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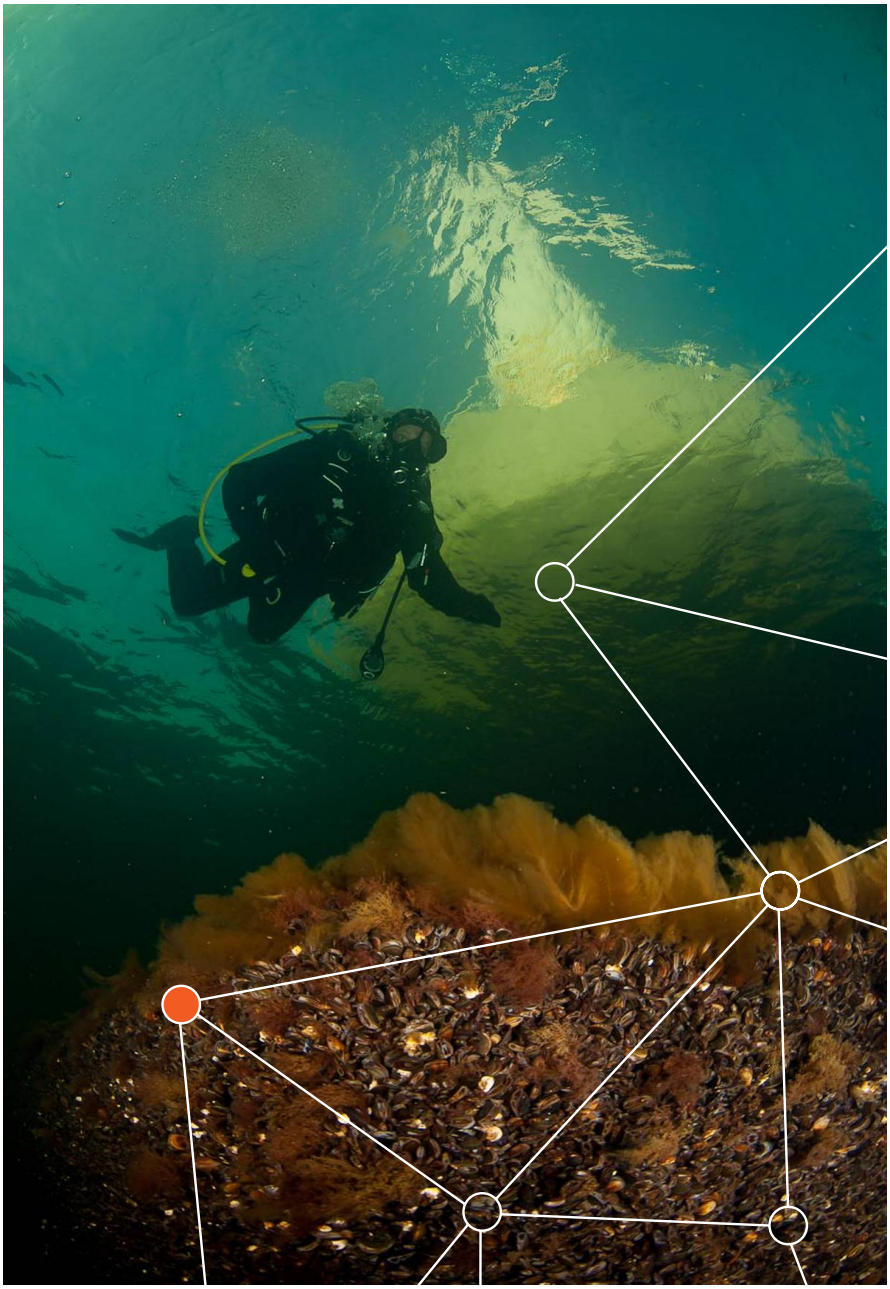

ICES INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
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Multidisciplinary perspectives in the use (and misuse) of science and scientific advice in marine spatial planning

Editors

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1 Introduction

It is recognized that a key goal of an ecosystem-based management approach (EBM) is sustainable use of natural resources that provide ecosystem goods and services (Cooper, 2013). In a marine context, EBM considers marine ecosystem health in the management of human activities that affect marine and coastal areas. The intent is that ecosystem components that are critical to maintaining ecosystem structure, function, environmental quality, and ecosystem services are maintained at appropriate temporal and spatial scales. This will ensure that these properties and functions are sustainable over time. Thus, impacts of activities on ecosystem components need to be maintained at levels that ensure this sustainability.

Use of marine space has increased significantly as a result of new demands for space, such as renewable ocean energy extraction including wind farms (driven by climate-change policies) and aquaculture (for food security). These increasingly compete with existing demands such as shipping and other maritime industries. This increased competition for space (e.g. between offshore wind farms, fisheries, and shipping) has resulted in increased conflict among maritime users, but also conflicting policy targets/goals (e.g. between environmental and economic policies).

Anticipating the future consequences of these pressures and drivers of change on marine life/resources and of adaptation and mitigation measures (such as the introduction of new technologies and structures, new ballast-water practices, ocean and offshore wind energy devices, and new fishing strategies) is a prerequisite to informing the development and implementation of forthcoming strategies, policies, and regulations such as marine spatial planning, the EU Marine Strategy Framework Directive (MSFD), the IMO Ballast Water Management Convention, and the EU Integrated Maritime Policy (IMP).

Marine/maritime spatial planning (MSP) is seen as a key tool for dealing with real and perceived conflicting uses, the development of sustainable spatial use patterns in marine areas, and achieving environmental targets such as the "good environmental status" in the MSFD. Marine spatial planning processes support operational management by bringing together ecosystem and socio-economic knowledge to identify management priorities for specific areas and providing a bridge between socio-economic and ecosystem-related policy targets.

Marine/maritime spatial planning is embedded in many coastal and marine policies such as the MSFD and the IMP and currently is being promoted at several levels, including HELCOM and VASAB for the Baltic Sea and OSPAR for the Northeast Atlantic.

At each stage of any MSP initiative, there is a broad range of scientific and socio-economic knowledge requirements. In establishing the scope, MSP requires spatial and temporal knowledge of existing ecosystem components in addition to comparable data regarding human use (i.e. ecosystem goods and services) and an understanding of the many institutional and administrative settings at several planning scales. The subsequent assessment stage needs to ascertain the interactions between ecosystem components and existing drivers and pressures in order to develop planning and management strategies. Although considerable discussion has occurred regarding the need to address science–policy gaps in decision-making, the challenge of transforming scientific data and information into transparent and widely accepted management decisions and measures remains. Similar challenges exist for quality assurance, transparency,

and prevention of misuse and misinterpretation of presented data, information, and scientific advice.

Twenty-two papers and three posters were presented at the Joint ICES/PICES Theme Session on "Multidisciplinary perspectives in the use (and misuse) of science and scientific advice in Marine Spatial Planning", held during the 2012 ICES Annual Science Conference (ASC) in Bergen, Norway. They offered concepts and decision frameworks of MSP processes, discussing specific case studies from different areas and tools to support decision-making in European countries, Canada, and the US. As set in the original theme session description, the papers covered the following topics:

- Multidisciplinary research approaches, which refer to the use of information within decision-making processes and address policies and regulations across multiple sectors;
- Natural or social science-based approaches, which assess cumulative environmental impacts and aim to establish knowledge-based management thresholds and targets;
- Research on interactions between human activities, related socio-economic drivers, and ecosystem changes, which refer to the resulting impacts on marine ecosystem goods and services;
- The use of ecological risk assessment as a means of setting management objectives and providing guidance in setting cross-sector marine spatial planning priorities, including the application of "Good Environmental Status" to identify risks; and
- Examples, which show best practises in the use of scientific data, information, and advice, including quality assurance in the decision-making process.

Based on inputs from several papers, there was much discussion about the role of science and scientific uncertainty and the difficulty in communicating these concepts with clients/stakeholders/managers at various steps along the MSP process. The need for a common language that bridges multiple disciplines was identified as one impediment to communication. The role of science in the negotiation processes varies greatly depending on the governance structures of MSP processes in each of the ICES Member Countries and the presented cases. Yet, throughout any MSP process, there are different scientific advice requirements that encompass a broad range of disciplines, data, and expert knowledge/opinion. In some processes, scientists are directly involved in the negotiation process and can sometimes end up facilitating the processes between stakeholders and planners. The more traditional and accepted role of scientific advice is to provide the basis for understanding ecological, social, economic, and legal constraints in the development of spatial and temporal management strategies. One challenge that is always at the forefront of these processes is related to conversion of descriptive science into spatial and temporal management strategies that meet set objectives. Impact assessments can elegantly describe potential impacts in relation to a given driver activity and its pressures on the ecosystem. Although there are still significant challenges, innovative methodologies are being developed and applied to identify and describe significant ecosystem and biological components as well as any impacts upon them; these rely on the availability of a vast array of data and knowledge. However, when requesting that this information be couched within a management context, all of this great science gets stranded in uncertainty. It is evident that the mandate and role of science and scientists in an MSP process should be clarified early in the process. When asking for advice, the question should be specific to the step of the MSP process that will allow scientists to bind their advice. However, (normative) assumptions made

in formulating an advice request or research question need to be made transparent. On the other hand, scientific advisory processes are key in the formulation of public policy and should not be side-tracked by scientific uncertainty, especially in ill-conceived requests for scientific advice.

MSP requires the input of a multitude of disciplines throughout the process. Although this is not an inclusive list, such disciplines typically include ecology, oceanography, social and anthropological sciences, economics, law, management, and public policy-making. Governance structures and implicated stakeholders have to understand the advice provided (including the associated uncertainty) and incorporate these in the development of an MSP plan. However, they typically face the so-called "debate and jargon of the disciplines" that can create confusion and uncertainty regarding the advice. In some cases, there may be the appearance of conflicting values and competing interests among the experts and the type of information requested from stakeholders which will impede trust and hamper consensus. Ideally, in the development of MSP plans, structured and normalized definitions throughout the process would ensure consistency and transparency, which will improve the process. These processes have to identify priority issues that need to be managed on the basis of the current available scientific advice. Land planning and risk management processes and tools can be used in a management context and could provide the needed level of normalization. Such frameworks and definitions should be developed for application in MSP.

Several papers discussed conflict resolution and geo-spatial tools in support of decision-making, e.g. priority-setting approaches, geo-spatial approaches to documenting fisheries and other human activities, and ecological components of the marine spatial planning area. Conflict resolution and geo-spatial analytical tools can be valuable integrators of specialized information that will facilitate communication to planners and stakeholders. However, the scientific and technical underpinning of these tools must be based on sound scientific methods where data manipulation and assumptions are fully documented in a clear and transparent manner. This documentation is particularly important to demonstrate how and for what purpose stakeholder inputs will be used in such tools. "Black boxes", where stakeholders and managers do not understand how input data are transferred into the output data and advice, need to be avoided. Given the extensive use of geo-spatial representation of data in MSP processes, there is a need to normalize and document the algorithms used in generating the maps that take into account the intended use of the map, scale, and resolution limitations, and the assumptions in the input data. Metadata should be available for each map explaining data sources, methods used, presentation standards, and interpretation limitations. These rules should also be considered for specific conflict-resolution tools such as Bayesian analysis approaches to assessing risk and priority setting of objectives and management strategies.

The theme session highlighted the need to frame the scientific and stakeholder policy advice for each step of the MSP process. Such requirements should be developed in the initial planning stages of an MSP process and should be reviewed as the process unfolds. It would provide the basis to identify appropriate data and tools to support the advice and would also facilitate the framing of the uncertainties.

In this report, we provide/summarize some of the presentations and posters from the theme session. Both the session and some of the contributions stem from discussions of the ICES Working Group on Marine Planning and Coastal Zone Management

(WGMPCZM). Discussions at the session also contributed to the ICES Cooperative Research Report 327 entitled "Marine Spatial Planning Quality Management System" (Cormier *et al.,* 2015).

2 Multidisciplinary considerations

MSP is primarily a policy-setting social process that is informed by scientific and technical knowledge and information. The participants represent very different constituencies and also have very different roles to play. Transparency, in such a process, is as much a function of information sharing as it is a function of clearly understanding the perspectives and concern of each participant as well as their roles and responsibilities. The planner is there to lead and manage the process in relation to public-policy objectives. Other competent authorities may be there to ensure that the plan is achievable within legislative and administrative constraints. In terms of stakeholders, they do not all have the same stakes – even more so, some of the stakes may be controversial in nature. Industry, in addition to development aspirations, may participate to ensure that economic and technical aspects are considered. Environmental NGOs may focus on environmental and nature conservation concerns, while coastal communities and the fishing industry may participate to ensure that access concerns and local interests are also considered.

2.1 Science–policy advice in MSP decision-making processes

In an MSP context, decision-making processes are related to the need to allocate space that addresses economic development aspirations, while also addressing environmental concerns within the scope of a given public policy setting. Scientific and technical advice should be based on questions developed by government authorities, industry, and stakeholders involved in the planning process in cooperation with scientific and technical experts. This approach provides assurance that the advisory process will deliver advice that is relevant to issues and objectives of the planning process. The scientific and technical advice would have been guided and derived from the requirements of the public policy setting and the expectations of the competent authorities, industry stakeholders, and communities of interest. Such processes integrate current data, published literature, and, in some cases, expert opinion in the formulation of advice to specific questions generated during the planning process.

However, the content of the scientific advice will vary greatly in relation to the question being asked. Science for the formulation of strategic policy decisions is often related to the new development proposals. A question such as "is this new development a good idea or not from a national policy-setting perspective" would require an assessment of potential environmental impacts, socio-economic consequences, and legislative repercussions. In some cases, the assessment may need to include ecosystem and management boundaries. Science for the formulation of regulations, standard operating procedures, or guidelines is often related to evaluation of management options to avoid environmental effects or health and safety incidents. A question such as "how much space needs to be set aside for…" or "when can this activity take place…" would require a very different knowledge base that would have to consider scenarios, effectiveness of management approaches, and the feasibility of implementing any particular approach. Science for the formulation of environmental advice is often related to the "state of the environment" or "ecosystem health" concerns. For example, questions such as "what are the significant ecosystem functions needed to support this ecosystem service" or "what are the significant ecosystem components that need protection" would have to combine ecosystem knowledge with the pressures generated by human activities being planned to identify protection and restoration measures. During the planning process, the scientific and technical policy advice should be formulated from the questions raised by the managers and stakeholders involved in the planning. Thus, directed from the maritime policies and the planning process.

2.2 Uncertainty implications in MSP decision-making processes

In MSP, uncertainty is most often perceived as the potential environmental impacts of the various socio-economic scenarios being contemplated during the planning process. However, uncertainty also lies in the effectiveness of the spatial and temporal management measures being proposed in the plan. Uncertainty can be related to the direction of future development as new technologies or opportunities presents themselves as well as to the future state of the environment. It can also be related to changing values and priorities of society and the public policy process.

Although the future is uncertain, one can assume some certainty that the intensity of human activities in marine areas will continue to increase as a result of political, economic, and societal development. New activities will emerge among traditional uses which will shift public policy processes outside traditional sectoral and environmental management paradigms. A planning process is inherently uncertain as it has to find solutions to address conflicting policy objectives and differing jurisdictions in order to produce a plan that will be implementable. Working within a continuous improvement process, the cycle of planning, implementing, monitoring, and reviewing is required not only from an adaptive management approach, but also to adapt the plan to changing policy and societal contexts instead of having a mainly data-driven process. MSP has to design a plan that addresses user-to-user conflicts as well as environmental concerns where scientific knowledge of environmental issues is but one of the elements to inform the process.

In a management context, uncertainty is in relation to achieving the objectives (ISO, 2009). In MSP, the allocation of space to specific or combined uses and for conservation measures is intended to reduce the uncertainty in achieving the objectives established at the onset of the planning process. Although precautionary approaches may be used in the allocation itself, it is in the implementation and the monitoring that the performance of the plan can be ascertained and revised. For example, scientific uncertainty usually lies within the impact predictions, the effectiveness of the spatial allocations intended to prevent or mitigate impacts, or in predicting the future environmental states or trends. Environmental research improves our knowledge and understanding of ecosystem functions and states. However, monitoring programmes need to be tailored to measure the effectiveness of the spatial allocations in the implemented plan in relation to environmental objectives. There is also uncertainty concerning the effects of the activities of sectors operating within their spatial allocation specified in the plan. Surveillance and compliance verification initiatives are also needed to ensure that the spatial allocations and related management measures are being implemented adequately. Combined with scientific research and monitoring, the implementation and compliance play an important role in characterizing the effectiveness of the management measures in contrast to environmental trends being observed in monitoring. In a review, the questions would be "are the spatial allocations effective at achieving environmental outcomes?" as opposed to "are environmental trends related to external factors that are undermining the plan's spatial allocation?". These two aspects of uncertainty are mostly related to scientific and technical questions. Another layer of uncertainty lies in the policy and management activities of the planning, review, and implementation processes. The uncertainty in achieving objectives may also lie in the lack of clear or tangible policy objectives or in the presence of multiple incompatible objectives, in the communication ambiguities between science, management, and stakeholders, or in the lack of jurisdictional coordination and enforcement. Performance evaluations combined with stakeholder interviews can provide insight as to the gaps that may lie in the planning process, implementation, and even the monitoring.

A key aim of a planning process is to characterize and educate people regarding these uncertainties in order to reach a common understanding of what they are. The planning process can then undertake discussions on the feasibility of managing specific uncertainties in contrast to those that are outside the realm of the planning process or that cannot be addressed by the plan.

2.3 Geo-spatial analysis implications in MSP decision-making processes

Geo-spatial analysis of human activities occurring in a given management area as well as the distribution of ecosystem functions and components provide the basis for identifying potential user-to-user conflicts and environmental impacts. The additional integration of future spatial uses resulting from development policy objectives is technically a key use of geo-spatial analysis in MSP. Although it is well understood that the maps produced are static in time and space, they provide a starting point for the planning process and play a key role in developing an understanding of user-to-user spatial conflict as well as significant ecosystem functions and components.

During a planning process, maps cannot be updated continuously without providing a full description of what is being updated and why. Assumptions based on the understanding of what the map is providing form the basis for decisions made during the process. Although updates are intended to improve the information or the reliability of the maps, the resulting maps may create confusion among stakeholders that can undermine the negotiations as well as credibility of the process itself. The original maps should always be kept in the records and the updated maps should have detailed descriptions of the changes made in the metadata that are usually attached to them.

