



TRANSNATIONAL SCENARIOS SYNTHESIS

RESULTS OF THE SCENARIO BUILDING PROCESSES DEVELOPED BY VALMER'S CASE STUDY SITES

Authors: Juliette Herry, Aidan Winder

Contributors: Nicolas Beaumont, Andrew Bell, Dominique Davoult, Karine Dedieu, Wendy Dodds, Laura Friedrich, Charlie Griffiths, Steven Guilbert, Olivier Guyader, Tara Hooper, Phillipa Hoskin, Olivia Langmead, Martial Laurans, Philippe Le Niliot, Anahita Marzin, Rémi Mongruel, François Morisseau, Manuelle Philippe, Ness Smith, Alice Vanhoutte-Brunier, Diane Vaschalde.

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Aims of the document and elements presented

This report aims to summarise the *scenario building process* that was used with stakeholders in the VALMER project. The project is about *assessing marine ecosystem services in the western Channel* and uses a scenario building process to engage stakeholders. The project's methodology involved an *ecosystem services analysis* using *data* gathered from six *case study sites* found in the UK and France. The results of the analyses were then used to try and *improve marine planning and governance*.

This document can be read in conjunction with the VALMER *scenarios guidelines* document that sets out how to run a scenarios building exercise with stakeholders.

Here we have set out the approaches adopted in each of the six case study sites and this includes a brief introduction to the site, the ecosystem services assessment, the scenarios approach and the use of the outputs from the scenarios for management. Importantly, the document also gives information on what the advantages and disadvantages of the scenarios process, the difficulties encountered and some tips for running a scenario session. Finally, the learning from the process is translated into some recommendations for a successful site based scenario building exercise for use by practitioners.

Understanding the scenarios process

The *scenarios building process* is a tool for engaging stakeholders in decisions. In VALMER it has been used in six natural sites that have environmental management issues. These issues are being approached using an *ecosystem services analysis* methodology. Natural sites inevitably have a number of different individuals, groups and organisations that have an interest in them. It is important that they all understand each other's responsibilities and needs and how these impact on the site in question. Building scenarios provide an interactive way of bringing the various interests together in a creative and constructive discussion that can progress from a hypothetical situation as far as agreeing what actions to take, should the participants wish.

The essential element of all scenario building processes is that a plausible but, as yet, unachieved series of events are agreed by consensus as a possible way forward. They are often time-consuming to put together but this should result in a positive interaction between the different interests that results in the avoidance of lasting differences and a greater understanding of the needs and responsibilities of others. Essential elements of building successful scenarios are in ensuring that a sense of respect for others is at the heart of the process; that there is fairness and transparency to the process and that democratic decision-making is used.

Other key elements also include the use of accurate data as *evidence* and the inclusion of the right participants, be they from a local business such as a fisherman, a community representatives such as councillors, government agencies or researchers and scientists.

Scenario building can represent a *safe* territory, in which there is a more open discussion than might otherwise have been possible. It is a recognised strength of the scenario process that the participants can, by agreement, take their discussions as far as they feel comfortable so opening up the opportunity for real progress to be made.

Background to the scenarios

During the initial planning of the VALMER project, it was agreed that there was a considerable amount to be gained by combining the theory of an ecosystem services analysis with the practical needs of managing a natural site. In this way, theory would be taken beyond the scientific journal and site management would be improved by making decisions based on scientific evidence.

The six natural sites were identified as having a potential to benefit from this approach. Each of these sites, to a greater or lesser extent, had already been subject to some degree of management intervention. All of them were sites that were valued greatly for their natural, commercial and social assets. They were all sites where a need for intervention had been identified and this gave rise to many individuals, experts, organisations and businesses coming forward and expressing an interest in influencing management decisions. Given this, developing scenarios, with their inherent flexibility and participative nature, appeared to be a good way of bringing the various parties together.

Each of the case study sites was given the choice of which scenario methodology to use. The options can be found in the scenario guidelines that have been prepared as part of the VALMER project. The approaches adopted have varied from the relatively simple, involving a small group of professionals to the more complex with a series of workshops and meetings. One site chose a participative approach that did not follow the scenario methodology, which demonstrated that bespoke solutions need to be adopted depending on site management requirements. Each site completed a participative exercise with stakeholders as part of the VALMER project, which has led to site management being taken forward and improved.

★ Scenario building approaches developed by VALMER's case study sites



Map of the six VALMER case study sites

1. North Devon

Authors

O. Langmead¹, T. Hooper², C. Griffiths¹, N. Beaumont² and S. Guilbert³

¹ Marine Biological Association of the UK

² Plymouth Marine Laboratory

³ Devon Maritime Forum/Devon County Council

1.1. Case study site description

1.1.1. Physical environment

The North Devon case study site encompasses the marine and coastal parts of the UNESCO North Devon Biosphere Reserve (NDBR) (Figure 1). The area of over 1000 km² includes the Taw-Torridge Estuary as well as important marine and coastal habitats ranging from rocky foreshore, sand dunes and various types of saltmarsh to intertidal and subtidal mud and sand flats. The coast in the area is rural and relatively undeveloped, with only small towns and villages.

The site encompasses a number of sensitive and ecologically important habitats that are covered by national and European nature conservation designations, including the Braunton Burrows sand dune Special Area of Conservation (SAC) and the North Devon Coasts Area of Outstanding Natural Beauty (AONB). Lundy Island is designated as a Site of Special Scientific Interest (SSSI) for its plant life and seabirds. The waters around Lundy were England's first Marine Protected Area (MPA), as a voluntary and later as a statutory marine nature reserve. Lundy became an SAC in 2005 and was the first Marine Conservation Zone (MCZ) to be designated under the 2009 Marine and Coastal Access Act. Features of conservation around Lundy include eight species of coral as well as species associated with the rocky reef habitats.

Furthermore, the North Devon site is a nursery and spawning ground for a number of commercially important species including crabs and lobsters, rays, Dover sole, plaice, cod and whiting.

1.1.2. Main activities and uses

The local economy relies to a large extent on marine and coastal tourism and recreation. The beaches along the North Devon coast are popular with surfers. There are good dive sites along the coast as well as around Lundy Island. Lundy itself is a popular destination for nature enthusiasts and birdwatchers but also offers opportunities for seeing other marine wildlife such as seals. Other recreational activities in the area include walking and cycling on the South West Coast Path and the Tarka Trail. The harbours in the NDBR provide moorings for yachts, and charter boats offer trips to go angling, diving or marine wildlife watching.

Commercial fisheries are the second, major marine contributor to the local economy. Fishing activities in the NDBR include bottom trawling, potting, line fishing and netting, as well as crab tiling in the estuary. The main targeted species in the area are skate and ray, whelk, lobster, brown crab, squid, sea bass, plaice and Dover sole. There are no active aggregate dredging or disposal sites, although there are historic disposal sites off Hartland Point and Woolacombe Bay. While traditional marine resource extraction at the site is limited to fisheries, areas in and around the NDBR have been identified as potential sites for the development of marine renewable energies. The Crown Estate identified an area just north of the NDBR marine site as a Round 3 offshore windfarm licence area. Although the development of the Atlantic Array windfarm at this site was cancelled in 2014, an offshore windfarm could poten-

tially be developed at this site in the future. Further, the Crown Estate has given a permit for a tidal demonstration zone off Foreland Point in Lynmouth Bay where new tidal stream devices will be tested.

There is some commercial shipping in the area, mainly timber and clay being exported from Bideford Harbour. Aggregates gained from a dredging area to the north of the NDBR marine site are landed at Bideford. The site is also occasionally used for shelter by ships going in and out of the Port of Bristol. The shipyard in Appledore supplies sections for new Royal Navy ships as well as constructing a series of vessels for the Irish navy. Overall, there are seven small ports and harbours in the area. Local fish catches are landed into Bideford and Appledore as well as Ilfracombe and Clovelly. Other uses of the NDBR marine site military training areas off Braunton Burrows and along parts of its western and northern borders as well as transatlantic cables which come onshore off Woolacombe.

1.1.3. Governance arrangements

The most significant governance framework at the case study site is the NDBR, which was established 2003 under the UNESCO Man and Biosphere Reserve programme. Biosphere Reserves aim to reconnect people with their local environment and to promote sustainable development based local community efforts and sound science. The NDBR has three functions: conservation of special landscapes and wildlife as well as the rich cultural heritage in the area, learning and research, and community based sustainable development. The site is divided into three management zones: a core, buffer and transition zone (Figure 1). In the core area the focus is on nature conservation. The main objective for the buffer zone is the careful management of natural and cultural resources by and for local communities. The transition zone makes up the largest part of the NDBR. Here, management focuses on ensuring that communities can thrive sustainably in an enhanced environment. The marine section of the NDBR is part of the transition zone.

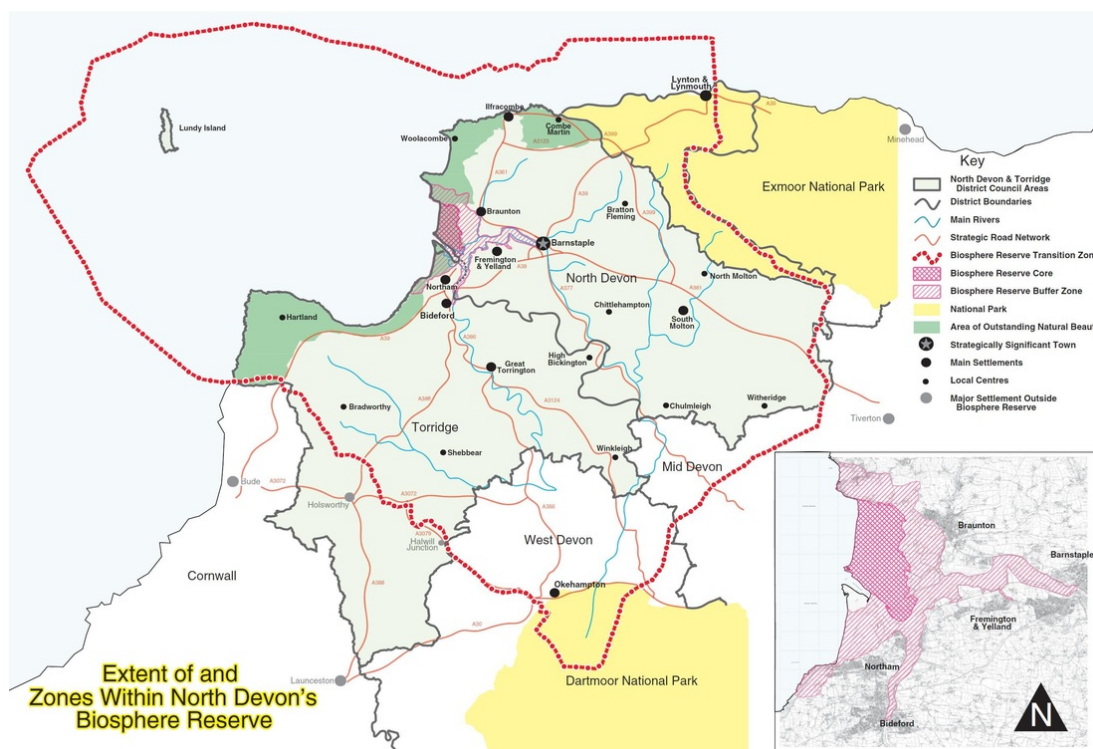


Figure 1. The North Devon Biosphere Reserve, including the three zones

The management of the NDBR marine site is determined by a series of statutory and non-statutory plans and strategies. These include the Devon and Severn Inshore Fisheries and Conservation Authority (IFCA) byelaws, the Lundy SAC designation and MCZ zoning scheme, the North Devon AONB Management Strategy, the NDBR Strategy for Sustainable Development and associated Action Plan, the Taw-Torridge Estuary Management and Action Plans, the Northern Devon Fisheries Local Action Group (FLAG) Development Strategy, as well as shoreline management plans, catchment flood management plans and strategic flood risk assessments. In addition, there are voluntary management agreements in place at the site, such as the Ray Box to the north of Lundy for which local fishermen have adopted a seasonal closure and minimum landing size for rays.

The NDBR Partnership provides a support network for local authorities to help them fulfil their commitments to jointly manage the Biosphere Reserve. Its membership includes local authorities, statutory and non-statutory governmental bodies and stakeholders with a local interest, such as fishermen, farmers or NGOs:

- Christie Devon Estates
- Ministry of Defence
- Devon County Council, Torridge District Council, North Devon Council
- North Devon Coast AONB Partnership
- Taw Torridge Estuary Forum
- Environment Agency
- Natural England
- Educational institutions
- Representatives from northern Devon commerce and industry
- Farmers and fishermen's associations
- National Trust
- Devon Wildlife Trust
- Devon and Severn Inshore Fisheries and Conservation Authority (IFCA)
- Coastwise North Devon (a local NGO that champions the North Devon marine and coastal environment through public engagement)

As required by the UNESCO Seville 95 Strategy, the Partnership developed a vision and strategy for the management of the Biosphere Reserve. The current strategy for 2014 to 2024 is based on previous strategies as well as a review of the state of the Biosphere Reserve and is aligned with the statutory and non-statutory local plans mentioned above. The strategy identifies a series of environmental, social and economic issues and pressures in the NDBR as well as policies to address these in order to achieve the aims of the Biosphere Reserve. The vision included in this strategy is for the NDBR to become a model for sustainable community and economy by 2030. A key cornerstone of this vision is the restoration and conservation of the Biosphere Reserve's ecosystems and habitats. This includes coastal management that is focused on enabling natural coastal processes to facilitate the adaptation to sea level rise and other climate change impacts. For the marine area of the NDBR the vision is to have high water quality and thriving, biodiverse marine wildlife that support human enjoyment as well as the local fishing industry. This is to be achieved through careful management by fishermen and other marine stakeholders.

The marine conservation interests of the NDBR are represented by the NDBR Marine Working Group which brings together local leisure, fishing and conservation stakeholders. Another influential group in the management of the NDBR marine site is the Northern Devon Fisheries Local Action Group (FLAG). The FLAG is a partnership of local fishermen, local authorities, statutory and non-statutory governmental bodies and local stakeholders with an interest in fisheries and the marine environment. It is one of six FLAGS in England that were set up to deliver a European Fisheries Fund grant programme between 2012 and 2015. The programme aims to support the sustainable development of small fishing communities such as those in North Devon.

1.2. The VALMER ecosystem services assessment (ESA)

1.2.1. Description of the stakeholder group

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 (Table 1). 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.

Organisation	Sector	Role	MWG ‡	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	✓	✓	✓	✓	✓
NDBR	Environment	Data Analyst		✓	✓		
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		✓	✓	✓	
NDBR MWG	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

Table 1. Composition and meeting attendance of the North Devon Case Study Stakeholder Group.

1.2.2. Stakeholder engagement process

The stakeholder engagement process is outlined in Table 2. 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.

Work shop	Date	Content	Outputs
1	13 December 2013	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Compiled datasets validated • Additional data and wider expert knowledge gathered on ecology, activities and management
2	30 January 2014	<ul style="list-style-type: none"> • Recap on project and case study • Overview of scenario process • Scene setting – current activities • Scenario prioritisation • Introduction to scenario development • Developing scenarios 	<ul style="list-style-type: none"> • Identification of a suite of scenarios for further refinement, with narratives and maps showing resulting changes in activities in the case study area
3	20 March 2014	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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
4	25 September 2014	<ul style="list-style-type: none"> • Case study recap • Scenario development review • Introduction to the socioecological model • SES model results • Breakout groups to discuss governance implications 	<ul style="list-style-type: none"> • Stakeholder understanding of the scenario process • Stakeholder discussion on model outputs and relevance to governance

Table 2. Stakeholder engagement process.

1.2.3. Method to determine which ecosystem services were the focus at that site

Discussions with the NDBR Coordinator and other stakeholders identified a shortlist of five priorities. The “triage” process (WP1 guidelines; Pendleton et al., in press) 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. The triage scored each service against a series of criteria: the likely use of ESA outputs in management decisions, the potential for service delivery to change following management intervention and the relative influence of external factors (such as climate change or national policy) on service delivery. Both experts and stakeholders identified subtidal sedimentary habitats as the most appropriate focus.

1.2.4. ESA method and brief summary of key results

Habitats across the site were mapped, using recent and historic research as well as modelled maps (see Figure 5), and amalgamated into six habitat classes with similar characteristics (Figure 2). Different methods were used to determine the level of services provided by each habitat class:

- 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.

