National Marine Science **Plan**

Science program to support **Decision-making**

Plan for pilot implementation Integrated Ecosystem Assessments in Australia Working Group Report

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NATIONAL MARINE SCIENCE – COMMITTEE –

JULY 2022

NATIONAL MARINE SCIENCE COMMITTEE

This report was prepared by a subset of the Integrated Ecosystems Assessment Working Group formed by the National Marine Science Committee: David Smith (Chair, to March 2022), National Research Providers Network; Beth Fulton, CSIRO Oceans and Atmosphere; and, Anthony Boxshall (current Chair), Marine and Coastal Council, Victoria

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Acknowledgement of Country |

The NMSC acknowledges the Traditional Custodians and Elders of the land and sea on which we work and observe, and recognises their unique connection to land and sea. We pay our respects to Aboriginal and Torres Strait Islander peoples past, present and future.

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- NSW Marine Estate Management
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- ABARES
- Fisheries Research & Development Corporation
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- Australian Fisheries Management Authority
- NESP Marine and Coastal Hub

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Introduction and Aim of the Plan

The use of ocean and coastal area resources is expanding at a rapid (close to exponential) rate (Plaganyi and Fulton 2019, Jouffray et al., 2020) causing mounting pressure on coastal and marine systems through the activities of multiple sectors such as fisheries, oil and gas, marine renewable energy, seabed mining, shipping, and urban and coastal development. All of these activities are occurring against a background of climate-driven impacts (IPCC 2019), increasing risk and shifting baselines (Pauly 1995), necessitating climate resilient decisions about the management of coastal and marine resources. The five largest global risks are now perceived to be environmental - climate action failure, natural disasters, human-made environmental disasters, extreme weather and biodiversity loss (World Economic Forum Global Risks Perception Survey 2020). The challenges that this complexity pose becomes particularly clear where sectors have conflicting objectives or result in user conflict. All of this makes ensuring the sustainable management of these increasingly crowded marine spaces difficult – as it means balancing the needs and desires of the many competing users (including conservation), each with their own objectives, values, drivers and effects.

The full benefits and opportunities for maximising community wellbeing, through careful management of the blue economy (greater than $100 billion by 2025 in Australia alone – National Marine Science Plan 2015-25) cannot be fully met without adopting a new integrated approach that comprehensively takes into account the various objectives, requirements and values of the multiple sectors. The OECD conservatively estimated the value of the blue economy in 2010 at $US 1.5 trillion and this is anticipated to grow to $US 3 trillion by 2030 (OECD, 2016). Continued growth will place additional pressures on the ecosystems that support this economic activity. The number of interactions involved in these complex systems quickly exceed "common sense" judgment and can overwhelm those tasked with management, leading to conflicts between users, additional pressure on the systems and contentious decision making. Furthermore, extant approaches to management are sectorally based, treating individual ocean use sectors separately; fisheries, conservation, energy, shipping and Coastal Zone Management are generally all handled separately, by different regulatory bodies and jurisdictions, with little formal interaction, and generally through different legislative and policy instruments, which don't consider interactions within and between sectors, cumulative impacts or 'social licence to operate'. Therefore, such an integrated approach cannot be focused only on biophysical components but would need to be explicitly transdisciplinary – linking the physical environmental, natural world and the human parts of marine and coast systems by calling upon many expert disciplines (from First Nations, science, industry, regulatory bodies, NGOs, community groups etc). This new approach should not be a replacement for individual sector regulatory processes or marine spatial planning but would provide a broader context – a system level picture of what is going on. This would more transparently identify what needs to be considered with marine spatial planning and regulatory processes; going further than simple map overlays to look at interactions and trade-offs between different parts of marine and coastal systems (physical, natural and anthropogenic).

> *"The problem that this tool solves is a shared problem across all our jurisdictions. We should take a "bottom-up" approach (via jurisdictions and agencies) to prove the concept, and then make it national."*
> (Agency reps at IEA Implementation Planning workshop July 2021)

The NMSP recommended developing a dedicated and coordinated science program to support decision making by policymakers and marine industry. Science priorities included: improving the scientific evidence base and the available decision-support tools for those managing the impacts of multiple and cumulative drivers and pressures on marine systems; and the integration of social, economic and cultural factors into marine estate assessments, and into decision processes for resource allocation and development. While integrated frameworks are emerging in some States, Integrated Ecosystem Assessments (IEA) are the emerging international solution to this question of providing a scientific

evidence base to complex marine and coastal system management questions. The IEA approach was originally developed in the US and Europe to serve as a scientific foundation for marine ecosystem-based management. It is most useful in identifying trade-offs in the management of different marine industries and sectors, identifying cumulative impacts, and dealing explicitly with uncertainty. Consequently, an Integrated Ecosystem Assessments (IEA) Working Group was established by the National Marine Science Committee to consider how IEAs could be implemented in Australia.

The Working Group completed an extensive report in 2021 (Smith et al 2021). The report provided an overview of the IEA approach and current usage, compared it to other approaches, described Australian case studies and identified potential pilots. The recommendations of the report were that:

1. The NMSC continues to support IEAs as the preferred way of addressing the NMSP recommendation for a dedicated and coordinated science program to support decision-making by policymakers and marine industry.

2. A national trial of the potential pilot(s) is undertaken, the process and results of these pilots are evaluated and reviewed and used to develop a set of IEA Guidelines for implementation nationally.

3. The criteria and considerations identified by the working group are adopted to ensure the effectiveness of future IEAs.

4. The Working Group be expanded and tasked with developing an implementation plan in conjunction with decision-makers and other stakeholders.

The NMSC adopted these recommendations with a focus on expanding the working group the development of an implementation plan in conjunction with decision-makers and other stakeholders. The Australian State of Environment report 2021 (released in mid-2022) referenced the IEA tools and relevant NMSC reports in the marine chapter (SoE 2021, p175).

To develop this Implementation Plan, a series of workshops were held by the expanded working group. The results of those discussions are presented here. The aim of this plan is to provide further details on how pilots might be implemented, including progress to date, their rationale, required resources and timelines and potential governance. First aspects of the IEA approach, the international and national context are briefly summarised (full details can be found in Smith et al 2021).

While this report presents a single static summary of the status of IEA use across Australia in mid-2022, the IEA Implementation working group will continue to meet every 6 months to advance the use of IEA.

The core purpose of the Implementation Working Group meeting from now is to share intelligence and lessons learned from the applications of IEA approaches in the different jurisdictions, as a way to translate the science into practice – or as it was described in the July 2022 meeting: to move from a "science push" to an "end-user pull" approach.

Integrated Ecosystem Assessment Approach

The IEA approach (Figure 1) is an interdisciplinary and policy-orientated process. It uses multiple tools and methods to combine, interpret and communicate knowledge from diverse knowledge systems (i.e., multiple scientific disciplines, traditional and local knowledge, and experiential knowledge from industry). The resulting information is used to inform and enhance decision-making.

The individual tools used may change over time as technologies come and go. Likewise, the policies and ministries serviced can turnover. The underlying concept however remains stable: to provide a systemic view; to bring together information on the interactions and needs across different parts of the system; to make explicit the values and concerns of each sector; and ultimately to enable government, investors

and key stakeholders to evaluate development and environmental futures at regional and local scales; identifying areas where development and environmental conservation values overlap, compete or complement; and ensuring interactions and feedbacks between different aspects of the system (natural and anthropogenic), are recognised and that suitable options for processes and assessment practices are identified to avoid, mitigate or offset the risks involved for all parties and to a region's (environmental, economic, social or cultural) values.

Figure 1: The iterative Integrated Ecosystem Assessment (IEA) process

The IEA process includes several distinct steps (Figure 1), which are applied iteratively. These steps are:

1. **Engagement:** Initial and ongoing engagement keeps participants informed, addresses needs and issues, reduces misunderstanding and builds support for management actions.
2. **Scoping:** Identifies the geographic area, valued components of the system to be managed – environmental, economic, social and cultural – associated pressures and management objectives.
3. **Identifying indicators:** Easily measured indicators, which track the status and any changes in the valued system components (ecosystem and socio-economic).
4. **Assessing system status:** Integrate information across the set of indicators to assess system status and trends relative to historical conditions and management goals.
5. **Assessing risk:** Determine the likelihood that each indicator will reach or remain in an undesirable state, given the combined impact of existing pressures and proposed activities.
6. **Assessing uncertainty:** Identify uncertainties associated with the risk analyses, existing knowledge, different value systems, and the variability of natural systems.
7. **Evaluating management options:** Translate the findings of the previous assessment steps into implications for management.

