements with the exchanges with other users in the sector during the lifetime of the project.

i. To assess the disease status of native oyster by tracing virus and bacteria from known point insources is key to identify the main risks associated with restoration projects. It is also key to identify inputs that are detrimental to mariculture and to bring these issues to policy and decision makers. The main cost of inaction in this aspect will be related with a decline in quality of habitats for native oysters
ii. To provide environmental data and short-term forecasts for parameters that may affect production (mortality and growth). Historical data series and statistical analysis of observational data and short-term forecasts of parameters that can be used as proxies for virus and bacterial contamination, detritus, etc are needed. A key aspect is to identify seasonality in primary productivity and scope for growth of bivalves in mariculture and wild populations. The main cost of inaction in this aspect will be related to a decline in production of bivalves due to unfavourable conditions.
iii. To provide data on status (distribution and biomass) of native oyster stocks using synoptic maps is key to identify locations most suitable to native oysterground restoration and to avoid resourcing restoration in the wrong location. The main cost of inaction in this aspect will be related to poor capacity to restore native oyster grounds.
iv. To determine the distribution of suitable habitat for native oyster using synoptic maps of salinity, temperature, chlorophyll is key to identify areas of high primary productivity in the area for bivalve mariculture. The main cost of inaction in this aspect will be related to poor conservation status of habitats if detrimental inputs continue or increase.

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At this moment current actions are simply based on market conditions and readiness for harvest. At the moment, the available information is: River and groundwaters inputs (but need to be improved), outputs from an ocean circulation model but with a too low resolution and point estimates of SST. The main gaps are the lack of tools/data for tracking of viral and bacterial inputs, the improvement of the spatio/temporal resolution of the data and its integration of data to a single point access platform. Ideally, this platform should be easily available showing critical parameters in a synoptic way and producing reliable short-term forecasts.

3.3.2. Sectorial user requirements

The specific requirements for each of the needs detailed in the previous sections and in terms of type of service, variables/parameters, spatio-temporal resolution and coverage are summarized in Table 17 - Detail of specific requirements for the restoration sector related to the needs detailed in the previous section: i- Status of native oyster stocks, ii-assess disease status of oysters, iii-distribution of suitable habitat for native oyster, iv- environmental data and short-term forecasts for parameters that may affect production (mortality and growth). The requirements are classified in terms of the temporal scales needed for an effective action. [1]drfit trajectories of gears or seeds; [2] or plankton biomass; [3]waste water discharge or E. coli concentration; [4]oil spills and contaminants; [5]growth rate of considered species; [6]light, turbidity, Total Suspended Matter (TSM); [7] for the specific case of tides.Table 17.

		Mid-term		Long-term	
		i	ii	iii	iv
Type of Service / frequency	Operational				
	One-time				
	On demand				
Parameters	SSH / tides				
	Wind				
	Storms				
	Waves				
	Currents				
	Temperature				
	Salinity				
	Drift[1]				
	DO				
	Toxic algae				
	Nutrients				
	chl-a[2]				
	Waste water[3]				
	contaminants[4]				
	growth rate[5]				
	light, TSM[6]				
	Biotoxins				
	Bomania				
	Noro Virus				
Temporal coverage	Historical				
	Nowcast				

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	Forecast	1-7d	1-7d	1-7d	1-7d
Temporal resolution		1h	1d	1h	1d
Spatial coverage	station				
	maps				
	vertical	Surface/3D	Surface /3D	Surface/3D	Surface/3D
Spatial resolution		70m	70m	70m	70m

Table 17 - Detail of specific requirements for the restoration sector related to the needs detailed in the previous section: i- Status of native oyster stocks, ii-assess disease status of oysters, iii- distribution of suitable habitat for native oyster, iv- environmental data and short-term forecasts for parameters that may affect production (mortality and growth). The requirements are classified in terms of the temporal scales needed for an effective action. [1]drfit trajectories of gears or seeds; [2] or plankton biomass; [3]waste water discharge or E. coli concentration; [4]oil spills and contaminants; [5]growth rate of considered species; [6]light, turbidity, Total Suspended Matter (TSM); [7] for the specific case of tides.

3.3.3. Technical readiness level of the sector

The key user in the Oysterground Restoration sector within the FORCOAST consortium (Cuan Beo) has experience on the use of met-ocean tools and information and weather forecast services through their collaboration with Marine Institute. They are familiar with computer systems and web, table applications and can handle detailed mapping software. Specific difficulties with the user uptake of the FORCOAST services and products are not foreseen.