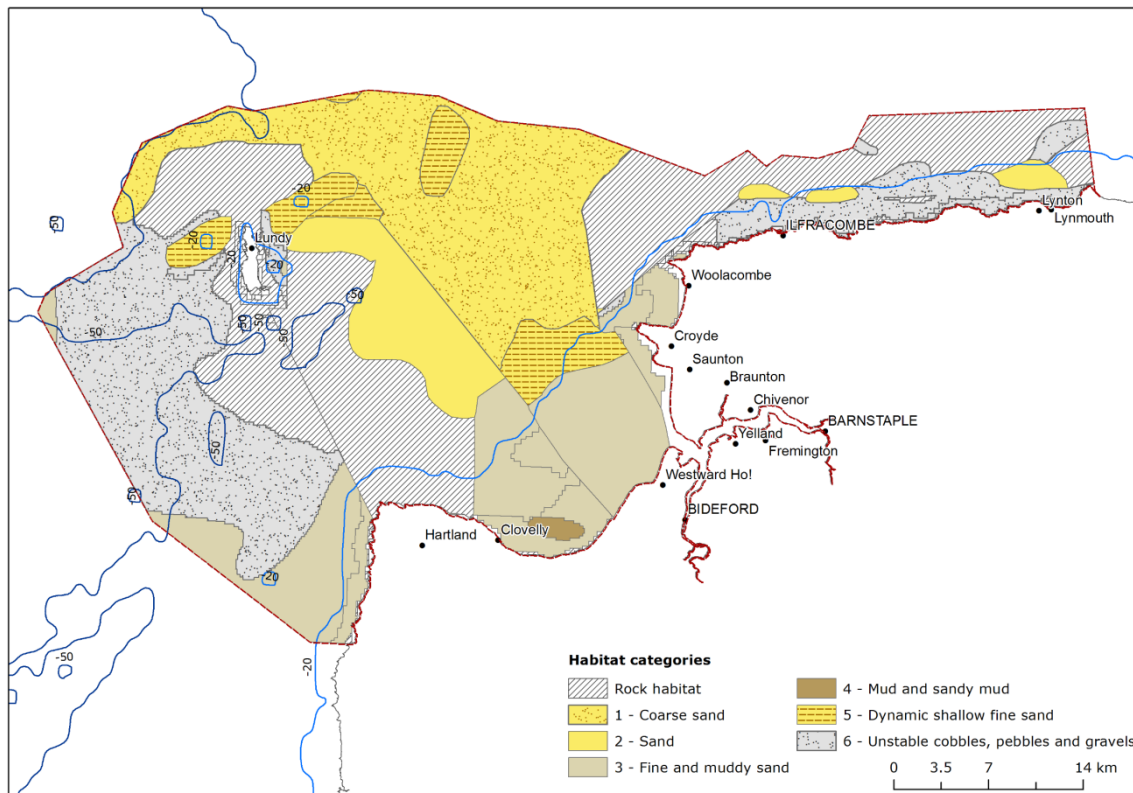


Figure 2. Broad habitat types classified according to fishing pressure sensitivity and ecosystem service contribution.

This produced a matrix (Table 3) linking habitat types to ecosystem service, using qualitative indicators, which 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. 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 Figure 13).

<u>Habitat category</u>	<u>Nursery habitat</u>				<u>Waste processing</u>	<u>Carbon storage</u>
	Bass, Sole, Plaice	Lobster	Cod	Skates & Rays		
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

Table 3. The relationship between habitat type and ecosystem service delivery.

1.3. The scenarios 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 (

Figure) and broadly corresponds to the scenario guidelines.

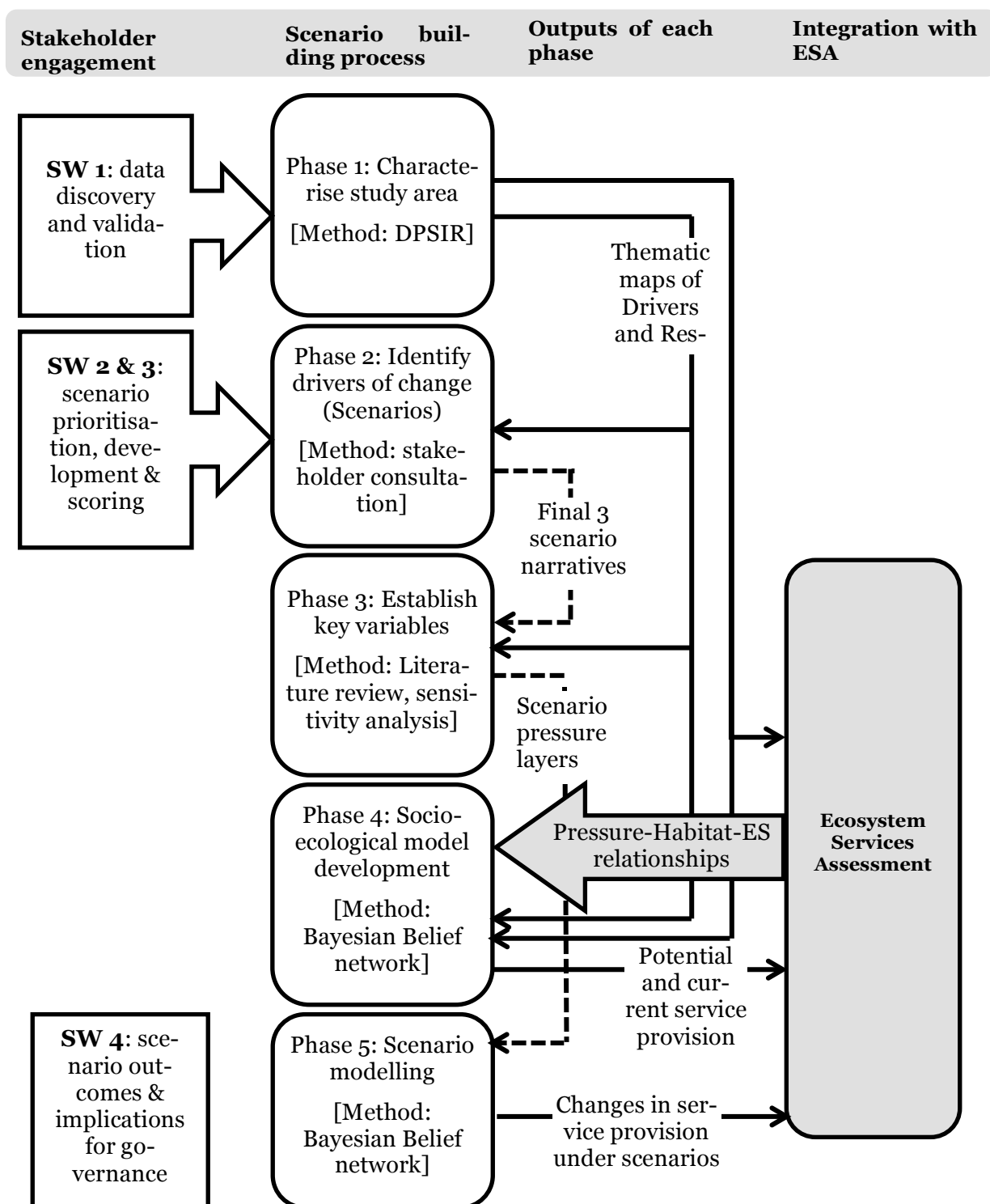


Figure 3. Scenario development process indicating stakeholder engagement through four stakeholder workshops (SW) and integration with the ecosystem services assessment.

1.3.1. Detailed description of the scenarios approach

Phase 1. Characterising the North Devon Case Study area

A Driver-Pressure-State-Welfare-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.

Maps of the ‘current situation’ were produced to show the spatial extent and where relevant, intensity of indicators for each of the DSR elements. 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 stakeholder group (Meeting 1) and were supplemented with further data and expert knowledge and validated (Table 4). 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) are given in Figures 4-6.

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

DPSIR component	Thematic map	Content
STATE	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
RESPONSES	Subtidal habitats	Combined subtidal habitat map
	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

Table 4. Driver-State-Response thematic maps

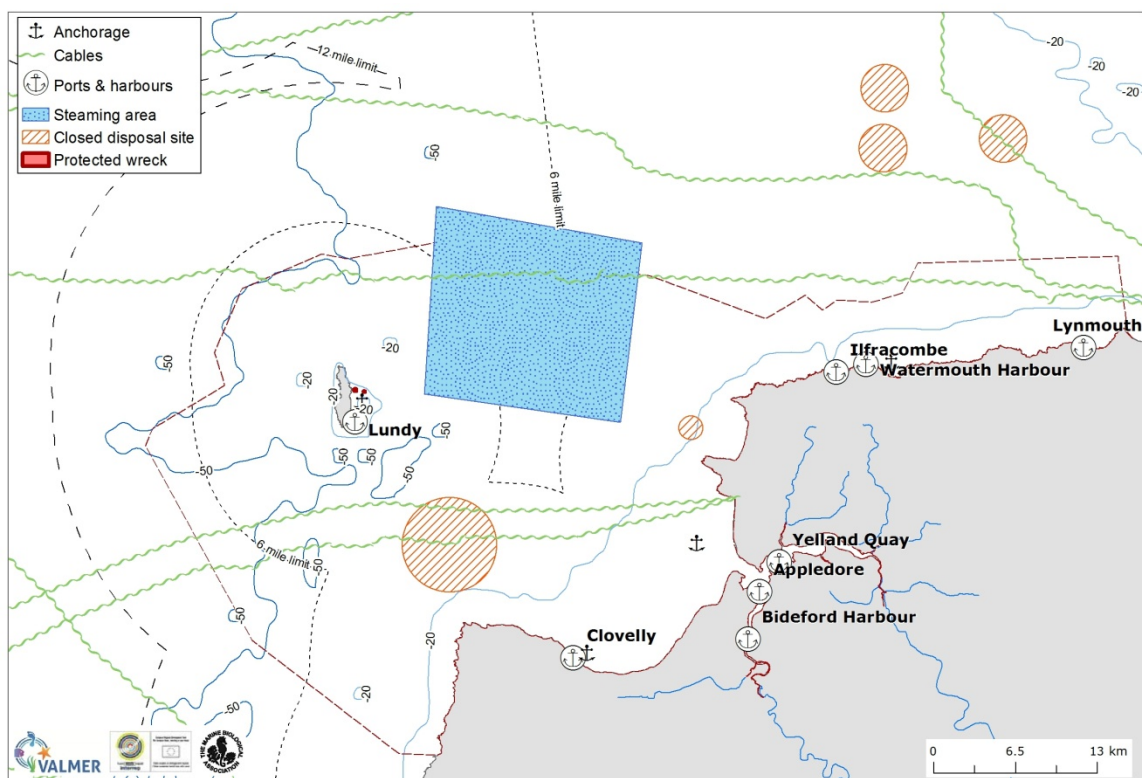


Figure 4. Example *Driver* thematic map - ports and shipping (various sources)

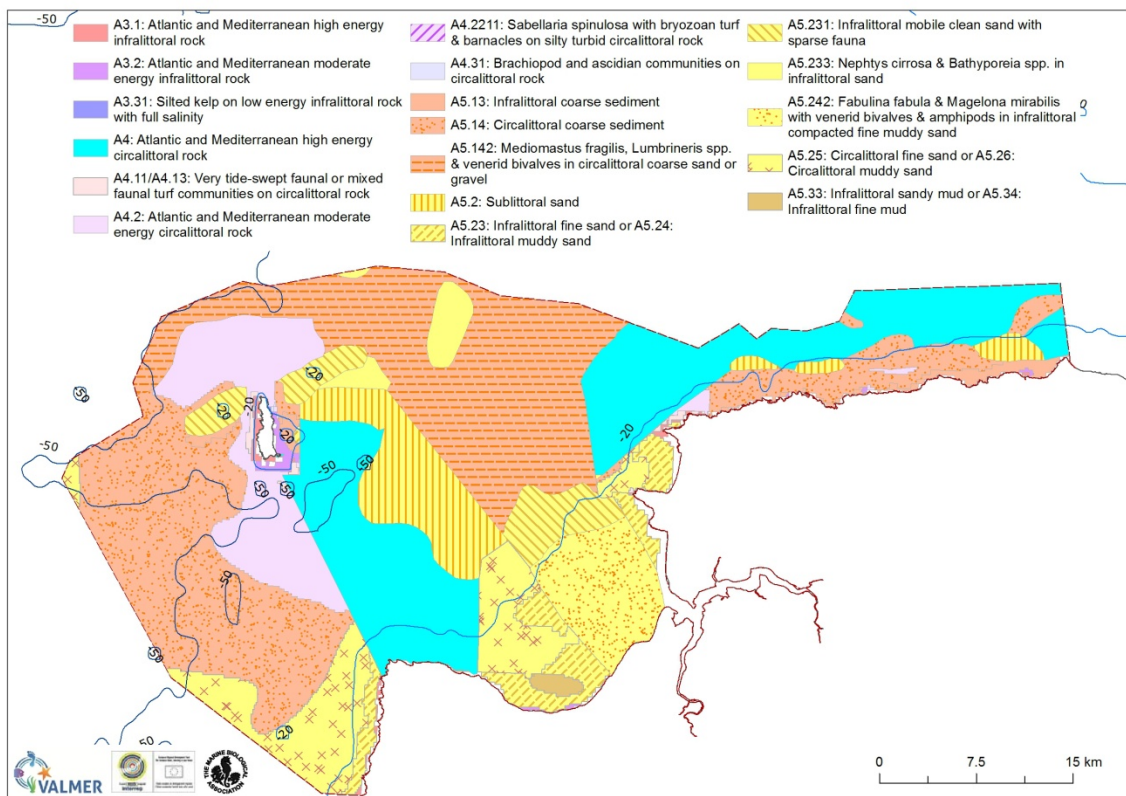


Figure 5. Ecological *State* thematic map: combined subtidal benthic habitats map (sources: RWE surveys, UKSeaMap, Warwick & Davis Bristol Channel sediments, BIOMOR4 (Outer Bristol Channel Survey), Lundy Habitat mapping surveys, Barnstaple Bay grab sampling, MNCR Inlets in the Bristol Channel).

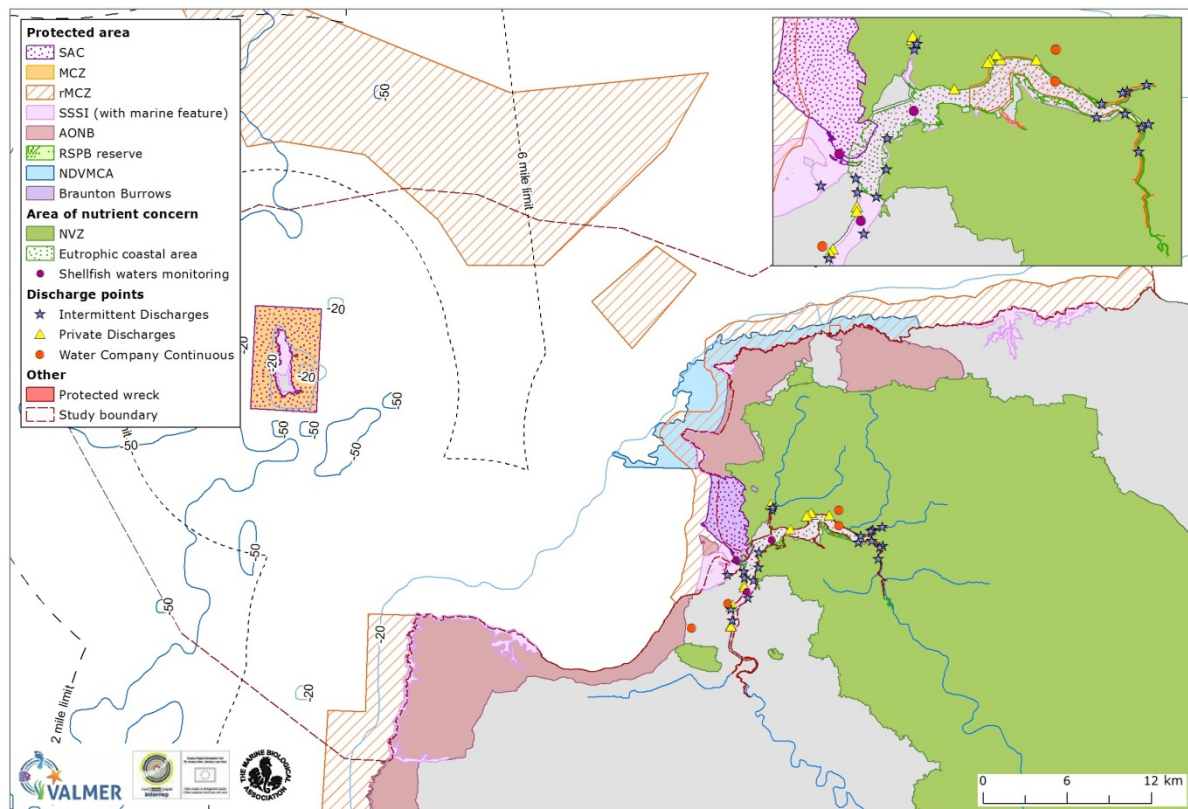


Figure 6. Example management *Response* thematic map – conservation areas (various sources)

Phase 2. Identifying the drivers of change (scenario themes) using stakeholder consultation

Key issues of local importance were identified and scored, then prioritised during the second stakeholder workshop. 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). Prioritisation of the remaining scenarios was carried out at the third stakeholder workshop, where some scenarios were also dismissed outright by stakeholders (Table 5). The outcome was three scenarios:

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

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
rMCZ designation	rMCZ designation	rMCZ designation	rMCZ 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.

Table 5. Development of scenarios with stakeholder group leading to the final three scenarios.

1.4. Description of scenarios developed in VALMER

SCENARIO 1

Marine Conservation Zone designation

Assumption: All five recommended Marine Conservation Zones (rMCZs) in the North Devon Biosphere Reserve area are designated (Figure). All of these sites, with the exception of Morte Platform, were included in Tranche 2 of the rMCZs put forward for designation by Defra (2014). However, Morte Platform rMCZ, 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 rMCZs 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.

