Practical steps to implementation of integrated marine management


Gavin A. Begg, Robert L. Stephenson, Tim Ward, Bronwyn M. Gillanders and Tony Smith

SARDI Publication No. F2015/000465-1
SARDI Research Report Series No. 848

FRDC PROJECT NO. F2008/328.21

SARDI Aquatic Sciences
PO Box 120 Henley Beach SA 5022

July 2015

Final report for the Spencer Gulf Ecosystem and Development Initiative and the Fisheries Research and Development Corporation
Practical steps to implementation of integrated marine management


Final report for the Spencer Gulf Ecosystem and Development Initiative and the Fisheries Research and Development Corporation

Gavin A. Begg, Robert L. Stephenson, Tim Ward, Bronwyn M. Gillanders and Tony Smith

SARDI Publication No. F2015/000465-1
SARDI Research Report Series No. 848
FRDC PROJECT NO. F2008/328.21

July 2015
## Contents

- Contents ............................................................................................................................... iv
- Figures ................................................................................................................................... v
- Acknowledgments ................................................................................................................. vi
- Abbreviations ........................................................................................................................ vi
- Executive Summary ............................................................................................................. vii
- Introduction ........................................................................................................................... 1
- Objectives .............................................................................................................................. 2
- Methods ................................................................................................................................. 3
- Results ................................................................................................................................... 4
- Discussion .............................................................................................................................. 17
- Conclusion ............................................................................................................................. 21
- Implications .......................................................................................................................... 23
- Appendix 1: Project Staff ...................................................................................................... 24
- Appendix 2: Intellectual Property .......................................................................................... 24
- Appendix 3: References ....................................................................................................... 24
- Appendix 4: Workshop Agenda ............................................................................................ 25
- Appendix 5: Workshop Presentations ................................................................................... 43
Figures

**Figure 1.** Examples of global progress towards integrated marine (oceans) management (from Ward et al., see Appendix 5) ........................................................................................................4

**Figure 2.** Integrated marine management captures the range of user groups, often with competing objectives (from Fulton, see Appendix 5). ...............................................................6

**Figure 3.** Typology of objectives – strategic to process (from Walshe, see Appendix 5). .......7

**Figure 4.** Example of objective setting across multiple stakeholders (from Poiner and McIntosh, see Appendix 5). ........................................................................................................8

**Figure 5.** Example of a feedback process for defining and evaluating objectives and their trade-offs (from Walshe, see Appendix 5). .................................................................9

**Figure 6.** Tools available to support integrated marine management (from Jakeman, see Appendix 5). ........................................................................................................................10

**Figure 7.** Understanding cumulative impacts involves assessing the effects of multiple activities (from Fogarty, see Appendix 5). ...........................................................................10

**Figure 8.** Examples demonstrating complexity of management arrangements across Commonwealth and State jurisdictions (from Musso, Harman, see Appendix 5). ..........17

**Figure 9.** Step-wise policy-shifts, such as integrated marine management, require a greater demand for science to support decision-makers (from Haward, see Appendix 5).....18

**Figure 10.** Common framework for specifying multiple objectives across multiple activities (from Stephenson, see Appendix 5) .................................................................19

**Figure 11.** Common framework enables assessment of alternate management scenarios and their trade-offs (from Stephenson, see Appendix 5) ..................................................20
Acknowledgments

We thank the representatives of the jurisdictions, industry and research bodies who participated in the workshop, as well as Dr Michael Steer and Jane Ham (SARDI) for assistance in documenting the workshop discussions and report formatting, respectively. We acknowledge the funding and organisational support of the Spencer Gulf Ecosystem and Development Initiative (SGEDI; which includes the industry investors BHP Billiton, Santos, Arrium, Alinta, Nyrstar, Centrex, Flinders Ports, and research partners the University of Adelaide, SARDI and Flinders University), Fisheries Research and Development Corporation (FRDC), PIRSA SARDI, and the Canadian Fisheries Research Network. Dr Robert Stephenson’s participation in the workshop was funded through the FRDC People Development Program Visiting Expert Award on behalf of the Australian Government.

Abbreviations

CPUE – Catch Per Unit Effort
EAF – Ecosystem Approach to Fisheries
EBFM – Ecosystem Based Fisheries Management
ESD – Ecologically Sustainable Development
FAO – Food and Agricultural Organisation
FGM – Fishery Gross Margin
FRDC – Fisheries Research and Development Corporation
GVP – Gross Value of Production
MEY – Maximum Economic Yield
PIRSA – Primary Industries and Regions South Australia
SARDI – South Australian Research and Development Institute
SGEDI – Spencer Gulf Ecosystem and Development Initiative
TAC – Total Allowable Catch
Executive Summary

Marine ecosystems are becoming increasingly crowded with a growing demand by multiple users for space and resources. Integrated marine management is a logical and necessary step in progressing our understanding of the cumulative impacts of multiple activities, avoiding unintended consequences of sector-specific management and dealing with competing/conflicting interests among stakeholders. Integrated marine (or oceans) management is the coordinated management of diverse activities with consideration of ecological, economic, social and institutional (i.e. governance) objectives to sustainably develop our coasts and oceans.

Spencer Gulf, South Australia, is an example of a marine ecosystem that supports a diverse array of economically important industries, popular recreational activities and marine species of conservation significance. The region has significant opportunities for expansion of mining, with a large number of new mineral extraction and processing ventures proposed. Associated with this expansion will be increased shipping and port development. Consequently, there is a need for an integrated approach to port development, shipping, fisheries, aquaculture and other competing activities in the Gulf to inform critical management decisions. Spencer Gulf could be used nationally as a case study in integrated marine management, building on the current research and engagement initiative driven by industry and the community.

An international workshop was held on 13-15 April 2015, at the South Australian Research and Development Institute (SARDI), South Australia, to discuss the steps involved and lessons learned in the practical implementation of integrated marine management. International and national case studies were examined in the context of governance, stakeholder objectives and tools for integration, as well as a dedicated session on the progress towards integrated marine management in Spencer Gulf.

The principles of integrated marine management have become more coherently defined over the last decade. Despite these efforts, integrated marine management is, at best, a work in progress, and has largely not progressed from the single sectoral approaches which it aims to unify. The transition to a systematic, integrated approach will not be easy, fast or simple but is likely to be gradual, iterative and adaptive, and require strong leadership and stakeholder engagement.

Integrated marine management requires the articulation and assessment of a comprehensive set of objectives and strategies, including ecological, social, economic and institutional dimensions. The challenge is to establish a broader set of common objectives across stakeholders and understand the trade-offs, where conflicts are inevitable through competing needs.

This report summarises key concepts, information and discussions held at the workshop, and provides recommendations as to potential steps forward for the practical implementation of integrated marine management. The knowledge gained from the workshop can be used to inform the development of a blueprint for the potential implementation of integrated marine management in Spencer Gulf, and elsewhere.

This workshop was initiated through funding from the Spencer Gulf Ecosystem and Development Initiative (SGEDI) and the Visiting Expert Award from the Fisheries Research and Development Corporation (FRDC) People Development Program.

Keywords

Integration; ecosystem based management; integrated marine management; integrated oceans management; Spencer Gulf.
Introduction

Spencer Gulf, like many of the world’s coastal ecosystems, supports a diverse array of economically important industries, popular recreational activities and marine species of conservation significance. The region has significant opportunities for expansion of mining, with a large number of new mineral extraction and processing ventures proposed. Associated with this expansion will be increased shipping, port development and potentially biosecurity risks. Spencer Gulf is also recognised for its clean, green image and high quality seafood production and has several tourism ventures based on environmental assets (e.g. giant Australian cuttlefish). Fisheries (e.g. prawns, blue swimmer crabs, snapper, garfish, King George whiting, abalone, southern rock lobster) and aquaculture (e.g. southern bluefin tuna, yellowtail kingfish, abalone, oysters, mussels) in Spencer Gulf provide important economic returns to the State and some are expanding. Spencer Gulf includes several marine parks and is an important nursery area for many fish species.

The key question to answer is how South Australia can support development of mining ventures, expansion of fishing and aquaculture, and conservation and recreation needs, while simultaneously delivering on the environmental, social and economic objectives associated with Spencer Gulf. An integrated approach to marine management is required to ensure that the ecological, economic and social outcomes are optimised across industries and user groups for the benefit of all South Australians, while preserving the integrity of the ecosystem. Such an approach would provide all stakeholders with access to independent and credible information about Spencer Gulf and opportunities to better understand any potential impacts so that informed decisions can be made.

Communities and markets are demanding that these marine systems are managed sustainably and deliver an appropriate balance of economic, social and ecological benefits to surrounding communities. At the same time the community needs to ensure that decisions are based on informed science. Integrated decision-making, stakeholder engagement, and independent scientific advice based on sound knowledge of the system are critical for multiple use areas.

A range of agreements, policies and legal frameworks have been developed that call for the implementation of ‘ecosystem-based’ and/or ‘integrated’ management of marine ecosystems. In South Australia and many other places, however, current management largely occurs on a sector-by-sector basis.

The Spencer Gulf Ecosystem and Development Initiative (SGEDI) aims to develop a comprehensive and informed decision-support system to progress integrated marine management in Spencer Gulf. The initiative sets out to drive sound outcomes for all Gulf users and the environment. To date the initiative has identified substantial knowledge gaps with respect to the Gulf and engaged with a wide range of stakeholders across sectors and regions to determine important points of focus and interest. It is delivering an integrated science program, backed with structured decision-making, so that the environmental evidence can be most easily applied for economic and social outcomes.

Integrated marine or oceans management may be defined in several ways (see Haward, Appendix 5), but is taken here to mean the coordinated management of diverse activities with consideration of ecological, economic, social and institutional (i.e. governance – management arrangements and aspirations; roles and responsibilities; transparent, evidence-based decision-making) objectives to sustainably develop our coasts and oceans.

In this report we use integrated marine management and integrated oceans management interchangeably.
Objectives

The overall objective of the workshop was to provide a forum to discuss the steps involved and lessons learned in the practical implementation of integrated marine management.

To deliver this objective a stakeholder workshop was held involving natural resource managers, industry, community members and the research sector. The aims of the workshop were the following:

- To evaluate international and national progress towards integrated marine management.
- To identify the key elements that have been critical to the successful implementation of integrated marine management.

International and national case studies, at a range of spatial and jurisdictional scales, were examined to inform the development of an integrated marine management framework that incorporates multiple use and cumulative impacts, and identifies the economic, social and ecological benefits of integrated marine management.

The main outcome of the workshop was to provide an understanding of the challenges and steps required to successfully implement integrated marine management in Spencer Gulf.

This workshop builds on previous ecologically sustainable development and ecosystem based management initiatives (e.g. Smith and Hodge 2001, Fletcher et al. 2002, Millington and Fletcher 2008, Fletcher 2012, Begg et al. 2014), and is envisaged to be a pathway to integrated marine management.
Methods

An international workshop involving natural resource managers, industry, community members and the research sector was held on 13-15 April 2015, at the South Australian Research and Development Institute (SARDI), West Beach, South Australia (see Appendix 4 for the workshop agenda and list of participants).

The workshop was based around presentations and discussion of the following areas:

- Governance, legislative and policy frameworks;
- Stakeholder, multiple use objectives;
- Integration and cumulative impacts.

International and national case studies were examined in the context of the above critical elements that are fundamental to integrated marine (ocean) management. A dedicated session on the progress towards integrated marine management in Spencer Gulf concluded the workshop.

This report summarises key concepts, information and discussions held at the workshop, and provides recommendations as to potential steps forward for the practical implementation of integrated marine management.
Results

Overview

The principles of integrated marine management came together in the 1990s and have become more coherently defined over the last decade. However, despite these efforts, integrated marine management is, at best, a work in progress, and has largely not progressed from the single sectoral approaches which it aims to unify. The transition to a systematic, integrated approach will not be easy, fast or simple but is likely to be gradual, iterative and adaptive. Although implementation of integrated marine management poses a significant challenge, there is a need to progress in this direction because our oceans contain an increasing array of multi-sectoral activities and user-groups, often with competing objectives and needs. Integrated marine management is essential in overcoming some of the current shortcomings of single sectoral-based management, including the current lack of attention to cumulative impacts and trade-offs among competing user groups.

Governance, legislative and policy frameworks

There have been legislative changes in many countries over the past 20 years in support of integrated management of coastal and marine activities (Figure 1).

Integrated marine management in the USA is being implemented through a variety of policy avenues at State and National levels (see Foley, Appendix 5). The US National Oceans Policy (2010) calls for the development of integrated regional plans (in 9 areas) by 2020 to improve “Stewardship of the Ocean, Our Coasts, and the Great Lakes.” Successful State efforts to date, including the Massachusetts Ocean Plan, California’s Marine Life Protection Act, and the Puget Sound Partnership, demonstrate the need for a strong and clear mandate, political support and leadership, adequate funding, firm deadlines, willingness and capacity for stakeholders to engage, and a transparent decision-making process.

See Appendix 5 for the presentations given at the workshop.
In the European Union (EU) there are a mosaic of policies (where the EU has authority) and directives (for which the EU sets out results that Member States must achieve, monitored by the European Commission, and interpreted and implemented by Member States) encompassing the ecosystem approach, marine protected areas and spatial planning of activities (Dickey-Collas et al., Appendix 5). These include:

- Fisheries are governed by the Common Fisheries Policy (1972 updated in 2014);

In the EU, there are many diverse players, including international and national governments, local governments, regional sea commissions, advisory groups and stakeholder fora raising the question as to how the parts can work together for integrated management. Although there is no shared vision of what is meant by integration, Europe appears to be “learning by doing” as its already crowded seas experience greater demands placed on them by the EU blue growth agenda.

Canada’s Oceans Act (1996) provides the legal framework for integrated management; however, the Act is non-prescriptive and implementation has been limited (McIsaac, Stephenson, Appendix 5). A range of integrated marine management initiatives have been attempted. These include developments in large ocean management areas such as the Pacific North Coast Integrated Management Area (PNCIMA) and Eastern Scotian Shelf Integrated Management (ESSIM) in which government and stakeholders have defined and agreed to an overarching ecosystem based management framework; although these have not been operationalised. Other regional efforts include the Marine Planning Partnership of the North Pacific (MaPP) bi-lateral collaboration between the BC Government and 18 First Nations Governments, West Coast Aquatic (WCA) multi-jurisdictional collaboration, and the Southwest New Brunswick Marine Advisory Committee which is mandated to provide advice regarding integrated management to all levels of government. Getting beyond the strategic to practical integrated management, however, remains a challenge.

Australia has been attempting to develop and implement integrated oceans management since 1998 under the National Oceans Policy (1998) (Haward, Appendix 5; Vince et al. 2015).

The Regional Marine Planning (RMP) program, led by the National Oceans Office between 2001 and 2005, was the centrepiece of Australia’s Oceans Policy. It sought to integrate planning and management across a number of government portfolios with responsibility for activities in the ocean. While arguably responsible for a strengthened focus on the marine environment, the program as an exercise in integration failed, being replaced after a review in 2006 by the Bioregional Marine Planning program, which was entirely under the purview of the Minister for the Environment (Musso, Appendix 5).

A more successful example of integration is planning for the iconic Great Barrier Reef (GBR) (Harman, Appendix 5). The GBR Marine Park Authority, working with the Queensland Government, has developed a strategic assessment, program report and most recently the Reef 2050 Long-Term Sustainability Plan that will provide an over-arching management framework ensuring integration, coordination and alignment of actions to protect the values of the GBR World Heritage Area and continue to support ecologically sustainable development and use. This has been accomplished in spite of the complexities of jurisdictional boundaries across Commonwealth and State agencies. Key areas for focus include decision-making based on clear targets to maintain the GBR’s universal value, a cumulative impact assessment policy to manage impacts from multiple sources, a net benefit policy to guide actions aimed at restoring ecosystem health, a reef recovery program to support local communities and stakeholders to protect the GBR, and world-leading GBR-wide integrated monitoring and reporting.

A new State-wide approach to sustainable marine management is being implemented in New South Wales (NSW) (Apfel, Appendix 5). Following a 2011-2012 audit of NSW marine parks that
concluded effective marine management must extend beyond marine park boundaries, the NSW Government set up a strategic, evidence-based approach to managing the NSW marine estate as a continuous system. A new Marine Estate Management Authority has been established, and is overseeing the development of a Marine Estate Management Strategy. A new Marine Estate Expert Knowledge Panel, comprising six members, provides direct access to independent advice across ecological, economic and social science disciplines. The strategy will be underpinned by the first ever State-wide assessment of threats and risks, including cumulative and future impacts. Although the Marine Estate Management Authority has no regulatory powers, it offers a ‘whole of government’ strategy that will articulate how programs will be better coordinated and focused on priority threats to support a diverse, healthy and productive coast and sea.

Integrated, risk-based frameworks have been developed in Western Australia (WA) to implement regional level ecosystem based fisheries management (Fletcher, Appendix 5). The hierarchical structure considers both the individual impacts on the environment from each fishery and cumulative impacts from all fisheries-related activities operating in a region, while taking into account the social and economic objectives to deliver the best overall outcome to the community. To assist this approach, the new Aquatic Resources Management Act now requires development of Aquatic Resource Management Strategies (ARMS) that define, at a regional or resource level, the overall objectives (ecological, social, economic) for the coordinated management of each of the State’s major aquatic resources. These ARMS incorporate decisions related to the allocation of access to different sectors plus associated sectoral harvest use and resource protection plans. This regional level, risk-based approach has greatly improved the coordination and effectiveness of government planning and prioritisation processes. It also provides better linkages between fisheries management and regional planning generally undertaken by other marine based agencies that deal with coastal development, ports and shipping, mining/petroleum, etc.

Stakeholder objectives

A key component of integrated marine management is the complexity of assessing and integrating the cumulative impacts of multiple users and governance/policy arrangements with multiple (and often competing) objectives (Figure 2).

![Pragmatic Multiple Use Management](image)

**Figure 2.** Integrated marine management captures the range of user groups, often with competing objectives (from Fulton, see Appendix 5).

The setting of objectives is fundamental to effective planning and decision-making, but can be a difficult and slow process (Walshe, Appendix 5). It is recognised that explicit objectives are critical, and that objectives range from strategic to process (Figure 3). A key challenge in multi-stakeholder
settings, such as integrated marine management, is striking a balance between inclusivity and problem complexity. Good problem formulation promotes a collective understanding of where different stakeholder interests lie, and how they will be addressed. Decision-making is an iterative and adaptive process, where trade-offs between competing objectives need to be considered and uncertainty and risk is an inherent part of the process.

Figure 3. Typology of objectives – strategic to process (from Walshe, see Appendix 5).

Stakeholder values (and the objectives that underpin these) usually evolve during the decision-making process. Consequently, it is important for effective multi-stakeholder engagement that the different stakeholders understand the different options and their consequences, and that they immerse themselves in the decision-making process to fully comprehend the trade-offs. Consensus is desirable but not necessary for good decision-making, where socially-accepted outcomes based on a comprehensive understanding of the trade-offs is more achievable rather than any form of optimisation of competing objectives. Diverse and competing objectives reduce the probability of a single ‘best’ solution and emphasise the need for scenario comparison to show likely consequences of trade-offs.

Integrated marine management requires the articulation and assessment of a comprehensive set of objectives and strategies, including ecological, social, economic and institutional dimensions (Stephenson, Appendix 5). Therein lies the challenge for the practical implementation of integrated marine management, which inherently addresses multiple sectoral activities and community needs/aspirations to sustainably develop and manage the marine environment. The challenge is to establish a broader set of common objectives across stakeholders and understand the trade-offs, where conflicts are inevitable through competing needs; albeit that the ecological objectives have primacy, as a healthy environment and the maintenance of ecosystem service functions are fundamental to meeting the broader economic and social objectives.

Three presentations, at a range of jurisdictional and spatial scales, demonstrated the challenges in setting multi-stakeholder objectives (see Appendix 5).

Dickey-Collas et al. provided a perspective on the complexity involved in objective setting in the EU, where tension exists between objectives for the key policies. Recently, the European Commission began a process to reconcile the objectives, bringing the Common Fisheries Policy, Marine Strategy Framework Directive, Birds and Habitats Directive, Water Framework Directive and Marine Spatial Planning Directive into the same arena. Aspirational statements and vague language are used in the legislation as a means to reach a compromise. However, this approach can lead to ambiguity in the interpretation of objectives and in turn poses challenges for the development of a common understanding. A participatory process is required to operationalise the aspirational objectives, which will need a clear understanding of the trade-offs amongst objectives.
At the national scale, Stephenson summarised the experience in the development of a comprehensive set of objectives in integrated planning initiatives in eastern Canada. While ecological objectives related to productivity, biodiversity and habitat are well articulated, the same is not true of social and economic objectives, which tend to be implicit or generic. This is similar to most jurisdictions, although broader objective setting is starting to occur (e.g. Begg et al. 2014). Further, the practical implementation of economic, social and institutional objectives arising from Canadian policies presents a governance challenge. Conflicting objectives and the need to weigh trade-offs suggest the need for articulation of diverse management scenarios and development of appropriate governance fora in which management options can be discussed.

Poiner and McIntosh provided a local scale example of objective setting in the development of an ecosystem health report card to monitor the condition of Gladstone Harbour (Queensland, Australia), as part of the industry and community driven Gladstone Healthy Harbour Partnership. Concerns over the impacts of major industrial expansion, fish health incidents and habitat loss prompted a response from all the major stakeholders in the region to establish the partnership. The process to develop the partnership included setting operational objectives and indicators, and consisted of five key stages: 1) stakeholders in the region developed a vision for the future of Gladstone Harbour; 2) from this vision a series of specific objectives were developed; 3) these were used to derive appropriate and measurable indicators; and 4) a geographically representative monitoring program was designed, resulting in, 5) a series of scores which could be aggregated to overall indexes of harbour condition (Figure 4).

![Figure 4. Example of objective setting across multiple stakeholders (from Poiner and McIntosh, see Appendix 5).](image)

**Tools and integrative approaches**

A large part of integrated marine management is related to management decision-making. Techniques of management science are especially relevant. Walshe (Figure 5, Appendix 5) illustrates a process of defining the decision problem, articulating clear objectives and scenario comparison so that trade-offs may be considered explicitly (see also Stephenson, Jakeman, Appendix 5). These are best implemented as advice alternatives in a risk-based approach, recognising uncertainty (Fletcher, Jakeman, Appendix 5).
Integrated assessment is a meta-discipline and process designed to deal with multi-faceted, multi-use resource systems comprising inter-dependent social, economic and ecological components, and characterised by stakeholders with different and often conflicting goals. A broad palette of analytical tools, encompassing conceptual, structural, and empirical models, is now being applied in the integrated analysis of marine systems (see Fulton, Fogarty, Appendix 5). Models range from conceptual, that are especially useful in developing a collective understanding, to ‘toy and training’ models that show how systems work, to more specific sectoral models and attempts to model full systems (Fulton, Appendix 5). These approaches are complementary and address different needs. Conceptual models provide vital communication tools for stakeholders that can also provide the foundation for specification of both qualitative and quantitative modeling approaches. Structural models comprise the class of analytical models ranging from relatively simple input-output models to complex end-to-end models used in support of ecosystem-based management. Empirical methods, principally multivariate time series models, have provided avenues for analysis where a priori information on expected forms of structural models or the nature of interactive effects among stressors on ecosystem components is unknown or uncertain. There is no one size fits all approach to the successful integration of multiple information sources, drivers, feedbacks and objectives. There are different tools for different times and using a combination of tools can often provide useful insights and greater learning than persisting with one method in isolation (Figure 6).
<table>
<thead>
<tr>
<th>Tool Category</th>
<th>Examples of tools</th>
<th>Application</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Exploratory tools    | statistical analyses, data mining, multivariate exploratory techniques, data-based models | search for patterns in data and relationships between variables             | • Improve system understanding  
|                      |                                                        |                                                                            | • Identify indicators and criteria                                      |
| Knowledge representation tools | process-based models, integrated models such as Bayesian networks, decision trees, conceptual models, mind maps, spatial analysis, mapping | summarize and represent what is understood about the system by integrating or encoding knowledge and data | • Improve system understanding  
|                      |                                                        |                                                                            | • Communication of knowledge  
|                      |                                                        |                                                                            | • Social learning                                                        |
|                      |                                                        |                                                                            | • Identify knowledge gaps                                                |
| Optimisation tools   | multi-objective optimisation models, genetic algorithms, cost-benefit analysis | find the solution that optimises the objective function based on a single criterion, or finds the set of solutions at the Pareto frontier when multiple criteria are involved | • Improve system understanding  
|                      |                                                        |                                                                            | • Screen or evaluate alternative management options                       |
| Participatory tools  | participatory modelling, focus groups, scenario analysis, stakeholder workshops, role playing games | constitute interactive or deliberative approaches where stakeholders contribute by expressing their knowledge, ideas, preferences and/or values | • Identify objectives, issues, preferences, management options  
|                      |                                                        |                                                                            | • Obtain information from stakeholders                                  |
|                      |                                                        |                                                                            | • Improve system understanding                                            |
|                      |                                                        |                                                                            | • Social learning                                                         |
|                      |                                                        |                                                                            | • Support negotiation, reduce conflict and build trust                     |
| Prediction tools     | data-based models, process-based models, integrated models | estimate impacts of alternative scenarios on criteria of interest             | • Improve system understanding                                            |
|                      |                                                        |                                                                            | • Evaluate alternative management options                                 |
| Trade-off tools      | integrated models, MCDA                                 | explore trade-offs involved with different alternatives based on two or more criteria | • Improve system understanding                                            |
|                      |                                                        |                                                                            | • Evaluate alternative management options                                 |
|                      |                                                        |                                                                            | • Facilitate negotiation and conflict resolution                           |

Figure 6. Tools available to support integrated marine management (from Jakeman, see Appendix 5).

Understanding cumulative impacts of multiple activities is a critical gap in integrated marine management. Some impacts are direct, others are indirect. Where considered, impacts have often been assumed to be linear/additive, and are used as a first step in understanding cumulative effects, when in fact they may be non-linear/multiplicative. Scientific recommendations for conducting cumulative effects analyses are often not well aligned with legal mandates and case law in many jurisdictions. As a result, cumulative effects analyses usually do not fully incorporate the best available science and tend to be inconsistently applied (Foley, Appendix 5). Consideration of cumulative impacts is complicated by interaction among stressors and underlying ecosystem change (Fogarty, Figure 7, Appendix 5). Synthesis, integration and deliberation are essential.

Figure 7. Understanding cumulative impacts involves assessing the effects of multiple activities (from Fogarty, see Appendix 5).
Integrated marine management will require more and different information. Data capacity is changing (i.e. improved technology facilitates data collection but can result in large amounts of data to manage, increasing restraint in some government agencies is compromising the capacity to collect additional information, etc.) and monitoring is a core feature of recent marine plans (e.g. Harman, Appendix 5). Monitoring, aligned to integrated science plans, is undertaken to track the status and trend of key values, inform state-dependent decision-making, or learn more about system dynamics (e.g. Australia’s Integrated Marine Observing System (IMOS), see Moltmann, Appendix 5). There is increasing attention to monitoring by diverse ocean users, and a related need to ask what information, if we had it, would improve decisions, i.e. take a ‘value of information’ approach (Walshe, Appendix 5).
Spencer Gulf as a case study

Spencer Gulf, South Australia, is an important region for economic development in South Australia. This region has significant opportunities for expansion of mining, with a large number of new mineral extraction and processing ventures proposed in areas surrounding the Gulf. Associated with this expansion will be increased shipping, port development and potentially biosecurity risks. Currently, Spencer Gulf is recognised for its clean, green image and high quality seafood production; it also has several tourism ventures based on environmental assets. Fisheries (e.g. prawns, snapper, garfish, King George whiting, abalone, southern rock lobster) and aquaculture (southern bluefin tuna, yellowtail kingfish, abalone, oysters, mussels) in Spencer Gulf provide important economic returns to the State and have potential to expand. Spencer Gulf includes several marine parks. The region has important relict populations of tropical species (e.g. commercially fished blue crab), and also supports a significant breeding aggregation of giant Australian cuttlefish. It is an important nursery area for many fish species. There is potential for significant conflict among stakeholders in this region and the complex mixture of activities and values makes Spencer Gulf an ideal setting for a case study into integrated marine management.

