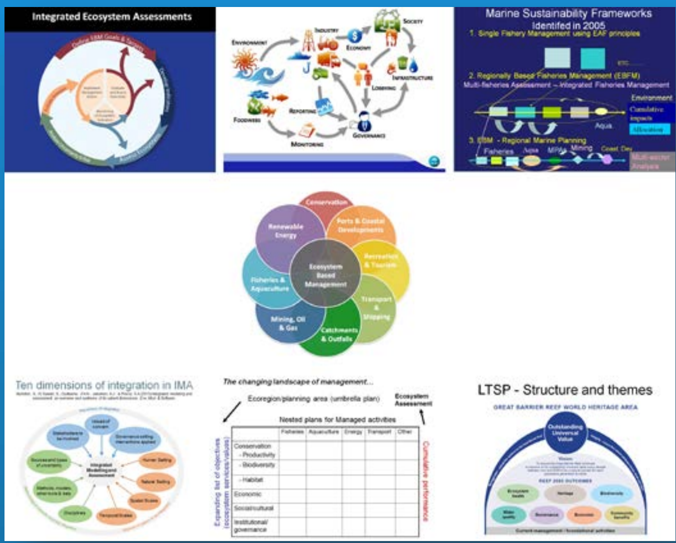
Practical steps to implementation of integrated marine management

Report of a Workshop, 13-15 April 2015



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

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July 2015

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

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In submitting this report, the researcher has agreed to FRDC publishing this material in its edited form.

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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[1]

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).

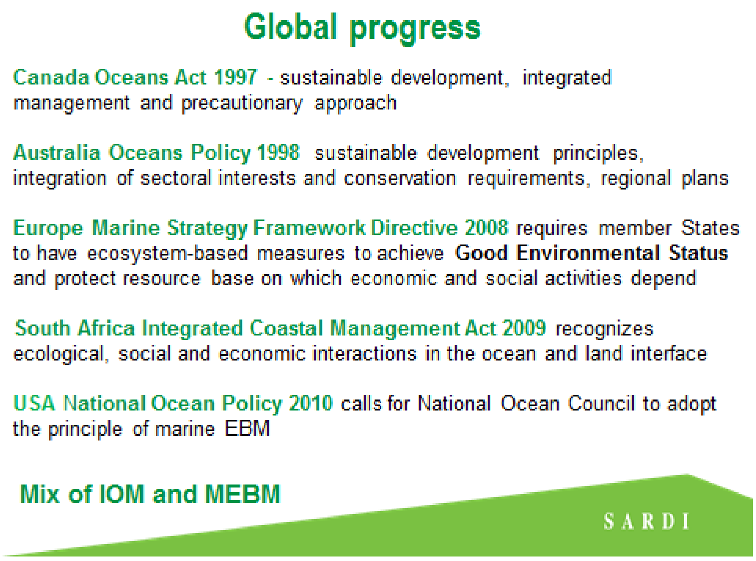

Figure 1. Examples of global progress towards integrated marine (oceans) management (from Ward et al., see Appendix 5).

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.

[1] 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);
- The Marine Strategy Framework Directive (2008) provides 11 descriptors of 'good environmental status';
- The Marine Spatial Planning Directive (2014) calls for plans in a 'blue growth' context ("coordinated and coherent decision-making to maximise the sustainable development, economic growth and social cohesion of Member States") by 2021.

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).

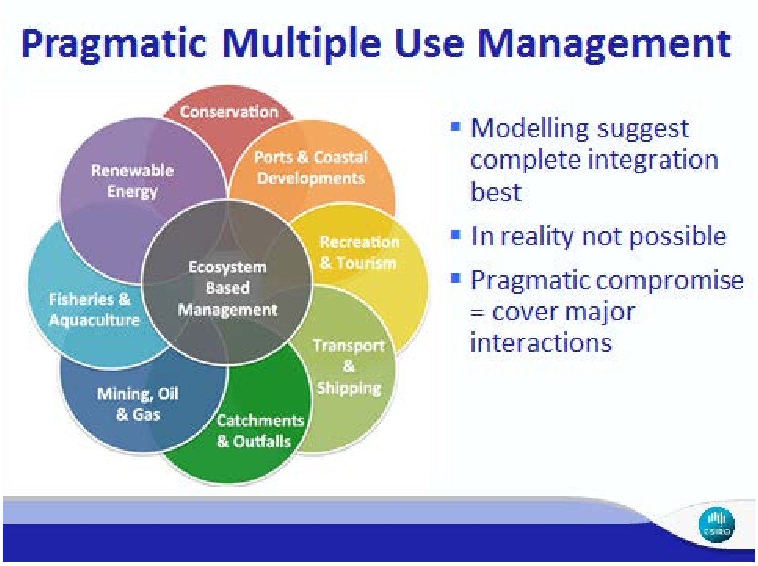

Figure 2. Integrated marine management captures the range of user groups, often with competing objectives (from Fulton, see Appendix 5).

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.

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.

Keeney (2007). Developing objectives and attributes. In: W. Edwards, R.F. Miles Jr., D. von Winterdfeldt, D. (eds). Advances in decision analysis. From foundations to applications. Cambridge University Press, Cambridge.

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).

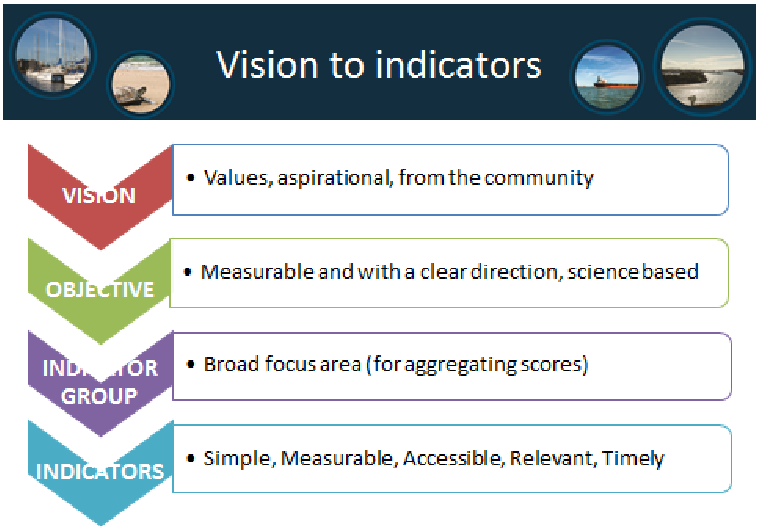

Figure 4. Example of objective setting across multiple stakeholders (from Poiner and McIntosh, see Appendix 5).

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).

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

Tools to support the IMA process

Tool Category	Examples of tools	Application	Purpose
Exploratory tools	statistical analysis, 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.

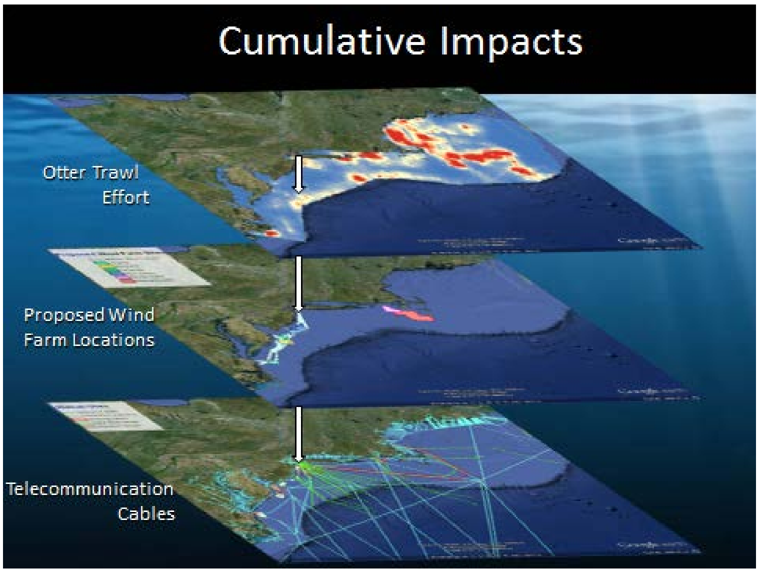

Figure 7. Understanding cumulative impacts involves assessing the effects of multiple activities (from Fogarty, see Appendix 5).

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 km^2), 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 km^2. 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

Attorney-General (2 acts)	***Minister for Sustainability, Environment and Conservation (9 acts)***	***Minister for Tourism***
Sea-Carriage Documents Act 1998	*Climate Change and Greenhouse Emissions Reduction Act 2007*	*South Australian Tourism Commission Act 1993*
Native Title (South Australia) Act 1994	*Coast Protection Act 1972*	***Minister for Transport and Infrastructure (5 acts)***
Minister for Agriculture, Food and Fisheries (2 acts)	*Environment Protection Act 1993*	*Harbors and Navigation Act 1993* (referred to above)
Aquaculture Act 2001	*Environment Protection (Sea Dumping) Act 1984*	*Marine Safety (Domestic Commercial Vessel) National Law (Application) Act 2013* (referred to above)
Fisheries Management Act 2007	*Historic Shipwrecks Act 1981*	*Maritime Services (Access) Act 2000*
Minister for Mineral Resources and Energy (2 acts plus 3 listed above)	*Marine Parks Act 2007*	*Protection of Marine Waters (Prevention of Pollution from Ships) Act 1987*
Petroleum and Geothermal Energy Act 2000	*National Parks and Wildlife Act 1972*	*South Australian Ports (Bulk Handling Facilities) Act 1996*
Offshore Minerals Act 2000	*Native vegetation Act 1991*	
Minister for Planning	*Natural Resources Management Act 2004*	
Development Act 1993	*Wilderness Protection Act 1992*	

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).

	Fisheries and Parks				Environment Protection					Resource Management			Transport	Culture	
ACTS / OBJECTIVES	Fisheries	Aquaculture	Marine Parks	National Parks	Environment Protection	Coast Protection	Prevention of pollution from Ships	Sea dumping	Climate Change & Greenhouse Emissions Reduction	Natural Resources Management	Petroleum and Geothermal Energy	Offshore Minerals	Harbors and Navigation	Native Title	Historic Shipwrecks
Conservation - productivity	✓✓	✓			✓				✓✓	✓✓✓					
Conservation - biodiversity	✓✓		✓✓✓	✓	✓				✓✓	✓✓✓		✓✓			
Conservation - habitat	✓✓		✓✓✓	✓✓	✓	✓✓✓	✓	✓✓		✓✓✓	✓✓	✓✓	✓✓		
Economic	✓✓✓	✓			✓✓✓				✓✓	✓✓✓.	✓✓		✓✓✓		
Social & cultural	✓✓✓	✓✓	✓✓✓	✓✓	✓✓✓	✓✓✓				✓✓	✓✓✓		✓✓	✓✓	✓✓
Institutional governance	✓✓✓	✓✓	✓✓✓		✓✓✓	✓✓		✓✓	✓✓	✓✓✓	✓✓✓		✓✓✓		
Research & education	✓✓	✓✓	✓			✓✓			✓✓✓	✓					

✓ implied; ✓✓ mentioned; ✓✓✓ detailed

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 *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.*

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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).

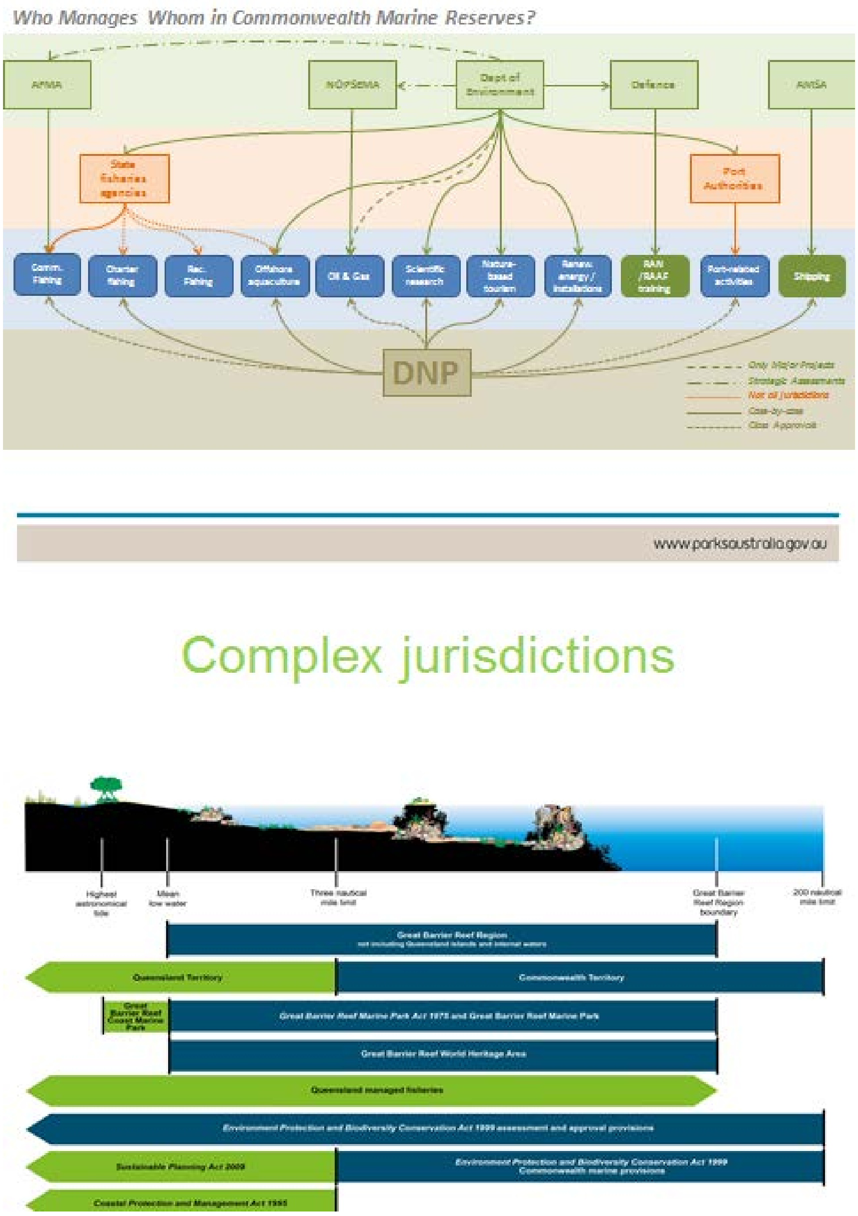

Figure 8. Examples demonstrating complexity of management arrangements across Commonwealth and State jurisdictions (from Musso, Harman, see Appendix 5).

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.

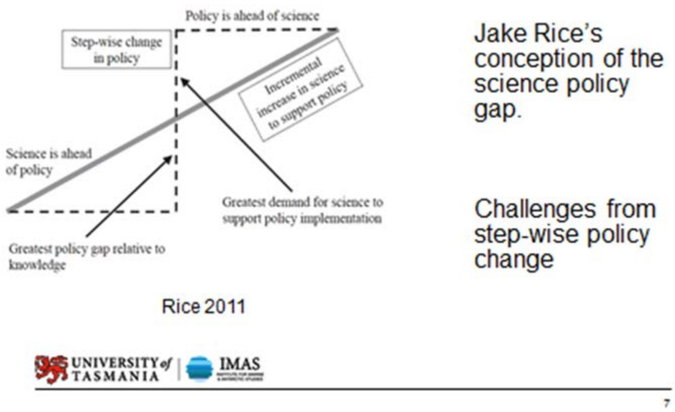

Figure 9. Step-wise policy-shifts, such as integrated marine management, require a greater demand for science to support decision-makers (from Haward, see Appendix 5).

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.

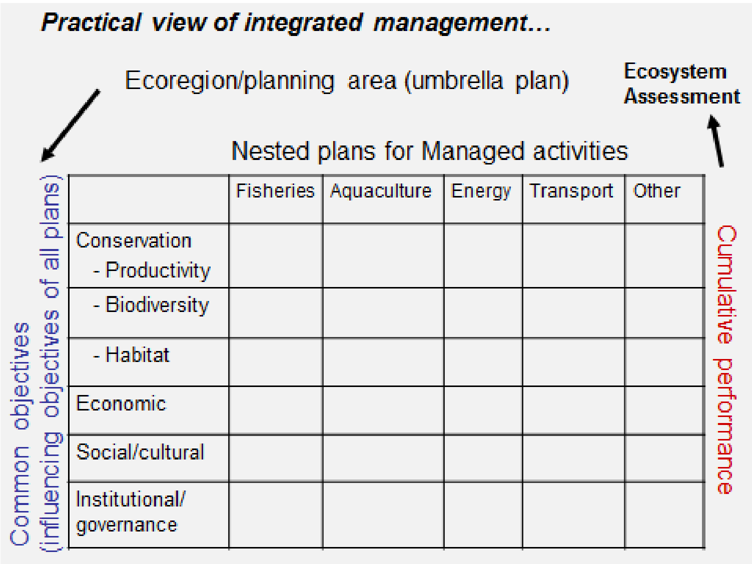

Figure 10. Common framework for specifying multiple objectives across multiple activities (from Stephenson, see Appendix 5).

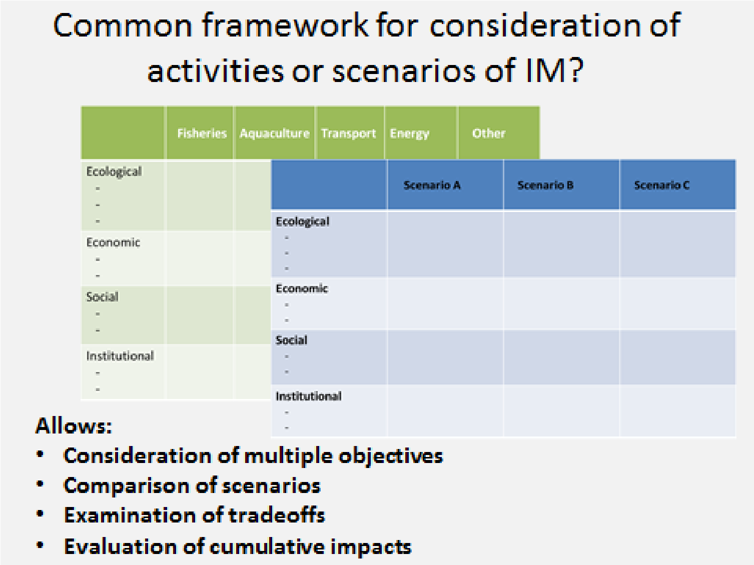

Figure 11. Common framework enables assessment of alternate management scenarios and their trade-offs (from Stephenson, see Appendix 5).

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

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Appendix 4: Workshop Agenda

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

- Gladstone Healthy Harbour Partnership – Ian Poiner

1200-1240: Lunch

1240-1540:

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 McGowan (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

<table>
<tr><td>Petrina Apfel

NSW Department of Primary Industries</td><td>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.</td></tr>
<tr><td colspan="2">'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.</td></tr>
<tr><td>Dr Phill Cassey

University of Adelaide</td><td>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.</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td>Dr Mark Dickey-Collas

ICES</td><td>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, DGENV 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</td></tr>
</table>

	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>
<tr><td>U.S. Geological Survey</td><td>where she is investigating the effects of the largest dam removal in U.S. history on coastal and nearshore ecosystems. Prior to the USGS, she was an Early Career Fellow at the Center for Ocean Solutions where she translated science to policy to inform some of the most pressing problems facing the ocean, including spatial planning, ecosystem-based management, cumulative effects, ocean acidification, and ocean tipping points. She has also worked closely with scientists from NIWA and the University of Auckland in New Zealand on spatial planning, risk assessment, and cumulative effects analyses in the Hauraki Gulf.</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td>Dr Beth Fulton

CSIRO</td><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>
<tr><td colspan="2">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.</td></tr>
<tr><td>Prof Bronwyn Gillanders

University of Adelaide</td><td>Bronwyn is a marine ecologist and Professor in the School of Biological Sciences and Environment Institute at the University of Adelaide. She is currently Deputy Director of the Environment Institute and leads the marine biology program. She has been involved with the Spencer Gulf Ecosystem and Development Initiative since its inception.</td></tr>
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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 **SARDI**	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 **Great Barrier Reef Marine Park Authority**	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 highlight 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 **ANU**	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 **T Buck Suzuki Foundation**	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 Kinghlas 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 km^2 includes the longest coastline (244,000 km) of any country in the world.	
A/Prof John Middleton **SARDI**	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.
CarCap – a decision support tool for aquaculture expansion and Gulf developments based on nutrient carrying capacity 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.	
Prof Tim Moltmann **IMOS – UTAS**	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 & Atmospheric Research Division based in Hobart. He has a particular interest in research infrastructure, and has

	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 **Department of the Environment**	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 **SARDI**	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

SOUTH AUSTRALIAN RESEARCH & DEVELOPMENT INSTITUTE
PIRSA

Tim Ward
Shirley Sorokin
Gavin Begg
Bronwyn Gillanders
Tony Smith
Robert Stephenson

Adelaide, 13 April 2015

PREMIUM FOOD AND WINE FROM OUR CLEAN ENVIRONMENT

The concept(s)

Ocean Environmental Management
Frankel (1995)
Integrated Coastal Zone Management
Turner and Adger 1996; DFO Canada (1998)
Principles for sustainable governance of the oceans
Costanza et al. (1998)
Integrated environmental management of the oceans
Atunes and Santos (1999)
Marine Ecosystem-based Management
Arkema et al. (2006); Curtin and Prellezo (2010)
Ecosystem approach to management
Walther and Mollmann (2014)

Integrated Ocean Management (IOM)
Marine Ecosystem-based Management (MEBM)

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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?)

Curtin and Prellezo (2010)

SARDI

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

Costanza et al. (1998) 'Principles for sustainable governance of the oceans'

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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

Walther and Mollmann (2014)

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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

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Regional Progress

Great Barrier Reef (Marine Park Act 1975) collaborative approach – Protection and Public enjoyment. Reef 2050 (just released) Long-term Sustainability Plan

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

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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)
recognises need for legislative integration
proposed Coast and Marine Act, Authority and Advisory Board

Marine Planning Framework 2006 (proposed six Marine Plans, Draft SG Marine Plan; Marine Managers Forum 1999)

LARGELY NOT PROGRESSED FROM SECTORIAL APPROACHES
Progress in MEBM
IOM Aspirational

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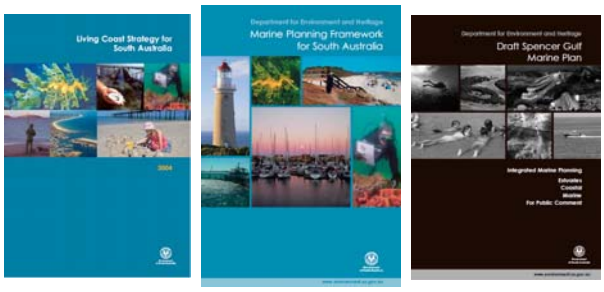
The starting point



Focus has been on conservation

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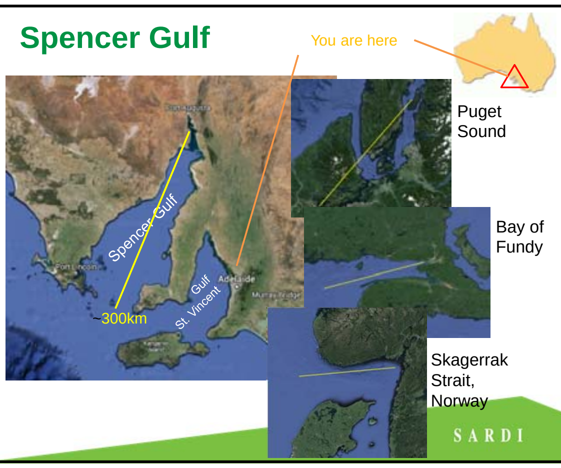
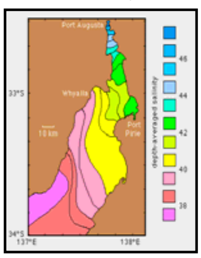
Spencer Gulf

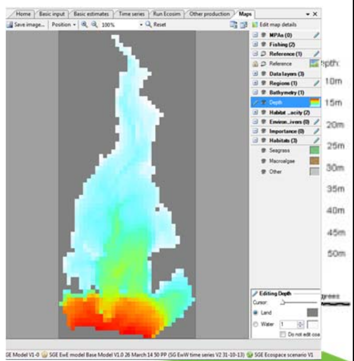


SARDI

Spencer Gulf

Inverse estuary





Low rainfall
High evaporation
Dodge tides
Large tidal velocities

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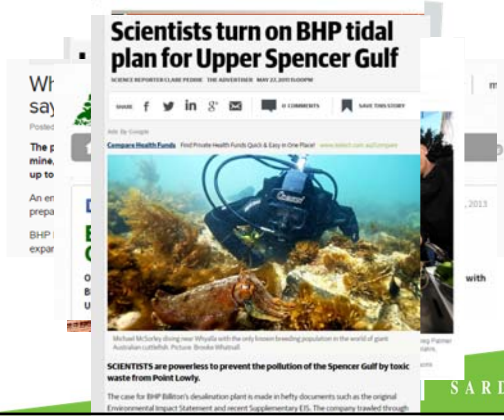
Important development zone and valuable ecosystems

User conflicts inevitable



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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

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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

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Outcomes and Outputs

SOUTH AUSTRALIAN RESEARCH & DEVELOPMENT INSTITUTE
PIRSA

Report

Future Collaborations

Paper

Progress towards implementation

PREMIUM FOOD AND WINE FROM OUR CLEAN ENVIRONMENT

SOUTH AUSTRALIA

Government of South Australia
Primary Industries and Regions SA

SARDI

Governance Frameworks for IM: Eastern Canada

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

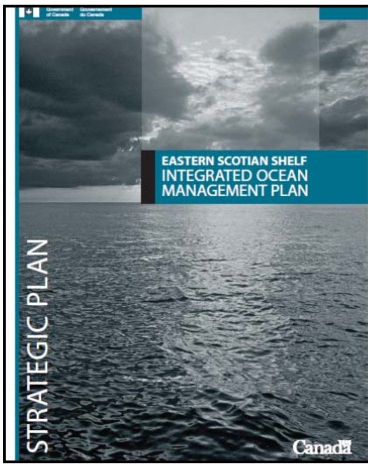
Canada's Oceans Act 1996

- 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



Pilot: ESSIM

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

Operating principles for collaborative planning

The collaborative planning model is founded upon the following operating principles:

- *Jurisdiction:* Management authorities and jurisdiction of government departments and agencies is acknowledged and affirmed.
- *Inclusion:* All stakeholders are included.
- *Consensus:* Decisions and recommendations are made by consensus and the process includes mechanisms for dispute resolution.
- *Accountability:* Accountability is expected of and demonstrated by all parties.
- *Evolution:* The process is designed to permit and support evolution and will be monitored and evaluated to support shared learning and adaptation.
- *Networking:* The process will continue to work through a network of stakeholders.
- *Transparency:* Decisions and recommendations are made openly, with information and results shared with all stakeholders.
- *Efficiency:* Issues are addressed in a timely manner.
- *Knowledge-based:* Decisions and recommendations are based on best available information.

ESSIM: Developed a comprehensive set of objectives and strategies for…

COLLABORATIVE GOVERNANCE AND INTEGRATED MANAGEMENT
- Effective governance structures and processes.
- Capacity among stakeholders.
- Knowledge to support integrated management.

SUSTAINABLE HUMAN USE
- Ecologically sustainable use of ocean space and resources.
- Sustainable communities and economic well-being.

HEALTHY ECOSYSTEMS
- Resilient and productive ecosystems, with diverse habitats, communities, species and populations.
- Strong marine environmental quality supports ecosystem functioning.

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

ESSIM: Success?

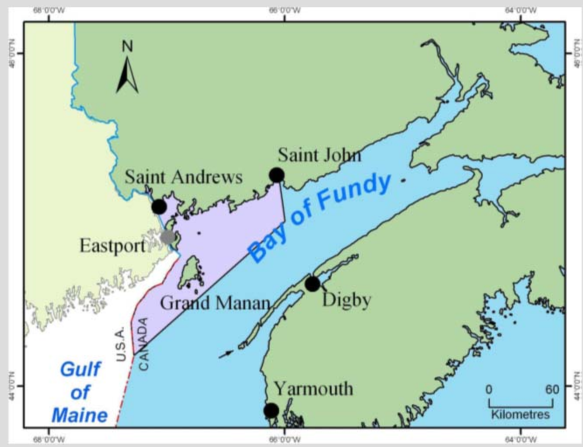
- Developed machinery of integrated management
  - ESSIM Forum, SAC, Intergovernmental Committee (RCCOM)
- Developed Integrated Plan
  - Vision, governance , objectives, strategies
- Not fully implemented/continued…paved the way for other Regional Planning initiatives
- Planning/management continues on activity basis
- http://www.mar.dfo-mpo.gc.ca/Maritimes/Oceans/OCMD/ESSIM/Reports

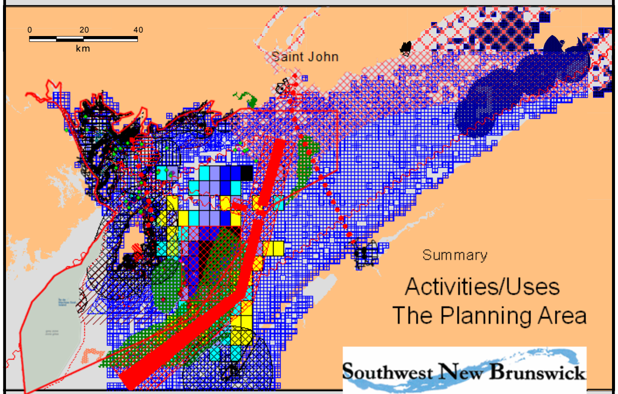
Beginning about 2004…

Southwest New Brunswick

MARINE RESOURCES PLANNING

CREATING A MARINE PLAN





Southwest New Brunswick
MARINE RESOURCES PLANNING

Credit: Blythe Chang and Fred Page

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

Southwest New Brunswick
MARINE RESOURCES PLANNING

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

Southwest New Brunswick
MARINE RESOURCES PLANNING

Southwest New Brunswick
MARINE RESOURCES PLANNING

↓ …2012

SWNB Marine Advisory Committee

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

(Societal expectation is greater than the minimum established in law = 'Social license')

- 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

ATTRIBUTES	OBJECTIVES / STRATEGIES with associated pressures
yield biomass recruitment size/age structure spatial extent spatial occupancy population richness predator forage community assemblage ('special species') trophic structure habitat structure ('special places') pollutant deaths/disorders physical hazard deaths behavior disturbance	**Productivity** • Keep fishing mortality moderate - Promote positive biomass change when biomass is low - Manage discards for all harvested species • Allow sufficient escapement from exploitation of spawning biomass • Limit disturbing activity in spawning areas/seasons • Control alteration of nutrient concentrations affecting primary production at the base of the food chain by algae **Biodiversity** • Control incidental mortality for all non-harvested species • Minimize unintended transmission of invasive species • Distribute population component mortality in relation to component biomass **Habitat** • Manage area disturbed of bottom habitat types • Limit introduction of contaminants, toxins and waste in habitat • Minimize deaths from lost gear/equipment • Control noise and light disturbance

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

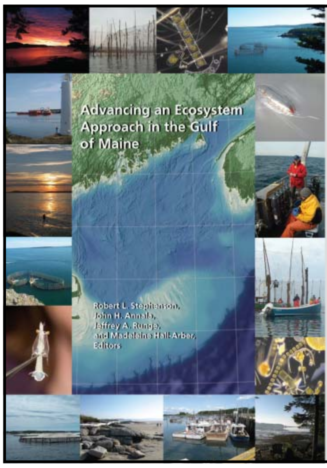
(http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/fish-ren-peche/sff-cpd/overview-cadre-eng.htm)

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



- **2012 report of International Symposium**
- **What progress?**
- **What priorities?**

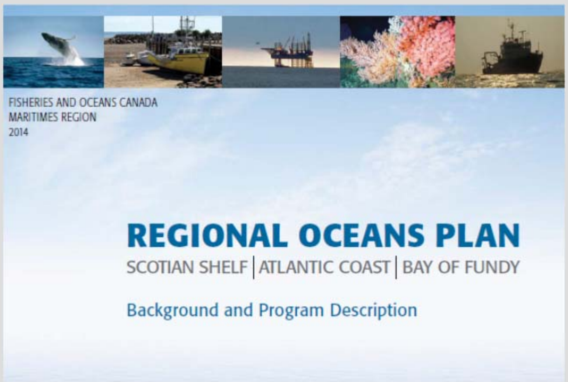
Criticisms of current management

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…



DFO 2014. Regional Oceans Plan – Maritimes Region

Three plans for the Region…

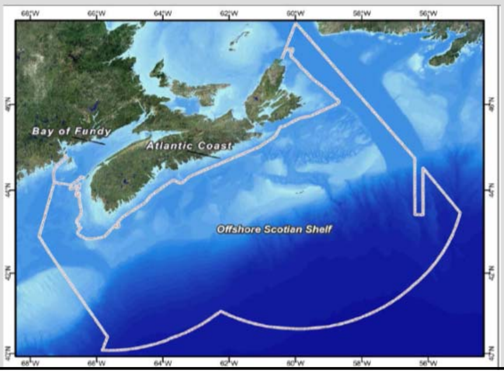


Figure 2: Regional Oceans Plan: Vision, Goals, Program Components and Activities

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
- Departmental Alignment
  - 'whole of DFO' approach

DFO 2014. Regional Oceans Plan – Maritimes Reg

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)