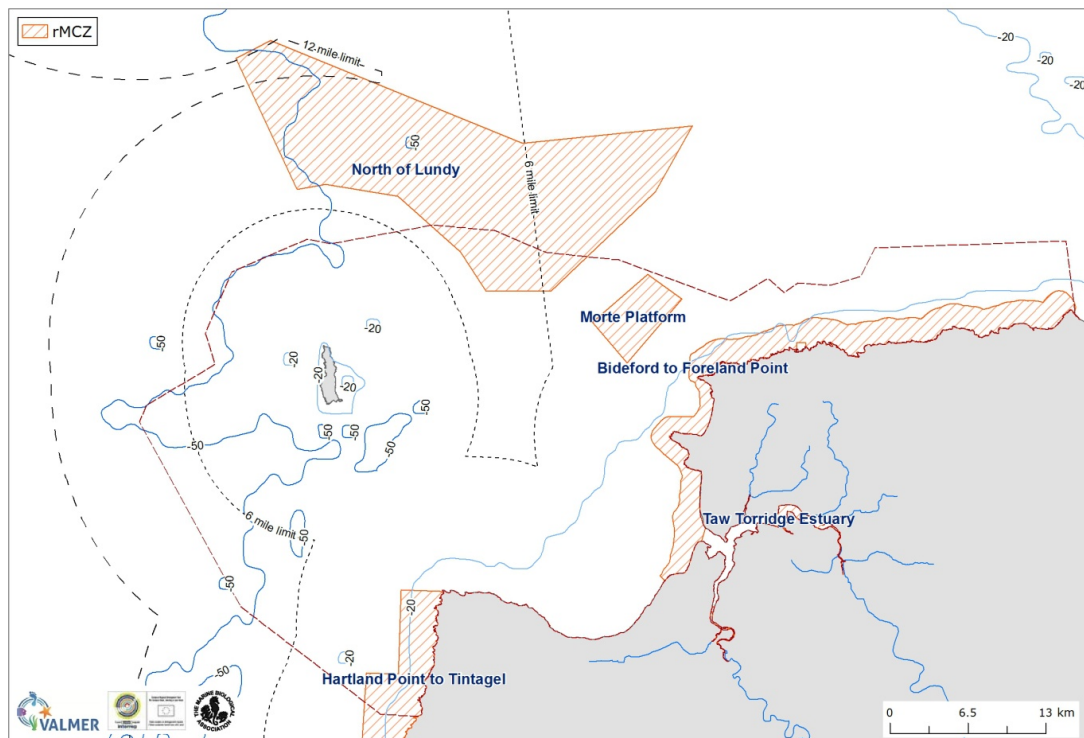


Figure 7. Recommended Marine Conservation Zones (rMCZs) within the North Devon Biosphere Reserve area.

Changes to existing activities

Our assumption is that demersal towed gears will be excluded from all rMCZs while static gears would be permitted. The response by the fisheries sector to new byelaws excluding them from rMCZ sites would be variable according to the location of each rMCZ (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).

SCENARIO 2

Aggregate extraction

Assumption: An aggregate extraction site is opened within the North Devon Biosphere Reserve (Figure). 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.

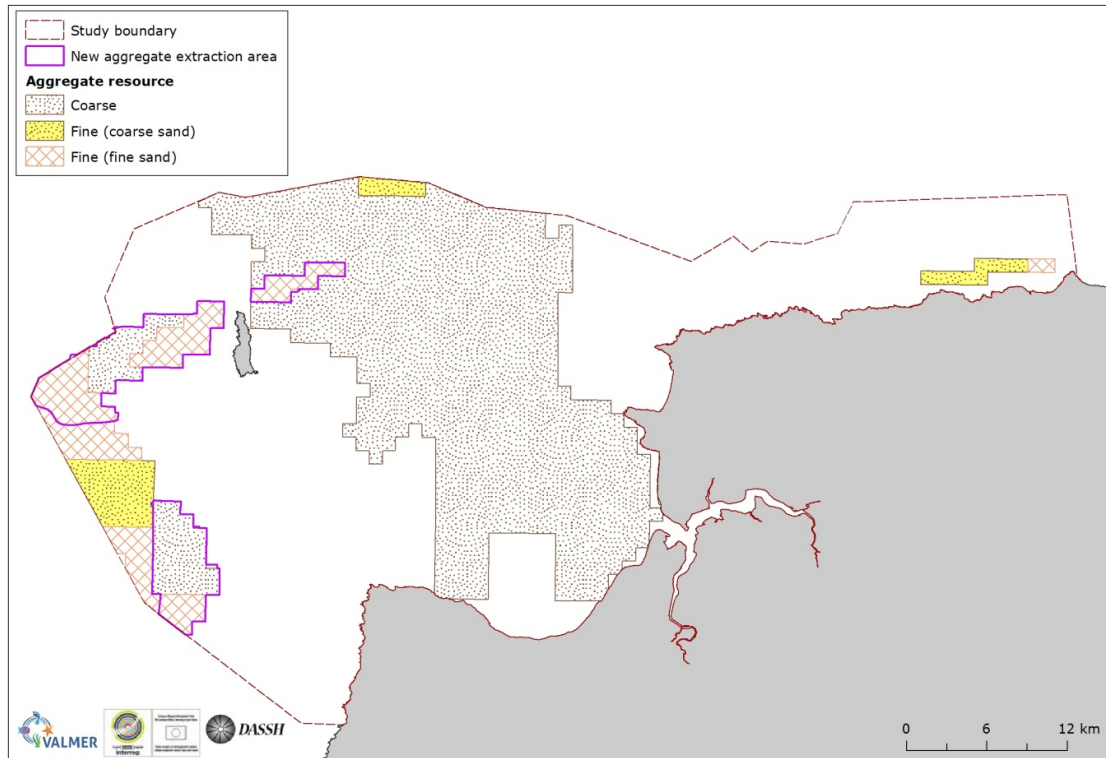


Figure 8. Resource map for aggregates in the North Devon Biosphere Reserve area with aggregate scenario extraction sites indicated.

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.

SCENARIO 3

Aquaculture development

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

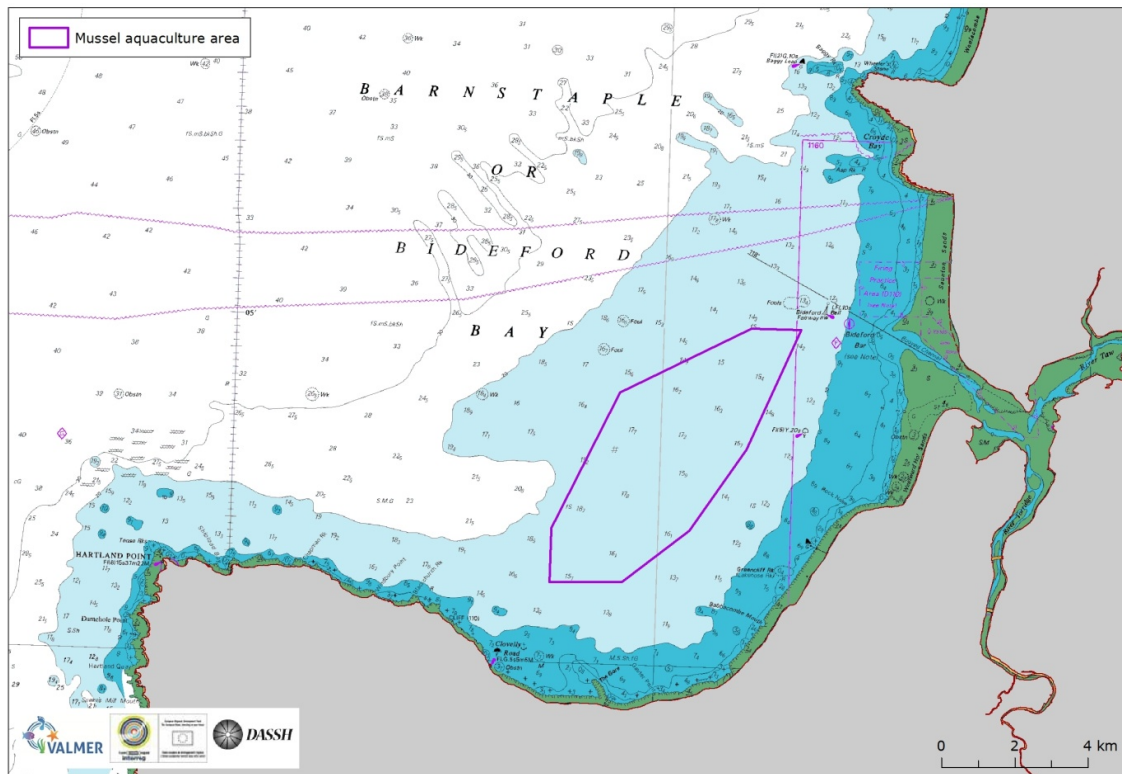


Figure 9. Location of the aquaculture development (offshore mussel farm).

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.

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 Fisherman (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.

Changes in key pressures were identified and quantified from the scenario narratives developed by the stakeholder group in collaboration with the project team. 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 (Figure 10).

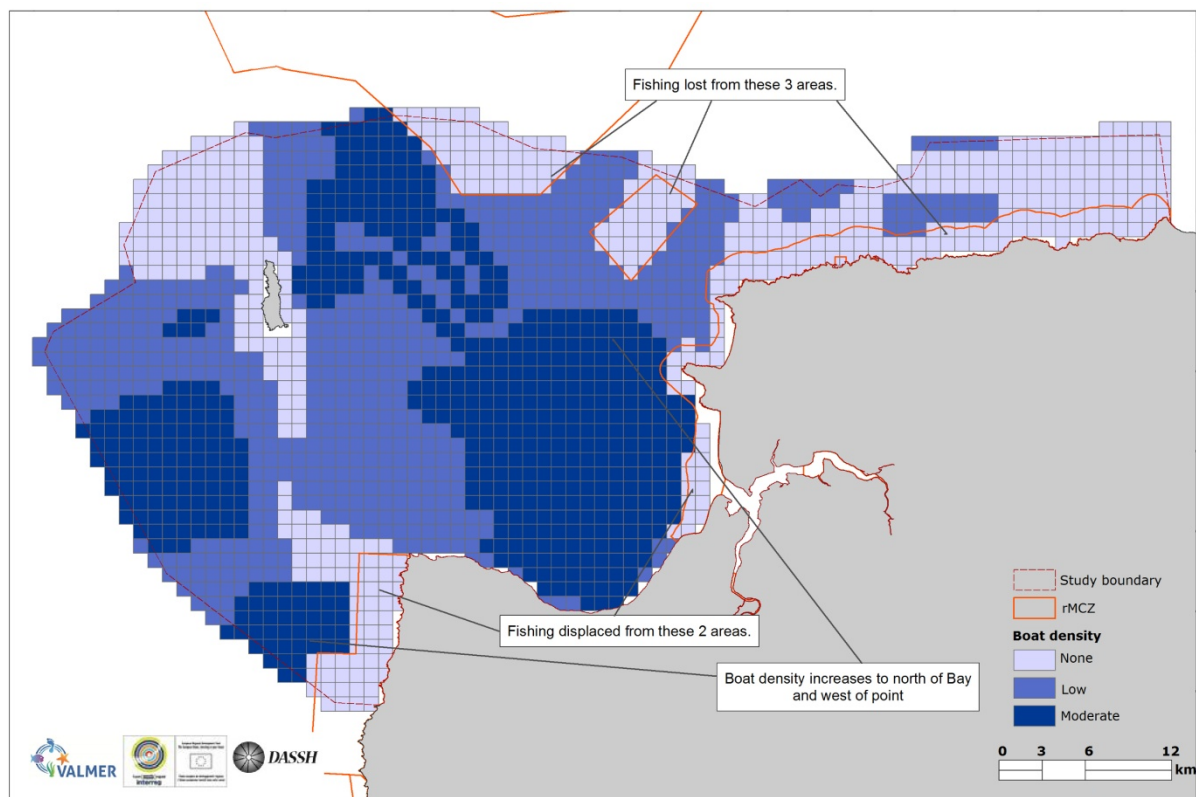


Figure 10. Example of a pressure layer used to condition the SES model: intensity of demersal fishing activity as a proxy for seabed abrasion under the rMCZ designation scenario. Loss of pressure and increases due to fisheries displacement are indicated.

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 (Figure 1). 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.

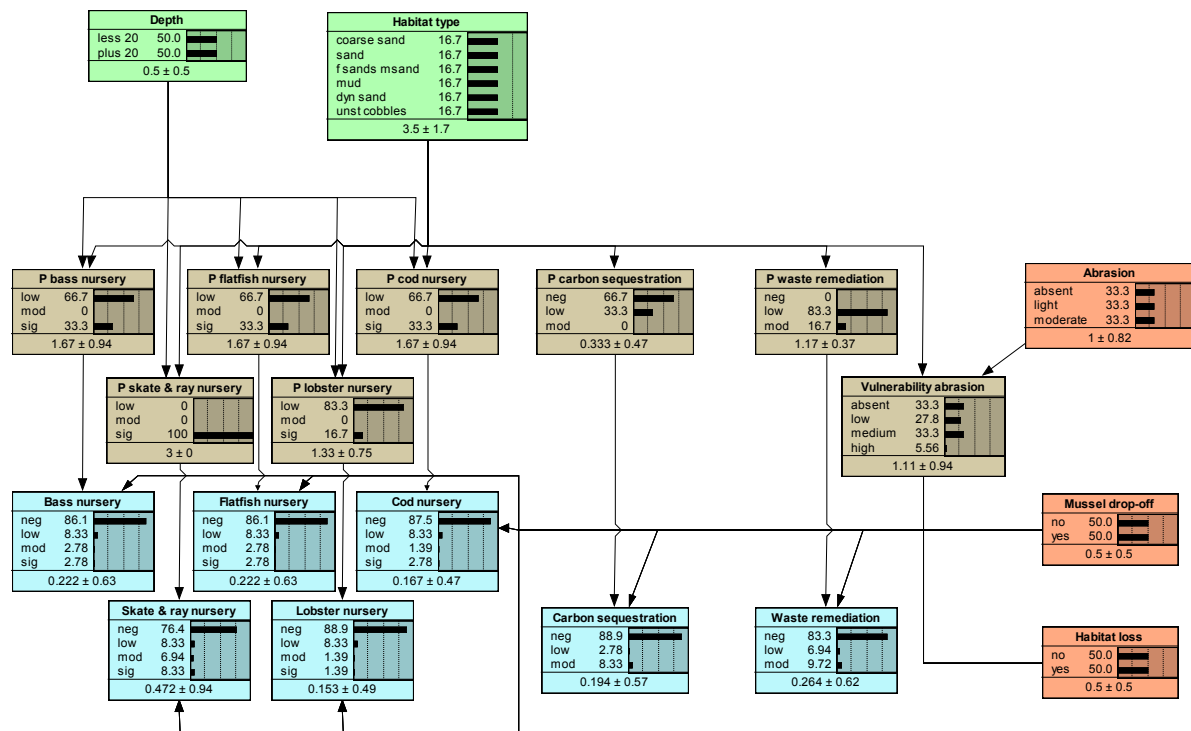


Figure 1. Socio-ecological model structure (GIS derived nodes are shown in green; Pressure nodes, brown; Potential service nodes, grey; and Actual service nodes in blue).

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 2).

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.

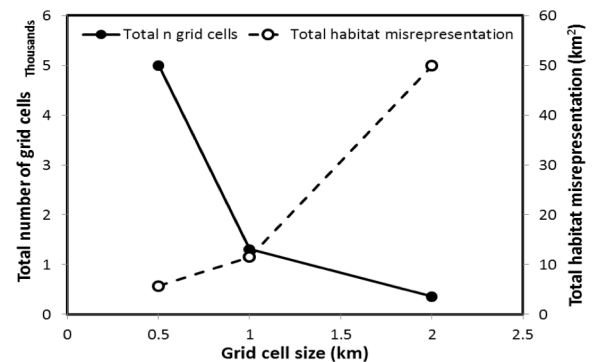


Figure 2. Determining the optimal grid size

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 $\geq 50\%$ of a grid cell was within a proposed development it was classified with the resulting pressure.

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 NDBR (Figure 3). 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.

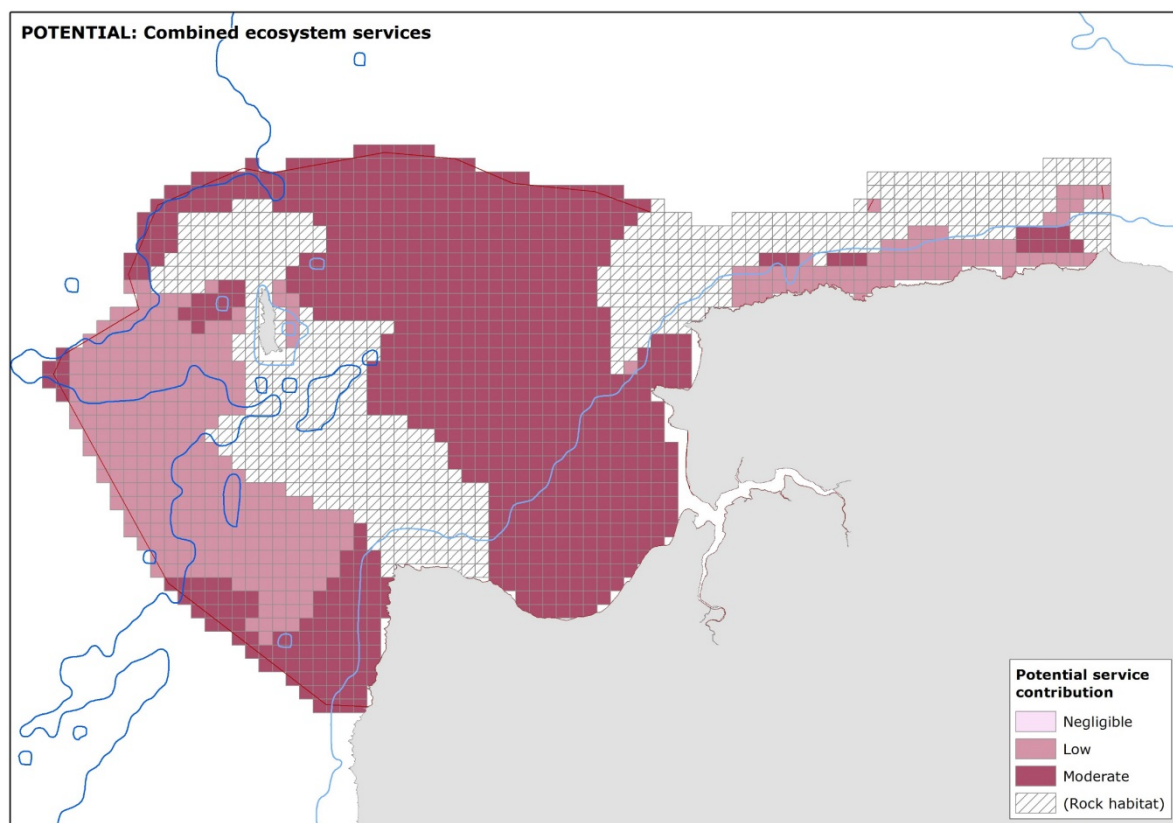


Figure 3. The potential combined delivery of nursery habitat, waste processing and carbon storage services across the North Devon Biosphere Reserve, aggregated to take account of stakeholder preferences.