Spencer Gulf is a large (approximately 7500 km²), sheltered, tidal, inverse estuary. The Gulf is 325 km long with a maximum width of ~100 km (Gillanders et al. 2013, Shepherd et al. 2014). The maximum depth is about 50 m and over 75% of the area is less than 30 m deep. The Gulf is surrounded by arid lands due to low rainfall in the region (250-600 mm per annum). The region also experiences high evaporation rates (2400 mm per annum). The combination of low rainfall and high evaporation results in the top of the Gulf reaching salinities in excess of 40‰. Inverse estuaries are not unique to the South Australian gulfs (Spencer Gulf and Gulf St Vincent). They are also found at Shark Bay in Western Australia, and in the Northern Hemisphere, (e.g. Red Sea, Persian and Arabian Gulfs, and the Mediterranean).

Governance

All of Spencer Gulf is included in the federal electoral division of Grey, which covers 904,881 km². Based on 2014 electoral boundaries there are five State Government electoral divisions: Flinders, Giles, Stuart, Frome and Goyder.

Three Regional Development Australia regions surround Spencer Gulf: Whyalla and Eyre Peninsula; Far North; and Yorke and Mid North. Regional Development Australia is an Australian Government initiative that brings together all levels of government to enhance the development of Australia’s regions. There are also two Natural Resource Management (NRM) regions which split Spencer Gulf in half (Eyre Peninsula on the western side; Northern and Yorke on the eastern side). These operate in a collaborative approach in partnership with the South Australian Department of Environment, Water and Natural Resources. The NRM boards aim to ensure that natural resources in their region are sustainably managed and provide benefits to landholders and the broader community.

Four key State Government agencies have responsibility for activities in Spencer Gulf:

- Department of Environment, Water and Natural Resources (DEWNR);
- Department of Planning, Transport and Infrastructure (DPTI);
- Department of State Development (DSD);
- Department of Primary Industries and Regions (PIRSA).

In addition, SA Water, Coast Protection Board, Environment Protection Authority, Defence SA, and South Australian Tourism Commission also have interests in Spencer Gulf.

The Minister for Transport and Infrastructure owns all of the adjacent and subjacent land in South Australia and has a statutory obligation to fulfil the objects of the Harbors and Navigation Act 1993. Ports are covered under the Maritime Services (Access) Act 2000 – this covers the three Flinders Ports-owned ports in Spencer Gulf. There are also indenture agreements (an agreement between the State and a company/companies that sets out rights and obligations of both parties) around two further ports that have been ratified through State Parliament, which are the responsibility of the Minister for Mineral Resources and Energy. One is the Stony Point (Liquids Project) Ratification Act 1981 regarding Port Bonython jetty that was constructed by Santos in 1982, and purchased by the State Government in 1983. The jetty is licenced and used by Santos under the above Ratification Act. The port at Whyalla
used by Arrium is also under two indenture agreements, the Whyalla Steel Works Act 1958 and Broken Hill Proprietary Company’s Indenture Act 1937.

Other legislation (ordered by the Minister responsible) of relevance to Spencer Gulf includes:

At the local government level there are 12 councils around Spencer Gulf, some of which have formed regional groups. For example, the Upper Spencer Gulf Common Purpose Group brings together the

<table>
<thead>
<tr>
<th>Attorney-General (2 acts)</th>
<th>Minister for Sustainability, Environment and Conservation (9 acts)</th>
<th>Minister for Tourism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native Title (South Australia) Act 1994</td>
<td>Coast Protection Act 1972</td>
<td>Minister for Transport and Infrastructure (5 acts)</td>
</tr>
<tr>
<td><strong>Minister for Agriculture, Food and Fisheries (2 acts)</strong></td>
<td>Environment Protection Act 1993</td>
<td>Harbors and Navigation Act 1993 (referred to above)</td>
</tr>
<tr>
<td><strong>Minister for Mineral Resources and Energy (2 acts plus 3 listed above)</strong></td>
<td>Marine Parks Act 2007</td>
<td>Protection of Marine Waters (Prevention of Pollution from Ships) Act 1987</td>
</tr>
<tr>
<td><strong>Minister for Planning</strong></td>
<td>Natural Resources Management Act 2004</td>
<td></td>
</tr>
<tr>
<td>Development Act 1993</td>
<td>Wilderness Protection Act 1992</td>
<td></td>
</tr>
</tbody>
</table>

councils encompassing Whyalla, Port Augusta and Port Pirie, as well as the RDAs and education providers in the region.

**Objectives**

South Australia’s Strategic Plan has seven priorities including realising the benefits of the mining boom for all, and premium food and wine from our clean environment. There are a number of relevant policy drivers associated with the Living Coast Strategy, Mining Infrastructure Plan, SA Multiple land-use framework, EPBC approvals and referrals process, and planning reform.

There are over 20 Acts of relevance to Spencer Gulf which are the responsibility of 6 Ministers plus the Attorney-General (see above). Many of these acts have objectives that overlap in relation to ecological, social, economic and institutional objectives (see summary below).
Marine planning

South Australia embarked on a marine planning process over 10 years ago, with a pilot marine plan for upper Spencer Gulf (a plan for lower Spencer Gulf was also envisaged) developed based on principles of ecosystem based management, ecologically sustainable development and adaptive management (Government of South Australia 2006, Day et al. 2008, Paxinos et al. 2008) (see Huppatz, Appendix 5). A zoning model was developed that grouped habitats and species into four ecologically rated zones that each had an impact threshold. The marine planning process was meant to complement the marine parks process. However, the marine planning framework was not implemented as government policy and has not developed further than the initial pilot project in Spencer Gulf. Its focus was largely on conservation rather than integrated management.

Tools

During the workshop three presentations (Middleton, Goldsworthy, Cassey, Appendix 5) demonstrated the types of decision support tools that have been or will be developed for Spencer Gulf. In addition, a project has started that will develop knowledge and tools to inform integrated management of Spencer Gulf (Gillanders, Appendix 5).

Several decision support tools currently exist for Spencer Gulf, although at present they are focused around fisheries and aquaculture. For example, a nutrient carrying capacity decision-support tool allows a rapid assessment of concentrations of nitrate, ammonia, dissolved oxygen, phytoplankton and detritus, along with flushing time scales such that aquaculture can be managed within the Gulf (Middleton, Appendix 5). Results from the model are applicable to any source of “pollutant”, for example, desalination brine, wastewater treatment plant and industry outfalls. Similar models could be developed for sediment transport (to address port development and shipping issues), as has been developed for prawn larval dispersal (McLeay et al., in press).

An ecosystem (food web) model in Spencer Gulf has been developed using Ecopath with Ecosim (Goldsworthy, Appendix 5). The model demonstrates the importance of primary producers (i.e. seagrass, macroalgae and phytoplankton) in the system, as well as the large biomass of crustaceans. A range of ecosystem indicators can be used to examine changes through time, and scenario testing has been undertaken to test different amounts of aquaculture, and changes in fisheries catch and effort. Finfish aquaculture, for example, indicates how bottom-up changes through additional nutrient loading can affect both benthic and pelagic systems through trophic cascades. This model is at the first stage

<table>
<thead>
<tr>
<th>ACTS</th>
<th>Fisheries and Parks</th>
<th>Environment Protection</th>
<th>Resource Management</th>
<th>Transport</th>
<th>Culture</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBJECTIVES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conservation - productivity</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Conservation - biodiversity</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Conservation - habitat</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Economic</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Social &amp; cultural</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Institutional governance</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Research &amp; education</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
</tbody>
</table>

✔ implied; ✔️ mentioned; ✔✔✔ detailed
of development and further work is required to develop a spatially explicit model and validate results (see Gillanders et al. 2015 for further details).

Current research in Spencer Gulf is also using ports and shipping as an example to develop knowledge and tools to inform integrated management (Cassey, Gillanders, Appendix 5). Spencer Gulf accommodates both international and domestic shipping, attracting export ships specialising in the transport of ores, minerals, grain and seeds and import ships with fertiliser, coal, minerals and petroleum products. The major shipping routes intersect commercially important fishing grounds and, in some locations, approach coastal aquaculture operations. Bulk and container ships are also increasing in size and draught, which may require the deepening and widening of many existing shipping channels. South Australia’s growing mining sector also requires additional ports.

The SGEDI-funded ports and shipping study has a number of objectives including identifying independent and cumulative impacts of human uses and associated stressors on marine habitats, conducting a detailed analysis of current shipping activities and predicting likely future scenarios for shipping and port development (Gillanders, Appendix 5). A model for visualising impacts of shipping type and frequency with predicted changes to port infrastructure and use is currently being constructed. This model will allow shipping lanes, their zone of influence, as well as vessel speeds and residence times to be estimated. A risk analysis for introduction and establishment of exotic pests and pathogens and a spatial risk assessment of impacts of future shipping on key iconic and threatened species will also be undertaken. Finally, there will be a synthesis of all information on the impacts of future shipping and port scenarios on the environment and other industries to identify tools needed to support future assessment and management of these activities.

Next steps

Spencer Gulf is becoming increasingly crowded with multiple users/activities, but there is no streamlined or efficient process to deal with competing/conflicting interests, suggesting a need for integrated marine management. There is an opportunity for Spencer Gulf to be used nationally as a case study—it currently has the private partnership, but needs public/government involvement. The connection to State Government is essential.

Governance

• There are three components to governance: government; stakeholders; and science, which capture the key aspects of decision-making, accountability and authority.

• There is a need for an appropriate integrated governance framework (i.e. enabling vs regulatory) that can inform all of the responsible sector and regional management agencies; this requires government involvement. It is not something that industry or researchers can achieve in isolation. Consideration is needed as to what is achievable/possible given the current governance arrangements. Empowerment, authority to act and leadership are key.

• As part of this approach there is a need to map the current decision-making processes, and review the roles of the different agencies, legislations, policies, structures, etc.

• Agencies (e.g. DPTI, DSD, DEWNR, PIRSA) with regulatory responsibilities in Spencer Gulf need to be engaged and discussions held around the broader concepts of integrated marine management and their appetite for change. The information required includes agency needs, and the value proposition from such an approach.

• An integrated management group, involving the key agencies may need to be established.
• There may be a need for research on governance options (e.g. state of play, different governance alternatives and scenarios, feedback on scenarios).

Engagement

• Engagement is required across all levels of government.

• Ongoing and regular engagement with the diverse range of stakeholders in Spencer Gulf is required.

• There is a need to continue to build on participatory stakeholder involvement that should be com-
mitted, accountable, inclusive, transparent and responsive.

- Engagement needs to occur in a collaborative manner to bring people together with diverse knowledge to provide a better outcome.
- There needs to be champions across all interest groups.

Science

- There is an opportunity to develop a national pilot in integrated marine management using Spencer Gulf as a case study.
- A baseline of measurements against which to determine change in the system is important.
- The study should include the development of simple, conceptual models (easier to communicate with), as well as complex ecosystem models.
- Need to identify, understand and integrate ecological, social, economic and institutional objectives and drivers.
- There is a need to establish the diverse team required for inter-disciplinary collaborations needed for integrated marine management.
- The Resources Infrastructure Taskforce provides an opportunity to ensure that the proposed science especially in relation to ports and shipping is relevant to government requirements.
- The research undertaken as part of the marine parks review process could be utilised if there is an on ground focus around Spencer Gulf.
- An understanding of cumulative impacts is important, rather than focusing on individual activities. Cumulative impacts should consider more than just additive effects.
- The science needs to be solution or problem focused, and scenario testing and consideration of trade-offs are essential.

References


Discussion

Australia, Canada, Europe and USA all have legislation calling for integrated marine management, but legislative frameworks are not achieving their full vision of integration. Implementation remains a challenge in spite of considerable effort in many areas. There are several reasons.

Integrated marine management is complex. It crosses jurisdictions and sectors. Activities in an area are often managed by different groups using different approaches. Australia, for example, has ‘fragmented decision-making’ resulting from complex State and Commonwealth jurisdictions, diverse sectoral plans and indigenous interests (Figure 8).

![Diagram](https://www.parksaustralia.gov.au)

**Figure 8.** Examples demonstrating complexity of management arrangements across Commonwealth and State jurisdictions (from Musso, Harman, see Appendix 5).

There is often competition (e.g. for space and resources), and conflicting jurisdictional and stakeholder priorities. Furthermore, there is a need for attention to cumulative impacts and trade-offs amongst competing users and interest groups. These, together with the complexity of
considering the natural and social systems illustrate the ‘Governance Challenge’ for integrated marine management.

Integrated marine management is seen by some stakeholders as complicating management, and adding another layer of bureaucracy and costs. Also, there seems in several cases to be a lack of interest among stakeholders and/or government in taking on the additional responsibility and complexity of integrated marine management. In these cases, the benefits of integrated management, such as assessing cumulative impacts and avoiding unintended consequences of sectoral-based management, may not have been well articulated or clearly understood. Limited resources can also prevent integration.

The challenge of implementing integrated marine management can arise more from governance issues than from limitations with the science. In cases of major step-wise policy-shifts, such as integrated marine management, there is a greater demand for science (and the necessary resources) to support decision-makers and stakeholders (Figure 9). At the same time, there is often a disconnect between political cycles (approximately 3-4 years), management cycles (on the order of a decade) and ecological scales (longer term). In the current fiscal environment where resources are limited and governments are being asked to do “more with less,” the challenges associated with major policy shifts are exacerbated. In such cases, leadership is essential (Smith, Appendix 5).

The challenge of integrated marine management also include the rationalisation of sector-based plans with area-based considerations for planning of the cumulative effects of multiple activities; the adaptation of governance that will allow efficient and viable activities within an inclusive participatory structure; and the adaptation of traditional science to meet increased demands of integration. In some cases the first initiatives under integrated marine management legislation have been the development of Marine Protected Areas (MPAs). MPAs and marine spatial planning are not in themselves integrated marine management, employing only a subset of the tools/strategies required for integration (see Foley, Fogarty, Appendix 5). In essence, MPAs are one of the “activities” using the marine space. Integrated marine management involves the coordination of management planning for diverse marine activities; MPAs (i.e. biodiversity conservation) can be viewed as one of those activities.

**Figure 9.** Step-wise policy-shifts, such as integrated marine management, require a greater demand for science to support decision-makers (from Haward, see Appendix 5).

There remains a gap in the governance that would empower implementation of integrated marine management ‘on the ground’. There is the need to link management of activities in an integrated framework. This would be facilitated by a coherent framework of objectives (ecological, social, economic), applied to all activities (to facilitate examination of cumulative effects) in an appropriate
governance structure. Collaboration between government and stakeholders requires leadership and time to build a basic common understanding of ecological and social systems. If a collaborative rationale for integrated management is a desired outcome, the governance process, stakeholder engagement, common objective setting and decision support tools need to be considered and agreed.

All stakeholders, including government, need to drive the process in developing a coherent framework of objectives for the effective implementation and success of integrated marine management. There needs be a clear understanding and articulation for why this is needed and the benefits such an approach will bring. Without this leadership, direction and ownership, the challenges with implementation will be difficult to overcome. Clear operational objectives need to be established and trade-offs between these assessed and understood. Science can assist in the development of a framework to evaluate objectives, and there are various tools available to assess trade-offs, such as management strategy evaluation and whole-of-system scenario modelling (Fulton, Fogarty, Jakeman, Smith, Appendix 5).

Stephenson outlined a framework where multiple objectives across multiple activities (or users) could be articulated (Figure 10). Such a framework captures the changing landscape of resource management and provides a consistent format for stakeholders to consider the full suite of ecological, social, economic and institutional objectives in a transparent and simple manner in order to evaluate trade-offs (Figure 11). Following the articulation of individual objectives, the challenge is in their integration, where trade-offs need to be considered and cumulative impacts determined to ensure unintended consequences of sectoral and isolated management of individual activities are reduced.

![Common framework for specifying multiple objectives across multiple activities](image)

**Figure 10.** Common framework for specifying multiple objectives across multiple activities (from Stephenson, see Appendix 5).
Figure 11. Common framework enables assessment of alternate management scenarios and their trade-offs (from Stephenson, see Appendix 5).
Conclusion

Common to integrated marine management is an emphasis on management decisions, attention to process, multiple objectives and the issue of integration across activities. Integrated marine management is not a replacement for existing sector-specific management, but adds value to management by addressing some of the aspects currently missing in sector-based planning, including:

- participatory, transparent and integrated governance;
- a broader set of objectives (ecological, economic, social and institutional aspects);
- emphasis on scenario comparison and structured decision-making;
- consideration of cumulative impacts;
- attention to interaction (conflict resolution) among sector-specific activities and trade-offs.

A number of lessons have been learnt over the past decade(s) following the initial foray into the implementation of integrated marine management; there is still much to be done. These include:

Integrated marine management is a necessity
- Oceans provide important ecosystem services; current, sector-based management has gaps that cannot be filled without integration.
- It offers the best option for successful management of multiple uses with diverse objectives.

Integrated marine management can/should fill major gaps
- There is a need for broader objectives covering multiple users, consideration of cumulative impacts, reduction of unintended consequences of sector-specific management and attention to conflicts/trade-offs. Integrated management can, if implemented properly, fulfill these needs.
- The key challenge in assessing cumulative impacts centres on interactions among stressors; understanding additive effects is a good first step, but there is a need to look beyond additive effects to synergistic and multiplicative interactions.

Integrated marine management is a challenge
- Most situations will involve multiple users, competing objectives, complex systems and governance, and limited resources.
- Implementation has largely failed in spite of enabling legislation.
- There is, to date, no recipe book or agreed best practice.
- In some cases major policy reform is required.

Integrated marine management tools are available
- Significant research has resulted in many relevant tools and approaches being developed. However, there is a disconnect/gap between the tools and step-wise change in the policies/processes that would facilitate implementation.
- Robust, independent science and monitoring programs are required to underpin implementation and evidence-based decision-making.

Integrated marine management is a process
- It is the implementation of a process for decision-making in relation to multiple objectives and many activities, and it is a process of decision-making/decision-support.
- Need to operationalise key concepts and objectives.
- Need adequate resourcing for the process; industry-government partnerships are beneficial in demonstrating support.
- Good process leads to good results. This should include authority/mandate/empowerment; appropriate participation; clear articulation of interests and agreed objectives; sharing information/knowledge among stakeholders; building a common understanding of the
system; establishing a collaborative and agreed approach to decision-making; monitoring, evaluation and adaption.

Integrated marine management can build on existing plans/processes
- More than spatial planning and MPAs, but they can provide a foundation for building plans/processes.
- There is no need to replace existing planning; but it can add value to existing processes.
- A practical approach to implementation is to have it influence existing planning for a common regional set of objectives.

Integrated marine management requires governance authority
- A major impediment to date has been practical governance arrangements that empower a group to undertake integration.
- Need either mandate or inducement for stakeholders, and to overcome any government intra-jurisdictional and/or –departmental challenges/tension.
- Need the spatial scale of planning to match governance.
- A ‘whole of government’ approach is critical.
- Political risks and imperatives need to be understood.
- Transparent decision-making processes are required; open access to data and information is needed.
- Governance and leadership are key.

Integrated marine management requires leadership
- Transformative policy change that is dependent on champions and strong leadership.
- At all levels – political, regulatory, stakeholders, research.
- Common vision and commitment are a necessity.
- Patience to follow the long road to changed management through iterative, step-wise progress.

Integrated marine management requires buy-in
- Provides an opportunity to engage in a beneficial process that can overcome problems of management if participants see the value of participation.
- Potential benefits need to be articulated and clearly understood.
- Engage stakeholders (including broader community) from the start; bring them along on the journey.
- Engagement needs to be effective, serious and sustained.
- Communication/consultation vital in developing trust and credibility.
Implications

Marine ecosystems around the world are becoming increasingly crowded with a growing demand for space and resources by multiple users. Integrated marine management is a logical and necessary step in progressing our understanding of the cumulative impacts of multiple activities and dealing with competing/conflicting interests among stakeholders. There is an opportunity for Spencer Gulf to be used nationally as a case study in integrated marine management, building on the current initiative driven by industry and community.

Spencer Gulf offers a prime potential case study for implementation of integrated marine management. The Gulf supports a range of economically important industries, popular recreational activities and marine species of conservation significance. The region has significant opportunities for expansion of mining, with a large number of new mineral extraction and processing ventures proposed. Associated with this expansion will be increased shipping and port development. Consequently, there is a need for an integrated approach to port development, shipping, fisheries, aquaculture and other competing activities in the Gulf to inform critical management questions.

Industry, through the Spencer Gulf Ecosystem and Development Initiative (SGEDI), has demonstrated their support for an integrated approach to management and the required need for an underpinning independent, collaborative science program. The SGEDI vision of a thriving Spencer Gulf region, where progressive developments occur, community opportunity is optimised, and the unique ecosystem is protected and enhanced is well aligned with the need for an integrated marine management framework, and offers a platform on which to build.

Funding from SGEDI and the FRDC People Development Program Visiting Expert Award provided the basis for this workshop, and has enabled the exploration for future collaborations and initiatives to progress integrated marine management.
Appendix 1: Project Staff

- Prof Gavin Begg – South Australian Research and Development Institute
- Dr Robert Stephenson – Canadian Fisheries Research Network
- A/Prof Tim Ward – South Australian Research and Development Institute
- Prof Bronwyn Gillanders – University of Adelaide
- A/Prof Tony Smith – CSIRO

Appendix 2: Intellectual Property

No intellectual property has been generated by this project.

Appendix 3: References


International Workshop: Practical steps to implementation of integrated marine management

13-15 April 2015
SARDI, West Beach

Agenda

Steering Committee – G. Begg (SARDI), R. Stephenson (Canadian Fisheries Research Network), T. Ward (SARDI), B. Gillanders (University of Adelaide), A. Smith (CSIRO)

Workshop Purpose:

- To evaluate international and national progress towards integrated marine management.
- To identify the key elements that have been critical to the successful implementation of integrated marine management.

The workshop will provide a forum to discuss the steps involved and lessons learned in the practical implementation of integrated marine management. International and national case studies, at a range of spatial and jurisdictional scales, will be examined to inform the development of an integrated marine management framework that incorporates multiple use and cumulative impacts, and identifies the economic, social and ecological benefits of integrated marine management.

The long term benefits of this workshop are envisaged to be a pathway to integrated marine management.

The first part of the workshop will focus on the governance and policy challenges of integrated marine management, with the second part of the workshop focused on the research and technical aspects required to support the implementation of integrated marine management.

The overall outcome of the workshop is to provide an understanding of the challenges and steps required to successfully implement integrated marine management in the Spencer Gulf.

The Spencer Gulf is a prospering development zone for South Australia, with mining, energy, fisheries, aquaculture, agriculture, coastal development and tourism activities. It also features rare and unique biodiversity of national significance. Ongoing development is anticipated in the region, with potential economic, environmental and social impacts that affect a diverse group of stakeholders. The Spencer Gulf and Ecosystem Development Initiative (SGEDI) aims to develop a comprehensive and informed decision support system with integrated marine management central to these aims.

The workshop is funded through SGEDI and the Fisheries Research and Development Corporation (FRDC).
DAY ONE (13 April 2015):

Morning tea on arrival

1000-1010: Welcome, introductions (Gavin Begg)

1010-1030:

Overview of integrated marine management; meaning/interpretation; challenges; purpose of workshop – Outcomes sought (Tim Ward)

1030-1245:

Governance, legislative & policy frameworks
What governance frameworks have been established to support integrated marine management? What are their strengths and weaknesses? What can we learn from attempts for implementation, such as Australia's Ocean Policy? What are the most appropriate pathways to establish a streamlined structure and process for integrated management that will allow ecological, economic and social outcomes to be achieved?

International case studies – Chair Tim Ward
- Eastern Canada – Rob Stephenson
- International/Western Canada – Jim McIsaac
- International/US example – Melissa Foley
- EU example – Mark Dickey-Collas

1245-1330: Lunch

1330-1630:

National case studies – Chair Gavin Begg
- National overview – Marcus Haward
- Commonwealth Oceans Policy – Barbara Musso
- Great Barrier Reef Marine Park – Sally Harman
- NSW Marine Estate – Petrina Apfel

1630: Close

DAY TWO (14 April 2015):

Morning tea on arrival

1000-1200:

Objectives
A key component of integrated marine management is the complexity of assessing and integrating the impacts of multiple users and governance/policy arrangements with multiple (and often competing) objectives. Questions to discuss include: How do operational objectives line up across multiple users? How are these derived and how are common objectives agreed? What are the challenges and impediments to be considered in reaching an agreed set of objectives for integrated marine management?

Chair – Gavin Begg
- Eastern Canada/Bay of Fundy – Rob Stephenson
- EU example – Mark Dickey-Collas
Integration & cumulative impacts

What are the steps involved for successful integration and decision making (i.e. from identifying key objectives, indicators, data collection methods, assessment, to monitoring to decisions)? How can knowledge of the system and decision-support tools be used to evaluate economic, social and ecological outcomes of management decisions and multiple use scenarios? What are the different approaches to decision support tools for assessing cumulative impacts and trade-offs among different sectors? What does an integrated monitoring program look like? It is not possible to monitor everything – what should be monitored and how do we best detect changes in ecosystem structure and function in a timely manner? This is a key R&D session to understand the state-of-the-art methods (and challenges) to identify and assess practical steps to successful integration and cumulative impacts across multiple users.

Chair – Rob Stephenson
- Mike Fogarty
- Melissa Foley
- Beth Fulton
- Tony Jakeman

1540 Introduction to Centre for Marine Socio-ecology – Stewart Frusher

1600: Close

DAY THREE (15 April 2015):

Morning tea on arrival

0940-1240:

Integration & cumulative impacts (cont.)

Chair – Bronwyn Gillanders
- Overview: decision making, multiple objectives – Terry Walshe
- Tony Smith
- Tim Moltmann
- Rick Fletcher
- Terry Walshe

1240-1320: Lunch

1320-1620:

Focused session on Spencer Gulf

This will be a dedicated session on understanding the governance arrangements and research and monitoring required for integrated marine management given the circumstances and interests in Spencer Gulf. The session will discuss (1) current governance arrangements and previous attempts for establishing integrated marine management frameworks; (2) outline the multiple users in Spencer Gulf, including current objectives and aspirations for the effective use of the gulf (based on previous SGEDI stakeholder workshops); and (3) the key science and monitoring required to support the implementation of integrated marine management in Spencer Gulf. The session will present a proposed science plan for Spencer Gulf to key stakeholders and invited speakers.
Chair – Gavin Begg
- Previous attempts (marine planning framework) – Tony Huppatz
- Spencer Gulf ‘objectives’ – Tim Ward
- Proposed integrated Spencer Gulf Science Plan – Bronwyn Gillanders
- Decision support tools – John Middleton/Simon Goldsworthy/Phill Cassey

Open group discussion

1620: Wrap up, Next steps, Workshop Close

DAY FOUR (16 April 2015):

Informal session on Spencer Gulf

This will be an informal session providing an opportunity for invited speakers to discuss Spencer Gulf integrated projects, as well as opportunities for broader R&D collaborations.

