COEXIST
Interaction in coastal waters

Guidance on a Better Integration of Aquaculture, Fisheries, and other Activities in the Coastal Zone

From tools to practical examples

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Interaction in coastal waters

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GUIDANCE ON A BETTER INTEGRATION OF AQUACULTURE, FISHERIES, AND OTHER ACTIVITIES IN THE COASTAL ZONE – FROM TOOLS TO PRACTICAL EXAMPLES

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Contents

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About

This guidance document provides a comprehensive assessment of the conflicts and synergies between fisheries, aquaculture and other activities in the coastal zone in six COEXIST case study areas. It forms deliverable D5.2 of the COEXIST project and synthesises deliverable D5.1, which provides a more detailed description of the methods used and results. This document also accounts for the views and expectations of stakeholders that were raised at the COEXIST stakeholder workshop held in Bergen, Norway, parallel to the ICES (International Council for the Exploration of the Sea) Annual Science Conference 2012. Over 30 stakeholders representing a variety of sectors, including aquaculture, fisheries, coastal zone management, tourism and energy, as well as 20 members from the COEXIST project and ICES representatives, attended this event. The stakeholders and COEXIST members were from Denmark, Finland, France, Germany, Ireland, Italy, Norway, Portugal, Spain, the Netherlands and the United Kingdom. The workshop aims were firstly to communicate the COEXIST project results and progress to stakeholders and the second major aim was to receive stakeholder feedback on the development of best practice guidance for spatial planning to integrate fisheries, aquaculture and further demands in the coastal zone.

An electronic version of this guidance document can be found on the project website. The electronic version is an interactive document that directs the reader to further background reading and related deliverables (see also Annex 1: List of Scientific Deliverables on page 53).

The project website (www.coexistproject.eu) with access to deliverables will be available until five years after the end of the project (i.e. June 2018).

List of Acronyms and Abbreviations

APPAA	Armona Pilot Area for Aquaculture Production (Área Piloto de Produção Aquícola da Armona)
CFP	Common Fisheries Policy (EU)
DE	Germany
DK	Denmark
DTS	Demersal Trawl and Seine (fishing gear)
FR	France
GIS	Geographic Information System
ICES	International Council for the Exploration of the Sea
ICZM	Integrated Coastal Zone Management
IMP	Integrated Maritime Policy
IMTA	Integrated Multi-Trophic Aquaculture
IRL	Ireland
LCA	Life Cycle Assessment
MBC	Mobile Bottom Contact (fishing gear)
MPA	Marine Protected Area
MPP	Marginal Physical Product
MSFD	Marine Strategy Framework Directive (EU)
MSP	Marine Spatial Planning
NGO	Non-governmental Organisation
NL	The Netherlands
NM	Nautical mile (approx. 1.85 km)
PG	Passive Gear
POM	Particulate Organic Matter
SAC	Special Area of Conservation
SCI	Sites of Community Importance
SPA	Special Protection Area
TAC	Total Allowable Catch
TBB	Trawl Beam Bottom
TBS	Beam Trawls Trageting Shrimp
VMS	Vessel Monitoring System

1. Instruction for Users

The purpose of this guidance document is to promote the better integration of aquaculture, fisheries and other activities in the coastal zone by the identification and application of appropriate spatial management tools (Chapter 3). The conclusions drawn and the recommendations in this document are largely based on the experience of applying a set of methods and technical tools to address a number of key questions in spatial management in six COEXIST case studies (Fig. 1). The COEXIST case study (CS) areas varied in size and focus and represented northern and southern European sea areas. More details can be found in the case study fact sheets Annex III: Case Study Fact Sheets on page 57.

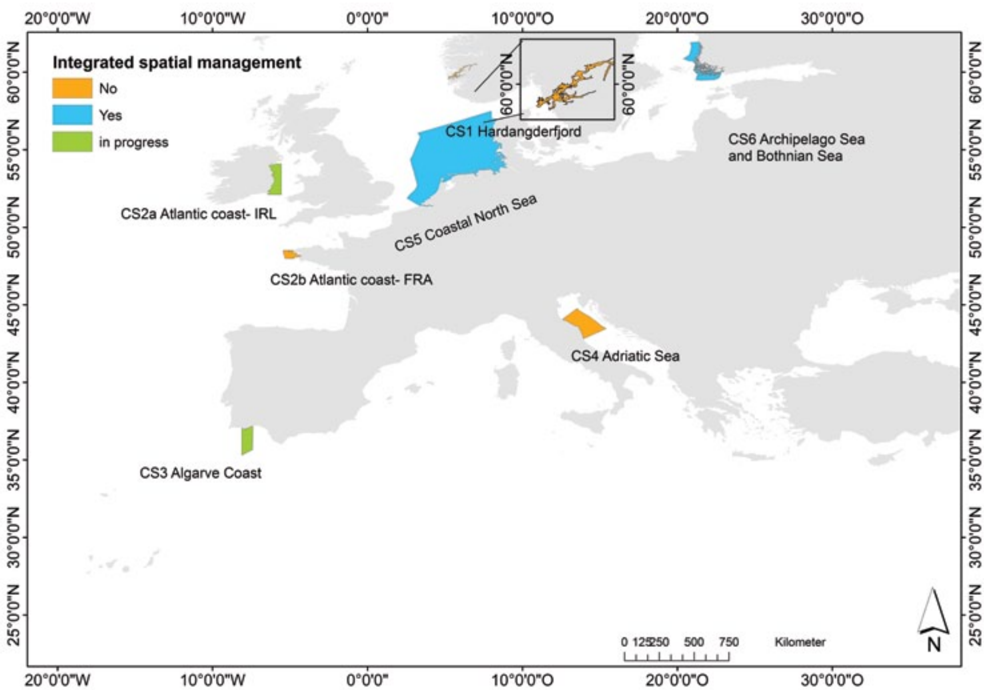


Figure 1: The status of integrated spatial management in the COEXIST case study areas.

A number of spatial management questions were compiled based on the original COEXIST objectives, the results of analysing the different case studies, and the outputs of the ICES/COEXIST stakeholder workshop.

These questions are organised around three main topics (Fig. 2):

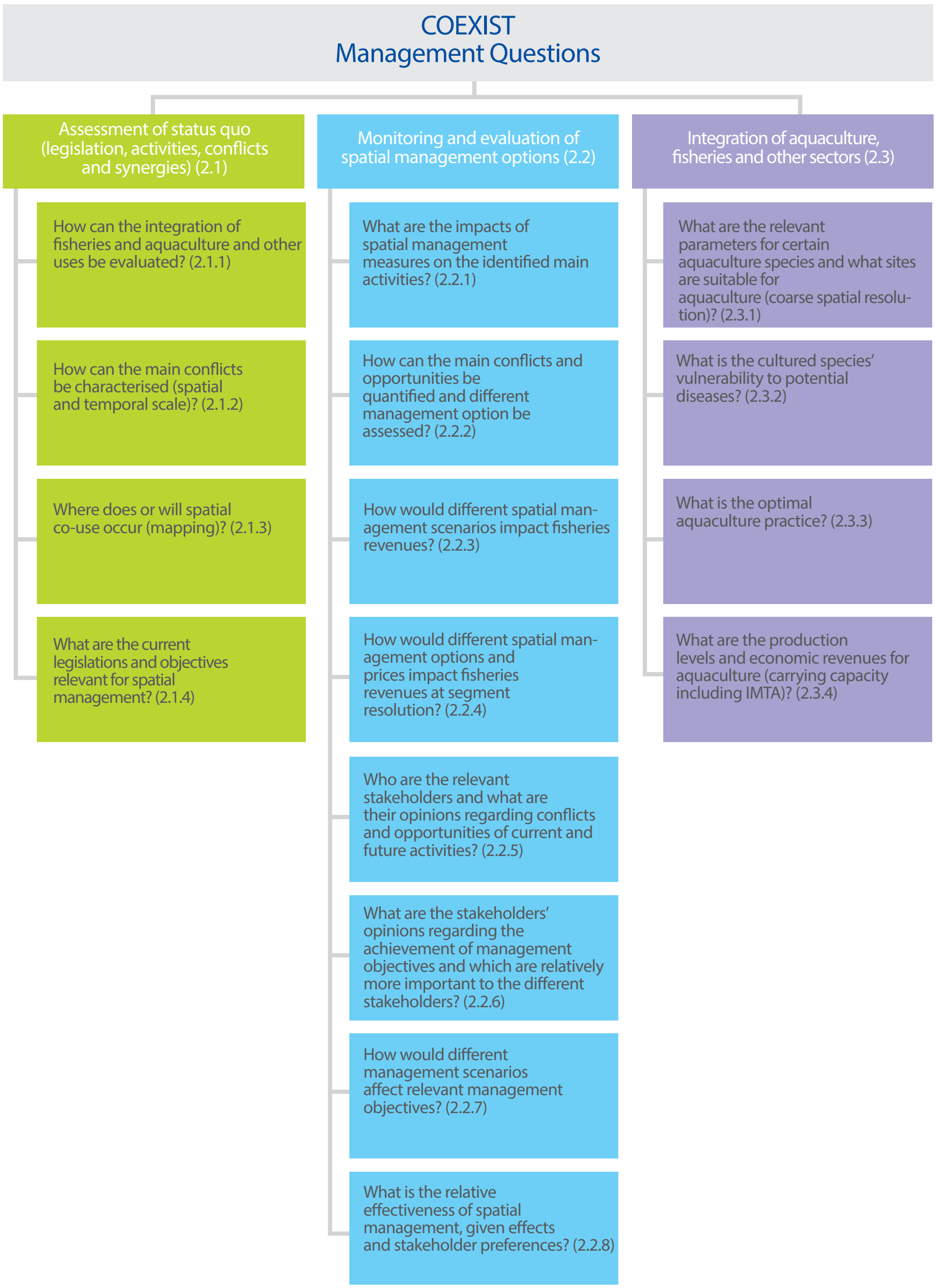


Figure 2: COEXIST topics and questions (chapter numbers in parentheses).

Different methods and tools have been applied and tested across the case studies in order to answer these specific questions addressing economic, ecological and social dimensions in marine spatial planning. Thus their application enables the provision of important information for decision makers in spatial management processes (Tab. 1).

Table 1: Tools used in the COEXIST case studies to address specific management questions.

Tool (No.)	Question addressed (Chapter No.)	Topic	Case Study Illustration
Mapping of Activities (past, present, future) (Tool 1)	Where does or will spatial co-use occur (mapping)? (2.1.3)	Assessment of status quo	Denmark, Germany, Netherlands: North Sea Coast (CS5)
Individual Stress Level Analysis (ISLA) (Tool 2)	How would different spatial management scenarios impact fisheries revenues? (2.2.3)	Monitoring and Evaluation	Denmark, Germany, Netherlands: North Sea Coast (CS5)
Analysis of Conflict Scores (Tool 3)	How can the main conflicts and opportunities be quantified and different management options be assessed? (2.2.2)	Monitoring and Evaluation	Italy, Adriatic Coast (CS4)
GRID (Tool 4)	How can the main conflicts be characterised (spatial and temporal scale)? (2.1.2)	Assessment of status quo	Italy, Adriatic Coast (CS4)
Stakeholder Consultation (Tool 5)	How can the integration of fisheries and aquaculture and other uses be evaluated? (2.1.1)	Assessment of status quo	Ireland, South Irish Sea (CS2a)
	How can the main conflicts be characterised (spatial and temporal scale)? (2.1.2)	Assessment of status quo	Italy, Adriatic Coast (CS4)
	What are the current legislations and objectives relevant for spatial management? (2.1.4)	Assessment of status quo	France, Atlantic Coast (CS2b)
	What are the impacts of spatial management measures on the identified main activities? (2.2.1)	Monitoring and Evaluation	Ireland, South Irish Sea (CS2a)
	Who are the relevant stakeholders and what are their opinions regarding conflicts and opportunities of current and future activities? (2.2.5)	Monitoring and Evaluation	Portugal, Algarve Coast (CS3)
FISHRENT (Tool 6)	How would different spatial management options and prices impact fisheries revenues at segment resolution? (2.2.4)	Monitoring and Evaluation	Denmark, Germany, Netherlands: North Sea Coast (CS5)
FARM (Tool 7) Detailed Ecosystem Model (Tool 8)	What are the production levels and economic revenues for aquaculture (carrying capacity including IMTA)? (2.3.4)	Integration of fisheries aquaculture and other uses	Portugal, Algarve Coast (CS3)
Suitability Maps (Tool 9)	Which are the relevant parameters for certain aquaculture species and which are the suitable aquaculture sites (coarse spatial resolution)? (2.3.1)	Integration of fisheries aquaculture and other uses	Finland, Baltic Sea (CS6)
Stakeholder Preferences (Tool 10)	What are the stakeholders' opinions regarding the achievement of management objectives and which are relatively more important to the different stakeholders? (2.2.6)	Monitoring and Evaluation	Ireland, South Irish Sea (CS2a)
Effect Table (Tool 11)	How would different management scenarios affect relevant management objectives? (2.2.7)	Monitoring and Evaluation	Finland, Baltic Sea (CS6)
Multi Criteria Analysis (MCA) (Tool 12)	What is the relative effectiveness of spatial management, given effects and stakeholder preferences? (2.2.8)	Monitoring and Evaluation	Norway, Hardangerfjord (CS1)

More specifically, the tools applied to answer the respective management questions (Fig. 3) include a broad variety of statistical methods, software, consultation methods, models and combinations of the aforementioned single parts. The tools also include advanced technologies in regard to the development and evaluation of management options. Their key attributes, such as costs, required expertise, strengths and weaknesses are described further in the Chapter 3: Tools. Combined in a structured process, these interdisciplinary and comprehensive tools are helping to analyse present management settings and the effects of future management options. Since stakeholder interactions are to be considered in management processes, the application of the respective tools can support transparency in decision-making, and acceptance of the decisions made. Potential end-users for these tools include industry (e.g. fisheries, energy and aquaculture), NGOs, governmental agencies (EU, national & regional authorities) and research institutes.

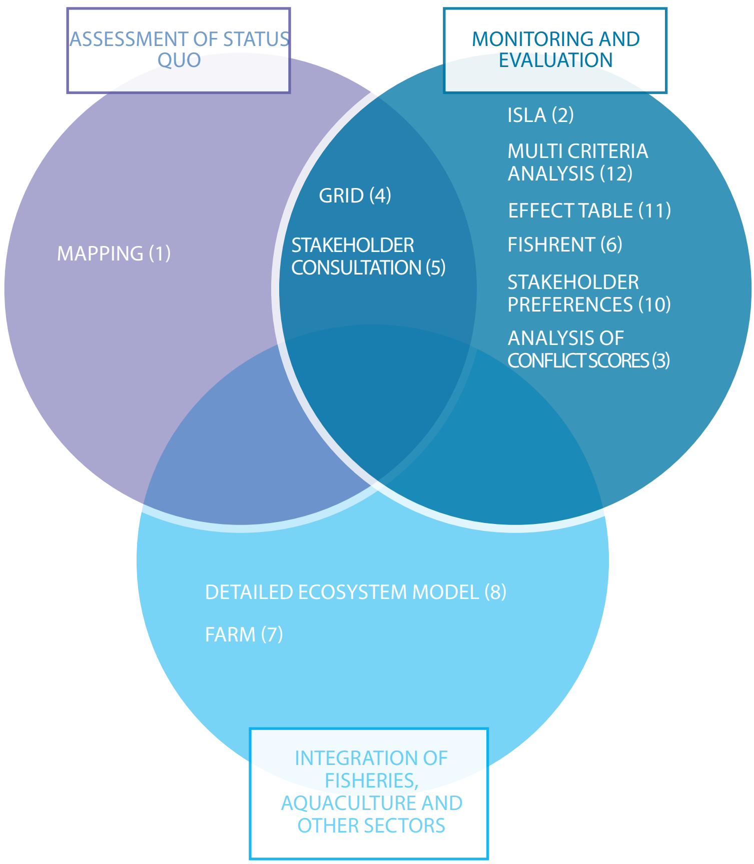


Figure 3: Use of tools to answer management questions in COEXIST.

2. Management and Research Questions Addressed

2.1 Assessment of status quo (legislation, activities, conflicts and synergies)

Marine space meets many different human needs, including the production of food, transport of goods, energy production, recreation, and nature conservation. This means that management decisions on how to best utilise this space are influenced by a variety of interests, including those of different industries, NGOs, and wider society. Also, limited available space often fosters the co-use of an area, with different activities performed in close vicinity to each other, or even on top of each other (e.g. aquaculture underneath wind turbines). These conditions can lead to conflicts and/or synergies between activities. Conflicts often occur where activities exclude each other (e.g. gill nets and trawling, wind farms and aggregate extraction). Synergies might emerge where infrastructure is used by different activities (e.g. water ways, harbours), or in cases where technical development in one sector supports another (e.g. the wind farm industry and offshore aquaculture).

The management of these activities is governed by laws and regulations that define marine spatial plans. These laws and regulations often have a direct impact on whether there are synergies or conflicts between activities by ruling whether co-location of particular activities is either permitted or even encouraged in a particular area. Another factor influencing marine spatial planning (MSP) or the introduction of a new activity is the provision of subsidies. Accordingly, the assessment of the status quo, i.e. reviewing the existing legislation, learning about past and present activities and gaining information about the conflicts and synergies in the particular marine space involved, is fundamental to successfully manage marine space.

2.1.1 How can the integration of fisheries and aquaculture and other uses be evaluated?

Sustainable management aims to promote sustainable development and healthy ecosystems by the optimal organisation of human activities in space and time. Successful integrated management of fisheries and aquaculture involves establishing and maintaining a long-lasting communication process between and within these two, often competing, sectors.

Stakeholder consultations are often useful to obtain an initial "snapshot" view of the temporal and spatial patterns of use and co-uses of an area by different activities (Tool 5). In particular, possible interactions between aquaculture and fisheries and other maritime users can be identified, e.g. where the same area is used or competed for (e.g. aquaculture sites and fisheries) or areas potentially supporting the multi-use of marine space, such as some wind farm areas. To a certain extent, a synergy between aquaculture, commercial fishing and even recreational fishing may be expected.

It is also important that any potential new conflicts between different existing human activities due to the integration of a new activity are identified. The effects of different possible management scenarios can be assessed in advance to minimise or even avoid future conflicts.

Spatial tools such as FISHRENT (Tool 6) provide economic estimates (e.g. gross value added, net profits) to evaluate the effects of spatial closures of fishing areas. By conducting an Individual Stress Level Analysis (Tool 2), the impact on a specific activity can be evaluated in terms of losses of parameters of interest (revenues, jobs, etc.). To gain an initial evaluation of the situation and to identify the effects on relevant objectives of different spatial management options, an Effect Table (Tool 11) can be utilised.