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 (Figure 4).

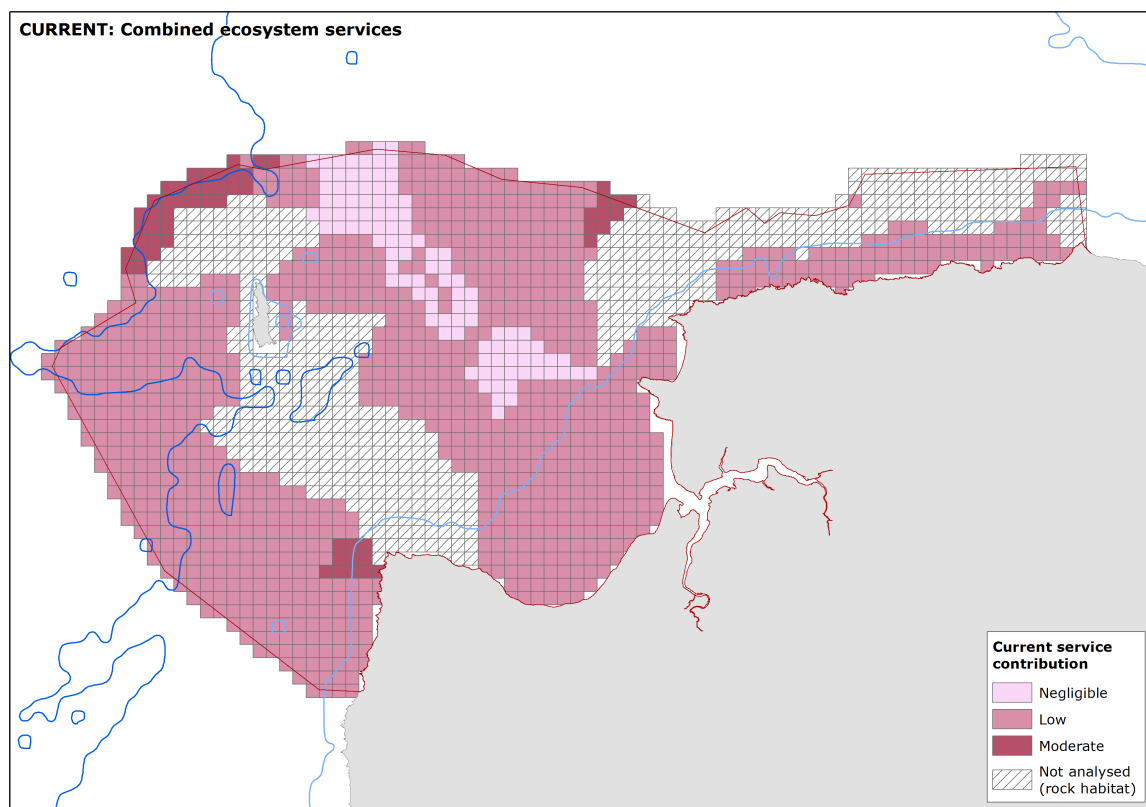


Figure 4. Assessment of the current provision of ecosystem services, based on current patterns of fishing pressure. This represents combined delivery of nursery habitat, waste processing and carbon storage services across the North Devon Biosphere Reserve, aggregated to take account of stakeholder preferences.

Phase 5. Scenario modelling

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. 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 (

Figure 5); 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.

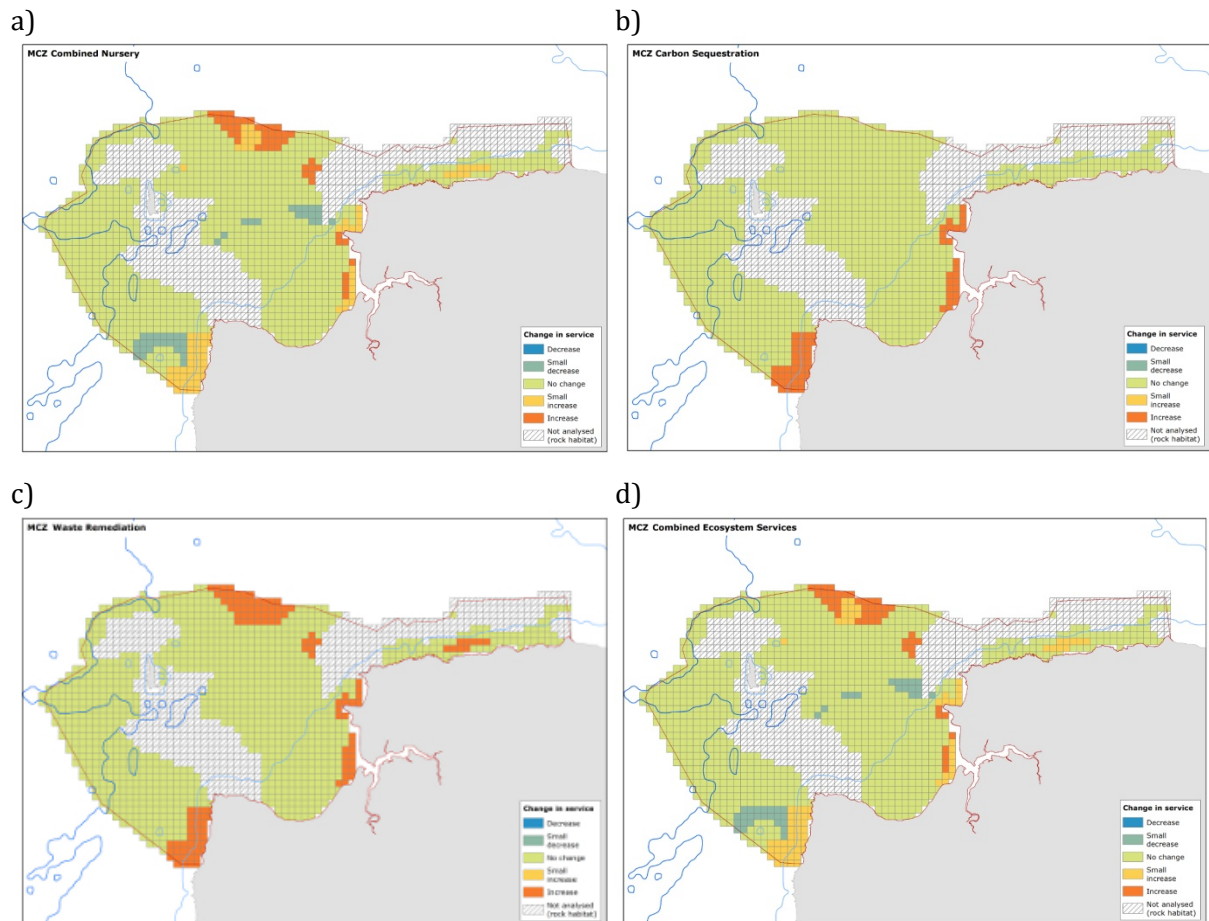


Figure 5. SES model derived scenario outcomes showing change in ecosystem service delivery by type (a-c) and combined (d) for recommended Marine Conservation Zone (rMCZ) designation scenario.

1.5. Scenarios experience sharing

The BBN 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. 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:

1. 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).
2. 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
3. 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).
4. 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.
5. 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).
6. The fishing activity information used to develop the abrasion layer was based on Finding Sanctuary's Fisherman. 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 BBN 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
- 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 BBN 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.

For more information

www.devon.gov.uk

www.northdevonbiosphere.org.uk

Contacts

Steven Guilbert (VALMER case study site coordinator)

Devon Maritime Forum

steven.guilbert@devon.gov.uk +44 (0)1392 383231

2. Plymouth Sound to Fowey

Authors

N. Smith¹, P. Hoskin², W. Dodds¹, T. Hooper³, L. Friedrich¹, N. Beaumont³ and C. Griffiths⁴.

¹ Plymouth University

² Cornwall County Council

³ Plymouth Marine Laboratory

⁴ Marine Biological Association of the UK

2.1. Case study 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 (Figure 16) ESA, to engage site stakeholders through participatory workshops and to promote the use of the ESA within local governance.

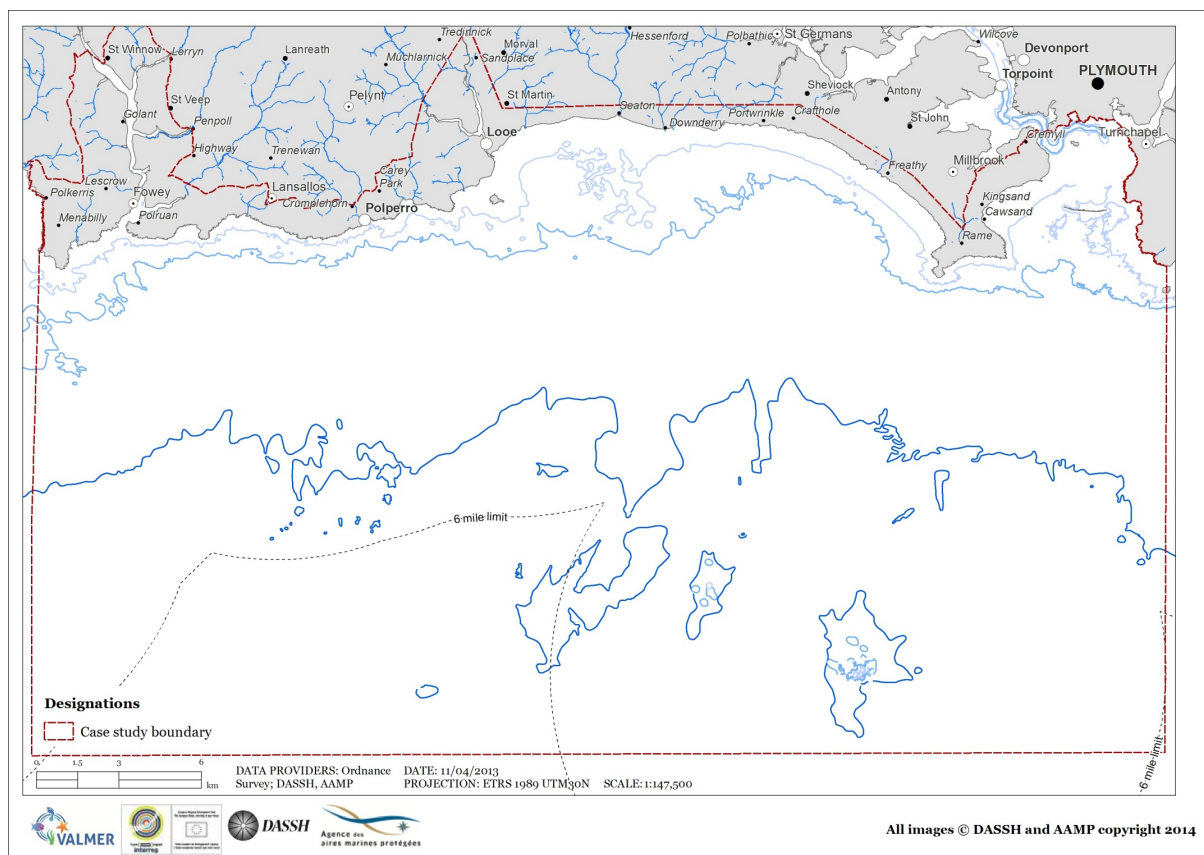


Figure 6. Map showing the Plymouth-Fowey Case Study site boundaries (MBA-DASSH 2014)

2.1.1. Physical environment

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 by small estuaries, rivers and streams, along with unstable soft cliffs that have seen numerous landslips due to recent episodes of flooding. 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.

Many parts of the site's coastal and marine environment are designated for conservation and landscape value. These include 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 Figure 17. 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.

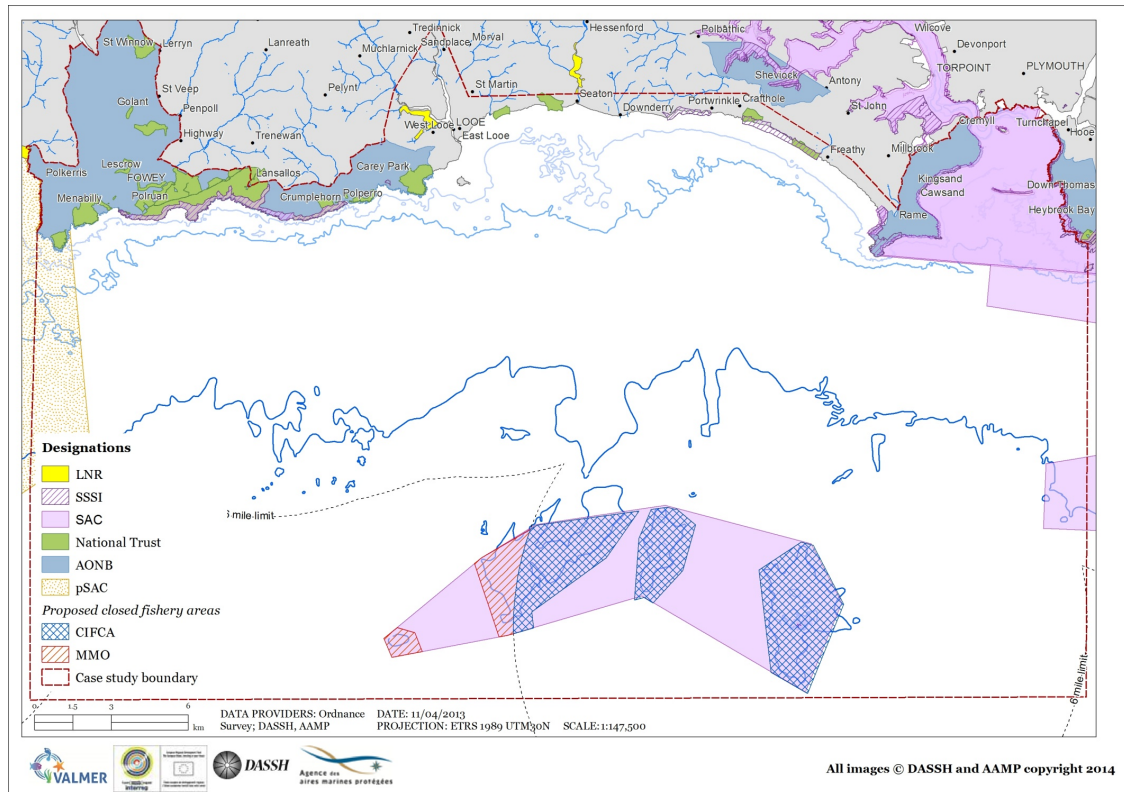


Figure 17. Map showing existing site conservation management within the case study (MBA-DASSH)

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

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. Figure 17 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 (Figure 18). 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. 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.

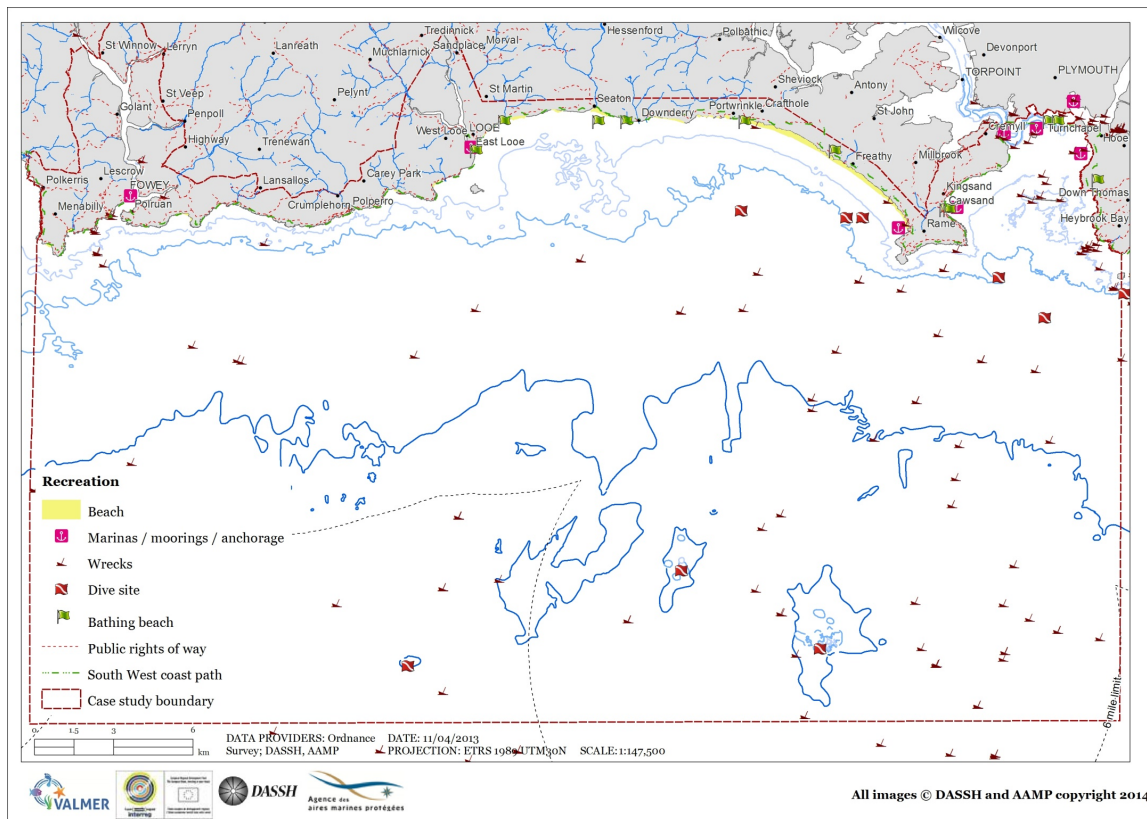


Figure 18. Map showing a number of recreational sites within the case study (MBA-DASSH, 2014)

2.1.3. 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, South Hams District Council and Cornwall Council). The Duchy of Cornwall, Cornwall Council and National Trust, as landowners, manage part of the case study site'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 with regards fisheries management. This gives rise to a considerable number 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 complementary plans and strategies relating to coastal and marine management. It is important however, to highlight that these documents only have pockets of influence within the site, either geographical or thematic. Only organisations such as Cornwall Council have a broad remit across the site and therefore, the potential to influence the whole of the site area. 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 (Figure 19). 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.