8. **Monitoring and evaluation:** Continued monitoring (systematic collection of environmental, social and economic data) and assessment of indicators, which outline management performance.

The benefits of this iterative, adaptive process accrue as each step is initiated and new information becomes available. The ultimate outcome being that decision-making is integrated into the system context, reducing the overall associated costs and risks (the true magnitude of which was previously unappreciated as it was spread over many portfolios and jurisdictions).

In describing the IEA process above, most of the components are also seen in other approaches and processes, especially other approaches building on adaptive management. Management generally involves governance processes and specific tools for deliver specific activities. Those familiar with processes such as marine spatial planning (MSP), ecosystem approach to fisheries (EAF) and integrated coastal zone management (ICZM) will see common touch points with IEA. Similarly, those used to implement management tools (e.g. marine protected areas (MPA) and zoning, fisheries closures, Particularly Sensitive Sea Areas (PSSA) and fisheries effort controls) will also see how IEA touches on how those tools are implemented. The key difference, however, is that the IEA process is more comprehensive and focussed on assessing the impacts of multiple sectors, particularly their interactions, with objectives either spanning all sectors or being shared between sectors.

Table S1 (provided in the appendix and derived from Dunstan *et al.,* 2016) provides a comparison of the different approaches to help those unfamiliar with IEA to see how it relates to other management and planning processes they may be more familiar with.

International and National Context

Over the past two decades the rapid expansion of uses of the ocean, increasing human population levels and a growing understanding of the collective footprint we have on the ocean has driven a search for more inclusive and comprehensive planning processes. The IEA process initially put forward by Levin *et al*., (2009) is both integrative and management oriented. Since its first inception it has continued to evolve in specific detail – as it is tailored to the conditions and needs at individual sites and as new tools become available – but the adaptive and integrative core concepts remain unchanged and follow the process outlined above. It's application in North America (via NOAA[1]) and Europe (via ICES[2] working groups) has seen it used for the identification of management issues across ecosystem components, cultural values and marine and coastal sectors.

The use of IEAs has also coincided globally, with a desire to find a means of identifying cumulative effects on ocean health and to support planning across sectors. Since the mid-1990s a number of methods have been put forward (e.g. Halpern et al 2012; Stelzemüller et al 2018), though most of these are still additive in nature (ignoring feedbacks and compounding interactions) and there is not yet a universally adopted approach. Nevertheless, from a scientific stand point integrated systemic approaches are more mature than may at first be appreciated from a practitioner's view point (DePiper *et al.,* 2017). There is certainly plenty of scope for refinement or modification – as dictated by jurisdictional needs – but the basic structure and flow of the IEA process are demonstrably in place in

[1] https://www.integratedecosystemassessment.noaa.gov/
[2] http://www.ices.dk/explore-veus/Action%20Areas/Pages/Integrated-ecosystem-assessments.aspx

the countries bordering North Atlantic; where IEAs are a natural progression in policy and regulatory shift to an ecosystem-based approach to resource and conservation management. The integrated management plans derived from the IEAs in these locations play a strategic role, informing planning and large-scale decision making around spatial zoning, levels of use and prioritisation of management interventions and funding across sectors. In particular, by taking a systemic view they have been able to make savings where funding originally applied by sector was failing to deliver on what were really cumulative effects problems. For example, in Chesapeake Bay millions had been separately invested into water quality improvement and shellfish fisheries recovery without appreciating the linked nature of the problem. Once the link was appreciated and a systemic view taken, working together across sectors saw greater outcomes with smaller overall investments as the different sectors were no longer (accidentally) working at odds.

The level of understanding required when implementing an IEA – such as understanding of the relationship between human activities and marine ecosystems, estimates of pressures and effects, and science-based advice regarding sustainable use and management options – means that IEAs in Europe and North America have been broken up regionally. This is because there is an appreciation that information availability and understanding that can enable IEA is not uniform across all areas and that there are different mixes of pressures and objectives in the different locations.

While full IEAs have never been undertaken in Australia, there are examples of similar but partial approaches that provide useful information on what has worked in an Australian context and what was less successful. A full description of some example case studies – Ningaloo, the Great Barrier Reef, Gladstone's Healthy Harbour Partnership and the alternative management strategies for the AFMA managed Southern and Eastern Scalefish and Shark Fishery – are provided in Smith et al (2021). In more recent years a push for more integrated planning and management at state government levels have seen exercises that are already close to IEAs in form and could create useful pilots of the process in Australia (discussed further in the next section).

One reason for Australia to be on a planning pathway that is already converging on an IEA approach is that key components of the basic concept underlies some Australian planning processes, particularly those relevant to Strategic Assessments under the EPBC Act. Moreover, the basic concepts of inclusive adaptive management also underly Australian sectoral management (e.g. in fisheries) and the creation of the Commonwealth Marine Parks.

The full IEA process is, however, richer than what has been applied historically in Australia. A full IEA involves a level of engagement (across sectors, interest groups etc), appreciation of interconnectivity, and formal iterative risk assessment not previously applied in Australian. Aspects of the approach have recently been met in NSW and Victoria, and Westport in Western Australia also seems to be on track. In those locations it is typically been the later steps that may not have seen the full IEA treatment – as discussed further in the following sections.

Over the past two decades (and especially within the last 10 years) more than 40% of Australia's coastline has been negatively affected by extreme events that damage marine habitats – such as seagrass, mangroves and kelps. This means that the services provided by those biodiverse ecosystems – water filtration, coastal protection, the formation of nursery grounds for coastal fish species, and carbon storage – have been reduced. At the same time the construction of infrastructure and the industrial use of coastal and ocean spaces has been expanding. Altogether the value of Australia's marine industries has grown from around $25 billion in 2001/2002 to over $80 billion in 2017/2018 (supporting close to 400,000 FTE workers, AIMS (2020)). Contributions come from a diverse set of sectors, though tourism and the energy sector dominate. The importance to the Australian economy is on part with the

construction industry, or agriculture, or coal mining. With the introduction of legislation pertaining to offshore renewable energy production passing through parliaments and planning processes in place for offshore developments the continuing upward trajectory seen in the northern hemisphere is likely. All this means that the pressure on Australia's marine and coastal socioecological systems and the need for IEAs will not diminish.

Rationale for Proposed Australian Pilots

The full IEA process has not been implemented to date anywhere in Australia, but a number of recent activities go some way through the process and may provide a good (and cost effective) launch point for complete pilots while delivering on their original purposes. These potential pilots and their progress are shown in Figure 2 and summarised briefly in the following sections. A longer list of activities, including past projects that can provide case study insights into individual steps of an IEA are summarised in Smith et al (2021).

