Victoria's Marine and Coastal Knowledge Framework & Strategic Directions 2020-22

May 2021

CoastKit

VICTORIA State Government | Environment, Land, Water and Planning

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Photo credit
Cover images curtesy of Dr Matt Edmunds (top left and right), Dr Paul Carnell (bottom left) and Dr Adrian Flynn (bottom right).

Acknowledgment

We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it. We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

We are committed to genuinely partner, and meaningfully engage, with Victoria's Traditional Owners and Aboriginal communities to support the protection of Country, the maintenance of spiritual and cultural practices and their broader aspirations in the 21st century and beyond.

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To find out more online:

- **Victoria’s Marine and Coastal Knowledge Framework**
  https://www.marineandcoasts.vic.gov.au/marine/marine-coastal-knowledge-framework
- **CoastKit Knowledge Management System**
  https://www.marineandcoasts.vic.gov.au/coastal-programs/coastkit
- **Protecting Victoria’s Environment – Biodiversity 2037**
  https://www.environment.vic.gov.au/biodiversity/biodiversity-plan
- **Victoria’s Marine and Coastal Policy**
  https://www.marineandcoasts.vic.gov.au/

Table of Contents

1 Introduction and background

This document describes the strategic directions for Victoria's Marine and Coastal Knowledge Framework (MACKF), and its achievements since the program's inception in 2017.

The MACKF was initiated following the recommendation by the Victorian Commissioner for Environmental Sustainability in the *State of the Bays 2016 Report*[1] to establish a mechanism for addressing knowledge gaps, reducing uncertainties and forming the future evidence base for assessing management interventions and environmental outcomes in Western Port and Port Phillip Bays (Figure 1). In the *State of Environment Report 2018*[2], the Commissioner further recommended the MACKF be expanded to include all marine and coastal environments across Victoria.

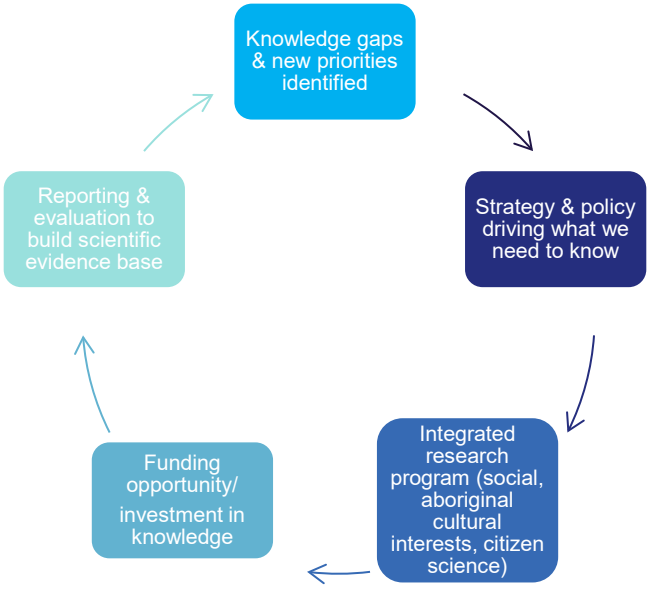

Figure 1 The original adapted management cycle for a marine knowledge framework proposed by the State of the Bays 2016 Report

The MACKF has been designed so all its components can be interconnected within a knowledge management system. The system is informed by contemporary policy requirements and principles[3], best-available technology and science, and the application needs for management, planning, evaluation and reporting (Figure 2).

Fundamentally, the MACKF aligns with the *Victorian Biodiversity Knowledge Framework*[4]. This Framework explains how to identify knowledge gaps in biodiversity science, so that we can better invest in research, monitoring and data collection.

The MACKF also serves as a decision support system for Victoria's *Marine and Coastal Policy (2020) and Marine Spatial Planning Framework*[5]. The Framework details the essential elements and steps necessary for achieving integrated and coordinated planning and management of Victoria's marine environment. It provides an overarching structure to guide planning, management and decision making by marine sectors.

As there was no information system suitable to support a MACKF prior to 2017, a new knowledge management system had to be developed. The design of the new system, now commonly termed as "CoastKit", has been informed by reviewing a range of national and international systems such as those implemented for the Great Barrier Reef[6], the European Commission's Marine Strategy Framework Directive (MSFD)[7], the European Nature Information System (EUNIS)[8], the UK's Joint Nature Conservation Council (JNCC)[9] and the Baltic Marine Environment Protection Commission (aka HELCOM)[10]. Ecosystem-based management principles and standards for marine and coastal sciences have been sourced from the literature (e.g. Long *et al* 2015)[11] and Australia's *National Marine Science Plan 2015-2025*[12].

2 Core pillars

The MACKF comprises 3 core pillars (Figure 2):

Drivers: the legal and policy setting components that authorise the MACKF, guided by internationally recognised scientific and management principles, and informed by the best available contemporary information.

Outputs: the technological components of the knowledge management system and various outputs underpinned by an array of scientific and socio-economic data.

Applications: the components that synthesise and apply the data and information products from the knowledge management system to support management and planning decisions, evaluation and reporting purposes.

The data and metadata within each component across the pillars are connected in a multi-relational database model. This facilitates for a wide range of functional capabilities that can be tailored to meet various decision support needs.

[1] https://www.ces.vic.gov.au/sotb

[2] https://www.ces.vic.gov.au/reports/state-environment-2018/marine-coastal-environments

[3] Includes https://www.vic.gov.au/information-management-whole-victorian-government#the-framework

[4] https://www.environment.vic.gov.au/biodiversity/knowledge-framework

[5] https://www.marineandcoasts.vic.gov.au/coastal-management/marine-and-coastal-policy

[6] https://ereefs.org.au/ereefs

[7] https://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm

[8] https://eunis.eea.europa.eu/habitats-code-browser.jsp

[9] https://jncc.gov.uk/monitoring/marine-monitoring-mapping/

[10] https://helcom.fi/about-us/

[11] https://doi.org/10.1016/j.marpol.2015.01.013

[12] https://www.marinescience.net.au/nationalmarinescienceplan/

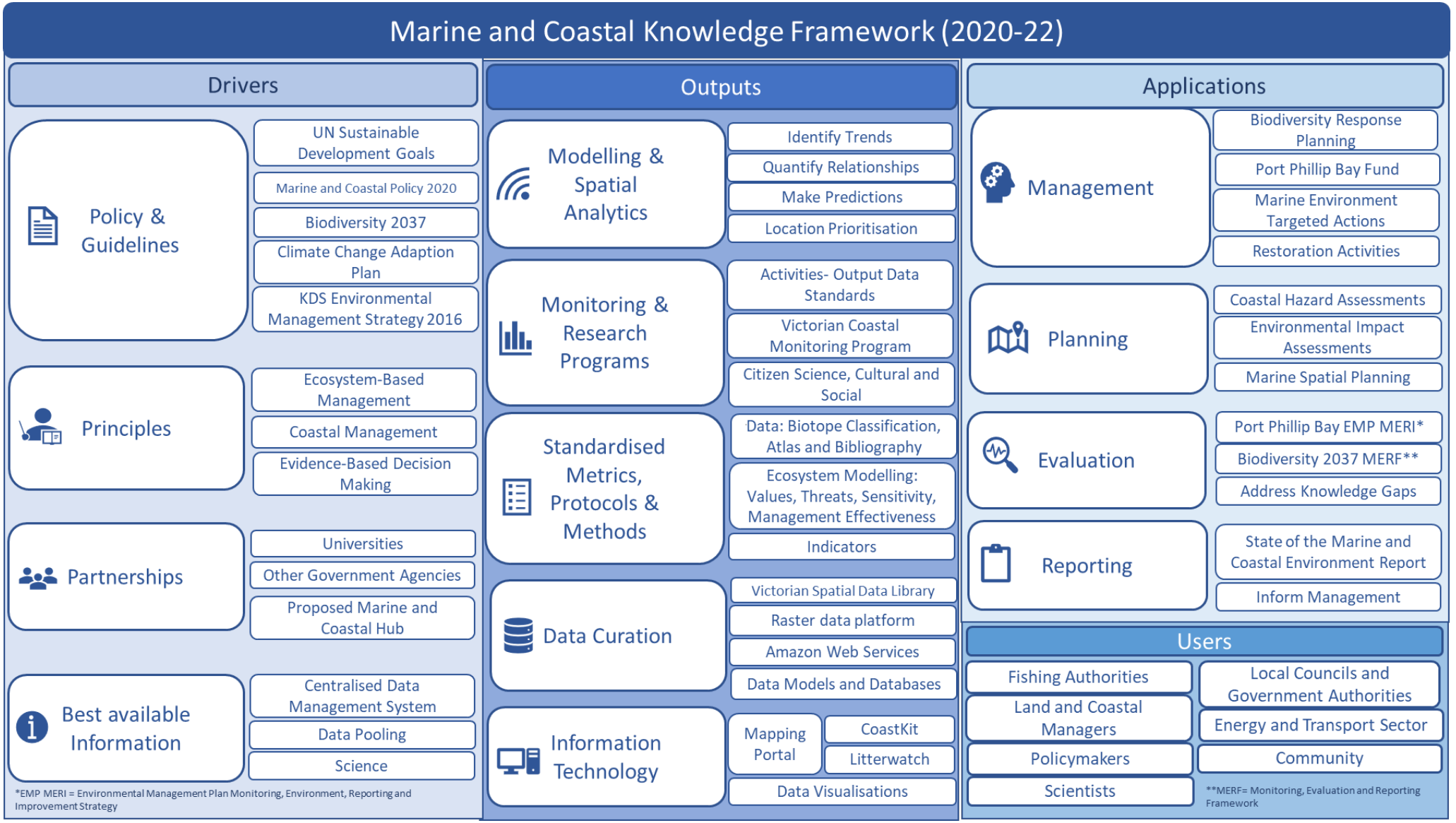

Figure 2: The architectural blueprint of the Marine and Coastal Knowledge Framework. Components are organised under 3 core pillars (Drivers, Outputs and Applications)

2.1 Drivers

The MACKF is authorised by a range of statutory instruments and agency business drivers which enables its scope and design to be defined (Figure 3). It also serves as a primary source of information and data for decision support which enables continued assessment and refinement (if necessary) of those drivers into the future.

Legal instruments influencing the management of Victoria's marine and coastal environment include[13]:

- *Flora and Fauna Guarantee Act 1988*
- *Marine and Coastal Act 2018*
- *Environment Protection Act 1970* and *Environment Protection Amendment Act 2018* (July 2021)
- *The Environment Effects Act 1978*
- *Climate Change Act 2017*
- *Fisheries Act 1995*
- *National Parks Act 1975* and *Crown Land (Reserves) Act 1978*
- *Traditional Owner Settlement Act 2010, Aboriginal Heritage Act 2006 and Native Title Act 1993.*

Key policy drivers include:

- The United Nations Sustainable Development Goals
- Protecting Victoria's Environment – Biodiversity 2037 (Biodiversity 2037)
- Marine and Coastal Policy 2020 and Marine Spatial Planning Framework (MSP Framework)
- Victoria's Climate Change Adaptation Plan 2017 – 2020

Aside from statutory instruments, national and international principles, existing knowledge and best available information are also drivers of the MACKF.

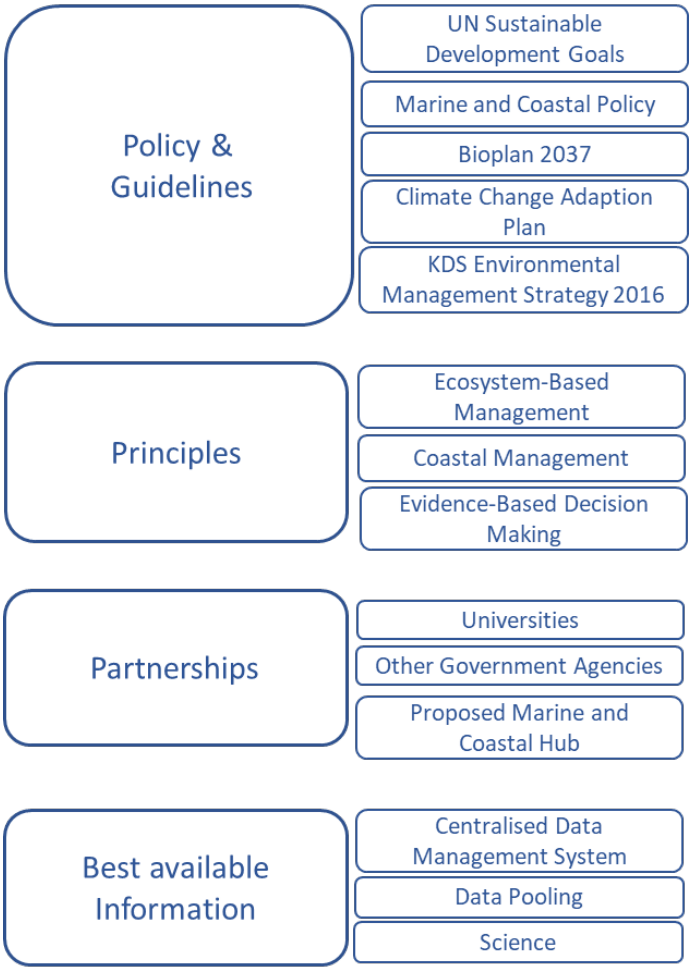

Figure 3: Schematic of the Drivers core pillar and its components (from Figure 2)

[13] Refer Appendix 2 of the Marine and Coastal Policy 2020 https://www.marineandcoasts.vic.gov.au/__data/assets/pdf_file/0027/456534/Marine-and-Coastal-Policy_Full.pdf

2.2 Outputs

The outputs pillar comprises the technological components where marine biodiversity and environmental data is standardised and curated using recognised classification standards and criteria.