Figure 19. Image of the front cover of the Cornwall Maritime Strategy and the strategy's vision for maritime Cornwall.

2.2. The VALMER ecosystem services assessment (ESA)

2.2.1. The VALMER stakeholders and engagement process

In the Plymouth-Fowey case study, the ESA process was informed and validated by local management stakeholders. Whilst there is not a singular body or forum coordinating stakeholder engagement and management, a culture of working together and collaboration currently exists. 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 (T&F) 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 (Tables 6 and 7). 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 T&F as the case study's management focus would relate only to the Cornish coast and seas.

Organisation/group/etc.	Stakeholder category	'before' survey	'after' survey	Inter-view
Cornwall Council: Environment, economy, sustainability, heritage and harbours. (5 representatives)	Local government authority	✓ ✓ ✓ ✓ ✓	✓ ✓	✓ ✓
Natural England (2 representatives)	Governmental body - environment	✓ ✓	✓	✓
Cornwall IFCA	Governmental body - marine	✓		
MMO (2 representatives)	Governmental body - marine	✓ ✓	✓	✓
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	✓	*✓	✓

Table 6. 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 interviews.

Task and Finish Group Workshops	Aims	Main activities
WS1 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.	<ul style="list-style-type: none"> • 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.
WS2 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.	<ul style="list-style-type: none"> • 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.
WS3 June 2014	Scenario development.	<ul style="list-style-type: none"> • 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.
WS4 October 2014	Scenario and ESA results.	<ul style="list-style-type: none"> • 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.

Table 7. The four Plymouth Sound- Fowey VALMER stakeholder workshops, including a description of the aims and main activities

2.2.2. Selecting the ESA Focus

Identification of the ESA 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 broad-scale ESA 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. Stakeholders also explicitly voiced a desire for cultural ecosystem services to be researched. This interest 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 ESA 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 ESA process consisted of four connected steps:

- A baseline assessment of key ecosystem service in the case study area.
- Stakeholder generated hypothetical future actions (resulting from the scenario building process undertaken during stakeholder meetings.)
- Actions developed into three hypothetical scenarios*.
- Scenarios applied to the baseline with associated recalculation of the ESA for each of the three scenarios.

2.2.3. Scenarios for Assessment

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. These were then assessed by the case study team which considered the suitability of each of the actions for the subsequent ESA. 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 ESA 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 ESA stage of the project, either alone or as grouped scenarios. A subsequent sifting process prioritised 3 scenarios suitable for ESA in the time available. The case study team set out a number of assumptions for each scenario in order to define them for the purposes of the ESA. Where possible, the assumptions were based on stakeholder-developed theoretical actions.

The three hypothetical scenarios developed for assessment were as follows:

1. *Recreational boating – exploring changes in ES delivery associated with changes in mooring type and a reduction in ecological footprint on the seabed.*
2. *MPAs – exploring changes in ES delivery associated with introduction of MPAs in the case study with high levels of protection i.e. no extraction or deposition.*
3. *Dredge disposal – exploring changes in ES delivery associated with closure of two disposal sites with combined materials taken to a re-opened site within the case study area further offshore.*

2.2.4. ESA Methods and Results

The ESA was undertaken by the Plymouth Marine Laboratory in collaboration with the Marine Biological Association (MBA) 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. A primarily qualitative assessment was made of how services might change under the management scenarios. 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.

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 MPA scenario highlighted the complex trade-offs that would require consideration in any management decision.

2.2.5. Governance mapping to support the ESA

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 (Figures 20 and 21). 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. It also 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 MBA 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/) (Figure 22).

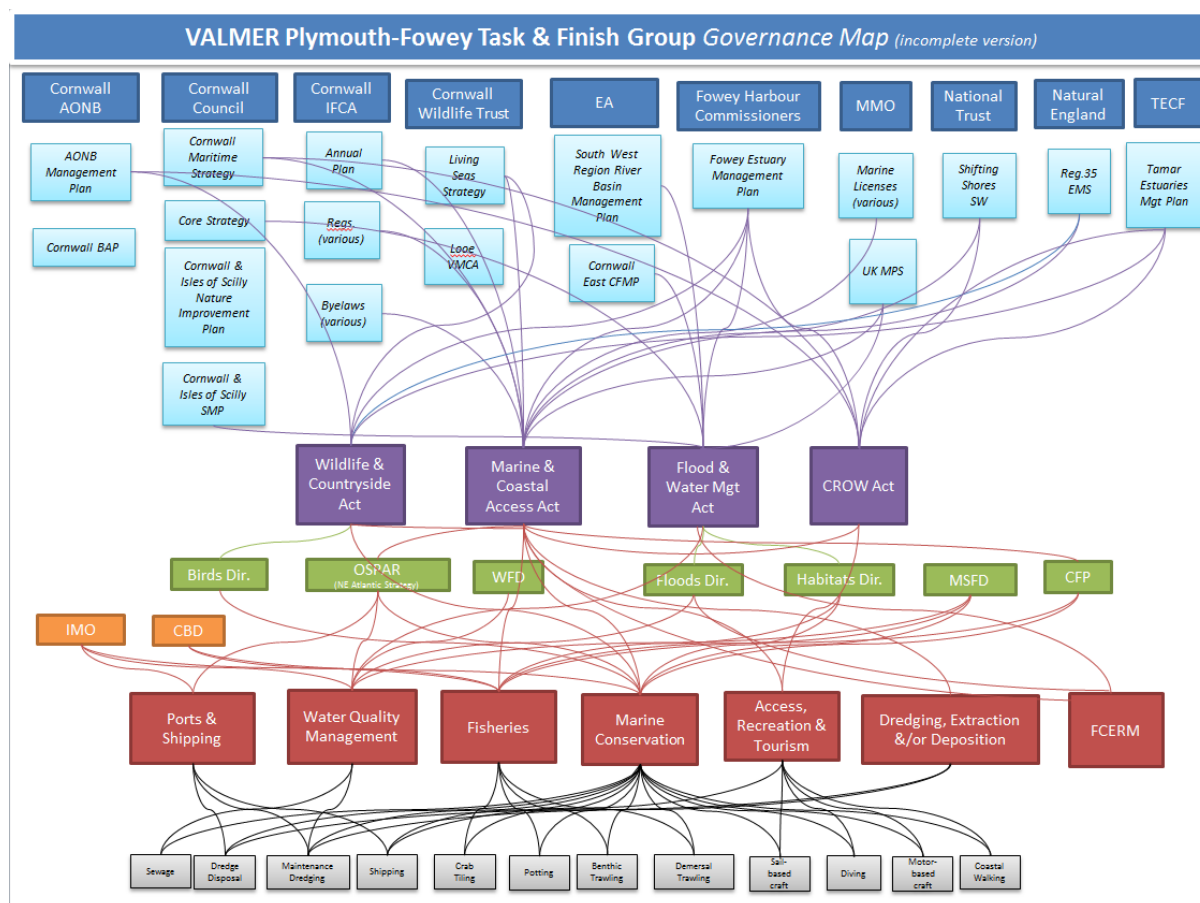


Figure 20. An early iteration of the Plymouth Sound- Fowey governance mapping, showing connections between Task and Finish Group member's plans and strategies, the supporting legislation and connections through to marine and coastal sectors and activities within the site

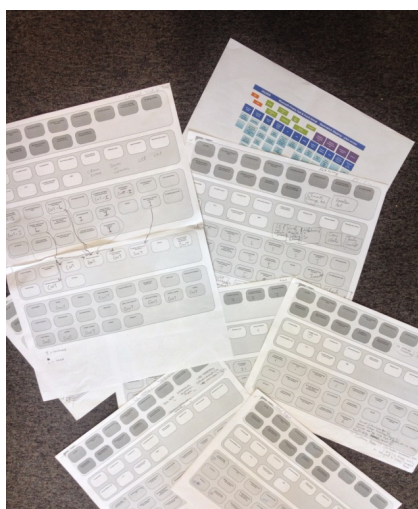


Figure 21. Stakeholder input into the governance mapping

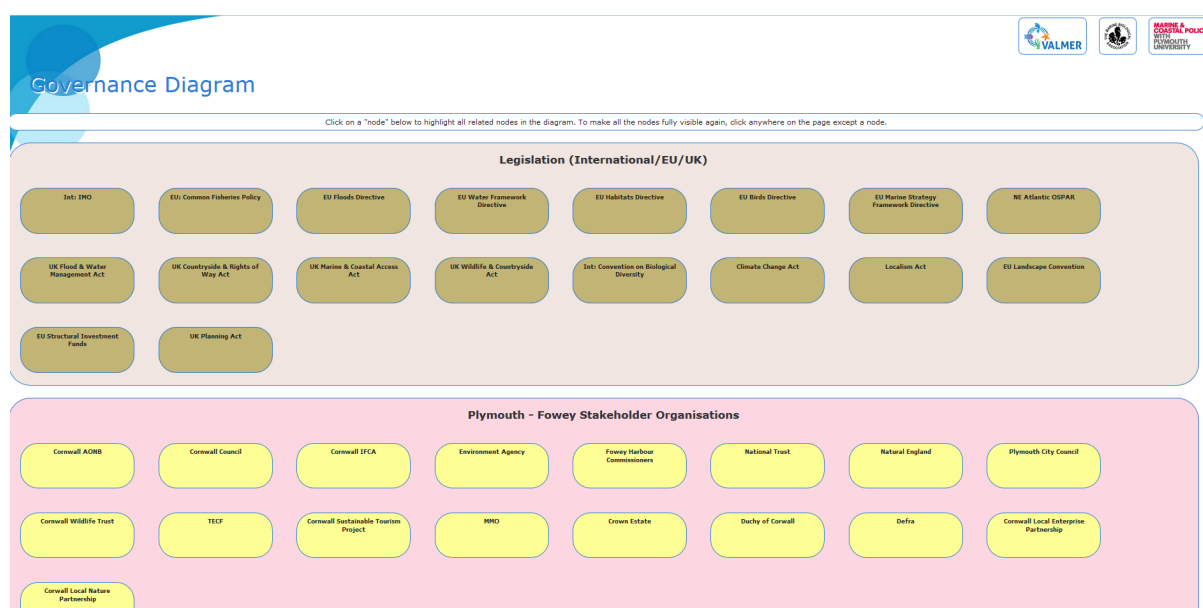


Figure 22. Screen grab of the web-based governance mapping, by clicking on one of the boxes known as 'nodes', all the related nodes then highlighted to the viewer

For more information

www.cornwall.gov.uk

Contacts

Phillipa Hoskin (VALMER case study site coordinator)

Cornwall County Council

phoskin@cornwall.gov.uk

Ness Smith (VALMER coordinator)

Plymouth University

ness.smith@plymouth.ac.uk

3. Poole harbour

Authors

A. Brocklesby¹, K. Buchan¹, W. Dodds², T. Hooper³, L. Friedrich², N. Beaumont³ and C. Griffiths⁴.

¹ Dorset County Council

² Plymouth University

³ Plymouth Marine Laboratory

⁴ Marine Biological Association of the UK

3.1. Case study site description

3.1.1. Physical environment

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 (Figure 23). The site, with its eight islands, encompasses a number of estuarine, wetland and heathland habitats, including saltmarshes, reed beds, mudflats, small beach areas, heathland, heath-woodland mosaics. 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 Ramsar site, Site of Special Scientific Interest (SSSI), Special Protection Area (SPA), Area of Outstanding Natural Beauty (AONB).

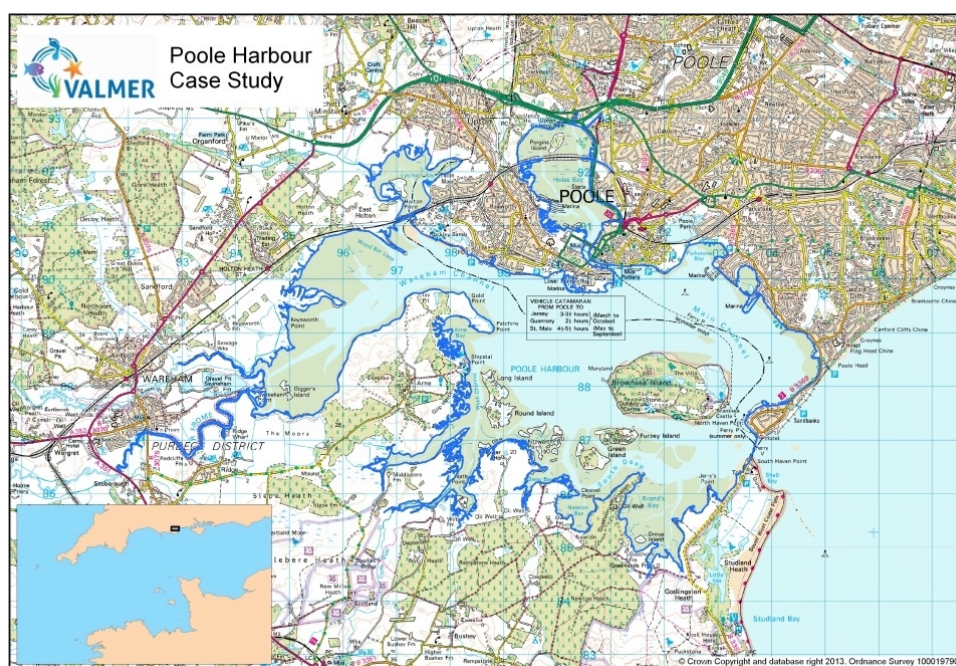


Figure 23. Plymouth Sound to Fowey case study site

3.1.2. Main activities and uses

As a busy commercial port, Poole Harbour supports significant shipping, including cargo and cross Channel ferries. It is 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 ten 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. Natural resource extraction occurs within the site.

3.1.3. Case study site governance

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. 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. A number of activities are zoned, for example, windsurfing is carried out in the Whitley Lake Zone (Figure 24). 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.

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, see Figure 25.