Maps are powerful communication tools that can bridge language and technical barriers. However, the metrics and presentation colour schemes are also an important aspect in the use of maps in planning processes. The presentation of a metric (e.g. numbers of vessels per square kilometre, fishing effort frequencies, ware height) within a colour scheme will communicate different things to different users of the maps. The typical use of green to red transition to represent intensity can be interpreted as increasing risks or likelihood of a hazard or impact occurring. The harmonization of the presentation is particularly important when comparing maps produced from different sets or within a cross-jurisdictional setting as each set of maps may have been produced to inform different policy contexts.

In addition to simply mapping what occurs where and when, geo-spatial analytical tools can also be used to assess risk and evaluate management scenarios. Maps produced within the specific policy context and questions resulting from the planning process help resolve and find spatial solutions to conflicts as well as perceived conflicts in a multi-stakeholder planning environment. The integration of modelling combined with management outcomes resulting from the planning process can also prove valuable in the design of monitoring and surveillance programmes.

2.4 Communication implications in MSP decision-making processes

Communication and engagement is likely the most important function of an MSP planning process. It also plays an important function in reporting the plan implementation and performance based on the results of monitoring. Communication is only one of the engagement elements of the planning process. A process educates and informs external participants, such as other competent authorities, industry sectors, and stakeholders, concerning objectives and the decisions being made as planning progresses. It also seeks feedback from all involved in terms of the spatial allocations being considered

and the potential impacts and legal implications that these may have on existing and future users of the area. The process also seeks advice from scientific and technical experts in relation to questions as well as questions received from stakeholders.

Effective communication involves knowing the audience, involving the scientific experts if the discussion is of a technical nature, and differentiating between scientific and technical information on one hand and value judgments on the other. This includes the use of appropriate language and the avoidance of overly technical jargon. It should position the elements of information within the marine spatial planning context. Ineffective communication can be perceived as a lack of transparency and can lead to a loss in credibility; hence, the communication should be using the appropriate language, fora, and media.

Communication and consultation processes help to

- establish the context for the planning process;
- ensure that the interests and values of industry and community stakeholders are understood and considered;
- ensure that the risks resulting from one user to other users as well as environmental conflicts are adequately identified;
- identify scientific and technical advisory needs as well as the expertise needed to provide the advice; and
- ensure that the MSP process and the resulting plan are endorsed and supported.

The understanding and perceptions of the risks vary from one person to another because of differences in values, objectives, assumptions, and concerns. Planning processes and communication activities need to avoid bias resulting from power structure among participating parties (Flyvbjerg, 1998). A participatory approach to the planning process facilitates an open exchange of factual information in contrast with value judgement allowing, in particular, the recognition of differences in terms of value judgements and concerns that may potentially undermine the engagement of a particular group or the credulity of the process itself.

3 Concluding remarks

Although MSP is a policy-development process for identifying conflicts and environmental issues and for allocating space for specific functions, the management of the planning activities and decision procedures themselves are as important (Hoyle, 2011). Whenever a consultation is initiated, advice is sought, or recommendations are being formulated, administrative procedures and practices should ensure that:

- there is consistency between the purpose of a given activity and the MSP planning objectives and that these are consistent with the feedback, advice, and expectations of the competent authorities, industry, and stakeholders;
- there is clarity in purpose of the MSP planning objectives and process in that people involved in the process understand what they are expected to provide as feedback and advice as well as understand what they are trying to achieve;
- the actions and decisions taken during the process are demonstrably connected to the objectives and that people involved in the process understand the context of the decisions in addressing the objectives;
- the consultation, scientific, and technical advisory processes address questions and concerns raised in planning and that deliberations reflect views and opinions of the constituencies represented at the table;
- the process has defined steps and expected outcomes to provide certainty and transparency as to the progress being made during the planning process; and
- periodic reviews and reporting are conducted to verify whether there is clear line of sight between the objectives initially established and the ongoing results of the planning, providing a forum for adjustments and improvements.

Although values may be intangible, it does not mean that they are non-existent and may be discarded during the planning process. These are most likely the basis of conflict that can undermine engagement and trust in the process. The participation of stakeholders is, therefore, more than a communication strategy. It should be about identifying tangible and intangible values and integrating these in the planning process. In some cases, intangible values may actually be concerns of losing something or of being impacted by the plans. Although a planning process may be inherently linear and policy-driven, the planning table ideally should provide a forum for discussion, education, feedback, and understanding within an atmosphere of equity and fairness. However, this does not necessarily mean that final decisions in a planning process are based on consensus by all stakeholders or even please everybody. Technically, participation by stakeholders means increasing the information base for decision-making and thereby identifying potential constraints for implementation. Furthermore, politically and socially, participation signals openness and provides transparency, which may improve acceptance of decisions in planning processes even by those who do not see themselves as beneficiaries and by the public.

4 Paper contributions

The following are summaries of papers contributed by the participants of the theme session.

4.1 Fishery vs. new concepts of the use of sea space: an example of the Polish marine areas

Eugeniusz Andrulewicz, Wojciech Pelczarski, Emil Kuzebski, and Lena Szymanek

This presentation discusses how the fishery may coexist with the new technical developments and with the existing and planned technical construction projects which are going to be set up in the Polish marine areas of the Baltic Sea. The Polish fishery will face restrictions of its activities in offshore and coastal waters due to numerous projects for energy production (wind farms), extraction of mineral resources (oil and gas, sand and gravel), and the laying of new pipelines and cables (Figure 4.1.1).

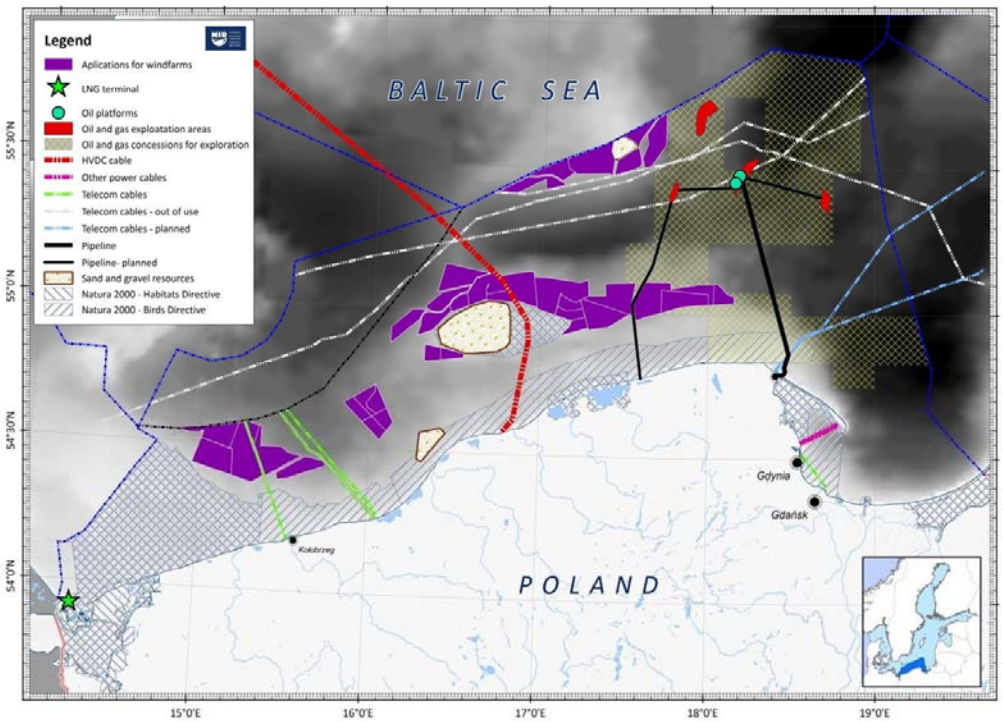

Figure 4.1.1. Polish marine areas of the Baltic Sea.

Valuation of the sea area used for the Polish fishery is based on a review of the monetary value of the fishery, fishing effort, and fish landings in the Polish marine areas, with special emphasis on areas restricted for technical construction projects. The paper also discusses how to diminish potential conflicts through the marine spatial planning process.

The authors indicate which parts of the sea are of vital importance for preserving the fishery and fish resources and those parts that can accommodate other activities. It is assumed that the Polish example might be a useful case study for the other Baltic countries.

4.2 The Trilateral Wadden Sea Cooperation: a model for transnational cooperation in MSP and MSFD

Christian Fischer and Andreas Kannen

4.2.1 Introduction

The Trilateral Wadden Sea Cooperation (TWSC) was founded by Denmark, the Netherlands, and Germany in 1978. The aim of the cooperation is to protect and conserve the Wadden Sea, covering management, monitoring, research, and political matters (CWSS, 2012). During its existence, important benefits for the Wadden Sea have been achieved by TWSC (Moser and Brown, 2007; CWSS, 2010).

For this research, the TWSC was analysed along two major questions:

- Which factors of cooperation played an important role in the evolution of TWSC?
- Can TWSC be regarded as a good example for transnational cooperation?

4.2.2 Method

In order to answer the central questions, three analytical steps were taken:

1) The TWSC was first analyzed using the Governance Baseline Method developed by Olsen *et al*. (2009). This provided an overview of the institutional development of TWSC based on document analysis" (Figure 4.2.2.1).

2) Second, the document analysis was cross-checked with four expert interviews to gain background information and insights not identifiable through document analysis.

3) The third step outlined lessons for marine spatial planning (MSP) and the Marine Strategy Framework Directive (MSFD).

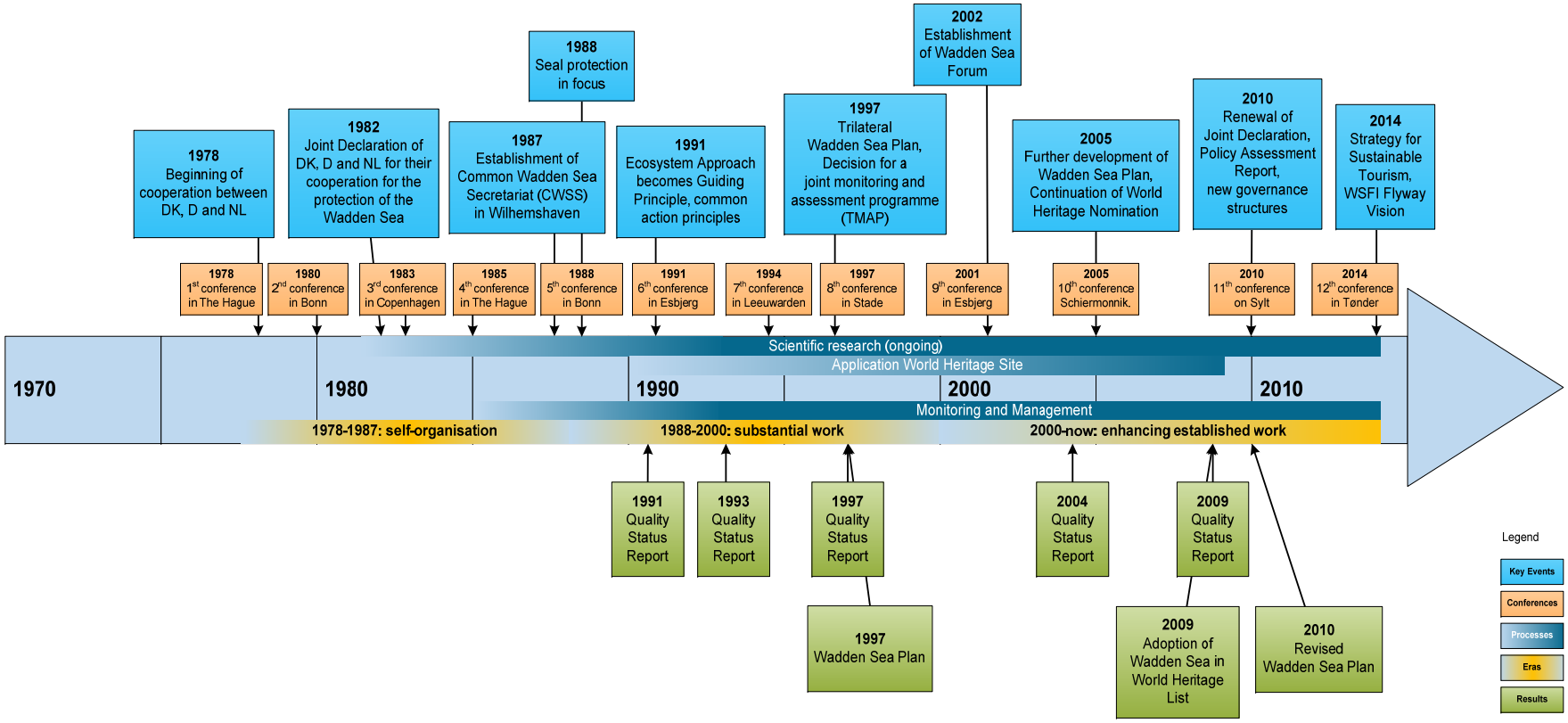

Figure 4.2.2.1. Key events, processes, and results of the Trilateral Wadden Sea Cooperation (Kannen, Gee, and Fischer, 2013).

4.2.3 Results

MSP and MSFD implementation is a resource-binding and labour-intensive process. Both processes demand intensified cooperation, which is a particular challenge (European Commission, 2008a, 2008b).

The following important cooperation factors influenced the transnational cooperation of TWSC:

- common interests (Joint Declaration in 1982, updated in 2010; Common Wadden Sea Secretariat, 2010);
- thematic limitation;
- small size of group;
- spatial and emotional identity with the Wadden Sea area;
- responsible node of coordination (with long-time staff);
- legally non-binding character (flexible solutions possible).

Thus, TWSC can be regarded as a good example for transnational cooperation.

4.2.4 Discussion

Transferability of the TWSC approach to other contexts is conceivable, but limited in practice. Other areas often have more neighbouring countries and, therefore, more diverse interests. Due to greater spatial variety, there may be less spatial and emotional identity as in the TWSC case.

One suggestion for transferring the success of the TWSC to other contexts is to use existing conventions for Europe's regional seas as nodes of coordination. Within these conventions, smaller groups could be built based on common interests and spatial identity/similarity. An interesting question is whether ecological regions coincide with regional identities.

Another suggestion is to start with non-statutory (non-governmental) cooperation, e.g. Plan Bothnia.

4.3 Incorporating social–cultural dimensions of ecosystem services in MSP

Kira Gee

4.3.1 Problem context for MSP

Maritime spatial planning (MSP) has gained prominence as a holistic, place-based approach to marine management tasked with managing a growing range of demands placed on the sea. Its challenge is to allocate sea space in line with the ecosystem approach, "analysing and planning the spatial and temporal distribution of human activities in sea areas to achieve economic, environmental and social objectives" (European Commission, 2013 p. 1). From an ecosystem-services perspective, MSP can also be understood as an attempt to allocate space to the full range of ecosystem services provided by the oceans (Lester *et al.*, 2013) in such a way that ecological and socio-economic objectives are met. In most cases, "the ultimate aim of maritime spatial planning is to draw up plans to identify the utilization of maritime space for different sea uses" (European Commission, 2013 p. 1).

Irrespective of the spatial scale of MSP and its statutory or non-statutory nature, planning is based on three main requirements:

- getting to know the resource: what are we dealing with? (ecology, different goods and services, new demands, trends in sea use);
- establishing risks that new uses or cumulative impacts might bring to the resource and to existing activities, goods, and services; and
- setting priorities for sea use.

4.3.2 MSP as a question of values

Setting priorities for sea use implies that choices need to be made with respect to different marine activities and the goods and services to be obtained from the sea. Ultimately, this is a question of values. At present, maximizing economic values is a clear political priority and a task levelled at MSP, as indicated by the EU's strategy for Blue Growth (European Commission, 2012a) and the Draft EU Directive on MSP and ICZM example (European Commission, 2013). But MSP is also recognized as a tool for preserving ecological values, as shown by the reference to spatial and temporal distribution control measures in the Marine Strategy Framework Directive (European Commission, 2008b). Given that MSP aims to reduce conflicts of use and promote sustainable growth, it clearly also deals with wider societal values such as fairness in the allocation of costs and benefits of sea use.

Most planners would agree that MSP should be as inclusive as possible with respect to the values it deals with, ensuring that a broad range of ecosystem services or different ways of valuing the sea are taken into account. Most would also probably agree that at least some participatory element is necessary when it comes to determining the relative importance of different services and benefits.

This contribution argues that two concepts of values are important which matter in the MSP process in different ways. The first is the view of values as preference-based values; in other words, objects, goods, and services that humans choose. Classifications commonly differentiate between the material and non-material value assigned to objects, which is closely related to the tangible (monetary) and intangible (non-monetary) benefits obtained from goods or ecosystem services. Despite calls for improvements (Schultz-Zehden and Gee, 2013), the knowledge base is reasonably good for some monetary values derived from the sea (e.g. fishing, ports, and shipping). There is also a reasonable evidence base for ecological values where established scientific methods are available to measure values such as biodiversity. However, for most other non-material values, the evidence base is poor. This is especially the case for socio-cultural values embodied in concepts such as seascape, home, tradition, nature, beauty, or spirituality. Accounting for these values represents both a conceptual and a methodological challenge. For example, how can the symbolic value of the sea as expressed in legends or stories be compared to hard economic facts such as the income derived from certain sea use, and which value should ultimately count for more? Nevertheless, if MSP is to encompass the entire range of values the sea provides, ways must be found to close the "socio-cultural values gap" and to include such non-material values in decision-making processes.

The second value concept is that of values as norms; in other words, the inner convictions and driving forces that determine why things matter to us. Inner convictions play a role in determining how much value is assigned to different goods and services, e.g. the belief that a beautiful sea view should count for more than an offshore wind farm. Here, the question is how these inner convictions and beliefs drive attitudes or the way we rate the benefits obtained from different ecosystem services.

Figure 4.3.2.1 places both value concepts in the context of the MSP process. The first concept—intangible values as preferences—comes into play during the data-collection and mapping stages of MSP. Key questions relate to the precise nature of intangible marine values, their identification for each respective context, and their location in space relative to other marine values. As is the case with ecological and economic values, key issues here are the identification of areas of high cultural value and assessment of their resilience in the face of change. The second value concept matters more during the comparative assessment of different values and the establishment of priorities. In the context of trade-offs, it is important to understand why particular values are considered a priority by different stakeholders and why certain values may seem less negotiable than others.