Case Study Illustration – Atlantic Coast Area – Ireland

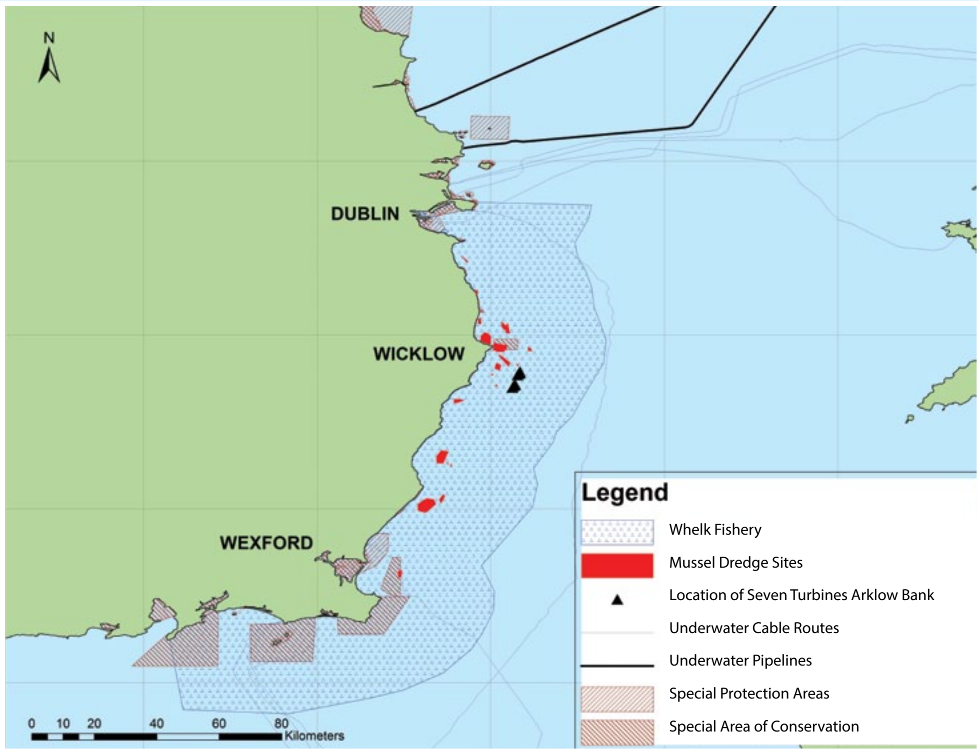


Figure 4: Map of the CS2a (Atlantic Coast Case Study Area – Ireland) illustrating important activities undertaken in this area.

Stakeholder Consultation (Tool 5) was used in the Atlantic Case Study Area – Ireland CS 2a (Fig. 4) to identify interactions between operators of mussel seed dredgers, whelk fishermen and other maritime users of the area. Six responses in total were received from the following: government agencies [1]; Industry [2]; and Industry Representative/NGOs - fisheries, conservation and tourism [3]. Areas of potential spatial conflict were identified between whelk fishermen and mussel dredgers regarding, for example, the loss of gear after being allegedly towed by the other gear types and the concern of the whelk fishermen that aquaculture installations could overlap with whelk fisheries. However, the stakeholder consultation also allowed recognition of beneficial relationships, e.g. combined use of support and infrastructure such as expert engineers, harbours and other operational infrastructure. Beneficial associations between conservation objectives and structures associated with wind farms were identified as these may prevent dredging or trawling activities in the immediate vicinity.

References:
Deliverable D2.1

2.1.2 How can the main conflicts be characterised (spatial and temporal scale)?

Limited available marine space may lead to spatial and temporal conflicts. To assess the current situation, and to identify effects on the prevailing management objectives of the implemented spatial management plan, conflicts should be characterised.

The knowledge about the character of conflicts on a spatial and temporal scale will: (i) increase the understanding of activities' interaction; (ii) identify where the conflicts stem from; and (iii) lead towards finding ways to solve conflicts by using different management approaches. There is no single tool or technique to achieve an acceptable level of knowledge about the relevant conflicts in an area of interest. In order to obtain this information, a set of different tools and techniques were applied in COEXIST. These included: a) Stakeholder Consultation (Tool 5); b) literature reviews (including the 'grey' literature and press publications); and c) application of tools (e.g. Mapping of Activities, Tool 1; Analysis of Conflict Scores, Tool 3; and GRID, Tool 4).

Case Study Illustration – Adriatic Sea Coast

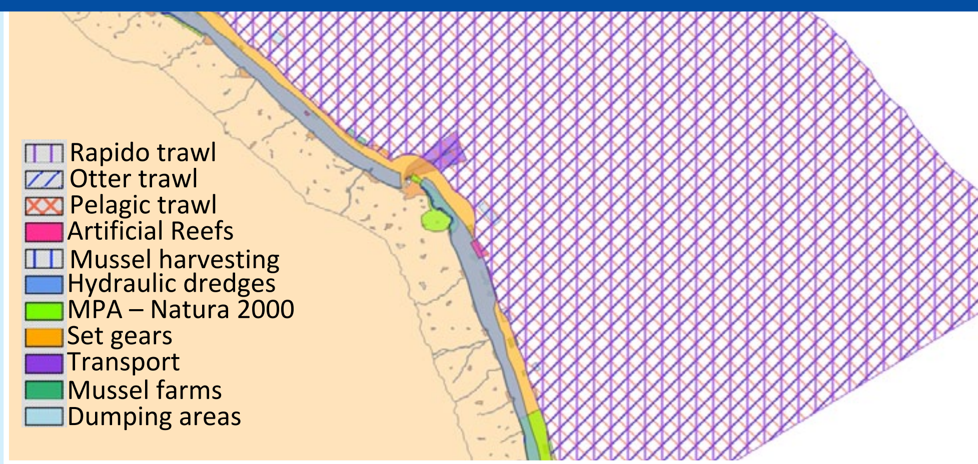


Figure 5: Map of the human activities carried out in the CS4 (Adriatic Sea Coast).

Key conflicts in the coastal area of the Adriatic Sea were derived from expert judgment, Stakeholder Consultation (Tool 5) and the application of GRID (Tool 4), which is both a web-based database and a tool for analysing interactions (conflicts and synergies) using a GIS application that analyses the spatial distribution of current and future activities and interactions.

The main conflicts in the case study were identified, taking into account two aspects:

a) Space: where two or more activities compete for the same area at sea (e.g. hydraulic dredges and gillnetters exploit the same grounds for most of the year and set gears are often damaged by hydraulic dredges).

b) Resources: when different human activities exploit the same resource (e.g. recreational fishermen often used a higher amount of set gears than the allowed and catch the same species targeted by professional fishers).

Moreover, interactions between human activities were characterised on the basis of the attributes of each activity: temporal, horizontal and vertical scales, mobility and location. All identified interactions might be strengthened by developing more effective management plans, a straight enforcement of rules (especially regarding safety issues) and the use of better technology to decrease waste production from aquaculture activities.

References: D2.1, D3.9

2.1.3 Where does or will spatial co-use occur (mapping)?

The development, implementation or adaptation of spatial management should be based on a sound knowledge base. This should comprise the available information on the spatial extension and intensity of past, current and future human activities. With the help of GIS (Mapping of Activities, Tool 1), such data can be visualised and further processed to identify spatially overlapping, or neighbouring, activities. Often activities coexist historically within a given area. However, visualisation and mapping facilitate better stakeholder communication and help to prioritise spatial management needs. Simple calculation of the spatial overlaps can also help to describe possible conflicts quantitatively.

Case Study Illustration – Coastal North Sea

A) B)

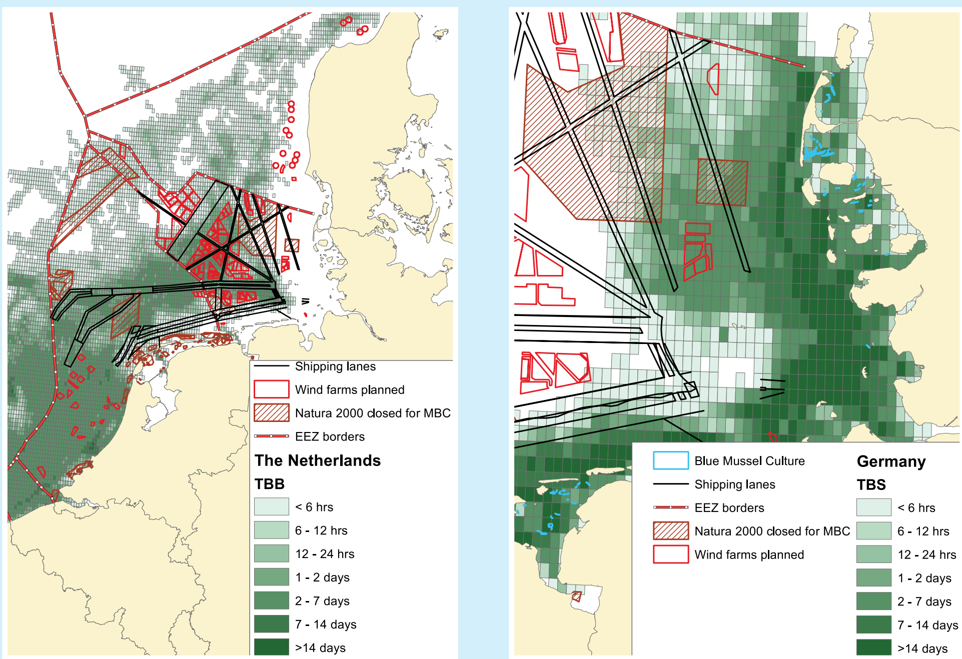


Figure 6: Fishing effort per year of two important fisheries in the CS5 (Coastal North Sea) is shown together with traffic lanes, wind farms (planned, existing, under construction) and hypothetical future management of Natura 2000 sites closed for mobile bottom contact (MBC) gears.

The Dutch fleet targeting flat fish with beam trawls (TBB; Fig. 6-A) shows high activities in the offshore areas and in the Dutch coastal zones. The effort of the German fleet targeting brown shrimp (Crangon crangon, TBS) concentrates in the coastal zones (Fig. 6-B). The maps indicate a certain spatial overlap between the future German wind farms and the Dutch fisheries, whereas the spatial overlap of the German shrimp fishery and future wind farms or Natura 2000 sites in the Exclusive Economic Zone (EEZ) is rather small. The close vicinity of German TBS effort and existing bottom mussel culture areas indicates an established coexistence within one of the Wadden Sea's national parks.

References:
D2.2, D3.2

2.1.4 What are the current legislations and objectives relevant for spatial management?

Legislation and agreements are made at different scales (international, regional, national and local) with often different overall aims and objectives. This can influence both the activities themselves as well as their spatial management. Often, legislation lower in the hierarchy specifies how the more general aims, over-arching larger-scale general laws, and agreements are to be implemented at the local scale. Typically, national and local laws specify the administrative processes and technical requirements involved in the implementation of spatial plans. Therefore, for the successful management of an area, knowledge of the laws in force there as well as knowledge of the corresponding objectives is crucial for a successful management process. An understanding of the current steering mechanisms used to implement the legislation will help to successfully alter these (if necessary), or demonstrate how to use them to reach specific objectives in spatial management. Stakeholder Consultation (Tool 5), in combination with a literature review, will give a good overview of the legislation in force in an area of interest.

Case Study Illustration – Atlantic Coast France

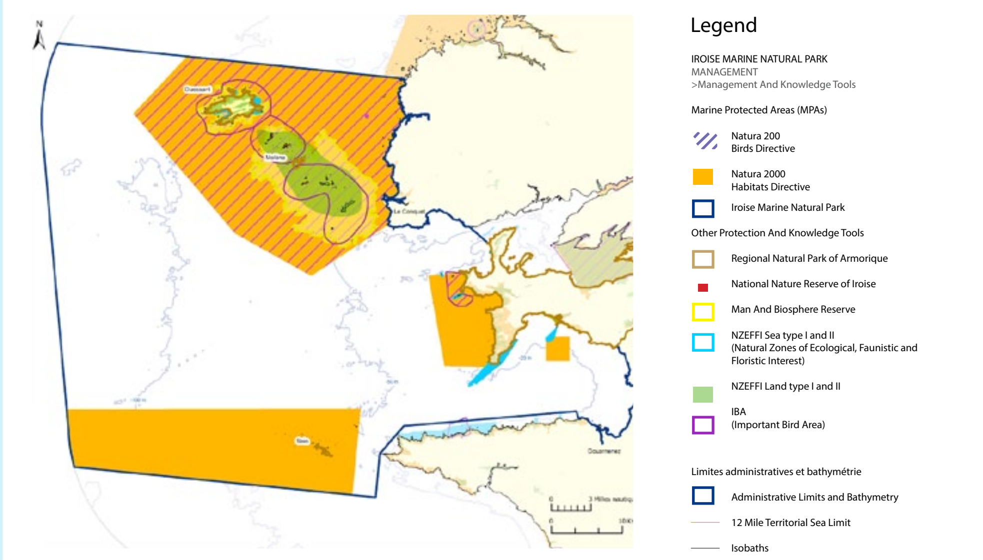


Figure 7: Main management tools in the case study CS2b (Atlantic Coast Case Study Area – France) to protect environment or to improve global knowledge. (Map credit: Agence des aires marines protégées)

Literature reviews as well as interviews undertaken with three different stakeholders were used to describe the different legislations and their objectives in this area (Atlantic Coast France, CS2b), where many levels of spatial management are in place. Some were directly linked to international legislation, such as Natura 2000 and Biosphere areas. These pieces of legislation aim to protect relevant habitats and ecosystems. Therefore, these specified areas need to be managed carefully. The development of leisure or professional activities must take into consideration the associated rules (e.g. access and also seasonal rules). Local rules have also been developed to manage the different fisheries. Seaweed and scallop fisheries operate seasonal calendars to manage both the effort and the stock biomass. Using different laws, activities are managed per number of vessels or by the limitation of fishing areas. The movements of military vessels or submarines result in spatial restrictions for other activities. All these legislations are developed to limit conflicts between activities, to ensure sustainable stock management, and to protect the environment.

References:

Deliverable D2.3 (Available on request by contacting: j.gault@ucc.ie)

2.2 Monitoring and Evaluation of Spatial Management

Monitoring and evaluation of implemented spatial management plans are essential components for effective adaptive marine management. The monitoring and evaluation of management performance should: i) demonstrate the extent to which the objectives have been achieved; ii) provide evidence-based feedback about what's working and what's not; and iii) reveal interactions between ecological components, human pressures and management efforts. Besides the monitoring and evaluation of an implemented spatial management, this theme also addresses the evaluation of future spatial management scenarios. The assessment of the potential impacts of these is crucial for policy makers, spatial planning authorities, and other stakeholders alike. In COEXIST, a set of methods and tools were applied and tested to monitor and evaluate both the existing spatial management plans and to evaluate different management options.

2.2.1 What are the impacts of spatial management measures on the identified main activities?

Determining the impact of spatial management measures is crucial to any manager who needs to decide which management option to implement. There is no single tool capable of answering this question. Thus a careful selection of the tools available to elucidate the effect of management options on the activities of interest is needed. A first step is the Consultation of Stakeholders (Tool 5), often experts in their own area of activity. A second step could then be the use of tools such as the Analysis of Stress Levels and Conflict Scores, and/or the use of FISHRENT (Tools 2, 3 and 6, respectively). Additionally the application of the WP4 evaluation framework (Stakeholder Preferences, Tool 10; Effect Table, Tool 11; and Multi Criteria Analysis, Tool 12) is also recommended.

Case Study Illustration – Atlantic Coast Ireland

COEXIST CONFLICTS AND BENEFICIAL RELATIONSHIPS

CS2a= South Irish Sea (no. of respondents=6)

83% of respondents were aware of conflicts

Conflicts

What are the causes of the current conflict?

Spatial conflict: conflict is between pots (whelk) and mussel dredgers, pots (lobster and crab) and scallop dredgers and pots (lobster and crab) and herring trawlers.

Lack of accountability: conflict arises from a lack of direct co-ordinated state accountability by lead departments/agencies when an issue/conflict arises.

Lack of planning: developer-led planning, inadequate regulation and lack of proper political oversight.

How can current conflict be resolved?

ICZM: better communication between sectors; state and stakeholder involvement.

Foreshore licensing changes: need for independent review of foreshore leases granted and progressed, and a robust Strategic Environmental Assessment, unconstrained by foreshore leases already granted and in the pipeline.

Figure 8: Stakeholder consultation responses to specific questions on conflicts and solutions in the CS2a (Atlantic Coast Case Study Area – Ireland).

Experts were asked how activities were currently managed in terms of spatial management measures, relevant legislation and decision-making processes through Stakeholder Consultation (Tool 5). This provided in-depth information on all aspects of governance. Responses received indicate that interactions between mussel dredging and other activities are not currently covered by the existing legal framework. Activities tend to be regulated under legislation that is not suitable and responsibility for the foreshore is divided between government departments. There is no overarching MSP or ICZM framework in place, though this is expected to change in late 2013. Management authorities interact with each other in a fragmented way. There is a clear division of responsibility up to a point: feedback from stakeholders indicates that management bodies are happy to let stakeholders resolve issues themselves in the absence of a strong management framework. Stakeholder Consultation is flexible and can be designed to fit any purpose.

References:

Deliverable D2.3 (Available on request by contacting: j.gault@ucc.ie)

2.2.2 How can the main conflicts and opportunities be quantified and different management options be assessed?

Evaluating current and future spatial management options is crucial for policy makers, spatial planning authorities, and other stakeholders alike. However, the evaluation and description of conflicts can be biased by the perception, information or the interest of a consulted person (e.g. expert, lobbyist). Therefore, a reproducible and transparent approach characterising spatial conflicts will help to determine which conflicts need to be actively managed and, if so, how urgently. Whereas some knowledge of existing conflicts might be gained from dealing with stakeholders, the comparison of multiple management options and their potential conflicts is often a complex task. However, small-scale management options can provide possible solutions for organising co-uses within an area with multiple activities. A transparent approach to evaluate spatial conflicts and counterbalance them with possible synergies is the Analysis of Conflict Scores (Tool 3), which is implemented in the web-based GRID (Tool 4).

Case Study Illustration – Adriatic Sea Coast

A)

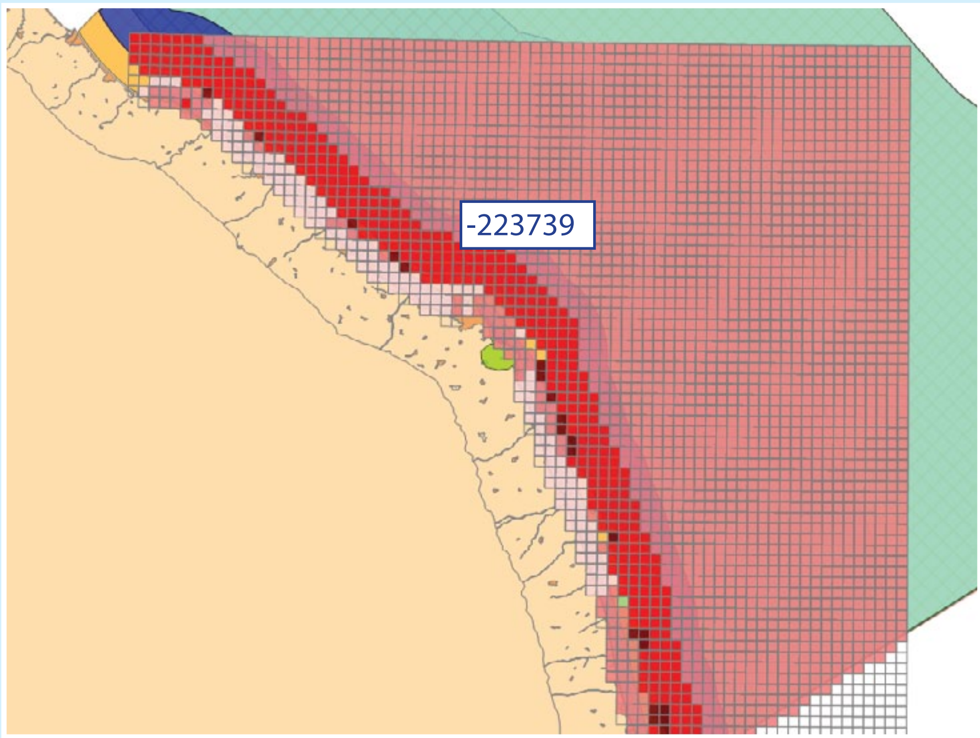
	CABLEP	OGEXTR	SET_GEAR	OTB_DEF	PTM_SPF	TBB_DEF	DRB_MOL	HHM_MOL	Artificial reef	NAT_CON	REF_BEACH
LGLINE_MO_sE	5	5	5	5	5	5	2	0	3	6	0
CABLEP		3	6	6	6	6	6	6	6	6	0
OGEXTR			5	5	5	5	5	0	0	6	0
SET_GEAR				4	4	4	4	4	3	0	0
OTB_DEF					2	2	2	0	5	6	0
PTM_SPF						2			5	6	0
TBB_DEF							2	0	5	6	0
DRB_DEF								0	5	6	0
HHM_MOL									3	0	0
Artificial Reef										3	0
NAT_CON											3

A: Interaction matrix of human activities in the CS4 (Adriatic Sea Coast)

Case Study Illustration – Adriatic Sea Coast
continued on next page

Case Study Illustration – Adriatic Sea Coast (continued)

B)



B: Sum of conflict scores in the CS4 (Adriatic Sea Coast)

Figure 9: Assessment of interactions and conflicts.