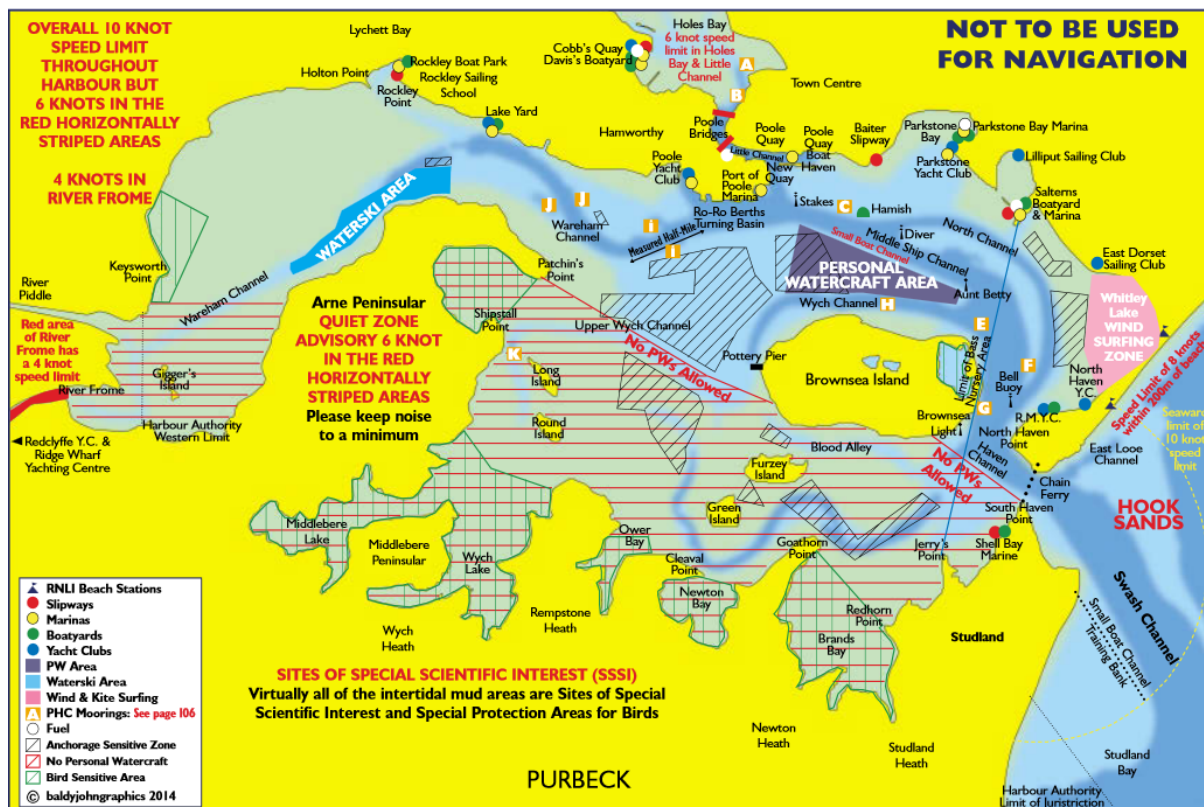


Figure 24. Map showing zoned areas for water-based activity in Poole Harbour (PHC, 2014)

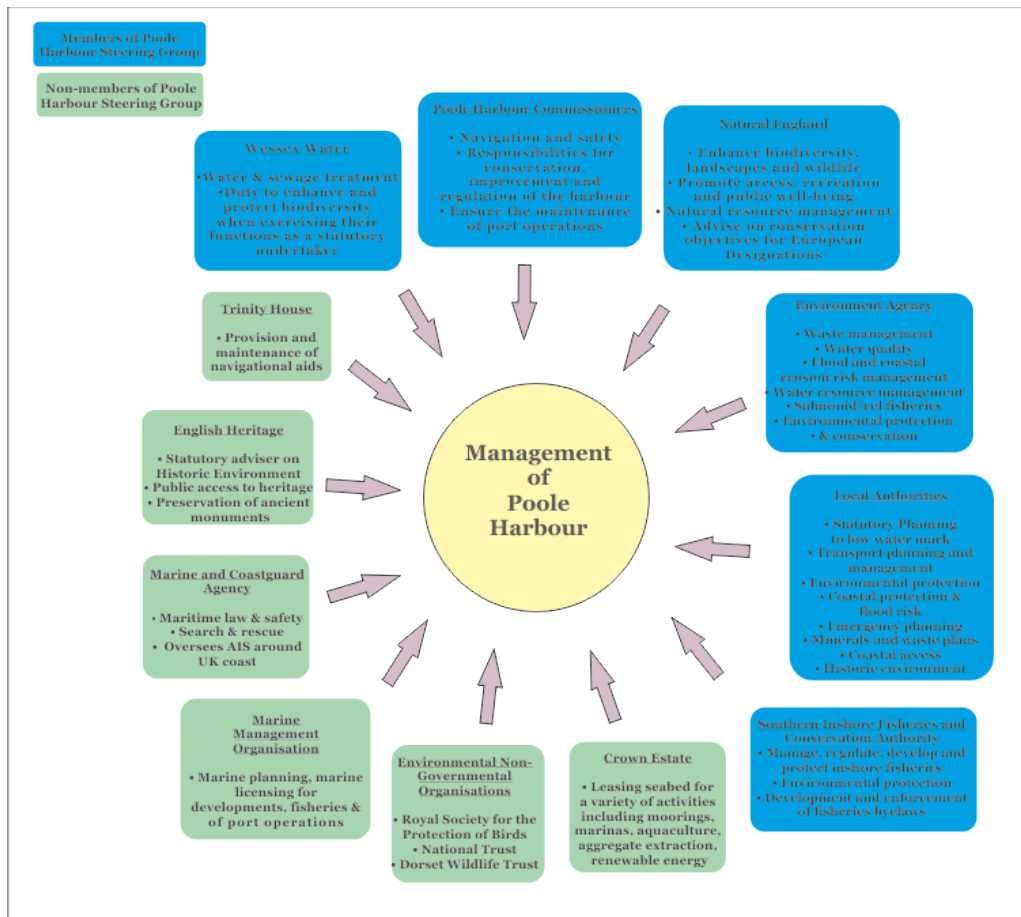


Figure 25. Poole Harbour Governance Framework

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. 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 Special Protection Area (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 (Figure 24).

Despite this complex situation, the PHSG 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 PHC, 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. This culture of stakeholder liaison and interest in the management of the harbour is to the benefit of the governance of this case study site.

3.2. The VALMER ecosystem services assessment (ESA)

3.2.1. Aims of the ESA

The stated aim for this ESA was to:

- Identify and understand the monetary value and priorities that recreational users place on the natural attributes of the harbour.
- Understand the real impact of potential changes on visitor numbers and visitor experience.
- Improve communication between the different activities.

3.2.2. Ecosystem services assessed in VALMER

Poole Harbour is considered to be an important area for tourism, 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 area. Despite this, the number of visitors and the value of recreation to the local economy had never been quantified. Furthermore, the relationship between the recreational activities and reliance on ecosystem services within the harbour was not well understood. This was the starting point for the VALMER ESA, which was coordinated by Dorset County Council and Dorset Coast Forum (DCC / DCF). The Poole Harbour ESA focused on the valuation, in monetary and non-monetary terms, of the cultural benefits of recreation supported by the harbour's marine ecosystem. The following six popular water-based activities which frequently occur in the harbour were assessed: kitesurfing, windsurfing, bird watching, jet skiing, water skiing and kayak/canoeing.

3.3. The scenarios approach

Why it was decided not to develop scenarios...

For the purposes of the Poole Harbour Study it was determined that the information provided from the questionnaires was adequate to consider future management and potential impacts on the ecosystem services provided to recreational users. In addition to the ESA described above, respondents to the questionnaires were asked to consider characteristics of Poole Harbour and attribute importance to them, that is, how one may be weighted against the other. For example, the importance of facilities, the cost of their activity and the importance of the natural environment. There was an opportunity to assess the impact of different factors influencing people's decisions to return to Poole Harbour to participate in their recreational activity, and opinions on current management and how management of their activity could be improved.

Questionnaire responses allowed us to consider the consequences of future changes such as reduced water quality, increased industrial activity, regular flooding of infrastructure utilised by recreational users, a decrease in wildlife and an increase in recreational users.

It was determined that there was not anything that the scenario building process would offer over and above the views and outcomes already derived from the questionnaires. Without being dismissive of the usefulness of the scenario process as a management tool in understanding management issues and making stakeholders think about the future and how ecosystems services may be affected in the future, it was considered that the scenario process may add a layer of complexity which would be unnecessary in determining the future management of the site, and the continued benefits which the estuarine ecosystem of the harbour provides to recreational users.

A key point in deciding not to use scenario building was the highly participative approach to management already existing in the harbour. There are clear management structures in place through the Poole Harbour Steering Group, and the Poole Harbour Commissioners who are pro-active in their approach to stakeholder engagement. Forward planning for potential management issues can be delivered through the Aquatic Management Plan and its regular reviews. Furthermore, the main issues identified in the questionnaires may be resolved through existing governance and management structures. However, one output from the project was the establishment of a recreation forum for the harbour. The purpose of this group is to encourage collaboration between recreation users and to provide an additional line of communication with regulators to improve safety and inform managers of emerging issues.

Data collected from the study is likely to be used by the local authority, Poole Harbour Commissioners and water sports providers to identify where improvements could be made to enhance safety and recreational user's experience in the harbour. For example, improvements made to facilities such as parking and the provision of changing facilities has the capacity to increase use and in turn the ecosystems services value of the harbour.

For more information

www.dorsetforyou.com/VALMER

Contacts

Ken Buchan (VALMER case study site coordinators)

Dorset County Council

k.buchan@dorsetcc.gov.uk

4. The Normand-Breton gulf

Authors

K. Dedieu¹, F. Morisseau¹

¹ French Marine Protected Areas Agency

4.1. Case study site description

4.1.1. Physical environment

The Normand-Breton gulf (NBG) case study site is a large marine area in the western part of the Channel, which includes French and Channel Islands marine waters (Figure 26). This area of over 11 000 km² comprises numerous marine protected areas with Ramsar, Natura 2000 sites, French designations sites and a proposed marine nature park within French waters.

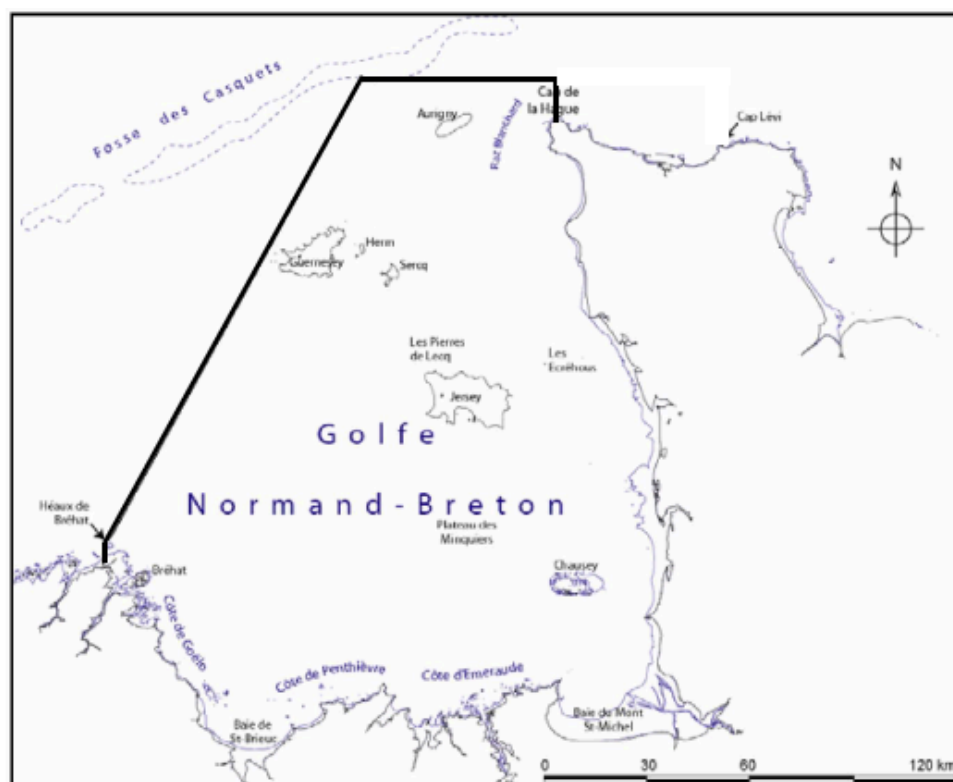


Figure 26. Perimeter of the Normand-Breton gulf (NBG)

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.

4.1.2. 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. Generally,

the whole coast, is characterised by small to medium towns and villages with economies reliant to a significant extent on shellfish farming, tourism and leisure, commercial fishing, agriculture, nuclear power and fuel reprocessing industries, aggregates extraction and, in the future, offshore renewables.

4.1.3. Case study site governance

There are many governance structures (MPAs, water management, etc.) in the area but no overall governance structure at the scale of the Gulf Normand Breton. 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 (AAMP). 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 Environment. 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 Ecosystem Services (ES) concept.

4.2. The VALMER ecosystem services assessment (ESA)

4.2.1. Aims of the ESA

Within the NBG 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 and storage and nutrient cycling.

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

Three main aims have been identified through the *Triage* process (Figure 27):

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

At the end of the 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.

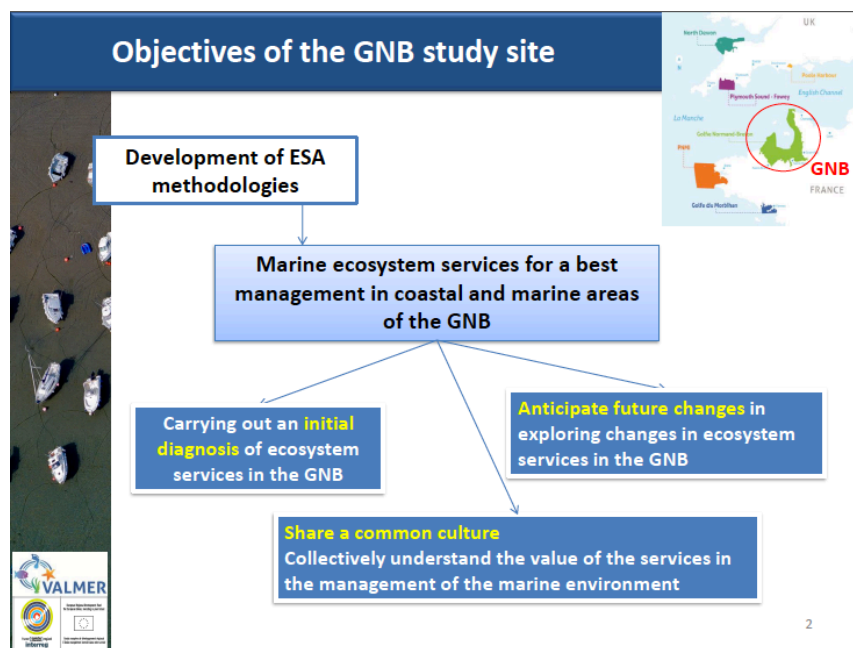


Figure 27. Objectives of the NBG case study site

4.2.2. Ecosystem services assessed in VALMER

After consulting local stakeholders, two main topics were identified to produce an initial diagnosis of ES in the area and to help anticipate of future changes:

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

4.2.3. What are the links between an ESA and scenarios?

In the NBG the ESA 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.

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.

Participatory scenarios will provide 4 contrasting visions of the future (ecological and economical/governance state). The work developed within the ESA 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 ESA helped to illustrate the consequences of degradation of ES on those activities.

4.3. The scenarios approach

4.3.1. What were the aims of the scenarios?

The aim of the scenario exercise in the NBG 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.

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.



The scenarios developed in the NBG 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 ES, using the results of the ESA done for the area. To achieve this, a collective approach that involved gathering interested stakeholders and VALMER scientific team (ecologists and economists) of the NBG, started during the autumn 2013.

4.3.2. 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 ES, 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 (Figure 28).



Figure 28. Steps of the scenarios approach developed in the NBG case study site

1. In May-July 2013, the NBG team contacted local stakeholders to involve them in the VALMER project.

2. The 15th November 2013: a “**Common culture Seminar** on the ecosystem services offered by the marine habitats of the NBG ” and a “ **Workshop 1 on issues** related to these ecosystem services” (*Asking: “What are the services offered by the marine habitats in the NBG?” and “ What are the issues related to these services?”*) were organised. These proved useful in identifying general issues concerning the ES of marine habitats in the NBG:

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

Those issues were too general and involved 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 (*see WP1 Guidelines*) has been done in strong collaboration with scientists of the VALMER NBG team. Each general subject has been broken down into combinations of human activity-habitat-ES. The 150 combinations obtained were tested by asking 3 questions (table 8): 1) the ES 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	HIGH	HIGH	MODERATE	LOW
INVASIVE SPECIES	PROVISIONNING	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

Table 8. Example of the TRIAGE process for the habitat A5.13 (Infra-littoral coarse sediment)

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

- 1) **The future of the scallop resource harvested on soft sediment** considering the implementation of management measures (e.g. eradication of the invasive slipper limpet, fisheries management, development of new activities as offshore wind, shellfish farming).
- 2) **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.
- 3) **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.
- 4) **The future of exploited resources on offshore sands**: fish, scallops in a context of changes in practice (e.g. new offshore wind projects, new protected areas for fisheries).

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**

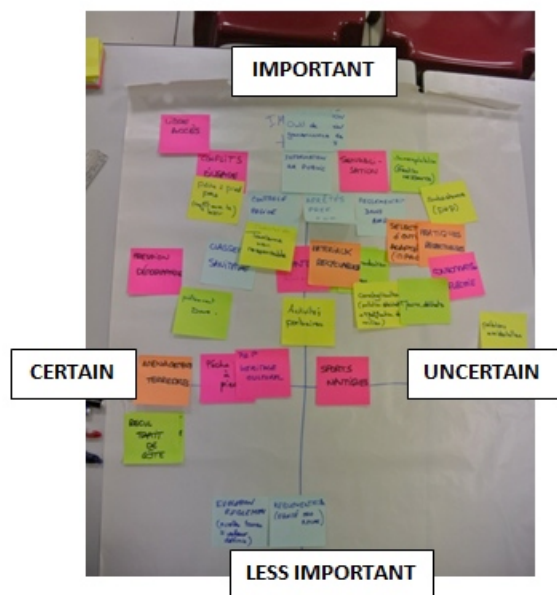
3. The 13th February 2014: "**Workshop 2: to identify issues to explore and start the development of scenarios**, *How can the issues identified evolve in the future?*" (20 participants)

The aim of this workshop was to collect key 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". 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 (Figure 29). The method was:

- 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.**

Figure 29. Picture showing the distribution of key elements depending of their degree of importance and uncertainty.



4. The 22th April 2014: "Workshop 3 to identify the structural elements needed to develop scenarios"

(20 participants)

Following the collective work of the workshop 2, the VALMER NBG team focused on all the items considered as "important" and then separated them into two classes according to their degree of uncertainty. This work allowed the identification of heavy trends (= items "important" and "certain" that will determine forcing settings) and the "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 NBG 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 (figure 30).

