Tools for Ecosystem Based Management

Working Group on the Ecosystem Approach to Ocean Health and Stressors

May 2018

Montreal, Canada
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11.7 Tool example: MICE to determine short term impact of advised catch levels on bycatch
Executive Summary

A host of tools exist to support trade-off analysis in Ecosystem Based Management (EBM). Improving understanding of the process leading to successful development and uptake of these tools was a central aim of the Atlantic Ocean Research Alliance (AORA) Tools for Ecosystem Based Management workshop, which took place in May 2018, Montreal, Canada. The AORA working group on the Ecosystem Approach to Ocean Health and Stressors has convened a number of workshops to explore mechanisms to enhance the uptake of science for EBM and potential alignment of research priorities in the North Atlantic.

Workshop participants identified criteria to analyse the elements of trade-off analysis tools used in a ‘successful’ application of EBM. This approach is referred to as the Marine Ecosystem Based Management System for Trade-off Analysis and Reconciliation (EBM-STAR). A successful application of a tool would cover some elements of identification, evaluation, and presentation of trade-offs, as well as evidence of use (of the tool) in decision-making, and validation of the trade-offs as part of an iterative and adaptive process. Case studies of EBM tools in operation were assessed using EBM-STAR after the workshop. The constituents of best practice for tool development were also highlighted.

General challenges in the use of tools for the provision of evidence into trade-offs for EBM were identified. One of the key challenges for the use of tools for EBM is improving the ease of use and uptake of tools in management and better incorporation of socio-economic considerations, especially valuation measures. Many resources have been invested in developing tools for EBM across the jurisdictions of the North Atlantic. However, few tools have been used operationally and even fewer are having their performance validated.

An iterative approach is required, and modellers, scientists, and managers should work in an adaptive manner when producing and implementing these tools. Tools need to be applied appropriately. They provide important insight into trade-offs in decision-making and improving transparency of management decisions.

Recommendations from the workshop include:

- Adapt tool development to ensure that social and institutional trade-offs become as explicit as ecosystem and economic trade-offs.
- Data and information from the presentation, utilization, and validation criteria of the EBM-STAR become available to improve advice.
- Perform validation in the EBM-STAR after use to demonstrate robustness to limited understanding of the system.
1 Preamble

The Vision of the Atlantic Ocean Research Alliance (AORA) Working Group on the Ecosystem Approach to Ocean Health and Stressors (EA2OHS) is to promote research to understand the North Atlantic Ocean in support of ecosystem-based management (EBM). EBM is recognized as the best means to advance knowledge to both manage use of marine ecosystems and their associated resources, across multiple ocean-use sectors, and across multiple stressors. Within the broad AORA EA2OHS effort, several task groups have formed to deliver an eight-step process. One is a task group on Tools for Ecosystem Based Management.

All task groups for EA2OHS are exploring mechanisms to enhance the uptake of science for EBM and potential alignment of research priorities in the North Atlantic. Despite widespread interest in Ecosystem Based Approaches as a management tool for ocean use, and a wide body of research on potential approaches, society has largely failed to operationalize the ecosystem approach. The AORA Working Group on the Ecosystem Approach to Ocean Health and Stressors (EA2OHS) report from 2017, highlighted that the key challenges for the use of tools for EBM was improving the ease of use and uptake of tools in management and better incorporation of socio-economic considerations, especially valuation measures.

“EBM recognizes that trade-offs are needed in the management of resources and human activities in ocean and coastal ecosystems. It is rarely possible to optimize all activities at once without some trade-off in uses and goals. For example, increased energy development might result in some loss or degradation of habitats, recreational areas, or fishing grounds, yet is often necessary to meet the nation’s energy demand. Under current management practices these trade-offs still exist but are not explicitly dealt with, and the interaction between sectors is often contentious and difficult to resolve. In practice, trade-offs and conflicts are often dealt with after the initial activity planning or permitting occurs, frequently resulting in long delays or lawsuits. Using an EBM approach, trade-offs are explicit and become part of the planning and permitting efforts, ensuring that all stakeholders have the opportunity to engage and resolve issues proactively.”
(from http://ecosystems.noaa.gov/EBM101/WhatisEcosystem-BasedManagement.aspx)

Given that EBM recognizes the interconnections between the physical, biological, and social (including cultural) and economic components of marine ecosystems, tools for addressing trade-offs associated with EBM must have some capacity to consider these major components and sectors. A portfolio of ecosystem, economic, social, and institutional management objectives exists in all jurisdictions in the North Atlantic. Given the complexity and breadth of trade-offs associated with EBM, addressing them appears daunting. Fortunately, much research effort has focused on this issue in recent years, developing and applying a wide range of tools for addressing trade-offs.

The AORA 2016 report acknowledged the availability of many existing tools to provide the evidence needed for EBM and many ecosystem-modelling catalogues of tools, but the development and advancement of these tools remains a need. A well thought out tool development process will help to identify the key elements and connections to consider and incorporate a broad range of stakeholders, managers, and scientists. Even if a tool lacks sufficient data to support binding decisions, the process will support a plan for conducting research and monitoring needed to provide those data.

The overarching goal of the task group is to create a document on the criteria for successful uptake and use of a tool in exploring trade-offs in EBM.

