# Ocean accounting pilot for Geographe Marine Park

## Synthesis report

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# Key findings

- The “Ocean accounting pilot for Geographe Marine Park” project is the first Australian Government led ocean environmental-economic account developed under the National Strategy and Action Plan for Environmental-Economic Accounting.
- The pilot accounting project applied internationally accepted accounting frameworks and technical guidance in an Australian marine context, building Australian and international experience in ocean accounting.
- The outcomes from the pilot ocean accounts demonstrate how ocean accounting can be used in policy and management planning. The structured information set resulting from the project can be used by Parks Australia to inform ongoing management of Australian Marine Parks.
- The pilot accounting project estimated the extent of seagrass, sandy bottom, rocky reef and kelp ecosystems in Geographe Marine Park, assessed the services and benefits provided by those ecosystems, and identified some potential human induced pressures on the marine park.
- Data collected as part of an accounting approach can inform the evaluation of management interventions related to Geographe Marine Park. Consistent data collection both inside and outside of Geographe Marine Park and across time is necessary for cause and effect analysis.
- The project provides a foundation for future investments in regularly updated ocean ecosystem accounts to enable evidence-based policy, including planning and strategy, regulation, management decisions and return on investment analysis.
- Environmental-economic accounting can add value to current monitoring approaches by organising existing data into an integrated and coherent narrative across multiple dimensions. Historically and in this project, bespoke data collection processes and missing information have impeded integration from occurring.
- The project has demonstrated that some ocean accounting could be scaled up to the national level effectively using existing data and leveraging the knowledge gained during this project. However, changes in scale are likely to change the purpose and use of accounts.
- The authors recommend any national rollout be accompanied by targeted investment in data collection, capacity building and research. Wherever possible, data collection should align with environmental-economic accounting guidelines and standards.
- There is a need for the development of consistent national methods for the collection of environmental data so the data can be integrated and readily incorporated into environmental-economic accounts.
- As ocean accounting evolves and additional data is collected, it will be important to update the accounts to incorporate changes in asset type, quantity, and quality as the composition of services and benefits will also change.

# Summary

This report provides a synthesis of the 'Ocean accounting pilot for Geographe Marine Park project' commissioned by the Australian Government Department of Agriculture, Water and the Environment. The pilot accounting project supports Australia's participation in the High Level Panel for a Sustainable Ocean Economy. The project used environmental-economic accounting approaches to organise economic, ecological, and social data to describe the services and benefits provided by the ecosystems in Geographe Marine Park. This synthesis report is underpinned by 4 technical documents, which include a stocktake and assessment of existing data, environmental-economic accounting methods, and initial accounts.

This project is an Australian first at producing ocean accounts to inform decision-making for a marine park. Geographe Marine Park is 1 of 14 marine parks managed by Parks Australia in the South-west Marine Parks Network, off Western Australia. The project provides a set of structured information that contributes to the ongoing management of the marine park, including:

- the design of the national Monitoring Evaluation Reporting and Improvement Framework and associated indicators
- local park management, by improving baseline understanding of values and pressures in the Geographe Marine Park
- risk assessments for prioritising monitoring and compliance activities across Australian Marine Parks.

The project used the United Nations System of Environmental-Economic Accounting frameworks to characterise Geographe Marine Park as a spatial set of ecosystem assets that provide a bundle of services and benefits (assets, condition, services, benefits). Policy governing ecologically sustainable use is key to maintaining Geographe Marine Park and the broad set of benefits the park provides. The accounting framework establishes a structured set of information that can be used for planning, regulatory decisions and return on investment analysis.

The headline outputs of the accounting exercise are provided in Figure 1, with the value of seagrass ecosystems specifically highlighted in Figure 2. The pilot accounting project examined four main ecosystem asset types across the 96,477 hectares of Geographe Marine Park including seagrass meadows (57%), sandy bottoms (42%) and smaller areas of rocky reef and kelp forest. Four ecosystem condition indicators (seagrass meadows density, fish biomass, fish abundance, species diversity) were also examined. These ecosystem assets contribute to economic and social wellbeing.

For example, the pilot accounting project showed that one hectare of seagrass meadows provides nursery services to key fish species at different quantities (6,227 kg tarwhine, 3,976 kg of sea mullet and 809 kg of King George whiting). Also, of the 45 medium to large boats and ships found to 'stop' for longer than 4 hours in the marine park between 2012 to 2020, 31 appeared to be in the seagrass meadows.

Overall, ecosystems in Geographe Marine Park contributed approximately $316,000 in 2019 to the gross operating surplus of the local economy through whale watching ($254,000) and

commercial fishing ($62,000). Also, many people enjoyed recreational activities in Geographe Bay. Recreational fishers took more than 12,000 fishing trips in 2018, which is valued at over $2.2 million (consumer surplus). Activities in adjacent state waters, and local icons such as the Busselton Jetty provide additional benefits to the local economy and influence activities in the Geographe Marine Park.

Beyond the market economy, seagrass meadows in Geographe Marine Park were estimated to store approximately 6.2 million tonnes of carbon in soil, and each year sequester approximately a further 27,569 tonnes (net) based on the estimates of seagrass extent in 2014. The annual amount sequestered is equivalent to 1,500 households' average carbon emissions per annum, with an estimated dollar value of $443,865 (if assumed $16.10 per tonne), thus contributing to climate change mitigation.

The measurement and accounting for cultural services was not in scope for this project, but key features of the bay are known to be highly valued by traditional owners and others in the local community. Geographe Marine Park is also home to a variety of species and thus plays an important role in biodiversity conservation.

The project has increased the awareness of the contribution of Geographe Marine Park to human wellbeing. Due to the limit of available data some accounts required extensive modelling, which impact the confidence of results. The project identified that, for application at a local scale, accounts should be further targeted to specific management issues of interest, and improvements to the resolution and frequency of existing data is required.

Findings from this project demonstrate that there may be sufficient information to scale up ocean accounts nationally. However, changes in scale are likely to change the purpose and use of accounts. Many of the datasets used in Geographe Marine Park are of national scale and the knowledge and relationships gained during this project can be leveraged. National accounts can provide important context for policy makers and can contribute to an integrated approach to Australia's national and international reporting commitments, such as the Sustainable Development Goals (SDG 15.9 and 17.19).

Targeted investment in data collection, capacity building and research would support a national rollout of ocean accounts. The benefit of future investments in environmental information will likely be higher if due consideration is given to environmental-economic accounting guidelines and standards.

To continue the development of ocean accounting nationally the authors recommend to:

- Undertake a regular comprehensive assessment of the extent and condition of ecosystem assets, to record changes over time
- Research the responsiveness of services and benefits to changes in extent and condition to better understand how changes to ecosystems affect human wellbeing
- Develop nationally consistent methods and align approaches to data collection on ecosystems to enable better integration of environmental information
- Develop a prioritisation framework for investing in information that is explicitly linked to accounting and decision-making and establish a working group to support the work.

**Figure 1 Geographe Marine Park – Summary Environmental Accounting Results**

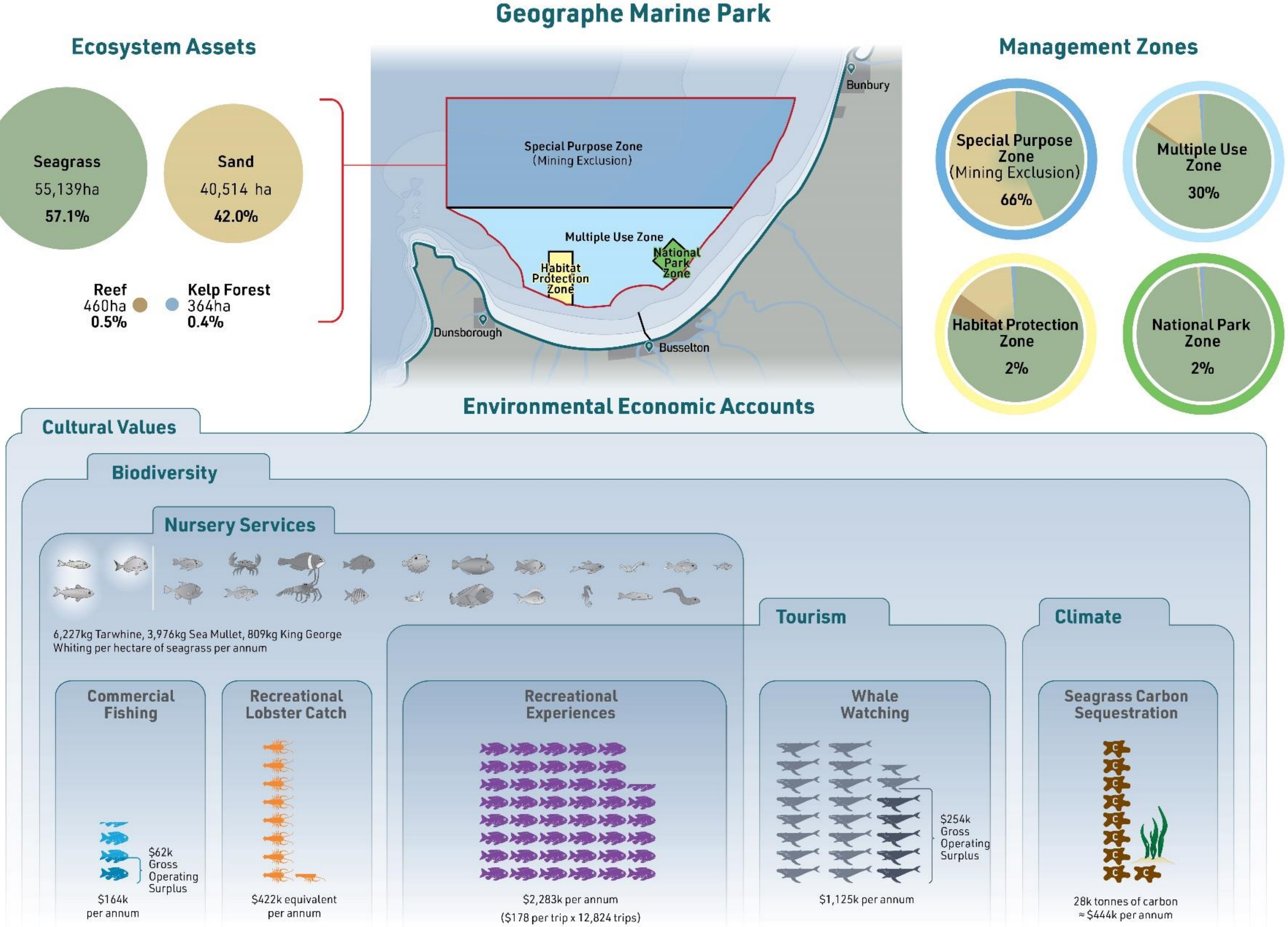
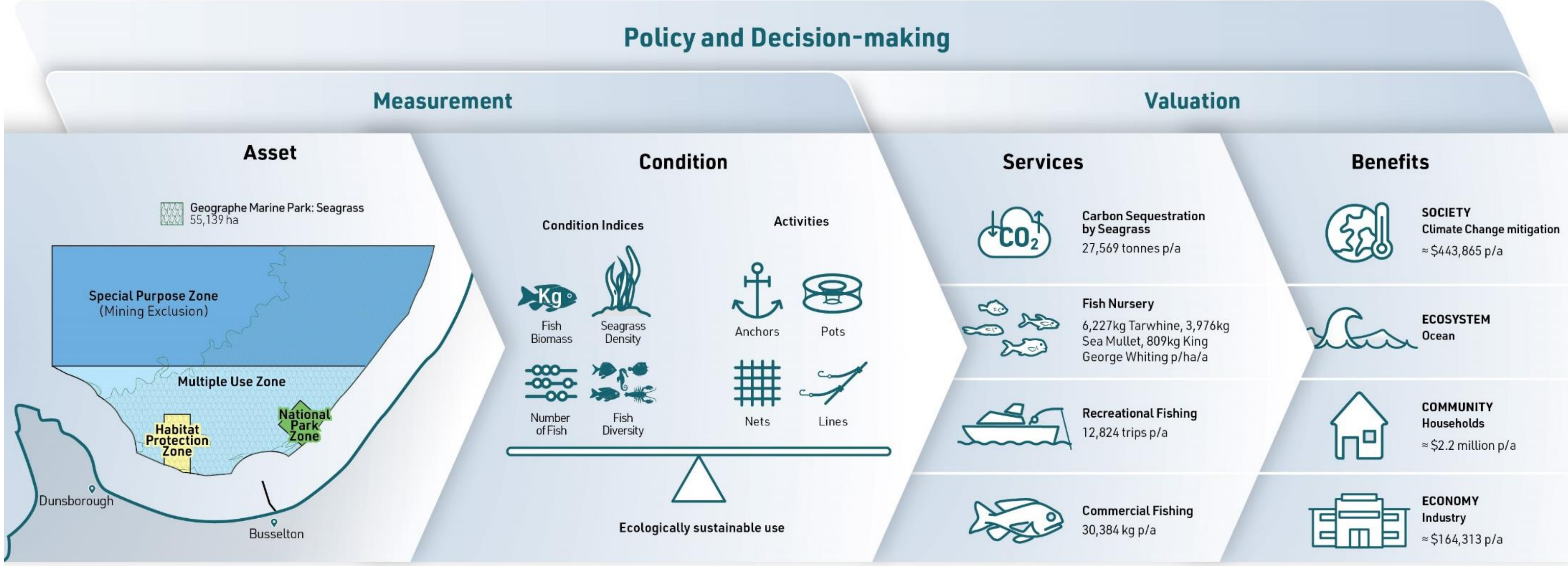


