VALMER

Marine ecosystem services

Assessment and valuation in support environnemental management

Case studies

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About

The VALMER project is an eleven partner, €4.7 million project co-funded by the INTERREG IV A Channel programme through the European Regional Development Fund, which aims to examine how improved marine ecosystem services assessment can support effective and informed marine management and planning.

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Layout

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The work presented here has been developed in six case studies of the VALMER Interreg 4A Channel project (2012-2015).

Coordination by M. Philippe[4], J. Ballé-Béganton[4] and D. Bailly[4] based on written contributions from K. Dedieu[1], F. Morisseau[1], R. Mongruel[2] and E. Thiébaut[3]

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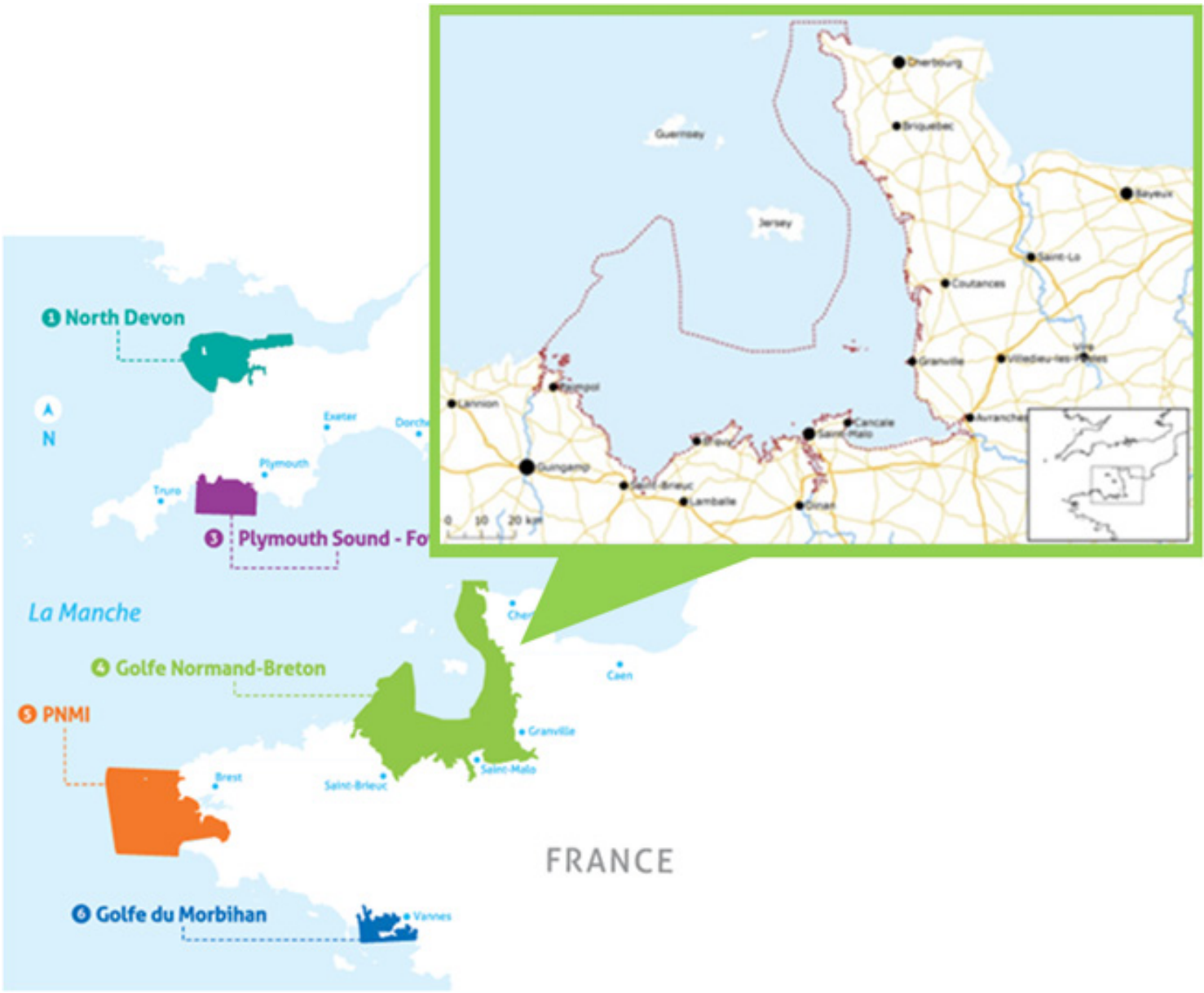
Site description



Within the area, lies a mosaic of marine and coastal habitats, which include sandy and rocky foreshores, sandy-mud estuaries, saltmarshes, biogenic reefs, intertidal sand flats and rocks, subtidal gravel, sands and rocky reefs.

Physical environment

The Golfe Normand-Breton case study site is a large marine area in the west part of the Channel, which includes French and Channel Islands marine waters. This area of over 11 000 km^2 comprises numerous marine protected areas with Ramsar, Natura 2000 sites, French designations sites and a proposed marine nature park within French waters.

Golfe Normand-Breton

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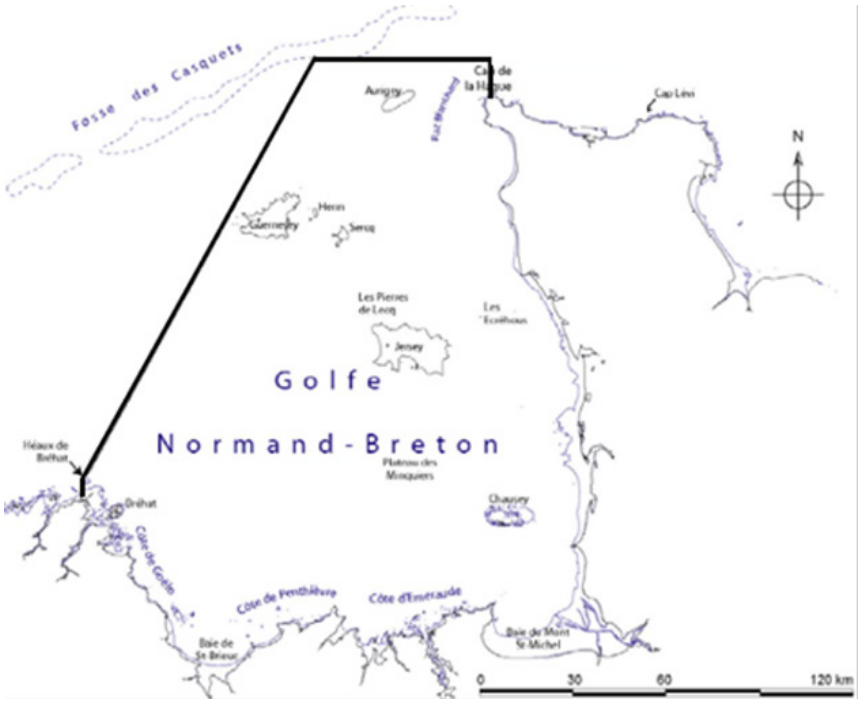

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Main Activities and Uses

In terms of human geography, the Normandy and Brittany coasts are heterogeneous. The coast of Normandy is generally less developed and urbanised than that of Brittany, which also has a higher population density and attracts more people for living and tourism.

With its bays, harbours, vast shores, numerous islands, and sandy, silty and rocky habitats performing many functions (coastal habitat nurseries, etc.), the Normano-Breton Gulf provides humankind with numerous services. Generally, the whole coast, is characterised by small to medium towns and villages with economies reliant to a significant extent on those services.

There is a great diversity and concentration of economic maritime activities such as :

- ✓ **professional fishing**
- ✓ **shellfish farming**
- ✓ **seaside tourism**
- ✓ **aggregate extraction**
- ✓ **agriculture**
- ✓ **nuclear power and fuel reprocessing industries**
- ✓ **recreational on-shore and boat-based fishing**
- ✓ **water sports**
- ✓ **nature observation**
- ✓ **gastronomy**

As well as broad range of uses of the sea and the foreshore. Others, such as **renewable marine energies** and certain forms of **aquaculture**, are extremely important for development in this area.

Together with the traditional activities carried out in the Gulf, the question arises of sharing the space between current and future activities, preserving marine habitats and species and maintaining the quality of the services that the marine environment provides.

Governance Arrangements

There are many governance structures (Marine Protected Areas, water management, etc.) in the area but no overall governance structure at the scale of the Gulf Normand Breton.

This process also had the goal to:

- ✓ acquire more knowledge on the socio ecological system of the area
- ✓ construct with local stakeholders and representatives of the area the basis for a marine park (with a 'common culture' and agreed socio-ecological issues for action).

Currently the marine park has not been created and this will depend on the decision of French Minister for the Environmental. This decision will trigger the development of a management plan agreed by a steering committee that will be composed of the stakeholders involved in the consultation process.

In this situation, the VALMER project presented **an opportunity to engage potential future members of the steering committee in thinking in terms of functionalities and ecosystems services,** creating a common culture and comprehension of the Ecosytem Services Approach.

In the framework of the proposed marine nature park for the area, a consultation process has been launched in 2011, led by a local team of the French agency for marine protected areas (Agence des Aires Marines Protégées).

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Aims of the Ecosystem Services Assessment

Within the Golfe Normand-Breton case study site a range of different marine and coastal habitats and ecosystems provide a suite of different services and benefits, which contribute in various ways to local economies and more broadly to human wellbeing.

Covering the greater part of the case study area are **subtidal muds, sands, and gravels** that incorporate a surprising range of habitats and are home to a rich variety of flora and fauna.

Although **intertidal marine habitats, composed of sandy or rocky foreshores, saltmarshes or biogenic reefs**, are less widespread, they also remain very important because they supply a range of ecological functions essential to the life cycles of marine species.

A wide range of potential services and benefits from these marine habitats was identified but the key ones are:

- ✓ **fish and shellfish stocks**
- ✓ **marine materials stocks**
- ✓ **carbon sequestration**
- ✓ **cultural heritage**
- ✓ **leisure and recreation**
- ✓ **storage and nutrient cycling**

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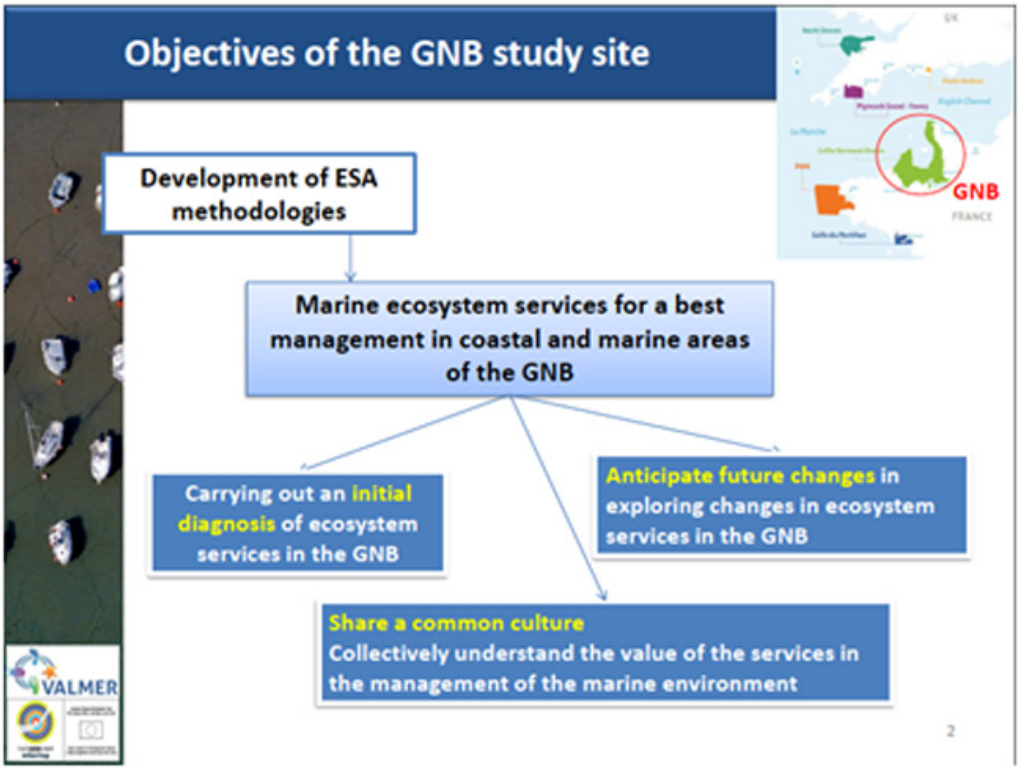
Since, the projected Golfe Normand-Breton park will manage the Natura 2000 marine sites and will have to write the DOCOB's (aims document), the ecosystem services approach gave the opportunity to help the definition of future actions thought a new approach i.e. functional and not sectorial (e.g. N2000 is focused on the protection of listed species and habitats and present actions did not take into account the functioning of the marine environment).

Three main aims have been identified through the TRIAGE process:

1. Carrying out an initial diagnosis of ecosystem services in the Golfe Normand-Breton
2. Anticipating future changes in exploring changes in ecosystem services in the GNB to facilitate trade-offs of priorities for a more integrated management of sea
3. Sharing a common culture

At the end of the VALMER project, it was realised that in this site's context (a large area with many different issues), the scenarios were very qualitative and that their main goal had switched from the anticipated trade-offs to creating a common culture by thinking collectively of different futures in term of ecosystem services.

After consulting local stakeholders, two main topics were identified to produce an initial diagnosis of ecosystem services in the area and to help anticipate of future changes: Food services offered by coastal and offshore marine habitats and Recreational services offered by foreshore marine habitats



Ecosystem Services Assessment Methods and Results

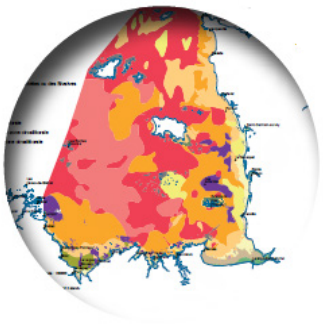
In the Golfe Normand-Breton, ecosystem services valuation is applied within a broad framework meeting the need to establish a first diagnosis of the «Gulf» macro-ecosystem which has never been done before.

Various valuation tools have been developed and tested in the Golfe Normand-Breton by economists, ecologists and fisheries experts from Ifremer, Université de Bretagne Occidentale and the Station Biologique de Roscoff to try to value as many services as possible during the project.

1. Linking Habitats, Functions and Services

The identification of ecosystem services linked to benthic habitats in the Golfe Normand-Breton, which is specific in that it features all of the Channel marine habitats, was therefore the first step in meeting the goal of a diagnosis.

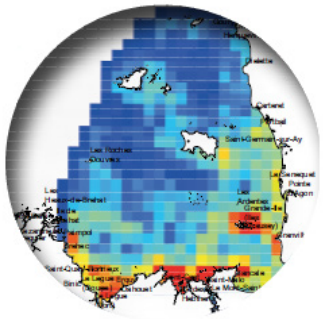
The nature of relations between habitats and ecosystem services is still at the semi-quantitative stage on many of them, due to a lack of knowledge or indicators.



Ecologists from the Station Biologique de Roscoff and Ifremer set out to explain and quantify the links that exist between benthic habitats, ecological functions and ecosystem services; «habitat-ecological function» and «habitat-ecosystem service» matrices were thus developed for the benthic habitats.

See "Linking Habitats, Functions and Services", page 15

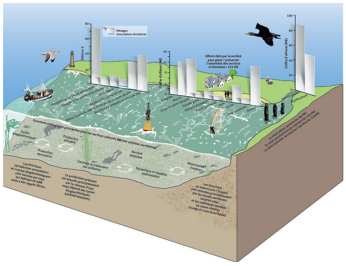
2. InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs)



The InVEST software programme was used to identify habitats the most subject to human-induced pressure and to assess their vulnerability in terms of providing ecosystem services. This modelling work uses the map of benthic habitats developed by ecologists as well as a whole load of data on pressure sustained by the various habitats and their sensitivity to it.

See "InVEST", page 18

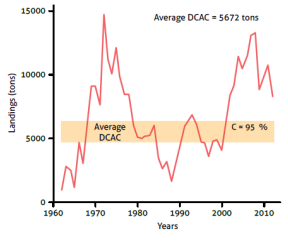
3. Ecological accounting



An activity counting approach based on the Golfe Normand-Breton's ecosystems aims to explain the complex links that exist between the main ecosystem services and the local economy.

See "Ecosystem accounting", page 19

4. Food provisioning services



Graph showing the catch and sustainable fishing level for scallops

To study the offshore fish production service, traditional and empirical approaches were used by fisheries experts and economists to determine a sustainable level of fishing for nine species in the Golfe Normand-Breton and to characterise the socioeconomic contributions/dependencies of fleets on the stocks studied. The nine species are: scallop, whelk, cuttlefish, spider crab, lobster, black sea bream, Dover sole, Venus clam, common skate.

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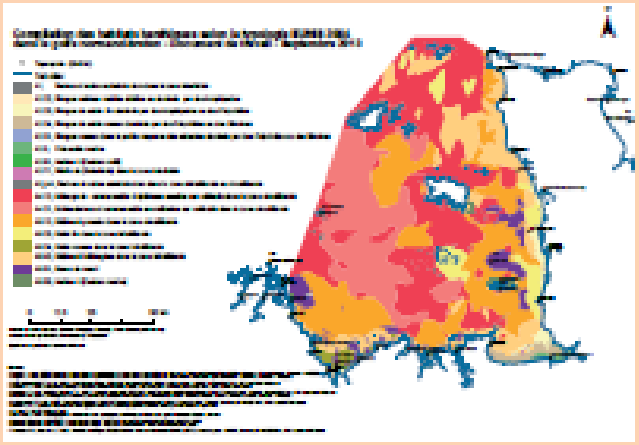
1. HABITATS / FONCTIONS / SERVICES
ÉCOLOGUES

Cartographie actualisée
des habitats benthiques du GNB.

Explication et quantification
des liens entre habitats benthiques,
fonctions écologiques et services
écosystémiques.



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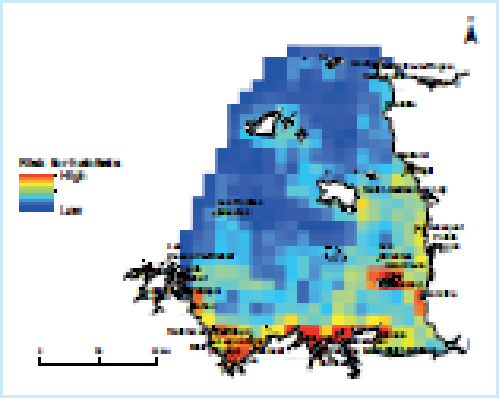
2. InVEST®
ÉCONOMISTES/GÉOMATICIENS

Utilisation du logiciel InVEST pour identifier
les habitats les plus soumis à des pressions d'origine
anthropique et pour évaluer leur vulnérabilité à
fournir des services écosystémiques.
Ces modélisations font appel à la carte des habitats
benthiques développée
en 1. mais aussi à de nombreuses données sur
les pressions subies par les différents habitats
et leur sensibilité à ces pressions.



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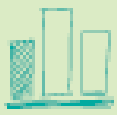
COMPTABILITÉ D'ÉCOSYSTÈMES
3. *ÉCONOMISTES*

Développement d'une comptabilité
des activités basées
sur les écosystèmes du GNB.

Ce travail de comptabilité vise
à expliciter les liens complexes
entre les activités humaines
et les services procurés
par les écosystèmes
(services écosystémiques).



Il a bénéficié à la fois du travail
réalisé par les halieutes
et de l'expertise des écologues
pour décrire les liens
entre services écosystémiques
et activités humaines.

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4. SERVICE D'APPROVISIONNEMENT ALIMENTAIRE
ÉCONOMISTES/HALIEUTES

Détermination d'un niveau
de pêche soutenable
pour neuf espèces du GNB
et caractérisation
socio-économique
des flottilles dépendant
spécifiquement de l'exploitation
de ces ressources dans le GNB.

Thanks to the information obtained through these valuations, efforts made by society to preserve ecosystems and the related services (e.g. fisheries management, protected areas, improving water quality, etc.) can be compared with the socioeconomic contribution derived from these services by human activities. Carried out by economists, this approach benefitted both from work done by fisheries experts and the expertise of ecologists to describe the links between ecosystem services and human activities.

The case study team produced a brochure in french which describes in more detail the four valuation methods used in the Golfe Normand Breton and the key results.

However, even if it is often referred to in the "cascade approach", the relationships between habitat, functions and services within marine ecosystems are not well known and understood.

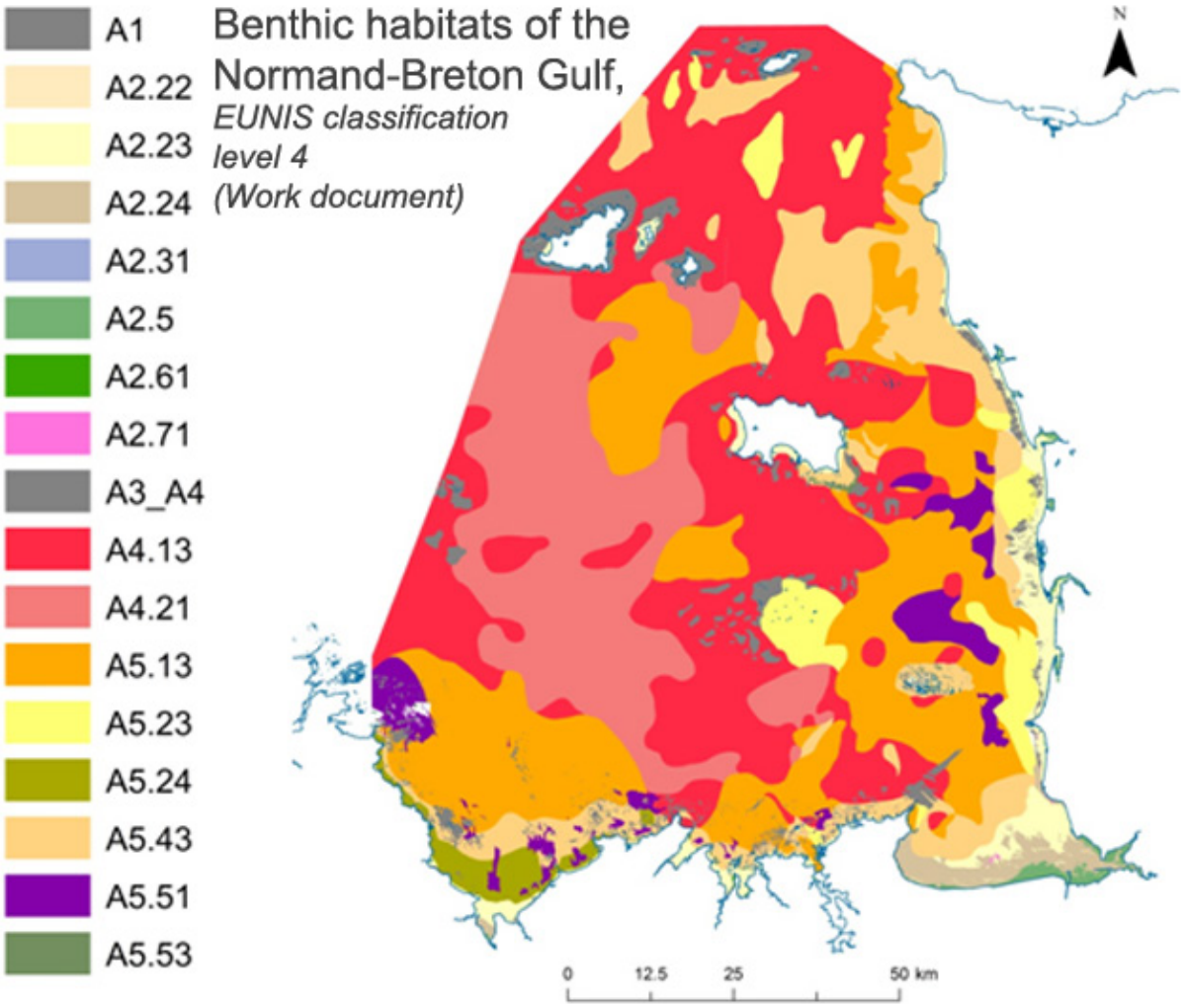
Linking Habitats, Functions and Services

In most cases, Marine Ecosystem Services Assessment is required in the context of a marine policy which may target the protection of marine habitats and biodiversity. Such policies are better informed by assessments which highlight the most important habitats or the key ecological functions for delivering ecosystem services.

A step forward in that direction was attempted in the Golfe Normand-Breton study site, which proposed a first overview of the services delivered by the diverse habitats of this site in the prospect of the creation of new Marine Protected Area.

Being part of an initial diagnosis, this exercise tried to identify and assess the contribution of all the habitats to key ecological functions and services.

The identification phase raised the issue of the appropriate scale, considering habitat heterogeneity and knowledge gaps.



It appeared feasible to recreate a complete map of the diverse habitats of the site using *EUNIS classification level 4*; however, this map was based on a set of oceanographic data collected over more than 40 years, what indicates that the current status of some habitats may remain doubtful.

The second step of this work consisted in linking those habitats with functions and services based on the available knowledge. The ecological functions were assessed using a large variety of sources.

Peer-reviewed papers were used first, some of them concerning a smaller part of the Golfe Normand-Breton (Mont-Saint-Michel Bay), comparable close areas (Bay of Morlaix) or more distant areas (Bay of Arcachon). Other sources included **unpublished in-situ observations** or **simple expert judgment.**

	A2.22	A2.23	A2.24	A2.31	A2.5	A2.61	A2.71	A4.13	A4.21	A5.13	A5.23	A5.24	A5.43	A5.51	A5.53
Gross primary production ($gC.m^{-2}.y^{-1}$)	~0	~10	23.5-50	135	675-1350	189-852	nd	~1	~1	<1	0-10	6-200	31	241	111-2599
Secondary production ($gC.m^{-2}.y^{-1}$)	0-5	4-15	4-15	15-30	0-5	25-30	nd	5-20	20-100	1.5-7	2.2-9.3	10-15	75-110	10	12-125
Habitat provision															
Nurseries (Σ Nb of species x importance)		5	2	9	3					3	2	8	9	3	6
Spawning grounds (Σ Nb of species x importance)								2	2	3		3	3	3	2
Stocking and waste of pollutants															
Nitrogen cycling ($\mu mol.m^{-2}.h^{-1}$)	~0	2-10 (2-4)	80-160 (4-60)	160-240 (15-56)	~0	<0	nd	40	120	40	70-200	130-300	210	53-226	Sink ?
Calcification ($gCaCO_3.m^{-2}.an^{-1}$)	~0	~0	10-120		~0		nd		682			69-104	515	490	
Respiration ($gC.m^{-2}.y^{-1}$)	~0	~30	30-100	110	nd	832-936	nd		204		60		180-440	407	54-1400
Erosion and sediment stability															
Formation of physical barriers															

Main ecological functions delivered by the various habitats of the Normand-Breton Gulf

This variety and heterogeneity of sources led the ecologists from the study site team to propose a **confidence interval** for the assessment of ecological functions based on three criteria:

1. the **quality of information sources**, considering the nature of the source (peer-reviewed papers, reports, expert judgement) and the nature of the data (field observations, modeling results)

2. the **applicability of evidence**, according to the nature of the habitat and the location (increasing distance from Gulf Normand-Breton to English Channel and North-East Atlantic)

3. the **degree of concordance**, which depend on the number of observations and the range of values.

The ecological assessment of the GNB highlighted the importance of four categories of habitats:

- ✓ **coastal saltmarshes and saline reedbeds** *(Eunis A2.5)*
- ✓ **littoral and sub-littoral seagrass beds** *(Eunis A2.61 and A5.53)*
- ✓ **heterogeneous sediments in the infralittoral zone** *(Eunis A5.24, A5.43)*
- ✓ **maerl beds** *(Eunis A5.51)*

The main functions which these habitats deliver are **gross primary production, secondary production, habitat provision, nurseries, stocking and waste of pollutants, nitrogen cycling, calcification and respiration**.

Based on expert judgment only, the link between habitats and services was also assessed, which revealed the major role:

- ✓ of intertidal habitats for shellfish farming
- ✓ of coarse sand and gravel habitats for commercial fishing

The results showed that, as expected, the near shore areas exhibit higher risk values, which means that these habitats are more exposed to pressures unlike the habitats in the offshore areas.

- ✓ of saltmarsh for traditional activities, of intertidal habitats for recreative activities but also for other cultural services
- ✓ of some offshore habitats in contributing to the cultural heritage in relation with fishing activities
- ✓ of offshore habitats in the provision of nurseries and the ocean nourishment.

The analysis suggested also the possible contribution of nearshore habitats to the regulation of water quality and coastal protection and the possible negative effects of some habitats on some services (e.g. act as a source of CO2).

This attempt to fill the knowledge gaps concerning the habitats-functions-services relationships in marine ecosystems produced the following insights:

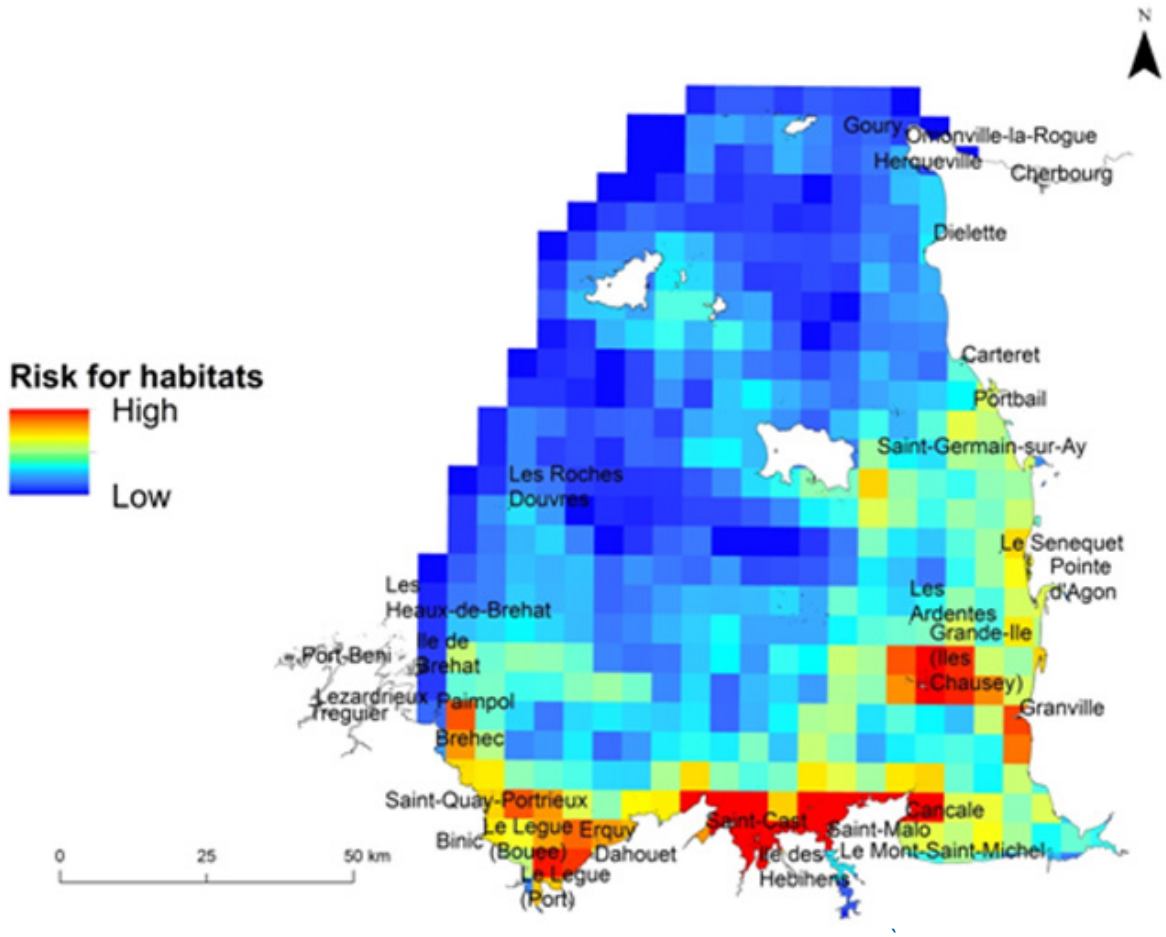
- ✓ Carrying out such an analysis based on literature review and exchanges with experts is time-consuming, but it generates no additional costs from field observations and experimentations. However, available knowledge may not be sufficient to assess the current status of all the habitats.
- ✓ Large gaps in functional ecology prevent from properly assessing the role of the main habitats in regulation services: this is due to lack of basic data, the limitations of data collected for other purposes and also heterogeneity in ecological functions.
- ✓ As it remains difficult to assess all the relationships between habitats and functions or services, it is clearly needed to focus on some major functions and services according to the management issues.
- ✓ Finally, the analysis of the habitats-functions-services relationships, although complicated, may help to move further from a static vision toward a dynamic system, taking into account the changes in the services delivery in response to human pressures.
- ✓ More work is also need to better understand the cumulative effects of pressure on ecological functions and ecosystem services.

InVEST

InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) is a suite of software models used to map and value the goods and services, which has been developed by the Natural Capital Project at the Stanford University.

The InVEST habitat risk assessment (HRA) model was applied as part of the initial diagnosis of the ecosystem services delivered by the Golfe Normand-Breton [Cabral et al., 2014]. This model allows users to assess the risk posed to coastal and marine habitats by human activities and the potential consequences of exposure for the delivery of environmental services and biodiversity.

The likelihood of exposure of the habitat to the stressor and the consequence of this exposure was done using expert knowledge by assigning a rating to a set of criteria for each attribute.



Cumulative habitat risk in the Golfe Normand-Breton

Ecosystem accounting

In the VALMER project, a satellite ecosystem account was developed which encompasses the activities using or maintaining the ecosystem services. This is a functional account which estimates the resources and expenditures of these activities.

An important issue for the integration of ecosystems in the "System of environmental-economic accounting" [SEEA, 2012] is the assessment of ecosystem cultural services. Most of those services are obtained through a process of "production for own use" by the households. It is thus necessary to extend the production boundary of the System of National Account in order to integrate those activities.

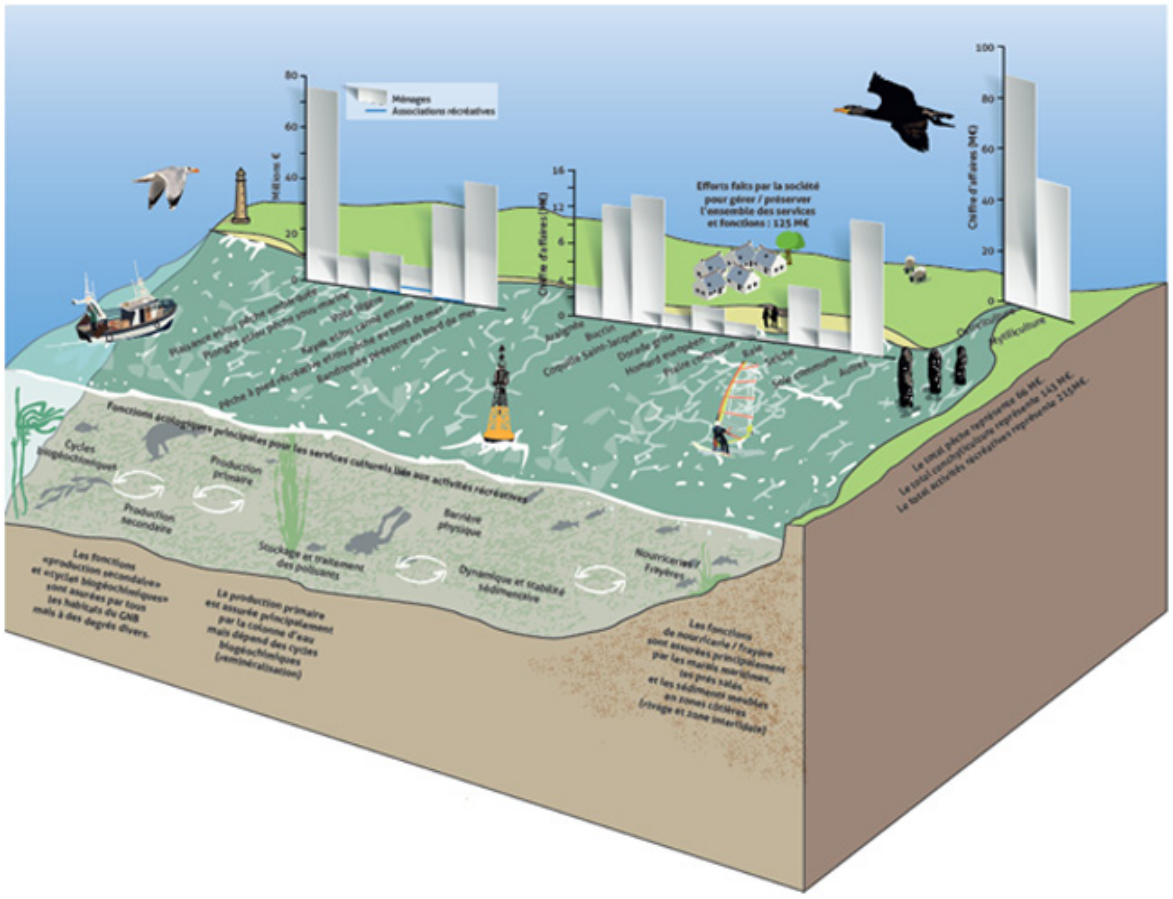
The valuation of this production means (including time) served as the basis for estimating the production value of the ecosystem services. The consumption time was divided into different types of ecosystem services consumption (recreational fishing, seascape) and other recreational activities (sport).