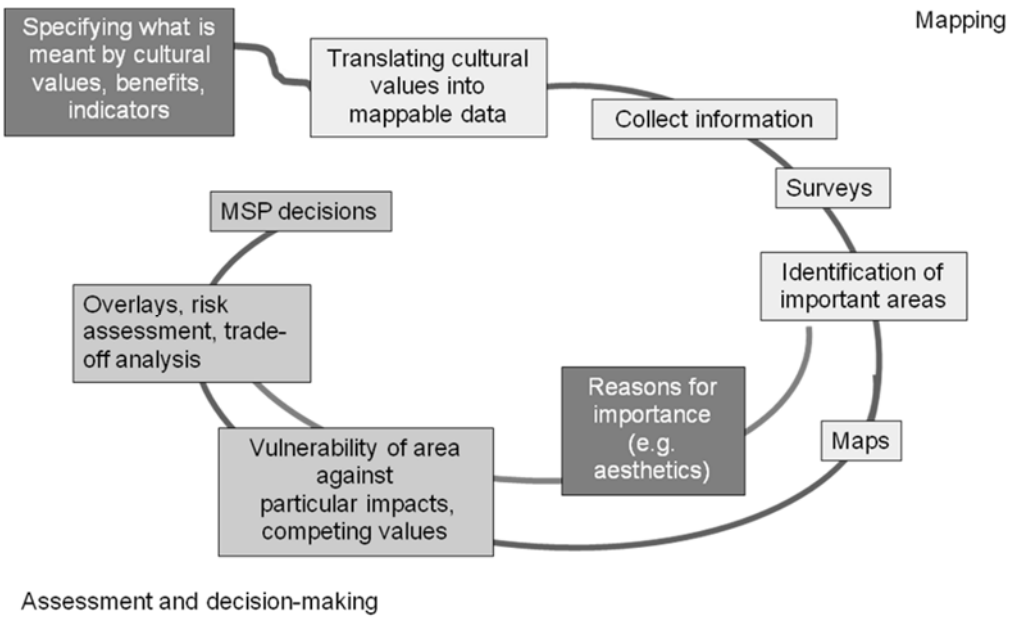

Figure 4.3.2.1. The role of preference-based values and values as norms at different stages of MSP.

The following sets out some of the current challenges associated with these value concepts.

4.3.3 Making the intangible tangible: the concept of cultural ecosystem services

One of the key questions in the above context is how to translate the inherently intangible cultural values into more tangible units that will lend themselves to the type of comparative value assessments required by MSP. A common approach has been to break down cultural values into conceptual units. A well-known classification system and possible framework for capturing the wide range of non-material values associated with the sea is that of cultural ecosystem services (CES). CES are defined as "the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences" (Millennium Ecosystem Assessment, 2005 p. 40), or the "ecosystem's contribution to the non-material benefits (e.g. capabilities and experiences) that arise from human–ecosystem relationships" (Chan *et al.*, 2012). Intangible CES have been shown to substantially contribute to human well-being, and many are also linked to moral concerns, which can act as a motivational force for people to protect ecosystems (Klain and Chan, 2012) or their local home region (Ratter and Gee, 2012). The *Millennium Ecosystem Assessment* provides the following categories of CES:

- Cultural diversity
- Spiritual and religious values
- Knowledge systems (traditional and formal)
- Educational values
- Inspiration
- Aesthetic values
- Social relations
- Sense of place
- Cultural heritage values
- Recreation and ecotourism

A wide range of literature has developed which deals with various aspects of CES at different spatial levels. In terms of categories, recreation and aesthetic values have received the most attention as they are comparatively easy to elicit. Many studies have a methodological focus, concentrating on different ways of collecting and quantifying intangible values (e.g. Gee and Burkhard, 2010; Norton *et al.,* 2012; van Berkel and Verburg, 2012; Hernández-Morcillo *et al.,* 2013; Plieninger *et al.,* 2013). Indirect measures of value are commonly employed, such as distribution patterns and their correlation with particular landscape attributes (see e.g. Dalton *et al*., 2010; Nahuelhual *et al*., 2013), as are monetary methods such as willingness to pay to estimate the value of aesthetic experiences (e.g. Adamowicz *et al.,* 1998; Biénabe and Hearne, 2006; García-Llorente *et al.*, 2012). Authors have also pointed to the importance of deliberation in valuing ecosystem services (Kenter *et al*., 2011) or the role of subjective metrics (Satterfield *et al*., 2013). There has also been more general criticism of the concept of ecosystem services for its inability to address the diversity of values and failure to recognize the ubiquity of intangible values across CES categories (Chan *et al*., 2012).

Despite the strong interest in CES, few studies so far specifically focus on the marine environment or explicitly deal with the link between CES and MSP. Exceptions include participatory mapping exercises of coastal and marine values in Canada and Scotland (Dalton *et al*., 2010; Alexander *et al*., 2012; Klain and Chan, 2012), attempts to establish the value of marine biodiversity to the leisure industry and linking this to MSP (Rees *et al*., 2010; Ruiz-Frau *et al*., 2013), tools to assess trade-offs between different ecosystem services (Lester *et al*., 2013), or tools to assess the value of multiple services provided by marine ecosystems (Guerry *et al*., 2012). Maps have also been highlighted as an important means for assessing spatial trade-offs among ecosystem services (Martinez-Harms and Balvanera, 2012). Their recent review of methods for mapping ecosystem services found that cultural and supporting ecosystem services were the least frequently mapped, although recreation was the third most frequent of 19 different ecosystem services mapped (Martinez-Harms and Balvanera, 2012). The authors note that ecosystem services critical to human welfare such as scenic beauty are rarely addressed and that more formal research is needed to address these gaps. This seems to particularly apply to the marine context.

So, how to translate the essentially theoretical concepts of CES and intangible values into an applied MSP context? Working with CES in practice, it can be helpful to differentiate between ecosystem services on the one hand and the benefits obtained from these on the other. The services concept can be useful in collecting baseline information, ensuring MSP takes account of the full range of services provided by the sea. Benefits can offer a useful basis during the later stages of the MSP process when it comes to weighing the relative importance of different values. However, a range of open questions remains for working with intangible values in the specific context of MSP. Some

of the conceptual challenges and opportunities for working with CES are presented below.

4.3.4 The composite nature of what is valued

Although the above CES categories go some way towards describing intangible values, careful consideration must be given to what exactly is being described in each case. Conceptually, there is a difference between "the thing itself", appreciation of the thing, and knowledge of the thing (Brown, 1984). The "thing itself" can be a physical object or a service, such as elements of the physical landscape (waves, sand, wind) or a coastal landscape. Appreciation is an expression of the benefits obtained from a service, which can be economic, aesthetic, emotional, or moral and translated into valuation by individuals, groups, or society. Knowledge of the thing, in turn, may be unrelated to benefit and simply be the value of knowing that something exists (intrinsic or existence value).

Classifications, however, only go so far in describing precisely what is valued. One of the key problems with respect to CES is that experiences consist of "bundles" of services, benefits, and values (Klain and Chan, 2012). Various links exist between the setting of an experience (e.g. physical landscape values), the experience itself, and other factors. For example, aesthetic CES can be classed as a place-based service, but the aesthetic experience and thus the appreciation and value assigned to the CES depend on other factors such as social context, societal norms, access, weather, and even the mood of the observer. The recreational experience of fishing may involve provisioning and aesthetic ecosystem services, yield spiritual and health benefits, and touch upon intrinsic or bequest values (Klain and Chan, 2012). Classification and attempts to quantify benefits may actually cause the essence and, therefore, the real value of such bundles to be lost.

Even if the problem of separating services and benefits can be resolved, difficulties remain in assessing how much benefit is created by which CES, where and when this is created, and who obtains these benefits. In the Millennium Ecosystem Assessment (2005), the benefits derived from ecosystem services are linked to human well-being, where descriptors may include economic proxies such as income or jobs generated, but also non-monetary proxies such as quality of life. Quite apart from the issue of composite experiences and values, weighing up the relative merit of these constituents is a difficult task. For example, how strong is the contribution of habitat and species value to personal well-being, and whose well-being should count? Different constituencies may value CES benefits differently, causing misalignments between the value ascribed to a habitat by local communities and wider communities of interest. Some attempts have been made to establish qualitative links between different CES and the non-monetary contributions to human well-being (Millennium Ecosystem Assessment, 2005; Busch *et al.*, 2011; Summers *et al.*, 2012), but quantification of these links has so far proven elusive.

Figures 4.3.4.1 and 4.3.4.2 illustrate the problem of value bundles and the problem of working with set CES categories. Figure 4.3.4.1 shows the results of two surveys carried out among local residents on the western coast of Schleswig-Holstein (Germany). An open question "What do you spontaneously think of when you hear 'North Sea'?" was asked to establish spontaneous associations with the "North Sea". Most respondents offered a wide range of associations, consisting of objects in the environment (such as dikes and lighthouses), composite images of the environment (such as landscape character), experiences in the environment, benefits derived from the environment, images of nature, symbolic meanings of the North Sea, and "Heimat" (home), a German term

encompassing identity, belonging, and place attachment. The range of answers received from each person shows that perception of the sea is never one-dimensional, but a composite image that only emerges in its entirety when all elements are bundled together.

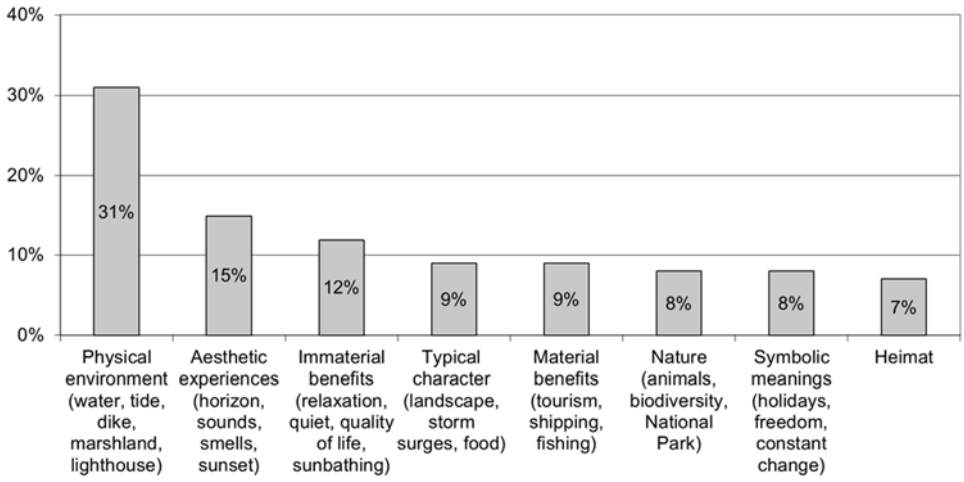

Figure 4.3.4.1. Survey results from the German North Sea coast (west coast of Schleswig-Holstein 2005/2012): responses to the open question "What do you spontaneously think of when you hear "North Sea"? (Each category gives the percentage of mentions out of a total of 2052) (587 respondents).

Figure 4.3.4.2 illustrates the practical difficulty of working with the Millennium Ecosystem Assessment CES categories. In one of the surveys mentioned above (see Gee and Burkhard, 2010 for methodological details), a second open question was asked to establish which values were rated most highly by local residents. The fresh sea air and the special North Sea climate emerged as the most frequently mentioned values, followed closely by the aesthetic qualities of the seascape and tranquillity.

Whilst seascape qualities, landscape qualities, and other aesthetic qualities can be assigned to the category of "aesthetic CES" relatively easily, there are no immediately obvious CES categories for values such as fresh air, tranquillity, or "elements of nature", which is a collection of nature-related values (e.g. species or habitats). "Specific sense of place" (often linked to "home" in this example) is a classic example of a composite value that defies simple categorization because it includes aspects of recreational value, aesthetic value, identity, the natural environment, and others. "Tranquillity and relaxation" are not a service, but benefits obtained from experiencing the coastal environment, which places them into a different category altogether.

A key lesson to be drawn from these examples is that the specific categories for CES and benefits need to be defined for each specific context. Definitions and metrics need to emerge from interaction with stakeholders or communities, taking care that processes and results reflect values that are meaningful in each specific MSP context. Different social science and anthropological methods are available for eliciting values and benefits (e.g. questionnaire surveys, interviews), although care needs to be taken to define the appropriate constituency and to attain inclusiveness. An example of operationalizing socio-cultural values for MSP is offered by the Canadian SECOA project (The Southern Gulf of St Lawrence Coalition on Sustainability, 2009).

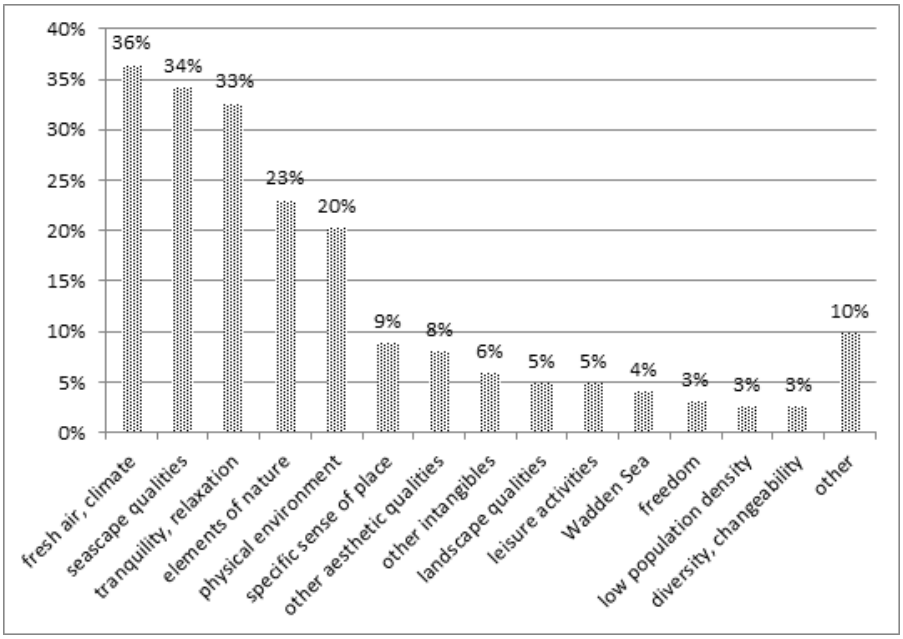

Figure 4.3.4.2. Survey results from the German Wadden Sea: responses to the open question "What do you treasure most of all about the sea and the west coast?" (multiple answers were possible, with each category showing the percentage of answers received from 387 respondents).

4.3.5 Non-material values and space

Decision-making in MSP often relies on maps that visualize trends, pressures, and opportunities for marine space. To increase visibility of socio-cultural values it is, therefore, helpful to include these in mapping exercises to show their spatial distribution and density.

Place-based cultural values can be located in space in a way that is comparable to material values, generating distribution maps or "hotspot maps" for socio-cultural values similar to the distribution of other resources. Participatory processes have been tested in various contexts to map a broad range of place-based values, including the wilderness value of places, their therapeutic value, biodiversity value, learning value, or creative value (see e.g. Brown, 2005, 2012; Brown and Raymond, 2007; Alexander *et al.*, 2012). An advantage of GIS-based participatory mapping is that overlays can easily be produced and areas can be pinpointed that are valued for different or several reasons or by particular persons or interest groups. Nevertheless, different ways of seeing may need to be found to account for cultural values in four dimensions, and different ways may also need to be found for representing cultural values that cannot be pictured in two dimensions. A related difficulty lies in dealing with values that are not location-specific, such as the generic value attached to nature, intrinsic values, or spiritual values not linked to particular sites. In the sea, cultural values are often associated with particular practices (e.g. traditional fishing), where the problem of mobile resources can create spatial and temporal shifts in the value base. The drawbacks of mapping also include the need for "map literacy" of the participating persons and their willingness to pinpoint places in space (Klain and Chan, 2012).

4.3.6 Tracing shifts in values and benefits

Values are not static, but change over time. The outcome of priority-setting in MSP, therefore, not only depends on who is involved, but also when it takes place. A survey in Germany, for example, found that the aesthetics of wind farms are valued differently by older and younger people (GEO Magazin, 2008), pointing to a generational shift in

preferences. Value and benefit assessments, therefore, need to be regularly updated much like the regular monitoring of economic and ecological developments. This, in turn, requires a precise definition of what is being monitored and standardized methodology.

CES can be a useful framework for assessing actual or expected shifts in values. A case study in Germany used an adaptation of the Millennium Ecosystem Assessment CES categories for assessing the expected impacts of offshore wind farming on non-material marine values. Figure 4.3.6.1 shows the expected value shifts obtained from a questionnaire survey of local residents (see Lange *et al*., 2010). Residents in northern Germany almost universally expect offshore wind farming to have a negative impact on habitat and species values, but consider the impacts on cultural heritage, seascape aesthetics, and the overall beauty of the landscape to be less significant. A range of opinions was expressed for the impact of offshore wind farming on recreational values, knowledge systems, sense of place, and the image of the region, indicating uncertainty, but also a potential value gain. Offshore wind farms were expected to increase the inspirational value of the sea. For all categories, the expected value shifts not only depend on the understanding and appreciation of the affected values (e.g. particular appreciation of the "unspoilt" seascape), but also on personal beliefs about offshore wind farming (e.g. the belief that offshore wind farms are beautiful, invisible from the shore, or detract from the tourist image of the region as an "unspoilt" cultural landscape with a big open sky).