DFO 2014. Regional Oceans Plan – Maritimes Region

ROP – Guiding principles:

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

DFO 2014. Regional Oceans Plan – Maritimes Reg

…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 Regio

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)

The changing landscape of management…

Ecoregion/planning area (umbrella plan)

Ecosystem Assessment

Nested plans for Managed activities

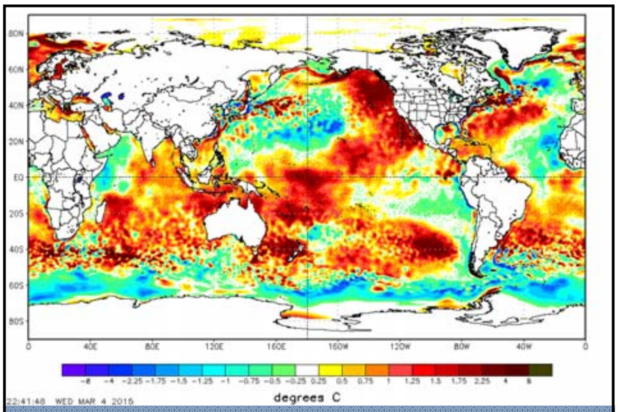
Expanding list of objectives (ecosystem services/values)

Cumulative performance

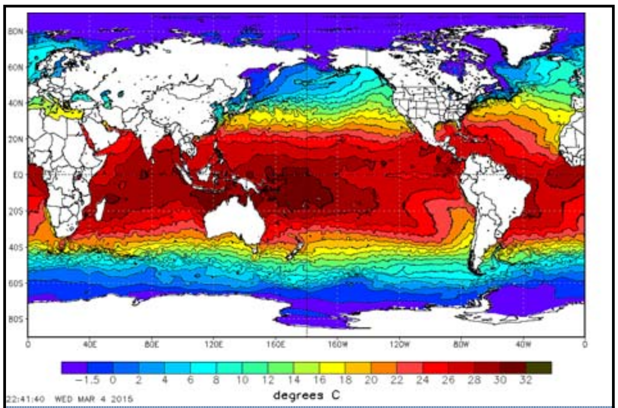
	Fisheries	Aquaculture	Energy	Transport	Other
Conservation - Productivity					
- Biodiversity					
- Habitat					
Economic					
Social/cultural					
Institutional/ governance					

Some Canadian Experience on Integrated Marine Management

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



Oceans are Special



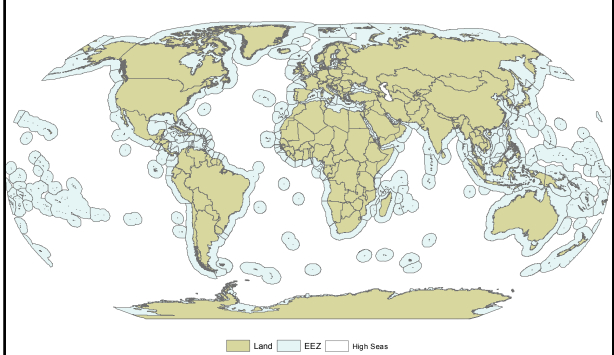
Sea Surface Temperature

From Freedom of-the-seas

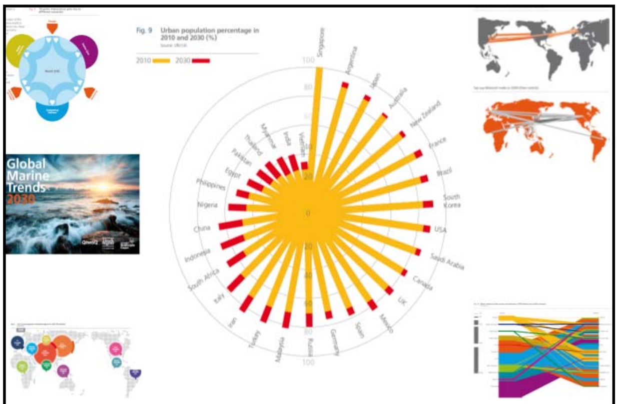
"Through the last century oceans were generating a multitude of claims, counterclaims and sovereignty disputes." UN-LOS-HP

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

To Law of the Sea - UNCLOS



World Exclusive Economic Zones

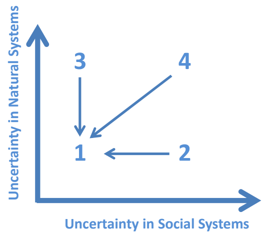


Global Marine Trends 2030

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)

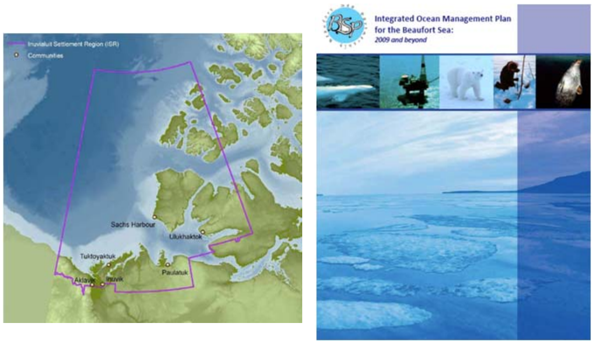
Large Ocean Management Areas

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.

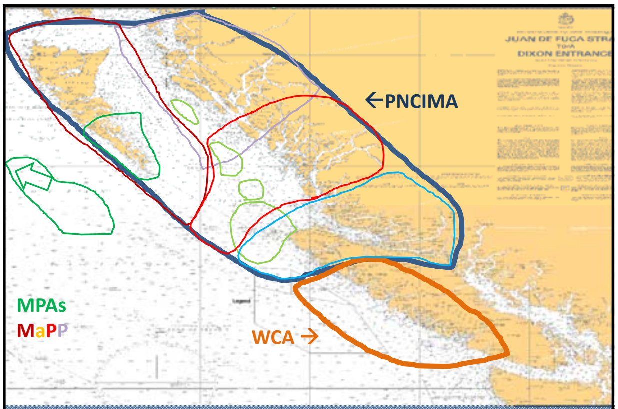
EBM differs from current approaches that usually focus on a single species, sector, activity or concern; it considers the cumulative impacts of different sectors.

Science Consensus Statement on Marine EBM 2005

Ecosystem Based Management



LOMA Plan for the Beaufort Sea



Governance & Canada's Pacific Coast

Pacific North Coast Integrated Management Area

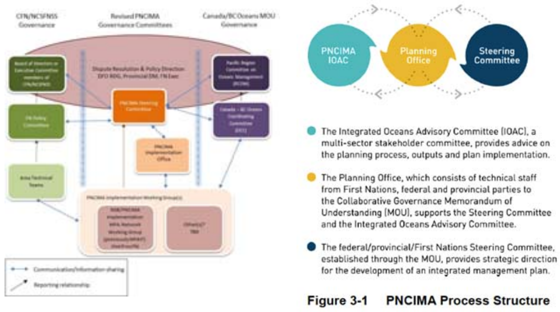


Figure 3-1 PNCIMA Process Structure

PNCIMA Governance Structures

Figure 4-1 Components of the PNCIMA Ecosystem-Based Management (EBM) Framework

PNCIMA EBM Framework

Definition: 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

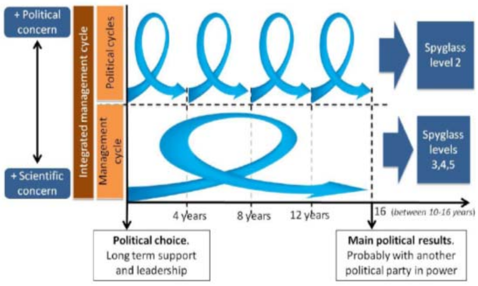
Goal 1: Integrity of the marine ecosystems.

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.

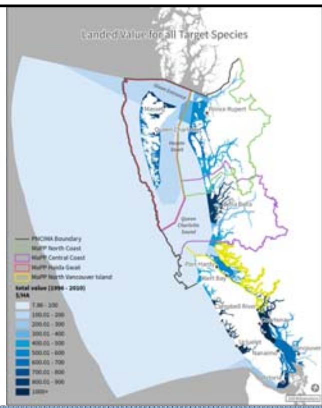
Goal 4: Improved understanding of complex marine ecosystems and changing marine environments.

PNCIMA Interconnected EBM Goals



Spyglass Framework 2014

Political Cycle vs Management Cycle

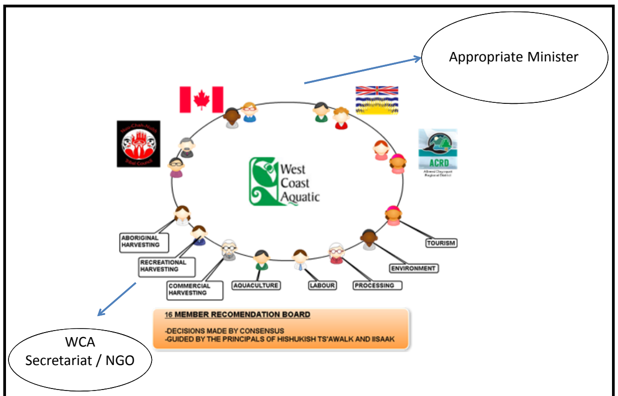


Marine Planning Partnership – BC & FNs

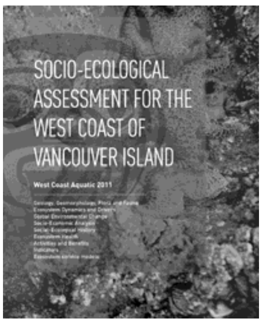
MPAs, NMCAs, mNWA, MPA Network

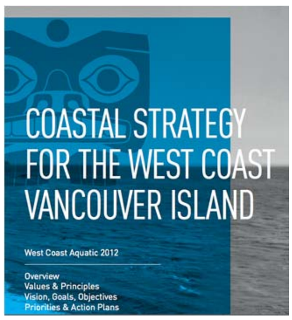
- Coastline similar in length to Portugal or Oregon
- a rich and abundant coastal region defined by fresh and sea water resources

West Coast Aquatic - More Value, Less Risk



Governance





Outcomes

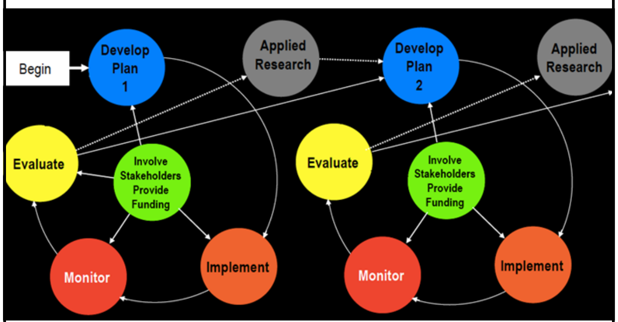
The public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, social objectives that are usually specified through a political process.

Ehler & Douvere "Vision for a Sea Change" 2006

What is Marine Spatial Planning?

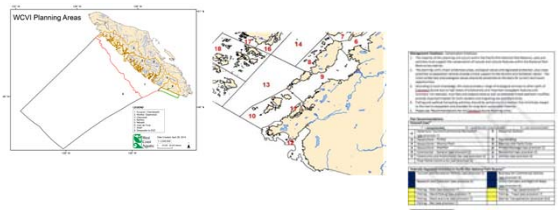
1) Define Context and Authority
2) Obtain Financial Support
3) Organize Stakeholder Participation
4) Organize the process Through Pre-Planning
5) Analyzing Current Conditions
6) Analyzing Future Conditions
7) Develop Spatial Plan
8) Implement and Enforce the Plan
9) Monitoring and Evaluating Performance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

10 Steps of MSP

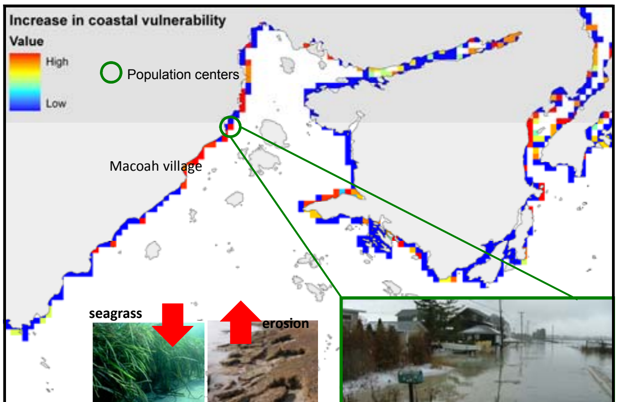


Continuing MSP Cycle

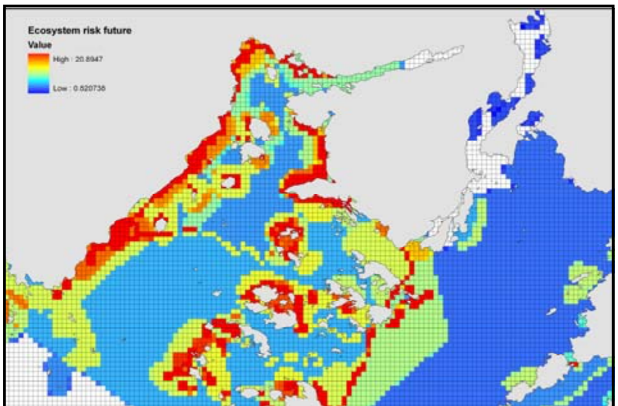
- Management Emphasis
- Recommended, not recommended and conditional uses
- Activities and areas requiring advanced management measures



Marine Spatial Plans



Identify tradeoffs between human uses and ecosystem services



Cumulative Risk Assessment

Good process, good results, less time, money, and frustration.

The bottom line for gov't and business…

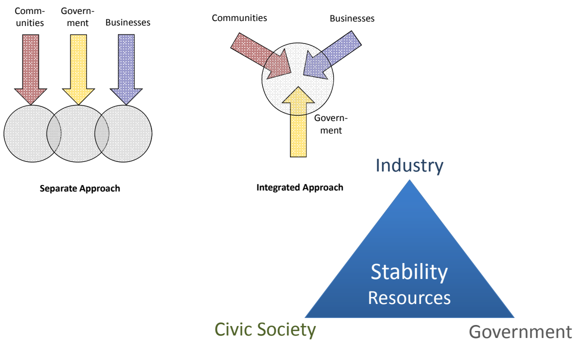
Lessons Learned

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

Lessons Learned

Jim McIsaac – jamcisaac@shaw.ca



Integration

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

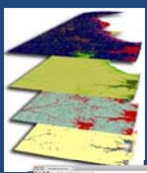
Common needs & challenges in integrated management

1. Goals and objectives

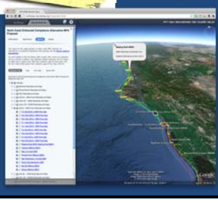
- Specific goals and objectives
- Time frame
- Lead agency
- Science-based
- Role of stakeholders

Common needs & challenges in integrated management

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?

Common needs & challenges in integrated management

3. Human uses

Activity mapping
- Recreational fishing
- Emerging uses

Common needs & challenges in integrated management

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

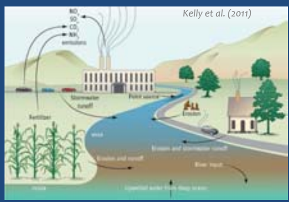
Common needs & challenges in integrated management

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

U.S. National Ocean Policy (2010)

"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

U.S. National Ocean Policy (2010)

"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)

- First attempt failed
- Second attempt succeeded
- Established a network of marine protected areas throughout state waters (0 to 3 nm)
- Four planning areas
- Four types of protected areas – marine reserve, conservation area, marine park, recreational management area

California Marine Life Protection Act (1999)

Addressing needs & challenges:

1. Goals & objectives
   - Extensive stakeholder involvement in second attempt
   - Best available science requirement
2. Data & tools
   - MarineMap developed for the process & used by stakeholders
4. Important ecosystem components
   - "Rules of thumb" for size and spacing
   - All habitat types had to be represented in proposal

Puget Sound Partnership (2007)

- State agency created in 2007
- Coordinate entities to restore Puget Sound

Puget Sound Partnership (2007)

Addressing needs & challenges:

1. Goals & objectives
   - Science action plans
4. Important ecosystem components
   - Ecosystem indicators for each of six goals and targets for each
6. Land-sea 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

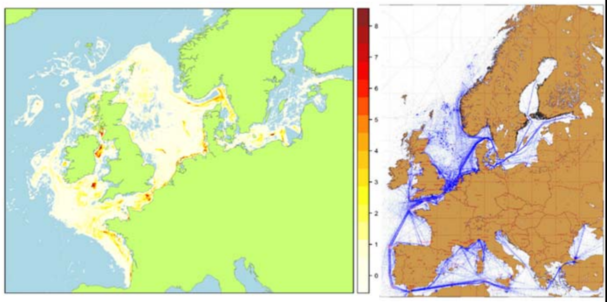
1. Learn what you have, what you don't have, and what you need to have
   - Especially true for data
2. Develop a science framework
   - Underpins the whole plan
   - Best available science requirement
3. Coordinate and fund scientific research
   - Facilitates a broader understanding of the system
   - 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

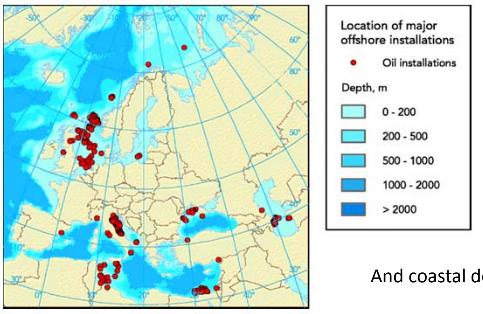
@DickeyCollas

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

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Formal Institutions

Council of Ministers | European Parliament

European Commission | European Court of Justice

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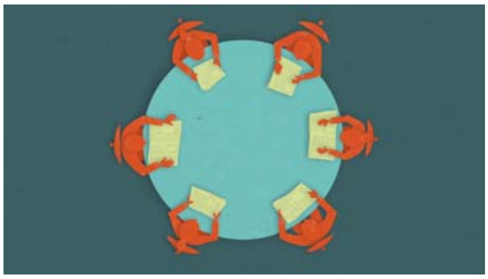
Member states, stakeholder groups



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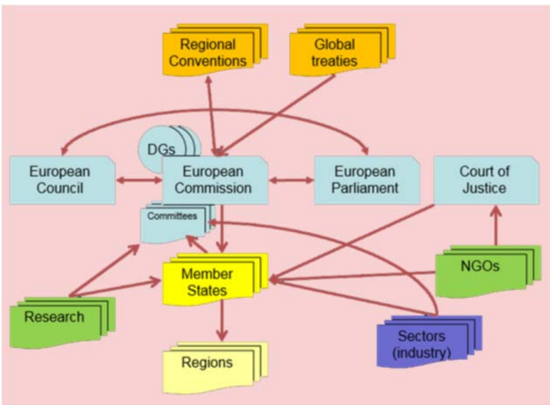

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EU Legislation

Maritime Spatial Planning Directive
2014

Common Fisheries Policy (CFP)
1972-2014

Marine Strategy Framework Directive (MSFD)
2008

Habitat Directive
Natura2000 1992
Birds Directive 1979

Oil & gas national

Transport
Energy
Regions
Labour conditions

Water Framework Directive 2000

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Policy Domains

Name	Acronym	Type	DG
Maritime Spatial Planning Directive	MSPD	Directive	MARE
Common Fisheries Policy	CFP	Policy	MARE
Marine Strategy Framework Directive	MSFD	Directive	ENV
Habitat & Birds Natura2000	H&BD (N2000)	Directive	ENV
Water Framework Directive	WFD	Directive	ENV

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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

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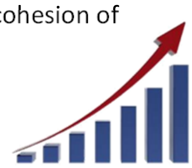
Maritime Spatial Planning Directive

Focus on blue growth.

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



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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

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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.

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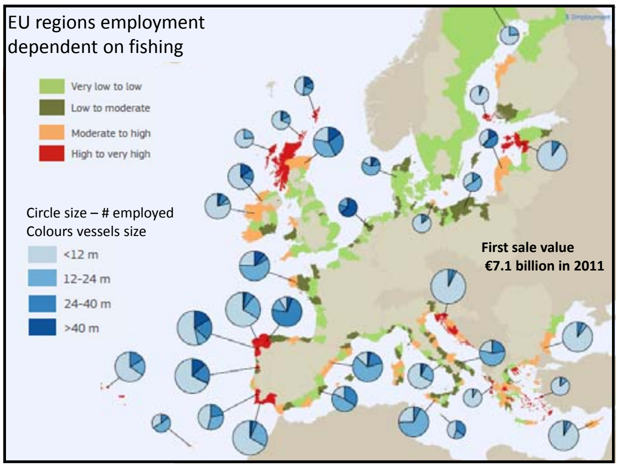
Common Fisheries Policy

Reformed in 1982, 1992, 2002, 2014

- 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



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Marine Strategy Framework Directive

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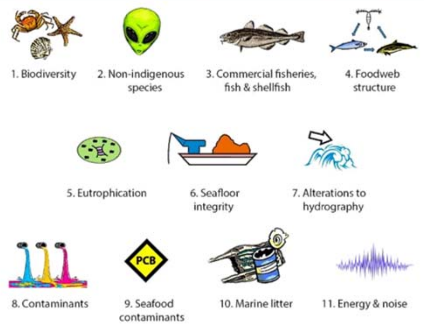
Marine Strategy Framework Directive



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Habitat & Birds Directives (Natura2000)

EU wide network of nature protection areas

Valuable & threatened species & habitats

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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

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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

HELCOM

OSPAR COMMISSION

Protecting and conserving the North-East Atlantic and its resources

UNITED NATIONS ENVIRONMENT PROGRAMME MEDITERRANEAN ACTION PLAN for the Barcelona Convention

Commission on the Protection of the Black Sea Against Pollution

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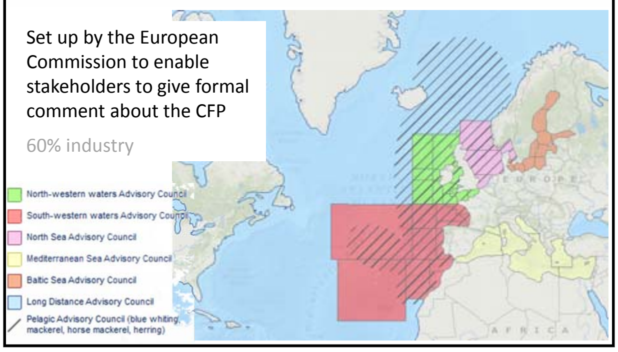
Advisory Councils

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

60% industry



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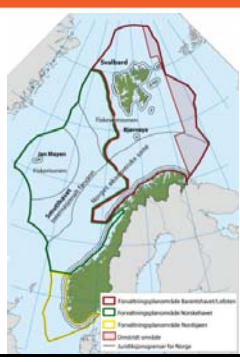
Norway

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

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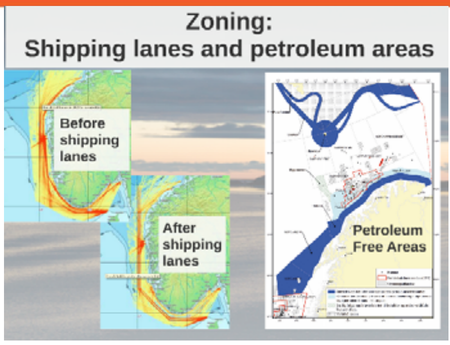
Norway - impact



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The power play within the EU

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

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Who loses influence with integration?

Tools used
Common Fisheries Policy
Marine Strat. Framework Dir
Birds & Habitats Dir
Water Framework Dir
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Players
European Commission
European Council
European Parliament
Member States
Advice Councils
Regional Sea Conventions

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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

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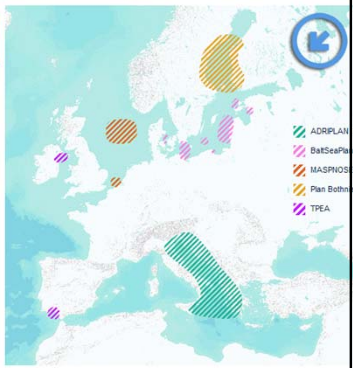
EU MSP projects



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

http://ec.europa.eu/maritimeaffairs/policy/maritime_spatial_planning/index_en.htm

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Aligning of Ecoregions

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EU exporting ecosystem, social and cultural impacts.

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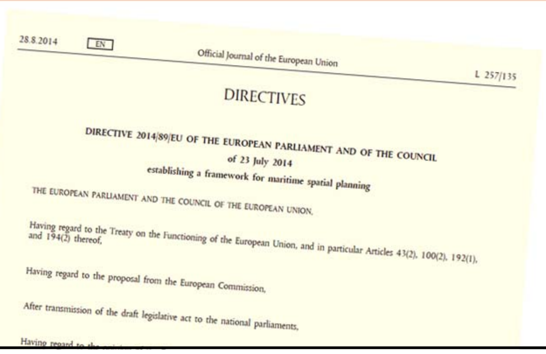
Not sure of likely impact of new directive



28.8.2014 EN Official Journal of the European Union L 257/135

DIRECTIVES

DIRECTIVE 2014/89/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 23 July 2014
establishing a framework for maritime spatial planning

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty on the Functioning of the European Union, and in particular Articles 43(2), 100(2), 192(1), and 194(2) thereof,

Having regard to the proposal from the European Commission,

After transmission of the draft legislative act to the national parliaments,

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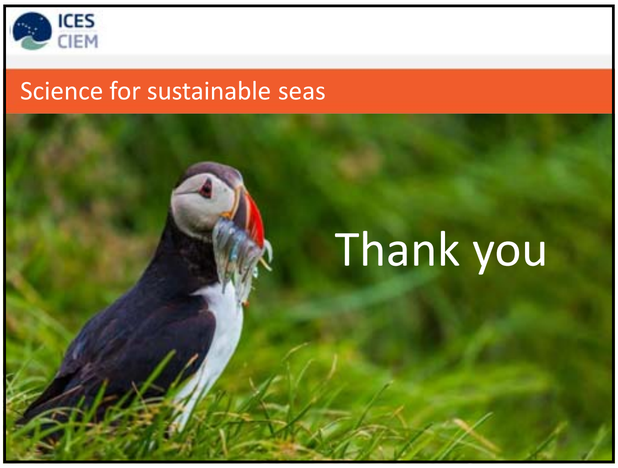
David Goldsborough...

"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."


ICES
CIEM
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

UNIVERSITY of TASMANIA | IMAS

Outline

Integrated Oceans Management

Integrated Oceans Management – A National Overview

The Australian Oceans Policy: Looking back, Moving Forward

Where to now?

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2

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 sectorspecific 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).

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3

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,

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4

A Marine Nation (2009)

Improved governance - *oversight and coordinationof 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.

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5

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

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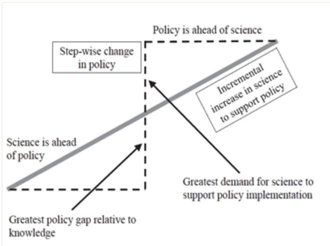
6



Rice 2011

Jake Rice's conception of the science policy gap.

Challenges from step-wise policy change

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7

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.

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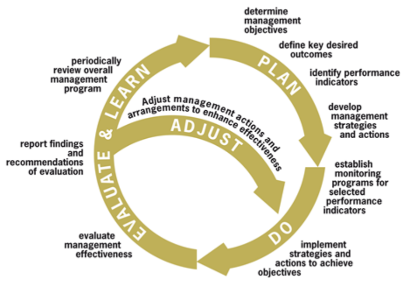
Adaptive Management Cycle



Jones (2009)

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Stakeholder Engagement and Expectations

Stakeholder engagement

Who?,
When?,
How?

Managing Expectations

A key lesson from the *Oceans Policy* story…

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10

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).

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A final thought

Problems in ocean resources management derive from governance not science.

(Crowder et al 2006: 617)

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12

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Vince, J., ADM. Smith; KJ. Sainsbury, ID. Creswell, DC. Smith & M. Haward, 2015 Australia's Oceans Policy: past, present and future *Marine Policy*, 57: 1-8.

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Australian Government
Parks Australia

The Commonwealth marine planning experience

From Oceans Policy to Marine Bioregional Planning

Dr Barbara Musso
Commonwealth Marine Reserves Branch
Parks Australia Division

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.

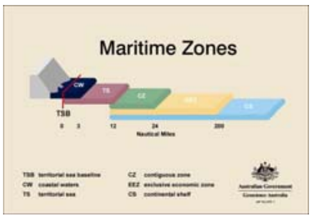
GOALS FOR AUSTRALIA'S OCEANS

In seeking to care for, understand and use our oceans wisely, *Australia's Oceans Policy* has the following broad goals.

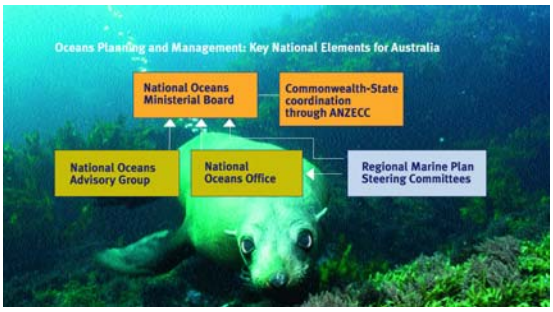
1. To exercise and protect Australia's rights and jurisdiction over offshore areas, including offshore resources.
2. To meet Australia's international obligations under the United Nations Convention on the Law of the Sea and other international treaties.
3. To understand and protect Australia's marine 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)

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South-east RMP

- Scoping
- Assessment
- Draft Plan

- No clear model
- "Learning by doing"
- No carrot & no stick…

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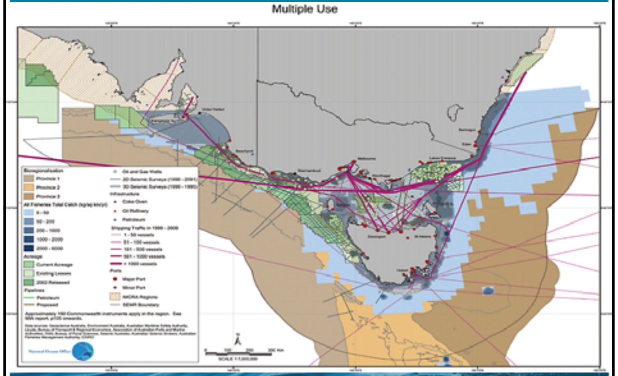
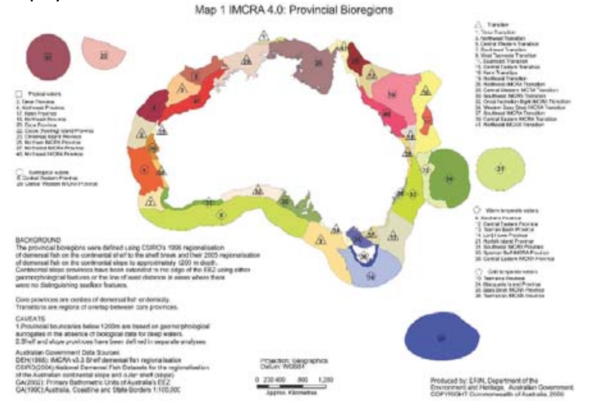


Outputs

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

www.parksaustralia.gov.au

Biophysical information:



Positive change

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

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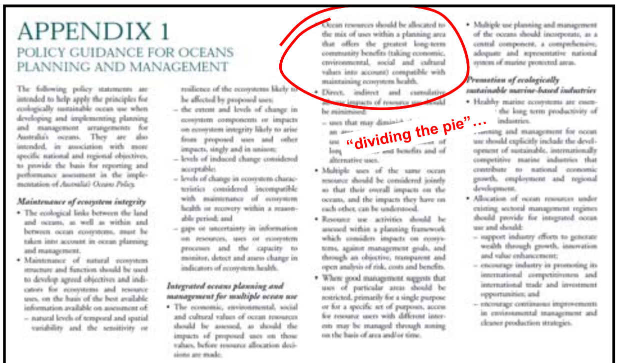
However…

- 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.."



APPENDIX 1
POLICY GUIDANCE FOR OCEANS PLANNING AND MANAGEMENT

The following policy statements are intended to help apply the principles for ecologically sustainable ocean use when developing and implementing planning and management arrangements for Australia's oceans. They are also intended, in association with more specific national and regional objectives, to provide the basis for reporting and performance assessment in the implementation of *Australia's Oceans Policy*.

Maintenance of ecosystem integrity

- The ecological links between the land and oceans, as well as within and between ocean ecosystems, must be taken into account in ocean planning and management.
- Maintenance of natural ecosystem structure and function should be used to develop agreed objectives and indicators for ecosystems and resource uses, on the basis of the best available information available on assessment of:
  - natural levels of temporal and spatial variability and the sensitivity or resilience of the ecosystems likely to be affected by proposed uses;
  - the extent and levels of change in ecosystem components or impacts on ecosystem integrity likely to arise from proposed uses and other impacts, singly and in unison;
  - levels of induced change considered acceptable;
  - levels of change in ecosystem characteristics considered incompatible with maintenance of ecosystem health or recovery within a reasonable period; and
  - gaps or uncertainty in information on resources, uses or ecosystem processes and the capacity to monitor, detect and assess change in indicators of ecosystem health.

