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JPI Oceans support action

SEVENTH FRAMEWORK PROGRAMME

Improving Science-Policy Interfaces:

Recommendations for JPI Oceans

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1 INTRODUCTION

Science plays an important role in environmental policies. It is used to make management decisions that attempt to limit the impact of human activities on the environment. However, in many cases the way in which science is communicated to policy makers is insufficient. Policy makers can misunderstand the limitations of scientific knowledge and scientists may not understand what policy makers require.

This report builds on the outcomes of the first publication of the CSA Oceans Work Package 5 (Redd *et al.*, 2013). That deliverable reported on an extensive stakeholder consultation which intended to discover examples of best practice and identify where JPI Oceans could add value in the science-policy landscape at European level. In this deliverable, we aim to supplement the outcomes of the consultations to determine the current and future needs of policy makers and advisors from relevant international, European and national public bodies. We also discuss what actions JPI Oceans could do to add value to existing science-policy mechanisms. This is considered in the context of joint programming, and looks at how other similar organisations have been effective at adding value.

Firstly, we explore five examples of science-policy mechanisms as case studies. The case studies were selected to demonstrate examples of best practice, including examples highlighted by stakeholders and other known mechanisms, to explore how they work and what makes them effective.

The second section of this report investigates how new technology and methodologies could be useful in improving science-policy interfaces. This section contains a number of specific examples of existing projects that could be considered relevant or cutting edge, while they are not discussed in detail, links have been provided for further reading. There are several examples of ongoing work in individual Member States; these examples are mostly drawn from the CSA Oceans consultation exercise.

The third section explores how JPI Oceans could act to improve science-policy interfaces. This section looks at the recommendations made by stakeholders and attempts to briefly summarise the context and identifies how JPI Oceans could add value without duplicating existing efforts in the field. In this section we also discuss how JPI Oceans could add value to the science-policy interactions in ten strategic areas identified by its Strategic Advisory Board (StAB). These areas were defined in a workshop held between CSA Oceans and the StAB in July, 2014.

2 GLOBAL CASE STUDY: INTERNATIONAL PANEL ON CLIMATE CHANGE

RATIONALE

During preliminary analysis of the CSA Oceans stakeholder consultations, the Intergovernmental Panel on Climate Change IPCC was identified by a number of stakeholders as being an effective science-policy mechanism. The aim of this case study is to try and understand why it is perceived to be effective and what lessons might be drawn, given that governments are increasingly being required to produce environmental assessments, such as Good Environmental Status under the MSFD to chart progress and inform policy in the marine environment.

The study also reflects on another method of assessment used by the UK's Marine Climate Change Impacts Partnership (MCCIP). MCCIP uses a scorecard mechanism to assess various pressures on the marine environment and serves as a useful comparison to the relatively larger IPCC assessment.

This case study will attempt to tease out specific lessons learned from these processes and how they might help JPI Oceans develop a strategy for its science-policy activities at European level to support and compliment the efforts made by this and other organisations.

METHODS

This case study looks at the process and products of two assessment mechanisms, the IPCC and MCCIP. The study relies on desk-based research and analyses the publications of both mechanisms to understand the underlying work practices that make them effective. Where possible, these working practices are illustrated with examples to demonstrate how they work in practice. The objective of this case study is to understand the fundamental principles of environmental assessment for policy and how this could benefit JPI Oceans.

IPCC STRUCTURE AND STATUS

The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change. It was established by the United Nations Environment Programme (UNEP)[1] and the World Meteorological Organisation (WMO)[2] in 1988 to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts. In the same year, the UN General Assembly endorsed the action by WMO and UNEP in jointly establishing the IPCC[3].

The IPCC is an intergovernmental body. It is open to all member countries of the United Nations and WMO; there are currently 195 member countries. Governments participate in the review process and the plenary Sessions, where main decisions about the IPCC work programme are taken and reports are accepted, adopted, and approved. The IPCC Bureau Members, including the Chair, are also elected during the plenary Sessions.

The IPCC is a scientific body under the auspices of the United Nations. It reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide and

[1] http://www.ipcc.ch/docs/UNEP_GC-14_decision_IPCC_1987.pdf
[2] http://www.ipcc.ch/docs/WMO_resolution4_on_IPCC_1988.pdf
[3] http://www.ipcc.ch/docs/UNGA43-53.pdf

relevant to the understanding of climate change. It does not conduct its own research, nor does it monitor climate related data or parameters.

Thousands of scientists from all over the world contribute to the work of the IPCC on a voluntary basis. Review is an essential part of the IPCC process to ensure an objective and complete assessment of the current information. IPCC aims to reflect a range of views and expertise. The Secretariat[4] coordinates all the IPCC work and liaises with Governments. It is supported by WMO and UNEP[5] and is hosted in the WMO headquarters in Geneva.

The IPCC seeks to provide statements to decision makers that are up to date, authoritative and comprehensive, based on rigorous analyses. By endorsing the IPCC reports, governments acknowledge the authority of their scientific content. The intention is to provide neutral, policy-relevant information that is never policy-prescriptive. The clients for IPCC reports are therefore national Governments who use the information to inform their national policies as well as their approach to international Treaties, such as the Kyoto Protocol. However, the reports are also used by a wide range of stakeholders and command high public and media interest.

METHODOLOGY OF IPCC

The main 'product' of the IPCC process is in the form of the synthesis report. The Synthesis Report (SYR) uses material contained within IPCC Assessment Reports and Special Reports. The working procedures are rigourously defined and agreed on an intergovernmental basis. Particular features of the SYR is that it should be based exclusively on material contained in the three Working Group Reports and Special Reports produced during the 5th or previous Assessment Cycles. This longevity has lead to increasing confidence in the basic science over the Assessment cycles. The SYR consist of two parts:

1. Summary for Policymakers (SPM): up to 8 pages of text excluding the tables, maps, boxes and figures;
2. Longer Report: up to 30 pages of text excluding the tables, maps, boxes and figures.

The SYR publication also contains annexes such as a glossary, list of authors, reviewers, Review Editors, and an index.

The full process is complex. The writing and review of IPCC reports and other publications is done in accordance with the *Procedures for the preparation, review, acceptance, adoption, approval and publication of IPCC Reports* contained in Appendix A to the *Principles Governing IPCC Work*. These procedures, which were initially adopted by the 15th Session of the IPCC in 1999 and have been regularly reviewed and revised since then, provide detailed procedures for the preparation of the various types of IPCC material namely:

A. IPCC Reports which include Assessments, Synthesis and Special Reports and their Summaries for Policymakers and Methodology Reports.
B. Technical Papers which are based on the material already in the Assessment, Synthesis and Special Reports and their Summaries for Policymakers and Methodology Reports.
C. Supporting Materials which consist of workshop proceedings and materials from expert meetings which are either commissioned or supported by the IPCC; software or databases to facilitate the use of IPCC
D. Methodology Reports; and guidance materials to guide and assist in the preparation of comprehensive and scientifically sound IPCC Reports and Technical Papers.

The procedures address all steps leading to the preparation of IPCC material starting with the scoping process, nomination process and selection of authors, preparation of drafts by the

[4] http://www.ipcc.ch/organization/organization_secretariat.shtml
[5] http://www.ipcc.ch/docs/MOU_between_UNEP_and_WMO_on_IPCC-1989.pdf

writing teams, the review by experts and governments and finally the approval, adoption and acceptance process in plenary sessions. They also contain definitions of IPCC terms and its main bodies and a description of tasks of authors, reviewers, review editors and government focal points.

The IPCC's agreed communication strategy provides a valuable reference document for understanding the principles of providing advice to policy makers and the wider community[6]. The IPCC has two main communications goals. Firstly, to communicate its assessment findings and methodologies, by providing clear and balanced information on climate change, including scientific uncertainties, without compromising accuracy; secondly to explain the way the IPCC works, selects its authors and reviewers and produces its reports and other products. This will promote the understanding of the reports and underpin its reputation as a credible, transparent, balanced and authoritative scientific body.

The time and effort that is put into the production of the reports is significant. The 5th report was produced over a 4 year period and contained around 2,200 pages in 14 Chapters. The Atlas of Regional Projections and the report lists 259 Authors from 39 Countries. It was reported that the review process addressed 54,677 Review Comments by 1089 Experts. The Summary for Policymakers, overall only 28 pages in length, condensed and presented its main messages in 19 Headlines **statements**. Using a multidisciplinary approach, the IPCC uses expert knowledge from a broad range of scientific disciplines. The whole process is supported by a relatively small Secretariat of around 13 staff.

CHALLENGES

As well as being open to scientific challenge and opinion, the process of the IPCC also faces challenges as a science-policy mechanism. Recognising these, IPCC has already formed a task group to improve its operation and products. Factors under consideration are likely to include the frequency and complexity of reporting, including the scope for developing interim reports, the ways that stakeholders are engaged, the skills that lead and other authors need, and the way that scientists are recognised for their time and contributions. The process is expensive in terms of time and effort, though this is difficult to quantify. There are calls for the summaries to use better graphics and new visualisation tools and 'human impact stories' but it is unclear who would be responsible for producing these. Arguably any widening of the presentation from the factual science risks the introduction of emotive messages at the expense of scientific impartiality. These issues, amongst others, are discussed in a number of publications such as the report *Climate policy: Streamlining IPCC reports* (Griggs, 2014).

The UK Parliament's House of Commons Select Committee on Energy and Climate change has also recently examined the process and findings of these IPCC. The outcome of this review, published 29 July 2014 concluded that the IPCC has responded extremely well to constructive criticism in the last few years and has tightened its review processes to make its Fifth Assessment Report (AR5) the most exhaustive and heavily scrutinised Assessment Report to-date[7] and compiled to the highest standards of scholarship. The committee found the science to be robust and but called on the IPCC to continue to improve its transparency. The IPCC would benefit, they say, from recruiting a small team of non-climate scientists to observe the review process and the plenary meetings where the Summary for Policymakers is agreed.

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[6] IPCC 35th SESSION, 6-9 June 2012, GENEVA, SWITZERLAND, DECISIONS TAKEN WITH RESPECT TO THE REVIEW OF IPCC PROCESSES AND PROCEDURES, COMMUNICATIONS STRATEGY. http://www.ipcc.ch/news_and_events/news_and_events.shtml

[7] http://www.parliament.uk/business/committees/committees-a-z/commons-select/energy-and-climate-change-committee/news/report-ipcc-5-assessment-review/

RECOGNISING SCIENTIFIC INVOLVEMENT

One of the striking features of the IPCC process 4th assessment was the high profile recognition of its impact, which also had motivating effect for the scientists involved. The 2007 Nobel Peace Prize was awarded jointly to Intergovernmental Panel on Climate Change (IPCC) and Albert Arnold (Al) Gore Jr. *"for their efforts to build up and disseminate greater knowledge about man-made climate change and to lay the foundations for the measures that are needed to counteract such change".*

Many scientists involved in the process perceive an element of personal kudos. This may also be reinforced at national level where scientific organisations, and agencies use IPCC assessments as part of their impact measures. Governments too are keen to point out how many scientists from their countries were involved.

THE UN ASSESSMENT OF ASSESSMENTS PROCESS

Though not emphasised in the responses to the CSA Oceans stakeholder consultation, the UN's process of assessments is also pertinent, particularly the report *An Assessment of Assessments Findings of the Group of Experts Pursuant to UNGA Resolution 60/30, Summary for Decision Makers, Towards a Regular Process for Global Reporting and Assessment of the State of the Marine Environment including Socio-economic Aspects' IOC/INF-1256*. The report concluded that while assessment capacity is strong in many regions, there is clearly a need to develop greater expertise and infrastructure around the globe in the technical aspects of marine assessment. It identified major areas that require immediate, concerted and continuous attention as:

1. Ensuring that assessment processes are well designed and clearly link assessment processes and policy-makers. They should be conducted to the highest standards and be fully documented by the institutions responsible for assessments;
2. Improving data accessibility and interoperability so that assessments can be extended and scaled up or down within and across regions;
3. Increasing the consistency of selection and use of indicators and reference points to guide the interpretation of status and trends;
4. Developing integrated ecosystem assessments that can inform on the state of systems rather than just individual sectors or ecosystem components and which include social and economic aspects;
5. Strengthening the mandates of institutions to undertake fully integrated assessments; and
6. Strengthening capacity for response assessments that are linked directly to the findings of state, pressure and impact assessments.

The report also identified design features for an effective assessment and illustrated these with examples of best practice. These strategic priorities are clearly relevant to many other science-policy mechanisms and, along with other related work, could provide a useful range of recommendations for the design of assessment processes in the marine environment which might be helpful to inform any further European level based activity.

A DIFFERENT TYPE OF ASSESSMENT: SCORECARDS

The main output of the IPCC process is an assessment report of some 2000 pages with a short, headline summary for policy makers. The assessment products of the UKs Marine Climate Change Impacts Partnership (MCCIP) are much shorter documents again, which focus heavily on visual representation of data and advice.

MCCIP was established to provide a coordinated transfer of high quality evidence on marine climate change impacts and guidance on adaption to policy advisors and decision makers. As a partnership between Government departments, agencies and industry, it provides a focus for

those who would provide evidence from the coastal fringe, UK shelf seas and beyond. The advice MCCIP produces is intended for marine and coastal stakeholders, including policy makers, to enable them to make informed decisions based upon quality assured science. The key objectives for the MCCIP are to:

1. Develop and maintain a coordinating framework for marine climate change partners in the UK.
2. Build the knowledge base and consolidate evidence of marine climate change impacts, with emphasis on the spatial dimension where possible.
3. Provide effective mechanisms for the efficient transfer of marine climate change knowledge from the scientific community to policy advisers and decision makers.
4. Develop guidance and build upon best practice for adaptation tools and strategies available to stakeholders (e.g. 'climate smart' approaches).
5. Identify present shortcomings in UK marine climate science (i.e. what other science could be done / supported to help decision makers and UK marine industries).
6. Actively engage with partners and consult wider communities on requirements for climate change tools and information (e.g. marine scenarios of climate change).

MCCIP STRUCTURE

Like similar advisory organisations, the structure of MCCIP is one of the key factors in its success.

Steering Group: The primary purpose of the Steering Group (SG) is to deliver the MCCIP aim. All MCCIP partners are entitled to participate in the steering group's work. The objectives of the steering group are as follows:

- Oversee the development of the Partnership.
- Receive progress updates on MCCIP products and Expert Advisory Group discussions.
- Provide Communication Quality Assurance for the Annual Report Card and Briefing Notes, to ensure messages are clearly communicated and fit for purpose.
- Oversee the arrangements for partner and stakeholder engagement.
- Provide feedback on the performance of the MCCIP Secretariat.
- Provide a forum for partners in climate / marine related developments.
- Assign tasks to working groups as appropriate.
- Agree to required updates in the Business Plan.
- Monitor and evaluate implementation of the Business Plan.

Annual Report Card Working Group (ARCWG): This group oversees the operational delivery of the main MCCIP scientific products, notably the annual report cards and special topic reports. The ARCWY commissions the contributing scientists, and identifies appropriate specialists to peer-review the quality of the science. The latest report card, published in November 2013, contained contributions from over 150 leading UK scientists across 33 marine and coastal topics.

Climate Smart Working Group (CSWG): This new working group engages with marine user communities and oversees the climate adaptation deliverables (sector reports or similar related products). The formation of this group is a direct response to the phase I mid-term review to make advising on adaptation strategies a core element of phase II.

Expert Advisory Panel (EAP): The EAP will review the scientific content of MCCIP outputs, enabling MCCIP to maintain science quality as its foundation for relevance and credibility. The expert base required will need to be fluid to ensure that the best people are approached to quality assure both new (climate smart) and evolving (annual and special report card) products. The chair of the EAP will report back to the SG on its activities and request inputs from the SG members as appropriate. The EAP chair is Prof John Baxter, currently based at Scottish Natural Heritage.

Secretariat: a secretariat for MCCIP is based at Cefas, which acts as a central source of information and focal point. The MCCIP Secretariat is responsible for the daily running of MCCIP, gathering information and producing a clear overview of effort and outcomes.

ANNUAL REPORT CARD AND SPECIAL TOPIC REPORT CARDS

One of the most important outputs of MCCIP is its Annual Report Card (ARC). The ARC is a synthesis of the previous years work, delivered in a highly visual way to ensure that it is easily accessible and can lead directly to actions. The ARC is designed to answer three key questions:

1. What is the current state of scientific understanding of marine climate change in our oceans and seas?
1. What changes have been observed and what could happen in the future?
2. How much of this is hard fact and how much is interpretation?

While the ARC provides high-level statements for policy makers, the underlying evidence is accessible through the online version of the report. The evidence is fully referenced and key sources of information are highlighted to allow the user to trace the advice back and look at each subject in more detail. The ARC also attempts to identify gaps in the scientific knowledge that need to be addressed to understand the impacts of climate change. Some 30 full reports are available and these are also occasionally supplemented with 'special report topic cards'. The next special report will be on MSFD and GES.

Belgium Compendium for Coast and Sea
In collaboration with a network of experts, Flanders Marine Institute (VLIZ) developed the Compendium for Coast and Sea which aims to aggregate objective and scientifically-underpinned information and data from Flemish/Belgian marine and maritime research. The integrated and border-crossing character (including the land-sea border) of the Compendium contributes to an improved communication within and from the fragmented marine/maritime scientific world and increases the accessibility and visibility of the marine/maritime research (a 'business card' of the Flemish/Belgian marine and maritime scientific community). Hence, the compendium serves as a tool in support of a Sustainable and Integrated Maritime Policy and Coastal Zone Management. The Compendium for Coast and Sea gives full access to information about the socio-economic, ecological and institutional aspects of the coast and the sea in Flanders and Belgium. It is a one-stop-shop for policy makers to find relevant scientific information. www.vliz.be/en/compendium-coast-and-sea

An example of an assessment tool used in Belgium from the CSA Oceans Consultation

LESSONS LEARNED

The IPCC is an example of a specific type of science-policy mechanism; indeed it is perhaps the biggest example both in terms of the number of scientists involved and the number of disciplines represented. The advice it provides is generally accepted by governments, regardless of political alignment, and is a testament to its relevance, credibility and transparency. From it, there are a number of key lessons which can be learned and, while not all could be replicated in a smaller process, provide an understanding as to what makes it successful. These points include:

- The large number of scientists can give 'degree of consensus and credibility', though the intellectual effort involved is considerable.
- A system based on peer review of published papers ensures that advice is independent and represents the expertise of the scientific community.

- Credibility of authors is important, including careful consideration of who can represent the views of the organisation.
- To be broadly accepted by governments, the advice must be policy-relevant and yet policy-neutral.
- Providing a summary for policy makers in language they understand and in context provides an introduction to the complex scientific content. However, the calls for the summaries to use better graphics and new visualisation tools shows that an extra level is needed to provide more information to policy makers, but in a form that is understandable to a non-scientific audience.
- Need for robust, transparent and defendable Evidence base - 'rigours guidelines' on what material is eligible, how panels work, how authors are identified and selected.
- Network of government contacts engaged from start – intergovernmental as well as individual scientists.
- The profile and media coverage of the outputs is high and truly international. A clear well developed Communications strategy underpins the process.
- From outset there was a clear timeline and policy channel for the science and a well-designed rationale for seeking scientific input.
- Assessments must be planned on meaningful timescales that optimise the need for the information against available budget and other resource.
- Scientists gain a high level of recognition for being part of the IPCC process, but if the work is on a voluntary basis the time and effort need to be recognised in some way.

The example of MCCIP is useful in demonstrating how an assessment process can be used in the marine environment. There are a number of key features of the process that make it successful which include:

- Co-design approach that involves multiple agencies, research funders and policy makers;
- Presentation of clear, concise and summarised information, using strong graphics, indicators, headlines and examples. Its outputs are presented in a range of formats including succinct powerpoint presentations, briefing document and web based resource which are all directly traceable back to the original scientist inputs and feeder documents;
- A regular annual review process ensures that policy makers are informed on the most up to date science and also sets a precedent to expect this science;
- A system that not only presents advice, but also identifies the research priorities and knowledge gaps;
- Building on this work with additional materials pertinent to particular sectors and shareholders.

3 REGIONAL CASE STUDY: THE INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

RATIONALE

During preliminary analysis of the CSA Oceans stakeholder consultations, ICES was identified by a number of stakeholders as being an effective science-policy mechanism. The aim of this case study is to try and understand why it is perceived to be effective. To this end it will be important to understand how ICES operates. It will become clear that ICES is an organisation that has evolved over a century into what we see today. In fact many of the changes that have taken place over the last decade provide an insight into the changing nature of the policy requirements of marine science. ICES has adapted to these changes by drawing on the expertise of its members and its secretariat. This case study will attempt to tease out the lessons learned by ICES and how they might help JPI Oceans develop a strategy to support and compliment the efforts made by this and other similar organisations.

METHODS

This case study mostly relies on reviewing existing literature. One of the main sources for this study the book *The Paradoxes of Transparency*[1]. The book is an extensive review of the *modus operandi* of ICES and its relationship with the European Commission; the book is based, in part, on structured interviews with participants of the ICES process, including scientists responsible for generating the scientific advice. Other significant materials reviewed include the *ICES Annual report 2012* and the *ICES 2014 Strategic Plan.* The former document mostly demonstrates what ICES has done and the latter reflects what ICES hopes to do in the near future.

Other documents have been studied to provide supplementary information and to validate what has been found. In addition to the literature, several semi-structured interviews were conducted with members of the organisation.

WHAT IS ICES?

The International Council for the Exploration of the Sea (ICES) was established in 1902 and received a legal foundation and international status through a 1964 Convention. Today it is an intergovernmental organisation of 20 member countries that produces advice to be used in legally binding decision-making.

ICES is perhaps best known for its annual fish stock assessments which are used to set catch quotas for the Common Fisheries Policy (Churchill & Owen, 2010). However, ICES also provides advice on an *ad hoc* basis to other clients. To focus on ICES as a science-policy organisation, this case study purposely avoids discussing how the advice is used once it has been submitted to a client, except in relation to feedback mechanisms.

THE STRUCTURE AND ORGANISATION OF ICES

Understanding the structure of ICES (Figure 1) is fundamental to understanding how it operates as a science-policy system. At the core of ICES is the secretariat, based in Copenhagen, and employing around 50 staff. The greater network of ICES is made up of over 4000 scientists, of which 1600 take part in annual activities, from nearly 300 institutes. On the one hand these scientists can be viewed as a reservoir of expertise that ICES can draw upon to produce advice and on the other can be seen as collaborative partners. Two bodies, the Science Committee (SCICOM) and the Advisory Committee (ACOM) coordinate the expert groups.

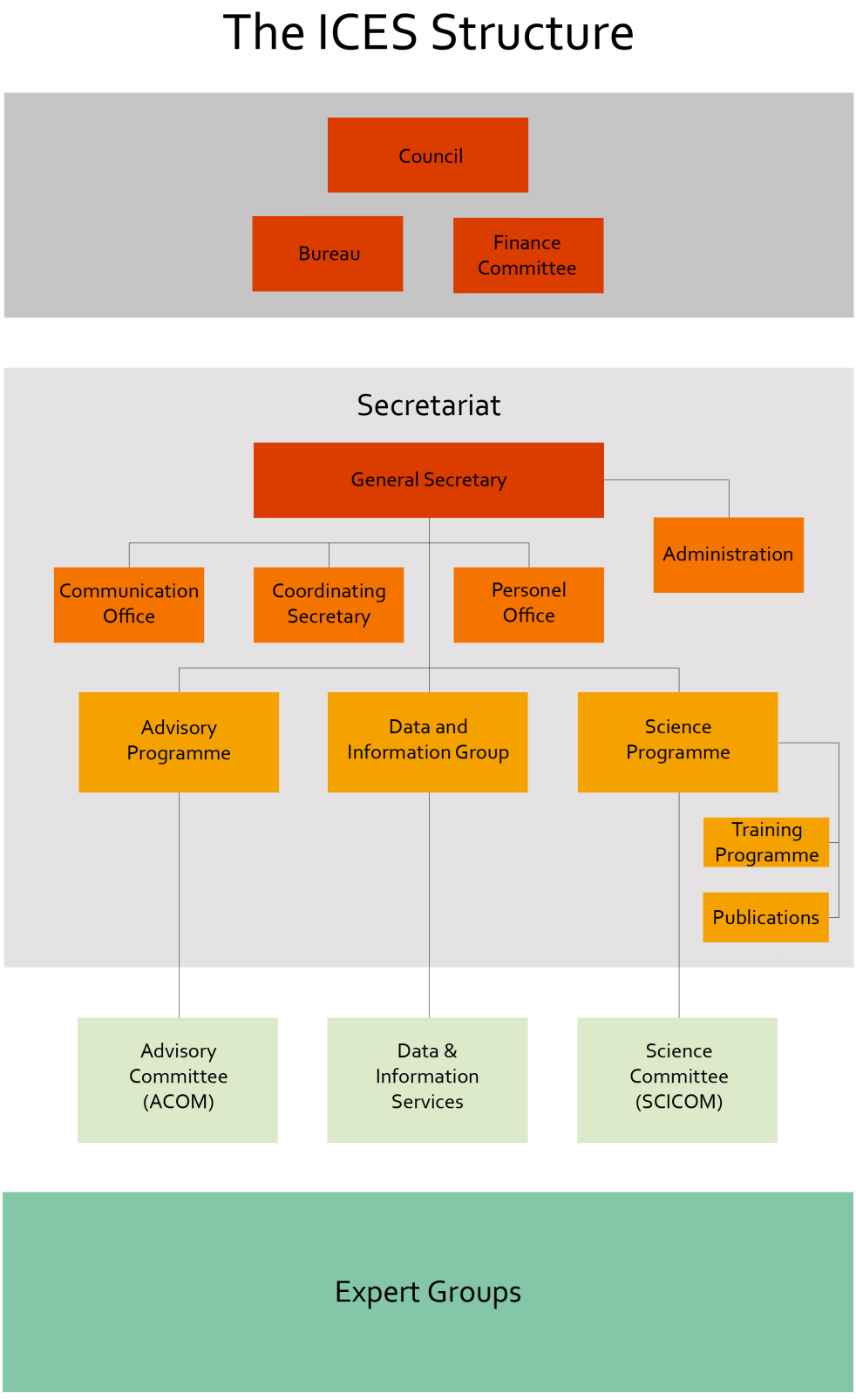


Figure 1 The structure of the International Council for the Exploration of the Sea (ICES)

SCIENCE COMMITTEE

SCICOM is the main scientific body of ICES overseeing marine science work in ocean dynamics; climate variability and change; ecology and ecosystem function; survey and sampling; integrated assessment and modelling; fishery, aquaculture and environmental science. SCICOM is managed under the direction of a Chair and has one member per member country, who is usually employed in national fisheries research institutes. It also has the ability to elect up to five additional members to increase capability. Within SCICOM, Steering Groups manage the Expert Groups portfolios to ensure advice is coordinated and Operational Groups develop policies, publications and programmes. A Business Group assists the SCICOM Chair in matters regarding the implementation of SCICOM decisions. ICES hosts an Annual Science Conference to provide the ICES community with an opportunity to meet and discuss their science and bring new participants into ICES activities.

ADVISORY COMMITTEE

ACOM is responsible for formulating the science into advice for policy. Like SCICOM, ACOM is composed of one representative from each of the member countries under the direction of an independent chair appointed by ICES Council. It establishes and manages the necessary advisory procedures and processes, and designs the strategies needed to prepare, deliver, and disseminate advice. ACOM also hosts an annual meeting with the recipients of advice and stakeholders to discuss issues of common interest between the different users of ICES advice.