Conflict scores were calculated (see also Tool 3) and the assessment of management measures were performed using GRID (Tool 4). Rules were defined to calculate the relative conflict potential between two or more spatially overlapping activities, such as fisheries and aggregate extraction, or any other spatially distributed activity. The relative spatial conflict scores can be seen in Fig. 9-A and ranged from 2 to 6. The GRID GIS allows the visualisation of the areas where two activities overlap with the corresponding conflict score.

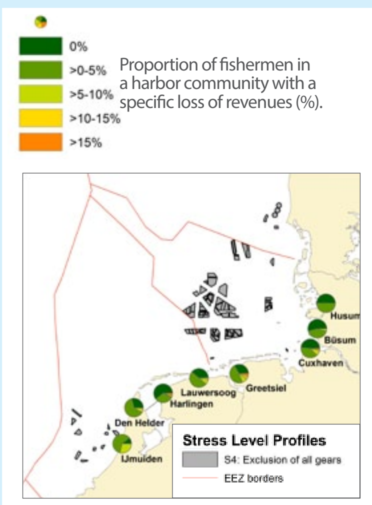
By selecting more than two activities, it is possible to visualise the total conflict score in the study area. Subdividing the area according to a grid enables the planning authority to calculate the sum of conflict scores (Fig. 9-B) for each cell.

References:
Deliverable D3.9

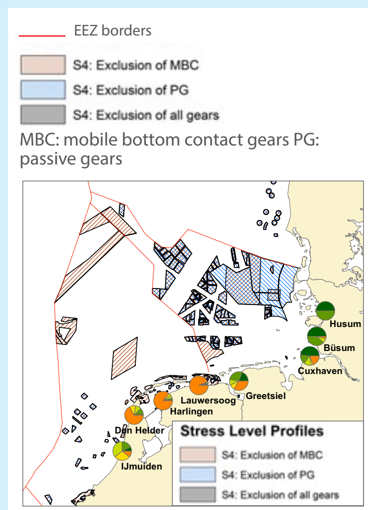
2.2.3 How would different spatial management options impact fisheries revenues?

The economic outcome of different management options is often crucial information, on the basis of which managers may decide which management option to choose from. Estimating industry and social wellbeing and how to counterbalance these is often very difficult due to lack of available data and/or resources. Therefore, a simple approach to calculate the stress for a specific industry that may result from changes in the spatial extent of a competing activity (either through a shift in policy or internal adjustment) was developed in COEXIST. The concept of Individual Stress Level Analysis (Tool 2) allows an estimation of impact of spatial management options by using data on the past spatial distribution of an activity. In principle, depending on the available data, many economical (i.e. profits, revenues), ecological (habitat losses) and social aspects (people employed, food produced) could be tested with this approach. In COEXIST different scenarios were tested by comparing the "spatial losses" of individual fishermen in terms of revenues.

Case Study Illustration – Coastal North Sea Individual Stress Level Analysis (ISLA)



Scenario 2: 50% of planned wind farms being built



Scenario 4: 100% of planned wind farms being built and hypothetical fisheries management in Natura 2000 areas

Figure 10: Simplified profiles of Individual Stress Levels (ISL) per revenue for selected harbours of the CS5 (Coastal North Sea). Two of five tested different scenarios are on display.

In this case study, five scenarios according to the designated Natura 2000 sites and approval processes of wind farms, were developed and tested for their impact on the fishing fleets of the Netherlands and Germany. The Individual Stress Level Analysis (ISLA, Tool 2) reveals that North Sea fishermen are likely to suffer cumulative losses from wind farms and Natura 2000 sites. Further, the Dutch and German fleets will be affected differently. In scenario four in Lauwersoog (NL) more than 90% of the vessels with mobile bottom contact (MBC, e.g. beam trawls) or passive gear (PG, e.g. gill nets) will lose fishing grounds, from which more than 15% of revenues were previously gained. In contrast, in Husum (DE) about 50% of the German vessels will lose fishing grounds from which less than 5% of revenues were gained.

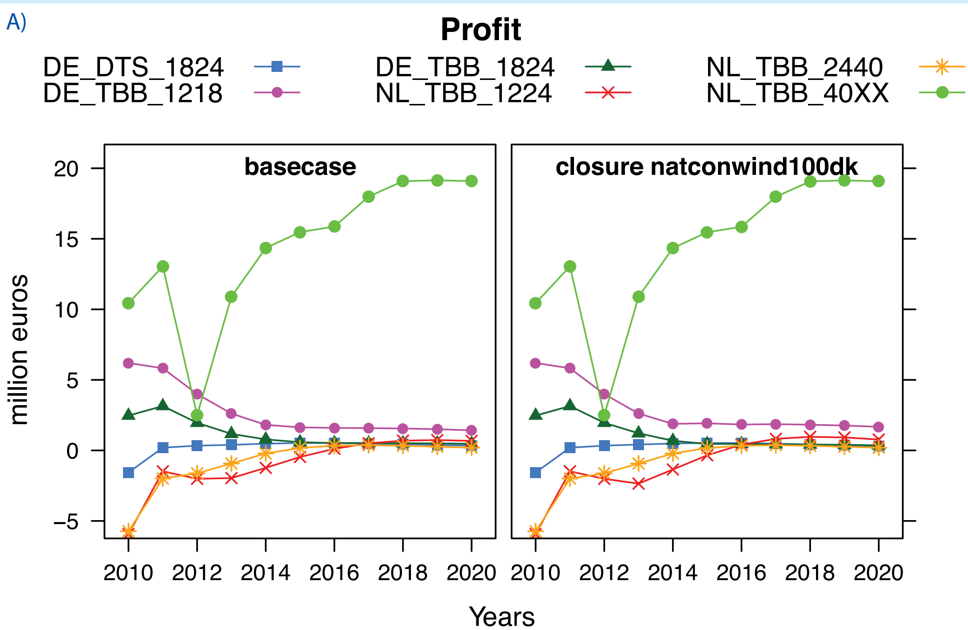
References: Deliverable D3.2

2.2.4 How would different spatial management options and prices (fuel, products) impact fisheries economics at segment resolution?

The assessment of economic impacts of potential management options is often key information in a decision-making process. For instance, the predicted economic impact of a certain management option will give the first indication of how the fishing community will respond to its implementation. Simple approaches can often evaluate single aspects of any such evaluation, e.g. the viability of a particular fishery, whereas bio-economic models have the potential to account for multiple effects and analyse complex systems. In COEXIST, a spatially resolved bio-economic model was developed and applied in the CS Coastal North Sea (FISHRENT, Tool 6). Using FISHRENT enables the planning authority to analyse both the economic and ecological effects of spatial management options on fleet segments.

Case Study Illustration – Coastal North Sea

A)

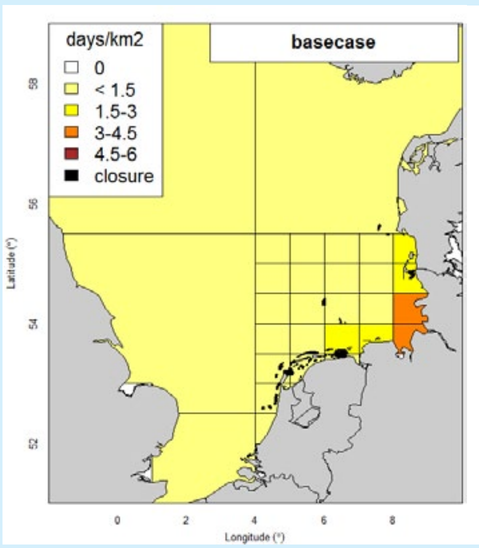


Profit of fleet segments defined by country (DE: Germany, NL: The Netherlands), the main gear operated (TBB: beam trawl, DTS: demersal trawl and seine) and the size category of the vessels in metres (1824: 18 to 24m, 2440: 24 to 40m, 40XX: larger than 40m).

Case Study Illustration – Coastal North Sea
continued on next page

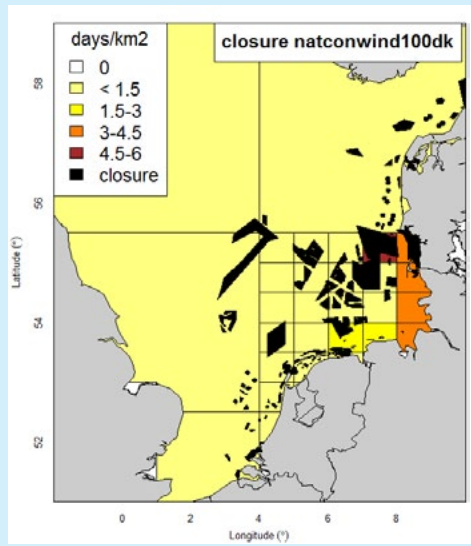
Case Study Illustration – Coastal North Sea (continued)

B)



Fishing effort in 2020. Basecase: no areas closed for fisheries.

C)



Fishing effort in 2020. Scenario 5 (Closure Natconwind100dk): 100% of planned wind farms being built, hypothetical fisheries management in Natura 2000 areas (including all fishing banned in the Danish designated Natura 2000 areas).

Figure 11: Profit of fleet segments (A) and fishing effort of two scenarios (B, C).

Profit per fleet segment obtained using FISHRENT (Fig. 11-A) under two different spatial management regimes (basecase [no closures] and one of five CO-EXIST scenarios, i.e. scenario 5) show that closures would have a limited impact on the profitability of fishing segments in the North Sea. The differences observed are mainly due to the entry and exit of vessels that are conditioned by the average profitability of the fleet segment and the conservation of a minimum level of effort per vessel. Because the closures are small compared to the total fishing area (North Sea) and we assume that biomass is homogenously distributed within an area, fishers still have access to enough biomass to cover their catch (Fig. 11-B & C). However, open areas become crowded.

References:

D3.3, D4.2 (Available on request by contacting the COEXIST Case Study Leader)

2.2.5 Who are the relevant stakeholders and what are their opinions regarding conflicts and opportunities of current and future activities?

Activities are conducted by several different individuals, groups of people or companies. Furthermore, some activities are managed by official authorities or within a group of companies or by NGOs. Whereas some of these stakeholders have major powers to influence policy and legislation, others feel they have limited or no powers to do so. However, the knowledge of the relevant stakeholders is crucial to the dissemination of information and to help to start dialogues to search for solutions in case of conflicts, and to indicate synergies.

By applying a set of tools and techniques a sound picture of the stakeholder landscape can be gained:

- Mapping of Activities (Tool 1)
- Searching for companies, authorities or NGOs performing or managing these activities
- Searching literature and press for stakeholders
- See lists of attendances of conferences and hearings
- Consulting known stakeholders to indicate other stakeholders and to indicate relevant/"powerful" stakeholders (Tool 5)

"The input of stakeholders is critical to determining the likely value and capacity of the system… The stakeholders are the ones living and working in the system and their observations are valuable to informing and improving science. Improved science informs better management"- quote from government agency respondent (D2.1). Whereas some stakeholders report one conflict being extremely intense, others evaluate the same as not being existent. The same is true for synergies between activities in the same area. However, stakeholders are often much closer to the community and have insider knowledge which is often not accessible to the managers or scientists. Therefore, a trustworthy relationship between managers and stakeholders might be the key to gain the necessary knowledge. However, the possibility of biased information given by stakeholders to achieve certain goals also needs some consideration.

In summary, Stakeholder Consultation in various forms (from one-to-one conversations to online questionnaires) can increase the knowledge to perform optimised management of an area.

Case Study Illustration – Algarve Coast

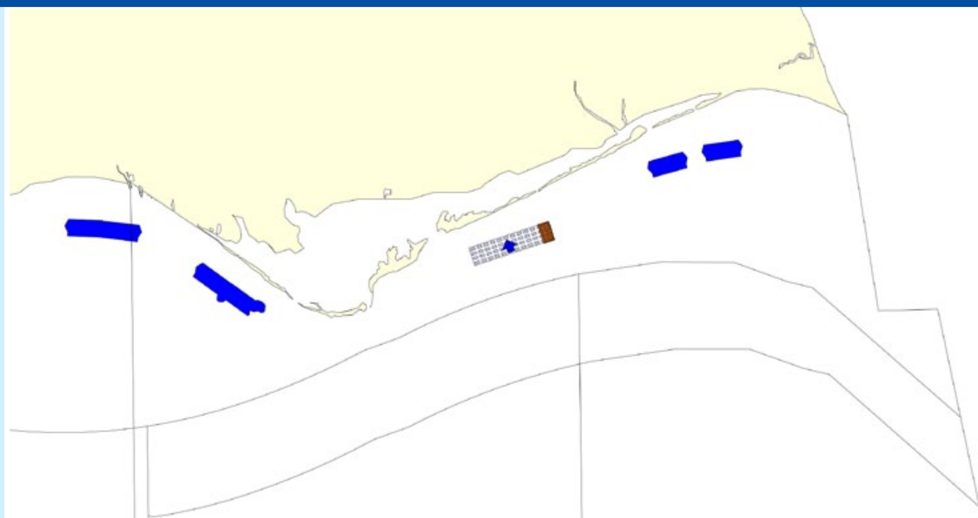


Figure 12: Current situation at the CS3 (Algarve Coast). Blue polygons represent artificial reef areas, with the rectangular grid-box representing the offshore aquaculture area.

The main stakeholders in the Algarve case study were drawn from the following sectors: fishing, aquaculture, tourism, energy, NGOs (environmental, producers and others), local authorities (municipalities), and the scientific community.

The fishing sector's point of view is usually proactive when considering the development of artificial reefs (blue polygons in Fig. 12) since the presence of artificial reefs enhances fisheries. However, some respondents were reticent about the development of offshore aquaculture (rectangular grid-box). Some sections of the tourism sector could benefit from fish products available (e.g. hotels, restaurants), whilst others may perceive some aspects of fisheries and aquaculture as competitors for coastal space. NGOs cover a wide range of different interests and can be either more environmentally- or production-oriented. Local authorities view the enhancement of artificial reefs or offshore aquaculture areas as an opportunity for local development.

References: D2.1

2.2.6 What are the stakeholders' opinions regarding the achievement of management objectives and which objectives are relatively more important to the different stakeholders?

Stakeholders are expected to have different opinions about which objectives they find most important. An advantage of involving stakeholders in the analysis is that differences in stakeholder preference become clear, and potential areas of disagreement can be identified. Many different stakeholders are affected by marine spatial management, and different opinions related to the importance of different management impacts form a potential source of conflict. Successful management for one stakeholder may have negative connotations for others. Identifying the relative importance of the different types of outcomes of any management option to different stakeholders is therefore important when attempting to develop a solution acceptable to the differing groups.

Please note that the results in D4.2 were produced in the process of developing and testing a method. They are highly dependent on the context and the preferences of the stakeholders involved. At the present stage they are not applicable as a basis for policy-making (Stakeholder Preferences, Tool 10).

Case Study Illustration – Atlantic Coast Ireland

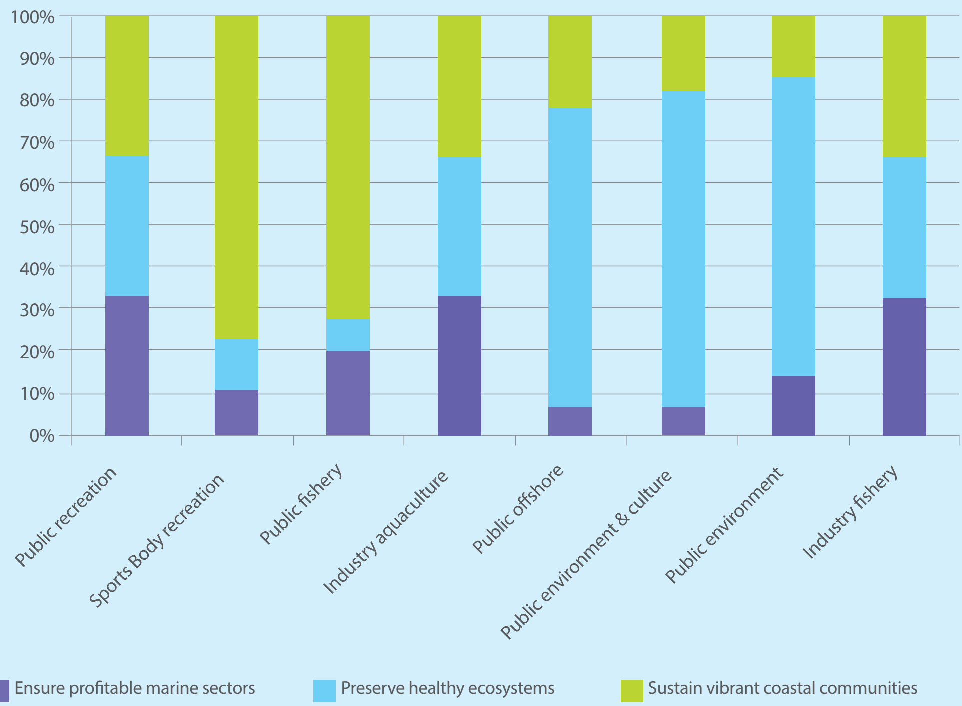


Figure 13: Graph showing the results from the questionnaire survey with respect to economic, social and environmental objectives (each bar corresponds to an individual respondent).

A total of eight stakeholders completed an online questionnaire to indicate their preferences concerning management objectives for the Irish case study area with respect to the following economic, societal and ecological objectives, namely: (i) ensuring profitable marine sectors; (ii) preserving healthy ecosystems; and (iii) sustaining vibrant coastal communities. Respondents included representatives from industry, private representatives and the public, representing the following sectors: aquaculture, fisheries, environmental conservation, cultural heritage, offshore energy, planning, recreation and tourism. Across the sectors, preserving healthy ecosystems and sustaining vibrant coastal communities were, on average, of equal importance whilst ensuring profitable marine sectors was deemed much less important. Further analysis (not shown) was conducted under sub-sectors for each of the three objectives and considered the following aspects: (i) increase competitiveness, reduce conflicts, improve infrastructure; (ii) water quality, stock health and biodiversity; and (iii) cultural heritage, renewable energy, recreation, employment, climate change and food security.

References:

D4.2 CS2a (Atlantic Coast – Ireland) (Available on request by contacting: j.gault@ucc.ie)

2.2.7 How would different management scenarios impact relevant management objectives?

For the planning of a new policy, the effectiveness of different management scenarios can be evaluated in relation to the present policy. The relevant management objectives that support the new marine policy can be identified through a process involving the stakeholders. The possible marine management options may be suggested by stakeholders, authorities or researchers. These are then to be evaluated regarding their effectiveness in relation to the relevant objectives. This process includes cross-tabling the management scenarios, together with the objectives, and their subsequent evaluation by an expert group. The created table (Effect Table, Tool 11) shows which management scenarios are more or less effective compared with the policy employed so far (e.g. indicated by green and red, respectively, in Tab. 2). In this way the most appropriate management strategies can be more easily located.