The value of the cultural ecosystem services production was finally estimated as a proportional share of the real consumption time.

In the Golfe Normand-Breton study site, a survey was carried out to estimates the means that households dedicate to the production of the recreational ecosystem services they consume: it necessitates preparation time, travel, materials, etc.

Finally, this contributed to a comprehensive picture of the ecosystem services targeted, for production or consumption, by human activities in the Normand-Breton Gulf for the year 2013.

In a first implementation stage, this ecosystem accounting approach necessitates methodological developments, which may be time consuming, however the approach can be easily repeated over time thereafter and can support marine management policies which build on the Ecosystem Services Approach for balancing uses and conservation.



Production value of the activities producing and/or consuming ecosystem services in the Normand -Breton Gulf (2013).

Links between the Ecosystem Services Assessment and the scenarios

In the Golfe Normand-Breton the Ecosystem Services Assessment has been led entirely by the scientific team of the project, providing a range of very advanced methodologies to provide an initial diagnosis of the situation.

The marine park has not been created yet so there is no collective management process. Therefore it was not possible to use and share this new knowledge with stakeholders in the context of decisions on specific management issues.

Participatory scenarios will provide four contrasting visions of the future (ecological and economical/governance state). The work developed within the Ecosystem Services Assessment helped to describe qualitatively the ecological consequences of each future on functionalities and ecosystem services. By helping to characterize the current situation (relative importance of economic activities), the Ecosystem Services Assessment helped to illustrate the consequences of degradation of ecosystem services on those activities.

In this context, the scenario exercise was very important so as to include and engage local stakeholders in our examination of ecosystem services and to create a common culture around those new concepts.

In this context, the development of exploratory scenarios was a good way of collectively exploring different management actions and socio-economic and environmental possible dynamics in this area.

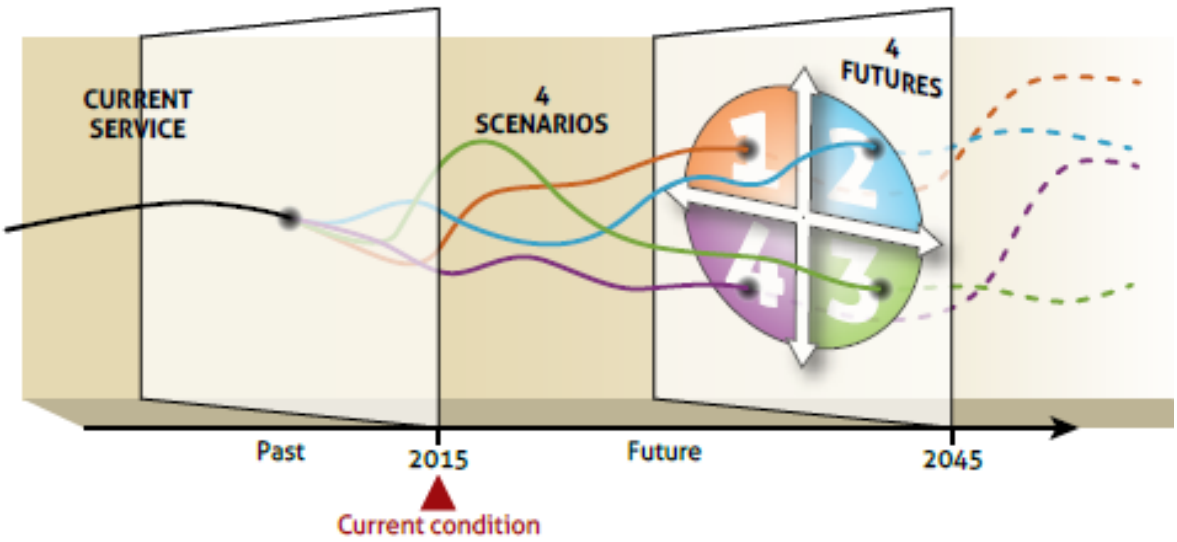
Aims of scenario building process?

The aim of the scenario exercise in the Golfe Normand-Breton was to provide a few contrasting future scenarios, helping us to think collectively about their consequences in term of ecosystem services and creating a common culture of understanding.

The scenarios developed in the Golfe Normand-Breton explore a range of possible management situations, economic and governance hypothesis, associated anthropogenic pressures (e.g. fishing, shellfish farming, moorings, decreasing water quality, invasive species, etc.) and natural process (e.g. climate change) that could have an impact on marine habitats and their ability to provide the various ecosystem services identified.

The final goal of the process is to determine, as quantitatively as possible, how the scenarios affect the functional, provisioning and recreational ecosystem services, using the results of the Ecosystem Services Assessment done for the area.

To achieve this a collective approach that involved gathering interested stakeholders and VALMER scientific team (ecologists and economists) of the Golfe Normand-Breton, started during the autumn 2013.



Detailed description of the scenarios approach

The tools used to build the scenarios were chosen using the VALMER scenario technical guidelines. It was important to have a method allowing involvement of stakeholders in the determination of important elements to be considered and to construct the scenarios stories. The **PESTLE analysis and matrixes** have been chosen as good way to do it.

A Seminar on ecosystem services, four workshops and thirteen focus groups (bilateral interviews) were organized in order to identify the topics to be explored, to build the scenarios and to present them to stakeholders.

Steps of the scenarios approach developed in the Golfe Normand-Bretoncase study site

Step1

In May-July 2013, the Golfe Normand-Breton team contacted local stakeholders to involve them in the VALMER project.

Step 2

On November,15th 2013: a ***"Common culture Seminar on the ecosystem services offered by the marine habitats of the Golfe Normand-Breton"*** and a ***" Workshop 1 on issues related to these ecosystem services"*** (Asking: "What are the services offered by the marine habitats in the Golfe Normand-Breton?" and " What are the issues related to these services?") were organised.

These proved useful in identifying general issues concerning the ecosystem services of marine habitats in the Golfe Normand-Breton:

- ✓ Soft sediments coastal habitats
- ✓ Energy offshore locations
- ✓ The marine harvesting activities (e.g. fishing)

Those issues were too general and concerning too many habitats, functionalities and services to be explored in scenarios. In order to define well-focused and realistic subjects for scenario development, the **TRIAGE methodology** has been done in strong collaboration with scientists of the VALMER Golfe Normand-Breton team.

Each general subject has been broken down into combinations of human activity-habitat-ecosystem services.

The 150 combinations obtained were tested by asking 3 questions:

1. the ecosystem services potential of change
2. the influence of the local management
3. the effect of local vs. global pressures.

A5.13	ECOSYSTEM SERVICES (ES)	POTENTIAL FOR ES TO CHANGE	INFLUENCE OF MANAGEMENT ON ES CHANGE	INFLUENCE OF LOCAL FACTORS AFFECTING ES	INFLUENCE OF OTHER FACTORS AFFECTING ES (OUTSIDE THE SYSTEM)
FISHERIES	FOOD PROVISIONNING	HIGH	HIGH	MODERATE	LOW
INVASIVE SPECIES		HIGH	MODERATE	HIGH	MODERATE
FISHERIES	SYMBOLIC & AESTHETIC VALUES	HIGH	HIGH	MODERATE	LOW
EXTRACTION	RAW MATERIAL	HIGH	HIGH	LOW	LOW
ARTIFICIALISATION		MODERATE	HIGH	HIGH	LOW
INVASIVE SPECIES		HIGH	HIGH	LOW	LOW

Example of the TRIAGE process for the habitat Infralittoral coarse sediment (Eunis A5.13)

The aim of this workshop was to collect keys elements to construct the narrative scenarios. For this, the stakeholders were divided into four groups: two groups working on "recreational services" and two groups working on "food services".

This process allowed us to defined 4 well-focused subjects:

- ✓ **The future of the scallop's resource harvested on soft sediment** considering the implementation of management measures (e.g. fight against the invasive slipper limpet, fisheries management, development of new activities as offshore wind, shellfish farming).
- ✓ **The future of bivalve exploitation relative to changes in practices** (e.g. shellfish farming, leisure fishing) in a context of coastal population and activities increasing, and potential decrease of water quality.
- ✓ **The future of foreshore's recreational activities** (access and share of the space) in a context of coastal population and activities increasing, and potential decrease of water quality.
- ✓ **The future of exploited resources on offshore sands**: fish, scallops in a context of practice's changes (e.g. new offshore wind projects, fisheries protected areas).

Summary sheets of each topic were distributed to stakeholders in order to debate and try to find a consensus. Moreover, an anonymous web survey was undertaken to identify a consensus on the subject to be selected. The survey's results were then completed by the existing scientific knowledge (qualitative and quantitative) for each subject, so as to determine a common topic, interesting and feasible to support a solid scenario development process.

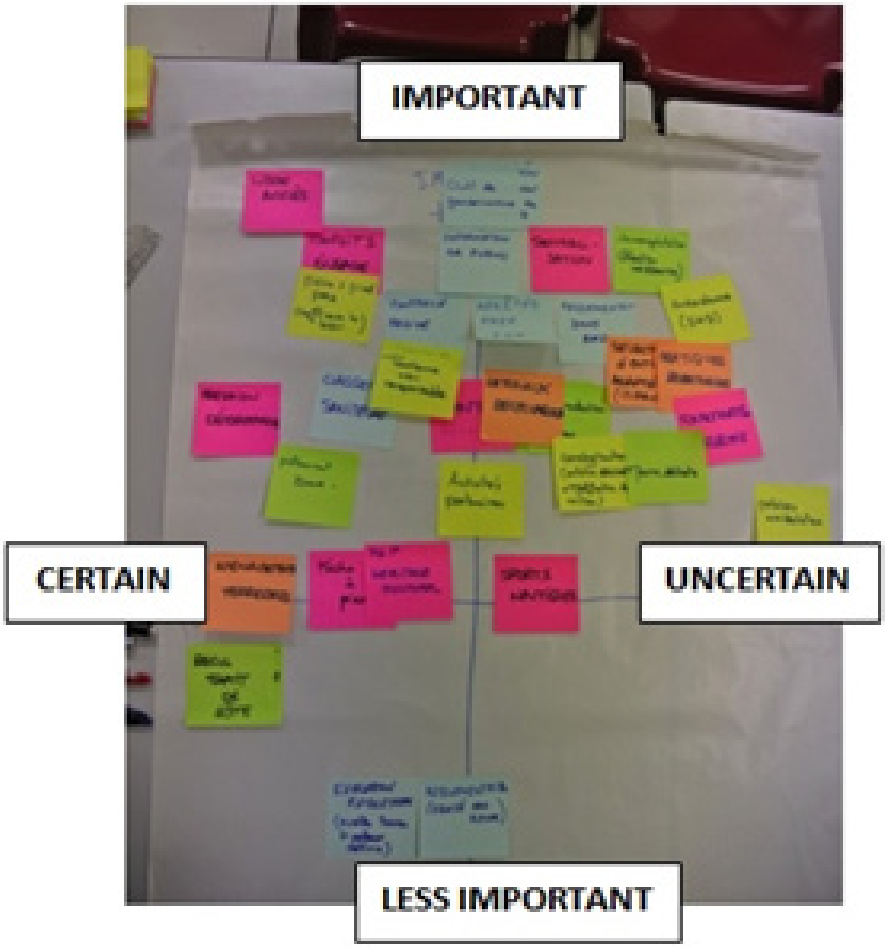
Unfortunately, it was not possible to identify a single priority issue. It was therefore decided to work on two topics:

1. **Food services offered by coastal and offshore marine habitats**
2. **Recreational services offered by foreshore marine** habitats

Step 3

On February, 13th 2014: "Workshop 2: to identify issues to explore and start the development of scenarios: How the issues identified can evolve in the future?" *(20 participants)*

In each group, the participants expressed their views on key elements (as an unprioritised list) related to the subject matter using the PESTLE categories (Policy and regulation / Economics / Society / Environment / Technology).



At the second workshop the participants sorted the list from the first workshop according to their importance level (vertical axis) and their probability of occurrence (horizontal axis) as follows):

1. Sort the items on list in the order of highest to lowest importance, placing them on the vertical axis
2. Then, keeping the vertical placement, move the items along the horizontal axis and
3. The development potential of each subject **in the next 30 years** is then shown in a simple and relative way.

Following the collective work of the workshop 2, the VALMER Golfe Normand-Breton team focused on all the items considered as «important» and then separated them into two classes according to their degree of uncertainty.

Step 4

On April, 22th 2014: **"Workshop 3 to identify the structural elements needed to develop scenarios"** *(20 participants)*

This work allowed the identification of:

- ✓ **heavy trends**: items "important" and "certain" that will determine forcing settings
- ✓ **critical uncertainties**: items "important" and "uncertain" that will determine the course of scenarios depending of their occurrence or non-occurrence.

From the "critical uncertainties" identified, the project Golfe Normand-Breton team defined two independent axes as structures to develop the scenarios for the two topics selected:

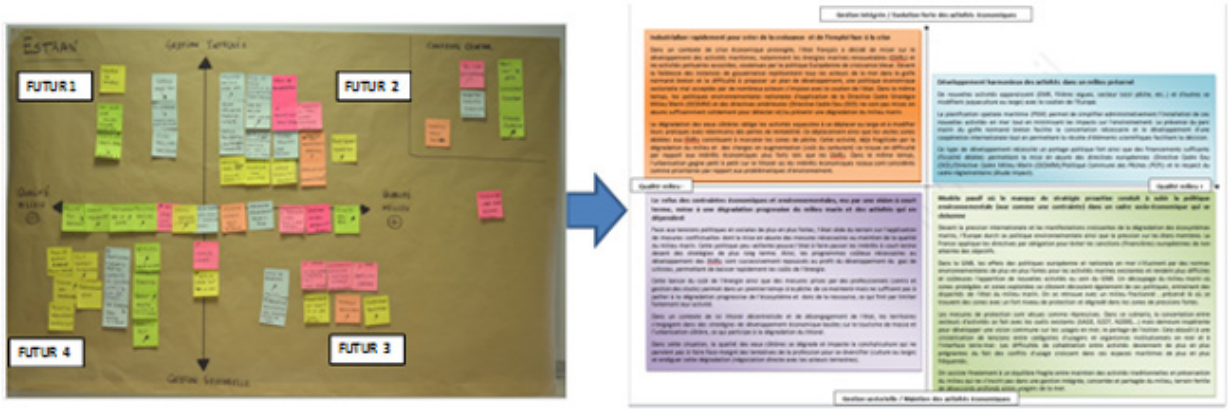
1 - Food services offered by coastal and offshore marine habitats

- ✓ Vertical axis: **"Strong evolution of economic activities" / "Maintenance of economic activities"**
- ✓ Horizontal axis: **"Low environmental quality" / "Good environmental quality"**

2 - Recreational services offered by foreshore marine habitats

- ✓ Vertical axis: **"Integrated management" / "Sectorial management"**
- ✓ Horizontal axis: **"Low environmental quality" / "Good environmental quality"**

All the elements identified by stakeholders were then redistributed between those axes for each subject, creating the base for the scenario storyline.



Pictures showing the result of workshop 3. The key elements have been distributed collectively following the scenario axes, allowing the team the write the first scenarios storylines.

Step 5

Summer 2014: **"twelve focus groups with relevant groups of stakeholders"** were conducted.

In order to complete the content of scenarios a number of bilateral interviews have been undertaken with relevant stakeholders or representatives of organizations from within the Golfe Normand-Breton area including state agencies (water, coastal management, N2000, marine protected areas), natural reserve, NGOs, county councils, offshore renewable energy, fisheries, shellfish farming and mineral and aggregate extraction.

Those perceptions were then integrated to form the content of each future scenario ensuring its integral coherency. During the review process, it was decided that the fusion the four scenarios for both subjects " Food services offered by coastal and offshore marine habitats" and "Recreational services offered by foreshore marine habitats" would be used.

In each interview, people were asked to give their perception of their activities in relation to each scenario and the future it predicted.

Step 6

On November, 27th 2014: **"Workshop 4: collective scenario validation".**

The scenarios were distributed by email to the stakeholders, then presented and discussed collectively.

This collective validation was then followed by a carousel exercise: stakeholders were divided into four groups working successively (15 min for each group) on the cartographic representation of each scenario.

This step allowed us to go further in the scenario analysis, validate and complete each scenario map.

What were the advantages and disadvantages of the scenarios methods used?

The first difficulty was in choosing the most appropriate methodology in relation to our needs.

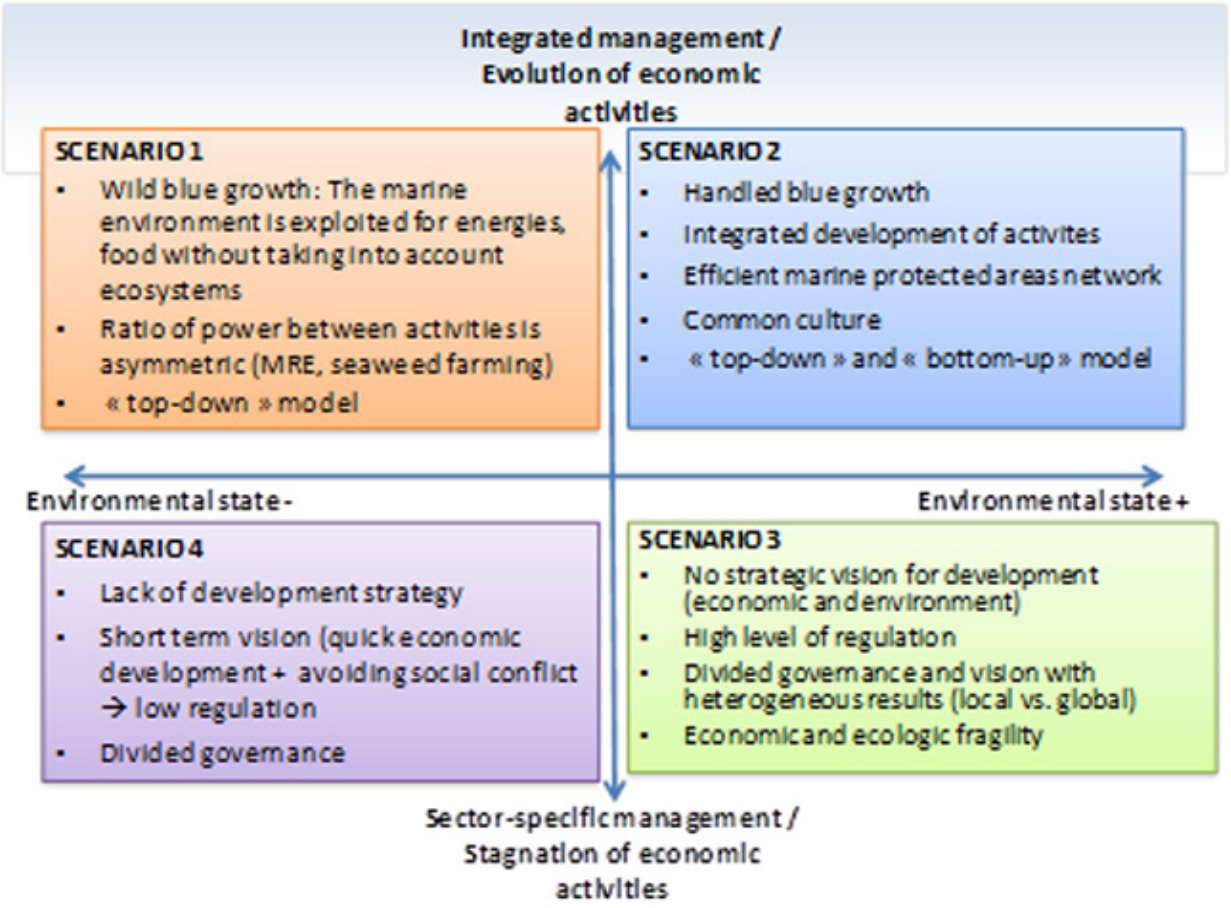
It was very helpful to be able to draw from the experience of some people from the VALMER project that had already used this method previously.

In the study site situation, it was extremely important to enable stakeholders to participate fully in the creation of the scenarios and the PESTLE methodology was very adapted to achieve that goal.

Moreover, the use of a well-defined participatory framework allowed us to give the opportunity to every stakeholder present in the room to participate and to build productive and effective workshops.

As the PESTLE methodology was new for the study site team, one of the major difficulties was to understand how to use it and the best way to facilitate the process.

Scenario description



Summary of the four scenarios developed in the Golfe Normand-Breton case study site

SCENARIO 1

Rapid industrialization to create growth and employment in an economic crisis context

In a context of prolonged economic crisis, the French government has decided to focus on the development of maritime activities, including marine renewables energies and port-related activities, supported by the European political blue growth.

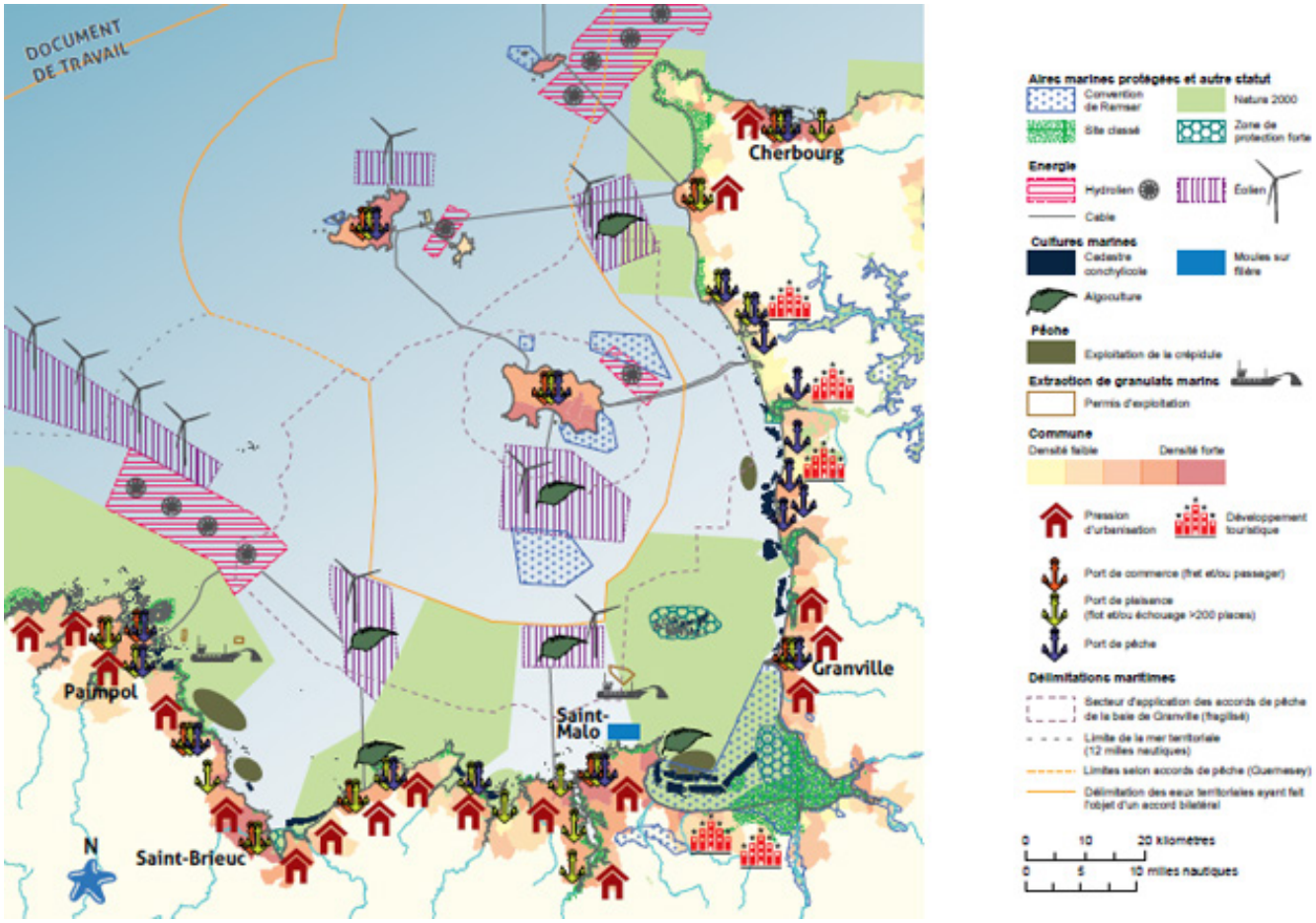
The weakness and fragmentation of governance institutions representing all stakeholders for the marine environment at the Golfe Normand-Breton scale does not allow the introduction of an integrated management plan.

In this context, some activities develop more than others with the support of sector-oriented policies. At the same time, the national application of the Marine Strategy Framework Directive and previous directives (Water Framework Directive) are not implemented sufficiently firmly to detect and/or prevent the degradation of the marine environment.

The degradation of coastal waters pushes aquaculture activities to move offshore and to change their practices albeit with production losses.

This movement and the large areas dedicated to offshore renewable energies contribute to reduce and break up fishing areas. This activity already weakened by environmental degradation and expenses increasing (fuel cost) are in difficulty compared to the strongest economic interests such as marine renewable energies.

At the same time, urbanization is gradually increasingon the coast where local economic interests are considered as a priority over environmental issues.



Visual restitution of the scenario 1 developed in the Golfe Normand-Breton during the VALMER project.

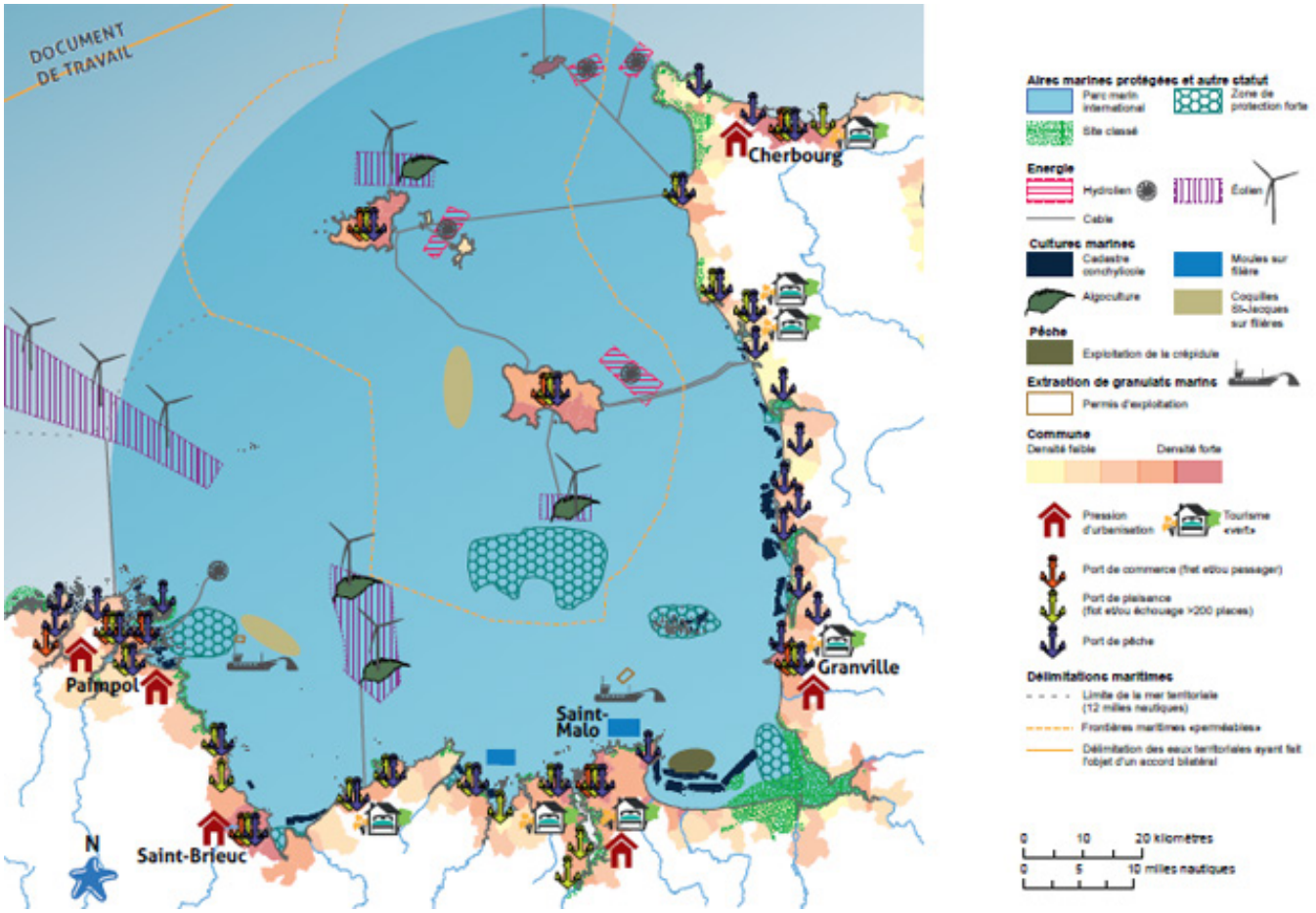
SCENARIO 2
Harmonious development of activities in a protected environment

New activities appear (marine renewable energy, seaweed farming, recreational fishing sector, etc.) and others are changing (offshore aquaculture) with the support of the European Union.

Maritime spatial planning (MSP) enables the administrative simplification of the installation of the new offshore activities while minimizing environmental impacts.

The presence of a Marine Park for the Norman Breton Gulf facilitates the coordination and development of cooperation with the Channel Islands and benefits from the gathering of scientific information that also facilitates decisions.

This type of development requires strong political support and adequate funding (environmental taxes) for the implementation of European Directives (Water Framework Directive (WFD) / Marine Environment Framework Directive (MSFD) / Common Fisheries Policy (CFP)) and compliance with the regulatory framework (Impact Assessment).



Visual restitution of the scenario 2 developed in the Golfe Normand-Breton during the VALMER project.

SCENARIO 3

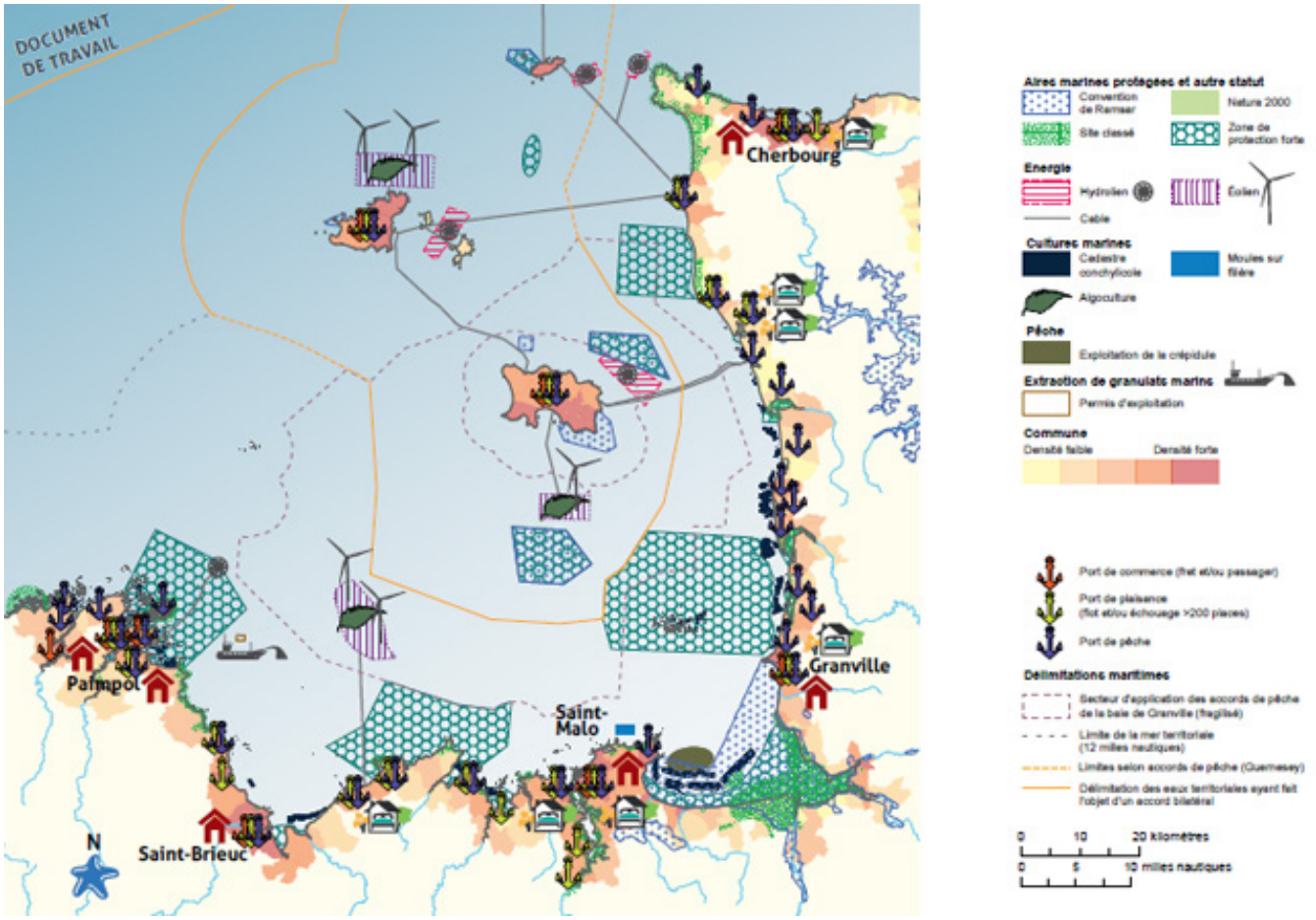
Passive model where the lack of a proactive strategy leads the vigorous en-forcement of environmental policy (seen as a constraint) in a compartmental-ized socio-economic framework

Faced with international pressure and the growing manifestations of the degradation of marine ecosystems, the European Union tightens its environmental policy as well as the pressure on member states to conform. France is forced to achieve its environmental objectives to avoid financial sanctions.

There is a need for quick results: environmental standards are increased in the Golfe Normand-Breton and this makes it more difficult and expensive for the emergence of new activities. The sea is divided between areas with a high level of protection and areas where protection is limited to certain zones, resulting in disparities in the state of the marine environment.

Protective measures are seen as restrictive. In this scenario, cooperation between sectors is done with existing tools (SAGE, SCOT, N2000...) but it remains impossible to develop a common vision on the uses of the sea. This results in an increase of tensions between categories of users and institutional bodies at sea and on the land-sea interface.

Finally we see a delicate balance between maintaining traditional activities and the conservation of the natural environment and the lack of integrated management, giving fertile territory for deep disagreements between users of the sea and of the coast to develop.



Visual restitution of the scenario 3 developed in the Golfe Normand-Breton during the VALMER project.

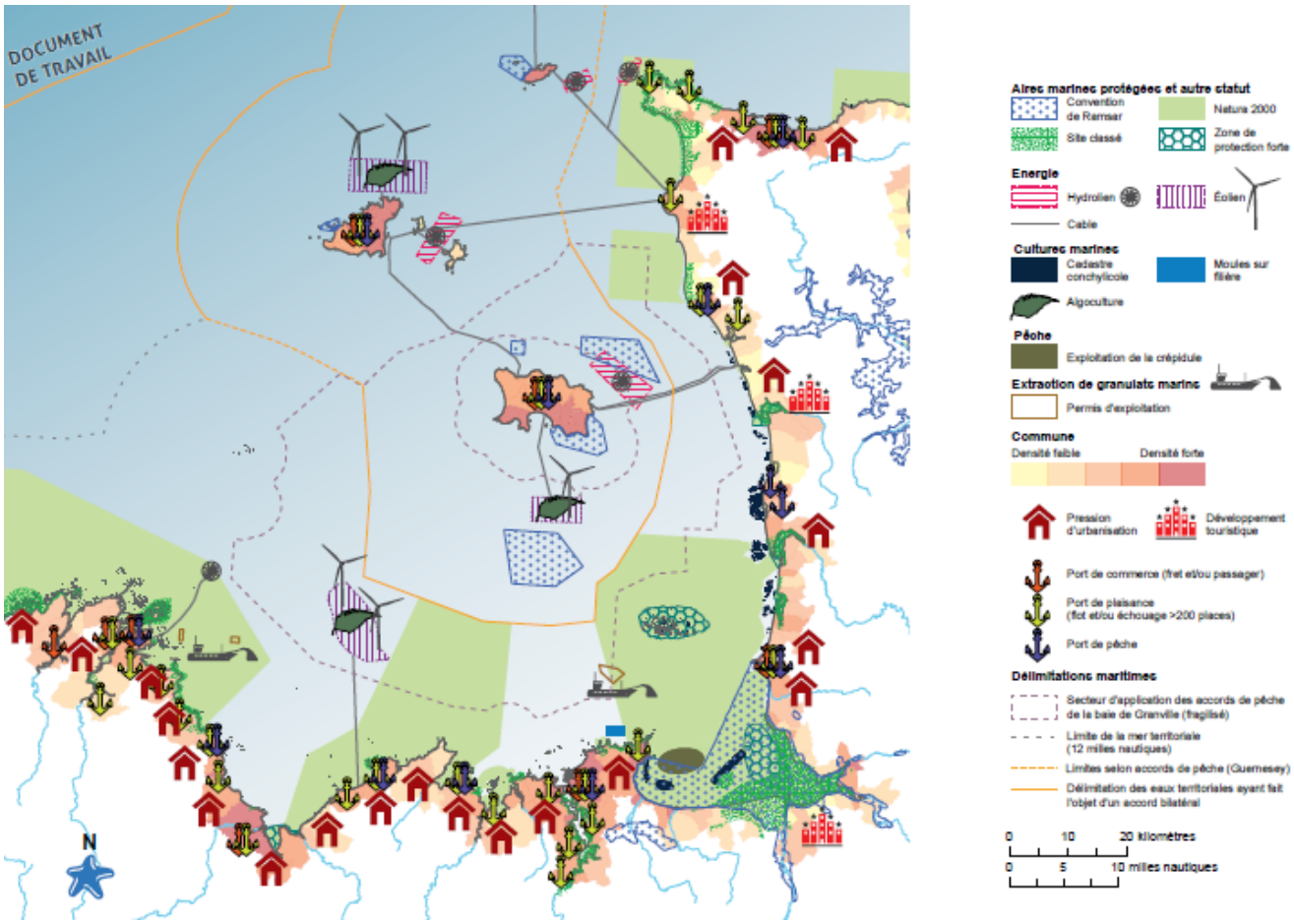
SCENARIO 4

The deliberate ignoring of economic and environmental constraints, driven by short-term view, leads to a gradual degradation of the marine environment and the activities that depends on it

Faced with increasingly strong political and social tensions, the state loses ground on the implementation of conflicting measures including the measures necessary to maintain the quality of the marine environment. This weakness favours short-term interests at the expense of a longer-term strategy. Thus, expensive programmes for the development of EMRs are successively postponed and the development of shale gas is favoured to quickly lower the cost of energy. The decrease in the cost of energy initially makes fishing more viable, economically. However, environment continues to degrade, which eventually impacts on the quantity of fish caught so reducing fishing activity.