COOPERATION BETWEEN THE COMMITTEES

Naturally, there are overlaps between ACOM and SCICOM that require coordination and this has led to the creation of formal mechanisms. ACOM/SCICOM Strategic Initiatives introduce innovative and interdisciplinary thinking to ICES, on topics that are cross-cutting and requiring additional partners outside the ICES constituency. The SCICOM Business Group also meets regularly with the ACOM Leadership team, to steer and develop common actions.

The structure of ICES is relatively flexible and adapts to the changing requirements of the ICES user base; in this way the organisation appears to evolve organically. Unlike some international organisations, the ICES Secretariat has quite extensive and has growing responsibilities. Alongside its administrative support role, it is also responsible for managing ICES data through the ICES Data Centre. The secretariat also hosts the Advisory Programme, which has an editorial function that requires its staff to make judgments in what could be seen as a 'natural scientific review process' (Wilson, 2009).

HOW DOES ICES FUNCTION

As a scientific advisory body, ICES relies on a pool of semi-regular experts. While these experts technically work on a voluntary basis, most are required to attend to fulfil organisational or funding commitments. Experts are nominated by a national delegate or invited by the Chair of a group. Independent experts can apply to work in a particular group through the Secretariat. Advice is generated in response to specific requests from the clients of ICES, although it will give non-commissioned advice in response to emergency situations.

ADVICE AT TECHNICAL LEVEL

ICES provides advice in several different ways to different organisations. It is best known for its advice to the European Commission in support of the Common Fisheries Policy. However, it also responds to the policy and legal needs of its member countries, multinational and international organisations (ICES, 2011). Individual advice is specific, often relating to one

species in a particular location, but this can form part of a larger body of advice, which includes multiple species across a region.

The format of advice produced is usually a combination of text, tables and graphics; the language used could be described as scientific. However, some advisory reports contain more visual elements, such as a traffic light system for required action, which would be more accessible to a non-scientific audience (ICES, 2011).

SETTING GOALS

ICES also publishes an overview of its advice in a separate publication, ICES Popular Advice. This document gives one page summaries of different species by region, including adult stock size, landings, stock status and a brief summary of the ICES quota recommendations for the next year. ICES have created an interactive map for their popular advice that allows users to find advice based on the geographical location of the species. There are also plans to overlay marine ecosystems on this map that will provide an overview of the features and give an assessment of its health[8].

Defining the boundary of what constitutes scientific advice is important, especially when the science is used to support policy decisions (Wilson, 2009). Traditionally, ICES has drawn the boundary at a technical level; it would provide advice on fish species but not fisheries, which are a social construct. However, with policies such as the MSFD requiring an ecosystem approach, ICES may need to evaluate where it draws the science boundary. This will most likely be driven by the specific requirements of the end user. It may be necessary to re-evaluate what science is legitimate to be included in scientific advice; this is especially true for social and economic sciences.

UNCERTAINTY

Perhaps the most significant problem with providing advice to policy makers is how to deal with uncertainty. Ultimately, it can be used to undermine decisions if left unaddressed, rendering the science-policy process useless.

Within the ICES working groups, the uncertainty around the advice being generated is thought to be a major factor in increasing work pressure and the number of hours required to agree on the advice (Wilson, 2009). This challenge could be solved by utislising new technologies and software to make the process more efficient.

One of the challenges of communicating uncertainty is understanding the requirements of the end user. It is generally accepted that an ideal advisory mechanism is one where scientists and the managers work together; it is usually when this does not happen that uncertainty is misunderstood. On one occasion, DG MARE has stated that ICES did not effectively communicate the underlying uncertainty effectively. However, on this occasion DG MARE did not specify what the expressions of uncertainty should consist of and it was felt that the decision was being left up to ICES (Wilson, 2009). One way of reducing uncertainty is to create an extended peer review system, while ICES has not formally adopted one, some practices of the Advisory Programme are similar to other extended peer review systems.

[8] ICES Press Release- New interactive map makes ICES advice more accessible to the public (Available online): http://www.ices.dk/news-and-events/news-archive/press-releases/Pages/Press%20Release%20-%20New-interactive-map-makes-ICES-advice-more-accessible-to-the-public.aspx

TRANSPARENCY

To operate as a trusted science-policy interface organisation, the ICES process must be acceptably transparent. One of the ways in which ICES has tried to increase transparency is by allowing observers into working group meetings. It should be noted that this has been resisted in other science-policy mechanisms. However, within ICES, it has been found that scientists involved in meetings with observers present have generally responded positively (Wilson, 2009). Observers to the scientific activities must be accepted by the Chair of a meeting and those wishing to observe advisory activities must be approved by ICES. If transparency could be measured, it would be the perception of both the end user and the stakeholders that the advice produced is an accurate representation of the scientific consensus. One way of ensuring transparency when generating advice is to ensure that the level and detail of advice is given consistency, to ensure past and present advice is comparable.

One way in which the changes of working practices in ICES has led to more transparency can be observed from stakeholders such as the National Federation of Fishermen's Organisations (NFFO). The NFFO recognises that the historical relationship between fishermen and scientists was fraught and that the ICES advisory process used to be opaque. However, it recently published an article praising the transparency of the advisory process, which now allows stakeholders to question the assumptions, models, data, processes and procedures; it believes that fisheries science is stronger as a result (NFFO, 2014).

WHAT CHALLENGES FACE ICES?

One of the ways in which ICES advice remains relevant is by evolving to meet the requirements of its user base. The recent publication of a Strategic Plan for 2014-2018 sets out how this next evolution might look. The key challenge identified in the document is how to produce integrated ecosystem advice (ICES, 2014). The effort to move towards integrated advice has been in development for several years, including discussions with competent authorities and stakeholders in 2012 (ICES, 2013a). The Strategic Plan outlines seven goals under four pillars:

- Pillar One: Building a foundation of science
    - Goal 1 – Develop an integrated, interdisciplinary understanding of the structure, dynamics, and the resilience and response of marine ecosystems to charge
    - Goal 2- Understand the relationship between human activities and marine ecosystems, estimate pressures and impacts, and develop science-based, sustainable pathways
- Pillar Two: Producing the information and advice decision-makers need
    - Goal 3 – Evaluate and advise on options for the sustainable use and protection of marine ecosystems
- Pillar Three: Underpinning science and advice through data and information services
    - Goal 4 – Promote the advancement of data and information services for science and advice needs
    - Goal 5 – Catalyse best practices in marine data management, and promote the ICES data nodes as a global resource
- Pillar Four: Supporting the organisation through the work of the Secretariat
    - Goal 6 – Foster the science, the advisory, and the data and information services through the work of the Secretariat
    - Goal 7 – Ensure an efficient and effective organisation

Perhaps the most concerning issue with the ICES system is the ability to recruit and maintain an expert base which is able to provide integrated ecosystem advice. After extensive interviews with members of different scientific working groups Wilson (2009) found that the experts often work at their physical limits, sometimes through the night, to come to a consensus. This pressure was thought to arise from the uncertainty involved in assessments.

ICES AND THE MSFD

The Strategic Plan of ICES recognises that the nature of marine management is moving from a sectoral approach to an interdisciplinary ecosystem approach. Policies like the MSFD require a different approach to knowledge transfer. ICES, like other stakeholders, has contributed to the development and implementation of the MSFD. It has worked in partnership with the European Joint Research Centre to provide background information on criteria and methodological standards on Good Environmental Status, this work is summarised in Table 1. It has provided most information on Descriptor 3 (commercially exploited fish and shellfish), as this is an area in which it has a proven capacity to provide advice. Further focus has been mainly on Descriptors 1 (Biological diversity), 4 (Elements of marine food webs) and 6 (Sea-floor integrity). Additional initiatives on a specific topic for other descriptors have also been produced, like for Descriptor 2 (Non-indigenous species), Descriptor 5 (Human-induced eutrophication), Descriptor 7 (Permanent alteration of hydrographical conditions), Descriptor 8 (Concentrations of contaminants), Descriptor 10 (Properties and quantities of marine litter) and Descriptor 11 (Introduction of energy, including underwater noise).

Table 1 ICES Activities relating to the implementation of the MSFD (ICES, 2013a)

EU Marine Strategy Framework Directive	**ICES Contribution**
1. Initial Assessment	Scientific development, benchmarking and operationalisation of Integrated Ecosystem Assessments, taking into account MSFD requirements.
2. Good Environmental Status	Operationalise and concept review, including development and test of new assessment methodologies.
2.a Indicators	Review of existing indicators, and selection and development of new integrated CFP and MSFD indicators.
2.b Environmental targets	Development of methodologies to facilitate target setting and evaluation.
3. Monitoring Programmes	Coordination of international monitoring programmes for fish stocks and ecosystems. Development of monitoring guidelines, programmes, and integrated ecosystem surveys.
4. Programmes of Measures	Management strategy evaluation tools for simulation of management measures and review of proposed measures.
5. Marine spatial panning, including marine protected areas	Contributions to the development of next generation ecosystem-based marine spatial planning. Identification and review of proposed MPAs and EBSAs.
6. Interregional cooperation	Supporting compatibility and coherence between regions.
7. Data handling, dissemination, and display	Provision of data related services.

8. Training	Provision of tailor made MSFD relevant training.
9. Engaging the Network	Sponsoring Science symposia and conferences, and participation in external projects towards development, stimulation and synthesis of relevant science. Strengthening cooperative science approaches.

While ICES has access to a strong pool of environmental scientists, it has traditionally avoided including economic or social sciences in its advice. This omission has most likely arisen from the requirements of its users. In developing an advisory system for the MSFD, the inclusion of environmental, social and economic scientific advice is crucial in facilitating an ecosystem approach. Its experience and capabilities place ICES in a good position to contribute to the scientific knowledge requirements of the MSFD, broadening the science boundary to include socio-economic scientific advice should not be seen as a dilution of ICES core values. It is important to remember that environmental science is based on our best understanding of natural systems and that the models and forecasting tools used by environmental scientists are not so different to those used by economic and social scientists.

ICES is now collaborating with the European Joint Research Centre (JRC) to develop a Marine Competence Centre for Good Environmental Status that will build on previous scientific and technical support for MSFD implementation (Larkin *et al.*, 2014). The Competence Centre will be used to provide expertise on specific scientific, policy-related and applied issues, in the context of MSFD, in response to requests from the European Commission and individual Member States. Although it is in an early stage of development, it appears that the Competence Centre will utilise a pool of experts working in *ad hoc* groups. It is clear that ICES will bring considerable expertise and experience to developing a science-policy mechanism for the implementation of the MSFD.

The MSFD is not the only policy ICES is involved in. It is also looking at ways in which it can facilitate multinational cooperation to implement other directives such as the new EU Maritime Spatial Planning Directive (ICES, 2013b) and the European Fisheries Fund's operational programmes.

LESSONS LEARNED

Understanding why ICES is perceived to be effective is challenging. Indeed evaluating the effectiveness of any science-policy mechanism is challenging, as each one is unique. There are, however, several concepts that underline these mechanisms such as transparency and the communication of uncertainty.

As one of the most established marine science organisations working at a European Level, JPI Oceans could learn from ICES and would benefit from working in cooperation when it is appropriate.

EVOLUTION OF RESPONDING TO USER NEEDS

ICES responds to changing user needs in both an active and a passive way. It proactively attempts to understand the changing nature of marine governance and plans for the future; an example of this is the ICES Strategic Plan (2014). It also routinely responds to the science requirements of the Common Fisheries Policy, in this way it ensures that its advice is relevant to the needs of the user.

BIG DATA

The ICES Data Centre has been developing its capacity over the last decade to become a good example of data management. The web format in which the interface is presented is designed to be intuitive and give easy access to the data used to support ICES advice.

ICES has also developed a toolbox of applications, software, calculators and dictionaries which can be used to submit, extract and manipulate data. These data tools are an example of how Big Data can be applied in the marine environment to promote transparency and increase the usefulness of data.

VISUALISATION

There are examples of data visulisation in different forms of ICES advice but it is only more recently that it has made use of online and interactive tools. ICES have created an interactive map for their popular advice that allows users to find advice based on the geographical location of the species. This is also set to expand and feature more information on the status of different marine habitats.

TRANSPARANCY

The case of ICES outlines the fundamental importance of transparency. There is no way to measure it, except in the perceptions of the scientists, policy makers and stakeholders involved. By allowing stakeholders to sit as observers has increased the perception of transparency in ICES, and this is shown in the NFFO article. Other organisations, which have not taken this step, are sometimes reluctant to allow outside observers; this is counterintuitive to open and impartial scientific advice. Within ICES, some have noted an increase in the efficiency of scientists working to generate advice.

RECOGNISING SCIENCE FOR POLICY

As with many science-policy systems, the ICES expert scientists work on a voluntary or semi-voluntary basis. Motivation ranges from interest to career development and sometimes an organisational or national funding requirement. This issue brings to light the disparity between the current methods for recognising scientific work, publishing peer-reviewed papers, and the increasing requirement for scientists to produce advice for policy makers. This is not a fault of ICES or any science-policy mechanism, but a shift in cultural norms. The challenge is to find a way to recognise this involvement without compromising on scientific excellence.

The strength of ICES is in its dual culture. Its advisory side produces usable information to policy makers while remaining linked with, and accountable to, the science side. Its history of providing fisheries advice means that it is uncompromising on providing technical advice. In this way it has learnt that science should not be diluted as it makes its way across the science-policy interface; experience in communicating uncertainty has reinforced the limits of scientific knowledge.

UNCERTAINTY

One of the most challenging aspects of ICES advice is how to deal with uncertainty. Over time, ICES has developed a methodology on how to manage uncertainty and ensure that it is presented clearly in its advice. ICES has developed an informal extended peer review system in the Advisory Programme. This review process, carried out by members of the secretariat, highlights discrepancies in the advice generated in working groups before it is submitted. In this way, uncertainty in the science can be addressed before the client of the ICES advice receives it. While this does not reduce uncertainty in the science itself, it does produce a clearer advice.

4 EUROPEAN CASE STUDY: THE EUROPEAN COMMISSION AND EUROPEAN DIRECTIVES

RATIONALE

Among the European marine environmental protection legislation three organisational pathways of science-policy funding could be distinguished:

- the Birds and Habitats Directives mainly draw on fragmented national and regional science-policy experiences, the latter derived from cooperation through European LIFE and structural funds of INTERREG programmes (European Fund for Regional Development),
- the WFD and MSFD are supported mainly by more European-wide science-policy mechanisms drawn from European research budgets from FP5 to FP7 and through to the current H2020 programme,
- the CFP science-policy draws on European structural funds of the European Fishery Fund (EFF) resulting in national projects, as well as on European research budgets leading to European projects. The EFF is now transformed into the European Maritime and Fisheries Fund (EMFF).

Chapter 3 of Deliverable 5.1 (Redd *et al.*, 2013) explained how the CFP and European Framework Directives, like the WFD and MSFD, are designed to include some organisational aspects to ensure that relevant research results can be taken into account during the implementation of a Directive through different bodies established by the Directive and at specific moments during the implementation cycles to feed into the management plans that need to be established at regular intervals.

The case studies on IPPC, ICES and IMO in this deliverable illustrate how research-performing organisations or end-user international policy organisations designed their science to policy processes. As a large research-funding organisation as well as a policy-making organisation, the EC has also funds specific efforts to design pathways to distil advice from their funded research in relation to specific Directives. Since ICES makes a major contribution to the CFP, this case study will focus on initiatives for the WFD and MSFD as the Directives supported by significant European research budgets.

METHOD

This case study highlights the results of specific science-policy interface projects funded by the EC. It is based on desk-based research relevant to science-policy interface initiatives funded by the EC, as well as the experience of one of the authors with the WFD and the MSFD at national and European level. All the reports cited are listed in the references section of this case study. Though not going into the same detail as here, several contributors to the CSA consultation process mentioned that the JPI might learn from the experiences of the WFD development in particular.

CONTRIBUTIONS OF THE EC TO THE SCIENCE-POLICY INTERFACE FOR THE WFD

From the 5th FP (1998-2002) to the 7th FP (2007-2013) water has been identified as a key action for environmental and sustainable development research. More than €150 million have been invested in research projects directly relevant to the WFD in FP5 (Quevauviller, 2007). In

fact emphasis has been given to problem-solving approach and support to relevant EU policies, especially the WFD. The 5th FP also represents a turning point in water research in the following respect. To further enhance the impact of EU-funded research, projects within the same thematic area were clustered together in order to improve coordination and synergies, promote integration and synthesis of results of policy needs, create platforms/fora for active communication and targeted dissemination of research project results of the EC DG RTD to key stakeholders and end-users (Quevauviller, 2007). In the 6th FP (2002-2006) water research continued to be supported, complementing and expanding research undertaken in FP5 to support EU policies and developing tools for sustainable water management in the EU (Quevauviller, 2007). Three specific FP7 science-policy interface (SPI) projects are explained further below.

WISE AND WISE-RTD

The EC commissioned the design of a central SPI website for the WFD, called the Water Information System for Europe (www.wise-rtd.info/en). It was designed to have a central access point to information on water policy in the European Union and related scientific knowledge, modelling and assessment results that include some interactive maps (http://water.europa.eu/info). These four themes link webpages on:

- EU water policies (link to DG ENV site with EC policy implementation reports and supporting activities…)
- Data and themes (link to EEA, Eurostat and 1 JRC webpage, with reported datasets, interactive maps, statistics, indicators,...)
- Modelling (links to some JRC webpages with forecasting services)
- Projects and research (inventory for links to recently completed and ongoing water related projects and research activities in relation to major milestones of all EU Water Directives and the US Clean Water Act) = **WISE-RTD**.

The WISE-RTD web portal is a science-policy interfacing instrument which aims to enhance the accessibility of results of RTD projects to a range of stakeholders, including policy implementers, industry, non-governmental organisations (NGOs), etc., and to technically support the interfaces (Interwies and Borowski, 2007). Good practices, identified by several EU FP5 up to FP7 SPI projects, were implemented for the WISE-RTD portal, as further explained through the SPI Water Cluster in the next section.

- A dedicated tool WPIS (**Web Portal Input System**) has been created to upload the projects/RTD results to the WISE-RTD Web Portal, automatically linking the information to the diverse sets of policy instruments.
- Water research results have been linked to policy guidelines (e.g. Directives) making it easy to search and understand their inter-relation. **Two types of guided searches** have been created in the WISE-RTD Water Knowledge Portal which intelligently links research projects with water policies; **one for policy–interested people that starts from the water policies to find research results** and **one for researchers/ consultants that is thematic based on major water issues**.
- Through WISE-RTD policy factsheets were distributed to provide an easy-to-read overview of EU policies, which are crucial for research and business activities. They were further developed to include an overview of the impacts of the policies on industry (SPI-Water Cluster, A. 2013).
- The gaps in science-policy-industry communication arise from differences in language terminology and poor understanding of the perspective of each group in seeing the same water issues. To address this, an interactive e-learning programme was produced with a role-play between a researcher, a policy-implementer and an industry consultant in helping the learner understand the issue from different perspectives. This approach in bridging the science-policy-industry gap received very positive feedback (SPI-Water Cluster, A. 2013).

THE SPI-WATER CLUSTER FOR THE WFD BY THE SCIENTIFIC COMMUNITY

The WISE-RTD work started with the FP5 project HarmoniCA (http://www.harmoni-ca.info/) that needed to deliver a framework for harmonising ICT tools and guidelines for integrated river basin management and improving water quality. Although much of the work involved ICT tools, HarmoniCA was not about ICT tools as such, but rather about harmonisation and guidance on proper development and use of ICT tools in the light of effective and efficient development of integrated river basin management plans and the implementation of the WFD. The communication, information exchange and harmonisation in this project was geared to the development of a widely accepted, flexible, harmonised modelling toolbox, including ICT tools, guidance and methodologies, which can be applied by the various stakeholders in river basins (EC, 2005). As a follow-up to the FP5 HarmoniCA and the subsequent FP6 SPI-Water project (2006-2008, http://www.spi-water.eu/index.cgi?s_id=55), three specific SPI projects were granted in FP7 (STEP-WISE, STREAM and WaterDiss 2.0, 2011-2012) to support the communication and dissemination of EU water-research project results. They were jointly called the SPI-Water cluster (http://www.spi-water.eu/). One joint deliverable was to design over two years a Roadmap focusing on communication efforts of EU water research projects to reach distinct targeted audiences, improving accessibility to water research results, speeding up their uptake and strengthening the Water Science-Policy-Industry Interface to become results-oriented. These projects had similar tasks for the WFD as the STAGES project currently had for the MSFD, including screening of projects completed in the past and running at that time: since 2006 alone, more than 450 projects related to water research have been supported in the main EC programmes LIFE, FP7, CIP and INTERREG (SPI-Water Cluster, A. 2013).

The executive summary of their Roadmap for SPI is given in the box below:

SPI-Water Roadmap Recommendations:

Increase communication efforts of EU water research projects to reach distinct targeted audiences

Research funding organisations, e.g. EC, should insist that their projects create a professional communication strategy targeting the necessary stakeholders for uptake of their results through:

- (two page) layman factsheets, which are entered into the WISE-RTD Water Knowledge Portal. This enables searching for research results based on topic, related policy, region, etc.;
- tailored seminars to reach diverse stakeholders;
- stakeholder representation in the projects' consortiums;
- the creation of thematic conferences where projects present their results; these conferences are organised by professional organisers and are advertised on a central website;
- promoting e-Learning courses and summer schools allowing the audience to better engage in the topic.

Improve accessibility to water research results and speed up their transfer

Relevant flexibility in resources-planning with respect to dissemination activities should be allowed for dissemination shortly after the project ends. The production of layman reports focusing on the results of the projects should be made obligatory. The use of online tools, which can present information on various projects at the same time and disseminate the research results as widely as possible, web platforms, e-learning, webinars and social media should be encouraged.

Strengthen the Water Science-Policy-Industry Interface to become results-oriented

Research projects should write, in a standardised-format, a policy statement for each reporting period to demonstrate how results are relevant for EU and national politicians. These policy briefs should be shared on a central website; WISE-RTD is ideal for this purpose.

Thematic conferences of projects from the different EU funding schemes should involve the EC and EP units or committees and also local and regional policy makers and implementers. Thematic conferences with input from a number of projects are believed to be more attractive to participants from small-medium sized enterprises (SMEs) and industry than smaller conferences based around a single research project. 'Water Science meets Policy and Industry' events should be organised by the EC on a regular basis with specific focus on themes that will be of relevance for the policy implementation in the following years.

THE SPI IN SUPPORT OF THE WFD BY THE EC AND THE MEMBER STATES IN THE WFD COMMON IMPLEMENTATION STRATEGY

With respect to WFD implementation, the Common Implementation Strategy (CIS) ensures that regular contacts and information exchanges take place among policy implementers and the Commission through specific working groups (see Deliverable 5.1, Redd *et al.*, 2013). Mainly in the ECOSTAT and the Chemical Monitoring Activity this exchange also involves RTD project coordinators (Quevauviller *et al.*, 2008). The need for a sustainable Science Policy Interface (SPI) in support of water policies had been discussed for some years within the framework of the WFD and related RTD projects. As a follow-up, a preliminary activity was initiated on 24-25 November 2008 in Paris (FR) with voluntary countries, stakeholders and the participation of the EC (Directorate-General for Research & Innovation (DG RTD)), aiming to investigate ways to establish a SPI mechanism to identify research gaps, ensure an effective communication and transfer of scientific information, and help to highlight opportunities for demonstrating applicability at river basin level as well as helping WFD-implementers to identify practical research needs to be communicated to RTD funding organisations for possible consideration.

Based on this work, the Water Directors of the European Union established an ad-hoc activity on Water Science-Policy Interface under the CIS of the WFD in December 2009. This CIS-SPI activity, jointly led by the EC (DG RTD) and France (ONEMA - French National Agency for Water and Aquatic Environments), aimed to promote closer links among research projects and WFD-implementers and up-take of scientific knowledge and research results by WFD-implementers. In this perspective, the mandate of the CIS-SPI activity included three tasks for the period 2010-2012 (EU 2013):

- Task 1: inventory of research and implementation needs from CIS groups;
- Task 2: identify available research and research gaps;
- Task 3: improve transfer and usability of research outputs.

The CIS-SPI activity has notably triggered an exercise in research needs identification and prioritisation, and attempted to set up operational ways of transferring research outcomes and knowledge to support the implementation of the WFD. A full report has been published (EU 2013), a list of research needs, a list of available literature and (mainly EC funded) project knowledge matching these needs and a list of remaining knowledge gaps following this matching exercise. This latter list has been passed to EC DG RTD and JPI Water.

Based on the experience gained during the 3-year mandate of the ad-hoc experimental CIS-SPI activity seven main recommendations were drawn for the future if a continuous science-policy interface were to be carried out in the context of the CIS. They are provided in the box below.

Recommendation 1: move from an ad-hoc experience of SPI activity towards a more sustainable and systematic one. This needs to rely on sustained, dedicated, appropriately resourced and trained people acting as SPI correspondents (such as knowledge brokers) having this activity in their agenda and mandates and thus avoid potential conflicts of interest in time management with other tasks. Knowledge brokering has to be recognised and rewarded to promote the emergence of skilled experts. Availability of budget/ resources for knowledge brokering may help. By adopting these new approaches, one can expect a significant improvement of the current situation which is based on the best effort of a very few people already overloaded with other tasks; this would add significantly to the effectiveness of the process.

Recommendation 2: adopt SPI as a pervasive CIS working principle and mainstream SPI objectives and methodologies across all levels of the CIS in order to improve efficiency and consolidate today's very diverse SPI approaches by the CIS groups. Improve the active knowledge exchange directly within the CIS groups by making an efficient use of internal and external expertise on a need-oriented basis. These could include formalising the requirement for CIS-SPI activities in each CIS WG by requiring the mandates to specify this. A successful trust building in continuous SPI activity could significantly improve participation at all levels as well as achieving a wider SPI involvement by all Member States.

Recommendation 3: enhance transfer and sharing of knowledge and experience focusing on CIS themes, in particular at the river basin level, to test various tools and methods to facilitate this transfer in close connection with experts of CIS. This should enable to develop and promote guidance for concrete transfer of knowledge resulting from EU and national R&D projects, to agree on repositories and invent alert systems to reach policy-makers and implementers from EU to catchment scale.

Recommendation 4: consolidate and implement a methodology for regular and more frequent mapping of research and prioritisation of research gaps to regularly feed research call programming at EU and national or regional levels.

Recommendation 5: develop an "archive" of successful past projects, by making information included on specialised project websites available even after the termination

Recommendation 6: internationalise the CIS-SPI experience in connection with the SPI elements of the Ministerial declaration resulting from the 6th world water forum.

Recommendation 7: explore the possibility for a new follow-up CIS activity on guidance for applying an ecosystem services approach (ESA) in support of the implementation of the WFD.

The main message was to establish a sustainable networking platform providing the policy sector with complete scientific information agreed both by scientific and political sectors; such a platform would allow water managers to provide scientists with feedback on their needs for information. To support this activity a new type of translator/facilitator [knowledge broker] for SPI is needed.

The interface should be based on a network consisting of committed people being able to dedicate the necessary time and resources on the SPI-relevant tasks and facilitated by identified SPI-leaders. To ensure a continuous update of the needs, some tasks (e.g. knowledge transfer and expression of needs) should be carried out on a regular basis. Basically, the SPI activity should facilitate the continuous communication between policy makers, policy end-users and the scientific community, including:

- Science to policy communication: transfer of existing knowledge and communication of research outputs to the CIS groups, allowing an easy access to information with the support of a permanent tool (e.g. European Water Community, Wise-RTD).
- Policy to science communication: identification of needs for technical and scientific information by the CIS groups reflecting also the needs at the river basin levels.