Please note that the results in D4.2 (including Tab. 2) were produced in the process of developing and testing a method. They are highly dependent on the context, the experts and the stakeholders involved. At the present stage they are not applicable as a basis for policy-making.

Case Study Illustration – Baltic Sea

Objectives \ Management scenarios	Nutrient recycling by Baltic Sea feed	Net loading by removal of less valuable fish	Governance collaboration across sectors (increasing coherence)	Eco-(etc.) labels	Organic Production (labels)	Fishers' and fish farmers' access to privately owned waters	Fishery (market-driven, ITQ,etc.) regulation	Aquaculture regulation (taxes, subsidies, emissions trading, etc.)	Offshore farming	Water recirculation farming
Economic objective	green	green	green	red	red	green	green	green	green	
Reduce governmental support	green	green	red				green	green		
Increase governmental support for fisheries/aquaculture	green	green	red	green	green	green	green	green	green	green
Expand space for recreational use	red	red				red	red	red	green	
Ecological objective	green	green	green	green	green		red	red	green	green
Protect biological resources	green	green		green	green		red	red	green	green
Avoid ecological catastrophes	red	red	green					red		
Protect birds and sea mammals	red	red	green			red		red		
Social and cultural objective	green	green	green		green	green	red	red	red	red
Ensure working opportunities	red	red				green			red	red
Ensure recreation	red	red								red
Avoid externalities from industries			red	green					red	red
Preserve landscapes	red	red				red			green	
Preserve archaeological, cultural and identity aspects	red	red							red	red

Table 2: Effect table showing the results of an assessment of management scenarios with respect to identified economic, ecological and social objectives by a total of 10 experts in Finland. Whereas white is judged as 'no impact' compared with present, green is judged as 'positive impact' and red indicates 'negative impact' compared with present.

In the Finnish case study, 10 management options were evaluated according to their effect on the economic, ecologic, and social/cultural objectives. Whereas most options will have a positive effect on the economic objectives it seems that many of the social and cultural objectives are not met (except working opportunities). All of the tested management options have positive and negative impacts on the objectives, indicating an always existing trade-off between specific objectives. This underlines the need for a transparent documentation and discussion of this outcome during the decision processes in management.

References

D4.2 – CS6 (Baltic Sea) (Available on request by contacting: Timo.Makinen@rktl.fi)

2.2.8 What is the relative effectiveness of spatial management, given effects and stakeholder preferences?

Central to effectiveness measurements of marine spatial management are assessments of long-term impacts on natural resources as well as risk assessments on the people who depend on them. The need to evaluate effectiveness is not limited to marine spatial area evaluation, rather it is developed as an approach to a wider notion of marine spatial management aiming to improve the effectiveness of management efforts and related human resource allocation. Any likely closures, such as possible future Natura 2000 areas, as well as wind parks, are central to the analysis which aggregates effects and weights to find a relative ranking value of the different scenarios (Multi Criteria Analysis, Tool 12, the highest ranking value on the stacked bar graph (Fig. 14) is the most effective one).

Please note that the results in D4.2 (Fig. 14) were produced in the process of developing and testing a method. They are highly dependent on the context, the experts and the stakeholders involved. At the present stage they are not applicable as a basis for policy-making.

Case Study Illustration – Hardangerfjord

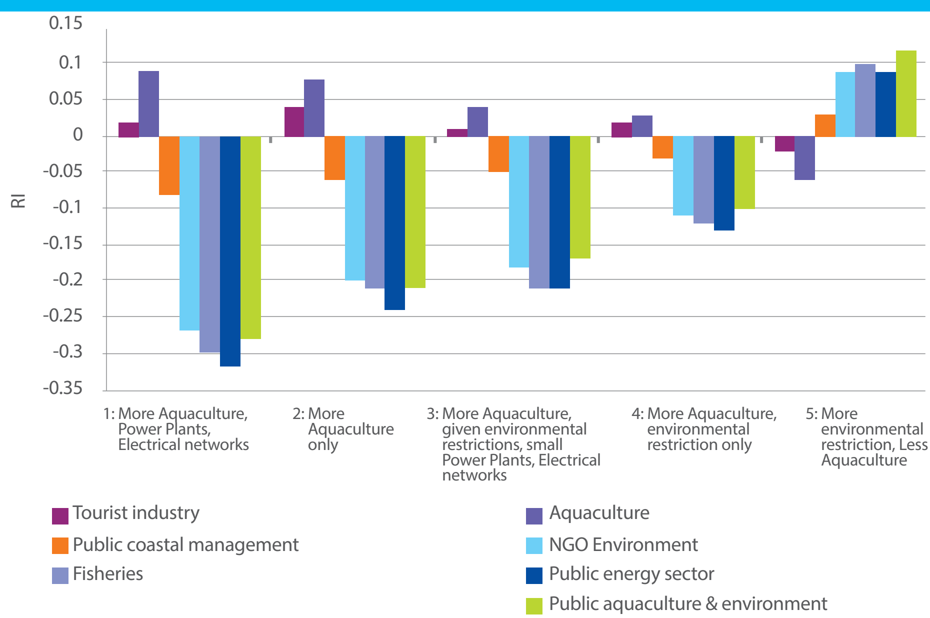


Figure 14: Ranking index (RI) of five scenarios according to the effects set in the multi criteria analysis.

In the Hardangerfjord the five tested scenarios were constructed in two dimensions.

First dimension: a) more aquaculture, b) more aquaculture, but with stronger environmental restrictions, or c) no growth in aquaculture.

Second dimension: increased building of the electric web and many new small-scale hydroelectric power plants. The results indicate that most respondents considered the development of aquaculture as well as building of electric cables and hydroelectric power plants as positive (except the aquaculture and tourism industries), but negative for all other users of the area. The only alternative that featured reduced aquaculture and no new hydroelectric development was considered to be positive for other users but negative for the aquaculture and tourism industries.

References

D4.2 – CS1 (Hardangerfjord) (Available on request by contacting: oivind.bergh@imr.no)

2.3 Integration of aquaculture, fisheries and other sectors

Integrated ecosystem-based management aims to promote sustainable development and healthy ecosystems by optimally organising human activities in space and time. Possible consequences of the development, implementation or adaptation of marine sectors need to be studied in advance, using the best available information regarding their spatial extent as well as their intensity. Aquaculture is one of the fastest growing segments, therefore the following facts should be considered. Water quality is often critical to the success of an aquaculture operation. Extensive research regarding the local conditions in the study area and the key environmental variables for the planned aquaculture operation have to be conducted. From this, the parameters for the targeted species can be generated by taking into account the relationship between the spatial distribution of the species and important environmental variables. However, it also has to be taken into consideration that an aquaculture operation can constitute a risk to its environment. For instance, disease problems may affect wild populations as well as result in economic losses for the aquaculture operator. Using medicines (including antibiotics) and other chemicals (e.g. biocides and antifouling compounds) in an irresponsible way may further result in environmental impacts. Additionally, aquaculture can pose a conflict with fisheries regarding space issues. As spatial conflicts do not necessarily result in problems (e.g. spatial multi-use of wind farms is a possibility) and, to a certain extent, may support each other (aquaculture, commercial fishing and even recreational fishing may provide common employment and service sector opportunities), possible synergies need to be considered as well. As COEXIST had a particular focus on the aquaculture sector, these issues have been addressed by the selected management questions.

2.3.1 What are the relevant parameters for certain aquaculture species and what sites are suitable for aquaculture?

A range of important water quality and hydrographic information (seasonal temperature, dissolved oxygen levels and salinity profiles, water depth, winds and currents, tidal ranges and flows, phytoplankton indices, etc.) are crucial indicators for the success of an aquaculture activity in a given area. Therefore, the regional development of aquaculture requires an insight into in relevant water quality parameters for the area. These can be obtained from an extensive literature research, questionnaires to relevant stakeholders (fishery sector) or by relevant monitoring programmes. Collected data from a given area can then be analysed (taking into account the relationship between the spatial distribution of the species and important environmental variables) and an area's suitability for a targeted species can then be evaluated.

Creating Suitability Maps (Tool 9) for aquaculture allows for better stakeholder communication and facilitates the management process. For most of the species, water quality, salinity, temperature, and oxygen are the most relevant key parameters. Furthermore, for e.g. shellfish production, food condition (primary production and phytoplankton composition) also has to be taken into account. Changes in the water temperature will also affect growth and reproduction, for example, as has been observed in the European whitefish.

Case Study Illustration – Baltic Sea

Suitability areas for cultivation of European whitefish (Coregonus lavaretus)

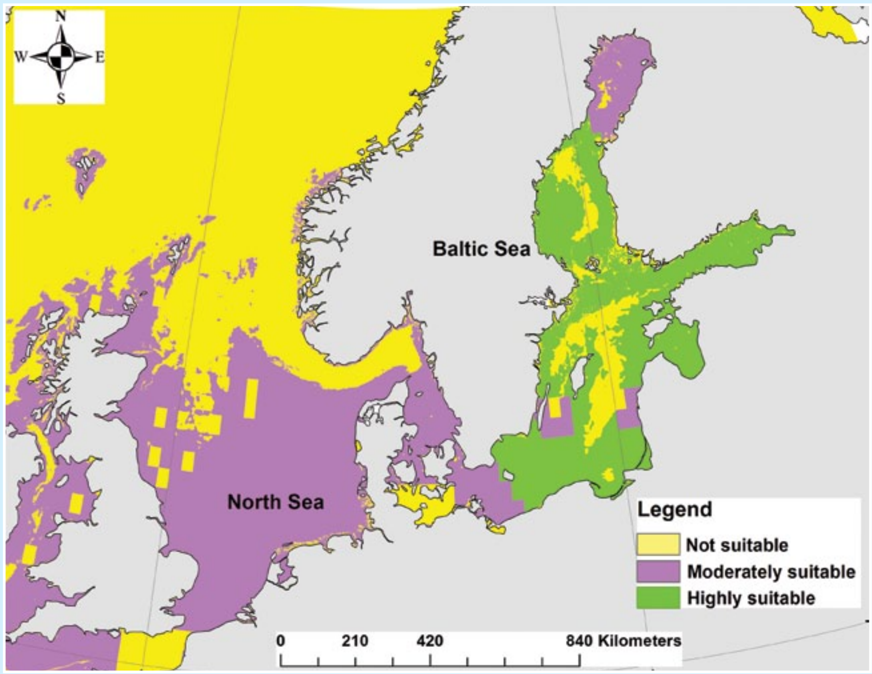


Figure 15: Importance of water salinity for cultivation of European whitefish (Coregonus lavaretus).

Relevant physical and biological parameters are used to determine in a first instance an area's suitability for a given species (Suitability Maps, Tool 9). This figure shows highly suitable areas (green) for the cultivation of European whitefish. As indicated on the map, suitable areas are found in areas of low salinity like in the Eastern Baltic. After this rather coarse assessment a more detailed analysis can be conducted at finer resolutions within selected areas.

References

D1.1

2.3.2 What is the cultured species' vulnerability to potential diseases?

Ensuring high quality aquaculture systems means to rank the biology of the cultured species first, followed by environmental factors. Hence, the species' vulnerability to potential diseases has to be part of an extensive research during the planning process. Quantitative and qualitative data on the planned aquaculture activity have to be understood in order to maintain the health of the cultured organisms but also of the wild stocks.

To gain rapid diagnoses of farm management measures for diseases and to use an approach supported by robust science, the tool FISHNETS (Tool 13, not tested yet) could be particularly suitable. The tool also supports the aquaculture site selection process as well as providing recommendations to determine the optimal culture practice. Therefore, FISHNETS can be used in three steps: (1) site selection; (2) risk rating; and (3) spotting optimal culture practice.

Case Study Illustration – Hardangerfjord

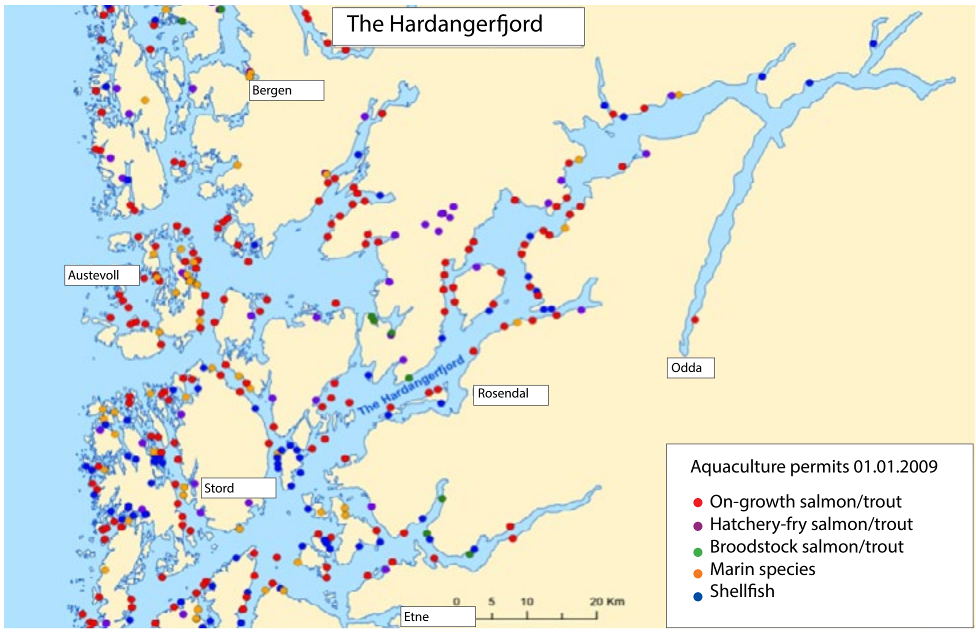


Figure 16: Location and target species of aquaculture enterprises in CS1 (Hardangerfjord).

Despite the overall disease situation in salmon, farming in Norway is good. However, some diseases are not controlled efficiently. In particular, salmon lice produced in farms may cause problems for wild salmonids, and other parasites may be abundant too. Also, viral diseases in Atlantic salmon give rise to concern, particularly Infectious Salmon Anaemia Virus (ISAV) and Salmonid Alphavirus (SAV), which are causing mortalities in farms and could potentially spread to wild fish stocks. Bacterial diseases of salmon are generally well-controlled by vaccines and the consumption of antibiotics is now negligible. No vaccine is yet available for salmon lice, and vaccines against viral diseases are not as effective as those against bacterial diseases. Mandatory following and synchronised delousing campaigns are used to keep environmental concentrations of pathogens low.

References
D2.1, D3.6

2.3.3 What is the optimal aquaculture practice?

Balancing protection of the marine environment with the sustainable development of economic activities are the most important objectives of an ecosystem-based marine management approach. It is necessary to take these objectives into account when defining optimal aquaculture practices. To ensure the optimal aquaculture system, the biology as well as the sensitivity of potential culture species must be considered. A knowledge base concerning these factors accelerates the process of identifying the best aquaculture practice.

FARM (Tool 7) and Detailed Ecosystem Models (Tool 8) can be used to support Integrated Multi-Trophic Aquaculture (IMTA) systems.

Case Study Illustration – Atlantic Coast Area - France

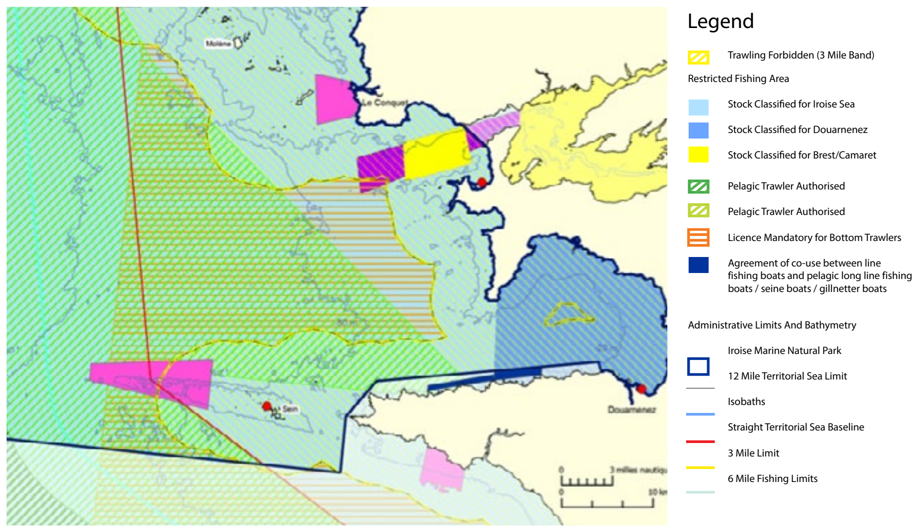


Figure 17: Location of the different areas where the production activities are developed as fishing and aquaculture.

In case study CS2b, the main aquaculture activities are linked to mussel and oyster production in the bay of Brest. All the potential locations are fully utilised for these production systems. Currently, predation due to seabream (Sparus aurata) can cause losses every year from the summer to the end of autumn. Seabass and seaweed aquaculture also exist on a smaller scale. The oceanographic characteristics of the area out of the Bay of Brest in the Iroise Sea may favour the expanded development of seaweed culture there. Many local projects want to promote this production, with the aims of producing seaweed for human consumption, 'blue' chemistry (the aim is to replace some petrol molecules), organic agriculture treatments and human medicine. To develop seaweed aquaculture, studies need to be carried out to select the right areas. Environmental parameters tend to be the most critical factors in successful production systems. In the future, FARM (Tool 7) will be useful in the case of algoculture development.

References

D1.1, D2.1

2.3.4 What are the production levels and economic revenues for aquaculture (carrying capacity including IMTA)?

An ecosystem approach to marine spatial management integrates ecological, social, and economic interests. As the promotion of sustainable development is one of the most important management objectives, aquaculture is often supported, as it creates added economic value. Proactive management should therefore consider the environmental, social, and economic sustainability of aquaculture.

This creates a need to optimise production levels, environmental effects, and profit for specific aquaculture types, i.e. to determine both carrying capacity and aid in effective site selection. The FARM model (Tool 7) allows a farm-scale evaluation of sustainability in both monoculture and Integrated Multi-Trophic Aquaculture (IMTA) systems, i.e. for finfish, shellfish, and seaweeds. As a complement, Detailed Ecosystem Models, e.g. EcoWin2000 (Tool 8) may be used to assess system-scale carrying capacity for aquaculture. Arguably, for policy development, this should precede a more detailed local-scale analysis.

Case Study Illustration – Algarve Coast

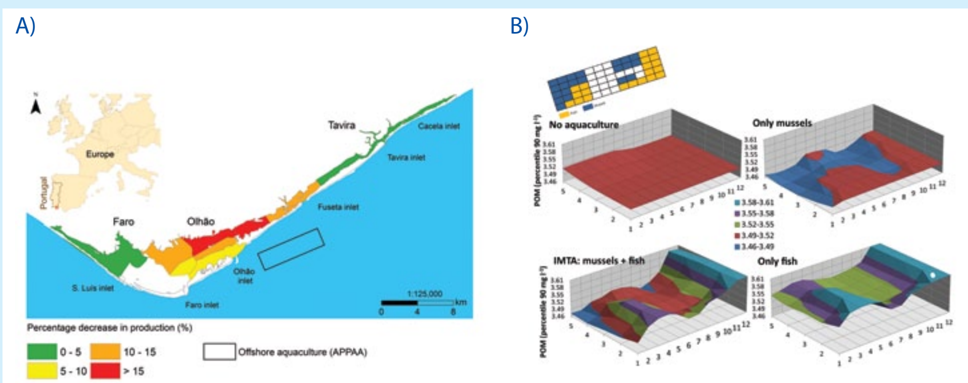


Figure 18: A) Armona Pilot Aquaculture Production Area (APPAA), Ria Formosa, Portugal, and change in clam production in the lagoon with the addition of mussel culture in the APPAA; B) Food availability as POM in the APPAA with the mussel and seabream culture combinations.