Agenda

1. How do we go from a non-integrated framework to an integrated framework in terms of legislative requirements; Science program; Stakeholder engagement? What are the key steps required? What might and might not work?

2. Discussion and feedback around SGEDI ports and shipping proposal
   - Key research activities and outcomes
   - Are we missing anything in matrix?

3. Potential research publication from workshop
Attendees

AFMA: Nick Rayns
AIMS: Terry Walshe
ANU: Tony Jakeman

Canadian Fisheries Research Network: Rob Stephenson

CSIRO: Beth Fulton, David Smith, Tony Smith

Conservation Council SA: Alex Gaut

Department of the Environment: Barbara Musso

DEDJTR Fisheries Victoria: Kirrily Noonan

DEWNR: Sandy Carruthers, Tony Huppatz, Brad Page, Patricia von Baumgarten

DPTI: Jenny Cassidy

DSD: Rob Thomas, Benjamin Zammit

EPA: Sam Gaylard

FRDC: Carolyn Stewardson

GBRMPA: Sally Harman

Gladstone Harbour Healthy Partnership: Ian Poiner

ICES: Mark Dickey-Collas

IMOS: Tim Moltmann

Industry – fishing: Steve Bowley (SAORC), Simon Clark (Spencer Gulf Prawn Fishery), Trudy McGowen (SAOGA)

NOAA: Michael Fogarty

NSW DPI: Petrina Apfel

PIRSA: Heidi Alleway, Michelle Besley, Matt Hoare, Annabel Jones, Jonathan McPhail, Brad Milic, Kate Rodda, Keith Rowling, Doug Young

SARDI: Gavin Begg, Marty Deveney, Simon Goldsworthy, John Middleton, Shirley Sorokin, Mike Steer, Jason Tanner, Tim Ward

SGEDI: John Bastion

SA Water: Jackie Griggs

Tbuck Suzuki Environmental Foundation: Jim McIsaac

University of Adelaide: Phill Cassey, Simon Divecha, Bronwyn Gillanders, Thomas Prowse, Sally Scrivens

University of Tasmania: Stewart Frusher, Marcus Haward
Upper Spencer Gulf Common Purpose Group: Anita Crisp

U.S. Geological Survey: Melissa Foley

WA Fisheries: Rick Fletcher
**Abstracts**

**Petrina Apfel**  
NSW Department of Primary Industries  

Petrina Apfel has been closely involved in developing an innovative cross-agency approach to managing NSW coasts and waters for four years. Petrina is a Principal Policy Officer with the NSW Department of Primary Industries. She is the marine estate Secretariat Manager. She supports the NSW Marine Estate Management Authority and expert knowledge panel. She also managed the secretariat for the Independent Scientific Audit of Marine Parks in NSW. Petrina has experience leading the development and enforcement of legislation across different jurisdictions, including the NSW Marine Estate Management Act 2014 and matters of national environmental significance under the EPBC Act.

'Beyond boundaries: NSW Marine Estate'

What does a new statewide approach to sustainable marine management look like? A 2012 audit of NSW marine parks concluded that effective marine management must extend beyond marine park boundaries. The NSW Government has set up a strategic, evidence-based approach to managing the NSW marine estate as a continuous system. A new Marine Estate Management Authority has been established. This Authority is overseeing the development of a Marine Estate Management Strategy. The strategy will be underpinned by assessment of threats and risks. It will articulate how government programs will be better coordinated and focus on priority threats, to support a diverse, healthy and productive coast and sea now and into the future.

**Dr Phill Cassey**  
University of Adelaide  

Phill Cassey is Head of the Invasion Ecology Group at the University of Adelaide, and co-Director of the Environment Institute’s Centre for Conservation Science and Technology. He is a quantitative ecologist who works at the forefront of biosecurity preparedness and transport pathway risk mitigation.

**Current shipping transport into Australia and predictions of likely future scenarios for shipping activities**

Both the International Maritime Organization and the Australian Government have developed policy seeking to reduce the risk of ship-mediated biological marine invasions. We constructed models for the transfer of ballast water into Australian waters, based on historic ballast survey data. We used these models to hindcast ballast water discharge over all vessels that arrived in Australian waters between 1999–2012. We used models for propagule survival to compare the risk of ballast-mediated propagule transport between ecoregions. We found that total annual ballast discharge volume into Australia more than doubled over the study period, with the vast majority of ballast water discharge and propagule pressure associated with bulk carrier traffic. As such, the ecoregions suffering the greatest risk are those associated with the export of mining commodities.

**Dr Mark Dickey-Collas**  
ICES  

Mark Dickey-Collas (@DickeyCollas) is the ecosystem approach coordinator in the secretariat of the International Council for the Exploration of the Sea (ICES) based in Copenhagen. ICES is an intergovernmental organisation (20 member countries) that focuses on marine science for sustainable use of the seas in the North Atlantic region. It is a network of more than 4000 scientists from over 350 marine institutes. Mark facilitates the development of the ecosystem approach for sustainable exploitation of the marine ecosystem and regional ecosystem assessments. He is currently active with ICES’ contribution to the EU marine strategy framework directive (MSFD). Mark liaises with OSPAR, HELCOM, IUCN, FAO, DG ENV and the European Environment Agency on issues such as ecosystem assessment, Good Environmental Status, vulnerable species and impacts of fishing. Mark has 20 years experience in providing fisheries science advice to national and international institutions and has a particular expertise in pelagic fish and fisheries. His scientific
experience is in the field of population dynamics, ecosystem modelling and the policy/science interface (http://www.researcherid.com/rid/A-8036-2008). Mark has a thorough knowledge of the scientific infrastructure and governance frameworks of Europe regularly working across EU framework programmes, national programmes and the Nordic Council of Ministers. He enjoys the challenges created when building and converting scientific knowledge into the evidence to guide policy development and has a proven track record of successfully working with stakeholders including government departments, industry representatives, skippers, NGOs and intergovernmental organisations from across Europe, North America, the North Atlantic and the Arctic.

Europe perspective on governance, legislative and policy frameworks

(Mark Dickey-Collas, Erik Olsen, Martin Pastoors)

A summary of the existing international and some national frameworks will be provided, with particular focus on the EU, Norway and the Netherlands. Recent examples will be used to highlight the strengths and weaknesses of the European approaches. As in many regions, there are a multitude of players, with international and national governments, local government, regional sea commissions, advisory groupings and stakeholder fora. Although there is no shared vision of what is meant by integration, Europe appears to be “learning by doing” as its already crowded seas experience greater demands placed on them by the EU blue growth agenda.

Europe perspective on objectives

(Mark Dickey-Collas, Erik Olsen, Martin Pastoors)

Within the EU, there exists a tension between the objectives for various policies and recently the European Commission has begun a process to trying to reconcile objectives. This brings the Common Fisheries Policy, the Marine Strategy Framework Directive, the Birds and Habitats Directive, the Water Framework Directive and the Marine Spatial Planning Directive into the same arena. The competency for differing policies/directives is held by differing players. The European approach to gain agreement by using vague language in the legislation leads to ambiguity in objectives, which poses challenges for the development of common understanding.

Dr Rick Fletcher

Department of Fisheries, WA

Rick obtained an Honours Degree from the University of Melbourne and a PhD in subtidal marine ecology from the University of Sydney. Since then he has had nearly 30 years’ experience in research and development on fisheries assessment, policy and governance issues in Australia and internationally. Over the past decade he has led a number of national initiatives that have successfully developed and implemented risk based ecosystem approaches for fisheries and aquaculture within Australia. In addition to currently being Executive Director - Research for the Department of Fisheries in Western Australia, he has been a consultant on ecosystem approaches, risk assessment and management for international agencies including the FAO and other Regional Fisheries agencies within Africa, Asia and the South Pacific. He is currently a member of NSW Marine Estate Knowledge Panel which is tasked with developing the methods to enable a coordinated approach to the management of this entire system.

Implementing a cost effective, risk-based approach to enable integrated, regional level fisheries management – no simulations required

Adopting multi-fishery, ecosystem based approaches is often thought to require complex simulation models and significant levels of data. The risk-based frameworks that have been developed in Western Australia to implement regional level Ecosystem Based Fisheries
Management (EBFM) can, however, be applied without any models. The hierarchical system considers both the individual impacts on the environment from each fishery and the cumulative impacts from all fisheries-related activities operating in a region while taking into account the social and economic objectives to deliver the best overall outcome to the community. To assist this EBFM approach, the new Aquatic Resources Management Act in WA now requires development of Aquatic Resource Management Strategies (ARMS) that define, at a regional or resource level, the overall objectives (ecological, social, economic) for the coordinated management of each of the State’s major aquatic resources. These ARMS incorporate any decisions related to the allocation of access to different sectors plus any associated sectoral harvest use and resource protection plans. The regional level, risk based approach has greatly improved the coordination and effectiveness of departmental planning and prioritisation processes. It also provides better linkages between fisheries management and the regional planning generally undertaken by other marine based agencies that deal with coastal development, ports and shipping, mining/petroleum, etc.

Dr Michael Fogarty
NOAA

Dr Michael J. Fogarty is the Chief of the Ecosystem Assessment Program at the Northeast Fisheries Science Center, Woods Hole, MA where he has been employed since 1980. He received his doctorate from the University of Rhode Island. He currently holds adjunct appointments at the Graduate School of Oceanography, University of Rhode Island and the School of Marine Science and Technology, University of Massachusetts. He has served on numerous national and international panels and committees including the Science Committee of the Global Ocean Observing System Program, the Scientific Steering Committee of the U.S. Global Ocean Ecosystem Dynamics (GLOBEC) Program (Chair 1997-2002), the Science Board of the Comparative Analysis of Marine Ecosystem Organization Program and the Lenfest EBFM Scientific Advisory Panel. His research interests center on the ecosystem effects of fishing, the role of climate change in marine ecosystem dynamics and strategies for implementing marine Ecosystem-Based Management. He is co-editor of the recently issued Volume 16 of The Sea: Marine Ecosystem-Based Management (Harvard University Press).

Pulling the pieces together: empirical methods for integration and cumulative impact analysis

A broad palette of analytical tools, encompassing, conceptual, structural, and empirical models, is now being applied in the Integrated Analysis of marine systems. These approaches are complementary and address different needs. Conceptual models provide vital communication tools for stakeholders that can also provide the foundation for specification of both qualitative and quantitative modeling approaches. Structural models as defined here comprise the class of analytical models ranging from relatively simple input-output models to complex end-to-end models used in support of ecosystem-based management. Empirical methods, principally multivariate time series models, have provided avenues for analysis where a priori information on expected forms of structural models or the nature of interactive effects among stressors on ecosystem components is unknown or uncertain. Here I focus on this latter class of analytical methods and the ways in which integration and cumulative impact analysis have been approached using multivariate statistical tools. Familiar examples include Principal Component Analysis, Canonical Correlation Analysis, and Redundancy Analysis. Other approaches more specifically suited to the analysis of time series of indicators are increasingly finding application in integrated Analysis. These methods include Dynamic Factor Analysis, Minimum/Maximum Autocorrelation Factor Analysis, Multivariate Adaptive Regression Splines, and new class of nonlinear, nonparametric time series models. Ultimately, our objective is to link measures of cumulative impact to ecosystem state variables and/or the sustainable delivery of ecosystem services. Here, I provide a brief introduction to these approaches and their potential utility as integrative tools for ecosystem-based management.

Prof Melissa Foley

Melissa Foley received her PhD from the University of California Santa Cruz and is currently a Research Ecologist with the United States Geological Survey (USGS) in Santa Cruz, California.
<table>
<thead>
<tr>
<th>Dr Beth Fulton</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CSIRO</strong></td>
</tr>
<tr>
<td>Beth Fulton is a Principal Research Scientist with the CSIRO and a member of the Centre for Marine Socioecology at UTAS. She developed the Atlantis modelling framework, used to provide strategic advice around management of marine resources and conservation. It has been applied in more than 30 marine ecosystems around the world to provide advice on managing potentially competing uses of marine environments, indicators and monitoring, and adaptation to global change. Beth also helped co-develop modelling frameworks that take systems based thinking and management strategy evaluation to the topic of sustainable multiple use management of complex coastal socioecological systems.</td>
</tr>
</tbody>
</table>

**Integrated marine management policy and implementation in the U.S.: opportunities, challenges, and lessons learned**

Integrated marine management in the U.S. is being implemented using a variety of policy avenues at State and National levels. I will discuss examples ranging across geographies, including the U.S. Ocean Policy, the Massachusetts Ocean Plan, California's Marine Life Protection Act, and the Puget Sound Partnership and highlight the opportunities, challenges, and lessons learned from these examples.

**Understanding the intersections between the science, law, and practice of cumulative effects analyses around the Pacific**

Scientific recommendations for conducting cumulative effects analyses are often not well aligned with legal mandates and case law in many jurisdictions. As a result, cumulative effects analyses do not fully incorporate the best available science and tend to be inconsistent across projects. I will present the results of our study looking at the state of the practice of cumulative effects analyses in California, USA; British Columbia, Canada; Queensland, Australia; and New Zealand and will highlight where practice assessments could be improved to better incorporate the best available science of cumulative effects.

**Model based approaches to considering cumulative impacts and tradeoffs**

There is no one size fits all approach to the successful integration of multiple information sources, drivers, feedbacks and objectives. There are different tools for different times and using a set in combination can often provide useful insights and greater learning than persisting with one method in isolation. Bringing together the integration jigsaw can be done in many ways, starting with corners (well defined sub problems) and building out, starting with big picture concepts and back filling details. Drawing on case study examples a quick taster of a diversity of approaches will be presented. In terms of lessons learnt from these applications, on the technical side, experience has shown that the single most important feature is to make sure that the integration isn’t lost in the effort. On the decision support side the important thing is to provide useful information, globally this has been the harder lesson to learn.

**Integrated marine management policy and implementation in the U.S.: opportunities, challenges, and lessons learned**

Integrated marine management in the U.S. is being implemented using a variety of policy avenues at State and National levels. I will discuss examples ranging across geographies, including the U.S. Ocean Policy, the Massachusetts Ocean Plan, California’s Marine Life Protection Act, and the Puget Sound Partnership and highlight the opportunities, challenges, and lessons learned from these examples.

**Understanding the intersections between the science, law, and practice of cumulative effects analyses around the Pacific**

Scientific recommendations for conducting cumulative effects analyses are often not well aligned with legal mandates and case law in many jurisdictions. As a result, cumulative effects analyses do not fully incorporate the best available science and tend to be inconsistent across projects. I will present the results of our study looking at the state of the practice of cumulative effects analyses in California, USA; British Columbia, Canada; Queensland, Australia; and New Zealand and will highlight where practice assessments could be improved to better incorporate the best available science of cumulative effects.

**Model based approaches to considering cumulative impacts and tradeoffs**

There is no one size fits all approach to the successful integration of multiple information sources, drivers, feedbacks and objectives. There are different tools for different times and using a set in combination can often provide useful insights and greater learning than persisting with one method in isolation. Bringing together the integration jigsaw can be done in many ways, starting with corners (well defined sub problems) and building out, starting with big picture concepts and back filling details. Drawing on case study examples a quick taster of a diversity of approaches will be presented. In terms of lessons learnt from these applications, on the technical side, experience has shown that the single most important feature is to make sure that the integration isn’t lost in the effort. On the decision support side the important thing is to provide useful information, globally this has been the harder lesson to learn.

**Model based approaches to considering cumulative impacts and tradeoffs**

There is no one size fits all approach to the successful integration of multiple information sources, drivers, feedbacks and objectives. There are different tools for different times and using a set in combination can often provide useful insights and greater learning than persisting with one method in isolation. Bringing together the integration jigsaw can be done in many ways, starting with corners (well defined sub problems) and building out, starting with big picture concepts and back filling details. Drawing on case study examples a quick taster of a diversity of approaches will be presented. In terms of lessons learnt from these applications, on the technical side, experience has shown that the single most important feature is to make sure that the integration isn’t lost in the effort. On the decision support side the important thing is to provide useful information, globally this has been the harder lesson to learn.

**Model based approaches to considering cumulative impacts and tradeoffs**

There is no one size fits all approach to the successful integration of multiple information sources, drivers, feedbacks and objectives. There are different tools for different times and using a set in combination can often provide useful insights and greater learning than persisting with one method in isolation. Bringing together the integration jigsaw can be done in many ways, starting with corners (well defined sub problems) and building out, starting with big picture concepts and back filling details. Drawing on case study examples a quick taster of a diversity of approaches will be presented. In terms of lessons learnt from these applications, on the technical side, experience has shown that the single most important feature is to make sure that the integration isn’t lost in the effort. On the decision support side the important thing is to provide useful information, globally this has been the harder lesson to learn.
Spencer Gulf: proposed integrated Spencer Gulf Science Plan

Spencer Gulf is an important region for economic development in South Australia. A large number of new mineral extraction and processing ventures are proposed. Associated new ports and increased shipping in the region have the potential to impact on other users of this crowded waterway. We are using shipping and ports as a case study to inform implementation of an integrated approach to marine management of Spencer Gulf. In this presentation I will outline the vision, objectives and research programs including proposed outputs for the broader Spencer Gulf Ecosystem and Development Initiative (SGEDI) and then focus on the shipping and ports case study that is currently being undertaken. Outcomes of the ports and shipping case study will include a demonstration of benefits of integrated marine management, but also ongoing engagement of all stakeholders. The broader SGEDI initiative will ensure that ecological, economic and social outcomes are optimised for the benefit of all South Australians and avoid the need for costly rehabilitation programs to restore the system if it becomes degraded.

Prof Simon Goldsworthy

Simon Goldsworthy is a Principal Scientist with SARDI Aquatic Sciences, where he heads up the Threatened, Endangered and Protected Species (TEPS) Subprogram. His main research interests include the ecology of marine mammals and seabirds, the mitigation of interactions between protected species and fisheries and food web modelling. His research has underpinned conservation and management programs that enable the recovery of species and the development and introduction of sustainable fisheries practices.

Development of a Spencer Gulf ecosystem model for fisheries and aquaculture

Development of ecological models for the Spencer Gulf Ecosystem (SGE) is critical to understanding the key drivers and sensitivities in the ecosystem, and to provide a means to resolve and attribute potential impacts to the ecosystem from multiple human stressors and environmental change. The Ecopath with Ecosim (EwE) software was used to develop a trophic mass-balance model of the SGE, with three main objectives: 1) to develop a range of ecosystem performance indicators to assess the state of the ecosystem; 2) to provide capacity to resolve complex dynamic interactions between multiple fisheries and aquaculture industries and attribute their potential impacts on each other and the marine ecosystem; and 3) to enable scenario testing to examine potential ecosystem impacts from changes to fisheries and aquaculture production. The EwE model was constructed for a 20 year time period (1991-2010) and incorporated 78 functional or trophic groups based on similarities in diet, habitat, foraging behaviour, size, consumption and rates of production, as well as 27 fishing fleets for which landings and effort data were available for the 20 year period and two aquaculture industries. Key findings of the SGE model will be presented with respect to trophic structure, key changes to the ecosystem over the last 20 years, and ecosystem health. In addition, the results from three scenario simulations will be presented. These examined potential ecosystems response to changes in production in the finfish aquaculture industry (southern bluefin tuna, yellow-tail kingfish), and changes in catches and fishing effort in the two largest volume fisheries in Spencer Gulf, the sardine and western king prawn fisheries.

Sally Harman

Sally joined the Great Barrier Reef Marine Park Authority 13 years ago as a Graduate Marine Park Planner and has gone on to work in a range of roles and build her skills and expertise in marine park management. She recently re-joined the Great Barrier Reef Operations Branch to amend one of their key management tools, the Whitsundays Plan of Management. Sally’s career highlights include stakeholder engagement during the 2003 rezoning, three years with the compliance team and project managing GBRMPA’s $5 million crown-of-thorns starfish control program. Sally is passionate about involving users in decision making to implement practical on-ground outcomes that benefit the Great Barrier Reef. She has a degree in Applied Science (Biology), a Diploma in Project Management and is a Marine Parks Inspector.
Long term sustainability and the Great Barrier Reef

The Great Barrier Reef is a national and international icon. Stretching over 2300 km along the Queensland coast and 250 km at its widest section, its size alone is remarkable. Add in complex jurisdictional boundaries across Commonwealth and State agencies, a World Heritage Area under international scrutiny, an outlook report highlighting declining values and a multiple use marine park with a $5.6 billion per annum economic contribution from Reef-dependent industries and the world gets a little interesting. In response to many of these concerns the Great Barrier Reef Marine Park Authority has been working with the Queensland Government to develop a strategic assessment, program report and most recently a Long-Term Sustainability Plan. The Reef 2050 Long-Term Sustainability Plan will provide an over-arching management framework ensuring integration, coordination and alignment of actions to protect the values of the Great Barrier Reef World Heritage Area and continue to support ecologically sustainable development and use.

Key areas for focus include:

- Prohibiting dredging for the development of new ports or the expansion outside of key long-established port areas
- Decision making based on clear targets to maintain the Reef’s Outstanding Universal Value
- A cumulative impact assessment policy to manage impacts from multiple sources
- A net benefit policy to guide actions aimed at restoring ecosystem health
- A reef recovery program to support local communities and stakeholders to protect the reef
- World-leading, Reef-wide integrated monitoring and reporting.

Prof Marcus Haward

Oceans and Cryosphere Centre, Institute for Marine and Antarctic Studies
University of Tasmania

Professor Marcus Haward is a political scientist specialising in oceans and Antarctic governance and marine resources management at the Institute for Marine and Antarctic Studies (IMAS), University of Tasmania. Marcus has over 150 research publications, and his books include Oceans Governance in the Twenty-first Century: Managing the Blue Planet (with Joanna Vince) Edward Elgar 2008; and Global Commodity Governance: State Responses to Sustainable Forest and Fisheries Certification (with Fred Gale) Palgrave Macmillan, 2011. He is editor of the Australian Journal of Maritime and Oceans Affairs published by Taylor and Francis.

Integrated oceans management in Australia: Looking back, moving forward

Australia’s experience with developing and implementing its national Oceans Policy from 1998 provides important and useful opportunities for ‘lesson drawing’ in implementing integrated oceans management. The first part of the presentation explores Australian experiences in developing national frameworks, focusing directly on integrated oceans management for what? for whom? and why?

The second part looks forward. In developing policy responses for integrated oceans management – two key issues appear significant. The first is the influence of inter- and intra-governmental relations in terms of process and outcomes, the second the demands on science through a ‘step change’ shift in moving from a sectoral to an integrated focus to ocean governance.

The presentation concludes by considering lessons from Australia’s experience.

Tony Huppatz
DEWNR

Tony Huppatz is the Principal Coastal Planner in the Coast and River Murray Unit of the Department of Environment, Water and Natural Resources in South Australia, and previously a member of the former Intergovernmental Coastal Advisory Group. The unit’s coastal planning work seeks to have coastal issues addressed in the State’s planning system. That system includes a hierarchical structure of planning strategies guiding the Development Plans which, in turn, are the documents against
which development applications are assessed. In 2007, Tony was engaged in preliminary drafting work that sought to translate the draft Spencer Gulf Marine Plan to the relevant Development Plan.

**South Australia’s Marine Planning Framework – the draft Spencer Gulf Marine Plan**

The Marine Planning Framework sought the preparation of six regional marine plans, based on eight marine bioregions covering all of South Australia’s waters. Marine plans were to be supported by a Performance Assessment System. The methodology and principles of the marine planning model were piloted through the development of the draft Spencer Gulf Marine Plan. The presentation examines the draft Plan, its proposed translation to the Development Plan, and the current state of play.

**Prof Tony Jakeman**

Tony Jakeman is Professor, Fenner School of Environment and Society, and Director of the Integrated Catchment Assessment and Management Centre, The Australian National University. His early background was in applied mathematics and hydrological modelling. Long-term interests include integrated assessment methods and decision support systems for water and associated land resource problems, including modelling and management of water supply and quality problems in relation to climate, land use and policy changes and their effects on biophysical and socioeconomic outcomes.

**Integrated assessment and modelling: lessons from water resource management**

Integrated Assessment is a metadiscipline and process designed to deal with multifaceted, multi-use resource systems comprising interdependent social, economic and ecological components, and characterised by stakeholders with different and often conflicting goals. When undertaking an IA project we must be attentive to which dimensions we are actually addressing, and which we are not. And indeed where do we start? Are some dimensions primary and to be looked at first before decisions are taken on addressing other dimensions? The selection of an appropriate modelling platform and associated tools for an IA needs to be justified and guidance on this is now available. Management of uncertainty is a crucial issue that is gaining increasing attention. A framework to identify and prioritise attention to critical uncertainties and their propagation will be discussed. Scenario modelling for addressing uncertainties in models and future forcing conditions has many advantages for stakeholder engagement and social learning. Lessons from case studies around water resource management issues will be summarised.

**Jim McIsaac**

Jim McIsaac is the executive director of the T Buck Suzuki Foundation, a fisheries foundation founded in 1981. Over the last 10 years he has been involved in various marine planning and MPA processes in Canada Pacific including: the Pacific North Coast Integrated Management Area, the Marine Planning Partnership of the North Pacific, West Coast Aquatic Management Board, Gwaii Haanas National Marine Conservation Area, Sgaan Kinglas Bowie Seamount MPA, Scott Island Marine National Wildlife Area proposal, and Hecate Strait Glass Sponge Reef MPA Area of Interest.

**Collaboration and uncertainty in Canada’s Pacific Ocean Estate**

Canada’s Pacific Coast provides a complex landscape to study oceans governance with federal, provincial, regional, local and First Nations jurisdictions colliding and uncertainty mounting with First Nations’ rights and title claims. Add in commercial, recreational and First Nations fisheries, aquaculture, shipping, tourism, conservation, forestry, recreation, renewable and non-renewable energy stakeholder organizations with varying marine interests and use conflicts, and the stage is set for complex management challenges.

Canada, as a signatory to the UNCLOS, has an international commitment to sustainable development of its ocean estate. Canada’s Oceans Act 1996 provides the legal framework for integrated management, however the Act is non-prescriptive and the lead agency, Fisheries
and Oceans Canada, is generally underfunded for the task at hand.

Since the ratification of UNCLOS and passing the Oceans Act, progress in Canada has been limited. In large ocean management area (LOMA) processes like the Pacific North Coast Integrated Management Area (PNCIMA), an overarching ecosystem based management framework has been defined and generally agreed to by governments and stakeholders.

Getting beyond the strategic to integrated management planning remains a challenge. A variety of different process formats have been attempted. Three processes will be reviewed: PNCIMA with a tri-lateral MOU; Marine Planning Partnership (MaPP) with a bi-lateral LOI; and West Coast Aquatic (WCA) with multi-lateral collaborative TOR. Funding mechanisms from fully public, to public-private-partnership (P3) have been a key source for conflict.

Collaboration between governments and stakeholders requires leadership and time to build a basic common understanding of ecological and social systems. If a collaborative rationale for integrated management is a desired outcome, what process design, stakeholder engagement, common objective setting and decision support tools, are important for getting there?

Canada’s ocean estate of 6 million km² includes the longest coastline (244,000 km) of any country in the world.