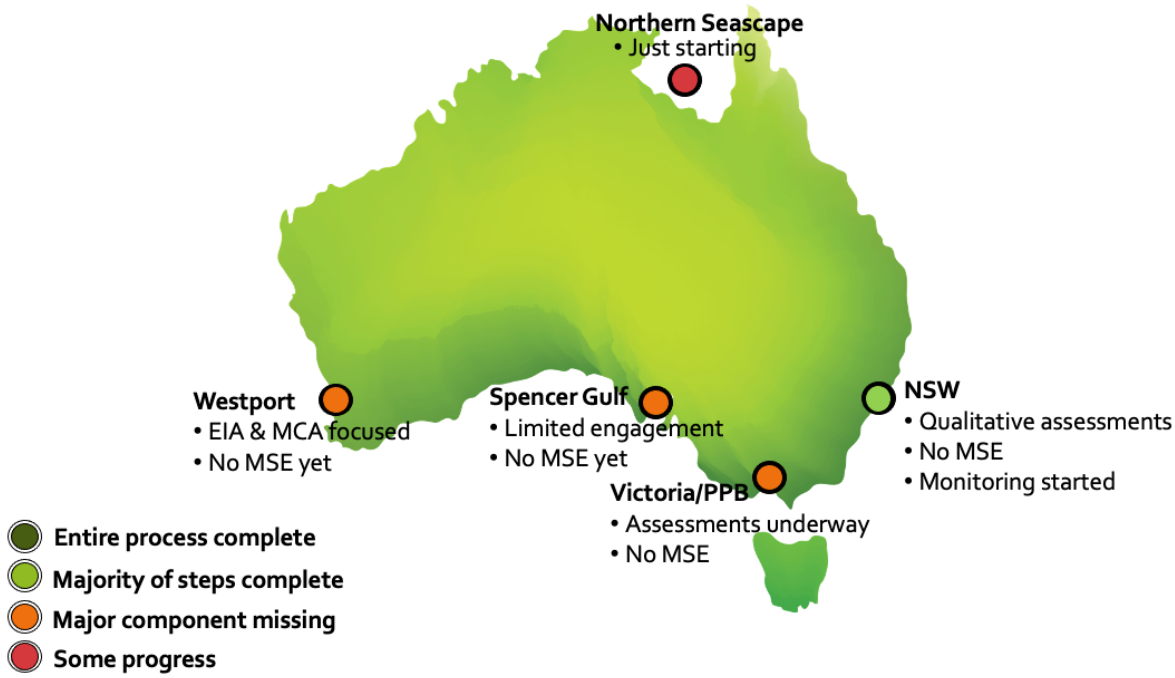

Figure 2: Location of potential pilots and a qualitative indication of IEA progress to date

The potential pilots have been selected in conjunction with agency representatives from the different jurisdictions around Australia. In this way we can guarantee they are part of ongoing policy processes with legitimate potential for on the ground impact. This tight link to a path to impact means that the IEA implementation (and any necessary refinements) would be ensured to meet Australia's needs. Smith et al (2021) identified 4 pilots. Following the workshops an additional pilot, Westport WA, was added.

These proposed pilots cover different spatial extents, are from regions with different ecosystems, different sets of industries and competing objectives, represent areas of differing user complexity and different levels of data and knowledge to assess the effectiveness of the tools with different levels of certainty in data and information. By testing this range of locations, a benchmark set of needs can be articulated for other future uses, locations and jurisdictions in Australia.

The maturity of each of the potential pilots was rated (either by experts on that system or using information provided by the experts) in terms of whether the components for a full IEA have been, are partially in place or would still need to be completed. The rating system used is outlined in Table 1. The ratings (summarised in the following sections) indicate that the proposed pilots fit into 3 categories; highly mature; work in progress; and little or no progress.

Table 1: Description of IEA components and what is required to receive a rating of "Yes (available/complete)", "Partial" or "No". Note that darker red in the No column (as shown in the overall status entry here) indicates that the enabling element does not yet exist or that the IEA stage has not been commenced.

	Description of what is required to achieve this rating		
	Yes	**Partial**	**No**
Overall Status			
IEA Stages (in the case study tables this will be coloured based on the scores across all of the IEA stages)			
Initial engagement (often in the form of objectives defined by all participating groups)*	Objectives agreed by all parties	Objectives agreed on by some parties (some conflicts or gaps remain)	No agreed objectives
Scoping	Scoping defined and complete	Scope partially defined (e.g. across only some dimensions)	Scoping incomplete
Indicator development	Indicators defined and agreed	Indicators identified for at least some components (may not yet be verified)	Indicators have not been identified
Ecosystem assessment	Assessment complete	Assessment in progress but incomplete (e.g. only for some aspects/sectors)	Assessment just commenced or little progress
Risk assessment	Assessment complete	Assessment in progress but incomplete	Assessment just commenced or little progress
Uncertainty assessment	Assessment complete	Assessment in progress but incomplete	Assessment just commenced or little progress
Evaluation of management options	MSE model exists and assessment complete	Model development in progress/complete but assessment not finalised	No MSE model exists or assessment has made little progress
Monitoring and evaluation	Monitoring program implemented in adaptive management framework	Monitoring program relatively recently introduced in an adaptive management framework	Monitoring program just being formulated or is not part of adaptive management
Iteration	Ongoing cycle of engagement, review and updates on objectives and performance	Some communication of outcomes or haphazard inclusion of some parties in subsequent rounds	Failure to engage and no updates provided to broader audiences

Consistent **engagement** is crucial

* This engagement must include all key players – across research/academia, industry, other users, regulators, traditional owners, other members of civil society

We also provide preliminary estimates of the resources required to complete a full IEA for each pilot. However, the options for the required resources could include a step-change approach or a gradual and incremental collaboration. It is important to note that for the latter, there are

significant advantages in working through steps of an IEA even if a full IEA is not completed. The approach taken will depend on opportunities presented by each pilot

Victorian Coastline

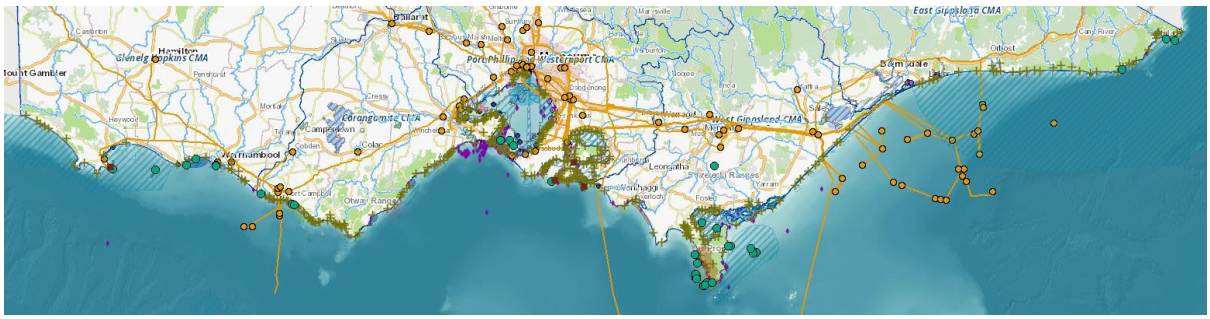

Figure 3: Location of Victorian Coastline Pilot area. *This image sourced from the Victorian Department of Environment, Land, Water and Planning is a visual example of the complexity of arrangements and activities in the Victorian marine estate.*

Scope and Progress to date

There are two distinct geographic options for a Victorian site in a broader national pilot study of IEA. Both have different drivers and levels of maturity of available data, information and management tools. Much of the available data and information in Victoria is patchy and partial, spatially incomplete and/or strongly sector based. As Victoria is the State with the smallest coastline length in Australia (only 2512 km long), the geographic scope could be expanded to include the entire Victoria marine environment. This could include or exclude the 3 other major, fully marine embayments in Victoria (i.e., Port Phillip, Western Port and Corner Inlet). While Gippsland Lakes are genuinely estuarine (and marine in many places) they are not fully marine and could be considered in or out of scope. While there are similar traditional owner, recreational and biodiversity drivers as for Port Phillip Bay resulting from the inclusion of the Outer Coast as the Victorian option, there are different industry, and fisheries drivers for the Outer Coast. One important and major benefit of the Outer Coast being considered as the Victorian option is the new Marine Spatial Planning Framework (DELWP 2020[3]). This framework is designed to enable decision-making to resolve cross-sectoral conflicts over use in the Victorian marine environment.

A Victorian site (Figure 3) in the national pilot study of implementing IEA could be characterised as a "Work in Progress" site: new, very contemporary and moderately matured frameworks, practices and processes, coupled with steeply growing access to data and information, low-medium "off-the-shelf" modelling capacity, a number of genuine wicked problems, and medium to high levels of agency, community and political interest. Progress against IEA components for Victoria's coastline is shown below with that for Port Phillip Bay for comparative purposes.