Various IMTA scenarios were tested in the southwest European area (Fig.18-A) in order to compare: i) production levels; ii) economic revenue; and iii) environmental impact of different species combinations and spatial distribution. Tools 7 (FARM scale model) and 8 (EcoWin2000 ecological model) were used for this purpose. Ecosystem services and bioremediation performed by bivalves in an IMTA scenario are shown in Fig. 18-B: Organic waste from offshore finfish culture is reduced by the mussels, simultaneously increasing the harvestable biomass and nutrient bioextraction. Finally, the impact due to food competition of offshore mussel aquaculture on the production of lagoon clams is shown in Fig. 18-A.

References
D3.4, D3.7

3. Tools

3.1.1 Tool 1: Mapping of Activities (past, present, future)

This tool uses GIS software to analyse and visualise information on the location of the current and planned activities. It addresses the questions 'Do overlapping activities exist?', 'Where to expect conflicts?' and 'How does a specific management result in a change of conflicts?'

General requirements:
Mapping requires the use of GIS-Software (e.g. ESRI, Post-GIS, Mapviewer, R) and the collation and storage of spatially resolved data in a standardised geodatabase. This involves communication with the respective data holders. In cases where spatial data are not available, stakeholder information needs to be converted into a digital format.

Strength:
Easy to understand, at first glance; any spatial resolution can be displayed (depending on the data).

Weakness:
No elaborated analysis. In areas of interest which are managed by different national or even international agencies the information might be very difficult to procure. The processing of different formats and joining the data in one analysis is labour intensive and requires a significant amount of software skills.

Costs:
0-10,000€ for software; days to weeks to gather information, combine shapes and make analysis; weeks of training courses for personnel.

Skills needed to operate the tool:
Software (GIS) and programming skills.

Operators and level of expertise required:
Research institutes, engineering consultants; medium to high.

References:
D2.2, D3.2

ESRI 2010. ArcGIS Desktop 10, Service Pack 3: Redlands, CA: Environmental Systems Research Institute, Inc.

Hintzen, N. T., Bastardie, F., Beare, D., Piet, G. J., Ulrich, C., Deporte, N., Egekvist, J., and Degel, H., 2012. VMStools: Open-source software for the processing, analysis and visualisation of fisheries logbook and VMS data. Fish. Res. 115:31-43.

VMStools: http://code.google.com/p/vmstools/

3.1.2 Tool 2: Individual Stress Level Analysis (ISLA)

This tool quantifies the impact on the activity of interest by future activities in terms of losses of parameters of interest while using R software (revenues, jobs, etc.)

General requirements:
R (SAS). Input data: spatial information on existing (including parameter of interest) and future activities, e.g. Fisheries (VMS; logbook & Landing data), Windfarms/Turbines (position, MW produced), aquaculture production, jobs, etc.

Strength:
Easy to understand, first analysis of future situation; test of cumulative spatial stressors; high spatial resolution.

Weakness:
No estimate of profit losses, compensations are not considered, only analysis of past situation with future plans; no modelling of future.

Costs:
0€ for R software; ~10,000€ for SAS software.

Skills needed to operate the tool:
Software and programming skills; weeks of training.

Operators and level of expertise required:
Research institutes, engineering consultants; medium to high.

References:
D3.2

Hintzen, N. T., Bastardie, F., Beare, D., Piet, G. J., Ulrich, C., Deporte, N., Egekvist, J., and Degel, H., 2012. VMStools: Open-source software for the processing, analysis and visualisation of fisheries logbook and VMS data. Fish. Res. 115:31-43.

VMStools: http://code.google.com/p/vmstools/

3.1.3 Tool 3: Analysis of Conflict Scores

This tool allows a (semi-)quantitative conflict analysis and can answer some questions such as how does the conflict score change with management options or did a changed management result in a change of conflicts? It uses spread sheet programs and is based on expert judgement rather than data.

General requirements:
Spreadsheet applications (Microsoft Excel or Access; OpenOffice Calc), with diagram and table outputs. No data needed, but good knowledge about activity traits.

Strength:
Transparent & reproducible approach to analyse expert knowledge.

Weakness:
Based just on expert knowledge rather than on data.

Costs:
0-1000€ for software.

Skills needed to operate the tool:
Software skills.

Operators and level of expertise required:
Industry, NGOs, governmental agencies; simple.

References:
D3.9

Conflict Scores Excel sheet on project website

3.1.4 Tool 4: GRID

(GeoReference Interactions Database) is a web-based flexible database connected with a number of tools (stress level and conflict score analyses) to analyse marine activities and interactions (conflicts and synergies). GRID has a dedicated GIS application to analyse spatial distribution of present and future activities and interactions.

General requirements:
Shapes of activities, information on activity traits, see above.

Strength:
No extra software needed; use without programming skills.

Weakness:
Simple maps.

Costs:
0€ for software; training costs depend on agreement.

Skills needed to operate the tool:
Software (GIS) and programming skills, GIS.

Operators and level of expertise required:
COEXIST personnel (regional administrator), in case of non-sensitive data also non-COEXIST personnel in "user" mode; medium to high (data processing and input).

References:
D3.9

http://www.seagrid.an.ismar.cnr.it/grid

3.1.5 Tool 5: Stakeholder Consultation

The Stakeholder Consultation tool can be applied in various forms (from one-to-one conversations to online questionnaires). It should be used to increase the knowledge and to optimise the management of an area.

General requirements:
List of stakeholders and questions.

Strength:
Easy to deploy. Simple method of engaging stakeholders to obtain viewpoints.

Weakness:
Requires a lot of time. Subjective and open to different interpretations. Needs engagement from relevant stakeholders. Lack of weighting.

Costs:
0-100€ for software; weeks to months of training.

Skills needed to operate the tool:
Experience (expertise) in stakeholder engagement. Questionnaire design (question construction).

Operators and level of expertise required:
Coastal managers, research institutes, engineering consultants; medium to high.

References:
D2.1

3.1.6 Tool 6: FISHRENT

This is a multi-fleet, multispecies, bio-economic simulation and optimisation model to evaluate management strategies. This model can be used to simulate different spatial management plans and to analyse the influence of future development of wind farms and Natura 2000 sites. Species and fisheries of focus are the mixed flatfish fisheries targeting plaice and sole and the fisheries for brown shrimp.

General requirements:

R, GAMS, using a web-based interface. Input data: two Microsoft Excel files with data parameters and set definitions: species, segments, TAC, economical data, price data, landing, spatial data, biological data, catch-effort and management data. Data must be collected in relation to the scenarios to be tested.

Strength:

Application is web-based, no need to buy software (GAMS). No need to have programming skills. Multidisciplinary tool.

Weakness:

Extensive data needed to run the model. High level of expertise and time required. Biological data is usually not available at a fine scale and the distribution of biomass within an area is assumed homogenous. This can lead to under- or over-estimating the effects of the partial closure of an area.

Costs:

No costs, weeks to months.

Skills needed to operate the tool:

Fishery economist; Months of training.

Operators and level of expertise required:

Research institute; high: gather the right information in the format required; to elaborate scenarios.

References:

D3.3

Salz, P., Buisman, E., Soma, K., Frost, H., Accadia, P., Prellezo, R., 2011. FISHRENT.
Bio-economic simulation and optimisation model for fisheries.
http://www.lei.dlo.nl/publicaties/PDF/2011/2011-024.pdf
Model: http://www3.lei.wur.nl/fishrent/

3.1.7 Tool 7: FARM

Farm Aquaculture Resource Management (FARM) models growth and environmental effects of cultivation for different species, including IMTA, both in open water and onshore such as carrying capacity (production, environmental effects). The model has been further adapted and validated for four main species.

General requirements:
FARM requires console-based software and needs information about current speed, environmental drivers for growth and culture practice. The outputs of FARM provide data sheets, graphs and the mass balance resulting out of the IMTA.

Strength:
Supported by complex well-established models, extensively used and published.

Weakness:
Screening purposes only, probabilistic.

Costs:
No costs to COEXIST community; no training required.

Skills needed to operate the tool:
Subject matter: knowledge of aquaculture; technical: similar to operating a Smartphone.

Operators and level of expertise required:
Farmers, managers; medium (subject), low (technical).

References:
D3.4, D3.7

Model: http://www.ecowin.org/coexist/farm/

3.1.8 Tool 8: Detailed Ecosystem Model

System-scale ecological models are physical and biogeochemical models using hydrodynamic model outputs, watershed modelling, water quality and biological resources data such as EcoWin2000. They provide results such as: how do different components of an ecosystem interact, what is the system-scale carrying capacity for aquaculture and how diseases spread through water circulation and other factors?

General requirements:
Console-based software (EcoWin2000 model). The outputs include hydrodynamic models, watershed modelling, water quality and biological resources data.

Strength:
Detailed analytical powers, extensibility of components.

Weakness:
Complex to set up and use.

Costs:
50-100,000€; three months training.

Skills needed to operate the tool:
Good understanding of aquatic ecosystem processes, computational data handling, GIS.

Operators and level of expertise required:
Technician, manager, depending on outputs required; medium to high.

References:
D3.7

3.1.9 Tool 9: Suitability Maps

The objective of suitability mapping for aquaculture is to produce map(s) showing which coastal areas (marine ecosystems) - based on physical characteristics - are suitable for different aquaculture activities. Thus suitability maps can be interesting for spatial planners to scope suitable areas for aquaculture or to assess different planning options.

General requirements:
Model Builder tool of ArcGIS. Input data: preference and tolerance levels for water salinity, temperature, water depth, sediment type, wind, currents (tides), wave heights, chlorophyll-a, and dissolved oxygen.

Strength:
Easy to understand at first glance; any parameter for certain aquaculture species can be identified (depending on the data), additional layers can be added, like socio-economic information. Could be used for scenario studies, i.e. consequences for aquaculture of changes in temperatures.

Weakness:
No elaborated analysis. Small-scale data might be very difficult to source. The analysis of data requires a certain amount of software skills.

Costs:
0-6000€ for software, 2000€ for training; days required to gather information and make analysis.

Skills needed to operate the tool:
GIS skills, aquaculture expertise.

Operators and level of expertise required:
Research institutes, engineering consultants; medium to high.

References:
D1.1

S2494 - Coregonus lavaretus – Whitefish, 2006, European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora http://jncc.defra.gov.uk/pdf/Article17/FCS2007-S2494-Final.pdf.

Lundsgaard-Hansen, B., Matthews, B., et al. (2013). "Adaptive plasticity and genetic divergence in feeding efficiency during parallel adaptive radiation of whitefish (Coregonus spp.)." Journal of Evolutionary Biology 26(3): 483-498.

Lumb, Chelsey E., and Johnson, Timothy B., 2012. Retrospective growth analysis of lake whitefish (Coregonus clupeaformis) in Lakes Erie and Ontario, 1954–2003. Advanc. Limnol. 63, p. 429–454. Biology and Management of Coregonid Fishes – 2008.

3.1.10 Tool 10: Stakeholder Preferences

This tool represents Step 4 of the Evaluation framework (WP4).

General requirements:
Definite/ Expert Choice; input needed: stakeholder list, interviews, questionnaire survey.

Strength:
Insights into respective peoples' understanding of what is important.

Weakness:
Possible exclusion of relevant people/groups.

Costs:
750€; Definite, 15 days free download Expert Choice; one month training, if experienced.

Skills needed to operate the tool:
Analytic Hierarchy Process (AHP) related-knowledge.

Operators and level of expertise required:
Research institutes, engineering consultants; medium to high.

References:
D4.2 Step 4 (Available on request by contacting the COEXIST Case Study Leader)
Soma, K., Ramos, J., Bergh, Ø., Schulze, T., Mäkinen, T., Grati, F., Fitzpatrick, M., Stenberg, C., Van Oostenbrugge, H., Stelzenmüller, V., Van Duijn, Ar., Buisman, E., Hoefnagel, E. (in prep). Evaluating effectiveness of future spatial scenarios in European coastal waters – the 'mapping out' approach.

3.1.11 Tool 11: Effect Table

This tool represents Step 6A and B of the Evaluation framework (WP4).

General requirements:
FISHRENT results, spatial mapping. Input data: twofold: 1) quantitative: identify indicators for each objective and estimate effect, and 2) qualitative: assign effects by expert judgment.

Strength:
Easy to understand, overview of situation.

Weakness:
Challenge to find good indicators and uncertainties related with effects.

Costs:
0-500€ for Excel software.

Skills needed to operate the tool:
Analytic Hierarchy Process (AHP) related knowledge; weeks of training.

Operators and level of expertise required:
Research institutes, engineering consultants; medium to high.

References:
D4.2 Step 6A (Available on request by contacting the COEXIST Case Study Leader)

Soma, K., Ramos, J., Bergh, Ø., Schulze, T., Mäkinen, T., Grati, F., Fitzpatrick, M., Stenberg, C., Van Oostenbrugge, H., Stelzenmüller, V., Van Duijn, Ar., Buisman, E., Hoefnagel, E. (in prep). Evaluating effectiveness of future spatial scenarios in European coastal waters – the 'mapping out' approach.

3.1.12 Tool 12: Multi Criteria Analysis (MCA)

This tool represents Step 6C of the Evaluation framework (WP4).

General requirements:
Definite/Expert Choice; input: objectives, relevant spatial management options, stakeholder preferences and effects.

Strength:
Insights into which management strategies are favorable to different groups, and long term.

Weakness:
Important details lost due to standardisation, therefore stakeholder preferences and effect table must be seen as results!

Costs:
750€; Definite, 15 days free download Expert Choice; one month of training, if experienced.

Skills needed to operate the tool:
Software.

Operators and level of expertise required:
Research institutes, engineering consultants; medium to high.

References:
D4.2 Step 6C (Available on request by contacting the COEXIST Case Study Leader)

Soma, K., Ramos, J., Bergh, Ø., Schulze, T., Mäkinen, T., Grati, F., Fitzpatrick, M., Stenberg, C., Van Oostenbrugge, H., Stelzenmüller, V., Van Duijn, Ar., Buisman, E., Hoefnagel, E. (in prep). Evaluating effectiveness of future spatial scenarios in European coastal waters – the 'mapping out' approach.

3.1.13 Tool 13: FISHNETS

The Disease model FISHNETS (Farmed Inshore Species Health NETwork System) is an aquaculture farm disease screening model looking at: (1) site selection; (2) species' vulnerability; and (3) optimal culture practice.

General requirements:
Console-based software as well as existing quantitative and qualitative data on the planned aquaculture activity. The outputs include risk rating (e.g. vulnerability of species) and recommendations concerning aquaculture techniques.

Strength:
Rapid diagnostics, approach supported by robust science, impact of farm management measures for disease.

Weakness:
Screening purposes only, probabilistic.

Costs:
No costs; No training required.

Operators and level of expertise required:
Farmers, managers; medium (subject), low (technical).

References:
D.3.8

www.ecowin.org/coexist/fishnets

Glossary

Bio-economic model
A bio-economic model is a theoretical construct that represents the biological and economic system with a set of variables and a set of logical and quantitative relationships between them. Bio-economic models can be classified into two categories, simulation (what if) and/or optimisation (what's best). Simulation models strive to simulate a system by projecting a set of biological and economic variables or parameters into future scenarios to evaluate alternative management strategies. Optimisation models are designed to find an optimal solution of an objective function under certain economic and/or biological constraints. (FISHRENT, Tool 6 in COEXIST, is doing both.)

Coastal zone
The interface between land and sea, delineated as the part of the land affected by its proximity to the sea, and the part of the sea affected by its proximity to the land.

Coastal zone management
See Integrated Coastal Zone Management (ICZM).

Conflict
A state of disharmony between incompatible or antithetical persons, ideas, or interests; a clash.

Co-use
In COEXIST the co-use of an area is understood as more than one activity being conducted in close vicinity to each other and/or within a spatial entity (e.g. National Park). So an EEZ of a state may be co-used by many activities, whereas specific areas within (like wind farm areas) may not be co-used by different activities.

Effectiveness
Effectiveness is the degree to which the objectives are achieved.

Efficiency
Efficiency is determined with reference to costs (e.g. expenditure, time, effort).

Framework
Broad overview, outline, or skeleton of interlinked items which supports a particular approach to a specific objective, and serves as a guide that can be modified as required by adding or deleting items.

Governance
Governance is the whole of public as well as private interactions taken to solve problems and create societal opportunities. It includes the formulation and application of principles guiding those interactions and care for institutions that enable them.

Impact
In a stakeholder analysis, the impact is the interest(s) each stakeholder has on a given program or project. A stakeholder can be positively or negatively impacted by a programme or project.

Indicator
Progress in relation to operational objectives will be measured using indicators and associated reference points and directions. An indicator is a measure, or a collection of measures, that describes the condition of an ecosystem or one of its critical components.

Integrated Coastal Zone Management
The multifaceted approach to the management of coastal resources has become known as integrated coastal management (ICM), integrated coastal zone management (ICZM) or integrated coastal area management (ICAM). The process of combining all aspects of the human, physical and biological aspects of the coastal zone within a single management framework.

Institution
Structure of social order and cooperation governing the behaviour of a set of individuals within a given community.

Interaction
An interaction is the influence of a compartment on another compartment. This includes indirect/direct, positive/negative influences.

Management plan
The systematic collection of information and development of specific strategies and actions that will bring about a desired outcome.

Management scenario
Spatial management options.

Management tool
A management tool is something chosen and then applied to achieve a desired management outcome.

Marine spatial planning
Process of analysing and allocating parts of three-dimensional marine spaces to specific uses, to achieve ecological, economic, and social objectives that are usually specified through the political process. In COEXIST the control and organisation of the position, area and size of human activities at seas and oceans are understood.

Model
Any artificial representation of systems that translates data into information.

Scenario
A well-defined, connected sequence of features, events and processes that can be thought of as an outline of a possible future condition of the repository system.

Socio-economic
Field of study that examines social and economic factors to better understand how the combination of both can have an influence.

Spatial planning
Spatial planning refers to the methods used largely by the public sector to influence the future distribution of spatial activity.

Spatial management
The management of all activities (natural and non-natural) within a defined (marine) area.

Stakeholder
Individuals, enterprises or organisations conducting, managing or influencing activities in a specific area. Gains and losses (both economical and non-material) depend on the success or failure of a project, such as the managing of an area.

Sustainable development
Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Synergy
The combined power of a group of things when they are working together which is greater than the total power achieved by each working separately.