Integrated oceans planning and management for multiple ocean use

- The economic, environmental, social and cultural values of ocean resources should be assessed, as should the impacts of proposed uses on those values, before resource allocation decisions are made.
- Ocean resources should be allocated to the mix of uses within a planning area that offers the greatest long-term community benefits (taking economic, environmental, social and cultural values into account) compatible with maintaining ecosystem health.
- Direct, indirect and cumulative impacts of resource use should be minimised:
  - uses that may dimin…
- Multiple uses of the same ocean resource should be considered jointly so that their overall impacts on the oceans, and the impacts they have on each other, can be understood.
- Resource use activities should be assessed within a planning framework which considers impacts on ecosystems, against management goals, and through an objective, transparent and open analysis of risk, costs and benefits.
- Where good management suggests that uses of particular areas should be restricted, primarily for a single purpose or for a specific set of purposes, access for resource users with different interests may be managed through zoning on the basis of area and/or time.
- 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.

Promotion of ecologically sustainable marine-based industries

- Healthy marine ecosystems are essential … the long term productivity of … industries.
- … Planning and management for ocean use should explicitly include the development of sustainable, internationally competitive marine industries that contribute to national economic growth, employment and regional development.
- Allocation of ocean resources under existing sectoral management regimes should provide for integrated ocean use and should:
  - support industry efforts to generate wealth through growth, innovation and value enhancement;
  - encourage industry in promoting its international competitiveness and international trade and investment opportunities; and
  - encourage continuous improvements in environmental management and cleaner production strategies.

"dividing the pie"…

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

MBP - outputs

- 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."

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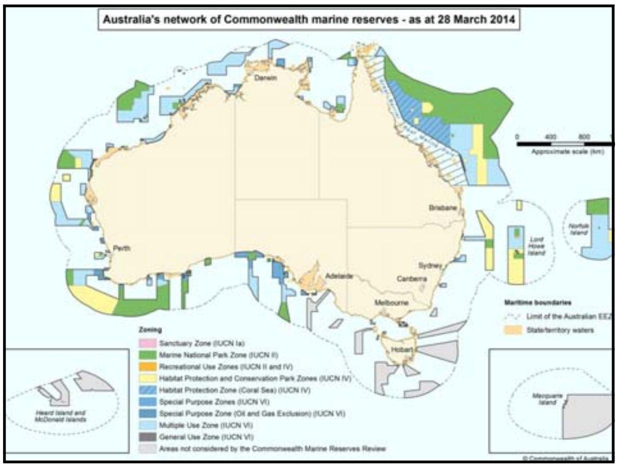
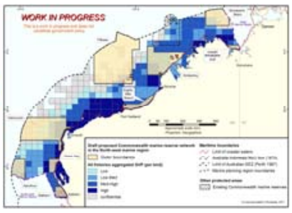


Socio-economic data



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

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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

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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

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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

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Shipping

Recreational Fishing

Nature-based tourism

Port-related activities

Renewable energy

Commercial Fishing

Oil & Gas

Scientific research

Telecommunications

Charter fishing

RAN /RAAF training

Offshore aquaculture

Mineral mining

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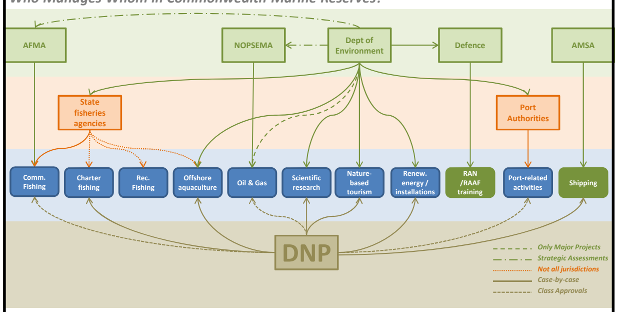
Who Manages Whom in Commonwealth Marine Reserves?



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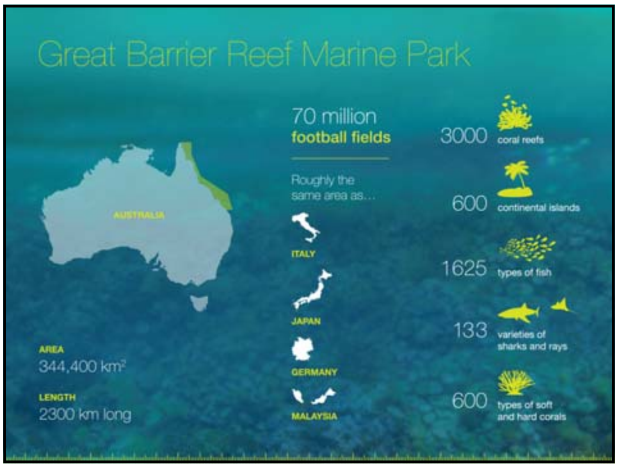
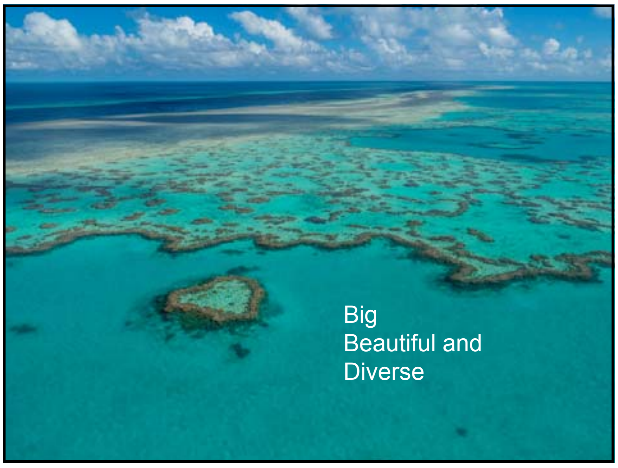
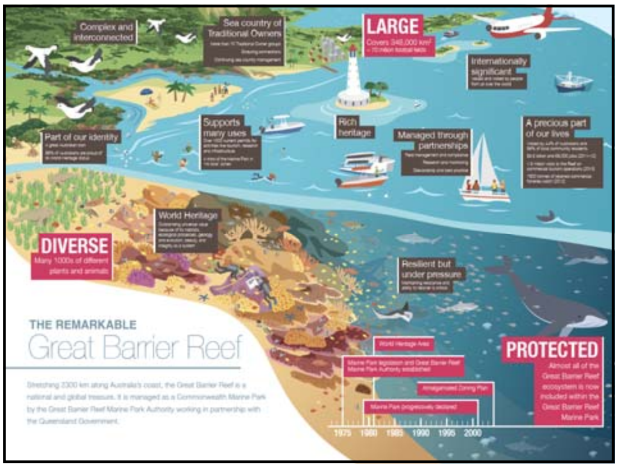
Australian Government
Great Barrier Reef Marine Park Authority
Integrated management of the Great Barrier Reef
Presented by Sally Harman, Planning Manager
Great Barrier Reef Marine Park Authority


Australian Government
Great Barrier Reef Marine Park Authority
Overview
1. Introduction
2. Foundations
3. Current situation – impacts, World Heritage, reports
4. Future – core business and recent adaptations


Great Barrier Reef Marine Park
70 million
football fields
Roughly the same area as…
ITALY
JAPAN
GERMANY
MALAYSIA
AUSTRALIA
AREA
344,400 km²
LENGTH
2300 km long
3000 coral reefs
600 continental islands
1625 types of fish
133 varieties of sharks and rays
600 types of soft and hard corals

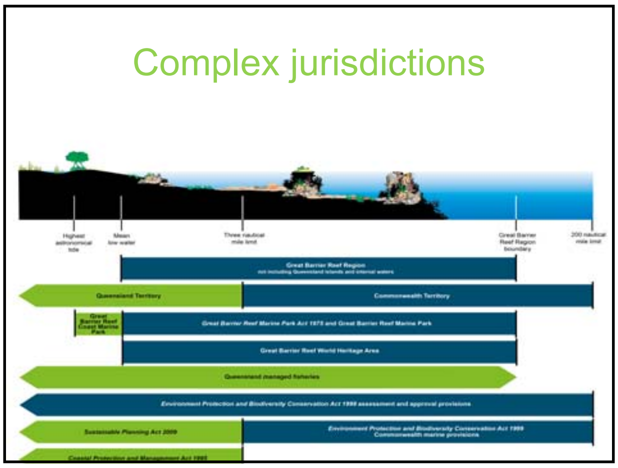

Big
Beautiful and
Diverse


Outstanding universal value as a
World Heritage area
Northern Great Barrier Reef - August 2014


Complex and interconnected
Sea country of Traditional Owners
LARGE
Internationally significant
Part of our identity
Supports many uses
Rich heritage
Managed through partnerships
A precious part of our lives
World Heritage
DIVERSE
Resilient but under pressure
PROTECTED
THE REMARKABLE
Great Barrier Reef


Multiple Use


Governance
Commonwealth
Minister for Environment
MPA Board
Intergovernmental agreement
Reef Advisory Committees
Local Marine Advisory Committees
GREAT BARRIER REEF INTERGOVERNMENTAL AGREEMENT
OUR mission
The long-term protection, ecologically sustainable use, understanding and enjoyment of the Great Barrier Reef for all Australians and the international community through the care and management of the Marine Park.
www.gbrmpa.gov.au


Complex jurisdictions
Highest astronomical tide
Mean low water
Three nautical mile limit
Great Barrier Reef Region boundary
200 nautical mile limit
Great Barrier Reef Region
not including Queensland islands and internal waters
Queensland Territory
Commonwealth Territory
Great Barrier Reef Coast Marine Park
Great Barrier Reef Marine Park Act 1975 and Great Barrier Reef Marine Park
Great Barrier Reef World Heritage Area
Queensland managed fisheries
Environment Protection and Biodiversity Conservation Act 1999 assessment and approval provisions
Sustainable Planning Act 2009
Environment Protection and Biodiversity Conservation Act 1999 Commonwealth marine provisions
Coastal Protection and Management Act 1995


Field Operations in the Great Barrier Reef World Heritage Area
Australian Government
Great Barrier Reef Marine Park Authority
Queensland Government
www.gbrmpa.gov.au
www.qld.gov.au


Our management tools are designed to protect the Region's values and allow ecologically sustainable use
TOOLS FOR MANAGING THE REEF
The Great Barrier Reef Marine Park Act 1975 and its supporting regulations are the principal legislation for protection and management of the Great Barrier Reef.
The Authority uses a wide range of management tools to achieve the Reef's long-term protection, ecologically sustainable use, understanding and enjoyment:
Acts and regulations
Zoning Plan
plans of management
permits (including environmental impact assessment)
fees and charges
Traditional Owner agreements
compliance
site infrastructure
policy
partnerships
stewardship and best practice
education and community awareness
research and monitoring
reporting.


Australian Government
Great Barrier Reef Marine Park Authority
Foundation examples
Oldies but goodies
1. Zoning
2. Outside influences
3. Stewardship/community engagement

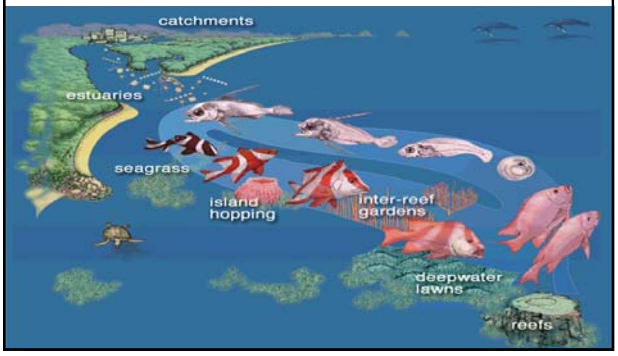
Great Barrier Reef Marine Park Zoning Plan

1 July 2004

Australian Government
Great Barrier Reef Marine Park Authority

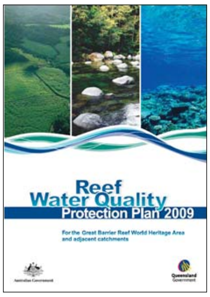
Preservation	0.2%	(0.1%)
Marine National Park	33.3%	(4.6%)
Scientific Research	0.05%	(0.01%)
Buffer Zone	2.9%	(0.1%)
Conservation Park	1.5%	(0.6%)
Habitat Protection	28.2%	(15.2%)
General Use	33.8%	(77.9%)

Science communication tool



Great Barrier Reef Water Quality Protection Plan (Reef Plan)

Joint Australian and Queensland government initiative to improve land management practices



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."

Released 2003
Updated 2009 & 2013

Key action = Paddock to Reef integrated monitoring, modelling and reporting program

www.gbrmpa.gov.au

Engagement/stewardship

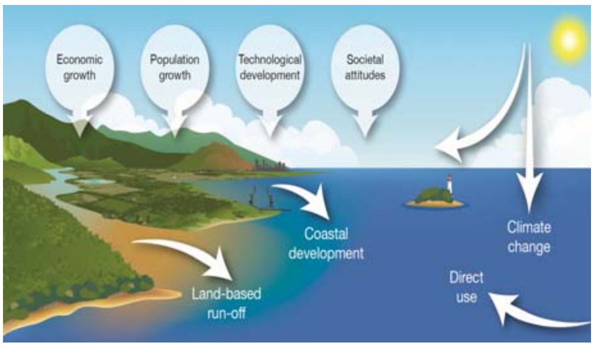
- Traditional Owners - TUMRAs
- Eye on the Reef
- Reef Guardians

Australian Government
Great Barrier Reef Marine Park Authority

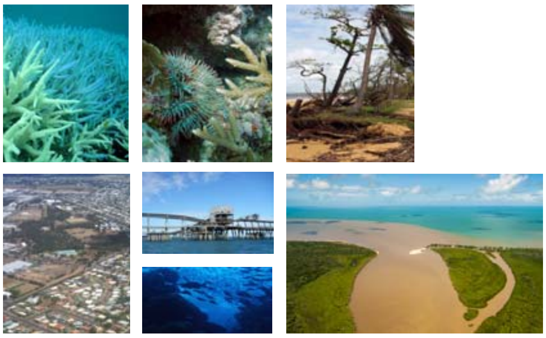
CURRENT SITUATION

Impacts, World Heritage and reports

Drivers



Pressures



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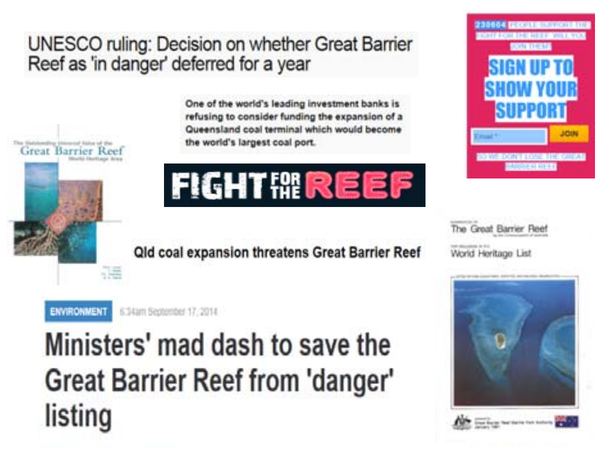


Two major reports

Australian Government
Great Barrier Reef Marine Park Authority

- 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*

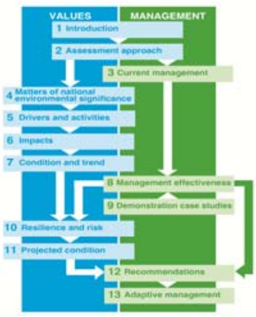
Great Barrier Reef Region Strategic Assessment

- Part of a comprehensive strategic assessment for World Heritage Area
- Prepared under *Environment Protection and Biodiversity Conservation Act 1999*
- Makes recommendations
- Includes a 25-year management program

Increasing complexity

Management topic	Summary	Effectiveness of existing measures: Context	Planning	Inputs	Processes	Outputs	Outcomes
Climate change	There is sound Region-scale management for climate change; management focus has declined on a broader scale.	↓	↓	↘	↓	↔	↓
Coastal development	It is too early to judge the effectiveness of changes to coastal development policy. Understanding of connectivity between the Region and its adjacent coast has improved.	↗	↗	↔	↔	↔	↔
Land-based run-off	Programs addressing land-based run-off have better focus, clearer targets, coordinated monitoring and improved outputs.	↔	↑	↗	↑	↑	↔
Ports	Individual ports are generally well managed; there has been a lack of coordinated planning and guidance.						
Fishing	Understanding of fishing and its impacts has improved; however, outcomes remain poor.	↔	↔	↔	↔	↔	↔
Heritage values	The Region's heritage values are better defined and there is an increasing management focus.	↓	↓	↔	↘	↘	↘
Commercial marine tourism	Sound governance and industry partnerships are in place to address tourism issues. Effectiveness of tourism management has declined as emphasis has shifted to emerging issues.	↔	↓	↘	↓	↔	↔
Recreation (not including fishing)	An overarching recreation management strategy has improved understanding and coordination.	↔	↔	↘	↘	↔	↔
Traditional use of marine resources	There is strong cooperative management of traditional use of marine resource; outcomes have improved with improved planning and inputs.	↗	↑	↑	↗	↔	↑
Biodiversity values	There is an improved focus on biodiversity outcomes, including an overarching strategy.	↔	↔	↔	↔	↔	↘
Community benefits of the environment	Understanding of community benefits is improving; their consideration lacks a policy framework.						
Shipping	Shipping is generally well regulated and well managed; future risks are being addressed.						
Research activities	There is strong collaboration in management research; improvements are slow.	↗	↓	↓	↓	↔	↔
Defence activities	Defence activities continue to be managed very effectively with close cooperation between agencies.	↔	↘	↓	↔	↔	↔

Strategic Assessment



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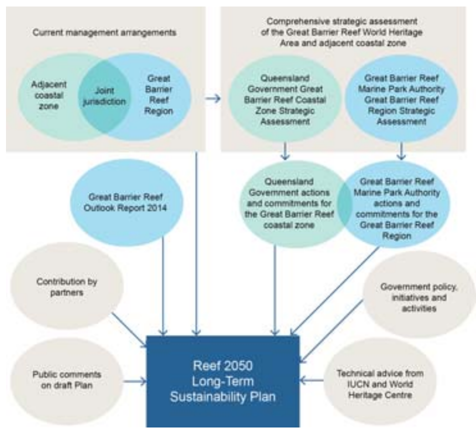


LTSP - Structure and themes

LTSP Key Elements

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

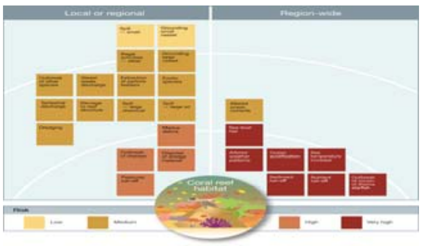
Dredging

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

Plans to dump dredge spoils on Great Barrier Reef heritage area axed

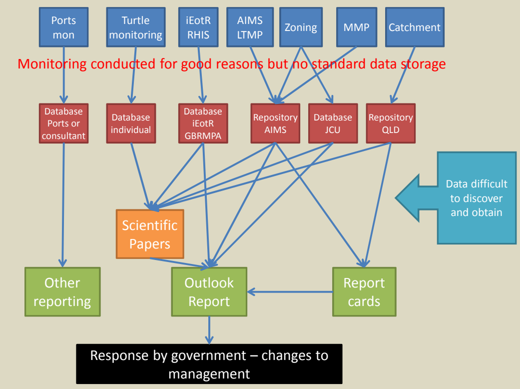
www.gbrmpa.gov.au

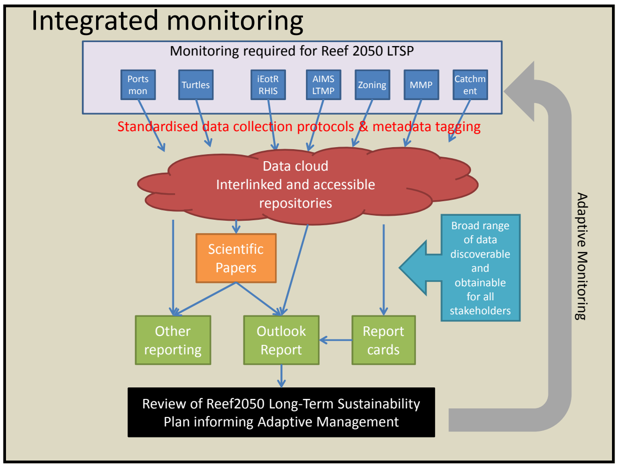
Need to manage cumulative threats

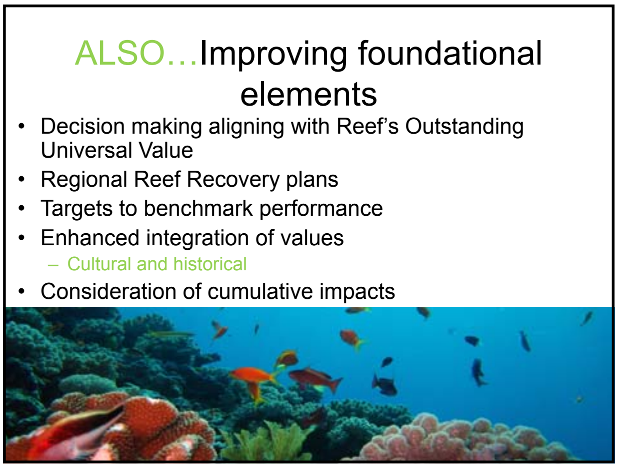


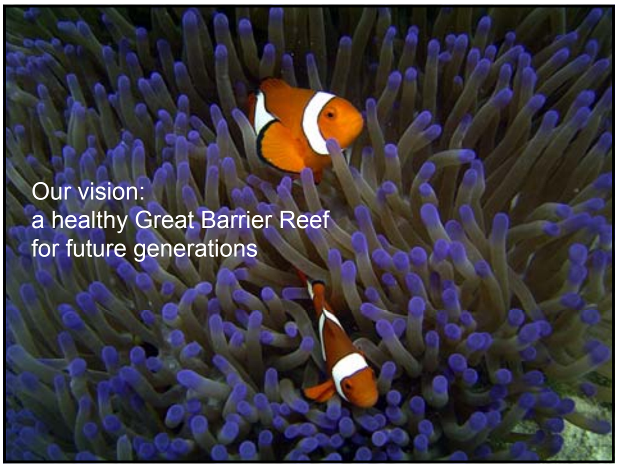
www.gbrmpa.gov.au

Monitoring – currently




Integrated monitoring
Monitoring required for Reef 2050 LTSP
Ports mon
Turtles
iEotR RHIS
AIMS LTMP
Zoning
MMP
Catchm ent
Standardised data collection protocols & metadata tagging
Data cloud
Interlinked and accessible repositories
Scientific Papers
Broad range of data discoverable and obtainable for all stakeholders
Other reporting
Outlook Report
Report cards
Review of Reef2050 Long-Term Sustainability Plan informing Adaptive Management
Adaptive Monitoring


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


Australian Government
Great Barrier Reef Marine Park Authority
www.gbrmpa.gov.au
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

Marine Estate Management Authority

Beyond Boundaries: NSW marine estate

Petrina Apfel

NSW Dept Primary Industries

SA workshop

April 2015 (30 mins)

Overview

NSW Governance

- structures, processes
- depts, committees, legislation, strategies

NSW Policy

- key concepts, intent, actions
- evidence-based, strategic, triple-bottom-line, transparent

NSW marine estate

Governance

Minister for Primary Industries | Minister for the Environment

Marine Estate Management Authority

Independent Chair

- Trade and Investment (DPI)
- Environment and Heritage
- Planning
- Transport for NSW (Maritime)
- Chair MEEKP

Steering Committee
- executive reps

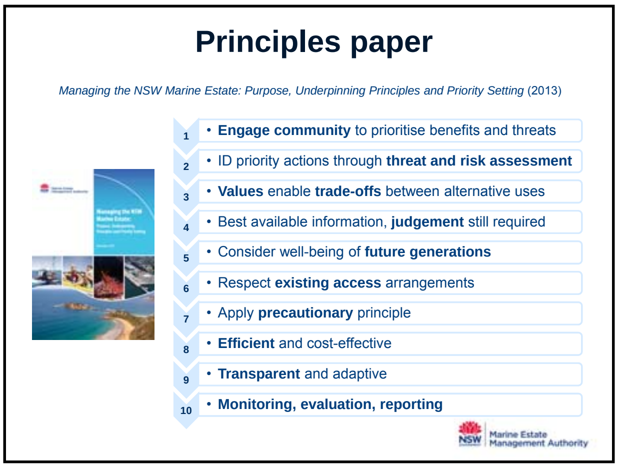
Marine Estate Expert Knowledge Panel
- independent
- ecological, economic, social science expertise

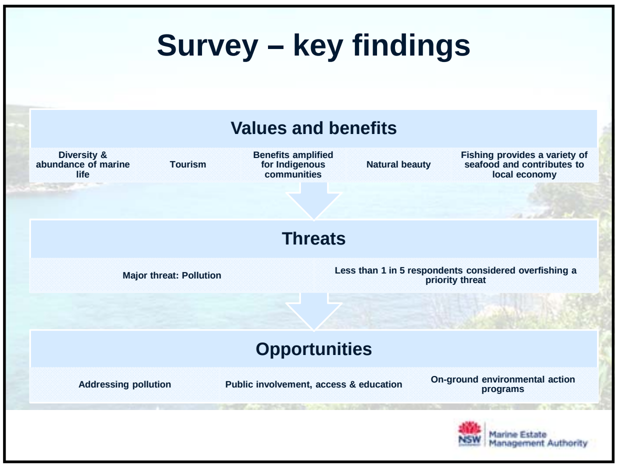
Inter-agency Working Groups
- departmental officers
- project specific

Schedule of works

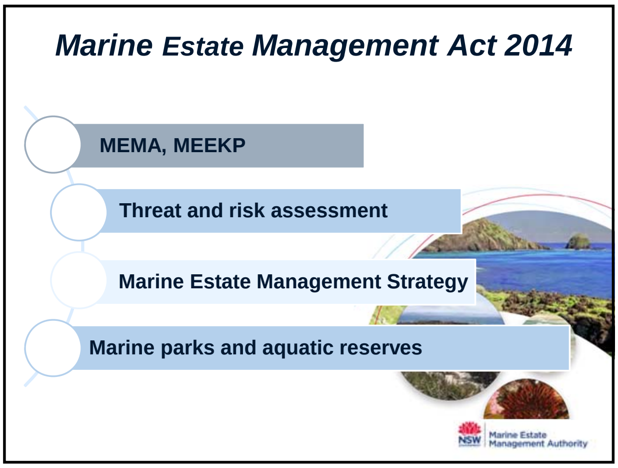

Objectives
Marine Estate Management Authority


Healthy coast & sea
Managed for the greatest well-being of the community
Now and into the future
Marine Estate Management Authority


Principles paper
Managing the NSW Marine Estate: Purpose, Underpinning Principles and Priority Setting (2013)
1 • Engage community to prioritise benefits and threats
2 • ID 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
Marine Estate Management Authority


Survey – key findings
Values and benefits
Diversity & abundance of marine life
Tourism
Benefits amplified for Indigenous communities
Natural beauty
Fishing provides a variety 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
Marine Estate Management Authority


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 Authority


Marine Estate Management Act 2014
MEMA, MEEKP
Threat and risk assessment
Marine Estate Management Strategy
Marine parks and aquatic reserves
Marine Estate Management Authority

Threat and Risk Assessment Framework

Publication: Early 2015

- Risk ranking
- Guidance not prescriptive steps
- Likelihood and consequence
- Ecological, economic & social threats to benefits
- Different spatial and temporal scales

NSW Marine Estate Management Authority

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

NSW Marine Estate Management Authority

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

NSW Marine Estate Management Authority

Threat and Risk Assessment

- Implementation of framework
- statewide scale…
- economic, social & environmental benefits
- …assessment of threats to benefits
- evidence-based risk analysis
- expert input
- identify priority threats
- draft report for public comment mid 2015
- final report

NSW Marine Estate Management Authority

Marine Estate Management Strategy

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

NSW Marine Estate Management Authority

Lesson 1

NSW Marine Estate Management Authority

Lesson 2

NSW Marine Estate Management Authority

Lesson 3

NSW Marine Estate Management Authority

www.marine.nsw.gov.au

NSW Department of Primary Industries

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


BY JOHN S. HAMMOND, RALPH L. KEENEY, AND HOWARD RAIFFA

THE HIDDEN TRAPS IN DECISION MAKING

Objective			Alternatives			
			Do nothing	A1	A2	A3
Conserve the reef	Proxy – coral cover	More is better	20%	30%	35%	60%
Costs to industry	Natural - $M	Less is better	1	2	2	20
Costs of implementation	Natural - $M	Less is better	1	10	15	30

---

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.**

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Generating Objectives: Can Decision Makers Articulate What They Want?

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Kurt A. Carlson, Ralph L. Keeney
Fuqua School of Business, Duke University, Durham, North Carolina 27708
{kurt.carlson@duke.edu, keeneyr@aol.com}

Objectives have long been considered a basis for sound decision making. This research examines the ability of decision makers to generate self-relevant objectives for consequential decisions. In three empirical studies, participants consistently omitted nearly half of the objectives that they later identified as personally relevant. More surprisingly, omitted objectives were perceived to be almost as important as those generated by participants on their own. These empirical results were replicated in a real-world case study of strategic decision making at a high-tech firm. Overall, our research suggests that decision makers are considerably deficient in utilizing personal knowledge and values to form objectives for the decisions they face.

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.

Keeney (2007). Developing objectives and attributes. In: W. Edwards, R.F. Miles Jr., D. von Winterfeldt, D. (eds). Advances in decision analysis. From foundations to applications. Cambridge University Press, Cambridge.

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.

Keeney (2007). Developing objectives and attributes. In: W. Edwards, R.F. Miles Jr., D. von Winterfeldt, D. (eds). Advances in decision analysis. From foundations to applications. Cambridge University Press, Cambridge.

Possingham, 2001

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.

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

	Sites							
Species	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
Loggerhead Shrike	1	1	1	1	1	1	0	1
Western Burrowing Owl	1	1	1	1	0	0	0	1
Grasshopper Sparrow	1	1	0	1	1	1	0	0
Ferruginous Hawk	1	1	1	0	0	0	1	1
Sage Thrasher	1	1	1	1	0	0	1	0
Western Sage Grouse	1	0	0	0	1	1	1	0
Sage Sparrow	1	0	1	1	0	0	0	0
White Pelican	1	1	1	0	0	0	0	0
Bald Eagle	0	1	0	0	1	0	0	0
Forster's Tern	0	0	1	0	0	0	0	0

	Sites								
Species	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Populations captured**
Loggerhead Shrike	1	1	**1**	1	**1**	1	0	1	**2**
Western Burrowing Owl	1	1	**1**	1	**0**	0	0	1	**1**
Grasshopper Sparrow	1	1	**0**	1	**1**	1	0	0	**1**
Ferruginous Hawk	1	1	**1**	0	**0**	0	1	1	**1**
Sage Thrasher	1	1	**1**	1	**0**	0	1	0	**1**
Western Sage Grouse	1	0	**0**	0	**1**	1	1	0	**1**
Sage Sparrow	1	0	**1**	1	**0**	0	0	0	**1**
White Pelican	1	1	**1**	0	**0**	0	0	0	**1**
Bald Eagle	0	1	**0**	0	**1**	0	0	0	**1**
Forster's Tern	0	0	**1**	0	**0**	0	0	0	**1**

	Sites								
Species	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Populations captured**
Loggerhead Shrike	**1**	**1**	1	1	1	1	0	1	**2**
Western Burrowing Owl	**1**	**1**	1	1	0	0	0	1	**2**
Grasshopper Sparrow	**1**	**1**	0	1	1	1	0	0	**2**
Ferruginous Hawk	**1**	**1**	1	0	0	0	1	1	**2**
Sage Thrasher	**1**	**1**	1	1	0	0	1	0	**2**
Western Sage Grouse	**1**	**0**	0	0	1	1	1	0	**1**
Sage Sparrow	**1**	**0**	1	1	0	0	0	0	**1**
White Pelican	**1**	**1**	1	0	0	0	0	0	**2**
Bald Eagle	**0**	**1**	0	0	1	0	0	0	**1**
Forster's Tern	**0**	**0**	1	0	0	0	0	0	**0**

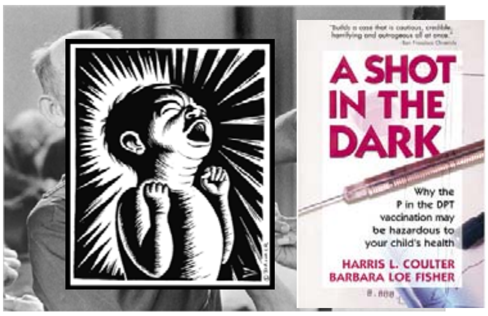
	Sites								
Species	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Populations captured**
Loggerhead Shrike	1	1	1	1	1	1	0	1	**3**
Western Burrowing Owl	1	1	1	1	0	0	0	1	**3**
Grasshopper Sparrow	1	1	0	1	1	1	0	0	**2**
Ferruginous Hawk	1	1	1	0	0	0	1	1	**3**
Sage Thrasher	1	1	1	1	0	0	1	0	**3**
Western Sage Grouse	1	0	0	0	1	1	1	0	**1**
Sage Sparrow	1	0	1	1	0	0	0	0	**2**
White Pelican	1	1	1	0	0	0	0	0	**3**
Bald Eagle	0	1	0	0	1	0	0	0	**1**
Forster's Tern	0	0	1	0	0	0	0	0	**1**

Objective		**Alternative**		
		C, E	**A, B**	**A, B, C**
Loggerhead Shrike	*more is better*	2	2	3
Western Burrowing Owl	*more is better*	1	2	3
Grasshopper Sparrow	*more is better*	1	2	2
Ferruginous Hawk	*more is better*	1	2	3
Sage Thrasher	*more is better*	1	2	3
Western Sage Grouse	*more is better*	1	1	1
Sage Sparrow	*more is better*	1	1	2
White Pelican	*more is better*	1	2	3
Bald Eagle	*more is better*	1	1	1
Forster's Tern	*more is better*	1	0	1
Cost	*less is better*	\$2*x*	\$2*x*	\$3*x*

- **S** pecific
- **M** easurable
- **A** ttainable
- **R** elevant
- **T** imely

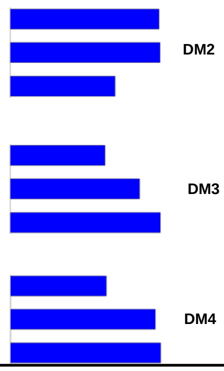
- **D** reamy
- **A** spirations that
- **F** orsake
- **T** rade-offs

Pertussis vaccination

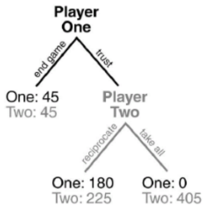


Sensitivity analysis - weights

	decision-maker			
	1	2	3	4
cost	0.30	0.05	0.70	0.10
health outcomes	0.50	0.90	0.20	0.20
acceptability	0.20	0.05	0.10	0.70
sum	1.00	1.00	1.00	1.00



- 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….