Expected outcomes of the workshop:

- Improved understanding of the process leading to successful development and uptake of tools in management
Expected products of the workshop:

- Report back to EA2OHS, AORA and national entities to advance EBM
- Manuscript to be submitted to a peer reviewed journal

The AORA workshop is organised by the AORA Coordination and Support Action (AORA-CSA) that assists the AORA Working Groups. The above workshop is supported by the AORA-CSA Work Package 4.

The AORA-CSA has received funding from the European Union’s Horizon 2020 programme under grant agreement no. 652677, therefore limited funding for travel and subsistence costs has been provided for expert participation through the AORA-CSA.
2 Introduction

Numerous efforts have documented and debated the need for ecosystem-based management (EBM) of the ocean. EBM is emphasised in Canada in the Oceans Act, and numerous programs administered by Fisheries and Oceans Canada such as the Ecosystem Research Initiatives (Canada), by the National Ocean Policy and Ecosystem-based Fisheries Management Policy statement (US), and in the EU by the Integrated Maritime Policy, Marine Strategy Framework Directive, and the Common Fisheries Policy. The multiple uses of the ocean, multiple stressors on marine ecosystems, and multiple user-groups or stakeholders interested in the ocean, result in multiple mandates and jurisdictions to manage use of ocean components (Holsman et al., 2017). The trade-offs within and across a growing number of ocean-use sectors and changing use patterns underscores the need for an integrated, more systematic means of managing ocean use (Smith et al., 2017). This gap links with the prioritisation of management objectives. Furthermore, although many stressors with second or even third order effects may be managed directly, they can have far-reaching consequences on other facets of ocean ecosystems and uses. Hence, the need to consider cumulative effects in a marine ecosystem.

EBM is a broad approach to management of activities that affect and respond to changes in the ecosystem. We define ecosystems beyond biological or ecological systems, necessarily including human systems as well. The critical feature of EBM is that it acts as a systematic, holistic lens through which to approach ocean management.

EBM suggests institutions and organizations need to act differently, approaching ocean management comprehensively, adding in new values and considerations not traditionally incorporated in ocean management decision making. In the future EBM will focus on an ecosystem basis - meaning a dynamic, interactive environment encompassing human, biological, and ecological spheres.

Trade-offs inevitably result from many activities influencing each other and from diverse management objectives. Currently, management decisions are often based on a process of evaluation of biological aspects (often elaborate with peer reviewed public advice) with social and economic considerations that occur in a later, political, process that is not transparent and without rigorous analysis of the full range of trade-offs. There is need for consideration of trade-offs arising from overlap and interactions among activities, but also the trade-offs within an activity arising from conflicting objectives such as economic efficiency vs distribution of benefits. EBM implementation supported by tools can help to make these trade-off decisions explicit.
3 The workshop

The AORA Tools for EBM workshop took place in association with the World Conference on Marine Biodiversity, and the co-supported sessions of H2020 projects Atlas and Sponges. Nine experts participated from all three Galway Statement jurisdictions (see section 11 for the full list of participants, also pictured below in Figure 3.1).

![AORA tools workshop participants](image)

Figure 3.1 The participants of the AORA EA2OHS tools workshop in Montreal, May 2018.

A manuscript for submission to a peer-reviewed journal will follow as a major outcome from this workshop, and this report specifically focuses on the process and broad conclusions of the workshop, rather than the specific arguments and methods.

The following objectives summarize the terms of reference of the group:

1. identify criteria for assessing the success of tools,
2. categorise tools that can address cross sectorial trade-offs and multiple objectives,
3. apply these criteria to identify successful applications of tools,
4. recommend further development of the application of tools to achieve successful EBM.

Following on from the previous AORA EA2OHS reports, the workshop was inspired by the concept that there are central challenges to implementing EBM. These challenges include the definition of management objectives (ecosystem, economic, social and institutional), a process of explicit trade-off analysis and reporting, the ability to account for cumulative and downstream effects, and the availability of an institutional framework for decision-making and implementation of management action.
4 Characterisation of trade-offs and tools

4.1 What is a trade-off?

The AORA glossary of terms provides the following definition of trade-off “A choice that involves losing one quality or service (of an ecosystem) in return for gaining another quality or service. Many decisions affecting ecosystems involve trade-offs, sometimes mainly in the long term.” TEEB (2010)

Workshop participants explored the concept of trade-offs and highlighted the existence of trade-offs among objectives, among and within sectors, between providing clear information and providing knowledge on all consequences of all potential management measures. Also between the requirement for and speed management action (e.g. urgent or longer-term action) and the detail, precision, or quality assurance of the evidence used to inform that action. To aid management, all trade-offs should link to manageable actions, underscoring the importance of linking trade-offs to management objectives and typically requiring prioritisation of objectives.