For more definitions see Glossary in D1.4 – Task 1.1, list of definitions, and the Glossary in D5.1. available on www.coexistproject.eu

Acknowledgments

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Annex I: List of Scientific Deliverables

Del. no.	Deliverable name
D1.1	Map(s) of Europe showing which coastal areas (marine ecosystems) have which specific characteristics based on physical characteristics and suitability for aquaculture
D1.2	Matrices of interactions of aquaculture versus fisheries
D1.3	Matrices of interactions of aquaculture and fisheries versus other activities in the coastal zone
D1.4	Working document WP1, including DPSI (driver-pressure-state-impact-response) elements to be described for each case study and contributing matrices to infer the most relevant interactions (benefits and conflicts) between activities
D1.5	Characterisation of ecosystems
D2.1	A stakeholder map and database for each case study area (legal, institutional and policy frameworks)
D2.2	Report on the potential use of GIS and other scenario-based simulation and visualisation tools
D2.3	Report on institutional analysis (Available on request by contacting: j.gault@ucc.ie)
D2.4	Development of indicators of best practice (legal, institutional and policy frameworks)
D2.5	A comprehensive review of the legal, policy and institutional frameworks that cover the current approaches to interactions between aquaculture, fisheries and other sectors and identifying barriers to, and opportunities for, more efficient management
D3.1	Parameterised and validated population models for appropriate species of wild finfish, bivalves and crustaceans
D3.2	Report on economic analysis in coastal fisheries on the basis of revenue for individual profession and fishing trips
D3.3	Coastal fisheries fleet models
D3.4	Validated farm-scale models for aquaculture
D3.5	Report on assessment of aquaculture and fisheries production scale effect on environment
D3.6	Report on pathogens impact on farmed and wild fish, with salmon lice in a fjord system as a model (farm-fishery interactions)
D3.7	Combined local-scale and system-scale models (production/disease/GIS)
D3.8	Screening models for decision support on aquaculture siting and risk analysis
D3.9	GRID Model (GeoReference Interactions Database)
D4.1	An internal working document containing the developed framework for multi-objective quantitative and qualitative evaluation of marine spatial management in coastal zones

D4.2 For each case study a final report containing measured cumulative impacts of the aggregate coastal activities, evaluation of the effectiveness and efficiency of currently applied spatial management tools, and results of scenario studies, that incorporate the best practices and proposed improvements to existing spatial management tools, on the effects of aquaculture, fisheries and other activities in coastal zones (Available on request by contacting the COEXIST Case Study Leader)

D4.3 Submission of a peer-reviewed paper on the development of a framework for multi-objective quantitative and qualitative evaluation of marine spatial management in coastal zones

D5.1 Working document describing general conclusions from the overall comparison of realised management methods and modelled alternative scenarios in spatial planning

D5.2 Document: guideline for best practice in spatial planning to integrate fisheries aquaculture and further demands in the coastal zone. Potential end-users will be the EU commission and national level decision makers as the synthesis aims at supporting European maritime policy

Annex II: COEXIST Consortium

Logo	Institute	Contact person	Responsibility
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IMARES WAGENINGEN UR	Institute for Marine Resources and Ecosystem Studies (IMARES), The Netherlands www.imares.wur.nl/uk/	Bas Bolman (WP1 lead) bas.bolman@wur.nl	WP1 Leader
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RIISTAN- JA KALANTUTKIMUS SYKE	The Game and Fisheries Research Institute, Finland www.rktl.fi/english/ Finnish Environment Institute, Finland www.ymparisto.fi	Timo Mäkinen (CSL) timo.makinen@rktl.fi Juha Grönroos juha.gronroos@ymparisto.fi	CS 6 Baltic Sea Leader
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AQUATT	AquaTT UETP Ltd, Ireland www.aquatt.ie	Emma Bello Gomez emma@aquatt.ie	WP6 Leader

Annex III: Case Studies

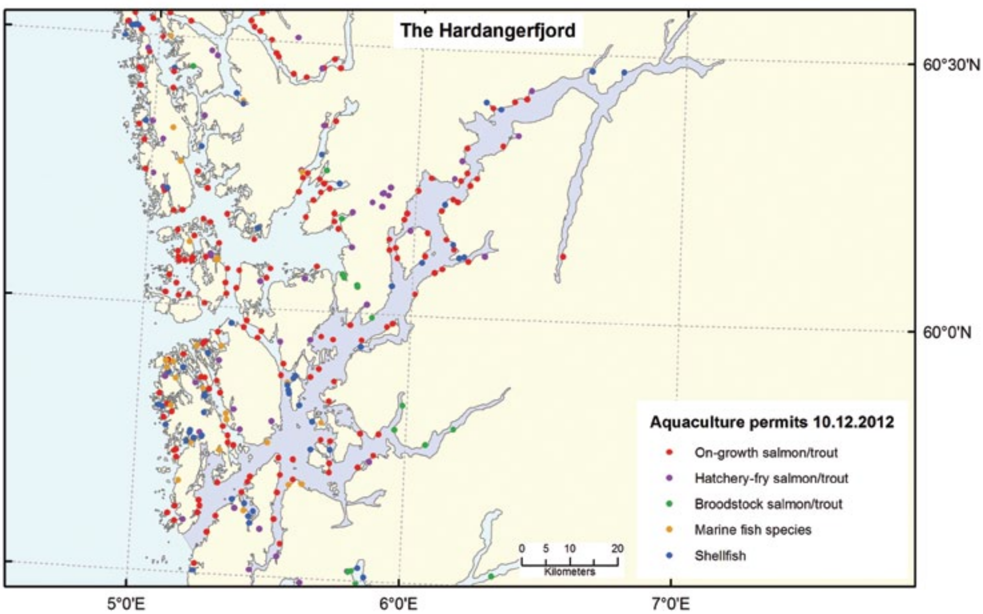
CASE STUDIES

Photo courtesy of © Helen Petersen

Case Study 1 – Hardangerfjord: Norway

Site Description

The ecosystem in Hardangerfjord has been of high importance for man since Norway was populated after the Ice Age. The villages and agricultural areas surrounding the fjord are ancient cultural landscapes. At present, the fjord serves many functions for fisheries and aquaculture, for recreation, tourism and cultural identity, and as a climate moderator in the fruit growing districts as well as a transportation route for people and cargo.



MAP The Hardangerfjord showing the location of the various aquaculture permits (December 2012). Salmon farming is dominant in terms of economy as well as biomass, but there are also permits for cod and other marine fish, and shellfish. In addition there are several permits for smolt production in fresh water.

Case Study Site Characteristics

The Hardangerfjord is a result of geological processes that took place during the Ice Age. At 179km in length, it is Norway's second largest fjord and has several side fjords, constituting a deep valley both below and above sea level. The fjord's largest depth is 839m. The outer part of the fjord is highly influenced by the Scandinavian coastal current, originating from the Baltic. There are major sources of freshwater from the glaciers and mountain areas surrounding the fjord, which tend to produce a distinct upper layer of brackish water 5-10m deep, with a surface salinity of <15-20 PSU from spring to late autumn. Temperature in upper layers varies greatly during the year, with typical values ranging from 2-4°C during winter to around 15°C in the summer. Deep water layers are more stable with respect to temperature and salinity. The Hardangervidda mountain plateau and the Folgefonna glacier are the major national parks in the area.

Activities in the Case Study Site

A large salmon-farming industry is located in the fjord. Total salmon production in the fjord passed 58,000 tonnes in 2008. There is considerable concern about proliferation of pathogenic organisms within salmon farms affecting wild salmon and of the genetic impact of escapees. Rivers are utilised for large scale hydroelectric power production. Tourism and leisure activities are also important for the area.

Legal and Policy Framework

In Hardangerfjord, there is a national policy and legal framework to develop the fisheries and aquaculture sectors. The key pieces of legislation are the Planning and Building Act, the Aquaculture Act, the Biodiversity Act, the Pollution Act and the Food Act. Fisheries and aquaculture policy and legislation are the responsibility of the central government through the Ministry of Fisheries and Coastal Affairs, while environmental policy is the responsibility of the Ministry of the Environment. The County Governor's Office is the regional representation of the central departments. The Governor's Office has an environmental section which is tasked with the implementation of environmental legislation.

A number of additional agencies are involved in both fisheries and aquaculture as well as environmental management. The Directorate of Fisheries and the National Food Safety Authority are involved in fisheries and aquaculture management. Likewise the Directorate of Nature Management implements environmental policy and the legislation that pertains to this. Municipalities and County Councils (local and regional authorities) also have a role to play in fisheries and aquaculture management.

Management Authorities

The Management Authorities with responsibility for fisheries and aquaculture in this case study are:

- Ministry of Fisheries and Coastal Affairs (governmental)
- Directorate of Fisheries (fisheries, aquaculture)
- National Food Safety Authority (fish diseases)
- Municipalities (12)
- County Council of Hordaland County (regional)
- County Governor of Hordaland (governmental)

Planning powers of sub-national government relating to fisheries and aquaculture are split up into various bodies in the Hardangerfjord case study area. Here the County Councils are presumed to take a coordinating role in developing aquaculture (and other industries). However, the licensing of new aquaculture permits for salmonids per county is an exclusive right of the government (Ministry of Fisheries and Coastal Affairs). The actual licensing is decided by the County Councils. The County Councils have little influence over fisheries.

Main Conflict Types

- Space for aquaculture vs. conservation
- Pathogen dispersal from aquaculture, in particular salmon lice affecting wild salmon stocks
- Genetic impact from aquaculture (escaped salmon influencing the genetic composition of wild salmon stocks)
- Management of hydroelectric power plants – impact on hydrography indirectly affecting aquaculture as well as fisheries and the overall environment in the fjord
- Electric cables from hydroelectric power plants vs. conservation as well as tourist industry interests

Integrated Coastal Zone Management & Maritime Spatial Planning

Coastal planning is mandated from the Planning and Building Act (PBA) 1985, last revised in July 2009. Under this Act, the municipalities are responsible to ensure the development of public services, land use and other natural resources as well as zoning for different uses. The Act may be regarded as novel as it also granted municipal authorities the right to establish legally binding plans for coastal waters immediately adjacent to the land area.

Future Scenarios Affecting Status Quo of Aquaculture/Fisheries

Environmental/Biological/Chemical

- Climate changes
- New diseases
- Parasites
- Escape of farmed salmon
- Discharge of nutrients and chemicals

Governance

- New political objectives, elections
- Change in popular opinion

Industrial

- New industry e.g. power lines
- Increased utilisation of remaining waterfalls for hydroelectric production
- Electric subsea cables as an alternative to land-based cables

Opportunities for Co-Existence

- River owners and sport fishermen coordinating their actions
- Wrasse fisheries and aquaculture work together (wrasse used as cleaner fish in aquaculture)
- New applications of subsea technology from the oil industry are found in aquaculture
- Tourism utilising local food produced from fisheries and aquaculture – educational tourism tours on boats and aquaculture demonstration facilities
- Collaboration on cultivation of stocks and removal of escapees between fishermen and aquaculture. The producers of hydropower as well as the tourist industry have a common interest in conserving fish stocks
- Fisheries knowledge made available to other stakeholders (for instance cable planning)

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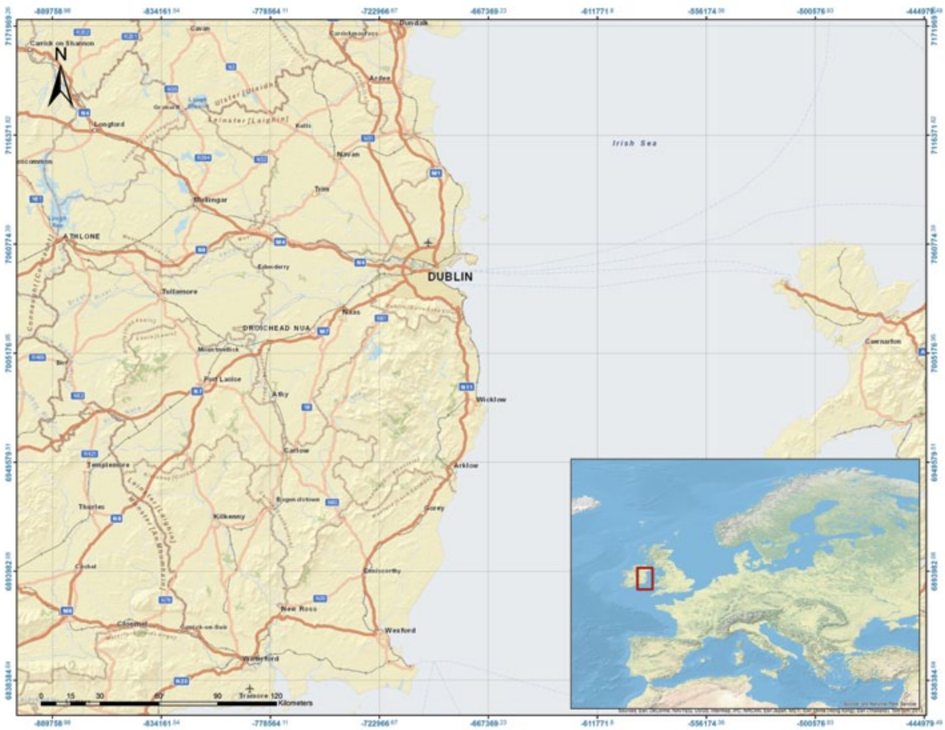
Case Study 2A – Atlantic Coast Areas: Ireland

Site Description

The case study area is located to the East of the Republic of Ireland in the Irish Sea as indicated on the map. Atlantic coastal waters and the Irish Sea contain productive and heavily exploited fisheries sites and support high levels of aquaculture production. Other activities in the area include offshore energy and marine recreation and nature conservation.



MAP Case study area located off the east coast of the Republic of Ireland.

Case Study Site Characteristics

The Celtic Sea lies to the south of Ireland, and the Irish Sea to the east. Both seas are located on a continental shelf with water depths not exceeding 200m. The region's oceanography is complex with water masses with distinct characteristics interacting and mixing. The Gulf Stream forms part of the main circulation cycle of surface water in the North Atlantic Ocean, moving heat from the equator to the Arctic. The North Atlantic Drift (NAD) is the broad, northward flow of surface waters that replaces the sinking waters in the North Atlantic polar seas. Further division of the NAD takes place, moving this water around Ireland and Britain. The impact of the NAD on Ireland's shelf waters and atmosphere is to maintain much warmer conditions than would be expected for its northerly position, hence, increasing the biological productivity and biodiversity of the marine environment and helping to reduce atmospheric temperature extremes over land, with winter-summer temperature differences of only 10°C.

Activities in the Case Study Site

Mussel seed dredging in the case study site is associated with mussel trestle culture. Collected mussel seed is relayed in licensed areas. Whelk and crab potting, beam trawling for scallops and trawling for white fish (mainly Cod, Haddock, Hake and Whiting) also take place. The case study site includes an operational wind farm on the Arklow bank and is used for recreation, being located close to the Irish capital, Dublin.

Legal and Policy Framework

Legally, seed mussel dredging is classed as fishing rather than an aquaculture activity. As such it falls under the scope of the Sea Fisheries and Maritime Jurisdiction Act, 2006. Opening and closing of the fishery is controlled by the associated statutory instruments, for example Mussel Seed (Closing of Fisheries) (No. 2) Regulations 2010 [S.I No. 572 of 2010]; European Communities (Control on Mussel Fishing) Regulations 2008 [S.I No. 347 of 2008], etc. These define areas where seed mussel dredging is prohibited, with many of the designated areas coinciding with areas designated as part of the Natura 2000 process.

Nothing in these regulations, however, affects the harvesting of mussel seed in accordance with an aquaculture licence. Interactions between mussel dredging and other activities are not covered by the existing legislative framework. Primary responsibility for fisheries and aquaculture rests with the Department of Agriculture, Fisheries and Food (DAFF) which also has a number of bodies under its aegis that are also involved in aspects of management (BIM and the Marine Institute).

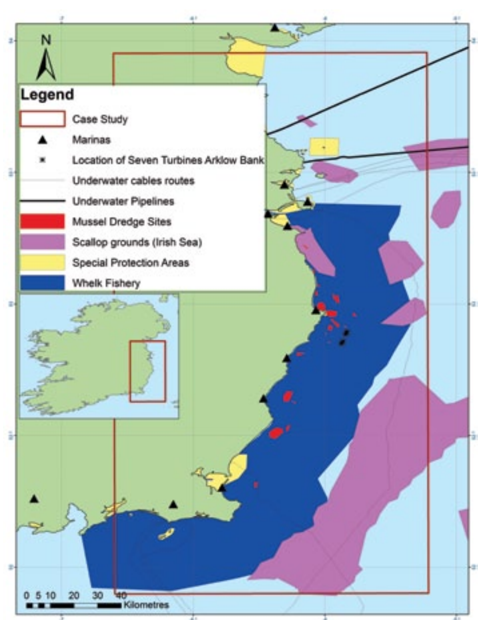
Management Authorities

The Management Authorities who have responsibility for fisheries and aquaculture in this case study site are:

- Department of Agriculture, Fisheries and Food
- Bord Iascaigh Mhara (BIM)
- Marine Institute
- Irish Naval Service

Management authorities interact with each other in a fragmented way in the case study site. Mussel seed dredgers feel that the sector is ignored and suffers from the lack of clearly defined management authority with dedicated responsibility for this area.

In this case study site, sub-national government has no role in relation to fisheries and aquaculture management given that, legally, the jurisdiction of local authorities extends only to the Mean High Water Mark. Foreshore (HWM to 12 mile limit) developments that adjoin the functional area of a local authority require planning permission under planning legislation as well as a foreshore licence or lease under foreshore



legislation.

Main Conflict Types

Potential conflict industries include the seed mussel dredgers, whelk/crab/lobster potters and the marine leisure and ocean energy industries. Spatial pressure is added through the designation of coastal and marine protected areas, where certain activities are partially or completely prohibited. Conflict arises from a lack of direct coordinated State accountability by lead departments and agencies when an issue arises. The stakeholders of the area cite the lack of strategic planning as the main barrier to resolving conflicts.

Integrated Coastal Zone Management & Maritime Spatial Planning

No ICZM policy or dedicated MSP system exists in this case study site. Work is ongoing in Ireland in relation to re-examining and amending the foreshore planning regime with implications for broader marine and coastal management. It is expected that some form of MSP will become operational in the coming years (2013-2014) but the details of what this will look like and the institutions responsible are not known at this time.

Future Scenarios Affecting Status Quo of Aquaculture/Fisheries

- Climate change
- Legislation (local, national and EU)
- Lack of statutory awareness of potential of marine leisure activities to local economies
- Irish Offshore Renewable Energy Development Plan and future offshore energy developments

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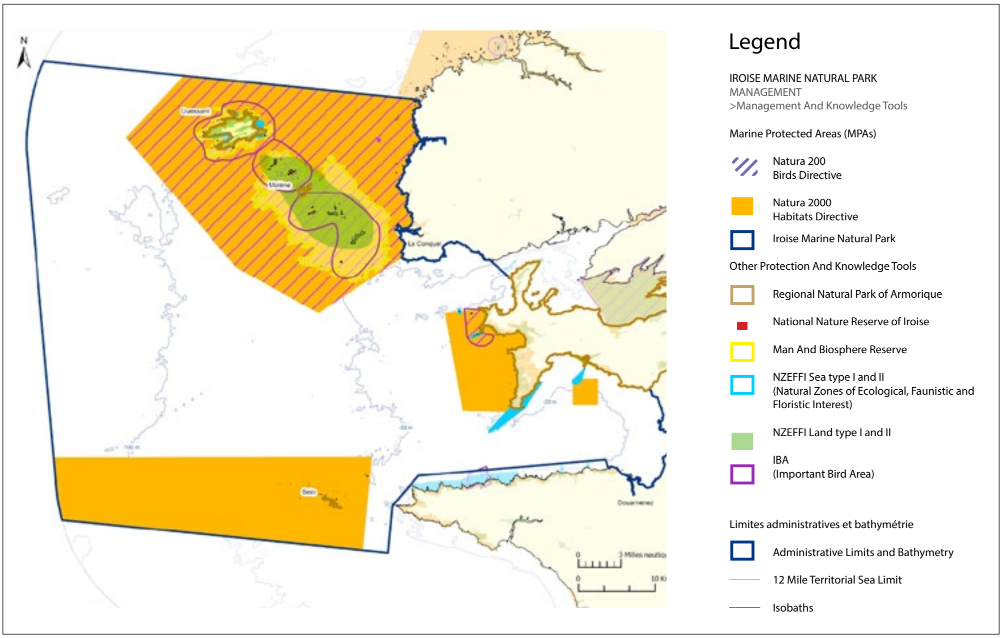
Photo courtesy of © Ifremer

Case Study 2B – Atlantic Coast Areas: France

Site Description

The Iroise Sea is located on the western part of Brittany, France. Seaweed and bivalve fisheries provide an original example of interaction between coastal fisheries and sea-ranching (Iroise Natural Park). On the other hand, seaweed harvesting is located in some environment management areas like Natura 2000 sites. This situation can generate conflict interactions.