[3] https://www.marineandcoasts.vic.gov.au/__data/assets/pdf_file/0027/456534/Marine-and-Coastal-Policy_Full.pdf Page 64

	Status for Port Phillip Bay	Status for Victorian Outer Coast
Overall Status	Work in Progress	Work in Progress
IEA Stages		
Engagement	Yes (High)	~ Partial
Scoping	Partial/complete	~ Partial
Indicator development	~ Partial	~ Partial
Ecosystem assessment	~ Partial	~ Partial
Risk assessment	~ Partial	× Not initiated (Partial in MPAs)
Uncertainty assessment	× Not initiated	× Not initiated
Evaluating Management Options	× Not initiated	× Not initiated
Monitoring and evaluation	~ Partial	~ Partial
Iteration	Partial/complete	~ Partial (beginning)
Notes on available models	PPBIM, EwE, (outdated) Atlantis	NA – there is nothing available that covers the full outer coast of Victoria
Key references & links	Grey literature reports[4]	Grey literature reports[5]

[4] https://www.marineandcoasts.vic.gov.au/__data/assets/pdf_file/0021/330519/Final-Transition-Plan_August-2018.pdf
https://www.environment.vic.gov.au/__data/assets/pdf_file/0025/49813/Marine-and-Coastal-Ecosystem-Accounting-Port-Phillip-Bay.pdf
https://www.marineandcoasts.vic.gov.au/__data/assets/pdf_file/0024/88710/PPB-EMP-2017-Main-Doc.pdf
https://www.ces.vic.gov.au/sites/default/files/reports/State%20of%20the%20Bays%20Update%202017.pdf

[5] https://www.ces.vic.gov.au/reports/state-environment-2018/marine-coastal-environments
https://www.ces.vic.gov.au/sites/default/files/SoE2018ScientificAssessment_MC.pdf
https://www.marineandcoasts.vic.gov.au/__data/assets/pdf_file/0021/330519/Final-Transition-Plan_August-2018.pdf
https://www.environment.vic.gov.au/__data/assets/pdf_file/0025/49813/Marine-and-Coastal-Ecosystem-Accounting-Port-Phillip-Bay.pdf
https://www.marineandcoasts.vic.gov.au/__data/assets/pdf_file/0024/88710/PPB-EMP-2017-Main-Doc.pdf
https://www.ces.vic.gov.au/sites/default/files/reports/State%20of%20the%20Bays%20Update%202017.pdf
Statewide Social research:
https://www.marineandcoasts.vic.gov.au/__data/assets/pdf_file/0029/438329/Final-Report-Wave-5-Victorian-Marine-and-Coastal-Attitudes-Research.pdf
Links to fisheries related research/data can be found at: https://vfa.vic.gov.au/recreational-fishing/recreational-fishing-grants-program/licence-fees-at-work/your-licence-fees-at-work-research-reports

Opportunities, resources required and timelines

There is the need, and opportunity for a large-scale pilot of this decision-making process to be trialled in Victoria in the short-term future. There are current state-wide processes that could enable this to occur. The Marine and Coastal Policy 2020 contains a Marine Spatial Planning Framework that is currently being implemented and the Commissioner for Environmental Sustainability is required to deliver a State of the Marine and Coastal Environment for Victoria in coming years. Both processes require some of the gaps identified in the table above to be filled to achieve their stated outcomes. Hence there is an opportunity to explore use of the IEA process to support the achievement of Victorian policy outcomes, while building on the expanded knowledge base begin created under these scheduled activities.

Given the leverage created by the scheduled activity, to deliver on the stated policy objectives, and fill the scientific gaps for an IEA pilot for either Port Phillip Bay or the Victorian Outer Coast, an investment in the range of $3-4 million is estimated to be needed.

Timeline

Implementation of the Marine and Coastal Policy 2020 and its Marine Spatial Planning Framework is underway. The Marine and Coastal Strategy 2022 sets out the Victorian Government's direction and priorities for implementation of the policy and framework over the next five years.

Pilot Governance

Victorian sites offer the opportunity of a relatively matured governance and legislative framework with a new and very contemporary Act (MACA 2018[6]), a strong current focus of agencies, State Government agenda of reform for climate resilience and sustainable use (DELWP 2018[7]), new marine and coastal management tools being rolled out and used (DELWP 2020[8]), very high public profile and population use (VCC – Wave 4 2011[9] and VMaCC – Wave 5 2019[10]) all based on a foundation of low-medium data, information and knowledge products (Victorian SoE 2018[11]). The Marine and Coastal Strategy, which was released in May 2022, includes five key actions for the next five years. One of these actions is focused on continuing implementation of Victoria's Marine Spatial Planning Framework.

There will be the first ever Victorian Marine and Coastal State of the Environment report completed in 2022-23 (DELWP 2018[12]). There are growing, large scale offshore renewable energy projects planned or in preparatory stages (e.g., Star of the South[13]), which are highlighting the challenges of navigating expanded uses of the offshore environments when there is little understanding of cumulative effects and evolving federal policies and requirements. Moreover, challenges to historically dominant

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[6] https://www.legislation.vic.gov.au/in-force/acts/marine-and-coastal-act-2018/003
[7] https://www.marineandcoasts.vic.gov.au/__data/assets/pdf_file/0021/330519/Final-Transition-Plan_August-2018.pdf
[8] https://www.marineandcoasts.vic.gov.au/__data/assets/pdf_file/0027/456534/Marine-and-Coastal-Policy_Full.pdf
https://www.marineandcoasts.vic.gov.au/coastal-management/marine-and-coastal-strategy
[9] https://www.marineandcoasts.vic.gov.au/__data/assets/pdf_file/0024/405951/Wave_4_Report_270201_FINAL.pdf
[10] https://www.marineandcoasts.vic.gov.au/__data/assets/pdf_file/0029/438329/Final-Report-Wave-5-Victorian-Marine-and-Coastal-Attitudes-Research.pdf?_ga=2.43190949.1821754841.1590133832-1640165112.1590133832
[11] https://www.ces.vic.gov.au/sites/default/files/SoE2018ScientificAssessment_MC.pdf
[12] https://www.marineandcoasts.vic.gov.au/__data/assets/pdf_file/0021/330519/Final-Transition-Plan_August-2018.pdf Page 18
[13] http://www.starofthesouth.com.au/the-project

industries, such as fisheries (due to the impacts of climate change; Pecl *et al.,* 2011) mean maintaining sustainability will not necessarily be straightforward.

The Victorian Government is in treaty negotiations with Traditional Owners (see First Peoples' Assembly[14]), which offers a genuine overlay of traditional owner input and influence on any IEA pilot involving sea country. In a number of places there are active Country Plans that include sea country priorities (e.g., GLWaC 2015[15] and Eastern Marr 2015[16]).

NSW Marine Estate

Scope and Progress to date

The marine estate is one of the most significant natural resources in NSW and includes around one million hectares of estuary and ocean, with more than 1,750 kilometres of ocean coastline, 6,500 kilometres of estuarine and coastal lakes foreshores, 826 beaches, 44 offshore islands, and 185 estuaries and coastal lakes. Over six million people live within 50 kilometres of the coastline, including the people of eleven coastal Aboriginal nations who are intimately connected to their Land and Sea Country. The NSW community derives social, cultural, and economic benefits from the marine estate, which are underpinned by good water quality, healthy habitats, and diverse and abundant marine life.

In 2018, the Marine Estate Management Authority released the Marine Estate Management Strategy (MEMS) (MEMA, 2018)[17], which provides the overarching framework for coordinated management of the marine estate to deliver its vision for 'a healthy coast and sea, managed for the greatest well-being of the community, now and into the future' (Brooks and Fairfull, 2017).

A key input into the strategy were the results of a threat and risk assessment of the entire marine estate (BMT WBM 2017)[18], which was conducted in accordance with the principles developed by the Authority for such assessments, and was guided by the Authority's Threat and Risk Assessment Framework (MEMA 2015[19]). An important step in categorising risk was the description of a region's environmental assets and evaluation of the threats to these assets from the specific activities (MEMA, 2017a)[20]. In NSW, these threats and resulting risks were assessed by defining a set of common stressors that may result in impacts on specific environmental assets, including seabed habitats and associated assemblages, the water column, and threatened and protected species.