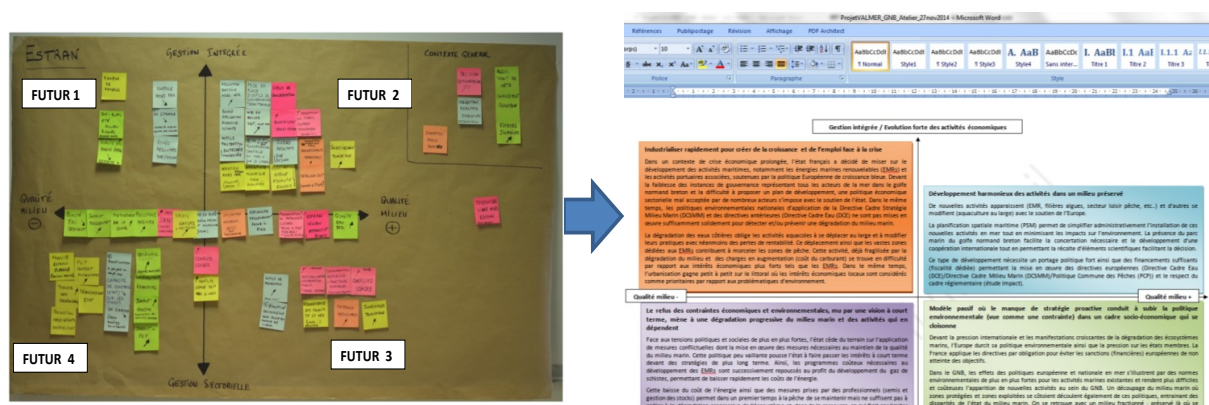


Figure 30. Pictures showing the result of workshop 3. The key elements have been distributed collectively following the scenario axes, allowing the team the write the first scenarios storylines.

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 NBG area including state agencies (water, coastal management, N2000, marine protected areas), nature reserve, NGOs, county councils, offshore renewable energy, fisheries, shellfish farming and mineral and aggregate extraction.

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

6. The 27th November 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 (Figure 31).

4.3.3. 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. As the PESTLE methodology was new within the project, one of the major difficulties was to understand it, more particularly to explain it, given the information available in the guidelines.. It was very helpful to be able to draw from the experience of people that had already used this method. In this situation it was extremely important to allow stakeholders to participate fully in the creation of the scenarios and this methodology was 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 and to build productive and effective workshops.

4.4. Description of scenarios developed in VALMER

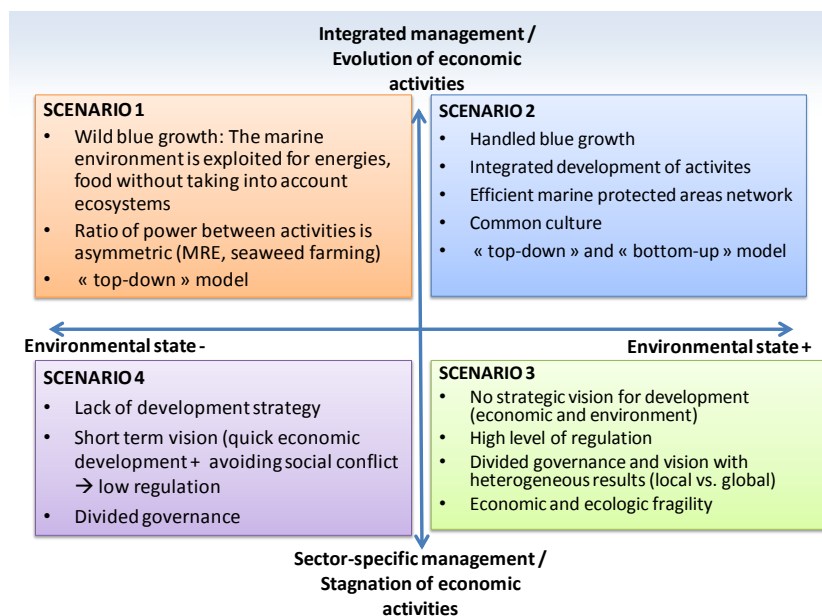


Figure 31. Summary of the four scenarios developed in the NBG case study site

SCENARIO 1

Rapid industrialization to create growth and employment in an economic crisis context (Figure 32)

In a context of prolonged economic crisis, the French government has decided to focus on the development of maritime activities, including marine renewables (EMRs) 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 Norman Breton Gulf 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 (MSFD) and previous directives (Water Framework Directive (WFD)) 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 increasing on the coast where local economic interests are considered as a priority over environmental issues.



Figure 32. Visual representation of the scenario 1 developed in the NBG 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).

SCENARIO 3

Passive model where the lack of a proactive strategy leads the vigorous enforcement of environmental policy (seen as a constraint) in a compartmentalized 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 NBG 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 etc.) 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.

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, the environment continues to degrade, which eventually impacts on the quantity of fish caught so reducing fishing activity.

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 terrestrial interests).

4.5. Use of scenarios outputs for management

4.5.1. 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).

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.

The scenarios developed recognise the perceptions of a wide range of stakeholders on most of the NBG 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.

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

4.6. Scenarios experience sharing

4.6.1. 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.

On the other side, this exercise has been a great opportunity for MPA management team to understand better the links between public policies, activity planning at different scales and stakeholders perceptions. 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.

4.6.2. Difficulties encountered

The first problem in the NBG was to ensure that well-focused and relevant subjects for ES scenario development were chosen whilst not being too prescriptive on topics for discussion with stakeholders. The use of the *Triage* methodology, whilst if time consuming, has helped greatly in this process. It was often challenging to assume the double identity of facilitators and stakeholder. The *Triage* process helped in demonstrating transparency and to avoid the questioning of the objectivity of the process by stakeholders.

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 ESA 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 ES variations.

4.6.3. 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.

For more information

<http://www.aires-marines.fr>

<http://www.aires-marines.fr/L-Agence/Organisation/Missions-d-etude-de-parc/Golfe-normand-breton>

Contact

Karine Dedieu (VALMER case study site coordinator)

Agence des aires marines protégées

karine.dedieu@aires-marines.fr

+33 (0)2 33 69 20 83

5. Marine Natural Park of Iroise Sea

Authors

A. Vanhoutte¹, P. Le Nilliot¹, Rémi Mongruel², Anahita Marzin², Martial Laurans², Olivier Guyader², Dominique Davoult³ and Diane Vaschalde⁴

¹ Marine Natural Park of Iroise Sea (MNPI)

² IFREMER

³ Biological Station of Roscoff

⁴ Marine Protected Areas French Agency

5.1. Case study site description

5.1.1. Physical environment

The Marine Natural Park of Iroise Sea (MNPI) 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 (Figure 33). The Molène's archipelago, where are to be found the most divers European algae *Laminaria* fields and the most extensive ones in France. It is a shallow area of nearly 400 km² 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 NMPI 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 for 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.



Figure 33. Perimeter of the Marine Natural Park of Iroise Sea (Agence des aires marines protégées, SHOM)

5.1.2. 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 port of Brest and agriculture.

5.1.3. Case study site governance

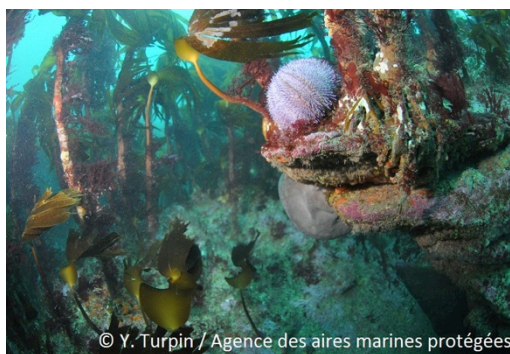
In particular regarding kelp harvesting, a dedicated commission of the Regional Fisheries Committee (CRPMEM) is in charge of defining proposals for kelp exploitation management rules, which are then amended and codified by the State representative.

The creation of the Marine Natural Park of Iroise Sea was a long-term participative process which ended with the settlement of a management board led by the 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 and 1 elected board member of the terrestrial Regional Natural Park of Armorique.

5.2. The VALMER ecosystem services assessment (ESA)

5.2.1. Aims of the ESA

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.

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.

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 NMPI, through the ecosystem services assessment (ESA) 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 Marine Natural Park of Iroise Sea is trying to answer through VALMER is **“How do we manage the kelp forest in the best way to conserve the kelp and allow its sustainable harvesting by fishermen?”**.



Laminaria digitata



Laminaria hyperborea

The NMPI 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 and
- evaluate the long-term effects of the pressures on the functioning of kelp forest habitat

5.2.2. Ecosystem services assessed in VALMER

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 Marine Natural Park of Iroise Sea was the **ES 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 WP1 recommendations for operational ES assessment, 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 (Figure 34). The initial list encompassed up to 30 ES and was then reduced to 9 ES, which would be of interest for assessment, according to the *Triage* approach (Pendleton et al., in press).

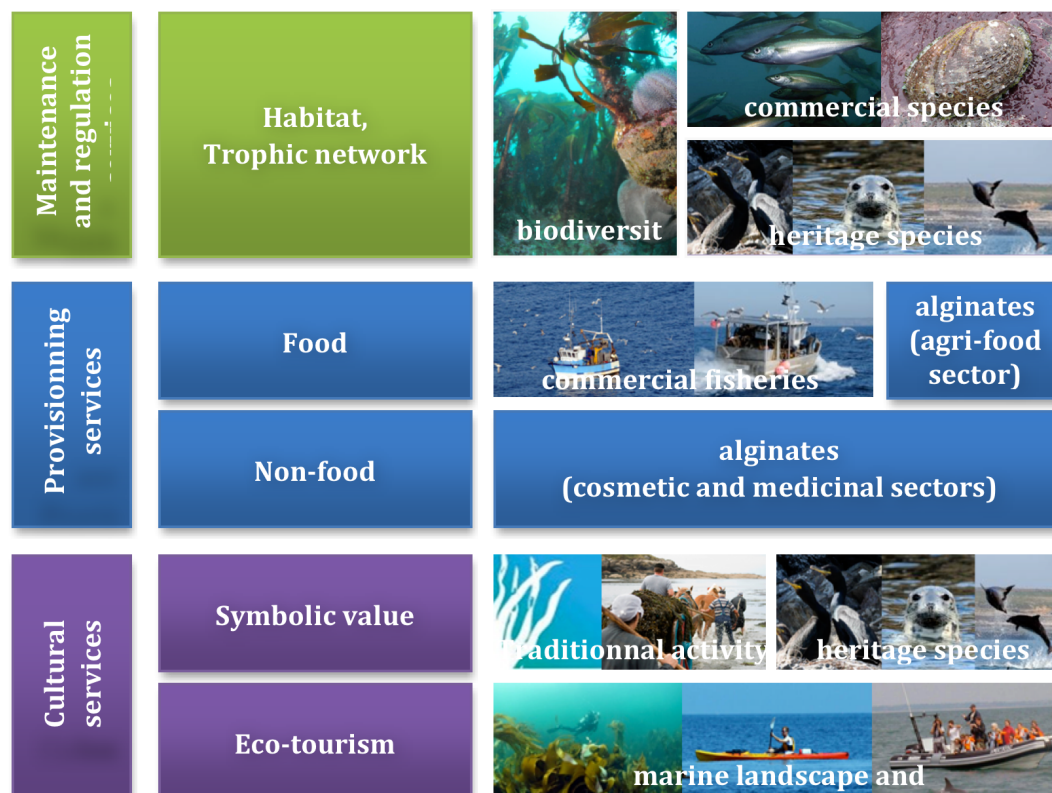


Figure 34. Ecosystem services selected from the TRIAGE approach

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 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.

At the same time, a study was conducted on the impact of different algae harvesting techniques (combs, *scoubidou*s) 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.

5.2.1. What are the links between an ESA and scenarios?

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 ES provided by kelp forest in the in the Molène archipelago (Figure 35).

Indicators were used to compare the scenarios options. For many indicators, the functional link between the kelp field and the corresponding ES was not quantitatively established at this state of the scientific knowledge. These indicators were often directly or indirectly linked to migrating species. This was the case for the commercial fish species as 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. If possible, changes in them were described quantitatively. If not, only global qualitative trends were provided.

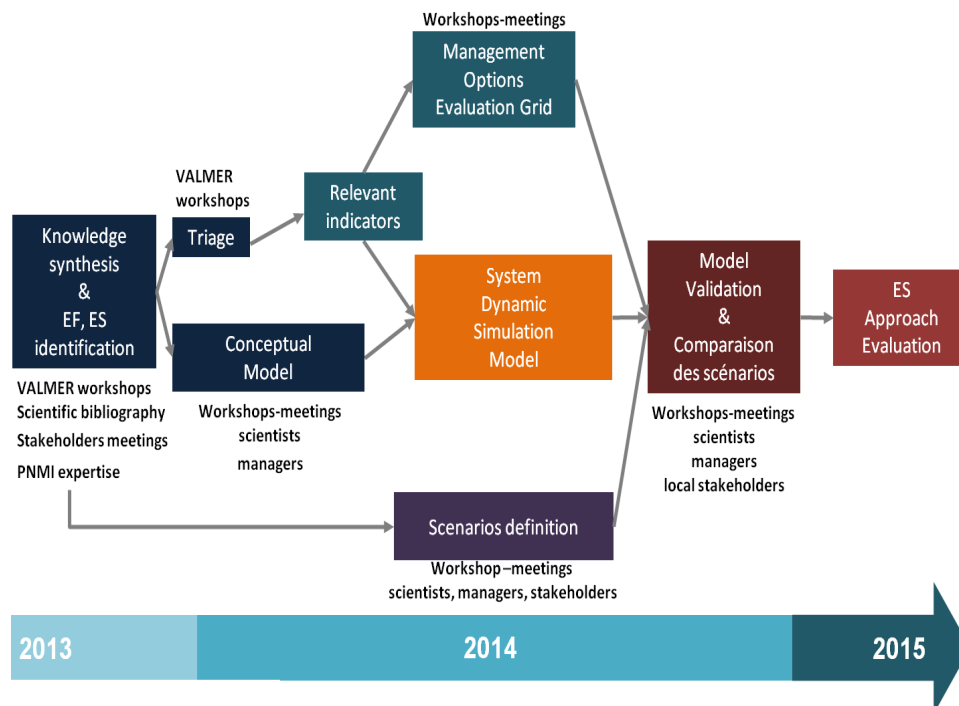


Figure 35. Links between the steps of ESA and scenarios approach developed in the NMPI

5.3. The scenarios approach

5.3.1. What were the aims of the scenarios?

The scenarios aimed at comparing management options, in the context of various possible changes in the kelp socio-ecosystem. 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. Some scientists and managers, who were part of the VALMER NMPI 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 reseeded 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).

5.3.2. Detailed description of the scenarios approach

The scenario approach developed in the Marine Natural Park of Iroise Sea was based on the modelling tool's ability to simulate the influence of adaptive strategies on ES which itself arises from an integrated approach started several years ago. Thus, we can identify steps initiated before the VALMER process (A), and steps mainly developed during the project (B). They are listed below:

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 NMPI

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, NMPI officers, fishermen and kelp processing plants representatives. For the scenario exercise, the dedicated events were:

1. A scenario planning meeting was organized in June 2014 with scientists and managers with the objective of analysing the system drivers gathered at previously. 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 ES 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
	Winter storms
	Processing plants capacity
	Kelp price
Adaptive	Closed areas for harvesting

Trending factors of change

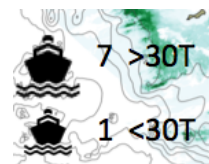
- Environmental factors: **winter storms** events remove large amounts of kelp plants and modify the spatial distribution of algae fields. The increase in the number and the strength of winter storm events had been documented but is recognized as being an uncontrollable external factor.
- Economic factors: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

Adaptive 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.

Adaptive	Fleet capacity
	Production per boat
	Harvest calendar
	Regulated access régulé
	Closed areas for harvesting

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 ES 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 restarts 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.

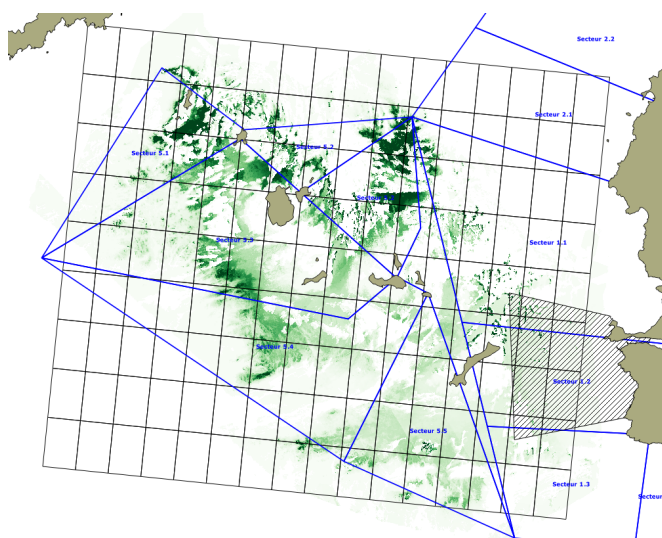


Regulated access

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.



5.3.1. 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 stakeholders.

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 ES 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 underestimate 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.

5.4. Description of scenarios developed in VALMER

Firstly, the model is designed to test the efficiency of adaptive strategies (= scenarios) on the ES 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".

5.5. Use of scenarios outputs for management

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

In the first instance, simple scenarios would 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 bringing 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.

5.5.2. Have management recommendations been identified for future?

At this stage, the use of the dynamic model of kelp ES for 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 step further.

5.6. Scenarios experience sharing

5.6.1. 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 asked to take part to the VALMER exercise were mainly linked to the kelp sector. But the VALMER staff also participated in meeting 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.

5.6.2. Difficulties encountered

One major difficulty encountered with the local fisheries committee was explaining that the NMPI was not trying to take-over from 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 ES assessment tool, in order to quickly inform the debates.

In VALMER, the NMPI relied on the "interviews" and "participative approach" for choosing and building scenarios.