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?

2

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)?

6

…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

Southwest New Brunswick
MARINE RESOURCES PLANNING

ESSIM

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

COLLABORATIVE GOVERNANCE AND INTEGRATED MANAGEMENT
- Effective governance structures and processes.
- Capacity among stakeholders.
- Knowledge to support integrated management.

SUSTAINABLE HUMAN USE	HEALTHY ECOSYSTEMS
• Ecologically sustainable use of ocean space and resources. • Sustainable communities and economic well-being.	• Resilient and productive ecosystems, with diverse habitats, communities, species and populations. • Strong marine environmental quality supports ecosystem functioning.

9

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)

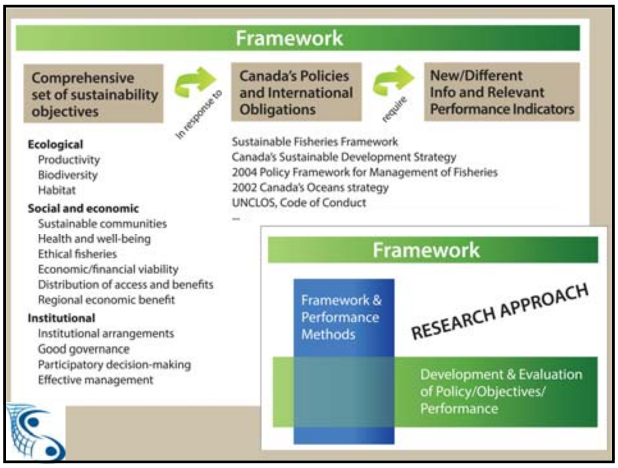
- Productivity
  - Primary Productivity
  - Community Productivity
  - Population Productivity
- Biodiversity
  - Species Diversity
  - Population Diversity
- Habitat
- Social and Economic objectives

(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

Demands consideration of a broader set of objectives and comprehensive evaluation



(What are the elements analogous to 'Productivity, biodiversity and habitat'?)

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)

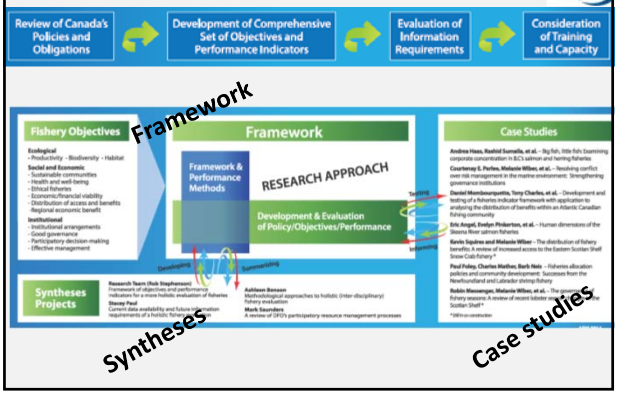
16

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

17

Project 1.1 research



2014 – Continued work on Evaluation Framework for Sustainable fisheries (V 2.1) - Summary

Ecological Domain	
Dimension	Goals
Conservation	Ecological Productivity and Geographic Range, Genetic Diversity, Biodiversity
Habitat & Environment	Substrate Quality, Water Quality
Ecosystem Functionality	Food-web Stability, Invasive Species, Regime Shifts

Socio-economic Domain	
Dimension	Goals
Health and wellbeing	Basic Needs, Food Security, Food Safety, Occupational Safety, Informed Citizenry, Vital Civic Culture, Wellbeing
Equity and fairness	Fairness, Access Stability, Costs & Benefits, Risks & Rewards, Livelihoods,
Economic and financial	Human Capital, Efficiency, Financial Viability, Labour, Markets, Economic Sustainability

Institutional Domain	
Dimension	Goals
Structure	Rules, Resources, Agreements
Process	Collaborative, Cooperative, Inclusive, Informed, Predictable, Flexible, Transparent
Outcomes	Compliance, Power Dynamics, Appropriateness, Trade-offs, Assessment

Objectives 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**

Several relevant studies…

- Practical implementation of social and economic elements in ecosystem based fisheries management and integrated fisheries management frameworks (SARDI Research Report 765; March 2014)
- Developing and testing social objectives for fisheries management (FRDC 2010-40)

21

Useful structure for IM?

Common objectives

	Fisheries	Aquaculture	Transport	Energy	Other
Ecological - - -					
Economic - -					
Social - -					
Institutional - - - -					

Cumulative impacts

Help structure conversation

Objectives?

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

Objectives

	Scenario A (status quo)	Scenario B	Scenario C
Ecological - - -			
Economic - -			
Social - -			
Institutional - -			

Compare Scenarios/options

Management options

Objectives

	Scenario A	Scenario B	Scenario C
Ecological - - -			
Economic - -			
Social - -			
Institutional - -			

Competing objectives

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

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Compare Scenarios/options

Management options

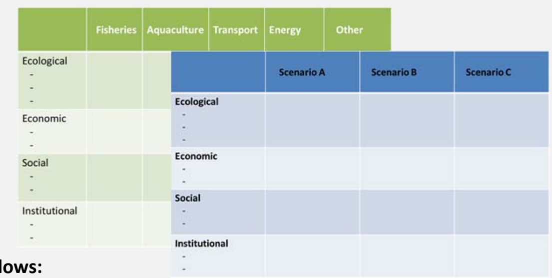
Objectives

	Scenario A	Scenario B	Scenario C
Ecological - - -	acceptable	acceptable	improvement
Economic - -			
Social - -			
Institutional - -	No change required	More participatory	Participatory and easily implemented

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**

The changing landscape of management…

Ecoregion/planning area (umbrella plan)

Ecosystem Assessment

Nested plans for Managed activities

Expanding list of objectives (ecosystem services/values)

	Fisheries	Aquaculture	Energy	Transport	Other
Conservation - Productivity					
- Biodiversity					
- Habitat					
Economic					
Social/cultural					
Institutional/ governance					

Cumulative performance

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 ?

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 V1 (Part… showing format)

Project 1.1 Framework, Relevant Canadian Policies and Indicators

Elements of Objectives	Canadian and International Policies: Objectives, Principles and Aims	Potential Performance Indicators
Ecological **Productivity** Primary productivity Secondary productivity Trophic structure	Ensure continued health and productivity of Canada's fisheries and healthy fish stocks -SFF Long-Term sustainability -SFF – fish renew; WPS Maintenance of target, bycatch, and ecologically dependent species and their relationships within the bounds of natural fluctuations in abundance -SFF – new forage Minimization of the risk of changes to species' abundances or relationships which are difficult or impossible to reverse -SFF – new forage Conservation of marine resources and habitats -AFPR; POF; WPS	• chlorophyll level • biomass (of individual populations, species and trophic levels) • maximum sustainable yield • abundance of target catch • abundance of bycatch • mean trophic level
Biodiversity Within population Within species Community	Protect biodiversity -SFF, MPA Maintenance of full reproductive potential of the forage species, including genetic diversity and geographic population structure -SFF – new forage; WPS; Aichi Reduce direct pressures -Aichi	• change in genetic diversity • within species genetic richness • persistence of population sub-units • species richness • species evenness • community composition • change in community diversity • age structure
Habitat Physical habitat, Chemical habitat, Ecosystem services	Healthy environment -SDS; COS Protect and conserve fisheries habitat -SFF; WPS; AFPR; MPA Maintain habitat and ecosystem integrity -WPS Sustainable use of resources and habitats -Code	• change in habitat diversity • habitat quality and extent • area impacted by fishery activity • oxygen and pH levels • temperature • nutrient levels • concentrations of toxics

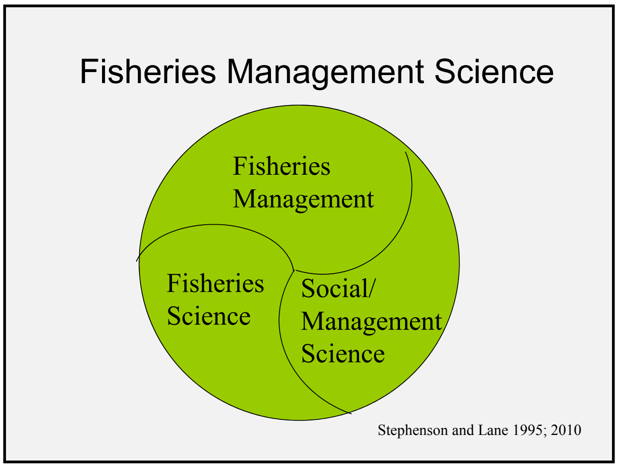
→ Draft Framework Table Dec 2012 → file: framework table_2013-02-11_long.docx

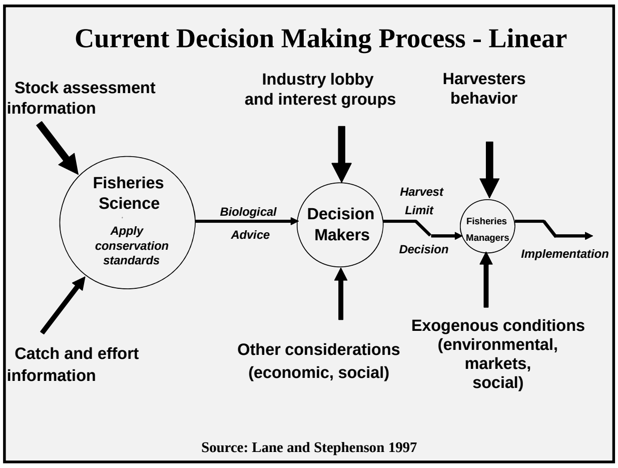
	Objectives?	Information?	Analyses?	Used in decisions?
Ecological	Yes	Yes	Yes	Yes
Economic	Yes	Yes	Yes	Yes
Social/cultural	General Variable	No	No	Yes
Institutional	Yes			

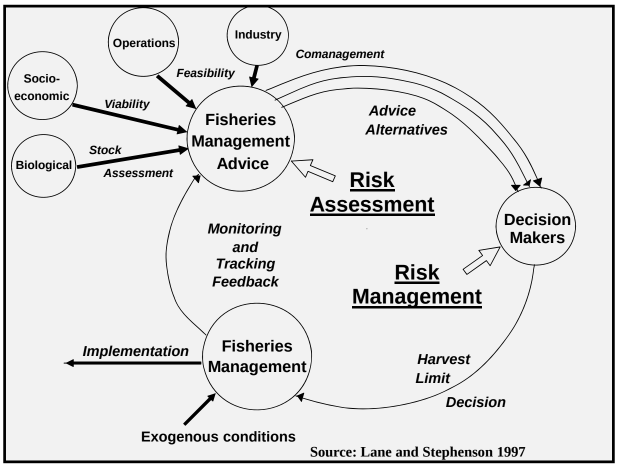
(Stacey Paul…review of IFMP's shows gradient)

	Is More Information Required?	What type?	Who is best to provide it?	What is our capacity to provide it?
Ecological	No*	?		
Economic	Yes			
Social/Cultural	Yes			
Institutional	Yes			

(S. Paul)


Fisheries Management Science
Fisheries Management
Fisheries Science
Social/ Management Science
Stephenson and Lane 1995; 2010


Current Decision Making Process - Linear
Stock assessment information
Industry lobby and interest groups
Harvesters behavior
Fisheries Science
Apply conservation standards
Biological Advice
Decision Makers
Harvest Limit
Decision
Fisheries Managers
Implementation
Catch and effort information
Other considerations (economic, social)
Exogenous conditions (environmental, markets, social)
Source: Lane and Stephenson 1997


Operations
Industry
Socio-economic
Biological
Comanagement
Feasibility
Viability
Stock Assessment
Fisheries Management Advice
Advice Alternatives
Risk Assessment
Decision Makers
Monitoring and Tracking Feedback
Risk Management
Implementation
Fisheries Management
Harvest Limit
Decision
Exogenous conditions
Source: Lane and Stephenson 1997

ICES CIEM

European Perspective on Objectives.

Mark Dickey-Collas

@DickeyCollas

Science for sustainable seas • International Council for the Exploration of the Sea • www.ices.dk

ICES CIEM

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

ICES CIEM

Paraphase objectives

Maritime Spatial Planning Directive — create a plan for marine space

Common Fisheries Policy (CFP) — sustainable fisheries

Marine Strategy Framework (MSFD) — good environmental status

Habitat & Birds Directive — species & habitat conservation

Water Framework — clean water

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Use of language

Reform of CFP 2014

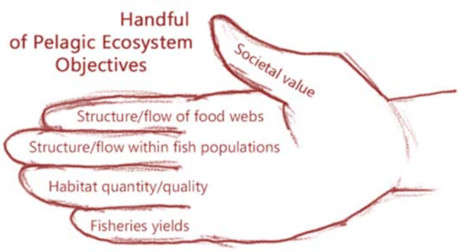
Vague language used as a way to reach compromise.

e.g. interpretation of operational use of MSY is weak.

Aspirational statements used.

ICES CIEM

Balancing ecosystem approach objectives in fisheries

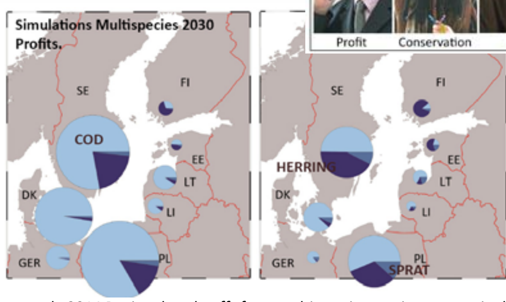


Partnership: fishing industry, scientists, eNGOs, policy developers

Trenkel et al. 2015

ICES CIEM

Trade Offs – Baltic Sea



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

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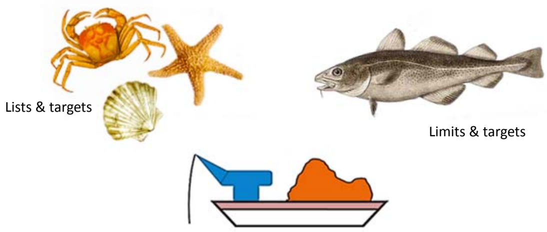
Marine strategy framework directive

Both conservation and sustainable use



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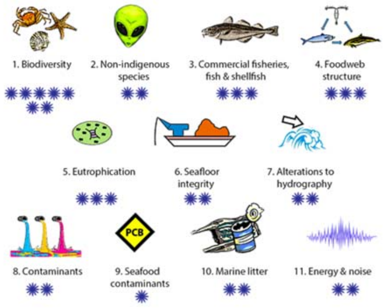
Good Environmental Status for 11



Criteria: ✱

NO
Trade Offs
4 Targets

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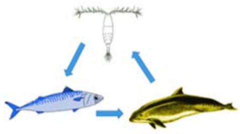
Policy science jumps

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

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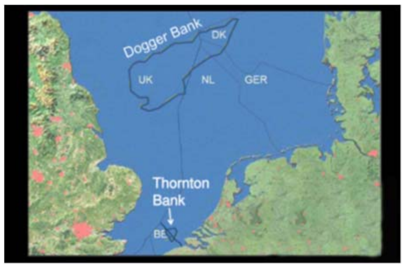
Birds and habitats directives

Natura 2000 protected areas

Worked example
Dogger Bank



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Dogger Bank

Spatial management of the DB

- Fisheries Management in Relation to Nature Conservation
- Legal framework Natura 2000, Habitats directive:
  - EU Habitat H1110 ('sandbanks slightly covered by seawater all the time')
- Legal obligations Member States (UK, NL and GER)
- But also wind farm development (UK)

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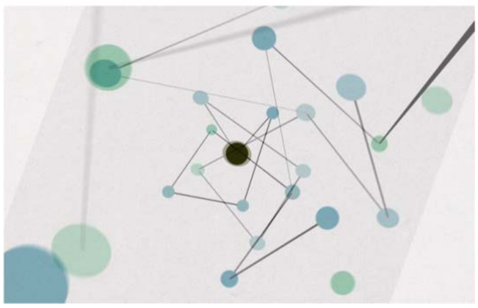
Process – multi stage 2010-2013



Including: FIMPAS (NL only), Dogger Bank SG, MASPNOSE, North Sea RAC

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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

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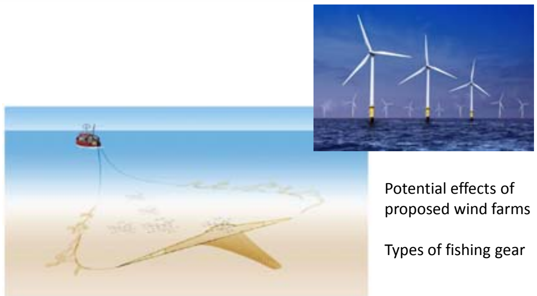
Various positions and manoeuvring



Potential effects of proposed wind farms

Types of fishing gear

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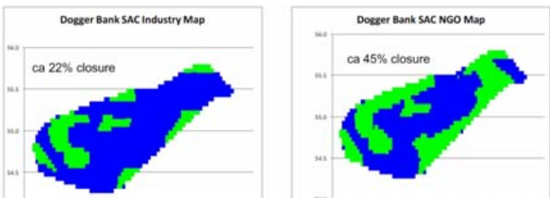
Two final suggestions



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.

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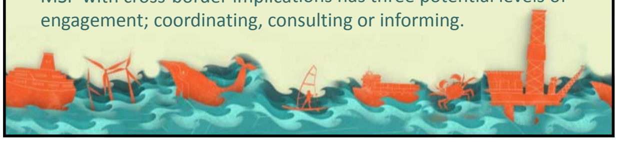
Some lessoned learned

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.



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ICES science for sustainable seas

Thank you

Gladstone Healthy Harbour Partnership

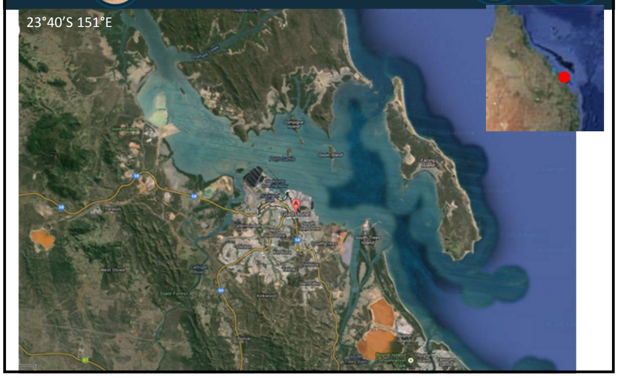
The Gladstone Healthy Harbour Partnership (GHHP) Report Card a whole-of-system report card to monitor and maintain/improve the condition of Gladstone Harbour

Ian Poiner (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



Gladstone
Major Port & Industrial Centre

Gladstone Harbour Controversies

Gladstone Harbour Controversies

2010 → 2011 → 2012 → 2013 → 2014

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 temporally closes all fishing in Gladstone Harbour

2012
- Jan: Gladstone Fish Health Scientific Advisory Panel Report – inconclusive
- Mar: UNESCO reactive monitoring mission visits GBR

2013
- July: Independent Review of Port of Gladstone – environmental management good but not unified, no assessment of cumulative impacts, need improved engagement.
- Sept: Western Basin Dredging concludes
- Nov: GHHP launched

2014
- Apr: Federal Bund Wall Inquiry – location of monitoring sites not adequate to determine effects, poor record keeping
- Dec: GHHP pilot report card
- Dec: 1st LNG exports from GH

6

What is the GHHP?

Community | Research | Industry

Gladstone Healthy Harbour Partnership

Traditional Owners | Government | Independent Science

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

7

GHHP Partners

26 Partners

- 13 Industry
- 3 Government (Commonwealth, State and Local)
- 2 Traditional Owner groups
- 2 Community groups
- 6 Res. agencies/Univ.

8

Gladstone Healthy Harbour Partnership

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 Chair: Paul Birch

GHHP Partners

Management Committee (10 members)

ISP Chair: Ian Poiner

Independent Science Panel (11 members)

Secretariat
Rachael Stegemann

Communications Team
Lyndal Hansen
Crystal McGregor

Science Team
John Kirkwood
Mark Schultz
Uthpala Pinto

Implementation

Design | **Piloting** | **Operational**

2013 Report card framework recommendation

2014 Pilot report card & final program design

2015 First complete report card & Gladstone Harbour Model

10+ yrs

Science Program

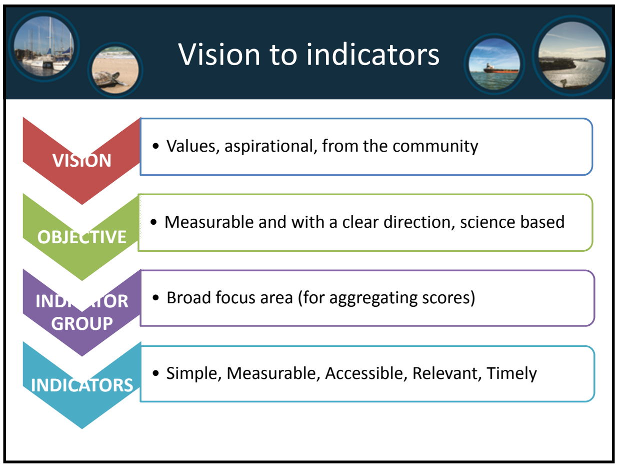
Design phase 2013
- Develop vision and objectives
- Review harbour related studies
- Develop conceptual model
- Review statistical issues related to report cards
- Review other report cards
- Develop report card framework recommendations
- Select candidate indicators

Pilot phase 2014
- Develop Data & Info. Mgt. System
- Define thresholds & baselines
- Develop GHM scenarios based on pilot RC
- Develop scoring and aggregation methodology
- Develop fish health priorities
- Release pilot report card
- Pilot candidate indicators
- Partner & stakeholder consultation
- Develop cultural heritage indicators

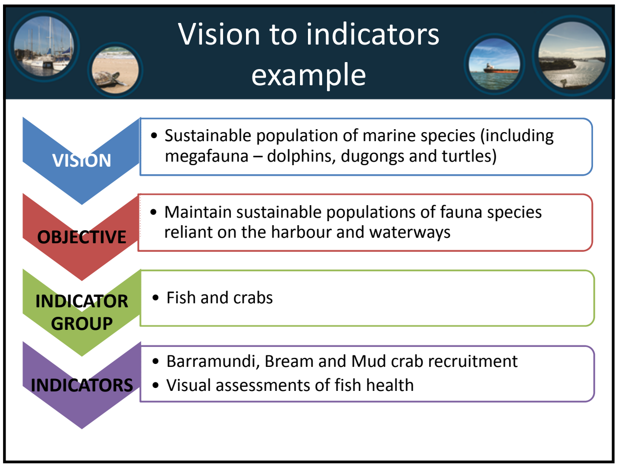
Operational phase 2015+
- Review report card methodology
- Priority research projects
- First report card 2015
- Implement fish health research program
- Undertake scenario analysis based on 2015 RC
- Monitor key habitats - corals & mangroves

Targeted research to improve the report card and monitoring efficiencies

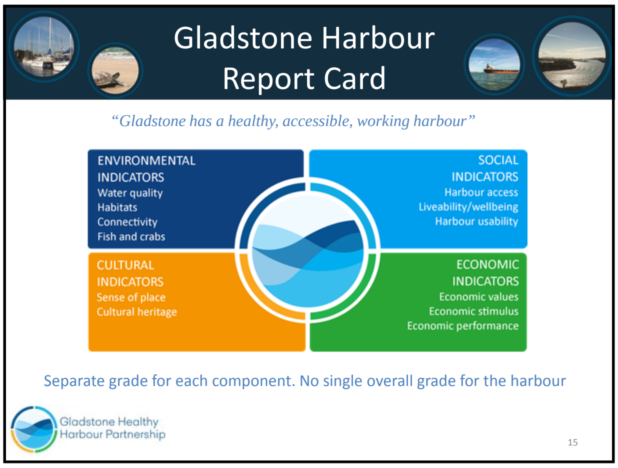
Fish health research program



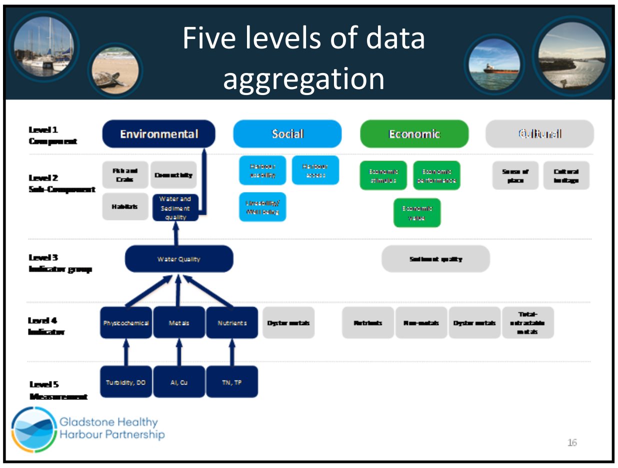
Vision to indicators
VISION
Values, aspirational, from the community
OBJECTIVE
Measurable and with a clear direction, science based
INDICATOR GROUP
Broad focus area (for aggregating scores)
INDICATORS
Simple, Measurable, Accessible, Relevant, Timely



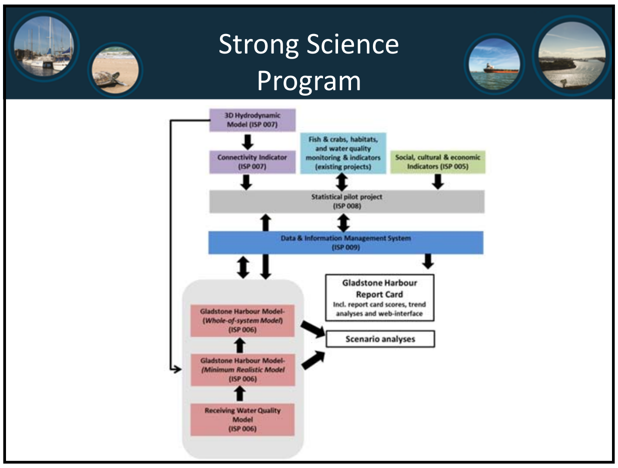
Vision to indicators example
VISION
Sustainable population of marine species (including megafauna – dolphins, dugongs and turtles)
OBJECTIVE
Maintain sustainable populations of fauna species reliant on the harbour and waterways
INDICATOR GROUP
Fish and crabs
INDICATORS
Barramundi, Bream and Mud crab recruitment
Visual assessments of fish health



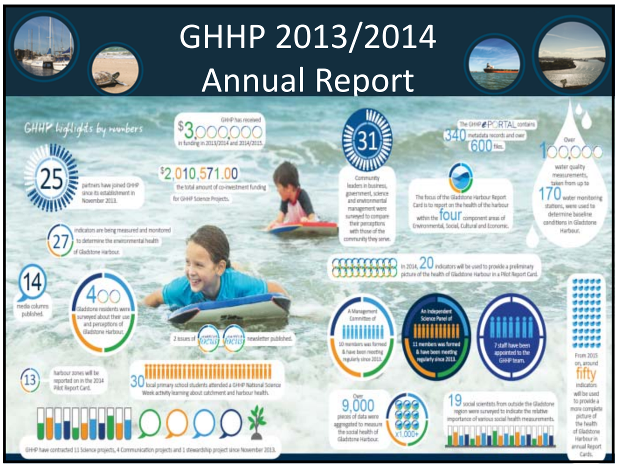
Gladstone Harbour Report Card
"Gladstone has a healthy, accessible, working harbour"
ENVIRONMENTAL INDICATORS
Water quality
Habitats
Connectivity
Fish and crabs
SOCIAL INDICATORS
Harbour access
Liveability/wellbeing
Harbour usability
CULTURAL INDICATORS
Sense of place
Cultural heritage
ECONOMIC INDICATORS
Economic values
Economic stimulus
Economic performance
Separate grade for each component. No single overall grade for the harbour
Gladstone Healthy Harbour Partnership
15



Five levels of data aggregation
Level 1 Component
Level 2 Sub-Component
Level 3 Indicator group
Level 4 Indicator
Level 5 Measurement
Environmental
Social
Economic
Cultural
Water Quality
Physicochemical
Metals
Nutrients
Turbidity, DO
Al, Cu
TN, TP
Gladstone Healthy Harbour Partnership
16



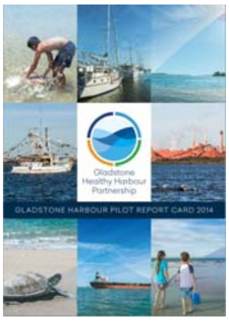
Strong Science Program
3D Hydrodynamic Model (ISP 007)
Connectivity Indicator (ISP 007)
Fish & crabs, habitats, and water quality monitoring & indicators (existing projects)
Social, cultural & economic indicators (ISP 005)
Statistical pilot project (ISP 008)
Data & Information Management System (ISP 009)
Gladstone Harbour Report Card
Incl. report card scores, trend analyses and web-interface
Scenario analyses
Gladstone Harbour Model- (Whole-of-system Model) (ISP 006)
Gladstone Harbour Model- (Minimum Realistic Model) (ISP 006)
Receiving Water Quality Model (ISP 006)



GHHP 2013/2014 Annual Report

2014 Pilot Report Card

Component & Indicator Group	2014 PILOT	2015
ENVIRONMENT (Overall Grade)	✓	✓
Water & Sediment Quality	✓	✓
Habitats		✓
Connectivity		✓
Fish & crabs		✓
SOCIAL (Overall Grade)	✓	✓
Harbour access	✓	✓
Liveability/wellbeing	✓	✓
Harbour usability	✓	✓
CULTURAL (Overall Grade)		✓
Sense of place		✓
Cultural heritage		✓
ECONOMIC (Overall Grade)	✓	✓
Economic values	✓	✓
Economic stimulus	✓	✓
Economic performance	✓	✓



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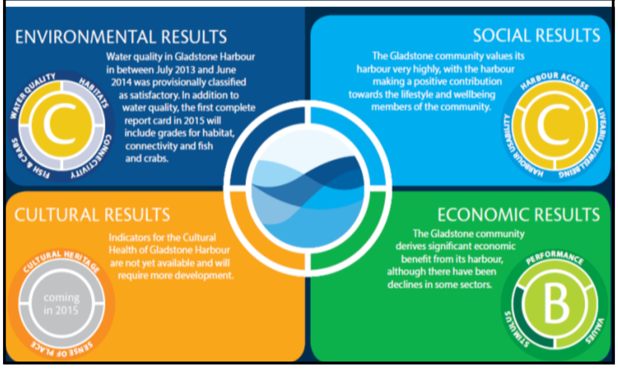
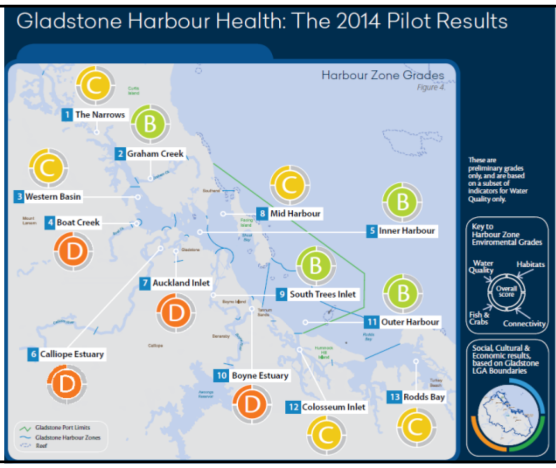
Pilot Report Card Results





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

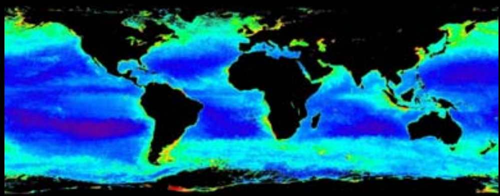
- champions and strong leadership
- setting clear goals (led by stakeholders, refined by scientists)
- strong links to all end users at each stage
- flexibility in implementation,
- effective communication
- rigorous science – challenging, innovative and resourced (observation, experimentation, modelling 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


Questions?
Gladstone Healthy
Harbour Partnership

Pulling the Pieces Together: Empirical Methods for Integration and Cumulative Impact Analysis