- Defining a research agenda: systematic matching of the needs against existing knowledge, and regularly communicating identified research gaps to the funding organisations.

Despite the fact that the need was identified to establish a better acknowledged and sustainable science-policy interfacing within the CIS framework, the SPI co-leaders had to take note that no clear need for a transversal SPI activity across the different CIS working groups has been expressed by the CIS groups at the CIS SCG meeting of November 2013. They then recommended not pursuing with a transversal SPI activity attached to the SCG. Nevertheless they would like again to encourage all CIS groups to implement SPI activities within their groups as this has proved very instrumental for achieving their mandates. The CIS groups shall now decide on their own how they proceed with this.

CONTRIBUTIONS OF THE EC TO THE SPI FOR THE MSFD

THE SPI IN SUPPORT OF THE MSFD BY THE EC AND THE PCG IN THE MSFD COMMON IMPLEMENTATION STRATEGY

With respect to MSFD implementation, the Common Implementation Strategy (CIS) ensures that regular contacts and information exchanges take place among policy implementers and the Commission through specific working groups (see Deliverable 5.1, Redd *et al.*, 2013). Within the CIS, the MSFD Project Coordination Group (PCG) is an important platform for exchange of information on relevant projects and coordination of activities including the identification of MSFD-relevant knowledge and of future short-, mid- and long-term research needs. The PCG could address issues which can possibly be resolved in the short to mid-term by research groups (such as the PERSEUS) or other projects.

The MSFD stipulates that 'where practical and appropriate' the RSCs should be used to ensure coordination among Member States and with third countries in the development of marine strategies. Therefore, an important aim of the current CIS process for 2014-2016 (EC, 2014a) is to further strengthen the role of the Regional Sea Conventions (RSCs), namely the Oslo-Paris Convention (OSPAR), the Helsinki Convention (HELCOM), the Barcelona Convention (UNEP MAP) and the Bucharest Convention (BSC). Where the EU is a Contracting Party to a RSC, the implementation of the MSFD should also be seen as the European commitment to these conventions, which, per se, are directly linked to marine good environmental status. To support and contribute the strengthening process, a study was commissioned by the EC DG ENV to analyse the specific needs of regional conventions to fulfil their role in the MSFD. The results are available in von Homeyer *et al.*, 2013.

The CIS programme for 2014-2016 also specified on Science-policy interface (coordinated through the PCG): development and establishment of a science-policy interface addressing aspects of dissemination, relevance for the MSFD implementation and identification of future short-, mid- and long-term research needs (supported by STAGES and JPI Oceans) (EC, 2014a).

As part of the implementation process of the MSFD, the EU Commission and the EEA, together with the Regional Sea Conventions and EU Member States, are also putting in place a streamlined and efficient management system of data, information and knowledge. This public system will be called WISE-Marine and will be shared between all stakeholders. The INSPIRE Directive will deliver an infrastructure for spatial information in Europe (EEA, 2014).

A last important activity that related to SPI are the pilot projects launched by the EC DG ENV on New knowledge for an integrated Management of Human Activity in the Sea. The purpose

of these Pilot Projects is to develop a new concept and decision-making tools for integrated environmental monitoring for the MSFD to support management of human activities in EU marine waters. The project will develop integrated monitoring strategies in selected pilot regions and scope the potential for joint programmes. Another specific contract provides background information/carries out preparatory work for development of EU guidance documents on implementation of WFD, MSFD in relation to sustainable aquaculture.

A full overview of the projects launched by the EC DG ENV in relation to the MSFD can be found at the CIRCA portal within the folder of the PCG meetings. All documentation related to the projects can be found online[9]

THE STAGES PROJECT BY THE SCIENTIFIC COMMUNITY

STAGES is an EC-funded Coordination and Support Action (FP7-ENV-2012) that runs for 2 years from September 2012 to August 2014. It aims to improve the scientific knowledge base to support the implementation of the MSFD. STAGES has two overarching goals: to synthesise the information from MSFD relevant research projects and to develop a platform to ensure that the knowledge generated through European science and technology can be channelled effectively to a broad range of relevant end users, to inform and facilitate implementation of the MSFD and the achievement of GES (http://www.stagesproject.eu/). With this purpose in mind, the specific objectives of STAGES are to:

1. Identify and synthesise the knowledge generated through EU and national research funded activities with relevance to MSFD objectives and make it widely accessible to policy and decision makers and to MSFD stakeholders.
2. Identify the needs for further research to improve the scientific underpinning for the implementation of the MSFD.
3. Provide concrete, pragmatic and ready-to-use recommendations on the development of an effective European science-policy platform to support implementation of the MSFD.

The STAGES proposal for an effective European science-policy platform to support implementation of the MSFD (from Larkin *et al.*, 2014) presents four key components of a MSFD SPI:

- **Harnessing MSFD-relevant scientific knowledge**
- **Scientific and technical advice**
- **Expert evaluation and synthesis of scientific knowledge**
- **Knowledge Brokerage** (encompassing elements of knowledge transfer, exchange, communication, dissemination) that is required at some level for the three processes above.

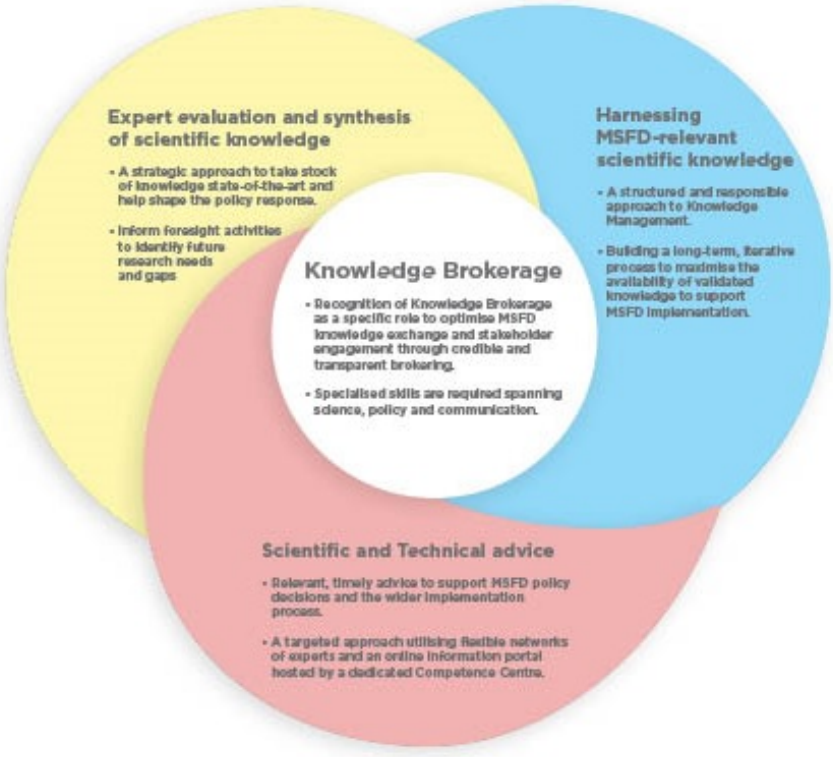
The proposal has been developed in the context of cross-cutting activities such as the need for both bottom-up (science-driven) and top-down (policy-driven) dialogues, the need for relevant and timely interaction with wider stakeholders, and to take into account the geographical scales and cyclical nature of the MSFD implementation process.

[9] https://circabc.europa.eu/w/browse/7e4036ec-36b5-43b6-aafe-ce8b6e6d02c0.

The SPI architecture proposed takes into account two parallel time-lines for improving the knowledge base available to support MSFD implementation:

1. **Short-term**: **harnessing existing knowledge** and utilizing expert/advisory groups to provide **scientific advice** to support policy implementation in the short-term.
2. **Long-term**: Conducting **scientific syntheses** and reviews of existing knowledge to inform policy of the state-of-the-art in MSFD-relevant knowledge and to identify knowledge gaps that can be addressed by funding new research in the longer-term.

The four key components are summarised as follows in Larkin *et al.*, 2014:



In the SPI-Water Cluster, the emphasis of SPI was put on actions during the implementation of a project, less attention went to the long-term perspective, which was only partly covered with the recommendation to produce layman factsheets to be entered into the WISE-RTD Water Knowledge Portal. This would enable searching for research results based on topic, related policy, region, etc.

Compared to the previous SPI exercise for the WFD, STAGES also distinguished more clearly

- short-, mid- and longer-term ambitions and potential implementation steps to achieve these;
- the harnessing of knowledge and the longer-term scientific syntheses required with a specific frequency to illustrate a compilation overview of the current state-of-art of scientific knowledge;
- the potential role of different key players, including the research funding organisations (deciding on which knowledge is relevant should be managed through an ongoing interaction between the knowledge producers (e.g. the scientific community) and MSFD implementers (e.g. national competent authorities);
- necessary skills and capacity for knowledge brokerage.

STAGES will finalise and distribute the final proposal and other key deliverables by early September 2014.

BONUS – SCIENCE FOR A BETTER FUTURE OF THE BALTIC SEA REGION

BONUS is the first regional research governance framework at regional seas level, establishing a network and partnership of key agencies funding research, with the aim to deepen the understanding of conditions for science-based management of environmental issues in the Baltic Sea. It developed from a BONUS ERA-NET project under the EU 6th Framework Programme that was implemented during the period 2003-2008. In June 2010, the European Parliament supported the European Council's decision that launched a new research and development programme to protect the Baltic Sea, BONUS, worth of EUR 100 million for the years 2010-2017 under Article 185 (formerly 169) of the Treaty of the European Community (http://www.bonusportal.org/).

BONUS brings together the research communities of marine, maritime, economical and societal research to address the major challenges faced by the Baltic Sea region. The EU framework provides mechanism for combining national research funding to jointly fund applied research. By addressing policy-driven research issues and carefully designing themes and timings of the forthcoming calls for research proposals, BONUS can offer a foundation and support for achieving the objectives of several relevant policies and strategies, and help in reaching the good environmental status of the Baltic Sea (http://www.bonusportal.org/).

- BONUS builds on the ERA-NET and BONUS+ programmes and has engaged to date over 100 research institutes and universities in nine Baltic Sea countries.
- BONUS combines research related to the Baltic Sea system into a joint and durable interdisciplinary and focused multinational programme that supports the Baltic Sea region's sustainable development.
- BONUS produces knowledge to support development and implementation of regulations, regional and national coastal and marine environmental policies and management practices specifically tailored for the Baltic Sea region, in particular HELCOM's Baltic Sea Action Plan.
- BONUS issues calls for competitive proposals and funding projects of high excellence and relevance based on its strategic research agenda; this is developed in close collaboration with stakeholders across the Baltic Sea region.
- BONUS facilitates researchers' collaboration, networking, human capacity building and joint use of research infrastructures.

Briefing documents highlighting key results of the BONUS+ projects finishing in 2011 have been prepared in October 2011 for policymakers in order to provide quick information about each of the 16 projects. On the back cover of each 4-page briefing there is an 'at a glance' section summary 'in bullets' format, listing the main results making these quick reference points to the latest top Baltic Sea research.

LESSONS LEARNED

- In the past 10 years alone, €1.8 billion were invested in water (World Water Day – EU research on Water MEMO/12/203 Event Date: 22/03/2012). However, there is little record of how this investment has led to the development of knowledge, technologies, etc. in order to increase the sustainability of our environment and to create economic growth and social welfare (SPI-Water Cluster, A. 2013).

- The way research outputs have been integrated into WFD implementation has been discussed in Quevauviller *et al.*, 2008; Quevauviller, 2010; Sessa, 2012. While research needs were generally well considered in successive FPs, projects could often not anticipate the way monitoring programmes would be designed by Member States. This has sometimes led to results which, although they had potential, were not fit for policy development. In addition, the coordination among different actors has not been

sufficient to allow a full integration of scientific inputs from RTD projects into the policy discussions (Quevauviller *et al.*, 2008).

KEY WEAKNESSES AND SUCCESSES FACTORS OF THE SPI CASE STUDY EXAMPLES

- The common denominator of the EC-funded initiatives is the fact that they have been ad-hoc (short-term and project based), even if they targeted a long-term end product (WISE with WISE-RTD) and were mainly driven by the end-users (i.e. DG ENV, Member State environmental authorities in the CIS, JRC Competence Centre for GES) who want to receive compiled scientific knowledge. From the knowledge producer side only the funding mediator of the EC DG RTD was closely involved in the set-up that resulted in tools that should be used by the knowledge-producers on a voluntary basis, which did not sufficiently continue to happen (WISE-RTD is underexploited). Even though entirely end-user driven, the WFD CIS-SPI study concluded that the funding organisations should take the lead to keep research information available. The knowledge-users in the WFD CIS did not continue to steer the SPI mechanism to be driven from their side alone.

- The Intergovernmental Panel on Climate Change (IPCC) study showed that each piece of advice can be tracked back to individual scientist level. Many scientists involved in the IPCC process perceive an element of personal recognition. This may also be reinforced at national level in scientific organisations and agencies and also governments that use IPCC involvement as part of their 'impact measures' and are keen to point out how many scientists from their countries were involved. This does not happen yet at all for scientific input in European Directives or national policies, which seems to be a major gap.

- Another difference between the EC-funded initiatives on one hand and the BONUS (jointly Member States and EC funding) and IPCC SPI process on the other hand is the continuous support of a long-term small Secretariat that forms the link between the individual inputs and the compilation end product. A central long-term coordination of the inputs of knowledge providers has not been established yet by the EC SPI initiatives. BONUS also ensures a structured contact between the national science funding agencies and the knowledge-users in HELCOM, which seems to be quite effective.

REACH DISTINCT TARGETED AUDIENCES

- There is a lack of contact between science and policy, each having their own area of publications, timescales, funding schemes and events with limited attendance of policy makers at research disseminating events and vice versa. Also the involvement of politicians in dissemination events, research or demonstration projects, etc. is limited, specifically on a local or regional level. However, there are sporadic examples identified where researchers work closely with local municipalities in defining research needs. This ensures a fast uptake for the social and environmental good (SPI-Water Cluster, A. 2013).

- Considering all ongoing projects the frequency at which events take place is high. The challenge is how the outcomes of these events can be accumulated and fed to policy makers in a clear and useable way.

- A lot of European (and national) projects lack a targeted communication strategy focused on reaching those stakeholders who actually need the results and those who would benefit most from their uptake (i.e. the country representatives in the Common Implementation Strategy bodies of European Directives, as explained in Deliverable 5.1, Redd *et al.*, 2014). The focus is mainly put on reaching a certain required number of people, instead of reaching the right people. Evaluation takes place based on this

number and not on the actual effect these decision groups have for the project and on the water issues (SPI-Water Cluster, A. 2013).

- Some agencies, such as the Department for International Development in the UK, have started to require researchers to spend 10% of their budget on communication with non-academic partners (Quevauviller *et al.*, 2008).

- BONUS is a good example of centralising scientific knowledge for the implementation of the MSFD and the HELCOM's Baltic Sea Action Plan. There is a perception that BONUS lacks flexible financial contract formulae to enable more co-design programmes between the research community and the monitoring and policy community (like environmental authorities) to properly engage both communities in joint ventures with mutual commitments.

ACCESSIBILITY OF KNOWLEDGE

Access to scientific knowledge:

- Each EU-funded project has its own website. There is centralised information on these projects for each funding program, but this rarely gives more than a general project description that is written at the beginning of the project. There is a need for an overview of the different funding programs with links to achieved outputs, results and experiences from these projects (SPI-Water Cluster, A. 2013).

- The quality of the project information on Community Research and Development Information Service (CORDIS) is low; abstracts are usually from the proposal phase and achievements are rarely indicated. Most of the project research results are not in the public domain of these websites. Knowledge translation and knowledge transfer have proven difficult due to either proprietary rights or lack of continuing and wider dissemination (SPI-Water Cluster, A. 2013).

- There is little structured follow up by the funding organisations on research results that are interesting for further exploration or specific targeted further development. Therefore opportunities to speed up the transfer of research results are missed and knowledge might even get lost. This is indeed in contrast to other EC programmes i.e. Eurostars (https://www.eurostars-eureka.eu/), which requires projects to provide a cost-benefit analysis of their results and are required to bring their development to the market (SPI-Water Cluster, A. 2013).

Access to policy knowledge:

- To foster open access and information sharing on EC policies, the EC created an internet-based platform, the so-called "CIRCA" (Communication Information Resource Centre Administrator) with open access to European Working Group documents. Since this is designed and useful for and structured according to the working group activities, it is difficult for the scientific community to use in order to derive key policy development information in a time efficient way. WISE-RTD was therefore a step in the good direction.

EXPERTS SELECTION PROCESS

- From the SPI-Water cluster work for the WFD by the community the majority of the scientific or consultant partners are no longer active in relation to WFD SPI work, which is a loss of expertise and capacity that existed in the past. They were selected on the strength of the consortium and the submitted project proposal, but only worked for 2 years on the topic.

- The funded FP projects can propose or design a specific SPI mechanism, but lack the continuity to materialise and further improve the suggested developments.

RECOGNISING SCIENCE FOR POLICY

- WISE RTD is under-explored. Centralisation of science-policy learning is a requirement for efficiency. Centralisation does not mean that responsibility needs to be more centralised, rather the contributions of several organisations/science funding sources need to be channelled into a more common linking end-point. Centralisation efforts have already been made by the EC: a central portal, a lot of seed money for design and development and the right intentions were in place. But it did not work sufficiently. Why? One of the major barriers may still be the lack of recognition of science for policy, as scientists lack rewarding incentives to use the tools created to communicate their results in a more targeted way, although there is also room for improvement of the client friendliness of the currently existing web portals.

CONCLUSIONS

- Many science-policy interface studies conclude similarly. Many stress the lack of a convenient long-term and continuously updated overview of achieved outputs and the synergy of these multiple findings into coherent messages for policy makers.

- Whilst many stakeholders see a value for Knowledge Brokerage in a future SPI, this capacity is largely lacking. Establishing knowledge brokers requires dedicated financing from multiple sources (e.g. national, regional and European) to develop an appropriate structure towards achieving more coherence across Member States (STAGES project, Larkin *et al.*, 2014).

KEY SUCCESS FACTORS

- Individual scientists need to be engaged on the long-term to enhance their career development through recognition of their added value and knowledge. Otherwise any tool requesting knowledge input from them will die out.

- A joint responsibility between science funding agencies, knowledge-producers and knowledge-users needs to be established. An initiative steered by any one of them will not be most effective.

- A long-term supporting coordination team needs to be established, in contact with funding agencies, knowledge-producers and knowledge-users.

REACH DISTINCT TARGETED AUDIENCES

- Communication of EU projects is predominantly addressed towards the same audience. Organisations involved in EU projects often have a network of EU active organisations and information doesn't "leave" this network (SPI-Water Cluster, A. 2013). Therefore, it seems crucial to connect networks with each other that are apparently not currently used to exchanging knowledge.

- Use high profile speakers and good networking opportunities to create impact (SPI-Water Cluster, A. 2013).

- Disseminate the benefits of your research, not only the results. Translate the benefits to financial and societal results of interest to the stakeholders (SPI-Water Cluster, A. 2013).

- Scientists and policy-makers must understand and distinguish actions between three types (SPI-Water Cluster, A. 2013):
    - classic decision-making: trying to get the answer to what to do and how to do it
    - advocacy: determining an evidence base in order to have a position accepted or rejected
    - marketing: understanding how the argument should be explained and illustrated for other stakeholders to understand the key points.

CO-DESIGN

- Research proposals should be evaluated not only by researchers but also by other stakeholders (SPI-Water Cluster, A. 2013).
- Involve all concerned stakeholders at the beginning of research projects or even in the definition of it, in order to both provide input to the research process and to have easy access to the knowledge created. Keep stakeholders involved through progress reports and engage them in the end products of the research (SPI-Water Cluster, A. 2013).
- The relevance of science advice, evidence produced is really dependent on how the question is framed – there is a need to be very specific about what and why (STAGES project, Larkin *et al.*, 2014). To meet this need, OSPAR is producing a science strategic agenda that will involve multi-disciplinary science (natural and socio-economic) sourced from a range of knowledge producers.
- Choose the right representatives who are able to take up the results (SPI-Water Cluster, A. 2013).
- Be aware of the timing issues as policy-cycles differ. Take advantage of the "policy windows of opportunity" (SPI-Water Cluster, A. 2013).
- Distinguish between different stakeholders. Create brainstorming events where industry, research and policy mingle and exchange ideas (SPI-Water Cluster, A. 2013).
- An important outcome of dialogue is the development of trust. Significant barriers still remain in building mutual familiarity among scientists and policy makers. All of the parties involved in the science-policy interface need to create opportunities for dialogue. This helps to improve not only communication but also mutual understanding between the policy and science communities. Learning is an interactive, two-way process in which both decision makers and scientists stand to learn from each other. Dialogue helps with aspects of knowledge sharing that are widely underestimated in their importance: familiarity, the building of trust, and informal interaction (Quevauviller *et al.*, 2008).

ACCESSIBILITY OF KNOWLEDGE

- There is a need for an overview of the different funding programs with links to achieved outputs, results and experiences from these projects (SPI-Water Cluster, A. 2013).
- The funding organisations should take the lead to keep research information available (SPI-Water Cluster, A. 2013).
- There is a necessity to transform the scientific results into a more friendly and accessible language as well as presentation format. Make use of knowledge brokers

with experience in research and industry activities to find the link between research-policy-industry (SPI-Water Cluster, EC 2013; STAGES project, Larkin *et al.*, 2014; Quevauviller *et al.*, 2008).

- Commission a cost-benefit analysis and specification of key nodes where knowledge brokers could make the most added value (STAGES project, Larkin *et al.*, 2014).

- There is a need for short-term harnessing of relevant scientific knowledge and production of scientific and technical advice and long-term expert evaluation and synthesis of scientific knowledge (STAGES project, Larkin *et al.*, 2014).

- The STAGES project recommends the 'Marine Knowledge Gate' (http://www.kg.eurocean.org/) as a useful tool for harnessing relevant scientific knowledge, but this portal is not used yet by policy makers. It is a good basis as a comprehensive catalogue of projects and outputs, but further intelligent development is needed to merge it with the concept of WISE-RTD.

- Synergies between research projects must be looked at and project results should be disseminated thematically. Horizontal projects including professional communication agencies should be set up to augment communication strategies, organise joint thematic conferences for all running projects and reach a wide audience. Projects should be strongly pushed to use their services (SPI-Water Cluster, A. 2013).

- Distributed storage of information is considered problematic. Therefore a web-based repository for dissemination of projects, deliverables and documents or even of websites is encouraged. There should be fixed templates and guidance for their use. Ultimately there should be one access point for uploading and access of information. Use existing communities, industry groups, … rather than create your own (SPI-Water Cluster, A. 2013).

- Ring-fenced funds should be available for post-project dissemination activities with funds released based on a checklist of completed activities (SPI-Water Cluster, A. 2013).

VISUALISATION OF KNOWLEDGE

- Growing emphasis has been put on the development of user friendly web-portals and e-learning in the studies conducted on effective SPI mechanisms.

- Use new media, simple videos/animations to spread results widely (SPI-Water Cluster, A. 2013).

RECOGNISING SCIENCE FOR POLICY

- Recognise knowledge producers including the academic research community, industry etc. (STAGES project, Larkin *et al.*, 2014).

- Change the scientific citation system, so that scientists receive a reward and have an incentive to address and reach out to policy-makers and industry (SPI-Water Cluster, A. 2013).

- Use professional writers, or rely on consortium skills. If the importance of dissemination of results is demonstrated to the researchers, they will be more eager to cooperate in adequate dissemination (SPI-Water Cluster, A. 2013).

5 NATIONAL CASE STUDY: IMPLEMENTATION OF THE MSFD IN THE UK

RATIONALE

The UK Government has developed a number of ways of making the best science and science advice available to support policy and decision-makers developing and implementing marine policies. This makes the UK's experience a useful case study. Government departments have set up agencies to provide evidence and advice and have set up partnerships with other organisations to ensure appropriate collaboration at a UK level.

METHOD

This case study describes how the UK government and the science community work together. It draws on examples from England (Defra and Cefas) and at UK level (UK Marine Monitoring and Assessment Strategy), with a particular focus on the work of Centre for the Environment, Fisheries and Aquaculture Science (Cefas) in the science-policy interface.

BACKGROUND

The UK Government has a long history of engaging with science on issues of marine policy and management, stemming from the late 1800s with a focus on fisheries issues through much of the 20th century and continuing to date. The UK was a founder member of the International Council for the Exploration of the Seas (ICES) which provides a regional science-policy interface. The work of ICES, however, depends significantly on the research and advisory work carried out by the individual member states.

Growing concerns in the latter half of the 20th century led to an increasing need for scientific advice on a wide range of subjects relating to biodiversity, fisheries and the consequences of contaminants entering the sea. Much of this work has become increasingly focussed on delivering requirements expressed at a European level, applicable at a regional scale and guiding the actions of the Member States of Europe. The implementation of the Marine Strategy Framework Directive[10] has thrown up new challenges for the Member States in terms of the holistic scope and ambition of the directive in delivering an ecosystem-based approach to the management of the seas. There is also a need for strong regional co-ordination.

DEFRA AND THE NETWORK

The Department for Environment, Food and Rural Affairs (Defra) provides the UK lead for Marine Policy and has an ambition codified as an overarching vision. The vision, published in 2002[11], is to 'achieve clean, safe, healthy, productive and biologically diverse seas and oceans'

[10] Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:164:0019:0040:EN:PDF

[11] Safeguarding our Seas: A strategy for the conservation and sustainable development of our marine environment, 2002: http://archive.defra.gov.uk/environment/marine/legislation/strategy.htm

and to have done this 'within a generation'. The Defra Marine Programme employs a number of scientists to commission and manage the delivery of research as well as to provide advice based on this work.

The Centre for Environment, Fisheries and Aquaculture Science (Cefas) is a marine science agency within Defra. A significant part of the work is to provide evidence and advice to support Defra needs. This is achieved through conducting research and monitoring activities as well as a wider advisory capacity. Cefas plays a key role in the technical work that underpins the delivery of the MSFD.

The Defra Network contains a number of organisations that provide similar functions to Cefas but with different remits and scope. The Environment Agency (EA) covers environmental issues for land, air and coastal waters. The remit covers implementation of the Water Framework Directive which has an overlap with MSFD. The Joint Nature Conservation Committee (JNCC) covers conservation issues including biodiversity on land and in UK waters and is a statutory adviser to the UK government. JNCC's remit covers implementation of the Habitats[12] and Birds Directives[13]. Natural England (NE) has responsibility for 'managing' biodiversity in England and the Marine Management Organisation (MMO) has responsibilities for managing the users of the seas in fulfilment of the UK Marine and Coastal Access Act[14]. The EA, JNCC, NE and MMO are Non Departmental Public Bodies at arms length from government, ensuring independence of advice.

For the purposes of this case study, the primary example of the marine policy-marine science interface is contained in the constitution of Cefas. The Cefas Chief Scientific Adviser works with a number of lead advisers who focus on different aspects of science including marine environment, marine fisheries and marine biodiversity to deliver the advice required by the department. These same individuals also act as the main contacts with Defra policy leads and are therefore 'knowledge brokers'. Knowledge brokers have been defined as individuals with science-policy communication skills base that can act as independent and credible brokers to facilitate wider science-policy dialogues and the communication/dissemination process[15]. While these individuals are expert in their own right and very experienced, they are expected to liaise with other experts and carry out specific information research in drawing together the required advice. Any advice is subject to an internal review and/or a peer review. The work follows guidance provided by the UK Chief Scientific Adviser (UKCSA) covering scientific advisory processes in government.