**Figure 2 Geographe Marine Park – Framing seagrass ecosystems as an asset**



# Introduction

The management of the world's oceans requires achieving a balance between protecting the marine environment and developing opportunities for sustainable use and enjoyment that promote social wellbeing and equitable prosperity. A sustainable ocean economy, one that maintains the resilience and health of the ocean, while providing socio-economic benefits to diverse groups of people, is central to building a better future for people and the planet.

Sustainable ocean management is complex. Challenges include coordination across whole of government, private and public sector dynamics, differences across disciplines (for example, ecology and economics), and missing and fragmented information. This is further complicated by a complexity of management levers that can be applied at different scales including protection, regulation of use, restoration, and behaviour change.

Marine parks are part of the Australian Government's approach to managing Australia's oceans. They help to conserve marine habitats and species (biodiversity) and allow places for people to watch wildlife, dive and go boating, snorkelling, and fishing. Australian Marine Parks contribute to human health and wellbeing, by ensuring a sustainable natural environment is maintained for the creation of jobs in industries like fishing and tourism, the provision of food and energy, and opportunities for experiences in nature.

Good ocean policy requires good information if it is to be founded on solid evidence, be efficiently implemented, and receive broad support across Australian society (National Marine Science Committee, 2015). The United Nations System of Environmental-Economic Accounting (SEEA) provides an approach to creating an agreed set of information that can be used by ocean managers. It stipulates a set of principles and processes to organise social, economic, and environmental data, and ensures the information is spatially and temporally comparable.

The 'Ocean accounting pilot for Geographe Marine Park' project demonstrates how ocean accounting can be used to support the sustainable management of Australian Marine Parks. A broader perspective on sustainable management for areas around the marine park could focus on extending the work to encompass state waters and coastal assets. The project has 3 key objectives:

1) Provide structured environmental, cultural, social, and/or economic information to contribute to the Parks Australia Monitoring, Evaluation, Reporting and Improvement (MERI) system
2) Improve the understanding of how ocean accounting can assist with the sustainable management of marine resources, including to support Australia's participation in the High Level Panel for Sustainable Ocean Economy
3) Trial the internationally accepted SEEA frameworks (as part of the Department of Agriculture, Water and the Environment 'Environmental-Economic Accounting: A Common National Approach – Strategy and Action Plan') and Technical Guidance on Ocean Accounting in an Australian marine context and assess feasibility for broader application.

This report, compiled by IDEEA Group for the Australian Government Department of Agriculture, Water, and the Environment, is a synthesis of the project findings and recommendations. The report is the fifth in a series of 5 reports:

1) *Geographe Marine Park – data inventory report*: a list of potential data sources for ocean accounting in Geographe Marine Park
2) *Geographe Marine Park – data assessment report*: an assessment of the data sources that are used for ocean accounting in Geographe Marine Park
3) *Geographe Marine Park – ocean accounts methodologies assessment report*: an assessment of the methodologies that are used for ocean accounting in Geographe Marine Park
4) *Geographe Marine Park – ocean accounting report – initial estimates*: a series of tables, graphs, and maps as well as written descriptions to summarise, interpret and analyse the outputs of the accounting process
5) ***Geographe Marine Park – project synthesis report***

The project synthesis report provides an overview of:

- Australian Marine Parks and their management
- The compilation and results from the accounts produced for Geographe Marine Park
- How ocean accounts can inform management and decision-making within Geographe Marine Park
- How ocean accounts and the data sources and methods that underpin them can be improved to better support ocean management and decision-making
- Next steps and recommendations

# 1 Australian Marine Parks

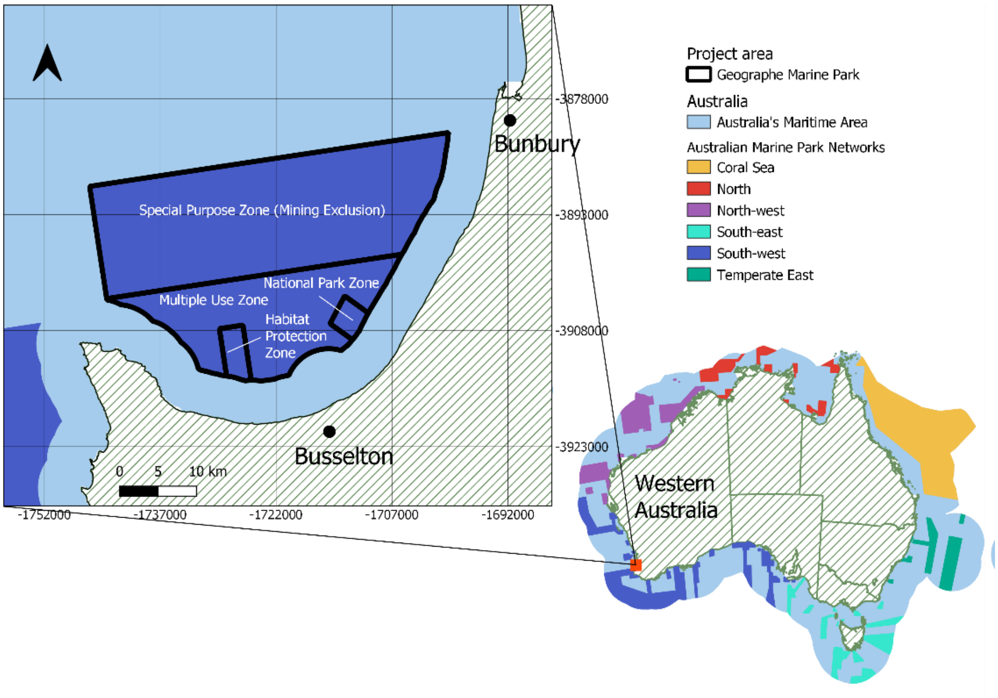
Australian Marine Parks are a core component of Australia's 3.3 million square kilometre National Representative System of Marine Protected Areas, which includes state, territory, and Commonwealth-managed marine parks. Australian Marine Parks occur in Commonwealth waters that extend from the outer edge of state and territory coastal waters (generally 3 nautical miles or approximately 5.5 km from the shore) to the outer boundary of Australia's exclusive economic zone (EEZ) (200 nautical miles or approximately 370 km from the shore).

There are 58 marine parks managed by the Director of National Parks, supported by Parks Australia. These parks are structured into 5 networks (North, North-west, South-west, South-east and Temperate East) and one large marine park (Coral Sea) (Figure 3). The objective of the Director is that marine parks are healthy, resilient, and well-managed to enhance Australia's wellbeing. A broad range of management actions are available including licensing, permits and approvals, zoning, compliance and enforcement, research and monitoring, and provision of visitor information.

## 1.1 Geographe Marine Park

Geographe Marine Park is 1 of 14 marine parks managed by Parks Australia in the South-west Marine Parks Network (see Figure 3). Geographe Marine Park is located within Geographe Bay, nearby Bunbury and Busselton, approximately 200 kilometres south of Perth, the capital city of Western Australia. Geographe Marine Park was declared in 2012 and the management plan (and hence management) came into effect on 1 July 2018. Geographe Marine Park is adjacent to the Ngari Capes Marine Park, which is managed by the Western Australian Government.