5.6.3. Tips

The technical scenarios guidelines provided interesting information on stakeholder's engagement and scenarios building methods. However, these tools were not used directly in the NMPI 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 of the local context
- Carefully refine the scope of the ES assessment during the *Triage* in order to analyse the factors of change in the system and to develop the exploratory scenarios

For more information

<http://www.parc-marin-iroise.fr>

<http://www.parc-marin-iroise.com/content/view/full/5254>

<http://www.aires-marines.fr>

Contacts

Philippe Le Niliot (VALMER case study site coordinator)

Agence des Aires Marines Protégées

philippe.leniliot@aires-marines.fr

+33 (0)2 98 44 17 00

Photo crédits

Y. Turpin, S. Pianalto, B. Dumeau, S. Brégeon, S. Dromzée, F. Boileau, C. Lefeuvre (Agence des aires marines protégées)

T. Abiven (Maison de l'algue de Lanildut)

E. Chevillotte (Forum de l'algue de Lanildut)

G. Gautier (Ouest France)

6. Gulf of Morbihan

Authors

J. Herry¹, M. Philippe²

¹ Regional Natural Park of the Gulf of Morbihan

² AMURE Laboratory, University of Brest

6.1. Case study site description

6.1.1. Physical environment

The gulf du Morbihan (GDM) is located in south Brittany, in the Morbihan Department. The boundary of the case study site is as for the Regional Natural Park (RNP) of the Gulf of Morbihan (Figure 36). The area includes thirty municipalities and an associated marine area of 125 km². This marine area is connected to the Atlantic Ocean by a narrow channel. The GDM is famous for its rich biodiversity, natural and cultural heritage, with various habitats (mud-flats, rocky foreshores, seagrass beds, etc.) and landscape.



Figure 36. Perimeter of the Regional Natural Park of the Gulf du Morbihan

6.1.2. Main activities and uses

The gulf of 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.

6.1.3. Case study site governance

The aim of the RNP is to achieve sustainable development and one that conserves environmental richness in the long-term. This RNP is a voluntary tool based on a Charter with many actions to implement 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. It provides a common framework for future actions on water quality, biodiversity, integrated coastal management, natural and cultural heritage. The Charter includes three key themes:

1. Enhance heritage assets
2. Support sustainable development
3. Put people at the heart of all work

6.2. The VALMER ecosystem services assessment (ESA)

6.2.1. Aims of the ESA

The RNP is the overall coordinator of the Natura 2000 area in the gulf of Morbihan. This is an important area for seagrass beds, the second largest area in the metropolitan France after Arcachon. 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 levels 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 GDM: *Zostera marina* and *Zostera noltei*. In 2007, this represented, respectively 11 km² and 8 km².



Zostera marina (© Olivier Dugornay - IFREMER)



Zostera marina (© RNP)

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 RNP decided to experiment with the ecosystem services approach put forward in VALMER. 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 gulf, in 2016.

The ESA was designed to:

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

The results of this *Triage* process (see WP1 guidelines) are presented in the table 9.

Aims selected	Why?
1. Raise awareness on seagrass issues	Because perceptions of seagrass beds are different between stakeholders
2. Realize an integrated assessment to improve management	Because knowledge of 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

Table 9. Aims selected through the TRIAGE approach in the gulf of Morbihan

6.2.2. Ecosystem services assessed in VALMER

Through the VALMER project, the ecosystem services approach in the GDM 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).

At the beginning of the project, it was decided do not assess a monetary value of the seagrass beds of the gulf of Morbihan. Indeed, the VALMER GDM team preferred to develop a multi-criteria assessment approach based on social, economic and environmental criteria. The VALMER team tried to identify 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 to identify the natural and human factors that could affect the level of the ES offered by seagrass beds.

This assessment has been done by combining several steps and tools (Figure 37):

- A scientific literature review
- Interviews
- Focus-groups
- A “choice experiment” survey
- Map analysis



Figure 37. Overview of steps and tools developed in the GDM case study site

The ESA was useful in the gulf of 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 GDM 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.

6.2.1. What are the links between an ESA and 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 ES offered by these marine habitats.

6.3. The scenarios approach

6.3.1. What were the aims of the scenarios?

The scenarios developed in the gulf 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 ES 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.

6.3.2. Detailed description of the scenarios approach

1.

Thanks to the ESA of seagrass beds of the gulf, four scenarios (= management strategies) have been identified (table 10).

<p>SCENARIO 1</p> <p>Seagrass beds are in good condition.</p> <p>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.</p>	<p>SCENARIO 2</p> <p>Improve the condition of all seagrass beds around the gulf of Morbihan.</p> <p>Limit pressures on all potential areas (known to have been colonized by seagrass beds).</p>
<p>SCENARIO 3</p> <p>Just maintain seagrass beds where the pressure and impact are not of great concern and prioritize activities elsewhere.</p>	<p>SCENARIO 4</p> <p>Improve the condition of seagrass beds by conserving strategic areas in good condition in the long-term.</p>

Table 10. Summary of the four scenarios developed in the GDM case study site

2. These four scenarios were presented the 18th September 2014 to 20 participants during a “**scenarios workshop**”. Through an open discussion based on maps illustrating the four scenarios, the stakeholders have identified for each of them their strengths, weaknesses, opportunities and threats through an adapted “SWOT” analysis (Table 11).



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

Table 11. Example of an adapted SWOT analysis undertaken for the scenario 1

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 (Figure 38).




Rating scale

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 FEASIBLE
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?		

Figure 38. Rating scale used to rank the desirability and feasibility of each scenario

Using an Excel algorithm, the results were then analysed to identify if there was consensus between the participants (Figure 39).

- This means  that there is a **consensus to say “YES”**
- This means  that there is a **consensus to say “NO”**
- This means  that there is **no consensus**









	DESIRABLE?	FEASIBLE?
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		

Figure 39. Example of results obtained by the “Abaque de Régnier”

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...

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 gulf of Morbihan (Table 12). 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

Table 12. Example of management measures proposed by the participants at the scenarios workshop

A total of twenty management measures were proposed and explained to the participants during the workshop.

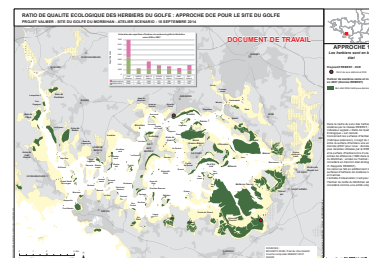
6.4. Description of scenarios developed in VALMER

Each scenario summarizes 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, also help to illustrate the scenarios.

SCENARIO 1

Seagrass beds are in good condition.

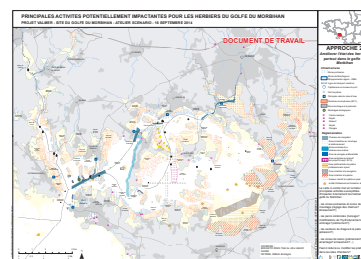
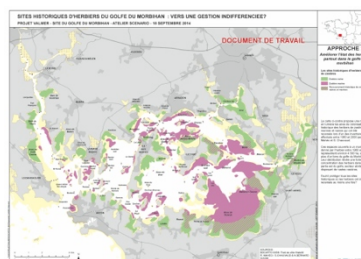
It is not necessary to change the level of protection but a programme must be implemented to monitor their condition in the long-term and prevent any deterioration.



SCENARIO 2

Improve the condition of all seagrass beds around the gulf of Morbihan.

Limit pressure on all potential areas known to have been colonized by seagrass beds.



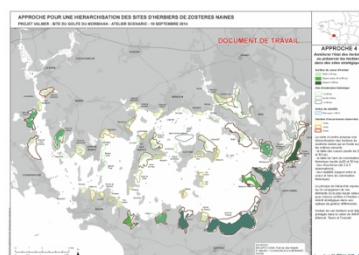
SCENARIO 3

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



SCENARIO 4

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



6.5. Use of scenarios outputs for management

6.5.1. 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 gulf of Morbihan (a marine planning tool) that will be reviewed in 2016, and also to complete the Aims Document N2000 in the gulf. These results will be spread as far as possible in order to help other areas that face the same issues (e.g. N2000 managers).

6.5.2. 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 gulf with the participation of local stakeholders.

6.6. Scenarios experience sharing

6.6.1. 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 gulf 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. 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.

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 reproached by other users.

6.6.2. Difficulties encountered

The major difficulty encountered in the gulf du Morbihan during VALMER 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 in the gulf.

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.). 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
- 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

6.6.3. 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

For more information

www.golfe-morbihan.fr
www.umar-amure.fr

Contacts

Juliette Herry (VALMER case study site coordinator)
Natural Regional Park of the Gulf of Morbihan
juliette.herry@golfe-morbihan.fr
+33 (0)2 97 62 36 24

Manuelle Philippe (Scientist)
UMR AMURE, University of Brest
manuelle.philippe@univ-brest.fr
+33 (0)2 29 00 85 28

★ Recommendations and advice from the VALMER “scenario building” process

Two workshops were held on the 5th and 15th December 2014 at Séné (France) and at County Hall, Exeter (UK). The purpose of these workshops was to discuss, analyse and record the scenario building experiences of the six VALMER case study sites and to compare them.

Following the presentations an open discussion was facilitated by the VALMER Work Package 3 lead organisation (The Regional Natural Park of the Gulf of Morbihan in France and the Devon County Council in UK). The facilitated discussion allowed for a comparison of experiences and an overall consensus on the outcomes of the analysis.

In addition, under VALMER Work Package 4, an independent stakeholder questionnaire was undertaken and this included a question relating to the scenario process. There were some interesting and useful responses and these have helped inform the process of learning from the experience of conducting scenarios.

Set out below are the advantages and disadvantages of using the scenario process, as identified by case study site coordinators that participated in the UK based workshop and from the answers to the questionnaire. These sources have also been used to list some considerations to be used when designing a scenario development methodology.

7. Advantages of developing scenarios for site management

- *The concept of the ‘theoretical’ approach that scenarios offer can help promote more willingness to engage in discussion.*
- *Scenario development can result in very creative ideas coming forward with a great opportunity for lateral thinking.*
- *The initial stages of developing scenarios can be very helpful in building an agreement of what is to be discussed and what is not and in establishing a baseline of understanding of the site.*
- *Scenario development can result in a helpful overview being arrived at for a particular site or management issue.*
- *Scenario development can help build understanding of a management issue.*
- *At a local level, issues can be ‘brought to life.’*
- *Scenario development is a useful means for building trust and cross-sector knowledge and understanding.*
- *A well run scenario process can convince stakeholders of the feasibility or otherwise of a course of action so unrealistic expectations can be managed.*
- *There is the opportunity for the scenario process to present and review more acute options than might otherwise have been considered but this is not always comfortable territory for all.*
- *Using scenario development to plan in the long-term lends a greater opportunity for agreement to be reached.*
- *The outputs from scenario development can be used to present evidence to decision makers outside of the scenario process.*
- *There is an opportunity to develop the outputs from case study sites into practical actions in the future.*
- *New perspectives on management issues can result from scenario development.*
- *The scenario process, if well run, will be enjoyed by the participants.*

8. Disadvantages of developing scenarios for site management

- *To be successful, scenario development must be given sufficient time, which can be longer than expected.*
- *It is important not to underestimate the lead-in time in the scenario development process.*
- *If the selection of scenario themes is driven primarily by the availability of particular data, it can inadvertently disengage some stakeholders as local perceptions of priorities appear to be arbitrarily dismissed.*
- *Without a sufficient availability of resources scenarios can be partial in their success, in that they either just engage a selected and compliant group of stakeholders or they are channelled into investigating issues for which a critical mass of data exists.*
- *If the use of extremes in the scenario building process (e.g. an Armageddon scenario) is not understood then it can be counterproductive in engaging stakeholders.*
- *For management issues within the marine environment it is often difficult to secure truly maritime practitioner stakeholders.*
- *Some stakeholders have concerns that outputs are merely theoretical and that they have little or no probability of happening, which can in extreme circumstances lead to some stakeholders withdrawing from the process.*
- *Scenarios are not the simplest stakeholder engagement tools.*
- *If a consistent group of stakeholders cannot be maintained throughout the process, continuity is compromised and effort wasted.*

9. Some considerations when designing the methodology

- *The capacity within an organisation to undertake the development of scenarios and the expertise it has are important limiting factors that need to be acknowledged at the outset.*
- *Openness and transparency in selecting and developing scenarios are critical factors in reaching successful outcomes.*
- *It is helpful, generally to include professional, technical and scientific stakeholders in the process of building scenarios.*
- *Ensuring that the stakeholder group has the confidence that all important sectors and interests are represented helps to build commitment.*
- *It is very important to ensure that all stakeholders that have chosen to participate are then enabled to do so by ensuring they are provided with the necessary knowledge and understanding of issues and that no group is ignored.*
- *A scenario building exercise would be improved by ensuring that realism is maximised at the planning stage.*
- *The choice of scenarios to work on should be determined at the outset by taking a broad view of all management issues on a site.*
- *Stakeholders wish scenarios to be very relevant to local ventures including businesses.*
- *Having sufficient and appropriate data for stakeholders to use is important. Missing data can detract from the stakeholders' confidence in the process.*
- *Scenarios need to be sufficiently different from the processes that are being evaluated to provide contrast.*
- *It is important to ensure that the balance of effort between the scenario process and any analytical process such as an ecosystems services assessment is decided carefully beforehand.*
- *Theoretical, unrealistic and unachievable scenarios lose credibility with stakeholders.*
- *Having understandable and sufficiently accurate modelling software as a support tool is Voting on options is an effective way of making decisions.*
- *important in building the confidence of stakeholders.*
- *Positive results are more readily arrived at if there is no perception of decisions being 'loaded.'*
- *It can make discussions easier if there is not a formalised management structure in place.*

10. What are the stakeholders' points of view on the scenarios exercises?

Advantages

"Scenarios provided a framework for the discussion needed to get to the bottom of an issue"

"It is a very interesting exercise. Looking at the future was a little bit scaring, but we haven't often the opportunity to look at how the area will look like in thirty years"

"Scenarios are a lively way of explaining where the different management options will lead, it makes it clearer, easier to understand"

"The scenario approach shows that all stakeholders are responsible and can all contribute to preserving the ecosystem services issue"

"The scenario building workshop was useful and interesting because there was reasonable mixed bag of stakeholders, was interesting to understand the different impacts on stakeholders was useful, and was able to learn a lot about the local area with there being local stakeholders at the meeting"

"The scenario building process was good for looking at feasibility and working out whether it was even worth doing an assessment. Thinking about the management along the way is important, it's not just the end result, because the end result isn't the be all and end all"

Disadvantages

"The limitation of the scenarios approach is that it simplifies things and decisions in the scenario building process can be quite arbitrary; there is the risk that scenarios lead to a false sense of certainty; they show some possible pathways for the future but one should not assume that they clarify the future"

"Can be challenging, because scenarios need to give sufficient contrast within the processes that are being evaluated, and requires ability to think laterally, beyond familiar"

"Changes in stakeholder who came to the different meetings made aspects of scenarios building difficult"

11. Ten key recommendations



Illustration: Yann Souche
(The French MPA's Agency)

★ Conclusion

The VALMER project aimed to develop integrated approaches for marine management based on the combination of an ecosystem services assessment (ESA) and building site based scenarios. Thus, the six VALMER case study sites have explored potential marine management strategies for their areas.

The scenarios building processes proved useful in:

- Considering the interactions between species, habitats, human activities and governance regimes.
- Supporting the managers of natural sites to make decisions, based on different options, relating to the continued sustainable development of their sites and the maintenance of ecosystem services.

The type of scenarios approaches, methods and tools used were very dependent of the local context (aims followed, local governance, degree of action in decision-making, relationships with stakeholders, etc.). This synthesis of the scenario process tries to illustrate this diversity of situations encountered in the VALMER project; to share lessons learned and give feedback on the experiences encountered and offers advice to other sites that would also like to use scenarios tools.

It was not possible for the VALMER case studies sites to develop a “marine vision”, as intended, during the project for two major reasons:

- 1) The lack of direct authority to implement the management policy or management changes proposed during the project
- 2) The time needed to create an integrated marine strategy (i.e. bringing together all the decision-making organisations concerned)

However, it was possible for each case study site to produce advice and recommendations that will support decision-makers in the development of future local marine strategies. The awareness of ecosystem services offered by marine habitats was demonstrated well by the experimental VALMER approaches, and the involvement of local stakeholders. This will help greatly the successful implementation of effective management measures in the future.

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★ Appendix

Summary table of the objectives of the study sites and methods used in each territory

	North Devon	Poole Harbour	Sound to Fowey	Gulf Normand-Breton	Natural Marine Park of Iroise sea	Gulf of Morbihan
Issue / Question	Impact on benthic habitats	Recreational Use	Mixed	Increasing demand of all uses	Increasing demand for kelps	Improve seagrass preservation
Habitat studied	Benthic off-shore	Mixed (Harbour)	Mixed (coastal and offshore)	Intertidal zone; fish habitats	Kelp forests	Seagrass beds
Ecosystem Services	Fisheries, nutrient cycling, carbon cycling	Recreation	Varied	Recreative services, Provisioning services	Food, remarkable species, ecotourism	Maintenance and regulation services
Aim for ESA	Design management options	Improve knowledge	Initial diagnosis	Initial diagnosis; Exploratory scenarios	Compare Management options	Raising awareness
Methods used	Bayesian Belief Networks	TCM, survey	Varied	INVEST Ecosystem accounting	Indicators Dynamic modelling	Choice experiment
Aim for scenarios		X	Produce a draft action plan to deliver parts of the Environmental objective of the Cornwall Maritime Strategy	Engage stakeholders	Compare different kelp management strategies to achieve a sustainable exploitation	Compare management options to preserve seagrass beds
Type of scenarios	Exploratory	X	Exploratory	Exploratory	Normative	Exploratory
Methods used	Bayesian belief network model	X	PESTLE Backcasting	PESTLE Matrixes	Brainstorming	SWOT analysis Abaque de Régnier

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For more information, contact:

Herry Juliette

Case study site coordinator of the Gulf of Morbihan

+33 (0)2 97 62 36 24 - juliette.herry@golfe-morbihan.fr



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