The Defra Network organisations will have similar processes and all fulfil the requirements of the UKCSA Guidance[16]. The essence is to confirm that the advice is evidence-based and that there is quality control.

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[12] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31992L0043

[13] Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (this is the codified version of Directive 79/409/EEC as amended): http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0147

[14] Marine and Coastal Access Act, 2009: https://www.gov.uk/government/publications/marine-and-coastal-access-act-2009

[15] STAGES Proposal and recommendations for a science-policy interfaces (SPI) to support MSFD implementation, draft 17 July 2014; www.stagesproject.eu

[16] Guidance on the roles and responsibilities of chief scientific advisers (CSAs) and their supporting teams. BIS/12/534: https://www.gov.uk/government/publications/chief-scientific-advisers-and-their-officials

UK MARINE MONITORING AND ASSESSMENT STRATEGY (UKMMAS)

The United Kingdom consists of a number of different countries with their own governmental arrangements. This includes agencies carrying out similar functions under devolved powers for environmental issues. For example, the Environment Agency carries out functions in England, the Scottish Environment Protection Agency carries out functions in Scotland and Natural Resources Wales and the Northern Ireland Environment Agency do the same in Wales and Northern Ireland. As a result there is a need to co-ordinate this work. Since 2003 this co-ordination has been carried out under a framework known as UKMMAS.

Overall co-ordination of marine science in support of UK policy is the responsibility of the Marine Science Co-ordination Committee (MSCC). The UKMMAS is an organisational framework sitting under the MSCC that helps governments deliver monitoring and assessment and compiles evidence to support policy development and implementation (Figure 2). More than 20 organisations are directly involved in UKMMAS. UKMMAS work is overseen by the Marine Assessment and Reporting Group (MARG). MARG brings together senior managers with responsibility for marine monitoring, observation and assessment from UK public bodies. The group identifies ways of carrying out assessments to meet policy needs, with existing resources and scientific knowledge. It also directs the implementation of suitable programmes, reviews assessments and recommends changes to monitoring programmes as needed. The work of MARG is underpinned by the following Evidence Groups; Healthy and Biologically Diverse Seas (HBDSEG), Clean and Safe Seas (CSSEG), Productive Seas (PSEG) and Ocean Processes (OPEG). Importantly, the committees and working groups enable further information exchange and contribute to provision of advice on different aspects of the marine environment. This work also builds the inter-organisational relationships which lead to effective delivery of policy-relevant science.

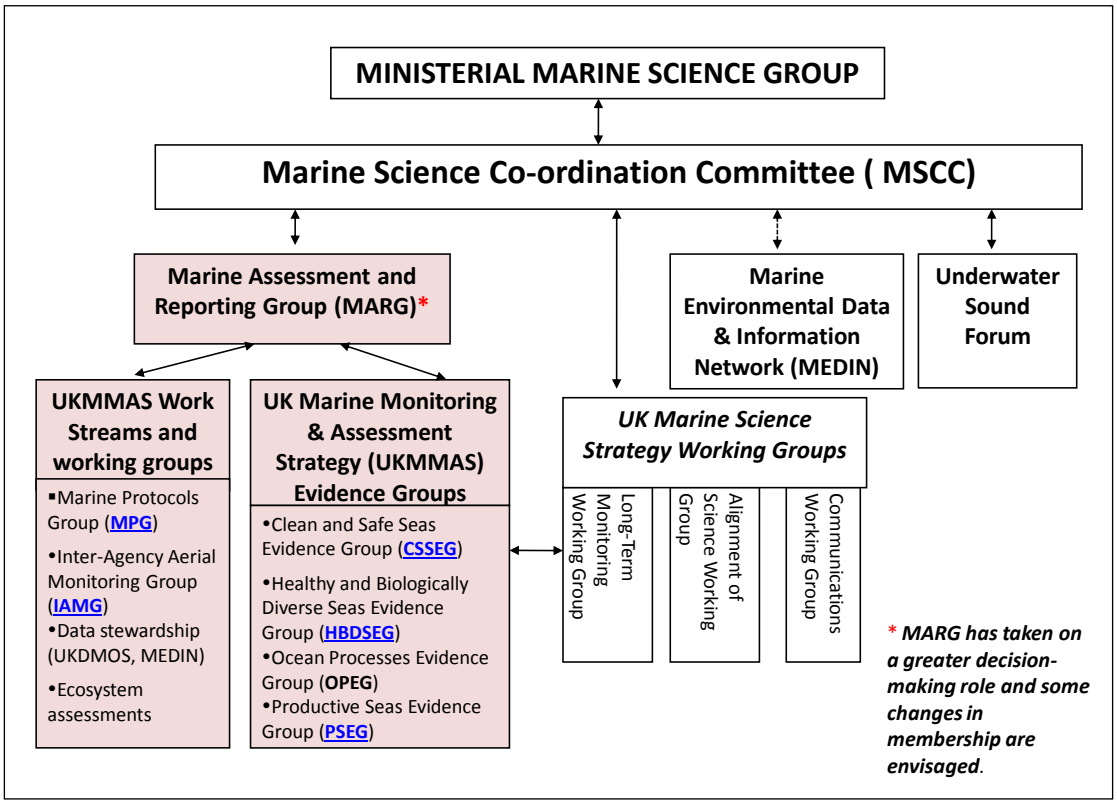

Figure 2: Structure of the Marine Science Coordination Committee

MAKING THE SCIENCE-POLICY INTERFACE WORK

There are ample opportunities where science and policy come together to exchange information and to more formally ensure that the best science is available to those expected to make decisions. This is either in relation to achieving the vision (set at UK and European level) or in delivering the more specific but related requirements of, for example, the MSFD. The approach in the UK of having lead advisors, i.e. knowledge brokers, who are charged with drawing together information, depends on specific relationships both with the policy community and with the broader science community. It requires considerable willingness to engage as the process takes time and is relationship, as well as process-based. This approach makes certain the best available understanding from all parties is used and leads to efficiency in delivering the relevant information. As the knowledge landscape becomes more complex the more difficult it is for simple relationships to be effective. In this case it is often for the policy lead to sift relevant information but this places both a burden and responsibility back to a different key people. Adequate resourcing for this sort of activity does not seem to match the growing need for the support.

Guaranteeing an adequate flow of new information out of the science process and into the advisory process has always been a specific challenge. Many lead advisers are active in research in their fields which provides opportunities to keep up to date on science developments. Even so, with the proliferation of scientific research at national and European (not to say global) levels it is increasingly important that the outputs of such projects are communicated in a clear and timely manner. There can be barriers to this when the timescales of scientific publication are taken into account. While there has been improvement to the timeliness of science information having an impact on policy there is an inevitable delay. There are often benefits to this to ensure that the science has been properly reviewed and is robust to challenge before it is used to influence the activities of humans and the seas.

Opportunities can also arise for individual scientists from the Defra network organisations to be seconded to Defra, acting as knowledge brokers and facilitating science-policy communication. For example, there are currently several people from Cefas seconded part-time or full-time to Defra teams; MSFD Implementation Team, Marine Biodiversity Team and Marine Evidence Team, Chemicals and Biotechnology Team. Similarly, there are Cefas experts seconded to the Welsh Assembly Government on the MSFD team.

IMPLEMENTING THE MSFD

The MSFD provides for a timeline of activity to prepare and deliver a Marine Strategy for the Member State, taking account of the regional context and working in coordination with neighbouring countries. The starting point was the preparation of an Initial Assessment and, on that basis, the determination of Good Environmental Status (GES) and associated targets and indicators for assessing progress towards achieving GES.

The UK was fortunate that as part of the process to deliver the UK Marine Vision the UKMMAS Community had published a report on the status of the seas around the UK (Charting Progress 2,

2010[17]). This report covered much of the information required to understand status under the MSFD, but there were areas that had not been covered and these required further assessment on the basis of existing information. The Initial Assessment (and Charting Progress 2) represents a key product generated at the science policy interface. The project was steered by a small group of senior scientists and policy makers providing a framework for many scientists to contribute information about the state of the seas. The work was divided between the different UKMMAS Evidence Groups covering, 'clean, safe' seas, 'healthy, biologically diverse' seas, 'productive' seas and a group covering ocean processes and climate change. Each group had responsibility for different topics some of which map to the MSFD descriptors such as eutrophication (D5) and contaminants (D8). Lead authors for each topic carried out reviews, liaised with relevant experts and together with colleagues in the group assessed new evidence derived from monitoring programmes. There were areas that did not have a history of monitoring including noise, litter and elements of biodiversity where the best evidence available was assessed.

Responsibility for developing the determination of GES and the proposals for targets and indicators was given to Cefas and JNCC (see above) to coordinate the technical work. Each organisation identified a lead advisor (for MSFD) and an advisor for each MSFD Descriptor. In each case the knowledge broker prepared a proposal based on discussion with policy leads and interpreting the meaning of the directive. This proposal was shared for comment and contribution with fellow lead advisors in other organisations and university colleagues. A first revision of the proposal was reviewed by the relevant UKMMAS Evidence Groups ensuring that a broad range of science expertise was brought to bear. The entire package of proposals was submitted to public scrutiny after ministerial agreement.

A similar process was deployed for the design of the future MSFD monitoring programme, involving: the development of technical proposals; the consultation amongst experts and the Evidence Groups; followed by public consultation. Technical input to the design of the monitoring work continues to be crucial given the tight financial situation to make sure that best value for money is achieved.

CONCLUSIONS

The UK Government has a long history of engaging with science on issues of marine policy and management, and the importance of science-policy exchanges is recognised and respected by all participants in the process. Policy-makers are fully conscious of the need for scientific knowledge to make evidence-based decisions and scientists recognise the importance of focussing their research to fill gaps in knowledge that will lead to better policy-making.

The UK Government has developed a formal science-policy structure through its infrastructure of agencies and partnerships, with overall co-ordination of marine science in support of UK policy being the responsibility of the Marine Science Co-ordination Committee. Scientists and policy-makers work together towards the shared vision to 'achieve clean, safe, healthy, productive and biologically diverse seas and oceans' and to have done this 'within a generation'. There is an expectation on scientists not only to deliver research, but also to provide advice based on this work. This means scientists become familiar with interpreting and presenting their science to a non-scientific audience in a form that means it is understood and has influence on policy. Any

[17] Charting Progress 2; the state of the UK Seas: http://chartingprogress.defra.gov.uk/

advice is subject to an internal review and/or a peer review, so policy-makers can act on advice secure in the knowledge that it is robust.

Ultimately the success of the science-policy process depends on specific relationships both with the policy community and with the broader science community. A particularly successful and effective scheme has been for individual scientists from the Defra network organisations to be seconded to Defra, acting as knowledge brokers and facilitating science-policy communication.

Maintaining continuity and depth of expertise is central to successful science-policy processes. This is not just about capturing the relevant information and ensuring its availability but also about having the ongoing relationships that enable the effective transfer and use of the information. Continuous dialogue is a necessary part of the process especially where an adaptive management regime is being developed.

LESSONS LEARNED

- Maintain continuity and depth of available expertise; both in terms of science and policy.
- Make use of knowledge brokers to facilitate the transfer of knowledge from the scientific community to policy makers.
- Establishing effective and lasting relationships that enable the effective transfer and use of information.
- Maintain continuous dialogue between scientists and policy experts.

6 INDUSTRY CASE STUDY: THE INTERNATIONAL MARITIME ORGANISATION

RATIONALE

While much of the focus of science-policy mechanisms focus on science generated by national research laboratories, it is also important to consider that knowledge is not the preserve of scientists alone. When formulating policy, it is equally important to consider the social and economic implications of decisions made to ensure that the management is practical.

The case study of the International Maritime Organisation (IMO) is an opportunity to investigate how scientific knowledge and advice from industry come together in the decision making process. It looks at the role of NGO advisors, representing industrial, societal and environmental groups, in IMO and the way in which science is used in IMO decision-making.

METHODS

To understand how the IMO and its advisory bodies work this case study investigates a series of documents produced by the IMO as guidelines for participation. It also uses a similar approach to understanding GESAMP and uses a review of the mechanism to understand what is effective and what was recommended to improve it. To understand how NGOs are involved in IMO, this case study uses the outcomes of a meeting with IMarEST.

WHAT IS THE IMO?

IMO is an agency of the United Nations that is responsible for the safety and security of international shipping and the prevention of marine pollution from ships. It was established by means of a Convention in 1948 and met for the first time in 1959. It currently has 170 Member States.

WHAT DOES IT DO?

The IMO was initially established to develop treaties and other legislation concerning the safety of shipping and the prevention of marine pollution. However, as Figure 3 shows, the bulk of the work was completed in the first twenty years of operations. Having completed this, the IMO now concentrates on keeping legislation up to date and encouraging ratification by as many countries as possible. This is not to say that it has stopped producing new legislation, a recent example being the Ballast Water Convention in 2004, which will be discussed below.

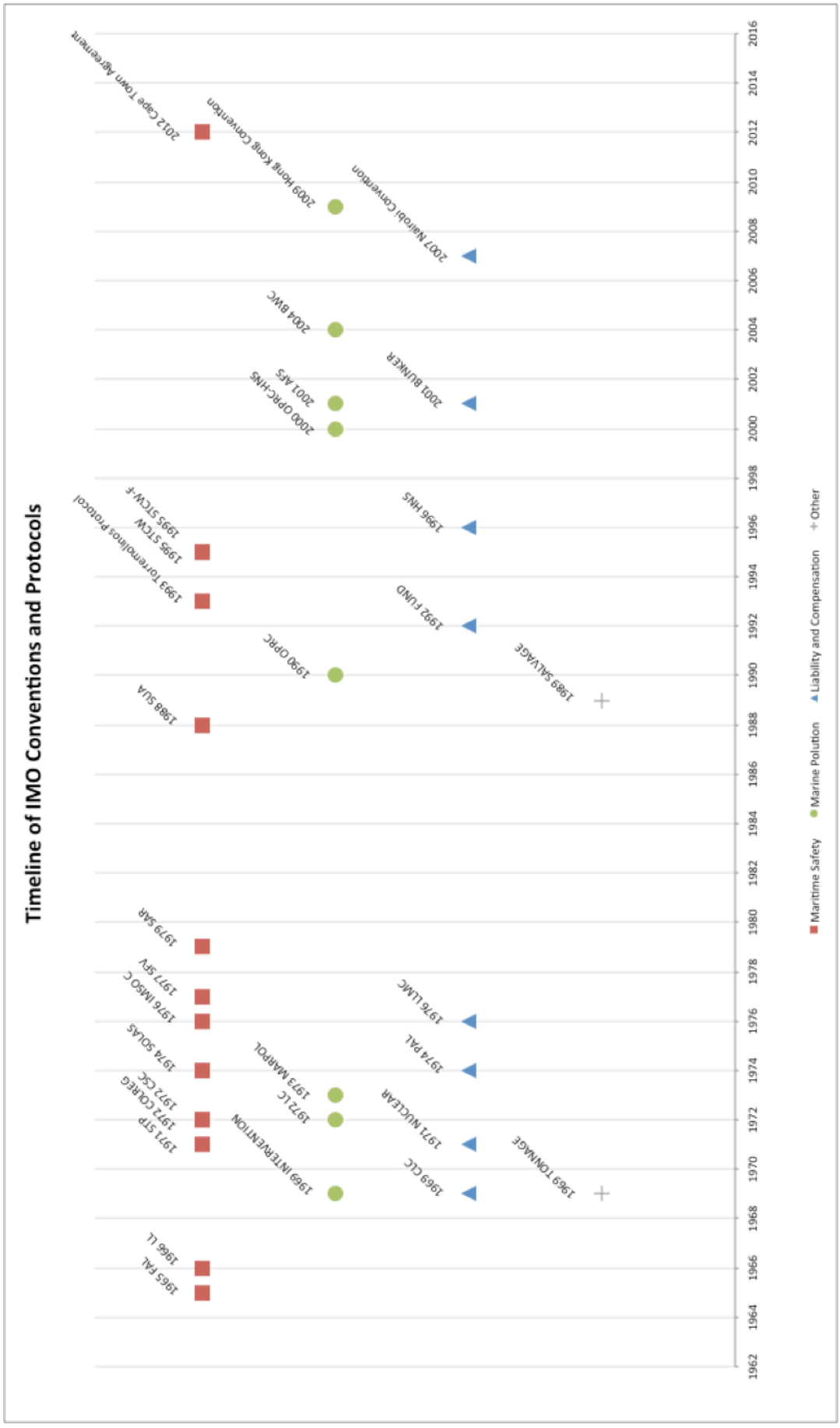

Figure 3 Timeline of the publication of IMO conventions and protocols

THE STRUCTURE OF IMO

THE ASSEMBLY

The governing body of IMO is made up of the 170 Member States and is know as the Assembly. It usually meets every two years to adopt the future budget and technical resolutions and recommendations prepared by subsidiary bodies during the previous two years.

THE COUNCIL

The Council acts as the governing body between Assembly sessions, it prepares the budget and work programmes for the Assembly. The Assembly elects a Council to serve for two year terms, the most recent election created a 40 member council to sit between 2014 and 2015. Membership of the council is divided into three categories to ensure a proportional representation of different interests, these categories and their representation for 2014-2015 are:

- Category (a) 10 States with the largest interest in providing international shipping services:
    - China, Greece, Italy, Japan, Norway, Panama, Republic of Korea, Russian Federation, United Kingdom, United States.

- Category (b) 10 States with the largest interest in international seaborne trade:
    - Argentina, Bangladesh, Brazil, Canada, France, Germany, India, Netherlands, Spain, Sweden.

- Category (c) 20 States not elected under (a) or (b) above, which have special interests in maritime transport or navigation and whose election to the Council will ensure the representation of all major geographic areas of the world:
    - Australia, Bahamas, Belgium, Chile, Cyprus, Denmark, Indonesia, Jamaica, Kenya, Liberia, Malaysia, Malta, Mexico, Morocco, Peru, Philippines, Singapore, South Africa, Thailand, Turkey.

IMO COMMITTEES

Five main committees carry out the main technical work of IMO. The two largest committees, MSC and MEPC, are supported by a number of sub-committees. The five are listed below with a summary of their main functions.

- *Maritime Safety Committee (MSC)* – The MSC is the highest technical body of the Organisation. It considers all matters concerned with the safety of maritime activities. It is also responsible for considering and submitting recommendations and guidelines on safety for possible adaptation by the Assembly.

- *Marine Environment Protection* Committee *(MEPC)* – The MEPC is empowered to consider any matter within the scope of the Organisation concerned with prevention and control of pollution from ships. In particular it is concerned with the adoption and amendment of conventions and other regulations and measures to ensure their enforcement

- *Legal Committee* – The Legal Committee deals with any legal matters within the scope of the Organisation. It was established in the aftermath of the Torrey Canyon disaster (Nanda, 1967). The Legal Committee is also empowered to perform any duties within its

scope which may be assigned by or under any other international instrument and accepted by the Organisation.

- *Technical Co-operation Committee* – The Technical Cooperation Committee considers matters concerned with the implementation of technical co-operation projects for which the Organisation acts as the executing or co-operating agency.

- *Facilitation Committee* – The Facilitation Committee aims to eliminate unnecessary formalities and bureaucracy in international shipping by implementing all aspects of the Convention on Facilitation of International Maritime Traffic 1965 and any matter within the scope of the Organisation concerned with the facilitation of international maritime traffic. In particular in recent years the Committee's work, in accordance with the wishes of the Assembly, has been to ensure that the right balance is struck between maritime security and international maritime trade.

SECRETARIAT

The Secretariat of IMO consists of the Secretary-General and some 300 international personnel based at the headquarters of the Organisation in London. The Secretary-General of IMO is Mr. Koji Sekimizu of Japan who was appointed to the position with effect from 1 January 2012.

WHO IS INVOLVED?

MEMBER STATES

The IMO currently has 170 Member States and three Associated Members. Only three countries with sea borders that are recognised by the UN are not members of IMO; the Federated States of Micronesia, Nauru and Niue.

NON-GOVERNMENTAL ORGANISATIONS

There are 77 Non-Governmental Organisations (NGOs) within IMO. The majority of the NGOs represent different industry groups, but there are also education alliances and environmental groups (Table 3). NGOs may be granted consultative status by the Council, with the approval of the Assembly, and therefore are able to make contributions to the work of IMO. The rules and responsibilities of NGOs within IMO are discussed below.

INTERGOVERNMENTAL ORGANISATIONS

IMO formally co-operates with Intergovernmental Organisations (IGOs) who share common interests. There are currently 63 IGOs within IMO which are limited to being observers; unlike NGOs they are not able to contribute. The role of IGOs is to ensure maximum cooperation and to avoid duplication between IMO and other organisations.

ADVISORY MECHANISMS OF THE IMO

Scientific and technical advice is presented to the members of IMO by several mechanisms. While there are undoubtedly mechanisms within individual Member States to support the decision-making abilities of their representatives, it is beyond the scope of this study these further.

FORMAL PROCESS OF ALLOWING NGOS TO INTERACT WITH MEMBER STATES

The role of NGOs within IMO is to serve as observers and advisors on technical and scientific issues. There are currently ten rules that govern the eligibility of NGOs to be part of the IMO process (IMO, 2013). In summary, the activities of the organisation must be relevant to IMO, it must operate on an international level and must demonstrate it has considerable expertise and has the capacity to contribute to IMO. Even if the organisation demonstrates these pre-requisites for membership, the Council must also ensure that granting consultative status will not lead to duplication or conflict. This may occur if the organisations interests are already adequately represented or it has access to IMO through another organisation already in consultative status.

Once appointed, an NGO is granted privileges as a consultant. They have the right to receive the provisional agenda for sessions of the Assembly, the Council and the various committees of IMO. They also have the right to submit documents, which are of interest to the NGO, to the Assembly, the Council and the committees of IMO; these documents must take into account the rules of procedure, which include deadlines.

An NGO can be present at plenary sessions of the Assembly and, upon invitation of the Secretary General, at sessions of the Council and the committees. During meetings, NGO observers are permitted to speak on any item of the agenda of special interest to their organisation. They are not, however, given voting rights, which are the sole preserve of Member States.

Once granted consultative status, NGOs have an obligation to attend and participate in meetings and actively disseminated and promote the work of IMO. A periodic review of NGO consultative status is carried out to ensure that organisations are fulfilling their commitments to IMO. If the Council or the Assembly concludes that an NGO no longer adequately represents the interests it purports to represent, its consultative status may be withdrawn.

The formal process by which NGOs interact with IMO is clearly designed with a purpose. In theory, it establishes a mechanism that allows independent scientific and technical advice to facilitate the discussions between the Member States. By providing an agenda before meetings and the ability to view relevant documents in advance, the process should provide a level playing field for discussions during meetings. While this process could be seen as fair and transparent, internally at least, there are drawbacks to employing this approach. Namely the speed at which discussions take place, as explored below.

GESAMP

The Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) was established in 1968. It is a group of natural and social scientists sponsored by eight UN bodies including IMO, FAO, UNEP, WHO, WMO, IAEA, UNESCO, IOC and UN. It provides advice on marine environmental issues of concern to those bodies.

While GESAMP meets annually to discuss emerging issues, designated working groups carry out most of the substantive work. These working groups are formed of experts, who are invited to take part, and are chaired by a GESAMP member (Wells, 2002). There are currently six working groups, though this number changes frequently, and GESAMP has published 87 volumes in its Reports and Studies series. Experts are nominated to a pool by sponsoring bodies and other UN organisations, their Member States, regional organisations, international scientific bodies and NGOs, the GESAMP Executive Committee and sitting GESAMP Members. Individuals are also permitted to nominate themselves if they feel sufficiently qualified to contribute to GESAMP. The Executive Committee and Chairs screen prospective experts and enter them into a Pool of

Experts database. However, it is likely that GESAMP finds it harder to recruit volunteer experts as employers are less willing to allow their employees to take on time consuming commitments outside of their organisations (MacDonald, Cordes, & Wells, 2004).

Experts participate in GESAMP working groups on a voluntary basis. Working groups are mostly set up on an *ad hoc* basis; meetings themselves are highly technical and produce reports on very specific topics. Most working groups exist for one to three years, but some persist for much longer to provide advice for on-going issues. The Working Group on the Evaluation of the Hazards of Harmful Substances Carried by Ships (EHS), for example, began in 1972 as an *ad hoc* working group, but in 1974 became the principle body that evaluates the hazards of chemicals carried by ships for IMO and the MARPOL Convention (Wells, Höfer, & Nauke, 1999).

In 2000, the Executive Director of UNEP, one of the sponsoring organisations of GESAMP, proposed an in-depth and independent review of GESAMP. The review, published in 2001, reviewed documents, used questionnaires and conducted interviews to give an assessment and make recommendations on how GESAMP operates (Bradley *et al.*, 2001). The assessment found that GESAMP products are held in high regard by United Nations agencies. However, the report also proposed sweeping changes to the organisation in the form of 11 recommendations (Bradley *et al.*, 2001). This eventually led to the publication of a new Strategic Vision for GESAMP (IMO, 2005).

The report recommended the establishment of a GESAMP office, which has subsequently been created within the IMO headquarters. It was found that GESAMP members were overstaying the four-year term of their membership. The Strategic Vision reiterated this point by committing to end the practice of extended memberships. The review also found that experts were predominantly from North America and Europe; it proposed holding meetings in different parts of the world to encourage more international participation. The experts that participated were weighted towards natural science and it was suggested that there needed to be more involvement of social and political scientists.

The assessment found that was no formalised procedure to ensure that the Working Groups had sufficient resources to support the participation of experts, with some unsponsored groups operating on a "shoestring". However, it also found that there is not necessarily a correlation between the quality of the end product and the financial support. Often those based on single, focused topics produced a better product.

The assessment reviewed publications of GESAMP and found that products were well received by the sponsoring organisations, but that there was certainly room to improve uptake by the wider community. This conclusion was based on citation analysis of reports. The reason for this general lack of usage, beyond the UN, stemmed from two factors. Firstly, there was no standardised format for publications. Secondly, there was a lack of what might be called a marketing strategy. The assessment recommended that reports should be produced to be reader-friendly, but without compromising the quality of the content. It also suggested that GESAMP should improve its web presence and use electronic publications more effectively. A subsequent study of the uptake of GESAMP publications produced set of recommendations that could be used to standardise and promote its products; this is available Table 2. These recommendations may be useful in developing a strategy for the publication of future actions of JPI Oceans.