3.3.4. Specific regional requirements

3.3.4.1. Pilot 5

The Galway Bay pilot area is located on the west coast of Ireland and contains within it several of the few remaining Ostrea edulis (European native oyster) populations in Ireland as well as a multitude of bivalve mariculture production sites. The current distribution of native oysters is known from recent MI surveys and occurs mainly in an area north-east of Eddy Island and east to the Clarin River but there is evidence of sporadic distribution along most of the Southern Bay. There is a discrete bed of surf clam (Spisula solida) in inner Galway Bay, just north of Eddy Is. The main aquaculture activities are intertidal oyster culture and subtidal suspended mussel culture. The Pacific oyster (Crassostrea gigas) is cultured on trestles in intertidal areas. Mussels (Mytilus edulis) are cultured using droppers from longlines held by floats or rafts. Galway Bay is approximately 50 kilometres in length and 30 kilometres in width and contains within it 9 distinct classified shellfish production areas located at Mweeloon, Clarinbridge, Killeenaran, Corraduff, Doorus Point, Kinvara, Auginish, Poulnaclough, and Ballyvaughan Bay's. Galway Bay receives freshwater inputs from the Galway Bay Southeast catchment, this catchment includes the area drained by all streams entering tidal water in Galway Bay between Black Head and Renmore Point, Galway, draining a total area of 1,270km². Three main sources include the Clarin River, the Dunkellin river and the groundwater entering along the southern shore of the Bay. In the North of the Bay the Corrib catchment enters the bay, this catchment includes the area drained by the River Corrib and all streams entering tidal water between Renmore Point and Nimmo's Pier, Galway, draining a total area of 3,112km². All of these freshwater inputs result in a large fluctuation in salinity and temperature during the year depending on the amount of rainfall, average salinity count of 30ppt in the summer months and 25 ppt in the winter months. While a temperature high of 18 degrees Celsius during late summer down to 8 degrees in early spring would be normal.

Ostrea edulis populations in Galway Bay have depleted significantly from their one time substantial abundance due to a combination of factors including the haplosporididian parasite, the bonamia ostrea parasite, norovirus, poor fisheries management and increased mortalities owing to low salinity and siltation events in the bay due to high volumes of discharge from the surrounding land based water catchments. These challenges present equal difficulty in achieving sustainable bivalve

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mariculture in Galway Bay and accordingly overcoming these will advance bivalve mariculture and oysterground restoration efforts substantially in Galway Bay.

Understanding the challenges in greater detail and identifying practical solutions to remedy them is the primary focus of the Galway Bay pilot. The aim of the Galway Bay pilot is to develop ocean modelling products and services that can provide real-time water quality analyses which will detect harmful parasites and diseases affecting bivalve health, excessive dissolved nutrients arising from eutrophication from surrounding land based catchments, harmful algae blooms that negatively affect oyster growth, low salinity and siltation events that make restoration sites unsustainable for oyster growth and generally poor water quality for recreational Galway Bay users.

The specific requirements and key activities for PILOT 5 are:

- Detailed water quality analyses available in real time that identifies potential risks to bivalve health.
- Prediction of oyster spat arrival timing and food availability for bivalves.
- Predict eutrophication, low salinity and siltation events owing to substantial freshwater discharges.
- Identify best locations to install remote sensors.
- Identify suitable locations to lay cultch for native oyster recruitment.
- Detailed water quality analyses available in real time that identifies potential risks to human health by tracing virus and bacteria from known point insources.
- Monitor turbidity and sediment concentration.

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4 Conclusions

A cross-pilot and cross-sector analysis of the stakeholders and shareholders relevant to FORCOAST projects objectives has been performed. Internal and external intermediate and final users in the three target sectors: wild fisheries, bivalve mariculture, oysterground restoration. Exchanges with these users have enabled a better understanding of their needs in terms of information and specific requirements.

The sector of bivalve mariculture is the most widely represented by a significant number of intermediate and final users within several pilots inside FORCOAST. To find commonalities between the requirements gathered for the different users and regions was challenging and special efforts will be needed to ensure to converge towards services/products useful for different areas and activities. In the case of wild fisheries and osyterground restoration, the convergence towards defining common requirements was more straightforward since they are only present in 3 of the eight pilots. Special care should be taken in both cases to ensure contacts with the identified final user in the pilots and outside to ensure the uptake of the services and products and their applicability to areas with similar activities.

The main common drivers for the development tailored of services and products for the three sectors have been detailed and analysed depending on the temporal scales needed for action:

(Short-term) - Operational design of the work plan for the following day, or next days, for planning or adapting daily operations in the farm or site, decide on harvesting and when and where to go for fishing, localize lost gears and planning of special protection or mitigation measures in case of special events.