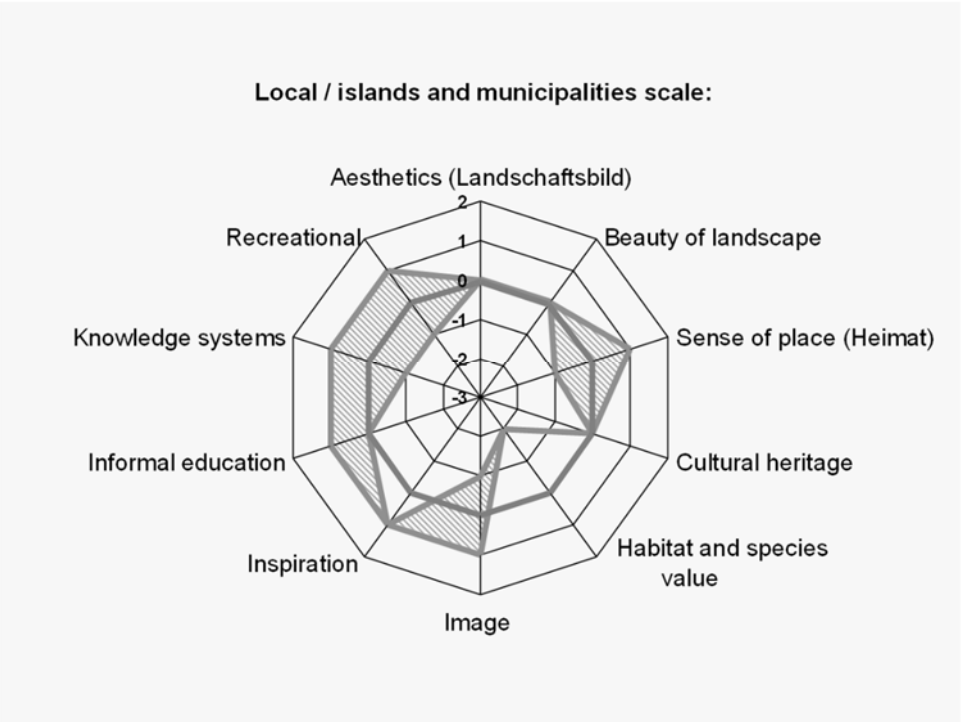

Figure 4.3.6.1. Expected impacts of offshore wind farms on cultural ecosystem services as rated by local residents (see Lange *et al*., 2010 for methodology). Relevant CES are shown at the edges of the diagram. Values −2 to +2 describe the impact ratings on CES. The shaded areas visualize the impact range, i.e. the range of personal preferences. The reference state (actual condition, the North Sea without offshore wind farms, central line) is set at 0. Results are based on the assumption that offshore wind farms will not be visible from the coast (from Lange *et al*., 2010 p. 135).

4.3.7 Issues of scale in value assessments

There is evidence that value assessments are scale-dependent. The above investigation of expected impacts of offshore wind farming on CES found that local stakeholders assess potential changes in CES differently than regional and national stakeholders (Lange *et al*., 2010). In the above example, local communities are divided over their willingness to engage in trade-offs between benefits obtained from CES and potential benefits associated with offshore wind farming (such as clean energy generation). In contrast, many regional and national stakeholders almost exclusively focus on benefits obtained from offshore wind farming, overlooking or discounting the price that would need to be paid locally in terms of non-material values. The reverse situation is also conceivable: local communities may feel they receive no benefit from a CES and would be willing to give up the service, but the same CES may be highly valued by society or wider communities of interest such as recreational groups which push for its preservation. This raises the question of which scale should count for more. Are local views more important than regional views? Although one of the tasks of MSP is clearly to balance such expectations and differing value judgements, there is no universally valid way of resolving such dilemmas. Solutions will need to emerge from consultation and participatory planning processes that allow for a fair representation of different views and value perspectives.

4.3.8 The link between inner convictions and attitudes

Difficulties and opportunities for using CES in the context of MSP have been raised in the previous sections. The main argument is that a complete range of intangible cultural values needs to be included in MSP assessments to the extent possible. Difficulties were highlighted in defining cultural services and benefits, and mapping exercises were suggested as a means of increasing the visibility of intangible values. Community or stakeholder involvement was described as a key prerequisite for defining the relevant cultural values and benefits in each case.

In this section, emphasis is on the importance of the link between the preferences expressed and the inner convictions a person holds ("held values"). Recognition of this link is particularly important in MSP processes where understanding deeper value-sets and world views can contribute to better communication between stakeholders and, ultimately, conflict resolution. Held values influence beliefs and attitudes, e.g. to new sea uses, which is why attention should not only be given to the attitudes expressed in particular situations (e.g. resistance to offshore wind farming), but also to the driving forces fuelling these attitudes. The reasons for a "no" to offshore wind farming are many, ranging from "not in my backyard" argumentation to the pragmatic belief that better alternatives exist, or to deeply held principles and conflicting moral values. A recent study shows that values associated with offshore wind farming (such as the belief that renewable energies are relevant and important) and estimates of the likely impacts of offshore wind farming are key factors in determining acceptance. At the same time, concerns over potential impacts of offshore wind farming do not always translate into rejection of offshore wind farming; nor do persons unconcerned about the impacts of offshore wind farming automatically hold a positive attitude. This is due to mental trade-offs that occur between offshore wind values and the personal value base, expressed in general beliefs about nature, nature ideologies, and general beliefs about the sea, such as viewing the sea as a "last wilderness" or having a moral duty to protect marine flora and fauna from harm (Gee, 2013).

For the purpose of planning processes such as MSP, a combined value assessment is therefore suggested, establishing not only the preferred non-material values, but also

the inner convictions of those in the community and/or stakeholders that are the key driving forces of these preferences. Inner convictions may be about nature and the marine environment, e.g. "it is the duty of humans to protect nature for nature's sake", or about future generations, e.g. "it is the duty of humans to pass on the environment in a certain state or to ensure a good life for the next generation", or about particular sea uses, e.g. "the sea should not be industrialized". Social science methods such as in-depth interviews are available to elicit and assess inner beliefs and values. In cases where contention has already sprung up, analysis of such inner beliefs and values can help uncover the rationale behind particular argumentation, leading to better understanding of opinions and helping planners to find innovative solutions.

4.3.9 Conclusion

For a meaningful and inclusive debate, decision-making processes need to cover the entire range of values that can be identified in a particular place. Current planning processes in the marine environment have a tendency to use rational scientific approaches, often excluding more meaning-related and emotional views of place and the values held by local communities. This particularly includes intangible sea values such as those encompassed by socio-cultural concepts, including nature, sense of place, and the seascape. In order to increase local participation in planning processes as well as transparency, local intangible values should be taken into account to broaden the value base upon which MSP is placed. There is a particular need to incorporate "hidden" values not readily expressed by interest groups. Initiatives to map such values by means of participative processes are now beginning to address this problem, and concepts such as CES can help to begin eliciting values from individuals and communities.

Since the MSP process needs to allow for dialogue on the relative importance of different values, a combined value assessment is suggested to understand deeper value-sets and world views as a prerequisite to understanding conflicts.

A three-step process is suggested to make values amenable to MSP (Figure 4.3.2.1), tackling some of the problems outlined in a participative process. The first step is to specify what is meant by cultural values. This step is essentially conceptual, drawing up a framework or classification system for describing CES and clarifying what is meant by benefits and services for the specific area and constituency involved. Ideally, this framework will also include indicators for each category of CES. The second step is to map the established value categories in space. This leads to the identification of culturally important areas. Importantly, this step should also capture why these particular areas have been identified as important; in other words, identify the personal value bases upon which stakeholders base their judgments. The third step is to carry out a risk or vulnerability assessment of the culturally important areas identified. MSP decisions are made at the end of the third step.

4.4 Representation of the use of marine space by commercial fisheries in marine spatial planning

Andronikos Kafas, Gareth Jones, Robert Watret, Ian Davies, and Beth Scott

Successful marine spatial planning requires that the underlying data and process of marine activities can gain the confidence of a wide range of stakeholders. Fishers are major users of our seas and, therefore, are of particular importance in marine planning consideration. Appropriate representation of fisheries in marine planning systems needs to take account of the spatial variability in landings and fishing practices. An understanding of the year-to-year stability in fisheries patterns can avoid over-reliance on data from short periods that may not accurately reflect longer-term patterns.

Generally, European Union (EU) Member States can obtain information relating to the spatial distribution of fishing activity by logbooks and vessel monitoring system (VMS) data. These data are complementary, and their coupling has already proven powerful. While logbooks provide useful information on several aspects of fishing, data are considered to be of low spatial resolution. The most reliable source of spatially explicit fishing vessel data is still the European Commission (EC) Vessel Monitoring System which provides information on the exact location and identification of all vessels ≥15 m overall length.

In this study, anonymized VMS data for all UK vessels landing in UK ports in 2007–2011 were combined with landings information. Fishing activity was identified by applying a simple speed threshold (Lee *et al.*, 2010). Weights and values have been allocated to VMS pings by applying a sophisticated approach which uses ICES rectangles, divisions, and weights on points according to time (Holmes *et al.*, 2011). A collection of weight and value rules separated the data into groups representing key sectors of the Scottish fishing fleet such as crab (*Cancer pagurus*), lobster (*Homarus gammarus*), squid (*Loligo vulgaris*), Norway lobster (*Nephrops norvegicus* – mobile and static), demersal (mobile: see Figure 4.4.1a; and static), scallop (*Pecten maximus*), pelagic, mackerel (*Scomber scombrus*), and herring (*Clupea harengus*) fisheries.

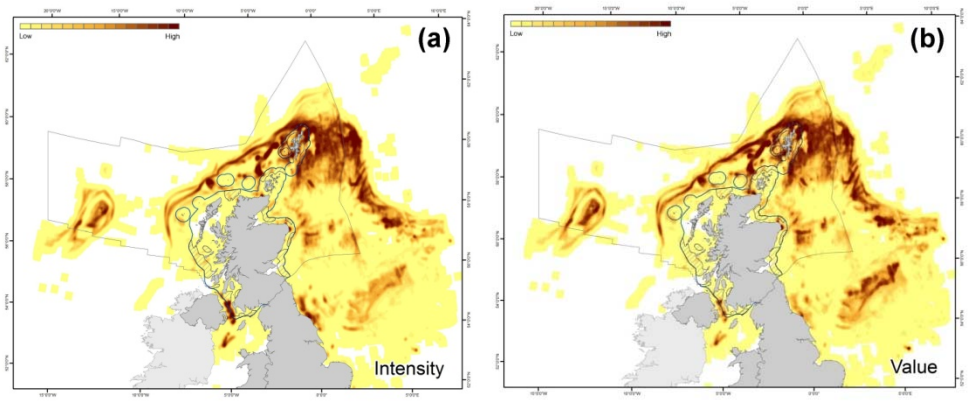

Figure 4.4.1. (a) Amalgamated spatial variability of demersal fisheries (mobile gears) in the UK for 2007–2011. (b) The same data weighted by the value of landings.

Non-parametric density analysis was selected over the commonly used quadrate count to develop GIS layers describing annual distribution of fisheries. A Gaussian kernel density estimation with a data-driven bandwidth selection approach (smoothed cross-validation) was used, resulting in high quality contour maps which form a better estimate of the spatial extent of fishing activity and the underlying structure. Several years' data have been amalgamated and effectively showed spatial patterns in higher solution for both intensely and infrequently fished areas throughout that period. These layers have also been weighted by landings (tonnes) and value (cash value in GBP) to represent the most productive and economically important areas, respectively (Figure 4.4.1b).

In conclusion, a clear understanding and representation of the spatial distribution of marine fisheries in Scottish waters was achieved, removing many of the problems associated with the traditional gridded presentations. Spatial patterns coming from this study were validated to be consistent with the underlying biology of the species. Areas important to the fishing industry at a national level were identified to inform the marine spatial planning process in Scotland.

4.5 Science–policy interactions: between policy fragmentation, integration, and new paradigms for planning and management

Andreas Kannen

Human activities in marine areas are increasing in number and intensity, and patterns of sea use are changing as a result of political, economic, and societal developments. Associated with the multitude of issues and sea uses are fragmented policy frameworks, not only divided by sectors, but also between environmental regimes and the balancing approach of marine/maritime spatial planning. The implementation of resulting management plans is hampered by the potentially conflicting policy objectives and differing jurisdictions at various levels of government in a given geographical area. Furthermore, neither long-term climate change impacts nor future socio-economic and cultural developments can be precisely predicted and put in definite numbers to offer a definitive guide for policy development. Planning under these circumstances can be characterized by the term "planning under uncertainty" and requires a move towards continuous planning processes that react to changing contexts instead of mainly data-driven decisions. Today's prevailing approach of scientific management seems to be ill-equipped to offer solutions under these circumstances, e.g. in dealing with transboundary cumulative effects or normative and value-driven conflicts between different actors. This presentation will illustrate such problems and argue for a move towards adaptive, transnational, and participative modes of coastal and marine governance based on research which analyses the particular social, cultural, and normative context of decision-making. It aims to link the context in which institutions act to potential contributions of research and set the stage for further discussions within the session and beyond.

4.6 Petroleum activities in the Lofoten area: definition of a worst-case scenario

Kjellrun Hiis Hauge, Anne Blanchard, Ragnhild Boland, Jan Helge Fosså, Daniel Howell, and Frode Vikebø

The complexity and uncertainty surrounding environmental problems can fuel heated debates between stakeholders with conflicting interests, priorities, and agendas. Many such debates have arisen at the "science–policy interface" relative to calls to open new areas for petroleum activities in the Lofoten area in northern Norway. The Lofoten is a particularly valuable and vulnerable archipelago, known for its unique landscape and as a key spawning and nursery area for several fish stocks, also hosting the world's largest-known deep-sea coral reef. Introducing petroleum activities brings additional competition for this valuable space and demands an assessment of the "worst-case scenario" of an oil spill to support political decision-making. However, such a complex model introduces numerous uncertainties, which have become contentious both within the scientific community and in dialogue with the petroleum industry. A comprehensive worst-case scenario must look at the possible effects on all ecosystems and species of the area, at every stage of their lifespan, together with effects on other sectors of activity (particularly the tourism and fishery industries), and the socio-cultural characteristics of the region. This paper unpacks the debate surrounding the science and uncertainties of calculating the worst-case scenario in the Lofoten, focusing on three key aspects: (i) whether historic oil spill events are to be used as supporting empirical data; (ii) assessing the effects of an oil spill on the environment; and (iii) proposing measures to be taken on the basis of the worst-case scenario.

4.6.1 Introduction

The question of opening Norway's northern offshore areas to petroleum production has been a long and heated political debate in Norway. The values at stake are considerable. On one hand, having petroleum production promises to uphold Norway's economic wealth and standard of living. On the other hand, it is feared that petroleum production, and in particular a major oil spill in the Lofoten area, would disturb vulnerable ecosystems and thereby damage key national fisheries and local sectors, such as aquaculture and tourism. Norway's identity is an essential part of the public debate, which reflects opposite conclusions. On one hand, increased activity in the Lofoten area might prevent picturesque coastal villages from being abandoned. On the other hand, petroleum production in the Lofoten area, whether there be a blowout or not, might destroy the image of Norway's most treasured landscape.

Large areas have been opened to petroleum exploitation in Norwegian waters in recent years, but some areas remain closed due to overlap with some of the worlds' largest fish stocks and bird colonies. "Opened" means that potential future oil exploration are allowed in the area, but petroleum companies must apply for specific blocks in order to start actual production. Decisions around the opening of new areas are contentious and depend, among other reasons, on scientific environmental impact assessments, including the establishment of a "worst-case scenario".

Worst-case scenarios are defined by a risk approach where the probability of a major oil spill is multiplied by its environmental impact. However, because these assessments are very complex, as they refer to a range of processes and species, and as they can be used to either promote or prevent action, the quality and legitimacy of scientific advice is at the centre of the social debates. The handling of uncertainty associated with the probability, characteristics, and impacts of a major oil spill may influence the outcome of risk calculations and thus the basis for political decisions on opening areas, or not, for petroleum activity. Therefore, uncertainty plays a crucial role in the controversy by allowing different interpretations and opinions. Uncertainties relative to the worst-case scenario have been emphasized by some and downplayed by others.

In 2002, Norwegian authorities, representing the Ministry of Fisheries and Coastal Affairs, the Ministry of the Environment, and the Ministry of Petroleum and Energy produced a multisectoral management plan for the Barents Sea and the Lofoten area based on multisectoral values and multidisciplinary research (Miljøverndepartementet, 2006). The management plan takes into account both socio-economic and environmental interests. On this basis, the same ministries initiated a multisectoral working group on risk to strengthen the basis for risk evaluations associated with acute contamination in the Barents Sea and the Lofoten area. Before this working group was created, the petroleum sector had the sole responsibility of developing the tools for calculating risks. Now, the petroleum sector together with the fisheries and environmental sectors cooperate and produce consensus-based reports on these issues. There have been several discussions and disagreements within the working group and in other cooperation arenas on the choice of empirical data for calculating the relevant size and probability of a major oil spill, and on the ecological processes to include in simulations in order to assess environmental effects. The worst-case scenario is not yet settled for the Lofoten area, and improvements are sought through scientific research, some in cooperation between the oil industry and marine research institutes.

A strategy for establishing a worst-case scenario that can support decision-making is to fill remaining knowledge gaps. Meanwhile, awaiting a comprehensive worst-case scenario, marine scientists have adopted the precautionary principle in their advice

until adequate knowledge is acquired. The petroleum industry has accused these scientific advisors of hiding behind the precautionary principle, arguing that knowledge gaps can always be found and that, accordingly, they should not lean towards strict decisions regarding the opening of areas for petroleum activity.

In the academic literature, different views are expressed on the handling of uncertainty concerning this policy issue. Hjermann *et al*. (2007) express confidence in appropriate worst-case scenarios, but only if specific knowledge gaps are filled beforehand and if the remaining uncertainty is handled by Monte Carlo simulations. Knol (2010), on the other hand, concludes that since the issue bears high stakes and creates tension on what should be done, and because values and interests are embedded in the construction of knowledge, "filling" knowledge gaps will not adequately support decision-making. She further argues that marine scientists construct uncertainty through this approach (Knol, 2010). Indeed, by extending the amount of knowledge around the issue, the possibility of encountering new, uncertain aspects of knowledge is increasing. Therefore, what should the role of science be in these complex, highly disputed, and uncertain issues?

It has long been argued that policy problems characterized by high stakes, uncertain facts, and conflicting values need new approaches to science. Rather than trying to reduce it, uncertainty should be at the centre of the debates by, for example, reflecting on how, or whether, scientific questions fit the policy questions (see Funtowicz and Ravetz, 1990, 1993; Wynne, 1992; Walker *et al*., 2003; van der Sluijs *et al*., 2004; Funtowicz and Strand, 2007). Indeed, steered by different interests, knowledge, and beliefs, some actors might focus (consciously or unconsciously) on particular aspects of the issue that are resilient to petroleum activities, while others might rather cast light on the most vulnerable components of the issue, resulting in highly different outcomes in terms of risks.

In this context, the aim of this paper, at its initial stage, is to initiate a discussion on the handling of key uncertainties associated with defining the worst-case scenario for the Lofoten area from three perspectives: (i) the handling itself, (ii) whether it influences how science fits the policy problem, and (iii) how it may affect the science–policy interface.

4.6.2 Inherent uncertainties

When establishing worst-case scenarios, the probability of a major oil spill, its size, and its chemical compound are determined based on previous oil spills. Previous oil spills with comparable technical, geological, and oceanographic features have been considered relevant. However, the question of how similar such features need to be in order to define them as "relevant" is a matter of choice. Experts' decision on what relevant oil spills should be taken into account, the relevant size of an oil spill, the relevant distribution of oil at the surface of the water, and the sites relevant for future exploration (i.e. on the shelf or on the ridge) have indeed been questioned. An especially contentious point has been whether to rescale worst-case scenarios for the Lofoten area according to the 2010 Deepwater Horizon.