4.2 Customary best practice for developing tools

The best practice in the development of tools considers the following concepts:

- Construct the evidence using credible methods
- Document and peer review the process for evidence construction
- Address uncertainty
- Realistic cost of tool development and application
- Develop the tool through co-creation/participatory processes
- Ensure legitimacy of the process of tool development because the outcomes are used in public decision-making
- Quality control the process for use of the tool, include training of users
- Ensure socially accepted treatment of data, data management, and decision-making (FAIR principles)
- Use methods tools accepted in the wider independent scientific community (i.e. wider acceptance than two reviewers of a journal)
- Ideally, test the tool in a range of situations to ensure that it is robust and remains useful

4.3 Identifying the criteria for assessing the success of tools EBM-STAR

The workshop identified the criteria to analyse the elements of tool use in a ‘successful’ application of EBM that considers the use of tools in trade-off analysis. We termed this approach the Marine Ecosystem Based Management System for Trade-off Analysis and Reconciliation (EBM-STAR, Figure 4.1). It is recognised that no tool is likely to cover all of these elements.

A successful application of a tool would cover some elements of:

- Identify: Identify key trade-offs, noting that presenting all possible trade-off often results in excessive information. Effective communication often requires identifying the most important information for the specific management decision.
- Evaluate: Evaluate key trade-offs among diverse objectives and sectors and ensure the consequences of the trade-offs are apparent.
- Present: Present key trade-offs to users (managers or stakeholders), effectively communicating the trade-offs to stakeholders and to decision makers.
• **Use**: Use the evidence in the arena of decision-making. The use of evidence does not imply that the presentation of evidence must result in changes to management decision, just that it entered the arena.

• **Validate**: Validate trade-offs after the process to ensure an iterative and adaptive process of both tool development and EBM overall. Specifically, validate the proposed consequences of the management decision against the actual effects of the outcome.

While the elements could be interpreted as a linear or cyclical process, however, stand-alone elements in the process comprise the EBM-STAR. In any EBM process, tools should be available to cover all elements; but no one tool should necessarily cover all elements.

![Figure 4.1 Marine Ecosystem Based Management System for Trade-off Analysis and Reconciliation (EBM-STAR).](image-url)

**EBM System for Trade-off Analysis and Reconciliation (EBM STAR)**
Criteria for successful tools for trade-off analysis

- Tool identified trade-off
- Trade-off validated
- Tool evaluated trade-off
- Tool used in trade-off decision
- Tool presented trade-off
5 Assessment of tools for EBM trade-offs

5.1 Tools to address trade-offs among objectives and across sectors

Workshop participants further developed a table on tools for EBM initially created at the AORA EA2OHS Reykjavik (2017) working group meeting, considering both quantitative and qualitative approaches. The workshop categorised the types of tools either as tools in themselves or as frameworks/processes. The tools in these categories were assessed for their mix of applications to heuristic, strategic, and tactical management challenges. The assessment concentrated on the utility of the tools in each category across sectors (fisheries, aquaculture, mineral resources, energy, transportation, tourism and recreation, construction, ship building, education and R&D, public administration; following Surís-Regueiro et al., 2013) and across multiple pillars of objectives (ecosystem, economic, social and institutional; following Stephenson et al., 2017, 2018, Marshall et al., 2018). The group distinguished between the ability to apply tools versus those actually applied operationally by management, and provided examples of tools in each category. We will use these examples to evaluate the success of application of tools against EBM-STAR criteria described in section 4.3. We also considered the strengths, limitations, and ability to incorporate spatial aspects.

The tool categories include:

- Conceptual modelling
- Static spatial planning and evaluation tools
- Models of intermediate complexity
- Strategic simulation models
- Bayesian belief networks
- Dynamic spatial models

The framework or process categories include:

- Risk assessment
- Management strategy evaluation
- Multi-criteria decision making
- Ecosystem services framework
- Strategic environmental assessment

Workshop participants thought it unlikely that any one tool could account for all sectors and pillars of objectives.

5.2 Assessment of categories of tools

The categories of tools were allocated to participants of the workshop. Examples of applications of tools to operational EBM will be used to assess the success of the tool using EBM-STAR criteria (section 4.3). These will be included in the findings of the peer-reviewed publication and in later AORA reports.

Initial findings suggest that while many tool categories could potentially examine trade-offs between management objective pillars, few have been operationally applied for social and even fewer in the institutional management objectives. Although many marine EBM trade-off decisions have implicitly incorporated social and institutional objectives (e.g. social and economic objectives in the EU Common Fisheries Programme); the use of the evidence base in those decisions, and the actual decision making process has proven opaque and difficult to assess. Current examples of EBM offer little indication of explicit evidence use and explicit and transparent deci-
sion making for social and institutional management objectives. The reporting of EBM-STAR criteria on presentation, usage, and validation of the application of tools in the EBM trade-off process generally appears outside the primary research literature, adding to the opaque nature of the evidence base by which to assess the EBM-STAR elements (Figure 5.1). Even when documented, these reports are difficult to systematically access, compile, and scrutinise. Confidential processes and implicit decision-making further prevent systematic assessment of success in the opaque parts of EBM-STAR.

Figure 5.1. A conceptualisation of the increasing opaqueness of the evidence base by which to assess the tools used in EBM, which is caused by the different level and nature of reporting of each element of the EBM-STAR.
6 General challenges in the use of tools for the provision of evidence into trade-offs for EBM

Providing tools for the provision of evidence to inform trade-offs for EBM brings numerous challenges. Many resources are spent developing tools that are never utilized operationally (tactical or strategic). This lack of uptake frustrates research funders. The workshop highlighted the following issues as challenges to the application of evidence based tools into management:

The *customary best practice* described in section 4.2 is not used. This first issue is crucial. As described by much literature on science for society when operating in the management arena, i.e. mode 2 science (Gibbons et al., 1994) requires a change in methods and approaches.