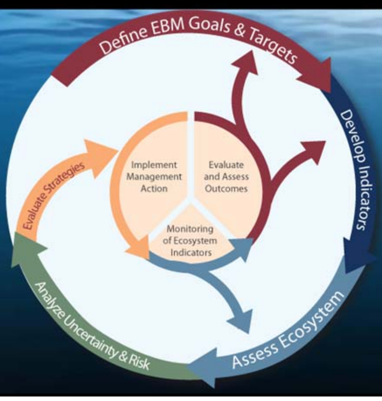


Michael J. Fogarty
Ecosystem Assessment Program
Northeast Fisheries Science Center
Woods Hole, MA

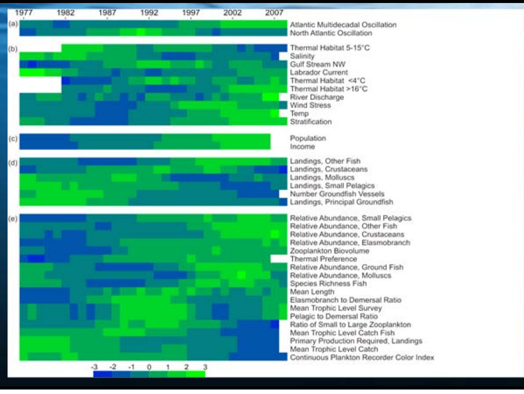
Preview of Coming Attractions:

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

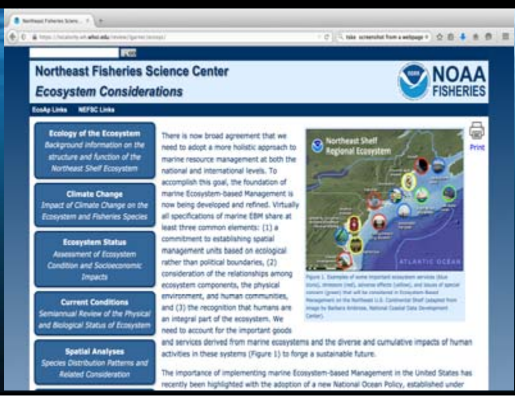
Integrated Ecosystem Assessments



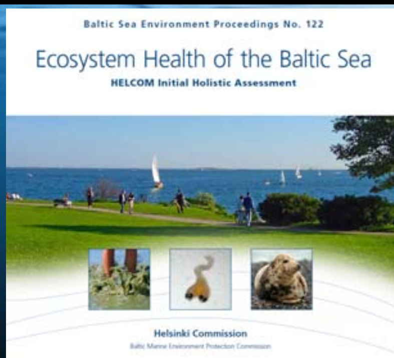
Compiling Indicators:



Condition and Status Reports

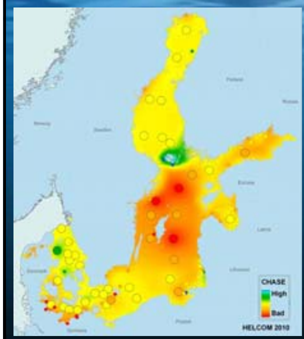


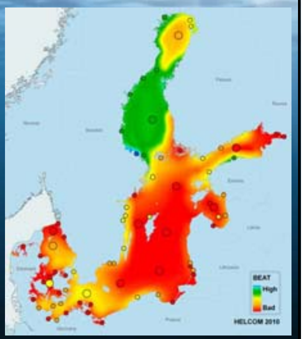
Measuring Ecosystem Status



Marine strategy framework directive approach

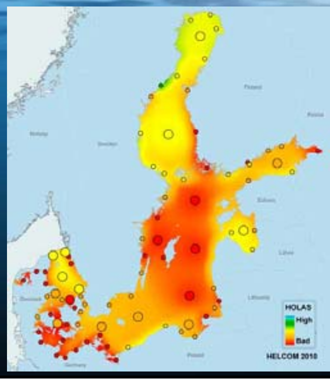
Baltic Sea Ecosystem Health Assessment



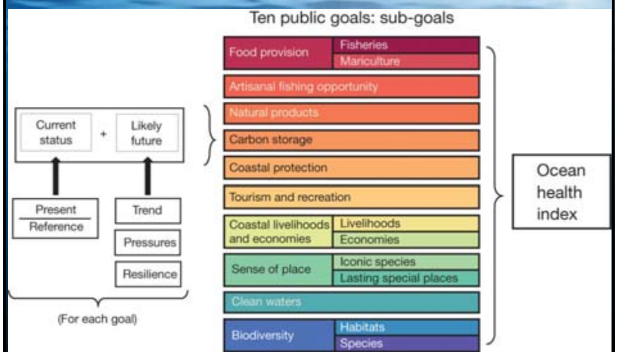


Hazardous Substances   Biodiversity

Baltic Sea Holistic Assessment (HOLAS)
Tool: Additive Model

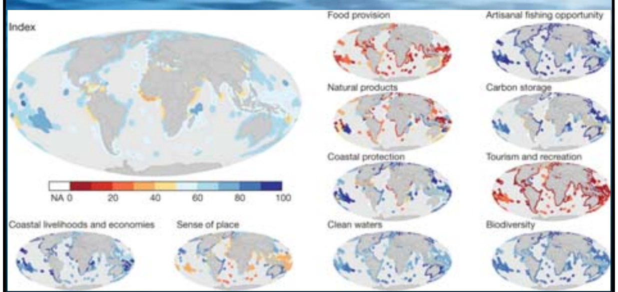


Humans as Part of the Ecosystem: Ocean Health and Benefits Index



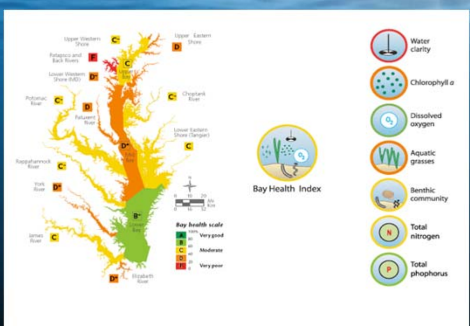
Source: Halpern et al. 2012. Nature 488: 615-622.

Global Distribution of Ocean Health and Benefits Index



Source: Halpern et al. 2012. Nature 488: 615-622.

Chesapeake Bay Report Card



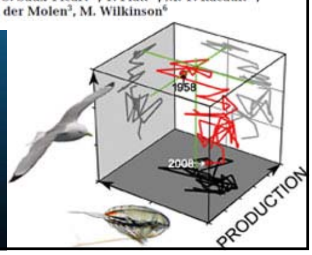
State-Space Approach

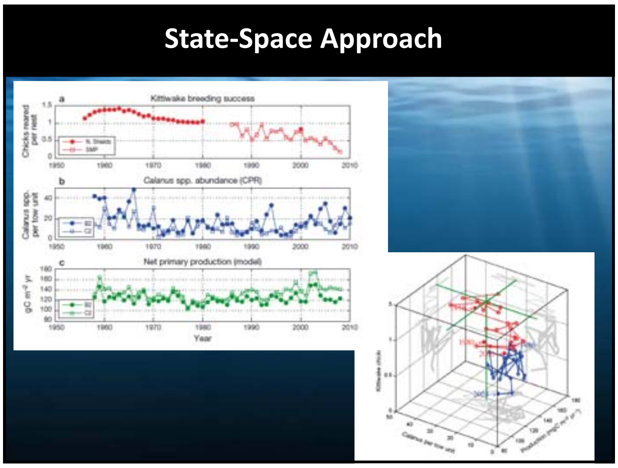
FREE ACCESS

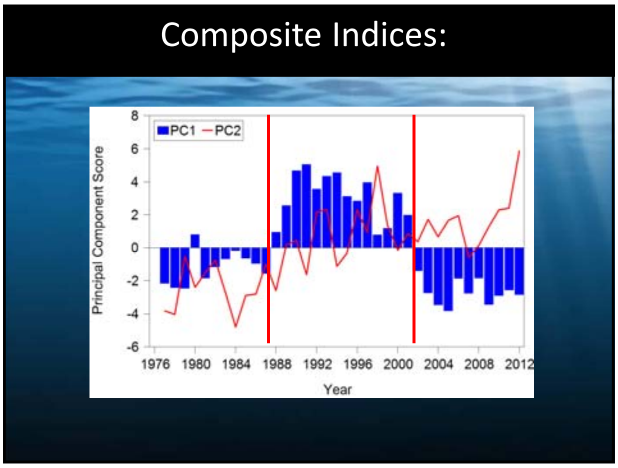
FEATURE ARTICLE: REVIEW

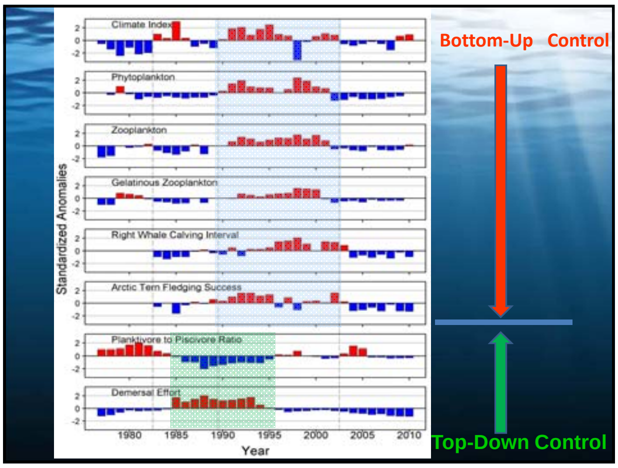
Framework for understanding marine ecosystem health

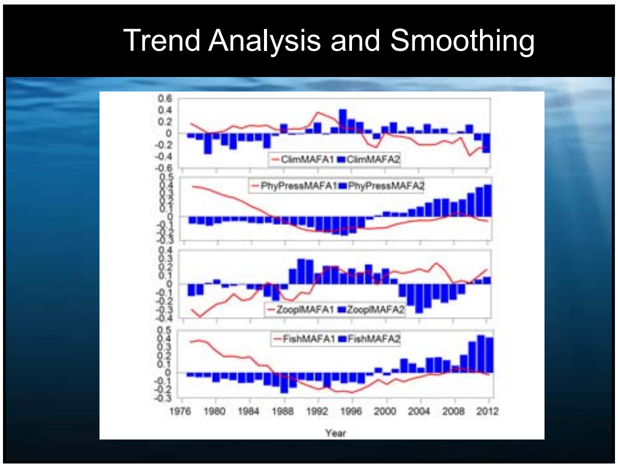
P. Tett[1,*], R. J. Gowen[2], S. J. Painting[3], M. Elliott[4], R. Forster[3], D. K. Mills[3], E. Bresnan[5], E. Capuzzo[3], T. F. Fernandes[6], J. Foden[3], R. J. Geider[7], L. C. Gilpin[6], M. Huxham[6], A. L. McQuatters-Gollop[9], S. J. Malcolm[3], S. Saux-Picart[10], T. Platt[10], M.-F. Racault[10], S. Sathyendranath[10], J. van der Molen[3], M. Wilkinson[6]

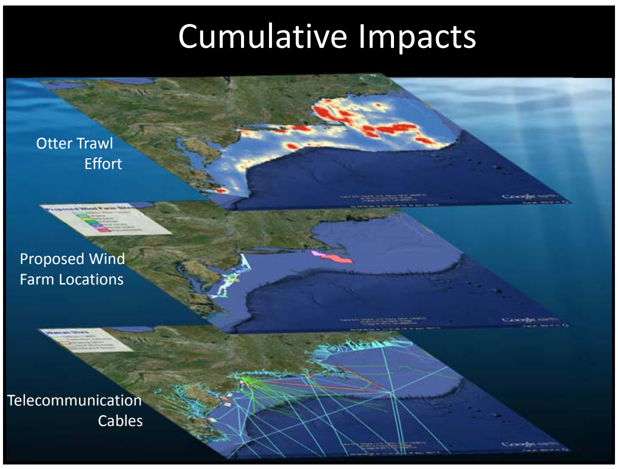


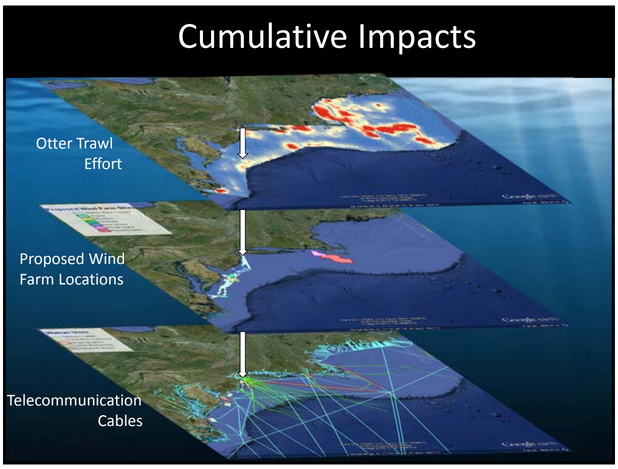

State-Space Approach
Kittiwake breeding success
Calanus spp. abundance (CPR)
Net primary production (model)
Year


Composite Indices:
PC1
PC2
Principal Component Score
Year

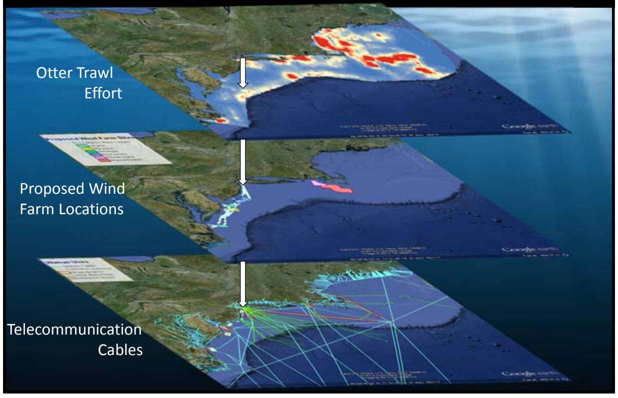

Bottom-Up Control
Top-Down Control
Climate Index
Phytoplankton
Zooplankton
Gelatinous Zooplankton
Right Whale Calving Interval
Arctic Tern Fledging Success
Planktivore to Piscivore Ratio
Demersal Effort
Standardized Anomalies
Year


Trend Analysis and Smoothing
ClimMAFA1
ClimMAFA2
PhyPressMAFA1
PhyPressMAFA2
ZooplMAFA1
ZooplMAFA2
FishMAFA1
FishMAFA2
Year

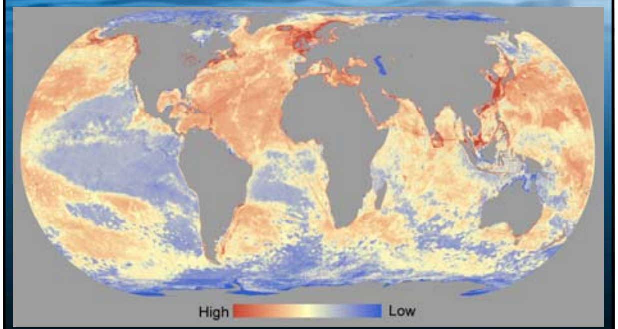

Cumulative Impacts
Otter Trawl
Effort
Proposed Wind
Farm Locations
Telecommunication
Cables


Cumulative Impacts
Otter Trawl
Effort
Proposed Wind
Farm Locations
Telecommunication
Cables

Cumulative Impacts

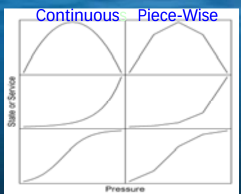


Cumulative Impacts of Human Activities in the Ocean: Additive Model



Source: Halpern et al. 2008. Science 319:948-952

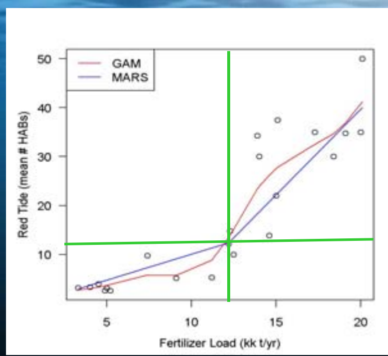
Determining Reference Points: Identifying Inflection Points



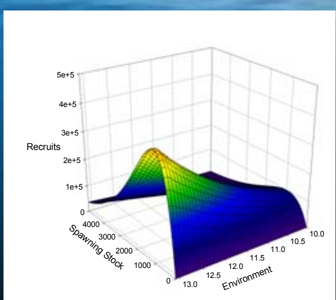
Objective Methods of selecting reference points can be implemented by Identifying inflection points in continuous functions.

Empirical determination of breakpoints in data series for which an *a priori* specification of structural form has not been made can also be made.

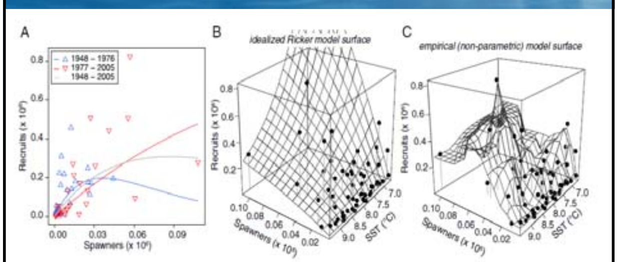
Determining Reference Points: Identifying Inflection Points



Reference Points with Multiple Drivers



Empirical Dynamic Modeling: Assessing the Effects of Interacting Stressors



Source: Ye et al. 2008. PNAS 319:948-952

Summary

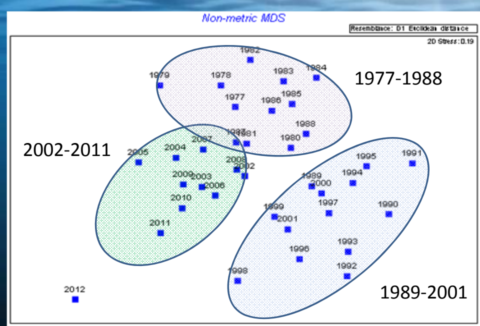
- Wide Spectrum of Analytical Tools Available
- Synthesis and Integration Essential in Extracting Signals of Change in the Ecosystem
- Sudden Change Common – Shifts Happen!
- Key Challenge in Assessing Cumulative Impacts Centers on Interactions Among Stressors
- Well-defined Reference Points Essential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

It’s the economy , stupid

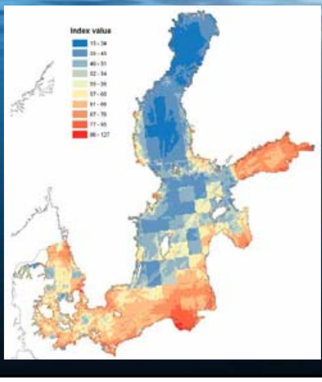
It’s the ecosystem, stupid

#EcoStupid

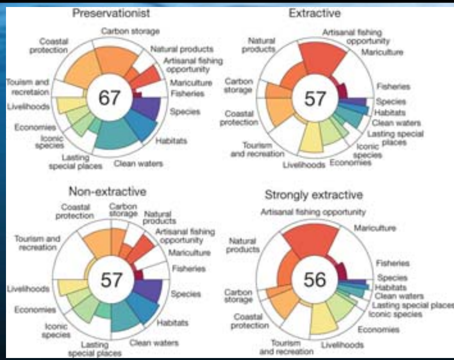
Regime Shift on the Northeast U.S. Shelf?



Baltic Sea Cumulative Impact Map

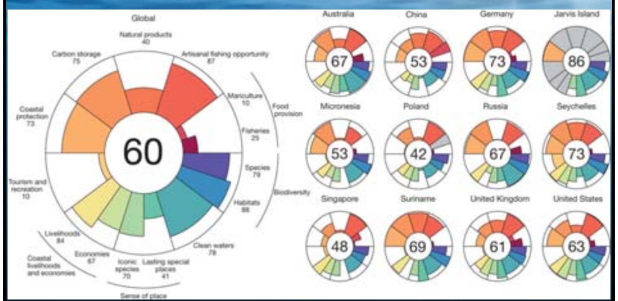


Effects of Different Value Systems on Ocean Health and Benefits Index



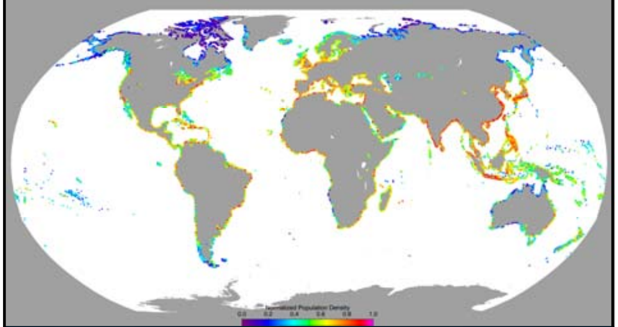
Source: Halpern et al. 2012. Nature 488: 615-622.

Global Score for Ocean Health and Benefits Index

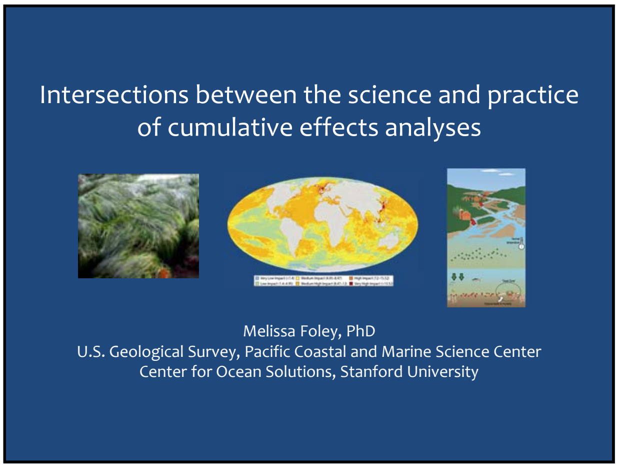


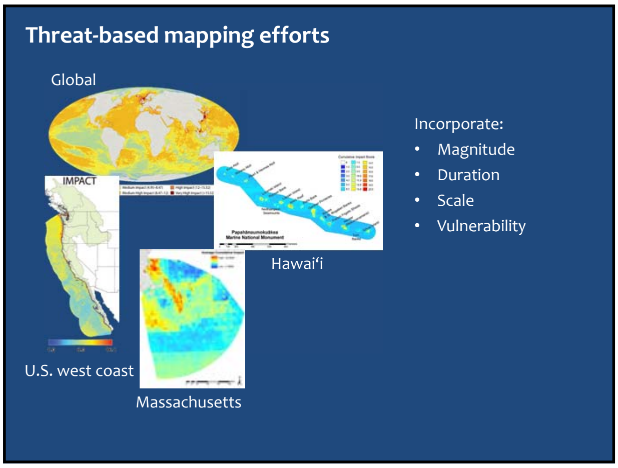
Source: Halpern et al. 2012. Nature 488: 615-622.

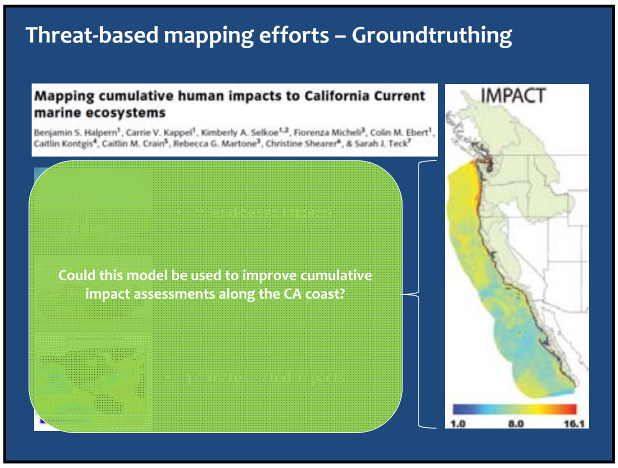
Drivers: Human Coastal Population Density

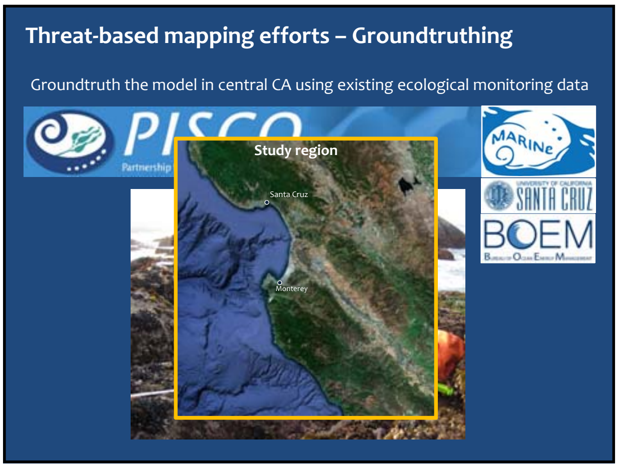


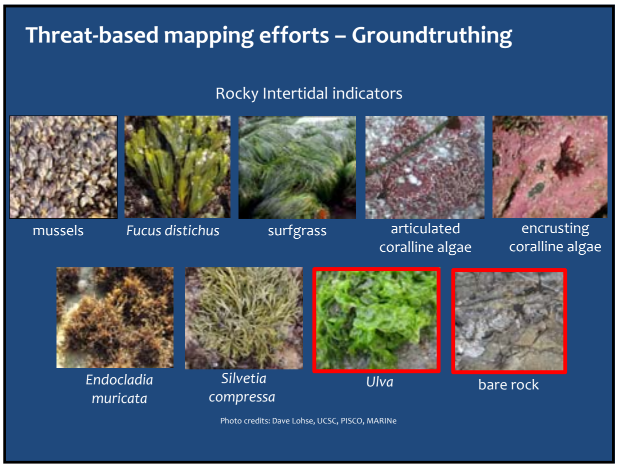
Source: Halpern et al. 2008. Science 319:948-952

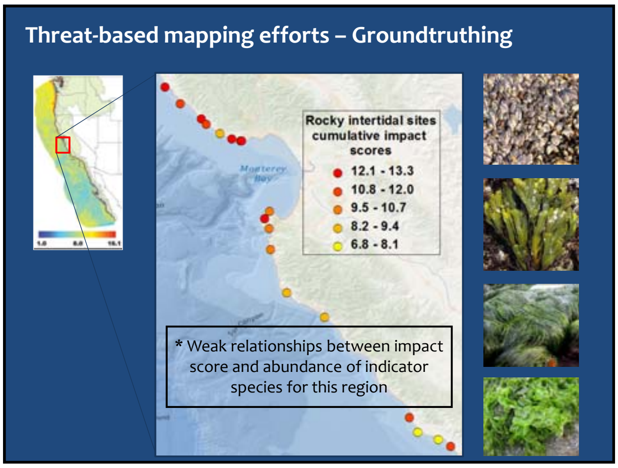

Intersections between the science and practice of cumulative effects analyses
Melissa Foley, PhD
U.S. Geological Survey, Pacific Coastal and Marine Science Center
Center for Ocean Solutions, Stanford University


Threat-based mapping efforts
Global
IMPACT
Hawai'i
U.S. west coast
Massachusetts
Incorporate:
• Magnitude
• Duration
• Scale
• Vulnerability

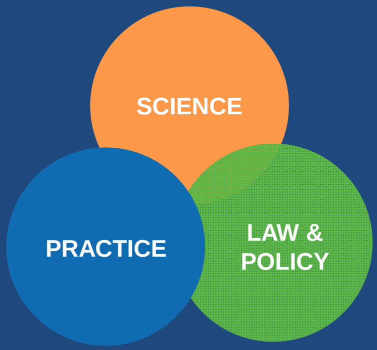

Threat-based mapping efforts – Groundtruthing
Mapping cumulative human impacts to California Current marine ecosystems
Could this model be used to improve cumulative impact assessments along the CA coast?
IMPACT
1.0
8.0
16.1


Threat-based mapping efforts – Groundtruthing
Groundtruth the model in central CA using existing ecological monitoring data
PISCO
Partnership
Study region
Santa Cruz
Monterey
MARINe
SANTA CRUZ
BOEM

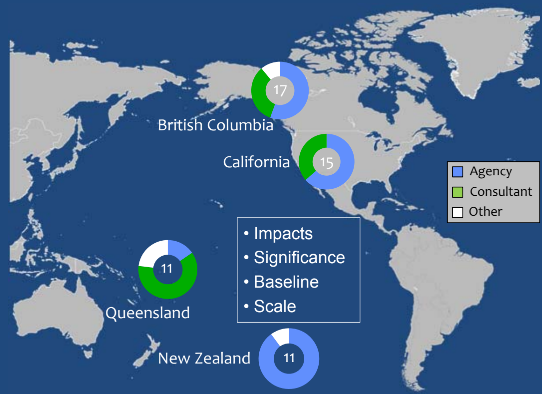

Threat-based mapping efforts – Groundtruthing
Rocky Intertidal indicators
mussels
Fucus distichus
surfgrass
articulated coralline algae
encrusting coralline algae
Endocladia muricata
Silvetia compressa
Ulva
bare rock
Photo credits: Dave Lohse, UCSC, PISCO, MARINe


Threat-based mapping efforts – Groundtruthing
Rocky intertidal sites cumulative impact scores
12.1 - 13.3
10.8 - 12.0
9.5 - 10.7
8.2 - 9.4
6.8 - 8.1
Monterey Bay
* Weak relationships between impact score and abundance of indicator species for this region

How are cumulative effects assessed?

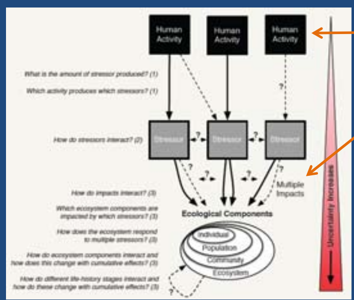


How are cumulative effects assessed?



- Impacts
- Significance
- Baseline
- Scale

What qualifies as an impact?



Clarke Murray et al. 2014

PRACTICE

SCIENCE

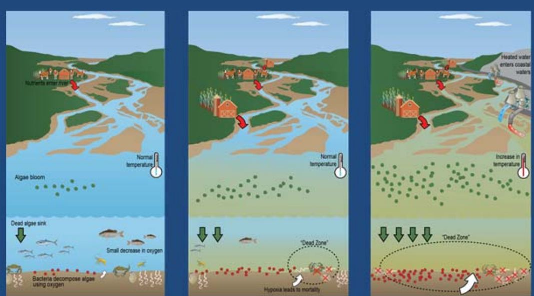
What qualifies as an impact?