During Workshop 4, some stakeholders pointed out that well-presented scenarios could help them to understand the issues from their areas (risks/opportunities) and explain them to others.

In a context of decentralized maritime law enforcement, disengagement of the state, and lowered environmental standards, regions engage in economic development strategies based on mass tourism and coastal urbanization with a lack of waste water management. Given this situation, coastal water quality deteriorates and impacts on the shellfish industry that fails to cope despite attempts to diversify the activity and stop the degradation (direct negotiation with land actors).



Visual restitution of the scenario 4 developed in the Golfe Normand-Breton during the VALMER project.

Use of scenarios outputs for management

How will the scenarios results be used after the VALMER project for marine management?

The scenarios developed were disseminated through brochures and a knowledge platform made available to stakeholders and concerned institutions. They were also presented in a more interactive way at the end of the project during the validation seminar (*workshop 4*).

The scenarios developed recognise the perceptions of a wide range of stakeholders on most of the Golfe Normand-Breton activities including: European/national/local policies, state of the environment, strategic development of some sectors, etc.

Therefore, it could be useful material to contribute to the preparation of marine park management plan in the future.

Have management recommendations been identified for future?

Due to the management situation, the aim was to produce contrasting exploratory scenarios to set-out different potential future situations in terms of ecosystem services.

Some of the scenarios developed are more "desirable" than others but all of them are the results of a multiplicity yet hypothetical process.

Therefore, it is not possible to provide management recommendation at this stage despite having characterized triggering/risk factors that make us fall into "undesirable future".

The preferred scenario would require agreement at a more formal level in the future for it to become operative.

Scenarios experience sharing

Advantages and disadvantages

In the framework of the proposed marine nature park on the area, a consultation process was launched in 2011, led by a local team of the French agency of marine protected areas (AAMP) with the stakeholders of this area.

This has meant that these stakeholders were already familiar with this kind of participatory exercise so the expected added value of helping the dialogue and creation of a common culture had already been attained, partially. The exercise however, remained relatively consensual and some gains were made.

For the VALMER project, even with the site stakeholders having already undertaken such participatory exercises, the process of thinking in terms of ecosystem services has helped the overall understanding in the area of the relationship between the natural environment and economic activities.

This exercise has been a great opportunity for the Marine Protected Area management team to better understand the links between public policies, activity planning at different scales and stakeholders perceptions.

Difficulties encountered

The first problem in the Golfe Normand-Breton was to ensure that well-focused and relevant subjects for ecosystem services scenario development were chosen while being unrestrictive on open with the discussions with stakeholders. The use of the triage methodology, whilst if time consuming, has helped greatly in this process.

It was often challenging as Marine Protected Area managers to assume the double identity of facilitators and stakeholder.

In this hypothetical management situation (i.e. no binding decision at stake), the engagement of stakeholders depended purely on their willingness and interest to participate and it was difficult to maintain their interest for the full duration of the project.

At the same time, this "no stake" situation allowed us to have a high degree of freedom in what was said during the debates.

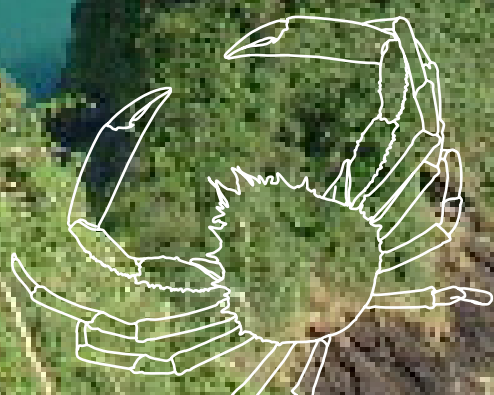
Finally, as the Ecosystem Services Assessment and the scenario development were two separate processes, it was difficult to find a way to assemble them in the right order to translate the scenarios into potential ecosystem services variations.

The triage process helped in demonstrating transparency and to avoid the questioning of the objectivity of the process by stakeholders.

Tips

- ✓ Carefully delimitate the aim of scenarios: adapt the level of detail to the potential goal (modelling, to tell a story, etc.)
- ✓ Engage a diversity of stakeholders: engage stakeholders from many different sectors (and not only representatives from organisations)
- ✓ Use different participation methodologies: post-its, carrousel, etc.

North Devon



Contents

The work presented here has been developed in six case studies of the VALMER Interreg 4A Channel project (2012-2015).

Coordination by M. Philippe[4], J. Ballé-Béganton[4] and D. Bailly[5] based on written contributions from O. Langmead[2,] T. Hooper[8], C. Griffiths[2], N. Beaumont[3] and S. Guilbert[1]

[1] Devon County Council / Devon Maritime Forum

[2] Marine Biological Association of the UK

[3] Plymouth Marine Laboratory

[4] Université de Bretagne Occidentale – Brest/ UMR AMURE

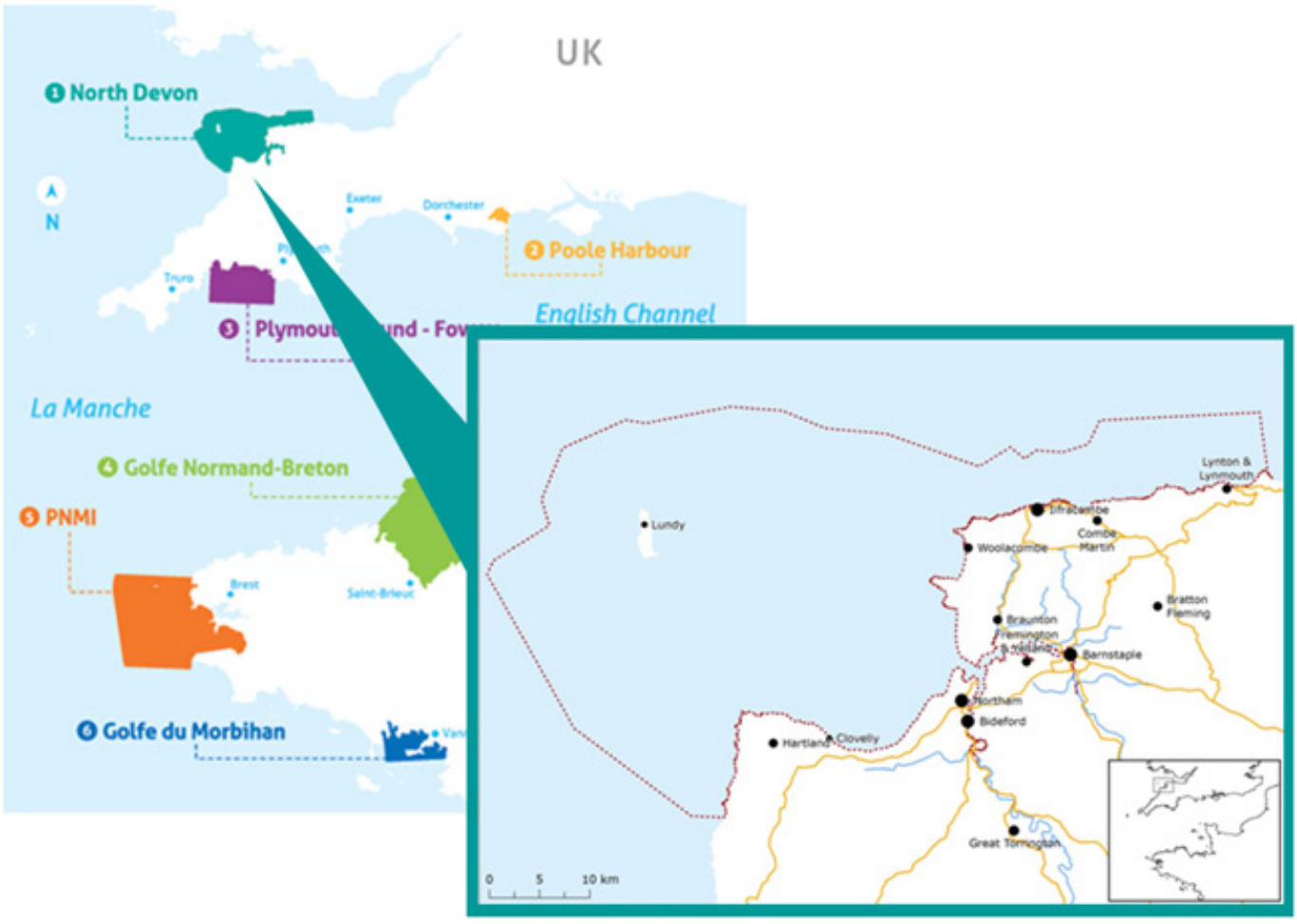
Site description

The core of the North Devon Biosphere Reserve is the Braunton Burrows dune system. The marine area of the North Devon Biosphere Reserve extends over 1500 km^2 of primarily sedimentary habitats and includes the Lundy Island Marine Nature Reserve, an Area of Outstanding Natural Beauty and Sites of Special Scientific Interest.

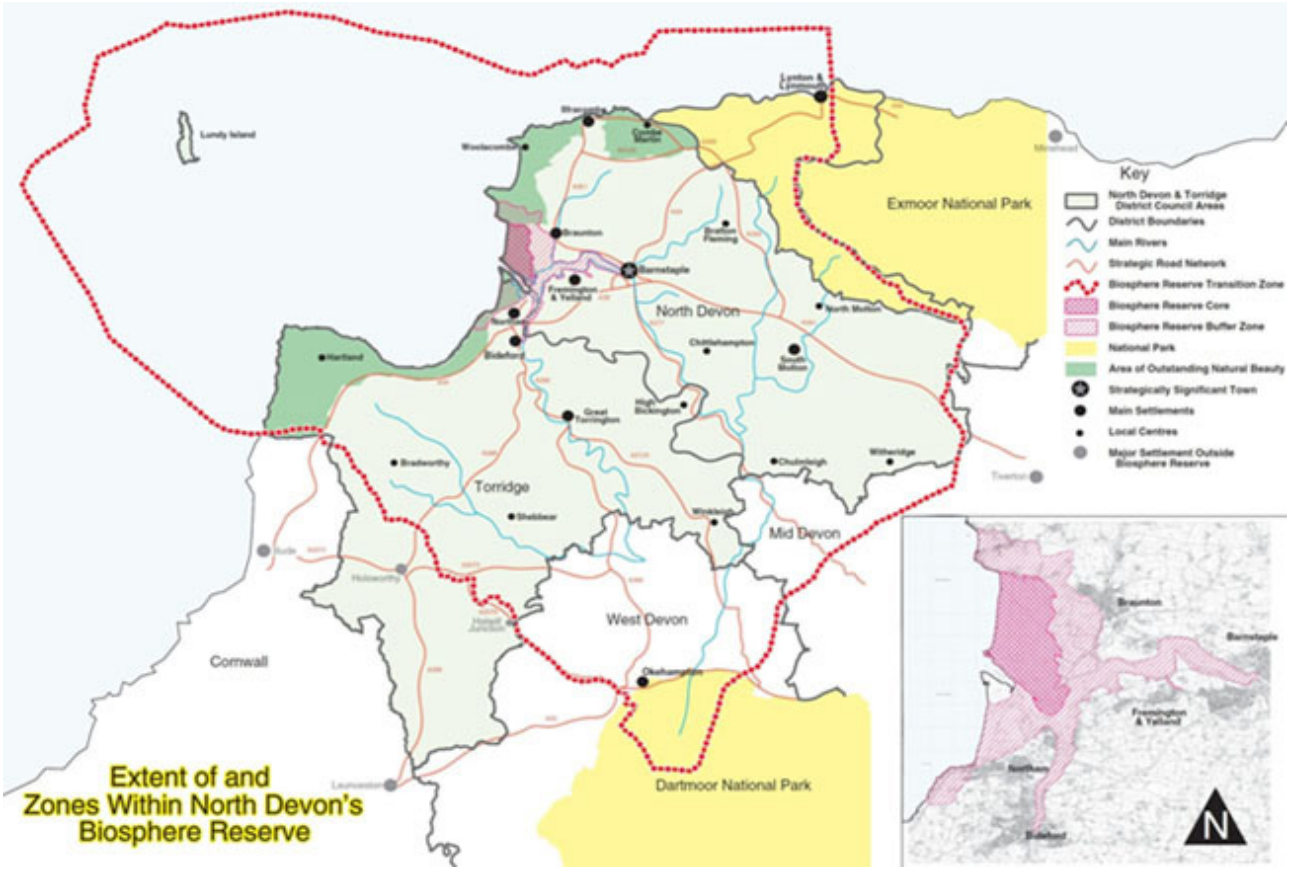
Tourism is a very important source of income for the local community, and fishing contributes to both the economy and the cultural heritage of the area.

Find out more about the:

- ✓ Devon County Council: http://www.devon.gov.uk/
- ✓ Lundy Island Marine Nature Reserve: http://www.lundymcz.org.uk/
- ✓ Area of Outstanding Natural Beauty: http://www.landscapesforlife.org.uk/

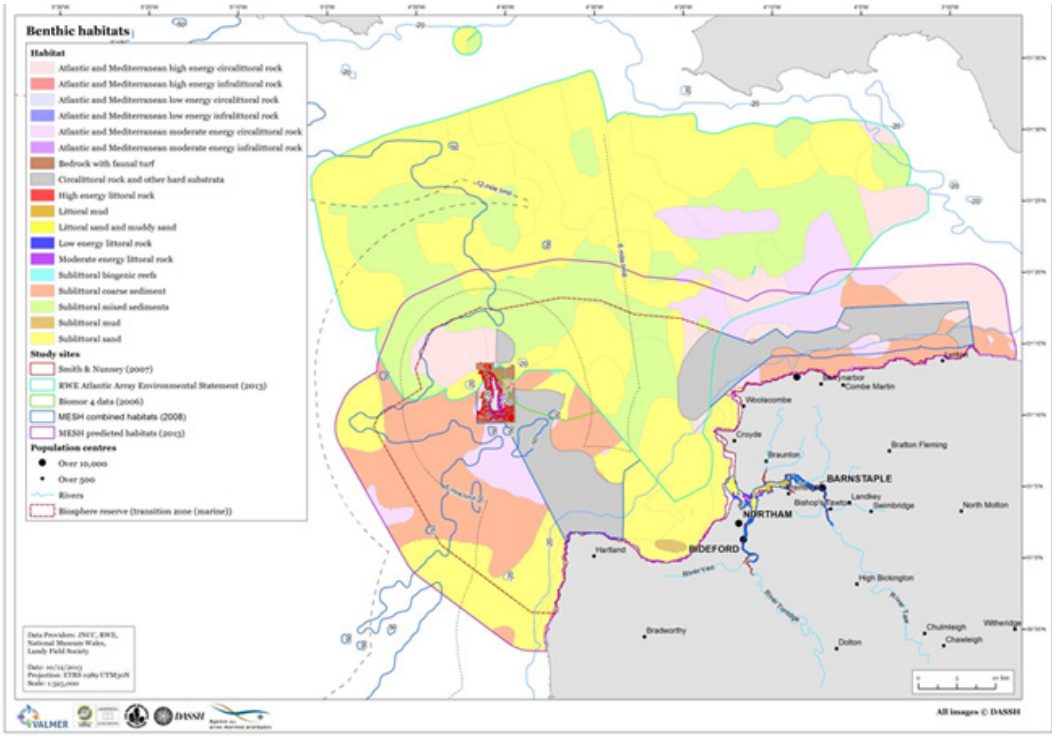


Biosphere reserve map



Focus of study

What habitats? Subtidal Sediments



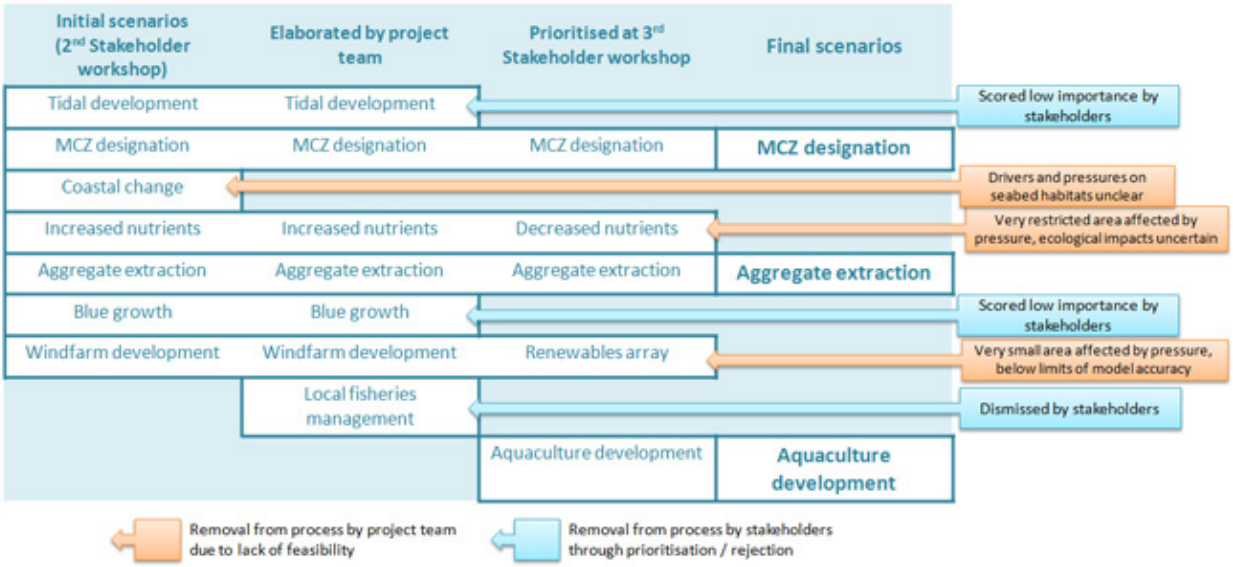
Subtidal habitats

What ecosystem services?

- ✓ Nursery habitats and food for commercially targeted fish and shellfish: bass, cod, skate & ray, lobster, flatfish (sole & plaice)
- ✓ Waste remediation
- ✓ Carbon sequestration

Objective

The objective was to raise awareness of the importance of sedimentary habitats, and to explore whether it was possible to generate information that would support the North Devon Biosphere Reserve management partnership's input into local and national initiatives including the designation of Marine Conservation Zones and the proposed development of an offshore wind farm.



Summary of Scenario Process

Key stakeholders and their involvement

The stakeholder group comprised the Marine Working Group (MWG) of the North Devon UNESCO Biosphere Reserve (NDBR) plus additional stakeholders to encompass sectors and interest groups relevant to the case study area.

There were additional stakeholders who expressed an interest in the project and a desire to be consulted and kept informed about the Case Study's progress, but did not attend any workshops.

Stakeholder engagement process

Stakeholder meeting

The stakeholder engagement process is outlined in the following table. All Stakeholder Workshops involved sharing knowledge between stakeholders and the project team.

This was structured with presentations explaining the purpose of the workshop and case study progress, with information relevant to specific tasks delivered, after which tasks were undertaken in facilitated breakout groups. The exception was Workshop 3 which was conducted entirely in plenary.

Stakeholder workshops

Method to determine which ecosystem services were the focus

Discussions with the North Devon Biosphere Reserve Coordinator and other stakeholders identified a shortlist of five priorities.

The "triage" process [Mongruel et al. 2015; Pendleton et al., 2014; Charles et al., 2015] was then used (in a deliberative process by experts and through an online survey of stakeholders) to determine the usefulness of an ecosystem service assessment (ESA) for each of the issues shortlisted.

Links to document access are available online on ZOTERO marine ecosystem services group :

www.zotero.org/groups/marine_ecosystem_services/items

Composition and meeting attendance of the North Devon Case Study Stakeholder Group.

Organisation	Sector	Role	North Devon UNESCO Biosphere Reserve Marine Working Group	Workshop Attendance			
				One	Two	Three	Four
Appledore sub-aqua club	Community	Diver		✓	✓	✓	✓
Coastwise	Community	Co-Chair	✓	✓			
Ilfracombe and North Devon Sub-aqua Club	Community	Diver		✓			✓
Ilfracombe and North Devon Sub-aqua Club	Community	Diver			✓		
Ilfracombe and North Devon Sub-aqua Club	Community	Secretary/Diver					✓
NDBR MWG/Coastwise	Community	Chair	✓	✓	✓	✓	✓
North Devon Yacht Club	Community	Secretary		✓	✓	✓	✓
Devon Wildlife Trust	Environment	Senior Marine Officer	✓		✓		✓
Lundy Field Society	Environment	Chair			✓		
National Trust	Environment	Properties Manager			✓		
North Devon Biosphere Reserve (NDBR)	Environment	Manager	✓	✓	✓	✓	✓
North Devon Biosphere Reserve (NDBR)	Environment	Data Analyst		✓	✓		
North Devon Biosphere Reserve (NDBR)	Environment	Intern					✓
Appledore and Bideford Harbour	Industry/Fishing	Harbour Master		✓	✓	✓	✓
Clovelly Harbour Association	Industry/Fishing	Harbour Master					
Commercial Fisherman	Industry/Fishing	Clovelly Shellfisherman	✓			✓	
Ilfracombe Harbour	Industry/Fishing	Harbour Master		✓	✓	✓	
North Devon UNESCO Biosphere Reserve Marine Working Group	Industry/Fishing		✓	✓			
North Devon Council/North Devon+	Industry/Fishing	Senior Regeneration Officer		✓	✓		✓
North Devon Fisherman's Association	Industry/Fishing	Chair	✓			✓	
North Devon Fisheries Local Action Group/North Devon AONB	Industry/Fishing	Chair/Chair	✓	✓	✓	✓	✓
North Devon/Barnstaple Chamber of Commerce	Industry/Fishing	Former Chair		✓			✓
SEAFish (also D & S IFCA and North Devon AONB)	Industry/Fishing	Chair/Chair/Manager	✓	✓		✓	✓
Sea-scope	Industry/Fishing	Consultant			✓		
Devon and Severn IFCA	Regulator	Deputy Chief Officer		✓			
Devon and Severn IFCA	Regulator	Senior Scientific Officer				✓	✓
MMO	Regulator	Incident Control Officer			✓		
MMO	Regulator	Marine Enforcement Officer		✓	✓		
Natural England	Regulator	Senior Marine Advisor	✓	✓			
Natural England	Regulator	Marine Advisor	✓	✓	✓		✓
North Devon Council	Regulator	Landscape & Countryside Officer					✓
Number of attendees				18	17	11	16

The triage scored each service against a series of criteria:

- ✓ the likely use of an ecosystem service assessment outputs in management decisions
- ✓ the potential for service delivery to change following management intervention
- ✓ the relative influence of external factors (such as climate change or national policy) on service delivery.

© North Devon's Biosphere Reserve

Ecosystem Services Assessment method and key results

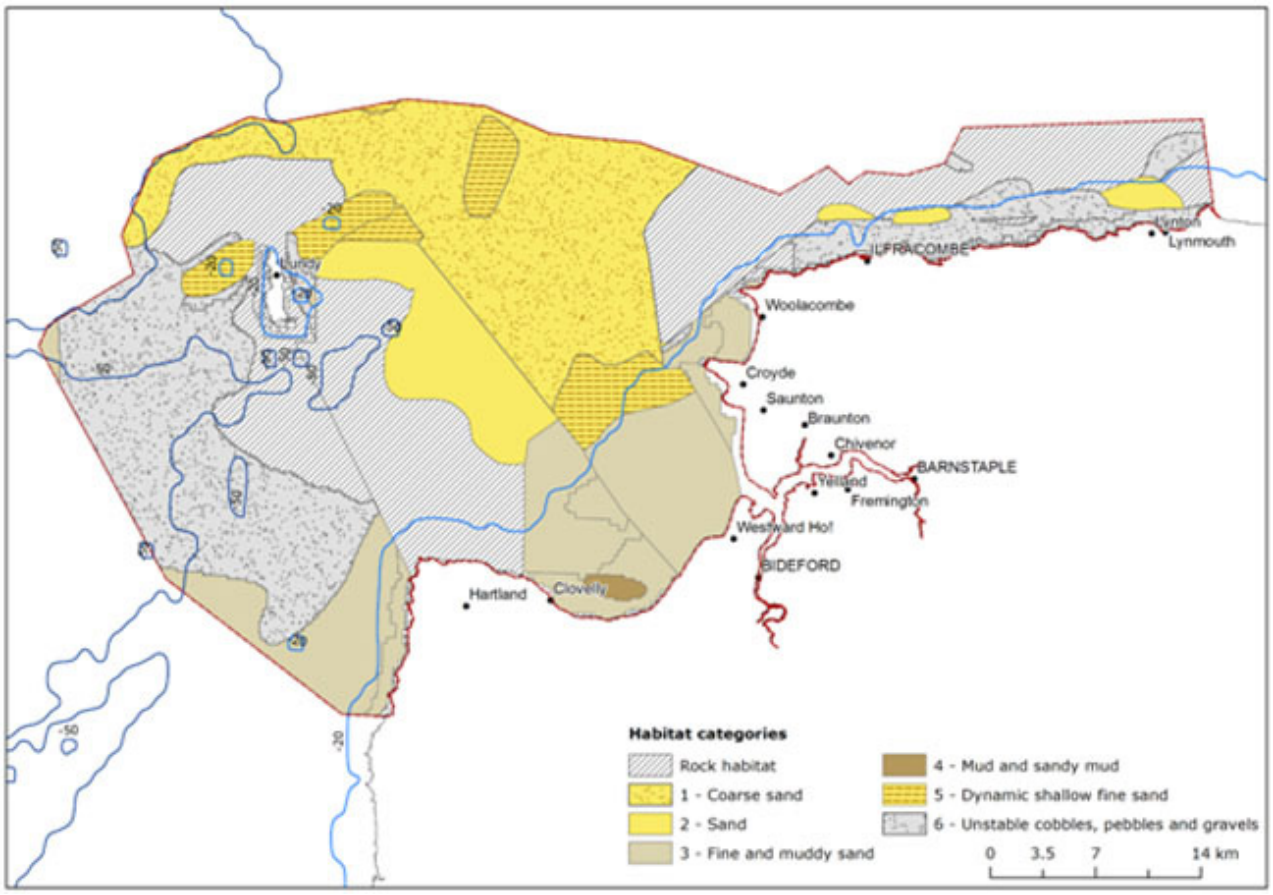
Habitats across the site were mapped, using recent and historic research as well as modelled maps, and amalgamated into six habitat classes with similar characteristics.

Different methods were used to determine the level of services provided by each habitat class:

Workshops	Content	Outputs
Stakeholder Workshop 1 13 December 2013	▪ Introduce marine ecosystem services concept ▪ Introduce project and objectives ▪ Overview of the case study site ▪ Showcase data and validate ▪ Overview of scenario process ▪ Future meetings and ToR	▪ Compiled datasets validated ▪ Additional data and wider expert knowledge gathered on ecology, activities and management
Stakeholder Workshop 2 30 January 2014	▪ Recap on project and case study ▪ Overview of scenario process ▪ Scene setting – current activities ▪ Scenario prioritisation ▪ Introduction to scenario development ▪ Developing scenarios	▪ Identification of a suite of scenarios for further refinement, with narratives and maps showing resulting changes in activities in the case study area
Stakeholder Workshop 3 20 March 2014	▪ Recap on project and progress towards goals ▪ Presentation of scenarios together with pressure maps ▪ Scenario scoring and discussion ▪ Presentation of ecosystem services assessment ▪ Introduction to the socioecological model	▪ Final scenarios for conditioning the socioecological model ▪ Stakeholder understanding of the current state of ecosystem services in the case study area, key areas for service delivery and areas of potential high service provision
Stakeholder Workshop 4 25 September 2014	▪ Case study recap ▪ Scenario development review ▪ Introduction to the socio-ecological model ▪ SES model results ▪ Breakout groups to discuss governance implications	▪ Stakeholder understanding of the scenario process ▪ Stakeholder discussion on model outputs and relevance to governance

- ✓ Nursery provision: a literature review determined the preferences of juveniles for sediment type and water depth;
- ✓ Waste processing: considered bioturbation (how much the species present rework the sediment, and hence the potential for waste to be oxygenated, buried and otherwise neutralised) using empirical data;
- ✓ Carbon storage: was based on sediment mud content.

Both experts and stakeholders identified subtidal sedimentary habitats as the most appropriate focus.



Broad habitat types classified according to fishing pressure sensitivity and ecosystem service contribution.

This produced a matrix (following table) linking habitat types to ecosystem service, using qualitative indicators.

It demonstrated that carbon storage was generally negligible due to the absence of vegetated habitats, and waste processing was mostly low, with the presence of large bivalves in coarse sediments key to the delivery of this service. Nursery habitat provision was significant for at least one key species for each of the habitats.

A confidence assessment was included, depending on the quality and quantity of the evidence available.

Relationship between habitat type and ecosystem service delivery

Habitat category	Nursery habitat: Bass, Sole, Plaice	Nursery habitat: Lobster	Nursery habitat: Cod	Nursery habitat: Skates & Rays	Waste processing	Carbon storage
Coarse sands/gravels						
Subtidal stable muddy sands, sandy muds and muds:						
a) sand						
b) fine & muddy sand						
c) mud & sandy mud						
Dynamic, shallow water fine sands						
Unstable cobbles, pebbles, gravels						
Confidence	*High*	*Low*	*Low*	*Medium*	*Low*	*Low*

Potential to supply ecosystem service: Significant Moderate Low Negligible

An example map of potential service delivery based on the relationship between habitat type and ecosystem service delivery (but not considering the current pattern of pressures that might reduce the provision of ecosystem services) is given in section "Scenario phase 4: Developing and parameterizing the socio-ecological model", page 58).

Scenario process

Within the context of this work, scenario means plausible, relevant management options and rather than internally consistent divergent futures formulated through analysis of possible societal, political and economic changes.

The scenarios for this case study were exploratory and built around a 15 year time horizon. The scenario process was divided into 5 phases.

Scenario phase 1: Characterising the North Devon Case Study area

A Driver-Pressure-State-Impact-Response (DPSIR) analysis was carried out to characterise the North Devon case study site, focus data collection and inform the ecosystem services assessment, scenario development with stakeholders and socio-ecological modelling work.

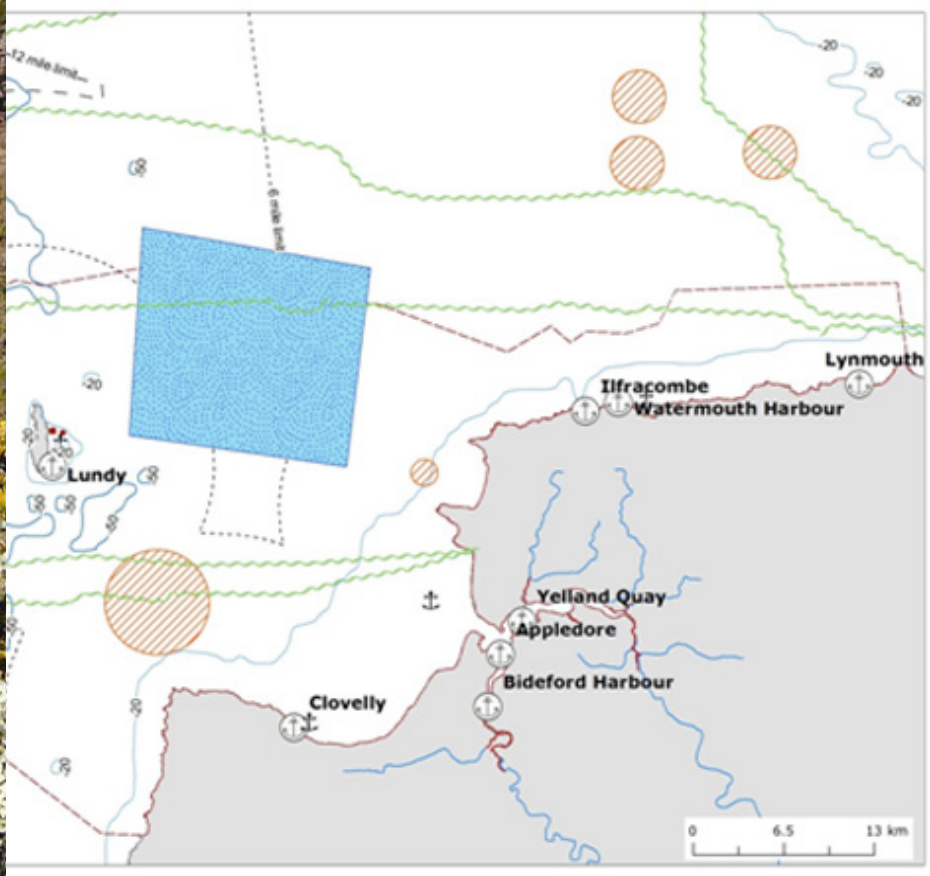
- ✓ Drivers were considered to be proximal (i.e. activities) rather than underlying (social, political, economic or climatic).

- ✓ Pressures associated with activities were identified via literature review and established frameworks e.g. JNCC activities/pressures matrix, MarLIN.
- ✓ State corresponds to the subtidal sediment habitats and their ecological communities. Considerable species and habitats records data on the subtidal sediment habitats were collated in a geospatial database in order to generate a composite habitat map of the area, together with a confidence map of the underlying data. This not only informed the ecosystem services assessment, but also provided the foundation layer for the socio-ecological model.
- ✓ Impact is emergent from this study as the human welfare impacts of pressures on the subtidal sediment habitats.
- ✓ Responses comprised both the existing arrangement of management interventions e.g. fisheries restrictions, MPAs, plus possible future ones such as the designation of Marine Conservation Zones.

These were used in the ecosystem services assessment and comprised the comparator for the socio-ecological model outputs for changes in service flows under divergent management scenarios.

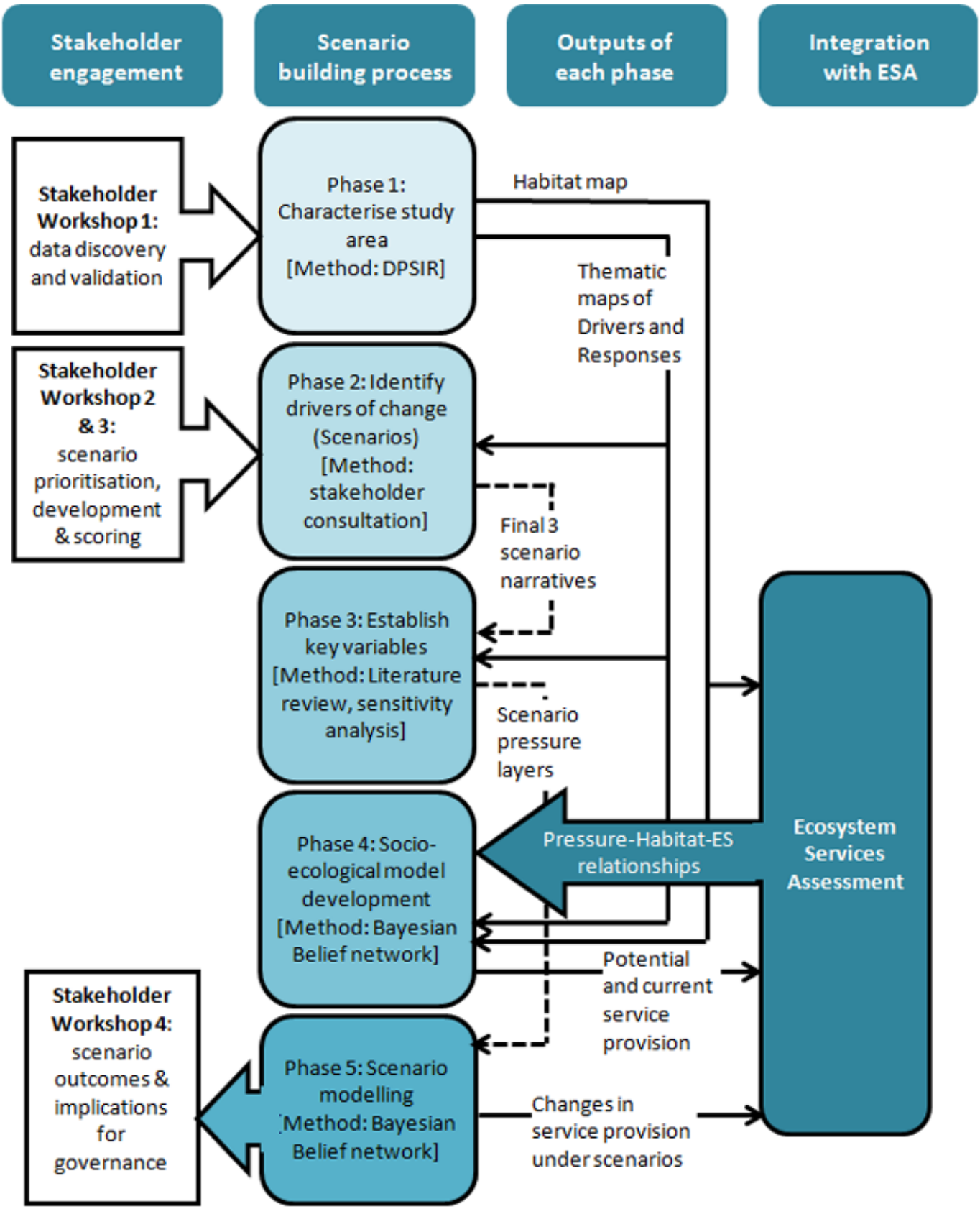
The maps were presented to the first stakeholder group meeting and were supplemented with further data and expert knowledge and validated (following table).