Given the site, the season, the type of oil, and the size of the oil field, simulations of a worst-case scenario are carried out. Predicting impacts of a major oil spill is complex. Ideally, an assessment of the impacts on the ecosystems would include every species, impacts relative to all distances from the origin of the oil spill, short- and long-term impacts, and cascading effects on ecosystem components. This is elusive as models are not capable of dealing with such complexity and potential emergent properties, and as

numerous knowledge gaps remain. Norway's most economically important fish stock is Northeast Arctic cod (*Gadus morhua*), which migrates from the Barents Sea to the Lofoten area to spawn. Consequently, cod is the main focus in establishing a worst-case scenario, and especially cod larvae because of their vulnerability to oil spills. Ongoing research is improving the knowledge basis for assessing possible impacts on the cod stock, but other impacts on the ecosystem remain unknown.

When we look at how uncertainty is handled in calculating the various components of a worst-case scenario, applied methods include error bars, safety factors, and scenarios presenting different possible futures. In principle, these approaches are incommensurable, implying that their combination gives little meaning in grasping the uncertainty in risk calculations.

4.6.3 Issues to be discussed

Science plays an important role in the policy debates on whether or not to open the Lofoten area to petroleum production. We believe that scientific knowledge constitutes an important basis for decision-making and, specifically, that refining the knowledge base for worst-case scenarios can be helpful in discussing which sites for petroleum production may cause less harm in case of a major oil spill. However, the relevance of a worst-case scenario for deciding whether to open an area should be challenged. At present, we are discussing several facets of worst-case scenarios. First, given the inherent uncertainties, is it possible to arrive at a certain number, which we can conclude is the "best" one? Is this number useful for the question of whether to open the Lofoten area for petroleum production? Second, how can we understand the concept of worst-case scenario and its political role in decision-making? Third, keeping in mind the great values at stake, what is the role of uncertainty in the policy debate? Fourth, could other pieces of scientific knowledge be relevant for the final policy decision? And finally, what can the above perspectives offer to the policy debate?

4.6.4 Acknowledgements

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4.7 Shetland Marine Spatial Plan: an ecosystem-based approach in formulating marine policy and management options

Christina Kelly, Lorraine Gray, Rachel Shucksmith, and Jacqueline Tweddle

Marine environmental policy is an important aspect of the current European, UK, and Scottish environmental agenda. The development of the Shetland Marine Spatial Plan (SMSP) was initiated by the Scottish Government and has been implemented on a voluntary basis since 2008. It has been utilized successfully as a tool to guide developers and others in proposing changes to existing uses (such as aquaculture and fishing) and introduction of new uses (such as expansion of ports, renewable energy, and oil and gas infrastructure). More recently, it has been used by managers to voluntarily close areas containing sensitive habitats to scallop dredging and develop oil spill contingency planning to protect important habitats. Through policy, it provides suggestions, proposes directions, and highlights opportunity for development. This paper demonstrates the benefits of spatial management with a focus on using geo-spatial analysis to map cumulative pressure areas around the Shetland Islands based on an ecosystem-based risk assessment and how this will assist in the implementation of marine policy. Simultaneously, by ensuring the provision of clean, healthy, diverse, and productive

seas through sustainable marine policy, other environmental targets such as achieving "good environmental status" under the Marine Strategy Framework Directive are also implemented.

4.7.1 Introduction

Marine spatial planning (MSP) is recognized as an important tool in the sustainable management of marine ecosystems (Schaefer and Barale, 2011). Until recently, governments applied a mainly sectoral approach towards marine issues, but now realize that a more integrated approach is required to manage increasing pressures on the marine environment (Olsen *et al.*, 2011). New emerging demands on marine space and resources, such as renewable energy developments, highlight the potential for user–user conflicts (i.e. with fishing activities as well as user–environment conflicts). Traditionally, marine space has been predominantly regulated within individual economic sectors (Douvere, 2008), such as shipping channels and aquaculture sites, and there has been little consideration of the effects of individual and multiple developments on other human activities or the marine environment (Ehler and Douvere, 2009). Conflicts between other users and the marine environment jeopardize the ability of the ocean to provide the necessary ecosystem goods and services upon which many depend (Ehler and Douvere, 2009).

On 10 October 2007, the European Commission (EC) adopted the Communication on Integrated Maritime Policy (IMP) for the European Union (EU), also referred to as the "Blue Book" (European Commission, 2007). This acknowledged the need to act in a coordinated manner to respond to pressures from multiple users. The Communication suggests a governance framework and cross-sectoral tools necessary for an EU integrated maritime policy. Included are a set of main actions that the EC will pursue, guided by the principles of subsidiarity and competitiveness, the ecosystem approach, and stakeholder participation. One action includes the development of a roadmap towards MSP by EU Member States. As a consequence, the Communication titled "Roadmap for Maritime Spatial Planning: Achieving Common Principles in the EU" was adopted by the EC on 25 November 2008 and aims to facilitate the development of MSP by EU Member States and to stimulate its implementation at national and EU levels (European Commission, 2008a). The Roadmap sets out key principles for MSP and encourages the development of a common approach among EU Member States.

In 2008, the EU also adopted the Marine Strategy Framework Directive (MSFD) which aims to achieve or maintain good environmental status (GES) of the marine environment by 2020 (European Commission, 2012b). The MSFD requires EU Member States to apply an ecosystem approach and to ensure that pressure from human activities is compatible with GES. The MSFD has been described as the environmental pillar of the Integrated Maritime Policy (European Commission, 2008a).

An ecosystem-based approach to MSP must consider the entire ecosystem, including human beings. The ultimate objective of ecosystem-based management is to maintain an ecosystem in a healthy, productive, and resilient condition, providing the goods and services that humans want and need (Ehler and Douvere, 2009). In this respect, ecosystem-based management differs from traditional approaches that focus on a single species, sector, activity, or concern. The ecosystem approach considers the cumulative impacts of different sectors.

4.7.2 National and regional context in MSP

Presently, MSP in the UK is being implemented in England and Wales under the Marine and Coastal Access Act, 2009, in Scotland under the Marine (Scotland) Act, 2010,

and legislation has been proposed for Northern Ireland. This legislation sets out the framework for marine management which includes the preparation of marine plans and marine licensing. The overall aim of the legislation is to achieve "clean, healthy, safe, productive and biologically diverse oceans and seas" (HM Government, 2011).

Prior to any European guidance on MSP, the Scottish Government proactively instigated research in 2006 into the sustainable management of Scotland's marine resources. The Scottish Sustainable Marine Environment Initiative (SSMEI), led by the Scottish Government in collaboration with local authorities and other partners, aimed to develop and test new approaches to improve the sustainable management of Scotland's marine environment through the establishment of four pilot projects (Marine Scotland, 2010). The four pilot projects were based in the Firth of Clyde, Shetland Islands, the Sound of Mull, and the Berwickshire coast. Three of the four projects have developed local marine plans (Clyde, Shetland, and Mull). This paper focuses on the continuing work of the Shetland Islands Marine Spatial Plan (SMSP).

4.7.3 Shetland Islands Marine Spatial Plan

The SMSP was first developed in 2006 under the auspices of SSMEI, with the first draft plan voluntarily adopted by the local planning authority, statutory consultees, and local developers in 2008. The project was guided by a national and local steering group. Since the launch of the third edition and the end of the pilot project in 2010, the SMSP has continued to engage regularly with key stakeholders and a local advisory group.

The SMSP continues to receive funding from the Scottish Government through Marine Scotland and is continuously developed as part of the core work of the NAFC Marine Centre, Shetland Islands, which is an associate partner of the University of the Highlands and Islands, Scotland. The SMSP represents an innovative approach to marine planning, based on Scottish Ministers' commitment to making marine management more efficient, inclusive, and accessible now and for future generations.

The SMSP, in its third edition, contains spatial data on the marine and coastal environment and its various uses. It establishes an overarching policy framework to guide the placement of activity from marine renewable energy to aquaculture. The primary focus of the SMSP is to provide more information to public bodies, who have responsibilities for marine and coastal planning functions, and to developers. It will inform decision-making, guide priorities, and seeks to achieve a balance between national and local interests (NAFC Marine Centre, 2012). Notwithstanding its statutory ordnance through the Marine (Scotland) Act, 2010, it is anticipated that the fourth edition of the SMSP will be formally adopted through the Shetland Islands Council's Local Development Plan as Supplementary Guidance in 2013. The SMSP policies and maps will become a material consideration in the determination of new applications and licences for marine development by the local planning and regulatory authorities. This marks a unique and significant move to standardize the approaches and responsibilities between terrestrial and marine planning jurisdictions and reflects a more integrated approach to coastal zone management and MSP.

As the SMSP progresses towards a fourth edition, it is being utilized for applied projects that result in further supporting information and guidance. It has been used by managers to successfully close sea areas to scallop dredging to preserve subtidal biogenic reefs and evaluate the socio-economic importance of the marine environment to the local fishing industry. More recently, projects include the publication of Regional Locational Guidance for Wave and Tidal Devices in the Shetland Islands (Tweddle *et al.*, 2012), monitoring and mapping invasive non-native species around the Shetland

Islands, and a Review of the Marine Spatial Plan for the Shetland Islands (Kelly *et al*., 2012). The Review of the SMSP is a brief report summarizing the findings of a quantitative and qualitative appraisal of the third edition of the SMSP. The Review includes an analysis of responses from a previous SMSP consultation in 2010 and results from a number of focused questionnaires and surveys carried out with key stakeholders. The overall findings provide a good overview of the SMSP achievements to date, including its successful endorsement internationally as an exemplar case study for marine spatial planning (Kelly *et al*., 2012).

As the SMSP already identifies potential impacts between activities and important species and habitats around Shetland through a sensitivity matrix, the next phase is to address cumulative impacts, interactions, and capacity of the marine resource to accommodate future sustainable development.

4.7.4 Assessing cumulative impacts using an ecosystem-based risk assessment

During development of their national marine plan, the Scottish Government included an interactions matrix which provided an initial simplified view of the likely level of interactions between a range of marine users (Scottish Government, 2011). However, in a review of the work conducted in the MSP pilot projects funded under SSMEI, it was acknowledged that whilst the process of identifying interactions between different uses/activities and with the marine environment had been effectively carried out in some cases, it would have been more relevant to test whether a more "spatially specific" approach to this exercise would identify particular locations where specific policies are required to resolve interactions (Marine Scotland, 2010). In this context, the assessment of cumulative impacts using an ecosystem-based risk assessment was deemed a more suitable option for the SMSP. This involved using GIS to map cumulative pressure areas around Shetland based on the output scores of the ecosystem risk assessment. This location-specific method moved away from the generic, single-sector-analysis approach of the interactions matrix and was deemed more relevant and sympathetic to local factors.

An integrated ecosystem assessment (IEA) is a synthesis and quantitative analysis of information on relevant physical, chemical, ecological, and human processes in relation to specific ecosystem management objectives (ESMWG, 2011). While methodologies for the assessment of cumulative impacts are still in early development, the IEA provides a consultative process to identify priority management issues and provide robust decision-support information. It is acknowledged that other methodologies are being tested elsewhere (EOEEA, 2009; Eastwood *et al*., 2007; Foden *et al*., 2011; Farmer *et al*., 2012; Stelzenmuller *et al*., 2012); however, none are universally recognized or accepted. Nevertheless, some methods have influenced the SMSP approach (Levin *et al*., 2009; Robinson and Knights, 2011).

4.7.5 Methodology

The integrated ecosystem-based risk assessment (ERA) concept developed as part of the SMSP has evolved from the original SMSP marine biodiversity risk assessment first explored in 2008. The revised assessment incorporates the range of pressures and impacts identified in Annex III, Table 2 of the MSFD (European Commission, 2008a) which are scored by each activity in line with a range of criteria. Following a review of a number of cumulative impact assessments, it became apparent and logical to quantify the potential impacts as set out in the MSFD. In the UK, a number of assessments already apply different criteria against these identified impacts (Robinson and Knights, 2011; Marshall *et al*., 2012). Given the MSFD requirement to report on the current state

of UK seas, detailed characteristics of GES, and associated targets and indicators by 2012, a greater focus has been placed on determining the likely impacts of human activities on the marine environment (Baxter *et al*., 2011; Defra and Marine Scotland, 2012). The SMSP ERA matrix has incorporated information from the Scottish Marine Atlas (Baxter *et al*., 2011) as a foundation for identifying the pressures and impacts associated with certain marine activities in Scottish waters. Other assessments (Defra and Marine Scotland, 2012; Marshall *et al*., 2012) including OSPAR QSR2010 (OSPAR, 2010) have also been utilized to predict impacts and outcomes from interactions.

The SMSP ERA explored the different marine activities currently regulated around Shetland: commercial fishing, aquaculture, transport, coastal infrastructure, renewables, dredging and disposal, tourism and recreation, oil and gas pipelines, telecommunication cables, and effluent discharges. These activities and their direct effects were assessed; e.g. commercial fishing activities and the different types of gear used and associated effects. A summary of these activities is included in Table 4.7.5.1. This analysis was carried out for all marine activities around Shetland. "Direct effects" were considered as effects that are directly linked to "driver/pressure" combinations (HELCOM/VASAB *et al*., 2012)[1].

Direct effects of each activity and associated impacts (Table 4.7.5.2) were assessed against a set of criteria (Table 4.7.5.3), which was initially developed by members of the local steering group (Spatial Analysis subgroup). Each of the associated impacts was assigned scores in terms of likelihood of impact, frequency of the activity, timescale to recovery, likely extent of permitted footprint, and confidence in the data used. The scores were then added together for the latter four criteria and multiplied by the former "likelihood" impact score. The score was assigned an index value out of a maximum score of 1 and integrated into maps of different activities.

All activity data were converted into a raster using ESRI ArcGIS. The "raster calculator" tool was used to reclassify the data. The rasters for each sector were summed using a spatial analysis "weighted sum" tool in ArcGIS where weight = x and "x" is the cumulative score for each pressure. This resulted in a spatial overview map of cumulative impacts. A map based on preliminary scores is included in Figure 4.7.5.1. It is acknowledged that there are many spatial analysis tools and software available (Stelzenmuller *et al*., 2012) to do a similar analysis. However, for the purpose of this exercise, the "weighted sum" tool was deemed applicable for local circumstances, being understandable and relevant to non-expert stakeholders. Advice was sought from the Spatial Analysis subgroup which comprised members with detailed sector-specific knowledge in relation to the impact scores. The outcome from this session was that further consultation on the scoring and criteria is required to refine the process and ensure that the mapping outputs are tangible and meaningful. The objective of the ongoing consultation is to ensure a more informed and balanced assessment of the cumulative impacts involving marine industry experts and local practitioners.

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[1] **Direct effects** form the basis for the development and implementation of operational, spatial, and temporal management measures to reduce the risk of direct effects. Direct effects are ecosystem, social, cultural, and economic impacts. **Indirect effects** are considered as secondary effects occurring once a direct effect has occurred. These would include impacts to ecosystem processes and components as well as socio-economics impacts. Indirect effects are difficult to model or predict because their occurrence may also be amplified by natural variations in ecosystem processes.

Table 4.7.5.1. Sample of commercial fishing activities and direct effects. This analysis was carried out for all other mapped marine activities around Shetland, i.e. aquaculture, transport, coastal infrastructure, renewables, dredging and disposal, tourism and recreation, oil and gas pipelines, telecommunication cables, and effluent discharges.

Marine activity	Activity detail	Direct effects (pressures)
Commercial fishing	Creeling and potting Gill netting Seine netting Hook and line (jigging) Pelagic trawling Whitefish trawling /demersal otter trawling Demersal otter trawling (twin rig only in Shetland) Demersal pair trawling Pair seining Scallop dredging Shellfish trawling	Steaming –atmospheric emissions Collisions Interaction with seabed Physical damage to seabed and habitat Impact on/removal of non-target species Impact on/removal of target species Ghostfishing (lost gear continuing to fish) Anti-fouling, litter, lost gear, ballast water Entanglement /by-catch/waste products

Table 4.7.5.2. Pressures used to determine and evaluate the potential impacts from human activities in relation to the marine environment around Shetland waters.

Threats/pressures	
Physical loss	Smothering Sealing/obstruction
Physical damage	Abrasion Extraction
Other physical disturbance	Underwater noise Marine litter
Interference with hydrological processes	Temperature change Salinity changes Change in pH Change in wave exposure Change in water flow rates
Contamination by hazardous substances	Introduction of synthetic compounds (e.g. pesticides, antifoulants, pharmaceuticals) Introduction of non-synthetic substances and compounds (e.g. heavy metals, hydrocarbons) Introduction of radionuclides
Systematic and/or intentional release of substances	Introduction of other substances, whether solid, liquid, or gas, in marine waters, resulting from their systematic and/or intentional release into the marine environment, as permitted in accordance with other community legislation and/or international conventions
Nutrient and organic matter enrichment	Nitrogen and phosphorus Inputs of organic matter

Threats/pressures	
Biological disturbance	Introduction of microbial pathogens, Introduction of invasive non-native species, Selective extraction of species, including incidental non-target catches
Death or injury by collision	Death or injury by collision
Barrier to species movement	Preventing the natural movement of mobile species along a key route of travel
Electromagnetic changes	Change in the amount and/or distribution and/or periodicity of electromagnetic energy emitted in a marine area (e.g. from electrical sources such as underwater cables)

Table 4.7.5.3. (A–E). Criteria used to quantify the potential impacts of differing activities on the marine environment.

