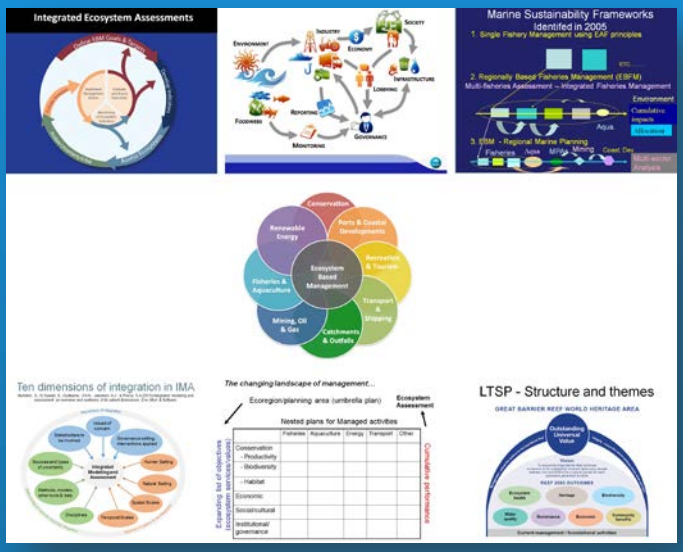
SOUTH AUSTRALIAN RESEARCH & DEVELOPMENT INSTITUTE
PIRSA

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

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

ISBN: 978-1-921563-80-5

FRDC PROJECT NO. F2008/328.21

SARDI Aquatic Sciences
PO Box 120 Henley Beach SA 5022

July 2015

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

PREMIUM FOOD AND WINE FROM OUR CLEAN ENVIRONMENT

FRDC FISHERIES RESEARCH & DEVELOPMENT CORPORATION

SOUTH AUSTRALIA

Government of South Australia
Primary Industries and Regions SA

SARDI RESEARCH AND DEVELOPMENT INSTITUTE

Practical steps to implementation of integrated marine management

Report of a Workshop, 13-15 April 2015

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

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

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

ISBN: 978-1-921563-80-5

FRDC PROJECT NO. F2008/328.21

July 2015

ISBN: 978-1-921563-80-5

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

F2008/328.21

2015

Ownership of Intellectual property rights

This publication (and any information sourced from it) should be attributed to:
Begg, G. A., Stephenson, R. L., Ward, T. M., Gillanders, B. M. and Smith, A.D. *Practical steps to implementation of integrated marine management. Final report for the Spencer Gulf Ecosystem and Development Initiative and the Fisheries Research and Development Corporation*, Adelaide, July.

Creative Commons licence

Disclaimer

Researcher Contact Details

Name:	Gavin Begg
Address:	SARDI 2 Hamra Ave
	West Beach SA 5024
Phone:	08 8207 5482
Fax:	08 8207 5481
Email:	Gavin.Begg@sa.gov.au

FRDC Contact Details

Address:	25 Geils Court
	Deakin ACT 2600
Phone:	02 6285 0400
Fax:	02 6285 0499
Email:	frdc@frdc.com.au
Web:	www.frdc.com.au

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

Contents

Figures

Acknowledgments

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

Abbreviations

CPUE – Catch Per Unit Effort

EAF – Ecosystem Approach to Fisheries

EBFM – Ecosystem Based Fisheries Management

ESD – Ecologically Sustainable Development

FAO – Food and Agricultural Organisation

FGM – Fishery Gross Margin

FRDC – Fisheries Research and Development Corporation

GVP – Gross Value of Production

MEY – Maximum Economic Yield

PIRSA – Primary Industries and Regions South Australia

SARDI – South Australian Research and Development Institute

SGEDI – Spencer Gulf Ecosystem and Development Initiative

TAC – Total Allowable Catch

Executive Summary

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

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

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

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

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

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

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

Keywords

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

Introduction

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

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

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

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

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

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

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

Objectives

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

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

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

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

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

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

Methods

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

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

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

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

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

Results[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).