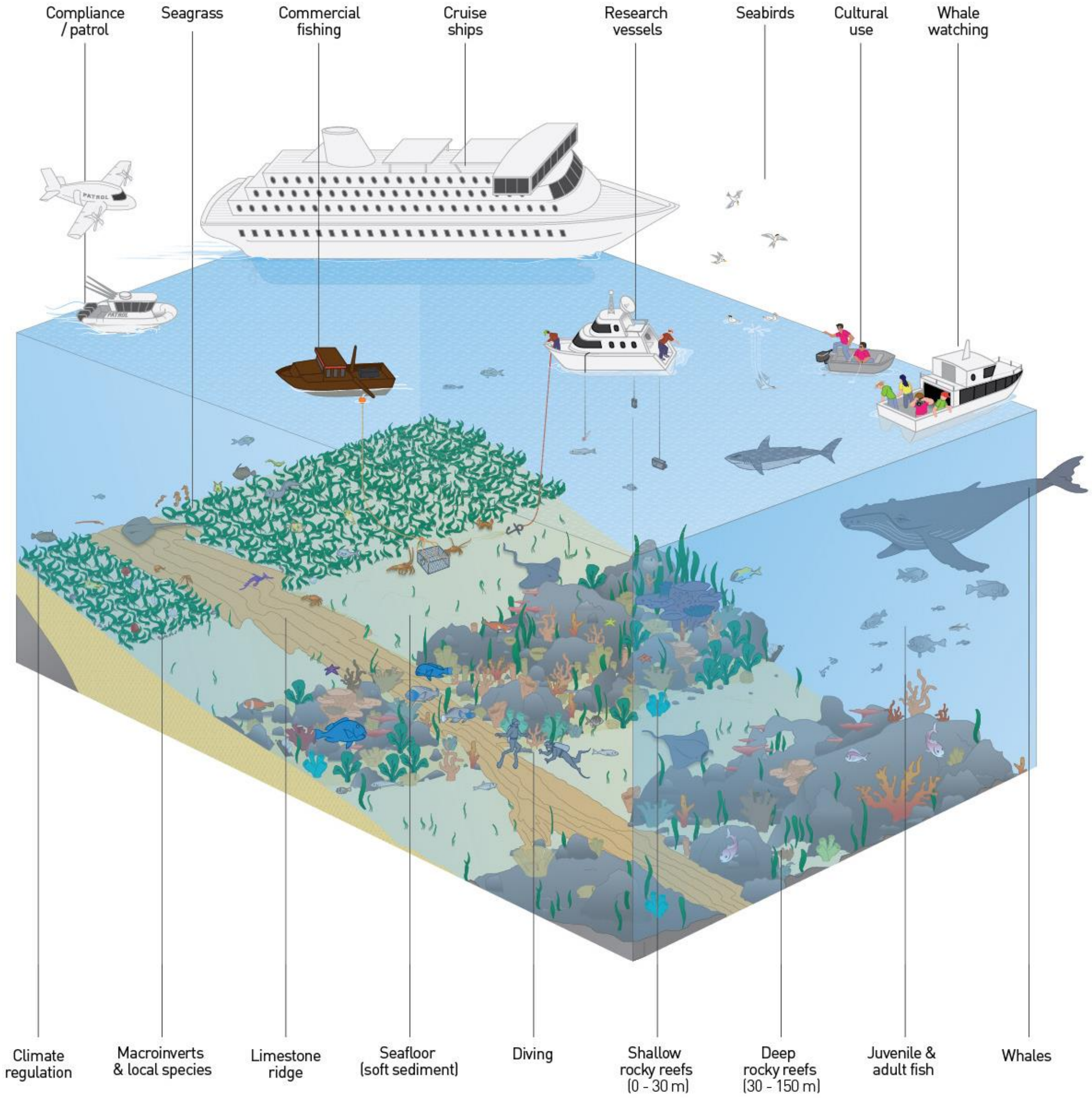
**Figure 3 Geographe Marine Park accounting area 2020**




Note: Spatial data on Australian Marine Parks has been used to create this map
Source: Department of the Environment and Energy, 2018

Geographe Marine Park contains a diverse range of ecosystems such as seagrass meadows and rocky reefs. These ecosystems are home to numerous species of fish and other marine animals such as whales. Figure 4 provides a conceptual diagram for Geographe Marine Park. These ecosystems and species, or assets, provide a bundle of services, including nutrient cycling, carbon sequestration and storage, nursery, and fish provisioning services. Recreational activities such as fishing, scuba diving, and whale watching also occur in Geographe Marine Park. In many instances, people also value the existence of species. There are various inshore and coastal assets, including State waters (located inshore from Geographe Marine Park and containing Ngari Capes Marine Park), and built assets such as the iconic Busselton Jetty, which contribute to the local economy and influence the activity in Geographe Marine Park. The Busselton Jetty provides a unique underwater observatory and is the longest Jetty in the southern hemisphere, attracting significant tourism activity to the region.

**Figure 4 Geographe Marine Park conceptual diagram**




The broader benefits of the marine habitats and species in Geographe Marine Park include health and wellbeing benefits (for example through benefits associated with exercise, recreation and food), economic benefits (for example through contributing to profits and employment), social and cultural benefits (for example maintaining connections to sea country) and environmental benefits (for example, conservation of biodiversity and increased resilience against pressures, sustaining the economic, social, and health and wellbeing benefits). There are many different organisations across both the private and public sector (for example, Busselton residents, domestic and international visitors, local businesses, and their supply chains) that are engaged in both the production and consumption of these benefits.

Unsustainable production and consumption of these benefits can impact Geographe Marine Park. For example, unsustainable fishing can deplete the stock of fish, boats can disturb whale migration patterns and anchoring can damage the seabed (seagrass and rocky reefs). Activities outside Australian Marine Parks, including agricultural runoff and litter from urban areas, can also impact the condition of ecosystems and other biotic (living) assets. Indirect impacts, for example carbon emissions, can affect sea surface temperature and acidity.

An example of how Parks Australia manages the use and health of Geographe Marine Park is through the use of zoning and related rules for managing activities to ensure protection of marine habitats and species while enabling sustainable use. The South-west Marine Parks Network Management Plan which commenced on 1 July 2018 specifies the zoning and associated rules for activities in Geographe Marine Park. For example, the Habitat Protection Zone excludes commercial fishing gear that interacts with the sea floor such as demersal longline but allows for other gear that operates in the water column such as dropline and hand collection. The National Park Zone excludes all extractive activities, but allows some tourism and recreation activities, and research.

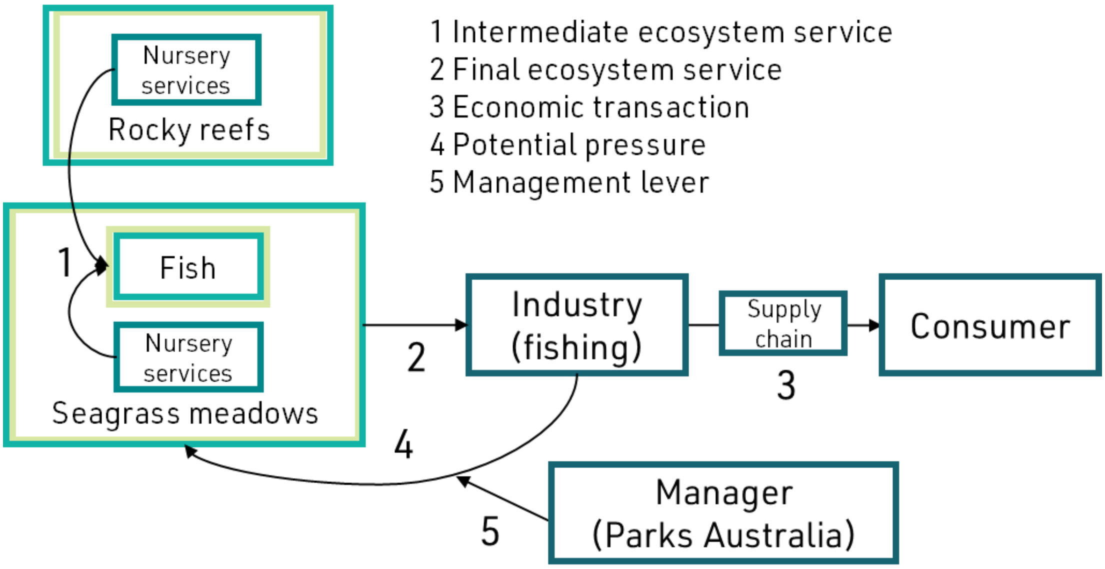
# 2 Accounting for our Oceans

This project applied the United Nations System of Environmental-Economic Accounting, specifically the Experimental Ecosystem Accounting framework, in addition to the draft Technical Guidance for Ocean Accounting. Information on ecosystems, species, uses, benefits, and pressures can be organised into an accounting framework that bridges ecology and economics. The core ecosystem accounting framework, Figure 5, describes the ocean as a set of assets, with a size and type (for example, extent or area of seagrass meadows) and condition (for example, characteristics such as seagrass density assessed against a reference condition) that produce a set of services (such as fish for food or a pleasant location for tourism). These assets and services have cultural and intrinsic value, and the user of services, whether a business, government, household, or community, also experiences some benefit.

**Figure 5 Core Ecosystem Accounting Framework**


The linkages between management and elements of the accounting framework are shown in Figure 6. This example is not exhaustive and could be extended to include benefits to other users such as recreational fishers.

**Figure 6 Management of oceans and the benefits they provide**




Parks Australia can manage the ecosystems in Geographe Marine Park (Figure 6 shows seagrass and rocky reef ecosystems) by regulating the use of the area through zoning and rules (see label 5 in Figure 6). The regulated ecosystems provide nursery services (see label 1) that contribute to the growth of fish. Some of these fish are caught by commercial fishers (see label 2 linking seagrass and industry). There is a potential pressure if this is harvested unsustainably (see label 4). The caught fish benefits the fishing industry, which enjoys profits, and also benefits households that consume the fish. This consumption can also generate further benefits to society. For example, the consumption of fish means that people will be employed to harvest it, and children eating that fish may grow to be strong and healthy.

Information on fish stocks, the condition of the seagrass and rocky reef ecosystems, the services being provided and how these contribute to the economy are key parts of ecosystem based management. Parks Australia can intervene to balance the benefits and the state of the ecosystems using the management tools available if they have reliable information that is integrated along these environmental, social and economic dimensions. The integration of information is central to accounting as it enables:

- An understanding of the benefits provided by particular ecosystem assets in the marine park, acknowledging that those benefits depend on a healthy and thriving ocean environment
- An understanding of whether the use of the asset that supplies those benefits is sustainable; that is its condition is not being damaged as a result of its use
- The subsequent identification of pressures on the condition of ocean ecosystems
- An understanding of the impact of management actions on ocean ecosystems and the benefits they provide.

Environmental-economic accounting details a set of concepts and principles for data collection, transformation, and organisation to support transparent and integrated decision-making. The concepts and principles involve consistent framing, classifications, transformation methods, and data collection methods. The key features of the information set produced by an accounting approach are described in Box 1.

### Box 1 Features of an environmental-economic accounting approach

**Linking activities to outcomes**

Ocean accounting integrates information on government activities and decision-making and ocean assets, and their capacity to contribute to the cultural, health and economic benefits for people

**Spatial**

Ocean accounting compiles information spatially to explicitly reflect the local context and dependencies on ocean assets

**Harmonised**

Ocean accounting generates information on ocean assets that is compatible with contemporary accounting and finance systems

**A Common language**

Ocean accounting provides a common language to identify problems, to exchange data, methods and experience, and to adapt solutions to multiple and changing beliefs and expectations

**Credible**

Ocean accounting stipulates process and methods with an aim of standardisation, enabling comprehensive verification and auditing.