A	Rating	Likelihood of impact/certainty	Commentary
	5	Definite/very high	Well documented evidence of impact occurring during normal operations or >1 accidental/illegal event per year
	4	Likely/high	Some evidence of impact occurring under normal operations or >1 accidental/illegal event in 5 years
	3	Possible/medium	Unknown level of impact/interaction or >1 accidental/illegal event in 10 years
	2	Unlikely/low	Very little interaction with habitats/species or >1 accidental/illegal event in 100 years
	1	Remote	No interaction with habitats/species

B	Rating	Frequency of activity /effort	Commentary
	5	Continual /very high	More or less constant year-round, lasting through multiple years or decades
	4	Regular /high	Every week
	3	Intermittent /moderate	Approximately once a month
	2	Brief /minimal	One-off event – over several days/irregular
	1	One-off event	One-off event – up to one day duration/infrequent

C	Rating	Timescale to ecosystem recovery /stability (following cessation of activity)	Commentary
	5	None	Recovery unlikely
	4	Low	> 10 years
	3	Medium	Several years (3–10 years)
	2	High	1–2 years
	1	Very high	Within 1 year

D	Rating	Extent of permitted impact / footprint	Commentary
	5	Very high–widespread	Serious damage to ecosystem – total loss or very major alteration to the key elements of the habitat
			Guide: > 80% of habitat lost
	4	High	Major loss or major alteration to key elements of the habitat
			Guide: 21–80% of habitat lost
	3	Moderate	Loss or alteration to one or more key elements of the habitat
			Guide: > 6–20% of habitat lost
	2	Site specific/localized/minimal	Minor shift away from baseline conditions
			Guide: > 1–5% of habitat lost
	1	Negligible	Very slight change from baseline condition
			Guide: <1% habitat lost

E	Rating	Confidence in maps	Commentary
	3	Low	An estimated location and questionable source or scale/extent of activity.
	2	Medium	A fixed location but questionable source or scale/extent of activity. Examples include shipwrecks, where there is point data available, but parts may be scattered on the seabed, and shellfish fishing grounds within management squares (which are to the nearest 5 km).
	1	High	A fixed location and of a good source or scale/extent of activity. Examples of these maps are oil and gas pipelines and aquaculture sites where standards on locations are required for planning purposes.

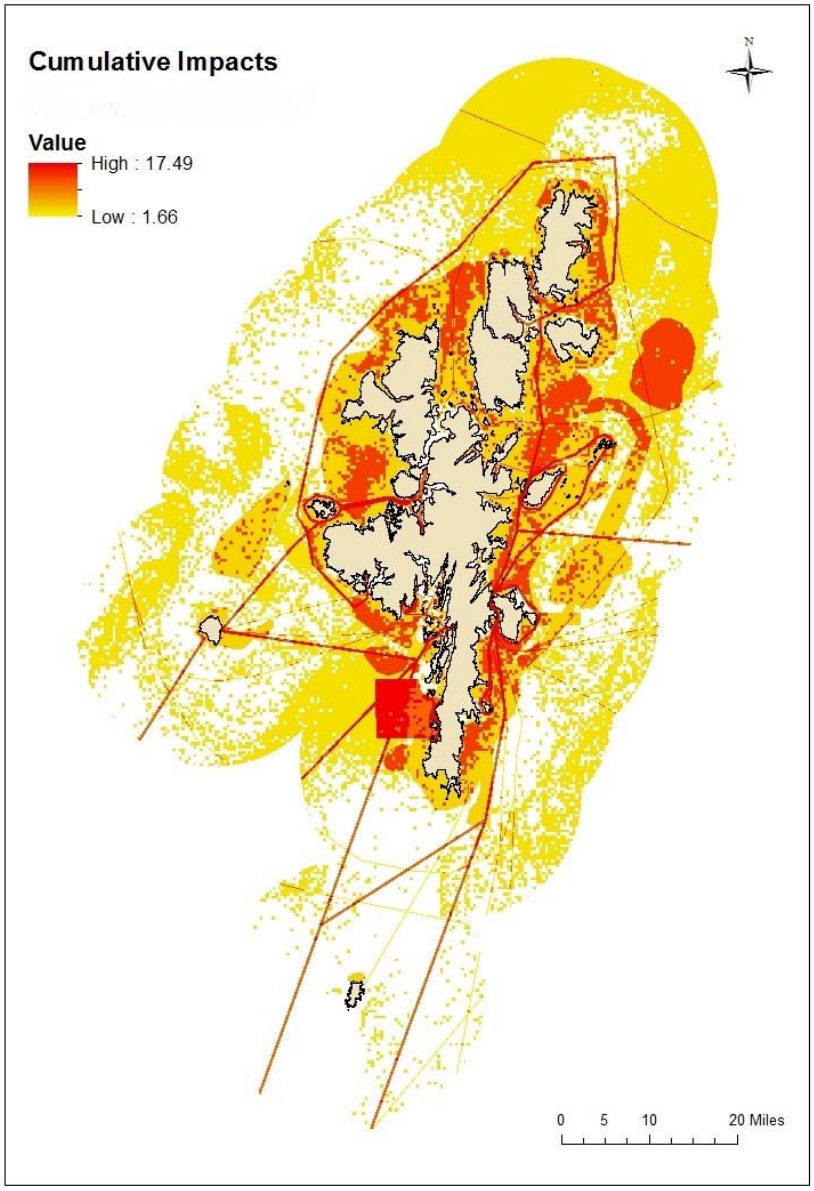

Figure 4.7.5.1. Preliminary map illustrating cumulative impacts.

4.7.6 Discussion

All European MS are contending with the assessment and reporting on the status of their marine waters under the MSFD; this includes an analysis of the cumulative impacts of human activities (Foden *et al*., 2011). Varying analytical approaches, methods, applications, and practical software tools are being developed internationally to facilitate an assessment of the relationships between human uses and ecosystem components (Alexander *et al*., 2012; Stelzenmuller *et al*., 2012). It is widely acknowledged that the issue is proving difficult to resolve (HELCOM/VASAB *et al*., 2012). For example, some human activities can have the same or similar effects on the marine environment and its ecosystems. Attempting to attribute or distinguish each effect to a single use in multiuse areas has not been achieved convincingly to date. Similarly, distinguishing the effects of human activities from natural disturbance is also proving difficult. This is further exacerbated by a lack of empirical data and modelling methodologies to carry

out the required integrated assessments to manage the cumulative effects of human activities (Eastwood *et al*., 2007; Leslie and McLeod, 2007; HELCOM/VASAB *et al*., 2012). However, MSP is about addressing uncertainties in a practical manner that is understandable and accessible to multiple potential users.

This paper outlines an attempt to map cumulative impacts using an integrated ERA and, in doing so, to deal with these uncertainties at a more local level. It is hoped that this exercise will promote discussion and debate among stakeholders and will help to advise and formulate MSP policy in the SMSP. Testing different approaches to integrated marine planning at a local level has the potential to inform policy and management measures at regional and national levels. Shetland is regarded as an ideal location to test this integrated ERA as the SMSP has been widely supported by the local community and marine practitioners. This is evident in its pending adoption as Supplementary Guidance to the Shetland Islands Council's Local Development Plan.

As consultation on the SMSP is ongoing with local expertise and stakeholders, there are opportunities to identify and improve on the limitations of the methodology. Other cumulative impact assessments (Robinson and Knights, 2011; Defra and Marine Scotland, 2012; Marshall *et al*., 2012) have predicted likely impacts and pressures from human activities, but have refrained from actually assigning a score or weight to the impact. This is understandable as attributing or distinguishing certain effects to a single use in multiuse areas has not yet been achieved (HELCOM/VASAB *et al*., 2012). Although applying weights/scores to different impacts/pressures during the current study could be perceived as subjective and, therefore, open to scrutiny, on-going consultation with local experts from differing backgrounds should allow for more objective outcomes to be achieved.

The criteria adopted in this exercise could be considered open to interpretation. More benchmarks could have been included, such as the resilience of ecological characteristics and the persistence of the pressure (Robinson and Knights, 2011). However, the "time-scale to recovery" criterion used as part of this assessment was also very dependent on the type of habitat and species likely to be affected by the impact and detailed knowledge of their ecological characteristics (e.g. sensitivity, resilience). This opens up the number of possibilities as to how the ERA can be developed further, e.g. all of the cumulative physical impacts on the seabed could be spatially overlain with vulnerable seabed habitats such as maerl beds. This type of treatment of data could trigger a need for further habitat management or policy development in the future for priority marine features.

As more and more marine planners deal with uncertainty, differing geo-spatial analytical approaches, applications, and software tools are being developed in response. Over 39 practical tools are reportedly available and have been applied in the marine environment in Europe, US, and Australia (Stelzenmuller *et al*., 2012). Therefore, there are many options available for scientists, programmers, and spatial planners to trial and determine which are suitable to their own requirements. As part of the current study, it was deemed that ESRI ArcGIS was suitable software to undertake the analysis, and the spatial analysis tools available were adequate to achieve the anticipated preliminary outputs.

It is not possible to plan and manage marine ecosystems or components of ecosystems; this is feasible only for human activities in marine areas. It is only possible for marine planners to allocate space to human activities, e.g. development areas for aquaculture (Ehler and Douvere, 2009). The ultimate goal of assessing cumulative impacts using

the ecosystem approach is to inform and develop marine planning policy and objectives which will safeguard the marine environment and ensure its sustainable provision of goods and services. Therefore, a fully consulted and balanced approach, as endorsed in this ERA, will be the first step in achieving this objective for Shetland.

4.7.7 Acknowledgements

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4.8 The science of negotiation: stakeholder engagement in discussions about science and uncertainty in the negotiations of a fisheries management plan for Dogger Bank under Natura 2000

Ina Krueger, Liv Berner, Rüdiger Wurzel, and Henriette Otter

4.8.1 Introduction

Policy processes in marine spatial planning seek to manage a decreasing space, as new sectors are competing with established sectors for access to the sea.

In scientific, as well as grey literature on MSP, it is a commonly accepted notion that decision-makers need to involve stakeholders in the decision-making process, and that decision-making processes should be based on the best available scientific data.

By opening up the policy-making arena to the broad range of interest groups commonly involved in and impacted by marine spatial planning, however, the traditional linear approach to policy-making is being challenged. With this process, the idealized notion of science fitting neatly into the linear policy process and providing rational and more or less unproblematic evidence on the issue in question before the politics begin also starts to crumble.

International negotiations on the newly appointed marine protected areas on Dogger Bank, where emerging plans for the establishment of offshore wind parks and the traditional fishing interests compete with national conservation goals, are a fascinating example of how stakeholders struggle to assess and transform scientific information into a fisheries management plan that not only provides the necessary steps to reach the biodiversity objectives of Natura 2000, but can also be widely accepted by all interest groups involved.

Around Dogger Bank, a submerged sandbank in the North Sea, national governments and sectoral stakeholders are trying to agree on a regulation which aims at restoring the habitat to a better conservation state. In this novel international process, the North Sea Regional Advisory Council (NS RAC, 2012) was invited to produce a first proposal for a fisheries management plan. As this process unfolded, fierce negotiations took place between state delegates, environmental NGOs, and fishers.

The present research provides a critical analysis of how, in the Dogger Bank negotiations, different stakeholder perceptions of scientific data and what role these data should play worked to structure and shape the policy-making process.

Drawing on stakeholder reflections in interviews, the way in which stakeholders make use of scientific and lay knowledge and how they question, interpret, and apply it in sometimes conflicting ways to build up arguments is analysed.

Conclusions are drawn from how continued disagreement about what constitutes the problem and potential solutions, expressed through a recurring quest for more, adequate, and robust scientific evidence by different stakeholder groups has influenced and structured the negotiation dynamics.

The traditional linear-policy model, which assumes that policy-making follows a clear, step-by-step protocol, in which every step builds on the previous step, is criticized by arguing that policy processes often do not follow such a linear, step-by-step order. Instead, they are shaped by many different factors and follow a pattern that rather resembles a web of interrelated decisions which evolve over time during the process of formulation and implementation (Hill, 1997; Keeley and Scoones, 1999). The different stakeholder perceptions of the scientific findings underlying the negotiations can work as an important factor in structuring the policy-making process.

4.8.2 Framework of analysis: the linear-policy model and the role of science in the policy-making process

Traditionally, policy development is often perceived according to a linear model (e.g. Porter and Hicks, 1995 cited in Levinson and Sutton, 2001) that can be expressed as follows:

- problem identification
- policy formulation
- adoption
- implementation
- evaluation

This model describes a simple one-way process that presents a given policy as a coordinated and logical strategy for solving a particular problem. Advocates of this linear-policy model follow the assumption that decision-makers exhibit a rational and instrumental behaviour (Simon, 1957; Keeley and Scoones, 1999). This presumes that the objectives in policy-making are clear, evaluation and monitoring mechanisms are explicit, and decision-makers enjoy a highly comprehensive overview.

However, as Lindblom (1959) argues in his famous essay, "The science of muddling through", such a rational, linear-policy-making process only potentially works for such small-scale problems, "where the total number of variables to be considered is small and value problems are restricted". Therefore, more generally, it can be argued that policies are courses of action, which are part of ongoing processes and interactions in which multiple actors bargain and negotiate over time (Dobuzinskis, 1992; Keeley and Scoones, 1999).

In line with this approach, polices are created in particular social contexts according to specific historical developments and are defined by, as well as defining for, particular possibilities for action. They are likewise embedded in particular discourses and practices that make certain expressions of problems and solutions more or less meaningful.

In environmental policy-making processes, where science plays an important role in framing the debate, as Keeley and Scoones (1999) argue, "conceptions of the world which become dominant in policy discussions are a reflection of the norms through which people are governed".

A linear model of environmental policy-making also makes the use of science seem quite straightforward, understanding scientific knowledge as a structuring element of the policy-making process: "scientists establish the facts about environmental realities, and policy-makers come up with policy options in the light of the facts"(Keeley and Scoones, 1999).

However, with the growing distrust of stakeholders in the policy institutions associated with science, in scientists, and even in science itself, the legitimacy and authority of the implementation of a rational linear policy model are also being challenged (Keeley and Scoones, 1999).

As we will show in this paper, science and the use of science develops together with the policy construction.

4.8.3 Dogger Bank case study in the science–policy framework

Dogger Bank is a large, shallow offshore sandbank area in the southern part of the North Sea, on which Germany, the Netherlands, and recently also the UK (designation process still ongoing) each have appointed a national marine protected area.

Active stakeholder involvement in the international negotiation of fisheries management measures started in May 2011 when the Dogger Bank Steering Group (DBSG), an international body consisting of delegates from the three countries (Denmark and the EC occupied observer roles) and entrusted with the task of negotiating a joint transnational fisheries management plan for the bank, decided to invite an international stakeholder group to formulate their own proposal for a fisheries management plan. Thus, the North Sea Regional Advisory Council (NS RAC), which until then had mainly been involved in fisheries management issues directly related to the EU's Common Fisheries Policy (CFP), was tasked with negotiating and putting forward to the DBSG a proposal for a fisheries management plan which could be agreed to by the main stakeholders with an interest in Dogger Bank either as users (i.e. fishers) or as advocates for the protection of the environment (i.e. ENGOs).

Previously, Germany, the Netherlands, and the UK had designated national Natura 2000 sites in their parts of Dogger Bank under the habitat type 1110b (Sandbanks which are slightly covered by sea water all the time) (European Commission, 1999), concluding that the sites were of high ecological value and currently not in a favourable conservation status. The reason for the unfavourable conservation status was the prevalence of short-lived, opportunistic species compared with long-lived species, presumably caused by fishing pressure on the area, originating from bottom-trawling activities employed to catch sole (*Solea solea*) and plaice (*Pleuronectes platessa*), and, to some extent, sandeel (*Ammodytes marinus*).

Contrary to the expectations of the Dogger Bank Steering Group, however, in the NS RAC negotiations, the struggle was not just about defining the appropriate fisheries management plan, (the relative size and location of closed zones for fishing on Dogger Bank), i.e. the solution to a predefined problem, but as much about defining the very problem to which the plan should provide the solution. After several extensions to the deadline for adoption of a common proposal, the process was concluded nine months later in April 2012 with a report in which the NS RAC expressed a joint vision on the general management approaches and objectives. However, no common position on the central zoning proposal for Dogger Bank could be reached, as the positions of fishers and ENGOs on what percentage of the total area should be closed and the location of the closed areas, were declared incompatible. Starting from the premise that the total size of the closed area(s) should be between 25 and 55% (a range pre-determined by

the Dogger Bank Steering Group), the fishers had argued for closing no more than 25% of the area, while environmental NGOs had decided that the lowest percent of closure they could agree to was 35%. The main reasons identified by fishers and NGOs for the failure to reach consensus were the unbridgeable differences between them, regarding:

- different perceptions of the unclear scientific base;
- the lack of sufficient scientific evidence;
- the lack of possibilities for the different parties to win anything by agreeing to a lower/higher percentage of closure; and
- the terms of reference to the stakeholder negotiations, which had been prescribed by the DBSG.

A national authority representative participating in the Dogger Bank Steering Group reflected on the policy-making process on Dogger Bank as follows:

> *"Normally in fisheries policy making, you would take a shared, scientifically defined problem as your starting point and then discuss the goals and measures afterwards. Here it is almost the contrary: you start with the goals or the framework, and afterwards you ask 'what is a good ecological status?"*

This quote expresses a perception of how problems should logically be solved. It reflects a typical understanding of linear-policy development.

Following a simple linear-policy model, such a logical way to go about creating an environmental marine conservation plan might look like the following:

- discovering/defining an environmental problem in a particular place;
- establishing the reasons for this problem;
- defining an appropriate solution (scientifically and politically); and
- implementing the solution.

With respect to the NS RAC negotiations of international fisheries management measures for the three marine protected areas on Dogger Bank, these steps could be operationalized in the following way:

1) definition and designation of the area as a valuable area in need for protection, diagnose that the area is not in a favourable conservation status;

2) determination that fishing pressure is the main reason for the unfavourable conservation status;

3) defining fisheries management measures; and

4) implementing fisheries management measures.

Following this logic, the researchers in this study entered the process somewhere between points 3 and 4, where it had been concluded by the Member States that there was a biodiversity problem on Dogger Bank, i.e. that the bank was not in a favourable conservation status (compare point 1). It had also been concluded that bottom touching fisheries were the likely cause of the problem, and that, hence, there was a need for fisheries management measures in order to bring the Dogger Bank protected areas back to a favourable conservation status (compare point 2).

Points 1 and 2 had thus already been decided by the Member States before stakeholder involvement started and the NS RAC had been invited to produce a proposal for management measures.

The negotiations of the NS RAC were thus meant to produce a clear management plan in accordance with this problem and solution. However, as our interviews revealed,

there were uncertainties and/or disagreements about almost all aspects of the definition of the problem and potential solution (points 1–3): (i) what it is that should be protected, (ii) whether it is worth protecting it, (iii) whether it is even damaged, (iv) what the cause of this damage is, and finally, as the negotiations should officially be about, (v) what kind of management plan might be an appropriate measure to solve the problem.

As we show in this paper, stakeholders from all parties continuously struggled with the scientific evidence on which each of the above-mentioned steps was built. The discussions about the definition of fisheries management measures (step 3) again and again returned to and revolved around the problem definition (step 1) and the identified reason for this problem (step 2), i.e. those steps which had been decided by the Member States without the involvement of stakeholders.