The process also included the identification and categorisation of the benefits that communities gain from the marine estate and the threats and risks to those benefits (Jordan *et al.,* 2016, Gollan *et al.,* 2019). A broad range of benefits were identified including participation (e.g., socialising and sense of community), enjoyment (e.g., enjoying the biodiversity and beauty), cultural heritage and use, intrinsic and bequest values, the viability of businesses, and direct economic values. Threats to community

[14] https://www.firstpeoplesvic.org/about/the-treaty-journey-so-far/
[15] https://www.gunaikurnai.org/wp-content/uploads/gk_whole-of-country%20plan%20LR%20FINAL%20270815.pdf
[16] http://easternmaar.com.au/wp-content/uploads/2012/10/EM_CountryPlan_FINAL.pdf
[17] https://www.marine.nsw.gov.au/__data/assets/pdf_file/0007/815596/Marine-Estate-Management-Strategy-2018-2028.pdf
[18] https://www.marine.nsw.gov.au/__data/assets/pdf_file/0010/736921/NSW-Marine-Estate-Threat-and-Risk-Assessment-Final-Report.pdf
[19] https://www.marine.nsw.gov.au/__data/assets/pdf_file/0010/561628/NSW-marine-estate_threat-and-risk-assess-framework.PDF
[20] https://www.marine.nsw.gov.au/__data/assets/pdf_file/0006/672198/NSW-Marine-Estate-Threat-and-Risk-Assessment-background-environmental-information-TARA-report.PDF

benefits were categorised as resource use conflict, environmental, governance, public safety, critical knowledge gaps and lack of access.

Over $105 million has been allocated to the MEMS by the NSW Government in its first four years of implementation, with a record $182 million now committed to the remaining six years of the ten-year Strategy. Progress in achieving identified outcomes is assessed at 2, 5 and 10 years to ensure outcomes are being met and intended benefits realised. This periodic evaluation is guided by Marine Integrated Monitoring and Evaluation Framework (Aither 2019)[21]. The environmental component is being evaluated through an environmental condition framework due for completion in mid-2022. The social, cultural and economic component is being evaluated through a community wellbeing framework, which includes an integrated set of wellbeing indicators. The monitoring program aims to measure and detect changes in community wellbeing at a local and state-wide scale within the NSW marine estate.

This is the most mature of the four pilots with most IEA components completed, summarised below. As with Victoria, however, alternative pilot locations exist within NSW. For example, work around Botany Bay may present a strong opportunity to complete an IEA in short order while simultaneously delivering into an ongoing process.

	Status for New South Wales waters
Overall Status	Almost complete
IEA Stages	
Engagement	Yes
Scoping	Yes
Indicator development	Yes
Ecosystem assessment	Yes
Risk assessment	Yes
Uncertainty assessment	Yes (qualitative)
Evaluating Management Options	~ Partial
Monitoring and evaluation	Yes (ongoing)
Iteration	Yes
Notes on available models	EwE, Atlantis (both for 1990s state)
Key references & links	Jordan *et al.,* (2016) Brooks and Fairfull (2017) Gollan *et al.*, (2019) Key relevant grey literature: MEMA (2015, 2017a,b, 2018) BMT WBM (2017) Aither (2019) Aither (2021)

[21] https://www.marine.nsw.gov.au/__data/assets/pdf_file/0004/1193296/MIMP-Framework.pdf

Opportunities, resources required and timelines

As the most mature of the pilots, most IEA components have been completed. The components that require further attention include Uncertainty Assessment and Evaluation of Management Options. The former would benefit from a quantitative analysis and the latter has been partially completed. Completing both components would provide greater certainty regarding potential future management options and trade-offs. These could be undertaken for less than $500K.

Timeline

To date, the MEMS has completed most of the IEA stages (see table above). MEMS has been funded in three stages. The first two stages have received over $105 million over four years. The NSW Government recently committed $182 million to continue to reduce priority threats over the remaining six years of the Strategy. which includes work), as well as the Marine Integrated Monitoring and evaluation to measure success is built into the implementation of the MEMS with Program (MIMP) for ongoing monitoring, formal program evaluations undertaken after 2, 5 and 10 years of delivery. These steps are planned and budgeted for, and on track to be undertaken as scheduled, to enable adaptive management., program health checks, and reporting. As such, the MIMP will be a centrepiece of the program guiding (i) monitoring condition and trend of environmental assets and community benefits, (ii) evaluating effectiveness of management initiatives, and (iii) filling key knowledge gaps, with a review of the State-wide Threat and Risk Assessment planned at 5 (mid-program) and 10 years (end of program) of program implementation after ten years

Pilot Governance

A governance and program management framework are already in place that coordinates across four agencies and facilitates broader partnerships. An independent panel assessed the MEMS against the Recurrent Expenditure Assurance Framework and gave it a confidence rating of HIGH based on the strong governance structures in place, and rigorous project management, reporting and risk management approaches. The Marine Estate Management Authority (MEMA) was established in 2013 and brings together the heads of the NSW Government agencies with key marine estate responsibilities. It advises the NSW Government on policies, priorities and the direction of management of the marine estate. Cross agency committees at various levels meet regularly to ensure integration and cooperation, such as the Marine Estate Agency Steering Committee (Director level) and the Intergovernmental Working Group (Program Leads and nine Initiative leads). They work closely with the independent Marine Estate Expert Knowledge Panel, who provide expert social, cultural, economic, and marine biological and ecological advice to MEMA on a range of priority areas. The Marine Integrated Monitoring Program Steering Committee has also been established to oversee the implementation of the MIMP and has cross membership with the management committees.

Spencer Gulf

Scope and progress to date

The most appropriate South Australian location for a case study in national pilot study of implementing IEA is Spencer Gulf (Shepherd *et al.,* 2014; Smith *et al.,* 2017; Stephenson *et al.,* 2019). Spencer Gulf is a region of high economic and cultural importance (Deloitte Access Economic 2017; Tanner *et al*., 2020). It was the focus of a broad attempt to establish ecosystem-based management of the State's coastal, estuarine and marine environments in the early 2000s (Day *et al*., 2008, Paxinos *et al.,* 2008). This

initiative resulted in the *Living Coast Strategy* (DEH 2004) and *Marine Planning Framework for South Australia* (DEH 2006a), but neither was implemented beyond the development of an initial pilot study in Spencer Gulf DEH (2006b).

The Spencer Gulf Ecosystem and Development Initiative[22] (SGEDI) was established in 2011, when a broad range of stakeholders recognised the need for a more integrated approach to development in the area. The focus of SGEDI has been to develop pilot tools to support integrated management and demonstrate the benefits of the approach (Bailleu and Ward 2019; Gillanders *et al.,* 2015, 2016). Risk assessments have been undertaken for key habitats (Doubleday *et al.,* 2017) and species (Robbins *et al.,* 2017). A spatial cumulative impact assessment has been undertaken that explicitly accounts for uncertainty (Jones *et al*., 2018). An ecosystem model (Ecopath with Ecosim) has been established (Gillanders *et al.,* 2013).

Tanner *et al.* (2020) identified around 170 different data time-series that could be used as the basis for establishing a suite of indicators of the overall social, economic and ecological status of Spencer Gulf. The next step is to consolidate the collated datasets into a smaller subset of indictors that could be utilised to monitor the status of the gulf and evaluate the impacts of future activities.

Progress against IEA components is summarised below.

	Status for Spencer Gulf
Overall Status	Work in Progress
IEA Stages	
Engagement	No (very limited)
Scoping	Yes
Indicator development	~ Partial
Ecosystem assessment	~ Partial
Risk assessment	~ Partial
Uncertainty assessment	~ Partial
Evaluating Management Options	× No
Monitoring and evaluation	~ Partial
Iteration	~ Partial
Notes on available models	Hydrodynamic, SDMs (seagrass) and EwE (Gillanders *et al.* 2015)
Key references & links	Bailleu and Ward TM (2019) Begg *et al.,* (2015) Doubleday *et al.*, (2017) Gillanders *et al.,* (2013, 2015, 2016) Jones *et al.,* (2018) Robbins *et al.,* (2017)

[22] https://www.adelaide.edu.au/environment/opportunities/spencer-gulf-ecosystem-and-development-initiative-sgedi

Opportunities, resources required and timelines

Much of the preliminary work needed to support an IEA of Spencer Gulf has already been done. The collation of information undertaken by Tanner *et al.* (2020) was an important step towards undertaking an IEA of Spencer Gulf.