- Direct effects
- Indirect effects

- Additive
- Synergistic
- Antagonistic

- Similar projects
- Similar impacts
- Ecological components

Setting a baseline of impact



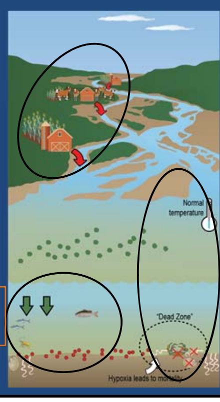
Past (5%) Current (37%) Future (0%)

(39%) (4%)

(11%)

Setting a baseline of impact

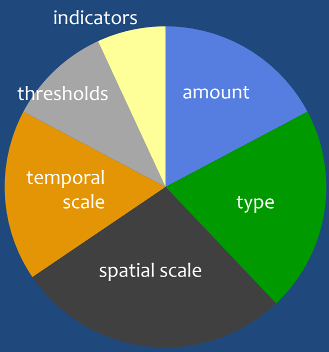
number of activities



amount of impact

ecosystem condition

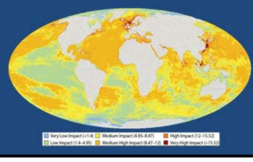
Determining the significance of effects



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

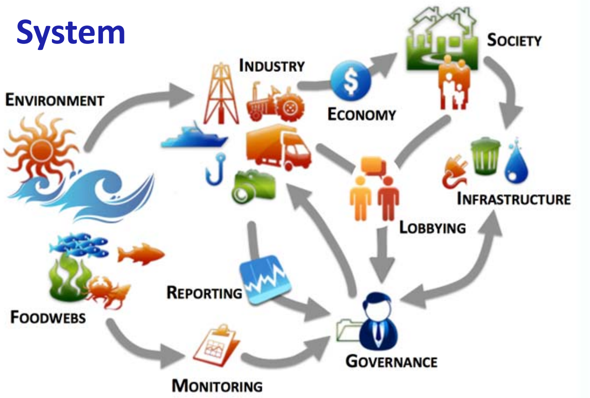
Beth Fulton, Fabio Boschetti, Rich Little

2015

CSIRO WEALTH FROM OCEANS FLAGSHIP
www.csiro.au

Adaptive Management Cycle

System



Problem types

Simple	Complex	Wicked
Clear problem Clear solution	Problem unclear Solutions possible with time	Problem & solutions keep shifting
Predictable Straightforward	Many elements Non linear Linked parts	Many elements Conflicting perspectives No "right" answer Last fix = new problem Never complete Changing beliefs & behaviour

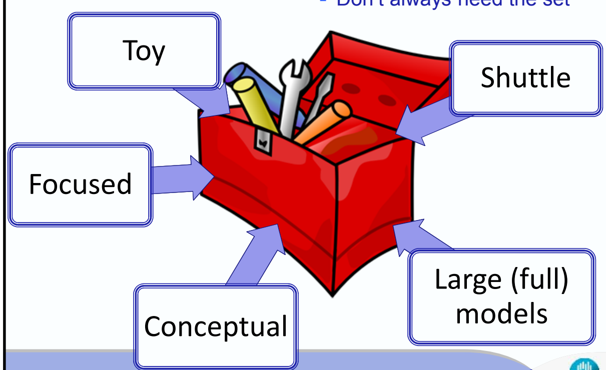
mofox.com, Rittel 1973

Wicked cumulative impacts

- Numerous possible explanations
- Can't be sure on top of all options
- Every case has idiosyncrasies
- Not good to be "wrong"
- Conclusion: impossible to deal with

Multiple models

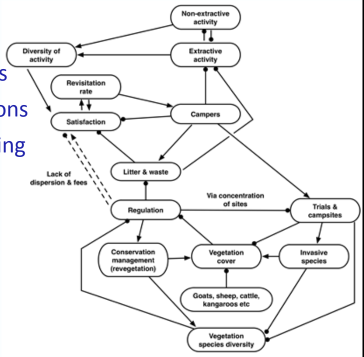
- All individually useful
- Don't always need the set



Conceptual

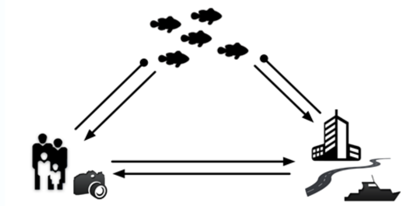
- Cross knowledge types
- Elicit system connections
- Collective understanding & discussion points

- Beginning to elicit response curves

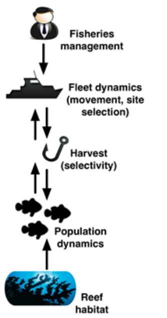


Toys & Training

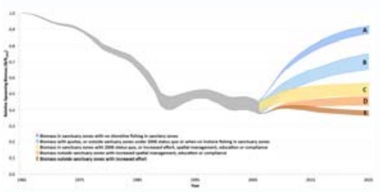
- Train on how modelling & systems work
- Show why intuition alone is not enough



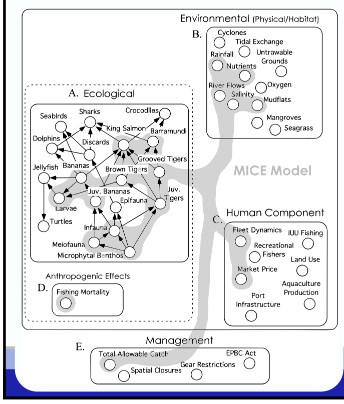
Focused



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



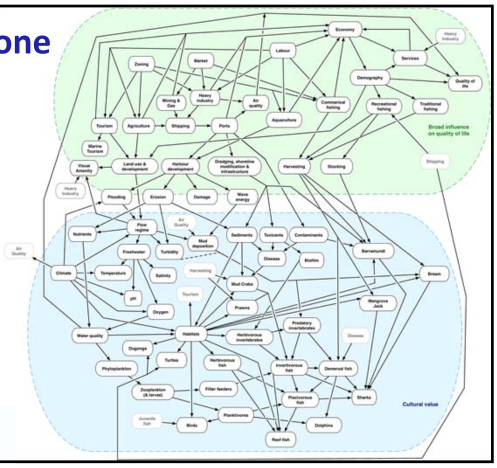
System models (of many sizes)



- Partial systems
  - Key players
  - MICE
  - Light touch on all
- "Full" systems

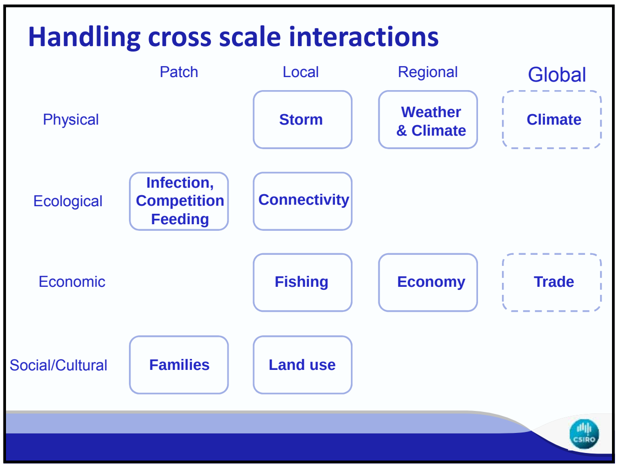
- Cumulative impacts surprises
- Highlight unanticipated outcomes due to feedbacks

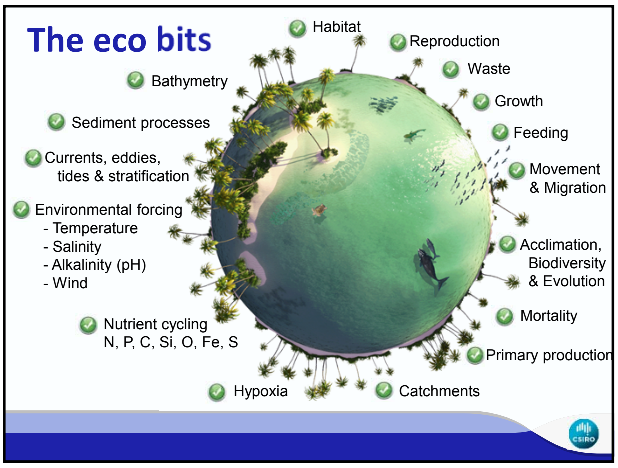
Gladstone

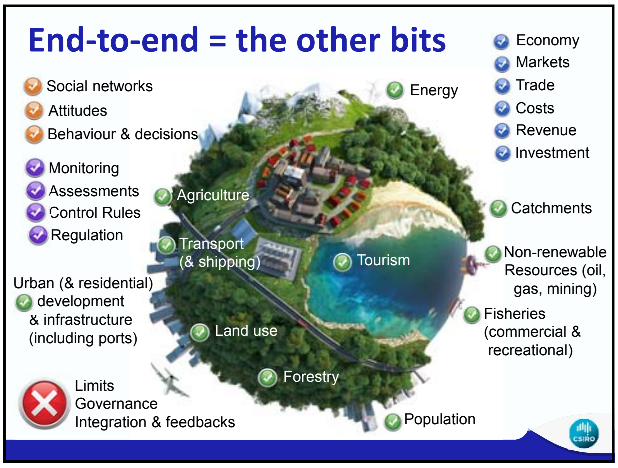


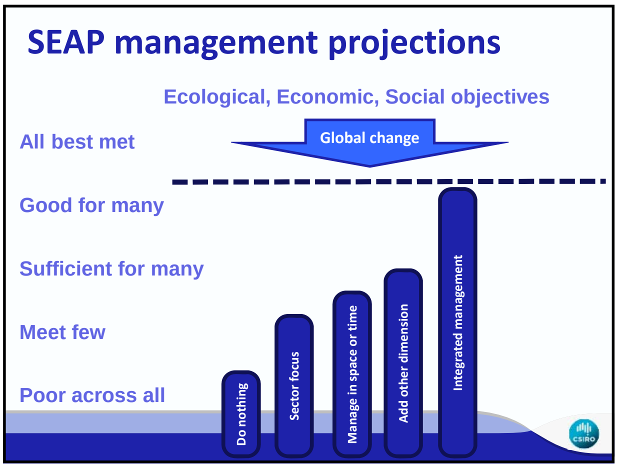
Handling cross scale interactions

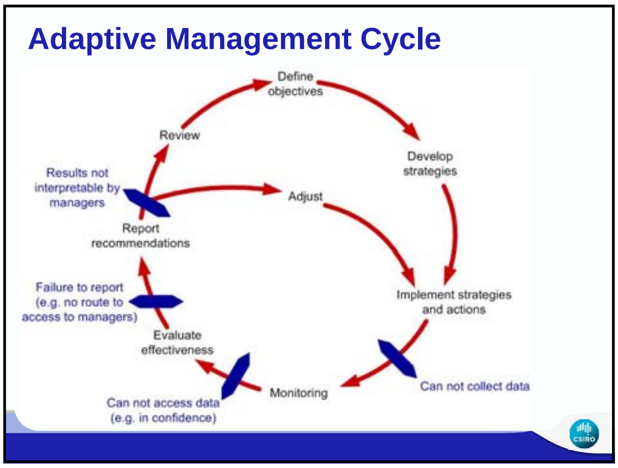
	Patch	Local	Regional	Global
Physical				
Ecological				
Economic				
Social/Cultural				

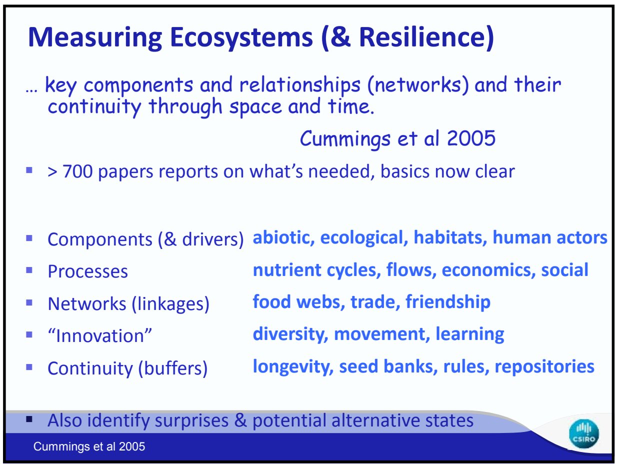

Handling cross scale interactions
Patch
Local
Regional
Global
Physical
Storm
Weather & Climate
Climate
Ecological
Infection, Competition Feeding
Connectivity
Economic
Fishing
Economy
Trade
Social/Cultural
Families
Land use


The eco bits
Habitat
Reproduction
Waste
Bathymetry
Growth
Sediment processes
Feeding
Currents, eddies, tides & stratification
Movement & Migration
Environmental forcing
- Temperature
- Salinity
- Alkalinity (pH)
- Wind
Acclimation, Biodiversity & Evolution
Mortality
Nutrient cycling N, P, C, Si, O, Fe, S
Primary production
Hypoxia
Catchments

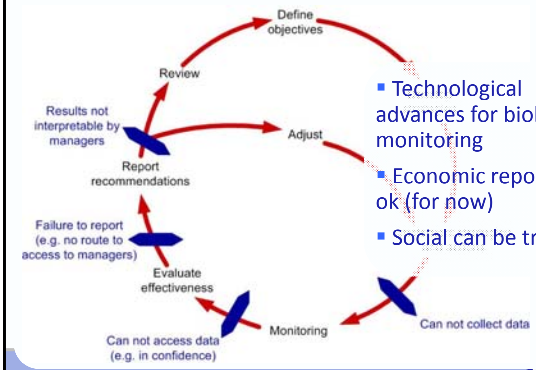

End-to-end = the other bits
Economy
Markets
Trade
Costs
Revenue
Investment
Social networks
Attitudes
Behaviour & decisions
Energy
Monitoring
Assessments
Control Rules
Regulation
Agriculture
Catchments
Transport (& shipping)
Tourism
Non-renewable Resources (oil, gas, mining)
Urban (& residential) development & infrastructure (including ports)
Fisheries (commercial & recreational)
Land use
Forestry
Limits
Governance
Integration & feedbacks
Population


SEAP management projections
Ecological, Economic, Social objectives
All best met
Global change
Good for many
Sufficient for many
Meet few
Poor across all
Do nothing
Sector focus
Manage in space or time
Add other dimension
Integrated management


Adaptive Management Cycle
Define objectives
Review
Develop strategies
Results not interpretable by managers
Adjust
Report recommendations
Failure to report (e.g. no route to access to managers)
Implement strategies and actions
Evaluate effectiveness
Can not collect data
Monitoring
Can not access data (e.g. in confidence)

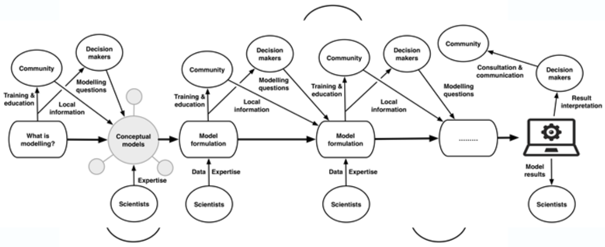

Measuring Ecosystems (& Resilience)
… key components and relationships (networks) and their continuity through space and time.
Cummings et al 2005
> 700 papers reports on what's needed, basics now clear
Components (& drivers) abiotic, ecological, habitats, human actors
Processes nutrient cycles, flows, economics, social
Networks (linkages) food webs, trade, friendship
"Innovation" diversity, movement, learning
Continuity (buffers) longevity, seed banks, rules, repositories
Also identify surprises & potential alternative states
Cummings et al 2005

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

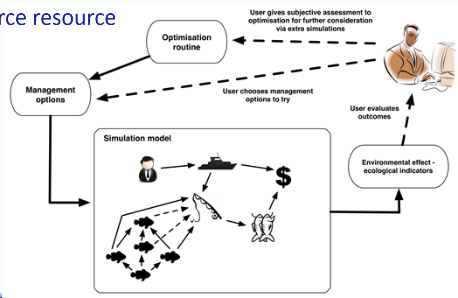
(MPAs along not enough)

Pragmatic Multiple Use Management

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

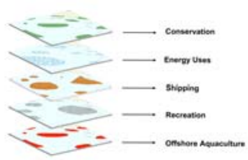
What is often asked for…

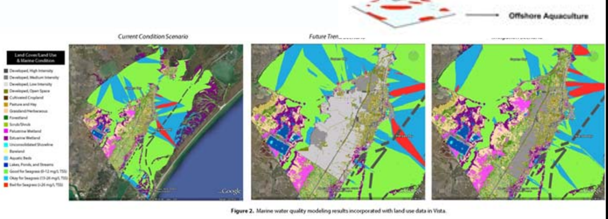
- Simple, clear, transparent (“rule of 5”)
- Can ask for optimisation (but not an obsession)
- Time = scarce resource



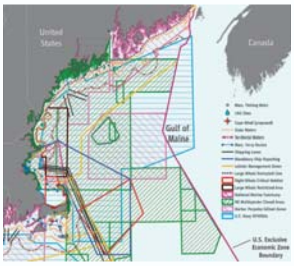
What is being asked for…

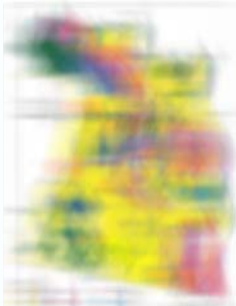
- Information integration (auto filled map layers)
- Maps (optimal allocations)





Dividing up the ocean





- Zoning to reduce conflict & complexity

Barriers to IM

① History

② Time (& resources)

③ Scepticism

danmgray.wordpress.com

Business Drive/Evolution to IM

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

WE CONTRIBUTE TO SOCIETY BECAUSE WE ARE SUCCESSFUL (GIVING SOMETHING BACK)	VS.	WE ARE SUCCESSFUL BECAUSE WE CONTRIBUTE TO SOCIETY (CREATING SHARED VALUE)
SHAREHOLDER VIEW		STAKEHOLDER VIEW
END OF THE PIPE		FUNDAMENTAL DESIGN VALUE
SELF-CONTAINED BOX FOR ALL THE "GOOD STUFF"		FULLY INTEGRATED INTO STRATEGY AND CULTURE
TACTICAL BOLT-ON TO "BUSINESS AS USUAL"	VS.	STRATEGIC DRIVER OF INNOVATION
FOCUS ON MINIMISING SIDE-EFFECTS		FOCUS ON MAXIMISING PRIMARY EFFECTS
LEADING MEASURE OF ACTIVITY (SEPARATE FROM CORE BUSINESS)		LAGGING MEASURE OF IMPACT (OF EVERYTHING YOU DO)
LEGAL COMPLIANCE AND REPUTATION MANAGEMENT		FUNDAMENTAL LONG-TERM BUSINESS VIABILITY

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

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Integrated Assessment and Modelling: Lessons from Water Resource Management

SARDI Workshop
April 13-16, 2015

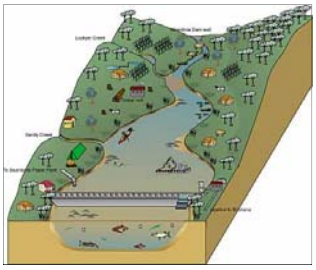
Tony Jakeman

Australian National University and National Centre for Groundwater Research and Training

tony.jakeman@anu.edu.au

Australian National University

Water Resources



- Multiple uses/functions
- Multiple stakeholders
- Competing goals
- Multiple decision makers
- Multiple pressures
- Limited resources
- Complexity
- Uncertainty

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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."

GWP-TAC4 (2000) Stockholm

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***

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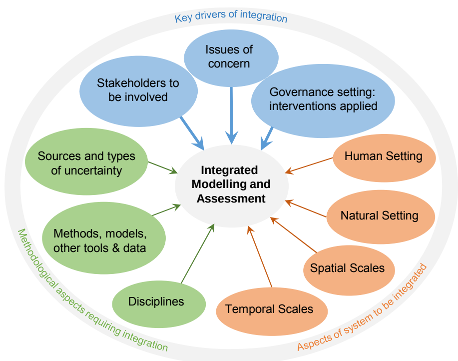
Integrated Modelling and Assessment

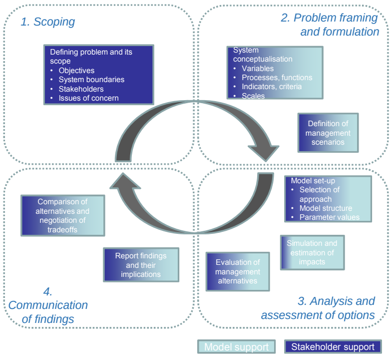
- Integrated modelling and assessment (IMA) aims to use models/tools to support improved decision-making
- Integration across (some or all of):
  - Different objectives like economic efficiency, ecological integrity and social equity (sustainability)
  - Different policy influences, other drivers & constraints
  - 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

Hamilton, S., El Sawah, S., Guillaume, J.H.A., Jakeman, A.J. & Pierce, S.A (2015) Integrated modeling and assessment: an overview and synthesis of its salient dimensions. *Env. Mod. & Software.*



IMA process phases and steps



To address perform IMA we require:

- Choice of apt Integrated Model(s) (& software platforms)
  - ➢ e.g. ABMs, BNs, SDs, coupled complex models (Kelly et al., 2013)
- IMA tools (a wealth of these available)
- An eclectic Uncertainty Identification & Assessment toolbox of approaches
  - ➢ esp. to identify which uncertainties matter & how much

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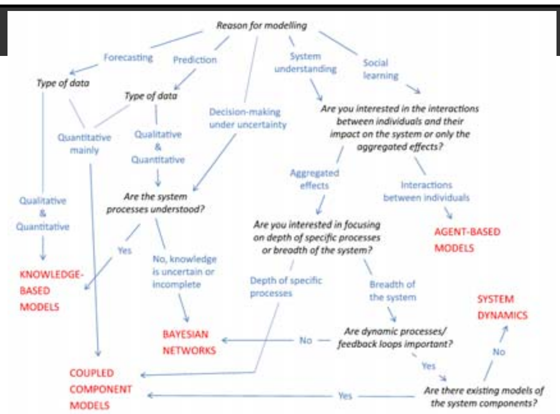
Integrated Modelling Approaches or Paradigms

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

Kelly, R.A., Jakeman, A.J. and 11 others (2013) Selecting among five common modelling approaches for integrated environmental assessment and management. Environmental Modelling and Software, 47: 159-181.



Kelly (Letcher) et al. (2013). Selecting among five common modelling approaches for integrated environmental assessment and management. *Environmental Modelling and Software*, **47**, 159-181

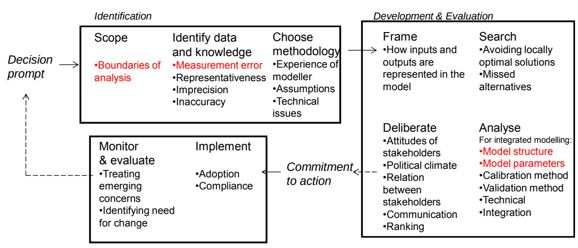
Tools to support the IMA process

Tool Category	Examples of tools	Application	Purpose
Exploratory tools	statistical analysis, 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

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:



Commonly discussed uncertainties in modelling are shown in red (Guillaume)

Approaches to assess & manage uncertainty

Purpose of uncertainty method

Identify — •Proper processes and protocols, good practice guidelines eg NUSAP
•Benchmark against standard, catalogue & rank uncertainties

(Prioritise) — •Significance for decision, risks incurred
•Sensitivity assessment
→ simplifying model/problem

(Reduce) At source — •Inverse modelling
•Data acquisition planning

Describe

Propagate In analysis — •Monte Carlo and related analyses inc Bayesian methods
•Scenario simulation
•Analysing model components then linkages

Communicate To decision makers — •Extended peer review & stakeholder involvement

Manage Remaining uncertainty — •Adaptive management

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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

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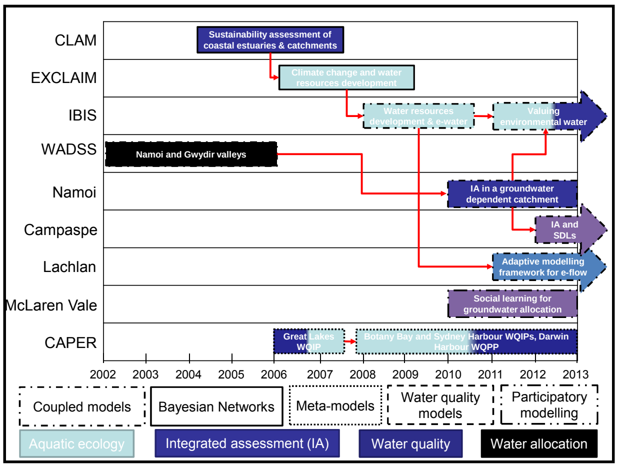

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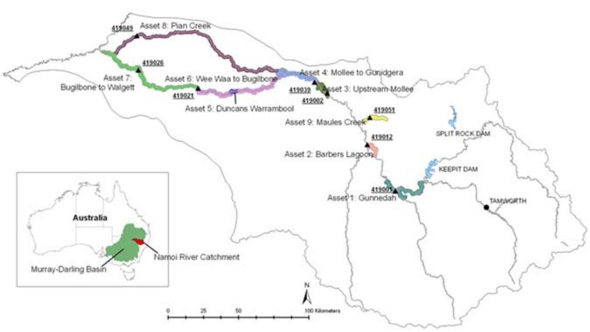
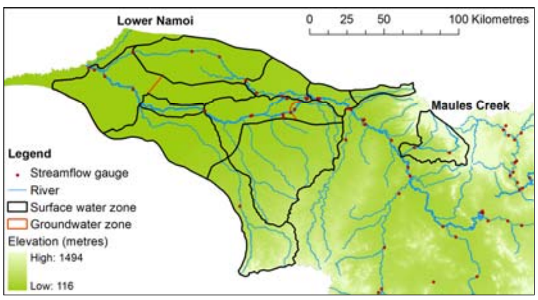
Socioeconomic & environmental impacts of climate change, technology and water policy drivers in the Namoi catchment

Tony Jakeman, Jenifer Ticehurst, Rachel Blakers, Barry Croke, Baihua Fu, Wendy Merritt, Darren Sinclair, Neil Gunningham, Joseph Guillaume, Andrew Ross (ANU)
Allan Curtis and Emily Sharp (CSU)
David Pannell, Alex Gardner, Alison Wilson and Madeleine Hartley (UWA)
Cameron Holley (UNSW)
Rebecca Kelly (iSNRM and ANU)
Steering Committee: State and local agencies, Namoi Water (irrigators)

Cotton Catchment Communities CRC



Hydrological model zones for Namoi model



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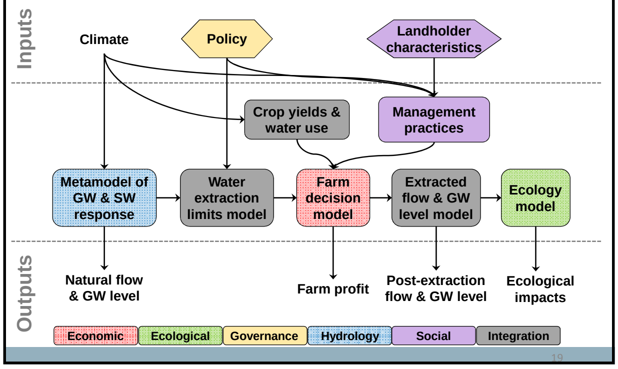
Overview of the Integrated Model



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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

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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

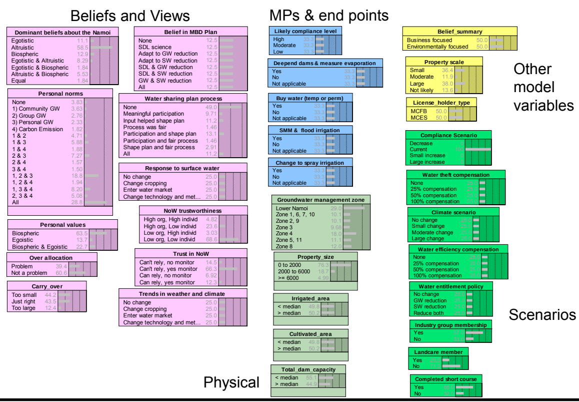
Development of the social BN for the Namoi

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

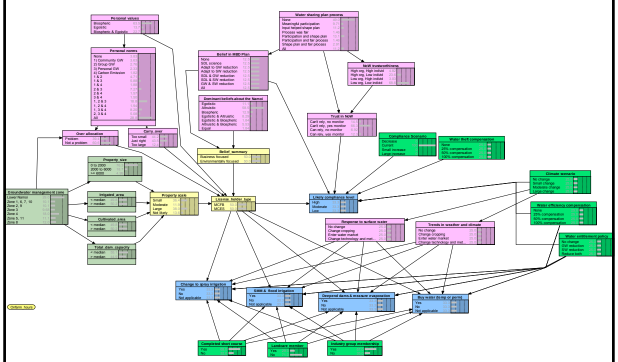
Management Practices

- 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



Develop into an influence diagram

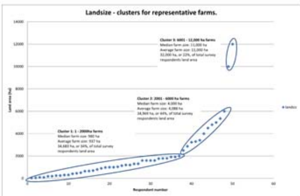


Economic questions

- 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?

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_1) at the time of rainfall
  - Empirical relationship between yield, PET, rain, soil moisture and temperature

Ecology

- 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

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.

What do scenarios have to offer?

- provide an interdisciplinary framework for analyzing 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 opinions; reduce collective biases; aid transparency
- embrace uncertainty both in system drivers & model assumptions: prediction is just a form of scenario modeling (usually applied very narrowly); find best/worst cases
- TOOL of choice for exploring those parts of the future where uncertainty is high and our control is low

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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
- **multi/nested-scale scenarios and cumulative impacts**
- understanding/modelling **socio-economic behaviour** and social (inc. policy) systems
- **integrating** this 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)

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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, …
- **Opportunitie**s: 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-jurisdictions** in scenario construction and analysis for coordination, educating and sharing knowledge

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

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References

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Jakeman, AJ, and 17 others (2014) Modelling for the complex issue of groundwater management. In: *Simulation and Modelling Methodologies, Technologies and Applications*. Advances in Intelligent Systems and Computing 256, pp. 25-41, Springer ISSN 2194-5357, ISBN 978-3-319-03580-2, DOI -10.1007/978-3-319-03581-9.

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

Tony Smith

IMM Workshop, Adelaide, April 2015

CSIRO WEALTH FROM OCEANS FLAGSHIP
www.csiro.au

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

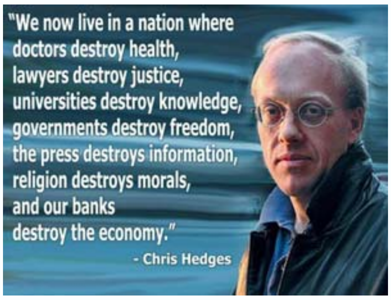
Political risks and imperatives

- IM a long process – usually covering multiple policy and election cycles (JMcI)
  - 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?



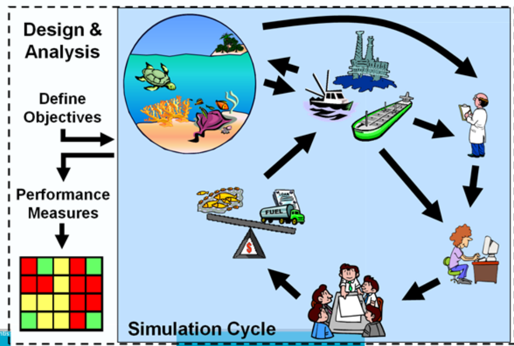
Research and IM

- 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

Decision making under uncertainty

Management Strategy Evaluation MSE



MSE and models

MSE not (just) modelling – decision framework (RS)

Tools for prediction (BF)
- Qualitative e.g. Delphic 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

IMOS Integrated Marine Observing System

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, modelling
  - 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

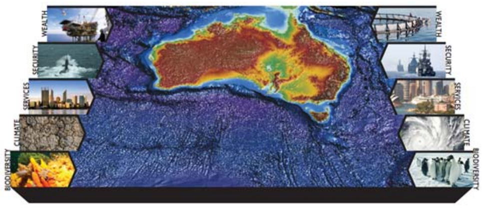
IMOS

What is IMOS and how does it work?

- Need, Capability, Impact

IMOS

Need for IMOS

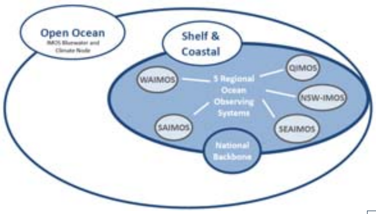


- Systematic and sustained observing of the marine environment
- Turning observations into data – real time, time series
- International collaboration, Australian role in a global effort

IMOS

Need for IMOS

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

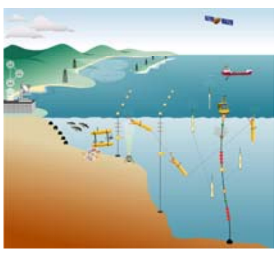


One national plan, six Node 'chapters' focused on the open ocean and regional marine systems

IMOS

IMOS Capability - multi-faceted, multi-institutional

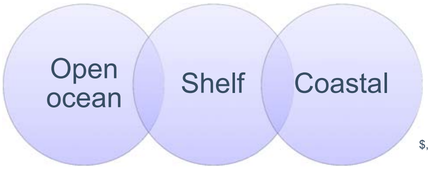
NCRIS National Research Infrastructure for Australia
An Australian Government Initiative



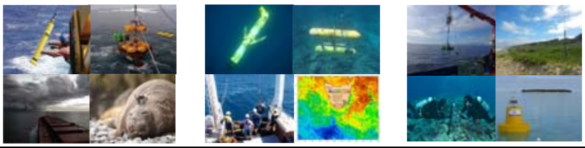
UTAS CSIRO Australian Institute of Marine Science UNSW Macquarie University Sydney SIMS The University of Western Australia Curtin University SARDI

IMOS

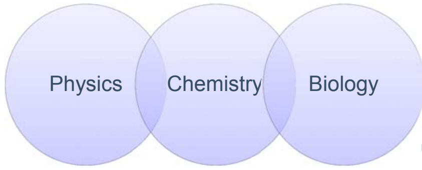
IMOS Capability
– integrated across scales



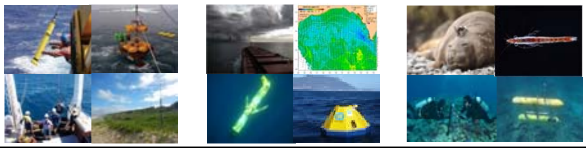
$, partnerships?



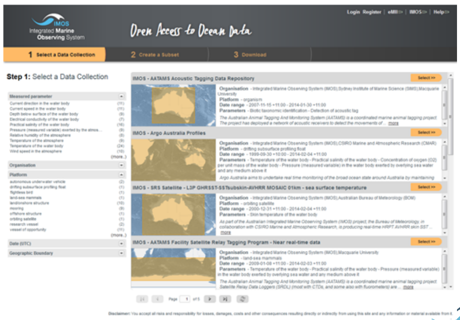
IMOS Capability
– integrated across disciplines



requirements?