<table>
<thead>
<tr>
<th>A/Prof John Middleton</th>
<th>SARDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>John Middleton has made significant contributions to understanding shelf and slope oceanic circulation through analytical and numerical models. He has demonstrated the importance of coastal trapped waves and bottom friction to upwelling. Notable recent contributions include progress in a) determination of the circulation along Australia’s southern shelves, slopes and Gulfs, b) the role of Sverdrup transport in driving downwelling in the central Great Australian Bight, and c) the development of new models for nutrient concentrations that arise from aquaculture leases. He leads the SARDI Oceanography group, as well as the Southern Australian Marine Observing System mooring facility.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CarCap – a decision support tool for aquaculture expansion and Gulf developments based on nutrient carrying capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A validated and coupled hydrodynamic/wave and biogeochemical model has been developed for Spencer Gulf. The aim of the model was to determine the concentrations and ecological carrying capacity of nutrient levels, below which the ecosystem is unharmed. Nutrient sources include those that arise from natural and anthropogenic causes, including waste water and industrial outfalls and fin-fish aquaculture. The results are obtained at the 600 m scale of the aquaculture leases to 300 km scale of the gulf. The results of several scenario studies have been packaged into a decision support tool (CarCap) so as to allow PIRSA to evaluate the relative importance of nutrient sources and determine where new aquaculture leases (and new outfalls) can be developed in a sustainable manner. The model results for phytoplankton have been incorporated into higher trophic ecosystem models (e.g., Ecosim) and CarCap could be extended to incorporate sea grasses and oyster aquaculture, as well as impacts of toxins and sediment transport generated by port developments in the Gulf.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prof Tim Moltmann</th>
<th>IMOS – UTAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tim Moltmann is the Director of Australia’s Integrated Marine Observing System (IMOS), based at the University of Tasmania in Hobart. In this role he is responsible for planning and implementation of a large ($40M pa) national collaborative research infrastructure program, which is deploying a wide range of observing equipment in the oceans around Australia and making all of the data openly available to the marine and climate science community and its stakeholders. Tim is a highly experienced Australian research leader, having worked at the Commonwealth Scientific and Industrial Research Organisation (CSIRO) for over a decade, rising to be Deputy Chief of the Marine &amp; Atmospheric Research Division based in Hobart. He has a particular interest in research infrastructure, and has</td>
<td></td>
</tr>
</tbody>
</table>
played a lead role in major national projects relating to large research vessels, and national marine information infrastructure.

### Integrated marine observing and data management

The session on Integration and cumulative impacts is concerned with the following questions - What does an integrated monitoring program look like? It is not possible to monitor everything – what should be monitored and how do we best detect changes in ecosystem structure and function in a timely manner?

This talk will focus on Australia’s experience over the last decade in establishing a national Integrated Marine Observing System (IMOS), which makes all of its data openly accessible. The design and evolution of the system will be discussed. Specific attention will be given to the relationships between observing and modelling, the interplay of research and operational use, and growing international interest in the issue of sustained ecological observing.

**Dr Barbara Musso**

Barbara Musso has been with the Australian Government’s Department of the Environment since 2005 and was previously at the National Oceans Office, where she was Director of Policy from 2001 to 2005. Barbara has a doctorate in marine biology and a masters degree in public administration, reflecting her long-standing interest in the interface between science and policy. She has 15 years experience in large scale marine planning and the establishment of marine protected areas. Prior to that, Barbara worked in participatory planning and multidisciplinary NRM programs with the Queensland government and the CSIRO.

**The Commonwealth Marine Planning experience: from Oceans Policy to Marine Bioregional Planning**

The Regional Marine Planning (RMP) program, led by the National Oceans Office between 2001 and 2005, was the centrepiece of Australia's Oceans Policy. It sought to integrate planning and management across the five portfolios with responsibility for activities in the ocean. While arguably responsible for a strengthened focus on the marine environment, the program as an exercise in integration failed, being replaced after a review in 2006 by the Bioregional Marine Planning program, which was entirely under the purview of the Minister for the Environment. This presentation offers some reflections on the challenges and mistakes of the RMP program and focuses on those lessons that might have broader and contemporary relevance.

**Dr Ian Poiner**

Ian’s scientific expertise is research into tropical marine systems, especially understanding how they are influenced by human activities. Of particular interest are the development of indicators of ocean health and their use in ocean observing networks, and the application of marine science to support policy, management and the sustainable development of marine industries. He has significant experience in the strategic development and planning of science, both as a practising scientist and at the organisational level. This is reflected in his successful leadership of the Australian Institute of Marine Science (2004-11), one of the world's leading tropical marine science institutions, and leadership of national and international research programs to support the sustainable use, conservation and management of marine ecosystems. Ian currently chairs the Gladstone Healthy Harbour Partnership Independent Science Panel, the Board of the Reef and Rainforest Research Centre Ltd, the Steering Committee of the Marine National Facility, the Advisory Boards of the Integrated Marine Observing System and the University of Western Australia Oceans Institute. Until 2012, he was the Chair of the International Scientific Steering Committee of the Census of Marine Life. The Census was a 10-year US$650 million international effort undertaken to assess the diversity, distribution
and abundance of marine life—a task never before attempted on a global scale and completed in 2012. The Committee was awarded Japan’s International Cosmos Prize in 2011.

The Gladstone Healthy Harbour Partnership (GHHP) Report Card a whole-of-system report card to monitor and maintain/improve the condition of Gladstone Harbour

(Ian Poiner, Emma McIntosh)

Integrated marine management aims to address the increasing pressures on coastal and near-shore marine environments arising from coastal development and expanding populations. Ecosystem health report cards are becoming an increasingly popular means of summarising the results of monitoring programs to assess the impact of multiple-use and to provide the knowledge base for an integrated approach to marine management. This paper outlines an example of a whole-of-system report card initiative developed to monitor the condition of Gladstone Harbour a multi-use port in the Great Barrier Reef World Heritage Area, Queensland, Australia. Concerns over the impacts of major industrial expansion, fish health incidents and habitat loss prompted a response from all the major stakeholders in the region to establish the Gladstone Healthy Harbour Partnership (www.ghhp.org.au). Here we outline the process followed to develop the partnership including setting operational objectives and indicators, and establishing the monitoring and reporting program underlying the annual Gladstone Harbour Report Card. The process consisted of five stages; 1) stakeholders in the region developed a vision for the future of Gladstone Harbour, 2) from this vision a series of specific objectives were developed, 3) these were used to derive appropriate and measurable indicators, and 4) a geographically representative monitoring program was designed, resulting in, 5) a series of scores which could be aggregated to overall indexes of harbour condition. In parallel to the development of the Report Card the Partnership is developing scenario analysis tools (Gladstone Harbour Model) that the Partnership will use to interpret and respond to annual report card results. The Report Card extends beyond traditional water quality or biological measurements, to include four dimensions of harbour health: environmental, social, cultural and economic. This novel approach recognises the wide range of uses of the harbour and the need to manage multiple use of the Harbour and to address cumulative impacts.

A/Prof Tony Smith

CSIRO

Tony Smith is a chief research scientist with CSIRO’s Oceans and Atmosphere Flagship, an Affiliate Professor at the School of Fisheries and Aquatic Sciences at the University of Washington, and a member of the Centre for Marine Socioecology at the University of Tasmania. His research interests span adaptive management, decision science, and ecosystem based fisheries management (EBFM). He is a member of the Technical Advisory Board of the Marine Stewardship Council and a member of the Fisheries Council of South Australia. He has provided advice on EBFM to the FAO, the European Parliament, and to national governments in the US, Canada, New Zealand, South Africa, Namibia, Chile and Ecuador. Tony was appointed a Member of the Order of Australia in 2011 for services to marine science supporting EBFM, harvest strategies, and policy governing sustainable fisheries.

Integrated marine management – reflections on 15 years in the (scientific advice) trenches

This presentation will draw on my experience over an extended period of time in trying to provide evidence-based advice to governments, organizations and stakeholders in support of IMM in its various guises. Topics covered may include adaptive management, risk assessment, management strategy evaluation, institutional analysis, and stakeholder engagement. Decision making under uncertainty and tradeoffs are likely to feature prominently. I will try to reflect on successes and failures in IMM and what we can learn from both.

Dr Rob Stephenson

Robert Stephenson has been a research scientist with the Canadian Department of Fisheries and Oceans (St. Andrews Biological Station) since 1984, and is currently Visiting Research
Canadian Fisheries Research Network

Professor at the University of New Brunswick. He is Principal Investigator of the Canadian Fisheries Research Network – an NSERC-funded network that is linking academics, industry and government in collaborative fisheries research across Canada. Stephenson has worked extensively on the ecology, assessment, and management of Atlantic herring, and more broadly on issues related to fisheries resource evaluation and Fisheries Management Science. Current research interests include the integration of ecological, economic social and institutional aspects of management, development of integrated coastal zone management, implementation of the ecosystem approach (particularly in fisheries and aquaculture), and development of policies and strategies for sustainability of marine activities.

Governance and legislation – Eastern Canada

Management of marine activities in the coastal zone in Canada is evolving to include the more holistic, cohesive, and participatory structure of Integrated Management under Canada's Oceans Act. In this presentation, I review recent evolution of Integrated Management thinking in Atlantic Canada as represented by developments in the herring fishery, the aquaculture industry, and attempts to put together integrated plans for the waters off Nova Scotia (the Eastern Scotian Shelf Integrated Management Plan) and New Brunswick (the SWNB Marine Planning Initiative). Challenges of integrated management include the rationalization of sector-based plans with area-based considerations for planning of the cumulative effects of multiple activities, the adaptation of governance that will allow efficient and viable activities within an inclusive participatory structure, and the adaptation of traditional science to meet increased demands of IM.

Objectives – Eastern Canada

Integrated management of marine activities requires attention to a broader set of ecological, economic, social and institutional objectives, and to the trade-offs among competing objectives. This presentation summarizes experience in development of a comprehensive set of objectives in integrated planning initiatives in eastern Canada and in the research of the Canadian Fisheries Research Network. While ecological objectives related to productivity, biodiversity and habitat are well articulated, the same is not true of social and economic objectives, which tend to be implicit or generic. Further, the practical implementation of economic, social and institutional objectives arising from Canadian policies presents a governance challenge. Conflicting objectives and the need to weigh trade-offs suggest the need for articulation of diverse management scenarios and development of appropriate governance fora in which management options can be discussed.

Dr Terry Walshe

AIMS

Terry Walshe is a Decision Scientist at the Australian Institute of Marine Science. His research deals with the intersection of technical and social dimensions of decision-making. He is especially interested in developing techniques that better address societal values, risk and uncertainty, and frailties in expert opinion. His work in research and consultancy includes contributions to forest management, conservation planning, fisheries management, alpine ecology, river restoration, fire management, irrigation, salinity, biosecurity, and management of the Great Barrier Reef.

The clunky art of setting objectives in multi-stakeholder settings

The setting of objectives is the cornerstone of effective planning and decision-making. But asking people what they seek to achieve in any context is often a frustrating and meandering process. A key challenge in multi-stakeholder settings is striking a balance between inclusivity and problem complexity. Good problem formulation promotes a collective understanding of where different interests lie, and how they will be addressed in subsequent analysis. Poor problem formulation is a recipe for disenchantment, or worse. Here we outline perspectives from decision science that can help progress effective problem formulation, including a typology of objectives, differentiating means and ends objectives, process
objectives and strategic objectives.

**Integrated and cost-effective monitoring**

Why do we monitor? Among other things, we may be interested in the status and trend of key values, state-dependent decision-making, or learning more about system dynamics. These are all entirely reasonable motivations for allocating substantial resources to monitoring. But any such allocation forgoes the opportunity to spend those same resources on direct management intervention. Here we outline how managers can think through the adequacy of their investment in monitoring, with emphasis on the integration of models and data, and the cost-effectiveness of data acquisition.

**A/Prof Tim Ward**  
Associate Professor Tim Ward leads SARDI research on finfish. He has full academic status at Flinders University of South Australia and is an affiliate of the University of Adelaide. He is one of Australia’s leading researchers on small pelagic fishes, routinely provides scientific advice to several fisheries management agencies and has taken a leading role in establishing several large multi-disciplinary science programs to support ecosystem-based management.

**Integrated marine management: definition, examples, challenges and the purpose of the workshop**  
(Tim Ward, Shirley Sorokin, Gavin Begg, Bronwyn Gillanders, Tony Smith, Robert Stephenson)

The principles of integrated marine management (IMM) or marine ecosystem-based management (EBM) coalesced in the 1990s and have become coherently defined over the last decade. Australia was an early adopter of the concept. The Great Barrier Reef Marine Park established in 1975 applies many of the principles of IMM and has long been recognised as a successful regional application. Australia’s Oceans Policy 1998 was one of the first national IMM frameworks. A spatial marine planning framework was developed for South Australia in the early 2000s. Despite these efforts, which include many notable successes, IMM in Australia is, at best, a work in progress. In South Australia, marine management has largely not progressed from the sectoral approaches which IMM aims to replace. A cursory review of the literature suggests that international progress has been similarly constrained; in fact it is recognised that the transition to a systematic, integrated approach will not be easy, fast or simple but is likely to be gradual, iterative and adaptive. This workshop is an activity of the Spencer Gulf Ecosystem and Development Initiative (SGEDI) and the Fisheries Research and Development Corporation (FRDC) that aims to: 1) evaluate international and national progress towards IMM; and 2) identify key elements that have been critical to the successful implementation of IMM. This knowledge will be used to inform the development of a blueprint for the potential implementation of IMM in Spencer Gulf.

**Multiple-use of Spencer Gulf: the current system and options for the future**  
(Tim Ward, Shirley Sorokin, Bronwyn Gillanders, Gavin Begg)

Spencer Gulf is used by a wide range of stakeholders for many disparate purposes. Activities are controlled by a diverse legislative framework that includes at least 15 separate Acts. This presentation provides examples of existing and potential conflicts among current and future user groups. It also summarises the range of ecological, economic and social objectives identified in the key legislative instruments that govern their activities. Particular consideration is given to ecological objectives related to productivity, biodiversity and habitat because these are often articulated explicitly. However, we also document the range of social and economic objectives while noting that in many cases these objectives are implied or generic. Current mechanisms for resolving disputes between user groups and addressing apparent conflicts between the objectives of different Acts are identified. We highlight the benefits of establishing scientific frameworks, stakeholder fora and governance processes for evaluating trade-offs in resource allocation.
Appendix 5: Workshop Presentations
Integrated ocean management; definition, examples, challenges and the purpose of the workshop

Tim Ward
Shirley Sorokin
Gavin Begg
Bronwen Gillanders
Tony Smith
Robert Stephenson
Adelaide, 13 April 2015

The concept(s)
Ocean Environmental Management
Frankel (1995)
Integrated Coastal Zone Management
Principles for sustainable governance of the oceans
Costanza et al. (1995)
Integrated environmental management of the oceans
Azarou and Santos (1995)
Marine Ecosystem-based Management
Atunes and Santos (1999)
Ecosystem approach to management
Walther and Molmann (2014)
Integrated Ocean Management (IOM)
Marine Ecosystem-based Management (MEBM)

IOM and MEBM
IOM focuses on accommodating multiple sectoral activities to sustainably develop coasts and oceans
Balance environmental, economic and social objectives

MEBM focuses on maintaining ecosystem service functions
Priority to environment due to pivotal importance in providing for economic and social needs (multiple-use marine protected areas?)

IOM Principles
1. Responsibility - use is sustainable, efficient and fair
2. Scale-matching* - scales of governance are appropriate [cohesive legislative, administrative and governance framework]
3. Precaution - in the face of uncertainty err on the side of caution
4. Adaptive management – continuous monitoring and review
5. Full cost allocation – all costs and benefits identified and allocated
6. Participation - stakeholder engagement and participation

Current situation
• IOM Principles generally agreed
• Desired by policy-makers, managers, scientists and industry
• Move to IOM is no longer an obscure vision
• Despite political and societal will and availability of scientific concepts and information

Implementation remains a challenge

Costanza et al. (1998) ‘Principles for sustainable governance of the oceans’
Walther and Molmann (2014)
Global progress

- **Canada Oceans Act 1997** - sustainable development, integrated management and precautionary approach
- **Australia Oceans Policy 1998** - sustainable development principles, integration of sectoral interests and conservation requirements, regional plans
- **Europe Marine Strategy Framework Directive 2008** requires member States to have ecosystem-based measures to achieve Good Environmental Status and protect resource base on which economic and social activities depend
- **South Africa Integrated Coastal Management Act 2009** recognizes ecological, social and economic interactions in the ocean and land interface
- **USA National Ocean Policy 2010** calls for National Ocean Council to adopt the principle of marine EBM

**Mix of IOM and MEBM**

Regional Progress

- **Gladstone Healthy Harbour** – bring together community, industry science government to improve the health of the harbour.
- **Morton Bay** - conserve unique values (environmental, social, cultural and economic) of marine park and ensure sustainable use for enjoyment and benefit of present and future generations
- **NSW Marine Estate** - recognise that effective coastal and marine management needs to be underpinned by evidence in regard to human activities and other factors that affect the marine estate
- **Western Australia’s Aquatic Resource Management Strategies** that define ecological, social, economic objectives for regions

**Mix of IOM and MEBM**

South Australia

- **Strategic Plan 2004** (Premium food and wine from our clean environment; marine biodiversity – 19 MPAs)
- **Natural Resources Management Act 2004** - integrated use, management and protection of natural resources
- **Living Coast Strategy 2004** (MEBM) recognizes need for legislative integration
  - proposed Coast and Marine Act, Authority and Advisory Board

**LARGELY NOT PROGRESSSED FROM SECTORIAL APPROACHES**

- **Progress in MEBM**
- **IOM Aspirational**

**The starting point**

Focus has been on conservation

Spencer Gulf

- You are here
- Puget Sound
- Bay of Fundy
- Skagerrak Strait, Norway

**Spencer Gulf**

- Low rainfall
- High evaporation
- Dodge tides
- Large tidal velocities

**Spencer Gulf**
Spencer Gulf Ecosystem and Development Initiative (SGEDI)

To drive sound outcomes for gulf users and the environment
Supported by ~$2.5 million of industry investment and research
Forum for stakeholder engagement
Better Information - data, tools, capabilities and networks to assess impacts
Inform approval applications - reduce costs and delays, assist development
Reduce conflict and increase community support
Thriving Gulf - balance environmental, economic and social objectives

Aims of this workshop

1. Evaluate international and national progress towards IOM.
2. Identify key elements that have been critical to the successful implementation of IOM.

Use knowledge develop a blueprint for potential implementation of IOM in Spencer Gulf

Outcomes and Outputs

Report
Future Collaborations
Paper
Progress towards implementation
Canada’s Oceans Act 1996

- DFO to lead and facilitate the development and implementation of plans for the integrated management of all activities... in or affecting estuaries, coastal waters and marine waters
- Develop and implement policies and programs... for the purpose of implementing integrated management plans

Implementation of Canada’s Oceans Act

- Canada’s Oceans Strategy 2002
- Policy and Operational Framework for integrated management of estuarine, coastal and marine environments in Canada 2002
- Focus:
  - Large Ocean Management Area pilot plans
  - Marine Protected areas
  - Ecologically and Biologically Significant Areas

ESSIM

- 1998-2006 development of Integrated Plan ‘to provide long-term direction and commitment for integrated, ecosystem-based and adaptive management of all marine activities...’
  - Strategies for Collaborative Governance and Integrated Management, Sustainable Human Use, Healthy Ecosystems
- 2006-2011 focus on implementing objectives and strategies
- Fostered development of:
  - ESSIM Forum
  - Stakeholder Advisory Council
  - Intergovernmental Committee

ESSIM

- ESSIM Forum
  - Regular, inclusive assembly of stakeholders (2x/yr)
  - Develop vision, goals, strategic direction
  - Not a decision-making body
- Stakeholder Advisory Council
  - 32 representative members (ind., gov’t, public)
  - Quarterly meetings + task groups; 2-3 yr terms
- Intergovernmental Committee
  - All relevant governments; including senior officials
- ESSIM Planning office
  - To facilitate; Housed within DFO
ESSIM: Developed a comprehensive set of objectives and strategies for...

Plan, completed in 2007, was never fully implemented but paved the way...

ESSIM: Success?

- Developed machinery of integrated management
  - ESSIM Forum, SAC, Intergovernmental Committee (RCCOM)
- Developed Integrated Plan
  - Vision, governance, objectives, strategies
- Not fully implemented/continued...paved the way for other Regional Planning initiatives
- Planning/management continues on activity basis

http://www.mar.dfo-mpo.gc.ca/Maritimes/Oceans/OCMD/ESSIM/Reports

Beginning about 2004...

Southwest New Brunswick

MARINE RESOURCES PLANNING

CREATING A MARINE PLAN
Major Issues/problems

- Competition/conflict re space
- Many of the things we ‘value’ are not currently being considered adequately
- Need a more diverse set of objectives reflecting ‘Community Values’ applied to all activities
- Need an open and transparent, participatory, process

MRP Community values?

- Protect habitat, natural environment
- Protect against pollution, Cumulative impacts
- Preserve biodiversity
- Protect heritage, traditions, equitable access
- Maintain community health and wellbeing
- Promote local employment and prosperity
- Promote financial self-sufficiency and sustainability
SWNB MAC Mandate

- Broadly representative knowledgeable group of 14
- Studying issues, with a ‘community lens’
- Providing advice to all relevant levels of government (public advice)

…”Applying community values to marine resources policies”

http://bofmrp.ca/home

SWNB MAC: Success?

- Relatively young advisory committee…still defining niche
- Provided advice on issue of marine debris
- Having problem finding topics for which existing process value broader perspective

http://bofmrp.ca/home

What about Fisheries?

Changes: Consideration of a greater range of ecosystem attributes

- Productivity
  - Primary Productivity
  - Community Productivity
  - Population Productivity

- Biodiversity
  - Species Diversity
  - Population Diversity
- Habitat

- Social and Economic objectives

Management Planning

Objective
- goals
  - e.g. maintain population productivity

Strategy
- ‘WHAT’ will be done
  - Keep fishing mortality below 0.2

Tactic
- ‘HOW’ it will be done
  - Catch quota

Strategies & Attributes

<table>
<thead>
<tr>
<th>ATTRIBUTES</th>
<th>OBJECTIVES</th>
<th>STRATEGIES with associated pressures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Productivity</td>
<td>- Keep fishing mortality moderate</td>
<td>- Promote positive biomass change when biomass is low</td>
</tr>
<tr>
<td></td>
<td>- Manage discards for all harvested species</td>
<td>- Optimize discard rates for harvesting biomass</td>
</tr>
<tr>
<td></td>
<td>- Maintain healthy stocks of key species</td>
<td>- Ensure sustainable harvest of key species</td>
</tr>
<tr>
<td></td>
<td>- Manage noise and light disturbance</td>
<td>- Control noise and light disturbance</td>
</tr>
</tbody>
</table>

| Biodiversity | - Control incidental mortality for all non-harvested species | - Minimize incidental mortality of invasive species |
|              | - Distribute population components in relation to component biomass |

| Habitat | - Manage and restore bottom habitat types | - Reduce abundance of components, species and species in habitat |
|         | - Minimize competition, predation and disease |
|         | - Control water and light conditions |

| Social and Economic objectives | - Manage and restore bottom habitat types | - Reduce abundance of components, species and species in habitat |
|                                 | - Minimize competition, predation and disease |
|                                 | - Control water and light conditions |
Sustainable Fisheries Framework

• Principles of EBFM
• Policies:
  – Decision-making framework incorporating PA
  – Guidance for rebuilding plans
  – Managing impact on benthic habitat
  – Ecological risk assessment framework
  – Policy for forage species
  – Managing bycatch
  – Integrated fisheries management plans


Analysis? Evaluation?

• 2005 Report of Commissioner for Sustainable Development...‘Promise of the Oceans Act has not been fulfilled’
  – No Oceans Management Plans
  – Little progress on MPA’s
  – No ‘state-of-the-oceans’ reports
  – Insufficient progress on 55 activities to be undertaken by 20 departments (since 2002)

Fisheries vs ‘Oceans’

• Sustainable Fisheries Framework is different from Regional Oceans Plan
• Both talk of EBFM and of ‘integrated oceans management’...but in different ways
• Oceans act IM activities are enabling...not regulatory

Criticisms of current management

1) activities managed by different groups using different tools/standards/approaches
2) Insufficient attention to full suite of values (esp social/economic aspects)
3) insufficient consideration of cumulative effects;
4) perception of a lack of transparency and lack of participation in management
5) insufficient public appreciation of the tradeoffs among activities when decisions are made

Most cannot be solved with existing assessment/management structure!

(Stephenson 2012)
The latest...

Regional Oceans Plan

<table>
<thead>
<tr>
<th>VISION</th>
<th>GOALS</th>
</tr>
</thead>
</table>
| Healthy marine and coastal ecosystems, sustainable communities and responsible use supported by effective management processes. | Effective decision-making
  - Decision support info and tools
  - Ecosystem Approach to Management
  - Spatial planning and management
  - Marine Conservation
    - MPAs, EBSAs
  - Collaboration and engagement
  - ‘whole of DFO’ approach |

ACTIVITIES

<table>
<thead>
<tr>
<th>PROGRAM COMPONENTS</th>
</tr>
</thead>
</table>
| Risk Assessment and Issue Prioritization
| Spatial Information and Analysis
| Operational, Science and Knowledge Products
| Environmental and Ecological Assessment and Reporting
| Fisheries and Aquaculture
| Oceans and Coastal Planning
| Marine Protected Area Planning and Management
| Collaboration and Engagement
| ‘whole of DFO’ approach |

ROP – Oceans Act context:

- National strategy for management (29, 30)
- Plans for integrated management of all activities (31)
- Policies and programs to implement IM (32)
- Coordination with relevant others (32)
- Designate (national system of) MPA’s (35)
- Establish marine env. quality guidelines (52)

ROP – Guiding principles:

- Sustainable development
- Precautionary approach
- Adaptive management
- Ecosystem approach to management
- Collaborative approach
- Integrated management

Three plans for the Region...

Regional Oceans Plan - Goals

- Effective decision-making
  - Decision support info and tools
- Ecosystem Approach to Management
- Spatial planning and management
- Marine Conservation
  - MPAs, EBSAs
- Collaboration and engagement
- ‘whole of DFO’ approach
...how well will ROPs work?

Integrated management is the planning and management of human activities in a comprehensive manner while considering all factors necessary for the conservation and sustainable use of marine resources and the shared use of ocean space.

DFO 2014. Regional Oceans Plan – Maritimes Region

Report card on coastal/marine resource management?

- Considerable recent advance – legislative advance, move toward EAM and IM

But…

- Insufficient consideration of cumulative effects
- Lack of consideration (and definition!) of full suite of conservation, social, economic and institutional goals
- No structure for consideration of tradeoffs among objectives…
- Insufficient governance structure for integrated management

To achieve Ecosystem approach and Integrated management?

- Diverse, common objectives
  – Higher standards of EAM and PA
- Applied to all activities
  – Cumulative effects
- Appropriate governance structure and methods
  – Issues can be articulated, compared and used as basis for rational decisions
  – Participatory process and appropriate jurisdiction

(Stephenson 2012)
Some Canadian Experience on Integrated Marine Management

Presented by: Jim McIsaac For: SARDI, West Beach, 13 April 2015

From Freedom of-the-seas

“Through the last century oceans were generating a multitude of claims, counterclaims and sovereignty disputes.”

- 1945 USA claims resources on shelf
- 1967 UN call for effective governance regime
- 1977 200nm Exclusive Economic Zone
- 1982 UN adopts Constitution for the Sea
- 1994 Law of the Sea ratified into force

To Law of the Sea - UNCLOS

Global Marine Trends 2030

Oceans are Special

Sea Surface Temperature

World Exclusive Economic Zones
Drivers
- Rising demand for resources
- Technological advances
- Declining fish stocks
- Climate change and pollution
- Weak high seas governance

Recommendations
- Put Healthy Ocean First
- Govern the high seas
- End high seas overfishing
- Stop IUU fishing
- Keep plastics out
- Set Oil & Gas Standards
- Raise accountability
- High Seas regeneration zone

Global Ocean Commission - 2014

Governance Challenge

1) Where Are We Today?
- Baseline/common understanding
2) Where Do We Want to Be?
- Alternative future scenarios
3) How Do We Get There?
- Backcast
- Management planning
4) What Have We Accomplished?
- Monitor, evaluate, adapt

Four Fundamental Questions

Canadian context
- Fisheries Act (1868) – Fishing industry focus
- Shipping Act (1936) – Shipping industry focus
- Oceans Act (1996) – All industries integrated ecosystem approach, sustainable development and economic diversification in EEZ

To manage EEZ

Canada’s Ocean Strategy
- The Beaufort Sea (1,750,000 km²)
- The Pacific North Coast (88,000 km²)
- Gulf of St. Lawrence (461,400 km²)
- Eastern Scotian Shelf (108,000 km²)
- Placentia Bay/Grand Banks (500,000 km²)

Large Ocean Management Areas

EBM is an integrated approach to management that considers the entire ecosystem, including humans. The goal of EBM is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need.

EBM differs from current approaches that usually focus on a single species, sector, activity or concern; it considers the cumulative impacts of different sectors.

Science Consensus Statement on Marine EBM 2005

Ecosystem Based Management
Ecosystem-based management is an adaptive approach to managing human activities that seeks to ensure the coexistence of healthy, fully functioning ecosystems and human communities.

Goal 1: Integrity of the marine ecosystems.

Goal 2: Human well-being supported through societal, economic, spiritual, and cultural connections to marine ecosystems.

Goal 3: Collaborative, effective, transparent, and integrated governance, management, and public engagement.

Goal 4: Improved understanding of complex marine ecosystems and changing marine environments.
• Coastline similar in length to Portugal or Oregon
• a rich and abundant coastal region defined by fresh and sea water resources
The public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, social objectives that are usually specified through a political process.

Ehler & Douvres “Vision for a Sea Change” 2006

What is Marine Spatial Planning?

1) Define Context and Authority
2) Obtain Financial Support
3) Organize Stakeholder Participation
4) Organize the process Through Pre-Planning
5) Analyzing Current Conditions
6) Analyzing Future Conditions
7) Develop Spatial Plan
8) Implement and Enforce the Plan
9) Monitoring and Evaluating Performance
10) Adapting the MSP Process

10 Steps of MSP

Continuing MSP Cycle

Management Emphasis
- Recommended, not recommended and conditional uses
- Activities and areas requiring advanced management measures

Marine Spatial Plans

Increase in coastal vulnerability

Cumulative Risk Assessment

Identify tradeoffs between human uses and ecosystem services
Good process, good results, less time, money, and frustration. The bottom line for gov’t and business...

**Governance and leadership are key**

- Good Process → Good Results
- Get place and scale right
- Engage stakeholders from start
- Outcome objectives
- Process to fit objective
- Build tools to fit process
- Value and use all available knowledge
- Build collaborative rationale for actions

---

Jim McIsaac – jamcisaac@shaw.ca

---

Integration

- Stability
- Resources
- Government
- Civic Society
- Industry
- Businesses
- Conservation
- Separate Approach
- Integrated Approach

---

Lessons Learned
Integrated Marine Management policy and implementation in the United States: challenges, opportunities, and lessons learned

Melissa Foley, PhD
U.S. Geological Survey, Pacific Coastal and Marine Science Center
Center for Ocean Solutions, Stanford University

Common needs & challenges in integrated management

1. Goals and objectives

- Specific goals and objectives
- Time frame
- Lead agency
- Science-based
- Role of stakeholders

2. Data & Tools

Data management
- What data are available?
- Who has the data?
- What additional data are needed?

Decision Support Tools
- What tool functions are necessary?
- Are existing tools appropriate?

3. Human uses

Activity mapping
- Recreational fishing
- Emerging uses

4. Ecosystem components

Habitat & species mapping
- What habitats and species are important?
- Where are they located?
- How are they connected?

Ecosystem Indicators
- Ecologically important
- Leading and diagnostic
- Socially relevant

5. Cumulative effects

Characteristics of stressors
- Type
- Overlap
- Intensity
- Vulnerability of ecosystem
Common needs & challenges in integrated management

6. Land-sea integration

- Existing jurisdiction?
- Included in policy?

Common needs & challenges in integrated management

7. Climate change

- Increasing temperature
- Altered ocean circulation
- Ocean acidification

Options for addressing needs & challenges

U.S. National Ocean Policy

Massachusetts Ocean Plan

California’s Marine Life Protection Act

Puget Sound Partnership


“Stewardship of the Ocean, Our Coasts, and the Great Lakes”

- Plans for EEZ (3 to 200 nm)
- Nine regions for planning
- Approved plans by 2020


“Stewardship of the Ocean, Our Coasts, and the Great Lakes”

Addressing needs & challenges:
1. Goals & objectives
   - Regional planning bodies leading efforts
   - Outreach with industry and stakeholders

2. Data & tools
   - Data added to oceans.data.gov by 2015
   - Regional Councils also have data portals

7. Climate change
   - Guide for identifying risks of climate change
   - Toolkit for building resilience (toolkit.climate.gov)

Massachusetts Oceans Act (2008)

- First spatial plan in 2009
- Updated in 2015
- 5000 meters seaward from MHW to 3 nm
- Three types of management areas - prohibited, renewable energy, general
- Plan integrated into Coastal Zone Management Program and Massachusetts Environmental Policy Act
Massachusetts Oceans Act (2008)

Addressing needs & challenges:
1. Goals & objectives
   - Over 250 stakeholder meetings in 18 months
2. Data & tools
   - Created MA Ocean Resource Information System (MORIS) data portal
3. Human uses
   - Extensive surveys for recreational fishing & boating
4. Important ecosystem components
   - Special, sensitive, or unique species (SSUs)
   - Use incompatibilities defined for SSUs
5. Cumulative effects
   - Cumulative effects mapping

California Marine Life Protection Act (1999)

Addressing needs & challenges:
1. Goals & objectives
2. Data & tools
   - Created MA Ocean Resource Information System (MORIS) data portal
3. Human uses
   - Extensive surveys for recreational fishing & boating
4. Important ecosystem components
   - "Rules of thumb" for size and spacing
   - All habitat types had to be represented in proposal

California Marine Life Protection Act (1999)

Addressing needs & challenges:
1. Goals & objectives
2. Data & tools
   - MarineMap developed for the process & used by stakeholders
3. Human uses
4. Important ecosystem components
   - "Rules of thumb" for size and spacing
   - All habitat types had to be represented in proposal

Puget Sound Partnership (2007)

Addressing needs & challenges:
1. Goals & objectives
2. Data & tools
3. Human uses
4. Important ecosystem components
   - Ecosystem indicators for each of six goals and targets for each
5. Land-use integration
   - Watershed is the unit of coordination

Puget Sound Partnership (2007)

Addressing needs & challenges:
1. Goals & objectives
2. Data & tools
3. Human uses
4. Important ecosystem components
   - Ecosystem indicators for each of six goals and targets for each
5. Land-use integration
   - Watershed is the unit of coordination

Ingredients for success

1. Strong and clear legal mandate (e.g., MOP, MLPA)
   - Goals, objectives, science requirements, adaptive management
2. Political support and leadership (e.g., MOP, PSP, and Regional Councils)
   - Support and leadership that lasts beyond term limits is critical
3. Adequate funding (e.g., MOP, MLPA)
   - Public-Private Partnerships can be extremely beneficial
4. Firm deadlines (e.g., MOP)
   - Keep it short so planning does not languish
   - Massachusetts had 18 month timeline vs. U.S. NOP with 7 year timeline
5. Willingness and capacity for stakeholders to engage
   - Includes citizens, scientific community, industry & decision-makers
6. Transparent decision-making process
   - Information availability
   - Conflict resolution process
   - Clear expectations
Realized benefits of integrated management & planning

1. Learn what you have, what you don’t have, and what you need to have
   • Especially true for data
2. Develop a science framework
   • Underpins the whole plan
   • Best available science requirement
3. Coordinate and fund scientific research
   • Facilitates a broader understanding of the system
   • Engages scientists in the process
4. Couple social and ecological data
   • Helps make trade-offs more transparent
5. Integrated communication
   • Facilitates for efficient and effective decision-making
6. Adaptive management
   • Scheduled, regular updates of the plan that incorporate new data, uses, and changing conditions
European governance, legislative & policy frameworks
Mark Dickey-Collas, Erik Olsen, Martin Pastoors

European Seas – history of supplying services
Times seabed disturbed by fishing per year (2009-2012) European shipping routes

Intensified in 20th century - offshore oil and gas
And coastal defences

Increased demands: renewable energy, aggregate extraction

Commitment to increase MPA, eco approach, blue growth

Marine Policy in EU
Formal Institutions

- Council of Ministers
- European Parliament
- European Commission
- European Court of Justice

Member states, stakeholder groups

EU Legislation

- Common Fisheries Policy (CFP) 1972-2014
- Birds Directive 1979

Policy Domains

<table>
<thead>
<tr>
<th>Name</th>
<th>Acronym</th>
<th>Type</th>
<th>DG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Fisheries Policy</td>
<td>CFP</td>
<td>Policy</td>
<td>MARE</td>
</tr>
<tr>
<td>Habitat &amp; Birds Natura2000</td>
<td>H&amp;BD</td>
<td>Directive</td>
<td>ENV</td>
</tr>
</tbody>
</table>

EU Directives:

Sets out results Member States must achieve
Monitored by European Commission
Interpreted by Member States, ECJ determines
Implemented by Member States
Often member states asked to act regionally
Maritime Spatial Planning Directive

Focus on blue growth.

“coordinated and coherent decision-making to maximise the sustainable development, economic growth and social cohesion of Member States”

MSPD Objectives 2014

“Sustainable development of energy sectors at sea, of maritime transport, and of fisheries and aquaculture sectors, and to the preservation, protection and improvement of the environment, Member States may pursue other objectives such as the promotion of sustainable tourism and the sustainable extraction of raw materials.”

Plans be submitted by 2021

MSPD no suggested approach regionalisation

The directive encourages working across national boundaries as good practice but no mechanism suggested.

Experience with MSFD is that countries struggle to join supra-national approaches.

Often reduces initiatives to the lowest common dominator.

Common Fisheries Policy


- Fishing & aquaculture are environmentally, economically & socially sustainable.
- Healthy food source for EU citizens.
- Foster a dynamic fishing industry and a fair standard of living for fishing communities.

Main tools:
fisheries management, international policy, market and trade policy, plus rules on funding, aquaculture and stakeholder involvement


GES
Good Environmental Status

Six year cycle, targets, assessments and implementation

EU regions employment dependent on fishing

Circle size – # employed
Colours vessels size

First sale value €7.1 billion in 2011

66

1. Biodiversity
2. Non-indigenous species
3. Commercial fisheries, fish & shellfish
4. Foodweb structure
5. Dredging
6. Sediment
7. Alteration to hydrograph
8. Contaminants
9. Sound level
10. Marine litter
11. Energy & waste

Habitat & Birds Directives (Natura2000)

EU wide network of nature protection areas
Valuable & threatened species & habitats

Water Framework Directive

Cleaner rivers, lakes, groundwater & coastal beaches
Bringing together of previous water legislation
Urban waste water to agriculture runoff
Coastal water and habitats

Regional Sea Conventions

Regional conventions on marine environmental management (most from 1970s).
EU member states plus Russia, Iceland and Norway are members.
Operate through national initiatives & legislation

Advisory Councils

Set up by the European Commission to enable stakeholders to give formal comment about the CFP

60% industry

Norway

establish the political & strategic framework (+guidelines) for management across economic sectors,
describe management measures to be implemented for the conservation and sustainable use

Integrated Management of the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands 2006
Integrated Management of the Marine Environment of the Norwegian Sea 2009
Integrated management of the marine environment in the North Sea and Skagerrak 2013

The approach evolved with each management plan
Norway - impact

The power play within the EU

Who loses influence with integration?

Tools used
- Common Fisheries Policy
- Marine Strats. Framework Dir
- Birds & Habitats Dir
- Water Framework Dir
- Maritime Spatial Planning

Players
- European Commission
- European Council
- European Parliament
- Member States
- Advice Councils
- Regional Sea Conventions

Who loses with integration?

Tools used
- Common Fisheries Policy
- Marine Strats. Framework Dir
- Birds & Habitats Dir
- Water Framework Dir
- Maritime Spatial Planning

Players
- European Commission
- European Council
- European Parliament
- Member States
- Advice Councils
- Regional Sea Conventions

Who loses with integration?

Tools used
- Common Fisheries Policy
- Marine Strats. Framework Dir
- Birds & Habitats Dir
- Water Framework Dir
- Maritime Spatial Planning

Players
- European Commission
- European Council
- European Parliament
- Member States
- Advice Councils
- Regional Sea Conventions

Who loses with integration?

Tools used
- Common Fisheries Policy
- Marine Strats. Framework Dir
- Birds & Habitats Dir
- Water Framework Dir
- Maritime Spatial Planning

Players
- European Commission
- European Council
- European Parliament
- Member States
- Advice Councils
- Regional Sea Conventions
Who loses with integration?

Tools used:
- Common Fisheries Policy
- Marine Strat. Framework Dir
- Birds & Habitats Dir
- Water Framework Dir
- Maritime Spatial Planning

Players:
- European Commission
- European Council
- European Parliament
- Member States
- Advice Councils
- Regional Sea Conventions

EU MSP projects

Next talk, look at reconciling objectives plus use a case study.


Aligning of Ecoregions

EU exporting ecosystem, social and cultural impacts.

Not sure of likely impact of new directive

David Goldsborough...

"1. MSP implementation in the EU is Member State driven and differs strongly between countries.
2. MSP plans range from actual spatial plans within legal national frameworks to long term spatial visions.
3. Due to these differences cross-border MSP has a low priority and is complex to achieve."
Science for sustainable seas

Thank you
Integrated Oceans Management in Australia: Looking Back, Moving Forward

Marcus Haward
13-16 April 2015
SARDI West Beach

Workshop – Practical steps to implementation of integrated marine management

Outline

Integrated Oceans Management

Integrated Oceans Management – A National Overview

The Australian Oceans Policy: Looking Back, Moving Forward

Where to now?

Integrated Oceans Management

Management that uses a decision making framework that meaningfully includes and considers all sectoral and community interests, ensures its management objectives and decision making processes are not dominated or determined by particular sectors or interest groups, and integrates sector-specific management processes to ensure that the four principles of multiple use management are addressed and achieved.

(Sainsbury et al 1997)

Management that recognises ecological, economic, social and cultural values, the impacts of uses on these values, involves coordination of sectoral management within and between spheres and levels of government and involvement of community and stakeholders groups in management decisions and implementation.

(Tsamenyi & Kenchington 2012).

Integrated Oceans Management – A National Overview

GBRMP
An ecosystem based, multiple-use area, supporting a range of communities and industries that depend on the Reef for recreation or their livelihoods.

Marine Park Zoning Plan identifying where particular activities are permitted or not permitted.

NSW Maritime Estate
All NSW citizens are entitled to have a say in how the Estate is used and managed to achieve the best outcomes for the community as a whole. Broad community input is therefore vital, as well as input from special interest stakeholders

Coordinated government and community action to enhance economic, social and environmental outcomes.

A Marine Nation (2009)

Improved governance - oversight and coordination of an invigorated national research effort… need for effective interface between marine science providers and policy makers ...

Marine Nation 2025 (2013)

Investment in science communication is needed to improve application and acceptance of science in policy, legislation and regulation.

Australia’s Oceans Policy Looking Back – Moving Forward

Multiple use management

Formal cross and intra-jurisdictional arrangements

Adaptive management

Science-based decision-making

Stakeholder involvement and expectations
Jake Rice's conception of the science policy gap.

Challenges from step-wise policy change

Adaptive Management Cycle

Adaptive Management

Links economic, social and ecological drivers of decision-making

The key to adaptive management is the iterative, cyclic and reflexive approach to decision making.

Opportunities for continual review of outputs and outcomes and allow adjustments.

Stakeholder Engagement and Expectations

Stakeholder engagement

Who?, When?, How?

Managing Expectations

A key lesson from the Oceans Policy story…

Lessons from Other Reforms

Structural manipulations cannot produce changes in behaviours, especially if existing behaviours are reinforced by other factors;

There is often greater willingness to coordinate programs at the bottom of organisations than at the top;

Timing is important; and

Formal methods of coordination may not be as beneficial as the more informal techniques involving bargaining and negotiation (Peters 1998).

A final thought

Problems in ocean resources management derive from governance not science.

(Crowder et al 2006: 617)
References

Crowder, LB., G. Osherenko, OR. Young, S. Airame EA, Norse, N. Baron, JC. Day, E.
Douwere, CN. Ether. BS. Halpern, SJ. Langdon, KL. McLeod, JC. Ogden, RE. Peach, AA.
313: 617-618.

Jones, G. 2009. 'Tasmania’s adaptive management system: A 30 year retrospective' paper
at 9th World Wilderness Congress, Mexico 9-13 November 2009.

Administration, 76: 205-211.

Rice, J. 2011. Managing fisheries well: delivering the promises of an ecosystem approach,

Management in the Australian Marine Environment: Principles, Definitions and Elements. A
Report Commissioned by Environment Australia, AGPS, Canberra.

Vince, J., ADM. Smith; KJ. Sainsbury, ID. Creswell, DC. Smith & M. Haward. 2015
The Commonwealth marine planning experience
From Oceans Policy to Marine Bioregional Planning

Outline:
• 2000-2004: Oceans Policy & Regional Marine Planning
• 2005: Review & Re-focus
• 2006-2012: Marine Bioregional Planning
• Reflections on key lessons
• Remaining challenges – Parks Australia’s perspective

Oceans Policy
• Launched 1998
• International and domestic drivers
• Commonwealth only
• Visionary, “ahead of time”
• Political leadership

Policy Goals
A VISION FOR AUSTRALIA’S OCEANS
Healthy oceans: cared for, understood and used wisely for the benefit of all, now and in the future.

GOALS FOR AUSTRALIA’S OCEANS
In seeking to care for, understand and use our oceans wisely, Australia’s Oceans Policy has the following broad goals.
1. To exercise and protect Australia’s rights and jurisdiction over offshore areas, including offshore resources.
3. To understand and protect Australia’s marine biological diversity, the ocean environment and its resources, and ensure ocean uses are ecologically sustainable.
4. To promote ecologically sustainable economic development and job creation.
5. To establish integrated oceans planning and management arrangements.
6. To accommodate community needs and aspirations.
7. To improve our expertise and capabilities in ocean-related management, science, technology and engineering.
8. To identify and protect our natural and cultural marine heritage.
9. To promote public awareness and understanding.

Context
• Fragmented decision-making
  – State and Commonwealth jurisdictions
  – Sectoral regulation
    – Fisheries
    – Oil & Gas
    – Shipping
    – Aquaculture
    – Tourism
• Indigenous interests

Institutional arrangements
From Australia’s Oceans Policy, Vol.1 (p.14)
Regional marine planning

- Ecosystem approach
- Multiple-use
- Participatory approach (stakeholders/Indigenous)
- Integrated planning, BUT:
  - Implementation by sectoral arrangements
  - Current constitutional arrangements (State vs Federal jurisdiction)

South-east RMP

- Scoping
- Assessment
- Draft Plan
- No clear model
- “Learning by doing”
- No carrot & no stick...

Outputs

- South-east Regional Marine Plan (2004)
- National Marine Bioregionalisation
- Indigenous ‘Sea Country’ plans
- Communication products
- Information management – Oceans Portal

Biophysical information:

Positive change

- Focus on marine environment
- Catalyst for cross-sectoral, cross-departmental liaison
- Key stakeholders brought together
- Driving improvements within sectoral management
However...

- Promised too much (too soon?)
- Lack of real buy-in within agencies
- Seen as encroaching/duplicating
- Failed to deliver “integrated allocation of resource use and access to achieve an acceptable balance.”

Reviews of Oceans Policy

- Norton Review 2002
  - Overall, good value for money
  - Confirmed governance
- Internal reviews 2004 / 2005
  - External factors
  - NOO absorbed into Department
  - Need for stronger focus and legislative basis
  - Clear roles and clear rationale for planning

Refocusing marine planning

- Bioregional Marine Planning Program
  - Ecosystem integrity
  - Participatory
- Brought under Environment Protection and Biodiversity Conservation Act 1999
- Purview of Environment Minister only
- Less ambitious / clearer bounds (legislative/institutional)
- Dual outcome:
  - Marine Bioregional Plans to guide future legislative decision-making
  - Regional networks of marine reserves (NRSMPA)

MBP - outputs

- Marine Bioregional Plans
  - improving understanding and management of marine ecosystems
  - improving application of Commonwealth environment legislation in our oceans
  - bioregional frameworks for decisions on:
    - New developments (energy; aquaculture; genetic resources etc.)
    - Sustainable fisheries
    - Species conservation
    - Sea dumping
    - Heritage values

- Australia’s Commonwealth marine reserves estate
  - the largest network of marine reserves in the world
  - 59 separate reserves
  - ~2.9 million square kilometres
  - 2/3 multiple use, 1/3 highly protected
Oceans Policy

“Multiple use planning and management of the oceans should incorporate, as a central component, a comprehensive, adequate and representative national system of marine protected areas.”

Socio-economic data

- Refined socio-economic data and cultural information
- Undertook assessments to inform zoning and activities permitted
- Incorporated new scientific information

Significant of consultation

- 2007 to 2009 - consultation on Bioregional Profiles
- 2009 to 2010 - consultation on Areas for Further Assessment
- 2011 to 2012 - 90 day consultation on draft marine reserves networks
- 2012 - 60 day consultation on final marine reserves networks
- 2012 - 30 day consultation on preparation of management plans
- 2013 - 30 day consultation on draft plans

- 250 public and stakeholder meetings attended by 2,000 people
- 210 public comment days
- > 740,000 public submissions

Key lessons

- Institutional/legal arrangements
  - Whole of government approach requires buy-on
  - “No carrot and no stick” (need either mandate or inducement)
  - Needs to be grounded in established arrangements
  - Importance of getting governance structures right
- Leadership style
  - Transformative
- Communication challenges
  - Trust/credibility
  - Informing public debate
- Certainty of process (helps with timeframes)
  - Objectives and outcomes
  - Scale
  - Operationalising key concepts

Looking ahead

- CMRs are “regulated areas”
- Increasing focus on multiple benefits
- Multiple use zones – reduce/avoid duplication
- Risk-based, standards-based approach to management
- Focus on performance monitoring & evaluation
  - Knowledge base
- Partnerships
Shipping
Recreational Fishing, Nature-based tourism, Port-related activities

Commercial Fishing
Oil & Gas, Scientific research, Renewable energy
Charter fishing, RAN/RAAF training, Offshore aquaculture

Who Manages Whom in Commonwealth Marine Reserves?

- AFMA
- DNP
- AMSA
- NOPSEMA
- Defence
- Port Authorities
- Scientific research
- State fisheries agencies
- AFMA
- Defence
- NOPSEMA
- AMSA
- DNP

Not all jurisdictions

Strategic Assessments
Case-by-case Approvals

Who Manages Whom in Commonwealth Marine Reserves?

- AFMA
- DNP
- AMSA
- NOPSEMA
- Defence
- Port Authorities
- Scientific research
- State fisheries agencies
- AFMA
- Defence
- NOPSEMA
- AMSA
- DNP

Not all jurisdictions

Strategic Assessments
Case-by-case Approvals

Who Manages Whom in Commonwealth Marine Reserves?

- AFMA
- DNP
- AMSA
- NOPSEMA
- Defence
- Port Authorities
- Scientific research
- State fisheries agencies
- AFMA
- Defence
- NOPSEMA
- AMSA
- DNP

Not all jurisdictions

Strategic Assessments
Case-by-case Approvals

Who Manages Whom in Commonwealth Marine Reserves?

- AFMA
- DNP
- AMSA
- NOPSEMA
- Defence
- Port Authorities
- Scientific research
- State fisheries agencies
- AFMA
- Defence
- NOPSEMA
- AMSA
- DNP

Not all jurisdictions

Strategic Assessments
Case-by-case Approvals

Who Manages Whom in Commonwealth Marine Reserves?

- AFMA
- DNP
- AMSA
- NOPSEMA
- Defence
- Port Authorities
- Scientific research
- State fisheries agencies
- AFMA
- Defence
- NOPSEMA
- AMSA
- DNP

Not all jurisdictions

Strategic Assessments
Case-by-case Approvals

Who Manages Whom in Commonwealth Marine Reserves?

- AFMA
- DNP
- AMSA
- NOPSEMA
- Defence
- Port Authorities
- Scientific research
- State fisheries agencies
- AFMA
- Defence
- NOPSEMA
- AMSA
- DNP

Not all jurisdictions

Strategic Assessments
Case-by-case Approvals

Who Manages Whom in Commonwealth Marine Reserves?

- AFMA
- DNP
- AMSA
- NOPSEMA
- Defence
- Port Authorities
- Scientific research
- State fisheries agencies
- AFMA
- Defence
- NOPSEMA
- AMSA
- DNP

Not all jurisdictions

Strategic Assessments
Case-by-case Approvals

Who Manages Whom in Commonwealth Marine Reserves?

- AFMA
- DNP
- AMSA
- NOPSEMA
- Defence
- Port Authorities
- Scientific research
- State fisheries agencies
- AFMA
- Defence
- NOPSEMA
- AMSA
- DNP

Not all jurisdictions

Strategic Assessments
Case-by-case Approvals

Who Manages Whom in Commonwealth Marine Reserves?

- AFMA
- DNP
- AMSA
- NOPSEMA
- Defence
- Port Authorities
- Scientific research
- State fisheries agencies
- AFMA
- Defence
- NOPSEMA
- AMSA
- DNP

Not all jurisdictions

Strategic Assessments
Case-by-case Approvals

Who Manages Whom in Commonwealth Marine Reserves?

- AFMA
- DNP
- AMSA
- NOPSEMA
- Defence
- Port Authorities
- Scientific research
- State fisheries agencies
- AFMA
- Defence
- NOPSEMA
- AMSA
- DNP

Not all jurisdictions

Strategic Assessments
Case-by-case Approvals

Who Manages Whom in Commonwealth Marine Reserves?

- AFMA
- DNP
- AMSA
- NOPSEMA
- Defence
- Port Authorities
- Scientific research
- State fisheries agencies
- AFMA
- Defence
- NOPSEMA
- AMSA
- DNP

Not all jurisdictions

Strategic Assessments
Case-by-case Approvals

Who Manages Whom in Commonwealth Marine Reserves?
Integrated management of the Great Barrier Reef

Presented by Sally Harman, Planning Manager
Great Barrier Reef Marine Park Authority

1. Introduction
2. Foundations
3. Current situation – impacts, World Heritage, reports
4. Future – core business and recent adaptations

Overview

Great Barrier Reef Marine Park

70 million football fields
Roughly the same area as...
...

AREA
79,400 km²

Kilometres
2,300 km long

79

Outstanding universal value as a World Heritage area

Big

Beautiful and Diverse
Governance

- Commonwealth
- Minister for Environment
- MPA Board
- Intergovernmental agreement
- Reef Advisory Committees
- Local Marine Advisory Committees

Our management tools are designed to protect the Region’s values and allow ecologically sustainable use.

Tools for Managing the Reef

1. Zoning
2. Outside influences
3. Stewardship/community engagement
### Great Barrier Reef Marine Park Zoning Plan

1 July 2004

<table>
<thead>
<tr>
<th>Use</th>
<th>Preservation</th>
<th>Marine National Park</th>
<th>Scientific Research</th>
<th>Buffer Zone</th>
<th>Conservation Park</th>
<th>Habitat Protection</th>
<th>General Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>0.2% (0.1%)</td>
<td>33.3% (4.6%)</td>
<td>0.0% (0.0%)</td>
<td>2.9% (0.1%)</td>
<td>1.5% (0.6%)</td>
<td>28.2% (15.2%)</td>
<td>33.8% (77.9%)</td>
</tr>
<tr>
<td>Previous</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Science communication tool

- **Current Situation**
  - Drivers
  - Economic growth
  - Population growth
  - Technology/development
  - Social attitudes
  - Climate change
  - Land-based run-off

- **Coastal development**
  - Direct use

### Engagement/stewardship

- **Updated goal:**
  - To ensure that by 2020 the quality of water entering the Reef from broad-scale land use has no detrimental impact on the health and resilience of the Great Barrier Reef.

- **Key action = Paddock to Reef**
  - Integrated monitoring, modelling and reporting program

- **Impacts, World Heritage and reports**

- **Joint Australian and Queensland government initiative to improve land management practices**

- **Released 2003**

- **Updated 2009 & 2013**

- **Engagement/stewardship**
  - **Traditional Owners - TUMRAs**
  - **Eye on the Reef**
  - **Reef Guardians**

- **www.gbmpa.gov.au**
Two major reports

- Prepared by the Great Barrier Reef Marine Park Authority
- Released on 12 August 2014

Great Barrier Reef Outlook Report 2014
- A five-yearly snapshot
- Assesses the Reef’s condition, trend, threats and management effectiveness
- Prepared under the Great Barrier Reef Marine Park Act 1975

Great Barrier Reef Region Strategic Assessment
- Part of a comprehensive strategic assessment for World Heritage Area
- Prepared under Environment Protection and Biodiversity Conservation Act 1999
- Includes recommendations
- Includes a 25-year management program

Strategic Assessment

UNESCO ruling: Decision on whether Great Barrier Reef as 'in danger' deferred for a year

Glad coal expansion threatens Great Barrier Reef

Ministers’ mad dash to save the Great Barrier Reef from ‘danger’ listing

Strategic Assessment

Reef 2050 Long-Term Sustainability Plan
LTSP - Structure and themes

GREAT BARRIER REEF WORLD HERITAGE AREA

LTSP Key Elements

- Integrated monitoring and reporting to drive adaptive management
- Governance arrangements with continued input
- Annual reporting (Full review – 5 years)

Looking forward
LTSP and foundational - both important

Dredging

- Dredge synthesis report
- No capital dredge spoil dumping
- No new ports

Need to manage cumulative threats

Monitoring – currently

- Scientific Papers
- Other reporting
- OutlookReport
- Report cards

Response by government - changes to management
**Integrated monitoring**

Monitoring required for Reef 2050 LTSP

- Photo logs
- Logs
- Work plans
- Data logs
- Input

Standardised data collection protocols & metadata tagging

Data cloud interlinked and accessible repositories

Scientific Papers

Other reporting

Outlook Report

Report cards

Broad range of data, discoverable and obtainable for all stakeholders

**ALSO... Improving foundational elements**

- Decision making aligning with Reef's Outstanding Universal Value
- Regional Reef Recovery plans
- Targets to benchmark performance
- Enhanced integration of values
  - Cultural and historical
- Consideration of cumulative impacts

---

**Our vision:**

a healthy Great Barrier Reef for future generations

---

**Our vision:**

Sally Harman, Planning Manager
Great Barrier Reef Marine Park Authority

Phone: +61 7 4750 0605
Email: sally.harman@gbrmpa.gov.au
Address: 2-68 Flinders St (PO Box 1379) Townsville QLD 4810

---

**www.gbrmpa.gov.au**

---

---
Principles paper

1. Engage community to prioritise benefits and threats
2. Identify priority actions through threat and risk assessment
3. Values enable trade-offs between alternative uses
4. Best available information, judgement still required
5. Consider well-being of future generations
6. Respect existing access arrangements
7. Apply precautionary principle
8. Efficient and cost-effective
9. Transparent and adaptive
10. Monitoring, evaluation, reporting

Survey – key findings

**Values and benefits**
- Tourism
- Diverse, abundant marine life
- Natural beauty
- Fishing provides a supply of seafood and contributes to local economy

**Threats**
- Major threat: Pollution
- Less than 1 in 5 respondents considered overfishing a priority threat

**Opportunities**
- Addressing pollution
- Public involvement, access & education
- On-ground environmental action programs

Key achievements

- Principles paper
- Community survey
- Comms and engagement strategy
- Beaches and headlands assessment
- Marine Estate Management Act 2014
- Threat and Risk Assessment Framework

**Marine Estate Management Act 2014**
- MEMA, MEEKP
- Threat and risk assessment
- Marine Estate Management Strategy
- Marine parks and aquatic reserves
Threat and Risk Assessment Framework

- Publication: Early 2015
- Guidance: not prescriptive steps
- Likelihood and consequence
- Different spatial and temporal scales
- Ecological, economic & social threats to benefits

Priorities 2015-2016

- Hawkesbury Shelf Marine Bioregion Assessment
- Threat and risk assessment
- Marine Estate Management Strategy
- Marine estate regulations
- Pilot management planning - Batemans and Solitary Islands MPs

Hawkesbury Shelf Marine Bioregion Study

- Options to enhance marine biodiversity conservation
- Will consider threats to marine biodiversity + risks of not adequately conserving it
- Focus on 15 priority sites
- Will inform decisions regarding marine protected areas along the Greater Sydney coast

Threat and Risk Assessment

- Implementation of framework
- ...assessment of threats to benefits
- identify priority threats
- statewide scale... evidence-based risk analysis
- economic, social & environmental benefits
- expert input
- final report

Marine Estate Management Strategy

- 10 year strategy
- Coordination of NSW government agencies
- Priority threats
- Management options and opportunities
- Implementation plan
- Monitoring & review

Lesson 1
Multi-objective decision making
or
Some of the many ways to bungle a complex multi-stakeholder problem

Terry Walshe
Australian Institute of Marine Science

Decision science
A formalization of common sense for decision problems which are too complex for informal use of common sense.
- Ralph Keeney

<table>
<thead>
<tr>
<th>Objective</th>
<th>Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do nothing</td>
<td>A1</td>
</tr>
<tr>
<td>Conserving the reef</td>
<td>More is better</td>
</tr>
<tr>
<td>Costs to industry</td>
<td>More is better</td>
</tr>
<tr>
<td>Costs of implementation</td>
<td>More is better</td>
</tr>
</tbody>
</table>

3 claims
• Decisions are dominated by values, not epistemic angst. Science is the caboose not the engine.
• Formally, values are underpinned by objectives. But we’re hopeless at articulating objectives.
• As analysts, we never get it right first time.
Desirable properties of objectives

**Completeness**
All relevant objectives (and alternatives) should be included.

**Operationality**
Attributes should be meaningful and assessable.

**Decomposability**
Attributes should be judgmentally independent

**Nonredundancy**
The set of attributes should be non-redundant to avoid double counting of the consequences.

**Minimum size**
The set of attributes should be minimal.

---

What’s the minimum set of sites that will capture at least one population of each species?

<table>
<thead>
<tr>
<th>Species</th>
<th>Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Sugarhead Spice</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>Western Burrowing Owl</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>Grasshopper Sparrow</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>Ferruginous Hawk</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>Sage Thrasher</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>Western Sage Thrasher</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>Sage Sparrow</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>White Pelican</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>Red Egret</td>
<td>0 0 0 0 0 0</td>
</tr>
<tr>
<td>Western Shrike</td>
<td>0 0 0 0 0 0</td>
</tr>
</tbody>
</table>

A typology of objectives

- **Strategic objectives**: objectives influenced by all of the decisions made over time by the organization or individual facing the decision at hand.
- **Fundamental objectives**: the ends objectives used to describe the consequences that essentially define the basic reasons for being interested in the decision.
- **Means objectives**: objectives that are important only for their influence on achievement of the fundamental objectives.
- **Process objectives**: objectives concerning how the decision is made rather than what decision is made.


---

What’s the minimum set of sites that will capture at least one population of each species?

<table>
<thead>
<tr>
<th>Species</th>
<th>Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Sugarhead Spice</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>Western Burrowing Owl</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>Grasshopper Sparrow</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>Ferruginous Hawk</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>Sage Thrasher</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>Western Sage Thrasher</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>Sage Sparrow</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>White Pelican</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>Red Egret</td>
<td>0 0 0 0 0 0</td>
</tr>
<tr>
<td>Western Shrike</td>
<td>0 0 0 0 0 0</td>
</tr>
</tbody>
</table>

1. Specify the management objective
2. List the management options and express them as control variables
3. Specify the system properties that describe the state of the system
4. Develop a conceptual model of the dynamics of the system being managed
5. Specify constraints that bound the decision variables and state variables
6. Be honest about what we don’t know.
7. Find solutions to the problem.
<table>
<thead>
<tr>
<th>Species</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>Populations captured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loggerhead Shrike</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Western Burrowing Owl</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Grasshopper Sparrow</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Ferruginous Hawk</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Sage Thrasher</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Western Sage Grouse</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Sage Sparrow</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>White Pelican</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Red Eagle</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Tender's Tern</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objective</th>
<th>Alternative</th>
<th>C, E</th>
<th>A, B, C</th>
<th>A, B, E, C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loggerhead Shrike</td>
<td>more is better</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Western Burrowing Owl</td>
<td>more is better</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Grasshopper Sparrow</td>
<td>more is better</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Ferruginous Hawk</td>
<td>more is better</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Sage Thrasher</td>
<td>more is better</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Western Sage Grouse</td>
<td>more is better</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sage Sparrow</td>
<td>more is better</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>White Pelican</td>
<td>more is better</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Red Eagle</td>
<td>more is better</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Tender’s Tern</td>
<td>more is better</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Bald Eagle</td>
<td>more is better</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

S specific
M measurable
A attainable
R relevant
T timely
D reamy
F forsake
Trade-offs

Sensitivity analysis - weights

<table>
<thead>
<tr>
<th>Decision-maker</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>0.30</td>
<td>0.70</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>Health outcomes</td>
<td>0.50</td>
<td>0.20</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>Acceptability</td>
<td>0.05</td>
<td>0.05</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>Sum</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

Full exemptions
Voluntary

DM1
DM2
DM3
DM4
• Values and preferences are not fixed, they evolve during a structured decision-making process.
• People learn about options and their consequences, but also about values, including their own and others.
• What is acceptable or preferred depends on the options.
• Consensus is desirable but not necessary for good policy making.

3 claims
• Decisions are dominated by values, not epistemic angst. Science is the caboose not the engine.
• Formally, values are underpinned by objectives. But we’re hopeless at articulating objectives.
• As analysts, we never get it right first time.

A partial remedy....

1. Clarify the Problem / Decision Context
2. Define Objectives & Evaluation Criteria
3. Develop Alternatives
4. Estimate Consequences
5. Make Trade-Offs and Choices
6. Implement and Monitor

iterate as required
## Objectives (of and for) for IM

Rob Stephenson – DFO St. Andrews, and University of New Brunswick

### Do we need Integrated Management?

What are we trying to achieve/solve?
What is wrong with the current system?
What value can we ‘add’?

Is IM necessary?
Why would people choose to participate?

### The literature litany...

- Failure of modern management
- Challenge of climate change
- The need to implement international agreements and national legislation re sustainability
- Unintended consequences of management

### Unintended consequences

- Fish stock collapse, threatened species
- Environmental degradation
- Social and economic consequences (e.g. overcapacity and corporate ownership of fisheries)
- Collapsed coastal communities

...in spite of elaborate fisheries/coastal management schemes

### Report card on coastal/marine resource management?

- Considerable recent advance – legislative advance, move toward EAM and IM
  
  But...
  - Insufficient consideration of cumulative effects
  - Lack of consideration (and definition!) of full suite of conservation, social, economic and institutional goals
  - No structure for consideration of tradeoffs among objectives...
  - Insufficient governance structure for integrated management

### Can IM resolve issues?

- Integrate ecological, social, economic and institutional goals?
- Consider cumulative effects?
- Consider tradeoffs; competing objectives?
- Reduce unintended consequences?
- Improve governance (participation/transparency)?
- Resolve spatial conflict (rearrange activities to achieve more)?
…add Community values/lens

- Protect habitat, natural environment
- Protect against pollution, Cumulative impacts
- Preserve biodiversity
- Protect heritage, traditions, equitable access
- Maintain community health and wellbeing
- Promote local employment and prosperity
- Promote financial self-sufficiency and sustainability

ESSIM

- Bring together diverse ocean uses to consider spatial planning, MPA, governance
- Common forum
- Coordinate government support

Can Integrated management achieve?

- Diverse, common objectives
  - Higher standards of EAM and PA
  - Ecological, social, economic and institutional
- Applied to all activities
  - Cumulative effects
- Appropriate governance structure and methods
  - Issues can be articulated, compared and used as basis for rational decisions
  - Participatory process and appropriate jurisdiction

(Stephenson 2012)

Industry Priorities: Need for research in support of...

- Sustainability
- Social acceptance
- Evolving ecosystem-based management
- Socio-economic viability
- Fishing community well-being

...a sustainable industry in a changing landscape of management
Expanding objectives of fisheries management (last 3 decades)

- **Productivity**
  - Primary Productivity
  - Community Productivity
  - Population Productivity

- **Biodiversity**
  - Species Diversity
  - Population Diversity

- **Habitat**

- **Social and Economic objectives**
  (Societal expectation is greater than the minimum established in law = 'Social license')

---

Canadian Policy

- **Sustainable Fisheries Framework**
- **Conservation & Sustainable Use policies**
- **IFMP** – identify goals; biological and socio-economic considerations for decisions
- **2011 - Commissioner for Sustainable Development**

- **Need explicit objectives:**
  - Healthy Ecosystems
  - Sustainable human use/Social and cultural wellbeing
  - Economic well-being
  - Collaborative governance and Integrated Management

---

Elements and objectives from the literature

- **Ecological**
  - Productivity
  - Biodiversity
  - Habitat

- **Social**
  - Social amenity and quality of life (including health)
  - Traditions and heritage
  - Viable communities

- **Economic**
  - Maximum sustainable economic yield
  - Equality for stakeholders
  - Employment

- **Institutional**
  - Community values
  - Adaptive management
  - Collaboration

(...From Working paper by Stephenson and Jennings Oct 2011)

---

April 2012 (Halifax meeting)

A sustainable fishery respects the ecological integrity of the ocean and its resources; is ethical, responsibly governed, economically viable and technologically appropriate; supports communities; draws on local culture, heritage, and diverse knowledge systems; and enhances health, wellbeing and the public good

---

Project 1.1 research

([Image])
**Objects for Integrated management?**

- Ecological objectives
  - Productivity
  - Biodiversity
  - Habitat

- Social and economic objectives
  - Sustainable communities
  - Health and well-being
  - Economic/financial value and viability
  - Distribution of access and benefits
  - Regional economic benefit

- Institutional objectives
  - Good governance
  - Participatory decision-making
  - Effective management
  - Minimize disruption caused by ecosystem change

---

**Useful structure for IM?**

<table>
<thead>
<tr>
<th>Fisheries</th>
<th>Aquaculture</th>
<th>Transport</th>
<th>Energy</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutional</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cumulative impacts**

---

**Help structure conversation**

- **Objective?**
  - Ecological
  - Economic
  - Social
  - Institutional

  - What do we care about?
  - What are we trying to achieve?

**Help structure conversation**

- Management options?
- What are the viable options for management?
- How do these meet our goals?
- Possible futures?
- What ‘new and different’ information is required...and who can best provide it?
Help structure conversation

Management options

<table>
<thead>
<tr>
<th>Ecological</th>
<th>Scenario A</th>
<th>Scenario B</th>
<th>Scenario C</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutional</td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Compare Scenarios/options

Management options

<table>
<thead>
<tr>
<th>Ecological</th>
<th>Scenario A</th>
<th>Scenario B</th>
<th>Scenario C</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>acceptable</td>
<td>acceptable</td>
<td>improvement</td>
</tr>
<tr>
<td>Economic</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutional</td>
<td>No change required</td>
<td>More participatory</td>
<td>Participatory and easily implemented</td>
</tr>
</tbody>
</table>

Competing objectives

- Diverse objectives reduce probability of single ‘best’ solution
- Obvious approach is to articulate scenarios to show likely consequences of scenarios

Is this a useful framework?

- Builds on what we have
  - Adds value to existing plans
- Helps overcome several ‘issues’
  - Allows more, common objectives
  - Improves consistency among activities
  - Allows consideration of cumulative impact
  - Allows examination of tradeoffs

Common framework for consideration of activities or scenarios of IM?

Allows:
- Consideration of multiple objectives
- Comparison of scenarios
- Examination of tradeoffs
- Evaluation of cumulative impacts
1.1 Specific Objectives

Emerging requirements for sustainability:
• criteria from Canadian policy for a sustainable fishery system,
• performance indicators and metrics for a ‘report card’
• test report card on various fishery case studies.

Enhanced fisheries knowledge for sustainability:
• Review what info is currently being used for assessment and management.
• Evaluate information requirements of social, economic and institutional aspects of sustainability.
• Evaluate the capacities of industry, government and academia to provide information required in future.

Enhanced participation in collaborative management:
• Identify training and capacity-building needs for participatory management

Framework can help?

To discuss objectives:
• What do we care about, what are we trying to achieve?
• What should we be tracking?

To develop management scenarios:
• What are the options for management?
• What are the possible futures?

To compare management scenarios or evaluate performance:
• How do management options compare in terms of objectives?
• Is management meeting objectives?
Fisheries Management Science

Fisheries Management
Fisheries Science
Social/Management Science

Stephenson and Lane 1995; 2010

Source: Lane and Stephenson 1997

Current Decision Making Process - Linear

Stock assessment information
Catch and effort information
Other considerations (economic, social)
Exogenous conditions (environmental, markets, social)

Industry lobby and interest groups
Harvesters behavior

Fisheries Science
Apply conservation standards

Biological Advice
Harvest Limit Decision
Implementation

Decision Makers

Advice Alternatives
Risk Management

Harvest Risk Decision Implementation

Risk Assessment
Monitor and Track Feedback
Risk Management

Implementation
Exogenous conditions

Source: Lane and Stephenson 1997

Fisheries Management Advice
Comanagement
Industry Operations
Socio-economic
Risk

Feasibility
Viability
Stock Assessment

Monitoring and Tracking Feedback
Exogenous conditions

Source: Lane and Stephenson 1997
Objectives

Yes, EU has higher order objectives in the legislation

Yes, we acknowledge that a participatory process is required to build operational objectives

Yes, it would be impossible to achieve all of the objectives at the same time

Yes, compromise and trade-offs are necessary, but politicians are unwilling to take up the challenge

Paraphrase objectives

Maritime Spatial Planning Directive

Common Fisheries Policy (CFP)

Marine Strategy Framework (MSFD)

Habitat & Species & habitat conservation

Trade-offs & conservation

Use of language

Reform of CFP 2014

Vague language used as a way to reach compromise. e.g. interpretation of operational use of MSY is weak. Aspirational statements used.

Trade Offs – Baltic Sea

Voss et al., 2014 Regional trade-offs from multi-species maximum sustainable yield (MMSY) management options
Marine strategy framework directive

Both conservation and sustainable use

Lists & targets
Limits & targets
Surveillance and more research

Good Environmental Status for 11

Criteria:

NO Trade Offs
4 Targets

Policy science jumps

Objectives for food web status

All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.

No potential operational targets

Birds and habitats directives

Natura 2000 protected areas

Worked example
Dogger Bank

Dogger Bank

Spatial management of the DB

- Fisheries Management In Relation to Nature Conservation
- Legal framework Natura 2000, Habitats directive:
  - EU Habitat H13.0 (sandbanks slightly covered by seawater all the time)
- Legal obligations Member States (UK, NL and GER)
- But also wind farm development (UK)

Process – multi stage 2010-2013

Including: RIMPAS (NL only), Dogger Bank SG, MASPNOSE, North Sea RAC
Concept
Combine two zones: free zone and management zone (no destructive gear) for whole Dogger Bank – management zone 25-55%.

Avoid patchy zones
Develop method for assessing social & economic considerations

Various positions and manoeuvring
Potential effects of proposed wind farms
Types of fishing gear

Two final suggestions
Agreement with UK, De, Dk using Dogger Bank Steering Group and then the NL parliament intervened. In a multilateral process, one stakeholder group used national opening to restart bilateral negotiations.

Some lesson learned
MSP requires a clear process with identified steps, deliverables, quality assurance, clear transparent stakeholder funding.
Model of negotiation framework for processes should be agreed on before a formal process to develop measures begins.
Effective stakeholder involvement in MSP requires a strategic differentiation between front-stage and back-stage transparency.
MSP with cross-border implications has three potential levels of engagement; coordinating, consulting or informing.

ICES science for sustainable seas
Thank you
The Gladstone Healthy Harbour Partnership (GHHP) Report Card a whole-of-system report card to monitor and maintain/improve the condition of Gladstone Harbour

Ian Poines (GHHP, Gladstone, Australia) & Emma McIntosh (Oxford University, UK)

Outline

• Orientation and context
• Gladstone Healthy Harbour Partnership
  – How it came about
  – Governance and implementation
  – Achievements to date
• Lessons learnt and future challenges

Orientation

23°40'S 151°E

Gladstone
Major Port & Industrial Centre

Gladstone Harbour

Controversies

2010
• Dec 2010 - Jan 2011: Flood & Awoonga Dam overflows
  • ~30,000 stocked barramundi introduced into Harbour

2011
• May: Western Basin Dredging commences
• June: Bund wall leaks
• Aug: Fish health issues, cloudy eyes, skin lesions & discolouration, mortality.
• Sept: Fisheries Queensland temporarily closes fishing in Gladstone Harbour

2012
• Sep: Western Basin Dredging concludes

2013
• Dec: Federal Board wall Inquiry – location of monitoring sites not determined, poor record keeping

2014
• Apr: Preliminary report
• Dec: 1st LNG exports from Gladstone Harbour
• Nov: GHHP launched

Gladstone Harbour Controversies

5 km
What is the GHHP?

The GHHP is a forum to bring together parties to maintain, and where necessary, improve the health of Gladstone Harbour.

PARTNERSHIP’S GUIDING PRINCIPLES

- Open, honest and accountable
- Annual reporting of the health of Gladstone Harbour
- Environmental, social, economic and cultural
- Monitoring to management recommendations
- Strong stakeholder engagement
- Independent and high quality science
- Build on existing monitoring programs

Governance structure of the GHHP

GHHP Partners

- Management Committee (10 members)
  - Secretariat: Rachael Stegemann
  - Communications Team: Lyndal Hansen, Crystal McGregor
  - Science Team: John Kirkwood, Mark Schultz, Uthpala Pinto

GHHP Chair: Paul Birch

Implementation

Design 2013 Report card framework recommendation

Piloting 2015 First complete report card & Gladstone Harbour Model

Operational 2014 Pilot report card & final program design

Science Program

Design phase 2013

- Develop a ten year strategic operating plan.
- Ensure all report cards are relevant.
- Ensure all report cards are relevant.
- Ensure all report cards are relevant.

Pilot phase 2014

- Develop pilot & pilot report card.
- Develop draft monitoring & planning.
- Develop draft management strategy.
- Develop draft report card.

Operational phase 2015+

- Pilot & pilot report card.
- Implement health research program.
**Vision to indicators**

- **VISION**
  - Values, aspirational, from the community

- **OBJECTIVE**
  - Measurable and with a clear direction, science based

- **INDICATOR GROUP**
  - Broad focus area (for aggregating scores)

- **INDICATORS**
  - Simple, Measurable, Accessible, Relevant, Timely

---

**Vision to indicators example**

- **VISION**
  - Sustainable population of marine species (including megafauna – dolphins, dugongs and turtles)

- **OBJECTIVE**
  - Maintain sustainable populations of fauna species reliant on the harbour and waterways

- **INDICATOR GROUP**
  - Fish and crabs

- **INDICATORS**
  - Barramundi, Bream and Mud crab recruitment
    - Visual assessments of fish health

---

**Gladstone Harbour Report Card**

“Gladstone has a healthy, accessible, working harbour”

Separate grade for each component. No single overall grade for the harbour

**Five levels of data aggregation**

---

**Strong Science Program**

**GHHP 2013/2014 Annual Report**
2014 Pilot Report Card

Pilot Report Card Results

Gladstone Harbour Health: The 2014 Pilot Results

Summary

- Gladstone Harbour Report Card and Gladstone Harbour Model - Stakeholder driven, informed by independent science

- Phase 1 – Design (2013)
  - Why a report card?
  - Who is it for?
  - What will it do?
  - Program design

- Phase 2 – Piloting (2014)
  - Building on past experiences
  - Trialling new approaches – social, cultural and economic
  - Enabling consultation and review
  - Final program design

- Phase 3 – Operational (2015 onwards)
  - Robust, long-term program
  - Strong links to management action
  - Independent scientific advice
  - Report Card and Gladstone Harbour Model

Lessons Learnt

- Champions and strong leadership
- Setting clear goals (led by stakeholders, refined by scientists)
- Strong links to all end users at each stage
- Flexibility in implementation,
  - Effective communication
  - Rigorous science – challenging, innovative and resourced
    (observation, experimentation, modelling and infrastructure)
  - Designed to link monitoring to actionable management recommendations – focus on uptake and impact
  - Transparency and open access to data and information (DIMS)
  - Accountable, including regular evaluations
  - Using existing monitoring programs – difficult
  - Pilot Year – good idea

Challenges & Risks

- Partnership’s willingness/ability to understand and articulate the need for environmental, cultural, social and/or economic trade-offs in response to Report Card results and provide clear actionable advice
- Independence has risks - how will the GHHP be embedded in the broader GBR Governance arrangements (State and Commonwealth)
- Science support – willingness to engage during the establishment phase but less enthused by the operational needs
- Driven by controversy – fish health, UNESCO assessment, NGO coal/ports agenda
- Resourcing – not cheap and currently has annual funding agreements
- Industry frustration – “when is the deal done!”
- Social – survey fatigue! (focus group feedback)
- Governance pressures - independent science – what does this mean? Relationship to the Partnership/Management Committee
Pulling the Pieces Together: Empirical Methods for Integration and Cumulative Impact Analysis

Michael J. Fogarty
Ecosystem Assessment Program
Northeast Fisheries Science Center
Woods Hole, MA

Preview of Coming Attractions:

• Transforming Data to Information
• Analytical Approaches
• Ecosystem Services in Space and Time
• Condition and Status Metrics
• Cumulative Impacts
• Reference Points

Integrated Ecosystem Assessments

Condition and Status Reports

Compiling Indicators:

Measuring Ecosystem Status

Marine strategy framework directive approach
Baltic Sea Ecosystem Health Assessment

Hazardous Substances  Biodiversity

Baltic Sea Holistic Assessment (HOLAS) Tool: Additive Model

Humans as Part of the Ecosystem:
Ocean Health and Benefits Index

Ten public goals: sub-goals

<table>
<thead>
<tr>
<th>Current status</th>
<th>Likely future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present reference</td>
<td></td>
</tr>
<tr>
<td>Procedural</td>
<td></td>
</tr>
<tr>
<td>Temporal</td>
<td></td>
</tr>
<tr>
<td>Pressures</td>
<td></td>
</tr>
<tr>
<td>Resilience</td>
<td></td>
</tr>
</tbody>
</table>

Ocean health index

Global Distribution of Ocean Health and Benefits Index


Chesapeake Bay Report Card

State-Space Approach

Framework for understanding marine ecosystem health
Objective Methods of selecting reference points can be implemented by identifying inflection points in continuous functions. Empirical determination of breakpoints in data series for which an a priori specification of structural form has not been made can also be made.
Summary

- Wide Spectrum of Analytical Tools Available
- Synthesis and Integration Essential in Extracting Signals of Change in the Ecosystem
- Sudden Change Common – Shifts Happen!
- Key Challenge in Assessing Cumulative Impacts Centers on Interactions Among Stressors
- Well-defined Reference Points Essential for Effective Management

It’s the economy, stupid

It’s the ecosystem, stupid

#EcoStupid

Regime Shift on the Northeast U.S. Shelf?
Baltic Sea Cumulative Impact Map

Effects of Different Value Systems on Ocean Health and Benefits Index

Global Score for Ocean Health and Benefits Index

Drivers: Human Coastal Population Density
Intersections between the science and practice of cumulative effects analyses

Melissa Foley, PhD
U.S. Geological Survey, Pacific Coastal and Marine Science Center
Center for Ocean Solutions, Stanford University

Threat-based mapping efforts

Global
- Magnitude
- Duration
- Scale
- Vulnerability

U.S. west coast

Hawai’I

Threat-based mapping efforts – Groundtruthing

Could this model be used to improve cumulative impact assessments along the CA coast?

Threat-based mapping efforts – Groundtruthing

Groundtruth the model in central CA using existing ecological monitoring data

Threat-based mapping efforts – Groundtruthing

Rocky Intertidal indicators

- mussels
- Fucus distichus
- surfgrass
- articulated coralline algae
- encrusting coralline algae
- Endocladia muricata
- Silvetia compressa
- Ulva
- bare rock

Photo credits: Dave Lohse, UCSC, PISCO, MARINe

Threat-based mapping efforts

Rocky intertidal sites cumulative impact scores
- 12.1 - 15.3
- 10.8 - 12.0
- 9.5 - 10.7
- 5.2 - 9.4
- 1.8 - 5.1

* Weak relationships between impact score and abundance of indicator species for this region
How are cumulative effects assessed?

Queensland

British Columbia

New Zealand

California

What qualifies as an impact?

• Similar projects
  • Similar impacts
  • Ecological components

• Additive
  • Synergistic
  • Antagonistic

Setting a baseline of impact

Past (5%)

Current (37%)

Future (0%)

(39%)

(43%)

(11%)
Determining the significance of effects

- indicators
- thresholds
- amount
- temporal scale
- type
- spatial scale

Cumulative effects in practice

- Landscape of CEAs is complex
- Analyses are qualitative & quantitative
- CEAs have little influence on permitting decisions

What methods are effective at meeting practitioners where they are while moving the practice forward?
Model based approaches to considering cumulative impacts and tradeoffs

Observations on barriers to IM

Beth Fulton, Fabio Boschetti, Rich Little

2015

CSIRO WEALTH FROM OCEANS FLAGSHIP

www.woof.org

Adaptive Management Cycle

System

Problem types

Wicked cumulative impacts

Multiple models
Conceptual
- Cross knowledge types
- Elicit system connections
- Collective understanding & discussion points
- Beginning to elicit response curves

Toys & Training
- Train on how modelling & systems work
- Show why intuition alone is not enough

Focused
- Sectoral models (often detailed)
  - other uses = external drivers
- Tactical value in own right (helps uptake)

System models (of many sizes)
- Partial systems
  - Key players
  - MICE
  - Light touch on all
- “Full” systems
- Cumulative impacts surprises
- Highlight unanticipated outcomes due to feedbacks

Gladstone

Handling cross scale interactions

<table>
<thead>
<tr>
<th>Patch</th>
<th>Local</th>
<th>Regional</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecological</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social/Cultural</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Handling cross scale interactions

Physical
- Patch
- Local
- Regional
- Global

Ecological
- Storm
- Weather & Climate

Economic
- Fishing
- Economy
- Trade

Social/Cultural
- Families
- Land use

The eco bits

Habitat
- Reproduction
- Waste
- Growth
- Feeding
- Movement & Migration
- Mortality

Environmental forcing
- Temperature
- Salinity
- Alkalinity (pH)
- Wind
- Currents, eddies, tides & stratification

Sediment processes
- Nutrient cycling
- N, P, C, Si, O, Fe, S

End-to-end = the other bits

Social networks
- Energy
- Economy
- Markets
- Trade
- Costs
- Revenue
- Investment
- Non-renewable Resources (oil, gas, mining)

Urban & residential development & infrastructure (including ports)

Agriculture
- Fishery
- Shipshape

Transport & shipment
- Tourism
- Land use
- Forestry

Endangering governance, integration & feedbacks

SEAP management projections

Ecological, Economic, Social objectives

All best met

Global change

Good for many

Sufficient for many

Meet few

Poor across all

Adaptive Management Cycle

Define objectives

Adjust

Develop strategies

Report recommendations

Review

Can not collect data (e.g., in confessions)

Can not access data (e.g., in confidentiality)

Evaluate effectiveness

Fail to report (e.g., no rule to access to managers)

Measuring Ecosystems (& Resilience)

- Key components and relationships (networks) and their continuity through space and time.

Cummings et al 2005

- > 700 papers reports on what’s needed, basics now clear

Components (& drivers) abiotic, ecological, habitats, human actors

Processes nutrient cycles, flows, economics, social

Networks (linkages) food webs, trade, friendship

“Innovation” diversity, movement, learning

Continuity (buffers) longevity, seed banks, rules, repositories
Adaptive Management Cycle

- Technological advances for biological monitoring
- Economic reporting ok (for now)
- Social can be tricky

Co-production of knowledge helps

- ... until people turn over
- Scale issues (more people to include = tougher)

Pragmatic Multiple Use Management

- Modelling suggest complete integration best
  (MPAs along not enough)

Pragmatic Multiple Use Management

- Modelling suggest complete integration best
- In reality not possible
- Pragmatic compromise = cover major interactions

What is often asked for...

- Simple, clear, transparent (“rule of 5”)
- Can ask for optimisation (but not an obsession)
- Time = scarce resource

What is being asked for...

- Information integration (auto filled map layers)
- Maps (optimal allocations)
Dividing up the ocean

- Zoning to reduce conflict & complexity

Barriers to IM

1. History
2. Time (& resources)
3. Scepticism

Business Drive/Evolution to IM

- Bottom up inclusion may evolve, but slow (“generational”)

In summary

- We have the technology...
- Barriers
  - Getting the message across
  - Psychology
  - Historical legacy
  - Available resources in a full life
- Changing mindset coming (but fast enough?)
- Pragmatism = worry about connections, build feedbacks into layers in mapping tools.

Thank you

CSIRO Marine and Atmospheric
Beth Fulton

1. +61 3 6233 5018
2. beth.fulton@csiro.au
Integrated water resources management

"Integrated water resources management is a process, which promotes the coordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems."


Integrated Assessment

- Integrated Assessment (IA) is the interdisciplinary process (meta-discipline) of integrating knowledge from various disciplines and stakeholder groups in order to evaluate a problem situation from a variety of perspectives and provide support for its (re)solution
- IA supports learning and decision processes and helps to identify desirable and possible options
- It therefore builds on two major pillars:
  - approaches to integrating knowledge about a problem domain
  - understanding policy and decision making processes
  - www.tias-web.info

Integrated Modelling and Assessment

- Integrated modelling and assessment (IMA) aims to use models/tools to support improved decision-making
- Integration across (some or all of):
  - Different objectives like economic efficiency, ecological integrity and social equity (sustainability)
  - Different policy influences, other drivers & constraints
  - Different resources (e.g. land, surface, ground water, estuaries, marine etc)
  - Multiple issues (human, water and land-related)
  - Different types of uses (agriculture, domestic, industrial)
  - Different interest groups

Ten dimensions of integration in IMA

- Issues of concern
- Governance setting: interventions applied
- Human Setting
- Natural Setting
- Spatial Scales
- Temporal Scales
- Disciplines
- Methods, models, other tools & data
- Sources and types of uncertainty
- Stakeholders to be involved

Integrated Water Resources

- Multiple uses/functions
- Multiple stakeholders
- Competing goals
- Multiple decision makers
- Multiple pressures
- Limited resources
- Complexity
- Uncertainty
Integrated Modelling Approaches or Paradigms

- System dynamics
- Bayesian networks
- Coupling complex models
- Agent-based models
- Hybrid expert systems


Tools to support the IMA process

<table>
<thead>
<tr>
<th>Category</th>
<th>Examples of tools</th>
<th>Application Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Expert-based</strong></td>
<td>Agent-based models, Bayesian networks, decision analysis &amp; representation tools</td>
<td>Knowledge management.</td>
</tr>
<tr>
<td><strong>Model-based</strong></td>
<td>Exploratory tools, data-based models, process-based models, integrated models such as system dynamics, simulation models, geographical information systems (GIS)</td>
<td>Exploratory and representation tools.</td>
</tr>
<tr>
<td><strong>Participatory</strong></td>
<td>Participatory tools, playing games, stakeholder workshops, role groups, scenario analysis, visualisation workshops, decision games, deliberation workshops</td>
<td>Participatory and role-playing games.</td>
</tr>
<tr>
<td><strong>Decision support systems</strong></td>
<td>Model support tools, model comparison tools, decision support systems</td>
<td>Decision support tools.</td>
</tr>
</tbody>
</table>

Sources of Uncertainty

Uncertainties accumulate throughout the model building process, and hence within the model and decisions based on it.

Examples throughout the decision making process:

- Comparison of alternative scenarios or options
- Deliberate conflict resolution
- Implementation of actions
- Communication

Commonly discussed uncertainties in modelling are shown in red (Guillaume)
Approaches to assess & manage uncertainty

- Proper processes and protocols, good practice guidelines e.g. NUSAP
- Benchmark against standard, catalogue & rank uncertainties
- Significance for decision, risks incurred
- Sensitivity assessment → simplifying model/problem
- Inverse modelling
- Data acquisition planning
- Monte Carlo and related analyses inc Bayesian methods
- Scenario simulation
- Analysing model components then linkages
- Extended peer review & stakeholder involvement
- Adaptive management

Purpose of uncertainty method

- Identify
  - (Reduce)
- Describe
- Propagate in analysis
- Communicate to decision makers
- Manage remaining uncertainty

Uncertainty Management

- Uncertainty is unavoidable
- Need to consider, rank and wherever possible quantify all important types and sources of uncertainty
- Integrated models: select model components and paradigms that acknowledge and are commensurate with the uncertainty in the science and social science; analyse model components then linkages
- Uncertainties from each of the decision making process steps must be appropriately managed and communicated

Socioeconomic & environmental impacts of climate change, technology and water policy drivers in the Namoi catchment

Tony Jakeman, Janelle Tishkoff, Rachel Blakers, Barry Drake, Baihua Fu, Wendy Merritt, Damien Sinclair, Neil Gunningham, Joseph Guillaume, Andrew Ross (ANU)

Allan Curtis and Emily Sharp (CSIRO)

David Pannell, Alex Gardner, Alison Wilson and Madeline Hartley (LWA)

Cameron Holley (UNSW)

Rebecca Kelly (iSNRM and ANU)

Steering Committee: State and local agencies, Namoi Water (irrigators)

Hydrological model zones for Namoi model
Social Research – Sharp and Curtis

- What **innovative practices** are landholders adopting now and who plans to do so in the future?

- What are the key drivers influencing landholder **adoption of innovative practices** and/or changes in land use in the Namoi catchment?

- Survey data for modelling in other project teams

Development of the social BN for the Namoi

- Predicting adoption of land management practices
- Identifying levers to influence land management

Management Practices

- Data from the survey: Reasonable level of uptake. Covered a variety of costs & knowledge to implement. Census and land use data too large scale, too infrequent or error-prone

- Actions taken or considered in the past 5 years, and the next 5 years
  - Change to spray irrigation
  - Implement soil moisture mapping
  - Modify flood irrigation approach
  - Deepen dam
  - Measure dam evaporation losses
  - Buy water on the temporary market
  - Buy water on the permanent market

Convert to BN variables

- **Beliefs and Views**
- **MPs & end points**
- **Other model variables**
- **Scenarios**

- **Physical**

Types of scenarios that can be run

- Changes in water access:
  - Groundwater, unregulated and regulated shares; trades
  - Commence and cease to pump thresholds
  - Carryover rules

- Farm capital
  - Areas laid out to irrigation; investment in infrastructure
  - Storage volumes and surface areas
  - Irrigation efficiency

- Economic climate – prices and costs
- Climate
Economics

- Developing a set of representative farm models – long run
- Using social survey data and from interviews with farmers
- No suitable ongoing monitoring

Crop yield model

- Metamodel of the APSIM model obtained through sensitivity analysis
  - A two layer model estimating soil moisture content (SMI) using the available inputs to improve the estimate of evapotranspiration (ET) and show the available water for crop use after considering runoff, infiltration and ET
  - Runoff determined by the soil moisture content of the top layer (SMI) at the time of rainfall
  - Empirical relationship between yield, PET, rain, soil moisture and temperature

Economy

- For 9 ecological assets, focuses on:
  - a sustained level of base flow which provides refuges during drought
  - regular flushing at various levels of benches and anabranches in order to increase habitat areas and transport nutrients and organic carbon to the river system
  - regular flooding to sustain the growth of riverine vegetation and support regeneration
  - suitable groundwater and salinity levels to allow the access to water by riverine vegetation, particularly during drought
- These management relevant concepts are implemented by multiple indicators

Economic questions

- What is the current agricultural production and profitability for cotton producing farms? This establishes a baseline for later analyses.
- What is the likely impact of the adoption of water-use adaptations on agricultural production and profitability for cotton-producing farms?
- What is the likely impact of the adoption of water-use adaptations on agricultural production and profitability with changed government policy (water allocations and efficiency incentives) for cotton producing farms?
- For the 3 scenarios above, what is the likely impact of climate change on agricultural production and profitability for cotton producing farms?

Ecology

- Issues Socio-economic and environmental trade-offs in water management that were informed by MDBA Plan
- Stakeholders Stakeholder participation through project advisory group and previous projects. Engagement through individual components
- Disciplines Representatives from social, governance, legal, hydrological, economic, ecological, and integration disciplines. Coalition of the willing showed respect and receptiveness. Language and concepts were shared. Intrinsic benefits of discipline components that serve the whole
- Methods, Models, tools & Data A wide variety of methods, models, tools and data were used. Key model was a coupled component model of appropriate complexity. Staged learning and manageable milestones
- Uncertainty Big issue: Analysis undertaken one component at a time, then their links and propagation. The biggest challenge is to do it comprehensively

Develop into an influence diagram
What do scenarios have to offer?

- provide an interdisciplinary framework for analysing complex environmental problems and envisioning solutions to these problems; seeking breadth and beyond the short term
- provide a picture of future alternative states of the environment in the absence of additional environmental policies ("baseline scenarios")
- illustrate how alternative policy pathways may, or may not, achieve environmental targets
- identify the robustness of a particular environmental policy under different future conditions; consequences and appropriate responses under different conditions
- helpful for organizing and communicating large amounts of complex information about the future evolution of an environmental problem
- raise awareness about the emergence of new or intensifying environmental problems and the current and future connection between different environmental problems
- help policymakers and others to "think big" about an environmental issue
- provide opportunity for stakeholders to get involved in the development of public policies (adaptive governance as learning accrues); stimulate imagination; support reasoning; shape outcomes; reduce collective biases; aid transparency
- embrace uncertainty both in system drivers & model assumptions: prediction is just one of the future where uncertainty is high and our control is low

What does an MDBA Plan stress test look like?

- Policies to be included: Water allocation reductions/SDLs (federal), extraction rules (state), energy interactions (inc. coal seam and shale gas), agricultural, environmental regulations
- External influences to be considered: climate, trade, input and equipment prices, ...
- Opportunities: managed aquifer recharge, export market improvements, collective/conjunctive use; other innovative policies across sectors
- Risks: difficult climate and extremes, markets dwindle, social perceptions and conflict, aquifers lose integrity (depletion, compaction, pollution), ecosystem services
- Outcomes of Indicative Interest: production values and their distribution (among entitlement holder types, industry, climate & seasonal risks...), groundwater integrity, ecological asset values, GDE impacts, water use efficiency improvements (comparison with the MDB Plan)...,
- Policy changes needed for conjunctive use, MAR, ...
- Uncertainties that matter identified
- Water use efficiencies and adaptive governance measures identified
- Involve the cross-jurisdictionality in scenario construction and analysis for coordination, educating and sharing knowledge

The frontier of scenario research

- combining qualitative and quantitative information and methods (intuition and rigour; translating scenario narratives into model inputs)
- participatory scenario development to share and generate knowledge and trust
- incorporating feedbacks and dynamics into scenarios
- multilayered scenarios and cumulative impacts
- understanding/modeling socio-economic behaviour and social (inc. policy) systems
- integrating with technological and biophysical characteristics to trigger shifts towards more sustainable pathways and correctable decisions
- using data mining, optimization, visualization and supercomputing to analyse and cluster big data re scenario modeling (large number of scenarios and outputs arises from the variety of speculated events and model uncertainty)

What’s missing that needs integration

- Water and energy sectors
- Social indicators: what do we want?
- Ecology: values, cultural flows
- Uncertainties
- Opportunities
- Unintended consequences: best and worst cases

References


Integrated marine management: reflections on 15 years in the (scientific advice) trenches

Tony Smith
IMM Workshop, Adelaide, April 2015

Reflections on experience

• Australian regulators
  • Australian Fisheries Management Authority
  • Department of Environment
  • National Oceans Office
  • Great barrier Reef Marine Park Authority
• Focus of integration
  • Ecosystem based fisheries management
  • Oceans policy and multiple use
• Forms of advice
  • Risk assessment
  • Management strategy evaluation (tradeoffs)

Lessons (for researchers)

• Effective leadership is crucial
• Stakeholder engagement needs to be serious and sustained
• Political risks and imperatives need to be understood
• Institutional issues can confound progress
• Research input is necessary but not sufficient

Leadership

• Need for champions
• Political, regulatory, stakeholders, research
• Common vision and commitment
• Timing and preparation

Stakeholder engagement

Political risks and imperatives

• IM a long process – usually covering multiple policy and election cycles (IMC)
  • Today’s opposition could be tomorrow’s government
  • Building broad stakeholder support helps but policies can still change for ideological or budgetary reasons
  • Don’t take too long about it? Progress in steps? (MF, IP)
• Political risk assessment more important than ecological risk assessment for decision makers!
Institutional and governance issues

- Governance, not research, is the main problem (MH)
- Who loses influence with integration? (MD-C)
- Are integrated management systems stable given what we know about human behaviour? (RF)
- Lack of buy-in by competing agencies (BM)
- Carrots and sticks (and lack of both) (BM)
- Organizational cultures vary making communication a challenge for researchers

Implications of loss of trust in institutions?

“We now live in a nation where doctors destroy health, lawyers destroy justice, universities destroy knowledge, governments destroy freedom, the press destroys information, religion destroys morals, and our banks destroy the economy.”

Chris Hadge

Research and IM

- Need diversity of disciplines
  - Natural sciences, social sciences, decision sciences, system sciences
- Need diversity of tools
- Need to mobilize data and information
- Roles of research
  - Identify issues, inform options, predict consequences ...
  - Highlight tradeoffs
- Acceptable impacts – social decisions informed by science
- Science, advocacy and trust
  - Projecting values, selling tools, advocating solutions

Research tools: risk assessment

Research tools: risk assessment

Management Strategy Evaluation MSE

Decision making under uncertainty
MSE and models

MSE not (just) modelling – decision framework (RS)
Tools for prediction (BF)
- Qualitative e.g. Delphi methods
- Loop analysis
- Bayesian networks
- MICE
- End to end
- SYSTEMS view common to all
- Methods that allow stakeholder input to model development

Decision support toolbox

Wicked problems

Wicked managers for wicked problems

Too many wicked problems
Paul Harris ANU (The Conversation, 8 Sept 2012)
The ancient Greeks knew that uncertainty and complexity were facts of life, to be lived with rather than managed away. As was irresolvable disagreement over values and ideas
Science in particular finds itself in the slightly sticky position of claiming to be central to the solution to the world’s most “wicked” problems … but then also complaining about the “irrationality” of political decisions and the politicisation of science
So let’s also agree to stop using the term “wicked problems”. If everything becomes “wicked” or “super-wicked”, then everyone will just give up. We need to work at our democracy, to encourage bright young people – in research and in government – to be filled with enthusiasm for spending their lives working on the big difficult problems of the time

What is IM (good) for?
- Cumulative impacts, unexpected consequences, …
- Is IM an “evolutionary stable state”?
Managing multiple uses and the scope of IM

One ring to rule them all? (and in the darkness bind them!)

Closing comments (mainly to researchers)

- Partner with champions
- Engage a range of disciplines
- Select tools fit for purpose
- Foster systems thinking
- Commit time and resources to stakeholder engagement
- Be vigilant about advocacy – focus on tradeoffs
- It's a long journey and there will be many setbacks
  - But be ready for the opportunities as well

Follow my advice and all will be well ...

Thank you

CSIRO Marine Laboratories, Hobart
Integrated Monitoring for Marine Management - experiences from Australia’s IMOS
Tim Moltmann, IMOS Director
Adelaide - 15 April, 2015

Outline of talk
• What is IMOS and how does it work?
  – Need, Capability, Impact
• Design and evolution of IMOS over a decade
  – Observing, data, modeling
  – Using ‘readiness’ to evolve the system
  – Research and operational use of data
  – Sustained ecological observing
• Sum up - IMOS experience, as relevant to integrated monitoring for marine management

What is IMOS and how does it work?
- Need, Capability, Impact

Need for IMOS
- Systematic and sustained observing of the marine environment
- Turning observations into data – real time, time series
- International collaboration, Australian role in a global effort

Need for IMOS
One national plan, six Node ‘chapters’ focused on the open ocean and regional marine systems

Why are we doing this? What do we need to observe, where, when and how?

IMOS Capability
- multi-faceted, multi-institutional
IMOS Capability
– integrated across scales

Open ocean
Shelf
Coastal

S. partnerships?

IMOS Capability
– integrated across disciplines

Physics
Chemistry
Biology

requirements?

IMOS Capability
- all data discoverable, accessible, usable and reusable

Impact of IMOS

Does it work?
- 4 key performance indicators

1. Deploy and recover equipment
2. Make data discoverable and accessible
3. Ensure stake and use of data
4. Ensure operational effectiveness of science outputs

Quarterly Milestones
Monthly Activity Plans (on the website)
Facility Workflows (on the website)
Monthly Data Reports (on the website)
IMOS Ocean Portal

Status of data holdings

- Argo Australia
  85,877,452 measurements
- SOOP
  201,904,494 measurements
- Deepwater moorings
  2,003 QC’d data files
- Glider
  26 platforms, 159 deployments
- AUV
  3,123,541 images
- Shelf/coastal moorings
  54 sites, 4,752 QC’d data files
- Noise loggers, OA moorings
- Radar
  3,862,997 files (radials)
- Animal tagging (satellite)
  237,946 CTD profiles
- Animal tagging, acoustic
  58,431,944 detections
- GBR sensor network
  7 sites, 250 sensors
- SST
- Ocean Colour
- Altimetry (daily GMSLA)

http://oceancurrent.imos.org.au/
Status of funding

Future NCRIS
NCRIS 15-16 (A)
NCRIS 15-16 (B)
NCRIS 2013
CRIS
EIF
NCRIS
~$145M core funding over 10 years, plus co-investment (47:53)

Design and evolution of IMOS over a decade

1. Observing, data, modelling
   - Regional modelling efforts building on regional observing systems
   - Biennial national mod/obs workshop
     - ACOMO 2012, 2014 ... 2016
   - Marine Virtual Laboratory (MARVL)
     - Additional ‘eResearch’/cyber infrastructure funding
   - Australian National Shelf Reanalysis project
     - Under development
   - Forum for Operational Oceanography
     - Fremantle (WA), 21-23 July 2015

2. Using ‘readiness’ to evolve the system
   - From the GOOS Framework for Ocean Observing
   - From the IMOS National Science and Implementation Plan

3. Research and operational use
   - IMOS has been established as a research infrastructure
     - Primary constituents are the research community
   - However it is ‘research with a purpose’
     - Focused on Need, and Impact
   - Stakeholders have been engaged in science planning
   - All data is openly accessible for use and reuse
   - Arguably, traditional distinctions between research and operational use are much less important in the ‘information age’
4. Sustained ecological observing

- Ocean observing systems have traditionally been seen as something for physical oceanographers studying climate (necessary, but not sufficient…)
- Over the last 5+ years, the Global Ocean Observing System (GOOS) has been repositioning itself to cover physics, chemistry and biology, open ocean to coast
  - IMOS is at the leading edge as a national system
- But from the ecological perspective we don’t really know what to measure, where, when and how
  - IMOS has taken a ‘no regrets’ approach by trophic level
    - benthos, primary/secondary producers, mid-tropics, apex predators
  - with obs considered individually or synergistically in ecosystem models

### Four points in summary

1. Define requirements
   - For IMOS, our science plans set out the why, and inform what to measure, where, when and how
2. Have the discipline of making all data available
   - This is probably THE key point
     - It’s not about ‘a portal’: it’s about quality, standards, vocabularies…
     - Unavailable data can never be turned into joined-up knowledge that informs integrated management
3. Think holistically, about all obs, all data, all modelling
   - Have a big vision, with open interfaces and porous boundaries
4. Continuously assess ‘readiness’, as it will change
   - Sustained ecological observing isn’t here, but it’s coming
   - Things need to move through this ‘pipeline’ over time

Sum up - IMOS experience as relevant to integrated monitoring for integrated management

- Sustained ecological observing programs cut it?
  - Yes

- Ocean observing systems have traditionally been seen as something for physical oceanographers studying climate (necessary, but not sufficient…)
  - Over the last 5+ years, the Global Ocean Observing System (GOOS) has been repositioning itself to cover physics, chemistry and biology, open ocean to coast
  - IMOS is at the leading edge as a national system
- But from the ecological perspective we don’t really know what to measure, where, when and how
  - IMOS has taken a ‘no regrets’ approach by trophic level
    - benthos, primary/secondary producers, mid-tropics, apex predators
  - with obs considered individually or synergistically in ecosystem models
Thank you

Discussion?
Implementing risk-based, regional level, integrated, ecosystem-approach fisheries management (EBFM) –

No simulation models required but plenty of patience!

Dr Rick Fletcher
Department of Fisheries
Western Australia

Background

- This a management-human behaviour modification process, science only informs
- Initiative in Australia goes back 15 years
- Many tools frameworks and system developed long ago many are not yet used
- Requires patience and step wise progress
- Must align with needs of management (ie decision making) not science and not even policy concept.

After 10 years – what had happened?

- Risk based management for individual fisheries adopted.
- Most major ecological problems for individual fisheries identified and addressed.
- Most commercial fisheries developing clearer harvest/decision rules.
- Multiple tools available for undertaking each of the steps in different types of fisheries and country situations – (see FAO EAF toolbox)
- But regional level planning and cumulative impacts were not covered – NGO concerns

Problem

- Avoid impossibly complex sets of issues, systems, models and uncertainties?
- Not duplicate fishery level actions
- Avoiding significant disruptions or large amount of additional resources.
- Moreover, would it really help, or was it just another ‘academic’ impractical concept?
- Overcome scepticism
• Needed a process to generate an integrated, holistic set of priorities.

STEP 1
CONSOLIDATE INDIVIDUAL RISKS INTO REGIONAL LEVEL CATEGORIES

Outcome
• Reduced the 600 separate ecological, social and economic risks down to 60 regional level risks
• This is still too many to address separately
• Many of the individual risks are interrelated
• Needed a process to generate an integrated, holistic set of priorities.

Step 1 – Consolidate Fish Species Assets

- Reduced the 600 separate ecological, social and economic risks down to 60 regional level risks
- This is still too many to address separately
- Many of the individual risks are interrelated
- Needed a process to generate an integrated, holistic set of priorities.
Basis for natural resource management

• We manage the community’s ecological assets to generate economic and social benefits for the community.
• Each consolidated ecological asset became a primary unit to integrate the ecological, social and economic benefits it generates AND the risks to these.
• A multi-criteria analysis integrates the scores to provide a priority score for each asset.

Priorities for West Coast

From the >600 issues identified there were 22 ecosystem level assets to manage but of these:
• 5 Urgent (scores >75) Lobster, Demersal Finfish, Governance (Internal and external consultation), Abrolhos Ecosystem
• 2 High (score 50-75)
• 6 Moderate (scores 30-50)
• 6 Low (scores 15-30)
• 6 Very Low (scores < 15)

Actually Using the System

• All bioregions now assessed with 80 Aquatic Assets across the state.
• All departmental activities assigned to managing risks to an ecological or an organisational asset.
• All risk scores are updated in risk register and reported annually in Status of Aquatic Resources.
• Generate shifts in resourcing during budget cycle.
• Currently the Fisheries Act being replaced by Aquatic Resources Act to enable regional level, resource based management (ie not activity based).
• New Harvest strategy policy developed to deal with multi-sector multi objectives and sector allocations.

Includes the objectives (ecological, and where needed, social and economic) and acceptable levels for each regional resource (asset).

This may require changes to one or more of the individual fisheries to meet these objectives.

Set allocations of access among sectors.

What is the current situation??

Everybody is busy but poor outcomes are generated.

• Multiple processes, duplications, gaps
• Lack of effective involvement, overloading of representatives
• No consensus or coordination
Conclusions EBFM

• Adopting an integrated, regional level 'ecosystem approach' for fisheries did not require a detailed understanding of the entire ecosystem.
• It required efficient consideration of risks to all assets and the associated stakeholder benefits.
• Determining which MOST required management to deliver the 'best' community outcomes.

Having the system actually used as the basis of agency planning and operations was essential for its ongoing value – not just an academic exercise. Implementing the new Act will embed this approach. Could not have been done without fishery level assessments already having been done.

Further Information

• Fletcher et al. (2012) Using a regional level, risk-based framework to cost-effectively implement Ecosystem Based Fisheries Management (EBFM). In: Global Progress on Ecosystem-Based Fisheries Management. pp. 129-146. Alaska Sea Grant College Program. doi: 10.4027/gpebfm.2012.07
• FAO-EAF Toolbox www.fao.org/fishery/efaf-net
Integrated and cost-effective monitoring

Terry Walsh
Australian Institute of Marine Science

Two claims
Monitoring need not always be worth the fuss
Working out how much to spend on monitoring is (a bit) tricky, but rocket science it ain’t.

Continuous improvement

• Conceptual underpinning consistent with “adaptive management”
• The contemporary fashion in the demonstration of diligence, accountability, transparency

Single attribute (CoTS) decision-making under risk

<table>
<thead>
<tr>
<th>Action</th>
<th>nutrient enrichment (0.70)</th>
<th>Predation release (0.30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture BMP</td>
<td>100 km²</td>
<td>300 km²</td>
</tr>
<tr>
<td>direct cull</td>
<td>400 km²</td>
<td>200 km²</td>
</tr>
</tbody>
</table>

\[
\text{Ag BMP} = 0.70 \times 100 + 0.30 \times 300 = 160 \text{ km}^2
\]

\[
\text{Direct cull} = 0.70 \times 400 + 0.30 \times 200 = 340 \text{ km}^2
\]
Expected value of perfect information = 0.70 \times 100 \text{ km}^2 + 0.30 \times 200 \text{ km}^2 = 130 \text{ km}^2.

The expected value of perfect information = 160 \text{ km}^2 - 130 \text{ km}^2 = 30 \text{ km}^2.

What would you pay to reduce the impact of CoTS by 30 \text{ km}^2?

- Determine system state for state-dependent decisions
- Determine system state to assess the degree to which management objectives are achieved
- Determine system state for comparison with model-based predictions to learn about system dynamics (i.e. do science)

In the context of accumulating scientific knowledge:

- Type I errors (α) lead to false knowledge (e.g., reading causation into random patterns)
- Type II errors lead to a missed opportunity to increase our understanding

In the context of environmental management:

- Type I errors (α) lead to false alarm (industry suffers)
- Type II errors lead to a false sense of security (the environment suffers)

Two cab companies operate in a city, the Blue and the Green (according to the colour of the cab they run). Eighty-five percent of the cabs in the city are Blue, and the remaining 15% are Green.

A cab was involved in a hit-and-run accident at night. A witness later identified the cab as a Green cab. The court tested the witness’ ability to distinguish between Blue and Green cabs under night-time visibility conditions. It found that the witness was able to identify each colour correctly about 80% of the time, but confused it with the other colour 20% of the time.

What do you think are the chances that the errant cab was Green, as the witness claimed?

---

Two claims

Monitoring need not always be worth the fuss
Working out how much to spend on monitoring is (a bit) tricky, but rocket science it ain’t.
SA's Marine Planning Framework
The Draft Spencer Gulf Marine Plan

Tony Huppatz
Principal Coastal Planner
Department of Environment, Water and Natural Resources

Presentation
- SA's coast and marine environments
- Coast and marine legislation and policies
- Marine Planning in SA
- Draft Spencer Gulf Plan
- Current development controls in Spencer Gulf

SA's coast

Spencer Gulf

Giant Australian Cuttlefish

‘Point Lowly, in the northern Spencer Gulf is the only known site in the world where Giant Australian Cuttlefish (Sepia apama) form dense spawning aggregations. Research to date has shown a significant decline in Giant Cuttlefish populations at the Point Lowly aggregation site, although the cause of the decline remains unclear’ (PIRSA 2013) .
Giant Australian Cuttlefish

SA Legislation
- Marine Parks Act 2007
- Development Act 1993
- Aquaculture Act 2001
- Fisheries Management Act 2007
- Harbors and Navigation Act 1993
- Environment Protection Act 1993
- Coast Protection Act 1972
- Natural Resources Management Act 2004

SA Policies
- SA’s Strategic Plan (7 Priorities)
- Creating a vibrant city
- An affordable place to live
- Every chance for every child
- Growing advanced manufacturing
- Safe communities, healthy neighbourhoods
- Realising the benefits of the mining boom for all
- Premium food and wine from our clean environment

SA Policies
- Living Coast Strategy
- Planning Strategy and Development Plans
- Aquaculture Act zone policies
- Environment Protection policies
- Coast Protection Board policy

Marine Planning in SA
- A whole of government program guiding ecological development and use of the marine, estuarine and coastal environments through integration of planning
- Ecosystem-based planning using environmental boundaries: 8 Marine Bioregions
Marine Planning in SA

• Regional Focus Documents (inventory for each planning area)
• 6 Marine Plans: first as pilot – Draft Spencer Gulf Marine Plan
• Performance Assessment System for each plan

Marine Planning in SA

...... these Marine Plans establish an overarching strategic planning framework to guide State and local government planners and natural resources managers in the development and use of the marine environment.

(Executive Summary, June 2006)

Spencer Gulf Marine Plan

Ecological Rated Zone 1

• To contain marine, estuarine and coastal habitats, and ecological processes of critical importance to the maintenance of biodiversity, ecological health and productivity of Spencer Gulf.

• Goal: not to exceed negligible impact to habitats or populations

  Negligible: unlikely to be measurable against background variability – recovery measured in days/weeks.
Ecological Rated Zone 2

- To contain marine, estuarine and coastal habitats and ecological processes that are essential to the maintenance of biodiversity, ecological health and productivity of Spencer Gulf.
- Goal: not to exceed minor impact to habitats or populations

Minor: measurable against background variability – recovery measured in weeks/months

---

Ecological Rated Zone 3

- To contain marine, estuarine and coastal habitats and ecological processes that contribute to the maintenance of biodiversity, ecological health and productivity of Spencer Gulf.
- Goal: not to exceed moderate impact to habitats or populations

Moderate: measurable changes to ecosystem components but not a major change in function (that is no loss of components) – recovery measured in months/years

---

Ecological Rated Zone 4

- To include those marine, estuarine and coastal areas for which the available scientific data are inadequate to identify their importance to the maintenance of biodiversity, ecological health and productivity of Spencer Gulf.
- Goal: not to exceed minor impact to habitats or populations (treated as an ER2 zone until research determines ultimate zoning)

---

Zones underpinned by Science

Examples:
- Habitats and processes
- Threatened and protected species
- Fish breeding areas
- Ecological importance

---

Zones informed by uses and activities

Examples:
- Towns & shacks
- Harbours & industry
- Aquaculture
- Commercial fishing
- Mining
- Recreational fishing

---

Performance Assessment System
Performance Assessment System

- To evaluate the effectiveness of Marine Plans;
- Link outcomes, criteria, performance indicators and benchmarks to the ecological variables and goals for each ER zone from the Marine Plan.
- Based on the Australian and New Zealand Conservation Council Best Practice Program (ANZECC 1997);

The Development Plan for Spencer Gulf

Objective (adapted from SGMP Vision statement and Goal 1):
- The conservation and ecologically sustainable use of the marine environment within Spencer Gulf (see Overlay Maps LNWCA (CW)/1a & 1b) by way of ecosystem based planning and management.

The possible Development Plan changes

Principles e.g. (adapted from SGMP objectives for ER Zones):
- Development in the Ecologically Rated Coastal Area 1 of Spencer Gulf (see Overlay Maps LNWCA (CW)/1a&1b) should not cause more than a negligible (cont.)...

The possible Development Plan changes

........ should not cause more than a negligible:
(a) loss of biodiversity;
(b) impediment of ecological processes;
(c) impact to seagrass, reef, mangrove, saltmarsh and soft-sediment habitats;
(d) loading of sediments with heavy metals, persistent organic pollutants and other contaminants; and
(e) change in water quality beyond the benchmark established by the Performance Assessment System for the Spencer Gulf Marine Plan.
The possible Development Plan changes
Principles (e.g. adapted from SGMP objectives for ER Zones):

• *Negligible impacts* to habitats or populations are considered to be those which are unlikely to be measurable against background variability. Habitat and ecosystem interactions may be occurring but it is unlikely that there would be any change outside of natural variation and recovery will occur in days.

What is the Development Plan for Spencer Gulf now?
• Coastal Waters Development Plan
• General Objectives and Principles
• Various Aquaculture zones established by Reg. 29(1)(b)
• Development approval not required for aquaculture in an Aquaculture Zone

Aquaculture Zone Provisions

AQUACULTURE ZONE

The objectives and principles of development control that follow apply in the Aquaculture Zone as shown on the map (Location Plan). If it is the intention to develop in the zone, the objectives and principles must be considered in detail.

OBJECTIVES

Objectives 1: A zone primarily for ecologically sustainable marine-based aquaculture.

PRINCIPLES OF DEVELOPMENT CONTROL

Principle 1: The following forms of development are encouraged in the zone.

• marine-based aquaculture
• fishery
• grow-out facility
• related infrastructure

Public Notification Category

All marine aquaculture is designated Category 1 terrestrial development within the zone.

What happened?

• In 2007 the effort was concentrated on the concurrent Marine Park process
• 19 Marine Parks declared in 2009 and zones established in 2014
• Current Marine Park effort on community engagement, risk-based compliance, monitoring, evaluation and reporting, and regional impact assessments

149
South Australia’s Major Mines

2004

- 20 Major Mines
- 33 Developing Projects
- 107 Prospects

“Growth pales in comparison to the future of South Australian mining”

SA Regional Mining & Infrastructure Plan – June 2014

- Capesize vessels
  - No ports in SA capable of loading vessels at jetty in volumes sufficient for mining
  - “Miners need access to high capacity ports which consolidate social and environmental impacts & allow all users to access cost effective shipping solutions”
- Multi-user ports
- Options: multiple small ports, single large port, three ports
- Three regions for port development
  - East coast of Central Eyre (1)
  - West coast of Northern Yorke Peninsula (2)
  - East coast of Northern Eyre Peninsula (3)
- Trade-off considered regarding number of ports
Key question

- How can we support development of mining ventures, expansion of fishing & aquaculture, and conservation & recreation needs, while simultaneously delivering on environmental, social and economic objectives?

Vision of SGEDI

- A thriving Spencer Gulf region, where progressive developments occur, community opportunity is optimised and the unique ecosystem is protected and enhanced

SGEDI: Integrated marine management

- Ensure that ecological, economic and social outcomes are optimised across industries and user groups
- Preserve the integrity of the ecosystem
- Reduce risk and avoid the need for costly restoration programs
- Facilitate investment in the region
Spencer Gulf Ecosystem Development Initiative

**Phase I**
2012 – 2013 (1 year)

- Stakeholder engagement
- Knowledge gaps document
- Business plan for phase II

- Ecosystem model for fisheries & aquaculture
- Existing datasets

Aquaculture/Fisheries
FRDC funded

Metadata collation
IMOS funded

Benefits – Initiative

- Engaging partners to address common problems
- Knowledge sharing of environmental information and data sets
- A credible independent voice
- Communication between partners and stakeholders allowing tensions and concerns to be raised early and discussed in the context of Gulf science

Stakeholder Workshops:
Sector-specific Workshop Summary

- Fisheries & aquaculture/Conservation & Recreation/Mining, Shipping etc
  - Transport corridor issues
  - Dredging & heavy metal mobilisation
  - Pollution (sediments, marine debris) / oil spill
  - Marine pests / ballast water & hull fouling
  - SLOSS infrastructure (Ports, desalination plants)
  - Lack of infrastructure
  - Land-based impacts
  - Cuttlefish declines

Stakeholder Workshops:
Regional Workshop Summary

- Concentration of industry on Point Lowly Peninsula
- Historical context & legacy of previous developments
- Links between Gulf and adjacent land/rivers/creeks

Stakeholder Workshops:
Workshop Summary – General Points

- Evidenced-based decision making required
- Climate scenarios to be considered in models
- Cumulative impacts to be considered
- Recreational use to be part of any trade-offs
- What are threshold levels, buffering capacity & resilience of system

- Future oriented perspective differed
- Way in which people perceived issues differed markedly across different regions and sectors

Knowledge gaps:
Key activities

- Fishing
- Aquaculture
- Desalination
- Urban development
- Resource development, energy & industrial
- Power production
- Shipping
- Ports & dredging
- Defence
- Other infrastructure development
  - Organic vegetables, biofuel facility
- Agriculture
- Recreation & ecotourism
- Conservation
What needs to be done?

- Integrate between ecological, economic & social objectives
  - Coordinate future management across government agencies
  - Develop tools to quantify & predict ecological, economic & social outcomes associated with different development scenarios
  - Establish an integrated ecosystem research & monitoring program → data & knowledge to inform decision-support tools & provide ongoing information on status of system

Research themes

- Governance
- Decision support tools
- Activities and impacts
- Social context
- Economics
- Pests and pathogens
- Iconic species
- Benthic ecology
- Pelagic ecology
- Oceanography

Outcomes

- Integrated marine management process
- Stakeholder and community engagement
- Informed and structured decision-making
- Conceptual and process models
- Integrated research and monitoring program

Outcomes of shipping & ports project

- Demonstrate benefits of integrated marine management in Spencer Gulf
- Enhance knowledge of & ensure ongoing engagement of all stakeholders thereby reducing conflict
- Provide knowledge of the system and assess decision support tools that allow outcomes of various management decisions & multiple use scenarios to be evaluated
- Inform understanding of individual and cumulative impacts of multiple users, allowing for evidence based decision making
- Provide baseline information on current & future activities and potential impacts in Spencer Gulf
- Ongoing engagement with managers & stakeholders including community

Developing knowledge and tools to inform future integrated management of Spencer Gulf: A case study on shipping and ports

- Synthesise existing information on current activities and impacts
- Conduct detailed analysis of current shipping activities and predict likely future scenarios for shipping and ports
- Conduct a risk assessment for introduction and establishment of pests and pathogens
- Conduct a risk assessment to identify key iconic and threatened species, data deficiencies and needs, and species status
- Develop tools for predicting interactions of future ports and shipping scenarios with other industries
- Present findings to managers and stakeholders
A Nutrient Carrying Capacity Decision Making Tool for Spencer Gulf

John Middleton, Mark Doubell, John Luick, Charles James, Paul van Ruth

Carrying Capacity Decision Tool

- New results (Middleton et al., 2014) have shown that the maximum allowed nutrient flux F (and finfish feed rates) can be related to the hydrodynamics which control the flushing time scale T∗.
- Results also applicable to any source of "pollutant" (e.g., desal output; waste water treatment plants, industry outputs).
- Also have run a coupled biogeochemical model for a variety of scenarios to determined the relative importance of nutrient inputs from the shelf, finfish aquaculture, industry etc. Not possible without IMOS data – end users Govt, industry, not just research!
- All incorporated into CarCap 1.0 – a GUI decision making tool for future developments.
- Whole of Gulf approach shows we are all playing in the one (SG) sandpit!

The role of Ocean Currents

The tidal currents are small near the bottom due to frictional effects but up to > 1 m/s in upper gulf.

Tides act to greatly enhance the horizontal diffusion and dilution of nutrients.

Note: winter (summer) flushing (blocking) of nutrient exchange between gulf and shelf: Speddies – blues sky res.

Models can be adapted for sediment transport (port developments) and particle tracking is incorporated (mass fish mortalities, HAB trajectories.

CarCap1.0: A Rapid Assessment Tool

Home Screen of CarCap GUI: user can rapidly look at various scenarios, focus on whole of gulf or sub regions, choose max concentration values allowed for various nutrients, time series and statistics: could overlay other variables (e.g., sea grass beds)
Flushing Time Scale $T^*$: shorter flushing scale means greater dispersion and carrying capacity.

Right figure: zoom in on red box – the region of interest to test Carrying Capacity for an existing finfish lease site.

Top Left: Site Assessment Tool – click on spot of interest.

Below right: Upper panel – gives NH$_4$ concentration for the year from simulation.

Below right: Bottom panel – gives actual feed rate (tonnes sardines/day) and theoretical allowed car-cap estimate (---) from flushing scale. Could be for new site of any nutrient source.

To do: nutrient sinks – oysters (IMTA).
Fifish aquaculture provides an example of how bottom-up changes through additional nutrient loading can affect both benthic and pelagic systems through trophic cascades.

Decision support tools
Scenario testing:
Increased aquaculture nutrient loading

- increased fishery effort
- increased nutrient loading

Increased benthic biomass

Increased pelagic biomass

Decision support tools
Scenario testing:
Increased current catch

- Biomass change at 2050 is plotted relative to the starting biomass in 2010 under the base scenario of no change (blue line) is relative to 2010 current catch levels.

- Increased exploitation rates impact trout on the targeted species (salmon), and their key predators.

- However, the relative magnitude reduction in cod biomass under outcome scenarios is less than expected in the base scenario, because of the level of biomass imposed on the model to ensure that shared options would not exceed the available biomass within the full model domain.

Decision support tools for SGE
Development of the ecosystem model is just the first step in a longer process of model improvement:

- More work is required to ensure that the information underlying the trophic network, biomass and exploitation rates is robust, and that areas are addressed.

- Improving the environmental time series data sets and identifying those with biological relevance that can be used to predict ecological responses (e.g. climate change impacts on fisheries and aquaculture productivity, wildlife (e.g. seals, birds)).

- Need to develop spatial explicit (biophysical) model, improve habitat layers, assess key habitats to trophic groups, and to spatially allocate fishing effort and aquaculture.

- Incorporating other key values (e.g. ports, MPAs) and cumulative impacts.

- Development of appropriate ecosystem indicators.

- Congruence using different modelling approaches.

- Model improvements will ultimately increase confidence and value in the model outputs and their utility as a decision support tools for complex natural resource management issues.
'Managing risk and preparedness across the biosecurity continuum'

Phill CASSEY • Tom PROWSE • Marty DEVENEY
Sally SCRIVENS

Contact: Assoc. Prof. Phill CASSEY
School of Biological Sciences
University of Adelaide
phill.cassey@adelaide.edu.au

Description:

**FRAMEWORK FOR PREDICTING SHIPPING IMPACTS**

**Purpose:**
1. To quantify the characteristics of the individual ships and shipping routes, and identify the location (and visitation frequency) of donor port ecoregions
2. To construct a model framework for visualising impacts of shipping type (and frequency), with predicted changes to Port infrastructure and use

**NUMBER OF TRIPS ORIGINATING FROM OVERSEAS PORTS (1999 – 2012)**

**CURRENT SHIPPING ACTIVITY TO AUSTRALIA**
INCREASE IN RECENT SHIPPING ACTIVITY TO AUSTRALIA

CURRENT SHIPPING ACTIVITY IN SPENCER GULF

AMSA’s Craft Tracking System (CTS)
- Current shipping lanes
- Zone of influence (width) of shipping lanes, and their predictability
- Vessel speeds
- Residence times (and variability)

CTS locations (5 month only)

CURRENT SHIPPING ACTIVITY IN SPENCER GULF

FISHING AND MANAGEMENT ZONES

Integrate with:
- Seabed bathymetry and multi-use zones
- Vessel characteristics (size, ballast capacity)
- Source ecoregion

+ Recreational use

CURRENT SHIPPING ACTIVITY: VESSEL CHARACTERISTICS

LATITUDE

CURRENT SHIPPING ACTIVITY: SOURCE ECOREGION

LONGITUDE

Mean ship length (m)
CURRENT SHIPPING ACTIVITY: BALLAST DISCHARGE

PORT EXPANSION & DEVELOPMENT IN SPENCER GULF

Construct models to:
- Predict the characteristics of new ships, and their likely source ecoregions
- Predict new shipping lanes and associated residence times

FRAMEWORK FOR PREDICTING SHIPPING IMPACTS

Outcomes:
1. Analysis of the individual ship characteristics, donor port ecoregions, and transport routes associated with Spencer Gulf shipping activity
2. A practical framework (and support tools) for visualising impacts of shipping type (and frequency), with predicted changes to port infrastructure and use
Multiple-use of Spencer Gulf; the current system and options for the future

Integrated Ocean Management (IOM)
Focuses on accommodating multiple sectoral activities to sustainably develop oceans
Balance environmental, economic and social objectives

Marine Ecosystem-based Management (MEBM)
Priority to environment due to pivotal importance in providing for economic and social needs
(multiple-use marine protected areas?)

Tim Ward
Shirley Sorokin
Bronwyn Gillanders
Gavin Begg
Adelaide, 15th April 2015

Integrated Ocean Management (IOM)
Focuses on accommodating multiple sectoral activities to sustainably develop oceans
Balance environmental, economic and social objectives

Marine Ecosystem-based Management (MEBM)
Priority to environment due to pivotal importance in providing for economic and social needs
(multiple-use marine protected areas?)

Curtin and Prebax (2010)

Current situation
• IOM Principles generally agreed
• Desired by policy-makers, managers, scientists and industry
• Clear ecological, economic and social benefits RS, BF, IP
• Despite political and societal will and availability of scientific concepts and information
IMPLEMENTATION REMAINS A CHALLENGE

Walther and Mollmann (2014)

South Australia
Strategic Plan 2004 (goal: Care for our oceans, coasts and marine environments; marine biodiversity – 19 MPAs)
Natural Resources Management Act 2004
integrated use, management and protection of natural resources
Living Coast Strategy 2004 (MEBM)
recognises need for legislative integration
proposed Coast and Marine Act, Authority and Advisory Board
LARGELY NOT PROGRESSED FROM SECTORIAL APPROACHES
Progress in MEBM
IOM Aspirational

The starting end point?
Focus on conservation – not IOM
Coast and Marine Act, Authority, etc – a step too far
Need incremental approach

Key SA Government
State Departments
Department of Environment, Water and Natural Resources (DEWNR)
Department of Planning, Transport and Infrastructure (DPTI)
Department of Primary Industries and Regions (PIRSA)
Department of State Development (DSD)
Defence SA

Bodies corporate
Coast Protection Board
Environment Protection Authority
SA Water
Not a theoretic problem

Who is the regulator?
- The Minister for Transport and Infrastructure owns all of the adjacent and subjacent land in South Australia
- One of his statutory obligation is to fulfil the objects of the Harbors and Navigation Act 1993

Jenny Cassidy DPTI – presentation WAC

Objects of the Act
- (c) to promote the safe, orderly and efficient movement of shipping within harbors;
- (e) to provide for the safe navigation of vessels in South Australian waters;
- (f) to provide for the safe use of South Australian waters for recreational and other aquatic activities;

Jenny Cassidy DPTI – presentation WAC

Conflicting use - what does this mean in practice?
- Recreational and tourism pursuits
- Environmental protection
- Military exercises
- Commercial activities

Jenny Cassidy DPTI – presentation WAC

Tuna pens near Port Lincoln

Current concerns
- Increase in tuna quota
- Expansion of zones further offshore in deeper, cleaner waters
- Intersecting with more known shipping routes
- Little recognition of the interaction with recreational sector

Likely increase in ports and shipping has major implications for all sectors
How will these impacts be managed?
Legislation – SG marine area
Key South Australian Legislation
Fisheries & Aquaculture Legislation (2 Acts)
Marine and National Parks (2 Acts)
Environment & Coast protection (5 Acts)
Natural Resources incl minerals & petroleum (3 Acts)
Harbors & navigation (1 Act)
Culture/social (2 Acts)

Natural Resources Management Act 2004
OBJECTIVES for IOM
- Covered within Objects of Act
- Conservation: productivity & biodiversity
- Conservation: biocentrism: Control biological diversity
- Conservation: MAG: Restore ecological systems - Ecological integrity
- Economic: Support sustainable production esp. agriculture and mining
- Needs of future generations
- Costs shared amongst users/consumers
- Social/cultural: Protect or enhance for future generations.
- Consideration to Aboriginal heritages
- Institutional/governance: Capacity for people to be involved in management
- Education initiatives
- Research & education: Education initiatives

Range of objects in Acts
SA Act
- Conservation - biodiversity
  - Protect from endangerment
Fisheries Act
  - Social/cultural
    - Recreational fisheries fostered
    - Provide education / Enjoyment
    - Enjoyment of parks by public
    - Enable people and communities to provide for their economic, social and physical well-being and for their health and safety
    - Safeguarding the environment for future generations
    - Education initiatives
    - Capacity for people to be involved in management
    - Consideration to Aboriginal heritages

What have we learned in last few days
IOM best option for managing multiple use/objectives/impacts
SA failure to implement not unusual
Scientific capability exists – but needs to be focussed (GHHHP)
Stakeholder Support for IOM is Strong – SGEDI
IOM can only be driven by Government
If key agencies recognise benefits and commit
Incremental approach necessary
AIMS FOR DISCUSSION
Identify key elements of success
Use expertise to get a sense of what will/won’t work