# 3 Accounting pilot for Geographe Marine Park – results

The Geographe Marine Park project has provided an opportunity to demonstrate ocean accounting in a local setting. Information organised by an accounting approach provides an integrated narrative across ecological and economic data that supports integrated decision-making. This project intends to support the management of Geographe Marine Park in 3 ways:

1) Enable adaptive management of Australian Marine Parks (see section 3.1) by informing the design of the national Monitoring Evaluation Reporting and Improvement (MERI) Framework and associated indicators
2) Understand and express the multiple values Australian Marine Parks offer (see section 3.2)
3) Understand transit behaviours and uses of Australian Marine Park space to inform desktop compliance risk assessments (see section 3.3)

## 3.1 Enabling adaptive management

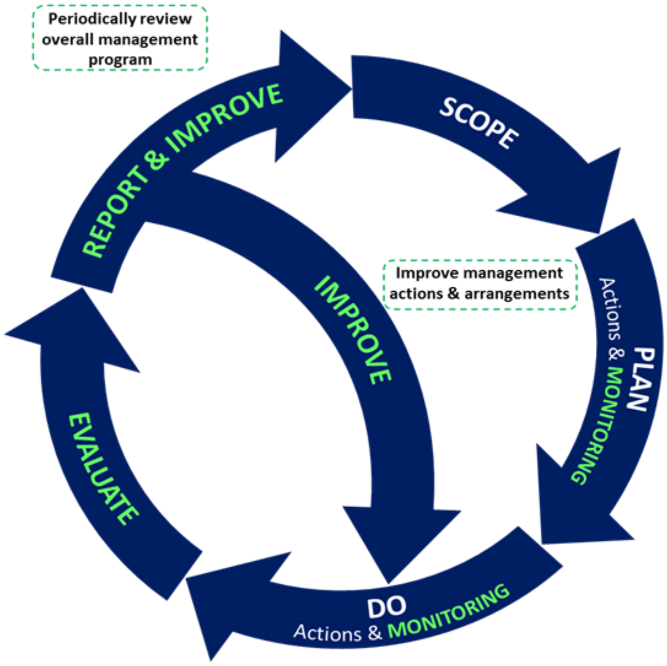
Adaptive management is a structured, iterative process to decision-making that depends on high quality information. The adaptive management approach is a cycle (see Figure 7) consisting of several steps including:

- Scope – identifying problems issues or areas
- Plan –assessing management options and prioritising management actions
- Do – implementing and monitoring the policies designed in the planning stage, for example permits, approvals and zoning
- Evaluate – evaluating the effectiveness of the policies implemented
- Report and improve – improving management actions.

Adaptive management processes rely on high quality information, for example information provided by a MERI Framework. An adaptive management approach, underpinned by good quality information, enables Parks Australia to:

- Make strategic planning decisions based on evidence
- Improve connections between management actions and conservation/management goals
- Learn from experience to build and adjust management actions through time
- Reduce uncertainty in decisions.

### Figure 7 Adaptive management cycle




Source: Parks Australia

Ocean accounting can inform the MERI Framework which underpins an adaptive management approach. Integrated and consistent information, produced as a result of ocean accounting, can be used to evaluate management actions and brings rigour and consistency to measurement across marine parks.

Parks Australia are in the early stages of applying the adaptive management cycle, with most management plans for Australian Marine Parks coming into effect in mid-2018. This project provides examples of how existing data can be synthesised and compared for decision-making purposes. It also provides insights into what and how Australian Marine Parks may be monitored in the future and different ways to analyse data for the evaluate stage (not just in Geographe Marine Park, but across all Australian Marine Parks).

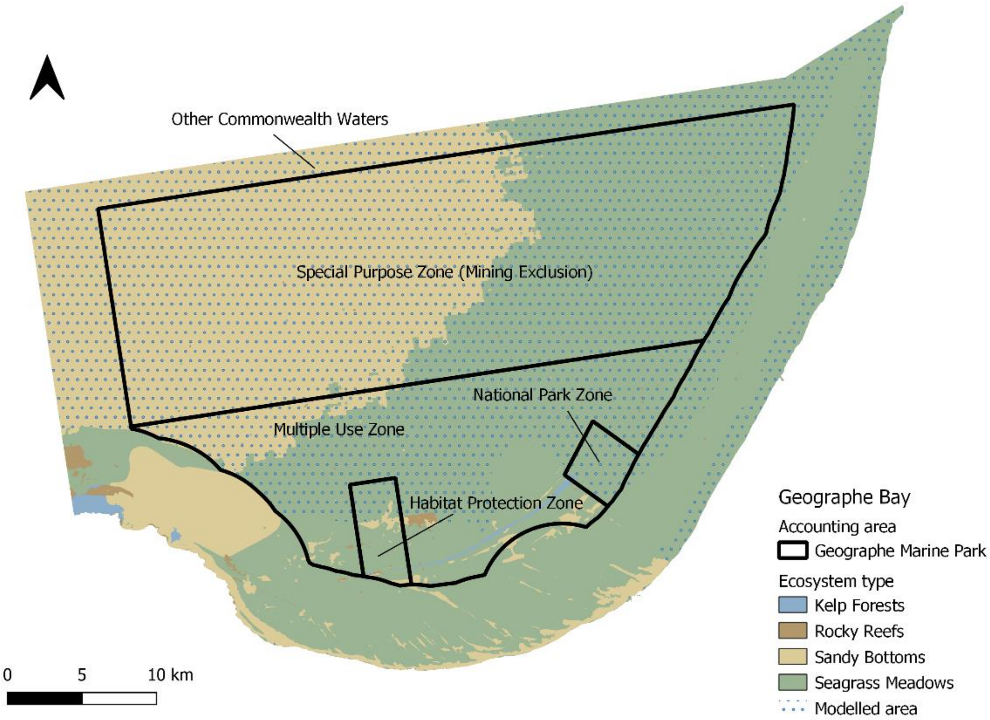
Australian Marine Parks have two key management objectives that are linked to the extent and condition of ocean ecosystems and the services and benefits they provide:

1) Protection and conservation of biodiversity and other natural, cultural and heritage values of marine parks; and
2) Ecologically sustainable use and enjoyment of the natural resources within marine parks, where this is consistent with the first objective.

The project has consolidated disparate pieces of information on ecosystem extent and condition (natural values in objective 1). Using the IUCN Global Ecosystem Typology (Keith *et al.*, 2020), the project provides a baseline for the extent of ecosystems in Geographe Marine Park totalling 96,477 hectares (Figure 8). Large areas of seagrass meadows are estimated to dominate Geographe Marine Park (55,139 hectares, 57% of the seafloor) compared with sandy bottoms (42%), rocky reef and kelp forest (<1%), including in 3 out of 4 of the zones. The share of rocky reef area is highest in the Habitat Protection Zone when compared to other zones within the marine park.

Figure 8 combines a number of datasets on ecosystem extent across different time periods. The dotted area is modelled, showing that only 10% of the marine park seafloor has been mapped previously. A key challenge is the lack of extent information collected, and the consistency of that data collection across time.

**Figure 8 Management areas and ecosystem types, Geographe Marine Park, 2014**




Note: (Keith et al., 2020) IUCN Global Ecosystem Typology applied. Extent map includes Geographe Bay to provide context to the ecosystems in Geographe Marine Park. 2014 was year of latest data set used in modelling of the extent layer. Source: Data from (Department of Parks and Wildlife, 2006; CSIRO, 2015; Emma Lawrence, Renae Hovey, Euan Harvey, Gary Kendrick and Williams, 2016; Lucieer et al., 2017)

Condition can be monitored across time to better understand the risk of ecosystem collapse. There is insufficient data to produce condition accounts for Geographe Marine Park. However, 4 condition indicators (seagrass meadows density, fish biomass, fish abundance, species diversity) have been aggregated and normalised to provide an overall score for each ecosystem type in Geographe Marine Park (see Table 1). Condition scores appear higher in the National Park and Habitat Protection Zones in 2014 when compared to the Multiple Use Zone and the Special Purpose Zone. The condition scores of seagrass meadows appear highest in the National Park Zone and Habitat Protection Zone. Specifically, seagrass meadow density appears highest in the National Park Zone, while the biomass of fish, fish abundance and species diversity in seagrass meadows all appear higher in the Habitat Protection Zone (Table 2). The condition scores of rocky reefs appear highest in the Habitat Protection Zone (Table 1).

## Table 1 Ecosystem condition indicators normalised, Geographe Marine Park, 2014

| Accounting area | Seagrass Meadows (0 to 1) | Rocky Reef (0 to 1) | Sandy Bottoms (0 to 1) | Kelp Forests (0 to 1) | All (0 to 1) |
|---|---|---|---|---|---|
| Habitat Protection Zone | 0.37 | 0.45 | 0.42 | 0.56 | 0.38 |
| Multiple Use Zone | 0.35 | 0.37 | 0.41 | 0.49 | 0.36 |
| National Park Zone | 0.38 | – | 0.41 | 0.56 | 0.38 |
| Special Purpose Zone | 0.32 | 0.38 | 0.33 | 0.41 | 0.33 |
| Total | 0.34 | 0.39 | 0.34 | 0.49 | 0.34 |

Note: Data from 2014 used to estimate condition. The numbers are most likely a lower bound of condition (i.e. condition is likely better than indicated by the scores). Raw point data has been interpolated using inverse distance weighted matrix. The further the distance from the observed data, the lower the confidence in the representativeness of the data, and therefore a lower value is given. The maximum value for each ecosystem has been used as the reference level to normalise data. Aggregates shown are area weighted estimates of the interpolated data. An equal weighting across indicators has been applied to create a condition index. Confidence is high at sample locations. Modelled estimates are conservative as they decrease with distance from the sample location. Statistical outliers have not been removed. Estimates can be improved with additional data collection stratified by ecosystem type and other attributes.
Source: Data from NERP survey used to estimate condition (Emma Lawrence, Renae Hovey, Euan Harvey, Gary Kendrick and Williams, 2016).

## Table 2 Seagrass meadows condition indicators, Geographe Marine Park, 2014

| Accounting area | Seagrass meadows density (score) | Biomass of fish > 20cm (kg) | Fish abundance (n) | Fish species diversity (n) |
|---|---|---|---|---|
| Habitat Protection Zone | 66.1 | 33.1 | 45.1 | 12.4 |
| Multiple Use Zone | 65.2 | 22.7 | 42.3 | 12.0 |
| National Park Zone | 79.6 | 17.2 | 36.5 | 12.1 |
| Special Purpose Zone | 60.8 | 20.0 | 37.2 | 11.2 |
| Total | 63.4 | 21.5 | 39.6 | 11.6 |

Note: Data from 2014 used to estimate condition. Note that the current data does not draw on all available data for nearshore waters as this area was not the focus of this study. Raw point data has been interpolated using inverse distance weighted matrix. Aggregates shown are area weighted estimates of the interpolated data. Confidence is high at sample locations. Modelled estimates are conservative as they decrease with distance from the sample location. Statistical outliers have not been removed. Estimates can be improved with additional data collection stratified by ecosystem type and other attributes. Seagrass meadows density score has been calculated by assigning a score to the different density categories (for example, sparse and dense), with greater density assumed to be in better condition. Biomass of large fish is equal to biomass of fish > 20cm and has been calculated using length weight relationships from Fishbase. Mean weights were used when weights were missing for species. Fish abundance is the number of fish observed. Fish species diversity represents species richness which is measured by the number of unique types of species observed.
Source: Data from NERP survey used to estimate condition (Emma Lawrence, Renae Hovey, Euan Harvey, Gary Kendrick & Williams, 2016).