Table 2 Publishing recommendations for GESAMP (MacDonald, Cordes &Wells, 2004)

Publishing Recommendations for GESAMP
• Emphasise the acronym GESAMP by placing it at the beginning of the full name of the organisation. The acronym by itself could become the official name, like some other UN agency names, e.g., UNESCO, UNICEE • Use only the acronym in the recommended citation format, e.g., GESAMP. (2001). A Sea of Troubles. Rep. Stud. No. 70. (35 pp.). • Establish a standardised name for the series with the acronym GESAMP at the beginning, and apply it consistently on cover titles and title pages, and in the recommended citation format. • Ensure that the title of each report is consistently the same in all locations where it is found: cover of a report, title page, recommended citation format, publication lists within printed reports, and on the GESAMP website. • Obtain a new ISSN when a name change occurs in GESAMP or in the report series. • Always include an ISBN in each published report, along with the ISSN. • Distribute new reports widely, with generous publicity. • Ensure that a copy of each new report is sent to each indexing agency. • Alert ASFA to the reports not already indexed. • Describe the peer review process in each report, and on the GESAMP website. • Consider publishing the reports in two series, one for thematic reports and one for reports of sessions, since the production and reviewing processes for the two types are markedly different. • Give much greater effort to ensure that the reports, especially the thematic ones, are translated, since GESAMP is a global advisory body sponsored by the UN. • Prepare book or journal versions of new thematic reports routinely. • Keep the website up-to-date, accurate, and relevant to potential users, to encourage use. • Continue creating electronic versions of older reports, especially thematic ones. • Centralise the production and distribution of the reports by a single agency or the GESAMP secretariat, if possible, to make it easier to carry out the other recommendations.

THE BALLAST WATER CONVENTION

To examine how advisory system operates in the IMO, it is useful to use a specific example. An arguably controversial example is the Ballast Water Convention. The Convention was designed to be an international response to the economic, social and environmental consequences of the introduction of invasive species from the ballast water of shipping. Ostenfeld (1908) published the first study that investigated the link between shipping and invasive species. The economic cost of these species can be staggering. A study in the US found that economic losses due to exotic fish is $5.4 billion annually, with some individual species accounting for up to US$1 billion of this individually (Pimentel, 2005). There are also significant risks to public health, through the introduction of parasitic organisms or diseases.

The issue was first raised at the IMO in the early 1970s and, through the MEPC, started developing an instrument in the early 1990s (Gollasch, 2007). As a result, the *International Guidelines for Preventing the Introduction of Unwanted Aquatic Organisms and Pathogens from Ships Ballast Water and Sediment Discharges* were adopted at the 31st Session of MEPC in 1991. However, it soon became apparent that it is not possible to completely prevent the introduction of unwanted organisms and so the original Resolution was replaced by the *Guidelines for the Control and Management of Ships' Ballast Water to Minimise the Transfer of Harmful Aquatic Organisms and Pathogens* in 1997.

These first two Resolutions were limited in effect since both were voluntary and it was recommended that the IMO work towards a legally binding international agreement. This eventually led to the 2004 *International Convention for the Control and Management of Ships'*

Ballast Water and Sediments, referred to here as the Ballast Water Convention. To enter into force, the convention requires ratification by no less than 30 States, representing at least 35% of the world's merchant tonnage. To date, 38 States have ratified the convention, but these only represent around 30% of the global tonnage. The ratification process has been criticised by the Secretary General of the IMO, Koji Sekimizu, for being "disappointingly slow"[18]. Indeed, it took more than ten years to formulate the legislation and 10 years since the adoption of the Ballast Water Management Convention in 2004.

There has been concern within the shipping industry over the Convention. Naturally, there is the issue of cost, with ballast water treatment systems costing up to $1.5 million. However, there has also been a lack of confidence in the systems that exist and a worry that the considerable investments will not perform as needed.

In anticipation of the eventual acceptance of the Convention, Europe and the United States have developed legislation to manage ballast water issues. In Europe, the Commission has 'strongly recommended' the ratification of the Ballast Water Convention by its Member States; in the interim the EU has several directives that cover the issue of ballast water and invasive species which include (EMSA, 2008):

- EC Marine Strategy Framework Directive 2008/56/EC;
- EC Marine Equipment Directive 96/98/EC – as amended by 2002/84/EC;
- EC Biocide Directive 98/8/EC;
- EC Port State Control Directive 95/21/EC; and,
- EC Port Waste Reception Facilities Directive 2000/59/EC

The United States has also developed its own guidelines, the *United States Ballast Water Regulations*. Three different legislative regimes governing ballast water will most likely have different requirements and standards. This fragmentation could lead to considerable costs to an industry that, by its very nature, operates on a global scale.

In the United Kingdom, the lack of knowledge about invasive species is seen as the limiting factor in developing an action. Some initial work is underway to understand the scale and risks posed by different pathways so that actions can be prioritised in the future (HoC, 2014). However, the UK has not yet ratified the Ballast Water Convention and so this research being carried out separately. The UK has not ratified the Convention as it believes that there are too many complications and uncertainties involved in sampling and analysing ballast water and that there is no guarantee that it will provide the biological and environmental safeguards it has been designed to offer (HoC, 2014).

HELCOM (Helsinki Convention) and OSPAR (Oslo-Paris Convention) established a joint group on Ballast Water Management (HELCOM/ OSPAR TG BALLAST) and agreed on joint guidelines for Ballast Water Management implementation. In the study of von Homeyer *et al.*, 2013 on the needs of Regional Sea Conventions (RSC) for the implementation of the MSFD, RSC stakeholders expressed the need for more research on alien species mediated by ballast water and a need to support further coordination on alien species control and the implementation of the IMO Ballast Water Management Convention. A desk study identified knowledge gaps in particular in the areas of biodiversity and food-webs, including microbial communities. This includes conceptual work to clarify how these components can be taken into account. Both HELCOM and OSPAR suggested von Homeyer *et al.*, 2013 that a project to support testing of monitoring protocols regarding ballast water in harbors and a research project to assess the risk of new species introductions through ballast water and to develop a method to formulate target species lists

[18] MPEC 66 meeting

would be very helpful. Also monitoring of loads and pressures needs to be improved and harmonized for maritime traffic related issues, like ballast water/alien species.

CONCLUSIONS

The advisory processes of IMO are well documented. The guidelines for NGO involvement within IMO are a good example of how to design an advisory process that is both clear and transparent. It could also be relevant to JPI Oceans if, at some stage, it is in a position to provide a unique perspective on issues relevant to IMO.

The 2001 review of GESAMP, for example, provides specific examples of what a science-policy advisory body needs to do to be effective. JPI Oceans could benefit from the content and recommendations of the review, by using it as a guideline on how to conduct science policy interactions for its future actions. The publication recommendations, for example, are a specific action that could be adapted to ensure the maximum uptake of future publications.

The terms by which scientists participate in GESAMP is an interesting concept. Fixed terms for participation should keep working groups at the forefront of scientific knowledge and reduce the likelihood of stagnation. However, a system like this could suffer from a loss of organisational knowledge. It is also true that the longer the term of service, the more experience is gained of writing advice for policy. A balanced solution to this could be to develop a hybrid approach allows for both permanent and fixed-term scientists to sit in working groups. This approach would ensure a legacy which maintains continuity in access to long term data and continuous monitoring, while also ensuring innovation and a smoother adoption of new approaches.

The development of the Ballast Water Convention is an example of how a specific piece of legislation is developed by IMO and some of the challenges it faces. The lengthy process involved in highlights the challenges faced when the balance of environmental, industry and societal needs is not met. It also highlights the need to address areas where the scientific knowledge is not sufficient and the need to address this in the early stages of policy development. The challenge for identifying the real scientific needs of a policy is how to narrow down general wishlists to specific actions. It is likely that potential policy areas for IMO to develop in the future will also be the areas where science is least developed, such as the deep sea resources and arctic exploration.

TABLE 3: NON GOVERNMENTAL ORGANISATIONS WITH CONSULTATION STATUS IN THE IMO

- Advisory Committee on Protection of the Sea (ACOPS) www.acops.org.uk
- Bureau International des Containers et du Transport Intermodal www.bic-code.org
- BIMCO www.bimco.org
- European Chemical Industry Council (CEFIC) www.cefic.org
- Community of European Shipyards' Associations (CESA) www.cesa.eu
- Comité International Radio-Maritime (CIRM) www.cirm.org
- Cruise Lines International Association (CLIA) www.cruising.org
- Comité Maritime International (CMI) www.comitemaritime.org
- Clean Shipping Coalition (CSC) www.cleanshipping.org
- Dangerous Goods Advisory Council (DGAC) www.dgac.org
- The European Association of Internal Combustion Engine Manufacturers (EUROMOT) www.euromot.org
- Friends of the Earth International (FOEI) www.foei.org
- The Federation of National Associations of Ship Brokers and Agents (FONASBA) www.fonasba.com
- Global Maritime Education and Training Association (GlobalMET) www.globalmet.org
- Greenpeace International www.greenpeace.org/international
- International Association of Airport and Seaport Police (IAASP) www.interportpolice.org
- International Association of Classification Societies (IACS) www.iacs.org.uk
- International Association of Drilling Contractors (IADC) www.iadc.org
- International Association of Institutes of Navigation (IAIN) www.iainav.org
- International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) www.iala-aism.org
- International Association of Maritime Universities (IAMU) www.iamu-edu.org
- International Association of Ports and Harbors (IAPH) www.iaphworldports.org
- International Bunker Industry Association (IBIA) www.ibia.net
- International Bulk Terminals Association (IBTA) www.drybulkterminals.org
- International Chamber of Commerce (ICC) www.iccwbo.org
- ICHCA International Limited (ICHCA) www.ichca.com
- International Christian Maritime Association (ICMA) www.icma.as
- International Council of Marine Industry Associations (ICOMIA) www.icomia.com
- International Chamber of Shipping (ICS) www.marisec.org
- International Electrotechnical Commission (IEC) www.iec.ch
- International Fund for Animal Welfare (IFAW) www.ifaw.org
- International Federation of Shipmasters' Associations (IFSMA) www.ifsma.org
- International Harbour Masters' Association (IHMA) www.harbourmaster.org
- Institute of International Container Lessors (IICL) www.iicl.org
- Iberoamerican Institute of Maritime Law (IIDM) www.iidmaritimo.org
- International Iron Metallics Association (IIMA) www.metallics.org.uk
- International Life-saving Appliance Manufacturers' Association (ILAMA) www.ilama.org
- The Institute of Marine Engineering, Science and Technology (IMarEST) www.imarest.org

- International Marine Contractors Association (IMCA) www.imca-int.com
- International Maritime Health Association (IMHA) www.imha.net
- International Maritime Lecturers Association (IMLA) www.imla.co
- International Maritime Pilots' Association (IMPA) www.impahq.org
- International Maritime Rescue Federation (IMRF) www.international-maritime-rescue.org
- International Association of Dry Cargo Shipowners (INTERCARGO) www.intercargo.org
- INTERFERRY www.interferry.com
- International Ship Managers' Association (InterManager) www.intermanager.org
- International Association of Independent Tanker Owners (INTERTANKO) www.intertanko.com
- International Ocean Institute (IOI) www.ioinst.org
- International Petroleum Industry Environmental Conservation Association (IPIECA) www.ipieca.org
- International Paint and Printing Ink Council (IPPIC) www.ippic.org
- International Parcel Tankers Association (IPTA) www.ipta.org.uk
- International Road Transport Union (IRU) www.iru.org
- International Sailing Federation (ISAF) www.sailing.org
- International Spill Control Organisation (ISCO) www.spillcontrol.org
- International Shipping Federation (ISF) www.ics-shipping.org
- International Organisation for Standardisation (ISO) www.iso.org
- International Shipsuppliers & Services Association (ISSA) www.shipsupply.org
- International Salvage Union (ISU) www.marine-salvage.com
- International Transport Workers' Federation (ITF) www.itfglobal.org.uk
- The International Tanker Owners Pollution Federation Limited (ITOPF) www.itopf.com
- International Towing Tank Conference (ITTC) http://ittc.sname.org
- International Union for Conservation of Nature (IUCN) www.iucn.org
- International Union of Marine Insurance (IUMI) www.iumi.com
- International Vessel Operators Dangerous Goods Association, Inc. (IVODGA) www.ivodga.com
- NACE International www.nace.org
- The Nautical Institute (NI) www.nautinst.org
- Oil Companies International Marine Forum (OCIMF) www.ocimf.com
- International Association of Oil and Gas Producers (OGP) www.ogp.org.uk
- International Group of Protection and Indemnity Associations (P & I Clubs) www.igpandi.org
- Pacific Environment www.pacificenvironment.org
- PIANC, the World Association for Waterborne Transport Infrastructure (PIANC) www.pianc.org
- The Royal Institution of Naval Architects (RINA) www.rina.org.uk
- Society of International Gas Tanker and Terminal Operators Limited (SIGTTO) www.sigtto.org
- Superyacht Builders Association (SYBAss) www.sybass.org
- World Nuclear Transport Institute (WNTI) www.wnti.co.uk
- World Shipping Council (WSC) www.worldshipping.org
- World Wide Fund For Nature (WWF) www.panda.org

8 FUTURE OF SCIENCE-POLICY INTERACTIONS

CO-DESIGN AND CO-PRODUCTION

The co-production of knowledge is one of the fundamental drivers behind the JPI concept. Co-design aims to align jointly funded science programmes, involving multiple research funders, and Ministries with responsibilities for policy development decision making and environmental management. It offers the prospect of more cost effective and societally relevant research outputs; designed to fit into a science-policy interface to ensure that research outputs are delivered and used in a timely way. Jointly funded co-design science programmes can include both research and infrastructure developments.

An established mechanism at National level is the UK initiative, "Living With Environmental Change," LWEC acts as a mechanism for stakeholder engagement and promotes co-design of UK research programmes. The LWEC Partnership consists of 22 public sector organisations that fund, carry out and use environmental research and observations. They include the UK research councils, government departments with environmental responsibilities, devolved administrations and government agencies; the private sector is represented by the Business Advisory Board. LWEC's Purpose is to ensure that decision makers in government, business and society have the knowledge, foresight and tools to mitigate, adapt to and benefit from environmental change. LWEC does not have a budget for funding research. Member organisations, that have their own budgets, pay an annual subscription and/or contribute staff resources to run a small secretariat and/ or contribute to common needs such as a database (Envirobase) of all the research they fund.

LWEC aims to facilitate a multi-perspective approach to research investment strategy. Partners can pool resources through LWEC to achieve a better return on their investments. It is often more cost-effective, for example, for two organisations who need different scientific evidence from a project to design the project together to get the results they both need rather than to fund two separate projects. LWEC acts in the role of an honest broker with experience of forging collaborations, which can result in rapid innovation and quicker delivery of results. LWEC has developed new ways to enable individual organisations to align their strategies to achieve a more holistic approach and avoid the risk of over-representation by one discipline or interest group. It has also addressed the need to manage contractual arrangements and changes in working practices that are required when individual organisations try to work together.

In terms of science-policy interfaces, LWEC has developed a set of Knowledge Exchange guidelines which include recommendations for programme co-design aimed at decision makers. They emphasise the need for realistic goal setting in both scientific terms and in impact and societal outcomes, clear stakeholder identification and effective governance arrangements including 'reference user groups'. They highlight the role and benefits of a dedicated knowledge exchange coordinator and dedicated funding for knowledge exchange activities at the programme level. This enables the integration of a range of research outputs into higher level policy messages, using effective knowledge brokerage tools and ensuring a knowledge legacy.

Marine Research programmes in the UK that have adopted a co-design approach include Marine ecosystems, Marine Renewable energy, Shelf Sea Biogeochemistry (each NERC and Defra), Ocean Acidification (NERC, Defra and DECC) and a new multi-partner programme on Valuing Nature, which is also referred to as ecosystem services.

LWEC also offers the opportunity to retrofit existing initiatives with a co-design approach, an example of which is the Sea Mammal Research Unit (SMRU)[19]. While SMRU had a range of funders, it did not have a co-design element to its programme and sought LWEC accreditation to achieve this. It already had an LWEC style approach to working and by being accredited has allowed SMRU to sustain and enhance the viability and effectiveness of the co-managed approach that they had, through cultural changes at the partner level. Being LWEC accredited has allowed leverage of significant amounts of additional funding from Scottish Government. Furthermore, there has been leverage of funds from Scottish Natural Heritage (SNH) and Natural England (NE) for on-going research.

Although this funding existed before LWEC accreditation, by being part of LWEC has allowed SNH and NE to justify the continuation investment. Through LWEC accreditation and cultural changes there is now very strong feedback between SMRU and the policy community. This has happened through SMRU offering an Advisory Service for policy makers with a 24-hour turnaround time within the working week. LWEC has improved interaction between individual partners and between SMRU and partners. This has led to new perspectives and behaviours and there is now a better understanding of the policy community and SMRU can tailor their activity and responses to questions that meet their needs more effectively. LWEC promotes its accreditation as a way of participating in wider stakeholder engagement programmes and more funding opportunities.

Co-design also offers prospects for the coordinated use of research and monitoring infrastructure. For example, the UK is currently planning a new project 'Marine Autonomous Systems in support of Marine Observations (MASSMO) which aims to deliver a targeted marine observation programmer using a fleet of marine autonomous platforms. MASSMO will deploy common sensors and operated in a coordinated way that will inform UK marine monitoring policy and its operations, particularly for MPAs and related conservation zones. This project will be one of the first to use a large fleet of different autonomous systems to measure multiple parameters of the marine environment and could be very influential in the future design of holistic habitat mapping and monitoring exercises.

Coordination in Portugal
The Interministerial Commission for Sea Affairs (CIAM-Comissão Interministerial para os Assuntos do Mar) was established in Portugal with the main goal of ensure, on a permanent basis, the joint interministerial proper monitoring and consultation of transversal policies in the context of maritime affairs, as well as the correct implementation of the National Strategy for the Sea.

An example of coordination from the CSA Oceans consultation

[19] Sea Mammal Research Unit co-design case study http://www.lwec.org.uk/stories/marine-management-case-study

COORDINATED DATA ACQUISITION

There are a number of national and international initiatives to join-up or integrate otherwise disparate networks of observing systems. The US Integrated Ocean Observing System (IOOS®), and the Australian IMOS (Integrated Marine Observing System (CHECK) are responding to national needs. The IOOS program has successfully demonstrated how to mobilise and coordinate national regional observing systems into a coherent whole. IOOS is an operational programme supported by federal and regional funding and a research and development programme supported through the National Science Foundation's (NSF) Ocean Observatories Initiative (OOI). Established in 2007, Australia's Integrated Marine Observing System (IMOS) has set out to build a collaborative research infrastructure for ocean observations. Similar initiatives are underway in Europe through EUROGOOS and at national levels, for example the formation of the UK's Integrated Marine Observing Network (UK-IMON).

With the advent of more sophisticated autonomous systems, the potential to coordinate data acquisition on regional and even global scales has greatly increased. An excellent example of how autonomous systems can fit into an integrated global ocean observation strategy is the Argo programme. While the Argo network has successfully collected temperature, salinity and current data for over ten years, many see a need to develop a new generation of Argo with chemical and biological sensors (Johnson *et al.*, 2009). This addition would greatly benefit some of the scientific gaps in policies relating to ocean acidification and eutrophication.

Argo

The Argo network is a global broad-scale array of temperature/salinity profiling floats. The floats work autonomously to take point measurements around the world.

Developments in sensor technology will soon bring new capabilities to the Argo array, such as the ability to measure biological and chemical properties of the water column.

www.argo.ucsd.edu

The use of autonomous systems for data collection offers many advantages over traditional research ships. This is not to say that the research ship is redundant, but that autonomous systems allow them to be used more effectively in the roles they are best suited to. While the initial investment in autonomous systems can be large, the ultimate ambition should be to create cost effective systems that are flexible enough to be used in a range of scenarios.

EVOLUTION OF EVIDENCE GATHERING

Ensuring continuity and comparability between data collected using different methods and platforms is essential in providing reliable advice for decision makers. Long term data series are used to underpin some of the most important principles of climate science and changes in the ocean. There are two approaches to this problem. The first is to establish one methodology and not to change it, such as is used in the Continuous Plankton Recorder experiments (Reid *et al.* 2003); this approach does not permit changes in the methodology and therefore cannot incorporate advances in technology. The second approach is to develop methodologies to ensure interoperability between time series. This approach allows for the latest use of technology but older datasets can be neglected or lost without sufficient planning.

While new technologies can be an attractive option for many reasons, they often require significant investment to develop. To be used in support of policy they must demonstrate that they are fit for purpose. It may be useful to develop a mechanism which screens new technologies that ensures that they are both fit for purpose and cost effective. In situations where a new development is clearly advantageous, it could be useful to fast track the development and ensure that the legislation governing their use is sufficiently flexible.

It is not only the development of new sensors and platforms that are changing the way in which measurements are made at sea. Developments in personal communication technology have led to many successful Citizen Science projects to monitor issues such as marine invasive species (Delaney *et al.* 2008). While there are many challenges to using citizen science in policy, such as improper data collection and data use, there is increasing evidence to show that it has been successful in directly influencing policy (Conrad & Hilchey, 2011).

GLOBAL OCEAN OBSERVATION SYSTEM

There are a wide range of operational and research infrastructures and related initiatives that collect, manage and use marine data to create knowledge and evidence. This has led to a complex landscape with some degree of fragmentation. JPI Oceans could play a key role in clarifying the vision and developing a strategy for assembling the parts into a finished product. It could do this by supporting initiatives, such as EuroGOOS, which aim to identify overlaps and duplication or where there is a gap altogether.

A useful starting point is to consider what constitutes a complete marine observing system. One view is that an observing network is of comprised a number of different components (Figure 4 and Table 4). These include data acquisition systems, data management and information systems.

One of the challenges for Europe and for JPI Oceans is to identify how best to make use of the different observing network components to improve knowledge and provide better evidence for many purposes.

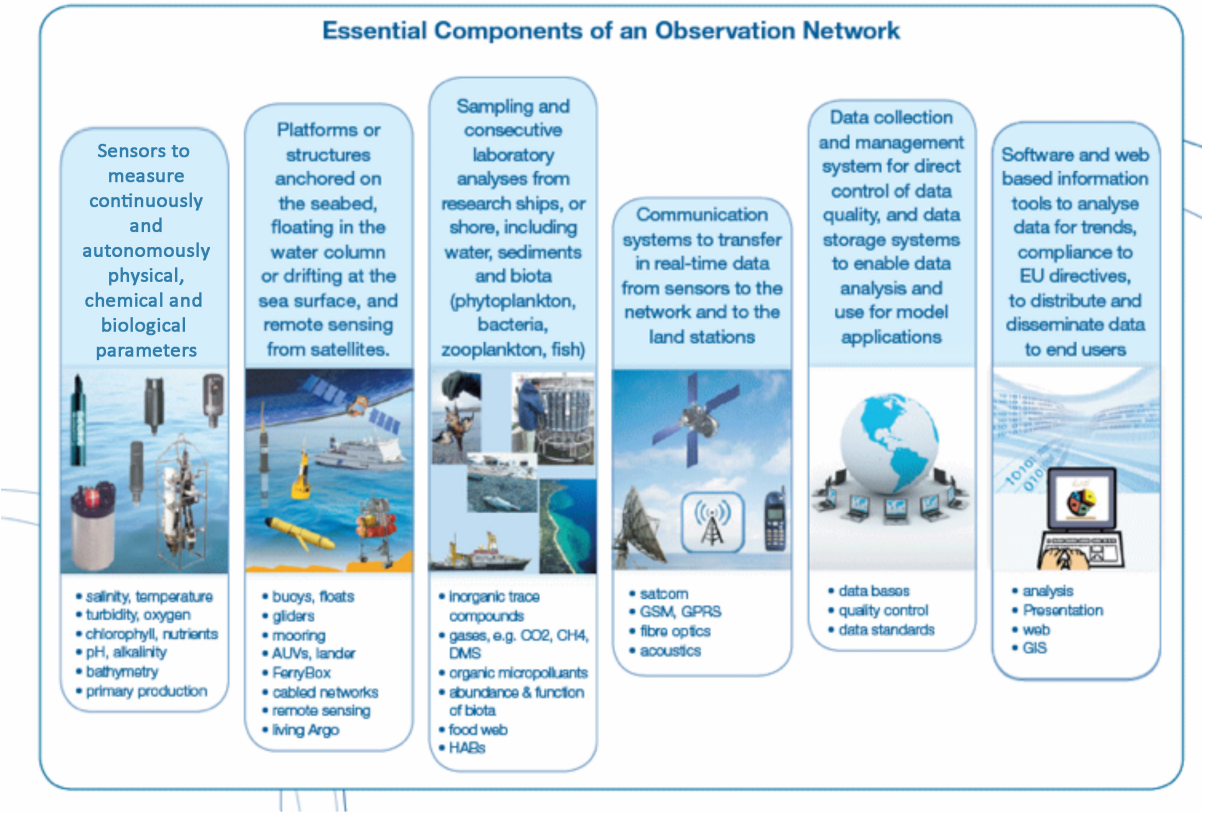

Figure 4. Components of an observation network

Component of observing system	**Existing initiatives**		
I. Data acquisition	• **Euro-Argo, EMSO, EMBRC, EUROSITES, Ferryboxes,** CPR, **satellite remote monitoring…** • **National marine infrastructures: oceanographic fleets, gliders, buoys, mapping of seabed (incl. habitats)…** • **Fisheries surveys** • **Marine biodiversity data → MARBEF**		
II. Data management	• Local data centres • National Data Centres • **SeaDataNet / EMODnet**	**SEADATANET - EMODNET**	
III. Data assembly and applications (Information Systems)	• EMODnet • LIFEWATCH • MyOcean… • iMarine		

Table 4. Mapping current operational and research infrastructures and releated initiatives on to the three primary components of an observing system

UK Integrated Marine Observing Network (UK-IMON)

About UK-IMON

The purpose of the UK Integrated Marine Observing Network (UK-IMON) is to draw together existing UK marine observatories and observing programmes in order to serve societal needs by providing reliable marine data and information for a better understanding of marine systems, improving safety, enhancing our economy and protecting the environment'.

The case for change

Marine data are expensive to collect, costing approximately £80 million per year (EC, 2009) in the UK and there is increasing pressure to reduce these costs. With a need for greater openness, accountability, sharing and access to these data and with new observational strategies, tools and technologies creating a 'data deluge', a common language needs to be developed between the many players and their numerous and diverse (observing) systems.

The way forward

Partnership and collaboration are the way forward. UK-IMON builds on the existing UK marine observing infrastructure.

Streamlining data to information

UK-IMON will streamline the flow of data from observations through to information tailored to meet defined user needs. It will build on existing marine observing systems and MEDIN (Marine Environmental Data and Information Network). It will also draw on major European data sources such as Copernicus (formerly Global Monitoring for Environmental Security) and make use of existing information systems such as the EMECO Datatool (www.emecodata.net).

Example of an integrated observation network from the CSA Oceans consultation

DATA MANAGEMENT

The management of data is crucial for its use in supporting policy decisions. One of the issues raised during the CSA Oceans stakeholder consultation was the need for a standardisation of marine data formats. The Marine Environment Data & Information Network (MEDIN) was established as a partnership of UK organisations committed to improving access to marine data. One of the key initiatives of MEDIN was to develop data standards in the form of common rules, conditions and guidelines. MEDIN promotes the use of standardised field names and controlled vocabularies so that datasets are described in a consistent way for every type of marine data.

It is impractical for humans to process multiple datasets of multidisciplinary data. To do this, web services are developed to allow computer-to-computer interoperability. Web services designed to allow online applications to communicate with one another without human intervention. An example of how web services can be used in an environmental field is the National Biodiversity Network (NBN)[20]. The NBN is a repository for UK biodiversity data which offers web services that enable other websites to dynamically access the data. Much of the data

[20] The National Biodiversity Network- www.nbn.org.uk

NBN provides was collected by citizen science scientist, indeed web services are particularly suited to maximising the value of Citizen Science projects (Silvetown, 2009).