Available data has been collated and a range of decision support tools has been established. The next logical step is to do a full IEA. The project would need to have a strong focus on engagement with key government and industry stakeholders. Conducting an IEA in Spencer Gulf would demonstrate the benefits of undertaking an IEA in a region where an integrated approach to management of marine systems has not been formally established. It would demonstrate to the South Australian government the benefits of this approach.

At the request of the South Australian Department for Environment and Water, SARDI recently developed a presentation to promote the concept of integrated management to the broader South Australian Government. This presentation has not yet been delivered to key agencies and would ideally be delivered within the context of a proposed national program to progress IEA.

The cost of undertaking a full IEA of Spencer Gulf would be approximately $2-3M.

Timeline

To date there is no established timeline for implementation, and further broad stakeholder discussions are ongoing.

Pilot Governance

Management of Spencer Gulf is currently delivered through at least 15 different South Australian Government Acts, with limited cross-referencing between different pieces of legislation, despite many having broadly similar objectives (Begg *et al.,* 2015). Management decisions are often made without fully considering the overall social, economic and ecological status of the region. Cumulative impacts are not considered explicitly.

Consequently, there is no current governance framework that could support this pilot. However, Marine Innovations Southern Australia (MISA), which was established in 2005, is a collaboration of South Australia's key government agencies responsible for natural resource management and industry development, peak seafood industry organisations, universities and marine research institutions. The involvement of industry, government and researchers in MISA makes it an excellent vehicle for engagement with a program to trial implementation of IEAs in Australia.

Cockburn Sound and Westport

Scope and progress to date

Fremantle Harbour has been an important port for Western Australia for over 100 hundred years and with Perth's urban development ongoing freight access will be important for future trade. The Western Australian government settled on a development and modernisation of container trade operations in Kwinana (Cockburn Sound) as the best option to support future needs. This new port is managed under the Department of Planning, Lands and Heritage, and is taking an integrative and inclusive approach to the vision and high-level designs for the terminal, marine infrastructure, road and rail networks, shipping channel, potential breakwater, back of port operations and environmental considerations.

The intention is to take an evidence-based approach, providing businesses and industry with the opportunity to bring innovative thinking to the ground up design of the developments and management

approaches. In addition, changes to the Western Australian Environmental Protection Act 86 in 2020 have increased the focus on understanding the cumulative impacts of activities in a regional context.

The Westport science programme being led by the Western Australian Marine Science Institution (WAMSI) that forms the basis of a comprehensive three-year research program to fill important knowledge gaps about the local ecosystem. Information systems have been developed to store geo-referenced information.

Progress against IEA components is summarised below.

	Status for Cockburn Sound
Overall Status	Work in Progress
IEA Stages	
Engagement	Yes
Scoping	Yes
Indicator development	~ Partial
Ecosystem assessment	~ Partial (EIA)
Risk assessment	~ Partial
Uncertainty assessment	~ Partial (For MCA)
Evaluating Management Options	~ Partial (options defined + decision support tools, no MSE)
Monitoring and evaluation	~ Partial
Iteration	x No
Notes on available models	Models are under development (hydrodynamics and EwE)
Key references & links	Westport Project Office publications https://westport.wa.gov.au/

Opportunities, resources required and timelines

The integrated and science-based approach is in line with an IEA and is considered critical for the area, as Cockburn Sound (Derbal Nara as it's known to Noongar people) has become less resilient over the past 60 years due to increasing urbanisation, recreational pressure and industrial traffic in the area. There is a desire to recognise, plan for and mitigate or offset any impacts to the local environment associated with the development. The socioecological (system design) approach being taken across interested parties, topic domains and the fully supply and value chain is again in line with an IEA.

In 2017 a report Cockburn Sound Drivers, Pressures, State, Impacts, Responses Assessment 2017: Summary Report" has been prepared for the Department of Water and Environmental Regulation, the Kwinana Industries Council, the City of Rockingham and the City of Kwinana on behalf of the Cockburn Sound Management Council.

https://www.wa.gov.au/system/files/2022-03/Cockburn-Sound-Drivers-Pressures-State-Impacts-Responses-Assessment-2017-summary-report.pdf

Leveraging the above report and acknowledging the changes to the Western Australian Environmental Protection Act 86 in 2020, WAMSI has been requested by the Western Australian Minister for Deputy Premier and Minister for State Development and Science, the Hon. Roger Cook, to develop a feasibility study and implementation plan for operationalising regional environmental analytics in Cockburn Sound. This study is underway and is due for completion at the end of 2022.

The feasibility study will develop options to progress the current (single client) Westport program, into a regional (multi-client) program. The research program will provide baselines for ongoing monitoring, inform mitigation and management strategies and provide simulation and decision support tools to support impact assessment and planning processes. By the end of the program many of the steps of a full IEA will be partially complete, the majority of the necessary information and tools will be in place and it would require a relatively modest investment to see how the entire process (which would only further delivery of the vision as articulated by the Westport Project Office).

Timeline

Feasibility study for regional analytics to be completed by December 2022.

Feasibility Study Governance

While science being done for Westport falls under WAMSI, the overall governance of the area is under the WA Department of Planning, Lands and Heritage. The governance model for the Feasibility Study is under development.

Northern Seascapes

Scope and progress to date

Northern Australia has been an attractive lure for development for some time. Its less crowded environs makes it attractive to onshore and offshore development and it boasts both significant and new opportunities for economic development and a landscape with environmental and cultural values of global, national, regional and Indigenous significance. It's remoteness unfortunately also means that aspects of the system's content and function, and its true capacity to sustainably support exploitation while also delivering valuable services, is poorly understood or articulated. This lack of knowledge hinders the assessment of development opportunities and robs decision-making processes of transparency; hampering State, Territory and local government agencies charged with prioritising and de-risking new areas for development while protecting the region's environmental and cultural values. This puts the environment at risk and leaves industries, financiers and communities uncertain and risk-averse about investment. The region is the focus of ongoing research efforts to collect and collate relevant information to feed current and future planning processes – e.g. through work by the CRC for Developing Northern Australia and building on work by the Tropical Rivers and Coastal Knowledge (TRaCK) consortium, the National Environmental Research Programme's (NERP) Northern Australia Hub and the National Environmental Science Program's (NESP) Northern Australia Environmental Resources Hub.

The NESP collaborative Northern Integrated Environmental Assessment project has undertaken a project to develop and demonstrate the value of a holistic integrated assessment approaches to strategic decision-making for sustainable development in Australia. The focus of the world spans terrestrial and some coastal/marine areas and while it has primarily begun with environmental focus it is

compatible with the IEA concepts[23]. The NESP project documented existing information, data needs, analysis and risk management approaches, and governance settings required for undertaking environmental assessments but is also appropriate for IEA and associated decision making. That is the NESP project has covered the scoping steps of an IEA for northern Australia, making it a good pilot IEA demonstration location. The NESP's information articulates the value of undertaking an IEA; detailing how relevant environmental, cultural, economic, and regulatory knowledge can be gathered, synthesised, analysed and presented to relevant stakeholders in the region and those further afield who have regulatory or commercial responsibilities in the area. It connects across the land-sea divide and provides preparatory steps for an assessment regarding available options for suitable tools, data, and prioritisation approaches. The NESP work also looks to provide guidance on strategic improvements for governance and engagement that will see significant enhancement of the capabilities of Australian agencies which will seem them well equipped to develop and refine IEA approaches.

Progress against IEA components is summarised below.