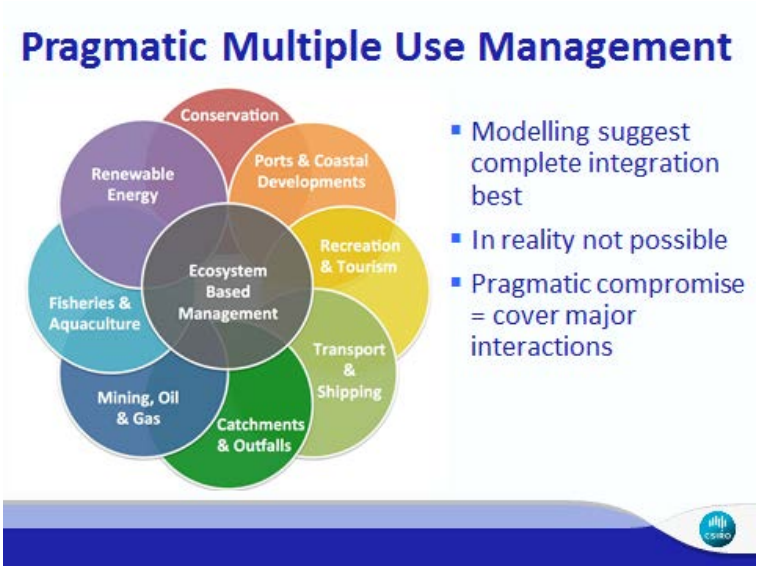


Figure 2. Integrated marine management captures the range of user groups, often with competing objectives (from Fulton, see Appendix 5).

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.

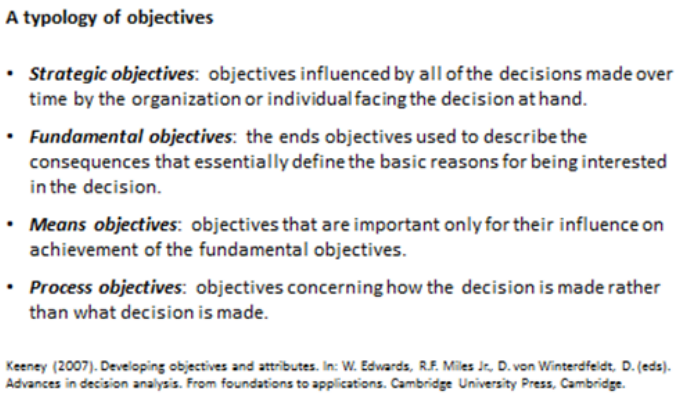


Figure 3. Typology of objectives – strategic to process (from Walshe, see Appendix 5).

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).

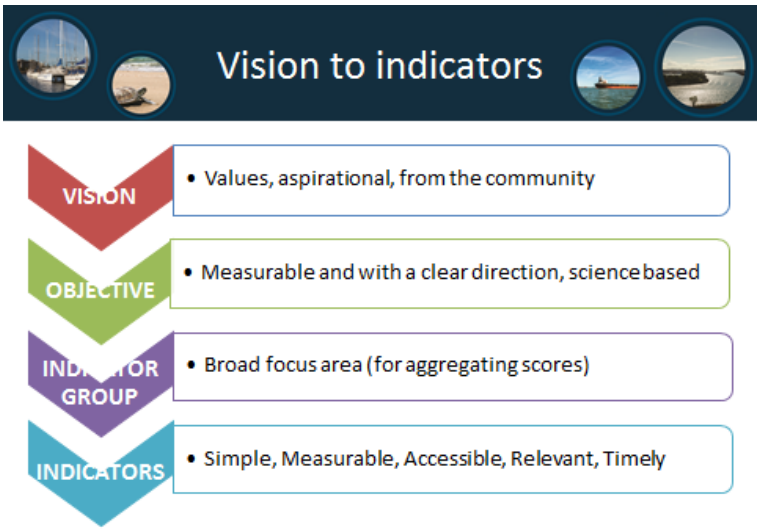


Figure 4. Example of objective setting across multiple stakeholders (from Poiner and McIntosh, see Appendix 5).

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.