4.8.4 Conclusions

By inviting the NS RAC to develop a fisheries management plan, the Dogger Bank Steering Group opened up the decision-making process to some extent, accommodating the widely accepted requirement to involve stakeholders in the policy and science arena. This can be interpreted as reflecting a general willingness to diverge from a linear, top-down, policy-making process and to move to a more open type of process. As stakeholders are involved, multiple perspectives on the problem at hand enter the debate, and, through open negotiation about goals and values, appropriate policy reactions result (compare Keeley and Scoones, 1999). Thereby, the policy process rather resembles a web of interrelated decisions which evolve over time during the process of formulation and implementation (Hill, 1997; Keeley and Scoones, 1999).

However, with the opportunity sought for manoeuvre in the negotiations delimited by pre-defined, but contested assumptions, stakeholders were arguably forced to conform to a linear policy-making approach. Thus, rather than a straightforward, open process, in which stakeholders could contribute to (i) the problem definition, (ii) the search for the reason of the problem, and finally (iii) the creation of a fisheries management plan, stakeholders were challenging the scientific evidence, and the negotiations experienced a continued struggle to redefine the very problem to be solved and to reopen a discussion which had already been closed by competent authorities.

4.9 Mapping inshore fishing activity to inform marine planning in Scotland: a pilot project using stakeholder data in the Pentland Firth and Orkney waters

Anne McLay, Matthew Gubbins, Gareth Jones, Robert Watret, Elisa Barreto, and David Bruce

Marine planning relies on robust data on human uses of the sea in order to minimize spatial conflicts and account for the cumulative effects of multiple activities in decision-making. Capture fisheries are major users of our seas, and it is important to account for the activity of this sector in marine plans. Activity and value data already exist for offshore fisheries in Scottish waters through the use of vessel monitoring systems (VMS) on large (>15 m) vessels and have been used in sectoral planning in Scotland to help identify areas of least conflict that may be suitable for marine renewable energy development. However, in many areas, the competition for space is greatest in inshore waters where most fishing is undertaken by small vessels (<15 m), which are not currently fitted with VMS.

We evaluate a pilot study aimed at mapping inshore fishing activity in the Pentland Firth and Orkney waters, an area in the north part of Scotland where there is considerable interest and potential for renewable energy development. The study used an interview-based methodology known as ScotMap. Locally-based fishers (187) were asked to identify the areas where they fish and provide associated information about their fishing vessels, fishing patterns, target species, and income. All information was recorded electronically via purpose-designed, graphical-user interface for GIS analyses. We describe the methodology, present examples of mapped outputs based on aggregated, gridded data, and consider the potential for extension and further development of the approach.

4.9.1 Introduction

Marine planning relies on robust data on human uses of the sea in order to minimize spatial conflicts and account for the cumulative effects of multiple activities in decision-making. Capture fisheries are major users of our seas, and it is important to account for the activity of this sector in marine plans. Spatially-resolved fishing activity data for large fishing vessels (>15 m) can be derived from vessel monitoring systems (VMS) and these, in combination with landings data, have already been used to inform sectoral planning for the renewable energy industry in Scotland and to help identify areas of least conflict that may be suitable for marine renewable energy development (Davies *et al*., 2012a, 2012b; Kafas *et al*., 2012). These do not, however, represent fishing activity of vessels <15 m in length which are not currently fitted with VMS, but which account for a substantial proportion of landings from some inshore areas where competition for marine space is often most intense. A more detailed understanding of the spatial distribution and economic importance of fishing activity by this component of the fleet in Scottish waters is required by Marine Scotland to inform decisions in various policy areas, including marine spatial planning, sustainable development of offshore renewable energy, nature conservation, and fisheries management.

A pilot study to trial an interview-based methodology to collect information on inshore fisheries activity directly from fisheries stakeholders was conducted in the Pentland Firth and Orkney waters strategic area starting in June 2011. The project, known as ScotMap, uses a questionnaire and mapping approach originally developed during the Fishermap project and subsequently used in an electronic form in UK waters in the Finding Sanctuary project (des Clers *et al*., 2008; Lieberknecht *et al*., 2011). The aim of the ScotMap pilot was primarily to test the methodology and uptake and whether it could be used to obtain detailed spatially-resolved information on inshore fishing activity which would include identification of areas fished, seasonal usage, targeted species, fishing method and gear used, number of people employed, and the contribution sea areas make to income from fishing.

4.9.2 Methods

Face-to-face interviews with individual fishers were conducted between June and October 2011 by staff from Marine Scotland Compliance. The target respondents were skippers/owners of vessels registered in the ports of Kirkwall and Scrabster who were known to fish in the Pentland Firth and Orkney waters. During the interviews, fishers were asked a series of questions about their fishing vessel, fishing patterns, crew, and species targeted. They were also asked for information about vessel earnings from fishing, specifically gross vessel earnings, averaged over the past five years and the maximum and minimum vessel gross earnings over the same period. Fishing areas or "polygons", as identified by each fisher, were drawn on a map, and associated information relating to target species, fishing method, and value of each polygon, as a percentage

of average gross vessel earning, was recorded. All of the information, including the fishing polygons, was recorded electronically via ScotMap[2], which is a purpose-designed, graphical-user interface linked to a GIS programme ArcMap (version 9.3.1), and written down to geodatabases.

Each fisher taking part signed a data consent form to ensure that participants understood the purpose of the study and knew how the information they contributed would be handled. The form sets out the obligations of the data collectors and the organizations which will use the data to ensure that commercial confidentiality is maintained and that personal data are not disclosed.

The response to the request for information was very positive, with almost 100% of the fishers contacted agreeing to be interviewed. The only fishers who declined to take part did so on the grounds that they were not currently fishing. A total of 187 interviews were conducted between May and October 2011.

Data collected during interviews were subject to a series of checks prior to analysis. Complete records were available for 176 interviews, the majority of which were with skippers of creel fishing vessels <15 m in length (Table 4.9.2.1). Six skippers declined to give financial information. Various omissions, errors, or inconsistencies in the data from five other interviews meant that these were not included in the analysis.

[2] The ScotMap Graphical User Interface (GUI) is a modification of FisherMap, which was developed by researchers at the University of Kent for the Finding Sanctuary Project, subsequently modified for use by Marine Scotland.

Table 4.9.2.1. Number of interviews by vessel size category and fishing method.

Fishing method	≤9.99 m	10–14.99 m	≥15 m	Total
Bottom seine	0	0	1	1
Dredge	1	1	0	2
Gillnet	1	0	0	1
Longline	1	0	0	1
Creel	109	32	5	146
Scallop diver	11	3	0	14
Towed dredge	1	1	1	3
Trawl	0	3	5	8
Total	124	40	12	176

The complete interview records consisted of 490 fishing polygons representing fishing areas, each associated with information on fishing method, gear, target species, and percentage contribution to vessel earnings, linked to a series of tables containing other information on the fishers and fishing vessel. The majority of the fishing polygons (309) related to creel fishing.

The spatial and tabulated data from all the interviews were combined and analysed to provide datasets suitable for mapping in terms of value (i) absolute monetary value, (ii) sum of percentage values, (iii) usage number of boats, and (iv) number of employees. A programme code in python to grid the data was developed for the analysis.

In the case of absolute monetary value, the code calculates a value for each mapped polygon based on its percentage contribution to vessel earnings and the vessel average annual gross earnings data. Polygons are then associated with a grid of squares, and the monetary value attributed to each polygon is divided equally between all the grid squares with which the polygon overlaps. The values associated with each grid square are then summed to produce a gridded dataset which can be mapped.

The sum of percentage values associated with each grid square were calculated similarly, based on an equal distribution of the polygon percentage value among the all overlapping grid squares. The summed percentage values for each grid square were standardized against the highest value, set for these purposes at 100. Treating the data in this way allows for an assessment of "value" which is independent of gross vessel earnings, which can vary greatly among different vessel size classes and between boats targeting relatively high- and low-value species.

To depict usage of different sea areas in terms of the number of boats, the polygons for each vessel were again associated with a grid. Each vessel was counted once in each overlapping grid square (partial or complete overlap), and these counts were summed to derive the number of unique boats per grid square. Numbers employed (skipper plus crew) recorded during the interviews were treated similarly to derive data to depict numbers employed per grid square.

Data were gridded to both coarse and fine grids, with latitude/longitude dimensions of 0.1 x 0.1 and 0.025 x 0.025 decimal degrees, respectively. The coarse grid gives 50 grid squares per ICES statistical rectangle, and the fine grid gives 400 grid squares. The code was applied to the entire dataset and to subsets of the data based on combinations of vessel length (all vessels interviewed, all vessels <15 m, vessels 10–15 m, and <10 m length), gear type, and target species. A total of 380 datasets were generated.

In relation to the gridding technique applied, it should be noted that (i) the allocation of polygon values to grid squares are equal irrespective of the actual proportion of the polygon which falls within the grid, (ii) the area of the grid squares based on regular latitudinal and longitudinal intervals varies with latitude (e.g. in this case, the area covered by a 0.025 x 0.025 degree grid is 3.7 km^2 in the northern part of the study area compared with 4.6 km^2 in the southern part), and (iii) any rounding-up of values or potential inaccuracies associated with particular polygons will be propagated across different grid squares.

To assess the extent to which the vessels interviewed represent fishing activity in the Pentland Firth and Orkney waters strategic area, we extracted vessel data landings statistics reported for statistical rectangles 47E6, 47E7, 46E6, and 46E7 in 2009 and 2010. For vessels <15 m in length, those interviewed accounted for >80% of the landings (tonnage all species) in both years. Vessels >15 m accounted for only 5–7% of the tonnage reported for these rectangles in these years. We consider the <15-m vessel category to be reasonably well sampled and the larger vessel category inadequately sampled. Mapped outputs presented below are for interviewed vessels <15 m in length. It should be noted that these maps will not include activity by other vessels fishing, but not registered in ports, in the study area.

4.9.3 Results

Examples of mapped outputs from the pilot study are shown in Figures 4.9.3.1–4.9.3.4. These indicate that all of the Pentland Firth and Orkney waters are fished by <15-m vessels to a greater or lesser extent and allow us to distinguish areas of relatively high fishing activity and/or value. For example, maps based on vessel numbers indicate that some interisland waters are associated with higher levels of usage and high earnings compared to the western part of the Pentland Firth which appears to be less intensively fished. This could reflect poor sampling of vessels fishing in this area. Vessels fishing in statistical rectangle 46E5 have not, to date, been well sampled.

There is a reasonably close spatial correlation between the number of boats and the number of employees. This is to be expected as the number of employees is essentially a function of boat. Within the interview sample, larger boats (i.e. those 10–15 m in length) typically have more crew members than smaller <10 m vessels, many of which are crewed by one man. Thus, care needs to be taken when interpreting spatial patterns, particularly if vessel length classes or different types of fishing activity are not equally represented in the data. There is also some spatial correlation between absolute monetary value and number of boats, with relatively high values mapping in interisland and some coastal areas. The highest-value areas reflect both usage (numbers of boats) and the relatively high value of target species, such as lobster and scallops which are important in the areas.

A slightly different representation of the value of fishing is provided by the map of the sum of percentage value. This reflects the importance of creel fishing and its representation in the interview sample. Creel fishing occurs over a wide sea area around the Orkney Isles, but waters close to the coast are particularly important to smaller boats, mostly <10 m in length, for which a large proportion of the vessels' income comes from grounds close inshore.

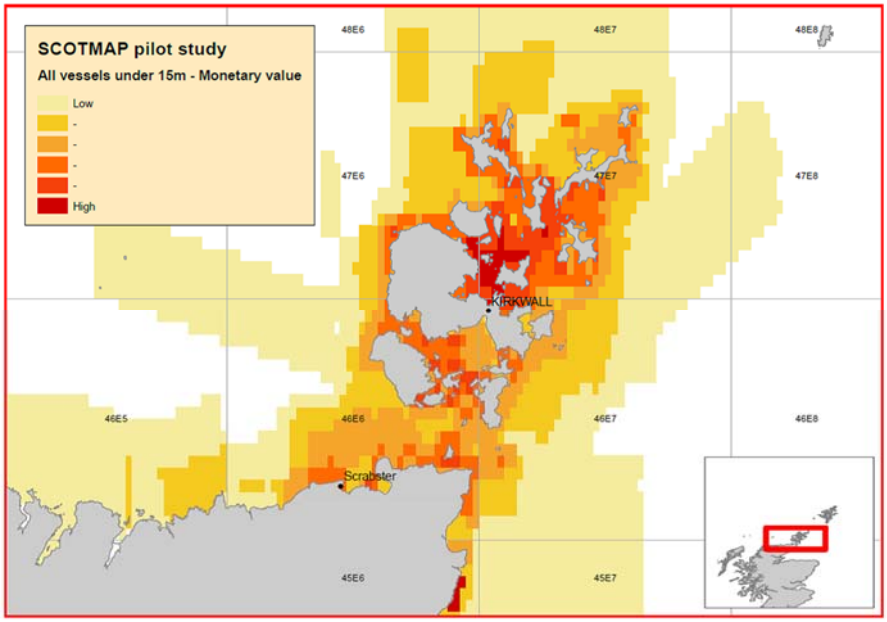

Figure 4.9.3.1. Relative monetary value by area for all vessels <15 m length.

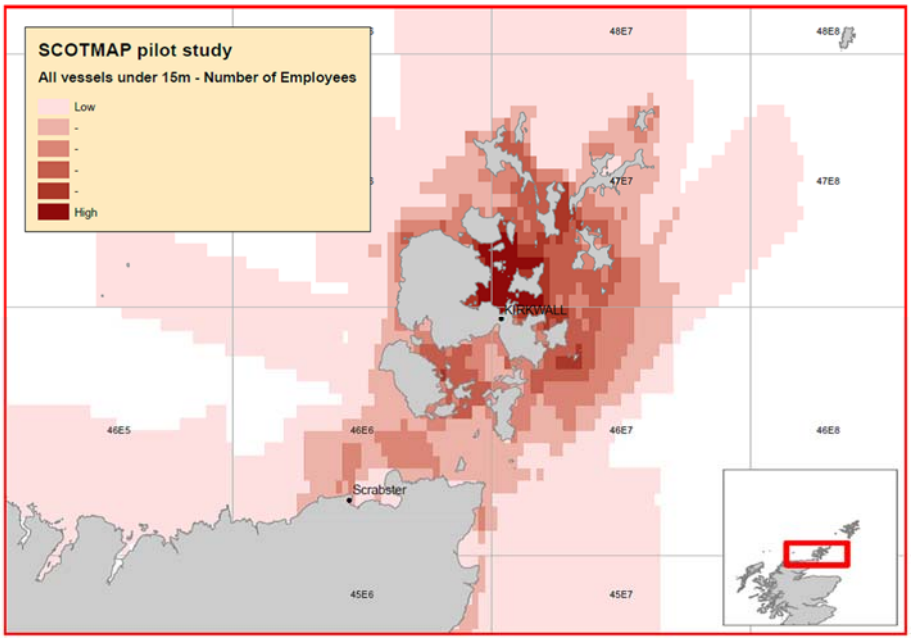

Figure 4.9.3.2. Relative number of employees by area for vessels <15 m length.

4.9.4 Discussion

The fishing industry's response to the request for information and the data collected during the pilot study in the Pentland Firth and Orkney waters suggests that the Scot-Map interview-based approach can be successfully applied to derive fine-scale, spatially-resolved information about fishing activity. The interview data and the analysis method have allowed us to aggregate information provided by numerous individuals to map fishing activity for vessels <15 m in terms of both value and usage. Numerous datasets were generated from the analyses, and it is possible to combine and subset the data in many different ways to investigate, for example, seasonal patterns of usage, and to identify sea areas supporting particular fisheries, defined in terms of gear and or target species. Any interpretation or use of these outputs needs, however, to take

account of the information on which they are based, particularly the extent to which it represents all the relevant fishing activity within the area.

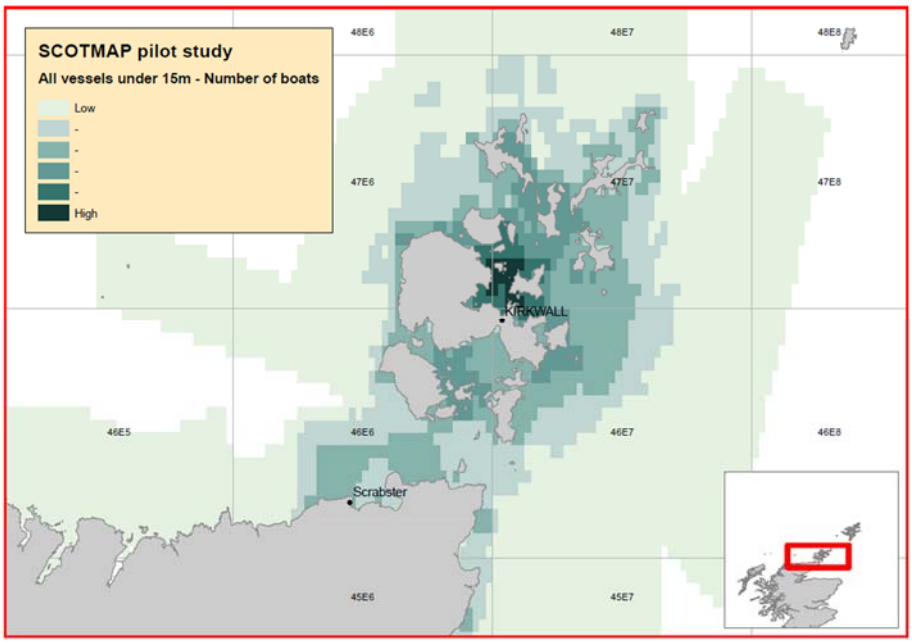

Figure 4.9.3.3. Relative number of boats (<15 m length) fishing in the study area.