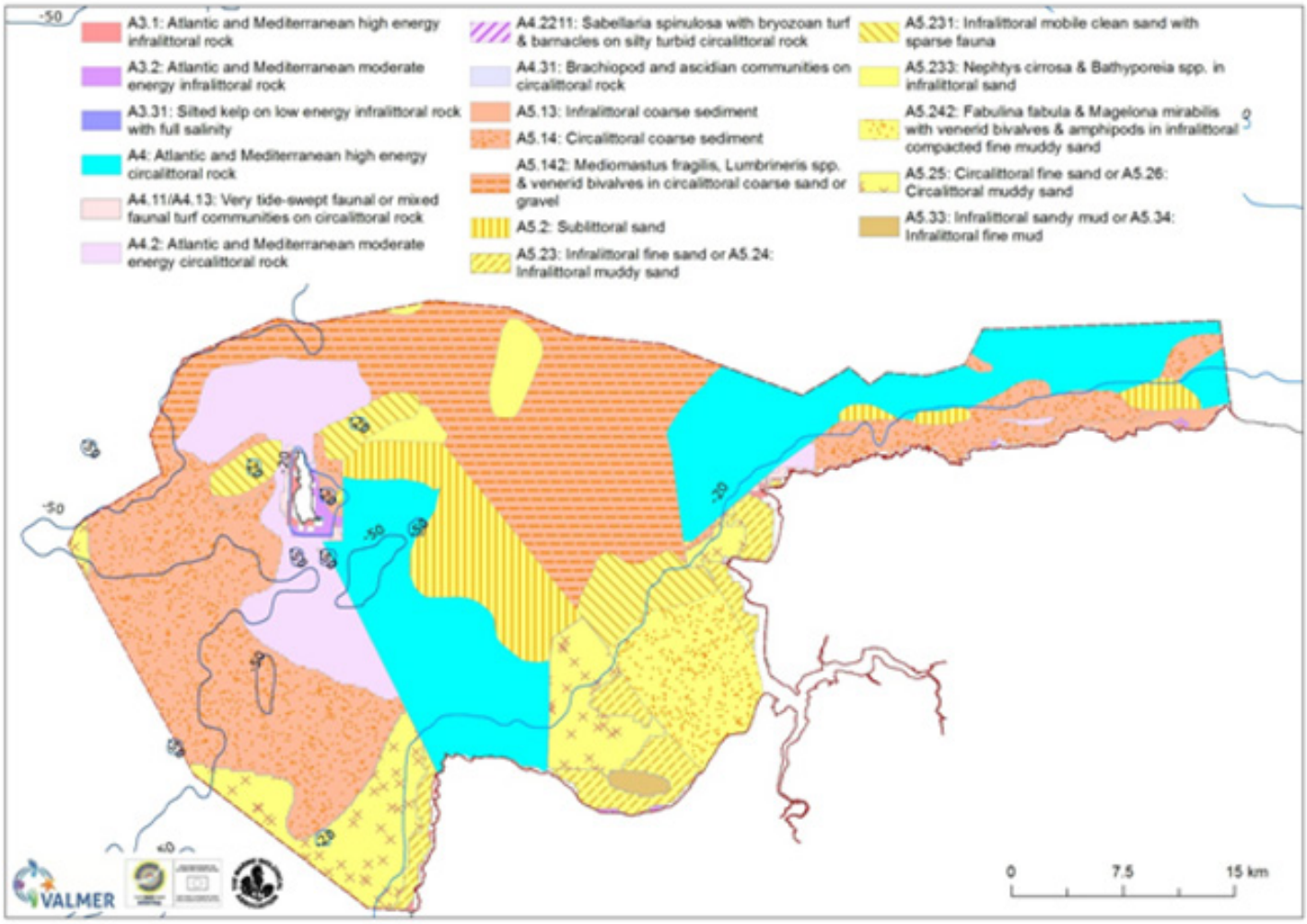
An example thematic map for a Driver (ports and shipping) and management Response (conservation areas) and the ecological State of the seabed (combined habitats map) is given in the following figures.



Example of Driver thematic map - ports and shipping (various sources).

Scenario development process indicating stakeholder engagement through four stakeholder workshops and integration with the ecosystem services assessment



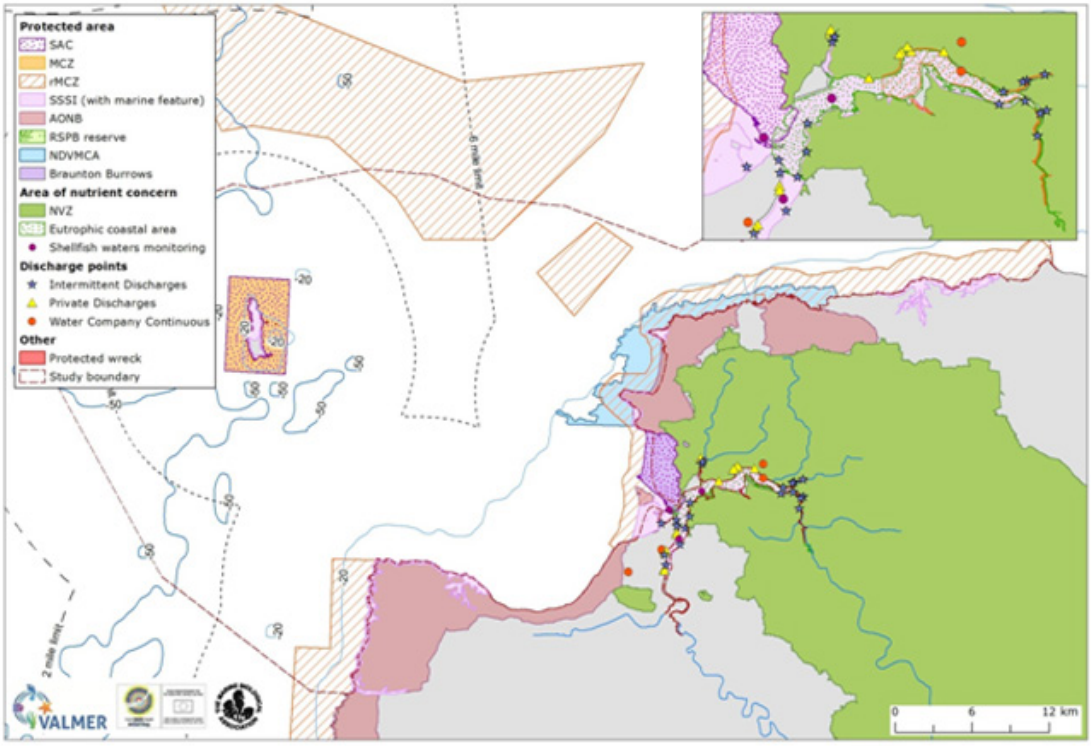


Maps of the 'current situation' were produced to show the spatial extent and where relevant, intensity of indicators for each of the Driver-State-Response elements.

Ecological State thematic map: combined subtidal benthic habitats map (sources: RWE surveys, UKSeaMap, Warwick & Davis Bristol Channel sediments, BIOMOR4 (Outer Bristol Channel Survey), Lundy Habitat mapping surveys, Barnstaple Bay grab sampling, MNCR Inlets in the Bristol Channel).

Driver-State-Response thematic maps

DPSIR component	Thematic map	Content
Drivers	**Commercial fisheries**	Potting Static nets Mobile demersal Lines
	Leisure and recreation	Diving Angling Surfing Boating Bathing Heritage Coast
	Ports and shipping	Maintenance dredging Anchorages Cables Ports and harbours Steaming areas Spoil disposal sites (historic) Protected wrecks
	Aggregates	Extraction sites Resource maps
	Military zones	Production/storage areas (quarry and tank farm) Harbour facilities Military practice areas Areas restricted to military
	Renewable energy	North Devon tidal energy demonstration zone North Devon tidal energy demonstration area Wind energy licence area Atlantic Array cable corridor
State	**Subtidal habitats**	Combined subtidal habitat map
Responses	**Conservation areas**	Special Areas of Conservation (SAC) Marine Conservation Zone (MCZ) Recommended MCZ Site of Special Scientific Interest (SSSI) with marine features Area of Outstanding Natural Beauty (AONB) RSPB reserve North Devon Voluntary Marine Conservation Area Nitrate Vulnerable Zone Eutrophic Coastal Area Discharge points (private and water company)
	Fisheries restrictions	Lundy No-Take Zone (NTZ) Lundy No-Towed Gear area Lundy No-Spear Fishing area Whelk Box Ray Box Trevose Box Coastal fixed net restrictions Shellfish waters



Example management Response thematic map – conservation areas (various sources).

Scenario phase 2: Identifying the scenario themes using stakeholder consultation

The project team further elaborated the resulting scenarios. During this process, some scenarios were excluded because the pressures on the seafloor habitat were hard to quantify or extremely low (below the limits required for the model to detect changes from the current situation).

Key issues of local importance were identified and scored, then prioritised during the second stakeholder workshop.

Prioritisation of the remaining scenarios was carried out at the third stakeholder workshop, where some scenarios were also dismissed outright by stakeholders (following table).

The outcome was three scenarios:

- ✓ Recommended Marine Conservation Zone (rMCZ) designation
- ✓ Aggregate extraction
- ✓ Aquaculture development (offshore mussel farm)

Development of scenarios with stakeholder group leading to the final three scenarios

Initial scenarios (Stakeholder Workshop 2)	Elaborated by project team	Prioritised at Stakeholder Workshop 3	Final scenarios	Comments
Tidal development	Tidal development			Scored low importance by stakeholders
Recommended Marine Conservation Zone designation	Recommended Marine Conservation Zone designation	Recommended Marine Conservation Zone designation	**Recommended Marine Conservation Zone designation**	Tranche 2 rMCZs does not include Morte platform, thus two subscenarios including and not including Morte Platform were devised
Coastal change				Drivers and pressures on seabed habitats unclear
Increased nutrients	Increased nutrients	Decreased nutrients		Very restricted area (only within estuary) affected by pressure, ecological impacts uncertain
Aggregate extraction	Aggregate extraction	Aggregate extraction	**Aggregate extraction**	Extraction site underwent changes due to seabed depth constraints
Blue growth	Blue growth			Scored low importance by stakeholders
Windfarm development	Windfarm development	Renewables array		Very small area affected by pressure, below limits of model accuracy
	Local fisheries management.*			Dismissed by stakeholders - led by fisheries sector
		Aquaculture development**	**Aquaculture development**	Introduced at Workshop 3 by stakeholders as a replacement to Local fisheries management

** Local fisheries management was suggested at Stakeholder Workshop 2, but time prevented its development during that event, so the scenario was subsequently developed by the project team.*

*** Aquaculture development was added, at the request of Stakeholders during Stakeholder Workshop 3, as an alternative fisheries development option following the rejection of the proposed local fisheries management scenario.*

Final scenario 1: Marine Conservation Zone designation

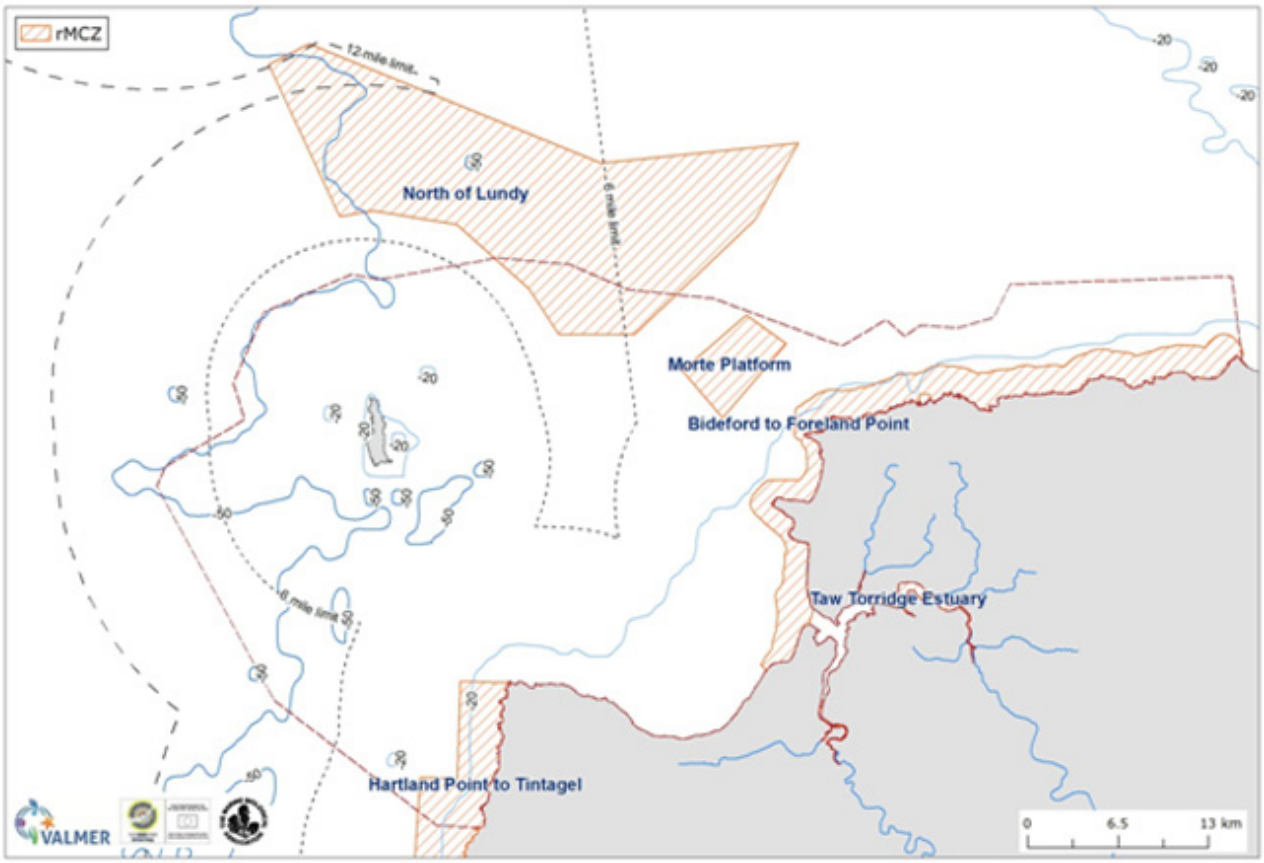
Assumption

All five recommended Marine Conservation Zones (rMCZs) in the North Devon Biosphere Reserve area are designated.

All of these sites, with the exception of Morte Platform, were included in Tranche 2 of the recommended Marine Conservation Zones put forward for designation by Defra [2014].

However, Morte Platform recommended Marine Conservation Zones, was put forward by Finding Sanctuary, the South West Regional project, in their recommendations to government in 2011 [Lieberknecht et al. 2011].

Thus within the recommended Marine Conservation Zones scenario, two sub-scenarios were constructed to examine the implications of designation both with and without Morte platform included to determine the importance of this site to the provision of ecosystem services.



Recommended Marine Conservation Zones (rMCZs) within the North Devon Biosphere Reserve area

Links to document access are available online on ZOTERO marine ecosystem services group :

www.zotero.org/groups/marine_ecosystem_services/items

Changes to existing activities

The response by the fisheries sector to new byelaws excluding them from recommended Marine Conservation Zones sites would be variable according to the location of each recommended Marine Conservation Zones (this is based on discussions with fishermen):

- ✓ Demersal mobile effort at Morte Platform and North of Lundy is lost;
- ✓ Demersal mobile effort at Hartland Point to Tintagel and Bideford to Foreland Point is displaced to nearby areas (aside from demersal trawling north of Lynmouth which is lost).
- ✓ Maintenance dredging within the Bideford–Foreland Point would continue.

Key Drivers

The main drivers for this are international policies on biodiversity conservation, including the Convention on Biological diversity and OSPAR. There is also a requirement for a well-managed network of MPAs within the EU Marine Strategy Framework Directive (2008/56/EC). This is transposed into UK policy within the Marine & Coastal Access Act [2009].

Final scenario 2: Aggregate extraction

Assumption

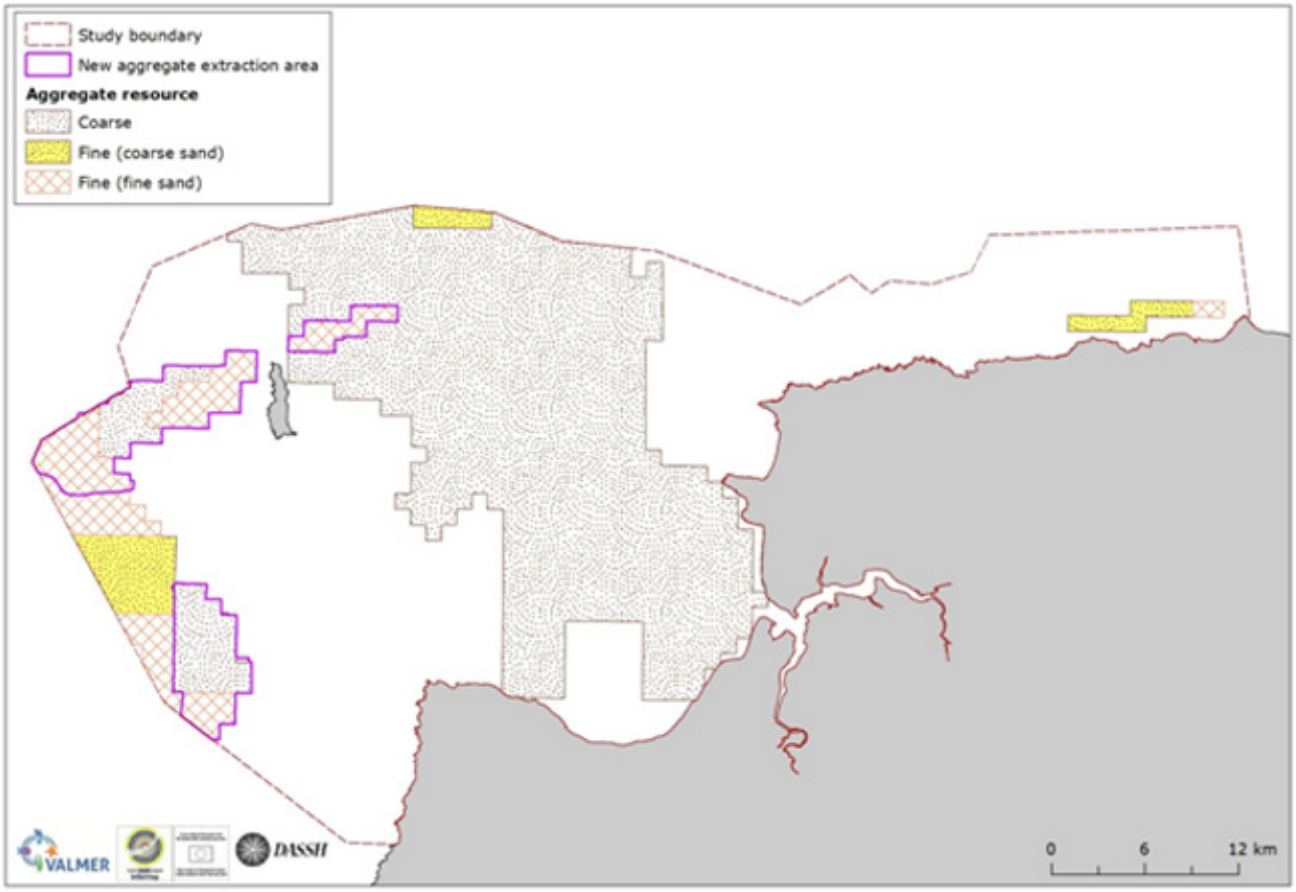
An aggregate extraction site is opened within the North Devon Biosphere Reserve. The footprint is approximately the same as the current extraction site in the Bristol Channel (86 km2). A combination of different aggregates types (fine and coarse sand) is extracted for use in the construction industry.

Changes to existing activities

Demersal trawling would be excluded from the extraction sites and a 1km exclusion zone surrounding them, and displaced into adjacent waters.

Key Drivers

As the UK economy starts to recover, the housing and construction sectors are beginning to grow again. There is a demand for marine sand and gravel.



Resource map for aggregates in the North Devon Biosphere Reserve area with aggregate scenario extraction sites indicated.

Final scenario 3: Aquaculture development

Assumption

An offshore mussel farm is sited in Bideford Bay, the only location suitable within the North Devon Biosphere Reserve. It comprises ropes between moorings with suspended mussel ropes.

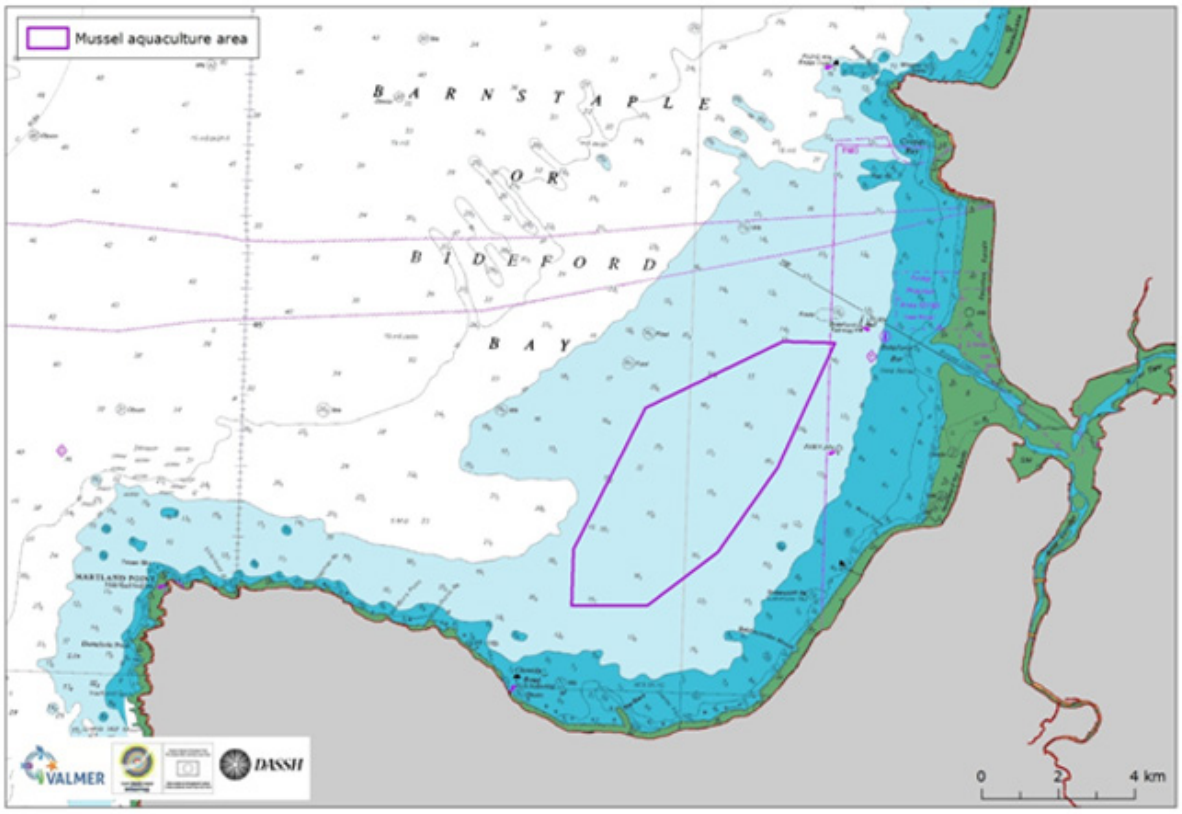
Our assumption is that demersal towed gears will be excluded from all recommended Marine Conservation Zones while static gears would be permitted.

Changes to existing activities

Demersal trawling would be excluded from the aquaculture site and a 1km exclusion zone surrounding it, and displaced into adjacent waters.

Key Drivers

Demand for sustainable seafood, and 'blue growth' to increase socio-economic activity in the area are the main drivers of this scenario.



Location of the aquaculture development (offshore mussel farm).

Scenario phase 3: Establishing the key variables and developing pressure maps

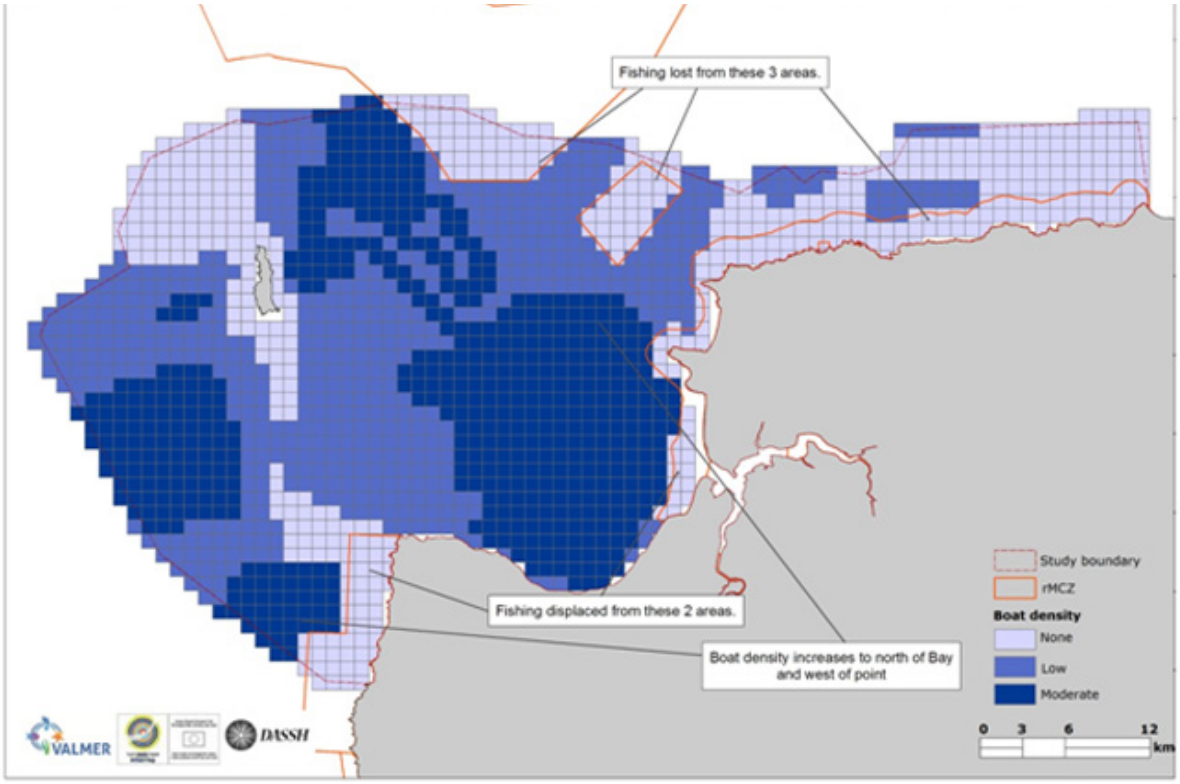
Pressure maps were developed using the activity maps generated by the DPSIR analysis. Fishing activity was the most important due to its large spatial footprint across the case study area. Levels of fishing activity (given in Finding Sanctuary's Fishermap [des Clers et al., 2008] as boat density per month) were rescaled to align with a known classification of intensities of activities and ecological impacts on benthic habitats [Hall et al. 2008] and comprised the abrasion pressure layer.

These were represented in terms of changes in intensity and spatial extent relative to the current situation (known activities and their pressures).

The effect of these pressures on the subtidal sediment habitats and their capacity to deliver the selected ecosystem services was established from a review of the literature.

The results of this work comprised detailed scenario descriptions and pressure layers for conditioning the socio-ecological model.

Changes in key pressures were identified and quantified from the scenario narratives developed by the stakeholder group in collaboration with the project team.

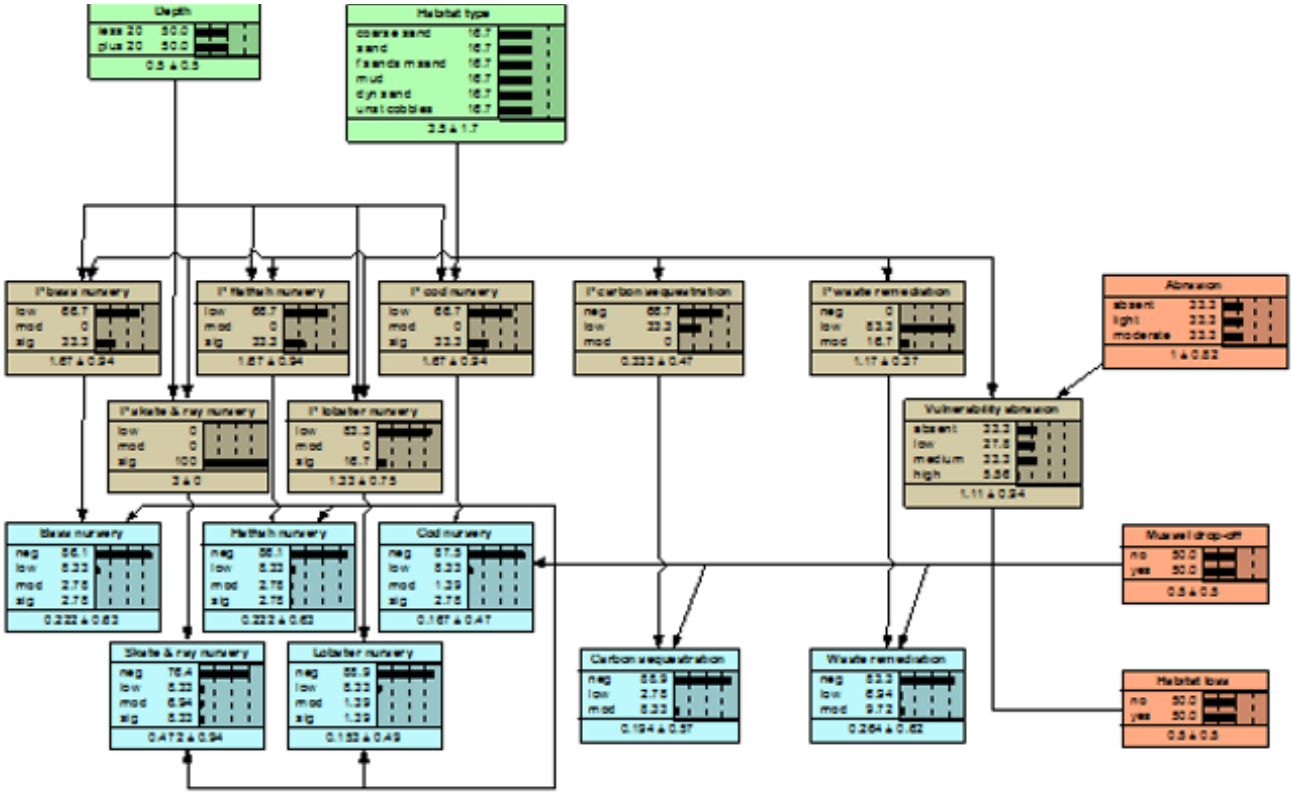


Example of a pressure layer used to condition the SES model: intensity of demersal fishing activity as a proxy for seabed abrasion under the rMCZ designation scenario. Loss of pressure and increases due to fisheries displacement are indicated.

Scenario phase 4: Developing and parameterizing the socio-ecological model

A Bayesian belief network (BBN) model was developed to represent the Pressure - State - Impact relationships for subtidal seabed habitats. Nodes comprised four main types:

- ✓ GIS derived nodes take data directly from the geospatial database (e.g. habitat type, depth);
- ✓ Pressure nodes represent spatial configuration and intensity of pressures under the current pattern of usage and were conditioned to simulate the management scenarios;
- ✓ Potential service nodes, showing the potential for ecosystem service provision based solely on geospatial criteria;
- ✓ Actual service nodes, representing the influence of pressures on the delivery of ecosystem services, using stakeholder derived weightings to aggregate values.

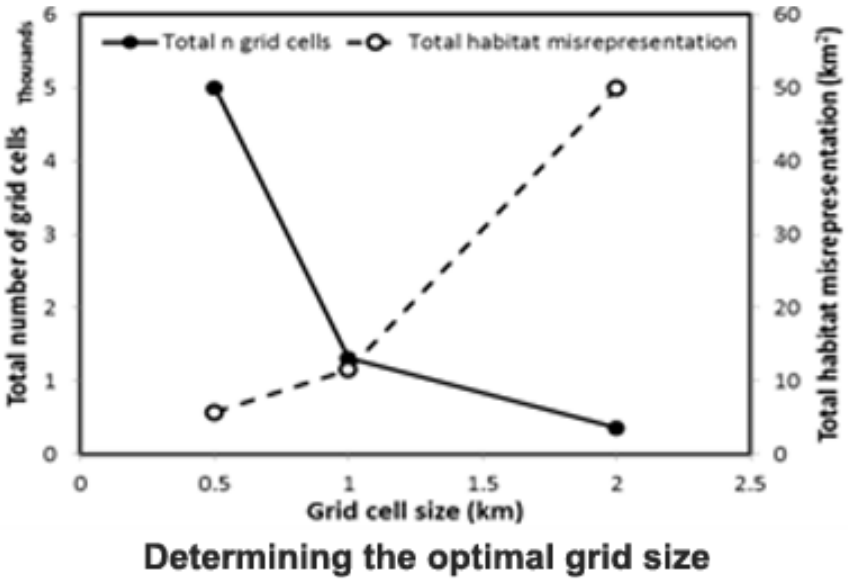


Socio-ecological model structure (GIS derived nodes are shown in green; Pressure nodes, brown; Potential service nodes, grey; and Actual service nodes in blue.

The underlying habitat map was gridded using the majority habitat within each and the optimal grid size of 1km2 was selected that most accurately represented the underlying habitats (low misrepresentation) and was not unduly computationally intensive (not excessive numbers of grid cells, Figure 11). Grid cells were removed if from the analysis if they:

- ✓ contained >50% sea along the landward boundary;
- ✓ did not fall within the NDBR seaward boundary; or
- ✓ were classified as rock biotopes.

These steps resulted in the final habitat map that was used as the base layer for the socio-ecological model comprising 1142 grid cells. All other layers were gridded to 1km2. Scenario pressure layers were gridded, if ≥50% of a grid cell was within a proposed development it was classified with the resulting pressure.



BBN Optimal grid size

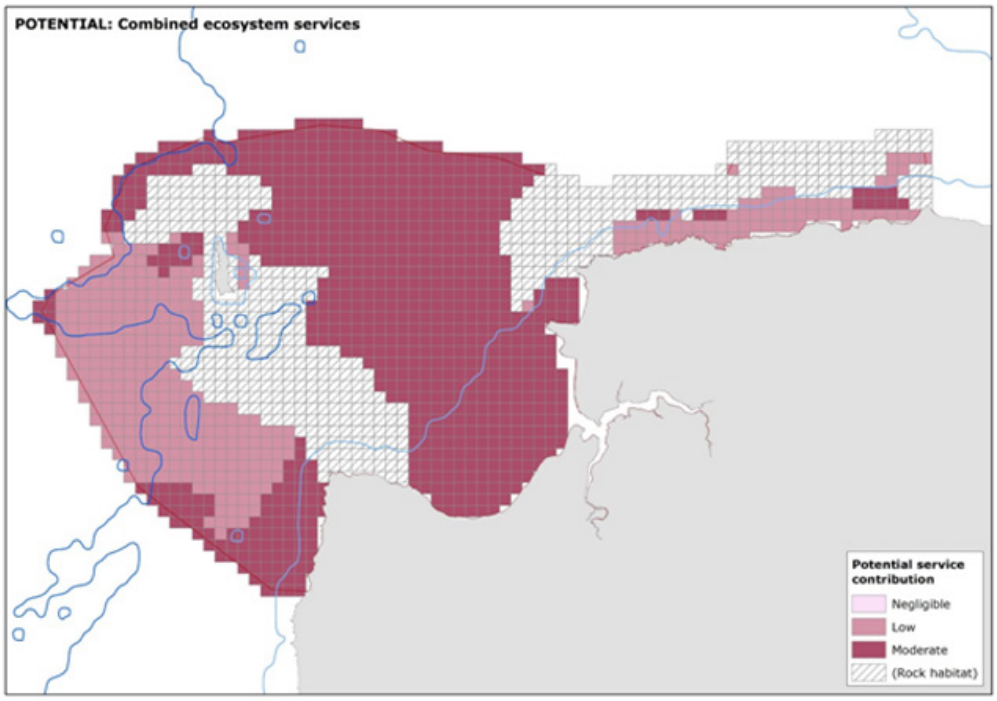
Information on the relationship between pressures, subtidal sediments and their capacity to provide ecosystem services was used to construct conditional probability tables to underpin causal relationships within the socio-ecological model.