MAP In case study 2b, the majority of activities occur in areas which are included in different type of management areas. The status of these areas has to be taken into account while developing fishing activity, seaweed harvesting or tourism.
(Credits: Agence des aires marines protégées)

Case Study Site Characteristics

The case study site lies near the Celtic Sea and is characterised by low ponds. The area is covered by high tides, which makes it important to Europe because, due to these natural conditions, a diversity of substrates and habitats can be found there. Almost 300 seaweed species, sponges, anemones as well as corals are of particular interest. That is why a public marine protected area as well as Natura 2000 sites have been established in the region. The Iroise Sea contains habitats of almost all the species that can be found in the French Atlantic Ocean and in the Channel. The case study can be divided in two areas, the open sea and the Bay of Brest, which is an almost closed sea with a specific ecosystem. The salinity (around 35 PSU) is quite stable in the area, except in the Bay of Brest because of seasonal freshwater inputs. While there is good water quality in the open sea, the water quality status gets worse foreshore due to the input of human activities.

Activities in the Case Study Site

Fishing activities are quite important in the area, especially in the MNPI (Marine Natural Park of Iroise Sea). The fishing vessels operate mainly on a small-scale in coastal areas. Aquaculture is limited to an area in the Bay of Brest where it is located near the commercial harbour and the area used for military activities. Here, we study the seaweed fishery in the Molene-Ouessant island archipelago (included in the marine protected area) and the shellfish fisheries in the Bay of Brest, with both these fisheries being outside the marine protected area.

Legal and Policy Framework

There is a national policy and legal framework addressing the issues of concern, to a varying degree. The key objectives are the management of exploitable renewable marine resources, the protection of biodiversity and the sustainable use of the marine environment. A range of organisations are responsible for the development of these policies, including local and regional fishery committees as well as departmental and regional authorities for land territories and the sea. In this area, the French authorities created the country's first marine park, officially known as the "Parc naturel marin d'Iroise" or the Marine Natural Park of the Iroise Sea (MNPI). The main objectives of this park are to increase the knowledge of the marine environment, to protect the habitats and species within this area and to develop all kinds of marine activities. The park covers an area of 3550km^2 from the north coast of Ushant to the south coast of the Ile de Sein, the mainland coastline to the east of the limit of French territorial waters on the west.

Management Authorities

The Management Authorities who have responsibility for fisheries and aquaculture in this case study are:

- National administration for fisheries and aquaculture
- Ifremer
- Marine Natural Park of Iroise Sea

There is a clear division of responsibility between local and regional fisheries committees and administration. The main aim of the sub-national administration (Departmental and regional state authority for territories and sea) is to apply national and European fishery regulations.

The Brittany region (sub-national government) has no specific authority in terms of fishery management. The local and regional fishery committees, however, have the capacity to propose management rules on their spatial competence areas (local stocks) and the sub-national administration is in charge of validating their proposals according to both national and/or European rules. Some local management rules are said to be more restrictive than national ones.

Main Conflict Types

Among the different conflicts some are more stressful, as the following four outline:

- Lobster potters and abalone fishery with the seaweed harvesting fishery
- Ecosystem conservation with the seaweed harvesting fishery
- Military activities with scallop fishery
- Recreational fishing with the longline seabass fishery

Integrated Coastal Zone Management & Maritime Spatial Planning

In France, formal steps toward ICZM implementation only started in 2006. The enactment of Law ENE (Loi 2010-788 portant engagement national pour l'environnement [law on the national commitment to the environment]) in July 2010 provides a legal and institutional framework for sea and coastal zone management. This legislation also established the National Council for the Sea and Coasts (Conseil National de la mer et des littoraux) which comprises all the actors in maritime and coastal governance. This legislation will also transpose the requirements of the Marine Strategy Framework Directive. Some regional demonstration-type projects on MSP are operational at various locations around the French coast.

Future Scenarios Affecting Status Quo of Aquaculture/Fisheries

Environmental/Biological/Chemical

- Climate change
- Spread of disease

Governance

- Government/EU policy/legislation

Industrial

- New industry (e.g. ocean energy, new tourism initiatives, port development)

Opportunities for Co-Existence

- Fishermen and aquaculture infrastructure work together in order to fish the seabream and decrease the predation on mussels in this way
- Fishermen have developed a hatchery to produce young scallop to improve the recruitment in the bay of Brest
- The MPA finances several bathymetric studies to improve the knowledge of the Iroise ecosystem in the harvested seaweed areas or the resilience of the ecosystem after harvest
- Development of the Wastewater Treatment Plant (WWPT) in coastal villages and around the bay of Brest has increased the quality of water
- The existence of the MNPI is considered important as it facilitates communication and discussion between stakeholders in a "limited" environment. In effect, all projects must regard protection as the protection of the resources and mammals
- The MNPI finances many projects in order to improve a sustainable development of resources, to improve the knowledge and to ensure the protection of the marine ecosystem
- The increase of the wild oyster and a variegated scallop stock is perhaps a link for achieving better water quality. A lot of WWTPs have been built and the agriculture sectors have improved their practices
- Inclusion and engagement of stakeholders (e.g. fishermen) in decision-making processes are scheduled for the Marine Protected Areas (MPA)

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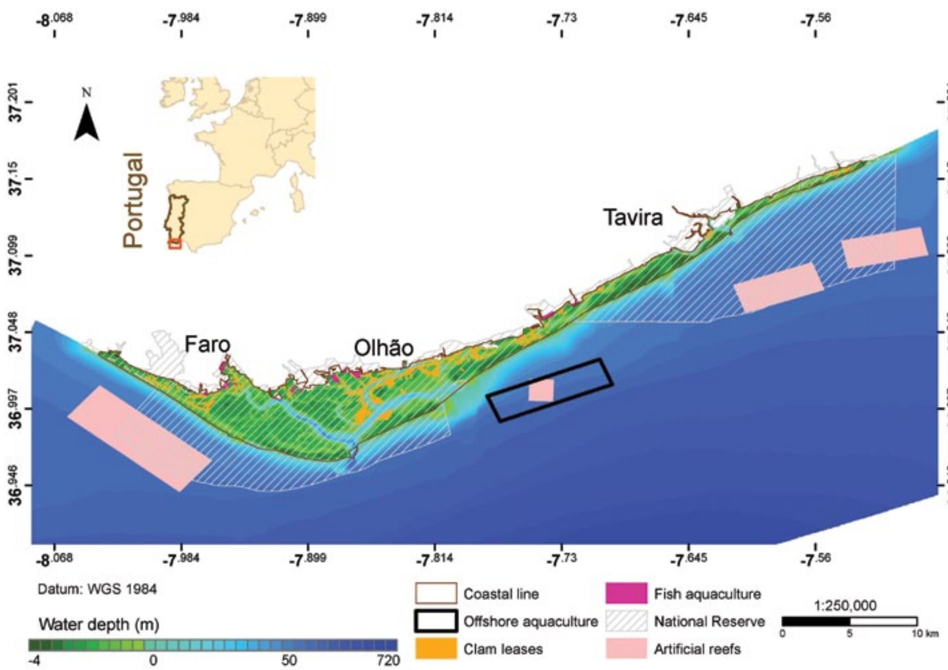
Case Study 3 – Algarve Coast: Portugal

Site Description

Due to its geo-location between the Mediterranean Sea, North Africa and the eastern Atlantic, the Algarve coastal waters are among the most productive of the Iberian Peninsula. However, due to the high diversity of the resources and generally calm ocean conditions, its fisheries are heavily exploited. Moreover, there is a high level of bivalve aquaculture production occurring in inshore estuarine-lagoon systems.



MAP Coastal activities interaction map. (Credits: IMAR)

Case Study Site Characteristics

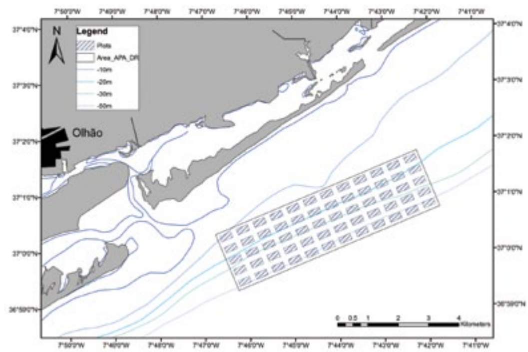
The case study area is near the Ria Formosa lagoon, which is an inland water area bordered by sandy barrier islands, and comprises an extensive area of salt marshes. There are no main tributaries into the system. The river Guadiana is the eastern boundary. The nearest tributary is the river Gilão, a small river that discharges into the Ria Formosa system, mainly during winter and spring seasons, with runoff waters coming from the hills. The lagoon is bordered by five sandy barrier islands and two peninsulas at each extreme. There are also six inlets, with one of these, an artificial inlet (located at Santa Maria cape), contributing to over 70% of the water balance from high and low tides inside the lagoon. The Ria Formosa is a nursery area for a large amount of fish species. Particular importance is given to several species from different taxa, including: seahorses; some bivalve species; cephalopods; waders and other birds; the common chameleon (reptile); and several small-sized mammals.

Activities in the Case Study Site

Major human activities include tourism as well as its related services and fisheries The latter play a very important role especially for pelagic fish, cephalopods and crustacean fisheries. Aquaculture activities occur mainly in inland waters where clam plots leased from the government are developed; more recently offshore aquaculture has been developed both for fish and bivalve production. Other activities include ferry transportation from and to sandy barrier islands and shipping via the Mediterranean Sea.

Legal and Policy Framework

Specifically dedicated legislation was enacted in 2008 to create the Aquatic Production Area of Armona (APAA). This has the following goals: (i) to establish rules to rear fish and shellfish in offshore waters as a pilot project and the general conditions eligible individuals have to follow; and (ii) to use signals recommended by the International Association of Aids to Navigation and Lighthouse Authorities in the associated maritime space. The legislation facilitates the allocation of specific plots to eligible individuals, who are either self-employed people, private firms, associations or cooperatives. The Algarve Region Hydrographic Administration (APA) is responsible for policy development relating to the water domain based on catchment areas, while the Directorate for Fisheries and Aquaculture (DGRM) is responsible for licensing activities and species in each plot. The latter is a national authority with representation at the regional level. The national fisheries and aquaculture research institute (IPMA) performs some pilot experiments in the APAA area, but in practice IPMA acts more as a stakeholder rather than as a formal management authority.



Management Authorities

The Management Authorities who have responsibility for fisheries and aquaculture in this case study are:

- Ministry of Agriculture, Sea, Environment, and Planning
- Directorate for Fisheries and Aquaculture (DGRM)
- Ria Formosa Natural Park (PNRF)
- Institute for the Investigation of Fisheries and the Sea (IPMA)

There is a synergistic relationship between the various management authorities.

In the Algarve coast, based on the response to the governance questionnaire, sub-national government has no planning powers relating to fisheries and aquaculture management.

Main Conflict Types

- Co-location of aquaculture with designated conservation and tourism areas
- Offshore aquaculture and fisheries in the same areas (the presence of the aquaculture plots excludes some fishing segments)
- Recreational boating and ships can change sediment properties and have detrimental consequences for aquaculture activities and species
- Bivalve fishing/gathering closures due to the detection of seasonal toxins and consequent preventative measures taken in order

to avoid health risks are not well accepted by some producers
- Fishing closures (e.g. sardine or other fish subjected to quota)

Integrated Coastal Zone Management & Maritime Spatial Planning

The entire Portuguese coastal zone is covered by nine Coastal Zone Spatial Plans (Planos de Ordenamento da Orla Costeira – POOC) which have all been approved and published. They cover the coastal strip (Public Maritime Domain) up to a maximum of 500m width and a maritime strip up to 30m deep. The plans cover both considerations such as flood risk, sea level rise and adaptation to climate change as well as use of beaches for tourism purposes but not coastal activities per se. Portugal has a dedicated Maritime Spatial Plan (Plano de Ordenamento do Espaço Marítimo [POEM]). The public consultation phase is on-going and so the final plan is not yet finalised.

Future Scenarios Affecting Status Quo of Aquaculture/Fisheries

Governance

- The publication of laws applied to the sector without prior consultation with producer and/or associations makes enforcement impossible afterwards
- The perception that aquaculture has a significant negative impact on ecosystems
- EU policy related to marine sciences

Industrial

- The interaction between the offshore production area in front of Armona that is destined to produce fish and bivalves
- New opportunities related to port and tourism activities

Opportunities for Co-Existence

- The Ria Formosa lagoon tourism/aquaculture industry: tourism can benefit from diversified recreational areas and guided trips and aquaculture can expand their products to additional customers
- The development of synergies between different sectors and the promotion of collaboration
- The possibility to create more economies of scale both between and within sectors of activity
- Ancillary aquaculture earth ponds can be used for recreational fisheries, bird watching, local area and landscape conservation, and environmental education

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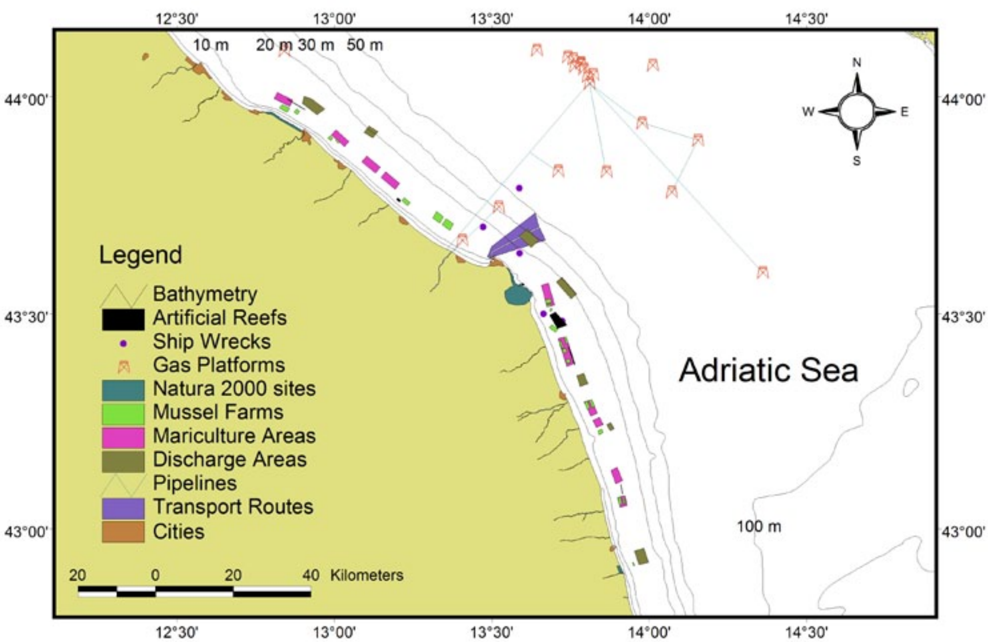
Photo courtesy of © CNR-ISMAR

Case Study 4 – Adriatic Sea Coast: Italy

Site Description

The Adriatic Sea is a peculiar, narrow epicontinental basin whose dimensions are about 200 x 800km and shows a low topographic gradient, ~ 0.02° on average, that increases only at the South of the Gargano promontory. The prevailing currents flow counter clockwise from the Strait of Otranto, along the eastern coast and back to the strait along the western (Italian) coast. Tidal movements are usually slight. Salinity is low because the Adriatic collects one third of the fresh water flowing into the Mediterranean, acting as a dilution basin. The surface water temperatures generally range from 24°C (75°F) in summer to 12°C (54°F) in winter.



MAP Activities in the case study area.

Case Study Site Characteristics

The study site chosen for the Adriatic Sea model is the coastal area of the Marche region. It is 137km long, characterised by eutrophic waters and accommodates space for several human activities, including fisheries and aquaculture. The former include small-scale fisheries (set nets, traps), hydraulic dredge fisheries of baby clams (Chamelea gallina), Mediterranean mussel (Mytilus galloprovincialis) harvesting on wild banks settled on the few rocky bottoms occurring in the area, recreational fisheries (spare fishing, trapslines and long-lines). The latter consists of intensive and extensive mussel (M. galloprovincialis) culture.

Activities in the Case Study Site

The main activities which take place in the study site are: fisheries; aquaculture (mussel culture on long-lines and on artificial reefs); gas extraction; cables and pipelines; conservation (MPAs, Natura 2000), recreational sailing; fishing and diving; dredging/dumping; tourism (beach tourism), shipping and transport; coastal construction (urban development, harbours, marinas, coastal protection); refurbish beaches, artificial reefs, urban and rural residues; and military activities. In addition, illegal trawling (bottom, pelagic, and rapido trawling) often occurs within 3nm offshore, creating conflicts with the other fisheries.

Legal and Policy Framework

A variety of both European and national (Italian) legislation applies to the issue in question. Council Regulation (EC) 1967/2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea has substituted the majority of Italian legislation on related issues. Accordingly, most legislation is now based on this regulation. Local stocks (non-mobile local resources) are regulated primarily at local level, by local authorities, and at regional level (regions in Italy are governed by regional authorities). Seasons, areas and quotas for certain species are decided between local fisheries representatives and relevant authorities. These change from time to time; all management are based on the wellbeing of the stock. The Ministry of Agriculture and Forestry develops specific policies and implements those in line with the EC DG for Maritime Affairs and Fisheries. This is complemented by the regional Department of Agriculture, Forestry and Fishery. A number of specific consortia for the management of bivalve fisheries and small-scale fisheries also exist as well as national and local fishermen organisations. Nationally the Environmental Protection Regional Agency (ARPA) is responsible for implementing environmental legislation and policy. There are also a number of local organisations that are responsible for the management of Marine Protected Areas (MPAs).

Management Authorities

The Management Authorities who have responsibility for fisheries and aquaculture in this case study are:

- National Government
- Regional Authorities
- Environmental Protection Agency

There is a clear division between management authorities but in reality this is not applied. In the Adriatic Sea coast, the Regional Authority has planning powers for aquaculture management. This extends to the 12 mile limit but in some cases it can extend further offshore under a discretionary power whereby the Regional Authority can add specific conditions if it feels it is necessary. The Regional Authority also has some responsibility for the management of the exploitation of certain local fish resources (e.g. quotas, areas, fishing season and licences for mussel harvesting on wild banks), while the Government has competency for the management of shared resources (between regions and countries). This includes, for example, the power to halt trawling on a seasonal basis each year. For the purposes of planning and policy, two commissions exist. One of these is dedicated to the fishing economy while the other is a technical and scientific commission.

Main Conflict Types

- Conflicts between hydraulic dredges and set gears
- Areas surrounding mussel farms cannot be exploited by professional fishers (waste produced by farms)
- Conflicts between recreational fishers and small scale-fishers
- Illegal trawling inside 3nm from coast vs. small-scale fishers
- Hydraulic dredges vs. cables and pipelines
- Hydraulic dredges vs. nature conservation (MPAs)
- Illegal fishing using set gears inside mussel farms
- Conflicts between set gears and recreational sailing

- Conflicts between set gears and recreational diving
- Mussel harvesting vs. recreational fishing (recreational fishers often illegally collect large quantities of mussels from wild banks)
- Conflicts between recreational sailing, recreational fishing, recreational diving and nature conservation (MPAs)

Integrated Coastal Zone Management & Maritime Spatial Planning

In the Adriatic Sea coast there is no dedicated coastal management plan but there are regional plans for certain fisheries that apply in the case study area. Here the regional authority made a plan to identify areas along the coast for mussel aquaculture. This plan sub-divides large areas into smaller areas for individual development so it operates similarly to Marine Spatial Planning (MSP) but only covers specific aquaculture activities. A similar type of 'planning' exists for hydraulic dredges. This is organised according to different fleets and was a deliberate reaction from the regional authority when conflicts in relation to this issue began. Now the areas are divided into three with specific fleets allocated to each area. At the national level, work is on-going on the development of a national Integrated Coastal Zone Management (ICZM) strategy.