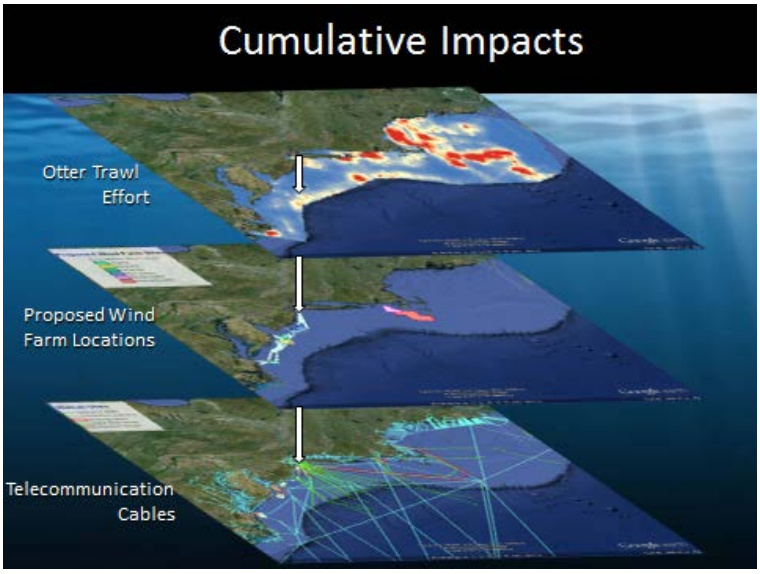


Figure 7. Understanding cumulative impacts involves assessing the effects of multiple activities (from Fogarty, see Appendix 5).

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.*

References

Day, V., Paxinos, R., Emmett, J., Wright, A., and Goecker, M. (2008). The marine planning framework for South Australia: A new ecosystem-based zoning policy for marine management. Marine Policy 32, 535-543.

Gillanders, B.M., Doubleday, Z., Cassey, P., Clarke, S., Connell, S.D., Deveney, M., Dittmann, S., Divecha, S., Doubell, M., Goldsworthy, S., Hayden, B., Huveneers, C., James, C., Leterme, S., Li, X., Loo, M., Luick, J., Meyer, W., Middleton, J., Miller, D., Moller, L., Prowse, T., Rogers, P., Russell, B.D., van Ruth, P., Tanner, J.E., Ward, T., Woodcock, S.H., and Young, M. (2013). Spencer Gulf Ecosystem and Development Initiative. Report on scenario development, stakeholder workshops, existing knowledge and information gaps. Report for Spencer Gulf Ecosystem and Development Initiative. The University of Adelaide, Adelaide. 94 pp.

Gillanders, B.M., Goldsworthy, S., Prowse, T.A.A., Doubell, M., Middleton, J., Rogers, P., Tanner, J.E., Clisby, N.A., James, C., Luick, J., van Ruth, P., Bradshaw, C.J.A., and Ward, T.M. (2015). Spencer Gulf research initiative: Development of an ecosystem model for fisheries and aquaculture. FRDC Project No 2011/205. University of Adelaide and SARDI Aquatic Sciences, Adelaide.

Government of South Australia. (2006). Marine planning framework for South Australia. Coast and Marine Conservation Branch, Natural and Cultural Heritage, Department for Environment and Heritage, Adelaide, p. 34.

McLeay, L., Doubell, M., Roberts, S., Dixon, C., Andreacchio, L., James, C., Luick, J., and Middleton, J. (in press). Prawn and crab harvest optimisation: a bio-physical management tool. Final Report to the Fisheries Research and Development Corporation. FRDC Project 2008/011. 80 pp.