EMECO Data tool
The EMECO Datatool provides an on-line approach to carrying out assessments of environmental quality. It provides a rapid mechanism to integrate the diverse data sets collected from many different platforms (ships, satellites, buoys) by different agencies and countries and turn these date into useable information and evidence to improve assessments of environmental quality. The tool is accessible through a web site (www.emecodata.net) and was developed using open source web-technologies meaning that it can be operated as a completely open and shared information system. The Datatool allow users to query the EMECO database using the web-based data interrogation tool via the user interface in order to generate data and information in a variety of different outputs. These include specific visual products for assesments; time-series charts and bespoke maps. The assessment map is a unique feature of this application in that it presents information on indicators (for example, chlorophyll concentration, oxygen concentration) specifically in the form required for policy purposes and, in particular, provides an estimate of confidence in the level of the indicator chosen. The application also outputs data for subsequent visualisation in Google Earth and outputs common data formats (XML, CSV) to allow for further post-processing or visualisation in other software packages. All of these outputs are generated "on the fly" i.e. they are not pre-prepared results but are results that arise as a result of a specific query. A full user guide giving details of the data sources and a description of how the tool works is available on the website. Wider uptake of the EMECO Datatool is already taking place within Cefas and it is being further developed as part of an EU Framework 7 programme (Jerico). The spatial domain of the application has been extended to include all the UK waters and now incorporates the ability to map data onto the Charting Progress 2 (CP2) water bodies. EU funding has also allowed the incorporation of satellite and model results. The Datatool was initially developed for improving assessments of eutrophication. Recently completed work funded by Defra set out to demonstrate wider capability. This has been carried out successfully extending capability to provide assessments of marine litter and commercial fisheries (crabs and lobster). This additional work also developed a 'dynamic reporting' capability allows for automatic updating of the assessment which can be published to the web or exported as a pdf file. New work funded by Defra will begin to extend capability across all of the requirements of the Marine Strategy Frameworks Directive that cover all trophic levels, from seabed to sea surface and at multiple spatial scales. As such the EMECO Datatool could provide the basis of a shared assessment and reporting system for all marine policies. This work is ground breaking in that provides a streamlined and efficient method of carrying out the very resource consuming exercise of environmental reporting and as a web based tool it provides a capability for multiple partners to collaborate and co-produce environmental assessment that improve confidence in the findings.

Example of a data management tool from the CSA Oceans consultation

INFORMATION SYSTEMS

Information systems are used to take marine data and provide useful products to users including policy makers. The Copernicus marine monitoring service, for example, provides regular and systematic information on the physical state of oceans and regional seas[21]. Information on currents, wind and sea ice can be used in improve shipping routes, offshore operations and search and rescue. It is designed to be a single interactive online portal which can give multiple types of information from different sources. There are many examples of similar tools in the marine environment, some are very specific in their user base and others aim to encompass multiple users needs.

Open information systems can be used to promote open science as an element of the co-production of knowledge. These systems work on the principle of collecting once and using many times and therefore aim to increase to cost effectiveness of gathering marine data. They also tend to promote transparency when used in generating evidence for policy makers by promoting the decentralisation of science.

POLICY FLEXIBILITY

To make most use of new technologies used to collect, manage or share data there needs to be a certain flexibility in the policies they are used to support. However, changing a policy costs time and money, which is why they are usually designed to be fairly rigid. Despite the costs of changing policies, there is a volume of evidence from economists that suggests that increasing flexibility has led to greater incentives for developing and adopting new technology and may themselves be a stimulator of new businesses and economic growth. While there is still a debate about the cost effectiveness of new policies, there is a wide agreement amongst economists that flexible, incentive-orientated policy approaches are more likely to produce low-cost solutions than prescriptive regulatory approaches (Maler & Vincent, 2005).

The challenge is to understand what technology has the potential to deliver a cost effective solution to management problems and to promote its use to support policy decisions. It could be useful to develop a fast track mechanism to ensure that, when a particularly useful new technology reaches its operational stage, the regulations governing its use have already been developed. The increasing potential to use autonomous vehicles for regulatory marine monitoring is likely to be a test case in the near future, certainly in the UK considerable effort is going into the understanding of the legal regime for the use of marine autonomous systems for both scientific and regulatory purposes.

BIG DATA AND HIGH PERFORMANCE COMPUTING

Big Data is an industry term for an area of scientific endeavour referred to as Data Intensive Science or e-Science. At its heart is the role of high performance computing facilities but the territory goes beyond computing. For example, the US Earth Cube initiative takes the view that we live in an age of observation and simulation. Its contention is that modern science is data and computer intensive and requires multidisciplinary collaborations to address complex question related to major issues facing society. To achieve this goal Earth

EarthCube

EarthCube aims to 'create a well-connected and simple environment to share data and knowledge in an open, transparent, and inclusive manner, thus accelerating our ability to understand and predict the Earth system'.

www.nsf.gov/geo/earthcube/index.jsp

[21] Copernicus European Earth Observation Programme- www.copernicus.eu

Cube takes the view that a unifying architecture needs to be developed that allow Data-Enabled Science based on Networks, Connected Facilities and New Computational Infrastructures. It bases its vision on the Internet paradigm that has lead to a transformation in the modality of science.

VISUALISATION

There has been an explosion in the development of visualisation software and web technologies and at the same time an increase in the societal understanding of visualisations of information and data. Good visualisations and graphics can provide the most universally engaging of outputs. Good visualisations should save time (in acquiring information), provide a means of identifying patterns, improve retention of information, stimulate thinking and further question and provide a means of visually evaluating hypotheses. Ultimately effective and compelling visualisations are better at getting the message across.

Despite this transformation in visualisation capability and broad scale dissemination through mass media and the web there has been little consideration of how to make best use of this new capability to improve the link between science and policy. To leverage the outcomes from this new capability requires bringing together previously unconnected communities in science, design, computation and policy in order to address this challenge. These new capabilities in visualisation are particularly important in the context of the data and with time.

JPI could:

- Foster the development of user-centred design approaches for maximising the impact of research in support of the MSFD
    - By involving end users in the design process to ensure products meet policy end-user need
- Develop guidelines for best practice in representing uncertainly in large multidimensional datasets
- Promote approaches that clarify the diversity of information pathways in order increase the impact and effectiveness of science-policy communication

Propose a workshop to bring together researchers and practitioners across Science, Design, Computer Science and Policy to establish new multidisciplinary research themes

One of the most challenging aspects of a science-policy interface is the way in which it handles uncertainty. Uncertainty comes in many forms and if not properly addressed, can lead to misunderstandings and ultimately poor uptake of scientific advice into policy. The use of visualisation tools has been shown to be effective at reducing uncertainty if used correctly. JPI Oceans could seek to share best practice of communicating uncertainty through capacity building workshops, training or conferences.

DATA SHARING

Data sharing and open access to data was one of the key issues raised in the CSA Oceans consultation. It is an area that is being focused on at the moment. The ambition is to reduce the fragmented approach to data storage to facilitate better data sharing. Initiatives such as EMODnet have been established to provide a focus point for marine data. However, the extent to which EMODnet will meet policy requirements is uncertain at this point. The overlap between ICES and EMODnet and indeed is Copernicus is uncertain. The extent to which EMODnet portals will produce products based on data holding is also unclear. One role for JPI Ocean could be to take ownership of the entire issue from the perspective of what is needed to address its key challenges. To do this effectively, there needs clarity about what decisions are required and what information is needed to address these. Even if the decisions and information needs change, to have a data management infrastructure whose design is driven by the need to address clear questions provides the best chance of providing an infrastructure that is useful. Data

(information) users not data managers should drive the design and, if successful, data management will provide a seamless from of data from those who acquire it to those who use it to create knowledge and better evidence.

Other examples of existing data sharing initiatves that exist were highlighted in the CSA Oceans consultation and are presented below.

Data sharing in the UK

MEDIN

Marine data are held by many organisations in the UK and are collected for many different purposes:

- for the timing of tides to determine the position of submerged obstacles
- about the position of submerged obstacles
- for marine conservation
- to monitor and forecast weather and ocean states
- to site marine structures
- for scientific research to understand marine processes

The Marine Environmental Data and Information Network (MEDIN) promotes sharing of, and improved access to, these data. It is an open partnership and its partners represent government departments, research institutions and private companies.

Marine data are expensive to collect and always unique in relation to time and geographical position. There are wide benefits to be gained from working together to share and properly manage these data.

HOW DATA SHARING IS ACHIEVED

MEDIN aims to provide:

- secure long-term management of marine datasets by setting up a network of Data Archive Centres (DACs)
- improved access to authoritative marine data held in this network, through a central discovery metadata portal
- an agreed set of common standards for metadata, data format and content maintained and supported by partners
- guidelines, contractual clauses and software tools to support standards and best practice data management

HOW MEDIN IS ORGANISED

Governance of MEDIN is through the MEDIN Sponsors Board and the MEDIN Executive Team. The network is funded by a consortium of sixteen sponsoring organisations. There are also MEDIN partners who are not necessarily sponsors but are organisations contributing to the work of MEDIN.

The MEDIN Partners Forum is an annual open partners meeting to review MEDIN activities and

discuss issues of relevance and interest.

Day-to-day operation of MEDIN is performed by the core team, based in Liverpool. MEDIN workstreams are the vehicle by which different tasks and activities are undertaken. Partners get directly involved in the working groups convened under these work streams.

More information on how MEDIN works can be found on our work stream documents page

MEDIN reports directly to the Marine Science Coordination Committee (MSCC)

The current mantra of data management is: 'to collect once and use many times'. An effective data management infrastructure will only achieve this outcome if data gatherers and data users make use of the infrastructure. The design of the infrastructure needs to be driven by clarity about the way in which data will be used and agreement with data collectors on how data and metadata should be made available. The emphasis needs to be on simplicity and efficiency in order to increase the likelihood of wide adoption of good practice in data management.

Example of data sharing from the CSA Oceans consultation

Data sharing in Poland
Institute of Meteorology and Water Management (IMGW) is a unit of the Ministry of the Environment www.mos.gov.pl. It is a state service responsible for provision of data and research related to meteorology, hydrology, oceanology, water management and engineering, quality of water resources, wastewater management and processing of wastewater residues. It performs the marine monitoring as part of the nation-wide state meteorological monitoring, and thus is related to implementation of key policies. IMGW's data access policy to the Polish scientific community is perceived to be restrictive and a barrier for the integration of knowledge. The most important parameters for the marine environment are air pressure, wind speed and direction, wave height and direction, seawater levels, water temperature. High charges for the use of these data inhibit in-depth studies by research units specialising in coastal and marine research. Bi-annual monitoring of near shore seabed from +2 to -6 m datum is carried out by the Maritime Offices. Although still difficult, the access to that data for outsiders is easier in this case.

Example of the challenges of sharing data from the CSA Oceans consultation

Data centre contributing to monitoring: Italy
The MATTM coordinates the national monitoring of waters and coastal marine environment program (PNAMC), aimed at understanding and protection of the sea and marine ecosystems, the identification of the causes of possible situations of degradation and the prevention and combating of pollution. This system has been designed to respond to the WFD (Water Framework Directive). The data are acquired regularly from the regional authorities and provided to the ISPRA National data bank. CNR has set-up a network of in situ buoy stations for research purpose. This buoys provides NRT data of physical and bio-geochemical essential parameters. CNR and other research organisations (OGS, CONISMA, INGV, SZN) acquire in situ observations during scientific cruises as well as using autonomous systems. Each research organisation has its own data managements system. Since at present there is not a National system of data collection and data management, the COI has established a technical Working Group to design a national oceanographic data management system that can constitute the Italian contribution to the IOC IODE Program. The Italian NODC will be a distributed system integrating the existing data banks actually present in the different organisations. No funds are actually available for NODC development. Nevertheless, Italian research organisations are participating to the European data infrastructures (eg. SeaDataNet, MyOcean) so part of the Italian oceanographic data are now through these European

infrastructures.

Example of a data centre involved in monitoring for the CSA Oceans consultation

DATA AVAILABILITY

One of the most consistent complaints amongst stakeholders was the lack of free access to data. Subsequent studies into this problem have found that there are several initiatives that exist to provide free access to data, such as EMODnet. However, it may be that these initiatives are not fully supported and this is an area that JPI Oceans could act to support. It is important to consider that data may be available but not usable; it could also be that while it is available, it is not freely available online.

MAPPING DATA PROVIDERS

To start it is useful to map the data providers in Europe. JPI Oceans could build on the work done by programmes such as EuroGOOS and Jerico, which is compiling a comprehensive panEuropean picture of data acquisition. The CSA Oceans consultation prompted some stakeholders to provide examples of initiatives such as the Romanian MARINEGEOHAZARDS which supplies data and information relating to water mass monitoring and seismic movements in the western Black Sea.

The need for shared information in order to address global problems was recognised at the Works Summit for Sustainable Development and lead to the formation of the Group on Earth Observations and the development of the Global Earth Observation System of Systems. Although paving the way to achieve an integrated system they don not adequately integrate biophysical and socioeconomic data.

STANDARDS

There are many issues with using science in support of policy. There is what can be described as a language barrier between the two communities; fundamentally this language barrier isn't about words, it is about the understanding of what science is. Typically, science used to support policy needs to be adapted to meet the requirements of policy makers, as shown in the ICES case study. However, whereas the CFP has evolved to require specific technical information, policies such as the MSFD are vague in their requirements of science to be used.

British Oceanographic Data Centre

BODC processes, archives and distributes biological, chemical, physical and geophysical marine data. It has several national and international roles. At an international level, BODC is one of over 60 national oceanographic data centres that form part of the IOC's network of data centres through its International Oceanographic Data and Information Exchange (IODE) committee. It also has an active role in the ICES Working Group on Marine Data Management.

www.bodc.ac.uk

It was suggested by some stakeholders that JPI Oceans could support attempts to standardise the way in which science is used to support policy. Very specific recommendations were made, such as standardising the measurements of water properties across Europe. The problem with standardising data is that there are so many researchers working in different environments, with different equipment, and different procedures to suit the research requirements, it is almost impossible to impose requirements from the top down without hampering the science. An alternative option is to encourage the use of data centres. Data centres, such as the British Oceanographic Data Centre, collect, store and distribute data. The advantage of this approach is that while it does not add significantly to the workload of scientists, a vast amount of data can be easily accessed and used for future scientific work or to support policy. If this is something that JPI Oceans were to support at a European

level, it should first identify the European equivalents of BODC, such as EMODnet and SeaDataNet, and then explore ways in which it could add value through its multilateral actions.

VIRTUAL SERVICES

Carrying out formal environmental assessments, for example the UKs Charting Progress 2 (CP2)[22], is resource intensive and time consuming. Assessments must be based on sound scientific evidence that has to be able to withstand legal scrutiny. The evidence requires a wide range of data and information with the final products based on analysis and interpretation by designated groups of expert. The CP2 set out to demonstrate the extent to which the UK achieved its vision of clean, safe, healthy, biologically diverse and productive seas and oceans, and is therefore similar in scope to the MSFD. The range of evidence required was enormous; from physics to fish and seabirds and at multiple spatial and temporal scales. The CP2 report formed the basis of the UKs initial assessment of GES; despite wide ranging evidence requirements, the process of assessment for the different aspects (e.g plankton, sea birds, ocean processes) are broadly similar. This includes acquiring data and information, filtering and turning the data and information into evidence that can be assessed to determine environmental status. In many cases key parts of this process were carried out in an *ad hoc* manner with individual scientists and institutions supplying information products for use in the assessment. The result is a highly heterogenous set of inputs that requires considerable effort to synthesise into a finished assessment and report. For example, it is difficult and time consuming to compare and synthesise information from climatologies supplied by different scientists for the same parameter when different methods (algorithms) are applied. This lack of a common workflow leads to inefficiencies and potential weakening of the evidence base for assessments.

To address some of these issues, the UK is developing a different approach (*Mills et al.*, 2011) based on the use of web technologies – an online data integration and environmental assessment system. In this approach, key parts of the assessment are carried out using data and the tools that reside in the cloud and can then be accessed through any web browser. The tools include the means to integrate different data sources, analyse and visualise the data as well as a reporting capability with outputs formatted as required for formal reporting purposes. There are a number of advantages to this streamlined approach. It provides an enduring and dynamic link between the data and the assessment products. Changes to the data are automatically reflected in the assessment products (e.g. tables, values of indicators, maps). As a web enabled assessment tool it can be shared across and between national and European institutes providing a working environment for co-production of assessments. Common workflows for analytical procedures can reduce the number of steps to process data and provide standard and inter-comparable products. Analytical procedures can be agreed nationally or regionally to promote confidence in the information. Scalability provides another advantage with the potential for providing a shared and collaborative capability, for example at the scale of the North Sea, where bordering states can have a common tool for the regional scale assessment required by the MSFD. Such an approach is timely as there is a growing need to demonstrate collaboration and coherence between Member States in assessments of environmental assessment.

[22] Available online at: http://chartingprogress.defra.gov.uk/

SCIENCE-POLICY INTERFACES

COMMUNICATION PLAN & FRAMEWORK

Many frameworks, guidelines and plans exist as an attempt to standardise or at least create a structure of what is needed for a science-policy interface.

JPI Oceans could promote the underlying principles of these plans, such as good stakeholder participation, and facilitate the sharing of best practice between organisations. This could be in the form of capacity building workshops, training or conferences. Identifying different arrangements is a first step in targeting areas that could benefit from capacity building that promotes an ecosystem approach. The CSA Oceans consultation identified specific national mechanisms that could be further investigated, these include:

Finland- National
Prime Minister's Office organises 2-4 times/year meetings for marine and maritime stakeholders (governmental offices, NGOs and business and trade organisations). The meetings are to inform and discuss about national comments on EU initiatives.
Romania- National
Each issue that requests specific expertise that can be provided only by researchers is requested by Ministries. As an example, monitoring of Black Sea level (as well as other parameters) is performed in Romania by National R&D Institute for Marine Sciences "Grigore Antipa" from Constanta. Ministry of Environments provide financial resources to this institute for receiving "up to date" information on this issue. Data regarding air quality (low level) are provided by National Agency for Environment Protection (ANPM) on regular basis.
Portugal- National
Through a governmental body (Portuguese Institute for the Sea and Atmosphere – IPMA; web link: https://www.ipma.pt/en/index.html), which is part of the central administration, and is responsible for producing political and technical advice and environment monitoring. Councils' remit to: • Advise on FCT's strategic plans for research, training and knowledge exchange, in order to increase Portugal's scientific competitiveness; • Advise FCT on building a multidisciplinary research community and supporting internationally competitive science in Portugal; Provide an appropriate environment for testing new ideas.
Norway- National
Environment.no: The Web site - State of the Environment Norway - aims to provide you with the latest information about the state and development of the environment. The service presents environmental topics in a simple and easy-to-follow way and provides access to more detailed

scientific presentations. On most of the pages you will also find further information about legislation and international agreements, environmental targets, references and relevant links. In addition you may download the latest datasets.
Denmark- National
Advisory services are given under 4 year rolling contracts by the Ministry of Food, Agriculture and Fisheries to the Technical University of Demark and by the Ministry of the Environment to the University of Aarhus. As of 2007, all relevant sector research institutes, with the exception of the Danish Meteorological Institute and the Geological Survey of Denmark and Greenland, both under the Ministry of Climate, Energy and Building, have been integrated into universities.
Portugal- International
The participation of the national funding agencies in European or international science-to-policy organisations or Committees as European Science Foundation (ESF), Science Europe (SE), European Cooperation in Science and Technology (COST) and Joint Research Centre (JRC).
UK-National
The LWEC Knowledge Exchange Guidelines are a good example of an organisations attempt to codify the science into policy process (LWEC, 2012). These guidelines are illustrated by case studies at each stage of the knowledge transfer process.

RECOGNISING SCIENCE FOR POLICY

While it is widely accepted that scientists should be involved in policy decisions, the traditional assessment tools used to evaluate scientists do not take this role into account.

JPI Oceans could help to develop a new method of assessment or accreditation that takes into account a research institutes contribution to society. It is important to stress that this approach should not undermine the value of blue-sky research, indeed such research benefits society in many ways in the short and long term. What is important is to ensure that scientists are recognised in a balanced way that recognises both the excellence of their research and their contributions to society. JPI Oceans could also look at the differences between public research organisations and universities to see how they interact with society at large.

There are already examples of how researchers are recognised for their contributions to policy and society. Some of these were highlighted in the CSA stakeholder consultation and are given below:

Co-production of science with policy use in mind
The Norwegian Environment Agency gets its allocation letter (with yearly funding and guidelines) from Ministry of the Environment. Norwegian Environment Agency is the competent authority for nature management and pollution control, and engage research institutes (e.g. NIVA, IMR, NINA) for carrying out tasks on monitoring, assessment and scientific advice. On the background of the allocation letter the Research institute produce scientifically based advice either on basis of existing research or in the case there are no relevant research, starts a new research projects. The research institute reports back to the ministry in yearly meetings, or through written reports.
Use of Consultants in Belgium
For the Marine Spatial Planning, the preliminary draft MSP has been drafted by Grontmij, a consultancy office having a lot of experience as regards spatial planning. This office has, in close cooperation with the advisor of the Minister and members of DG Environment, collected and managed the relevant existing data (national reports, scientific publications etc.). These data have been complemented by the data stemming from informal and formal consultation rounds with competent authorities and stakeholders. This public tender has been financed on the budget of the (federal) DG Environment. In parallel, a Strategic Environmental Report is developed, commissioned and funded by the (federal) DG Environment . The writer of that Report is Arcadis. Arcadis, in close cooperation with the advisor of the Minister and members of DG Environment, has collected and managed the relevant existing data (national reports, scientific publications etc.). These data have been complemented via contacts with competent authorities and stakeholders.

EDUCATION

One of the most pressing issues related to the interface between scientists and policy makers lies in the language used to communicate across the gap. It is a topic that is commonly observed yet little reported on in the literature. Sources that have discussed the idea have suggested that scientists are sometimes unaware of what policy makers require, particularly relating to scientific uncertainty (Holmes and Savgård, 2008). Conversely, policy makers, who are unfamiliar with scientific terminology, are accused of not asking the right questions. It has been suggested that there is a need for knowledge brokers to bridge science-policy interface (Holmes and Clark, 2008). These interpreters would describe the policy implications of new findings to policy makers, communicate the research priorities of policy makers to scientists, and provide an overview of the scientific consensus on relevant topics with information on uncertainties and unknowns (Holmes and Clark, 2008). Holmes & Clark (2008) proposed six attributes that knowledge brokers need to be successful:

1. A background in natural science to understand the scientific process and be able to communicate with researchers;
2. Good communication skills to engage with different audiences;
3. Good inter-personal skills to form networks with different stakeholders;
4. Expirience of policy making to understand how decisions are made;
5. Awareness of the bigger picture to see how issues are connected and to understand differnet perspectives of an issue;
6. Good judgement to make informed decisions on the basis of good evidence.

A network of researchers, intermediaries and policy makers could be used to promote

interdisciplinary knowledge transfer and cooperation (Holmes and Savgård, 2008). The European Research Area Board has already identified the need to support pan-European graduate and research schools to promote the mobility of researchers (Makarow, 2010).

One of the challenges facing students who would pursue a career in an interdisciplinary field is that there are few recognised career systems to enter into, even within universities (Clark *et al*, 2011). As a result of this, Clark et al argue that there is no consensus on the value of interdisciplinary research programmes, and that individuals are often forced to create their own career advancement.

NERC Policy Internship

NERC, in collaboration with the Biotechnology & Biological Sciences Research Council (BBSRC) and the Arts & Humanities Research Council (AHRC), organise internship placements for current NERC, BBSRC and AHRC funded PhD students to work in one of eight host organisations on a policy topic relevant to both the student and the host. The students are be expected to produce a briefing paper, participate in a policy inquiry and/or organise a policy event. The eight host organisations include three parliamentary organisations and five non-parliamentary organisations.

During their placement, interns work on an area of policy by contributing to one or more of the following activities:

- producing a policy briefing or contributing to a longer report
- participating in a policy inquiry
- researching, developing and organising a policy event or workshop
- any other related activities.

www.nerc.ac.uk/funding/available/postgrad/advanced/policy-interns

An understanding of how marine policy is formed is not usually a part of scientific degrees. The report *Navigating the Future IV* considers the introduction of socio-economics, policy and law a major challenge for degrees in marine sciences (EMB, 2013). While it is necessary to introduce students to this aspect of the application of science, it should not undermine the scientific content of their studies. In a report published in 2010, the Royal Society found that 53% of scientific related PhD graduates immediately started careers outside of a research; this figure increases to 80% after several years (The Royal Society, 2010). This may not be representative with students in the marine field, but it highlights the need to equip students with the tools to operate outside of a research environment.

Further consideration of human capacity building for science/policy interfaces is contained in the CSA Deliverable 6.2 (Coroner *et al.,* 2014).

OCEAN LITERACY

Environmental policy decisions must ultimately be supported by society as a whole. As such, the public should also understand the scientific evidence used to support decision-making. There are many projects that exist to promote ocean literacy in the marine environment which use different tools to educate the public in marine science such as popular science magazines, television programmes and citizen science projects.

There have been many attempts to measure public awareness of marine issues in different countries. These range from assessing the effectiveness of a single organisation (Fletcher *et al.,*

2009) to the awareness of a whole country (Steel *et al.,* 2009). These assessments unusually aim to assess the understanding of different terms or concepts that could be considered as descriptors. However, because each project is designed for a specific purpose, they are not easily comparable and could therefore not be used to make a comprehensive assessment of ocean literacy levels. These assessments are also usually designed as a one off, and as such there has been no real effort to create a long-term dataset. It may be useful to develop a standardised toolkit that could be used to assess ocean literacy. This is not to say that every researcher should use the same questionnaire for example, but that could be a single entity which tries to establish common practices which could be used to establish a long term dataset. It may also create a single data centre that holds the results of different studies and would allow researcher to develop methodologies to compare existing datasets.

JPI OCEANS AND THE MSFD

From the first analyses of stakeholder and research funding agencies' input, it is clear that the MSFD could play an important role in the JPI Oceans Strategic Research and Innovation Agenda (SRIA) for the coming years, as several Research Funding Agencies, international research organisations and Regional Sea Conventions' Secretariats have highlighted the need for more concerted action on environmental quality assessment, following compatible scientific principles, also in relation to the MSFD.

With 28 MS, of which 23 have marine areas, there is likely to be significant differences in the requirements for science. Nevertheless, each MS sits within and shares one or more marine (sub) regions and is explicitly required by the Directive to both determine GES at the level of the marine (sub) region and to work with neighbouring MS and third countries in order to implement the Directive and ensure the coordinated development of marine strategies for each marine region or sub region and achieve GES (see Deliverable 5.1, Redd *et al.*, 2013).

In the implementation of the MSFD, not only is the CIS, established by the EC and Member States (see Deliverable 5.1, Redd *et al.*, 2013), of major importance, but also the Regional Sea Conventions (RSC). The MSFD stipulates that 'where practical and appropriate' the RSCs should be used to ensure coordination among MS and with third countries in the development of marine strategies. At the same time, the MSFD should contribute to the fulfilment of the obligations and important commitments of the EU and/or its MS' under the RSCs (von Homeyer et al., 2013).

In substantive terms the RSCs can support the implementation of the MSFD in at least three main ways: by improving regional and cross-regional coherence of national implementation; by making the RSCs' long-standing experience and established structures for cooperation available to increase the efficiency and effectiveness of national implementation; and by offering practical opportunities for the mobilisation and coordination of relevant third countries' activities (von Homeyer et al., 2013).