The impact of off-park processes and drivers is an important consideration for marine park management that was not covered in this project. For instance, fish stocks flow into and out of Geographe Marine Park and may be affected by use that may change the services measured within the park. Further research would be needed to express external drivers in a way that managers can understand their relative impact.

## 3.2 Expression and understanding of multiple benefits

The quantity and quality of the ecosystems and biotic assets in Geographe Marine Park directly influences the quantity of services provided by the park and the benefits people receive. Table 3 provides a summary of services that have been estimated as part of this project. The table describes the contribution of the parks' ecosystems and biotic assets to the local economy (market and non-market), both in physical quantities and monetary terms. While these are initial estimates and further work and data collection is needed to refine them, this table is a powerful tool for communicating the multiple benefits provided by Geographe Marine Park. The ecosystem assets in Geographe Marine Park contribute to economic and social wellbeing more broadly.

Activities in Geographe Marine Park contributed approximately $316,412 in 2019 to the gross operating surplus of the local economy through whale watching ($253,950) and commercial fishing ($62,462), including approximately 30,384 kg commercial fish catch. Approximately 12,500 visitors undertook whale watching in the Geographe Bay overall and were estimated to spend $1,125,000 in the region in 2019.

Approximately 545,000 visitors enjoyed recreational activities in Geographe Bay. Recreational fishers captured approximately 6,692 kg of Western Rock Lobster valued at $421,616 and took around 12,824 fishing trips in 2018. Expenditure related to those trips (for example gear, travel, accommodation, and boat expenditure) was approximately $1,143 per trip. Recreational fishers' gross willingness to pay has been calculated at $16,940,650. This is inclusive of expenditure related to the trip ($14,657,958) and consumer surplus related to the experience ($2,282,692). Consumer surplus is the difference between the price that each consumer pays for the experience and their willingness to pay for the experience.

Seagrass meadows in Geographe Marine Park contribute to climate change mitigation and resilience. They store approximately 6,258,226 tonnes of carbon in soil, and each year sequester approximately 27,569 tonnes of carbon (net) based on the estimates of seagrass extent in 2014. This reflects the higher rate of sequestration and storage capacity observed in marine ecosystems compared with terrestrial systems. These results are equivalent to 1,500 households' average carbon emissions per annum, with an estimated dollar value of $443,865 (assuming $16.10 per tonne). All non-market ecosystem services values do not represent the value of a transaction in the economy.

Each hectare of seagrass meadows provides nursery services equivalent to approximately 6,227 kg of tarwhine, 3,976 kg of sea mullet and 809 kg of King George whiting per year. Information on other species could not be found for this project. The measurement and accounting for cultural services was not in scope for this project, but key features of the bay are known to be highly valued by traditional owners and others in the local community.

The relationship between built assets and ocean ecosystems is important to consider in future work. While there are no prominent built assets in Geographe Marine Park itself, Busselton Jetty provides access to State waters for people to enjoy nature. There were approximately 270,000 visitors to Busselton Jetty in the financial year from 2018 to 2019. Further work could be completed to estimate the contribution of Busselton Jetty and State waters more generally to tourism in the region.

As ocean accounting evolves and additional data is collected, it will be important to link the information in Table 4 to the assets that are being managed. Changes in asset type, quantity and quality will change the composition of services that are provided. In the meantime, this project provides an important first step in understanding the range of benefits provided from within Geographe Marine Park.

### Table 3 Initial estimates of ecosystem services and ecosystem uses, multiple years

| Service/use | Units | Quantity | Year | Area | User |
|---|---|---|---|---|---|
| **Fishing** | | | | | |
| Commercial fishing | Kg | 30,384 | 2019 | Geographe Marine Park | Industry |
| | Value ($AUD) | 164,313 | | | |
| | GOS ($AUD) | 62,462 | | | |
| Recreational fishing catch – western rock lobster | Kg | 6,692 | 2018 | Geographe Marine Park | Household |
| | Value ($AUD) | 421,616 | | | |
| Nursery – tarwhine | Kg/ha seagrass | 6,227 | 2014 | Geographe Bay | Ocean |
| Nursery – sea mullet | Kg/ha seagrass | 3,976 | | | |
| Nursery – King George whiting | Kg/ha seagrass | 809 | | | |
| **Recreation** | | | | | |
| Recreational activities | # domestic visitors participating in marine activities | 545,000 | 2018 | Geographe Bay | Household |
| Recreational fishing | # Fishing trips | 12,824 | 2018 | Geographe Marine Park | Household |
| | Consumer surplus ($AUD) | 2,282,692 | | | |
| | Gross WTP ($AUD) | 16,940,650 | | | |
| Whale watching tourism | Number of visitors | 12,500 | 2019 | Geographe Bay | Industry |
| | Value ($AUD) | 1,125,000 | | | |
| | GOS ($AUD) | 253,950 | | | |
| **Carbon** | | | | | |
| Seagrass carbon sequestration | Tonnes | 27,569 | 2014 | Geographe Marine Park | Government |
| | Value ($AUD) | 443,865 | | | |
| Seagrass soil carbon stock | Tonnes | 6,258,226 | 2015 | | |
| **Other ecosystem uses** | | | | | |
| Vessel parking (over 4 hours) | Quantity | 45 | 2012–2020 | Geographe Marine Park | Industry |

Note: kg/ha = Kilograms per hectare. WTP = willingness to pay. GOS = Gross Operating Surplus. Gross operating surplus is the total monetary output less the costs of production. Data has been transformed. Initial estimates only – care is required when interpreting these values. Measures of values noted in table vary and direct comparisons should be done with care. Difficulties exist when valuing non-market goods and services. For example, carbon and recreational fishing. See accounting and methodologies report for more information on individual methods and limitations. Prices are in AUD current, not constant. Service quantities are yearly quantities. Geographe Bay refers to the area containing Geographe Marine Park. The scope of this table is Geographe Marine Park. However, the scope has been expanded to Geographe Bay where there has been insufficient information to support a narrative of Geographe Marine Park.

Source: Data from (McLeod and Lindner, 2018; Australian Maritime Safety Authority, 2019; Ryan et al., 2019; Serrano et al., 2019; Tourism Research Australia, 2019; Department of Primary Industries and Regional Development, 2020; Jänes et al., 2020)

## 3.3 Transit and use of marine space

The ocean provides a medium for transportation, connecting suppliers and consumers, and providing people with avenues to enjoy the ocean. Vessels may have a deleterious effect on ocean ecosystems and Geographe Marine Park is no exception. For example, vessels can introduce pests and generate marine waste, and recreational boat operators may anchor and tear out or drag through a seagrass meadow which can be worked by storms to create erosions scars.

Parks Australia is responsible for regulatory development and implementation across Australian Marine Parks. This includes compliance and enforcement and assessment of activities (authorisations). Desktop compliance includes monitoring commercial fishing vessels use via Vessel Monitoring Systems and, to a lesser extent, via Automatic Information System. On-water compliance is undertaken on behalf of Parks Australia by agencies such as Australian Border Force and state government agencies via aerial and vessel patrols. These actions are particularly important as illegal activity, such as unauthorised fishing, can result in pressures that could negatively impact the extent and condition of ecosystems.

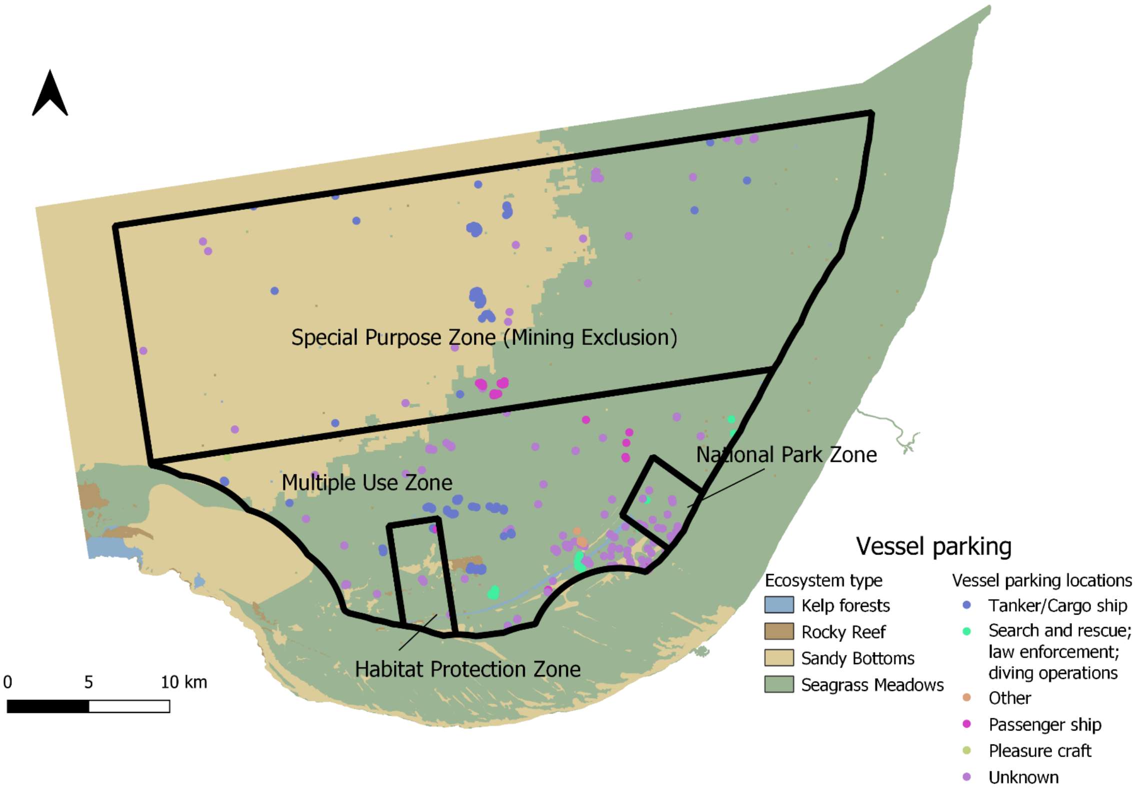
Australian Marine Parks cover a vast amount of ocean and it is not possible to monitor all activities that are undertaken. Any information or data to assist in detecting illegal activity or trends in use is informative for assessing risks, prioritising monitoring and surveillance activities and developing authorisation policies and conditions for authorisations.

Cruise ships are a vessel type that anchor in state waters for around 10 hours during the daytime, so passengers can engage in shore-based activities in Busselton. Automatic Identification System (AIS) data has revealed that some ships are remaining stationary in Geographe Marine Park, for up to 24 hours after leaving state waters. One explanation may be that cruise ships park in Geographe Marine Park when the weather does not permit disembarking. Figure 9 shows the location of these parking services.