It is difficult to design a tool without understanding how that tool will be used. Most AORA jurisdictions do not experience routinely utilized national or international arena or governance structure in which to use trade-off tools. Regional bodies exist, but often modellers and scientists are funded to produce tools for which there is no forum for uptake. Modellers and scientists are typically naive to the governance arena, and create tools assuming a central management process exists to utilize them. Much of the tool development for EBM trade-off analysis is anticipatory, with expectations that some uptake will occur once the tool has been developed. Tools will not be used unless management structures recognise the need for information on trade-offs and transparent explicit decision-making.

The suggested approaches also aim to reduce the use of badly designed tools and unreliable evidence.

**Lack of incentive for validation of tools and models.** Given the project-based and time limited funding available to develop most tools and models, few are used or maintained after development. In addition, individual scientists may not prioritize validating the tool, and the tool may be unpublishable. Validation rarely addresses structural uncertainty.

**Tools differ between sectors,** and require either harmonisation (e.g. spatial and temporal scale to facilitate cumulative effects) or some mechanism for integration of findings. The inclusion of cumulative effects is usually weak. Spatial/non-spatially explicit models required for some sectors and the combination of these remains a challenge in the EBM process.

**Integration of tools between research disciplines** represents a major challenge. The combining of quantitative, qualitative, and narrative approaches of research is still in its infancy in the marine EBM research field. How is information on human behaviour used to predict human behaviour and ecosystem consequences in scenarios of trade-offs? What is meant by quality assurance of narrative information when used to inform EBM trade-offs? These questions remain unanswered.

**Information on some objectives is not presented** in a way that allows informed trade-off decisions. This disconnect often highlights a lack of tradition or experience in communicating explicit economic trade-offs. Lack of trans/interdisciplinary processes or arenas further hinders the process. Frequently, lawmakers place many social, institutional, and economics objectives in the preamble of policies, legislation, or directives.

Similarly, **policy makers often desire non-transparent decision-making** and prefer to maintain the ignorance of policy choice decisions unless it leads to success. Significant research has addressed this issue within the evidence based decision-making research field.

Modellers, scientists, and managers are still challenged by the need to **prioritise the visualisation of scenarios and trade-offs**. Prioritizing the need to transfer complicated concepts and multilayer information remains a challenge. There are many publications on best practice for
visualisation of research outputs. Modellers, scientists, and managers are often reluctant to rationalise the results of trade-off analysis, instead prioritizing the need to show how much work has been done over the need to show the key consequences of the trade-offs.

As highlighted by other task groups and others, the project funding nature of research and development funding for tools for EBM and the EBM process as a whole makes development of operational tools more difficult (Link et al., 2018; Rudd et al., forthcoming). Some base funding to move from project to project would help. Funding for science in short duration projects makes long-term development, maintenance, and application difficult (Curtice et al., 2012).

Many of the criteria from EBM-STAR for success (Figure 4.1) are outside the current mechanism for rewarding and benefiting academic and institutional modellers, scientists, and managers. This gap poses challenges for career development in this field. It also falls outside traditional reporting and documenting (e.g. primary peer reviewed literature, books etc.). Indeed, usage and validation of tools cannot currently be considered a priority for success on the academic career path.

We note that trade-offs are inherent in marine management decision-making. We predict that marine management decision-making bodies will need to address trade-offs more explicitly going forward. In order to overcome the challenges listed above, we suggest explicit attention to trade-offs in both research (including advisory processes) and management associated with EBM. This would include:

- Development and implementation of approaches for explicit trade-off analyses,
- Use of the elements of EBM-STAR outlined in this report, including an iterative and adaptive approach to development of tools
- Consideration of ecological, social, economic and institutional considerations in decision-making
- Use of the additional best practices identified in this report.
### 7 Conclusion and recommendations

#### 7.1 Discussion

This assessment of the criteria for successful tool development and use in EBM is one task of the AORA Ecosystem Approach to Ocean Health and Stressors working group. Other tasks include working with stakeholders, mandates, sectors and pressures, and a common understanding and gaps in knowledge. Addressing these tasks will lead to a synthesis of research priorities for the North Atlantic.

This workshop also discussed various additional issues linked to EBM. The AORA mandates task group (AORA, 2018) found that the mandates for an ecosystem approach exist in all three jurisdictions, and yet the tools task group found that some jurisdictions lacked a forum to discuss and implement cross sectoral, cross objective, trade-offs.

The workshop re-emphasised the importance of evidence-based decision making in EBM. Many stakeholders and managers share this emphasis, however, moving to cross sectoral and cross objective trade-offs in EBM should not reduce the expected quality of the evidence. Participants suggested that they knew of cases where poorer quality science was used because it supported political and/or lobbying positions.