The model was run for every grid cell in the habitat base layer: 1) without pressures to generate potential service provision maps for each service type, and 2) with the fishing abrasion pressure map (derived from demersal fishing intensity maps) to generate service provision maps that best represent our understanding of current service delivery in the case study area.

In order to consolidate the information into a single map of aggregated services, stakeholders were asked to weight the different services and the different fishery species, which demonstrated that nursery habitats, in particular for bass, were prioritised.

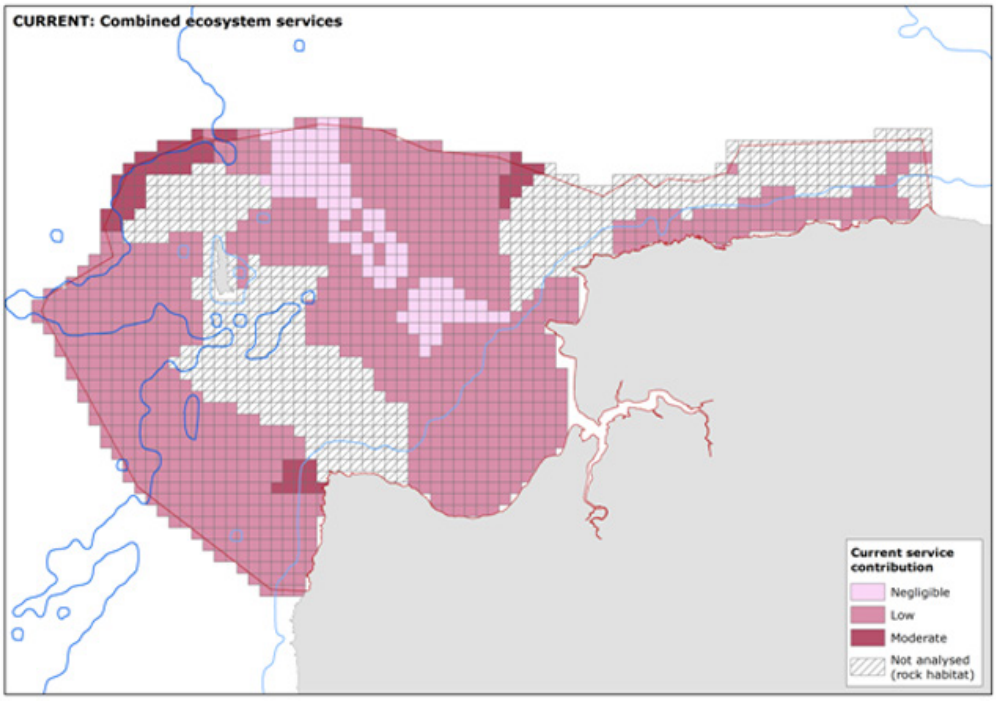
The combined ecosystem service map for potential provision (not taking into account current pressures) shows moderate levels of ecosystem service delivery throughout much of the North Devon Biosphere Reserve.

Lower levels of service provision is estimated for the western part and off the north coast due to coarse sediment habitat types that have negligible carbon sequestration and nursery value for plaice, bass, sole and lobster.



The potential combined delivery of nursery habitat, waste processing and carbon storage services across the North Devon Biosphere Reserve, aggregated to take account of stakeholder preferences.

The final map of the current status of aggregated service delivery (taking account of potential impacts from fishing activity) highlighted the importance of, Hartland Point, northwest of Lundy and near the Morte platform in the provision of the services considered.



Assessment of the current provision of ecosystem services, based on current patterns of fishing pressure. This represents combined delivery of nursery habitat, waste processing and carbon storage services across the North Devon Biosphere Reserve, aggregated to take account of stakeholder preferences.

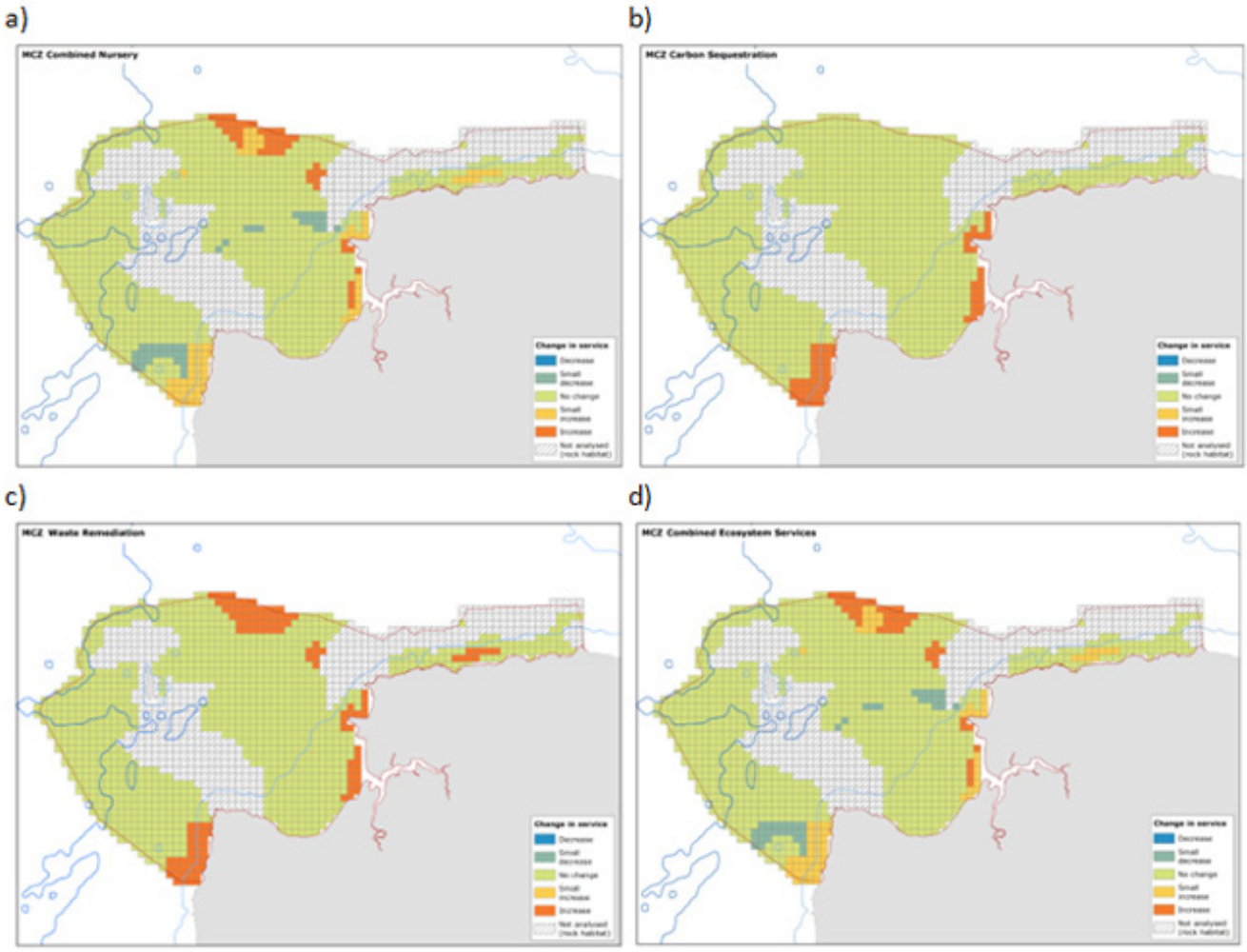
Pressure maps constructed for each scenario were used to condition the socio-ecological model, comprising direct pressures plus any indirect pressures such as demersal fishing displacement.

Scenario phase 5: Scenario modelling

These were used to condition the socio-ecological model and outcomes in terms of change to ecosystem service provision (relative the current situation) by ecosystem service type and all services combined was mapped.

The scenario outcomes and corresponding spatial patterns of change in ecosystem service delivery varied for each of the three scenarios.

For the designation of recommended Marine Conservation Zones scenario, provision of the different ecosystem service types is variable; nursery provision is increased in some areas (especially in the North of Lundy rMCZ site) and decreased in others (due to pressure increases from fishing displacement), while both carbon sequestration and waste remediation only increase in service provision in the protected areas since the areas subject to fisheries displacement had negligible service provision under the current scenario.



SES model derived scenario outcomes showing change in ecosystem service delivery by type (a-c) and combined (d) for recommended Marine Conservation Zone (rMCZ) designation scenario.

Conclusions

The process was complex and involved many assumptions but these were captured in the process, as was the uncertainty surrounding relationships at each stage

The main limitations were that:

- ✓ Three types of ecosystem service associated with subtidal sedimentary habitats were assessed, there are likely to be more but the linkages are harder to quantify and confidence is generally low [Potts et al., 2014].
- ✓ The ecosystem service assessment was presented as increases or decreases in service provision and not valued in monetary terms due to the lack of data for full economic assessment.
- ✓ Only subtidal sedimentary habitats were assessed and rock habitat types were not considered in this assessment giving a partial picture of the consequences of management scenarios on the North Devon Biosphere Reserve as a whole (subtidal rock habitats comprise 29.5% of the seabed).
- ✓ Intertidal and estuarine habitats were not considered in the ecosystem services assessment, which arguably may have high value for cultural services, but this was outside the scope of this project.
- ✓ The combined habitat map, used as a base layer for the model and in the ecosystem services assessment, had variable confidence associated with it; some areas of the NDBR have not been subject to recent, detailed surveys and were infilled with modelled data (UKSeaMap). This was at the level of broadscale habitats (EUNIS level 3) and it was not possible to resolve key ecological communities that may show differences in habitat sensitivity to pressures or provision of services leading to a lower confidence in our understanding of ecosystem service provision for certain areas (primarily the western part of the NDBR).
- ✓ The fishing activity information used to develop the abrasion layer was based on Finding Sanctuary's Fishermap. This represents the density of vessels using an area per month. It was used as a proxy for abrasion of the seabed by demersal trawl gear. More detailed information on patterns of fishing activity, trawl paths and the actual footprint on the seabed from demersal trawling would greatly improve our ability to represent the current provision of ecosystem services, and also increase the accuracy of any modelled changes in provision with management interventions.

The scope of the case study had to be constrained to maintain tractability, but it is clear that the results would be greatly improved from better ecological and socio-economic spatial datasets. However, the application of a spatially linked Bayesian Belief Network is novel and represents a significant advance in the field of socio-ecological modelling and ecosystem services assessment, not least as it was able to combine information of very different types:

- ✓ stakeholder derived scenarios
- ✓ geospatial records on seabed habitats

The Bayesian belief network socio-ecological modelling framework linked with a geospatial database was an innovative way to incorporate information from the ecosystem services assessment and scenarios developed with stakeholders and elaborate spatially representative changes in service provision.

- ✓ literature derived information on habitat sensitivities to activities, linkages between habitats and ecosystem services provision and pressures linked with human activities

This represents the first application of a spatially representative Bayesian Belief Network to explore ecosystem service delivery in a marine system at a local scale with real world management application.Socio-ecological modelled ecosystem service provision is already being used by managers such as the Inshore Fisheries Conservation Authority and UNESCO Biosphere Reserve Management to inform their activities and will likely contribute to evidence for designation of Tranche 2 rMCZs in the North Devon Biosphere Reserve.

Ifracombe from Hillsborough. Photographer Ray Culmer

Parc Naturel Marin d'Iroise

Contents

The work presented here has been developed in six case studies of the VALMER Interreg 4A Channel project (2012-2015).

Coordination by M. Philippe[4], J. Ballé-Béganton[4] and D. Bailly[4] based on written contributions from A. Vanhoutte-Brunier[1], P. Le Nilliot[1], R. Mongruel[2], A. Marzin[2], M. Laurans5, O. Guyader[2], D. Davoult[3] and D. Vaschalde[1]

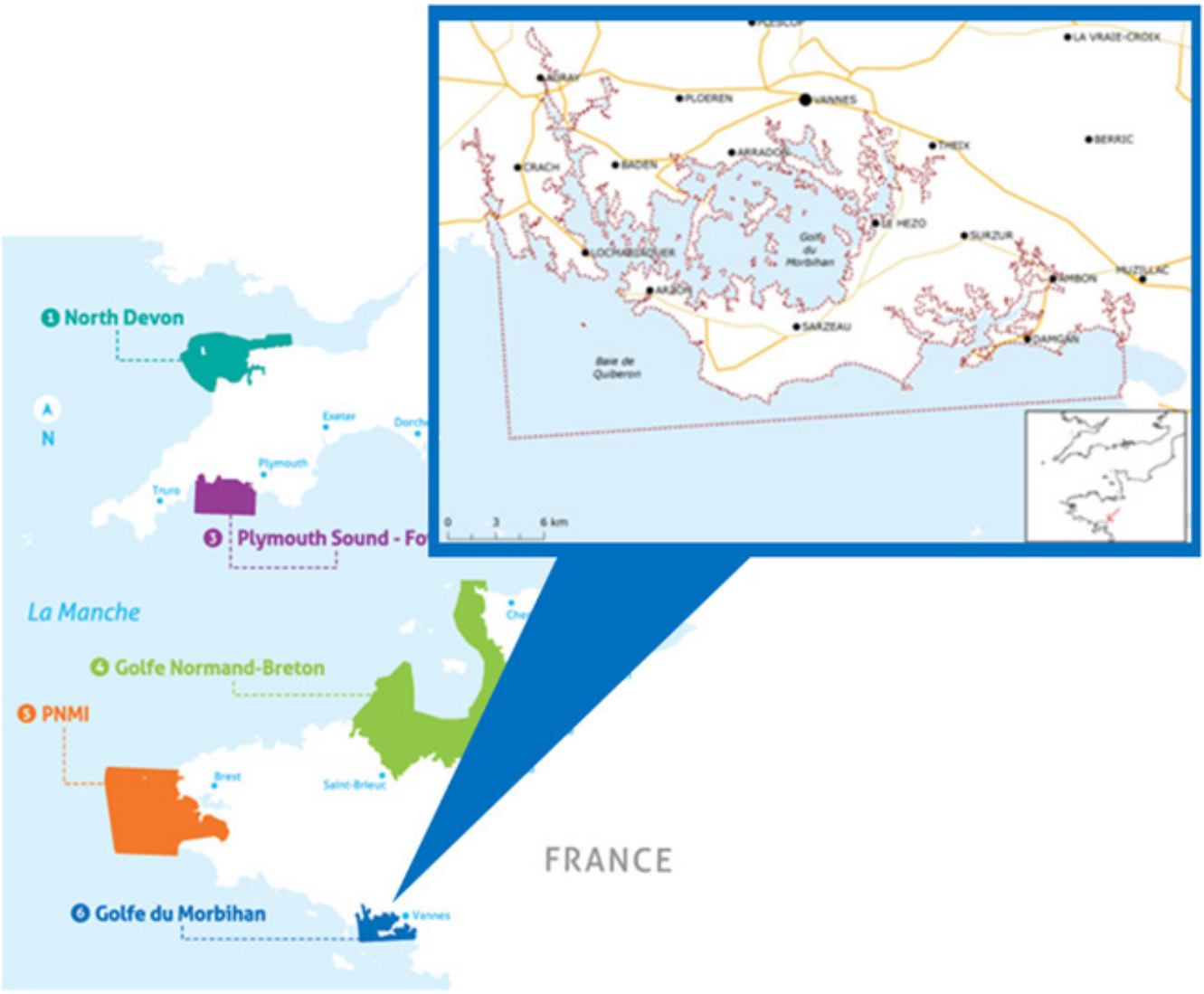
1 Agence des Aires Marines Protégées

2 Ifremer

3 Station Biologique de Roscoff – Université Pierre et Marie Curie

4 Université de Bretagne Occidentale – Brest/ UMR AMURE

Site description



Physical environment

The Parc Naturel Marin d'Iroise was created in 2007 off the coast of Finistère between the islands of Ushant, Molène and Sein and the coasts of Crozon headland and Douarnenez bay. The Molène's archipelago has the most diverse European algae Laminaria fields and the most extensive ones in France.

Perimeter of the Parc Naturel Marin d'Iroise (Agence des aires marines protégées, SHOM)

It is a shallow area of nearly 400 km^2 with rocky and sandy substrates, dotted by many small islands. This area is characterized by a huge tidal range and the proximity of the thermic Ushant front that mixes the coastal waters. As regards the latitude, the sea temperature remains quite low. The mixing prevents the seasonal thermocline settlement and the warming of the surface layer. These physical features enable the development of cold water affinity kelp species. Thus, the Parc Naturel Marin d'Iroise is the southern distribution limit of many species area and Laminaria digitata is considered as a sentinel of these species.

This area is particularly important due to the outstanding natural ecosystems containing dozens of species of algae, marine mammals and birds. In addition to its Marine Natural Park status, this region of the Iroise sea is a Marine Protected Area under the Oslo-Paris convention (OSPAR) and a large part of its perimeter is listed under the European Habitats and Birds directives (Natura 2000 network) and has been recognized as a UNESCO human biosphere reserve since 1989.

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Main activities and uses

The high productivity of the Iroise sea favours the **traditional fishing activities** and an **extremely varied cultural maritime heritage (fisheries and kelp)**. In recent years, **sea-life watching activities** are under development in the Molène's archipelago. Also there are pressures associated with the harbour of Brest and agriculture.

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Governance Arrangements

The creation of the Parc Naturel Marin d'Iroise was a long-term participative process which ended with the settlement of a management board led by the Finistère Department Council President and including a wide range of local stakeholders:

- ✓ 12 representatives from the maritime sector (fishermen, shellfish farmers, tourist industry)
- ✓ 11 local elected councillors (from the Region, the Department and the municipalities)
- ✓ 9 qualified personalities (scientists)
- ✓ 8 representatives of other users (recreational activities)
- ✓ 6 representatives of the State administration
- ✓ 2 representatives from environmental NGOs
- ✓ 1 elected board member of the terrestrial Parc Naturel Régional d'Armorique.

Regarding **kelp harvesting**, a dedicated commission of the Regional Fisheries Committee (CRPMEM) is in charge of defining proposals for kelp exploitation management rules, which are then amended and codified by the State representative.

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Aims of the Ecosystem Services Assessment

In the Iroise sea, two kelp species (Laminaria hyperborea and Laminaria digitata) are significant species playing a key role both as habitat provider and primary producer on the rocky shore of these cold marine waters. Being very productive and important in terms of biodiversity (more than 300 taxa), the kelp forests are equivalent of coral reefs for the temperate coastal environment.

Several species of European interest are found in this habitat. There are 150,000 Grey Seals in the Celtic Sea and 200 individuals in the Molène archipelago.

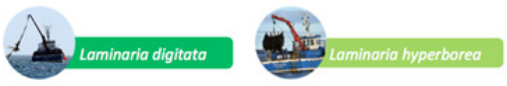
This species coexists well with seaweed harvesting, which is not the case of the Common Bottlenose Dolphin (12,000 individuals in the Celtic Sea and 60 in the Molène archipelago), which is very sensitive to noise. Since 1992, an evolution in the bottlenose group behavior has been observed, and they now seem to gather in the south of the archipelago where seaweed-harvesting effort is less important.

Kelp fields have been harvested in this area since the 19th century. Once required for the glass manufacturing industry then the iodine production, kelp is today sought for its alginate content. 60% of French kelp production is directly undertaken in the Molène's archipelago and it supplies the demand of the animal feed, pharmaceutical and cosmetics industries.

The management of the L. hyperborea fishery based on harvesting areas was negotiated and implemented fifteen years ago with kelp harvesters and is based on rotating harvesting zones and quotas. In a context of increasing demand of kelp (hyperborean spp.), the main objective of the Parc Naturel Marin d'Iroise, through the Ecosystem Services Approach, is to provide new insights to the current management debate and for the identification of new trade-offs.

The aim is to achieve precise management of the kelp field so as to allow a sustainable maximum yield for fishermen; an increase in employment linked to kelp harvesting and one that protects valuable species such as the Common Bottlenose Dolphin.

The question that the Parc Naturel Marin d'Iroise is trying to answer through the VALMER project is **"How do we manage the kelp forest in the best way to conserve the kelp and allow its sustainable harvesting by fishermen?"**.



The Parc Naturel Marin d'Iroise wished to define the best management measures for the kelp forest that will:

- ✓ **identify the marine ecological functions and services linked to the kelp forest habitat**
- ✓ **identify the main pressures on the kelp forest habitat**
- ✓ **evaluate the long-term effects of the pressures on the functioning of kelp forest habitat**

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Due to the recent introduction of the comb for L. hyperborea harvesting in Iroise and its strong impact on biodiversity and habitat structure, the use of this particular gear is debated within certain users groups (fishermen, recreational anglers) and managers concerned with conservation.

Ecosystem Services Assessment Methods

From an ecosystem services perspective, kelp ecosystems are used for alginate production but they also deliver many other services due to their bio-physical richness, their biodiversity and their contribution to the cultural heritage of the area. **The management plan for the sustainable exploitation of kelp resources has been selected as the topic that could be usefully re-examined using the ecosystem services approach.** This issue needs a **more integrated approach** as it is connected to other management objectives, especially the conservation of habitats and species, and the protection and promotion of maritime heritage.

The topic identified for study in the Parc Naturel Marin d'Iroise was the ecosystem services provided by kelp forest habitats.

The identification of ecosystem services provided by the Iroise kelp ecosystem was carried out by **experts (managers, ecologists and economists) on a consensus-based approach during the Triage process**.

In order to capture the **social perception of kelp ecosystem services**, the team relied mainly on the outcomes of discussions of the dedicated commission of the Regional Fisheries Committee (CRPMEM). The representations of the kelp socio-ecosystem and scenarios definition were completed by interviews with key stakeholders and meetings of scientific experts for the Iroise and managers of the French Marine Protected Areas Agency.

A detailed specification of kelp ecosystem services was built during **workshops and focus-groups meetings with scientists and stakeholders**. Following VALMER project recommendations for operational Ecosystem Services Assessment [Mongruel et al., 2015], a **systematic review of scientific knowledge** of kelp ecosystems was prepared and at the same time a **synthesis of human activities and social demand for kelp exploitation and conservation** to give a list of potential kelp related ecological functions and ecosystem services.

Considering the aim of the ecosystem services assessment and the numerous factors of influence, which must be taken into account, a dynamic system model for simulating the impacts of various fisheries management options (on four or five key ecosystem services) appeared to be the best approach.

The initial list encompassed up to 30 ecosystem services and was then reduced to 9 ecosystem services, which would be of interest for assessment, according to the Triage approach [Pendleton et al., 2014].

The first step was to build a **conceptual model of kelp ecosystems,** the functions they support for biodiversity and human activities and the governance system for the management of the whole ecosystem and resources.

A **numeric simulation model was built starting with the ecological component and followed by an integrated simulation to model the bio-economic aspect of the kelp fishery**, which is the core of the system model. It allows the predictive simulation of the influence of the management options on the ecological functions of the kelp fields for commercial and heritage species.

Ecosystem services selected from the TRIAGE approach

At the same time, **a study was conducted on the impact of different algae harvesting techniques** (combs, scoubidous) and it included: monitoring the survival of damaged algae, releases, habitat modifications, new hires, etc. This knowledge was completed by a scientific monitoring of the kelp population. Such data feed the modelling of the harvesting activity impact on the kelp population and enable the development of the kelp population dynamics model.

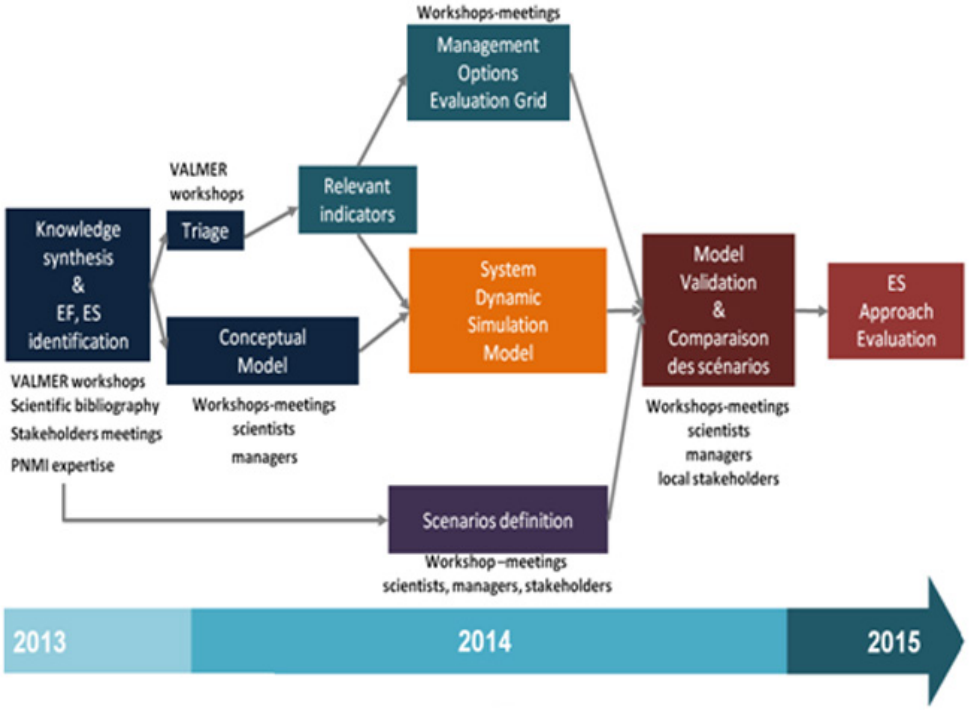
The simulation model of the kelp social-ecosystem was used to estimate a range of indicators that corresponded to the ecosystem services identified of the kelp forests of the Molène archipelago. This multi-criteria analysis grid was used to compare the impacts of scenarios on the ecosystem services.

Links between the Ecosystem Services Assessment and the scenarios

Indicators were used to compare the scenarios options. For many indicators, the functional link between the kelp field and the corresponding ecosystem services was not quantitatively established at this state of the scientific knowledge.

The exploratory "real-life" scenarios were used in order to compare the consequences of natural parameters (e.g. increase of storm events) and/or management changes on level of ecosystem services provided by kelp forest in the in the Molène archipelago.

These indicators were often directly or indirectly linked to migrating species. This was the case for the commercial fish species where stock levels in the Molène's archipelago were not known. Consequently, the kelp populations and harvesting model does not predict the changes shown by the indicators at the same informative level. When possible, changes in them were described quantitatively. If not, only global qualitative trends were provided.



Links between the steps of ESA and scenarios approach developed in the NMPI

Aims of scenario building process?

The scenarios aimed at comparing management options, in the context of various possible changes in the kelp socio-ecosystem. Some scientists and managers, who were part of the VALMER Parc Naturel Marin d'Iroise team, participated to the kelp management commission.

It was decided to **rely initially on the discussions of the commission to capture the social perception of kelp ecosystem services and management needs**. In addition to this, **interviews with other stakeholders were carried out in a second step to further refine the operational characterization of some management rules and other factors of change**.

Today, *Laminaria hyperborea* harvesting is managed through harvesting zones negotiated fifteen years ago with fishermen. Five large zones are subdivided into five sectors in which there is a rotation of harvesting and fallow periods. Each area is associated with a fishing quota fixed every year according to an assessment of the kelp standing biomass. When the

production reaches 20% of the standing biomass, the fishery is closed for five years.

Whilst this management regime is a useful first step towards a sustainable exploitation of the kelp resource, the existing kelp harvesting management is relatively crude and damaging and should be reviewed in order to integrate the increasing demand of the sodium alginate market. It should also take into account many factors recently discussed between fishermen, managers and scientists, in particular:

- ✓ **Accessibility:** total biomass of laminaria is different from the available biomass, which depends on the swell, the presence of rocks, etc. Today fishermen often operate in the same areas (accessible and benefiting from the proximity of natural reseeding sites). The harvesting of *Laminaria hyperborea* is not undertaken in winter due to weather conditions. At this time of year, species present in the kelp field (lobster, seabass, etc.) migrate to the Celtic Sea or the Bay of Biscay and then return in the spring. In winter, the algae are torn by the waves (about 300 000 tonnes), and fishermen often argue that they do not harvest as much as the quantity that reach the coast in winter due to storms.
- ✓ **The recent mapping of kelp:** the total biomass appears to have been underestimated and fishermen may not have reached the maximum production potential of the kelp field yet.
- ✓ **The improvement of the knowledge on the kelp dynamics and ecological functionality:** a new regime of kelp harvesting should better integrate the seasonality of the ecosystem services provision and identify the most damaging harvesting periods for the ecosystem balance.
- ✓ **Influence of environmental conditions:** the harvesting pressure on the kelp ecosystem should also be compared to the impact of regular large strandings of kelp that are observed after winter storms (about 300 000 tons).

Kelp management scenarios, tested in the VALMER project, are real-life scenarios agreed by harvesters, managers, scientists and state representatives, stakeholders and decision-makers upon a collaborative management process.

Detailed description of the scenarios approach

The scenario approach developed in the Parc Naturel Marin d'Iroise was based on the modelling tool's ability to simulate the influence of adaptive strategies on ecosystem services which itself arises from an integrated approach started several years ago.

Thus, we can identify steps initiated to the VALMER project process (A), and steps mainly developed during the project (B):

- ✓ A.1. Mapping of the rocky cover of the Molène archipelago.
- ✓ A.2. Data acquisition on the kelp population throughout the Molène's archipelago in order to feed a statistical model of the kelp biomass spatial distribution.
- ✓ A.3. Monitoring of fishing effort and harvested kelp using equipment deployed by volunteer fishing vessels and managed by Ifremer.

- ✓ A.4. Identification by stakeholders of areas with high environmental value (rest area, breeding, nursery, presence of species or habitat of European interest) where fishing could be banned.
- ✓ B.1. Refinement of the scope of the ES assessment during the Triage process following the identification of change within the social-ecosystem
- ✓ B.2. Gathering of the available data on marine activities related to the kelp habitat in the Parc Naturel Marin d'Iroise
- ✓ B.3. Determination of management measures for kelp fisheries on a finer scale than exist currently within the designated areas
- ✓ B.4. Comparison of scenarios with different management options, through a multi-criteria analysis grid

The basic structure of the management options was produced by the collaborative management system between harvesters, managers and state representatives. Additional expertise was required to further define operational rules or other factors of change regarding environmental drivers (climate), ecological status or economic constraints and opportunities.

This additional information for defining scenarios was gathered through interviews or focus-group meetings of scientists, Parc Naturel Marin d'Iroise officers, fishermen and kelp processing plants representatives. The scenario process followed the 5 following steps.

Step1

A **scenario planning meeting was organized in June 2014 with scientists and managers** with the objective of analysing the system drivers previously indentified. The Triage process helped the team to focus on the more relevant factors of change and the discussion of the influence of local management on ecosystem services in comparison with global pressures. This step was important for the integration of the appropriate levers in the dynamic system model. **Factors of change** were divided into two categories: **exogenous factors** that describe possible future evolutions and **internal factors** that reflect the ability of the system to develop adaptive strategies. Both categories are described as following:

Trending factors of change

Environmental factors:

Winter storms events remove large amounts of kelp plants and modify the spatial distribution of algae fields. The increase in the number and the strength of winter storm events had been documented but is recognized as being an uncontrollable external factor.

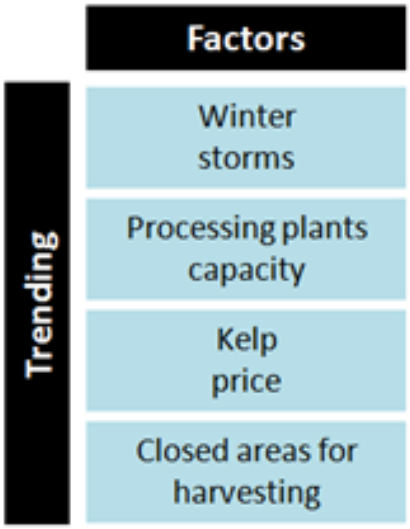
Economic factors:

The market for alginates is worldwide. Thus the Iroise kelp production depends on global trades rules. The kelp demand is increasing and **kelp prices** (different from a specie to another) are subject to fluctuations. In order to meet this demand, the kelp processing plants are increasing their **treatment capacity**.

Regulatory factors:

Creation of marine protected areas and set up of **closed areas** for exploitation.

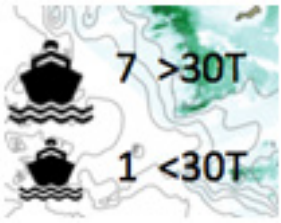
Adaptative factors of change



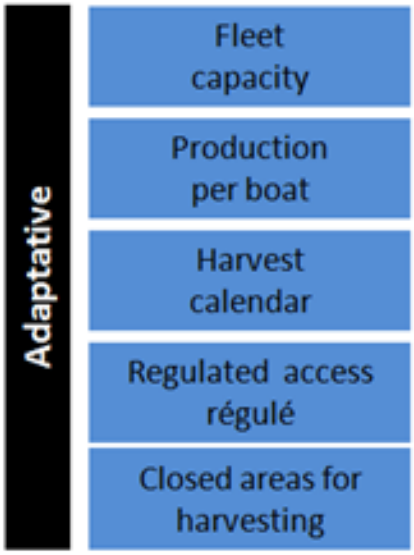
Economic factors:

Fishermen have individual contracts with two local kelp processing companies. These private contracts and the plant's alginate extraction capacity drive the harvest effort on a daily basis. These contractual bounds influence the **fleet composition and capacity**. The fleet targeting the both species is composed of eight boats. Seven boats with a hold capacity lower than thirty tonnes harvest *L. digitata* only.

A shift in fleet capacity between *L. hyperborea* and *L. digitata* may occur. Changes within the fleet towards larger *L. hyperborea* mono-specific designed boats were tested.



The strategy of the processing industry may also result in a relocation of the fishing fleet activities toward less controlled areas outside the park, with possible positive effects on all ecosystem services in the park perimeter, except the food provisioning ones.



Regulation factors:

Licenses

Most of the kelp production comes from *L. digitata*, which is supplied, to the agrifood industry. Nonetheless, the increasing demand for harvesting *L. hyperborea*, driven by the pharmaceutical industry, raises an important policy issue. *L. hyperborea* is currently targeted by vessels exploiting both species. In response to the needs of the pharmaceutical industry, some vessels, which are currently harvesting *L. digitata* only, could also ask for a fishing licence for *L. hyperborea*. The fishing effort could significantly increase despite a stable number of boats.

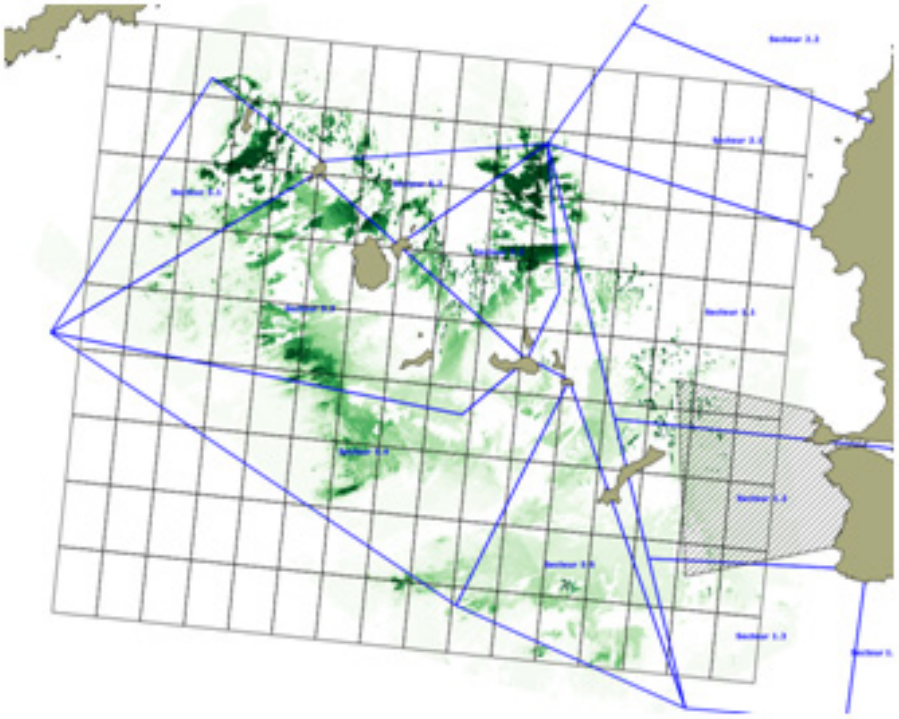
Quotas

The set-up of individual quotas is another regulation perspective.