	Status for Northern Seascapes
Overall Status	Work in Progress
IEA Stages	
Engagement	Work in Progress
Scoping	Yes
Indicator development	~ Partial
Ecosystem assessment	~ Partial
Risk assessment	~ Partial
Uncertainty assessment	× Not initiated
Evaluating Management Options	× Not initiated
Monitoring and evaluation	× Not initiated
Iteration	x Just beginning
Notes on available models	MaxEnt, qualitative, and GBR cumulative impacts
Key references & links	Davies and Kyne. (2018) Dunstan (2018) Dunstan *et al.* (in press) Kyne *et al.*, (2018)

Opportunities, resources required and timelines

This pilot remains a work in progress but also an opportunity, comparatively rare in Australia, to initiate IEA before many industries have sunk costs that can make it uneconomic to explore more integrated approaches. It is also an opportunity as it is an area where the government is actively seeking to attract investors by reducing the sovereign risk that develops from multiple jurisdictions and multiple sectors

[23] https://www.nespnorthern.edu.au/wp-content/uploads/2020/11/IEA-discussion-starter.pdf

(or sectoral agencies) with non-aligned objectives and expectations. The scientific aspects of the IEA have advanced beyond the scoping and objectives and these latter stages need to be developed in close collaboration with the jurisdictions involved. Broad policy objectives under the Northern Australia White Paper36 will need to be further specified as operational objectives before influential indicators can be prioritised, management strategies can be identified or monitoring and evaluation can begin.

The lack of clear pre-existing operational objectives opens the door to co-design of performance indicators and management strategies, but constraints on the resources to do this to full effect would need to be kept in mind. Preliminary indicators and management options have been developed for Australian Marine Parks (nationally) but that is one sector and cross sector connections and First Nations inclusion still need to be made more broadly.

This assessment focused NESP work dove tails nicely with separate NESP Marine Biodiversity Hub funded work that has collated the data on values and pressures in the marine domain of northern Australia; feeing an initial risk assessment for the region. The most recent NESP work has an increased focus on seascape approaches to marine management with the North Marine Region a focal area – given the overlaps between habitats, the distribution of species of conservation concern, changed water flows in the region and areas marked as potential greenfield development sites for marine industries, including aquaculture and renewable energy.

A successful outcome of the current cross-hub NESP IEA would be complementary or even identical approaches to IEA across land and water. Additional funding to complete this IEA would be around $2million, but it is certain to identify key uncertainties (scientific, governance and policy) that will require addressing subsequently. If successful, the IEA will be a living document that is periodically refined and reviewed to help scope and prioritize further investments over time

Timeline

To date there is no concrete timeline for the implementation of this pilot, noting that it is a truly multi-jurisdictional potential pilot involving QLD, NT, WA and the Commonwealth.

Pilot Governance

The nascent nature of this potential pilot makes governance less clear as there is not current a single established overarching body charged with the responsibility. It is little that state and territory government agencies will have a strong role to play. Research provision is currently primarily through the NESP and relevant CRCs.

Progress to date – at a glance

The summaries above show that while objectives and enabling elements exist in many cases, delivery of IEA (or similar processes) in Australia has not gone much past scoping and data collation stages until fairly recently. In the last few years NSW has moved to later steps in the IEA process, with Victoria and Western Australia also beginning to do likewise. Even where progress has been made to consider evaluating options and management priorities the steps have largely been undertaken qualitatively, given issues with available data and resources. This means that Australia is both an ideal candidate for implementation of IEA, but would also see significant and immediate benefits from clear handling of uncertainty and scientifically supported quantitative guidance.

In terms of what the specific pilots **Error! Reference source not found.** provides an at a glance summary with further detail in the individual sections above.

Table 2: Summary of the status of the proposed pilots

	Victoria	NSW	Spencer Gulf	Northern Seascape	Westport
Overall Status	Work in Progress	Almost complete	Work in Progress	Work in Progress	Work in Progress
Status of each IEA Stage					
Initial engagement (objectives setting by participating groups)	Yes (High) for PPB; Partial for coastline	Yes	No (very limited)	Work in Progress	Yes
Scoping	~ Partial	Yes	Yes	Yes	Yes
Indicator development	~ Partial	Yes	~ Partial	~ Partial	~ Partial
Ecosystem assessment	~ Partial	Yes	~ Partial	~ Partial	~ Partial (EIA)
Risk assessment	~ Partial for PPB × Not initiated (Partial in MPAs)	Yes	~ Partial	~ Partial	~ Partial
Uncertainty assessment	× Not initiated	Yes (qualitative)	~ Partial	× Not initiated	~ Partial (For MCA)
Evaluation of management options	× Not initiated	~ Partial	× No	× Not initiated	~ Partial (options defined + decision support tools, no MSE)

	Victoria	NSW	Spencer Gulf	Northern Seascape	Westport
Monitoring and evaluation	~ Partial	~ Partial (Commenced)	~ Partial	× Not initiated	~ Partial (just beginning)
Iteration	~ Partial	Yes	~ Partial	x Just beginning	x No
Noes on available models	PPBIM, EwE, (outdated) Atlantis for PPB; There is nothing available that covers the full outer coast of Victoria	EwE, Atlantis (both for 1990s state)	Hydrodynamic, SDMs (seagrass) and EwE (Gillanders *et al.* 2015)	MaxEnt, qualitative, and GBR cumulative impacts	Models under development (hydrodynamic and EwE)
Resources required	$3-4 million	$500,000	$2-3 million	$2-3 million	$500,000
Timeline	Large-scale pilot could be delivered relatively quickly (as extant aligned policy process underway).	The most mature of the four pilots, quantified forms of the outstanding components could be delivered relatively quickly	As much of the preliminary work is in place so the other components should be straightforward.	A rare "green fields" opportunity it would require a full project to complete but would see returns before many industries have sunk costs.	With many components underway an IEA could be completed as a refinement of the process already in place

Conclusions and Next Steps

A number of locations in Australia have been subject to assessments that share features with an IEA, in some cases they are very close to having stepped through an entire IEA. Successfully completing an IEA in the Australian context would see world's best practice operating in Australia, while also highlighting what has had to be modified for the Australian context.

While previous large-scale assessments in Australia have had only mixed uptake, this is not because of a complete lack of interest or any fundamental conceptual flaw. Instead, it reflects an historically mixed appetite politically for uptake, itself a manifestation of differing degrees of siloing of relevant regulatory, planning etc agencies. However, the pressure on Australia's coastlines and increasing societal unease around levels of pressure and anticipated future change means the policy landscape is changing. While jurisdictional complexities remain challenging, a growing desire to coordinate across departments (to simplify administrative requirements and legal complexities) exists. In addition, there are new desires for the inclusion of traditional owner inputs, creation of climate resilience and streamlined marine spatial planning. Risk-based approaches are shaping thinking and legislative reviews/reform, strongly influenced by the realisation that interactions and cumulative risk are growing in lock step with population, coastal and oceanic use levels, declining environmental status, and some fragility to net economic returns other community benefits. In turn, this has seen tensions grow around resource use conflict, governance, public safety, critical knowledge gaps and lack of access.

Australia has pockets of relevant best practice capability and experience but they are dispersed across the country in various independent initiatives. Nonetheless, there are good examples of partially integrated decisions in different locations. What is lacking is a coordinated and consistent approach to build a strong and distributed national capability that can support the process at scale, to enable more effective decision-making for the national benefit.

The level of investment required to see IEA through to completion in Australia is modest in terms of the scale of developments in the same regions. Nevertheless, the required investments are not trivial. They do; however, all show great additional benefit in terms of delivery into policy processes, development and planning, and into the expansion of knowledge of these systems.

In all cases a staged approach to implementation would be advantageous - in part because many of the pilots have already delivered aspects, or early stages, of an IEA; but also because a staged approach allows for the conclusion of the first iteration of the process even in the absence of complete information. A full iterative process has great value for steering a system long term – and for providing opportunities to refine the information used through time. It cannot be denied however that benefits accrue even before iterative information accumulates. The first (often qualitative) iteration, can provide significant advances in terms of prioritising actions, identifying gaps in knowledge, explicitly bring together the scientific community and other sectors of civil society in collaborative problem-solving context. Moreover, the individual steps of an IEA present 'no regrets' activities – such as progressing understanding, synthesising data critical to decision making (whether within or beyond an IEA) and bringing stakeholders together in a dialogue around expectations, objectives and feasible actions.