The workshop focused on trade-offs, which, by their nature reflect the need to manage local sectors, carrying out activities that produce pressures. Direct pressure state relationships are clearly linked. Many of the pressures that affect marine ecosystems have fewer local management links such as climate, invasive species, pollution (chemical), and eutrophication, and are thus not always directly manageable. The pressures could also be considered diffuse and some can be mitigated. The workshop did not consider these types of pressure, and nor did it consider tools for analysis and prediction of cumulative effects.

The workshop concluded that a perceived relative paucity of tools for social and institutional objectives constrained advancement of EBM. The workshop also emphasized the inclusion of personal values, cultural, and spiritual objectives, which could be resolved by including these considerations in the management objectives. Other participants emphasized a need to consider these in other stages of the EBM process. All participants did agree, however, that this issue will increase in prominence in future.

#### 7.2 Recommendations

- Adapt tool development to ensure that social and institutional trade-offs become as explicit as ecosystem and economic trade-offs.
- Data and information from the presentation, utilization, and validation criteria of the EBM-STAR become available to improve advice.
- Perform validation in the EBM-STAR after use to demonstrate robustness to our limited understanding of the system.

#### 7.3 Conclusions

Improved understanding of trade-offs is central to the ecosystem approach to management. A host of tools exist to support trade-off analysis in Ecosystem Based Management (EBM). Tools are used to assess the state and then explore the possible options and consequences of decision-making. The provision of tools for societal decision-making requires that modellers, scientists, and managers operate beyond the traditional boundaries of their training. When developing tools that conform to best practice (chapter 4), for use in the EBM arena, a number of challenges exist (including working across disciplines, combining evidence of differing veracities, co-production
with stakeholders, transparency of information and assumptions, simplification of complex processes when communicating outcomes, see chapter 6) and the process is often resource intensive. AORA EA2OHS has shown that there is a wealth of tools available for EBM in the North Atlantic, and whilst many management challenges require bespoke tools to address specific questions and evidence needs, the broad categories of tools highlighted here can be used to guide modellers, scientists, and managers towards application. Many resources have been invested in developing tools for EBM across the jurisdictions of the North Atlantic. However, few tools have been used operationally and even fewer are having their performance validated (see EBM star, chapter 4).

This report has further explored how and when tools can be used in EBM and in what situations the application of tools are appropriate. An iterative approach is required, and modellers, scientists, and managers should work in an adaptive manner when producing and implementing these tools. Tools need to be applied appropriately, but can provide important insight into trade-offs in decision-making and improving transparency of management decisions.
**References**


9 Background and overview of the Atlantic Ocean Research Alliance

The Atlantic Ocean Research Alliance (AORA) between Canada, the EU and the US was launched by the signatories of the Galway Statement on Atlantic Ocean Cooperation in May 2013. The AORA intend to advance the shared vision of an Atlantic Ocean that is healthy, resilient, safe, productive, understood and treasured so as to promote the well-being, prosperity and security of the present and future generations.

The AORA intend to advance this agenda:

- by taking stock of and utilising existing bilateral science and technology cooperation and multilateral cooperation frameworks including those related to ocean observation, and ocean literacy initiatives;
- recommending priorities for future cooperation and, where possible,
- coordinating the planning and programming of relevant activities in these areas including promoting researcher mobility.

To date the AORA have identified four priority cooperation areas (in no particular order below) and set-up an AORA Working Group on each of these:

- Ecosystem Approach to Ocean Health & Stressors
- Seabed Mapping
- Aquaculture
- Ocean Literacy

The Trilateral Galway Statement Implementation Committee oversees the implementation of this historic Atlantic Ocean Cooperation and the AORA Working Groups.

The above Committee is made up of three (3) Co-Chairs from the bodies mandated by each jurisdiction to implement the Galway Statement.

The AORA-CSA is one of the vehicles through which the AORA works to implement the Canada–EU-US Galway Statement on Atlantic Ocean Cooperation. The AORA-CSA supports the AORA by organising meetings, workshops and events as well as catalysing opportunities as part of that taking stock and moving forward together with the Atlantic Ocean Cooperation. The AORA-CSA has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement no. 652677.

This meeting/workshop is sponsored by the Atlantic Ocean Research Alliance, and is organised by Work Package 4 of the AORA-CSA. The AORA-CSA has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement no. 652677.
## Meeting Participants

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Terms of Reference

Conveners: M. Robin Anderson, Paul Snelgrove, Howard Townsend, Anna Rindorf, Mark Dickey-Collas

Overarching Goal: Create a document on what are the criteria for successful uptake and use of a tool in exploring trade-offs in EBM?

Expected participants: Providers of operational tools for EBM that use tools and have experienced tangible challenges.