Harvest calendar

The fleet specialized for *L. hyperborea* harvesting is also equipped for *L. digitata*. Usually the kelp harvesters change the device used, from the comb to the scoubidou at the end of March. The *L. hyperborea* harvest starts again in October. The scoubidou's use is not forbidden during spring and summer because *L. digitata* is targeted at this productive period of the year. Under the increasing demand of *L. hyperborea*, the fleet could become mono-specific and change its harvest calendar. In order to preserve the ecological functions of the kelp field during the productive period, an option tested is the banning of the comb use from June to October.

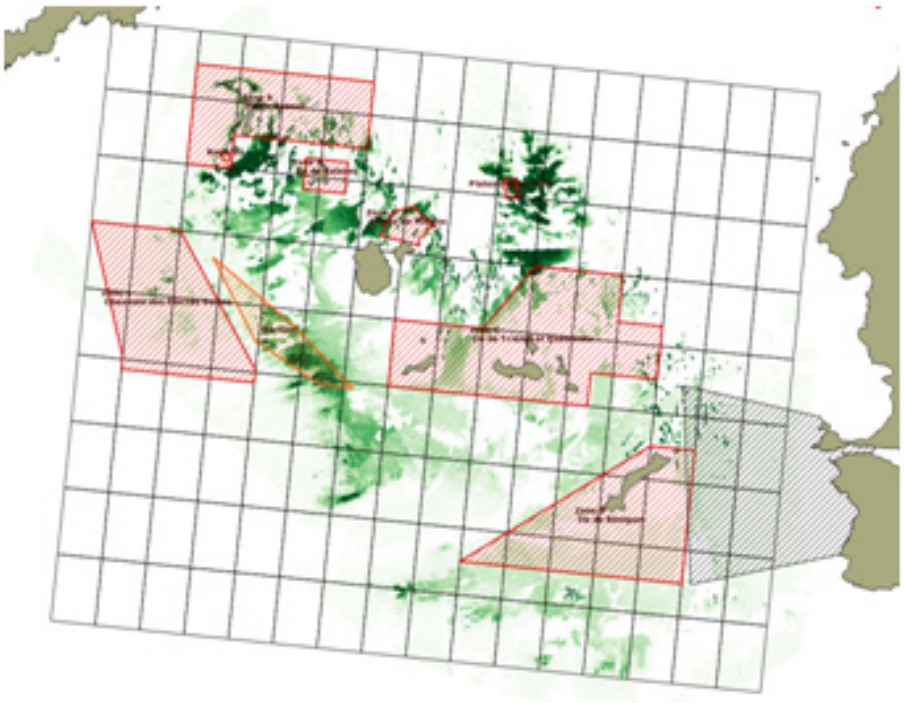
Regulated access



The maritime area is subdivided into large zones and sectors, with a fallow period of five years when the quota of the fishery is reached (delimited in blue on the figure opposite). The state representative regulation of 2014 asks to the professionals to organize the access to the resource on a more refined regular grid for the 1st January 2015.

Many options of rotation period were tested: three and seven years, in order to assess the time required for the ecological functions restoration. Many proposals were tested on the grid of 1'x1' resolution. The quotas were also discussed in the scenario exercise.

Closed areas



Aiming to (1) answer to the global trend conservation areas creations for the protection of the marine resources and (2) control the exploitation system, the local stakeholders of the Parc Naturel Marin d'Iroise debated these last months of management interventions. They defined closed areas with different purposes (biodiversity reservoir, refuge area for marine mammals, co-location with other fishermen and reference zone for scientific survey) and seasonal rules for kelp harvesting. They became effective in May 2014 by a state representative regulation (n° 2014-9271 decree).

Step 2

In October 2014, the scenario approach was presented to the kelp harvesting sector during a meeting of the kelp-working group of the Regional Fisheries Committee (CRPMEM). This working group was commissioned by the 2014-9271 decree to define new access rules (quotas, rotation sectors, harvesting calendar and fallow period). The VALMER team put forward the benefits of the new insights provided by the Ecosystem Services Approach. Many preliminary results of the Ecosystem Services Assessment state of reference had been shown. The presentation of the VALMER project also aimed to involve these stakeholders in the scenario building, in order to redefine the description of the fishery adaptive strategies. The model needed to be as realistic as possible to be accepted by this community.

The actors of the kelp sector also asked for a better understanding of how the spatial allocation of the fishing effort was estimated from the revenues and costs under constraints optimization in the bio-economic model.

Step 3

The involvement of stakeholder was successful, especially for developing the participative approach, with a group of five or six people who had also agreed to participate to one future meeting that was to occur in November 2014.

Step 4

The scenarios description was refined in January and February 2015. The VALMER study site team presented the factors of change to the kelp sector interests during a meeting of the Regional Fisheries Committee (CRPMEM) kelp commission in January.

The next step of the scenario building exercise would have been to organize a workshop with a larger range of stakeholders. The team prepared this workshop and developed methodologies (Régnier abacus, deliberation matrix). But at the last moment, the team was confronted with misunderstandings from some stakeholders.

In such a short time, at the end of the VALMER exercise, the time was not favourable to organising a meeting of a various range of stakeholders. It was decided to not formalize scenarios with them but only to demonstrate the usefulness of the model with theoretical scenarios proposed by the case study team.

What were the advantages and disadvantages of the scenarios methods used?

When a participative approach is developed for the scenario building exercise in a well-established institutional framework, it requires the involvement of pre-identified stake-holders.

The scenario approach was completely dependent of the construction, in parallel, of the dynamic model of the kelp social-ecosystem, which was also based on a participative approach. These two methodologies fed each other. At the end of the exercise, one integrated tool was available for the ecosystem services assessment with a multi-criteria grid for the analysis. When finished, this tool is particularly operational for helping the decision-making process. The risk is to under-estimate the time required by these two steps, in particular to achieve stakeholder involvement. In this context, stakeholder involvement tries to find a balance between a sufficient level of participation to the building of both the model and the scenarios, while avoiding too much additional work for the participants.

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participation to the building of both the model and the scenarios, while avoiding too much additional work for the participants.

Scenario description

- ✓ Firstly, the model is designed to test the efficiency of adaptive strategies (= scenarios) on the ecosystem services levels for the reference situation. Can a better trade-off be reached for the actual set of external conditions (same alginate demand, same winter storms frequency, same demand of MPA areas)? The reference year chosen is 2013, before the set-up of large closed areas by the 2014-9271 regulation.
- ✓ Secondly, the model predicts the effect of the adaptive strategies taken in response to the exogenous changes described in trending scenarios. These prospective scenarios consider evolution of one exogenous factor at a time or combine evolutions on different factors to test model responses to extreme perspectives. The modelling of extreme climatic changes could consist in increasing the frequency or cumulating the occurrences of winter storms, based on the magnitude of those observed in 2014.

Trending and adaptive scenarios which have been built with stakeholders were as realistic as possible in order to reflect the social demand and acceptability. In addition to these realistic or acceptable scenarios, some more contrasted perspectives, which could be seen as unrealistic for instance from the kelp sector point of view, were also investigated with the simulation model of the kelp socio-ecosystem as **"purely exploratory scenarios"**.

Use of scenarios outputs for management

How will the scenarios results be used after the VALMER project for marine management?

In the first instance, simple scenarios should be used to discuss and validate the model and also help stakeholders to take over the simulation model.

Following this, the scenarios could be refined through information gathered from all stakeholders, including experts and scientists.

Finally, the development of the model and the work on adaptive strategies will be useful to bring real-time support to kelp harvesting management. Such a tool aims to provide insights for the adaptive management of this economic activity related to the kelp provisioning services.

Have management recommendations been identified for future?

At this stage, the dynamic model of kelp ecosystem services comparing management options or simulating exploratory scenarios is only intended to help stakeholders and managers to better understand the

global functioning of the whole system and to become used to include a wider range of parameters and indicators in their judgement over the kelp socio-ecosystem evolution.

Using the model and the scenarios for operational management recommendations would be a further step.

Scenarios experience sharing

Advantages and disadvantages

Having some short-term objectives specified in the '2014-9271' regional regulation facilitated the kelp harvesters involvement in the scenario development.

The stakeholders who asked to participate in the VALMER exercise were mainly related to the kelp sector. But the VALMER staff also participated in meetings outside of the VALMER project, with other users groups, in order to analyze the debates around the kelp harvesting and, in some cases, to inform the public of both the active management plan and the current VALMER study.

Difficulties encountered

One major difficulty encountered with the local fisheries committee was explaining that the Parc Naturel Marin d'Iroise was not trying to take-over the fishermen's organization in the management of fisheries process.

It was essential to show that the assessment and scenarios were, in the VALMER context, "exploratory" and built to evaluate the effects of decisions taken.

Moreover, VALMER was an experimental project managed outside the common institutional context. It must be remembered that stakeholders were invited to join an exercise they did not ask for. It was a quite long process to convince them of the project's value. As these stakeholders also collaborate in many of the Park's current actions, the risk of consultation fatigue was real.

In addition, kelp-harvesting management was a very topical issue during the scenario-building phase. After a stormy 2014 winter that brought a sharp decline of the *L. digitata* standing biomass, the settlement of new banned L. *hyperborea* harvesting areas for ecological reasons was strongly debated, before the benefits of this new system could have been evaluated.

Even when the discussions with kelp harvesters were robust and challenging for both parties they conceded that they do need scientific advice for ascertaining production objectives, particularly when the standing biomass is affected by extreme hydrodynamic events. They saw the model development managed during VALMER as an opportunity that must be grasped.

During this particular year, the VALMER team also observed some recovery possibilities for the fishery. Such an experience illustrates the need to have a flexible ecosystem services assessment tool, in order to quickly inform the debates. In VALMER, the Parc Naturel Marin d'Iroise relied on

the “interviews” and “participative approach” for choosing and building scenarios.

Tips

The technical scenarios guidelines provided interesting information on stakeholder’s engagement and scenario building methods. However, these tools were not used directly in the Parc Naturel Marin d’Iroise study site for building scenarios. The assessing and comparing of “real-life” scenarios were more specifically based on modelling.

- ✓ Involve stakeholders as early as possible in the process because scenario building needs a learning phase. It is also important to run the exercise without disruption to the stakeholder’s day-to-day commercial activity.
- ✓ Scenario development is strongly dependent on the local context
- ✓ Carefully refine the scope of the ecosystem services assessment during the Triage in order to analyse the factors of change in the system and to develop the exploratory scenarios.

Faune du parc © Y. Turpin / AAMP

Flore du parc © Y. Turpin / AAMP

Golfe du Morbihan

Contents

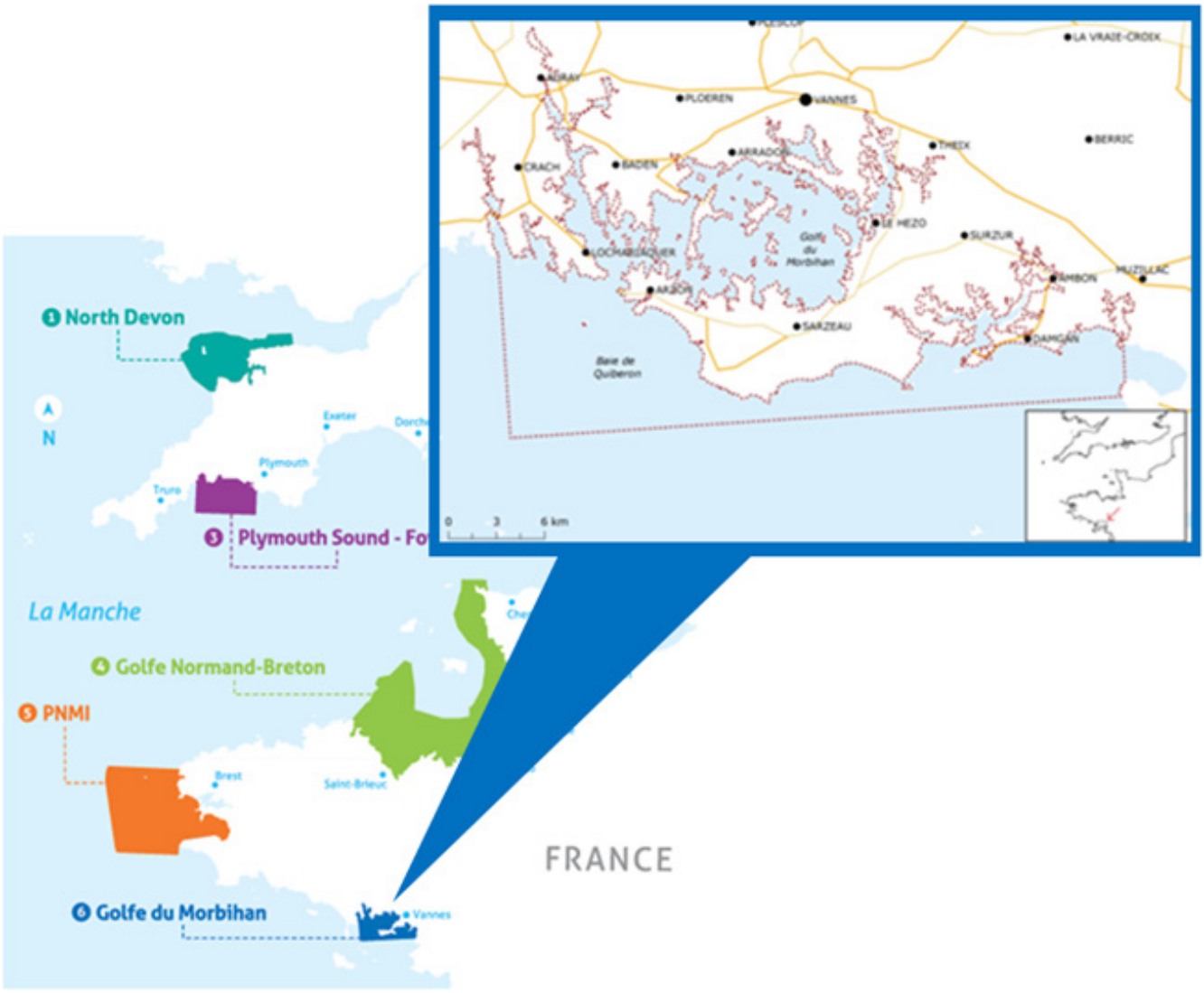
The work presented here has been developed in six case studies of the VALMER Interreg 4A Channel project (2012-2015).

Section coordination by M. Philippe[2], J. Ballé-Béganton[2] and D. Bailly[2] based on written contributions from J. Herry[1] and M. Philippe[2]

[1] Parc Naturel Régional du Golfe du Morbihan

[2] Université de Bretagne Occidentale – Brest/ UMR AMURE

Site description



Physical environment

The Golfe du Morbihan is located in south Brittany, in the Morbihan Department. The boundary of the case study site is the Parc Naturel Régional du Golfe du Morbihan. The area includes 30 municipalities and an associated marine area of 125 km^2. This marine area is connected to the Atlantic Ocean by a narrow channel. The population is about 166 000 inhabitants and it has multiplied by a factor of eight in the last forty years. Many professional and leisure activities coexist and include shell-fish farming, fishing, tourism, sailing etc. The pressure for living-space for people and space for commercial activity impacts on the natural environment, both terrestrial and marine.

The Golfe du Morbihan is famous for its large richness of biodiversity, natural and cultural heritage, with various habitats (mudflats, rocky foreshores, seagrass beds, etc.) and landscape.

Perimeter of the Regional Natural Park of the Gulf du Morbihan

Main Activities and Uses

The Golfe du Morbihan area offers a high quality of life and environment for local people and visitors. The population is about 166 000 and this has increased by a factor of eight in the last forty years. This demographic pressure on the area and more specifically on the coastline is as a result of fast and dynamic economic development.

Many professional and leisure activities coexist and include shellfish farming, fishing, tourism, sailing etc.

The pressure for living-space for people and space for commercial activity impacts on the natural environment, both terrestrial and marine.

Governance Arrangements

Parc Naturel Régional charter provides a common framework for future actions on water quality, biodiversity, integrated coastal management, natural and cultural heritage.

The aim of the Parc Naturel Régional is to achieve sustainable development and one that conserves environmental richness in the long-term. The Parc Naturel Régional is a voluntary tool based on a Charter with many actions to be implemented on the area.

The Charter is valid for the next twelve years and engages local authorities to a shared cooperative management approach for the gulf of Morbihan.

The Charter includes three key themes:

- ✓ Enhance heritage assets
- ✓ Support sustainable development
- ✓ Put people at the heart of all work

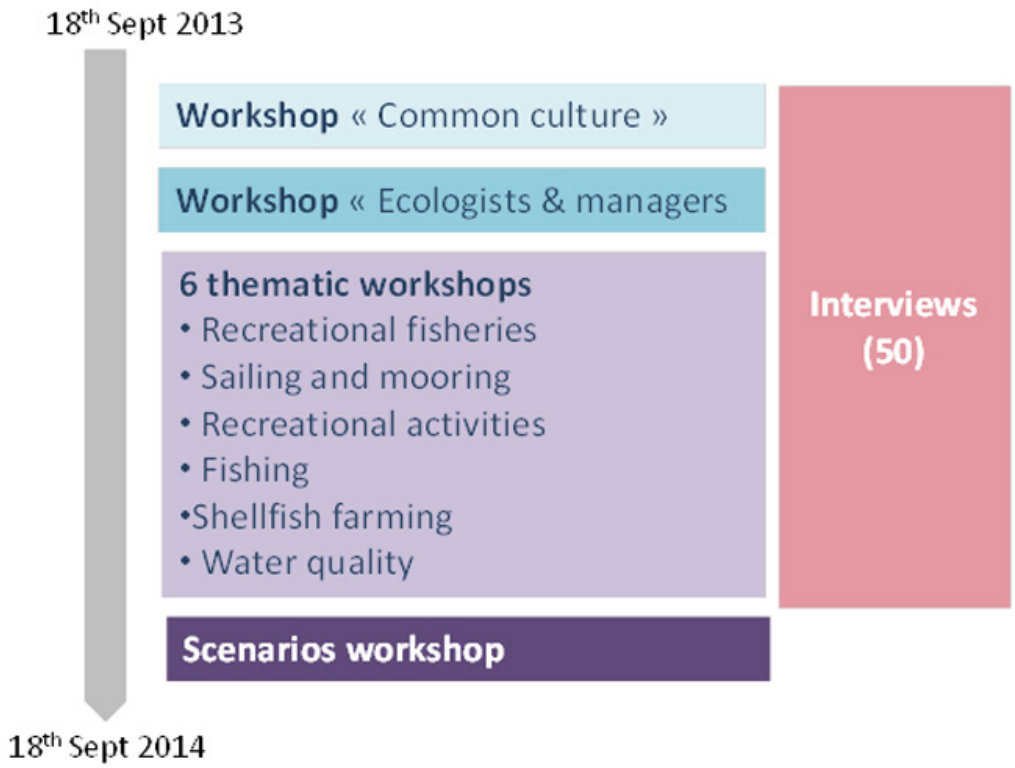
Key stakeholders and their involvement

The VALMER stakeholder engagement process in the Golfe du Morbihan was specific to the subject chosen. There was no pre-existing forum of stakeholders. Common practice in the Golfe du Morbihan is to create "task and finish groups" for each project according to the interest of the stakeholders in the subject of the project.

Over the course of one year, around 100 people have been involved in the project.

After having identified all the potential ecosystem services of the sea-grass beds and the activities that could have an impact on it, the project team invited all concerned stakeholder groups to participate to different workshops and interviewed over 50 stakeholders in the Golfe du Morbihan.

Each of the workshops included presentations of the topic, issues and project updates of the project as well as mapping and brainstorming sessions. The scenario workshop was based on the SWOT method (Strengths, Weaknesses, Opportunities, Threats) and the Regnier Abacus method.



Stakeholder engagement process in the Golfe du Morbihan case study site

The stakeholder engagement process was based on three idea:

- ✓ people are fully welcome to contribute to the project with their ideas and knowledge of the Golfe

- ✓ by having an intense rhythm of meetings, a good dynamic is maintained and people do not have the feeling that the project is going slow
- ✓ transparency is ensured in the delivery of the project progress and results, including the organisation of a final open event.

This final event was run on the 4th December 2014 and was open to anyone interested. 115 people participated. The open event encompassed a mix of presentations on the project, stakeholder and managers round tables, experience transfer from other sites and time for exchange.

Seagrass event, 4th Dec 2014, Golfe du Morbihan

Aims of the Ecosystem Services Assessment

Seagrass meadows are not algae but flowering plants. They live mainly on sandy-muddy substrates in sheltered marine areas. These remarkable habitats are protected at international, national and local level through different legislation and conventions (e.g. BERNE convention, OSPAR convention, European Habitat Framework Directive, local legislations.

Two species of seagrass are present in the Golfe du Morbihan: *Zostera marina* and *Zostera noltei*. In 2007, the seagrass beds represented, respectively 11 km2 and 8 km2.

Seagrass beds are sensitive to pressures impacting environmental quality (e.g. lack of light, herbicides, trampling, grubbing, etc.). Due to their high

ability to regenerate in a healthy environment, they are used as a water quality indicator for the European Water Framework Directive.

In order to reconcile the environmental conservation with development of activities, the Parc Naturel Régional decided to experiment the Ecosystem Services Approach put forward in the VALMER project. The aim was also to provide new ideas and information that could be used for the revision of the Scheme for Sea Development, a marine planning tool in the Golfe du Morbihan, in 2016.

The Ecosystem Services Assessment was designed to:

- ✓ Raise awareness on seagrass issues
- ✓ Improve the management of seagrass beds through an integrated assessment
- ✓ Identify management options to facilitate trade-offs

The results of this Triage process are presented in the following table.

The Parc Naturel Régional is the overall coordinator of the Natura 2000 area in the Golfe du Morbihan. This is an important area for seagrass beds, the second largest area in the metropolitan France after Arcachon.

RESULTS OF THE TRIAGE FOR THE ECOSYSTEM SERVICES ASSESSMENT

Aims selected to support seagrass beds conservation in the Golfe du Morbihan

Selected aims	Why ?
1 Raise awareness on the issue of seagrasses	Because perceptions of segrass beds are different from one stakeholder to another
2 Improve knowledge Make an integrated assessment	Because knowledge of the Golfe du Morbihan seagrass beds is very incomplete
3 Identify management options to facilitate trade-offs	For effective management of seagrass beds in the long-term considering the impacting activities

Ecosystem Services Assessment Methods and Results

Through the VALMER project, the Ecosystem Services Approach in the Golfe du Morbihan was used as a way to develop a systemic approach which would be useful in exploring all the elements linked to the seagrass beds management.

These would include: ecosystem services offered by seagrass beds to human activities and interaction between these activities and these marine habitats. The VALMER project team, together with scientists and local managers has undertaken a study of seagrass beds, with the participation of local stakeholders (state representatives, elected-members, professionals (fishermen, shellfish farmers), recreational activities, associations and local people).

The VALMER team listed all the ecosystem services offered by seagrass beds in the gulf of Morbihan (e.g. shelter for many species; food resource for birds feeding on their leaves (e.g. geese); improvement of sedimentation, etc.); and identified the natural and human factors that could affect the level of the ecosystem services offered by seagrass beds.

At the beginning of the project, it was decided do not to make a monetary valuation of the seagrass beds of the gulf of Morbihan.The VALMER Golfe du Morbiha team preferred to develop a multi-criteria assessment approach based on social, economic and environmental criteria.

This assessment has been done by combining several steps and tools:

- ✓ A scientific literature review
- ✓ Interviews
- ✓ Focus-groups
- ✓ A "choice experiment" survey
- ✓ Map analysis

Overview of the steps and tools developed in the Golfe du Morbihan case study site

The Ecosystem Services Approach was useful in the Golfe du Morbihan in order to:

- ✓ Structure a systemic view of the coastal social and ecological system
- ✓ Propose a new management approach under a participatory process
- ✓ Discuss seagrass beds management with local stakeholders

The approach developed in the Golfe du Morbihan tried to be the most participative as possible, based on knowledge sharing with stakeholders and to develop a common culture and build with them proposals to improve seagrass beds management.

Links between the Ecosystem Services Assessment and the scenarios

The VALMER team has used all the elements gathered during the project including from scientific literature, interviews, workshops and maps analysis to identify four possible management strategies of seagrass beds. These strategies became the four scenarios corresponding to different management situations with different consequences in terms of human pressures on seagrass beds, and the level of ecosystem services offered by these marine habitats.

Aims of the scenario building process?

The scenarios developed in the Golfe du Morbihan were used to support to the discussion with stakeholders on different possible management strategies (= scenarios). The aim was to present to them the fact that the management could be rethought in light of their outcomes in terms of the level of ecosystem services offered by seagrass beds. The idea was then to identify and propose actions that could be implemented to improve the actual management seagrass beds in the gulf.

Detailed description of the scenarios approach

Step 1

Thanks to the Ecosystem Services Assessment of seagrass beds of the Golfe du Morbihan, four scenarios (e.g. management strategies) have been identified.

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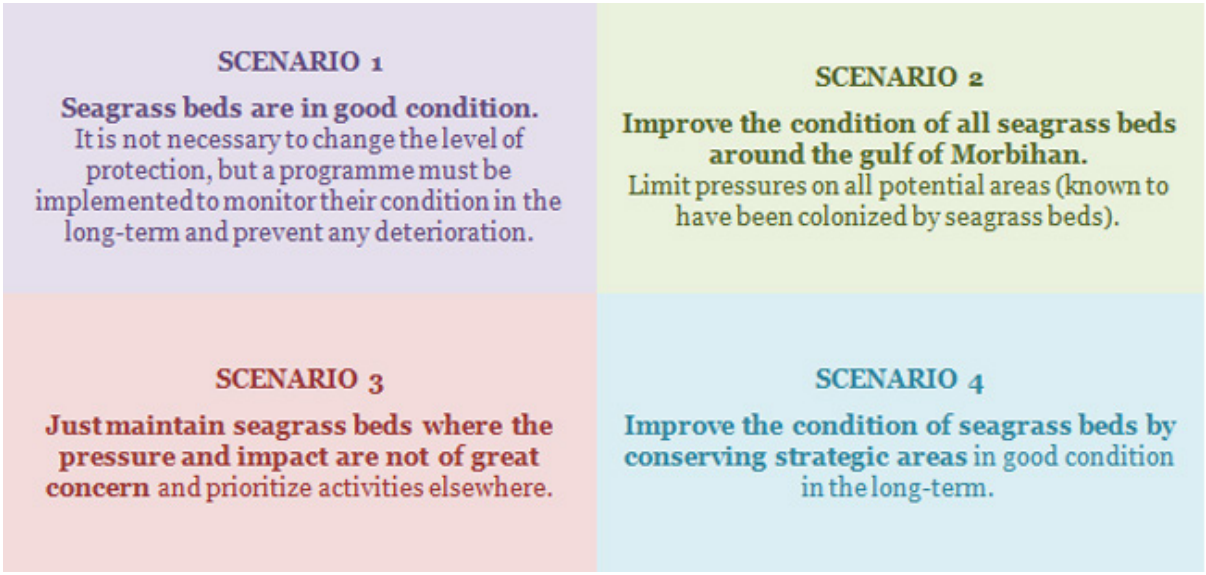


Summary of the four scenarios developed in the Golfe du Morbihan case study site

Step 2

These four scenarios were presented the September, 18th 2014 to 20 participants during a **"scenarios workshop"**. Through an open discussion based on maps illus-trating the four scenarios, the stakeholders have identified for each of them their strengths, weaknesses, opportunities and threats through an adapted "SWOT" analysis (strengths, weaknesses, opportunities and threats).

SCENARIO 1 Seagrass beds are in good condition...	
STRENGTHS	**WEAKNESSES**
▪ Social acceptability potentially strong ▪ Lower cost	▪ No social mobilization → risk of forgetting issues ▪ No distinction between marine seagrass and dwarf seagrass management
OPPORTUNITIES	**THREATS**
▪ Make an inventory of current regulations and maintain them ▪ Characterize pressures and know their potential impacts ▪ Ability to monitor seagrass ▪ Continue awareness, education and communication ▪ Using the best and most accurate diagnostic tools	▪ Evolution of a natural element that impacts seagrass beds ▪ Risk of degradation of seagrass beds that do not benefit from protection (increasing pressure) ▪ Increasing population → degradation of water quality ▪ Poor initial diagnosis of the state of seagrass beds

Example of an adapted SWOT analysis undertaken for the scenario 1

Step 3

The participants were then asked if they felt the scenarios were desirable and feasible. The method of the "Abaque de Régnier" was used to collect the quotes and identify the items on which there was consensus or not between the participants.

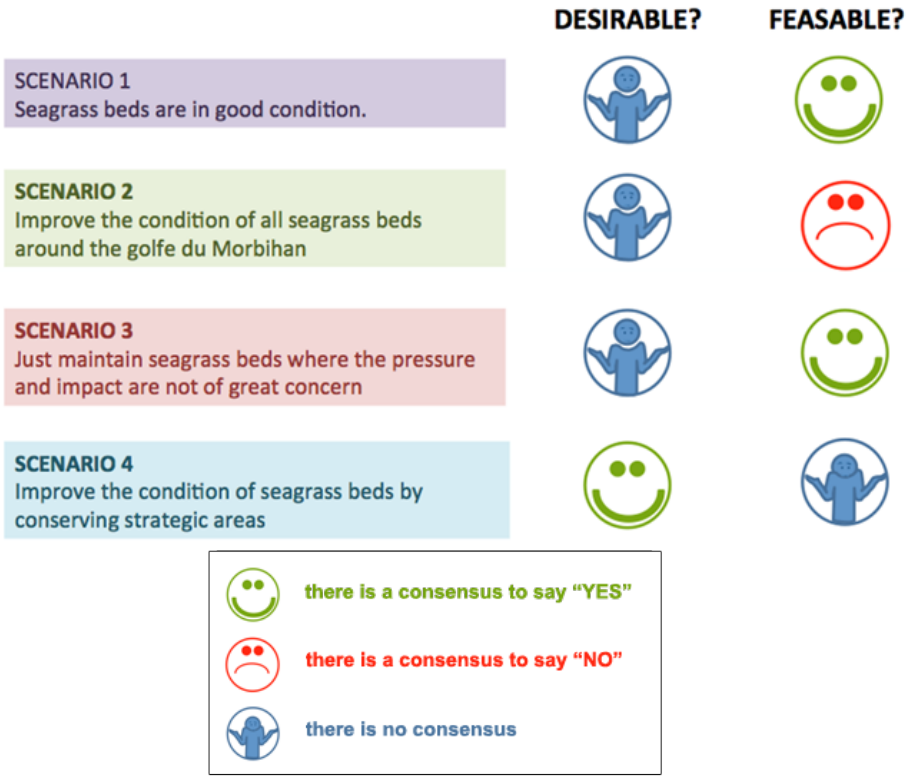
Using an Excel algorithm, the results were then analysed to identify if there was consensus between the participants.

- ✓ One of the major conclusions was that the scenario 4 was the only one on which there was a consensus saying that it was desirable.
- ✓ However, with regards to the feasibility of scenarios, the scenario 4 was also the only one with no consensus between the participants as to whether was feasible or not.
- ✓ The participants seemed to agree the fact that a new management of seagrass beds at a finer scale is needed but that this seemed also complex to implement...

Rating scale used to rank the desirability and feasibility of each scenario

1	2	3	4	5	6
Strongly agree	Agree	More or less agree	Not really agree	Not agree at all	I don't know

	This scenario is **DESIRABLE**	This scenario is **FEASABLE**
SCENARIO 1 Seagrass beds are in good condition		
SCENARIO 2 Improve the condition of all seagrass beds around the golfe du Morbihan		
SCENARIO 3 Just maintain seagrass beds where the pressure and impact are not of great concern		
SCENARIO 4 Improve the condition of seagrass beds by conserving strategic areas		
Other proposition?		



Example of results obtained by the "Abaque de Régnier"

Step 4

The next step during the "scenarios workshop" was to propose, in the light of the advantages and disadvantages of each scenario identified beforehand, possible management options that could be implemented to improve the seagrass beds of the Golfe du Morbihan. For each proposition considered by the participants, it was asked what the time horizon of implementing the management measure, the partnership required and the process of the implementation.

MANAGEMENT MEASURE	HORIZON	PARTNERSHIP	MODALITIES
Conduct pressure-impact studies	Middle and Long-term	Link with the LIFE project and with other N2000 sites	Research of threshold impacts beyond where seagrass beds can not survive or recover Is there homogeneous area to generalize experiments?
Develop a map atlas	At short-term and then on long-term	CEVA (overflights for dwarf seagrass) REBENT / DCE Network Aerial photos of RNP CRC / CDPMEM DDTM	In connection with a computer application Sharing of pictures taken for other reasons (green algae / RAC
Edit and distribute booklets and posters in town halls, captaincies, associations, tourist offices, clubs...	Short-term	Fishing guides	Journal articles in existing means of communication Fishing permits Vocational training Catalogues of boat and kayaks hirers / sellers
Educational bus	Middle-term (financial ressources?)	Vannes agglomeration Educational associations	Inform fishermen at high tides To share with other territories
Develop a website dedicated to seagrass beds	Short-term	N2000 animators Prefecture website	Websites of users of the sea (eg. Kitesurfing) NRP website Wikipedia

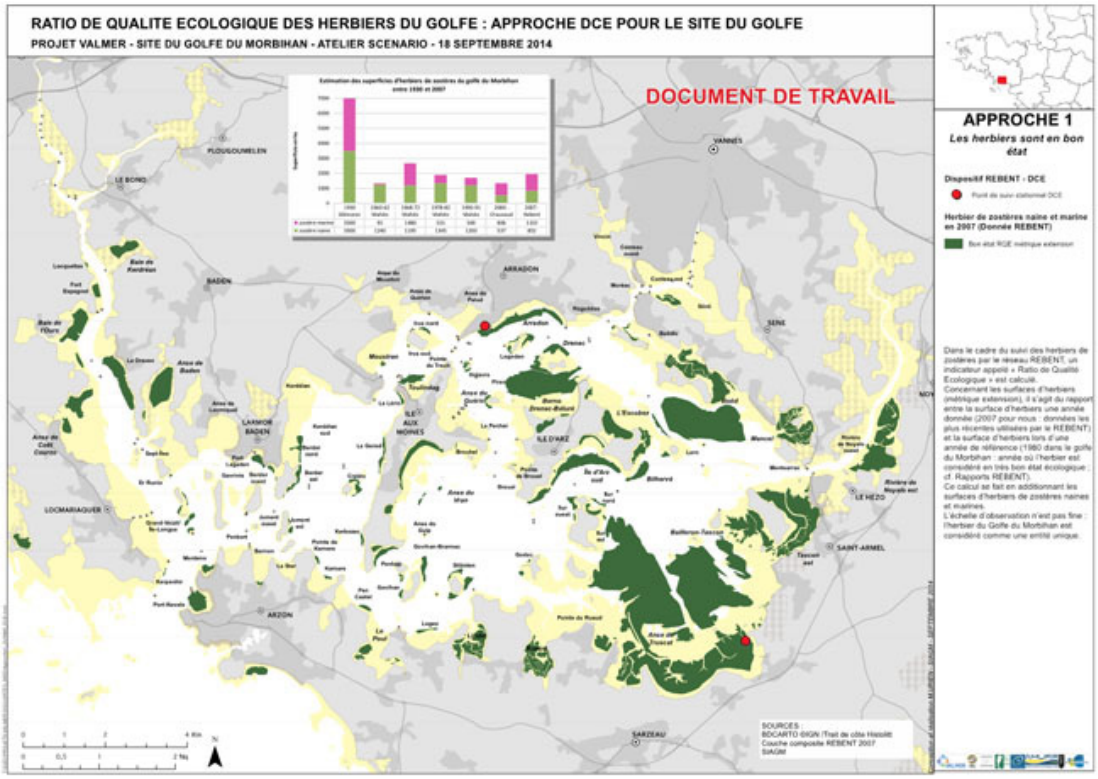
Example of management measures proposed by the participants at the scenarios workshop

A total of twenty management measures were identified by the participants during the workshop.

Scenario description

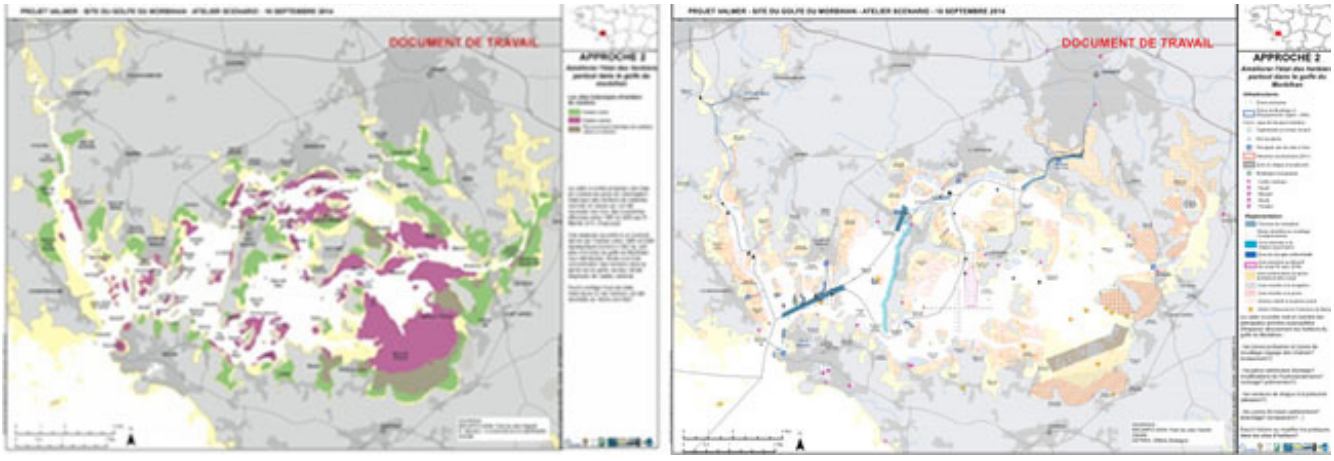
Each scenario summarises a management strategy or philosophy of seagrass beds in a few lines. Some maps are given, which help with the understanding of the consequences of the management approaches presented and also help to illustrate the scenarios.