While the IEA process can seem daunting in scope, scale and complexity it reflects the complex nature of coastal and oceanic social-ecological systems. The IEA process is therefore increasingly seen as the only way forward for crowded and stressed marine and coastal systems. Without an underlying structuring process significant tension/conflict, economic loss and environmental degradation will continue to result, potentially delivering Australian systems into undesirable states.

In addition to encouraging the support of jurisdictions that do want to see one of the pilots through to completion, it is recommended that the NMSC supports the continuation of the IEA Implementation Plan Working Group to provide oversight and help facilitate the pilots as appropriate, and importantly to support the translation of the science: to move from a "science push" to an "end-user pull" approach.

Appendix and Glossary

Comparison of IEA with other conceptually related management processes

The IEA process shares a conceptual foundation with many other planning processes that attempt to provide some kind of assessment at scale within the context of adaptive management. Table S1 summarises a number of these approaches. The United Nations Environmental Program (UNEP) has also integrated environmental assessment and reporting framework also shares the same basic steps as the IEA process. While the explicit terminology used for the two approaches may differ the core concepts are analogous. The UNEP approach is couched more explicitly in a Drivers, Pressures, State, Impact and Response (DPSIR) mode but the steps can be mapped relatively straightforwardly between the two approaches, especially if the pressures and drivers considered under the UNEP framework are kept broad as intended under the IEA approach outlined in this current document.

Table S1: Comparison of IEA and other management related processes. Note many of these are primarily based on single sectors, for example fisheries and conservation, with objectives relating only to that sector (there are no cross-sector objectives). Also note that CEAFM stands for Community-based Ecosystem Approach to Fisheries Management.

IEA Components	Marine Spatial Planning (MSP)	AFMA Harvest Strategy	Systematic Conservation Planning	FAO Ecosystem Approach to Fisheries	CEAFM
Engagement	Identifying need and establishing authority Organizing stakeholder participation	Stakeholder engagement and RAGs	Identifying & involving stakeholders Describing the context for conservation area Identifying conservation goals	Initial process planning and stakeholder support	The community involvement process. Assess requests, define scope,
Scoping	Obtaining financial support Organizing the process through pre-planning	Scoping	Scoping & costing the planning process	Defining the fishery, societal values and high-level objectives Finalise a scoping (EAF baseline) report	Set-up tasks for the promoting agency –broad goals, public awareness, review, stakeholders, legal basis
Indicator development		Empirical and model-based indicators of stock status		Indicator and Performance Measure selection	Define indicators and performance measures
Ecosystem assessment	Defining and analysing existing condition	Stock Assessment	Collecting data on socio-economic variables & threats Collecting data on biodiversity & other natural features	Asset and Issue identification	Identify and prioritize key issues

IEA Components	Marine Spatial Planning (MSP)	AFMA Harvest Strategy	Systematic Conservation Planning	FAO Ecosystem Approach to Fisheries	CEAFM
Risk assessment	Defining and analysing future conditions	ERAEF		Issue prioritisation and risk assessment	Identify and prioritize key issues
Uncertainty assessment	Implicit	Explicitly considered in quantitative assessments	Implicit	Explicitly considered in quantitative assessments (e.g. via parameter sensitivity analysis)	Implicit
Evaluation of Management Objectives	Preparing and approving the spatial management plan Implementing and enforcing the spatial management plan	MSE testing Harvest Strategy Control Rules Policy and management response	Setting conservation objectives Reviewing current achievement of objectives Selecting additional conservation areas Applying conservation actions to selected areas	Determine operational objectives Management option, evaluation and selection	Develop community goals and objectives Determine management actions and responsibilities Produce a community-owned management plan Formalising and implementing a community management plan
Monitoring and evaluation	Monitoring and evaluating performance Adapting the spatial management process	Monitoring key fishery indicators	Maintaining & monitoring conservation areas	Develop an Operational Plan and monitor its progress Reporting, communication and auditing of performance Formalization of the management 'plan' Review performance of the Management system	Monitoring performance; reviewing and adapting the plan
Iteration	Public comment cycle and periodic review	Co-management reference group meetings during the management cycle	Public comment cycle and periodic review	Co-management reference group meetings during the management cycle	Community consultation and public comments during the process

Glossary

This short section is to help clarify what the key terms used in this document mean and how they map to terminology in different jurisdictions in Australia.

Term	Definition or Equivalent terms
Activity	Actions by either individual users or sectors
Approach	Method or framework for working through the problem
Asset	The physical features of the system (not including people) that can be defined as environmental assets, cultural assets and infrastructure assets.
Communities	People who live close enough to affected areas that they have an immediate and tangible interest in the outcomes (e.g., some aboriginal groups, local property owners or recreational user groups)
Community wellbeing	The combination of economic, social and environmental benefits.
Cumulative impacts	The impact (positive or negative) resulting from the effects of one or more impacts, and the interactions between those impacts, added to other past, present and reasonably foreseeable future pressures.
Evaluation of Management Scenarios	A transparent and structured means of assessing management options (e.g., Management Strategy Evaluation (MSE))
Hazard	Any activity, event or substance that can cause damage to individuals or to valued aspects of a system (including system function). A failure to act can also pose a hazard.
Impact	A marked effect or influence on an individual or valued aspect of a system. More recently the term “effect” rather than “impact” has become more widely used as responses are not always negative, but all sources of change should be noted for planning purposes.
Indicator	A metric that tracks the state of a system attribute of interest - it may be a direct measure or it might be a more easily sampled proxy, and it may measure system condition or pressure.
Monitoring	Collection of data on specified indicators that allows an assessment of the extent and trend of progress towards achievement of objectives.
Objective	A desired outcome - can be specific to a particular stakeholder group or set in policy.

Term	Definition or Equivalent terms
Outcome	The consequence of a process, what changes once the process is complete
Pressure	Stressor exerting influence on the system, potentially creating disruption/disturbance (typically and anthropogenic activity or environmental driver)
Process	In this context it is the steps taken in completing an assessment and feeding that information to decision makers. In a policy context it is manner in which public policy is formed, implemented and evaluated.
Public	Group who lacks a direct connection to the outcomes but nonetheless have an interest in contributing (e.g., specific interest groups).
Risk	The likelihood of an undesired event occurring, or of suffering a loss or damage, as a result of a hazard.
Risk Assessment	A process made up of the steps of hazard identification, exposure and effects assessments and risk characterisation – essentially: “what are the potential hazards?”, “what is the level of exposure or likelihood of occurrence?”, “what is the consequence should it occur?”, “what is the final level of risk?”. This process should also highlight risk-reducing and risk mitigation measures. Risk assessments have many uses, but a major one is to assist decision makers with the complex choices regarding the options in managing or reducing risks to the system.
Risk Management	A structured process for identifying and analysing potential risks and devising and implementing responses appropriate to their effect. It begins by taking the risk characterisation from a risk assessment (which provides a prioritization of risks, categorization of recommended safeguards and mitigation measures, including their feasibility of implementation) and then steps through the decision-making process, which includes identifying risk tolerance, comparing regulatory options, to select the appropriate response to a potential hazard.
Stakeholders	Groups who have a professional or personal interest sufficient to justify engagement (e.g., some aboriginal groups, government regulators, industry representatives, NGOs etc.)
Trade off	The process of foregoing of one benefit or value for another that is regarded as more desirable or of greater importance
Tool	A piece of software or framework for working through a problem

Term	Definition or Equivalent terms
Value	In the context of an IEA, a value is equivalent to an Attribute, Asset, or "Feature that is special". This terminology is related to the broader definition from psychology that values are the standard a culture uses for discerning what is desirable/good/just in society. In this broader context, values are deeply embedded and are central to conveying a culture's beliefs (tenets or convictions held by that culture to be true).

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NATIONAL MARINE SCIENCE PLAN

Implementing Integrated Ecosystem Assessments (IEAs)
Working Group Report

IMPLEMENTATION PLAN

The Implementation Plan; the Full Technical Report;
and a Summary report
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