Table 4 shows the number of vessels parking for greater than 4 hours, which may suggest stopping, anchoring or dynamic positioning, in the zones of Geographe Marine Park from 2012 to 2020. Vessel types include for example medium to large tanker/cargo ships, search and rescue boats and cruise ships. The majority of the 45 vessels parked for more than 4 hours between 2012 and 2020, did so in the multiple use and special purpose zones. A total of 31 vessels were also found to park for longer than 4 hours in the seagrass meadows of all zoning areas in the marine park at periods between 2012 to 2020.

It is envisaged that additional data can be collected to determine the link between vessel use and ecosystem condition. It is currently unknown whether vessels are physically anchoring (and possibly damaging the seagrass or rocky reefs) or geo-anchoring/dynamic positioning. Either way, commercial vessels may require an authorisation to stop inside a marine park depending on what zone they are in, the type of vessel, and the reasons they are stopping. Identification of vessel types can inform targeted education to prevent these potential pressures, such as where, when, and how vessels can stop or anchor. The information can also be used to evaluate the effectiveness of existing regulation. In the future, the accounting approach can be used to correlate the vessel parking services with the condition of ecosystems, such as seagrass meadow density. Vessel parking hotspots can be targeted for condition monitoring of nearby ecosystems.

### Figure 9 Quantity of parking services, Geographe Marine Park 2012 to 2020




Note: The map shows the areas where vessels are potentially parked. Vessels have stopped if they are within 1KM of their last location. Note that a cluster of points may represent the same vessel that has drifted while it has stopped. Data is currently restricted to boats that have their Automatic Identification System (AIS) on, and vessels may turn this off. The map does not show length of stop time. 2020 numbers are from January to May.
Source: AIS data (Australian Maritime Safety Authority, 2020)

### Table 4 Vessel parking greater than 4 hours, Geographe Bay, 2012 to 2020

| Accounting area | 2012 (n) | 2013 (n) | 2014 (n) | 2015 (n) | 2016 (n) | 2017 (n) | 2018 (n) | 2019 (n) | 2020 (n) | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Commonwealth waters | | | | | | | | | | |
| Geographe Marine Park | | | | | | | | | | |
| Habitat Protection Zone | – | – | – | 1 | – | – | – | – | – | 1 |
| National Park Zone | – | – | – | 2 | – | – | – | – | – | 2 |
| Multiple Use Zone | 2 | 1 | 5 | 4 | 1 | 2 | 2 | 7 | 1 | 25 |
| Special Purpose Zone | – | 2 | 2 | 3 | 1 | – | 3 | 2 | 4 | 17 |
| Geographe Marine Park Total | 2 | 3 | 7 | 10 | 2 | 2 | 5 | 9 | 5 | 45 |

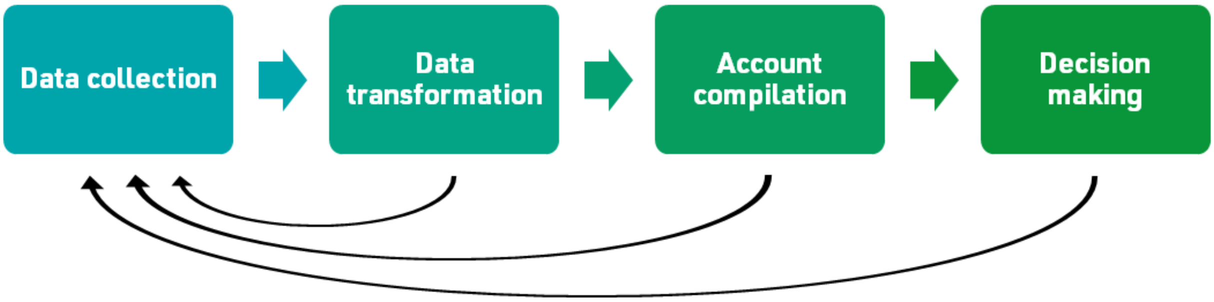
Note: 2020 numbers are from January to May. n = number of vessels defined as stopped. Vessels have stopped if they are within 1KM of their last location. AIS data used. Confidence in underlying data is high. Data is currently restricted to boats that have their Automatic Identification System (AIS) on, and vessels may turn this off.
Source: AIS data (Australian Maritime Safety Authority, 2020)

# 4 The accounting process – lessons learnt

The accounting process consists of 4 stages (see Figure 10). The first stage, data collection, involves researching and cataloguing data sets. The second stage, data transformation, involves the application of environmental-economic accounting principles, guidelines, and classifications, to ensure that data is comparable and aligned. The third stage, account compilation and build, involves compiling accounts and supplementary tables (accounts) from the account ready data produced during the data transformation stage. The fourth stage involves using the accounts in decision-making.

The decision makers (for example, governments, corporations, non-government organisations) utilise the accounts and account ready data in various ways. For example, the accounts can be used to create indicators such as the relative size of an ecosystem type and its condition, and the account ready data can be used to determine statistical relationships between variables (for example ecosystem size and type, and ecosystem services). Accounts and supplementary tables can be improved and modified based on requests from decision makers and the type of management questions that are being considered to support decision-making.

**Figure 10 The accounting process**




Observations about each of the stages from Figure 10 are provided in sections 4.1 to 4.4. The stages in Figure 10 are iterative and it is difficult to move through in a linear or fixed stepwise fashion. In addition, different accounts and the related data collections and transformations may be at different stages in the process. For example, an extent account may be compiled while data is still being collected for ecosystem services. Once data on ecosystem services is made available then a review of the extent account would be required to ensure there is alignment and spatial coherence. Further, discoveries during account compilation and data transformation may indicate that additional data needs to be collected or compiled from existing sources, for example by modelling.

The feedback loop between decision-making and data collection is central to improving information for evidence-based decision-making. Accounts need to be refined and tailored based on changing environmental conditions, new data, and the changing needs of decision makers. A better understanding of how decision makers use information to inform their decisions is required to ensure accounts are most useful. The benefits can then better be assessed against the cost of ocean accounting and additional data collection in improve accuracy and coverage of the accounting outputs. Including users in the design phase can contribute to more useful accounts.

Using existing data to build initial accounts may not reveal many new insights for local decision makers. This is likely due to missing data; the data being collected in a bespoke manner and not being interoperable. Undertaking the accounting process can inform future investment in data collection and improve the utility of both the data and any accounts produced. The account ready information set is an asset that needs to be maintained and improved through time to ensure it can continue to be relevant and provide services to decision makers and researchers in the various fields of environment and economic studies.

Ocean accounting, like the management of our oceans, requires a joint and coordinated effort across the public and private sector, academia, and NGOs. Data collection is variable across institutions, and accounts can provide a focal point for facilitating a constructive dialogue for coordination among these sectors. The accounting approach integrates expertise across a range of disciplines.

## 4.1 Data collection

Geographe Marine Park has been studied reasonably well when compared to other Australian Marine Parks. The data collection phase (IDEEA Group, 2020a) supported the discovery of environmental and economic data related to Geographe Marine Park. The data collection phase has:

- Identified existing information that can underpin the MERI system
- Identified information gaps
- Provided an example of how information collected by Parks Australia can be fed into the accounts.

This project relied on existing data only. While the project is a solid first effort at ocean accounting, additional data is required, through data collection or improved modelling and data integration, if the accounts are to be most useful for local management and decision-making. For example, current data on the ecosystems within Geographe Marine Park provide an understanding of the different ecosystem types, but their spatial distribution is not known with certainty. However, before sourcing additional data that would address this and other information gaps, it is necessary for account producers to understand how managers make local decisions to best support their decision-making processes and satisfy their data requirements (see section 4.4). The cost-benefit of investing in data collection and an accounting approach should also be considered.

The strengths and challenges associated with data availability during this project are outlined in Table 5. A key finding is that there are large information gaps on the extent and condition of the ecosystems. The resolution of the data was mixed and ranged from fine resolution point data to coarse regional data. The data ranged in spatial and temporal coverage, was collected at different spatial scales, and was temporally very limited (i.e. for much data there was only 1 reference period). A key priority is consistent and standardised monitoring of the extent and condition of ocean assets. There is also a need to understand the responsiveness of services and benefits to changes in extent and condition (measures of ecological characteristics and water quality/chemistry) across different locations. For example, there was not enough information to quantify the differences in nursery services across the ecosystem types. This requires ecosystem service models that vary by ecosystem type and ecosystem characteristics, for example, bathymetry and seagrass density.

Existing data collection processes could be adapted to enable the integration of different data sets, thus increasing the value and utility of future data collection. Developing standards on spatial data is also important to ensure integration can take place with minimum interpolation and/or extrapolation.

### Table 5 Overview of data availability

| Component | Strengths | Challenges |
|---|---|---|
| Ecosystem Extent | Geographe Marine Park surveyed in 2014. However, this had not been converted to extent estimates. | Only 10% of Geographe Marine Park had been mapped historically<br>A consistent classification of existing data had not been applied across different years<br>Input data presented as mixed habitat could be presented at finer scales, for example, proportions of habitat types or dominant ecosystem types<br>No time series |
| Species - biotic assets | Time series on relative whale abundance (2016 – 2019)<br>Large area of Geographe Marine Park surveyed for fish presence (2014) | Limited data on invertebrate presence<br>No time series<br>Limited spatial coverage of Geographe Marine Park<br>No quantitative stock assessments at the scale of interest |
| Ecosystem Condition | Biotic compositional characteristics well represented by 2014 survey<br>Time series for Rocky Reef condition, albeit at fine spatial scales | Lack of information on structural biotic characteristics of the ecosystems, for example, seagrass density, and abiotic characteristics, for example substrate type<br>Low spatial coverage of condition data<br>Lack of context specific thresholds for condition assessments (for example chlorophyll a)<br>Lack of information on reference condition<br>No time series with the exception of a small sample of rocky reef sites |
| Services | Information available across a number of different services<br>Time series on commercial fisheries and tourism | Data was at regional level, rather than specific to Geographe Marine Park<br>Some data, for example tourism, not attributable to Geographe Marine Park<br>Estimates of some services rely on extent data, which had low coverage |
| Benefits | Exchange values available for some services. | Not enough information to properly distinguish between the classes of users of the services (for example household demographics, business size, tourist type) |

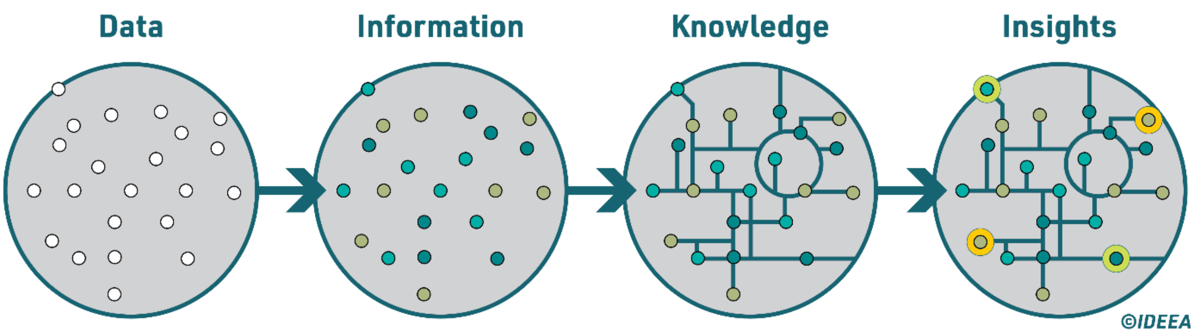
## 4.2 Data transformation

Data transformation is the process of converting raw data into account ready data (see the process of moving from data to information in Figure 11). The type of transformation required is related to the type, quantity and quality of data that is available, and what is being measured. An important part of transformation is ensuring that each account ready dataset is coherent with other account ready datasets. This enables knowledge and insights to be gained from disparate and bespoke data sets. In practice, coherence means that information on ecosystem type, its characteristics, and its extent and condition, are linked to the quantity of services, and thus ecological information is linked with economic information for decision-making.