Scenario 1



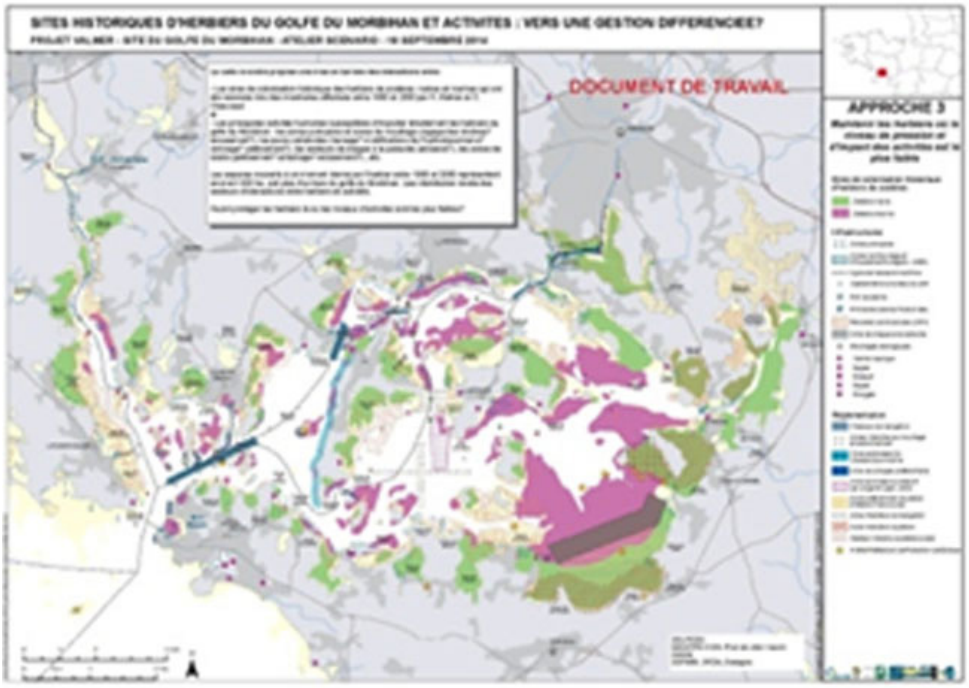
Seagrass beds are in good condition. It is not necessary to change the level of protection, but a programme must be implemented to monitor their condition in the long-term and prevent any deterioration.

Scenario 2



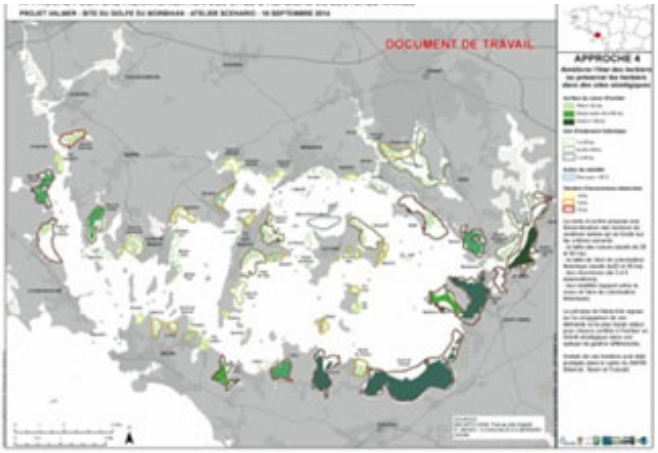
Improve the condition of all seagrass beds around the Golfe du Morbihan. Limit pressure on all potential areas known to have been colonized by seagrass beds.

Scenario 3



Just maintain seagrass beds where the level of pressure and impact are not of great concern. Prioritise activities elsewhere.

Scenario 4



Improve the condition of seagrass beds by conserving strategic areas in good condition in the long-term.

Use of scenarios outputs for management

How will the scenarios results be used after the VALMER project for marine management?

We hope that the VALMER project results will be useful for the Scheme for Sea Development of the Golfe du Morbihan (a marine planning tool) that will be reviewed in 2016, and also to complete the Aims Document Natura 2000 in the Golfe.

Have management recommendations been identified for the future?

The management measures proposed at the end of the "scenarios workshop" will be used as material to help elected members and decisions makers in their management choices. Maybe this will give the opportunity to collectively create a new management approach (awareness, communication, scientific studies and monitoring) to preserve the seagrass beds of the Golfe du Morbihan with the participation of local stakeholders.

The results will be spread as far as possible in order to help other areas that face the same issues (e.g. Natura 2000 managers).

Scenarios experience sharing

Advantages and disadvantages

Scenarios are participatory tools that are very useful in exploring and discovering new management approaches with stakeholders. They are a good way of creating and supporting discussion. In the Golfe du Morbihan, we have decided to develop exploratory scenarios as a way to illustrate different possible situations in the future and to compare them.

The aim was to deliberately create some distance from our actual management method and see if we could do it differently to improve the seagrass beds situation.

The process of scenario building was also useful to strengthen stakeholders' involvement.

Nevertheless, it also appeared also difficult for them to feel free to speak on the limits of the actual management frameworks for many reasons. For example, because:

- ✓ They did not understand the seagrass beds before the VALMER project
- ✓ There are uncertainties linked to the lack of knowledge and data on the level of ecosystem services offered by the seagrass beds of the gulf; the nature of interactions between seagrass beds and human activities; the links between pressures and impacts.
- ✓ It was difficult to criticize the actual management plan
- ✓ They sometimes had difficulties speaking in public
- ✓ They feared that their proposals could disadvantage their activity in the future and be a reproached by other users.

Used this way, scenarios were a real aid to develop a common culture and to create and share a global vision combining stakeholders' points of views as a way of supporting helpful reflection on an issue or even decision-making.

Difficulties encountered

The major difficulty encountered in the Golfe du Morbihan during the VALMER project was that seagrass beds were unknown to the majority of stakeholders. **We have discovered that paradoxically these habitats recognized for their importance for marine life, protected by different international conventions, European Directives and laws were also a mystery for the majority of inhabitants of the Golfe du Morbihan.**

In parallel, seagrass beds are subject to many pressures so it was sometimes difficult to engage stakeholders on the question of their management because they were not directly concerned as sea users but indirectly as people.

The uncertainties listed above also presented a difficulty in comparing the different scenarios. Sometimes this was because it was not possible to explain clearly the effects of possible actions taken to preserve seagrass beds on the level of their ecosystem services. On the other hand, the scenario exercises were useful in identifying these uncertainties.

Many lessons were learned during the project:

- ✓ Dwarf eelgrass and eelgrass have different ecologies and must be managed differently
- ✓ Diversity of interactions between seagrass bed ecology and human activities even if they are not perceived
- ✓ Many fears existed with sea users in that they saw their activity might be forbidden in order to preserve seagrass beds despite their general willingness to protect them

Another difficulty was that seagrass beds offer many benefits to human activities. However, these benefits are very general (e.g. raising biodiversity; improving sedimentation and water clarity etc.).

Tips

- ✓ Set out the project aims clearly
- ✓ Explain these aims, the approach and the methods used very clearly to the stakeholders
- ✓ Create confidence between stakeholders through transparency and open discussions
- ✓ Rely on existing networks to share and disseminate knowledge and data

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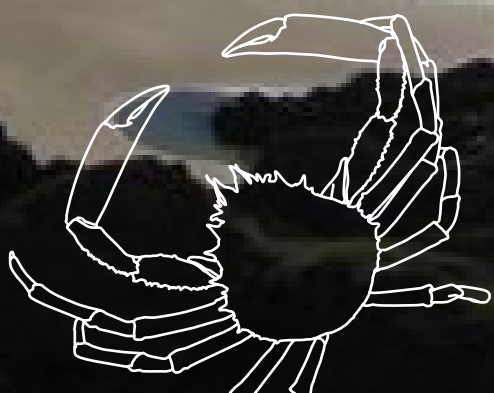
Plymouth Sound to Fowey



Contents

The work presented here has been developed in six case studies of the VALMER Interreg 4A Channel project (2012-2015).

Coordination by M. Philippe[5], J. Ballé-Béganton[5] and D. Bailly1[5] based on written contributions from N. Smith[4], P. Hoskin[1], W. Dodds[4], T. Hooper[3], L. Friedrich[4], N. Beaumont[3] and C. Griffiths[2]

[1] Cornwall Council

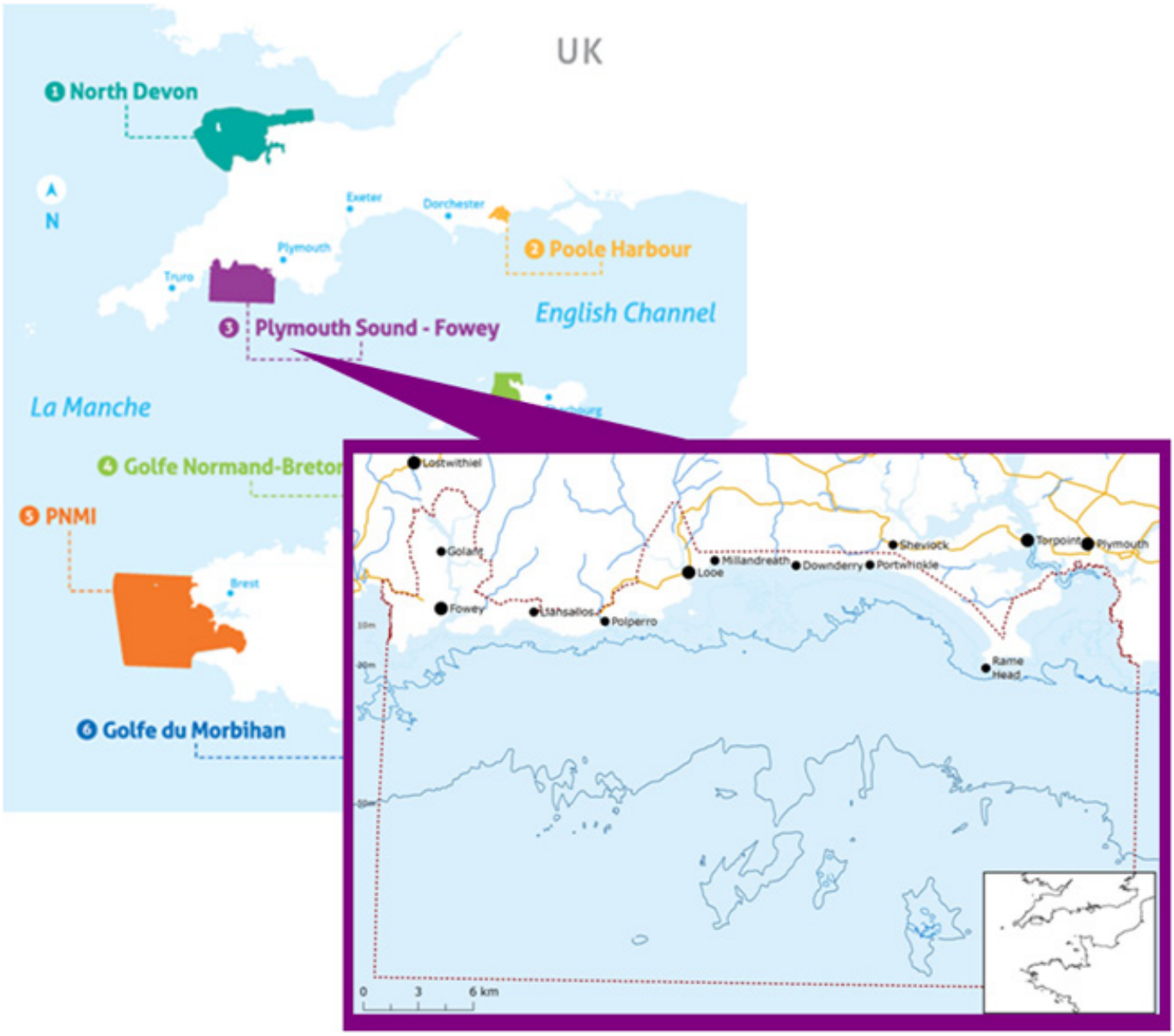
[2] Marine Biological Association of the UK

[3] Plymouth Marine Laboratory

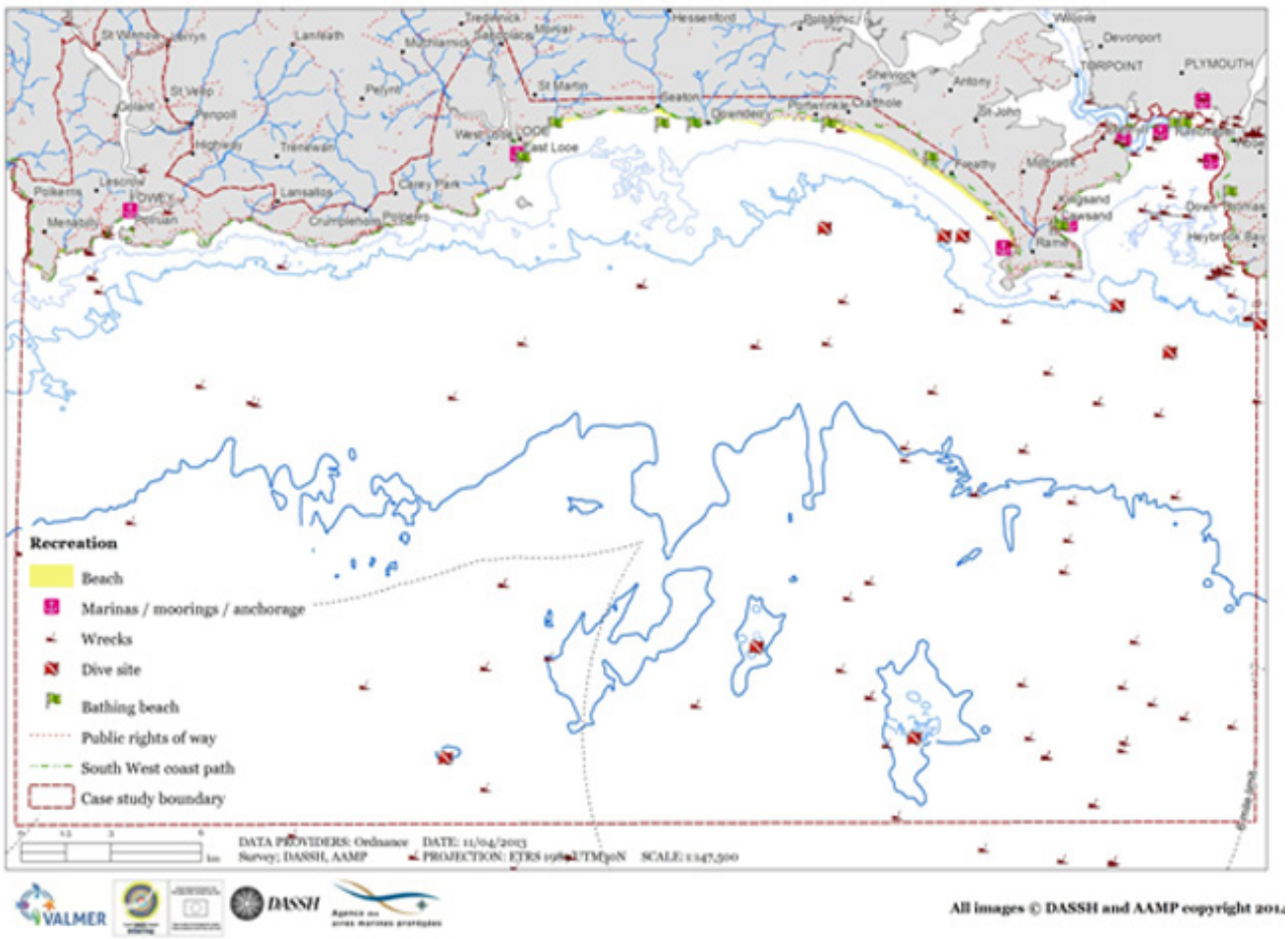
[4] Plymouth University

[5] Université de Bretagne Occidentale – Brest/ UMR AMURE

Site description



This case study was led by two part time coordinators, one within Cornwall Council and the other from Plymouth University. They worked together to inform the development of the site-specific Ecosystem Services Assessment, to engage site stakeholders through participatory workshops and to promote the use of the Ecosystem Services Approach within local governance.



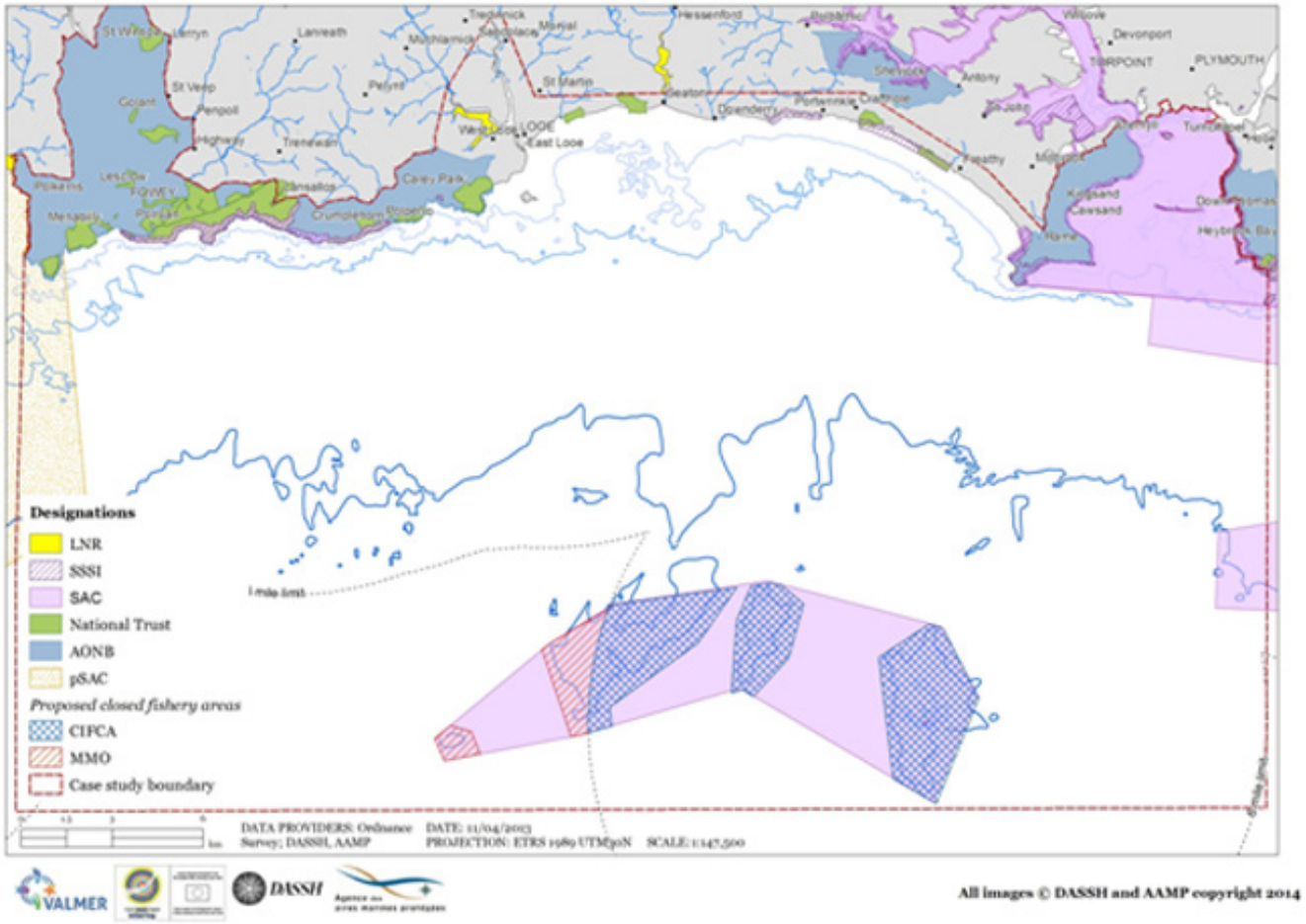
The landward part of the site is made up of a large stretch of open coast flanked by Rame Head and the Gribben Headland. It has mostly rural undeveloped stretches, with several exposed and sheltered beaches. The coast is indented bysmall estuaries, rivers and stream, along with unstable soft cliffs that have seen numerous landslips due to recent episodes of severe flooding.

Many parts of the site's coastal and marine environment are designated for conservation and landscape value.

The Tamar Estuaries complex drains into Plymouth Sound and have a significant influence over the physical characteristics of the marine and coastal area. Offshore habitats include rocky reefs and soft sandy sediments.

The site includes important European Marine Sites, for example, Plymouth Sound and Estuaries Special Area of Conservation (SAC) and the Start Point to Plymouth Sound and Eddystone SAC. The coast is part of the Cornwall Area of Outstanding Natural Beauty and supports a number of newly designated Marine Conservation Zones.

The major existing and proposed designations within the site boundary, both statutory and voluntary, can be seen in the following figure. In response to coastal hazards such as cliff failures and flooding, there are number coastal defences, both private and public, in place along the coast, to manage these risks.



Map showing existing site conservation management within the case study (MBA-DASSH)

Main Activities and Uses

The case study area adjoins one of the world's busiest shipping routes, the English Channel. Plymouth hosts the ***UK's largest naval base***, as well as having a commercial and a fishing port. Other parts of the case study site are used for ***coastal cargo and cruise shipping***, although this is limited by the small size and available infrastructure of the other harbours in the area, Fowey and Looe. ***Commercial fishing vessels*** also operate out of Fowey and Looe, as well as Polperro. Military exercises take place on the coast at Whitsand Bay and Tregantle Fort and offshore along the case study.

Plymouth Sound is heavily used by naval and other military operations, commercial shipping and the fishing industry.

The following figure illustrates some of the coastal and marine recreational activities that occur in the case study area. Running through the entire stretch of the study site is the South West Coast Path, providing access to this part of the Cornish coast and its many beaches.

Walkers and visitor numbers vary along the path's route, with the easterly sections of the coast path to Rame Head less well visited.

The towns of Looe, Polperro and Fowey are significant tourist attractions. Indeed, Fowey Harbour receives a growing number of ***cruise ship*** visits each year.

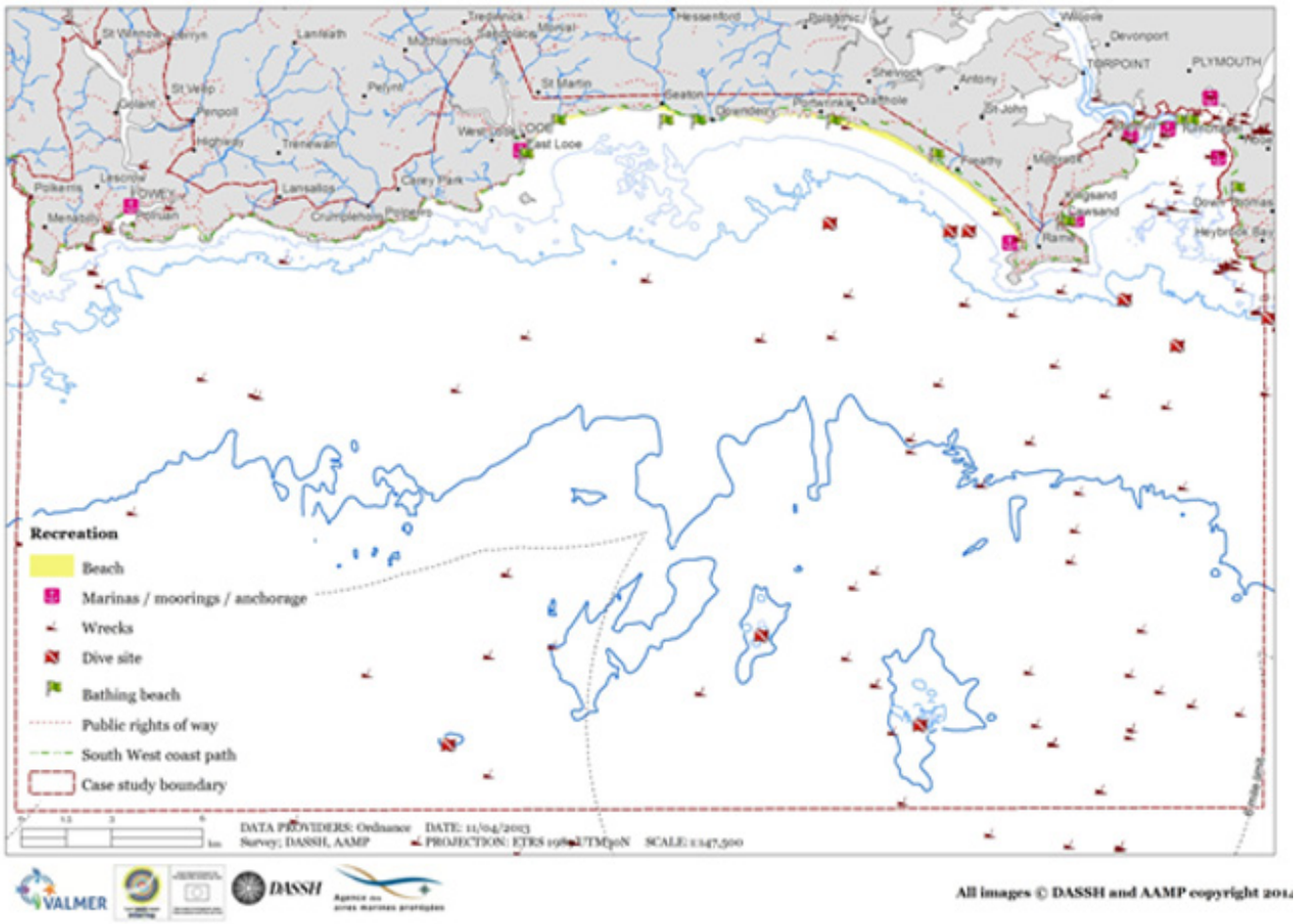
The area is considered important from a maritime cultural heritage perspective, due the large number of wrecks within the site. ***Scuba diving*** associated with these wrecks, including the HMS Scylla artificial reef. ***Yachting and recreational boating*** are also very popular with associated moorings, marinas and slipways.

Like much of the rest Cornwall and Devon, tourism and recreation are an important activity throughout the year, but concentrated in the summer season and shoulder months.

Both ***shore-based and boat-based angling*** occurs, with a number of angling competitions held throughout the year. There are a number of culturally significant landmarks in the area including the Eddystone lighthouse, Plymouth Breakwater, Rame Head Chapel, Tregantle Fort and St Catherines Castle. The area has long been an inspiration for art and literature.

A range of ***commercial fishing occurs, including demersal and benthic, along with potting and traps for shellfish***.

Within the case study there are ***two designated areas for disposing of estuarine dredged sediments***. One spoil site is situated south west of Rame Head, the other South East of Gribben Head.



Map showing a number of recreational sites within the case study (MBA-DASSH, 2014)

Governance Arrangements

The site was selected by the VALMER project to represent a typical stretch of Cornish coast with common coastal and marine activities, pressures and issues. The boundaries do not accord to a single joined-up governance structure or physical unit for management.

A significant number of organisations and managers operate within parts of the site, for example, a number of terrestrial planning authorities (Plymouth City Council, Devon County Council & Cornwall Council). The

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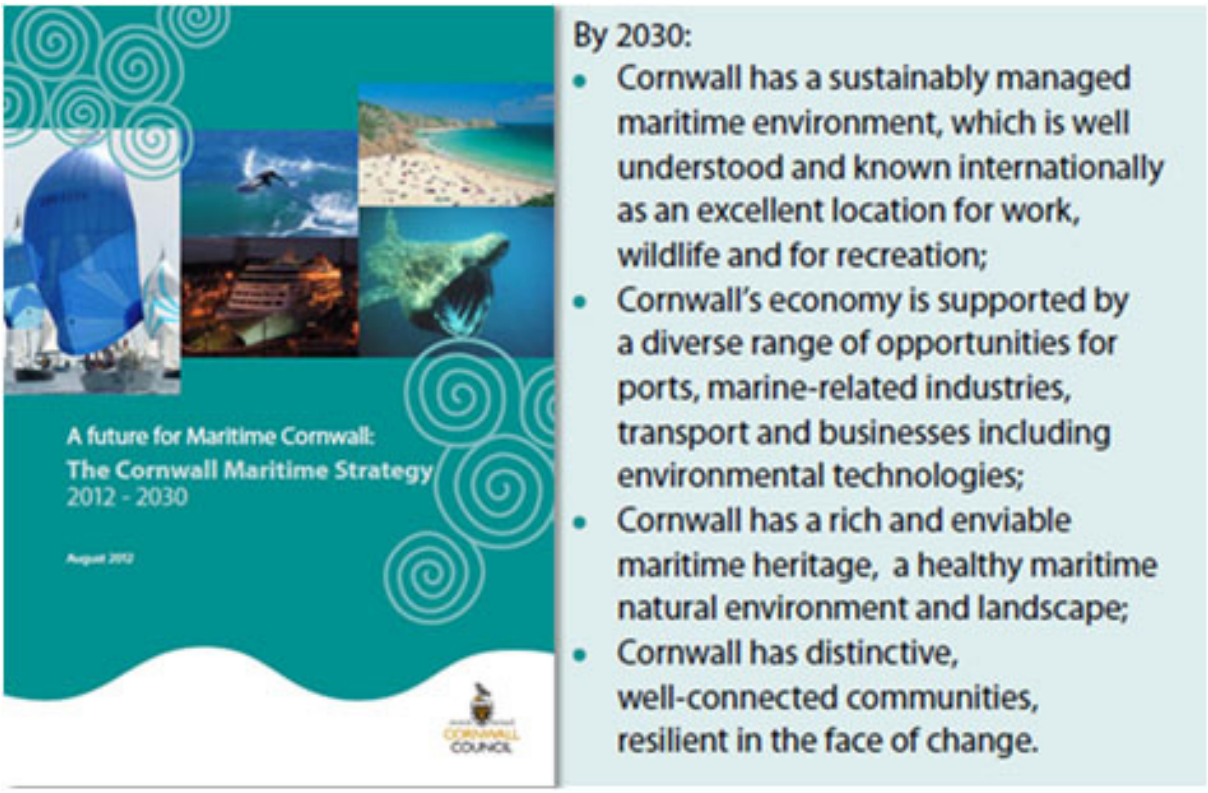
It is important, however, to highlight that management structures regulations, statutory and non-statutory documents only have pockets of influence within the site, either geographical or thematic. Only members such as Cornwall Council have a broad remit across the site and, therefore, the potential to influence the whole of the site area.

Duchy of Cornwall, Cornwall Council and National Trust as landowners manage part of the case study's coastline.

There are seven Harbour Authorities and the marine area is largely covered by the Cornwall Inshore Fisheries and Conservation Authority (IFCA) and Marine Management Organisation.

This gives rise to a considerable amount of management structures regulations, statutory and non-statutory documents. These deal with coastal risk management, via the Shoreline Management Plan, landscape conservation, via the AONB Management plan, development control via Local Plans, and estuary management, for example, through the Fowey and the Tamar Estuaries Management Plans. In policy terms, the site can be regarded as 'policy congested' in light of the plethora of overlapping and complimentary plans and strategies relating to coastal and marine management.

In September 2012 ***Cornwall Council published its Cornwall Maritime Strategy***. This high-level strategy document is the first of its kind and seeks to guide the future direction of work relating to maritime Cornwall. Maritime Action Plans have been drafted to support the strategy's vision, aims and objectives. The strategy has considerable potential to shape the future direction of coastal and marine management in the case study area.



Key stakeholders and their involvement

In the Plymouth-Fowey case study, the Ecosystem Services Assessment process was informed and validated by local management stakeholders. Within the case study area there are a number of stakeholder groupings that undertake cross-sectoral coastal and marine management,

for example the Tamar Estuaries Consultative Forum, Fowey Estuary Partnership and the Cornwall AONB Partnership.

A Task and Finish Group was established for the project. It consisted of key stakeholders responsible for the management of marine and coastal areas within the case study site (see following table).

It included representatives from local government authorities, environmental and marine governmental bodies, local harbour authorities, landscape and estuary management partnerships and NGOs.

Whilst the case study extended beyond Cornwall, representatives from the local authorities in Devon indicated that were happy not to participate in the Task and Finish Group as the case study's management focus would relate only to the Cornish coast and seas.

Whilst there is not a singular body or forum coordinating stakeholder engagement and management, a culture of working together and collaboration currently exists.

The VALMER Plymouth Sound to Fowey stakeholder group. The table divides the organisations or groups represented in the stakeholder group into categories and indicates whether the representatives took part in the 'before' and 'after' survey and stakeholder interview.

Organisation/group/etc.	Stakeholder category	'before' survey	'after' survey	Interview
Cornwall Council	Local government authority	✓	✓	✓
Environment, economy,		✓	✓	✓
sustainability, heritage, harbours.		✓		
(5 representatives)		✓		
		✓		
Natural England	Governmental body - environment	✓	✓	✓
(2 representatives)		✓		
Cornwall IFCA	Governmental body - marine	✓		
MMO	Governmental body - marine	✓	✓	✓
(2 representatives)		✓		
Fowey Harbour Commissioners	Harbour authority	✓	✓	✓
Cornwall AONB	Management partnership	✓		
Tamar Estuaries Consultative Forum	Management partnership	✓		
National Trust	NGO – heritage and conservation	✓	✓	✓
Cornwall Wildlife Trust	NGO - wildlife	✓	✓	✓

The four Plymouth Sound to Fowey VALMER stakeholder workshops, including a description of the aims and main activities

Task and Finish Group Workshops	Aims	Main activities
Stakeholder Workshop 1 May 2013	▪ Introduce the project, its aims and the Ecosystem Service Approach ▪ Introduce the rationale and aims for the case study ▪ Introduce the stakeholder to each other and agree a Terms of Reference for T&F membership ▪ Selection of ESA focus	▪ Completion of WP4 stakeholder 'before survey' ▪ Presentations on: the VALMER project; the Plymouth-Fowey case study site; ecosystem services and ESA; the use of ecosystem service valuation for governance; visualising spatial data for ESA ▪ Discussion and agreement for the scope and focus for the ESA ▪ Request for stakeholder-held data
Stakeholder Workshop 2 March 2014	▪ Validation of scenario focus for the case study ▪ Commencement of scenario building process with stakeholders ▪ Validation and enhancement of socio-ecological and governance models of the case study	▪ Presentations on: VALMER project update; data collection and baseline mapping for the site; cultural ecosystems services research; the case study scenario building approach; ▪ Breakout sessions to: validate and enhance socio-ecological model of the case study; validate and enhance governance modelling; PESTLE analysis ▪ Activities and discussion to work up the preferred options for scenario development
Stakeholder Workshop 3 June 2014	▪ Scenario development	▪ Presentations on: VALMER project update; three themes for scenario building, including selection rationale; principles of backcasting scenario building approach ▪ Three consecutive scenario building sessions to develop actions for each theme
Stakeholder Workshop 4 October 2014	▪ Scenario and ESA results	▪ Presentations on: VALMER project update, findings of Cultural ecosystem service research project, ecosystem services and the ESA process; ▪ Individual presentation and discussion of the baseline ESA results and ESA of three scenarios ▪ Completion of WP4 stakeholder 'after' survey ▪ Discussion of next steps, outputs and VALMER legacy

Selecting the Ecosystem Services Assessment Focus

Identification of the Ecosystem Services Assessment focus was guided by the VALMER case study team, in dialogue with members of the Task and Finish Group.

These discussions addressed a number of important issues, for example:

- ✓ What were the important ecosystem services and benefits, and site management issues and concerns?
- ✓ What could be achieved realistically with the resources available, including data and maps?

Through discussions with stakeholders it was agreed that a broadscale Ecosystem Services Assessment would be undertaken, entailing valuation and mapping of all marine and coastal ecosystem services within the site, wherever possible. This was felt to be a useful approach and that the associated outputs had the potential to benefit a range of marine and coastal management.

An interest in cultural services stemmed from the need to better understand the links between the marine environment and human well-being and the importance of tourism and recreation in the area.

A key consideration within these discussions was a desire by the Cornwall Council case study coordinator to explore how the Ecosystem Services Assessment and associated scenario development process could support the implementation of the Cornwall Maritime Strategy. The strategy explicitly states that it should be ensured, ***"that a sound evidence base, including socio-economic impacts and*** valuation ***of ecosystem goods and services, is used to inform all strategic decision making in the maritime area"*** [Cornwall Council 2012, p. 16].

The Ecosystem Services Assessment process consisted of four connected steps:

1. a baseline assessment of key ecosystem service in the case study area
2. stakeholder generated hypothetical future actions (resulting from the scenario building process undertaken during stakeholder meetings)
3. actions developed into three hypothetical scenarios
4. scenarios applied to the baseline with associated recalculation of the Ecosystem Services Assessment for each of the three scenarios.