(mid-term) - Ensure/monitor food availability and optimize mussels/oysters (including native oysters) grow rates and health conditions, though actions required at monthly to seasonal timescales.

(long-term) - Determine habitat suitability (for mariculture and native oysters) and planning of new locations.

The main requirements for wild fisheries are in the short-term time scale, while oysterground restoration activities require information mostly at mid-term and long-term time scales. The requirements for the bivalve mariculture span the three time-scale categories.

The details of the information needed in terms of variables, and spatiotemporal resolution and needs of specific technical solutions or considerations have also been gathered, as well as the specific requirements for some the different pilots (to feed into WP3, 4 and 5 plans).

Moreover, to ensure cross-pilot and cross-sector fertilization and uptake of the project the Stakeholders Advisory Board has been established, and specific efforts have been devoted to the identification of further potential users in other economic sectors (to feed WP6 business and WP7 marketing and communication plans).

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Annex I – Pilot Kick of Meetings

The Pilot Kick off (PKOs - MS18) meetings were organized with the main aim of: (i) assign tasks to the partners and establish a 6-month working plan, (ii) Identify additional partners or collaborators and (iii) Identify end-users for WP2 and (iv) analyse the state of the art of the modelling activities for WP3. The participation of stakeholders or their representatives to the PKOs was encouraged.

Dates and participants of each of the PKOs meetings are detailed in the following table:

Pilot	Location & date/time	Participants
1	Portugal 11 February 16:00	IST, Exporsado (SME) and Deltares
2	Pasaia, Spain 11 February 9:30	MI_ES (SME), AZTI (Including M. Sartuntun and L. Arantzamendi, as external experts representatives of the fisheries and mariculture sectors) and Deltares
3	Bulgaria 18 February 14:00	Terrasigna (SME), USOF and Deltares
4	Ostende, Belgium 12 February 11:00	ILVO, RBINS, Brevisco (SME) and Deltares
5	Galway, Ireland 27 February 15:30	Marine Institute, Cuan Beo and Deltares
6	Denmark 26 February 14:00	DMI, AU (Research), Oyster boat (SME, Oyster production) and Deltares
7	Constanţa, Romania 13 February 8:30	Jailoo, Liège University, NIMRD and Deltares
8	Italy 27 February 10:30	CNR, OGS and Deltares

Table 18: Location, times and dates of the Pilot Kick-off workshops

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Annex II - Questionaire for users and users requirement identification

The conception and distribution of a questionnaire, to undertake a user analysis for each pilot and identify users needs, was the second key action that enabled to gather the needed information for the competition of this deliverable. The "Feed-in User_requirements_template" was sent to the partners before the PKOs, and completed during and after the meetings.

The template consists of two main parts.

Part one – KEY_USERS - Stakeholder analysis within and across the different pilots and sectors. Three levels of users were considered: the final or intermediate users inside the FORCOAST consortium, final users inside the three target sectors (fisheries, bivalve mariculture, and oysterground restoration) in each pilot site, as well as other final users of other sectors that could also benefit from the project outcomes.

SECTOR		FISHERIES		OYSTERGROUND RESTORATION		BIVALVE MARICULTURE	
PILOT		n	[…]	n	[…]	n	[…]
FORCOAST USERS *(Users inside the consortium)*							
SECTORIAL FINAL USERS *External users inside the target sectors - please provide contact info (e.g. website, social media ids..)*							
OTHER SECTORIAL USERS *General users of other sectors that could also benefit from the project outcomes*	Maritime safety *(e.g: SAR operators, coastguard, oil spill response managers, maritime emergency managers, Navy, national and local security agencies)*						
	Water pollution *(e.g: Local authorities; European Marine Strategy Framework Directive - MSFD)*						
	Offshore Energy *(e.g: energy company managers; Environmental Impact Assessments…)*						
	Tourism & Recreational Activities (e.g: recreational sailing, sports sailing/regattas, surfing, diving, citizens, NGOs)						
	Coastal protection (e.g. government environmental managers, beach and coastal planners)						
	Ports &Shipping (e.g: port managers, port pilots, ferry companies/captains, shipping companies/ captains, cruise companies/captains …)						
	Sustainable Marine living Resources *(e.g: fisheries managers, fisheries scientists, commercial and recreational*						

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	fishermen, sustainability managers; HABs)						
	Weather & Climate *(e.g. Weather Forecast Centers, data for model validation, assimilation)*						
	Basic and applied research in coastal oceanography *(e.g: Academia, private research organizations, ONGs)*						
	Other (Please Specify)						

Part TWO – USERS_REQUIREMENTS - Stakeholder analysis within and across the different pilots and sectors. Three levels of users were considered: the final or intermediate users inside the FORCOAST consortium, final users inside the three target sectors (fisheries, bivalve mariculture, and oysterground restoration) in each pilot site, as well as other final users of other sectors that could also benefit from the project outcomes.