Despite the achieved positive aspects and recognised significant progress, reports published in February 2014 by the European Commission on the first phase of the implementation of the MSFD also paint a worrying picture (EC, 2014b):

- The initial assessment reports often give only a fragmented overview of the state of the marine environment, not always reflecting the available knowledge in its entirety.
- Another general concern is the lack of consistency in MS implementation. In particular the logical link between the initial assessment (the point of departure), the determination of GES (the final objective) and the targets (the effort needed to reach the objective, starting from the point of departure) has not been recognised by all.
- Significant commitments were made by all RSCs to implement the ecosystem approach and support MSFD implementation. Unfortunately, MS' use of the results of regional cooperation within their marine strategies varies. Sometimes, the relevant work developed under RSCs came too late, but when it was on time, it has not always been used in national reports. This has resulted in a lack of coherence within the EU, and also within the same marine region or subregion.

Thus, there is no shared EU understanding of GES, even at a (sub-)regional level. There are over 20 different GES determinations across the EU, and therefore no common or comparable goals (EC, 2014b).

The analysis of the first phase of implementation of the MSFD clearly shows that much more progress needs to be made to avoid an insufficient, inefficient, piecemeal and unnecessarily costly approach to the protection of the marine environment. It will also deprive economic operators of a level playing field across the EU and its marine regions. It jeopardises an important resource base, without which Blue Growth will not be sustainable in the long term (EC, 2014b).

For the EC, it is necessary to imply "renewed and intensified efforts and rapid and important change in the way MS, the European Commission, RSCs and other relevant organisations work together, focusing on joint action and planning, as well as policy coherence across sectors".

JPI Oceans could have a role in maximising the potential of the RSCs and the involvement of MS' research organisations within them.

As briefly explained in chapter 4, the EC DG ENV commissioned a study of the particular needs of the RSCs in relation to the MSFD. This is used as a background to identify needs where JPI Oceans could potentially also contribute. Support needs to consider both scientific knowledge gaps and more technical issues relating to the implementation of measures and monitoring.
Concerning general cross-cutting issues, the RSC and MS stakeholders identified a need

- to coordinate activities and exchange information relating to the definition of GES. In particular, there is a lack of expertise regarding the development of coherent and concrete indicators with GES boundaries and associated monitoring. More support for modelling could enable the adoption of common targets in some areas. This need particularly concerns capacity-building for project management at the regional level and specific research projects.
- to streamline the methodological approaches in determining GES by descriptors, criteria and/or indicators at the regional level that also reflect transboundary impacts. The criteria should include background concentrations, reference conditions and threshold values for the individual substantive monitoring elements. This will be important for the year 2014-2015.
- to develop a regional understanding of the ecosystem approach and further focus on integration, analysis of interlinkages, cumulative pressures and scientific links between the different indicators and targets of the different definitions of GES. The purpose is to ensure both cost-effectiveness and scientific accountability.
- to improve monitoring through coordinated use of novel observation tools and coordination of data-collection on sources, inputs and environmental status.
- for consultancy and technical support to improve coordination and data sharing. Available information systems have to be integrated/updated to respond to new requirements for data analysis, storage and reporting of assessments.
- for creating a platform for information exchange on a continuous basis, also between RSCs, e.g. on science and research needs and exchange of expertise and knowledge related to the implementation of MSFD requirements.
- to develop a well-functioning and transparent website to establish a good and accurate information-basis on currently implemented practices of indicators, assessments and targets for both the policy and scientific communities. The concept paper on the Competence Centre on MSFD of JRC and the proposed SPI mechanism for MSFD of STAGES mentioned this already.
- to better share the workload both vertically (among national, EU and regional levels) and horizontally (among RSCs and other organisations, such as ICES and JPI Oceans) to ensure communication between the policy, science and research funding bodies.
- to improve the coordination of on-going and future EU funded research projects (Horizon 2020 etc.). Project results must be integrated more effectively into the work of the RSCs.
- to support the development of a more strategic process which accompanies the implementation of the MSFD but is less constrained by the need to meet MSFD

implementation deadlines.

The following priority needs for each RSC relating to a European sea were identified by the study commissioned by the EC DG ENV, taking into account the analysis and assessment of stakeholder opinions and on the basis of the relevance for MSFD implementation. For each headline priority need (= bullet point below) a number of more specific needs are identified. For each specific need one or more support options are proposed, that can be found in von Homeyer *et al.*, 2013, together with the specific research gaps for each RSC.

Sixteen – that is significantly more than half of the total number of priority support options – concern the field of integrated monitoring and assessment. Data collection and reporting are clearly the second largest area, comprising almost a third of the total number of options. Only two priority support options fall within the development of regional programmes of measures (von Homeyer *et al.*, 2013).

Black Sea Commission (BSC)

- Development of a regional integrated assessment and monitoring programme (potential co-design opportunity with the JPI Oceans community);
- Development of an integrated structure for reporting;
- Definition of regional environmental targets and GES (potential co-design opportunity with the JPI Oceans community);
- Regionally coordinated data collection and information exchange (potential co-design opportunity with the JPI Oceans community);
- Development of a coordinated research programme (clear role within the JPI Oceans community).

The BSC stakeholders identified a general need for support for the research topics identified in the Black Sea Strategic Research Agenda of the SEAS ERA (Tübitak, 2012). The priorities could be considered at the regional, national and the EU level.
The RSC stakeholders identified a need to improve coordination of research. The documents should be examined by research funders who need to establish practices for "common programming" and "joint calls" (von Homeyer *et al.*, 2013).

Baltic Marine Environment Protection Commission (HELCOM)

- Revision of joint monitoring and assessment (potential co-design opportunity with the JPI Oceans community);
- Development of additional common indicators and targets (potential co-design opportunity with the JPI Oceans community);
- Joint Programme of Measures;
- Enhancing information systems and accessibility (potential co-design opportunity with the JPI Oceans community);
- Research to close knowledge gaps (clear role within the JPI Oceans community only in case it would not possible to cover within the BONUS set-up).

Within HELCOM headline priority needs, priority substantive environmental issues and pressures are covered. The selection of environmental issues is:

- Biodiversity
- Marine litter
- The impacts of shipping

While eutrophication is probably the most important underlying environmental problem in the Baltic Sea, HELCOM has long-standing experience in this area which may render HELCOM activities less dependent on additional external support projects in the specific context of MSFD implementation (von Homeyer *et al.*, 2013). However, this may be valuable experience that other RSCs and their scientific community may learn from to implement in a similar way in other regions in Europe, like in the North Sea and the Black Sea, potentially through JPI Oceans in connection to cross-cutting eutrophication, atmospheric pollution, ocean acidification and

climate change research.

OSPAR Commission on the protection of the marine environment of the North-East Atlantic (OSPAR)

- Development of a regional integrated assessment and monitoring programme (potential co-design opportunity with JPI Oceans community);
- Development of OSPAR common indicators;
- Supporting the coherent determination of GES (potential co-design opportunity with JPI Oceans community);
- Regionally coordinated data and information reporting (potential co-design opportunity with JPI Oceans community);
- Developing agreement on common policy requirements and opportunities for coordination in the development of measures.

The development of common targets is not explicitly included as a separate activity in this list. There are two main reasons for this: first, with the exception of large scale and transboundary issues, local and national targets may be sufficient given properly defined GES and the availability of common indicators. This constrains the role of the RSCs. Second, OSPAR follows a "bottom-up" approach which reflects the complexity of the North East Atlantic as a region. This limits OSPAR's capacity to develop targets ensuring (sub-) regional coherence (von Homeyer *et al.*, 2013). In case a significant critical mass of scientific expertise is organised to facilitate more scientific consensus on specific MSFD issues, potentially facilitated by JPI Oceans, this may have a positive effect on the "bottom-up" coherence building within OSPAR.

There is also a relationship with the more scientific work undertaken by the various working groups in ICES and a two-way exchange of information between ICES and OSPAR which often facilitates the work in OSPAR. How ICES works is described in the regional case study on ICES.

Within the OSPAR headline priority needs, the following priority substantive environmental issues were selected:

- Biodiversity;
- Marine litter;
- Impacts of shipping and off-shore industries, in particular underwater noise.

UNEP Mediterranean Action Plan (MAP)

- Development and implementation of an integrated and targeted monitoring programme (potential co-design opportunity with JPI Oceans community);
- Support regarding data collection, reporting and information systems (potential co-design opportunity with JPI Oceans community);
- Specification of GES, targets and environmental objectives (potential co-design opportunity with JPI Oceans community);
- Development of a coordinated research programme (clear role within the JPI Oceans community).

Regarding specific environmental issues, there are generally two types of areas. First, areas where a significant body of data/knowledge is already available, such as for example regarding hazardous substances, nutrients and many aspects of biodiversity. In these areas the main support needs to relate to sharing of good practice and experience, development of common methods, quantification of targets and specification of monitoring requirements and assessment of impacts, in particular cumulative impacts (von Homeyer *et al.*, 2013).

Regarding the second area, including marine litter, noise and certain economic activities, such as fishing and shipping, very little knowledge and data are available. The main issues relate to the development of common research projects and a common regional work programme to address gaps in data/knowledge, co-ordinated development of monitoring programmes and provision of baseline information through data-gathering and investigative monitoring are key issues (von Homeyer *et al.*, 2013).

The fragmentation of responsibilities and additional complexity with the non-EU members in the Mediterranean, will require substantial additional calibration work in relation to the study of von Homeyer *et al.*, 2013 in order to define where cooperation with JPI Oceans would be most helpful and efficient, as there is definitely a vast area of possibilities.

In order to steer some further development of potential areas of cooperation between JPI Oceans and the Regional Sea Conventions on the MSFD, the following time schedules have been added from von Homeyer et al., 2013. Highlights in yellow indicate the areas where potential co-design opportunities may have to be taken into account for the SRIA and the implementation plan of JPI Oceans. Still, this time framework for actions focuses on the next steps in implementing the MSFD (timing/MSFD requirements) as outlined in the Directive itself or the CIS draft work programme in the short term, prioritising 'critical' gaps which, if not addressed, would prevent or seriously hinder implementation of subsequent MSFD steps. For consideration of any longer-term cooperation with JPI Oceans, this timeline should be extended.

One of the clear messages from the CSA Oceans consultation was that there is a potential role for JPI Oceans as a forum to enhance cooperation and knowledge sharing and best practice between the RSC

INTEGRATED MONITORING AND ASSESSMENT	2014				2015				2016				2017				2018			
quarter year	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
WP1: Extending/improving integrated monitoring and assessment																				
Task 1.1: System review and design																				
Establishment of an integrated monitoring and assessment system; BSC3																				
Assessing and monitoring wider biodiversity status; OSP1																				
Exchange of information with other RSCs; BSC1																				
Support and capacity building in third countries; MAP3																				
Task 1.2: Harmonised monitoring of loads and pressures; HEL3																				
WP2: Targets and indicators																				
Task 2.1: Developing targets																				
Development of additional regional targets; HEL7 (addressed in BONUS?)																				
Enhanced cooperation among CPs for joint GES and target setting; BSC11																				
Task 2.2: Developing indicators																				
Development of additional regional pressure and state indicators; HEL9 (addressed in BONUS?)																				
Definition of threshold values, reference conditions, GES; MAP9																				
Potential common HELCOM/OSPAR indicators; OSP9																				
WP3: Data gathering and assessment methods																				
Task 3.1: Improvement of common data gathering methods																				
Joint sampling, analysis, data storage and quality assurance methods; HEL1																				
Updating and streamlining of data collection methodologies; MAP7																				
Improving the comparability of collected data; BSC16																				
Task 3.2: Improving assessment of cumulative impacts; MAP5																				
Task 3.3: Socio-economic assessment of impacts and measures																				
Assessment methods for socio-economic impacts of marine litter; OSP2																				
Enabling MSFD compatible socio-economic assessment ; MAP6																				

Member State MSFD milestones:	July: monitoring programme								By 2015: PoM established				By 2016: entry into operation of PoM				July: draft rev. IA, GES, targets				July: rev. IA, GES, targets			
Regional Seas Convention MSFD milestones (source: draft CIS workplan of June 2013)	July: Joint (coordinated) monitoring																July: rev. regional initial assessment, GES, targets			

DATA COLLECTION AND REPORTING	2014				2015				2016				2017				2018			
quarter year	***4,1***	*2*	*3*	*4*	***5,1***	*2*	*3*	*4*	***6,1***	*2*	*3*	*4*	***7,1***	*2*	*3*	*4*	***8,1***	*2*	*3*	*4*
WP1: Developing regional 'roof reports'																				
Strengthening of reporting at the HELCOM regional level, HEL6																				
Support for production of OSPAR 'roof reports'; OSP15																				
Support for drafting of BSC monitoring and PoM 'roof reports'; BSC4																				
WP2: Adaptation of data sharing platforms to new requirements																				
Adaptation of common data sharing platforms (MEDPOL); MAP8																				
Modernisation and operationalisation of OSPAR online data bases; OSP12																				
Improve data systems to make regional data more easily available; HEL13																				
Improvement of data coordination and sharing; BSC15																				
WP3: Support to develop and apply new data collection tools																				
Support for using ferry boxes, moorings, airborne surveillance etc, MAP4																				
PROJECT 3: DEVELOPING REGIONAL POMS																				
Supporting development of a HELCOM joint PoM; HEL12																				
Clarifying and supporting OSPAR contribution to PoMs; OSP17																				

Member State MSFD milestones:	July: monitoring programme				July: draft rev. IA, GES, targets	July: rev. IA, GES, targets
		By 2015: PoM established	By 2016: entry into operation of PoM			

Regional Seas Convention MSFD milestones (source: draft CIS workplan of June 2013):	July: Joint (coordinated) monitoring			July: rev. regional initial assessment, GES, targets	
Early 2014: Regional GES criteria	Late 2014: input rev. GES Decision; agreement data sharing EU/EEA etc	By 2015: Joint (coordinated) PoM	By 2016: agree data flows and needs for rev. initial assessment		

In relation to science-policy interface views were exchanged between the CSA Oceans WP5/JPI Oceans Secretariat and the STAGES project consortium concerning the development of a proposal for an effective European science-policy platform to support implementation of the MSFD.

The first analyses of the JPI Oceans stakeholder and research funding agencies' consultation formed a good basis to provide the following reflections in relation to the four key components of an effective SPI platform for the MSFD as proposed by STAGES:

- "Harnessing MSFD-relevant knowledge": In addition to its role as a strategic coordinator of joint research, JPI Oceans could, in the longer term, potentially act as a conduit for National research into the MSFD SPI.
- "Scientific and Technical Advice": The JPI member organisations may be well placed to signpost experts. JPI Oceans might also provide a mechanism to address gaps in knowledge or evidence through coordinated research actions, enhance awareness of research activities already underway and help facilitate efforts needed to transfer or translate research results into useful policy advice.
- "Expert Evaluation and Synthesis of Scientific Knowledge": In the short-term, JPI Oceans could act in a coordinating role for National research funding agencies, to disseminate research needs and knowledge gaps as identified through the SPI. National funding agencies could take forward information on MSFD knowledge gaps to inform National Research Agendas and to form coherent approaches to addressing MSFD research needs.
- "Knowledge Brokerage": some role for JPI Oceans would probably be quite specific and limited.

In order to emphasise that science-policy interface is a two-way mechanism, co-design of specific research projects or monitoring programmes could be an optimal way forward. Exchange between JPI Oceans and the PCG and/or MSCG is also indispensable to ensure that research results are provided at the right time to influence the MSFD programs of measures and to clarify where additional efforts in stronger regional cooperation and exchange of scientific practice are most needed. Sufficient attention should also be paid to incentives for scientists to be engaged closely in policy implementation or development.

As JPI Oceans aims to address societal challenges in relation to different European and international policies, it is important to emphasise that any SPI mechanism needs to reflect or be compatible with integration of information across disciplines, policies and the scientific, policy and industry community and needs to develop synergies between different organisations involved in different policies.

9 POTENTIAL ROLES OF JPI OCEANS

The Coordinated and Support Action, CSA Oceans, conducted an extensive stakeholder consultation during 2013. It attempted to identify existing activities and what the JPI could do to add value. The science-policy aspect of this consultation was reported in the first deliverable of this Work Package (Redd *et al.* 2014). In this section we discuss what JPI Oceans could do to support effective science-policy mechanisms by discussing the stakeholder recommendations. We also look at how JPI Oceans can act, to support science-policy in its actions.

JOINT PROGRAMMING

The concept of Joint Programming is essentially multilateralism, multiple countries working on a specific issue. The European Commission proposed specific Joint Programming Initiatives to align individual national research funding, which account for 85% of public research funding in Europe, to address common challenges (EC, 2008).

To understand how research conducted under Joint Programming can be best used for societal benefit, it is useful to look at existing multilateral research programmes. One such programme is the G8 Research Councils Initiative on Multilateral Research Funding, which is a coordinated effort to support multilateral research partnerships. The initiative is supported by the Natural Sciences and Engineering Research Council of Canada (NSERC), the French National Research Agency (ANR), the German Research Foundation (DFG), the Japan Society for the Promotion of Science (JSPS), the Russian Foundation for Basic Research (RFBR), the Research Councils of the United Kingdom (RCUK), and the U.S. National Science Foundation (NSF). Another example of an international collaboration project is the Belmont Forum which is a a high level group of the world's major and emerging funders of global environmental change research and international science councils. It was co-founded by NERC and the National Science Foundation (US) in 2009.

Research proposals made to the G8 Initiative must satisfy four criteria, listed in detail in Annex I. The second criteria point focuses on expected impacts of the work and how it will engage with research users be that policy makers, society, industry or something else. The proposal must also demonstrate that the collaboration focuses on global challenges for which solutions can only be achieved by global scientific approaches (NSERC, 2012). It is likely that JPI Oceans will need to set similar criteria for research carried out by its members and it would be beneficial to learn from similar approaches on how to ensure that the multilateral research achieves maximum relevance.

COOPERATION AND COORDINATION

By its nature, JPI Oceans will be a coordination platform in which multiple Member States cooperate on projects. National funding agencies usually require researchers to demonstrate the potential implications and applications of their findings in line with specific societal needs.

The principles of co-design were highlighted in the CSA consultation. It was found that it is important engage with the scientific community early to develop and test the practical application of policy measures against expectations. There is a need to recognise the costs to member states and to find ways to offset these. Opportunities to co-design programmes and jointly identify and address research needs, at the outset, should be taken and opportunities to use novel technologies to gain new insights or to collect data in new and more cost effective ways should be considered.

TRANS-BOUNDARY AND INTERNATIONAL COOPERATION

One of the messages drawn from the CSA Oceans consultation was the lack of focus for marine activities in Europe. One recommendation suggested that JPI Oceans could act as a focal point for international collaboration on certain topics. As a coordinator, JPI could provide a forum for existing projects working in the same area to come together to work on collaborative projects with countries outside of the EU. This is important for European policies, such as the MSFD in the Mediterranean, where Member States need to work with non-members to achieve environmental objective.

While JPI Oceans could act as a coordinator on an international level, it is unclear how it could provide a single voice for marine areas in Europe.

AVOIDING DUPLICATION

One of the underlying principles of JPI Oceans is that it should not duplicate what is already being done. To do this, the first stage of any action by JPI Oceans will be to understand the landscape. As JPI Oceans operates on the principle of variable geometry, actions will naturally draw interested parties who have an understanding of the existing landscape.

STRATEGIC PRIORITIES OF JPI OCEANS

On July 1 2014, the Strategic Advisory Board (StAB) of JPI Oceans met to discuss the strategic priorities for JPI Oceans. The Board reviewed a list of topics derived from the stakeholder consultations to draw up a recommended list of areas in which they believe JPI Oceans can add value. The strategic priorities are still subject to discussion and agreement by the Management Board. However, for the purpose of focusing on specific actions for JPI Oceans, these ten topics are addressed below.

Any activities carried out by JPI Oceans should be in line with the principle of variable geometry and with the intention of doing more than Member States can do individually. As with anything JPI Oceans attempts, the most important first step is to find out who is involved, what is being done and where the gaps are. In this section we explore how JPI Oceans could enhance the science-policy mechanisms for each of the strategic priorities without duplicating existing activities.

JPI OCEANS PILOT ACTIONS

JPI Oceans has developed a series of pilot actions which aim to test new instruments for cooperation and coordination. These actions are small-scale trials or test cases, limited in time and scope. While they are not based on recommendations from the stakeholder consultation, they clearly fit into areas where both the stakeholders and the StAB have set strategic priorities.

The current pilot actions were proposed and selected by the JPI Oceans Management Board and evaluated upon by the Strategic Advisory Board. The selection and evaluation was done based on a set of defined criteria (Annex II). These were agreed upon to provide a tool for assessing the relevance and maturity of proposed pilot actions prior to taking them forward in the direction of implementation.

1 SUSTAINABLE MANAGEMENT OF DEEP-SEA RESOURCES AND ECOSYSTEMS

Technological developments and a rising cost in traditional resource exploitation is making the deep sea an ever more attractive area for industrial development. However, the deep sea remains relatively unexplored and contains complex and untouched ecosystems and habitats.

The idea of harvesting deep-sea resources is not new; it is also true to say that discussions about management and concerns over the impact of activities has a long history. The phrase deep-sea resource is often used as an umbrella term that is very broad and complex in nature. Firstly, the resources can be split into living and non-living and can exist in the water column, generally below the photic zone, they can exist on the seabed or beneath it. Secondly, the deep-sea can be found in a range of legislative regimes from territorial seas, to EEZs and the High Seas (UN, 1982). There are therefore a large number of management structures to deal with the different combinations of resource location and legislative regime; in some cases there is a large degree of ambiguity as to who is responsible for the management.

Pilot Action: Ecological Aspects of Deep-Sea Mining

A pilot action to investigate the ecological aspects of deep-sea mining was proposed to the JPI Oceans Management Board in 2013. The aim of the study is to investigate the impacts of mining on benthic communities by focusing on four aspects:

- The direct bottom disturbance of collector systems;
- Indirect influences through re-sedimentation of the plume;
- Impact of discharge of waste waters from mining operations;
- Long-term effects on species composition during and after re-colonisation.

The first outcomes will provide more clarity on long-term ecological impacts and the design of a monitoring strategy and will make recommendations to policy-makers, industry and the International Seabed Authority.

To act effectively, JPI Oceans will need to identify the different policies that exist to manage different areas of the deep sea. Some of this activity is already being conducted by the European Marine Board. It may also be necessary to work with international organisations, such as the International Seabed Authority, when the activities of the Member States takes place on the High Seas.

2 TECHNOLOGY AND SENSOR DEVELOPMENTS INCLUDING FOR EXTREME ENVIRONMENTS

The way research is conducted at sea has been changing over the last few decades and in the last few years this rate of change has increased. The traditional reliance on large research vessels has given way to autonomous and automated systems both in, on and above the sea.

Pilot Action: Ecological Aspects of Micro-plastics

The accumulation of plastic litter in the environment has become a growing concern ever since the rise in plastics production. The pilot action will firstly focus on the development of analytical methods for micro-plastic particle research, with a focus on cost effectiveness and robustness. In the next phase, it will focus on an inter-laboratory study on micro-plastics in sediments and the transfer of micro-plastics into food chains and their effects.

The first expected outcomes of the project are validated, improved methods & protocols and harmonized, comparable micro-plastics data.

It will allow to better meet and further develop the respective requirements of the Marine Strategy Framework Directive and the ability to assess impacts of micro-plastic.

The accumulation of plastic litter in the environment has become a growing concern ever since the rise in plastics production.

Firstly, the increasing capacity to take measurements of the marine environment is leading to an explosion in the amount and type of data. In theory this increase in data should make scientific advice for policy stronger. However, there is an inevitable lag between the advent of a new big data environment and the tools and expertise to utilise it effectively.

One of the exciting opportunities of the recent technological developments is the potential for coordinated actions for specific policy needs. Using a combination of technologies and sensors, it is becoming more feasible to conduct a truly holistic assessment of the marine environment. However, it is also essential that these new systems are cost effective.

While technology and sensor development has made big advances in recent years, there are still limits to their operational capabilities. There is no substitute for the research vessel in extreme environments, such as in cold and deep waters; these are the areas that where policy developments are needed the most.

3 RISK ASSESSMENT AND RESPONSIBLE MANAGEMENT OF COASTAL AREAS AND ECOSYSTEMS

Integrated coastal zone management (ICZM) is the most complex area of marine management, with a large number of environmental socio-economic variables both nationally and internationally. One of the major issues is that, while the concept of ICZM exists, the actually policy tools needed to apply it in a practical way do not exist in Europe (Diedrich *et al*. 2010).

While there are no universal indicators that exist to manage coastal zones, there are a number of examples where they have been used both within and outside of Europe. One such example in the Balearic Islands developed a set of 54 indicators from an extensive stakeholder consultation process. A critical review of the process looked at the role of science in a participatory decision making process. It highlighted the disparity between traditional scientific outputs, such as peer-reviewed papers, and the societal requirements of science in an ecosystem approach (Diedrich *et al.* 2010). The difference between the two can be seen in the projects attempt to develop scientifically viable indicators, which are comparable internationally, but that are also relevant at a local scale to ensure implementation.

In this area JPI Oceans could start by identifying and promoting local success stories of ICZM. As both a top down and bottom up driven initiative, JPI Oceans is in a unique position to promote both local and international efforts in ICZM. As with other strategic areas, it could also address the disparity between scientific objectives and societal needs, especially at local levels. As with all attempts at an ecosystem approach, science should be used to support a participatory decision making process that involves all the stakeholders in a particular ecosystem. JPI Oceans could look at how to develop fit for purpose management strategies, such as marine protected areas, and support the future development of European legislation specifically relating to ICZM. While the coastal zone is complex, case studies exist to prove that it is not impossible.

4 LINKING OCEANS, HUMAN HEALTH AND WELLBEING

The European Marine Board outlined strategic research priority of oceans and human health in its 19th position paper (EMB, 2013). The paper summarises the current efforts involved in linking oceans to human health and highlights the gaps and opportunities. One key initiative is the MAES

Working Group that has proposed a conceptual framework that responds to EU policy questions regarding ecosystem assessment and services (Maes *et al.*, 2013).

It would be important to consider how JPI Oceans could work with the Regional Sea Conventions to support their role in monitoring and environmental protection. While there are many relevant European policies relating to oceans and human health, there is a lack of a coherent, holistic approach; JPI Oceans is in a position to address this issue. It would be useful to start by looking at how the USA has developed collaborations between its scientific and health research institutes. JPI Oceans could act as focal point for international collaborations between Europe and programmes in other States, such as the National Institute of Health, the National Science Foundation and NOAA programmes in the USA.

5 INTERDISCIPLINARY RESEARCH FOR GOOD ENVIRONMENTAL STATUS

One of the goals of an ecosystem based approach to marine management is to use interdisciplinary science to form a holistic view of the environment. The nature of marine habitats mean that they are not limited to national boundaries. Moreover, the interactions between different habitats can further complicate matters from a national perspective. It is for these reasons that efforts to implement ecosystem management, in the marine environment, require more collaboration between Member States. While this is challenging, there are additional benefits from working in partnership with other countries. As each Member State has its own priorities, it inevitable develops its own expertise; sharing this expertise in a joint research activity is not only more effective than acting alone, but it is also more cost effective. JPI Oceans is in a good position to encourage such joint research activities that target specific challenges and require a collaborative approach.