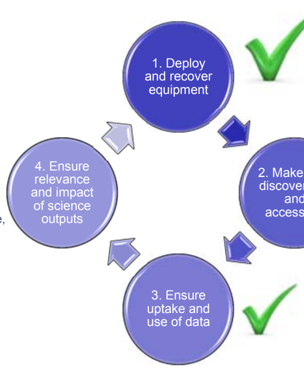


IMOS Capability
- all data discoverable, accessible, usable and reusable



Impact of IMOS

Does it work?
- 4 key performance indicators



- Quarterly Milestones (deployment and data)
- Monthly Activity Plans (on the website)
- Facility Workflows (on the web site)
- Monthly Data Reports (on the website)
- IMOS Ocean Portal

Good progress made, but 'closing the loop' continues to be hard work…

Publications Database

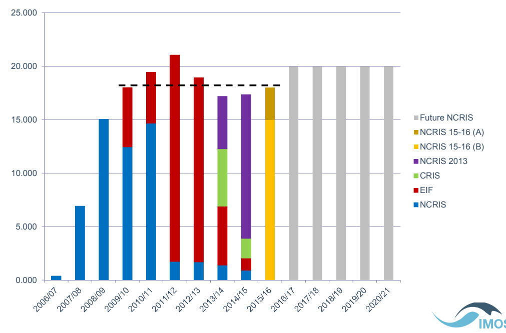
Status of data holdings
http://imos.org.au/imosdatareports.html

- 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)
  - 237,840 CTD profiles
- Animal tagging, acoustic
  - 58,431,944 detections
- GBR sensor network
  - 7 sites, 290 sensors
- SST
- Ocean Colour
- Altimetry (daily GMSLA)

http://oceancurrent.imos.org.au/

Status of funding

~$145M core funding over 10 years, plus co-investment (47:53)



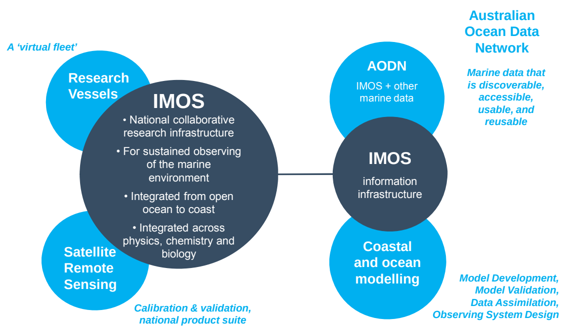
IMOS

Design and evolution of IMOS over a decade

– Observing, data, modelling
– Using 'readiness' to evolve the system
– Research and operational use of data
– Sustained ecological observing

IMOS

Designed through national science planning developed by regional science **Nodes**

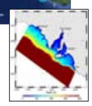


Implemented through national, multi-institutional **Facilities**, with all data shared

IMOS

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



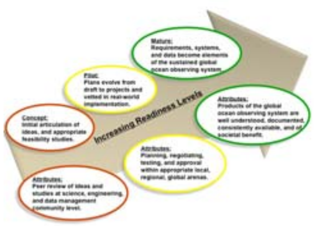
MARVL MARINE VIRTUAL LABORATORY

Forum for Operational Oceanography

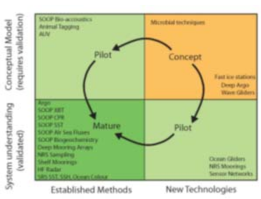
IMOS

2. Using 'readiness' to evolve the system

From the GOOS Framework for Ocean Observing



From the IMOS National Science and Implementation Plan

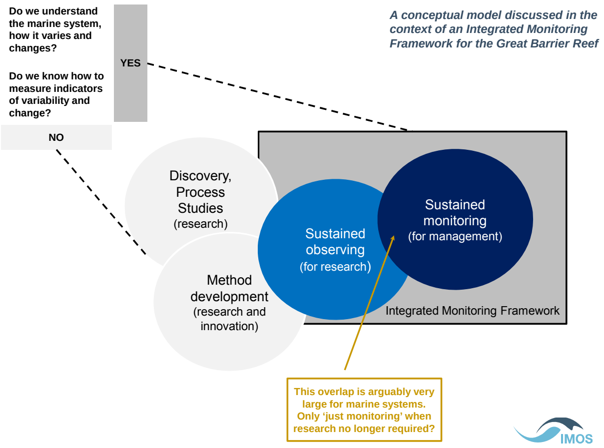


IMOS

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'

IMOS

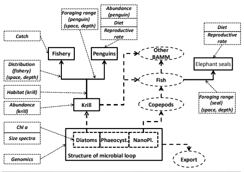


4. Sustained ecological observing

- 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

4. Sustained ecological observing

- A lot of focus globally on 'ecosystem' Essential Ocean Variables (eEOVs)
  - GOOS Biology & Ecosystems Panel
  - Pilot project in the Southern Ocean
- Will our current biological observing programs cut it?
  - e.g. measured Copepod abundance using CPR



4. Sustained ecological observing

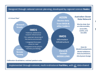
- IMOS partnering to begin looking at marine microbial biodiversity
- Started with sampling at 3 (of 7) National Reference Stations
  - Now going national (x7)
- New joint project with BioPlatforms Australia who will provide $1M of sequencing effort

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

Four points in summary
(I've probably 'telegraphed by punches'…)

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': its about quality, standards, vocabularies…
   - Unavailable data can never be turned into joined-up knowledge that informs integrated management

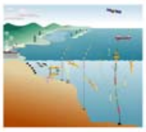


3. Think holistically, about all obs, all data, all modelling
   - Have a big vision, with open interfaces and porous boundaries

4. Continually assess 'readiness', as it will change
   - Sustained ecological observing isn't here, but it's coming
   - Things needs to move through this 'pipeline' over time

Thank you

Discussion?



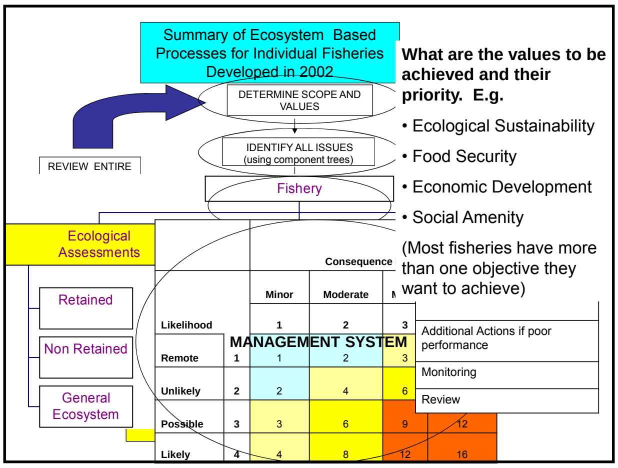
Implementing risk-based, regional level, integrated, ecosystem-approach fisheries management (EBFM) –

No simulation models required but plenty of patience!

Dr Rick Fletcher
Department of Fisheries
Western Australia

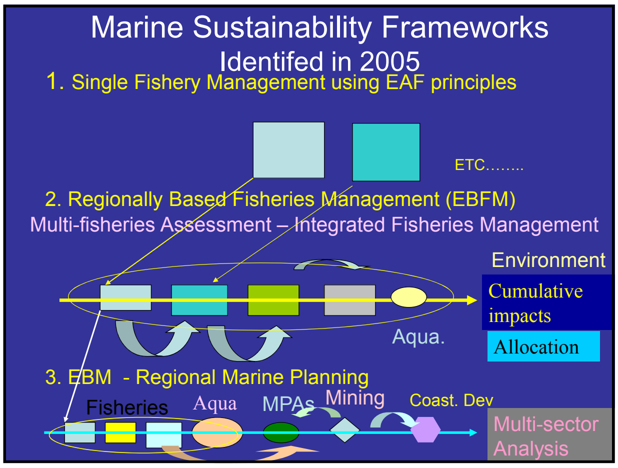
Background

- 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?

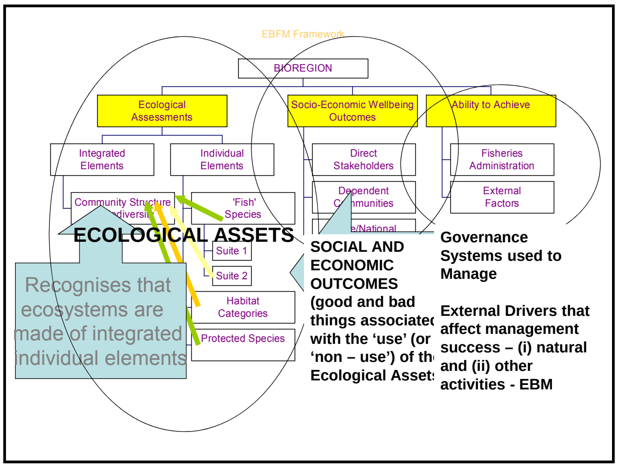
- Risk based management for individual fisheries adopted.
- Most major ecological problems for individual fisheries identified and addressed.
- Most commercial fisheries developing clearer harvest/decision rules.
- Multiple tools available for undertaking each of the steps in different types of fisheries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

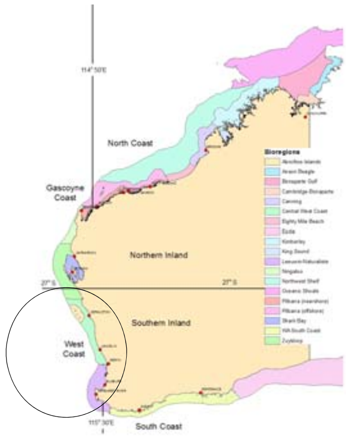


Problem

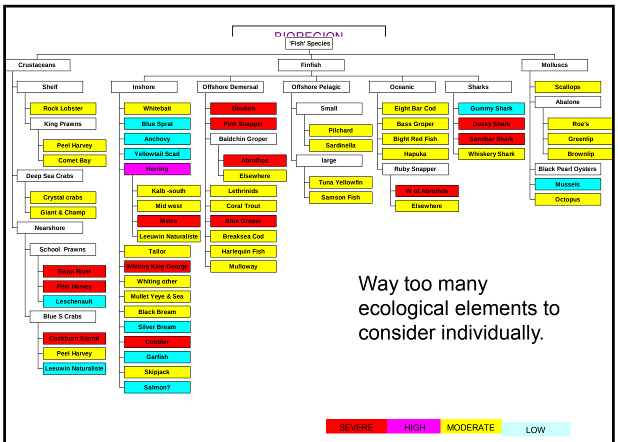
How to undertake integrated regional level management but

- 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 a another 'academic' impractical concept?
- Overcome scepticism





Used the West Coast Bioregion as the test case

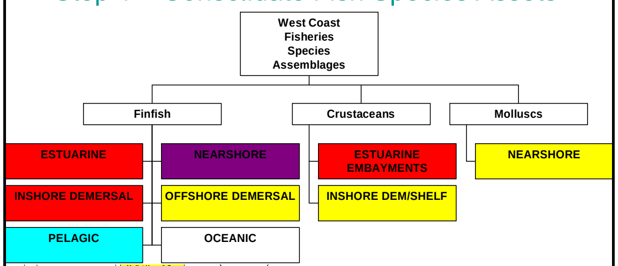


Way too many ecological elements to consider individually.

STEP 1

CONSOLIDATE INDIVIDUAL RISKS INTO REGIONAL LEVEL CATEGORIES

Step 1 – Consolidate Fish Species Assets



• Consolidated the 80 stock level risks down to just 9 Regional level Assets (Suite) and risks

•Status of 2-3 indicator species (most vulnerable) determines entire suite level risk

Similar concept applied to the other trees - ecosystems, habitats, protected species, social and economic, governance.

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.

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

2010 Ecological ASSET	Eco Risk Qual – Qua			Social Amenity	Risk (Qual)	nal cts r Agencies Manage)	2010 Dept. Fisheries Score and Priority (EBFM) FRMA	Whole of
WC Crust. Lobsters	3	5	5	4	3	0	111 Urgent	
WC Demersal Finfish	4	3			5			
WC Finfish Pelagic	2	1			1	0	4 Very Low	
WC Estuarine Ecosystems	5	3	3	4	4	4	25 Low/Mod	

Reduced catch by all sectors by half

Adopted MEY and Quotas

Set sectoral allocations and spatial separation

Reduced catch of all sectors (2 commercial and 2 recreational) by half

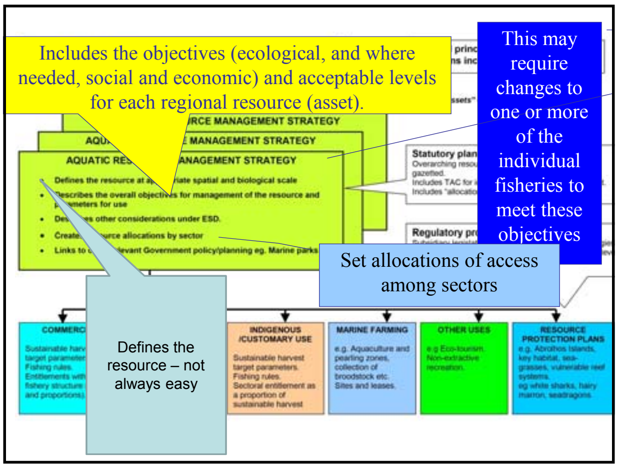
Priorities for West Coast

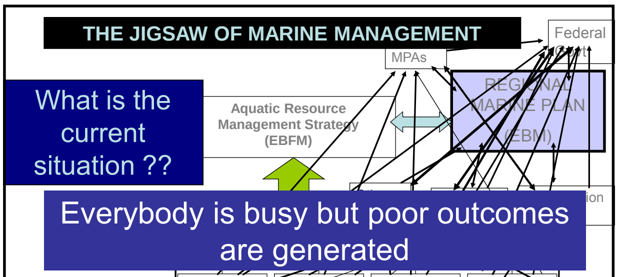
From the >600 issues identified there were 22 ecosystem level assets to manage but of these:

- 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

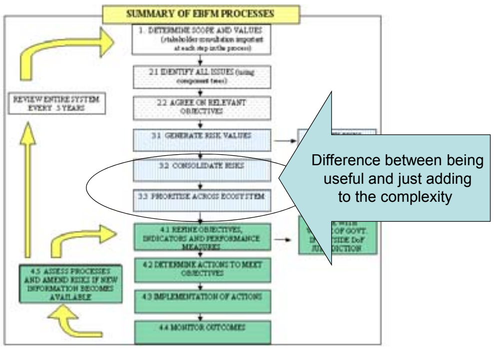
- All bioregions now assessed with 80 Aquatic Assets across the state.
- All departmental activities assigned to managing risks to an ecological or an organisational asset.
- All risk scores are updated in risk register and reported annually in Status of Aquatic Resources
- Generate shifts in resourcing 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





- Multiple processes, duplications, gaps
- Lack of effective involvement, overloading of representatives
- No consensus or coordination

EBFM - MULTI FISHERY ASSESSMENTS



This system for EBFM was agreed by AFMF in October 2010!

EBM APPROACH (MULTI SECTOR)

1. Identify or establish a group with overall responsibility for implementation.

2. Define the scope, including the boundaries of the ecosystem, and establish the overall ecological, social and economic values.

3. Agree on relevant objectives for the ecosystem and each asset based on the values.

4. Generate individual risk values and consolidate to asset level.

5. Prioritise assets across the ecosystem.

6. Determine actions to meet the objectives of the governing body and establish a Monitoring Evaluation and Reporting framework consistent with the CARF for the ecosystem and assets.

7. Develop and implement an action plan.

8. Regularly review outcomes, make necessary changes and communicate with stakeholders.

ONLY DIFFERENCE

This was agreed by the MACC working group in 2010 - even agreed to use IMCRA mesoscale assets as the units of assessment.

Some case studies were going to occur but MACC was abolished in 2011 and it did not progress

	Risk to Component	Risks to Benefits derived from component		Overall Level of Threat
	Intrinsic Value of Component t	Social Benefit	Economic Benefit	
Threat 1				Some
Threat 2				Little
Threat 3				Some
Threat 4				Considerable
RISK LEVEL	HIGH	LOW	MEDIUM	

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.

Considerations for EBM

Threat	Risk to Component	Risks to Benefits derived from component		Overall Level of Threat
	Intrinsic Value of Component t	Social Benefit	Economic Benefit	
Threat 1				Some
Threat 2				Little
Threat 3				Some
Threat 4				Considerable
RISK LEVEL	HIGH	LOW	MEDIUM	

Further Information

- Fletcher et al (2010) An Ecosystem Based Fisheries Management framework: the efficient, regional-level planning tool for management agencies. Marine Policy 34 (2010) 1226–1238
- 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
- Fletcher, W.J. (2012) National Application of Sustainability indicators for Australian fisheries. Part 2: Ecosystem based frameworks for aquaculture, multi-fishery and international applications. Final Report FRDC Project 2000/145. *Fisheries Research Report No. 235, Department of Fisheries, Western Australia 54pp* http://www.fish.wa.gov.au/Documents/research_reports/frr235.pdf
- FAO-EAF Toolbox www.fao.org/fishery/eaf-net
- Fletcher, W.J (2015) Review and refinement of an existing qualitative risk assessment method for application within an ecosystem-based management framework ICES J Marine Science doi:10.1093/icesjms/fsu142

Integrated and cost-effective monitoring

Terry Walshe
Australian Institute of Marine Science

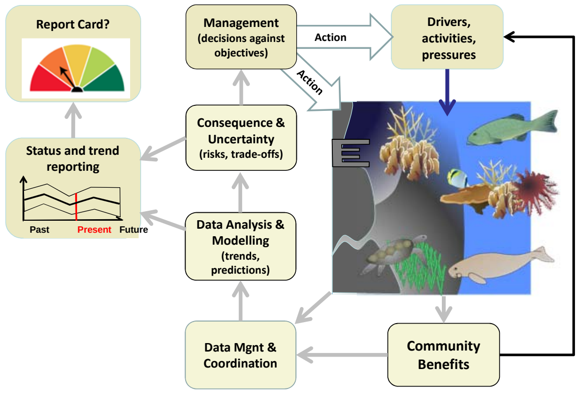
Two claims

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, accountabillity, transparency



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

single attribute (CoTS) decision-making under risk

Action	cause of outbreaks	
	nutrient enrichment (0.70)	Predation release (0.30)
Agriculture BMP	100 km²	300 km²
direct cull	400 km²	200 km²

Ag BMP = 0.70 × 100 + 0.30 × 300 = 160 km²

Direct cull = 0.70 × 400 + 0.30 × 200 = 340 km²

value of information

Action	cause of outbreaks	
	nutrient enrichment (0.70)	Predation release (0.30)
Agriculture BMP	100 km^2	300 km^2
direct cull	400 km^2	200 km^2

Expected value|perfect information = 0.70 × 100 km^2 + 0.30 × 200 km^2 = 130 km^2.

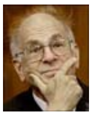
The expected value of perfect information = 160 km^2 - 130 km^2 = 30 km^2.

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

Why monitor?

- **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)**

Nichols JD and Williams BK (2006). Monitoring for conservation. Trends in Ecology and Evolution, 21: 668 – 673.

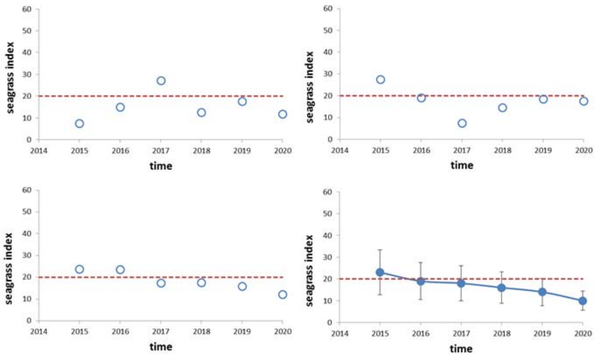



Traps in monitoring design

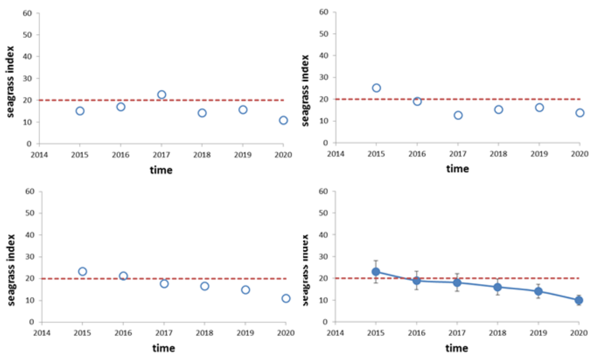
law of small numbers

base rate neglect

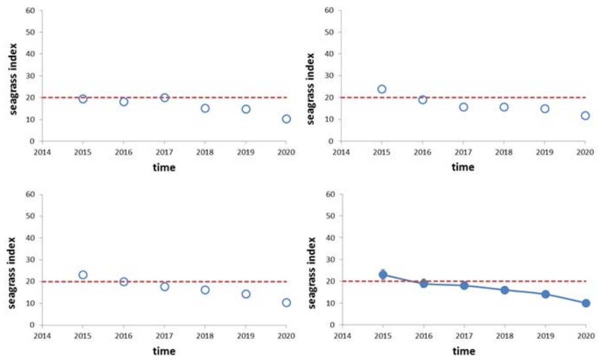
CV = 50%, *n* = 5



CV = 50%, *n* = 20



CV = 50%, *n* = 100



two kinds of mistakes in inference

In the context of accumulating scientific knowledge…..

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

In the context of environmental management…..

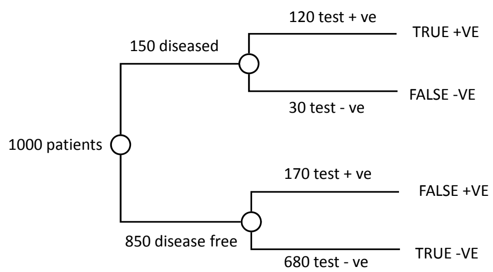
- Type I errors (α) lead to false alarm (industry suffers)
- Type II errors lead to a false sense of security (the environment suffers)

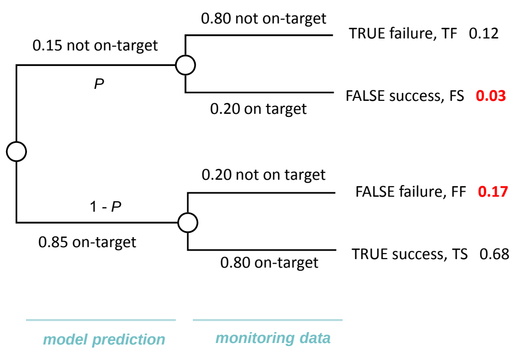
Two cab companies operate in a city, the Blue and the Green (according to the colour of the cab they run). Eighty-five percent of the cabs in the city are Blue, and the remaining 15% are Green.

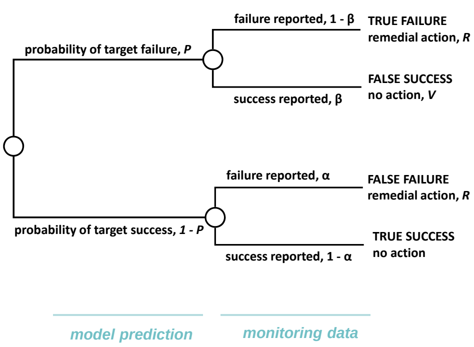
A cab was involved in a hit-and-run accident at night. A witness later identified the cab as a Green cab. The court tested the witness' ability to distinguish between Blue and Green cabs under night-time visibility conditions. It found that the witness was able to identify each colour correctly about 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?

Adapted from Eddy (1982)







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

Government of South Australia
Department of Environment,
Water and Natural Resources

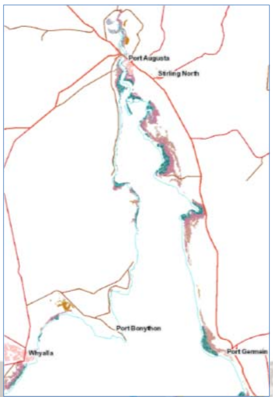
SA's coast

Government of South Australia
Department of Environment,
Water and Natural Resources

Spencer Gulf

Saltmarsh and Mangroves

- Intertidal Mangrove
- Intertidal Melaleuca
- Intertidal Samphire
- Intertidal Sedges
- Intertidal Cyanobacterial Mat
- Supratidal Mangrove
- Supratidal Melaleuca
- Supratidal Samphire
- Supratidal Sedges
- Supratidal Cyanobacterial Mat
- Stranded Tidal Samphire

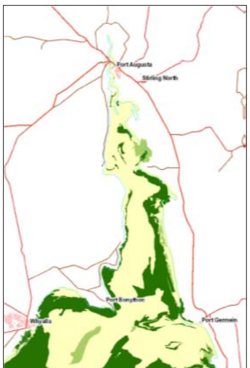


Government of South Australia
Department of Environment,
Water and Natural Resources

Spencer Gulf

National Benthic Mapping

- Sparse Seagrass
- Medium Seagrass
- Dense Seagrass
- Dense Seagrass Patches
- Granite Reef
- Heavy Limestone or Calcarenite Reef
- Low Profile Platform Reef
- Bare Sand



Government of South Australia
Department of Environment,
Water and Natural Resources

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) .

Government of South Australia
Department of Environment,
Water and Natural Resources

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

Government of South Australia
Department of Environment, Water and Natural Resources

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

Government of South Australia
Department of Environment, Water and Natural Resources

SA Policies

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

Government of South Australia
Department of Environment, Water and Natural Resources

Marine Planning in SA

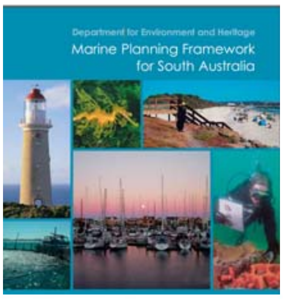
- A whole of government program guiding ecological development and use of the marine, estuarine and coastal environments through integration of planning
- Ecosystem-based planning using environmental boundaries: 8 Marine Bioregions

Government of South Australia
Department of Environment, Water and Natural Resources

Marine Planning in SA

Government of South Australia
Department of Environment, Water and Natural Resources

Marine Planning in SA



Marine Planning in SA

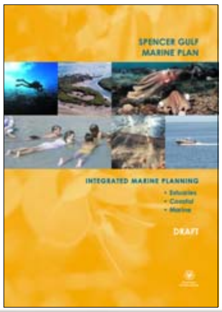
- Regional Focus Documents (inventory for each planning area)
- 6 Marine Plans: first as pilot – Draft Spencer Gulf Marine Plan
- Performance Assessment System for each plan

Marine Planning in SA

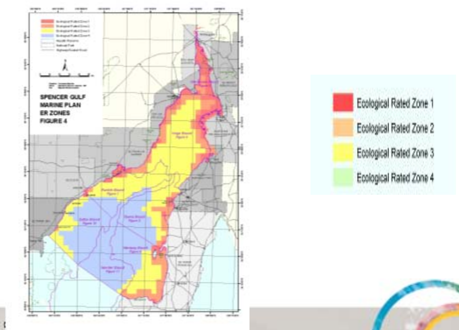
…… these Marine Plans establish an overarching strategic planning framework to guide State and local government planners and natural resources managers in the development and use of the marine environment.

(Executive Summary, June 2006)

Spencer Gulf Marine Plan



Spencer Gulf Marine Plan



Ecological Rated Zone 1

- To contain marine, estuarine and coastal habitats, and ecological processes <u>of critical importance</u> to the maintenance of biodiversity, ecological health and productivity of Spencer Gulf.
- Goal: not to exceed <u>negligible impact</u> 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 <u>essential</u> to the maintenance of biodiversity, ecological health and productivity of Spencer Gulf.
- Goal: not to exceed <u>minor impact</u> 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 <u>contribute</u> to the maintenance of biodiversity, ecological health and productivity of Spencer Gulf.
- Goal: not to exceed <u>moderate impact</u> 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

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Ecological Rated Zone 4

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

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Zones underpinned by Science

Examples:

- Habitats and processes
- threatened and protected species
- fish breeding areas
- ecological importance

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Zones informed by uses and activities

Examples:

- towns & shacks
- harbours & industry
- aquaculture
- commercial fishing
- mining
- recreational fishing

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Performance Assessment System

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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);

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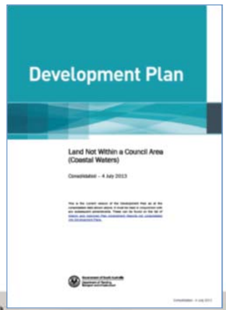
The Development Plan for Spencer Gulf



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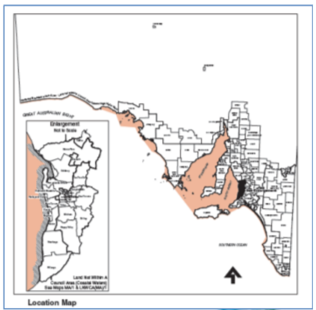
The Development Plan for Spencer Gulf



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The possible Development Plan changes

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.

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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.) …

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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.

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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

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Aquaculture Zone Provisions

AQUACULTURE ZONE

The objectives and principles of development control that follow apply in the Aquaculture Zone as shown on Zone Maps LNWCA(CW)/1 to 17 and 20 to 23.

OBJECTIVES

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

PRINCIPLES OF DEVELOPMENT CONTROL

Land Use

1 The following forms of development are envisaged in the zone:

(a) marine-based aquaculture

(i) hatchery

(ii) grow out facility

(iii) related infrastructure.

Public Notification Category

All marine aquaculture is designated Category 1 Development within the zone.

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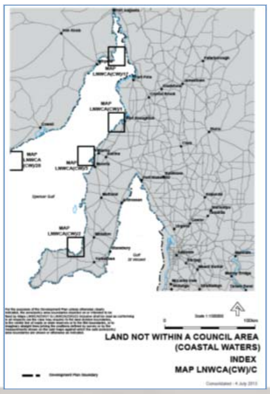

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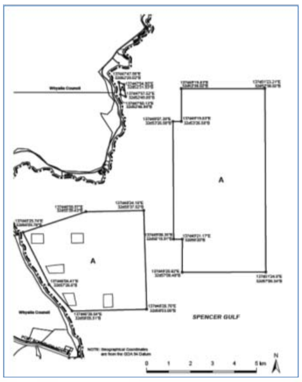

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What happened?

- 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

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of South Australia
Department of Environment,
Water and Natural Resources

Marine
Innovation
Southern Australia

MISA

Spencer Gulf Ecosystem Development Initiative

International workshop
13-16 April 2015

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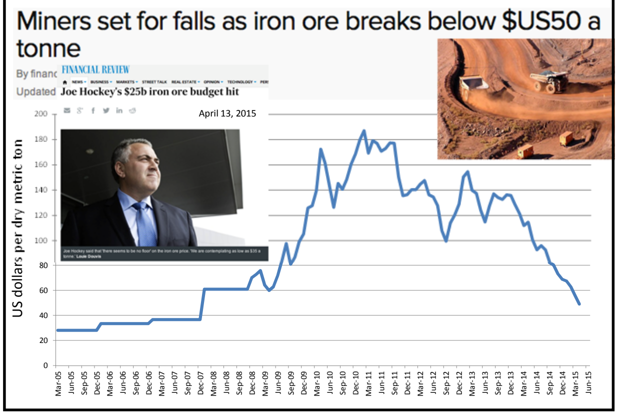
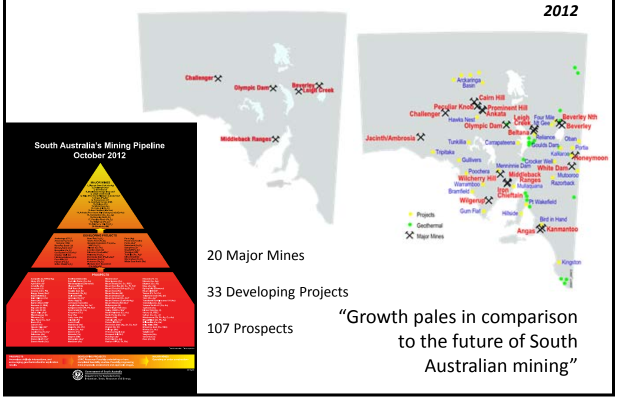


South Australia's Major Mines



20 Major Mines

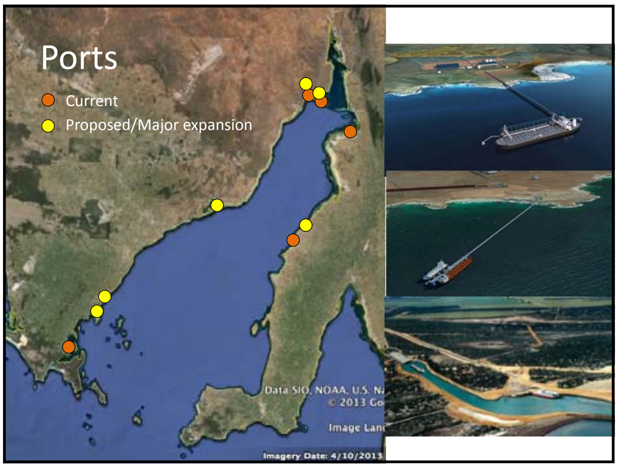
33 Developing Projects

107 Prospects

"Growth pales in comparison to the future of South Australian mining"

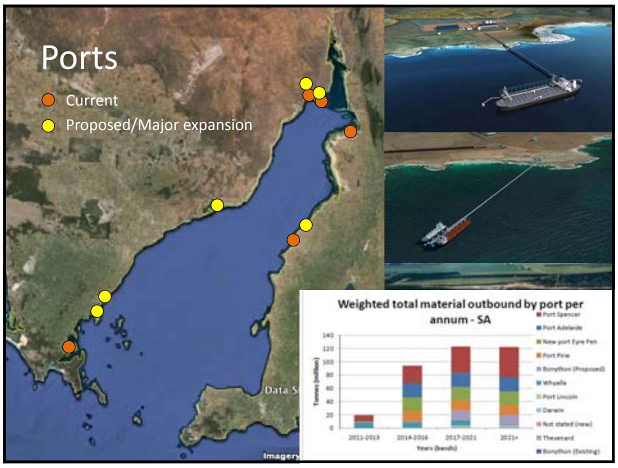
Ports

- Current
- Proposed/Major expansion



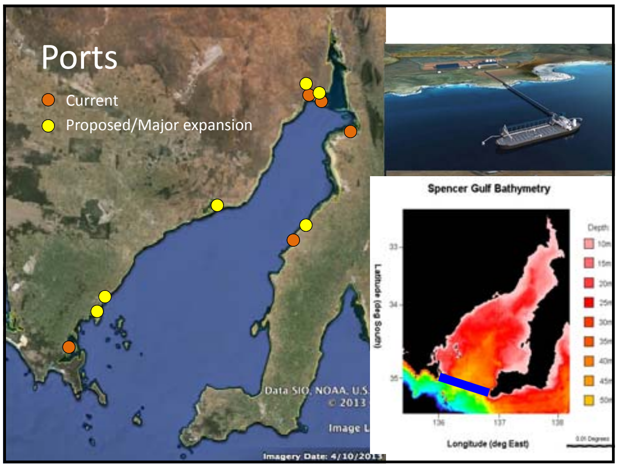
Ports

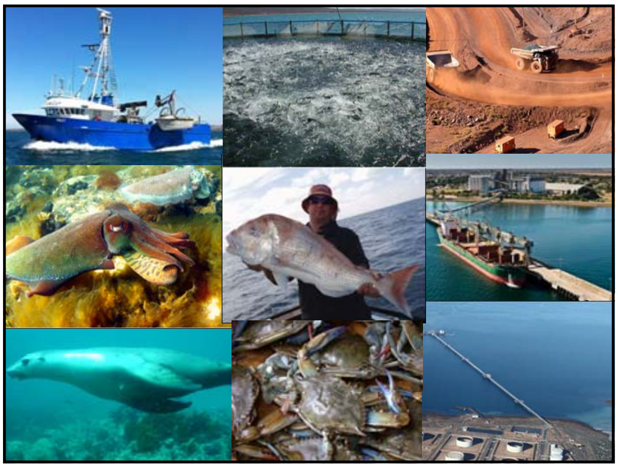
- Current
- Proposed/Major expansion



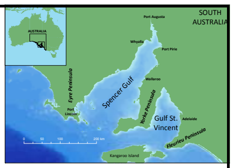
SA Regional Mining & Infrastructure Plan – June 2014