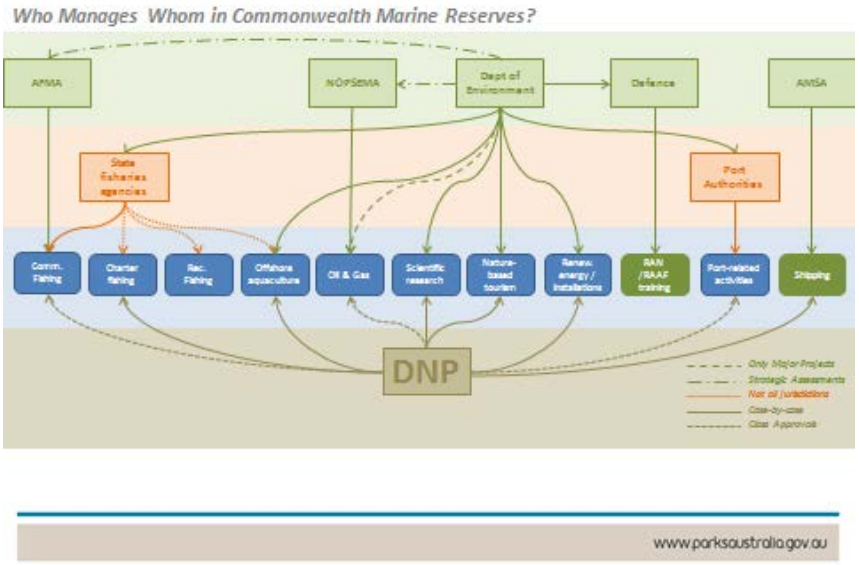
Paxinos, R., Wright, A., Day, V., Emmett, J., Frankiewicz, D., and Goecker, M. (2008). Marine spatial planning: Ecosystem-based zoning methodology for marine management in South Australia. Journal of Conservation Planning 4, 37-59.

Shepherd, S.A., Madigan, S., Gillanders, B.M., Murray Jones, S., and Wiltshire, D. (2014). Natural History of Spencer Gulf. Royal Society of South Australia, Adelaide.

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).



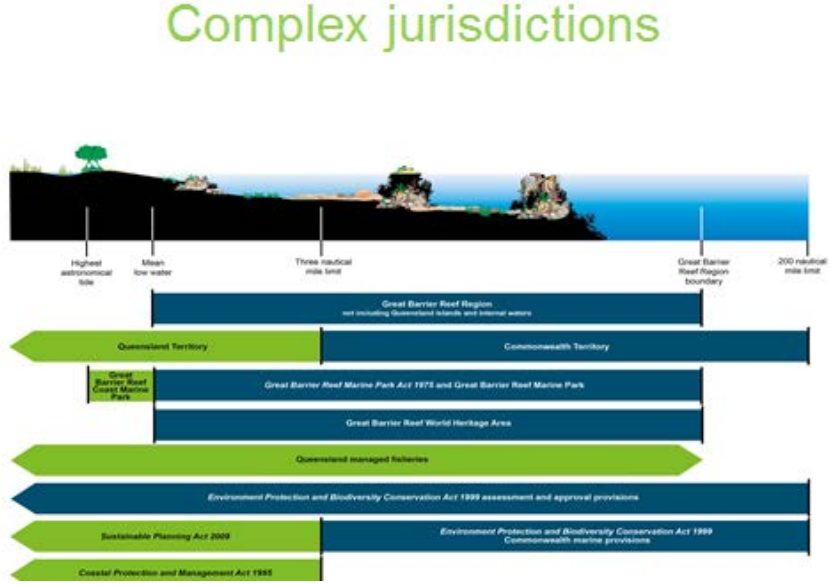


Figure 8. Examples demonstrating complexity of management arrangements across Commonwealth and State jurisdictions (from Musso, Harman, see Appendix 5).

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.

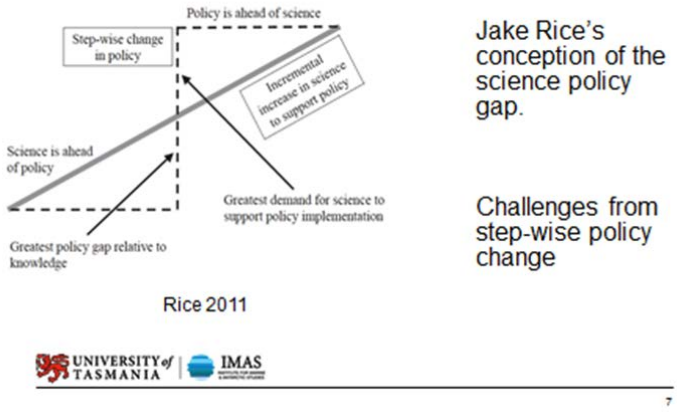


Figure 9. Step-wise policy-shifts, such as integrated marine management, require a greater demand for science to support decision-makers (from Haward, see Appendix 5).