Transformation requires the implementation of accounting principles including:

- consistent framing and classifications, including spatial frameworks and time frames
- consistent transformation methods, including approaches to modelling and classifications
- linking transformation to data collection to ensure consistent methods can be applied

**Figure 11 Transforming raw data to account ready data**




The transformation phase documented initial methods for producing ocean accounts that can be refined and improved over time (IDEEA Group, 2020b). There was enough existing data to produce account ready data. However, the quality of the account ready (transformed) data is highly dependent on the data available and the transformations applied. Many of the datasets were better suited to regional level accounts.

A comprehensive set of ocean accounts can be supported by a review of data collection, research on existing transformation approaches and collaboration on an effective approach to transformation. The final accounts are sensitive to any assumptions that are made about missing data and information. Decision makers will need to assess whether the transformations produce information that is suitable for their needs.

Two broad sets of transformations were applied in this project: spatial transformation and accounting transformation. Table 6 shows the challenges associated with these transformations and opportunities for improvement. The spatial transformations applied to data include:

- Spatial interpolation – modelling unknown areas, where unknown data is within the extent of known areas
- Spatial extrapolation – modelling unknown areas where unknown data is outside the extent of known areas

- Spatial apportionment – moving from larger spatial areas to smaller spatial areas by distributing the data across the smaller area
- Spatial transfer – estimation by using a value from outside the project area

The key challenge with spatial transformations occurred when statistical geographies differed or when data had been collected at different scales. For example, in many cases the resolution of the data did not match that of the accounting areas. Spatial transformations may introduce uncertainty in the account ready data as a number of assumptions are made. For example, bioregional level information on recreational fish catch, such as the quantity of different species caught, was apportioned to the area containing Geographe Marine Park using the population of coastal LGAs as weights. This assumes that population is a driver of recreational fishing in adjacent coastal waters and does not consider environmental factors that may affect the quantity of species that is available to be caught.

Missing information at a local scale also made it difficult to model and provide account ready data at the level of Geographe Marine Park. For example, existing data was not sufficiently detailed to understand how many times tourism operators went to Geographe Marine Park as opposed to other areas in Geographe Bay. Further, carbon sequestration was modelled using seagrass extent, and not on ecosystem characteristics such as seagrass density and bathymetry (the depth of underwater terrain). If fine scale accounts are desirable, then dedicated surveys that help apportion low resolution information to specific geographies will be important.

The measurement of ecosystem condition provided one of the biggest empirical challenges. Measurement of ecosystem condition involves the assessment of ecosystem characteristics against a reference level. A lack of information on an appropriate benchmark made it difficult to properly assess the health of the ecosystems. A key area of research for ecosystem accounting is the development of reference conditions, perhaps by expert elicitation.

**Table 6 Overview of transformation**

| Component | Transformation applied | Challenges | Opportunities |
|---|---|---|---|
| Ecosystem Extent | Interpolation<br>IUCN Global Ecosystem Typology | Missing data<br>Modelling with large unknown areas<br>Uncertainty in estimates | Increase sampling to improve estimates<br>Develop sensitivity analysis of modelling |
| Species - Biotic asset | None | Lack of data to assess fish stock | Review of data required to model fish stock |
| Ecosystem Condition | Interpolation<br>Normalisation<br>Ecosystem condition typology | Missing data<br>Determining reference level<br>Validity of interpolation method untested | Increase sampling to improve estimates<br>Derive reference level of ecosystems by different strata to improve interpretation of normalisation |
| Services | Transfer<br>Apportionment<br>Valuation | Accounting areas and statistical geographies do not align<br>Apportioning ecosystem services to ecosystem types/assets<br>Benefit transfer with lack of characteristics to base transfer on<br>Valuation of ecosystem services | Align statistical geographies where possible<br>Measure ecosystem services for each ecosystem asset<br>Collect data specific to Geographe Marine Park, for example boat ramp surveys |
| Benefits | Valuation | Moving from value of benefits to ecosystem service value<br>Choice of valuation method and lack of agreed valuation factors (for example, carbon price)<br>Valuing non-market ecosystem services when exchange prices are not available | Improved business surveys<br>Review of valuation techniques<br>Valuation database |

Note: see page 19 for explanation of spatial transformation applied

## 4.3 Account compilation

Account compilation is the process of turning account ready data into accounts (for example, supply and use tables and stock and flow tables) and supplementary tables. The project has provided an example of accounts that can be organised for Australian Marine Parks, including how they can be structured (IDEEA Group, 2020c). Table 7 provides an overview of the accounts produced during this project.

A key finding is that when compiling accounts for the first time, there will be iteration between collection, transformation, and compilation. For example, when compiling ecosystem accounts, the size of one service may be significantly greater than another, which in the first instance appears to be wrong. This may mean that additional data is needed to help verify or change the assumptions that have been made.

Over time, it is likely that ongoing improvements in data collection and transformation stages in the preparation of account ready data will make the account compilation task more straightforward. However, there will be a need to balance investments in these data improvements with parallel investment in the capability to use ecological, economic, geographic and accounting expertise to compile accounts. The integration phase whereby insights are gained from the comparison, confrontation and reconciliation of data is a fundamental aspect of the accounting process and one that adds significant value to decision-making processes.

**Table 7 Account tables compiled during the project**

| Account | Table type | Observations |
|---|---|---|
| • Ecosystem extent<br>• Carbon stock | Stock and flow table | Lack of time series prevented challenges for presenting stock and flow tables, which require an opening and a closing balance<br>Providing reasons for additions and reductions will require more information than just change |
| • Fisheries (commercial, recreational and nursery)<br>• Recreation (marine activities and whale watching)<br>• Carbon sequestration<br>• Vessel parking | Supply and use table | Not all services could be presented for Geographe Marine Park, with some needing to be presented at a bay wide scale, or for the Busselton area.<br>Further work is required to present information by ecosystem type<br>Difficulties presenting monetary values in account tables when they are not transaction values, for example consumer surplus<br>Nuance required when presenting information on abiotic services (for example, parking) as this is a use perspective |
| • All accounts presented as stock and flow tables and supply and use tables<br>• Ecosystem condition<br>• Sea surface temperature<br>• Chlorophyll-a<br>• Whale sightings<br>• Species presence<br>• Marine tourism | Supplementary table | There is additional benefit in producing point in time tables, or time series tables to support the stock and flow table and the supply and use table<br>Further work is required to bring other data into accounting formats |

Note: Supply and use tables link two economic or spatial units that are involved in a transaction. Stock and flow tables show the opening and closing quantity of an asset, and reasons for additions and reductions. Supplementary tables contain other pieces of information that are important to record such as time series, input-output tables and other tables that are used for analysis. More information on the accounts produced during this project can be found in table 2 of the accounting report.

The credibility of the accounts depends on the assumptions made in the transformation stage, the quality of the data underpinning them, and the resources committed to the integration of data and account compilation. A key priority is to understand statistical measures of error of the underlying data and then present them with the accounts. This can be important information for determining to what extent an account could be used as an input to decision-making. Further, where there are large statistical errors this could be used to prioritise future data review and refinement.

## 4.4 Decision-making

Judging the utility of ocean accounting ultimately depends on how the information is used in decision-making. There are various types of decisions that ocean accounting can underpin:

- Public sector policy including:
  - Planning and strategy (setting outcomes within and across sectors)
  - Regulatory decisions (authorising/not authorising/setting conditions for activities)
  - Operational and management decisions
  - Investment decisions
- Decisions to invest in information.

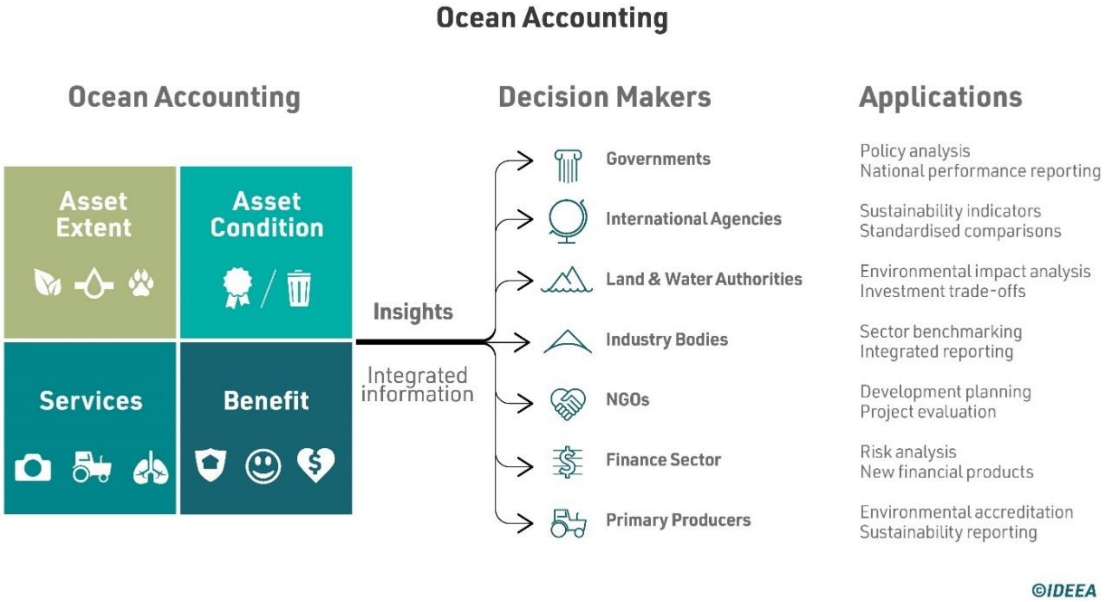
Management decisions draw on insights from information (see Figure 11). In their raw form, the accounts and supplementary tables can be used for problem identification and communication. The accounts in this project have enhanced awareness and provided greater depth to the current understanding of the multiple benefits provided by Geographe Marine Park. The information can also be used to inform risk assessments and prioritise future monitoring and surveillance activities.

Further use of the accounts in local decision-making is not clear due to the poor temporal and spatial coverage of the data on ecosystem extent and condition. Areas with additional data, for example nearshore ocean and coastal ecosystems, may be better areas to develop explicit use cases based on the accounting outputs. In such areas, indicators may be drawn from an account or supplementary tables and interpreted to determine which areas are declining in condition.