Terms of Reference:

1. Define what is meant by successful uptake
2. Explore the potential criteria for successful uptake
3. Explore factors that hinder uptake
4. Use examples to highlight success and poor uptake.
5. Synthesise result into a report and include ways to improve use of existing tools

Background material will include the table of tool classification from the 2017 AORA report (Annex 2).
Annex 1 - Case study examples

11.1 Tool example: Ecosystem Services Framework

Case Study - Belize Coastal Zone Management Plan: Integrated Valuation of Ecosystem Services and Trade-offs (InVEST)

The process: Development of model-based scenarios to inform coastal and marine spatial planning decisions. Use of maps to illustrate and evaluate scenarios. Modelers and mappers engaged stakeholders engaged through an iterative process of scenario development. Data on pertinent ecosystem services and stressors (e.g., coastal development, dredging, aquaculture and impacts on fishing and marine recreation) were collected to develop models and maps. The models were used to in scenarios to assess ecosystem service impacts of a variety of coastal resource policies. The results were used to inform national marine policy decisions in Belize - Integrated Coastal Zone Management Plan (ICZMP). The work was completed through collaborative effort between Coastal Zone Management Authority and Institute (CZMAI), World Wildlife Fund and the Natural Capital Project

STAR assessment:

4.1 (Trade-offs identified) - Across Multiple Sectors: fishing (e.g., lobster reef and mangrove habitats), tourism, coastal development, etc; considered multiple objectives: economic, well-being. Stakeholder process - included CZM team and reps from relevant ministers. Iterative approach. Used metrics that people cared about.

4.2 (Trade-offs evaluated) - Data, maps, simple models - evaluated across multiple scenarios. CZMAI designed three possible future zoning schemes to identify tradeoffs among alternative stakeholder visions and values. The planning team used the scenarios – at national and regional scales – to determine how alternative zoning schemes and use recommendations affect ecosystem services. This enabled configuration of a zoning scheme that limited impacts on habitats and the services they provide, while improving economic returns from sustainable uses.

4.3 (Trade-offs presented) - The resulting Plan was submitted to the Ministry of Forestry, Fisheries and Sustainable Development for approval and then go to the National Assembly for a vote in late 2013 or early 2014.

4.4 (Trade-offs decided) - This ecosystem-based approach formed the science basis for most of the coastal zone management recommendations presented in the ICZMP (2016).

4.5 (Trade-offs analysis worked) – As the ICZMP was just recently adopted, insufficient time has passed to allow evaluation of the trade-off analysis.

Conclusion: The implementation of an ecosystem services framework enable trade-offs to be identified and analyzed with extensive stakeholder engagement. Development of multiple coastal zone policy scenarios and clear presentation of policy outcomes enable decision-making and implementation of national policy. Accounting for uncertainty was limited or lacking.

References:


11.2 **Tool example: Risk Assessment - Pathways of Effects**

(a framework for application of DPSIR to risk assessment, DFO, 2012a)

Case Study – Anguniakvia Niqiqyuam Marine Protected Area Planning, Beaufort Sea, Canada

Pathways of Effects (PoE) used to identify risks associated with activities from ocean use sectors for marine conservation objectives (DFO 2014).

The process: Objectives for the MPA were identified (DFO 2011). An ecosystem overview was completed (Chambers and MacDonell 2012a). A PoE assessment of stressors and impacts was carried out (DFO 2014). A socio-economic assessment of the region (DFO 2012b) and a traditional ecological knowledge survey (Kavik-Axys Inc. 2012) were also completed. These reports and analyses informed the selection of the protection instrument (National Park vs MPA etc) and the final decisions on boundaries, management objectives, restricted activities for the Anguniakvia Niqiqyuam MPA.

Star assessment:

4.1 Potential impacts of activities were identified but trade-offs among objectives or sectors were not explicitly considered in the process.

4.2 PoE allowed for the explicit assessment of risks from all sectors but did not consider trade-offs or interactions.

4.3 PoE was presented with other information on ecosystem, socio-economic system, cultural knowledge and legislative/institutional context.

4.4 PoE was used in decision making process. However there does not appear to be documentation of the actual process followed.

4.5 MPA management objectives are suitable for monitoring to assess success and monitoring program development is ongoing(?) However success of uptake of PoE tools cannot be assessed given the lack of explicit tradeoff analysis.

Conclusion: The Anguniakvia Niqiqyuam MPA establishment process contained the elements of successful EBM tool application (PoE risk assessment, consideration of ecological, social cultural and institutional information) but did not explicitly consider tradeoffs in a transparent, evidence-based fashion.

References:


11.3 Tool example: Strategic Simulation Models (End-to-end models)

Case Study - Mississippi River Hydrodynamic & Delta Management Study

The process: A Hydrodynamic/Hydrologic working group developed a suite of models to simulate the pertinent physical process (e.g., sediment transport) in the river and adjacent basins. The output from these models contributes to the engineering, design, operation, and management of proposed river diversions and enhances understanding of the potential influence that diversions will have on river and wetland morphology. Output from the hydro- models were couple to a suite of ecological models (habitat suitability models and food web models – Ecopath with Ecosim & Ecospace, EwEE, and Complex Aquatic Simulation Model, CASM. This model coupling enable stakeholders to explore the potential impacts of environmental changes (e.g., wetland morphology, salinity) on the fisheries ecosystem (e.g., primary productivity and biomass/distribution of important fisheries stocks as well as marine mammals). EwEE model is published (de Mutsert et al 2017). Other models outlined in Expert Panel Report (2016).