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.

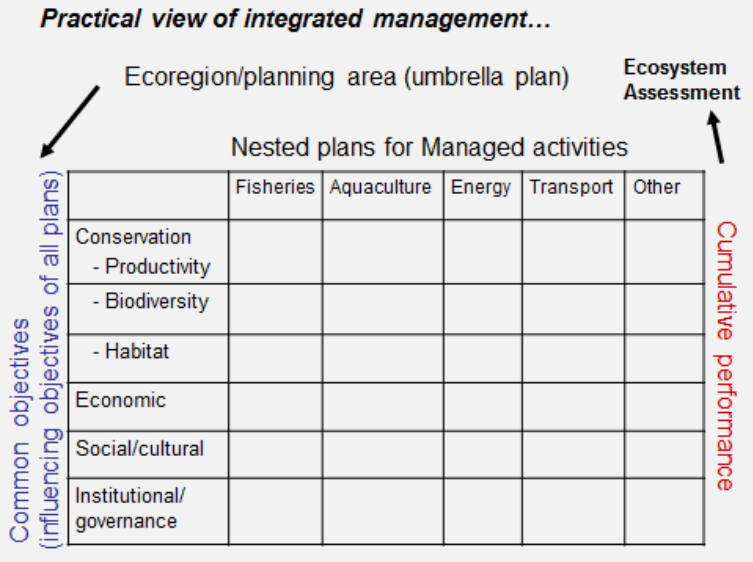


Figure 10. Common framework for specifying multiple objectives across multiple activities (from Stephenson, see Appendix 5).

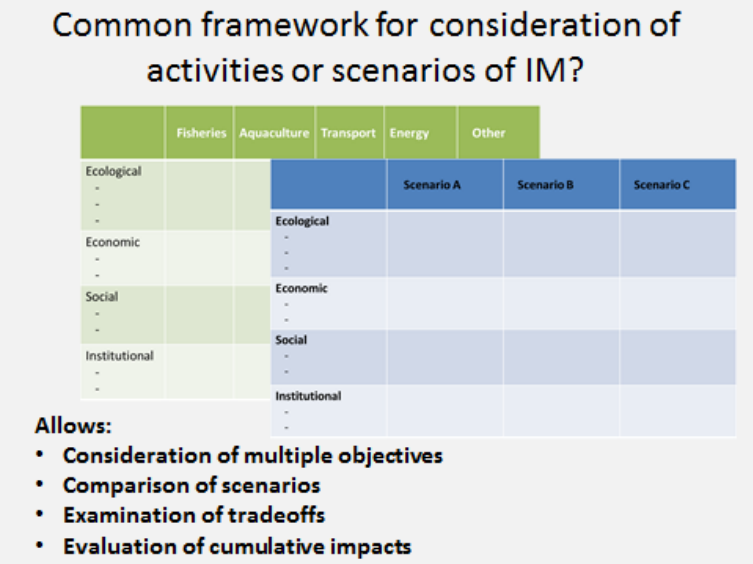


Figure 11. Common framework enables assessment of alternate management scenarios and their trade-offs (from Stephenson, see Appendix 5).

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

Begg, G.A., Brooks, K.J., Stephenson, R.L., and Sloan, S.R. (2014). Practical implementation of social and economic elements in ecosystem based fisheries management and integrated fisheries management frameworks. SARDI Publication No. F2014/000315-1, SARDI Research Report Series No. 765, Adelaide, 85 pp.

Fletcher, W.J. (2012). National Application of Sustainability Indicators for Australian Fisheries - Part 2: Ecosystem based frameworks for aquaculture, multi-fishery and international applications. FRDC Report – Project 2000/145 Part 2. Fisheries Research Report No 235 Department of Fisheries, Western Australia.