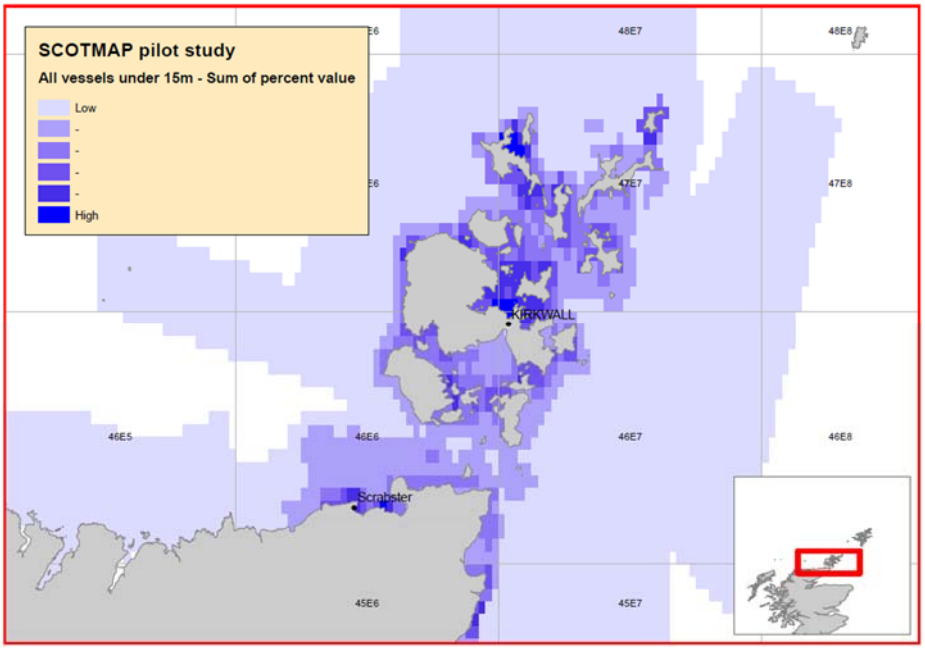

Figure 4.9.3.4. Relative importance of fishing areas for vessels <15 m, expressed as a cumulative percentage of vessel usage (non-monetary "value").

This pilot study targeted skippers of locally registered vessels in the ports of Kirkwall and Orkney. Most were skippers of small boats (<15 m) which fish locally. Creel fisheries for crab and lobster are particularly important. There are other larger vessels, also based locally, that fish both inside and outside the study area for shellfish or demersal fish species, and, equally, there will be other vessels, both large and small, that fish within the area which are not locally based. We have used reported landings statistics to assess the extent to which the interview sample is likely to have captured relevant

fishing activity within broad areas. There are no direct means to do this at the sub-rectangle level or to assess the accuracy of the spatial information provided by the individuals interviewed. The information was freely given by fishers who defined their fishing areas in different ways with varying degrees of spatial resolution, with the aim of contributing to an overall picture. The outputs are based on what is colloquially referred to as "soft data" (what people have told us) and should be borne in mind if they are to be used in the planning context.

As part of the pilot, we have tried to develop means to evaluate the combined datasets and have mapped outputs so that that fishing communities and those who might use the data can be confident that they provide a reasonable representation of fishing activity and also are aware of any inconsistencies or known limitations. Various maps have been made available to a project steering group and displayed in local fisheries offices. Others with local knowledge, including those involved in the data collection, also have provided comments. Looking ahead, local focus groups consisting of fisher's representatives and contributors to the study are being considered. It is important that fishing stakeholders have further opportunity to comment on the maps, particularly if additional data are collected.

In discussion with stakeholders, it has become apparent that they have concerns about planning decisions relying solely on measures of the absolute monetary value of fishing in any given area. There are some sea areas where income from fishing has a relatively small absolute value, but nevertheless plays a critical role in supporting small rural communities, often in remote areas. There may be limited possibilities for small fishing vessels to fish elsewhere. Other information on vessel size and home and landing port collected during ScotMap interviews could be interrogated and used to support a wider analysis of the socio-economic importance of fishing and/or the effects of fishing displacement, if used in conjunction with other information (e.g. employment in these areas).

The maps produced as a result of the pilot are effectively summaries or snapshots, based on fishing activity over the past five years. Spatial mapping, to some extent, assumes that distributions are reasonably stable both in space and time. For less-mobile shellfish species that have specific habitat requirements and are mainly caught in static gears, the assumption of spatial stability is probably reasonable. Spatial distribution of fishing using more mobile gears (e.g. trawling and dredging) is more likely to be more influenced by fish distribution and abundance. Fisheries change in either the numbers of boats fishing for different species or species combinations and the value of landings are likely to vary over time in relation to many factors, including stock abundance, market prices, and alternative fishing opportunities.

ScotMap is currently being rolled out to other areas of Scottish waters. Data from additional interviews will hopefully contribute to a more complete picture for the Pentland Firth and Orkney waters and ultimately in other areas. Although labour-intensive, the interview-based approach shows the potential to fill an important information gap relatively quickly. In the future, vessel monitoring systems, which are being introduced on vessels <15 m, offer a plausible alternative for data collection. In the meantime, further work on data analysis, including alternatives to the gridding approach, and different representations of fishing activity are planned. Consideration needs to be given as to how the data will be used and which datasets are likely to be most informative for the purposes of marine spatial planning at both the national and regional level and also to how information from ScotMap might be combined with that from VMS-monitored larger vessels to produce an integrated picture.

4.9.5 Acknowledgements

Thanks to all the skippers from Kirkwall and Scrabster for contributing information and to Marine Scotland Compliance staff who carried out the interviews.

4.10 Trawl fishers' perceptions as complementary inputs in developing effective management plans in the context of the Mediterranean multispecies fisheries

Vassiliki Vassilopoulou, Aikaterini Dogrammatzi, Konstantina Nantia Papadopoulou, Andreas Palialexis, John Haralabous, and Søren Qvist Eliasen

4.10.1 Introduction

Spatial approaches to fisheries management make use of a number of initiatives based on spatial-temporal limitations of fishing that range from marine reserves and no-take areas to temporary or permanent single-gear restrictions. In the Mediterranean Sea, the vast majority of fishing activities are concentrated along the continental shelf, although the extent of this zone into the basin is relatively narrow (Lleonart and Maynou, 2003). This results in serious concerns about overfishing the shelf-associated resources and destruction of their habitats (Caddy *et al.*, 1998). Hence, in recent decades, different types of spatial management initiatives, mainly as trawl exclusion zones, have been established for the purpose of rebuilding depleted resources and enhancing fisheries (Pipitone, 2012). A recent EU Regulation (1967/2006) attempted to further enhance protection of shelf areas through the enforcement of an additional measure prohibiting bottom trawling to a distance of 1.5 nautical miles from the coast and also minimizing conflicts with small-scale fisheries. Trawl fishers opposed this measure, considering it to be excessively harsh because it considerably restricts their fishing grounds. This study aims to provide insight into trawl fishers' perceptions regarding the effectiveness of the existing management system, discussing particular points related to spatial measures. The need for a participatory approach in decision-making, which will strengthen compliance and promote conservation goals and sustainability of fishery resources, is highlighted.

4.10.2 Material and methods

Questionnaires were constructed with the basic aim of contributing to the analysis of socio-economic and institutional drivers/incentives for discarding, as required by the MariFish Project BADMINTON (Bycatch And Discards: Management INdicators, Trends and locatiON). Interviews were "semi-structured"; the questions were neither highly structured (closed-ended questions) nor unstructured with open-ended questions that encouraged interviewees to express themselves in their own way. Semi-structured interviews offer carefully designed topics and questions in order to elicit the interviewee's ideas and opinions on the topic of interest, as well as to avoid leading the interviewee towards preconceived choices. In our case, they enabled openness and interaction with fishers who, aside from issues related to discarding, were also allowed to talk about their major concerns relative to the status and prevailing conditions of the trawl fishery in Greece. The interviewees were trawl fishers based in major ports in the Ionian, Aegean, and Cretan seas and had a very good idea of practices related to mixed demersal trawl fisheries in the area. Most interviews took place in facilities in the port and were 1–2 hours in duration. Qualitative responses by 17 trawl fishers were recorded at eight ports (Figure 4.10.2.1), three ports in the Ionian Sea (seven interviews), three ports in the Aegean Sea (seven interviews), and two ports in the Cretan Sea (three interviews). During the analysis, responses were categorized to convert a qualitative into a quantitative response. Through a scoring process, the identified issues were prioritized in each of the three areas, ranging from high-priority issues, when mentioned

by >70% of the interviewees (reflecting a high unsatisfactory perception), to low-priority issues, when quoted by <30% of fishers. Particularly for the Cretan Sea, because of the small number of interviewees, issues of high priority were considered to be those mentioned by all three fishers, while low-priority issues were those identified by only a single fisher.

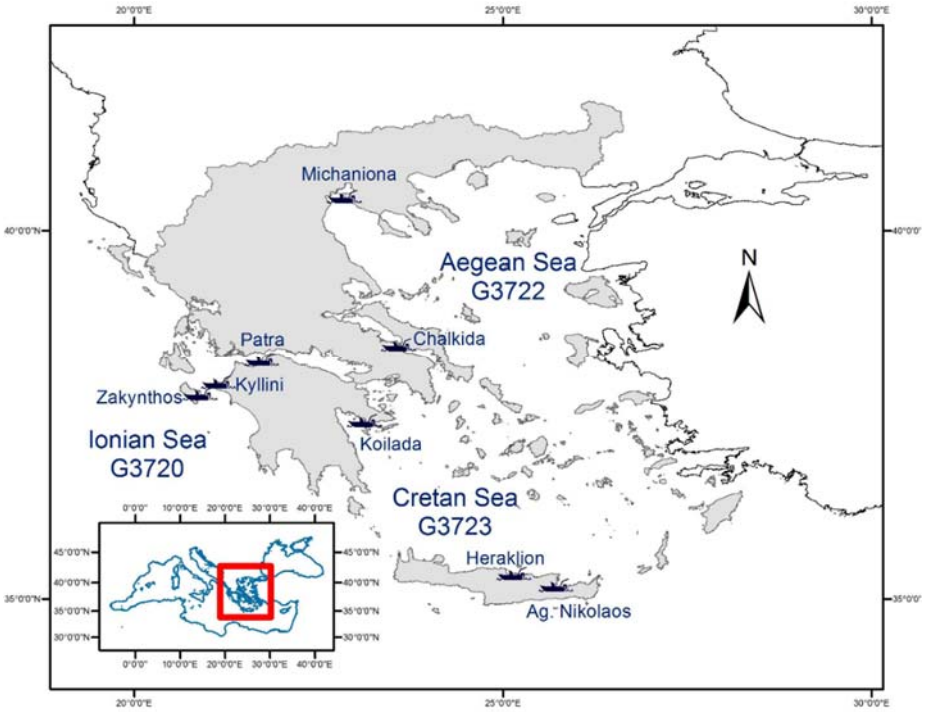

Figure 4.10.2.1. Study area with the associated ports where the interviews were conducted.

4.10.3 Results and discussion

Viewpoints on issues that were discussed during the interviews were grouped into five categories (Figure 4.10.3.1) and were analysed on a regional basis (i.e. Aegean, Ionian, Cretan seas) to visualize local conditions in Greek trawl fisheries and major concerns of fishers (Table 4.10.3.1). The first category comprised problems arising from impacts directly connected to fishing activities, including possible matters arising due to overfishing, discarding, bycatch of priority species, and conflicts with foreign fleets. It is important to note that this category attracted low attention (Table 4.10.3.1), and although almost all complained about declining catches, they blamed external factors such as pollution or even overexploitation of the resources from small-scale fisheries operating, as they stated, without control, while the bulk of the enforced measures concerned the operation of trawl fisheries. The major issue, according to fishers, coincided with foreign (Turkish) trawlers operating in the Aegean Sea, where Greek territorial waters extend to 6 nautical miles. Turkish fleets exploit shared stocks in international waters of the latter region, even during summer, when operation of Greek trawlers is prohibited, a measure established for the protection of spawning stocks of several demersal species.

Table 4.10.3.1. Significance of the issues as revealed by fishers in the Aegean, Ionian, and Cretan seas.

Problems Sea	Impact from fishing activities	Impact from other human activities	Organizational gaps	Management measures	Financial burdens
Ionian	Low	Medium	Medium	High	High
Aegean	Medium	High	Medium	High	High
Cretan	Low	Medium	Medium	High	High

The second category included impacts connected with other human activities, with pollution, particularly due to agricultural runoff, contributing to the deterioration of estuarine coastal ecosystems and nursery habitats (e.g. sea grass meadows) in specific areas, and marine litter, pointed out by most interviewees, being the major issues (Figure 4.10.3.1).

Two points related to certain organizational gaps of the fishery management system were highlighted as impediments that hinder the smooth operation of the trawlers in Greek waters. These points were (i) the lack of service infrastructure and supplies for surveillance equipment (i.e. VMS) in Greece, (ii) restricting the operation of a vessel for a number of days, and (iii) the poor information/limited mapping on certain priority for conservation habitats (Figure 4.10.3.1). For example, *Posidonia oceanica* meadows are listed as priority habitats under the EU's Habitats Directive, and Greece has banned the operation of trawlers on these bottoms. However, illegal fishing was recorded (Kiparissis *et al.*, 2011), underlining the necessity for mapping priority sea beds and then applying suitable spatial measures complemented by strong enforcement.

However, the two categories including respective issues arising from certain management measures and from financial/maintenance burdens were indicated by fishers as issues of major concern in all areas (Table 4.10.3.1), yielding low security and unsustainable livelihoods and deserving immediate attention by management officials. Among the issues related to various financial burdens, high fuel prices appeared to be the most important, while gear repair costs, unfair competition due to imported cheaper fishery products, and decreased/shifting market demand as a consequence of the economic crisis were also highlighted in many instances.

In relation to management measures, spatial measures related to the implementation of closed areas, banning of operations until 1.5 nautical miles offshore, and enforcement of more selective gears (i.e. the 40-mm square mesh) were frequently mentioned. The latter two measures resulted from the enforcement of the EC Regulation 1967/2006. Fishers considered that the ban on trawling in areas up to 1.5 nautical miles restricted their catches considerably and hence reduced their income, leading to their economic deprivation. The latter seems to be consistent with the results of a study conducted in Greek waters which demonstrated that a significant percentage (34%) of the trawl operations were accomplished within a distance of less than 1.5 nautical miles from the coast, and that landings from those operations represented about 30% of the total biomass, suggesting that the corresponding overall catch reduction should be >45% for certain coastal species of high commercial value (Tserpes *et al.*, 2011). Moreover, the aforementioned regulation imposes a modification of the previously enforced 40-mm diamond meshed codend to 40-mm square or 50-mm diamond, and fishers considered that this change contributed to a further reduction in their already declining catches.

They also felt that the new gear had an increased selectivity that allowed small individuals to escape; hence, they needed less time for sorting, and there was less discarding. Most of them complained, however, about the higher susceptibility of the new gear to damage, since they argued that it is more easily torn while towed. Finally, spatial closures imposed in the trawl fishery in certain areas were highlighted as unreasonable, since fishers' impressions were that at least certain areas were declared as no-take zones without prior scientific evidence, and no monitoring and evaluation of their effectiveness has taken place ever since. They suggested that measures should be taken based only on solid research, and they were quite positive about participating in specific targeted studies (e.g. testing new more selective gears).

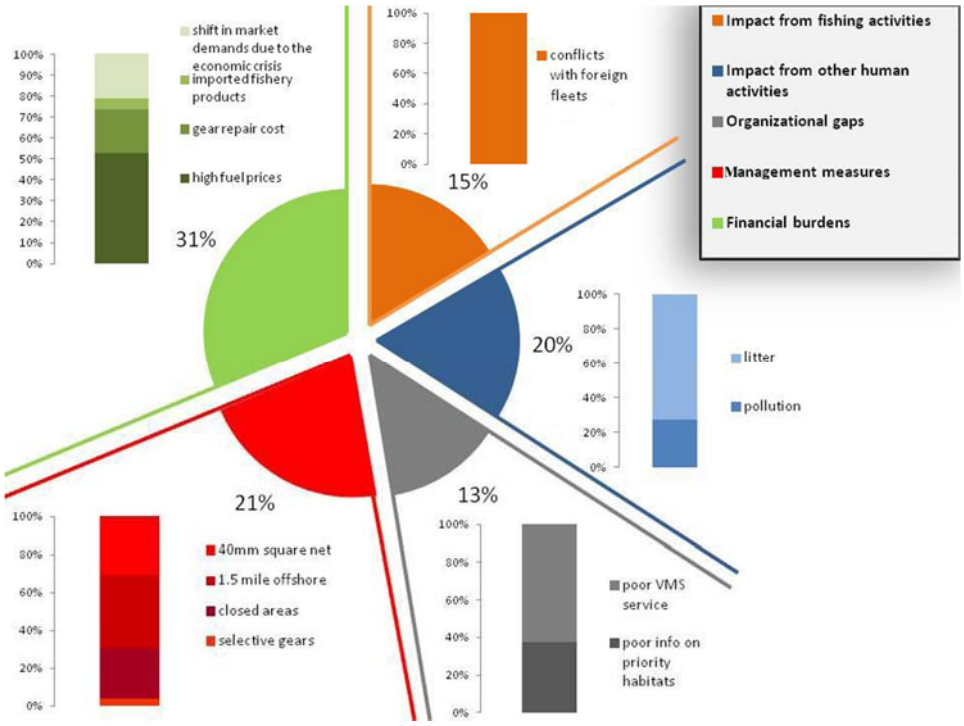

Figure 4.10.3.1. The pie chart indicates the five groups of critical issues concerning the Greek trawl fishery sector. Percentages in the pie chart reflect the proportion of fishers' concerns relative to the total number of issues that were discussed. The specific issues that made up each group are illustrated as bar with their percentage contribution shown.

4.10.4 Conclusions

Our findings indicate that among issues of high priority reflecting a high unsatisfactory perception and needing immediate actions are those related to certain spatial management measures referring to fishing grounds restrictions, which should be re-evaluated on the basis of solid scientific evidence. Financial burdens resulting mainly from high fuel costs, but also gear maintenance mainly due to the increased susceptibility to damage of the recently implemented 40-mm square net, were identified as further reducing fishers' incomes, leading to their economic deprivation. The fact that particular measures were considered unfair is possibly a basic reason influencing the relatively low compliance of the sector (Damalas and Vassilopoulou, 2013).

In general, trawl fishers perceived themselves as not being consulted or involved in the decision-making process, while they felt that they could offer suggestions that could improve the state of the stocks (e.g. spatial-temporal restrictions during spawning of demersal species). They appeared quite positive in raising their awareness relative to

findings of solid scientific research, and they also seemed willing to participate in studies they considered would provide knowledge that would improve the advice contributing to the adoption of effective measures. Indeed, the involvement of fishers in the decision-making process is of key importance since they have unique knowledge concerning local features and needs and can provide a better understanding of the potential impacts of measures. The latter can be used as complementary inputs to scientific results in the integrated and iterative process of adaptive management.

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