Future Scenarios Affecting Status Quo of Aquaculture/Fisheries

- Scenario 1: trawling banned inside 6nm
- Scenario 2: trawling banned inside 6nm and increase of mussel farms
- Scenario 3: trawling banned inside 6nm, increase of mussel farms and deployment of new artificial reefs
- Scenario 4: decrease of mussel density inside the mussel farms to 15ind.m^2
- Scenario 5: increase of density inside the mussel farms up to 1500ind.m^2

Opportunities for Co-Existence

- Exploiting synergies with recreational associations (both sailing and fishing), the Port Authority and the shipyard industry. The synergy creates work and income for the industries and assistance services for the pleasure sailors, as well as tourism promotion.
- Finfish repopulation due to the presence of the mussel farms. As fishing inside the farming areas is forbidden by local law, such areas act as protected zones where marine fauna can develop thanks to the absence of fishing pressure, the occurrence of submerged structures which create suitable habitats, and a greater food availability due to both mussels and epibionts settled on them. This positive effect favours either small-scale fishermen and trawlers who get high catches in the areas surrounding the farms. In addition, as most farms are situated close to the external limit of the coastal area (3nm), their physical presence contributes to obstacle illegal trawling inside the coastal area so protecting larvae and juveniles of many species.
- Strong synergies may exist between artificial reefs and set gears as well as between artificial reefs and recreational fishing and diving. Under appropriate management measures concerning seasons and gears, the areas occupied by artificial reefs could be exploited by small-scale fishers or could represent suitable areas for recreational fishers and divers.
- Marine protected areas can help to diversify small-scale fishers' income and to reduce the fishing effort. In fact, in some seasons a number of local fishermen could turn from fisheries to other activities associated with the MPAs (e.g: fishing tourism, charters,etc.).
- Artificial reefs and mussel harvesting/extensive mussel culture. Artificial reefs constitute suitable substrates for natural settlement of mussel larvae and make possible the development of consistent wild banks that could be exploited by fishermen and/or farmers.

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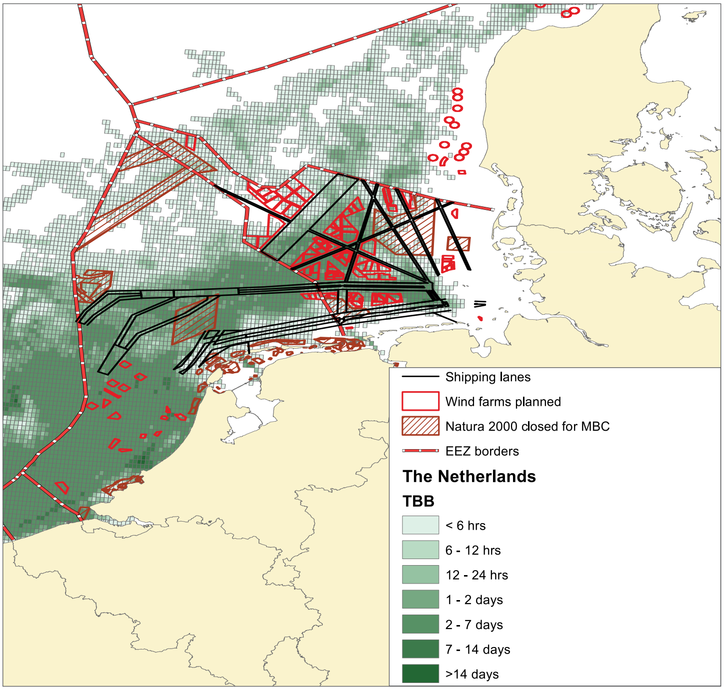
Case Study 5 – Coastal North Sea: Denmark, Germany, The Netherlands

Site Description

The case study area comprises the south eastern part of the North Sea, i.e. along the coastlines of the Denmark, Germany and The Netherlands. In the last decades human activities and the competition for space have increased. While many activities are regulated by spatial management, e.g. by means of priority areas, fisheries are not. In the near future, the fisheries sector runs a high risk of suffering from losses of fishing grounds.



MAP Effort (time per year) of Dutch fisheries using beam trawls and targeting flat fish (TBB) and areas which exclude all fishing (already built and planned wind farms) or mobile bottom contact gears due to existing and hypothetical future management in Natura 2000 sites.

Case Study Site Characteristics

The Greater North Sea is a semi-enclosed sea situated on the continental shelf of the North-East Atlantic Ocean. The sediment is sandy with patches of coarse sand, gravel and mud. Nutrient rich fresh water enters the coastal area from the rivers, including the rivers Thames, Scheldt, Meuse, Rhine, and Elbe. The North Sea is therefore highly productive, with highest primary production rates occuring in the coastal areas. The case study area includes the Wadden Sea, a shallow intertidal coastal water with tidal flats, channels and gullies, which is bordered by a row of islands. The study area concerns the shallow coastal area up to 50m depth.

Activities in the Case Study Site

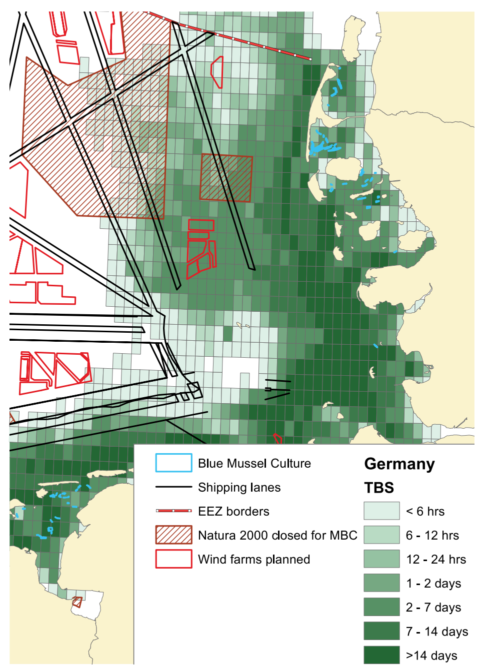
In the Coastal North Sea case study area, important human activities include: shipping; mining (oil, gas, gravel); offshore wind farms; cables/pipelines and various forms of fisheries, including beam trawling for flat fish, shrimp fishing, and pelagic trawling for round fish (e.g. herring); dredging for mussels, oyster and mussel cultivation; dumping; nature conservation (national parks and Nature 2000); military activities; and tourism and recreation.

Legal and Policy Framework

A range of international, national and regional policies and legislations apply to fisheries and aquaculture and other activities in the case study area. While fisheries are regulated by the EU Common Fisheries Policy, other activities are regulated by the member states. In the Netherlands, the Integrated Management Plan for the North Sea 2015 sets out how the North Sea will be managed in the next 10 years. In Germany, there is both a national policy and legal framework for sustainable development in the (German) North Sea Exclusive Economic Zone, and a local policy in the Territorial Seas, for which a number of federal ministries are responsible. In practice, implementation of national policies and applicable legislation are facilitated by the federal agencies of the aforementioned ministries. In the Danish part of the case study area there is no overall national spatial framework policy, instead management is carried out on a "case-by-case" basis and this is often based on public consultation.

Management Authorities

In the Netherlands, the management authority with responsibility for fisheries and aquaculture is the Ministry of Economic Affairs. The sub-national government has no role in the planning and management of fisheries and aquaculture in the North Sea as it is a national issue and managed by central authorities (Ministry of Infrastructure and Environment). This is also the case for issuing permits for activities. In the Wadden Sea, the Provinces are responsible for licensing and spatial management.



MAP Effort (time per year) of German brown shrimp fisheries using beam trawls (TBS) compared to a spatial scenario which excludes Mobile Bottom Contact gears from Natura 2000 sites and wind farms. Existing bottom mussel aquaculture sites are indicated in sheltered areas behind the islands.

In Germany, the management authorities with responsibility for fisheries and aquaculture are the ministries (environment, fisheries) of the federal states of the Federal Ministry of Food, Agriculture and Consumer Protection.

In Denmark, the management authorities with responsibility for fisheries and aquaculture are the Danish Directorate of Fisheries and the "Environmental Protection Agency".

Main Conflict Types

Offshore wind farm development entails the loss of fishing areas and can compete for space with aquaculture enterprises. Fishing in Natura 2000 sites is restricted to protect benthic habitats, birds and mammals. Large shipping lanes account for considerable space in the area and conflict with other uses. Fishing areas are further restricted due to seed mussel collectors, cables and pipelines.

Integrated Coastal Zone Management & Maritime Spatial Planning

The Netherlands has no dedicated strategy for ICZM. Instead, the National Water Plan and the Delta Programme are the key planning documents that relate to coastal policy. In Germany, an ICZM strategy is implemented in the Federal Regional Planning Act for the EEZ. The Territorial Seas are managed by the federal states. Denmark has not formally adopted a defined ICZM, but the ICZM-principles have been applied through a system of laws and regulations.

Future Scenarios Affecting Status Quo of Aquaculture/Fisheries

Environmental/Biological/Chemical: Changes in environmental conditions (climate change) could imply changes in the distribution of species, the availability of seed mussels, and foster the distribution of alien species and toxic algae. Oil spills are a risk for the ecosystem and its services.

Governance: Implementation and changes of European legislation e.g. Common Fisheries Policy, Birds and Habitats Directive (Natura 2000 areas), the Marine Strategy Framework Directive, etc., as well as national laws and acts, e.g. Renewable Energy Law in Germany, will influence the business environment.

Industrial: Competition for space with new offshore installations and their activities could affect the ability to maintain a fishery. The development of new technologies might foster the future availability of knowledge of the North Sea ecosystem.

Opportunities for Co-Existence

Shrimp fisheries could communicate seed mussel areas to aquaculture. Development of seed mussel collectors will reduce the need of seed mussel fishing and, with that, diminish the impact on the sea floor. Wind farm structures and aquaculture mussel/oyster beds provide habitats and refuges from fisheries for other species. Tourism benefits from conservation initiatives. The maritime atmosphere created by the presence of active fishing vessels. Tourists are often willing to pay higher prices for fresh, locally landed seafood products. Tidal ponds could be co-used for aquaculture; wave energy installations could protect offshore aquaculture facilities. Offshore logistics and personnel could jointly be used by wind farms, oil/gas and offshore aquaculture.

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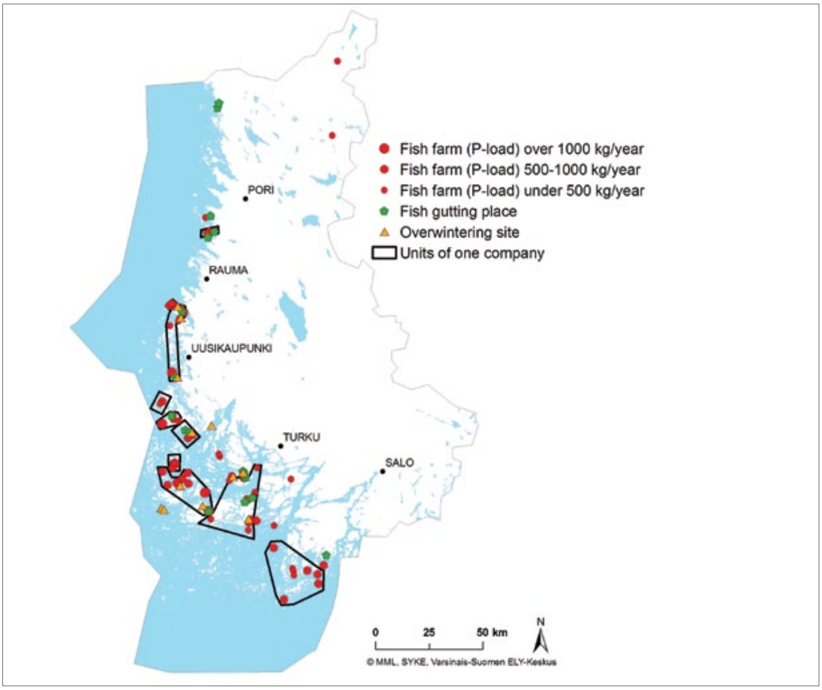
Case Study 6 – Baltic Sea: Finland

Photo courtesy of © Skye/RIISTAN -JA KALANTUTKIMUS

Site Description

In the Baltic Sea, fisheries and aquaculture industries have faced environmental and social conflicts which have affected their economic performance. New approaches to develop more sustainable governance have been raised by administrators, researchers and stakeholders. The central idea is to consider all the interactions in spatial planning in order to change the conflicts into synergies.



MAP Baltic Sea fish farms in SW-Finland Black line includes the units of one company
Fish farm unit over 1000kg/year production; Fish farm unit over 500-1000kg/year production
Fish farm unit under 500kg/year production; Overwintering site; Fish processing plant.

Case Study Site Characteristics

The Baltic Sea is a semi-closed brackish water sea. The Archipelago Sea is located in the Baltic Sea, Southwestern Finland. Characteristics of the Archipelago Sea is the high number of islands that make the area rather sheltered. Due to the brackish water character of the Baltic Sea, the fish that are found in northern Baltic Sea waters must adapt to minor salt content. The average depth of the Archipelago Sea is around 23m. In normal winters the ice covers the whole Archipelago Sea, in summer the water temperature may rise over 20°C.

Activities in the Case Study Site

Aquaculture activity of the study area is mostly rearing of rainbow trout (Oncorhynchus mykiss) in net cages, the end product weighing about 1.5kg. Commercial fisheries use relatively small boats on a family basis and typically use gill nets and trap nets. Leisure use of the area ranges from recreational fishing and people dwelling in their own summer houses, to boating and organised tourism. Environmental protection and private water ownership have limited operational opportunities for fish farming and fishing.

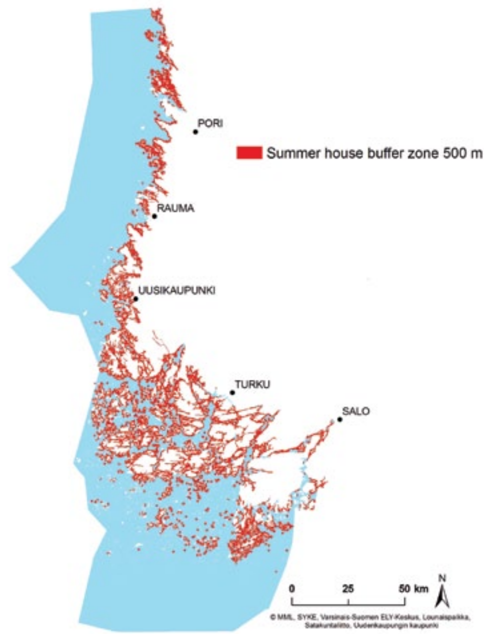
Legal and Policy Framework

There are a number of legal instruments and policies that relate to the issues of concern. National fisheries policy along with the Common Fisheries Policy (CFP) promotes the sustainable use of fish resources. The CFP provides a framework for governance of commercial fisheries but this applies further offshore than the case study areas go. The Environmental Protection Act and Decree requires that a fish farm needs an environmental permit if more than 2000kg of fish is produced per year or the annual consumption of feed exceeds 2000kg. In the last few years, Finland has reformed its land use planning system. The new system has three levels of land use plans: the regional land use plan, the local master plan and the local detailed plan. In addition, the Government defines national land use guidelines, which should be taken into account throughout the country in all land use decisions and land use planning.

Management Authorities

The Management Authorities with responsibility for fisheries and aquaculture in this case study are:

- Department of Fisheries and Game
- Ministry of Agriculture and Forestry
- Unit for Fisheries Industry
- Ministry of Environment
- Centres for Economic Development, Transport and the Environment
- Finnish Environment Institute
- Statistics Finland
- Finnish Food Safety Authority



Example of exclusion of the areas:
A summer house buffer zone of 500m marked with red.

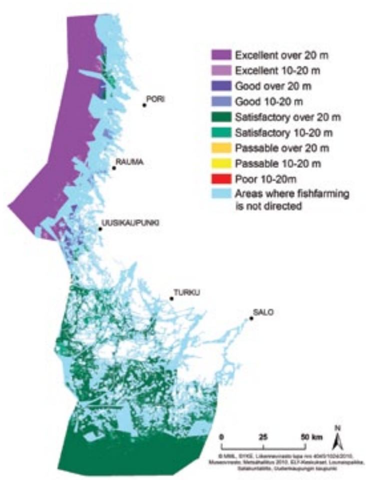
Recently the sectoral authorities were all unified to form just two bodies. If the regional council is interpreted to be a sub-national government, they do not have local planning power in relation to fisheries and aquaculture management. There is, however, a procedure ongoing at the Centre for Economic Development, Transport and the Environment which aims to develop a spatial plan for commercial fishing and aquaculture. The regional council is responsible for developing regional land use plans and for the spatial planning of fishing activities.

Main Conflict Types

- Aquaculture development vs. the environmental permit system
- Aquaculture development vs. summer house dwelling and recreation
- Commercial fishers' access to privately owned water areas
- Commercial fisheries vs. disturbances by recreational fishing
- Fisheries vs. protection of seals and cormorants
- Dredging/sand extraction

Integrated Coastal Zone Management & Maritime Spatial Planning

Finland has an Integrated Coastal Management Strategy but the status of its implementation is unknown (Thetis, 2011). There is a pilot ICZM project going on in the area north of the case study site. In relation to spatial planning, the Land Use and Building Act 2010 gives municipalities a large degree of autonomy in local land use planning.



The areas recognised suitable for aquaculture

Archipelago area	Area	Excluded
SW inner archipelago	681km^2	94%
SW middle archipelago	1285km^2	76%
SW outer archipelago	4217km^2	53%
Gulf of Bothnia inner coast	828km^2	95%
Gulf of Bothnia outer coast	1543km^2	72%
Archipelago and coastal area	554km^2	67%

The areas recognised suitable for aquaculture
Excellent 10-20m depth; Excellent 20-100m depth
Good 10-20m depth; Good 20-100m depth
Satisfactory 10-20m depth; Satisfactory 20-100m depth

This is guided by national land use guidlines from the national government and regional land use plans by the Regional Councils. All natural ecosystems in the coastal zone are protected by law (Thetis, 2011). The waters in the case study area are inshore waters (it is an archipelago). There is no formalised MSP approach in Finland as yet - management occurs on a sectoral basis.

Future Scenarios Affecting Status Quo of Aquaculture/Fisheries

Environmental/Biological/Chemical

- Diseases
- Climate change
- Eutrophication, oil spill risks
- Decrease of biodiversity and increase of mussel farms

Governance

- Increase of mussel farms and deployment of new artificial reefs
- Changes in the EU's agriculture and fisheries policies
- Cutting of the State's subsidies, abolishing fisheries advisory activities
- The implementation of regional plans, national park projects, environmental changes, warming of the climate, changes in the water and environmental protection legislation and in permit allocation practices
- Stricter environmental regulation
- The new Bothian Sea (Selkämeri) National Park. The site selections for aquaculture will based on biologists' defence and research claims

Industrial

- Decreased availability of feed
- The locations of the eventual windparks

Opportunities for Co-Existence

- The summer house dwelling may benefit commercial fishers. Tourism and recreational fishing benefit each other
- At present aquaculture supports other fish based economic activities, there is year-round supply of raw material for fish processing and logistics of transportation works
- Keeping the archipelago inhabited by means of fish based job opportunities increases the attractiveness of the whole region.
- The commercial fishing industry could help to remove nutrients to improve the state of the sea.

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