Information needs and implications

Sector		*EXAMPLES (These are orientative only, please do not stick to them an propose those adapted to ou pilot/sector)*
PILOT		***n [...]***
What do you need?	Purpose	*To inform oyster harvesting* *To support decision* *Monitoring and management of resources (e.g. fish stock assessment, spread of seeds)* *Planning of restoration or production activities (e.g. location for restoration, new installations, new activities)* *Assessment of ocean conditions for activities (e.g. plan routine operations, where/where to target fishing effort)* *Ensuring quality of the products (e.g. monitoring/forecasting eutrophication, water quality)* *Reducing mortality (e.g. monitoring/forecasting hypoxia)* *Alert systems, planning of special protection measures in case of special events (e.g. monitoring/forecasting storms, TS conditions, water quality, hypoxia)*
	Information needs	*Water temperature at oyster ground X tomorrow* *Change in water temperature between today and tomorrow* *Sea surface temperature data (historical, long-time series of SSTmaps)* *Sea and weather conditions - forecasts (as accurate as possible)* *Plankton concentration/primary productivity* *Oxygen concentration* *[...]*
Why do you need it?	Decision to support	*If the absolute water temperature at oyster ground X becomes to high, we could choose to already harvest the oysters, instead of having them die* *[...]*
What can you do with it?	Action perspective	*Preemptive harvesting of oysters yes/no* *[...]*

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How much is it worth?	Costs associated with decision	*If no action is taken and the temperature gets to high, expected costs due to the loss of the harvest could be X. If action is taken, associated costs would be Y (costs of measure) and Z (decrease in value of oysers)*
What do you presently do?	How do you presently decide on when to act	*Based on actual conditions we measure ourselves, combined with local weather forecasts and experience [...]*
	How often	*On average we face such a situation a couple of times each year*
Based on what?	Present information available	*We presently get SST forecasts from CMEMS. However, the quality of the forecasts is not sufficient in our area, and also it is very cumbersome to check the information every data. Hence we don't really use this data. We do check the local weather forecast to see what the expected (air) temperature will be tomorrow, and take regular temperature measurements on-site ourselves.*
	Limitations of present situation	*The information presently available is quite crude, and our present decision making process quite inaccurate. Last year, we lost a signficant part of our harvest as a consequence of not acting in time.*
What should we offer?	Foreseen use in FORCOAST	*If FORCOAST could provide highly accuracte SST forecasts at our oyster ground, and provide these through an easy to use web-app, which would inform us if thresholds relevant to our operation are exceeded, we would certainy use this information in our decision making process, and take this into account in our standard operating procedured.*
	Value of information	*We would potentially pay X euro/year for this information*

Details of information requirements

Type of Service / frequency	Operational	*x*
	One-time	
	On demand	
	Parameters	*Sea Surface Temperature, […]*
Temperoral coverage	Historical	
	Actual	*x*
	Forecast	*1 day*
Temporal resolution		*1 hrs*
Spatial coverage (horizontal)	Points	*Locations A, B and C*
	Spatial	
Spatial coverage (vertical)		*Surface*
Spatial resolution		*(point locations)*
Processing		*Daily min, max, mean*
Accuracy / skill		*RMSE = 0.1 ºC, BIAS = X, POD = Y, FAR = Z, etc*
Uncertainty characterisation		*Uncertainty bandwidth*
Thresholds		*25 ºC*

Platform requirements

Delivery method	Platform (website)	*x*
	API	

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Visualization	Timeseries	*Timeseries plots at locations of interest, showing actual and forecast SST. With uncertainy bandwidth around the forecast series.*
	Maps	*Color coded icons on the map based on threshold exceedance*
	Tables	*Tabular summary of statistics (min, max, mean)*
Decision support tooling		*Overview of threshold exceedances using green, amber, red color coding. Also possibility to key in own (custom) threshold is required.*
Service level		*The platform should be available and contain up-to-date information during regular office hours at least*
Other		*In threshold exceedance overview, can we also list the possible consequences of exceedance, as well as the various perspective actions?*

Table 19 – Contents and structure of the questionaire for users and users' requirements identification.

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