Pilot Action: Intercalibration for the EU Water Framework Directive

The JPI Ocean pilot action on intercalibration aims to create a long-term dialogue between environmental authorities and the scientific community of Member States to jointly solve scientific challenges associated with the WFD. Specifically it aims to:

- Find experienced scientific expert leads to perform required analyses in the most cost-efficient way for phytoplankton and benthic invertebrate fauna (as there are constraints in the availability of experts of national environmental authorities)
- Reduce fragmentation (of comparison calculation efforts) and increase efficiency in relation to the Water (and Marine Strategy) Framework Directive;
- Increase experience with joint data collection and analysis;
- Test a mechanism for joint funding from environmental authorities of 9 Member States (BE, DE, DK, FR, IE, NL, NO, SE, UK), surpassing the traditional model of joint calls, to obtain the performance improvements.
- Test co-design between environmental authorities and the scientific community from the development phase until finalisation of the results for an update of the European Commission Decision on the WFD intercalibration results.

The traditional approach to marine management was based on a sectoral approach. As such, the tools which have been developed to manage human activity in the marine environment are based on sectoral impacts. While this has led to a good understanding of individual impacts of human

activities, the understanding of cumulative impacts is little understood. This is also an area that JPI Oceans could encourage collaboration between Member States, as cumulative impacts can occur at multiple geographic levels.

In addition to encouraging specific actions for its Members, JPI Oceans could support existing initiatives such as the JRCs Marine Competence Centre for GES. There is a need to identify knowledge gaps to support GES at an early stage to ensure that they do not slow down efforts to reach GES. This could involve developing a standardised way for different advisory bodies to present the most pressing research needs. A potential mechanism for this is discussed in the case study for the IMO.

6 OBSERVING, MODELLING AND PREDICTING OCEAN STATE AND PROCESSES

The three core scientific requirements of marine management is the ability to observe, model and predict ocean states and processes.

The development of coordinated monitoring systems should provide a more cost effective and holistic approach to marine observation. An attempt to create a Global Ocean Observing System (GOOS) started in 1988, by an IOC ad hock expert group. GOOS is subdivided into Regional Alliances, with EU Member States forming EuroGOOS. However, Member States may also be members of other Alliances for specific regions such as the Mediterranean Ocean Network GOOS and the Black Sea GOOS.

Pilot Action: Multi-use of Infrastructure for Monitoring

The intention of this pilot action is to test the methodologies required to develop monitoring strategies. It will focus on integrated surveys but will also consider the requirements of other components during implementation. Its actions are directed to three components:

1. Setting up integrated monitoring surveys;
2. Enhancing integration of monitoring efforts;
3. Promoting data sharing and integrated information systems.

To demonstrate how infrastructure can be used for multiple purposes, the pilot action aims to incorporate monitoring for MSFD descriptors in the current International Bottom Trawl Survey.

The Joint action picks a number of indicators that require monitoring activities, to be added to current (fish stock) monitoring programs. The intention is to develop pilot studies to test these on current monitoring activities as soon as possible. The process of organising the pilot, the needs (budgets, equipment, time) and the limitations (vessels, crew, permits) are at the moment of more interest than the actual data collected at sea. Such information is a useful input for the project of the EC DG ENV to be able to calculate costs and design an efficient integrated monitoring program.

7 CLIMATE CHANGE IMPACT ON PHYSICAL AND BIOLOGICAL OCEAN PROCESSES

There are numerous publications within the European Member States which aim to document the impacts of climate change on physical and biological ocean processes.

One of the challenges in understanding the impacts of climate change on ocean processes is being able to compare different studies from around the world. To do this, data access needs to be both open and standardised. Many projects exist in Europe to promote data access and sharing but, while good examples exist, there is generally a lack of commitment to achieve the critical mass that is needed.

There are many different types of environmental assessments such as the IPCC. Assessments are useful because they provide a focus for scientific evidence which can be used to inform policy makers. In the long term, the science used to support the MSFD could be used to make an assessment of European Seas. Such an assessment would benefit from the methodologies from similar reports, like the IPCC, to combine information from the outputs from different Member States. This is an area in which JPI Oceans could coordinate the input of Member States

8 FOOD FROM THE SEA

The Common Fisheries Policy is the main tool used to manage food from the sea. ICES has traditionally provided the scientific advice used by the European Commission to set catch quotas. However, the future of food production from seas may not be based on traditional fisheries. Aquaculture is frequently promoted as an industry with great potential, yet production has been in steady decline since 1990 (Guillen & Motova, 2013). While production is falling or stagnant, there has been an increase in the value and profitability of the sector in recent years. The three factors highlighted as the main challenges facing European aquaculture are: fierce foreign competition, high labour and capital costs and administrative burdens that slow investment. If used well, science can be used to address all three of these issues and promote growth in the European aquaculture industry.

During the CSA stakeholder consultation, it was suggested that Europe could use environmental credentials to add value to products from the sea. This is especially true for the aquaculture industry if it is to compete with cheap imports from abroad. A knowledge based aquaculture industry could reduce the use of antibiotics and the amount of nutrients that seep into the surrounding environment. Sharing best practice across Europe would reduce the risks involved in investment in the setup of new aquaculture farms. Finally, a clearly defined role for science in aquaculture management would help to alleviate the administrative burdens placed on the aquaculture industry.

JPI Oceans could identify the specific science gaps needed to create a sustainable aquaculture industry. This science could in turn be used to formulate clear guidance from policymakers to industry and in doing so, reduce the administrative burdens that act to slow investment. JPI Oceans could also support initiatives, such as the Aquaculture Stewardship Council, that promote the environmental credentials of European aquaculture.

9 BLUE BIOTECHNOLOGY

Blue biotechnology was recognised as one of the great opportunities for marine industry in the European Marine Boards foresight report *Navigating the Future IV* (EMB, 2013). The report summarises the findings several science-policy initiatives and highlights the barriers and challenges that must first be addressed. There is thought to be a high level of fragmentation as a result of low coordination between Member States. The European Commission has supported a

range of initiatives to address these the challenges of developing the blue biotechnology industry. One of these was the EU FP7 Coordination and Support Action in Marine Biotechnology (CSA MarineBiotech), a collaborative network consisting of 11 partners from 9 European countries that worked from 2011-2013 to explore the opportunities and needs for European coordination, trans-national cooperation and joint activities in the area of marine biotechnology research; this gave rise to the FP7 ERA-NET scheme ERA-MarineBiotech. Yet many challenges remain; *Navigating the Future IV* outlines the need to:

- Further improve our understanding of the marine biotechnology landscape (in particular industrial activities, main key stakeholders and market trends) and ways to stimulate development from basic science to commercial applications;
- Stimulate the development of strategies and programmes at various levels (local/regional, national, sea basin and pan-European level) and align them with each other and with broader EU bioeconomy goals;
- Secure the development of marine biotechnology activities in a sustainable way, protecting the marine environment and MGRs with particular attention to deep-sea resources, developing new management tools and regulations where appropriate;
- Improve technology transfer mechanisms and industry/academic collaborative approaches to develop markets and businesses, making full use of the knowledge and networks of the local and regional blue biotech clusters in Europe; and
- Stimulate multidisciplinary education and training.

JPI Oceans build on the work of existing projects such as ERA-MarineBiotech and seek to address the challenges outlined in *Navigating the Future IV*. It may be beneficial to look at how the development of biotechnology from terrestrial ecosystems have been managed to see if there are examples of best practice.

10 RENEWABLE ENERGY

The European Union is on track to fulfil its Kyoto Protocol target of reducing greenhouse gas emissions by 20%, of the 1990 level, by 2020. Support for renewable energy has helped considerably in achieving this goal. In addition to reducing greenhouse emissions, renewable energy reduces the reliance on imported fossil fuels and the increasing price of oil, coal and gas (DECC, 2012). Renewable energy in the marine environment has mostly focused on wind to date. Other forms of energy such as wave, tidal and thermal have not been developed to full commercial scale, despite their potential capacity in Europe. Whilst wave, tidal and thermal generators are in their development stage they require political commitment in the form of funding and favourable tax incentives. To be confident in making such decisions, policy makers need evidence to support their decisions. The UK has a well developed development programme for marine renewable energy, it also hosts the European Marine Energy Centre on the Orkney Islands. To support the development of marine renewable energy, the UK government funded an Atlas of UK Marine Energy Renewable Resources[23]. The Atlas is an online portal for marine data relating to marine renewable energy; this is made available through a webGIS application that can be used to suit the users requirements. The advantage of the tool is that it is multifunctional and can be used equally as well for scientific purposes as it can for informing policy makers.

To encourage the development of more marine renewable energy platforms, JPI Oceans could support efforts to create a European wide atlas of renewable energy. There are also significant challenges locating marine energy farms, with many projects receiving strong local opposition. This highlights the need for the inclusion of stakeholders in decision making to avoid unnecessary costs and complications.

[23] Atlas of UK Marine Renewable Energy Resources. 2008. ABPmer. Date of access (10 July 2014) http://www.renewables-atlas.info

RECOMMENDATIONS FOR THE STRATEGIC RESEARCH AND INNOVATION AGENDA

The next step for this work package is to inform the development of the Strategic Research and Innovation Agenda of JPI Oceans. This will use the outcomes of the analysis of the CSA Oceans consultation and the subsequent research looking at examples of best practice in existing mechanisms. The preliminary advice for the SRIA is outlined below.

NEEDS for POLICY

Policy makers increasingly stress the need for evidence-based policy, and it is clear that sound policy-making relies upon a flow of reliable information from all relevant sectors, public and private. Marine and maritime policies are becoming wider in their scope and in their impact. The challenge for the scientific community is to transfer robust, impartial scientific evidence into the policy arena which can stand its ground in a wide, stakeholder driven, landscape.

CSA Oceans initial work focused on science-policy interface investigation on marine and maritime policies, as they reflect the societal challenges for the marine and maritime environment that are covered by the 3 goals of JPI Oceans, namely:

- Integrated Maritime Policy (IMP) and the EU Blue Growth Strategy;
- Marine Strategy Framework Directive (MSFD);
- Common fisheries policy (CFP);
- Maritime Spatial Planning (MSP) and Integrated Coastal Zone Management (ICZM);

JPI Oceans should also take into account other policies relating to climate and the protection of the earth system in which the oceans play an important role.

GAPS and BARRIERS

There are many well established science-policy processes, actors and organisations at local, regional, national, European and international levels. Analysis of the stakeholder responses has identified specific examples of best practice at different levels. Each JPI member state has its own mechanisms for advice and many mechanisms exist at European and International levels, working at a range of regional scales. Policy making is done at different organisational levels and the scientific evidence base, which informs policy making and implementation, derives from research outcomes commissioned and supported in many different ways. It ranges from specific consultation processes, built directly into the legislative process, to strategic commissioned research which has a particular policy outcome in mind. It can also include research which was initially driven by scientific curiosity which may be applicable to policy. As a result, the landscape is complex, crowded and occasionally controversial.

Many of stakeholders consulted have acknowledged that the field of communication in the European landscape is quite fragmented, with many organisations, platforms and networks communicating simultaneously. Policy makers hear different opinions and must make value judgements.

The science policy interface is complex and multifaceted. Science findings, reports and publications are only a starting point in providing evidence to policy-makers.

Stakeholders identified several weaknesses in the marine science-policy interfaces and suggested the following were needed:

- A comprehensive and up to date overview of who is doing what at the science-policy interface;

- An accurate and complete overview of scientific knowledge, even though there are many databases and literature reviews in existence;
- A comprehensive overview of policy knowledge, even though many reporting pathways exist;
- Better interaction and common fit-for-purpose language between the scientific community, policy makers and the private sector is underdeveloped;
- A fit-for-purpose structured long-term compilation of project results, that is interconnected and user friendly;
- Sufficient knowledge, data and information to provide appropriate evidence to support assessments or mitigation measures;
- Co-design of projects and policy, in particular across different priorities and/or budget and project time lines;
- Cooperation between the research and the monitoring community and between academia and government science funding;
- Incentives and recognition for researchers to be involved with generating advice for policy. Traditional means of assessment, e.g. number of quality publications, do not reflect science/policy impacts. Such impacts are also much harder to prove and formally recognise.
- Multidisciplinary human capacity; people knowledgeable in science and policy, as well as having technical knowledge.

The above mentioned complexity and fragmentation in the landscape are also important barriers to elaborating efficient solutions to the existing gaps. Raising awareness of existing networks and establishing new cooperation between different largely separate networks will be a main challenge to overcome these barriers.

OPPORTUNITIES

Scientists and policy-makers must work closer together to ensure research outcomes are understood, relevant and achieve maximum uptake and impact. Judgements of risk and uncertainty come in to play, as well as wider political drivers. Engaging policy-makers in science doesn't just mean making research results available. It also means helping them understand the implications and working with them to decide how to respond, and what additional research, monitoring or other activities are needed. The information needs to flow both ways.

Policy implementation is an ongoing process. Although the process varies, it commonly involves an evolutionary cycle. Since scientific findings can contribute to the initial development, the evaluation, and implementation of policy, it is important that scientists are involved in the entire policy life cycle to review and propose amendments which will improve the outcomes. A sustainable relationship between society and the ocean depends on creating capacity to develop and implement new strategies to more efficiently translate research results into effective decision-making tools.

Views from the CSA stakeholder consultation

The responses to the consultation process welcomed the prospect of more effective marine and maritime science-policy interfaces at a European Level. Though valid attempts have been made, it is clear that a one size fits all approach to science-policy mechanisms across the diverse interests of the marine and maritime communities will not work. Due to fragmentation and lack of coordination, many stakeholders believe that there is scope for JPI Oceans to play an important role in this landscape, improving science-policy interfaces.

Suggestions were made of potential actions for JPI Oceans. Some relate generically to improving the science-policy interface, others can be categorised under the wider umbrella of 'stakeholder engagement' and others still are specific to particular policies or regions. A further objective of the CSA consultations in 2013 was to identify specific knowledge gaps in the development and implementation of marine and maritime policies of relevance to the JPI ocean community. The interim findings from this work are summarised below under two broad science-policy strategic areas.

- Science policy interfaces
- Science-policy awareness raising

The requirements are set out in more detail in the CSA deliverable 5.1 'Mapping and preliminary analysis of policy needs for evidence, submitted to the Commission in February 2014'. Further developments on case studies are elaborated in this deliverable.

SCIENCE-POLICY INTERFACES

Stakeholders generally considered that improvements could be made at all stages of the science-policy process, for example:

- **Improving information exchange between science and policy makers** for existing and new knowledge, including knowledge translation and education around the respective needs of research and policy communities;

- **Facilitating interactions between them** through informed science commissioning and evidence collection, enhancing the engagement of scientists in the policy development and implementation processes;

- **Building capacity** in the longer term to ensure that the next generation of scientists and policy makers understand each other in order to facilitate co-design of science based policy.

There is also the potential to develop innovative approaches to coordination between Member States; based on the principles of co-designed research programmes, dual-use infrastructure for research and monitoring (see section on infrastructure), and greater data sharing. JPI can also work toward the integration of high performance computing, data analytics and visualisation facilities that make best use of all marine data rapidly turning data into knowledge.

ENABLING ACTIONS

Preliminary analysis of the consultation process has highlighted several enabling actions which JPI Oceans could develop and coordinate to add value, which include:

- **JPI Oceans** can share and make better and faster use of existing knowledge covering different disciplines. JPI Oceans can act as a clearing house and repository of information of key activities and people (who is doing what) in the marine/maritime science-policy interfaces in Member States, at the European level or other scales;

- **JPI Oceans** can build capacity for science-policy at European level - This could include facilitating training opportunities, developing and sharing best practice, and exemplar case studies ;

- **JPI Oceans** can perform specific actions in relation to the implementation of the MSFD, including encouraging and facilitating best practice sharing and cooperation between researchers, policy makers and regional science management organisations [such as HELCOM] working in regional basins by coordinating S/P meetings, briefings etc.;

- **JPI Oceans** can help stimulate co-design at pan European level of research programmes by research funding organisations and policy makers and ensure that any research activities it supports are scoped taking account of opportunities for co-design and co-implementation and that appropriate S/P mechanisms are built into the process;

- **JPI Oceans** can signpost experts with relevant expertise and experience to respond to specific policy requirements to national/regional research organisations able to provide expert advice to stakeholders and end users in each country and across regions.

AWARENESS RAISING OF STAKEHOLDERS, POLICY MAKERS AND GENERAL PUBLIC

Another problem identified by stakeholders is the need to improve the communication and raise the awareness of stakeholders, policy makers in general and the general public on ocean issues and challenges. A healthy relationship between society and the ocean also depends on creating capacity to develop and implement new strategies to educate and to instil a sense of stewardship in the public and among policy makers.

ENABLING ACTIONS

- **JPI Oceans** can provide a platform to discuss inputs and can speak with one "marine/maritime" voice to the EU to convey research outputs/recommendations to EU decision making bodies (EP, EC) to promote a sustainable blue economy at the highest levels of policy.

- **JPI Oceans** might provide a platform for funders of research to identify the key issues and challenges that need to be tackled and communicated at the highest policy level.

- **JPI Oceans** might provide a coordination platform, working with the many players already in the community, to raise awareness between stakeholders, policy makers and public, at EU and national level, on the state of our seas and oceans and the potential of ocean goods and services to boost the economy and better communicate the need for scientifically related knowledge, the uncertainties and risks.

- **JPI Oceans** could also be a marine focal point for European research funders in international programmes and a conduit to Member States for ocean related issues in the international landscape.
- **JPI Oceans** could coordinate foresight research (a) to avoid duplication and (b) to identify the best processes to put forward fit for purpose solutions.

10 CONCLUSIONS

This deliverable looks at the current and future needs of policy makers to make recommendations on what JPI Oceans could do to add value to existing science-policy mechanisms. Five case studies are studied to understand how different mechanism work at different scales and for different needs.

Case Studies

On a global level, the IPCC is perhaps the biggest example of a science-policy mechanism in terms of the time, number of scientists involved and its reach. It is governed by a set of procedures on how to prepare, review, accept, adopt, approve and publish evidence. This standardisation is fundamental to producing a coherent report from so many writers and contributors across multiple disciplines. However, while it could be perceived as the global standard for assessing climate change impacts, it is not without its limitations. It has been suggested that it should make more use of graphics and visualisation tools to make the information more accessible to audiences without a scientific background. It also requires large amount of investment in terms of time and resources. But, as a result of its prolific status, scientists who work on the assessments get more recognition and respect for being involved than in other science-policy interfaces. In the UK, MCCIP provides assessments on the marine environment in a slightly different way. For a start, its Annual Assessment Report is shorter and makes much better use of info graphics. The next Special Report it will publish will be on GES for MSFD and it is advisable that JPI Oceans follow this development to see what such an assessment contains.

At a regional level, ICES provides advice on an increasing number of areas of marine science. Its clients include the European Commission and national governments. ICES advice is technical in nature and is intended for specific uses within policies, such as setting catch quotas under the CFP. ICES was cited several times during the consultation exercise as an example of best practice. It is likely that the way in which it handles uncertainty and its transparency are key factors in this success. For example, its decision to allow stakeholder observers into workshops was hailed by stakeholders as great improvement to the transparency of its process. Recently, ICES has been developing its Data Centre to provide a single point for data related to its advice. This is made accessible through a number of online tools, designed with the end user in mind. The challenge for ICES now is how it will achieve the objectives of its strategic plan. As a major player with a long record of providing advice to policy makers, it is likely that JPI Oceans will need to cooperate with ICES on future actions and could benefit from its experience.

The first two case studies looked at science-policy mechanisms driven by the scientific community. At a European level, this report looked at how a top down driven process works within the European Commission. The EC commissioned a central science-policy interface for the WFD to ensure that all the knowledge required for its implementation was contained in one place. However, European Commission initiatives are funded on short timescales, even if the aspect of science they address is long term. As such, there is a tendency for the outputs of projects to get lost or not used to their full capacity. There is little record of what significant investment has led to in terms of knowledge gained and technologies developed. Proponents of scientific investment sometimes quote that every dollar invested in the US space programme there has been a return of $8 back into the economy. But without a record of outcomes of investment, it is difficult to track this in European marine science.

In its approach to setting targets for GES for the MSFD, the UK has made use of knowledge brokers to facilitate the transfer of knowledge from the scientific community to policy makers. These knowledge brokers are professional scientists embedded in relevant government

departments and are responsible for liaising with the scientific community at large to provide the evidence used to set targets for GES. The main challenge that has been experienced is the different time scales between scientific publications and policy developments.

The IMO provides an insight into how industry and scientific advice is used to make policies. The formal process by which NGOs are involved in IMO is an example of how to promote transparency. The guidelines that have been produced by IMO give NGOs a clear role in the policy development process and could help to inform other science-policy interfaces. The review of GESAMP also revealed some interesting insights into how a science-policy mechanism works and the 2001 review provided many interesting outcomes. Ultimately, the IMO case study highlights the need to identify the knowledge gaps early to avoid delays and unfeasible policy measures, as was found in the development of the Ballast Water Convention. One proposed solution to this would be to have a standing term of reference for groups within a science-policy mechanism to identify the important gaps to known policy areas to fund research. This could build that into the infrastructure of a group like ICES or IMO to flag up gaps in research.

The Future of Science-Policy

With a move towards an ecosystem approach of marine management, the ways in which science is used to support policy will also need to adapt. One of the key approaches to designing science for fit for policy is co-design. The principles of co-design lay the foundations for an integrated approach to science and thus scientific advice and, by studying existing activities, it is possible to learn how it can be done effectively.

The way in which we observer the marine environment is also changing from a sectorial approach to a more holistic one. The proliferation of new autonomous systems is allowing more frequent monitoring on a greater geographical scale. The challenge is to ensure that these new methods are fit for purpose and cost effective. This could be achieved by developing multipurpose infrastructure to meet different policy needs. New data collection techniques need to be supported by innovative data management tools, which will require more standardisation of data and meta-data. The regulatory framework for new technologies needs to be sufficiently flexible to allow the latest developments to be used to create evidence for policy needs.

New computing power and networking capabilities means that there are more opportunities to use existing data more creatively. The term Big Data is applied to technologies which process large and complex datasets. In the context of science-policy interfaces, Big Data offers more possibilities of measuring once and using many times. Systems that already exist are designed to be user focused and to make use of online visualisation tools to present the data in a usable way. There have also been developments in virtual services, which allow computers to work together without human input; this is particularly relevant in the marine sector.

There is a need to evaluate how well education systems prepare marine scientists to work in policy related research. With an increasing need for researchers to demonstrate the societal impacts of their work, it is more important than ever for early career researchers to be equipped with the right tools and experiences.

Potential Role of JPI Oceans

By looking at organisations that function in a similar way to JPI Ocean, it is possible to consider what it could do in an already crowded environment. As a long term initiative, JPI Oceans is in a position to coordinate existing activities to ensure a legacy of the relatively short lived initiatives funded by the EC. It has the potential to act across different policy areas, such as the MSFD, WFD and ICZM. The CSA Ocean stakeholder consultation suggested that there is a need for more standardisation of data across Europe and the need for better access to existing data. JPI Oceans could work with existing organisations to achieve this ambition. It was also suggested that there is a need for a focus point for marine activities in Europe and some kind of unified international representation. At this stage, it is unclear as to whether this is something JPI Oceans could do, as it does not have the remit to do this, but it could support future activities in this direction. There

is a need to develop a better way of recognising and rewarding scientific involvement in policy making.

The most important challenge for JPI Oceans is how to act without duplicating existing activities. To do this it must carefully consider its actions and involve the relevant stakeholders in its activities.

The StAB provided a list of ten strategic areas for JPI Oceans to focus on. This is useful in providing a focus for future science-policy activities but it is also important to consider that the focus of JPI Oceans is evolving with the needs of Member States. The first step for each of the strategic areas is to identify the relevant stakeholders, some of whom are discussed in this deliverable. From there JPI Oceans can look at the gaps in current activities and develop specific actions to improve how science is used to inform decisions on these topics.

Development of the Strategic Research and Innovation Agenda for JPI Oceans

The stakeholder consultation process identified a number of generic science-policy actions which JPI Oceans could address. This deliverable aims to expand the knowledge around these recommendations to inform the development of the Strategic Research and Innovation Agenda for JPI Oceans and enhance science-policy interfaces at a European Level.

ANNEX I: THE G8 RESEARCH COUNCILS INITIATIVE ON MULTILATERAL RESEARCH FUNDING- RESEARCH PROPOSAL CRITERIA

http://www.nserc-crsng.gc.ca/Professors-Professeurs/Grants-Subs/G8-G8_eng.asp

1. Quality/Intellectual Merit

- Scientific quality and innovativeness of the goals and objectives of the joint research plan.
- Added value to be expected from the international research collaboration.

How well does the activity advance knowledge and understanding within its own field and across different fields?

Does the proposal contribute to scientific excellence and significant progress toward the state of the art?

To what extent does the proposed activity suggest and explore creative, original concepts?

If these partnerships currently exist, what does this new funding allow them to do that they could not do otherwise?

What is the added value of the international cooperation? Where appropriate, this should also include the extent to which the partner organisations' existing investments are leveraged in the proposed project.

2. User Engagement and Societal/Broader Impacts

- Engagement of research users (relevant policy makers, regulators, NGOs, communities or industry) and the effectiveness of proposed knowledge exchange activities.
- Expected impacts (e.g., societal, policy related, economic).

What may be the benefits of the proposed activity to society, policy development or economies?

How have users been engaged and how effective are the proposed mechanisms for knowledge transfer to decision makers?

Does the project involve early career researchers?

Does the research collaboration focus on global challenges for which solutions can only be achieved by global scientific approaches?

3. Inter-Disciplinarity and Personnel/Quality of the Consortium

- Collaboration between natural and social sciences, and other sciences where relevant.
- Competence and expertise of team and complementarities of consortium (inter-disciplinary / inclusion of all necessary expertise).

How strong is the collaboration between the natural and social sciences?

How well qualified are the proposers (Leading Principal Investigator and team), in terms of science knowledge, expertise and experience, to conduct the project?

What is the quality of previous work in terms of past or potential contributions to, and impact on, the proposed and other areas of research?

Is the Leading Principal Investigator team (including any identified co-principal investigators) able to lead the project (e.g., having strong management and leadership skills, or having complementarity of expertise and synergy of the members of the team)?

4. Resources and Management

- Appropriateness of resources and funding requested.
- Balanced cooperation.

How well conceived and organised is the proposed activity?

Is there an operational plan with well-defined milestones in place?

Is the coordination plan adequate?

Is there sufficient access to resources?

Are the requested investments well justified and relevant?

Are the scientific and financial contributions requested of the partner organisations from each country well balanced?

ANNEX II: METHOD FOR ASSESSING JPI OCEANS PILOT ACTIONS

BASIC REQUIREMENTS & FEASIBILITY

- The pilot action addresses cross-cutting issues in line with the goals and objectives of JPI Oceans, as expressed in the Vision document.
- The pilot action will have a quick start, making primarily use of existing capacities and resources. Pilot actions should ideally be aimed at "low hanging fruit".
- The pilot action requires the support of at least 4 countries represented in JPI Oceans.
- The pilot action has a committed leader (JPI Oceans member country).

RELEVANCE & IMPACT

- The pilot action explores and utilizes synergies and complementarities between countries and/or capacities and/or scientific fields and/or science-industry-society to reach a common goal.
- The pilot action avoids unnecessary duplication of efforts by enhancing cooperation and/or coordination.
- The pilot action can potentially produce tangible outcomes within a time frame of 1-3 years.

ADDED VALUE FOR JPI OCEANS

- The pilot action tests modes of collaboration among countries for aligning national research programs, and for addressing the JPI-specific societal challenges in dialogue with representation of stakeholders (science, industry and policy) thereby contributing to an operational model for joint programming.
- The pilot action strengthens structures or processes that facilitate future collaboration of partners in JPI Oceans.

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