In other cases, the accounts and supplementary tables may be used as inputs into applications. For example, before making budget bids agencies may draw on the accounts and supplementary tables to make an ex-ante evaluation of policy choices using scenario analysis. For this type of analysis, it will be important to have an understanding of rates of change in ecosystem extent and condition. A number of other applications are shown in Figure 12. Government investment in accounting can add tremendous value for other decision makers, not just the public sector.

Accounts and supplementary tables will not always be a sufficient input for an application. For example, the evaluation of interventions in Geographe Marine Park, such as the effect of the management of IUCN zones on ecosystem condition, could be undertaken using a structured time series and the estimation of a business as usual scenario. Observations for the same unit (for example, an ecosystem asset) pre and post intervention and a number of control variables could be drawn from the account ready data to perform this analysis.

**Figure 12 Ocean accounting for decision-making**




A key benefit of this project is the knowledge gained from trialling environmental-economic accounting in Geographe Marine Park. The project provides the foundation for future investment in information for the management of Australian Marine Parks by:

- Providing a systematic stocktake of the information available to Parks Australia.
- Identifying information that can underpin the MERI system
- Identifying information gaps – contributing to the knowledge of ‘values’ in marine parks
- Informing priorities for ongoing monitoring in Geographe Marine Park”
- Providing methods for producing an information set that can be tested and improved
- Highlighting ways to present information on Geographe Marine Park

The benefits of ocean accounting to decision makers can be better understood before using the findings from the project to inform investments in data. For example, do ocean accounts inform the decision-making process, and does that process change decisions and benefit society? Additional research is required to quantify the benefits of accounting.

# 5 Scaling up the accounting process

One of the aims of this project was to test internationally accepted accounting frameworks and technical guidance in an Australian marine context and assess feasibility for broader application. The accounting frameworks and technical guidance has been found to be suitable for integrating existing data and identifying key data gaps. It can be applied at a local, state, or national level. Even though the Geographe Marine Park pilot was data poor, the lessons learnt are invaluable for future applications both in Australia and internationally, including scaling up to a national level. The lessons learnt are also applicable to other environments such as coastal and terrestrial areas.

The project has found that there is enough existing data to scale up some ocean accounts at the national level. Table 8 provides an assessment of the data, task, relative cost, expected spatial coverage, and time horizon for the different accounting components. This assessment is not exhaustive as it is based on experiences from Geographe Marine Park, but it is a reasonable starting point for scoping national accounts. Scaling up accounts will also require reconsideration of their purpose and intended use. For example, national level accounts that are not a compilation of local data would be better suited to address national level policy questions.

National level accounts could be produced with existing data for ecosystem extent, ecosystem services (commercial fisheries, and carbon stock and sequestration) and ecosystem use (parking and transportation). Ecosystem condition, nursery services, recreation activities and marine related tourism require further investigation. Many of the datasets used in the project, for example Seamap Australia, were national level datasets while others, for example commercial fish catch, are known to exist across the relevant states. Some datasets are localised (for example seagrass characteristics) and significant effort will be required to collate the datasets.

An important consideration is the desired resolution and coverage of the accounts. The scope of national ocean accounts should include seagrass, kelp forests, rocky reefs, sandy bottoms, coral reefs, and intertidal areas comprising of mangroves and tidal marshes. As some of the data sources are low resolution, it may be sensible to first achieve national coverage before developing approaches to transform the data to make it relevant to local areas. Further, it is likely that state waters and coastal ecosystems such as mangroves and tidal marshes will be better represented in national accounts when compared to ecosystems further offshore or in Commonwealth waters.

Until there is a standardised approach to data collection at a national scale, there will be some methodological difficulties in developing national ocean accounts. Rather than see the potential issues as a barrier, the learnings are likely to prove invaluable if a coordinated approach to accounting is taken, as detailed in the 'Environmental-Economic Accounting: A Common National Approach – Strategy and Action Plan'. A national accounting exercise should involve both the Commonwealth, State and Territory Governments to ensure that challenges are understood, and learnings can be shared. Where methodological issues are identified early, a case study approach that contrasts the accounts may be preferred to full roll out. The learnings from this approach will assist with data integration in the future.

Another consideration is the resources required to produce national accounts. Given that some of the methods have already been trialled and there is a clear work plan, the major costs will be associated with collecting data from the relevant states and coordinating feedback and review.

### Table 8 Scaling up

| Accounting component | Data | Tasks | Relative cost | Expected spatial coverage | Estimated time required |
|---|---|---|---|---|---|
| Ecosystem extent | Seamap Australia | Collect existing data not captured in Seamap Australia and assess differences<br>Model missing data and perform sensitivity analysis to different techniques<br>Concordance between Seamap Australia with IUCN Global Ecosystem Typology and Parks Australia Typology | Low – medium | Coastal waters | 6 months |
| Ecosystem condition | Reef Life Survey<br>Satellite data – mangroves and tidal marshes<br>Seagrass monitoring data | Collect survey data where required<br>Refine approach to measurement – assess interpolation against descriptive statistics from point data<br>Assess extent changes as way of measuring condition where there is a time series<br>Determine spatial scale for producing condition accounts<br>Develop approach to measuring reference condition | High | Patchy coverage | 1.5 years |
| Species – biotic assets | Stock assessments | Further research is required to determine what data is available | High | Unknown | 1.5 years |
| Ecosystem services and use | Statewide fisheries survey<br>National blue carbon data<br>Tourism Research Australia<br>Automatic vessel identification system | Collect data from relevant states in some cases<br>Determine spatial scale for producing accounts<br>Review approach to valuation. | Medium | Dependent on data set – for example tourism likely to be coastal coverage while vessel transport likely to be inclusive of coastal and offshore waters | 1 year |
| Benefits | Further research required | Further research required | Medium | Unknown | 1 year |

# 6 Recommendations

This project has combined a wealth of information to tell a narrative about Geographe Marine Park. This project is an important first step in framing the ocean as an asset that provides services, yet more work is needed to understand the levers available to Parks Australia and how they might use this information in decision-making. It is evident that additional data collection is required to understand key issues in more depth and to better understand change and trends at a local level.

## 6.1 Geographe Marine Park

There are several priority actions that can improve the information set for Geographe Marine Park so that it can be used more effectively to support decision-making:

- Case study on data integration – collect data following an accounting approach to enable better integration across extent, condition, services, and benefits. Sub sections of Geographe Marine Park, for example the Habitat Protection Zone and National Park Zone, could be used as the case study location as it would be possible to contrast between the approach taken in this project to evaluate the added value of collecting new data.
- Prioritise individual accounts in the following order:
  - Asset extent – collect additional data to better understand the ecosystem types, their extent and distribution in the marine park
  - Ecosystem condition – prioritise the measurement of condition based on the use of the ecosystem and its relative scarcity or abundance. A large part of condition measurement would be to engage ecologists to further understand reference condition and how this relates to the occurrence of particular species
  - Ecosystem services and benefits – identify ecosystem service hotspots and monitor the area to determine the impact of use on the extent and health of the ecosystem, and the effect on ecosystem service provision.
- Further develop accounts and supplementary tables to describe the links between cultural services and oceans
- Develop approaches to quantify species of fish, invertebrates, birds and marine plants. This will likely need additional data collection on species distribution and abundance
- Understand the relative contribution of nearshore and inshore ecosystems to ecosystem services. This could also include understanding and stratifying the supply of ecosystem services based on bathymetry and other ecosystem characteristics.

## 6.2 National environmental-economic accounting

A common national approach to ocean accounting presents a number of benefits for different institutions and can support an integrated approach to ocean management and reporting. The implementation of an accounting approach can create efficiencies in decision-making by:

- Gathering information once for multiple uses

- Providing a consistent set of information that can be used pre and post decision-making – meaning that expectations can be adjusted reliably
- Integrating analysis across different policy areas
- Linking micro to macro – to provide context for local decisions

An accounting approach can also reduce the costs associated with making decisions by:

- Reducing the time costs associated with an evidence-based approach by consolidating disparate pieces of information
- Reducing the transaction costs associated with communicating and sharing information across disciplines and institutions
- Enabling economists and policy makers to consider environmental information without incurring high learning costs
- Minimising risk (cost) of making poor decisions where there would otherwise be missing information.

Continued investment in developing methods and reviewing data will improve the utility of ocean accounting in evidence-based decision-making. The project has revealed that there are certain areas of focus if scaling up is to occur effectively, including institutional arrangements, decision-making, data collection and transformations.

### 6.2.1 Institutional arrangements

The accounting process will be most efficient and effective by having a central body that coordinates the production of accounts. The body should have a strong working relationship with relevant state and local institutions, and academia, and should impart authority to the information that is produced. The central body could recommend changes to institutional arrangements so there is coherence in the data collected, enabling it to be integrated more readily.

The central body can generate economies of scale in information production that other institutions can use, for example Parks Australia. It can also facilitate the ongoing development of standards for data collection, transformation, and integration. Establishing standard data quality assessment processes and technical advisory groups would be a part of this.

### 6.2.2 Decision-making

It is important to consider account production from the perspective of the user, and work backwards from there to prioritise account production, determine the frequency of data collection, and the granularity of data needed for decision-making. The mapping of decisions to specific applications, and then to information requirements can prioritise account production.

Budget constraints may mean that not all information desired by decision-makers can be supplied. Criteria to prioritise data collection across State and Commonwealth waters could include the scarcity and vulnerability of different ecosystems, the rate of ecological change, and the level of economic dependency. The importance and or potential ramifications of a decision should also be a factor when evaluating the pros and cons of data collection when there is uncertainty. With the development of information investment criteria, the accounting framework can support a coordinated and focussed approach to data collection that considers the return on investment in information.

Risk profiles for different public sector decision-making contexts can be developed to produce thresholds for data coverage and quality. This analysis can be used to evaluate whether investments in data collection will affect decision-making. It will be important for future accounts to have measures on confidence.

The accessibility of information for decision-makers is also an important consideration. Products like Seamap Australia already have national coverage of Australia and could be expanded to include condition and services. Dashboards could be linked into these products, and other information resources to provide indicators for decision-makers.

### 6.2.3 Data collection and transformation

There needs to be consistent and regular mapping of ecosystem extent and condition, including species monitoring. This is critical in the development of policy. The frequency of data collection may be informed by the habitat type and drivers that may be involved in driving changes in extent and condition.

There should be standardised collection of ecological data to improve the quality of the accounts and enable comparisons. This will also help automate the production of ecosystem extent and condition accounts. Monitoring can be expanded using pre-defined and cost-effective methods such as the use of baited videos and the Reef Life Survey. Consistent methods and metrics need to be developed for measuring condition of different ecosystem types. The establishment of reference conditions where there is missing information is important for the measurement of ecosystem condition.

Collaboration across all sectors (government, private, academia, community organisations) is important to encourage standardisation, coherence and sharing across the many diverse and ongoing data collection efforts. Some key data streams that could benefit from being guided by an accounting approach include scientific monitoring and research and environmental impact assessments. Standardising the collection of ecological data will improve the coherence with economic data at a local level, such as that collected by the Australian Bureau of Statistics.

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