This pillar comprises a vast array of marine and coastal data from historic and contemporary monitoring and research programs, in the form of observational records, remotely sensed data, models and map information products that are curated within an Amazon Web Service cloud platform (Figure 4).

Primary data is classified using holistic standardisation approaches, and tools are used to integrate data within open source databases that can be served to, and consumed by, a range of statistical, decision support and modelling software options. Access to the data and other outputs uses web portals and customised graphical user interfaces.

Key outputs include:

- A new hierarchical marine biodiversity classification system called the *Combined Biotope Classification Scheme* (CBiCS) and biotope distribution models
- Identification and spatial enabling of Priority Marine Features (areas providing important ecosystem or cultural services)
- Sensitivity ratings for marine biotopes and priority marine features to pressures and activities expressed through a Features Activity Sensitivity Tool (FeAST)
- Applying the Driving Forces-Pressures-State-Impacts-Responses (DPSIR) Framework to an ecosystem model-based network (EcoNet) and indicator development
- Adoption of Good Environmental Status descriptors for indicators
- Integration of ecosystem service descriptors for biotopes and features
- Spatially enabling marine and coastal management activities and linking to DELWP's output data standards

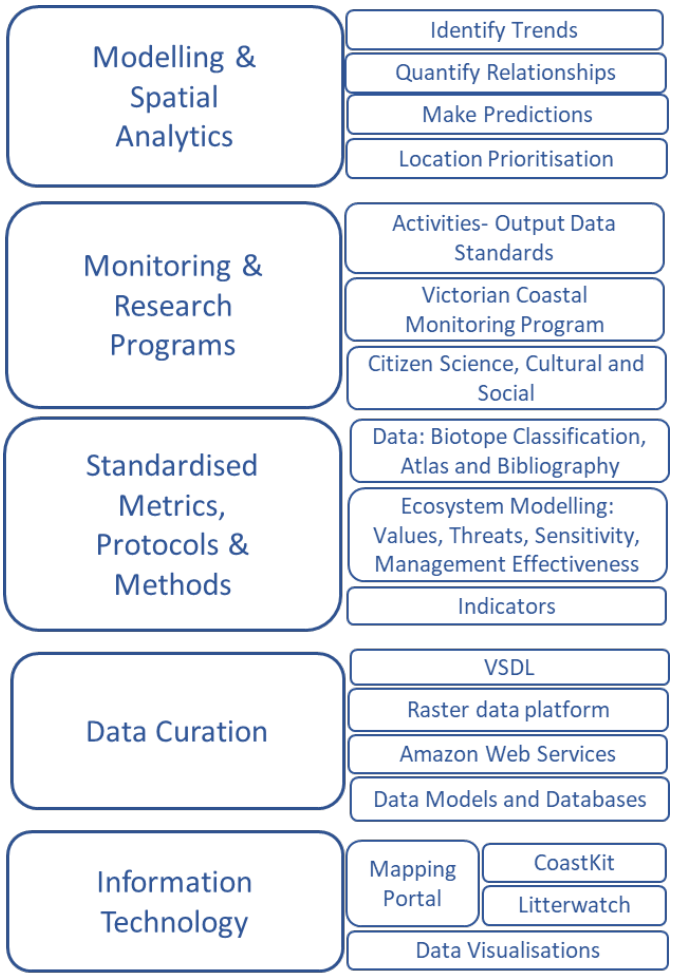

Figure 4: Schematic of the Output core pillar and its components (from Figure 2)

2.3 Applications

The applications pillar identifies the range of management, planning, evaluation and reporting components that draw on the output components (Figure 5).

The MACKF has attempted to identify priority applications that DELWP has responsibilities to support for management and reporting so the outputs are fit for purpose to meet their needs.

Key applications include:

- Biodiversity Response Planning
- Prioritising Port Phillip Bay Fund grants and other investment
- Indicators and report cards for the Port Phillip Bay Environmental Management Plan 2017-27 five yearly Monitoring, Evaluation, Reporting and Improvement Strategy (due 2023)
- Spatially enabled cumulative risk assessment information products to support forthcoming marine spatial planning
- Coastal hazard assessments and prioritising coastal adaptation and intervention projects

Figure 5: Schematic of the Applications core pillar and its components (from Figure 2)

3 Components of the Outputs Pillar

3.1 CoastKit[14]

A key objective in developing the MACKF is to consolidate and integrate marine data into one system. This system is termed 'CoastKit'[15], it is a relational database system and data applications platform that has been built to centralise marine and coastal scientific projects, data, images and resources into a knowledge management system. It provides ready access to these materials for managers and researchers (Section 3.11).

CoastKit (Figure 6) will facilitate data sharing and dashboard reporting on trends, condition and health using metrics agreed by the scientific community and by government agencies. This will help ensure planning and management decisions regarding use and development can be supported by an evidence-base.

The system has been built to house a geo-bibliography web tool (citations of published marine and coastal field studies in reports and journals) and information on how marine habitats are classified (section 3.2)., including where they are located and monitored

The Feature Atlas of CoastKit provides a spatial representation of cultural and socio-economic values and uses of the marine and coastal environment.

Combined with information on marine species diversity, marine biotopes and their ecosystem services, this will allow for a balanced assessment of ecological protection and sustainable uses which can support future marine spatial planning (Section 3.2).

The first version of CoastKit was launched in late 2020 at https://mapshare.vic.gov.au/coastkit/ to provide spatial data on the following themes:

- *Coastal* (e.g. assets, beaches of Victoria and outputs from hazard assessment projects)
- *Wetlands* (including catchment and estuaries)
- *Features Atlas* (significant life history sites and area, cultural values, management areas and activity areas)
- *Biotope Atlas*[16] (habitat distribution models, biotope classification and historic habitat surveys, species of conservation significance occurrence records)
- *PPB EMP Activity Information* - displaying activity areas for all projects documented in the PPB EMP Annual Report and Delivery Plan)

Further versions of the system with additional data sets and functionality, including links to other complementary web portals, will be rolled out progressively through 2021 and 2022.

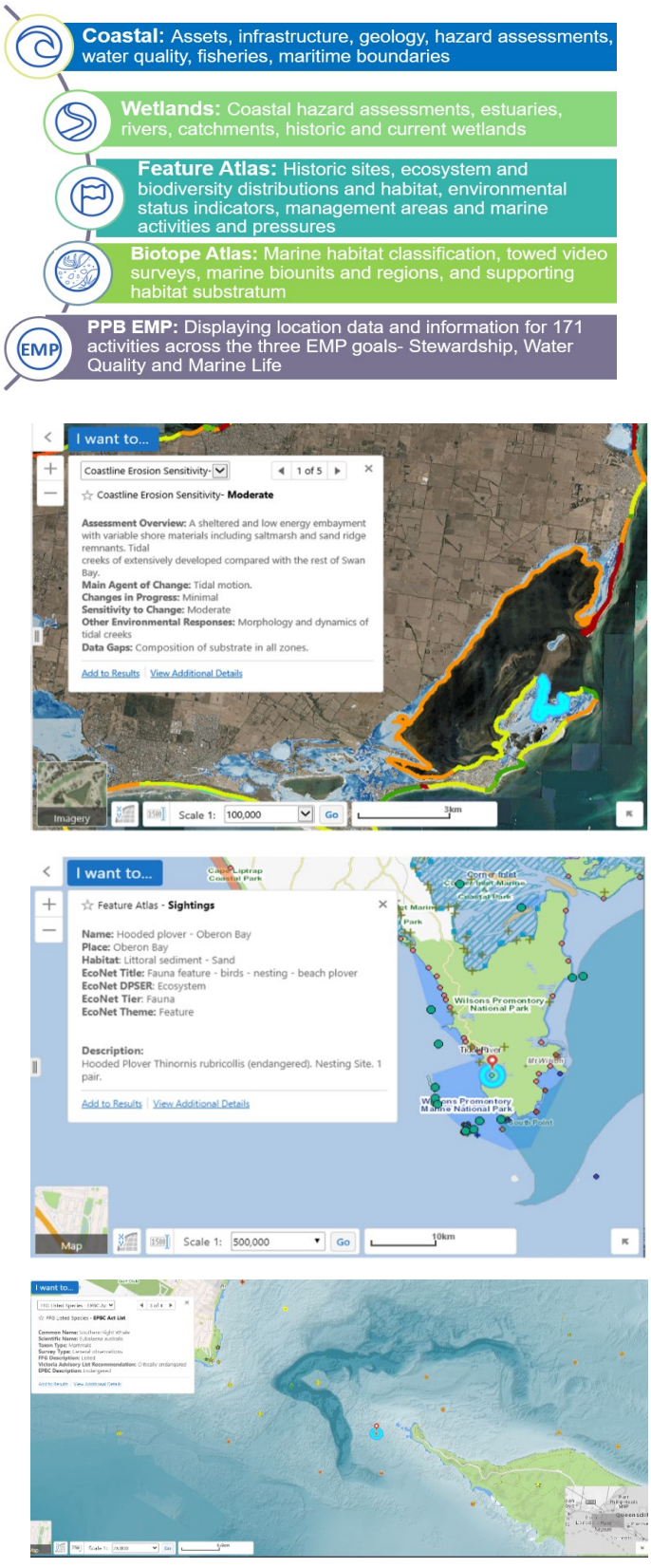

Figure 6: Screen shots of the CoastKit web mapping portal which will allow users to access spatial data from a variety of themes to support biodiversity conservation prioritisation, marine spatial planning and environmental assessments

[14] https://www.marineandcoasts.vic.gov.au/coastal-programs/coastkit

[15] https://mapshare.vic.gov.au/coastkit/

[16] Marine biotopes are described using a hierarchical classification schema termed the 'Combined Biodiversity Classification Scheme (CBiCS)'

3.2 Marine ecological classification and habitat distribution models

A new scheme for marine ecological classification, termed the *Combined Biotope Classification Scheme* (CBiCS), was developed to standardise the classification of observational and remotely sensed data collected during historic (and future) marine ecology surveys. The classification was adopted based on the JNCC applied for UK and European marine waters.[17]

The classification units of CBiCS are commonly termed "biotopes' which is defined as: "a community of species in a defined abiotic habitat." A biotope is therefore the resulting classification of physical habitats and biological assemblages co-occurring within the same spatial unit (Figure 7). Biotopes are now used as the standard for marine ecological classification when undertaking habitat distribution modelling, environmental assessments, biodiversity response planning, marine spatial planning and ecosystem accounting.

CBiCS attributes are organised into six hierarchical descriptors which are catalogued in a database [Figure 7(b)]. Survey records of the seafloor that have been classified are accessible through CoastKit (Section 3.1 and Figure 6). Users can query the variety of biotope records classified from historic underwater video or scientific diver surveys. These records have also been used as ground truthing records to inform habitat distribution models of Victoria's seafloor.