Fletcher, W.J., Chesson, J., Fisher, M., Sainsbury, K.J., Hundloe, T., Smith, A.D.M., and Whitworth, B. (2002). National ESD Reporting Framework for Australian Fisheries: The 'How To' Guide for Wild Capture Fisheries. FRDC Project 2000/145, Canberra, Australia.

Millington, P., and Fletcher, W. (2008). Geelong revisited: from ESD to EBFM - future directions for fisheries management.Workshop Report FRDC 2008/057. Pp. 58 in *Fisheries Occasional Publication*. Melbourne: Department of Fisheries, Western Australia.

Smith, D.C., and Hodge, R. (2001). ESD and fisheries: what, why, how and when. A stakeholders workshop. Proceedings. Geelong, Victoria, 23-14 March 2000. Seafood Industry Victoria, South Yarra, Victoria.

Vince, J., Smith, A.D.M., Sainsbury, K.J., Cresswell, I.D., Smith, D.C., and Haward, M. (2015). Australia's Oceans Policy: past, present and future. *Marine Policy* **57**, 1-8.

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

Petrina Apfel **NSW Department of Primary Industries**	Petrina Apfel has been closely involved in developing an innovative cross-agency approach to managing NSW coasts and waters for four years. Petrina is a Principal Policy Officer with the NSW Department of Primary Industries. She is the marine estate Secretariat Manager. She supports the NSW Marine Estate Management Authority and expert knowledge panel. She also managed the secretariat for the Independent Scientific Audit of Marine Parks in NSW. Petrina has experience leading the development and enforcement of legislation across different jurisdictions, including the NSW Marine Estate Management Act 2014 and matters of national environmental significance under the EPBC Act.
'Beyond boundaries: NSW Marine Estate' What does a new statewide approach to sustainable marine management look like? A 2012 audit of NSW marine parks concluded that effective marine management must extend beyond marine park boundaries. The NSW Government has set up a strategic, evidence-based approach to managing the NSW marine estate as a continuous system. A new Marine Estate Management Authority has been established. This Authority is overseeing the development of a Marine Estate Management Strategy. The strategy will be underpinned by assessment of threats and risks. It will articulate how government programs will be better coordinated and focus on priority threats, to support a diverse, healthy and productive coast and sea now and into the future.	
Dr Phill Cassey **University of Adelaide**	Phill Cassey is Head of the Invasion Ecology Group at the University of Adelaide, and co-Director of the Environment Institute's Centre for Conservation Science and Technology. He is a quantitative ecologist who works at the forefront of biosecurity preparedness and transport pathway risk mitigation.
Current shipping transport into Australia and predictions of likely future scenarios for shipping activities Both the International Maritime Organization and the Australian Government have developed policy seeking to reduce the risk of ship-mediated biological marine invasions. We constructed models for the transfer of ballast water into Australian waters, based on historic ballast survey data. We used these models to hindcast ballast water discharge over all vessels that arrived in Australian waters between 1999–2012. We used models for propagule survival to compare the risk of ballast-mediated propagule transport between ecoregions. We found that total annual ballast discharge volume into Australia more than doubled over the study period, with the vast majority of ballast water discharge and propagule pressure associated with bulk carrier traffic. As such, the ecoregions suffering the greatest risk are those associated with the export of mining commodities.	
Dr Mark Dickey-Collas **ICES**	Mark Dickey-Collas (@DickeyCollas) is the ecosystem approach coordinator in the secretariat of the International Council for the Exploration of the Sea (ICES) based in Copenhagen. ICES is an intergovernmental organisation (20 member countries) that focuses on marine science for sustainable use of the seas in the North Atlantic region. It is a network of more than 4000 scientists from over 350 marine institutes. Mark facilitates the development of the ecosystem approach for sustainable exploitation of the marine ecosystem and regional ecosystem assessments. He is currently active with ICES' contribution to the EU marine strategy framework directive (MSFD). Mark liaises with OSPAR, HELCOM, IUCN, FAO, 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

	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,

U.S. Geological Survey	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.

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.

Dr Beth Fulton **CSIRO**	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.

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.

Prof Bronwyn Gillanders **University of Adelaide**	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.

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