Stakeholders also explicitly voiced a desire for cultural ecosystem services to be researched.

The third VALMER Plymouth Sound to Fowey Task and Finish Group meeting saw stakeholders participate in scenario building exercises that generated 47 theoretical actions which could deliver environmental aims of the Cornwall Maritime Strategy.

Scenarios for Assessment

These were then assessed by the case study team which considered the suitability of each of the actions for the subsequent Ecosystem Services Assessment. Factors which were taken into account included the potential for the action to result in tangible effects on ecosystem services at the case study scale and whether gaps in the information needed to undertake the Ecosystem Services Assessment could easily be filled.

The first sifting process saw the Case Study team recommending that 19 of the 47 actions may be suitable for the Ecosystem Services Assessment stage of the project, either alone or as grouped scenarios.

A subsequent sifting process prioritised 3 scenarios suitable for Ecosystem Services Assessment in the time available.

The case study team set out a number of assumptions for each scenario in order to boundary them for the purposes of the Ecosystem Services Assessment. Where possible, the assumptions were based on stakeholder-developed theoretical actions.

The three hypothetical scenarios' developed for assessment were as follows:

- ✓ **Recreational boating:** exploring changes in ecosystem services delivery associated with changes in mooring type and a reduction in ecological footprint on the seabed.
- ✓ **Marine Protected Areas:** exploring changes in ecosystem services delivery associated with introduction of Marine Protected Areas in the case study with high levels of protection i.e. no extraction or deposition.
- ✓ **Dredge disposal:** exploring changes in ecosystem services delivery associated with closure of two disposal sites with combined materials taken to a re-opened site within the case study area further offshore.

Methods and Results

A primarily qualitative assessment was made of how services might change under the management scenarios.

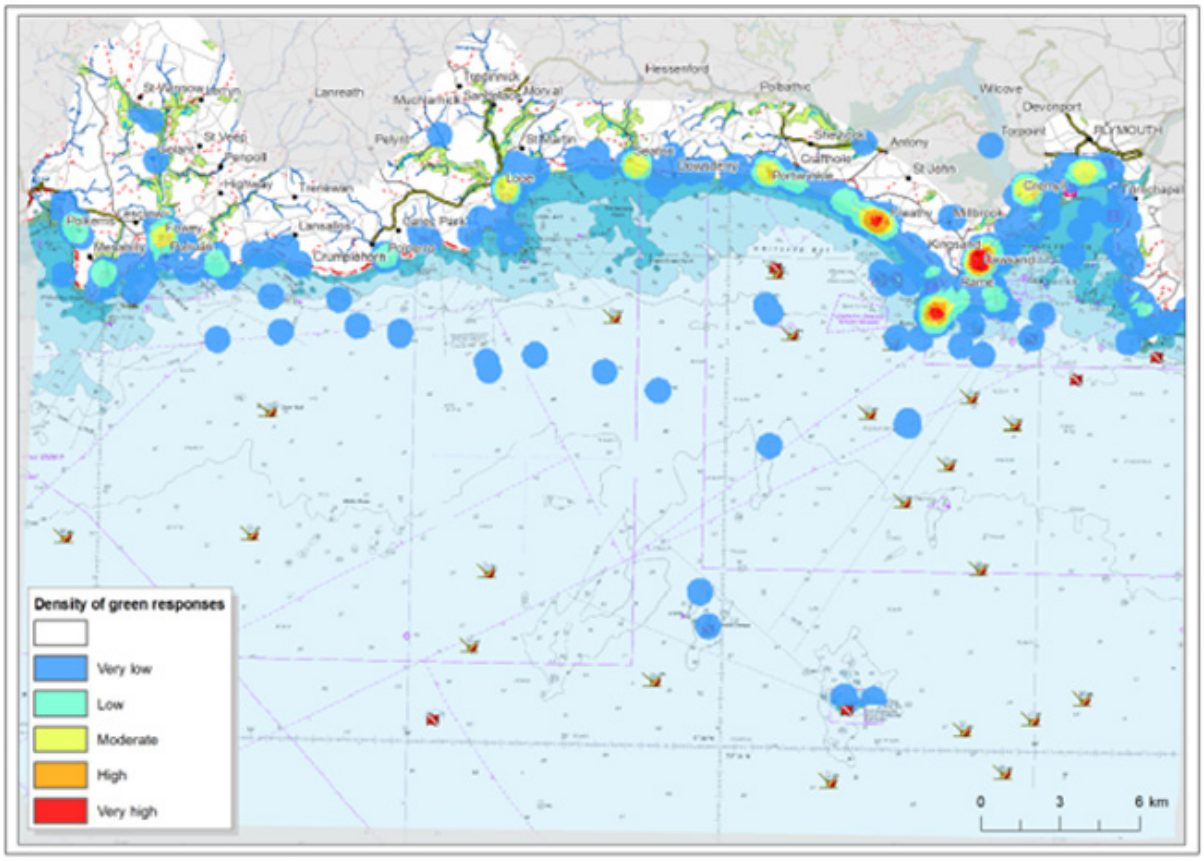
The Ecosystem Services Assessment was undertaken by Plymouth Marine Laboratory in collaboration with the Marine Biological Association of the UK who provided data and GIS mapping support.

Whilst this approach used existing data, the project added considerable value through its Data Discovery exercise, processing, analysis and presentation/visualisation for a baseline assessment. An additional discrete piece of research to quantify, map and visualise the health and wellbeing benefits associated with Plymouth Sound to Fowey area was undertaken by the University of Exeter [Willis et al., 2014].

The baseline assessment of multiple services was refined to focus on **nursery habitats for commercial species**, **carbon storage**, **sea defence** and **waste processing** (considering the supply of clean water, immobilisation of pollutants and nutrient cycling). This component of the study took a spatial approach, mapping the delivery of the services based on information within the literature concerning linkages between habitats and services.

Some quantification and **monetary valuation was however undertaken for carbon storage**.

The **assessment of cultural services** [Willis et al., 2014] **used an online and face-to-face survey with local residents**, containing a spatial component in which each respondent was asked to indicate three locations that were considered special, significant or valuable and three that were unpleasant, neglected or challenged.



Significant and valuable places in the Sound to Fowey case study identified by survey respondents

- ✓ The baseline maps of ecosystem service delivery illustrated the importance of Plymouth Sound, with its varied habitats, as a **nursery for a range of commercial species**.
- ✓ **The sand and coarse habitats that cover much of the case study site provided negligible levels of carbon storage relative to other habitats**, although value of the site for carbon storage nonetheless amounts to £1.4million per year. These habitats play a greater role in **nutrient cycling and the provision of clean water**.
- ✓ The value of the increased carbon storage through the **recovery of seagrass following the replacement of swing moorings** is unlikely to offset the costs of installing the new eco- buoys, although the values of other services that may also increase were not calculated.
- ✓ The **dredge disposal scenario** identified the potentially large increase in cultural services that could be obtained from relocation of the disposal site, while the **Marine Protected Area scenario** highlighted the complex trade-offs that would require consideration in any management decision.

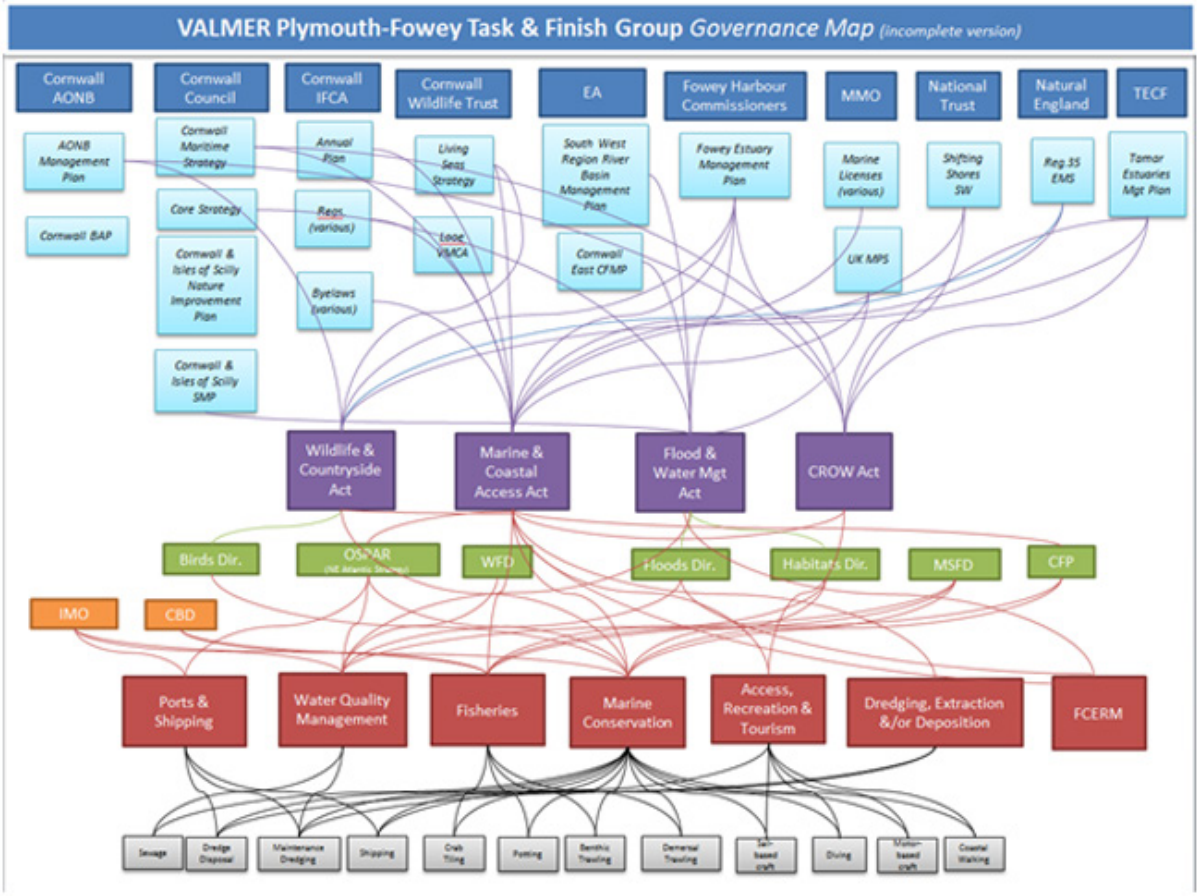
Governance mapping to support the assessment

The case study governance framework analysis highlighted a large volume of plans and strategies with numerous inter-linkages, horizontally

amongst the plans themselves and also vertically in relation to the activities and to marine ecosystems within the site.

In response to this, Plymouth University sought to map these governance connections. The purpose of this was twofold: firstly to trial methods for constructing and visualising governance, with the second objective relating this work being used by the stakeholder to support scenario development within the case study.

The mapping activity was shown to the Task and Finish Group during two of the stakeholder workshops, allowing them to improve and validate the connections between strategies and to feedback on visualisations methods, for example Microsoft PowerPoint and web-based versions (see following figures).

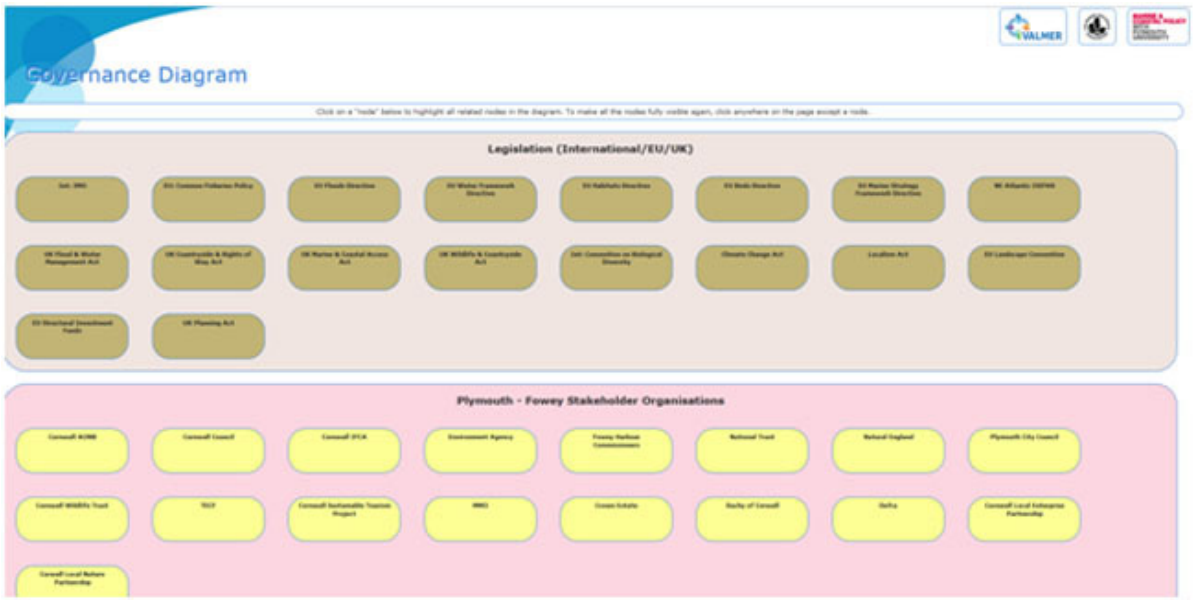


An early iteration of the Plymouth Sound- Fowey governance mapping, showing connections between Task and Finish Group member's plans and strategies, the supporting legislation, and connections through to marine and coastal sectors and activities within the site

The mapping allowed stakeholders to explore connections amongst various aspects of site governance and interventions within marine ecosystems; thus supporting greater awareness of ecosystem-based management.

The final version was developed in collaboration with the Marine Biological Association of the UK to create a web-based interactive site. It is supported by a Microsoft Excel file that makes nodal connections between organisations, strategies, legislation, marine sectors and activities. These are then highlighted when the viewer clicks on a node of interest: http://dassh.ac.uk/demonstrations/valmer/valmer_governance_2/

Positive feedback from stakeholders highlighted the value they could see in such mapping and visualisations, to help simplify the complex governance landscape that they as managers and regulators operate in.



Screen grab of the web-based governance mapping, by clicking on one of the boxes known as 'nodes', all the related nodes then highlighted to the viewer

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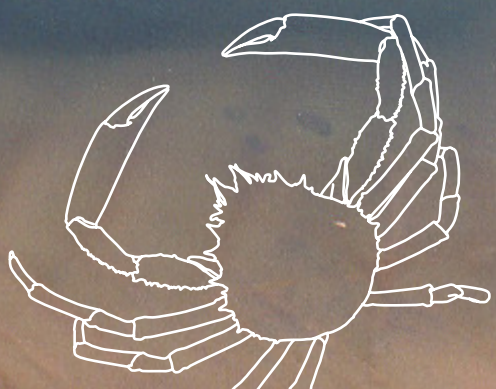
Poole Harbour



Contents

The work presented here has been developed in six case studies of the VALMER Interreg 4A Channel project (2012-2015).

Coordination by M. Philippe[5], J. Ballé-Béganton[5] and D. Bailly[5] based on written contributions from A. Brocklesby[1], K. Buchan[1], W. Dodds[4], T. Hooper[3], L. Friedrich[4], N. Beaumont[3] and C. Griffiths[2]

[1] Dorset County Council/Dorset Coast Forum

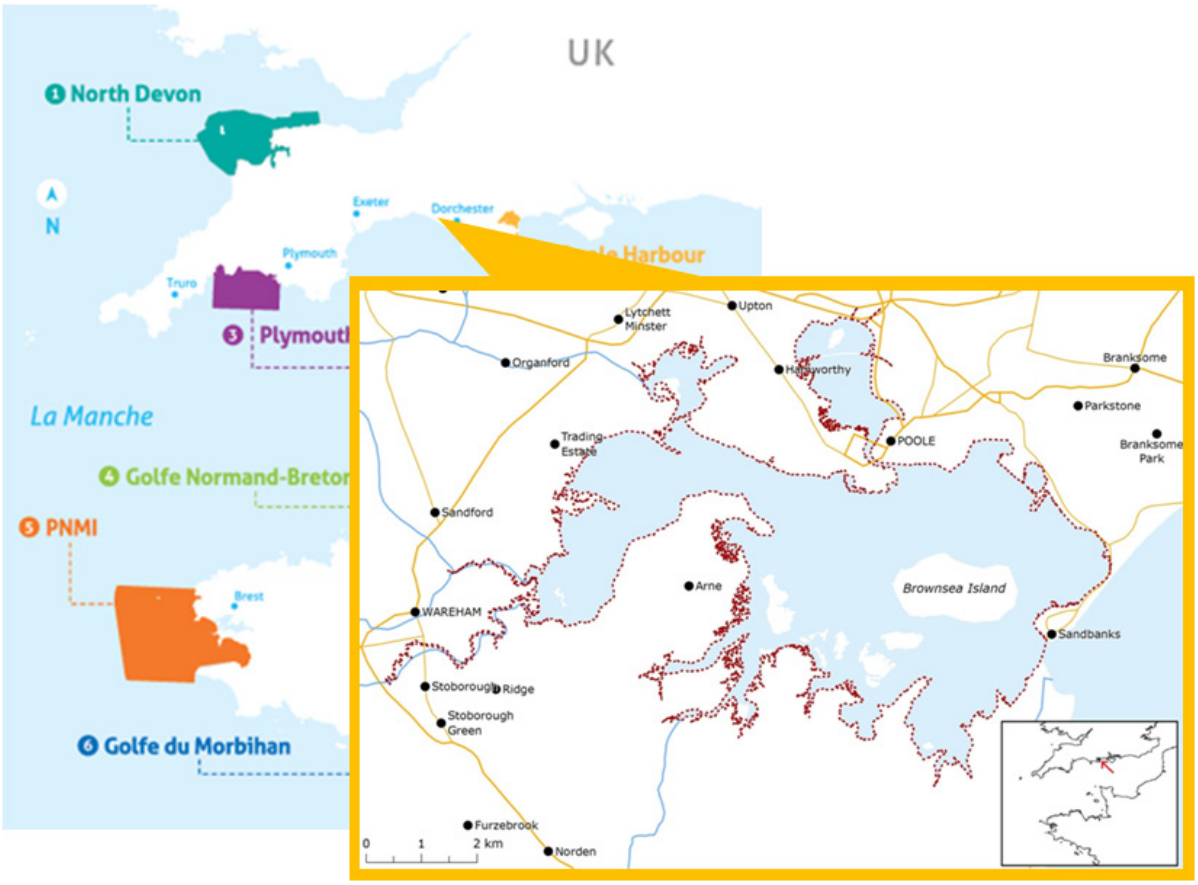
[2] Marine Biological Association of the UK

[3] Plymouth Marine Laboratory

[4] Plymouth University

[5] Université de Bretagne Occidentale – Brest/ UMR AMURE

Site description



Physical Environment

At 36km^2, it is one of the largest natural harbours in Europe. The site, with its eight islands, encompasses a number of estuarine, wetland and heathland habitats, including saltmarshes, reed beds, seagrass, mudflats, small beach areas, heathland, heath-woodland mosaics.

It has large areas of built environment that includes flood and coastal defences around the more urbanised North shore.

The Harbour is of high ecological value with a diversity of sensitive habitats and species, covered by a host of national, European and international nature conservation designations, including:

- ✓ multiple Sites of Special Scientific Interest (SSSI),
- ✓ RAMSAR for being the best and largest example of an estuary with lagoonal characteristics in Britain,
- ✓ Area of Outstanding Natural Beauty (AONB)
- ✓ Special Protection Area (SPA) for its internationally important wintering, migrating and breeding wildfowl and waders.

The Poole Harbour Special Protection Area is entirely marine in its designation, and protects a number of features of interest including *Recurvirosta avosetta*, *Sterna hirundo* and *Spartina anglica*. The harbour is also home to important bass nurseries.

Poole Harbour is considered to be one of the outstanding natural features of Southern England and one of the largest estuaries with an enclosed, lagoonal character in Britain.

Main Activities and Uses

- ✓ As a **busy commercial port**, Poole Harbour supports significant shipping, including cargo and cross-Channel ferries.
- ✓ It is also used extensively by the public for a **wide range of leisure and recreational activities**, which occur both in and around the harbour.
- ✓ There are **seven marinas and eight yacht clubs**, with five thousand moorings (a combination of swing moorings and sheltered marine and pontoon berths).
- ✓ Approximately **a hundred fishing boats** under 10 metres operate out of the harbour, as well as a large charter boat fleet for fishing and diving trips.
- ✓ There are a number of **shellfish farms** in the harbour, and associated designated shellfish waters under European legislation.
- ✓ Natural resource extraction occurs within the site, for example, there is an **undersea oil drilling operation** producing over 16,000 barrels a day.

There are over twenty different recreational activities taking place in Poole Harbour including walking, cycling, beach activities, watersports and a selection of powered and non-powered craft (sailing, powerboating, kayaking etc).

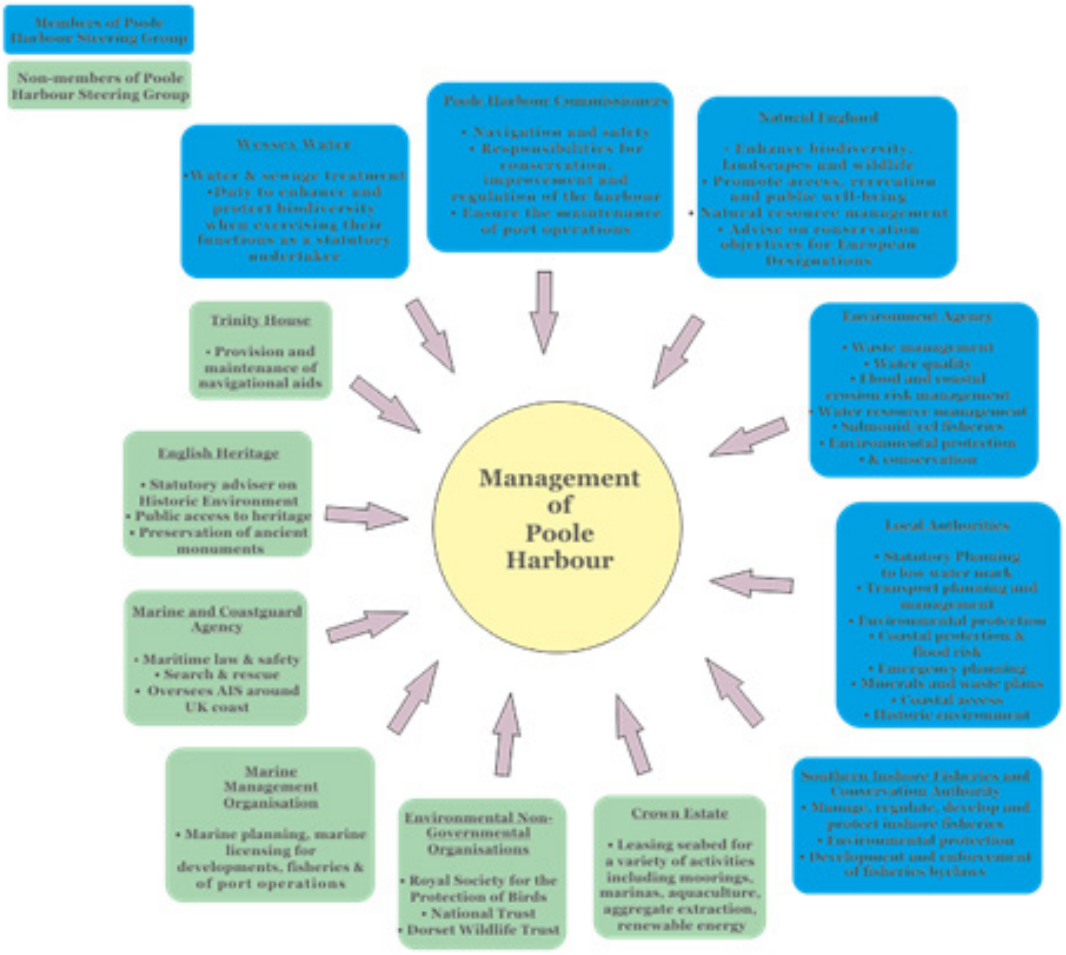
Recreational activities have been identified within the Dorset Coast Forum's www.icoast.co.uk, an interactive mapping website to provide information and advice on the facilities, transport, restricted areas and tide times for recreational activities taking place along the Dorset Coast.

Governance Arrangements

With such a wide range of commercial and public activities occurring in and around the harbour, the need to manage these different interests has long been recognised.

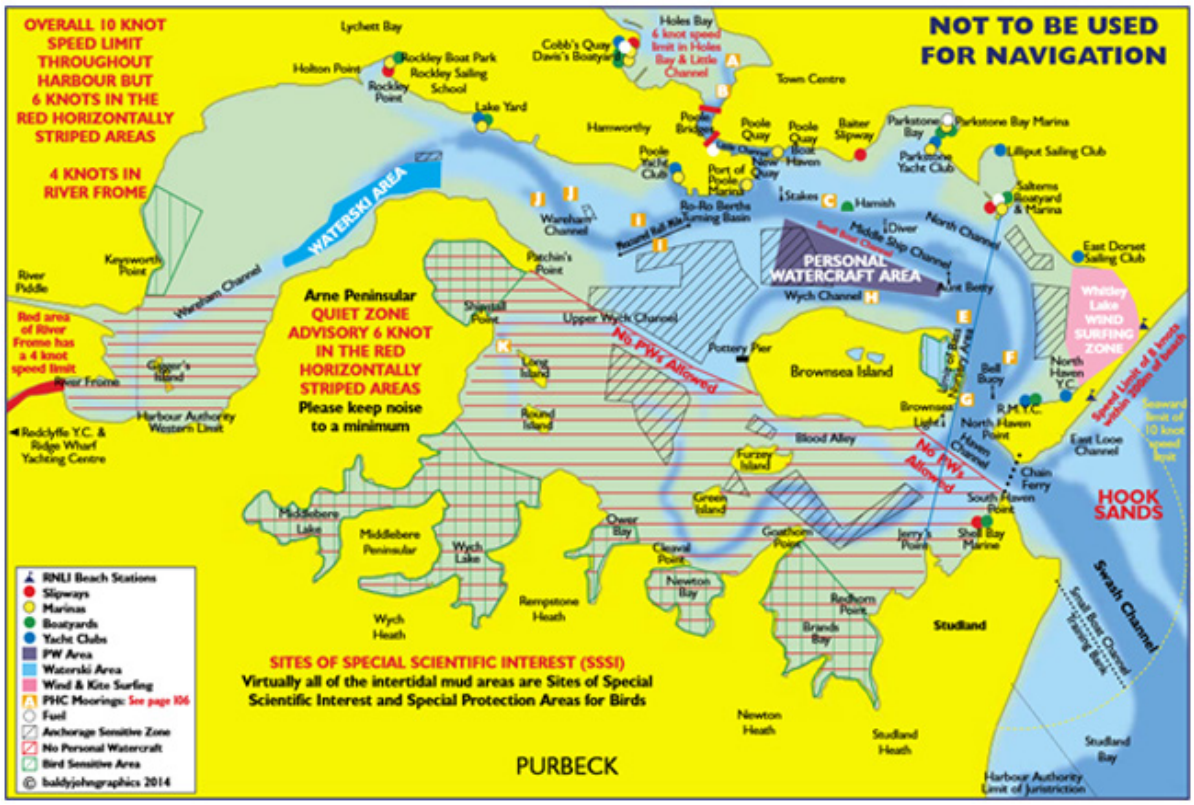
As with many coastal and marine environments, there are a plethora of statutory and non-statutory bodies in place that govern various aspects of the harbour, with the majority of these having their own planning documents and strategies.

The Poole Harbour Commissioners (PHC) have jurisdiction over water based activities that take place in the harbour and regulate these to ensure the safety of all harbour users.



Poole Harbour Governance Framework

A number of activities are zoned. Some activities are permitted; for example, jet skiing and waterskiing. Harbour access and speed restrictions are also used to manage these activities for safety and to reduce conflict between users, for example, encouraging launching of jetskiers at manned slipways with parking for cars and trailers, and restricting access to southern parts of the harbour where there are environmentally sensitive areas.



Map showing zoned areas for water based activity in Poole Harbour [PHC, 2014]

This seeks to provide a coordinated and effective framework for the management of Poole Harbour. It encompasses both the present and future needs of nature conservation including the previously mentioned SPA, of recreation, commercial user and other interests in the harbour. The plan is monitored and reviewed regularly. This document also serves as the Management Scheme for the Poole Harbour SPA.

The Poole Harbour Steering Group (PHSG) oversees the Aquatic Management Plan. It is a voluntary partnership that provides a framework for coordination between statutory bodies with responsibilities in the harbour.

The Poole Harbour Steering Groupmembership includes:

- ✓ Borough of Poole
- ✓ Dorset County Council
- ✓ Environment Agency
- ✓ Marine Management Organisation
- ✓ Natural England
- ✓ Poole Harbour Commissioners
- ✓ Purbeck District Council
- ✓ Southern Inshore Fisheries and Conservation Authority
- ✓ Wessex Water Services Ltd

PooleHarbour
AQUATIC MANAGEMENT PLAN

A key management framework that covers the entire site and integrates several organisations and issues is the Poole Harbour Steering Group's Aquatic Management Plan.

A culture of stakeholder liaison and interest in the management of the harbour is to the benefit of the governance of this case study site.

There are a number of relevant national bodies that are not members of the Poole Harbour Steering Group but are important to the site's management. These include the Crown Estate and English Heritage. In addition, there are other organisations and associations with an interest in the management of Poole Harbour and its surrounding coastline, namely Dorset Coast Forum, Dorset Wildlife Trust, RSPB, and local recreational user groups and clubs.

Despite this complex situation, the Poole Harbour Steering Group and the Aquatic Management Plan provide a focal point for the management of recreation within the harbour, bringing together managers and other stakeholders.

Furthermore, the Poole Harbour Commissioners, whose primary responsibility is to ensure safety of navigation, commercial revenue of the port and environmentally sustainable management, undertake extensive stakeholder liaison to balance environmental, commercial and leisure interests in the harbour.

Key stakeholders and their involvement

The Poole Harbour case study was subject to restricted staff resources and shorter time frames compared to the other five VALMER case studies. In consequence, the Poole Harbour stakeholders were not actively involved in the Ecosystem Services Assessment process or in scenario building, which is the main VALMER mechanism for integrating Ecosystem Services Assessment into site governance.

The key stakeholder group involved in the VALMER Poole Harbour case study was the Poole Harbour Steering Group.

The case study coordinator did, however, liaise consistently with Poole Harbour Commissioners throughout the Ecosystem Services Assessment process to ensure that the Ecosystem Services Assessment results would be relevant to Poole Harbour Commissioners and the other Poole Harbour Steering Group members. This liaison directly built upon Dorset Coast Forum's existing relationships with the Poole Harbour Steering Group and harbour users which have been fostered over many years through initiatives such as the C-SCOPE pilot marine planning project; with ongoing liaison to continue after the life of the VALMER project.

The case study coordinator attended a number of Poole Harbour Steering Group meetings to inform the stakeholders about VALMER and the Poole Harbour Ecosystem Services Assessment and to discuss the Ecosystem Services Assessment results and their application in site governance with the group.

In addition, the case study coordinator arranged a number of face to face meetings with the Poole Harbour Commissioners given their integral role in harbour management so as to brief the Poole Harbour Master and Chief Engineer on aspects of the project.

At the Poole Harbour Steering Group meeting in May 2013, the stakeholders were introduced to the VALMER project and the Poole Harbour case study. The travel cost method and analytic hierarchy process was explained and preliminary results from the surveys presented.

The stakeholders were not given any information about the ecosystem services approach more generally, such as, for example, an explanation of what ecosystem services are or examples of the different types of ecosystem services.

The Poole Harbour Ecosystem Services Assessment results were presented to the Poole Harbour Steering Group at the November 2013 meeting.

To capture the stakeholders' VALMER experience and evaluate their understanding of Ecosystem Services Assessment and their views on the usefulness of Ecosystem Services Assessment as a marine governance tool, the VALMER team conducted a number of surveys with members of the Poole Harbour Steering Group. This included a before and an after questionnaire and follow up interviews. The following table lists the organisations that were represented in the VALMER Poole Harbour stakeholder group and indicates who took part in the various VALMER surveys.

List of the organisations whose representatives on the Poole Harbour Steering Group took part in the VALMER before/after survey and interviews and identifies the type of stakeholder category that these organisations represent

Organisation	Stakeholder category	'before' survey	'after' survey	Interview
Borough of Poole	Local government authority	✓	✓	✓
Purbeck District Council	Local government authority	✓		
Environment Agency	Governmental body - environment	✓		
Natural England	Governmental body - environment	✓	✓	✓
Southern Inshore Fisheries and Conservation Authority	Governmental body - marine	✓		
Marine Management Organisation	Governmental body - marine	✓		
Poole Harbour Commissioners *(3 representatives)*	Harbour authority	✓	✓	✓
		✓		
			✓	
Wessex Water Services Ltd.	Water company	✓	✓	✓

** The Marine Management Organisation is not officially a member of the Poole Harbour Steering Group but plays a role in the management of Poole Harbour as a national governmental body. They were represented at the meeting at which the VALMER project was introduced and the 'before' survey circulated.*

To disseminate the results more widely to other harbour users and stakeholders, Dorset County Council / Dorset Coast Forum in collaboration with Poole Harbour Commissioners held an open evening meeting was held 29th January 2014. **In total, 45 attended including survey respondents, councillors, local authority officers, Poole Harbour Commissioners representatives, National Governing Body representatives, activity club representatives, NGO/charities/organisations (e.g. Environment Agency, Dorset Wildlife Trust and National Trust) and various watersport businesses from around Poole Harbour.**

Ecosystem Services Assessment

As stated, Poole Harbour is used extensively by the public for a wide range of leisure and recreational activities, with over twenty recreational activities occurring in and around the harbour. Recreation is clearly a significant use and economic activity both locally and within the Dorset

The Poole Harbour Ecosystem Services Assessment focused on the valuation, in monetary and non-monetary terms, of the cultural benefits of recreation supported by the harbour's marine ecosystem.

area. Despite this, the number of recreational visitors and the value of recreation to the local economy have never been quantified.

Furthermore, the relationship between the recreational activities and reliance on ecosystem services within the harbour is currently not well understood. This was the starting point for the VALMER Ecosystem Services Assessment coordinated by the Dorset County Council and Dorset Coast Forum (DCC / DCF).

As stated by the case study coordinator, this information was felt to be key: *"we knew this was a gap in knowledge that we wanted to get values for"*.

The study focused on generating new data for six popular water-based activities which frequently occur in the harbour : kitesurfing, windsurfing, bird watching, jet skiing, water skiing and kayak/canoeing.

The stated aim for this Ecosystem Services Assessment was to identify and understand the monetary value, priorities that users place on the natural attributes of the harbour, and opinions on management of their activity.

Methods and Key Results

Methods

Two periods of data collection were undertaken for the Poole Harbour Ecosystem Services Assessment, the first in 2013 and the second in 2014.

To secure the desired number of respondents, i.e. one hundred per activity, Dorset County Council / Dorset Coast Forum invested considerable time to raise awareness and engage as many people to help complete surveys. This engagement also raised interest and anticipation of the results amongst managers and users of the harbour.

The first piece of data collection comprised **a visitor survey for the six activities conducted during April to August 2013**, with the survey tailored to the specific activity being assessed. The surveys were primarily carried out online, although some postal surveys were sent to those renewing personal watercraft licences and other paper surveys were handed out at key sites where the activities are known to take place, e.g. Brownsea Island and Arne for bird watching and a number of launch sites for water-based activities.

To promote the survey, leaflets were developed and distributed widely, a webpage was developed to act as a point of contact for participants (www.dorsetforyou.com/valmer) and national sport governing bodies, local clubs and water sports shops and tuition businesses were contacted. Social media, national publications and local press were also used to promote the survey and seek respondents.

Within the surveys, a monetary value for each activity was determined using the travel cost method, which considered how much people spent to travel to Poole Harbour to undertaken their chosen activity. Information on local spending during their visit was also collected.

The respondents were also asked to prioritise different characteristics of Poole Harbour, using a multi-criteria analysis (the Analytic Hierarchy Process) to weight their preferences for environmental quality, cost and facilities. Survey respondents were asked additional questions, including how certain management issues would affect their continued use of Poole Harbour.

The Dorset Coast Forum process suggested that environmental quality, and particularly the presence of wildlife, was most important to users' enjoyment of recreation in Poole Harbour. However, in terms of management options that have the potential to increase and decrease visitor numbers, the management of water quality was found to be key to sustaining levels of participation in recreational activities.

Analytic Hierarchy Process (AHP) for Environmental Attributes in the harbor

For an overall monetary value for the six recreational activities, it was necessary to know the total number of people undertaking each of the

activities. As this information was also lacking, Dorset Coast Forum commissioned ecological consultants Footprint Ecology to undertake count surveys between May and August 2014, which involved 55 boat-based transects across the harbour and beam counters deployed for 80 days at bird watching at Arne and the Dorset Wildlife Trust's nature reserve on Brownsea Island.

Results

In total 546 survey responses were received, with half of the respondents living locally to Poole Harbour. This data was collated by Dorset County Council / Dorset Coast Forum and the socio-economic analysis done by Plymouth Marine Laboratory.

Results suggest an annual spend (on travel and local expenses) of £3.1million across the six activities considered. Birdwatching contributed over 60% of this, due to the high number of participants.