STAR assessment:

4.1 (Trade-offs identified) - Restoring marsh via freshwater/sediment diversion potentially results in long-term land-building, storm protection, and fisheries production. Short-term changes in salinity, temp, etc. may influence habitats, marine mammals, trophic interactions, fish distributions and abundance, fishing communities. Within sector- multiple fisheries; across sectors – shoreline rebuilding and protection associated with sediment redistribution vs. changes in productivity, abundance, and distributions of fish stocks and marine mammal populations;

4.2 (Trade-offs evaluated) - coupled hydrodynamic models and fisheries ecosystem models (EwE and CASM) to evaluate impacts of diversions on fish, mammals, etc. Human Dimensions working group evaluate results for socioecon concerns. Note: multiple models and sensitivity analysis to deal with uncertainty

4.3 (Trade-offs presented) - Overview of all diversion projects tested and presented to multi-agency working group and reviewed by expert panel (Expert Panel 2016); Round 2: Specific diversion project (Mid-Barataria Sediment Diversion Project) being tested using this framework currently results and decision expected in 1 year.

4.4 (Trade-offs decided) – Analysis incorporated in the Coastal Master Plan (2017) and decision was made to move forward with development and implementation of diversion projects in the region. Coastal Louisiana Protection Authority using this process for decision-making on development and implementation of the Mid-Barataria Sediment Diversion project (ongoing).

4.5 (Trade-offs analysis worked) – Further implementation of projects and long-term monitoring is needed to evaluate. Monitoring and adaptive management plan in place.

Conclusion: Strategic Simulation Modelling approach enabled identification of potential trade-offs associated with shoreline rebuilding through sediment diversion projects. First round was high-level strategic (e.g., focused on multiple sediment diversion projects). Multiple stakeholders and agencies were involved in the process. An adaptive management approach is being developed and implemented to ensure this process can be implemented with individual sediment diversion projects in the future.

Uncertainty was addressed through multiple hydro model scenarios and sensitivity runs in EwEE.
11.4 **Tool example: Dynamic spatial fisheries models to determine impacts of closed areas on species impacted by fisheries and fisheries**

Case Study – MSE to determine impacts of conservation areas (conservation) on species impacted by fisheries and fisheries (fisheries) in the Adriatic Sea.

The process: Scoping exercises provided information on aspects of interest including among other things hake, sole, mullet and mantis yield to fisheries, discards, effort in vulnerable habitats, changes in stock size and socioeconomic factors (e.g. Net Present Value and income equality). Following this, spatially explicit MSEs were constructed using the dynamic DISPLACE model to estimate impacts of suggested closed areas on these aspects. Subsequently, the results were presented to stakeholders and used in regional management of the Marche region in Italy.

STAR assessment:

4.1 (Trade-offs identified) – Trade-off identification was performed through first identifying the main objectives in a collaborative process with stakeholders and then considering whether there were substantial trade-off effects between these objectives.

4.2 (Trade-offs evaluated) – The trade offs were evaluated using the spatially explicit MSE dynamic model DISPLACE specifically adapted to the region.

4.3 (Trade-offs presented) – Model results were presented in regional Italian meetings with industry and managers.

4.4 (Trade-offs decided) – The management has been informed but decisions are still in being decided in an iterative process based on small changes to proposed management measures.

4.5 (Trade-offs analysis worked) – As the process is still ongoing, the success of the trade off analysis cannot be determined.

Conclusion: The process enabled a more informed discussion with stakeholders by quantifying the impact of spatial measures on the desired aspects. The study confirmed that no effort is displaced onto vulnerable benthic habitats and to grounds not suitable for the continued operation of fishing (Bastardie et al. 2017).

References:

11.5 Tool example: Multi-criteria Decision Making (MCDM)

Case Study – Horseshoe Crab, HC, fishery and Red Knot, RK, conservation. RK is a migratory shorebird; the *rufa* subspecies was listed as a candidate for Endangered Species Act protection.

The process: A technical working group developed coupled population projection models - RK vital rates linked to HC juvenile survival, explore different hypotheses about potential effects of HC fishery on RK population. Stakeholder concerns were noted in public meetings and heard through various stages of model development (public comment periods of technical meetings). The Work Group developed models to estimate horseshoe crab harvest levels that will support the energetic needs of the red knot population passing through Delaware Bay.

STAR assessment:

4.1 (Trade-offs identified) - Horseshoe Crab- bait fishery, biomedical industry (hemocyanin used for testing pharmaceuticals purity); Red Knot- endangered species; migrating red knots (shorebird) eat HC crab eggs in Delaware Bay (McGowan et al 2014, McGowan et al 2015)

Within sector - bait fishery and biomedical fishery; cross-sector: fisheries and recreation-tourism; conservation; note: not explicit modeling of within-sector objectives

4.2 (Trade-offs evaluated) - coupled population projection models - RK vital rates linked to HC juvenile survival, explore different hypotheses about effects of HC on RK population (McGowan et al 2011).

4.3 (Trade-offs presented) - Model results presented to Atlantic States Marine Fisheries Commission HC technical committees and management board (McGowan et al 2009)

4.4 (Trade-offs decided) - Red knot needs are were incorporated into HC fisheries management plan (1998) by addenda (Addendum VI 2010 & VII 2012).
4.5 (Trade-offs analysis worked) - Stock assessment and monitoring of HC is spotty. More researched needed to evaluate the strength of the modeled connections between HC and RK. (McGowan et al 2009)

Conclusion: The Horseshoe Crab-Red Knot MCDM process enable stakeholders to have their concerns considered, quantified (to the extent possible with available data), and used for making management decisions. Uncertainty was accounted for by using a range of population parameters (e.g., recruitment) in the coupled models). Trade-off analysis was used in decision-making and results of the initial analysis continue to be incorporated into the fisheries management plan.