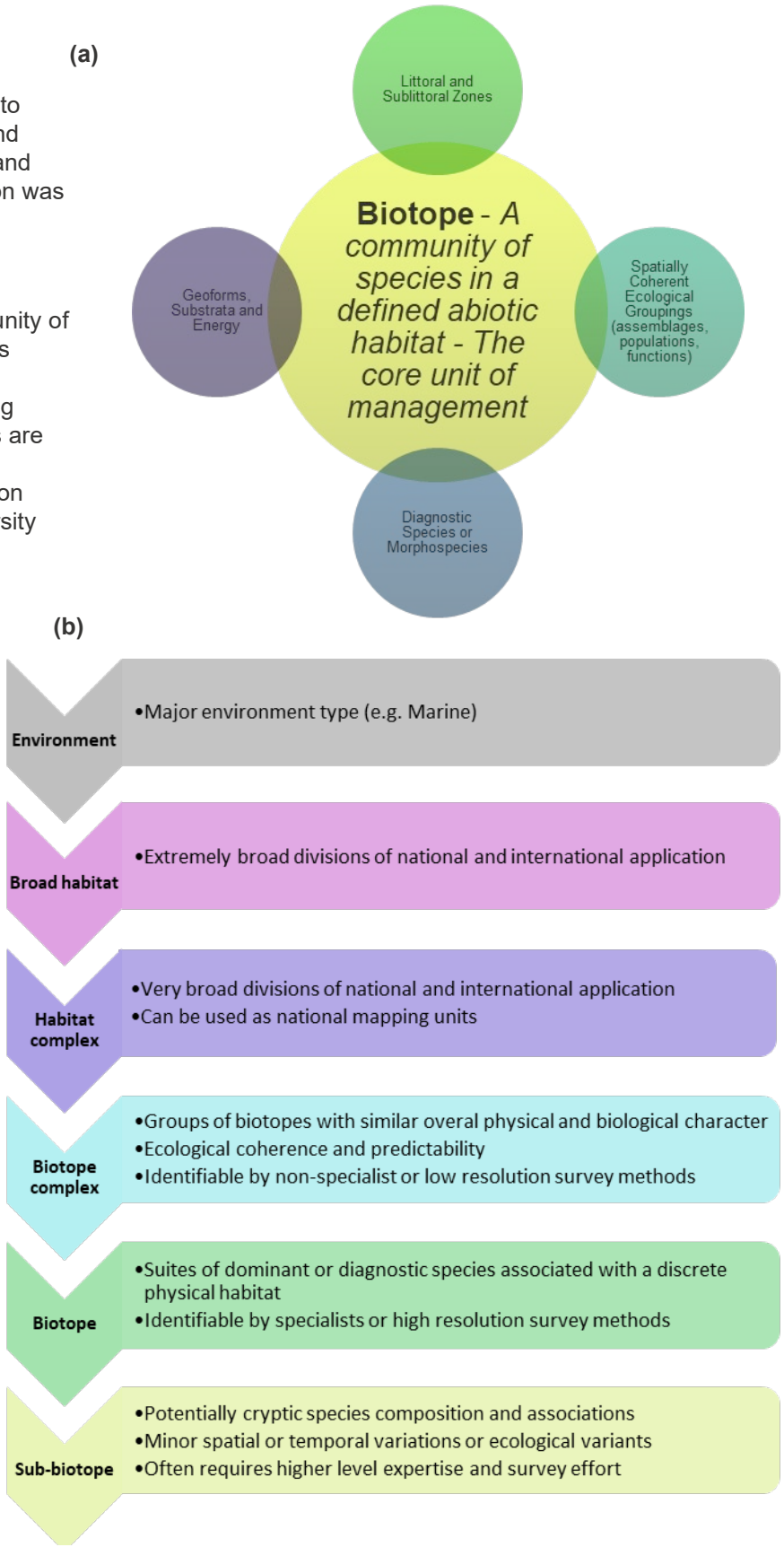

Figure 7:Descriptions of the CBiCS marine classification system for describing (a) individual biotopes, and (b) the six hierarchical attributes of the CBiCS schema

3.3 Priority Marine Features

Priority marine features have been catalogued throughout Victoria and are expressed spatially in the Feature Atlas of CoastKit (refer Section 3.1)

A priority marine feature can be:

- biotic (e.g. important breeding area)
- abiotic (e.g. ecologically significant geoform)
- ecosystem service (e.g. fishing site).

For example, priority marine features in Port Phillip Bay include:

- The St Kilda Little Penguin rookery
- Ramsar sites
- Diving, snorkelling and recreation sites
- Culturally significant sites

Biotopes that are part of, or neighbour a priority marine feature have increased sensitivity weighting to flag precaution around acceptable changes and impacts (refer Section 3.4 below).

[17] https://mhc.jncc.gov.uk/

3.4 EcoNet Models and the Driving Forces-Pressures-State-Impacts-Responses (DPSIR) Framework

Central to the design of outputs pillar is the adoption of the DPSIR framework which has been used to guide the assembly of data models that allows driving forces, activities and pressures to be interconnected to ecosystems, priority marine features, cultural and socio-economic values; and ecosystem services (Figure 9). This component of the MACKF is required to develop and deliver *Strategic Management Prospects*[18] equivalents for marine and coastal ecosystems.

3.4.1 EcoNet models

Ecosystem models have been constructed to represent the tropic relationships between marine biotopes and their constituent species. These models have been assembled from scientific evidence and expert knowledge using relational database tables joined in a network called EcoNet.

The ecosystem models use the DPSIR framework to link to relevant drivers, activities and pressures in a multi-relational network (Figure 9).

Each biotope and priority marine features have their 'sensitivity' to individual pressures scored based on its resistance and resilience to a particular pressure using the Marine Evidence based Sensitivity Assessment process adopted by the JNCC[19][20] (Figure 8). Sensitivity is defined as 'the intolerance of a species or habitat to damage from an external factor and the time taken for its subsequent recovery'.

With these data, a variety of network statistics can be derived from EcoNet models. For example, those biotopes and species that have high cumulative sensitivity scores across all pressures are of most concern to potential environmental impacts, particularly when multiple pressures occur in their spatial proximity. This sensitivity is calculated by node degree (number of links connected to a node), network pathway lengths, linkage strengths and whole-of-network topology statistics and comparisons.

EcoNet models allow interrogation of the system in the following ways that are relevant to interpreting condition and considering management responses:

- What are the biotope pressures and interdependencies?
- Through what mechanisms and intermediaries do pressures act in the biotope?
- Which parts of the ecosystem are most vulnerable to pressures?
- What biotopes are important for critical species?

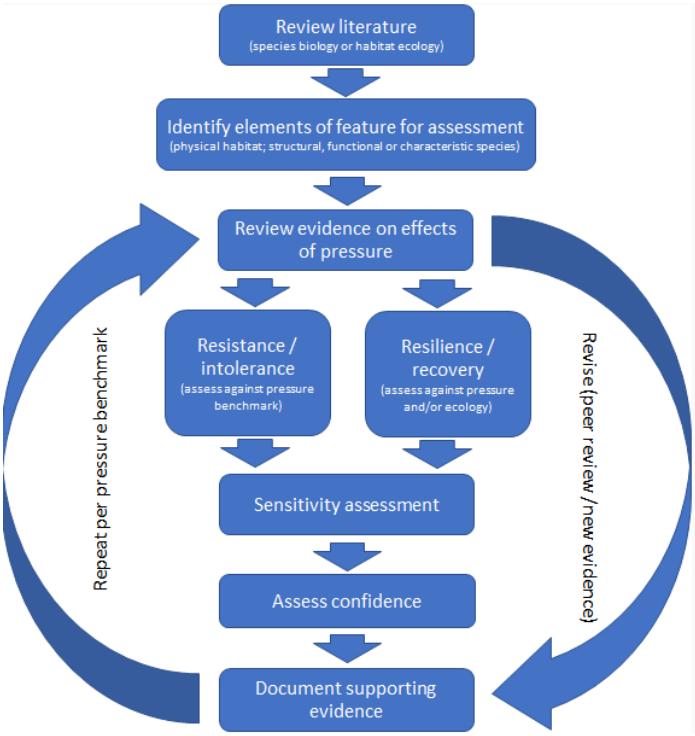

Figure 8: Marine Evidence based Sensitivity Assessment process

Having the Econet data spatially enabled in a DPSIR framework will help to inform future marine spatial planning and environmental assessments. Cumulative pressures and impacts can be assessed at both local and broader scales.

3.5 Feature Activity Sensitivity Tool (FeAST)

FeAST is a function using the EcoNet models that links activities and pressures to features and biotopes in a spatially explicit manner.

The tool allows spatial querying of what pressures impact on features or biotopes at a location or series of locations. This would be particularly useful for environmental assessments and marine spatial planning. The tool is based on that originally developed by Marine Scotland to inform marine planning.[21]

A pressure is defined as 'the mechanism through which an activity influences any part of the ecosystem'. Pressures can be physical (e.g. sub-surface abrasion or damage), chemical (e.g. organic enrichment) or biological (e.g. introduction of non-native species).

An activity may give rise to more than one pressure. Rather than assessing the impact of activities as a single impact, the pressure-based approach in FeAST supports clearer identification of the pathway(s) through which impacts on a feature or biotope may arise from the activity.

[18] http://delwp.maps.arcgis.com/apps/MapJournal/index.html?appid=e0289e3fe12f436490ef63d4444a05df

[19] https://www.marlin.ac.uk/sensitivity/sensitivity_rationale

[20] https://www.marlin.ac.uk/assets/pdf/MarESA-Sensitivity-Assessment-Guidance-Rpt-Mar2018v2.pdf

[21] https://www.marine.scotland.gov.uk/feast/

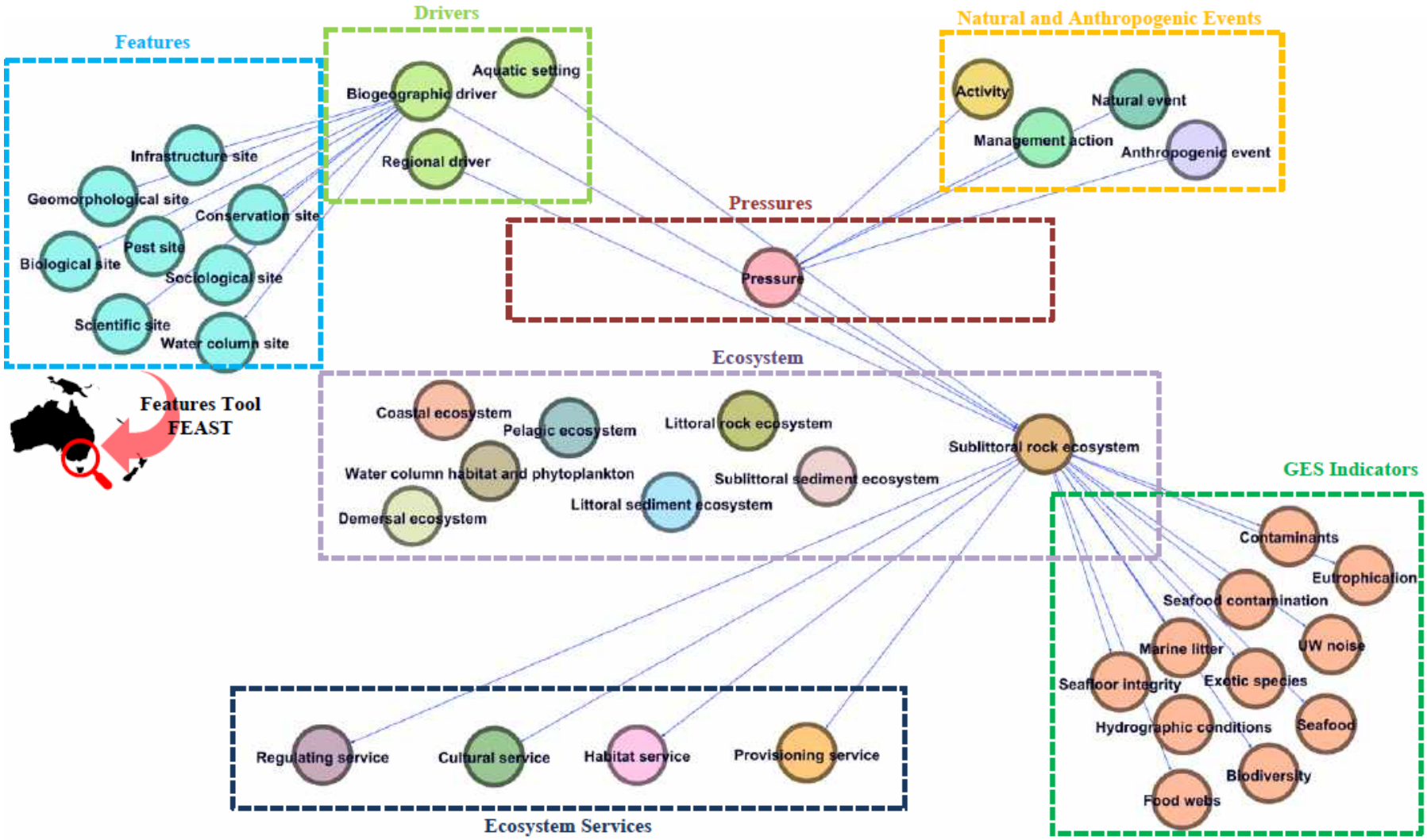

Figure 9: Schema illustrating how the DPSIR Framework informs the design and interrelationships between components and selected sub-components of the Outputs Pillar of the MACKF. In this example, drivers and pressures are linked to the sublittoral rock ecosystem model which vary in sensitivity. In turn, the responses of sublittoral rock ecosystems to these pressures can be evaluated by choosing appropriate indicators of GES (Section 6), and/or ecosystem services

3.6 Ecosystem Services

Ecosystem services are defined by the Millennium Ecosystem Assessment[22] as the outputs of ecosystems from which people and society derive benefits.

Victoria's marine and coastal ecosystems are fundamental to the economy and societal wellbeing. They contribute to Victoria's liveability and sustainability by providing clean water and air, habitats for species, and are the basis for many Victorian industries such as fisheries, aquaculture and tourism.

The integration of ecosystem services ensures the MACKF aligns with *Valuing and accounting for Victoria's environment: Strategic Plan 2015-2020.*[23] This plan has adopted the *United Nations System of Environmental-Economic Accounting* (SEEA)[24] to improve reporting, decision-making and evaluation.

Ecosystem services are integrated within EcoNet to allow users to understand the linkages between different components of the marine environment, the ecosystem services they provide, and how they might be affected by activities and pressures to biotopes (Figure 10) and principal marine features.

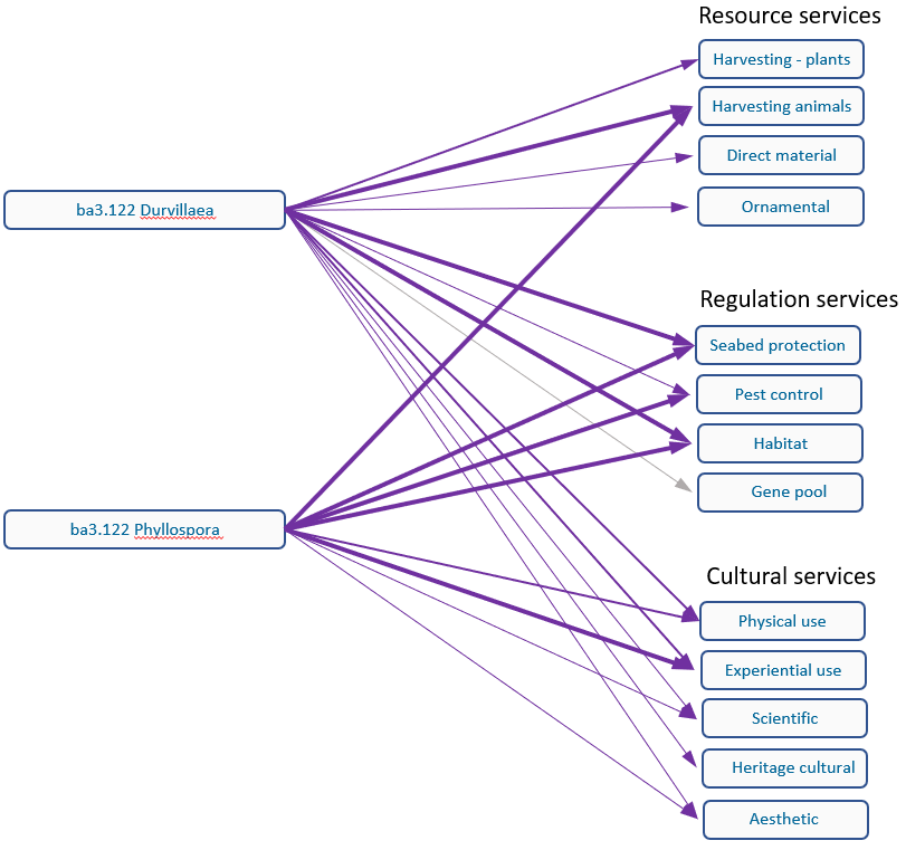

Figure 10: Diagram of data model showing the relationship of two kelp forest biotope communities dominated by *Durvillea* spp. and *Phyllospora* spp. to the ecosystem services they provide. The line thickness represents the relative importance of the kelp forest biotope in providing the service

In 2020, the MACKF has been populated with descriptive data under standard themes for classifying ecosystem services, including:

- Resource services
- Regulation services
- Cultural services

This will support developing a set of environmental-economic accounts for biotopes and features building on the case study - *Marine and Coastal Ecosystem Accounting: Port Phillip Bay*[25] undertaken for the Commissioner for Environmental Sustainability in 2016.

[22] https://www.millenniumassessment.org/en/index.html

[23] https://www.environment.vic.gov.au/__data/assets/pdf_file/0030/49809/DELWP-Strategic-Plan-Valuing-and-accounting-for-the-environment-2016-V7.pdf

[24] https://seea.un.org/

[25] https://www.environment.vic.gov.au/__data/assets/pdf_file/0025/49813/Marine-and-Coastal-Ecosystem-Accounting-Port-Phillip-Bay.pdf

3.7 Marine and Coastal Processes

The outputs pillar of the MACKF supports a range of marine and coastal physico-chemical datasets that when combined are used for understanding marine oceanography and coastal processes. Component data sets are derived from a range of equipment which includes:

Remote sensing equipment

- satellites
- cameras and light detection and ranging (LIDAR) sensors on aircraft and Unmanned Aerial Vehicles (UAVs)
- multibeam SONAR on vessels
- wave buoys and current meters
- water chemistry sensors and meters

Direct sensing equipment

- sediment grabs and cores on vessels or land
- vegetation quadrats and transects
- theodolites and inclinometers

3.7.1 Monitoring

Data from the above equipment is stored in a variety of formats and can be assembled in a time series to facilitate understanding of change and trends in physio-chemical processes at decadal, yearly, monthly, weekly and daily temporal scales depending on the needs of particular project applications such as:

- marine oceanography (wave height and direction, currents, bathymetry and sedimentary geology)
- coastal processes (shoreline morphometrics and near shore sediment transport)
- environmental (larval dispersion, nutrient flows and pollution discharges)

3.7.2 Modelling

The integration of data sets facilitates conceptual and numerical modelling of marine and coastal processes (Figure 11). Various modelling techniques can be selected and applied to provide managers and the community with an understanding of how the natural phyisico-chemical dynamics are influencing marine and coastal environments.

For example, numerical modelling tools can be applied for understanding shoreline change and predicting shoreline position in the future. Shoreline change is driven by the hydrodynamics of the adjoining marine waters which effects sediment movement, which in turn causes the net erosion or accretion of shorelines. The models employed to predict shoreline change integrate data sets such as historic shoreline positions, bathymetry, wave climate, tidal fluctuations, geology and sediment movement to produce visualisations and charts depicting shoreline behaviour.

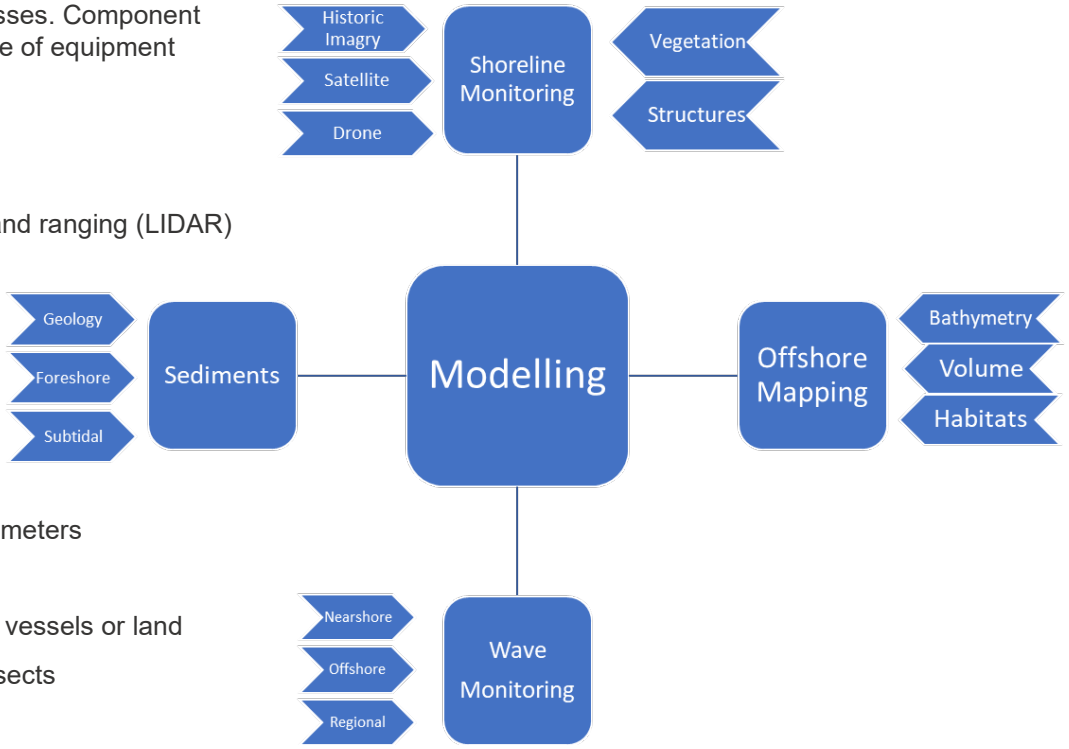

Figure 11: Example of multiple data sets that are integrated for modelling marine and coastal processes

3.7.3 Understanding change and coastal hazards

Data outputs from wave climate and sea level rise models, when integrated with climate change models, provide insight to how marine and coastal processes will change into the future, and what impacts this might cause to environmental and socio-economic values. In addition, sea level is also affected by short term fluctuations and regional variations which occur as a result of tides, storm surge events, ocean currents, and the El Nino – Southern Oscillation.

The MACKF has incorporated anticipated Sea Level Rise (SLR) and Storm Surge (STM) information for three future dates 2040, 2070 and 2100 based on a baseline calculated in 2009. The SLR and STM models are referenced to global climate models under future emission concentration scenario outputs, termed Representative Concentration Pathways[26].

This data can be used for coastal hazard assessments and adaptation planning at regional, local and specific scales across Victoria's coastal zone. The same data can be used to undertake biodiversity vulnerability assessments or inform restoration options for marine and coastal ecosystems such as wetlands, estuaries and seagrass beds.

[26] https://www.climatechangeinaustralia.gov.au/en/climate-campus/modelling-and-projections/projecting-future-climate/greenhouse-gas-scenarios/

3.8 Traditional Owners and Traditional Ecological Knowledge

Aboriginal peoples of the coastal and marine areas of Victoria identify today as Monero/Ngarigo, Bidwell, Yuin, Gunaikurnai, Boon Wurrung, Bunurong, Wurundjeri, Wathaurung/Wadawurrung, Eastern Maar and Gunditjmara. Six of these peoples are current Registered Aboriginal Parties[27] under the Victorian *Aboriginal Heritage Act 2006*:

- the Gunditjmara People represented by the Gunditj Mirring Traditional Owners Aboriginal Corporation
- the Eastern Maar People represented by the Easter Maar Aboriginal Corporation
- the Wadawurrung People represented by the Wadawurrung Traditional Owners Aboriginal Corporation
- the Bunurong People represented by the Bunurong Land Council Aboriginal Corporation
- the Gunaikurnai People represented by the Gunaikurnai Land and Waters Aboriginal Corporation
- The Wurundjeri People represented by the Wurundjeri Woi Wurrung Cultural Heritage Aboriginal Corporation[28]

Though each Aboriginal people of the coast have a distinct culture, there are common cultural features that link all Aboriginal peoples to land and sea. These include an understanding that all landforms, animals, plants, winds, tide and people are the result of journeys and actions taken by ancient creation ancestors.

These ancestors also established laws and customs about human behaviour and managing the environment. Another common feature of coastal Aboriginal peoples is the connectedness of land and sea: together they form people's "Sea Country" – a country of significant cultural sites and "Dreaming Tracks" of the creation ancestors.

DEWLP recognises the importance of the cultural, social and spiritual aspects of Sea Country that are predominantly derived from historical and contemporary accounts of Aboriginal dreaming stories. These stories are integral to understanding the importance of Sea Country and informing the development of frameworks that facilitate the cultural application of Sea Country management in the contemporary Victorian land and seascape. Sea Country plans are developed by Traditional Owners to express their vision aspiration, strategies and actions for their Country as a way of communicating their rights, cultural authority and interest in Country.

Traditional Ecological Knowledge (or Indigenous Ecological Knowledge) describes a cumulative body of knowledge, belief, and practice handed down through generations.

As set out in DELWP's *Pupangarli Marnmarnepu 'Owning our Future', Aboriginal Self-Determination Reform Strategy 2020-2025* [29], the Victorian Government has an obligation to work in partnership with Traditional Owners and Aboriginal Victorians to support their right to self-determination. DELWP is also committed to Indigenous Data Sovereignty which is the right of Aboriginal people to govern the collection, ownership and use of data about their communities, people, land and resources.

Regional Managers (Community and Partnerships Team) have responsibility to understand how those groups want to be engaged in a particular process or project. DELWP has a Traditional Owner and Aboriginal Community Engagement Framework, which provides detail on the eight guiding principles:

- Self-determination
- Traditional Owners as partners
- Place-based, whole-of-Country approach
- Respect for decision-making processes
- Aboriginal people set their own priorities
- Free, prior and informed consent
- Acknowledge past injustices and structural inequity
- Aboriginal cultural safety and competency.

A Victorian Traditional Owner Sea Country strategic framework was prepared for the Victorian Environment Assessment Council's *Assessment of the Values of Victoria's Marine Environment Report*[30] The framework articulates the measures that Traditional Owners say are needed to fill knowledge gaps and avoid threats to natural and cultural values.

The MACKF will support Aboriginal people with their endeavours to develop Sea Country Plans, and with the capture of Traditional Ecological Knowledge by following the principles of Traditional Owner and Aboriginal Community engagement, recognising Indigenous Data Sovereignty, and in a way that respects the traditional custodians of this knowledge.

[27] https://www.aboriginalheritagecouncil.vic.gov.au/victorias-current-registered-aboriginal-parties

[28] Proposed boundary variation published 7 June 2021 https://www.aboriginalheritagecouncil.vic.gov.au/wurundjeri-land-and-compensation-cultural-heritage-council-aboriginal-corporation

[29] https://www.delwp.vic.gov.au/aboriginalselfdetermination/self-determination-reform-strategy

[30] http://www.veac.vic.gov.au/investigation/assessment-of-the-values-of-victorias-marine-environment

3.9 Activity data capture and reporting

Data on where environmental and infrastructure activities are undertaken is collected as acquittal under the obligations of funding agreements or as a voluntary contribution. This data is useful in assessing progress in achieving objectives and targets of *Biodiversity 2037*, *Marine and Coastal Policy 2020* and can be applied to a range of agency policies, investment programs and funding sources such as the Sustainability Fund[31].

Activities should be developed in accordance to DELWP's *Output Delivery Standards*[32] (Figure 12) which provide guidance for consistent management activities and outputs. The information required for reporting and evaluating activities must meet DELWP's *Output Data Standards*[33] which provide guidance on reporting those management activities and outputs.

Activity output data can be recorded directly in ActivityKit[34] or STAR[35]. Marine and coastal activities output data is also available through CoastKit (Section 3.1).

Activity outputs are divided into four classes:

- Structural works: Activity outputs associated with stand-alone environmental goods (e.g.dune fencing).
- Environmental works: A mixture of goods and services outputs that modify characteristics of the environment (e.g. coastal wetland rehabilitation).
- Management services: Service outputs that involve changes in the behaviour of land managers (e.g. trapping and removal of feral animals).
- Planning and regulation: A mixture of goods and services outputs to communicate, administer, plan or gather information (e.g. engagement events).

Under Biodiversity 2037, an additional level of detail to the standards is required called the *Biodiversity 2037 Activity data requirements*[36]. In 2020-21, the standards are under review which will make them more applicable in marine and coastal environments (Figure 12 and Section 4.2).

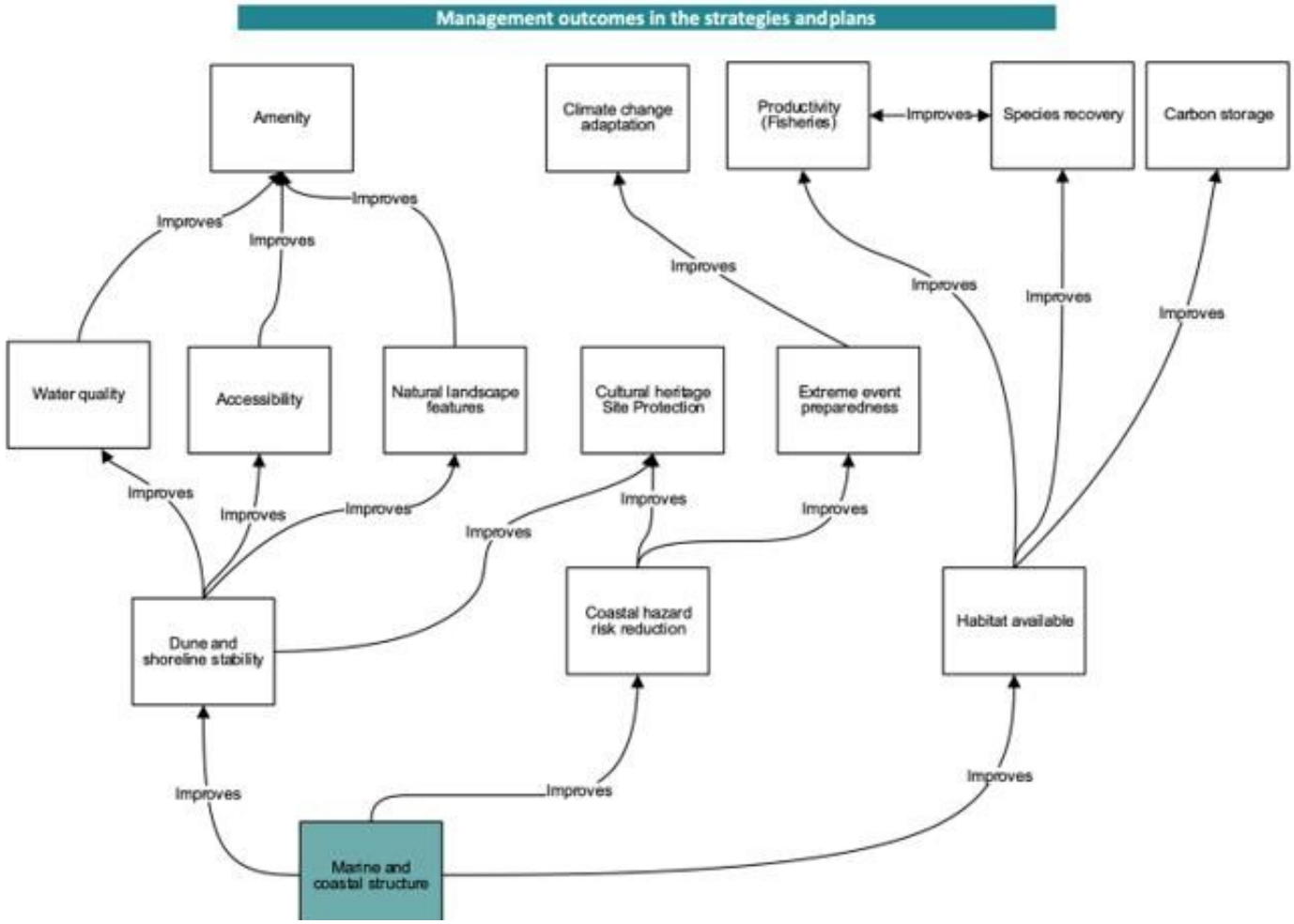

Figure 12: Decision tree logic for setting Output Delivery Standards for structural works on the coast

[31] https://www.environment.vic.gov.au/sustainability/sustainability-fund

[32] https://www.water.vic.gov.au/__data/assets/pdf_file/0016/52414/DELWP-OutputDeliveryStandard-web1.pdf

[33] https://www.water.vic.gov.au/__data/assets/pdf_file/0016/120463/DELWP-OutputDataStandard-web-V4.0.pdf

[34] https://activitykit.biodiversity.vic.gov.au/Html5Viewer/Index.html?viewer=ActivityKit

[35] https://www.environment.vic.gov.au/__data/assets/pdf_file/0014/440231/1.-STAR-overview.pdf

[36] https://www.environment.vic.gov.au/__data/assets/pdf_file/0029/466409/Bio2037_ActivityDataRequirementsV1.0.pdf

3.10 Citizen science

Volunteers contribute significantly to Victoria's environment, local communities and economy. Citizen science involves volunteers collaborating with scientists or other experts to collect data through monitoring and research.

It has been recognised that citizen science data provides tremendous opportunities for knowledge acquisition internationally[37] while fostering community stewardship and awareness.

DELWP's *Victorians Volunteering for Nature – Environmental Volunteering Plan 2018*[38] commits to developing and extending citizen science projects to connect scientists with volunteers. Under the MACKF, DELWP is supporting citizen science projects wherever possible to deliver targeted data acquisition.

3.10.1 LitterWatch Victoria[39]

Community groups and other organisations put in countless hours to reduce litter. They are cleaning up litter, collecting data and engaging others. Data is central to understanding litter trends and patterns, and whether our circular economy strategies to reduce litter will work over the medium term.

LitterWatch Victoria is a publicly accessible data application and mapping portal to manage and view different litter datasets (Figure 13). The program was developed in collaboration with community groups and agency partners for use in decision making and monitoring.

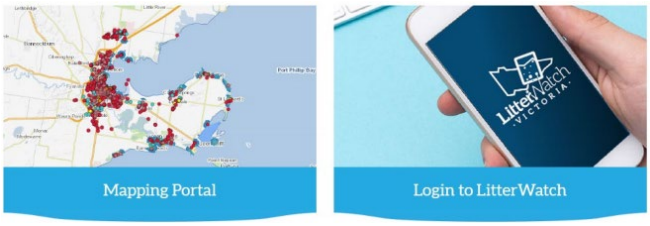

Figure 13: LitterWatch map portal and mobile App

3.10.2 The Victorian Coastal Monitoring Program (VCMP)[40]

The VCMP uses citizen scientists, supported by universities, to collect data using drone technology (Figure 14). Citizen-science drone surveys are a cost-effective method which both engages local communities in management and delivers highly precise and accurate data for researchers and managers. Drones enable rapid surveying of beach volumes and therefore provide critical information for determining the dynamism of beaches.

The data is available online to all community groups as geo-rectified 3D images. The approach allows fast assessment of changes (if any) in the volume, height and extent of sediment, and other features (such as beach wrack or dune vegetation).

Figure 14: Citizen scientists using drone technology to monitor the dynamic movement of Victoria's beaches.

[37] https://www.nature.com/articles/s41893-019-0390-3 https://www.unenvironment.org/news-and-stories/story/untapped-potential-citizen-science-track-progress-sustainable-development

[38] https://www.environment.vic.gov.au/volunteering

[39] https://www.litterwatchvictoria.org.au/

[40] https://www.marineandcoasts.vic.gov.au/coastal-programs/victorian-coastal-monitoring-program

3.11 Data management system

The MACKF is supported by DELWP's Enterprise Spatial Data Platform which enables data custodians to load, store, secure and publish their spatial data according to DELWP's Data Management Framework. It also enables data custodians to publish their data for broader use and information sharing. The capability is described in *Core Spatial Data Services Strategy 2018-2023*[41] which supports the Victorian Government's policy and standards for government information technology[42] and Open Data Policy[43]. The Enterprise Spatial Data Platform comprises 4 key components:

- Custodianship
- MetaShare for Metadata Entry
- Vector Data Platform for points, lines, polygons
- Raster Data Platform for aerial photography satellite imagery, 3D digital twin and point cloud

3.11.1 Mapshare

Mapshare is DELWP's corporate web mapping platform with access to a wide variety of interactive maps published by various DELWP businesses. Maps can be locked down for internal use or made accessible to external users.

The CoastKit portal (Section 3.1) is built on Mapshare which uses ERSI ArcGIS™ technology and Geocortex™[44] mapping applications. Spatial data on bio-physical themes such as bathymetry, species distribution records, marine habitats and socio-economic data themes can be displayed and made available for public access through the Data.VIC[45] (Figure 15).

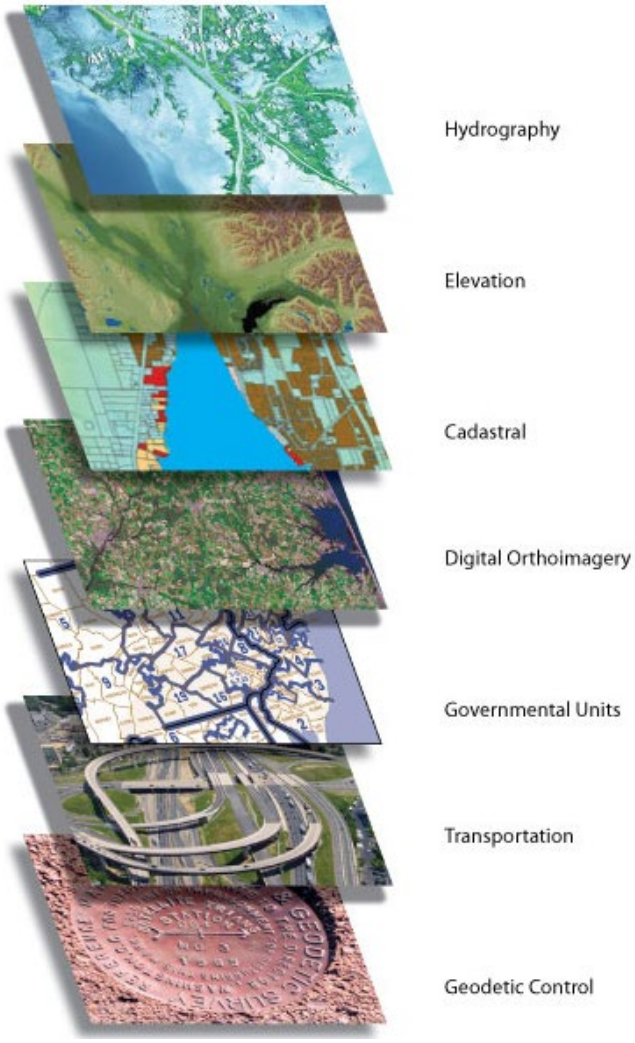

Figure 15: Schematic example of Mapshare data themes available through Data.VIC

3.11.2 CoastKit database components

Data for the CoastKit portal is managed in multi-relational tables created in PostgreSQL open source object-relational database[46] within DELWP's Amazon Web Service[47] (cloud) account. Coastkit currently comprises three component database modules (Figure 16):

- Q-Core: for monitoring and survey records, including EcoNet and FeAST data tables (sections 3.4 and 3.5)
- CBiCS: for managing the biotope classification catalogue (Section 3.2)
- Geo-Bibliography: for managing document records and their citations

A range of statistical and graphical functions can be achieved using R Statistics[48] from database queries and made available through the CoastKit web portal.

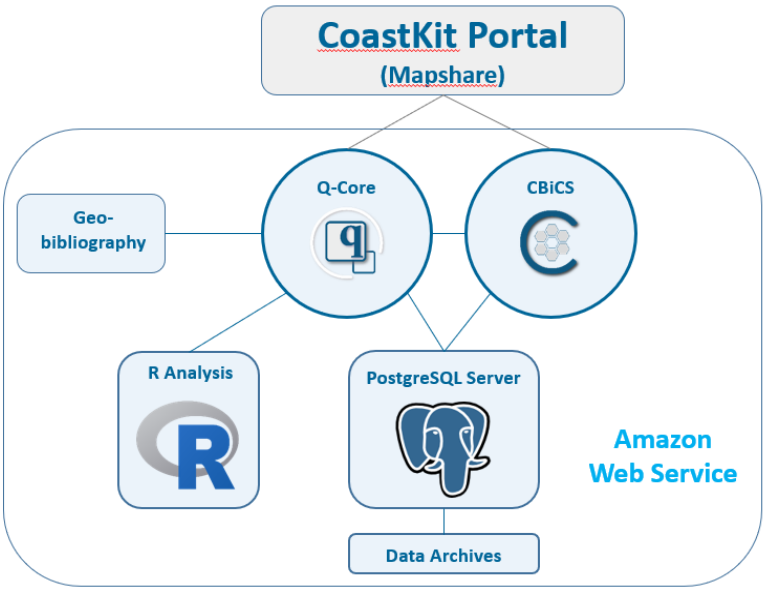

Figure 16: CoastKit database components

[41] https://www.delwp.vic.gov.au/__data/assets/pdf_file/0018/122184/DELWP-Core-Spatial-Data-Strategy-201804.pdf

[42] **https://www.vic.gov.au/policies-standards-for-government-IT**

[43] https://www.vic.gov.au/data-sharing-open-data

[44] https://www.geocortex.com/

[45] https://www.data.vic.gov.au/

[46] https://www.postgresql.org/

[47] https://aws.amazon.com/

[48] https://www.r-project.org/

4 Components of the Applications Pillar

4.1 Good Environmental Status

Good Environmental Status (GES) is the outcome-based reporting approach of the MACKF to determine and report if the different uses of the marine and coastal resources are conducted at a sustainable level[49].

GES is required by the *Marine and Coastal Policy 2020* and takes due regard to *Biodiversity 2037 MERF*.

GES involves selection of indicators and targets which are assessed by measuring the condition of the marine environment using up to 11 descriptors (below). Relevant indicators of GES are derived using data on biotopes, priority marine features and network analyses from EcoNet models described in section 3.4 (Figure 17)

4.2 Achieving GES

GES is achieved when the marine and coastal environment is ecologically diverse, clean, healthy and productive. More specifically, GES means that:

- Ecosystems and processes (including their hydro-morphological, physical and chemical conditions) are fully functioning and resilient to human-induced environmental change
- The decline of biodiversity caused by human activities is prevented and biodiversity is protected
- Human activities introducing substances and energy into the marine environment do not cause pollution effects. Noise from human activities is compatible with the marine environment and its ecosystems

GES has eleven descriptors which describe what the environment will look like when GES has been achieved. Each descriptor contains several criteria and standards for reporting on the achievement of GES:

- Biodiversity is maintained
- Exotic species do not adversely alter the ecosystem
- The population of commercial and recreational fish species is healthy
- Elements of food webs ensure long-term abundance and reproduction
- Eutrophication is minimised
- The sea floor integrity ensures functioning of the ecosystem
- Permanent alteration of hydrographical conditions does not adversely affect the ecosystem
- Concentrations of contaminants give no effects
- Contaminants in seafood are below safe levels
- Marine litter does not cause harm
- Introduction of energy (including underwater noise) does not adversely affect the ecosystem

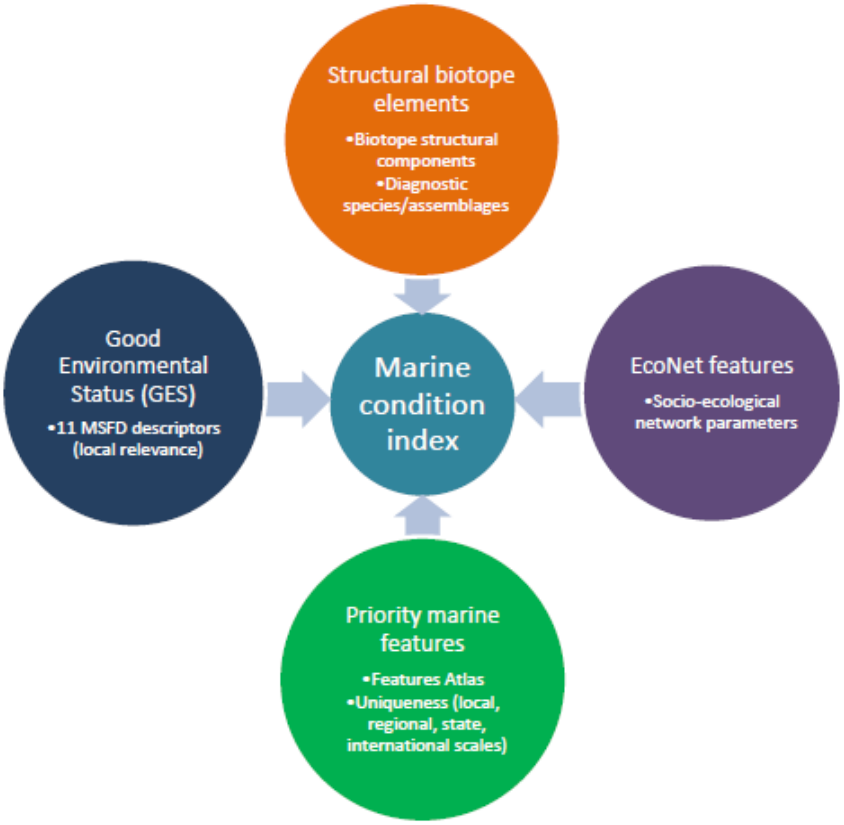

Figure 17: Schematic illustrating marine condition indices to assess GES can be derived from metrics associated with biotopes, priority marine features and network analyses of EcoNet models

[49] https://ec.europa.eu/environment/marine/good-environmental-status/index_en.htm

4.3 What is involved in defining GES and its indicators?

- GES involves the understanding of marine ecosystems and their responses to human activities, including climate change
- Adequate baseline knowledge is required to define GES.
- Different GES descriptors and indicators may be more relevant to one marine region and coastline, compared to others in different geographic locations
- Approaches to determine targets or reference conditions for the indicators used in assessing the environmental status can vary between geographic locations and ecosystems
- The identification, measurement and weighting of the components of the different indicators are synthesized into a single value or index. What components that are chosen will depend on various factors - For example, one indicator of biodiversity is the distribution range of species. However, the questions on how many species should be considered, whether all species are equally important, whether they should be considered as groups or as species and on a seasonal or annual basis needs to be agreed

4.4 GES Descriptors[50]

4.4.1 Descriptor 1: Biological diversity

Target levels are defined as being such that "the quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions" (Figure 18). Some deviation from reference conditions, because of human use of the marine environment, is acceptable, providing the terms of the Descriptor are still met.

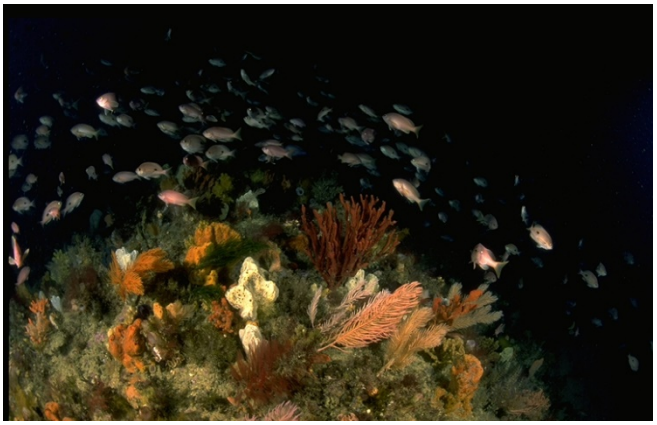

Figure 18: School of Butterfly Perch (*Caestoperca lepidoptera*) swimming over a biotope community comprising sponges and hydroids at Wilsons Promontory Marine Park. The classification of biotopes and their distribution is central to referencing marine biological diversity and condition (image curtesy Mary Malloy).

4.4.2 Descriptor 2: Marine exotic species

Exotic marine organisms (Figure 19) can cause adverse effects on environmental quality resulting from changes in biological, chemical and physical properties of aquatic ecosystems. These changes include, but are not limited to: elimination or extinction of sensitive and/or rare populations; alteration of native communities; algal blooms; modification of substrate conditions and the shore zones; alteration of oxygen and nutrient content, pH and transparency of water; accumulation of synthetic pollutants, etc.

The magnitude of impacts may vary from low to massive and they can be sporadic, short- term or permanent. The degradation gradient in relation to marine exotics is a function of their relative abundances and distribution ranges, which may vary from low abundances in one locality with no measurable adverse effects up to occurrence in high numbers in many localities, causing massive impact on native communities, habitats and ecosystem functioning.

Figure 19: The Northern Pacific Seastar (*Asterias amurensis*) is a marine exotic species, introduced to Victoria's marine waters in the early 1990s.

4.4.3 Descriptor 3: Exploited fish and shellfish

Since there is broad scientific evidence that GES cannot be achieved for all stocks simultaneously, a realistic threshold for the proportion of stocks with GES needs to be established above which the descriptor has achieved GES. GES is achieved for a particular stock only if criteria for all attributes are fulfilled.

4.4.4 Descriptor 4: Food webs

GES should ensure that populations of selected food web components occur at levels that are within acceptable ranges that will secure their long-term viability. GES will therefore be achieved when the indicators describing the various attributes of the descriptor reach the thresholds set for them.

[50] https://mcc.jrc.ec.europa.eu/main/index.py

4.4.5 Descriptor 5: Human induced eutrophication

GES has been achieved when the biological community remains well-balanced and retains all necessary functions in the absence of undesirable disturbance associated with eutrophication (e.g. excessive algal blooms, low dissolved oxygen, declines in seagrasses, kills of benthic organisms and/or fish) and/or where there are no nutrient-related impacts on sustainable use of ecosystem goods and services (Figure 20).

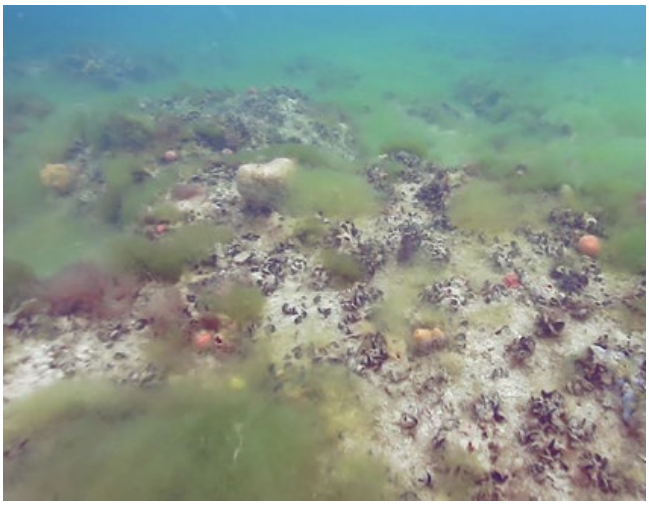

Figure 20: Filamentous green algae (also known as 'drift algae') smothering a biotope habitat in Port Phillip Bay, Victoria. The growth of the algae is a result of human induced eutrophication (image curtesy Adrian Flynn).

4.4.6 Descriptor 6: Seafloor integrity

The standard for GES should reflect the goals for management of the impacts of human activities on the sea floor. It is explicit in the definition of the descriptor that human uses of the ocean, including uses that affect the sea floor, are consistent with relevant policies, as long as those uses are sustainable.

Sustainability is achieved when the pressures associated with all those uses cumulatively do not hinder the ecosystem components to retain their natural diversity, productivity and dynamic ecological processes. Perturbations due to use must be small enough that recovery is rapid and secure if a use ceases.

4.4.7 Descriptor 7: Hydrographical conditions

Hydrographical conditions are characterized by the physical characteristics of seawater such as temperature, salinity, depth, currents, waves and turbulence. These characteristics play a crucial role in the dynamics of marine ecosystems and can be altered by human activities, especially in coastal areas. Alterations to hydrographical conditions can occur due o the construction of physical structures (such as wind turbines) or through excavation of navigational channels.

4.4.8 Descriptor 8: Contaminants

Biological effects should be assessed against threshold levels of response that are indicative of significant harm to the organisms concerned. Integration is greatly facilitated by coherent and consistent sets of assessment thresholds.

4.4.9 Descriptor 9: Contaminants in fish and seafood

GES would be achieved if all contaminants are at levels below the levels established for human consumption or showing a downward trend (for the substances for which monitoring is ongoing but for which levels have not yet been set). However, it is generally felt that GES for descriptor 9 must be judged in view of the monitoring of descriptor 8, also dealing with contaminants in marine environment.

4.4.10 Descriptor 10: Litter

Definitions of the acceptable levels of harm and GES must consider impacts as assessed by the amount of litter in different compartments of the marine environment (seabed, sea surface, water column, coastline), ecological effects of the litter such as plastics ingested by marine organisms or entanglement rates (Figure 21); and problems associated with degradation of litter (microparticles) as well as social and economic aspects. Tourism and visitation is strongly negatively affected by the presence of litter. An overriding objective will be a measurable and significant decrease (e.g. 10% per year for litter on coastlines) in the total amount of litter in the environment.

Figure 21: Seal entangled by plastic netting discarded from a vessel or shore-based facility (image curtesy Rebecca McIntosh and Simon Boag).

4.4.11 Descriptor 11: Energy and noise

GES occurs when there is no adverse effect of energy inputs on any component of the marine environment. However, such an objective is probably not achievable if, for instance, behavioural disturbance or mortality of plankton (including planktonic larvae) is considered an adverse effect. Such an objective is probably not also measurable for a very large proportion of organisms in the marine environment.

4.2 Marine and Coastal Stewardship Index (MCSI)

The MCSI was developed to score the environmental achievement of marine and coastal activities (as outlined in Section 3.9) to report on the level of active stewardship that is encouraged and supported by the Victorian government (e.g. *Victorian's Volunteering for Nature* and *Coastcare Victoria*).

An activity is assigned one of these four MCSI categories (Table 1) by assessment and scoring against the following five indicators:

- Environmental objectives
- Effort
- Environmental outcomes
- Accountability
- Adaptive management

Each of these five indicators is scored as 1-Minimal, 2-Low, 3-Medium and 4-High using criteria, and scores are totalled to derive the MCSI category (Table 2).

The MCSI will be initially applied to projects in Port Phillip Bay and refined as necessary through a technical review and consultation process to be conducted in 2021 and 2022.

Table 1: Activity categories of marine and coastal stewardship.

Category	Definition
Verified	Activity is highly targeted and delivers protection, enhancement and restoration of the marine and coastal environment
Focused	Activity contributes to the protection, enhancement and restoration of the marine and coastal environment
Enterprising	Untargeted on-ground activity is occurring, but its contribution to the protection, enhancement and restoration of the marine and coastal environment is small or unknown
Supporting	Activity develops skills and knowledge vital for effective stewardship

Table 2: Score ranges and corresponding MSCI category.

Total score	*1-5*	*6-12*	*13-16*	*17-20*
MCSI category	Supporting	Enterprising	Focused	Verified

5 Projects 2020-22

5.1 Protecting Victoria's Environment – Biodiversity 2037 (Biodiversity 2037)

The Flora and Fauna Guarantee Act 1988 authorises *Biodiversity 2037* which is Victoria's twenty-year plan for the future of Victoria's biodiversity. It sets the task of stopping the decline of and seeking a net improvement in the outlook across all species by 2037, while sustaining the state's strong economy.

The *Victorian Biodiversity Knowledge Framework* explains how to identify knowledge gaps in biodiversity science, so that we can better invest in research, monitoring and data collection, while the *Biodiversity 2037 Monitoring, Evaluation and Reporting Framework (MERF)* further supports by providing an overarching framework for the monitoring, evaluation, and reporting of biodiversity related strategies, regulations and programs.

Since 2017, the MACKF has progressively assembled the necessary driver and output components to enable marine and coastal biodiversity data to be compiled with standardised protocols output data standards (Figure 22) to align Biodiversity *2037* and facilitate evaluation through the *Biodiversity 2037 MERF*.

Biodiversity 2037 recognises the value of using strategic decision-support tools to prioritise action and focus more on earlier intervention. Decision-support tools are typically computer-based information products that inform choices at the management, operations, planning or policy level of an organisation.

The MACKF has been designed to meet the needs of Biodiversity 2037's NatureKit[51] products and tools through development of analogous data sets and models that represent marine biodiversity, ecological process and pressures (threats) that occur in the marine environment. These tools are under staged development through the CoastKit information system (Section 3.1).

NatureKit	CoastKit
Habitat Distribution Models	Biotope Distribution Models
Habitat Importance Models	Priority marine features
Threat Models	Threat Models (Pressures)
Benefit of Action Models	In development
Strategic Biodiversity Values	In development
Strategic Management Prospects	In development

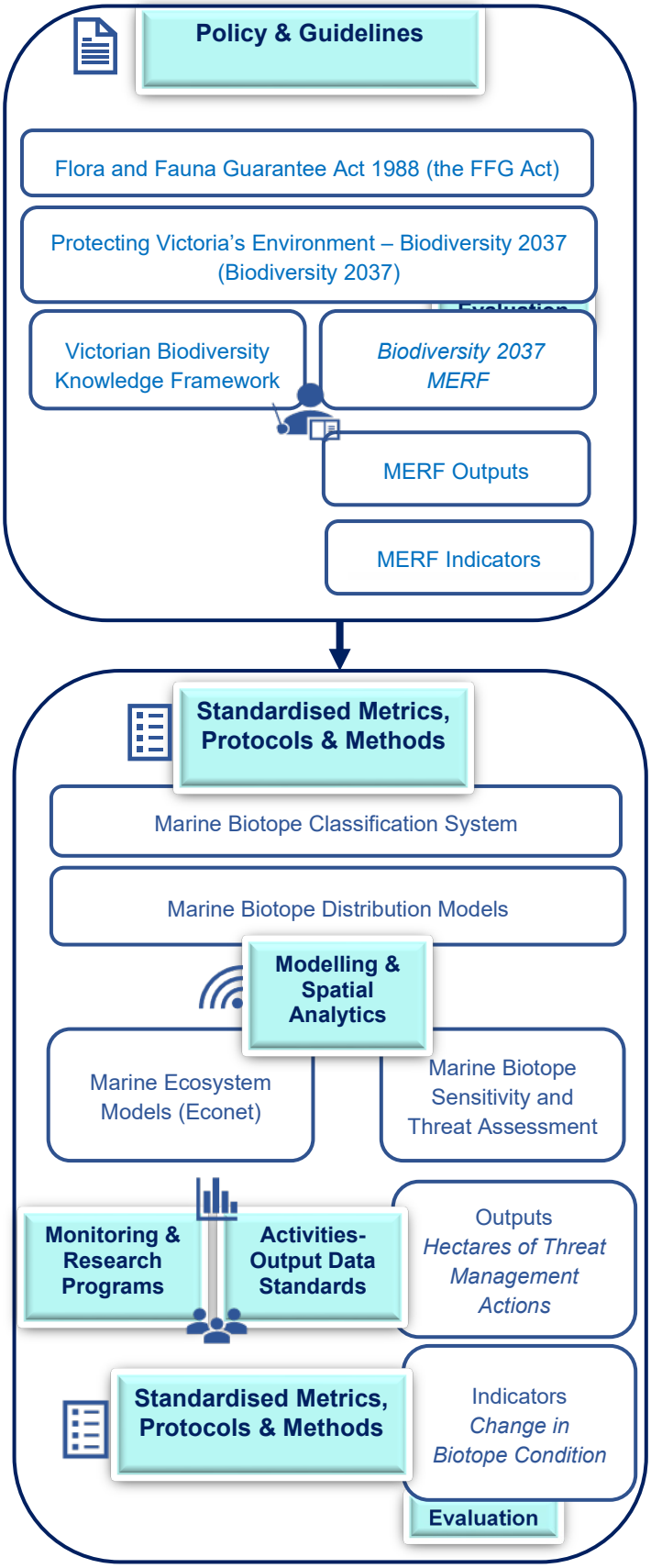

Figure 22: Illustration of how output and application components of the MACKF (Figure 2) are developed and linked in accordance with policy and guideline components to implement and inform the *Victorian Biodiversity Knowledge Framework* and *Biodiversity 2037 MERF*

[51] https://www.environment.vic.gov.au/biodiversity/natureprint

5.2 Marine and Coastal Policy 2020, including a Marine Spatial Planning Framework

The *Marine and Coastal Act 2018* requires a *Marine and Coastal Policy* designed to deliver a healthy, dynamic and biodiverse marine and coastal environment that is valued, and that benefits the Victorian community, now and in the future. The Act requires that the policy includes a *Marine Spatial Planning Framework* (MSP Framework) [52] that provides a process for achieving integrated and coordinated planning and management of the marine environment.

The MSP Framework has three primary functions:

- To support integration and coordination of planning and management across marine sectors, the land-sea interface and jurisdictional boundaries
- To support Traditional Owners, marine sectors, marine users and the community participate in marine planning and management
- To provide a process for:
    - determining where and when marine spatial planning is required
    - initiating, approving and undertaking marine spatial planning, including producing and implementing marine plans

The MSP Framework provides an overarching structure to guide planning, management and decision making by marine sectors, and includes a Statewide Assessment and development of Marine Spatial Planning Guidelines. The outputs and application components of MACKF could be used to assist in implementation of the MSP Framework, in particular undertaking MSP processes (Figure 23).

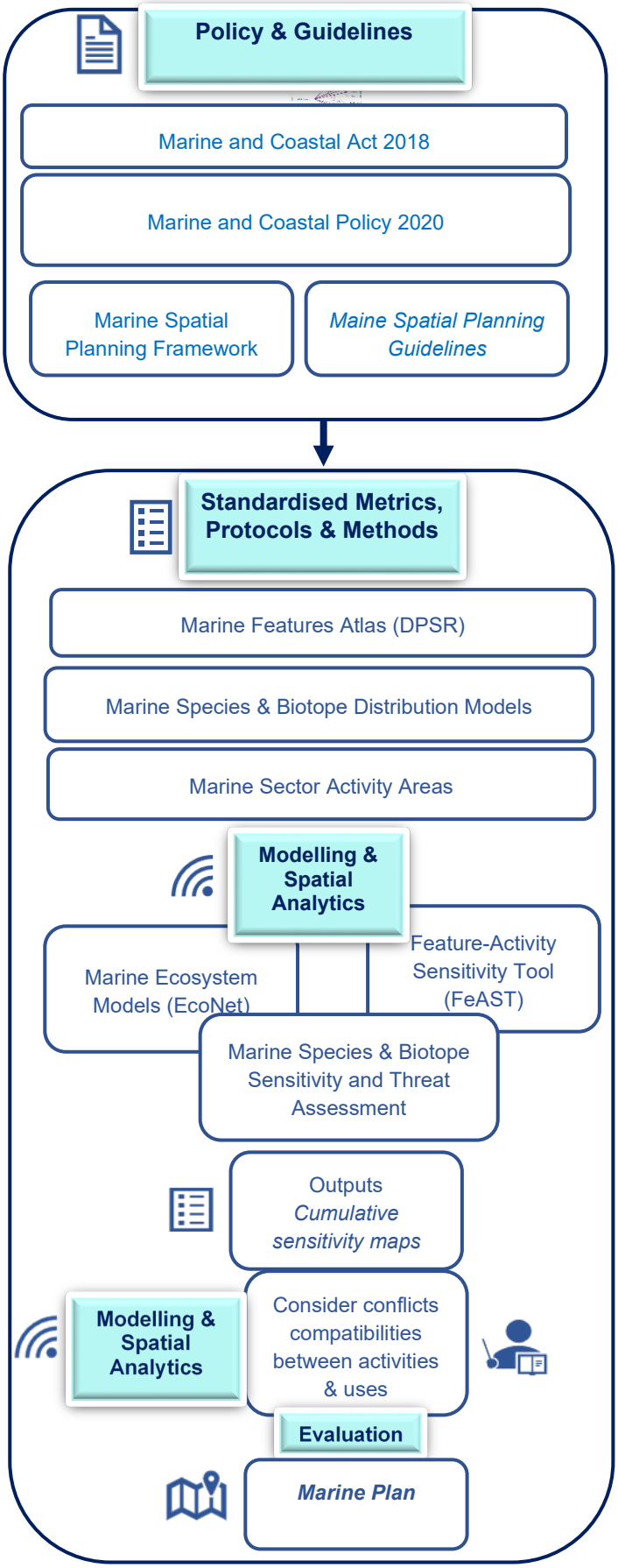

Figure 23: Illustration of how output and application components of the MACKF (refer Figure 2) are developed and linked in accordance with policy and guideline components to inform the MSP Framework.

[52] https://www.marineandcoasts.vic.gov.au/coastal-management/marine-and-coastal-policy

5.3 Port Phillip Bay Environmental Management Plan 2017-2027 (EMP) and Monitoring, Evaluation, Reporting and Improvement (MERI) Strategy 2022

The EMP[53] was developed in partnership between the Department of Environment, Land, Water and Planning (DELWP), Melbourne Water and the Environment Protection Authority (EPA) Victoria.

The EMP is authorised under the *Marine and Coastal Act 2018* and the *State Environment Protection Policy (Waters) 2018* [54] and establishes a framework to manage the health and resilience of the Bay for achieving environmental targets and beneficial use objectives.

The EMP's vision of 'a healthy Port Phillip Bay that is valued and cared for by all Victorians', and the following three main goals will guide future action and investment over the next 10 years:

- Stewardship of the Bay is fostered across community, industry and government
- Water quality is improved to ensure environmental health and community enjoyment of the Bay
- The Bay's habitats and marine life are thriving

The EMP MERI Strategy is currently under development to inform the five-yearly review of the EMP. The Strategy will assist in achieving the goals of the EMP; build understanding of the science underpinning the EMP; ensure accountability for efficient and effective use of public and private resources; and form a key part of the EMP communication strategy. EMP Partners and stakeholders are involved in its development.

The MACKF components will be applied to improve our understanding of the Bay's ecosystems and to support and guide the evaluation of the EMP by 2022 (Figure 24).

Report cards and visualisations will be developed to assess EMP achievements against the EMP's Priority Action Areas and communicate the environmental results of the MERI using indicators of *Good Environmental Status* (GES). Management activities and stakeholder engagement will be expressed with new indicators of *Marine and Coastal Stewardship.*

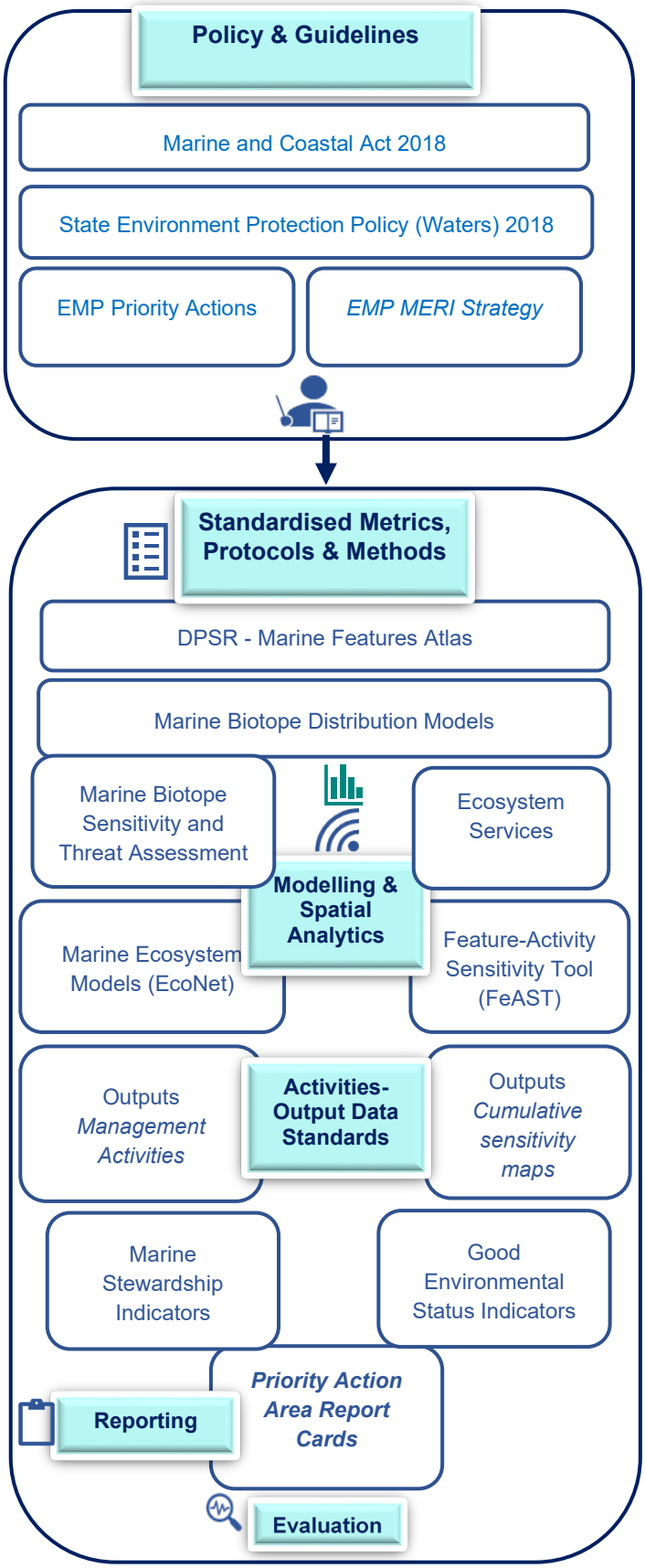

Figure 24: Illustration of how output and application components of the MACKF (refer Figure 2) are developed and linked in accordance with policy and guideline components to implement and inform the SEPP (Waters) and EMP MERI Strategy 2022

[53] https://www.marineandcoasts.vic.gov.au/coastal-programs/port-phillip-bay

[54] https://www.water.vic.gov.au/waterways-and-catchments/rivers-estuaries-and-waterways/state-environment-protection-policy

5.4 Victorian Coastal Monitoring Program - Marine and Coastal Policy 2020 and Victoria's Climate Change Adaptation Plan 2017 – 2020

The aim of the Victorian Coastal Monitoring Program (VCMP)[55] is to provide communities with information on coastal condition, change, hazards, and the expected impacts associated with climate change that will facilitate evidence-based decision making (i.e. invest in protection and intervention, or adaptation, or tolerate).

The VCMP aims to:

- Employ risk assessment frameworks that consider present day and future risks of erosion, inundation stability and physico-chemical variation to natural coastlines and engineered structures that will inform prioritisation of coastal monitoring.
- Develop partnerships with community groups (citizen science) and institutions to co-invest in coastal monitoring projects at both regional and local scales.
- Develop data management infrastructure and decision support tools (where necessary) for coastal monitoring data that will inform:
    - evaluation and application of policy, planning and climate adaptation instruments
    - investment and maintenance decisions for coastal protection structures
    - reporting requirements for various purposes (e.g. State of the Coasts reporting)

The VCMP was initiated in 2016-17 and currently runs to 2021-22. Project partnerships have been established with Deakin University, University of Melbourne and Monash University who have assembled specialists in the monitoring of wave climate, sediment movement and sediment budgets in priority coastal compartments of Victoria's open coastline, Western Port Bay and Port Phillip Bay.

Knowledge of sediment budgets will help us to identify which areas of Victoria's are likely to lose or gain sediment under sea level rise and changes to wave directions. This assessment is crucial for understanding current processes and predicting future effects to undertake informed coastal adaptation planning and investment (Figure 25).

Data and visualisation products from the VCMP will be added to the Coastkit database and web mapping portal during 2021-2022. In the interim, Deakin University is managing an ESRI Story Maps[56] site to provide information on the project, and examples of the data analytics and visualisations from the program.

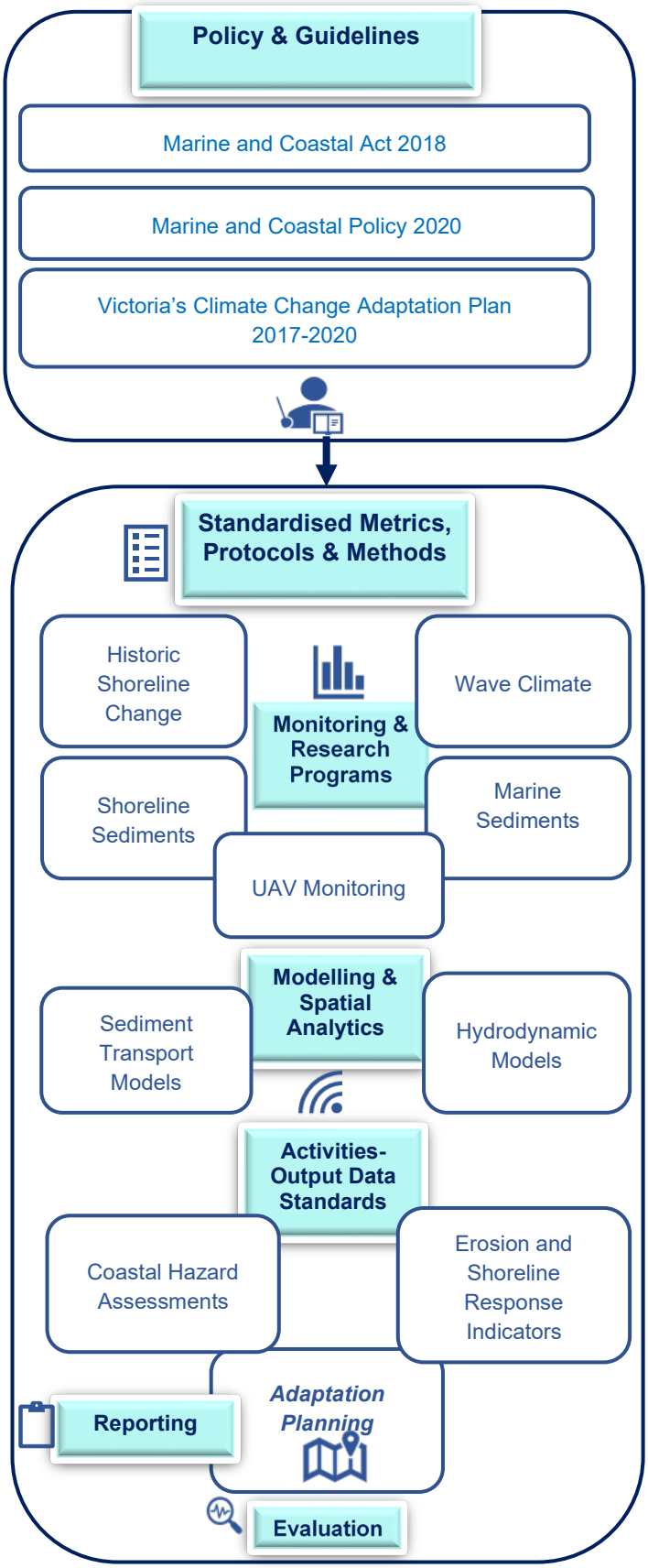

Figure 25: Illustration of how output and application components of the MACKF (refer Figure 2) are developed and linked in accordance with the Marine and Coastal Policy 2020 and the Climate Change Adaptation Plan 2017-2020 to inform coastal hazard assessments and adaptation planning

[55] https://www.marineandcoasts.vic.gov.au/coastal-programs/victorian-coastal-monitoring-program

[56] https://arcg.is/1yW5eL