- 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

Santos
Centrex Metals
Flinders Ports
bhpbilliton resourcing the future
Government of South Australia
alintaenergy
arrium mining and materials
nyrstar
FRDC
Environment Institute

MISA
The University of Adelaide
SARDI
Flinders University

Spencer Gulf Ecosystem Development Initiative

Phase I
2012 – 2013 (1 year)

Knowledge Discovery | Stakeholder Engagement | Scenario Development

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

Aquaculture/Fisheries
FRDC funded

- Ecosystem model for fisheries & aquaculture

Metadata collation
IMOS funded

- Existing datasets

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 Activities Outcomes	**Governance:** Undertake legislative, policy and governance research to support implementation of integrated marine management	**Decision support tools:** Develop models to evaluate individual and cumulative impacts and support scenario testing for ESD outcomes	**Impacts and activities:** Acquire and collate data on individual anthropogenic activities and cumulative impacts	**Social context:** Identify and map the social values of the Gulf to the community	**Economics:** Evaluate economic benefits of anthropogenic activities undertaken throughout the Gulf	**Pests and pathogens:** Develop tools and establish monitoring programs to detect incursions and assess and mitigate risks of exotic pests and pathogens becoming established	**Iconic species:** Evaluate distribution and abundance, movements, foraging patterns, trophic linkages and status of iconic, threatened, endangered and protected species	**Pelagic ecology:** Understand factors controlling the structure and function of the pelagic ecosystem. Establish a monitoring program (with indicators) to detect impacts	**Benthic ecology:** Understand factors controlling the structure and function of the benthic ecosystem. Establish a monitoring program (with indicators) to detect impacts	**Oceanography:** Establish an integrated oceanographic monitoring system for the Gulf. Develop hydrodynamic and biogeochemical models to underpin process studies
Governance process: Establish a streamlined structure and process for integrated management of Spencer Gulf to achieve ecological, economic and social outcomes	***Decisions about future ports and shipping are made collectively by government agencies responsible for Spencer Gulf's environments, resources, industries and people.***									
Stakeholder and community engagement: Structures and processes established for ongoing consultation with stakeholders and the community	**Stakeholders and communities engaged about costs/benefits, ecological impacts and interactions with other sectors of ports & shipping.**		**Effects of current and future shipping activities presented to stakeholders and community.**	Social implications of ports and shipping conveyed to stakeholders and community.	Economic implications of ports and shipping conveyed to stakeholders and community.					
Informed and structured decision-making: Knowledge of system and decision support tools used to evaluate ESD outcomes of various management decisions and multiple use scenarios	**Decisions on future ports and shipping are based on sound independent scientific advice about social, economic and ecological impacts and benefits of various scenarios.**	**Suite of tools is used to evaluate impacts and interactions with other sectors of future ports and shipping scenarios and to evaluate ESD outcomes.**	**Impacts and interactions of current and future shipping are assessed within the context of spatial knowledge of all current and future activities.**	Social implications of ports and shipping assessed on basis of detailed knowledge of social values of the Gulf.	Economic implications of future port and shipping scenarios quantified using economic models of Gulf communities.	**Risks of introduction and establishment of exotic pests and pathogens assessed for a range of future ports and shipping scenarios.**	**Implications of future ports and shipping scenarios for iconic and threatened species evaluated based on up to date scientific information.**	Implications of future ports and shipping scenarios on pelagic system assessed on basis of understanding of critical processes on spatial and temporal dynamics.	Implications of future ports and shipping scenarios on benthic system assessed on basis of understanding of critical processes on spatial and temporal dynamics.	Sediment transport model developed to inform distribution of sediments and turbidity, and potential implications for the Gulf.
Conceptual and process models: Information collated to develop qualitative and quantitative understanding of ecosystem structure and function			**Spatial and temporal patterns of current activities and impacts synthesised. Tools developed to evaluate future use scenarios.**	Detailed understanding established of social importance of Gulf environments to surrounding communities.	Understanding established of economic importance of Gulf environments to communities. Regional economic models developed.	Tools developed to assess risks of introducing exotic pests and pathogens. Monitoring system established for key ports.	Understanding developed of status, ecology and vulnerability to anthropogenic impacts of the Gulf's iconic and threatened species.	Baseline understanding established of spatial and temporal variation in structure and function of pelagic ecosystem.	Baseline understanding established of spatial and temporal variation in structure and function of benthic ecosystem.	Continue calibration, validation & extension of Gulf coupled hydrodynamic/ biogeochemical model
Integrated monitoring program: Monitoring system established to validate process models, evaluate impacts and detect changes in ecosystem structure and function.			Ongoing collation of information on activities and impacts.	Ongoing monitoring of Gulf communities.	Ongoing monitoring of Gulf economies.	Ongoing monitoring of key ports (linked to pelagic and benthic monitoring programs).	Ongoing monitoring of key species and populations.	Ongoing monitoring of pelagic system.	Ongoing monitoring of benthic habitats.	Integrated observing system established for Gulf.

Research themes

Governance: Undertake legislative, policy and governance research to support implementation of integrated marine management	**Decision support tools:** Develop models to evaluate individual and cumulative impacts and support scenario testing for ESD outcomes	**Impacts and activities:** Acquire and collate data on individual anthropogenic activities and cumulative impacts	**Social context:** Identify and map the social values of the Gulf to the community	**Economics:** Evaluate economic benefits of anthropogenic activities undertaken throughout the Gulf	**Pests and pathogens:** Develop tools and establish monitoring programs to detect incursions and assess and mitigate risks of exotic pests and pathogens becoming established	**Iconic species:** Evaluate distribution and abundance, movements, foraging patterns, trophic linkages and status of iconic, threatened, endangered and protected species	**Pelagic ecology:** Understand factors controlling the structure and function of the pelagic ecosystem. Establish a monitoring program (with indicators) to detect impacts	**Benthic ecology:** Understand factors controlling the structure and function of the benthic ecosystem. Establish a monitoring program (with indicators) to detect impacts	**Oceanography:** Establish an integrated oceanographic monitoring system for the Gulf. Develop hydrodynamic and biogeochemical models to underpin process studies

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

Research Activities
Outcomes
Governance process: Establish a streamlined structure and process for integrated management of Spencer Gulf to achieve ecological, economic and social outcomes
Stakeholder and community engagement: Structures and processes established for ongoing consultation with stakeholders and the community
Informed and structured decision-making: Knowledge of system and decision support tools used to evaluate ESD outcomes of various management decisions and multiple use scenarios
Conceptual and process models: Information collated to develop qualitative and quantitative understanding of ecosystem structure and function
Integrated monitoring program: Monitoring system established to validate process models, evaluate impacts and detect changes in ecosystem structure and function.

Outcomes

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

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

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**

https://www.adelaide.edu.au/environment/water/spencer-gulf/

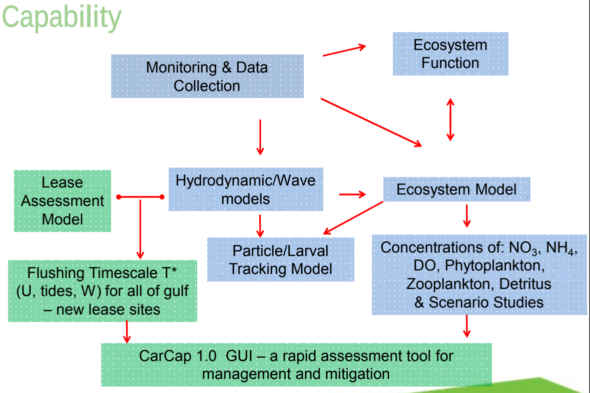
A Nutrient Carrying Capacity Decision Making Tool for Spencer Gulf

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

SOUTH AUSTRALIAN RESEARCH & DEVELOPMENT INSTITUTE
PIRSA

PREMIUM FOOD AND WINE FROM OUR CLEAN ENVIRONMENT · Australian Government Fisheries Research and Development Corporation · SOUTH AUSTRALIA · Government of South Australia Primary Industries and Regions SA · SARDI

Capability

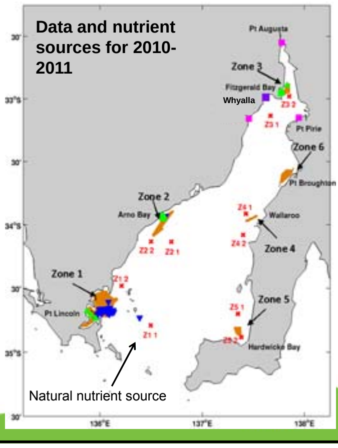


SARDI

Spencer Gulf

Legend

- 6 aquaculture zones (brown shaded regions)
- location of the ten sampling sites (red crosses)
- location of tuna (blue triangles) and finfish (green triangles) leases,
- location of waste water treatment plants (pink squares)
- Onesteel plant (purple square)
- Nutrient flux from shelf (SAIMOS)



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.

Play T/S Simulation

SARDI

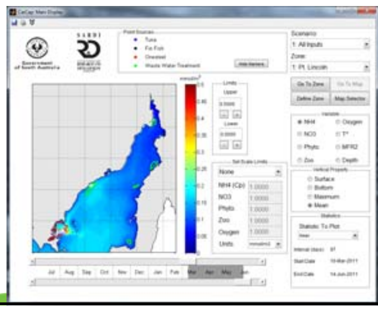
Carrying Capacity Decision Tool

- New results (Middleton et al; a,b 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., de-sal 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!
- (Play Movie)
- All incorporated into CarCap1.0 – a GUI decision making tool for future developments.
- Whole of Gulf approach shows we are all playing in the one (SG) sandpit!

SARDI

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)



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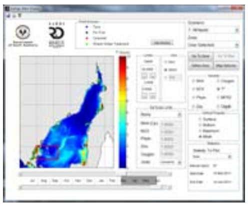
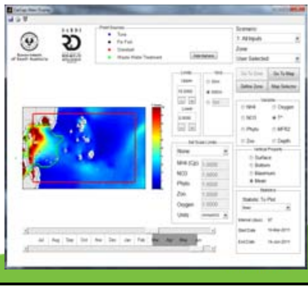
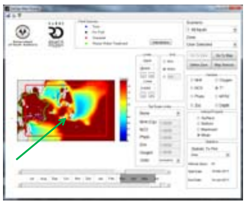
Flushing Time Scale T*: shorter flushing scale means greater dispersion and carrying capacity



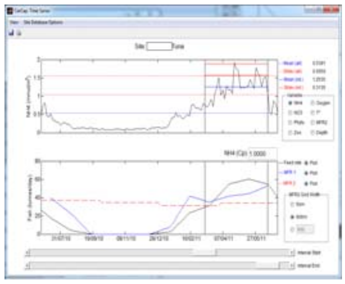


Right figure: zoom in on red box – the region of interest to test Carrying Capacity for an existing finfish lease site

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)

Developing a Spencer Gulf ecosystem model for fisheries and aquaculture

Decision support tools: ecological modelling

Partners: UoA, SARDI, PIRSA, FRDC

Collaborators: Bronwyn M. Gillanders, Thomas A.A. Prowse, Mark Doubell, John Middleton, Paul Rogers, Jason E. Tanner, Nathan A. Clisby, Charles James, John Luick, Paul van Ruth, Corey J. A. Bradshaw, Tim M. Ward

Simon Goldsworthy – SARDI Aquatic Sciences

FRDC THE UNIVERSITY of ADELAIDE Government of South Australia Primary Industries and Regions SA SOUTH AUSTRALIA Government of South Australia SARDI

Developing a Spencer Gulf ecosystem model for fisheries and aquaculture

Decision support tools: ecological modelling

SA sardine fishery	SBT grow-out industry	Spencer Gulf prawn fishery
TAC 23,000 t	~7,500 t	~1,700 t
GVP ~$20 M	GVP ~$150 M	GVP ~$28 M

How to balance fishing/aquaculture, mineral and conservation and recreation needs, while simultaneously delivering on the environmental, social and economic objectives associated with Spencer Gulf

Increasing need for decision support tools

SARDI

Developing a Spencer Gulf ecosystem model for fisheries and aquaculture

Ecopath with Ecosim (EwE) – Spencer Gulf Ecosystem (SGE)

Model area:
SGE model area 28,974 km^2

Functional groups:
The SGE model structure was built around 78 functional groups including:
- mammals (4),
- birds (6),
- chondrichthyans (9),
- teleosts (28) (including farmed SBT & YTK)
- cephalopods (4),
- other invertebrates (18),
- microbial (2),
- autotrophic (3),
- detritus (3) (including fish farm feed), and
- discard groups (1)

Dietary data:
A large dietary matrix was developed that included 328 prey taxa categories

Dietary information with high provenance to the SGE was used where available

Developing a Spencer Gulf ecosystem model for fisheries and aquaculture

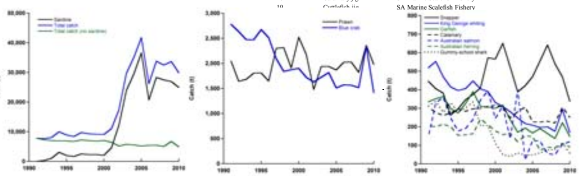
Fishery landings, discards and effort:
Fishery data on landings, discards and effort were obtained for the SGE region and broken down into 27 fishing fleets

Six main fishery management units:
- South Australian (SA) sardine (1 fleet),
- SA Marine Scalefish (19),
- Spencer Gulf prawn fishery (1),
- blue crab (2),
- abalone (2) and
- rock lobster (1).

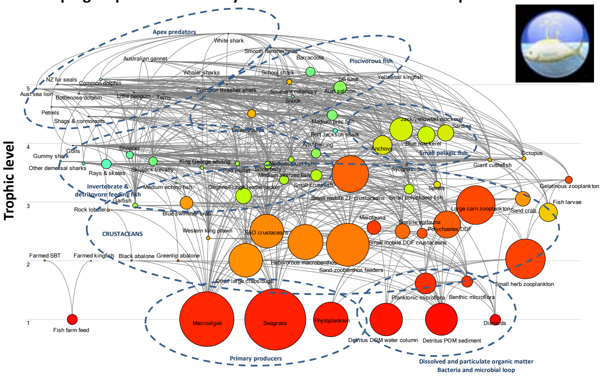
No.	Fleet name	Fishery Management Unit
1	Sardine	SA Sardine Fishery
2	Prawn	Spencer Gulf prawn fishery
3	Aust salmon PS	SA Marine Scalefish Fishery
4	Aust salmon HN	SA Marine Scalefish Fishery
5	Aust herring HN	SA Marine Scalefish Fishery
6	Garfish HN	SA Marine Scalefish Fishery
7	KGW HN	SA Marine Scalefish Fishery
8	Snook HN	SA Marine Scalefish Fishery
9	Other HN	SA Marine Scalefish Fishery
10	Garfish DN	SA Marine Scalefish Fishery
11	Snapper LL	SA Marine Scalefish Fishery
12	Snapper HL	SA Marine Scalefish Fishery
13	KGW HL	SA Marine Scalefish Fishery
14	Other HL	SA Marine Scalefish Fishery
15	Shark gillnet	SA Marine Scalefish Fishery
16	Shark LL	SA Marine Scalefish Fishery
17	Dropline	SA Marine Scalefish Fishery
18	Calamary jig	SA Marine Scalefish Fishery
19	Cuttlefish jig	SA Marine Scalefish Fishery

Time series on landings, discards and effort:
Annual fishery landings and effort data were obtained for all fleets between 1991 and 2010

Finfish aquaculture production and feed



Developing a Spencer Gulf ecosystem model for fisheries and aquaculture



Spencer Gulf Ecosystem Food Web

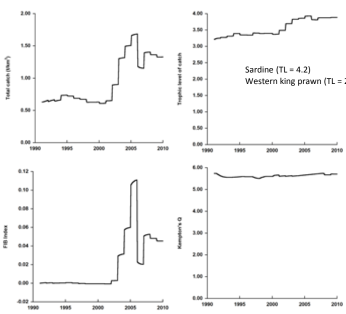
Decision support tools

Ecosystem indicators:
Total catch, trophic level of catch, Fishing in Balance (FIB) index, Kempton's Q

FIB index ~0 indicates high production at lower trophic levels with fishing in balance

FIB index >0 indicates an expansion of fishing and/or where bottom-up effects are occurring, resulting in more catch than expected

Both of these responses reflect the shift from prawns fishing being the dominant fishery in Spencer Gulf in the early 1990s to the sardine fishery being dominant by the mid-2000s



The Kempton's Q index usually decreases with increased fishing impacts (and loss of species with a trophic level >3) and increases with growing biomass of high trophic level species.

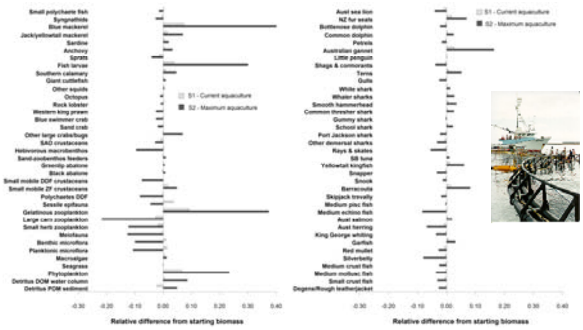
Results suggest that overall there has not been a marked change in biomass of species with a trophic level >3, nor has there been an increase in fishing impacts over the model period.

Many alternate ecosystem indicators out there: flows and biomasses - Total System Throughput (TST, the measure of total trophic flows within an ecosystem); Total Biomass of the community (TBco); mean Ecotrophic Efficiency (meanEE, the proportion of overall production used within the system) ; Flow to Detritus (FD/TST, the non-living particulate organic matter that returns to the trophic flow as a ratio of the total flow), total Respiration (per unit of trophic flow, R/TST), mean Transfer Efficiency (TEm, or the conversion of production from lower to higher trophic levels) et, etc,……**which are most relevant for which systems?**

Decision support tools

Scenario testing:
Increased aquaculture nutrient loading

Base scenario = 0 aquaculture
S1 = current aquaculture (~1.5 kT/yr)
S2 = maximum aquaculture (~6.1 kT/yr)



Finfish aquaculture provides an example of how bottom-up changes through additional nutrient loading can affect both benthic and pelagic systems through trophic cascades

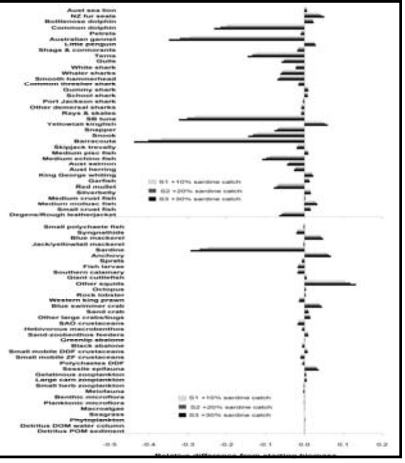
Decision support tools

Scenario testing:
Increased sardine catch

Biomass change at 2050 is plotted relative to the starting biomass in 2010 under the base scenario of Biomass change (from zero) is relative to 2010 sardine catch levels

Increased exploitation rates impact most on the target species (sardine), and their key predators

However, the relative magnitude reduction in sardine biomass under successive scenarios is less than expected in a closed system, because of the level of immigration of sardine biomass imposed on the model to ensure that observed catches would not exceed the available biomass within the SGE model domain



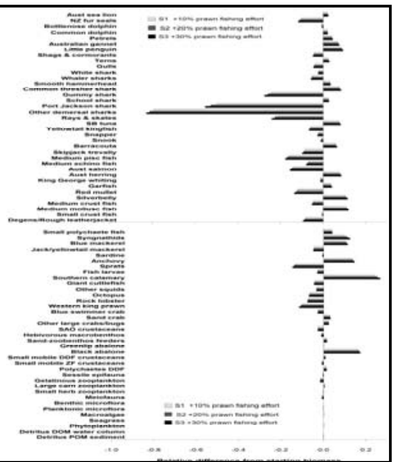
Decision support tools

Scenario testing:
Increased SG prawn fishing effort

The magnitude of biomass declines among trophic groups under increased fishery effort scenarios were an order of magnitude greater that those modelled under scenarios of increased catch

Scenario testing:

- examples provide an indication of the types of impacts that can be modelled
- there are many more possible scenarios from other fisheries that could be examined
- outputs should be viewed as indicative, informative, not quantitative



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 underpinning the trophic network, biomass and consumptions rates are robust, and that data gaps are addressed

Improving the environmental time series data sets and identifying those with biological relevance that can be used to predict ecological response - essential (e.g. climate change impacts on fisheries and aquaculture production, and the Spencer Gulf ecosystem)

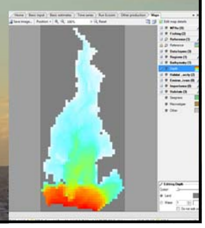
Need to develop spatial explicit (Ecospace) model, improve habitat layers, ascribe key habitats to trophic groups, and to spatially allocate fishing effort and aquaculture

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



Shipping Activity and Predicted Impacts

'Managing risk and preparedness across the biosecurity continuum'

Phill CASSEY · Tom PROWSE · Marty DEVENEY· Sally SCRIVENS

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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

Framework for predicting shipping impacts

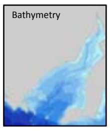
Processes

Biosecurity

Marine pests & diseases

Benthic disturbance

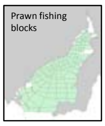
Keel clearance, dredging



Regions

Key industries

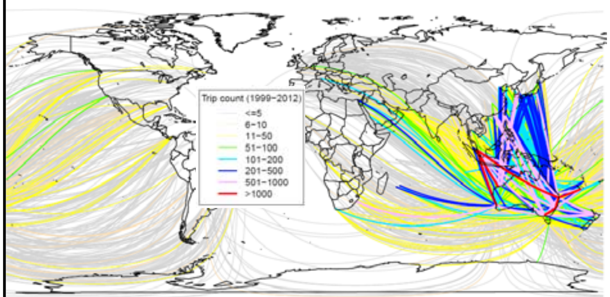
Fishing , aquaculture



Conservation

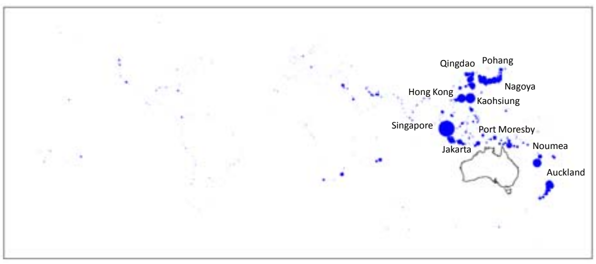
Marine parks, iconic species

Current shipping activity to Australia

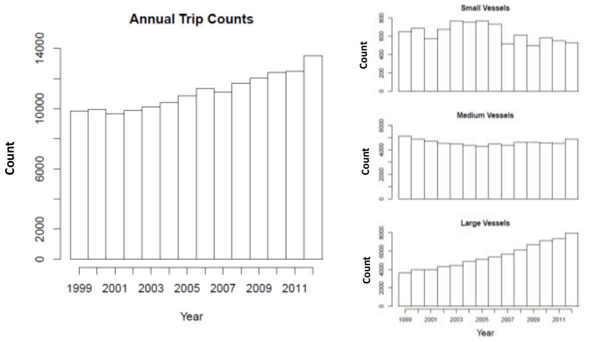


Number of trips originating from overseas ports (1999 – 2012)

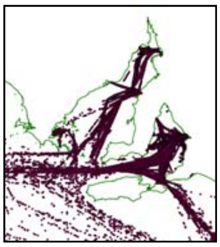
Number of trips originating from overseas ports (1999 – 2012)



Increase in recent shipping activity to Australia



Current shipping activity in Spencer Gulf

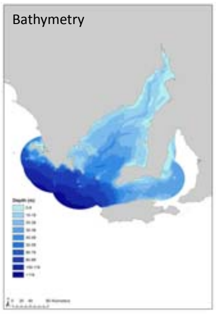


CTS locations (1 month only)

AMSA's Craft Tracking System (CTS)

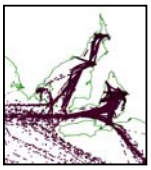
- Current shipping lanes
- Zone of influence (width) of shipping lanes, and their predictability
- Vessel speeds
- Residence times (and variability)

Current shipping activity in Spencer Gulf



Integrate with:

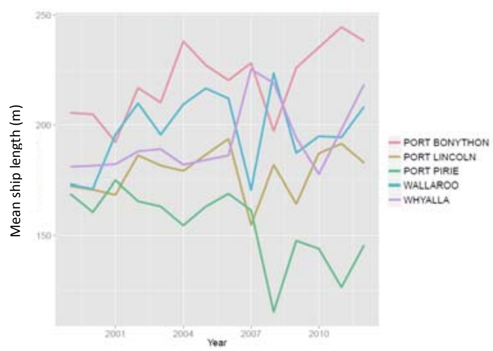
- Seabed bathymetry and multi-use zones
- Vessel characteristics (size, ballast capacity)
- Source ecoregion



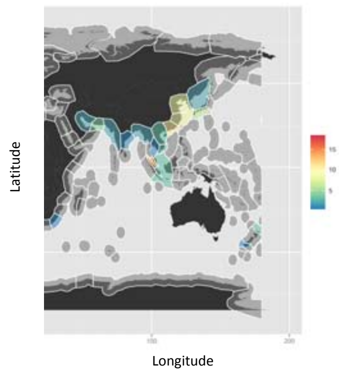
Fishing and management zones

+ Recreational use

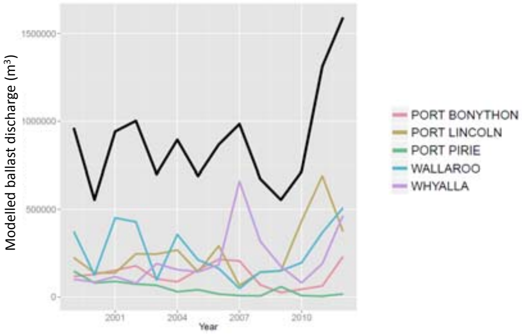
Current shipping activity: vessel characteristics



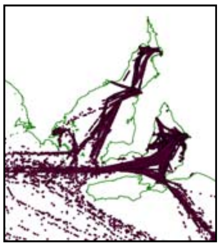
Current shipping activity: source ecoregion



Current shipping activity: ballast discharge



Port expansion & development in Spencer Gulf



CTS locations (1 month only)

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

SOUTH AUSTRALIAN RESEARCH & DEVELOPMENT INSTITUTE
PIRSA

Tim Ward
Shirley Sorokin
Bronwyn Gillanders
Gavin Begg

Adelaide, 15th April 2015

PREMIUM FOOD AND WINE FROM OUR CLEAN ENVIRONMENT

SOUTH AUSTRALIA

Government of South Australia
Primary Industries and Regions SA

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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 Prellezo (2010)

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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)

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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

Marine Planning Framework 2006 (proposed six Marine Plans, Draft SG Marine Plan; Marine Managers Forum 1999)

LARGELY NOT PROGRESSED FROM SECTORIAL APPROACHES
Progress in MEBM
IOM Aspirational

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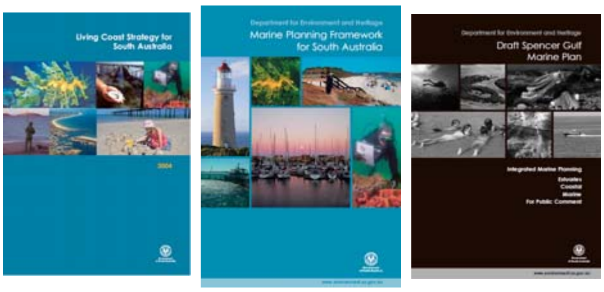
The ~~starting~~ end point?



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

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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

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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;
…

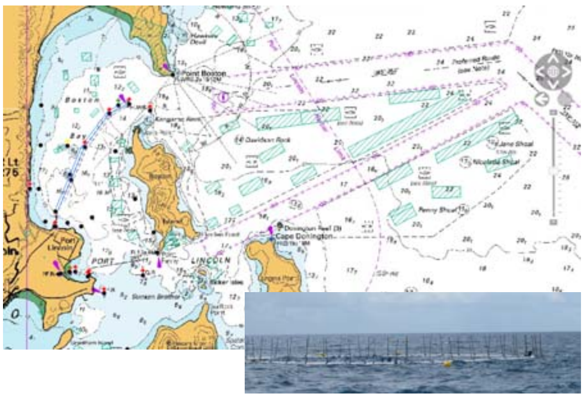
Jenny Cassidy DPTI – presentation WAC

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 (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)

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	Fisheries and Parks				Environment Protection					Resource Management			Transport	Culture	
OBJECTIVES / ACTS	Fisheries	Aquaculture	Marine Parks	National Parks	Environment Protection	Coast Protection	Prevention of pollution from Ships	Sea dumping	Climate Change & Greenhouse Emissions Reduction	Natural Resources Management	Petroleum and Geothermal Energy	Offshore Minerals	Harbors and Navigation	Native Title	Historic Shipwrecks
Conservation - productivity	✓✓	✓			✓				✓✓	✓✓✓					
Conservation - biodiversity	✓✓		✓✓✓	✓	✓				✓✓	✓✓✓		✓✓			
Conservation - habitat	✓✓		✓✓✓	✓✓	✓	✓✓✓	✓	✓✓		✓✓✓	✓✓	✓✓	✓✓		
Economic	✓✓✓	✓			✓✓✓				✓✓	✓✓✓.	✓✓		✓✓✓		
Social & cultural	✓✓✓	✓✓	✓✓✓	✓✓	✓✓✓	✓✓✓				✓✓	✓✓✓		✓✓	✓✓	✓✓
Institutional governance	✓✓✓	✓✓	✓✓✓		✓✓✓	✓✓		✓✓	✓✓	✓✓✓	✓✓✓		✓✓✓		
Research & education	✓✓	✓✓	✓			✓✓			✓✓✓	✓					

✓ implied ✓✓ mentioned ✓✓✓ detailed

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Natural Resources Management Act 2004	
OBJECTIVES for IOM	**Covered within Objects of Act**
Conservation - productivity	
Conservation - biodiversity	Protect biological diversity.
Conservation - habitat	Restore ecological systems - Ecological integrity. Prevention and control of pests. Careful evaluation of risks to environment.
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 heritage
Institutional/governance	Capacity for people to be involved in management – Involve public in decision making. Integrate long and short term economic, environmental and social. Lack of full scientific certainty not a reason to postpone prevention of environmental degradation. Local government a key participant.
Research & education	Education initiatives

	Fisheries and Parks				Environment Protection					Resource Management			Transport	Culture	
OBJECTIVES / ACTS	Fisheries	Aquaculture	Marine Parks	National Parks	Environment Protection	Coast Protection	Prevention of pollution from Ships	Sea dumping	Climate Change & Greenhouse Emissions Reduction	Natural Resources Management	Petroleum and Geothermal Energy	Offshore Minerals	Harbors and Navigation	Native Title	Historic Shipwrecks
Conservation - productivity	✓✓	✓			✓				✓✓	✓✓✓					
Conservation - biodiversity	✓✓		✓✓✓	✓	✓				✓✓	✓✓✓		✓✓			
Conservation - habitat	✓✓		✓✓✓	✓✓	✓	✓✓✓	✓	✓✓		✓✓✓	✓✓	✓✓	✓✓		
Economic	✓✓✓	✓			✓✓✓				✓✓	✓✓✓	✓✓		✓✓✓		
Social & cultural	✓✓✓	✓✓	✓✓✓	✓✓	✓✓✓	✓✓✓				✓✓	✓✓✓		✓✓	✓✓	✓✓
Institutional governance	✓✓✓	✓✓	✓✓✓		✓✓✓	✓✓		✓✓	✓✓	✓✓✓	✓✓✓		✓✓✓		
Research & education	✓✓	✓✓	✓			✓✓			✓✓✓	✓					

✓ implied ✓✓ mentioned ✓✓✓ detailed

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Range of objects in Acts

SA Act	Conservation - biodiversity
Fisheries Act	Protect from endangerment
Marin… Act	
Nation… and W… Act	
Enviro… Protec…	
Natura… Resou… Manag… Act	

SA Act	Social/cultural
Fisheries Act	Recreational fisheries fostered
Marine Parks Act	Protect cultural heritage Provide education / Enjoyment Protect for future generations
National Parks and Wildlife Act	Hunting and gathering by Aboriginal persons Enjoyment of parks by public
Environment Protection Act	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
Natural Resources Management Act	Education initiatives Capacity for people to be involved in management. Protect or enhance for future generations Consideration to Aboriginal heritage

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 focused (GHHP)

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

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