References:

11.6 Tool example: MSE to determine long term management targets for small pelagics

Case Study –MSE to determine management targets for fisheries on small pelagics considering impact on average income (fisheries) and required annual input to fishers and the processing industry (local rural community impact).

The process: Scoping exercises provided information on the main objectives in fisheries for small pelagics in the fishing industry (high average income, preferably every year to the fishery), from a conservation point of view (maintain spawning stock above levels adversely affecting the stock and dependent predators) and local processing industry (maintaining stable supply of commodities) (Rindorf et al 2018). Following this, MSEs were constructed to estimate average yield, frequency of low yields and risk of falling below agreed biomass levels under different management
strategies for North Sea sprat, sandeel and Norway pout (ICES 2014, 2017 and 2018). The MSEs were single stock models and though the effect of changes in predator abundance on estimates was considered, the model did not consider dynamic effects on dependent predators. Further, the exact effect of changes in supply on the processing industry was not estimated.

There are numerous models from other areas that could be used as examples of the same dynamic and trade-offs for forage fish, e.g. Punt et al. 2016, Bogstad and Gjøsæter 2001, Sainsbury et al. 2000, Sainsbury et al 1997).

STAR assessment:
4.1 (Trade-offs identified) – Trade-off identification was performed through first identifying the main objectives in a collaborative process with stakeholders and then considering whether there were substantial trade-off effects between these objectives. All methods were peer reviewed by ICES.
4.2 (Trade-offs evaluated) – The tradeoffs were evaluated using MSE models specifically adapted to each species (ICES 2014, 2017 and 2018). The potential management strategies were developed in a collaborative process with stakeholders.
4.3 (Trade-offs presented) – Model results have been presented in national Danish meetings with industry and managers and at EU level at advisory council meetings and been used to answer a request to ICES from Norway and the EU.
4.4 (Trade-offs decided) – The management method has continued to prioritize conservation as the highest ranking objective followed by average catches for sandeel and sprat and no change has occurred as a result of the presentations. However, several alternative management strategies have been rejected as realistic possibilities as these jeopardized conservation or average yield. For Norway pout, the advice was delivered in 2018 and decisions have yet to be made.
4.5 (Trade-offs analysis worked) – While no changes have been made to management, the historical development of the three stocks provide support for the prediction that the highest yield is achieved at the cost of stability and biomass above agreed levels.

Conclusion: The process enabled a more informed discussion with stakeholders by quantifying the cost of obtaining conservation, yield and stability targets to the other objectives. As the different stakeholder groups each held different objectives, the decisions of priority were based on legally binding objectives more than consensus between the groups. Stakeholders were able to articulate their suggestions, get the impact of these quantified, and used in making management decisions. Stochasticity was integral to the models and different kinds of structural uncertainty were evaluated. The trade-off analysis was presented to decision makers but the results did not change current management.

References:

ICES 2018. ICES Special Request Advice on EU/Norway request to ICES on evaluation of long-term management strategies for Norway pout in ICES Subarea 4 (North Sea) and Division 3.a (Skagerrak–Kattegat). Available at http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2018/Special_requests/eu-no.2018.07.pdf


11.7 Tool example: MICE to determine short term impact of advised catch levels on bycatch

Case Study –MICE to determine short-term impact of advised catch levels (fishery) on bycatch of potentially endangered and threatened species (conservation) using harbor porpoise as an example.

The process: Scoping exercises provided information on the main objectives in fisheries for demersal fish (avoid foregone yield), from a conservation point of view (maintain spawning stock above agreed levels and avoid increasing bycatch risk of harbor porpoise) (Rindorf et al. 2017). Following this, mixed fisheries tactical model were parameterised to estimate average yield and an index of risk of bycatch under different short term management strategies for demersal fisheries in the North Sea, including fisheries using static gear which potentially bycatch porpoises (ICES 2015).

STAR assessment:

4.1 (Trade-offs identified) – Trade-off identification was performed through first identifying the main objectives in a collaborative process with stakeholders and then considering whether there
were substantial trade-off effects between these objectives. All methods were peer reviewed by ICES.

4.2 (Trade-offs evaluated) – The trade-offs were evaluated using mixed fisheries models specifically adapted to the species (ICES 2015). The potential management strategies were previously developed in a collaborative process with stakeholders and appear as standard scenarios in ICES mixed fisheries advice.

4.3 (Trade-offs presented) – Model results have not been presented as the porpoise population is currently considered to be impacted below the agreed limit level in the North Sea, and there has subsequently been no requests for advice on the topic.

4.4 (Trade-offs decided) – None

4.5 (Trade-offs analysis worked) – No information.

Conclusion: The process provided the tools necessary to quantify changes to bycatch mortality as a result of different short term fishing scenarios but the importance of this advice was reduced by a general decrease in fishing effort in static gears and a subsequent decrease in concerns of excessive bycatch mortality.

References:
