Marine Biodiversity Values (MBV) Map

A spatial assessment of Victoria's listed and key marine and coastal biodiversity features

MAY 2024



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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.

DEECA is committed to genuinely partnering with Victorian Traditional Owners and Victoria's Aboriginal community to progress their aspirations.



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Glossary

Term	Definition
ARI	Arthur Rylah Institute for Environmental Research, Department of Energy, Environment and Climate Action.
BIA	Biologically important area, term defined by DCCEEW.
Biodiversity 2037	Victoria's plan to stop the decline of our native plants and animals and improve our natural environment.
Biodiversity Feature	Term widely used in systematic conservation planning and adopted in this report to represent important biodiversity values including species, communities, habitats, core life history sites and key ecological areas.
CoastKit	Victoria's marine and coastal interactive web-mapping portal for managers, researchers, consultants, and community.
DEECA	The Department of Energy, Environment and Climate Action - Victoria, Australia.
DCCEEW	The Department of Climate Change, Energy, the Environment and Water - Australian Government department.
EPBC Act	The <i>Environment Protection and Biodiversity Conservation Act 1999</i> is an Act of the Parliament of Australia that provides a framework for protection of the Australian environment, including its biodiversity and its natural and culturally significant places.
FFG Act	Victoria's <i>Flora and Fauna Guarantee Act 1988</i> provides for the listing of taxa (genera, species, subspecies and varieties), threatened communities of flora and fauna and potentially threatening processes. The purpose of this Act is to establish a legal and administrative structure to enable and promote the conservation of Victoria's native flora and fauna.
GIS	A geographic information system (GIS) is a system that creates, manages, analyses & maps all types of data.
HDM	Habitat distribution model. A model that spatially predicts the habitat distribution for flora and fauna species.
KEFs	Key ecological features are elements of the Commonwealth marine environment that are considered to be of regional importance for either a region's biodiversity or its ecosystem function and integrity (DCCEEW, 2024).
MACA	Victoria's <i>Marine and Coastal Act 2018</i> aims to protect Victoria's marine and coastal environment now and into the future.
MACKF	Marine and Coastal Knowledge Framework.
MBV	Marine Biodiversity Values.
MSP	Marine Spatial Planning.
NatureKit	NatureKit is a free online mapping and data exploration tool for biodiversity data integration and decision support. It is the terrestrial equivalent of CoastKit.
Ramsar	Ramsar is the Convention on Wetlands, a global agreement that protects and conserves wetlands and their resources.

SDM	Species Distribution Model. A model that spatially predicts the distribution range of a given species.
SNES	Species of National Environmental Significance, term defined by DCCEEW.
VBA	Victorian Biodiversity Atlas.
VEAC	Victorian Environmental Assessment Council.

1. Victoria's marine biodiversity

Victoria's marine and coastal environment supports a high diversity of plants and animals, many of which are endemic and found only in Victoria (VEAC 2019). The unique array of natural habitats along the coast provides essential refuge for many threatened and key species including the critically endangered orange bellied parrot, the endangered southern right whale and Australia's largest colony of little penguins.

Important habitats include Victoria's rocky reefs, vital for a diverse array of marine life, encompassing hundreds of species from fish and molluscs to crustaceans, marine worms, sea anemones, and various types of algae including those forming giant kelp beds (VEAC, 2019). Seagrass beds are another important habitat type in Port Phillip Bay, Western Port, and Corner Inlet, acting as crucial nurseries for numerous fish and invertebrate species and supporting commercially and recreationally important fish species such as King George whiting and black bream. The mosaic of coastal wetlands scattered along Victoria's coastline provide essential foraging grounds for migratory shorebirds like terns and curlews, with sites internationally recognised on the <u>East Asian-Australasian Flyway</u> Site Network and listed under the Ramsar Convention (Ramsar, 2023). Victoria also boasts the world's southernmost occurrence of mangroves, which play a multifaceted role and provide ecosystem services from critical habitat to coastal protection.

Prominent ecological features in Victoria include the Bonney coast upwelling near Portland, which supplies nutrient-rich waters to support a plethora of marine species including fish, seabirds, and marine mammals. The 2,512 km Victorian coastline also provides vital nursery areas and feeding grounds for migratory species such as blue whales, southern right whales, white sharks, and grey nurse sharks, connecting Victoria's marine ecosystems to other regions of Australia and the world.

The marine and coastal species and habitats of Victoria hold inherent value for its residents, providing essential environmental benefits, playing a vital role in Traditional Owner cultural heritage, and contributing to recreational, social, and economic well-being of all Victorians. To maintain and enhance Victoria's biodiversity, transparent and scientifically robust information is needed to support decision-making across marine and coastal ecosystems. Knowledge of the location and distribution of species is fundamental to their conservation and protection, and by incorporating information on biodiversity values into planning approaches we can better understand where and how to protect biodiversity.

Biodiversity values mapping provides decision-makers with an objective, comprehensive and spatially explicit view of the relative biodiversity importance of all parts of Victoria's state waters. Developing a Marine Biodiversity Values (MBV) map for Victoria that can be continuously updated helps to ensure that the best information can be considered during planning processes, activities, and developments in Victoria's marine and coastal environment.

1.1 Overall objectives

The objective of this work is to support planning decisions across Victoria's marine and coastal environment by synthesising currently available species information and providing a **first iteration** MBV map. This report presents the methods that underpin Victoria's MBV map, detailing the input data sources for each species represented in the map as well as the spatial prioritisation approach employed. The analysis ranks all locations across Victoria's marine environment for their ability to represent key marine and coastal biodiversity features. Biodiversity features is a term widely used in conservation biology (Margules and Pressey, 2000) and adopted in this report to represent important biodiversity values and alignment with Marxan and Zonation, two of the most widely used conservation-planning decision-support tools (Moilanen et al., 2009).

In this report, marine and coastal biodiversity features, hereafter referred to as biodiversity features, include listed, threatened, and key species, along with ecological features, communities, and habitats.

The final sections of the report discuss current data needs and limitations, and the potential applications and future advancements of the map.

Work described in this report aims to:

- **Outline a systematic repeatable approach** with clear steps, from gathering and processing biodiversity feature data to developing a spatial data model for MBV mapping.
- **Build an inventory** of available data for listed, threatened and key marine and coastal biodiversity features in Victoria.
- **Deliver a first statewide MBV map** which can be readily iterated and improved upon as new information becomes available.
- **Support spatial planning** by identifying ranked locations for listed, threatened and key marine and coastal biodiversity features across Victoria's marine environment. This information can support numerous spatial planning applications from offshore development to on-ground restoration.
- **identify data needs** by detailing data quality status for each biodiversity feature from deficient to best practice and highlight priority biodiversity features where distribution data is in most critical need.
- **Promote data exchange** and management which is iterative and supports automation and seamless data integration with future advances.

This work supports the implementation of the <u>Marine and Coastal Policy 2020</u> through key actions 4 and 5 of the <u>Marine and Coastal Strategy 2022</u>. By addressing knowledge gaps, this work builds key biodiversity knowledge which is underpinned by the <u>Marine and Coastal Knowledge</u> <u>Framework (MACKF)</u>. The spatially explicit outputs will enable those undertaking environmental assessments to consider key biodiversity values to manage the effects of various uses and evaluate trade-offs. This work also contributes to Victoria's long-term vision for biodiversity, Protecting Victoria's Environment – <u>Biodiversity 2037</u>, especially addressing the critical need to protect and conserve threatened species that are in decline and/or at risk of extinction.

2. Spatial context

2.1 Map extent

The map extent was designed to align with the marine and coastal environment defined by Victoria's <u>Marine and Coastal Act 2018</u> (MACA) which extends 5 km inland from the Victorian coast to 3 nm offshore. Figure 1 shows the study bounds of the MBV assessment.



Figure 1. Spatial extent of the Marine Biodiversity Values (MBV) map, extending 5 km inland and 3 nm offshore to the limit of Victorian state waters.

2.2 Spatial resolution

Grid cells or planning units (Di Minin E et al. 2014) are the standardised spatial components used for data processing and planning within a given land or seascape. In this case, grid cells are simply pixels on a map dividing the study area into uniform, equal parts. Defining the spatial resolution of planning units, in this case grid cells, is a key step in spatial data processing that underpins systematic conservation planning tools (Margules and Pressey, 2000).

For the map extent described above, the resolution or size of grid cells was defined as square units of 225 m² (Figure 2), resulting in a total of 401,448 units. The grid cell size was selected to align with the Department of Energy, Environment and Climate Action's (DEECA) terrestrial mapping outputs and tools displayed on <u>NatureKit</u>, to support future planning across both land and sea environments.



Figure 2. Example of the statewide square grid cells (225m x 225m).

3. Biodiversity features assessment

This section describes the input data for marine and coastal biodiversity features included in the first iteration of the MBV map. This foundational assessment collects information based on the inclusion criteria outlined below, focusing on biodiversity features.

3.1 Biodiversity features inclusion criteria

In this assessment, marine and coastal biodiversity features were considered as those identified as occurring primarily within the marine and coastal zone following the MACA boundary (Figure 1). This includes species that occupy or migrate through coastal habitat, beach, shoreline, or offshore areas within Victoria's state waters. The biodiversity features were selected for inclusion in the assessment based upon the following criteria:

- Listed species and communities
 - Under Victoria's <u>Flora and Fauna Guarantee Act 1988</u> (the FFG Act), including DEECA icon species in <u>Victoria's Faunal Emblems Program</u> (DEECA, 2023).
 - Under the Australian Government's <u>Environment Protection and Biodiversity</u> <u>Conservation Act 1999</u> (the EPBC Act), including the <u>Threatened Species Action Plan</u> <u>2022-2032 110 Priority species</u> (DCCEEW, 2022) and <u>Priority species identified for the</u> <u>Gippsland declaration area</u> (Marine and Coastal Hub, 2024).
- Habitat features statewide marine habitat complexes mapped in the <u>statewide marine</u> <u>habitat map (Mazor et al. 2023)</u>. These 24 habitats encompass a range of species, some of which may be unique, rare or vulnerable.
- **Key biodiversity features** defined here as biodiversity features that are not currently listed under the FFG Act, EPBC Act, or recognised as a statewide marine and coastal habitats, however, are considered to have important cultural, economic, ecological, or social value based on identification in the following references.
 - Fishery species key Victorian fish stocks (Bell et al. 2022).
 - A species of concern for offshore developments (Lumsden et al. 2019; Latitude 42; Reid et al. 2022, DCCEEW, 2022).

- Key ecological features (KEFs) are elements of the marine environment considered to be of regional importance for either a region's biodiversity or its ecosystem function and integrity (DCCEEW, 2024). <u>KEFs</u> are not matters of national environmental significance and have no legal status in their own right.
- Ecological keystone species an organism that has a profound effect on maintaining the structure of an ecosystem as a top-order predator, ecosystem engineer or mutualist (SoE DCCEEW 2021). There are currently no keystone species defined in Victoria's marine environment, but this criterion is included for future consideration.
- Species valued by Traditional Owners are recognised as cultural keystone species, vital to the cultural identity of communities, essential for sustenance, materials, medicine, and spiritual practices (IPBES, 2004). Although some species incorporated hold significance for Traditional Owners such as dolphins, birds, marine turtles, and whales (Barwon Coast 2023), partnering with Traditional Owners to undertake a comprehensive assessment of culturally significant species for Sea Country has not been undertaken for this first iteration and should be addressed in future iterations of the map.

A total of 311 marine and coastal biodiversity features were identified by applying the above criteria. Species listings from the FFG Act and EPBC Act were extracted in December 2023, updates thereafter have not been captured in this first assessment. These criteria provide a foundation for the first spatialised MBV assessment to be undertaken based on available species-specific information.

The focus of this analysis is species, habitats, and ecological features, aligning with DEECA's terrestrial information products, and as a result protected areas and conservation areas (e.g. Ramsar sites) were not incorporated. Protected areas should be considered in further planning and application. The total number of biodiversity features included in this analysis are relatively limited, largely due to the general paucity of information in marine ecosystems in comparison to the terrestrial environment. However, undertaking this analysis provides a systematic approach for synthesising multi-species information and supporting biodiversity decision-making (Early & Thomas 2007; Schmiing et al. 2014). This process also effectively identifies knowledge/data gaps and enables iterative inclusion of other biodiversity features as information becomes available.

Future iterations should undertake stakeholder engagement processes to determine whether revision of the biodiversity features inclusion criteria is necessary, and a systematic process to identify key biodiversity features. This process requires partnering and discussion with Sea Country Traditional Owners and embedding other forms of knowledge and information where appropriate to continuously improve the inclusion criteria and associated information products.

3.2 Biodiversity data synthesis

This assessment relied on the collation of readily available, publicly accessible data. However, it is important to note that other information sources exist such as non-spatialised data in reports, grey literature, and publications, and a comprehensive data synthesis and stakeholder engagement process should expand upon the first iteration analysis presented in this report.

Once a full features list was determined based on the biodiversity features inclusion criteria above, spatial data was sought and acquired from various sources and converted using ESRI ArcGIS Pro (2.8.8) software for processing methods into a uniform format that can be consistently assessed (Appendix <u>Table A1</u>).

In cases where multiple data sources for 1 species existed, multiple data products were integrated to create a representative statewide distribution layer (Table A1). This included any areas or sites identified in the sources below as significant for ecological function or life-history of a species, for

example breeding or foraging areas. The data quality of each source was also assessed against criteria (Table 1) to clarify the limitations of this first assessment and enable prioritisation of future data needs given the general paucity of high integrity data within the marine environment.

Data sources examined and included in this first assessment include:

Biologically Important Areas (BIAs)

<u>Biologically Important Areas</u> (BIAs) for protected marine species have been developed at a large scale for 70 marine species protected under the EPBC Act. They have been defined by the Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW) representing spatially defined core areas for significant species carrying out critical life functions such as reproduction, feeding, migration or resting. BIAs were available for 10 species within Victoria's marine and coastal environment at time of writing.

The following caveats are applicable:

- 1. BIAs do not represent full species range and so are different to distribution maps found in the Species Profile and Threats (<u>SPRAT</u>) database.
- 2. BIAs are not identified for all protected species or all areas of the marine environment.

BirdLife Australia

<u>BirdLife Australia</u> is a not-for-profit organisation dedicated to the conservation of birds and the collection of bird data. BirdLife's Australian Shorebird Monitoring Project provides a database comprising of the most complete shorebird count data available in Australia and helps to identify significant population changes over the long term. Survey data for 11 threatened species was processed in ArcGIS Pro using the Kernel Density tool to map 'hot spots' of high-density locations for each species. Only data observations recorded after 1 January 2000 have been included in the assessment.

CoastKit – DEECA

<u>CoastKit</u> is DEECA's online mapping service that hosts publicly available spatial information to support evidence-based decision making, assist with planning applications and highlight opportunities for restoration activities. The portal offers a broad diversity of mapped layers, video imagery, graphing capabilities, and decision-support tools. Species-specific data was extracted from the feature atlas on CoastKit using SQL queries, returning point and polygonised data.

The data on the feature atlas was compiled in 2019 (Matt Edmunds, Australian Marine Ecology) from publicly available data, and represents areas and sites of key biodiversity importance for life-history traits. <u>Key fish habitat locations</u>, for a subset of recreational marine fish species, have also been incorporated into the assessment, this original study was commissioned by the Victorian Fisheries Authority (VFA). Vector records were then batch buffered by 1 km and converted to a raster product.

CoastKit also hosts habitat records called biotopes which are recognisable assemblages of species that occur within particular environments and habitats. Biotopes in Victoria are classified using the Combined Biotope Classification Scheme (CBiCS; Edmunds and Flynn et al. 2018a) and include thousands of ground-truthed points from underwater imagery (Edmunds and Flynn (2015; 2018a; 2021). These records form the building blocks of Victoria's statewide habitat map whereby 32,998 habitat observation were combined with predictive machine learning modelling and mapping techniques that synthesis existing information. The resulting <u>statewide marine habitat map</u> (Mazor et al. 2023) represents 24 habitat complexes (CBiCS level 3) across the state, which have been incorporated into this assessment.

NatureKit – DEECA

<u>NatureKit</u> is an online mapping and data exploration tool for biodiversity data integration and decision support, with a primary focus on terrestrial ecosystems. <u>Habitat distribution models</u> (HDMs) have been developed from species observation records together with environmental variables to show the predicted habitat suitability of a location for a species on a scale of 1-100 (Thomson et al. 2020). HDMs have been extracted for 38 marine and coastal species from NatureKit and in some cases merged (Table A1) with additional offshore information, as the NatureKit HDMs are bounded by the coastline.

Species of National Environmental Significance (SNES) – DCCEEW

The <u>SNES</u> database has been developed by DCCEEW and contains generalised distribution maps for species, key ecological features and communities listed as threatened, marine, important or migratory on the EPBC Act. The product is updated every 6 months and is accurate to a 1 km grid resolution (0.01°) and 10 km for species classified as sensitive. The <u>Protected Matters Search Tool</u> utilises the SNES information to generate species reports. The <u>Species Profile and Threats</u> <u>Database (SPRAT)</u> was examined to ensure species listing and information was current.

Scientific literature

Species distribution maps published in peer-reviewed scientific publications or publicly available technical reports with relevance to the above assessment criteria were also included in this assessment. Key publications with accompanying data that were integrated into the first iteration map include studies on Victoria's marine sharks and rays (Graf 2023), seaweed (Young et al. 2022; Young et al. 2023), and abalone (Young et al. 2020). Data were derived from a variety of primary data sources referenced in the publications, including public databases mentioned above as well as other large-scale monitoring programs such as 1998 to 2015 data from Parks Victoria's Subtidal Reef Monitoring Program (SRMP).

Published spatial data on habitat distributions in Victoria have been captured and synthesised into the statewide marine habitat map on CoastKit. Data incorporated includes bay habitats (Edmunds and Flynn 2015; Edmunds and Flynn 2018b), open coast mapping by Deakin University's <u>Marine Mapping</u> lab (lerodiaconou 2007, Zavalas, et al. 2014; lerodiaconou et al. 2018, Young et al. 2022), wetland habitats (Boon et al. 2011), seagrass (Blake and Ball 2001), and other habitat mapping referenced within the statewide habitat map technical report (Mazor et al. 2023).

Although further sources of primary data, particularly survey records for a marine species, may be available within other publications, only readily available datasets appropriately processed into species distribution models and at a statewide scale, were incorporated in this analysis. For specific references by feature see Appendix Table A2. Future iterations of this work may explore additional data further.

Victoria's Biodiversity Atlas (VBA) – DEECA

The <u>VBA</u> includes a dynamic list of all species recorded in Victoria and associated information like conservation status. All observations accepted into the VBA have been reviewed by experts. Records were extracted from the <u>VBA portal</u> by taxon id for each species of interest. Verified data has been filtered by year after 01/01/2000, merged with BirdLife data if available, and processed to create kernel density maps using the Kernel Density tool in ArcGIS Pro.

3.3 Data quality assessment

To understand and prioritise the need for future work towards improving data, the quality of data available for each biodiversity feature was assessed using the criteria in Table 1. The assessed data quality represents an estimate of confidence in the data source, processing techniques, and data extent as of December 2023.

Data quality	Data score	Data description
Deficient	0	No data publicly available.
Limited	1	Coarse resolution spatial data available for key areas and locations of importance and/or lack of statewide information, unsystematic data collection and processing (e.g., inconsistent or not comprehensive survey methodologies and timepoints).
Moderate	2	Data has sufficient coverage across the biodiversity feature's distribution, and data-driven scientific approaches have been adopted for data collection and processing.
Adequate	3	Statewide species and habitat distribution models (or distribution models representing key biodiversity features) have been created utilising data from verifiable sources based on consistent survey methodologies that ensure coverage across the species' distribution range, and which have included a comprehensive set of environmental predictors.
Best practice	4	Species distribution models or models for key biodiversity features have been created, refined by stakeholder input, and consider temporal movements, connectivity, and migration routes.

Table 1. Data quality criteria used to rate each biodiversity feature layer.

3.4 Overview of biodiversity features assessed

Of the 311 marine and coastal features identified (Table A2) using the biodiversity features criteria above, spatial information was available for a total of 263 biodiversity features as of December 2023. Figure 3 displays the proportion contributed by each taxa group to the overall assessment, and Table 2 describes the biodiversity features included in the assessment, along with the data quality of all identified features. Data deficient biodiversity features (Table 1) have not been included in the assessment.



Figure 3. Proportion of 263 marine and coastal biodiversity features assessed across different taxa groups.

Table 2. A total of 263 marine and coastal biodiversity features are included in the analysis. Number listed denotes the totalnumber of taxa that are listed under either the FFG Act, EPBC Act or both. For the full taxa list seeTable .

Taxa group	Number assessed	Number listed	FFG Act	EPBC Act	Key biodiversity feature
Birds	117	111	43	110	6
Coastal bats	5	5	5	1	-
Key ecological features	2	0	0	0	2
Listed communities	7	7	3	4	-
Marine fish	55	42	6	41	13
Marine habitats	23	1	1	0	-
Marine invertebrates	16	2	2	0	14
Marine mammals	29	29	6	29	-
Marine plants	5	3	3	0	2
Marine reptiles	4	4	1	4	-
Total	263	204	70	189	59

Data Quality: Deficient = 48 spp., Limited = 139 spp., Moderate = 56 spp., Adequate = 68 spp.

The following sections provide an overview of the biodiversity features selected for the MBV assessment, with summary tables and data quality assessment results for each taxon group. The taxa sub-group type nomenclature has been adopted from DEECA's <u>VBA taxa list</u>.

3.4.1 Birds

Taxa sub-group	Number assessed	Number listed	FFG Act	EPBC Act	Key biodiversity features
Cormorants and terns	15	12	4	12	3
Land birds	7	7	1	7	-
Parrots	3	3	2	3	-
Raptors	2	2	1	2	-
Seabirds	39	39	10	39	-
Shorebirds	42	40	20	40	2
Waterbirds	9	7	4	7	2
Total	117	110	42	110	7

 Table 3. Summary table showing the sub-groups and number of species assessed for birds.

Data Quality: Deficient = 6 spp., Limited = 57 spp., Moderate = 31 spp., Adequate = 29 spp.

A wide variety of birds utilise Victoria's marine and coastal environment. Seabirds like albatrosses, shearwaters and petrels breed on land but forage and feed at sea, while shorebirds and waterbirds like sandpipers and snipes are found around coasts, wetlands, and mudflats. Many species of seabirds, shorebirds and waterbirds are migratory, spending part of the year in other regions or countries, so that conservation of their habitat in Victoria is of global importance (BirdLife, 2023).

Coastal ecosystems also provide vital breeding and feeding habitat for some land-based bird species, including the critically endangered orange bellied and swift parrots. Both species migrate annually across the Bass Strait between Tasmania and Victoria and have very small populations remaining in the wild (White et al. 2016). General threats to marine and coastal bird species include habitat change and loss, climate change and increase in introduced predators like feral cats and foxes. Potential sources of impact from offshore wind energy developments include light and noise, interaction with turbines leading to injury or mortality, and physical barriers to migration or feeding habitat (DCCEEW, 2023).

A total of 123 coastal and marine bird species were considered based on the inclusion criteria, with 117 species included based on data availability. Six listed species were not included in the assessment due to a lack of sufficient data but are distributed in Victoria. The species assessed include the sub-groups: cormorants and terns, land birds listed under the EPBC Act as marine, and parrots including bass strait migrants, seabirds, raptors (fish eating), shorebirds and waterbirds. Of the 42 species on the FFG Act, 15 species are listed as Critically Endangered, 18 listed as Endangered and 9 listed as Vulnerable.

3.4.2 Coastal bats

Species common name	Listed	FFG Act	EPBC Act		
Common bent winged bat	✓	CE	-		
(Miniopterus orianae)					
Eastern bent winged bat	\checkmark	CE	-		
(Miniopterus orianae oceanensis)					
Eastern horseshoe bat	\checkmark	EN	-		
(Rhinolophus megaphyllus)					
Southern bent winged bat	\checkmark	CE	CE		
(Miniopterus orianae bassanii)					
Yellow-bellied sheathtail bat	\checkmark	VU	-		
(Saccolaimus flaviventris)					
Total = 5	5	5	1		

Table 4. Summary table showing the number of species assessed for coastal bats.

Data Quality: Moderate = 1 sp., Adequate = 4 spp.

Bats are challenging to study due to their cryptic nature and nocturnal activity. As a result, they are often data deficient, with limited knowledge of population numbers, foraging behaviour, and roosting sites. The insectivorous bats included in this assessment mainly colonise hollows in vegetation, disused mine sites, and sea caves as roosting and maternity areas (DEECA, 2022). Many of these roosting and colony sites have a tidal water entry, with 17 coastal sites identified across the state on CoastKit. Foraging range can be extensive, and research shows the critically endangered southern bent-wing bat can fly at least 72 km in just a few hours (SWIFFT, 2023).

Bats are subject to a range of threats including human disturbance and loss or change of roosting or foraging habitat. Interactions with offshore wind turbines can pose a risk of collision or increased water pressure (barotrauma) resulting in injury or death (DCCEEW, 2023). Wind farm developments are listed as a threat to the southern bent-wing bat in the <u>National Recovery Plan</u> (DELWP 2020).

Five coastal bat species were identified for inclusion in the assessment. All five are listed under the FFG Act (3 Critically Endangered, 1 Endangered and 1 Vulnerable), with the <u>southern bent-wing bat</u> also listed under the EPBC Act. An additional species that may be relevant, the white-striped freetail bat *Austronomus australis*, has not been included as it is currently not listed under the FFG Act or EPBC Act. However, a study undertaken by the <u>Arthur Rylah Institute</u> (ARI) in 2019 identified this species as having the highest annual mortality rates of any native species of bird or bat at the Victorian wind farm sites investigated (Moloney et al. 2019). Records indicate that *A. australis* is a mainland dwelling species, however anecdotal evidence as well as calls detected (Cawthen, 2013) and recent observations recorded in Tasmania (71 on the <u>Natural Values Atlas</u>) suggest that this bat may have a movement pathway across the Bass Strait. This species should be strongly considered for inclusion in future analyses.

3.4.3 Key ecological features (KEFs)

Name of KEF	Listed	FFG Act	EPBC Act	Key biodiversity features	
Bonney coast upwelling	-	-	-	√	
East of Eden upwelling	-	-	-	\checkmark	
Total = 2	0	0	0	2	
Data Quality: Limited = 2 biodiversity features					

 Table 5. Summary table showing the number of assessed Key Ecological Features (KEFs).

Victoria is uniquely situated in that it benefits from two major upwelling systems recognised as KEFs. The Bonney coast upwelling is the largest and most predicable upwelling in the Great South Australian Coastal Upwelling System, with events occurring between November to May (Blue Whale Study, 2024). The Bonney upwellings bring cold and nutrient-rich water to the surface creating planktonic blooms and in turn attracting high numbers of pygmy blue whales, little penguins, and Australian fur seals (DCCEEW, 2024).

The East of Eden upwelling is driven by the East Australian current, resulting in mixing and nutrient enrichment events. These upwellings play a vital role in supporting fisheries and biodiversity, marked by high primary productivity for top order predators such as cetaceans, seabirds, and sharks (DCCEEW, 2024).

3.4.4 Listed communities

Table 6. Summary table showing the number of assessed FFG or EPBC Act listed communities.

Community name	Listed	FFG Act	EPBC Act
Giant Kelp Marine Forests of Southeast Australia	\checkmark	-	EN
Littoral Rainforest and Coastal Vine Thickets of East Australia	√	-	CE
Port Phillip Bay Entrance Deep Canyon Marine Community	✓	✓	-
River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria	✓	-	CE
San Remo Marine Community	\checkmark	\checkmark	
The assemblages of species associated with open- coast salt-wedge estuaries of western and central Victoria ecological community	✓	-	EN
Western Port Bryozoan Reef Community	\checkmark	\checkmark	-
Total = 7	7	3	4
Data Quality: Limited = 1 communities Moderate = 1	3 communities		

State and federally listed threatened ecological communities are distinctive natural assets that support and sustain a diverse range of organisms including threatened species, and act as

habitat refuges and ecosystem service providers. These communities are listed due to their risk of extinction (DCCEEW 2022).

Three of the seven communities included were FFG Act listed <u>marine communities</u>: the Port Phillip Bay Entrance Deep Canyon, a highly diverse and complex marine community of reef-dwelling sessile invertebrates with a significant number (115) of endemic sponges; the San Remo marine community, characterised by 93 species of opisthobranch mollusc; and the recently listed <u>Western</u> <u>Port Bryozoan Reef Community</u>, a restricted biogenic reef unique to Victoria with high vulnerability to physical damage.

Four EPBC Act listed communities are also found in Victoria: the open-coast salt-wedge estuaries of western and central Victoria; Giant Kelp Marine Forests of Southeast Australia; Littoral Rainforest and Coastal Vine Thickets of East Australia; and the river-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria. Along with other values such as threatened species, protected areas and heritage areas, these communities are considered nationally significant 'protected matters' otherwise known as <u>Matters of National Environmental Significance (MNES)</u>.

3.4.5 Marine fish

Taxa sub-group	Number assessed	Number listed	FFG Act	EPBC Act	Key biodiversity features
Elasmobranchii	15	6	2	6	9
(sharks, skates and rays)					
Syngnathiformes (seahorses, pipefishes, and seadragons)	30	30	0	30	0
Teleost	10	6	4	5	4
(bony fish)					
Total	55	42	6	41	13
Data Quality: Deficient = 19 spp., Limited = 45 spp., Moderate = 3 spp., Adequate = 7 spp.					

 Table 7. Summary table showing the number of species assessed for marine fish.

Victorian waters are home to many fish species that play an important role as prey species for marine mammals and birds and support important recreational and commercial fisheries. Fish rely on specific habitat types for shelter, such as reefs or seagrass beds, and food sources in the form of other fish, invertebrates, plankton, or algae. Nursery areas to shelter juveniles such as estuaries, seagrass beds and mangroves are also vital for healthy fish populations.

Three sub-groups of saltwater fishes were included for the assessment: Elasmobranchii or cartilaginous fish including sharks and rays; Syngnathiformes comprised of seahorses, seadragons and pipefish; and Teleosts or bony fish. Important commercial and recreational marine fish species such as King George whiting and black bream have been included where data are available.

Two species of anguillid eels found in Victoria; the longfin eel (*Anguilla reinhardtii*) and short-finned eel (*A. australis*) were identified for inclusion due to their significant cultural values to Traditional

Owners (Koster et al. 2021). However, given the absence of spatial data currently available, these species have not been incorporated into this iteration of the values assessment. Freshwater fish species are also not included in this assessment.

A total of 55 species were included in this assessment, of which 6 are listed under the FFG Act, 41 are listed under the EPBC Act, and 13 key species for Victoria.

3.4.6 Marine habitats

Broad habitats (CBiCS level 2)	Habitat complexes assessed (level 3)	FFG Act			
Littoral rock (ba1)	3	0			
Littoral sediment (ba2)	6	1			
Infralittoral rock (ba3)	3	0			
Circalittoral rock (ba4)	2	0			
Sublittoral sediment (ba5)	9	0			
Total	23	1			
Data Quality: Adequate = 23 habitat complexes					

 Table 8. Summary table showing the number of broad habitats assessed for marine habitats.

Statewide marine habitats were included in the assessment due to their ecological importance and to provide a surrogate for habitat-specific species (Dalleau et al. 2010). Victoria has a wide array of habitat forming species including kelp beds, seagrass, and rhodolite beds, which have been mapped into 24 habitat complexes within Victoria's statewide marine habitat map (Mazor et al. 2023).

These habitat complexes represent communities of species and were mapped according to a hierarchical classification scheme, CBiCS, from level 1-6 (Edmunds et al. 2018a). The assessment included 24 of Victoria's marine and coastal habitats, as mapped to CBiCS level 3, a full list of habitat complexes can be found in Table A2. Species associated with these habitat complexes that meet other inclusion criteria, such as FFG Act listed seagrass species or invertebrates, have been described in relevant species-specific sections. However, all species that make up habitat complexes are not considered separately in the analysis and only as part of the complex. Mangroves are the only habitat complex which comprises of 1 species, the grey mangrove *Avicennia marina subsp. Australasica*, and is listed as Endangered on the FFG Act.

All habitat data layers were assessed as adequate data quality for representing level 3. However, to account for habitat associated species diversity at a regional scale, the distribution map of each habitat complex was subdivided (using ArcGIS Pro 2.8.8 tools) into the 8 <u>National IMCRA</u> <u>bioregions</u> (version 3) and inputted into Zonation, to form a total of 184 layers. The marine bioregions include: Otways, Central Victoria, Port Phillip Bay region, Western Port region, Flinders region, Corner-Nooramunga region, Twofold Shelf and Gippsland Lakes region.

Further mapping of habitats to higher CBiCS levels, for example level 4, will improve representation of biodiversity features within the marine environment, particularly in bays and inlets with higher complexity and habitat mosaics.

3.4.7 Marine invertebrates

Taxa sub-group	Number assessed	Number listed	FFG Act	EPBC Act	Key biodiversity features	
Bivalves	2	0	0	0	2	
Bryozoan	1	0	0	0	1	
Cnidarian	3	0	0	0	3	
Crustaceans	4	2	2	0	2	
Echinodermata	1	0	0	0	1	
Gastropod	2	0	0	0	2	
Porifera	1	0	0	0	1	
Pycnogonida	1	0	0	0	1	
Tunicata	1	0	0	0	1	
Total	16	2	2	0	14	
Data Quality: Deficient - 21 cpp, Limited - 1 cpp, Mederate - 15 cpp						

Table 9. Summary table showing the number of species assessed by for marine invertebrates.

Data Quality: Deficient = 21 spp., Limited = 1 spp., Moderate = 15 spp.

Marine invertebrates are exceptionally diverse, comprising over 92% of marine species globally and have many important functions such as oxygenating the seafloor, breaking down organic material, and providing habitat structure and food sources for other organisms (Chen et al. 2021).

Less species-specific information exists for marine invertebrates compared to other taxa, reflecting the generally poor state of taxonomic, biological, and ecological knowledge regarding this group (Ponder et al. 2002). This is due to limited expertise in Australia, information bias towards accessible intertidal and shallow coastal waters, and limited funding and projects directed at marine invertebrate research (Ponder et al. 2002).

16 species with data available were included in this assessment, 2 of which are listed under the FFG Act, and 14 which represent key species for Victoria. In some cases, where species level information was not available, a higher taxonomic classification level was used to represent a sub-group, for example the phylum Porifera was used to represent all sponge species.

3.4.8 Marine mammals

Taxa Number sub-group assessed		Number listed	FFG Act	EPBC Act					
Cetaceans	26	26	4	26					
Pinnipeds	3	3	2	3					
Total	29	29	6	29					
Data Quality: Deficient = 1 sp., Limited = 26 spp., Moderate = 3 spp.									

Table 10. Summary table showing the number of species assessed for marine mammals.

Victoria's waters are home to many listed and key marine mammals, including the southern right whale, humpback whale, pygmy blue whale, Burrunan dolphin, common dolphin and the Australian fur seal. Some of these species are year-round residents while others, like many of the large whale species, migrate to Victorian waters to breed, raise young and feed on plankton associated with the nutrient-rich waters of the Bonney coast upwelling.

A total of 29 marine mammal species have data available, although mostly of limited quality, and were included in this assessment. The majority of species were cetaceans, represented by whales and dolphins, with 3 pinniped species also included comprising of seals and sealions. All 29 included species are listed under the EPBC Act, and 6 were also listed under the FFG Act. Data quality was assessed as limited for most of these species, this is based on the coarse resolution of data available.

Spatial and temporal information on migration routes, important for understanding potential sources of impact, is notably unavailable for these species and therefore a significant limitation in adequately representing their distribution range. Coastal ranging rodents and other mammals such as Rakali (*Hydromys chrysogaster*) have not been included in this first assessment.

3.4.9 Marine plants

Species common name	Listed	FFG Act	EPBC Act	Key biodiversity features						
Sea water-mat	\checkmark	CE	-	-						
Golden kelp	-	-	-	\checkmark						
Australian grass-wrack	\checkmark	EN	-	-						
Tasman grass-wrack	\checkmark	EN	-	-						
Crayweed	-	-	-	\checkmark						
Total = 5	3	3	0	2						
Data Quality: Deficient = 1 s	Data Quality: Deficient = 1 sp., Moderate = 5 spp.									

 Table 11. Summary table showing the number of species assessed for marine plants.

Marine plants are a vital component of Victoria's marine and coastal environment, providing habitat, food and other ecosystem services like coastal protection and nutrient cycling. For the purposes of this assessment, marine flora has been considered to be all vegetation types that interact with saltwater, either because they are found exclusively in the ocean, or via changing tidal regimes. As a result, only mangroves, saltmarsh and seagrass species have been included in the assessment (see 3.4.6 Marine habitat), other coastal plants were not assessed.

5 plant species have been included, either because they are listed under the FFG Act or EPBC Act, or because they are key habitat forming species. Most of the species had adequate habitat modelling data available except for the FFG Act listed seagrass species *Posidonia australis* and has therefore been excluded from the assessment.

3.4.9 Marine reptiles

Common name	Listed	FFG Act	EPBC Act					
Green sea turtle	\checkmark	-	VU					
Hawksbill sea turtle	\checkmark	-	VU					
Leatherback sea turtle	\checkmark	CE	EN					
Loggerhead sea turtle	\checkmark	-	EN					
Total = 4	4	1	4					
Data Quality: Limited = 4 sp	Data Quality: Limited = 4 spp.							

Table 12. Summary table showing the number of species assessed for marine reptiles.

Sea turtles are the only reptiles included in the assessment. Although they do not nest on Victoria's coastline, a recent study revealed Victoria and South-East Australia as an important foraging area for leatherback sea turtles during October to December (Hays et al. 2023). Sighting data is limited across Victoria, however some satellite tracking data shows evidence of migration paths from nesting beaches in Indonesia to Victoria's eastern waters which provide important foraging water temperatures (Hays et al. 2023).

Coastal dwelling reptiles such as snakes, lizards and skinks have been omitted from this assessment where their range is predominantly outside of the study area. Of the species of sea turtle included, all 4 were listed under the EPBC Act and 1 also listed under the FFG Act.

4. Spatial analysis

Systematic conservation planning tools are critical for ecologically informed spatial planning decisions (Margules and Pressey, 2000). Similar tools have been applied to hundreds of spatial conservation planning problems across the globe, for example the rezoning of the Great Barrer Reef Marine Park (Fernades et al. 2005).

4.1 Zonation

Zonation is a freely available software that is powerful, robust, well-vetted and widely applied globally for spatial planning (Moilanen et al. 2022a; 2022b). Although other decision-support tools exist, Zonation was implemented to align with DEECA's terrestrial biodiversity mapping (<u>NatureKit</u>), and for its core objective of a complementarity-based, balanced ranking of conservation priority over the entire landscape without setting specific targets (Moilanen et al. 2005; Moilanen et al. 2022a).

Other approaches are based on pre-determined targets, for example 20% of a species distribution or maximising biodiversity with a pre-determined budget. In comparison, Zonation does not require defined targets, but rather ranks all cells in the entire landscape/seascape in order of their biodiversity value (Moilanen et al. 2022a). The resulting maps can be used to identify fractions of the landscape that are highest (best biodiversity areas) and lowest.

The computation strategy, or ranking of Zonation, is based on the biodiversity feature richness, normalised by range-size in each grid cell (Moilanen et al. 2009). Biodiversity features with large distributions contribute very little to the conservation value of a single cell, whereas narrowly distributed features greatly increase the conservation value of grid cells that they occupy. Zonation aims to maximise biodiversity with each iteration removing 1 grid cell and recalculating

the conservation value for the remaining grid cells based on the remaining feature distributions (becoming smaller with each iteration). Zonation first removes grid cells with few, broadly distributed features, and during the ranking process these features become rare and rarer in the remaining landscape. The remaining highest priority fraction of the landscape/seascape will therefore contain grid cells with high species richness and high rarity (narrow endemics). New capabilities have been built into Zonation 5 used here, which include a superior meta-algorithm to improve processing time and capabilities (Figure 4; for full methods see Moilanen et al. 2022a).



Figure 4. An illustrative example of Zonation 5 and its ranking process for 6 landscape grid cells or planning units, and 3 biodiversity features. The unconditioned rank is based on weighted range-size rarity, and the conditional evaluation includes marginal losses where cells are removed iteratively until the priority ranking converges (Moilanen et al. 2022a).

4.2 Zonation application

Spatial information on marine and coastal biodiversity features (see section 3.1 for criteria) were processed for analysis with Zonation 5. Given that perfect data will never be available, Zonation provides a method of integrating data and information in various forms and can be adapted and updated as data becomes available (Lehtomäki and Moilanen 2013).

For example, Zonation can integrate a variety of data formats and information such as spatial distribution models and presence-absence information. This is accomplished by normalising input feature layers so that all grid cells of a feature layer across the whole landscape sum to 1 and the value for each cell becomes the fraction of the distribution (Moilanen et al. 2022).

To be compatible with Zonation, all spatial data were pre-processed into a standard raster format using ESRI ArcGIS Pro (2.8.8) with a uniform cell size of 225 m, projection in VicGrid 2020, and extent aligning with the marine and coastal environment (defined by the MACA).

The outputs of Zonation include:

1) Priority rank map which visualises the priority ranking of the landscape. Most valuable sites for biodiversity are ranked high (close to 100) and least valuable sites are ranked low (close

to 0). Prioritising with more than 100 biodiversity features (in raster format), generally means that the areas of the landscape with high rankings are expected to be stable to the addition of small amounts of data. This is because they represent areas favourable to many biodiversity features. The priority map output is described further in section 5.5. Marine Biodiversity Values (MBV) map.

2) Performance curve graph that quantifies the proportion of biodiversity feature (e.g., species distribution) that is covered by protecting top proportions of the landscape. Performance curves are produced for all biodiversity features, but a simplified aggregate interpretation is provided via the mean performance curve (



3) Figure 5).

Figure 5. Zonation performance curve graph representing the increase in coverage of biodiversity as the hypothetical proportion of landscape protected increases. The x-axis gives the proportion of the landscape (marine and coastal area), and the y-axis shows the fraction of the biodiversity feature's distribution covered at that rank. In this analysis, protecting the top 20% of the state's marine and coastal area covers 63% of distribution coverage for the 263 biodiversity features in the analysis. Increasing the level of protection to 30% provides 71% coverage of biodiversity features.

The sensitivity of the priority ranked map output was explored and tested by removing different sets of biodiversity features from the analysis to see how priorities were impacted. As expected, given the analysis incorporates >100 different biodiversity feature layers, changes to the number of features included, for example, excluding 50 features, did not influence the resulting statewide spatial pattern of biodiversity value rankings to any great extent.

Assigning higher weightings to specific biodiversity features or groups also had minimal effect, and as a result no weightings were applied in this analysis. This approach of no or equal weightings also aligns with methodology used for comparable Victorian terrestrial values mapping. Weightings can be easily incorporated and applied in future iterations of the MBV map but should be informed by stakeholder engagement processes. Based on the limited variation in results under sensitivity testing, the MBV map robustly represents areas of high biodiversity across the Victoria's state marine waters using currently available data.

5. Marine Biodiversity Values (MBV) map

The first statewide MBV map was developed based on 263 marine and coastal biodiversity features (Figure 6). The MBV map highlights areas of Victoria's state waters with low to high biodiversity values, ranked from 0-100. A highly ranked value (closest to 100 or yellow on the map) represents an area with high biodiversity, which plays an important role in supporting a wide variety of marine and coastal species and habitats.



Figure 6. Marine Biodiversity Values (MBV) map including 263 marine and coastal biodiversity features.

The associated performance curve (Figure 5) reveals the relationship between proportion of high ranked areas and biodiversity features coverage. For example, by protecting the top ranked 30% of marine and coastal extent, approximately 70% of each biodiversity feature's distribution will be covered. A biodiversity feature richness map (Figure A1) was also outputted by Zonation and highlights the large differences and importance of applying computationally sophisticated systematic conservation planning tools.

High biodiversity value areas (yellow in Figure 6) are areas to protect, conserve or avoid impacting where possible. The highly ranked sites are also those most irreplaceable, as there are few or no locations with these same biodiversity values. Lower biodiversity value areas (purple in Figure 6) may indicate either areas where not enough information has been collected to understand the biodiversity in that location, inland areas that may not be particularly valuable for marine and coastal biodiversity features but are important for terrestrial species, or areas where habitats tend to be more homogonous (e.g., open sandy areas) and hence support fewer species.



Figure 7. Top 20% ranked Marine Biodiversity Values (MBV) map.

Across Victoria's marine and coastal environment, 9 prominent clusters of high biodiversity values (Figure 7) can be observed, these are described below from west to east across the state:

- **Discovery Bay to Warrnambool** exposed open coast areas at the western side of the state. The importance of these areas is likely attributable to the high productivity associated with the Bonney coast upwelling, which attracts the most significant aggregations of blue whales in Australian waters. The area is also an important nursery ground for southern right whales, particularly at Logan's Beach near Warrnambool (Stamation et al. 2022). West of Portland, remnant giant kelp forests and stands (*Macrocystis pyrifera*) have been recorded. These canopy forming structures create complex habitats for a broad diversity of fish and invertebrate species, as well as providing a plethora of ecosystem services. Submerged volcanic structures are characteristic of the area, with unique benthic assemblages from bryozoan reefs, sea-fans, sponges, and soft corals (Edmunds and Flynn 2018b). Another important feature of the region is the <u>Deen Maar Indigenous Protected Area</u> (IPA). Established in 1999, the IPA covers a diverse range of coastal landscapes including Deen Maar Island. The island is of cultural significance to the Traditional Owners and provides habitat for one of the largest breeding colonies of Australian fur seals and many seabird species.
- **Surf Coast** is comprised of wave-dominated beaches and rocky headlands stretching from Apollo Bay to Torquay. Complex reef systems, diverse seaweed assemblages, rhodolith beds and intertidal limestone platforms characterise the region. This unique geomorphology and habitat structure supports a wide variety of marine invertebrates including nudibranchs, brittle stars, feather stars, abalone, bryozoans, crabs, sea stars (Edmunds and Flynn 2018b). The area is a popular tourist destination with the Great Ocean Road and encompasses 3 protected areas: Point Addis Marine National Park, Eagle Rock Marine Sanctuary and Point Danger Marine Sanctuary.
- **Port Phillip Bay Heads and Mud Islands** form the narrow entrance to the sheltered inlet of Port Phillip Bay. This unique physiographic setting is dominated by a tide-swept and submerged canyon system, responsible for driving cooler waters into the bay and is home to an FFG Act threatened listed community renowned for vast and endemic sponge gardens (Edmunds and Flynn, 2018b). The heads and associated <u>Port Phillip Bay Heads Marine National Park</u> provide a plethora of habitats suitable for a diverse range of marine life. This region also includes the extensive Great Sands flood-tide delta system and protruding <u>Mud Islands</u>. The sand bar environment is extremely changeable, driven by highly mobile sediments, tidal inundation, and storms. The area has recognised international significance as a Ramsar site, consisting of dense seagrass beds, mud flats, saltmarsh and dune shrubland, providing suitable habitat for shorebirds and coastal dwelling birds.
- **Port Phillip Bay Western Shoreline** spans from Werribee to Point Wilson on the fringe of Corio Bay. The area comprises both natural and artificial coastal habitats encompassing the Western Treatment Plants 10,500 ha of lagoons and irrigated paddocks. This coast and shoreline provide critical habitat for thousands of migratory birds and is also recognised as a Ramsar site (Loyn et al, 2014). The marine environment is dominated by fine grained sands and muds playing an important role in dentification processes, as well as epibiota-rich sediments, and seagrass beds.
- **Western Port** includes the Rhyll Segment of East Arm and Phillip Island. The sheltered embayment is influenced by strong tides creating dendritic channels and banks. The marine habitats present in this region are highly diverse including rocky reefs, rich epibiotic sediments, seagrass beds, biogenic reefs, saltmarsh and mangroves (Edmunds and Flynn, 2018b). This area provides habitat for numerous iconic biodiversity features such as the little penguin and Australian fur seal, as well as providing important fishery habitats, seagrass beds and diverse wetlands for a rich birdlife (Keough et al. 2011). 2 FFG Act listed communities are also found in this region, 3 Marine National Parks and Western Port is recognised as an The United Nations

Educational, Scientific and Cultural Organization (UNESCO) Biosphere Reserve and a Ramsar site.

- Wilsons Promontory forms the southernmost part of the Australian mainland and is home to one of the richest and most pristine marine ecosystems in Australia. This area supports persistent kelp beds, sponge gardens, a variety of biota including reef fish, migratory whales, and bird colonies (Edmunds and Flynn, 2018b). The area to the east is a key habitat for White Shark populations, acting as a nursery site. This priority area aligns with the <u>Wilsons Promontory</u> <u>Marine National Park.</u>
- **Corner Inlet and Nooramunga** a sheltered embayment comprising of channels, barrier islands and sand flats, just east of Wilson's prom including Port Welshpool and Port Albert. The area is renowned for an extremely productive fishery, with catches from King George whiting, flathead, flounder, garfish, gummy shark and calamari (VFA, 2020). Unique broadleaf Posidonia seagrass forests and Zostera seagrasses dominate the marine environment, alongside epibiota rich sediments and fringing coastal saltmarsh and mangroves (Edmunds and Flynn, 2018b). The area is also a Ramsar site providing wetland habitat and foraging areas for many migratory shorebirds.
- **Gippsland Lakes** around Lakes Entrance consists of a system of sheltered embayment's, channels and islands. Listed as a Ramsar wetland, ecological values include extensive seagrass beds, saltmarsh vegetation, and habitats for waterbirds and abundant fish. The area is also one of the only known habitats for the FFG Act listed Burrunan dolphin outside of Port Phillip Bay (EGCMA 2021).
- **Croajingolong coast, Gabo Island and Cape Howe** on the far-eastern edge of Victoria bordering New South Wales. The area is characterised by wave dominated beach, dune systems, lowprofile rocky shores, and unique assemblages of kelp and epibiota beds (Edmunds and Flynn, 2018b). The location has a high diversity of marine species due to mixing of warm eastern currents and cool southern waters (Whitmarsh et al. 2023) and is a hotspot for many fish species including sharks and rays. This area aligns with <u>Cape Howe Marine National Park</u>.

The high biodiversity value areas mentioned above are not exhaustive, and further quantitative analysis and exploring the map by region will likely reveal other key areas for biodiversity. The next sections of this report fucus on outlining the limitations of the MBV output, the overall need for better data (including higher resolution and more detailed mapping for biodiversity features), priority biodiversity features for data improvement, intended applications of the MBV map, priority actions to improve the MBV iterative mapping output, and future direction.

6. Limitations and data needs

The MBV map provides a first assessment and has been built with foundational data from publicly available data holdings. This enabled a first-of-its kind data inventory and stocktake for marine and coastal biodiversity features occurring in Victorian waters. However, given the overall paucity of data in the marine environment, there are several limitations that should be considered when interpreting the map:

- Biodiversity features included in the analysis are limited by the inclusion criteria and do not represent the full biodiversity in Victoria's marine and coastal environment, estimated to support more than 12,000 plant and animal species (DELWP 2020). Any applications of this map should consider implications of the many biodiversity features that are not included and the resulting limitations of the map. A thorough assessment of the inclusion criteria, particularly defining key biodiversity features, is needed to progress this work into the future.
- The map is static and currently relevant for December 2023, changes to species listings under the FFG Act or EPBC Act since this time will not be captured. Therefore, further

application of the MBV map should note possible changes and the time context it is relevant for. Such information will be incorporated in future iterations of the map as well as new biodiversity feature data that may come available after this time. Similarly, priority biodiversity features for data improvements (section 6.1) are likely to change over time and will be also updated in future work.

- Culturally significant species for Traditional Owners of Sea Country are an essential consideration for biodiversity values mapping. Although some culturally significant species are captured within the biodiversity features considered in this assessment, this should not be considered sufficient for culturally significant species. Future work should engage with Traditional Owners to develop similar products for culturally significant species employing the principles of self-determination and Indigenous Data Sovereignty (Victorian Aboriginal Heritage Council 2021).
- Only 85% of biodiversity features identified through our marine and coastal assessment criteria were incorporated in the resulting map, as 48 biodiversity features had no data available to enable their inclusion.
- Over half (60%) of the biodiversity features included in the MBV analysis and map have been assessed as having limited to deficient data quality. Many data sources included only a presence-only, or presence-absence type information, or were mapped at a coarse resolution. Additionally, given the scarcity of available marine species and habitat distribution data, in some cases data from historic or older sources were incorporated into the analysis, such as seagrass mapping undertaking in 2000 by Blake and Ball (2001). Hence, contemporary knowledge of distributions are required. More effort is needed to map important marine and coastal species and habitat distributions to a higher data quality standard.
- Areas with the most species information are likely within close proximity to high population centres (e.g. Melbourne and Geelong) and so are easily accessible, compared with remote places along Victoria's coastline and offshore waters where species survey information and consistent monitoring programs are scarce. Such remote areas may have higher biodiversity values than what is represented in the MBV map, with a low value reflecting a lack of data.
- Terrestrial coastal areas are represented as dark purple areas with lower biodiversity, reflecting the analysis scope of specifically marine and coastal biodiversity features. These terrestrial areas are likely outside of many marine and coastal species distribution ranges. Future work towards coupling this map with NatureKit's terrestrial biodiversity values map will provide a more reliable indication of onshore biodiversity values.
- Other limitations of the map include the absence of species connectivity, migration routes, movement pathways, and consideration of temporal range-shift patterns. Movement of marine and coastal species across different ecosystems is vital for supporting a range of key life functions, facilitating genetic diversity, ecological processes, and overall population viability (Beger et al. 2022). Understanding and including movements are even more crucial for critically endangered migratory species such as the orange bellied parrot and southern right whale. The persistence of such species relies on the ability to move between breeding sites, nursery areas, overwintering and foraging areas, across vast distances >1000 km. Incorporating this information will be critical in ensuring important ecological pathways and corridors are recognised for their biodiversity value and can be appropriately protected (Beger et al. 2022).
- Species distributions are dynamic and with climate change impacts range shifts are predicted for many species (Poloczanska et al. 2013; McHenry et al. 2019). These potential spatial changes are not well known and have therefore been excluded in this initial analysis but could be incorporated into this approach with future research, knowledge and available data.

6.1 Priority biodiversity features for data improvement

To determine biodiversity features with the highest priority for further data collection, the data quality assessment and inclusion criteria were combined to select biodiversity features that are:

- Species or communities listed as Critically Endangered or Endangered under the FFG Act and/or EPBC Act, and
- Data quality score of 0, 1 or 2 representing deficient, limited, or moderate data, or
- A migratory species where spatial information on movement patterns and migratory pathways is absent.

A total of **55 priority biodiversity features for data improvement** were identified under this criterion (Table 11), where improved spatial distribution mapping and data collection will greatly increase the utility of any biodiversity values assessment for Victoria or regionally. This list highlights the paucity of appropriate data for understanding the spatial location of marine and coastal biodiversity values.

The 55 priority biodiversity features for data improvement are distributed across all the taxa groups (Figure 7), with the highest number of biodiversity features within the birds and marine invertebrate groups. Species include albatrosses, the grey nurse shark, Burrunan dolphin, the southern right whale, far eastern curlew, sea cucumber and sea slug species, the swift and orange bellied parrots, and the leatherback sea turtle. Additionally, 4 EPBC listed communities were identified including the giant kelp (macrocystis) marine forests of Southeast Australia.

Importantly, this list of priority biodiversity features is based on information available at the time of analysis (December 2023). Future revisions to this priority list are required as new data becomes available, species and community listings change, and the biodiversity feature inclusion criteria is further developed with stakeholders and other sources of ecological knowledge.



Figure 7. Graph showing the spread of 55 priority biodiversity features for data improvement across taxa groups

Table 13. 55 priority biodiversity features for data improvement. These biodiversity features include 25 CriticallyEndangered and 21 Endangered FFG Act listed species, and 9 listed only on the EPBC Act. FFG and EPBC Act threatened

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status is represented by CE (Critically Endangered), EN (Endangered), and M = EPBC Act <u>listed marine species</u>, C = EPBC Act listed cetacean species, MI = EPBC Act listed <u>migratory species</u>.

Taxon group	Common name	Scientific name	FFG Act	EPBC Act
Divela	Curlew sandpiper	Calidris ferruginea	CE	CE, M, MI
Birds	Great knot	Calidris tenuirostris	CE	CE, M, MI
	Amsterdam albatross	Diomedea amsterdamensis		EN, M, MI
	Southern royal albatross	Diomedea epomophora	CE	VU, M, MI
	Wandering albatross	Diomedea exulans	CE	VU, M, MI
	Northern royal albatross	Diomedea sanfordi		EN, M, MI
	Swift parrot	Lathamus discolor	CE	CE, M
	Black-tailed godwit	Limosa limosa	CE	M, MI
	Southern giant petrel	Macronectes giganteus	EN	EN, M, MI
	Northern giant petrel	Macronectes halli	EN	VU, M, MI
	Orange bellied parrot	Neophema chrysogaster	CE	CE, M
	Eastern curlew	Numenius madagascariensis	CE	CE, M, MI
	White faced storm petrel	Pelagodroma marina	EN	М
	Sooty albatross	Phoebetria fusca	CE	VU, M, MI
	Light-mantled sooty albatross	Phoebetria palpebrata	CE	M, MI
	Australian Gould's petrel	Pterodroma leucoptera leucoptera		EN
	Fairy tern	Sternula nereis	CE	М
	Buller's albatross	Thalassarche bulleri	EN	VU, M, MI
	Indian yellow-nosed albatross	Thalassarche carteri		EN
	Shy albatross	Thalassarche cauta	EN	EN, M, MI
	Grey-headed albatross	Thalassarche chrysostoma	EN	EN, M, MI
	Chatham albatross	Thalassarche eremita		EN, M, MI
	Wood sandpiper	Tringa glareola	EN	M, MI
Coastal bats	Common bent winged bat	Miniopterus orianae	CE	
Listed communities	River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria	ΝΑ		CE
	Littoral Rainforest and Coastal Vine Thickets of East Australia	NA		CE
	The assemblages of species associated with open-coast salt- wedge estuaries of western and central Victoria ecological community	ΝΑ		EN
	Giant Kelp Marine Forests of Southeast Australia	NA		EN
Marino fish	Grey nurse shark	Carcharias taurus	CE	CE
Marine lish	White shark (great)	Carcharodon carcharias	EN	VU, MI
	Empire gudgeon	Hypseleotris compressa	CE	
	Australian whitebait	Lovettia sealii	CE	
	Flatback mangrovegoby	Mugilogobius platynotus	EN	
	Brittle star	Amphiura triscacantha	EN	
Marine invertebrates	Sea cucumber (5251)	Apsolidium densum	EN	
	Sea cucumber	Apsolidium falconerae	CE	

	Sea cucumber (5052)	Apsolidium handrecki	EN	
	Southern hooded shrimp	Athanopis australis	EN	
	Brackish jellyfish	Australomedusa baylii	EN	
	Port Phillip chiton (5254)	Bassethullia glypta	CE	
	Brittle star species	Clarkcoma australis	CE	
	Ghost shrimp (Michelea species 5256)	Michelea microphylla	CE	
	Sea slug	Platydoris galbana	EN	
	Ghost shrimp	Pseudocalliax tooradin	EN	
	Stalked hydroid	Ralpharia coccinea	CE	
	Sea slug	Rhodope rousei	CE	
	Sea cucumber species	Rowedota shepherdi	CE	
	Blue whale	Balaenoptera musculus	EN	EN, C, MI
	Southern right whale	Eubalaena australis	EN	EN, C, MI
Marine mammals	Humpback whale	Megaptera novaeangliae	CE	C, MI
	Australian sea lion	Neophoca cinerea	EN	EN, M
	Burrunan dolphin	Tursiops australis	CE	С
Marine plants	Fibre-ball weed	Posidonia australis	EN	
Marina rantilas	Loggerhead sea turtle	Caretta caretta		EN, M, MI
Murine repules	Leatherback sea turtle	Dermochelys coriacea	CE	EN, M, MI

7. Application and future advancements

7.1 MBV applications

The primary purpose of the MBV map is to provide information on marine and coastal biodiversity to support spatial planning and decision-making. Possible uses of the map include:

- Offshore development planning and approvals (site planning, environmental impact assessments).
- Marine Spatial Planning (MSP).
- Land-sea planning (e.g. regional planning).
- Protection and conservation planning (areas of highest biodiversity values).
- Scientific research and ecological monitoring (e.g. identify biodiversity features within a study area).
- Biodiversity offsets.
- Threatened species management.
- Restoration opportunities.

This work also supports the initial stages of MSP to define and analyse existing conditions and mapping important biological and ecological areas (DEECA 2023). It additionally compiles key information under the <u>Marine and Coastal Knowledge Framework (MACKF)</u> essential for undertaking a future cumulative risk assessment.

7.2 Priority actions for MBV improvement

Key actions or considerations for future work to build upon the current first iteration map and improve confidence in the assessment and MBV map output include:

- ✓ Marine and coastal stakeholder engagement and data elicitation, including a comprehensive assessment to define the biodiversity feature inclusion criteria.
- ✓ Apply self-determination and data sovereignty principles to work with Traditional Owners towards similar products or other approaches to support increased understanding and consideration of culturally significant species.
- ✓ Spatial data collection and processing for 55 priority marine and coastal biodiversity features requiring data improvement (for priority list see Section 6.1).
- ✓ Migration route mapping for migratory species and incorporation via connectivity in Zonation.
- ✓ Movements and pathway mapping including ecological functions and seasonal requirements.
- ✓ Expand Species Distribution Modelling (SDMs) covering the defined study region (best practice data quality of 4; Table 1) where data exist but modelling is yet to be undertaken.
- ✓ Higher resolution mapping at 75 m² grid cells to align with new DEECA terrestrial biodiversity values maps.

7.3 Future direction

The first map will be developed into a search tool on Victoria's marine knowledge platform <u>CoastKit</u> so that users can spatially interact with the biodiversity features information underpinning the MBV map. The search tool will synthesise underlying individual raster layers for each species, to extract a list of all species present within a user-defined area on CoastKit (Figure 8).

The search tool will be further incorporated into DEECA's <u>Features Activities Sensitivity Tool</u> (FeAST) to detail important biodiversity features that may be impacted by potential developments. This application can support all potential applications listed above by determining a first pass assessment of species in a spatial area, outlining their threatened status, and supporting environmental assessments.

h Merricks Mer Hinders Id Area Clear Area ct Grid:	Bainarring Baanarring Beach nicks Beach	Sor	HMAS Eerberus			
25						
ct Raster Function:						
arine Species Presence						
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Itically Endangered						
ibmit						
Species common name	Species scientific name	Taxon ID	FFG Description	Raster Type	Taxon Type	Taxon Level
Little Tern	Sternula albifrons	10117	Critically Endangered	PA	Waders	Species
Great Knot	Calidris tenuirostris	10165	Critically Endangered	HDM	Waders	Species
Curlew Sandpiper	Calidris ferruginea	10161	Critically Endangered	HDM	Waders	Species
Australasian Bittern	Botaurus poiciloptilus	10197	Critically Endangered	HDM	Other Non- passerine birds	Species
Plumed Egret	Ardea intermedia plumifera	10186	Critically Endangered	HDM	Other Non- passerine birds	Species
Sooty Albatross	Phoebetria fusca	10092	Critically Endangered	PA	Marine birds	Species

Figure 8. Screenshot from the example prototype of the MBV search tool in-action, showing the user-defined polygon on the map and the generated species list below, denoting common and scientific names, FFG Act list status and data type.

DEECA is committed to a continuous improvement approach, which enables products, map services and tools to be updated and refined as further data, computational power, research, and modelling methods become available. All biodiversity values mapping products have a version number and year to help identify the currency of each product. Everyone can contribute to the improvement of biodiversity mapping products. Species records can be submitted to the Victorian Biodiversity Atlas (VBA), a key data source for the MBV, or by providing data directly by contacting DEECA's Marine Knowledge Team.

This work accomplishes the first statewide synthesis of marine and coastal distribution data into a systematically driven MBV map. While considerable work is required to improve the information and address priority data needs, the map delivers quantitative data-driven results that are robust and transparent. This report outlines current standards for best practice data and analysis to inform decision making that supports protection of our marine and coastal biodiversity and helps achieve DEECA's <u>Biodiversity 2037</u> vision that Victoria's biodiversity is healthy, valued and actively cared for.

8. References

Barwon Coast (2023) *This is Wadawurrung Country*, Barwon Coast Committee of Management Inc, Barwon Heads, Victoria, available: <u>https://www.barwoncoast.com.au/aboriginal-heritage/</u>, accessed 20 December 2023.

Bell JD, Ingram BA, Gorfine HK and Conron SD (2022) <u>*Review of key Victorian fish stocks — 2021,*</u> Victorian Fisheries Authority Science Report Series No. 29, March 2022

Beger M, Metaxas A, Balbar AC, McGowan JA, Daigle R, Kuempel CD, Treml EA and Possingham HP (2022) Demystifying ecological connectivity for actionable spatial conservation planning. *Trends in Ecology & Evolution* 37: 1079-1091.

Blake S and Ball D (2001) Victorian Marine Habitat Database: Seagras Mapping of Port Phillip Bay. Geospatial Systems Section, Marine and Freshwater Resources Institute Report No. 39. Marine and Freshwater Resources Institute: Queenscliff.

Boon PI, Allen T, Brook J, Carr G, Frood D, Hoye J, Harty C, McMahon A, Mathews S, Rosengren N, Sinclair S (2011) Mangroves and coastal saltmarsh of Victoria: distribution, condition, threats and management. Report to DSE, Bendigo. 513 pp.

- BirdLife (2023) Migratory shorebirds, Australia, available via: <u>https://birdlife.org.au/programs/migratory-shorebirds/</u> accessed 20 December 2023.
- Blue Whale Study (2024) The Bonney Upwelling. Available via: <u>https://bluewhalestudy.org/the-bonney-upwelling/</u> accessed 19 February 2024.
- Chen EYS (2021) <u>Often overlooked: Understanding and meeting the current challenges of marine</u> <u>invertebrate conservation</u>, *Frontiers in Marine Science*, 8.
- Cawthen L (2013) White-striped freetail bat in Tasmania-resident, vagrant or climate change migrant? *Australian Mammalogy*. 35:251-254.
- Dalleau M, Andrefouet S, Wabnitz CC, Payri C, Wantiez L, Pichon M, Friedman KIM, Vigliola L and Benzoni F (2010) Use of habitats as surrogates of biodiversity for efficient coral reef conservation planning in Pacific Ocean islands. *Conservation Biology*, 24:541-552.
- DELWP (2020) National Recovery Plan for the Southern Bent-wing Bat *Miniopterus orianae bassanii*. Department of Environment, Land, Water and Planning, Victorian Government, Melbourne, available: <u>https://www.agriculture.gov.au/sites/default/files/documents/recovery-plan-southern-</u>

https://www.agriculture.gov.au/sites/default/files/documents/recovery-plan-southernbent-wing-bat.pdf

- DELWP (2020) Marine and coastal policy, Department of Environment, Land Water and Planning Victoria. <u>https://www.marineandcoasts.vic.gov</u>. au/__data/assets/pdf_file/0027/456534/Marine-and-Coastal-Policy_Full.pdf
- DEECA (2022) Discovering the secrets of Victoria's small bats. Available via: <u>https://www.ari.vic.gov.au/research/field-techniques-and-monitoring/discovering-the-</u> <u>secrets-of-victorias-small-bats</u> Available via: <u>https://www.ari.vic.gov.au/research/field-</u> <u>techniques-and-monitoring/discovering-the-secrets-of-victorias-small-bats</u>, accessed 20 December 2023
- DEECA (2023) Marine Spatial Planning Guidelines. The State of Victoria Department of Energy, Environment and Climate Action. Available: https://www.marineandcoasts.vic.gov.au/marine/marine-spatial-planning
- DCCEEW (2022) <u>About threatened ecological communities</u> Department of Climate Change, Energy, the Environment and Water, accessed 4 November 2023.

- DCCEEW (2023) Guidance Key environmental factors for offshore windfarm environmental impact assessment under the Environment Protection and Biodiversity Conservation Act 1999, Department of Climate Change, Energy, the Environment and Water, Canberra, July. CC BY 4.0.
- DCCEEW (2024) <u>Key ecological features</u>. Department of Climate Change, Energy, the Environment and Water, accessed 9th February 2024.
- Di Minin E, Veach V, Lehtomäki J, Montesino Pouzols F and Moilanen A (2014) A quick introduction to Zonation. Helsingin yliopisto, Helsinki.
- Early R. and Thomas CD (2007) Multispecies conservation planning: identifying landscapes for the conservation of viable populations using local and continental species priorities. *Journal of Applied Ecology*, 44: 253-262.
- Edmunds, M. and Flynn, A. (2015) A Victorian Marine Biotope Classification Scheme. Australian Marine Ecology Report No. 545. Melbourne.
- Edmunds, M. and Flynn, A. (2018a) CBiCS Classification of Victorian Biotopes. Report to Department of Environment, Land, Water and Planning. Australian Marine Ecology Report No. 560, Melbourne. 176 pp.
- Edmunds M and Flynn A (2018b)*Victorian Marine Biogeographical Settings*. Report to Department of Environment, Land, Water and Planning. Australian Marine Ecology Report No. 559, Melbourne.
- Edmunds M, Flynn A and Ferns L (2021) Combined Biotope Classification Scheme (CBiCS). A New Marine Ecological Classification Scheme to Meet New Challenges. The State of Victoria Department of Environment, Land, Water and Planning 2021.
- EGCMA (2021) *Gippsland Lakes Environment Report 2021: Report Card*, East Gippsland Catchment Management Authority, Bairnsdale.
- Fernandes L, Day J, Lewis A, Slegers S, Kerrigan B, Breen DAN, Cameron D, Jago B, Hall J, Lowe D and Innes J (2005) Establishing representative no-take areas in the Great Barrier Reef: large-scale implementation of theory on marine protected areas, *Conservation biology*, 19(6):1733-1744.
- Gill PC, Morrice MG, Page B, Pirzl R, Levings AH and Coyne M (2011) Blue whale habitat selection and within-season distribution in a regional upwelling system off southern Australia. *Mar Ecol Prog Ser Vol.* 421: 243–263.
- Graf LG (2023) Current and future distributions, abundance, and habitat associations of temperate sharks and rays across Victoria, Australia [Honours thesis, Deakin University].
- Hays GC, Morrice M and Tromp JJ (2023) <u>A review of the importance of south-east Australian</u> waters as a global hotspot for leatherback turtle foraging and entanglement threat in fisheries, Marine Biology 170(74).
- lerodiaconou D, Laurenson L, Burq S and Reston M (2007) Marine benthic habitat mapping using multibeam data, georeferenced video and image classification techniques in Victoria, Australia. *Journal of Spatial Science* 52: 93-104.
- Ierodiaconou D, Schimel ACG, Kennedy D, Monk J, Gaylard G, Young M, Diesing M and Rattray A (2018b) Combining pixel and object-based image analysis of ultra-high resolution multibeam bathymetry and backscatter for habitat mapping in shallow marine waters. *Marine Geophysical Research* 39, 271-288. https://doi.org/10.1007/s11001-017-9338- z
- IPBES (2004) Intergovernmental Science-Policy Platform On Biodiversity and Ecosystem Services-<u>Cultural Keystone Species.</u> Accessed on 21 December 2023

- Keough MJ et al. (2011) Understanding the Western Port Environment: a summary of current knowledge and priorities for future research. A report for Melbourne Water, Department of Sustainability and Environment and the Port Phillip and Western port CMA. Melbourne Water Corporation.
- Lehtomäki J and Moilanen A (2013) Methods and workflow for spatial conservation prioritization u sing Zonation, *Environmental Modelling & Software*, 47:128-137.
- Loyn RH, Rogers DI, Swindley RJ, Stamation K, Macak P and Menkhorst P (2014) *Waterbird monitoring at the Western Treatment Plant 2000-12*, ARI Technical Report Series No. 256. Department of Environment and Primary Industries, Heidelberg, Victoria
- Lumsden LF, Moloney P and Smales I (2019) *Developing a science-based approach to defining key* species of birds and bats of concern for wind farm developments in Victoria. Arthur Rylah Institute for Environmental Research Technical Report Series No. 301. Department of Environment, Land, Water and Planning, Heidelberg, Victoria.
- McHenry J, Welch H, Lester SE and Saba, V (2019) Projecting marine species range shifts from only temperature can mask climate vulnerability. *Global Change Biology*, 25:4208-4221.
- Marine and Coastal Hub, National Environment Science Program (2024) <u>Project 3.21: Identifying</u> <u>priority datasets for the Gippsland declaration area and pathways for their use in</u> <u>decision-making</u>. Accessed on 28th February 2024.
- Margules CR and Pressey RL, (2000) Systematic conservation planning. *Nature*, 405(6783):243-253.
- Mazor T, Watermeyer K, Hobley T, Grinter V, Holden R, MacDonald K and Ferns L (2023) Statewide Marine Habitat Map. Habitat Complex Modelling Method (CBiCS Level 3). The State of Victoria Department of Energy, Environment and Climate Action.
- Moilanen A, Lehtinen P, Kohonen I, Virtanen E, Jalkanen J and Kujala H (2022) Novel methods for spatial prioritization with applications in conservation, land use planning and ecological impact avoidance, *Methods in Ecology and Evolution*, 13:1062-1072.
- Moilanen A, Kohonen I, Lehtinen P, Jalkanen J, Virtanen E, Kujala H (2022) Zonation 5 v1.0 user manual User Version 1 April 2022.
- Moilanen A, Kujala H and Leathwick JR (2009) The Zonation framework and software for conservation prioritization. In Moilanen A, Wilson KA and Possingham HP (Eds.), *Spatial conservation prioritisation: Quantitative methods and computational tools*. Oxford: Oxford University Press.196–210.
- Moloney PD, Lumsden LF and Smales I (2019) *Investigation of existing post-construction mortality monitoring at Victorian wind farms to assess its utility in estimating mortality rates. Arthur Rylah Institute for Environmental Research Technical Report Series No. 302.* Department of Environment, Land, Water and Planning, Heidelberg, Victoria.
- Poloczanska ES, Brown CJ, Sydeman WJ, Kiessling W, Schoeman DS, Moore PJ, Brander K, Bruno JF, Buckley LB, Burrows MT and Duarte CM (2013) Global imprint of climate change on marine life. *Nature Climate Change*, *3*: 919-925.
- Ponder W, Hutchings P and Chapman R, (2002) <u>Overview of the conservation of Australian marine</u> <u>invertebrates.</u> *Report for Environment Australia, Australian Museum, Sydney.*
- Ramsar (2023) Ramsar the Convention on Wetlands, Convention on Wetlands Secretariat 2023, Available: <u>https://www.ramsar.org/</u>
- Reid K, Baker GB and Woehler E (2022) *Impacts on birds from Offshore Wind Farms in Australia*, Department of Climate Change, Energy, the Environment and Water, Canberra, CC BY 4.0.

- Schmiing M, Diogo H, Serrão Santos R and Afonso P (2015) Marine conservation of multispecies and multi-use areas with various conservation objectives and targets. *ICES Journal of Marine Science*, 72: 851-862.
- SoE DCCEEW (2021) State of the Environment, Australia Report. <u>Keystone Species</u>. Accessed on 21 December 2023.
- Stamation K and Watson M (2022) Supporting the recovery of the Southern Right Whale in eastern Australia: recommendations for threat mitigation, research and stakeholder engagement. Arthur Rylah Institute for Environmental Research Technical Report Series no. 362. Department of Energy, Environment and Climate Action, Heidelberg, Victoria.
- SWIFFT (2023) Southern Bent-wing Bat National Recovery Team, available via: <u>https://www.swifft.net.au/cb_pages/team_southern_bent-wing_bat_-_recovery_team.php</u> accessed on 20 December 2023.
- Thomson J, Regan TJ, Hollings T, Amos N, Geary WL, Parkes D, Hauser CE and White M (2020) Spatial conservation action planning in heterogeneous landscapes. *Biological Conservation*, 250; 108735.
- Victorian Fishery Authority (VFA) (2020) <u>World class fisheries management at Corner Inlet</u>. Accessed on 22nd February 2024.
- Victorian Environmental Assessment Council (VEAC) (2019) <u>Assessment of the Values of</u> <u>Victoria's Marine Environment</u> – 10 OFFICIAL Report. Victorian Environmental Assessment Council, Melbourne.
- Victorian Aboriginal Heritage Council (2021) <u>Taking Care of Culture Discussion Paper</u>. State of Victoria's Aboriginal Cultural Heritage Report.
- White M, Menkhorst P, Griffioen Green B, Salkin O and Pritchard R (2016) Orange-bellied Parrot: A retrospective analysis of winter habitat availability, 1985-2015. Arthur Rylah Institute for Environmental Research Technical Report Series Number 277. Department of Environment, Land, Water and Planning, Heidelberg, Victoria.
- Whitmarsh SK, Porskamp P, Tinkler P, Gray S, Howe S, Ierodiaconou D, Sams MA and Young MA (2023) *An integrated monitoring program for Cape Howe Marine National Park*, Parks Victoria Technical Series no. 119, Parks Victoria, Melbourne.
- Young M, Porskamp P, Murfitt S, Wines S, Tinkler P, Bursic, J, Allan B, Howe S, Whitmarsh S, Pocklington J and Ierodiaconou D (2022) <u>Baseline habitat mapping and enhanced</u> <u>monitoring trials of subtidal and intertidal reef habitats in Victoria's marine national parks</u> <u>and sanctuaries</u>. Parks Victoria Technical Series 116.
- Young MA, Treml, EA Beher J, Fredle M, Gorfine H, Miller AD, Swearer SE and Ierodiaconou D (2020) Using species distribution models to assess the long-term impacts of changing oceanographic conditions on abalone density in southeast Australia, *Ecography*, 43:1052-1064.
- Young MA, Porskamp P, Critchell K, Treml E, Ierodiaconou D, Pocklington JB, Sams MA (2022) Statewide assessment of Victorian marine protected areas using existing data. Parks Victoria Technical Series 118, Parks Victoria, Melbourne.
- Young MA, Critchell K, Miller AD, Treml EA, Sams M, Carvalho R and Ierodiaconou D (2023) Mapping the impacts of multiple stressors on the decline in kelps along the coast of Victoria, Australia. *Diversity and Distributions*, 29:199–220.
- Zavalas RD, Ierodiaconou D, Ryan A, Rattray A and Monk J (2014) Habitat Classification of Temperate Marine Macroalgal Communities Using Bathymetric LiDAR. *Remote Sensing* 6: 2154- 2175.

Appendix

Table A1. Data sources used for synthesising species data and information for the MBV assessment.

Data source	Original data format	GIS post-processing applied	Data accuracy	Approx. data quality
Biological important areas (BIAs)	Polygonised areas	Clipped and rasterised	1km grids	Limited (1)
BirdLife Australia	Observation points	Kernal density and rasterised	1m	Moderate (2)
CoastKit	Habitat distribution models	Clipped to each bioregion	25m, R ² 89%	Adequate (3)
	Sites, point data	1km buffer and rasterised	1km	Moderate (2)
	Polygonised area	Clipped and rasterised	1km	Limited (1)
Scientific publications	Habitat distribution models	None	225m	Adequate (3)
NatureKit	Species distribution models	None	225m	Adequate (3)
	Species distribution models that do not include species full range	None	225m	Limited (1)
Species of National Environmental Significance (SNES)	Polygonised areas	Clipped and rasterised	1km grids	Limited (1)
Victorian Biodiversity Atlas (VBA)	Observation points	Kernal density and rasterised	1m	Moderate (2)

Table A2. This is a list of 311 marine and coastal biodiversity features, identified in this assessment as a listed or key biodiversity features within state waters and MACA boundary. Data sources for 263 biodiversity features were identified and incorporated into the first iteration marine values map. The table details the: Victorian Biodiversity Atlas (VBA) Taxa ID, Taxon group and Subgroup, Common name and Scientific name, FFG Act status (CE = Critically Endangered, EN = Endangered, VU = Vulnerable, CD= Conservation Dependent), EPBC Act status (CE = Critically Endangered, EN = Endangered, EN = Endangered, VU = Vulnerable, M = Marine, MI = Migratory, C = Cetacean, CD = Conservation Dependent), inclusion in analysis (</ >

No.	Taxa ID	Taxon group	Subgroup	Common name	Scientific name	FFG Act	EPBC Act	Listed biodiversity feature	Habitat biodiversity feature	Key biodiversity feature	Data Qualit Y	Data Sources
1	4918	Marine fish	Teleost	Black bream	Acanthopagrus butcheri					✓	1	CoastKit
2	10157	Birds	Shorebirds	Common sandpiper	Actitis hypoleucos	VU	M, MI	\checkmark			3	SNES, NatureKit
3	525087	Marine fish	Elasmobranchii	Common thresher	Alopias vulpinus					\checkmark	1	CoastKit
4	50384 5	Marine plants		Sea water-mat	Althenia marina	CE		\checkmark			3	NatureKit
5	10122	Birds	Seabirds	Brow noddy	Anous stolidus		M, MI	✓			1	SNES
6	10199	Birds	Waterbirds	Magpie goose	Anseranas semipalmata	VU	М	\checkmark			3	NatureKit
7	10335	Birds	Land birds	Fork-tailed swift	Apus pacificus		M, MI	\checkmark			1	SNES
8	11543	Marine mammals	Pinniped	New Zealand fur seal/ Longnosed fur seal	Arctocephalus forsteri	VU	М	~			1	CoastKit
9	11542	Marine mammals	Pinniped	Australian fur seal	Arctocephalus pussillus		М	\checkmark			2	CoastKit, SNES
10	10977	Birds	Waterbirds	Cattle egret	Ardea ibis		М	\checkmark			1	SNES
11	10186	Birds	Waterbirds	Intermediate egret (plumed Egret)	Ardea intermedia	CE	М	\checkmark			3	NatureKit
12	10072	Birds	Seabirds	Flesh-footed shearwater	Ardenna carneipes		M, MI	\checkmark			1	SNES
13	10070	Birds	Seabirds	Sooty shearwater	Ardenna grisea		M, MI	\checkmark			1	NatureKit
14	10069	Birds	Seabirds	Wedge tailed shearwater	Ardenna pacifica		M, MI	\checkmark			1	BIA
15	10071	Birds	Seabirds	Short-tailed shearwater	Ardenna tenuirostris		M, MI	~			2	CoastKit, BIA
16	10129	Birds	Shorebirds	Ruddy turnstone	Arenaria interpres	EN	M, MI	~			3	CoastKit, NatureKit
17	NA	Marine invertebrates	Tunicata	Sea squirts	Ascidian sites (various sp.)					\checkmark	2	CoastKit

18	15253	Marine invertebrates	Crustaceans	Southern hooded shrimp	Athanopis australis	EN		\checkmark		2	CoastKit
19	50034 5	Marine habitats	Littoral sediment (ba2)	ba2.6 Mangrove (Grey mangrove)	Avicennia marina subsp. australasica	EN		~		3	CoastKit
20	11570	Marine mammals	Cetacean	Minke whale	Balaenoptera acutorostrata		С	~		1	SNES
21	11572	Marine mammals	Cetacean	Bryde's whale	Balaenoptera edeni		C, MI	~		1	SNES
22	11567	Marine mammals	Cetacean	Blue whale	Balaenoptera musculus	EN	EN, C, MI	~		2	(Gill et al. 2011)
23	11569	Marine mammals	Cetacean	Fin whale	Balaenoptera physalus		VU, C, MI	\checkmark		1	SNES
24	100107	Marine fish	Elasmobranchii	Short-tail stingray	Bathytoshia brevicaudata				✓	3	(Graf 2023)
25	NA	Marine mammals	Cetacean	Arnoux's beaked Whale	Berardius arnuxii		С	\checkmark		1	SNES
26	10197	Birds	Waterbirds	Australasian bittern	Botaurus poiciloptilus	CE	EN	\checkmark		3	NatureKit
27	NA	Marine invertebrates	Bryozoa	Bryozoan significant areas	Bryozoan				✓	2	CoastKit
28	10163	Birds	Shorebirds	Sharp-tailed sandpiper	Calidris acuminata		M, MI	~		1	SNES
29	10166	Birds	Shorebirds	Sanderling	Calidris alba		M, MI	\checkmark		1	CoastKit, SNES
30	10164	Birds	Shorebirds	Red knot	Calidris canutus	EN	EN, M, MI	\checkmark		3	NatureKit
31	10161	Birds	Shorebirds	Curlew sandpiper	Calidris ferruginea	CE	CE, M, MI	~		3	SNES, NatureKit
32	10978	Birds	Shorebirds	Pectoral sandpiper	Calidris melanotos		M, MI	\checkmark		1	SNES
33	10857	Birds	Shorebirds	Little stint	Calidris minuta		М	\checkmark		2	VBA, BirdLife
34	10162	Birds	Shorebirds	Red-necked stint	Calidris ruficollis		M, MI	\checkmark		1	CoastKit, SNES
35	10965	Birds	Shorebirds	Long-toed stint	Calidris subminuta		M, MI	\checkmark		1	SNES
36	10165	Birds	Shorebirds	Great knot	Calidris tenuirostris	CE	CE, M, MI	~		3	CoastKit, SNES, NatureKit
37	525092	Marine fish	Elasmobranchii	Australian ghostshark (elephant fish)	Callorhinchus milii				*	1	CoastKit
38	11564	Marine mammals	Cetacean	Pygmy right whale	Caperea marginata		C, MI	\checkmark		1	SNES
39	525161	Marine fish	Elasmobranchii	Oceanic whitetip shark	Carcharhinus longimanus		MI	~		1	SNES
40	14301	Marine fish	Elasmobranchii	Grey nurse shark (sand tiger shark)	Carcharias taurus	CE	CE	\checkmark		1	SNES
41	14300	Marine fish	Elasmobranchii	White shark (great)	Carcharodon carcharias	EN	VU, MI	√		1	CoastKit, BIA
42	528560	Marine reptiles		Loggerhead sea turtle	Caretta caretta		EN, M, MI	~		1	SNES
43	50413	Birds	Seabirds	Great skua	Catharacta skua		M	\checkmark		1	SNES

44	10000 3	Marine fish	Elasmobranchii	Australian swellshark	Cephaloscyllium laticeps				✓	3	(Graf 2023)
45	10140	Birds	Shorebirds	Double banded plover	Charadrius bicinctus		M, MI	✓		1	CoastKit, SNES
46	10141	Birds	Shorebirds	Greater sand plover	Charadrius leschenaultii	VU	VU, M, MI	\checkmark		3	NatureKit
47	10139	Birds	Shorebirds	Lesser sand plover	Charadrius mongolus	EN	EN, M, MI	\checkmark		3	SNES, NatureKit
48	10143	Birds	Shorebirds	Red capped plover	Charadrius ruficapillus		М	✓		1	CoastKit, SNES
49	10142	Birds	Shorebirds	Oriental plover	Charadrius veredus		M, MI	✓		1	SNES
50	12007	Marine reptiles		Green sea turtle	Chelonia mydas		VU, M, MI	\checkmark		1	SNES
51	10110	Birds	Cormorants and terns	Whiskered tern	Chlidonias hybrida				✓	1	CoastKit
52	10109	Birds	Cormorants and terns	White winged black tern	Chlidonias leucopterus		M, MI	\checkmark		1	CoastKit
53	10341	Birds	Land birds	Black-eared cuckoo	Chrysococcyx osculans		М	✓		1	SNES
54	4920	Marine fish	Teleost	Snapper	Chrysophrys auratus				✓	1	CoastKit
55	10203	Birds	Waterbirds	Black swan	Cygnus atratus				\checkmark	1	CoastKit
56	11616	Marine mammals	Cetacean	Common dolphin	Delphinus delphis		С	\checkmark		1	SNES
57	12013	Marine reptiles		Leatherback sea turtle	Dermochelys coriacea	CE	EN, M, MI	\checkmark		1	SNES
58	6018	Birds	Seabirds	Antipodean albatross	Diomedea antipodensis		VU, M, MI	✓		1	SNES
59	NA	Birds	Seabirds	Gibson's albatross	Diomedea antipodensis gibsoni		VU, M	✓		1	SNES
60	10974	Birds	Seabirds	Southern royal albatross	Diomedea epomophora	CE	VU, M, MI	✓		2	VBA, BirdLife
61	10086	Birds	Seabirds	Wandering albatross	Diomedea exulans	CE	VU, M, MI	\checkmark		1	SNES
62	6016	Birds	Seabirds	Northern royal albatross	Diomedea sanfordi		EN, M, MI	✓		1	SNES
63	NA	Marine invertebrates	Bivalve	Pippies	Donax deltoides				\checkmark	2	CoastKit
64	NA	Marine invertebrates	Echninoderms	Seastars	Echinodermata				√	2	CoastKit
65	100322	Marine plants		Golden kelp	Ecklonia radiata				\checkmark	3	(Young et al. 2022)
66	10185	Birds	Waterbirds	Little egret	Egretta garzetta	EN	М	✓		3	CoastKit, NatureKit
67	53047 3	Marine fish	Teleost	Saddletail grouper (Black rock cod)	Epinephelus daemelii		VU	\checkmark		1	SNES
68	12008	Marine reptiles		Hawksbill sea turtle	Eretmochelys imbricata		VU, M, MI	\checkmark		1	SNES
69	11561	Marine mammals	Cetacean	Southern right whale	Eubalaena australis	EN	EN, C, MI	✓		1	CoastKit, BIA
70	10005	Birds	Seabirds	Little penguin	Eudyptula minor		М	✓		2	CoastKit, SNES, BIA

71	NA	Birds	Seabirds	White-bellied storm- petrel	Fregetta grallaria grallaria		VU	\checkmark		1	SNES
72	903017	Marine fish	Elasmobranchii	School shark	Galeorhinus galeus		CD	\checkmark		1	CoastKit, SNES
73	10168	Birds	Shorebirds	Latham's snipe	Gallinago hardwickii		M, MI	\checkmark		1	CoastKit, SNES
74	NA	Birds	Shorebirds	Swinhoe's Snipe	Gallinago megala		M, MI	\checkmark		1	SNES
75	NA	Birds	Shorebirds	Pin-tailed snipe	Gallinago stenura		M, MI	\checkmark		1	SNES
76	10111	Birds	Cormorants and terns	Gull-billed tern	Gelochelidon nilotica	EN	M, MI	✓		З	NatureKit
77	90365 5	Marine mammals	Cetacean	Short-finned pilot whale	Globicephala macrorhynchus		С	\checkmark		1	SNES
78	11606	Marine mammals	Cetacean	Long-finned pilot whale	Globicephala melas		С	✓		1	SNES
79	11609	Marine mammals	Cetacean	Risso's dolphin	Grampus griseus		С	\checkmark		1	SNES
80	10131	Birds	Shorebirds	Sooty oystercatcher	Haematopus fuliginosus				\checkmark	2	CoastKit
81	10130	Birds	Shorebirds	Pied oystercatcher	Haematopus longirostris				\checkmark	2	CoastKit
82	10226	Birds	Raptor	White bellied sea eagle	Haliaeetus leucogaster	EN	М	\checkmark		3	CoastKit, NatureKit
83	903152	Marine invertebrates	Pycnogonida	rare crab species	Halicarcinus				\checkmark	2	CoastKit
84	100240	Marine invertebrates	Gastropod	Green lip abalone	Haliotis laevigata				\checkmark	2	CoastKit
85	100241	Marine invertebrates	Gastropod	Black lip abalone	Haliotis rubra				\checkmark	3	(Young et al. 2020)
86	10081	Birds	Seabirds	Blue petrel	Halobaena caerulea		VU, M	~		1	SNES
87	90340 0	Marine fish	Syngnathiformes	Upside-down pipefish	Heraldia nocturna		М	✓		1	SNES
88	100001	Marine fish	Elasmobranchii	Port Jackson shark	Heterodontus portusjacksoni				✓	2	CoastKit
89	507763	Marine plants		Australian grass- wrack	Heterozostera nigricaulis	EN		\checkmark		3	CoastKit, NatureKit
90	501660	Marine plants		Tasman grass-wrack	Heterozostera tasmanica	EN		✓		3	CoastKit, NatureKit
91	NA	Birds	Shorebirds	Black-winged stilt	Himantopus himantopus		М	\checkmark		1	SNES
92	530171	Marine fish	Syngnathiformes	Big-belly seahorse	Hippocampus abdominalis		М	\checkmark		1	SNES
93	4806	Marine fish	Syngnathiformes	Australian pot- bellied seahorse	Hippocampus bleekeri		М	\checkmark		1	CoastKit
94	4807	Marine fish	Syngnathiformes	Knobby seahorse (short head seahorse)	Hippocampus breviceps		М	√		1	SNES
95	903401	Marine fish	Syngnathiformes	Bullneck seahorse	Hippocampus minotaur		м	✓	 	1	SNES
96	10334	Birds	Land birds	White-throated needletail	Hirundapus caudacutus	VU	VU, M, MI	✓		3	NatureKit

97	4831	Marine fish	Syngnathiformes	Brigg's crested pipefish	Histiogamphelus briggsii		М	4		1	SNES
98	530173	Marine fish	Syngnathiformes	Macleay's crested pipefish	Histiogamphelus cristatus		Μ	\checkmark		1	SNES
99	104212	Marine invertebrates	Cnidarian	Stalked hydroid	Hybocodon cryptus				√	1	CoastKit
100	10112	Birds	Cormorants and terns	Caspian tern	Hydroprogne caspia	VU	M, MI	\checkmark		3	CoastKit, SNES, NatureKit
101	90340 3	Marine fish	Syngnathiformes	Knife snouted pipefish	Hypselognathus rostratus		Μ	√		1	SNES
102	4810	Marine fish	Syngnathiformes	Deepbody pipefish	Kaupus costatus		М	\checkmark		1	SNES
103	530175	Marine fish	Syngnathiformes	Kimbla pipefish	Kimblaeus bassensis		М	\checkmark		1	SNES
104	11581	Marine mammals	Cetacean	Pygmy sperm whale	Kogia breviceps		С	√		1	SNES
105	11582	Marine mammals	Cetacean	Dwarf sperm whale	Kogia sima		С	4		1	SNES
106	NA	Marine mammals	Cetacean	Dusky dolphin	Lagenorhynchus obscurus		C, MI	4		1	SNES
107	525121	Marine fish	Elasmobranchii	Porbeagle	Lamna nasus		М	\checkmark		1	SNES
108	10981	Birds	Seabirds	Kelp gull	Larus dominicanus		М	\checkmark		2	CoastKit, SNES
109	10125	Birds	Seabirds	Silver gull	Larus novaehollandiae		М	\checkmark		1	SNES
110	60126	Birds	Cormorants and terns	Pacific gull	Larus pacificus		М	4		2	CoastKit, SNES
111	10309	Birds	Parrots	Swift parrot	Lathamus discolor	CE	CE, M	\checkmark		3	NatureKit
112	4812	Marine fish	Syngnathiformes	Brushtailed pipefish	Leptoichthys fistularius		М	\checkmark		1	SNES
113	102756	Marine invertebrates	Crustaceans	Spider crab	Leptomithrax gaimardii				\checkmark	2	CoastKit
114	10167	Birds	Shorebirds	Broad-billed sandpiper	Limicola falcinellus		M, MI	4		1	SNES
115	10153	Birds	Shorebirds	Bar tailed godwit	Limosa lapponica	VU	M, MI	\checkmark		3	CoastKit, SNES, NatureKit
116	NA	Birds	Shorebirds	Nunivak bar-tailed godwit	Limosa lapponica baueri		VU	✓		1	SNES
117	528553	Birds	Shorebirds	Black-tailed godwit	Limosa limosa	CE	M, MI	\checkmark		2	VBA, BirdLife
118	4814	Marine fish	Syngnathiformes	Australian smooth pipefish	Lissocampus caudalis		М	\checkmark		1	SNES
119	4815	Marine fish	Syngnathiformes	Javelin pipefish	Lissocampus runa		М	\checkmark		1	SNES
120	NA	Marine mammals	Cetacean	Southern right whale dolphin	Lissodelphis peronii		С	√		1	SNES
121	10929	Birds	Seabirds	Southern giant petrel	Macronectes giganteus	EN	EN, M, MI	√		2	VBA, BirdLife
122	10937	Birds	Seabirds	Northern giant petrel	Macronectes halli	EN	VU, M, MI	✓		2	VBA, BirdLife
123	90340 8	Marine fish	Syngnathiformes	Sawtooth pipefish	Maroubra perserrata		M	✓		1	SNES

124	11575	Marine mammals	Cetacean	Humpback whale	Megaptera novaeangliae	CE	C, MI	✓		1	SNES
125	10329	Birds	Land birds	Rainbow bee-eater	Merops ornatus		М	\checkmark		1	SNES
126	11594	Marine mammals	Cetacean	Andrews' beaked whale	Mesoplodon bowdoini		С	✓		1	SNES
127	NA	Marine mammals	Cetacean	Hector's beaked whale	Mesoplodon hectori		С	4		1	SNES
128	11591	Marine mammals	Cetacean	Strap-toothed beaked whale	Mesoplodon layardii		С	4		1	SNES
129	11596	Marine mammals	Cetacean	True's beaked whale	Mesoplodon mirus		С	\checkmark		1	SNES
130	10100	Birds	Cormorants and terns	Little pied cormorant	Microcarbo melanoleucos				\checkmark	1	CoastKit
131	NA	Marine invertebrates	Crustaceans	Soldier crab	Mictyris platycheles				\checkmark	2	CoastKit
132	61341	Coastal bats		Common bent winged bat	Miniopterus orianae	CE		\checkmark		2	CoastKit
133	61343	Coastal bats		Southern bent winged bat	Miniopterus orianae bassanii	CE	CE	\checkmark		3	NatureKit
134	61342	Coastal bats		Eastern bent winged bat	Miniopterus orianae oceanensis	CE		4		3	NatureKit
135	530177	Marine fish	Syngnathiformes	Mollison's pipefish	Mitotichthys mollisoni		М	\checkmark		1	SNES
136	530178	Marine fish	Syngnathiformes	Halfbanded pipefish	Mitotichthys semistriatus		М	\checkmark		1	SNES
137	530179	Marine fish	Teleost	Tucker's pipefish	Mitotichthys tuckeri		М	\checkmark		1	SNES
138	104207	Marine invertebrates	Cnidarian	Gorgonian sea fans (family)	Mopsella sp.				\checkmark	2	CoastKit
139	10825	Birds	Seabirds	Cape gannet	Morus capensis		М	\checkmark		1	SNES
140	10104	Birds	Seabirds	Australian gannet	Morus serrator		М	\checkmark		2	CoastKit, BIA
141	10877	Birds	Land birds	Yellow wagtail	Motacilla flava		M, MI	\checkmark		1	SNES
142	903019	Marine fish	Elasmobranchii	Gummy shark	Mustelus antarcticus				√	2	CoastKit, (Graf 2023)
143	10366	Birds	Land birds	Satin flycatcher	Myiagra cyanoleuca		M, MI	\checkmark		1	SNES
144	4640	Marine fish	Elasmobranchii	Eagle ray	Myliobatis tenuicaudatus				✓	3	(Graf 2023)
145	4703	Marine fish	Teleost	Australian mudfish	Neochanna cleaveri	EN		\checkmark		3	NatureKit
146	10305	Birds	Parrots	Orange bellied parrot	Neophema chrysogaster	CE	CE, M	✓		3	CoastKit, NatureKit
147	10306	Birds	Parrots	Blue-winged parrot	Neophema chrysostoma		VU, M	\checkmark		3	NatureKit
148	11539	Marine mammals	Pinniped	Australian sea lion	Neophoca cinerea	EN	EN, M	✓		1	SNES
149	530180	Marine fish	Syngnathiformes	Red pipefish	Notiocampus ruber		М	✓		1	SNES
150	90302 3	Marine fish	Elasmobranchii	Broadnose sevengill shark	Notorynchus cepedianus				√	3	(Graf 2023)

151	10149	Birds	Shorebirds	Eastern curlew	Numenius madagascariensis	CE	CE, M, MI	\checkmark		3	CoastKit, NatureKit
152	10151	Birds	Shorebirds	Little curlew	Numenius minutus		M, MI	√		1	SNES
153	10150	Birds	Shorebirds	Whimbrel	Numenius phaeopus	EN	M, MI	✓		3	CoastKit, NatureKit
154	10063	Birds	Seabirds	Wilson's storm-petrel	Oceanites oceanicus		M, MI	\checkmark		2	VBA, BirdLife
155	11600	Marine mammals	Cetacean	Orca/ Killer whale	Orcinus orca		C, MI	✓		1	SNES
156	10083	Birds	Seabirds	Fairy prion	Pachyptila turtur		М	\checkmark		2	CoastKit, SNES
157	10241	Birds	Raptor	Osprey	Pandion haliaetus		M, MI	\checkmark		1	SNES
158	102586	Marine invertebrates	Bivalve	Commercial scallop	Pecten fumatus				✓	2	CoastKit
159	10065	Birds	Seabirds	White faced storm petrel	Pelagodroma marina	EN	М	✓		2	CoastKit, BIA
160	10085	Birds	Seabirds	Common diving petrel	Pelecanoides urinatrix		М	✓		2	CoastKit, BIA
161	10098	Birds	Cormorants and terns	Black faced shag (Cormorant)	Phalacrocorax fuscescens		М	✓		2	CoastKit, SNES
162	10099	Birds	Cormorants and terns	Australian pied cormorant	Phalacrocorax varius				✓	2	CoastKit
163	10932	Birds	Shorebirds	Red-necked phalarope	Phalaropus lobatus		M, MI	✓		1	SNES
164	10934	Birds	Shorebirds	Ruff	Philomachus pugnax		M, MI	\checkmark		1	SNES
165	10092	Birds	Seabirds	Sooty albatross	Phoebetria fusca	CE	VU, M, MI	\checkmark		2	VBA, BirdLife
166	NA	Marine fish	Syngnathiformes	Leafy seadragon	Phycodurus eques		М	\checkmark		1	SNES
167	100018	Marine fish	Syngnathiformes	Common seadragon	Phyllopteryx taeniolatus		М	√		2	CoastKit, SNES
168	100333	Marine plants		Crayweed	Phyllospora comosa				~	3	(Young et al. 2022)
169	11578	Marine mammals	Cetacean	Sperm whale	Physeter macrocephalus		C, MI	✓		1	SNES
170	10181	Birds	Waterbirds	Royal spoonbill	Platalea regia				✓	2	CoastKit
171	4857	Marine fish	Teleost	Southern sand flathead	Platycephalus bassensis				✓	1	CoastKit
172	10137	Birds	Shorebirds	Pacific golden plover	Pluvialis fulva	VU	M, MI	✓		3	CoastKit, NatureKit
173	10136	Birds	Shorebirds	Grey plover	Pluvialis squatarola	VU	M, MI	\checkmark		3	SNES, NatureKit
174	NA	Marine invertebrates	Porifera	Sponge significant areas	Porifera				~	2	CoastKit
175	10915	Birds	Seabirds	White-chinned petrel	Procellaria aequinoctialis		M, MI	\checkmark		2	VBA, BirdLife
176	4686	Marine fish	Teleost	Australian grayling	Prototroctes maraena	EN	VU	✓		3	SNES, NatureKit
177	15255	Marine invertebrates	Crustaceans	Ghost shrimp	Pseudocalliax tooradin	EN		✓		2	CoastKit

178	NA	Birds	Seabirds	White-necked petrel	Pterodroma cervicalis		М	\checkmark		1	SNES
179	10076	Birds	Seabirds	Soft-plumaged petrel	Pterodroma mollis		VU, M	~		1	SNES
180	4817	Marine fish	Syngnathiformes	Pug-nosed pipefish	Pugnaso curtirostris		М	✓		1	SNES
181	10148	Birds	Waterbirds	Red-necked avocet	Recurvirostra novaehollandiae		М	√		1	SNES
182	525128	Marine fish	Elasmobranchii	Whale shark	Rhincodon typus		VU, MI	✓		1	SNES
183	11303	Coastal bats		Eastern horseshoe bat	Rhinolophus megaphyllus	EN		~		3	CoastKit, NatureKit
184	10362	Birds	Land birds	Rufous fantail	Rhipidura rufifrons		M, MI	\checkmark		1	SNES
185	10170	Birds	Shorebirds	Australian painted- snipe	Rostratula australis	CE	EN, M	✓		3	SNES, NatureKit
186	11321	Coastal bats		Yellow-bellied sheathtail bat	Saccolaimus flaviventris	VU		✓		3	NatureKit
187	5067	Marine fish	Teleost	Blue warehou	Seriolella brama	CD	CD	~		1	SNES
188	4891	Marine fish	Teleost	King George whiting	Sillaginodes punctatus				\checkmark	1	CoastKit
189	NA	Marine invertebrates	Cnidarian	Seapens	Smiliasterias multipara				\checkmark	2	CoastKit
190	NA	Marine fish	Syngnathiformes	Robust pipehorse	Solegnathus robustus		М	\checkmark		1	SNES
191	4819	Marine fish	Syngnathiformes	Spiny pipehorse	Solegnathus spinossimus		М	\checkmark		1	SNES
192	10945	Birds	Seabirds	Pomarine jaeger	Stercorarius pomarinus		M, MI	✓		2	VBA, BirdLife
193	NA	Birds	Cormorants and terns	Crested tern	Sterna bergii		M, MI	~		1	SNES
194	10120	Birds	Cormorants and terns	Sooty tern	Sterna fuscata		М	~		1	SNES
195	10953	Birds	Cormorants and terns	Common tern	Sterna hirundo		M, MI	\checkmark		2	VBA, BirdLife
196	10114	Birds	Cormorants and terns	White-fronted tern	Sterna striata		М	\checkmark		2	VBA, BirdLife
197	10117	Birds	Cormorants and terns	Little tern	Sternula albifrons	CE	M, MI	\checkmark		3	CoastKit, SNES, NatureKit
198	10118	Birds	Cormorants and terns	Fairy tern	Sternula nereis	CE	М	\checkmark		2	CoastKit, SNES
199	4821	Marine fish	Syngnathiformes	Spotted pipefish	Stigmatopora argus		М	\checkmark		1	SNES
20 0	4822	Marine fish	Syngnathiformes	Widebody pipefish	Stigmatopora nigra		М	~		1	SNES
201	10173	Birds	Shorebirds	Australian pratincole	Stiltia isabella		М	✓		1	SNES
202	4824	Marine fish	Syngnathiformes	Ring-backed pipefish	Stipecampus cristatus		М	\checkmark		1	SNES
20 3	NA	Marine fish	Syngnathiformes	Double-ended pipefish	Syngnathoides biaculeatus		М	\checkmark		1	SNES
20 4	10931	Birds	Seabirds	Buller's albatross	Thalassarche bulleri	EN	VU, M, MI	~		2	VBA, BirdLife
20 5	NA	Birds	Seabirds	Northern buller's albatross	Thalassarche bulleri platei		VU, M	✓		1	SNES

20 6	10089	Birds	Seabirds	Indian yellow-nosed albatross	Thalassarche carteri	EN	VU, M, MI	\checkmark		2	VBA, BirdLife
207	10091	Birds	Seabirds	Shy albatross	Thalassarche cauta	EN	EN, M, MI	✓		1	SNES
20 8	10090	Birds	Seabirds	Grey-headed albatross	Thalassarche chrysostoma	EN	EN, M, MI	\checkmark		2	VBA, BirdLife
20 9	6020	Birds	Seabirds	Chatham albatross	Thalassarche eremita		EN, M, MI	\checkmark		1	SNES
210	903241	Birds	Seabirds	Campbell albatross	Thalassarche impavida		VU, M, MI	\checkmark		1	SNES
211	10088	Birds	Seabirds	Black-browed albatross	Thalassarche melanophris		VU, M, MI	\checkmark		1	SNES
212	6021	Birds	Seabirds	Salvin's albatross	Thalassarche salvini		VU, M, MI	✓		1	SNES
213	6022	Birds	Seabirds	White-capped albatross	Thalassarche steadi		VU, M, MI	\checkmark		1	SNES
214	10115	Birds	Cormorants and terns	Crested tern	Thalasseus bergii		M, MI	\checkmark		2	CoastKit
215	10138	Birds	Shorebirds	Hooded plover	Thinornis rubricollis	VU	М	\checkmark		2	CoastKit, SNES, NatureKit
216	10180	Birds	Waterbirds	Straw-necked ibis	Threskiornis spinicollis		М	✓		2	CoastKit
217	14207	Marine fish	Teleost	Southern bluefin tuna	Thunnus maccoyii	CD	CD	\checkmark		1	SNES
218	10155	Birds	Shorebirds	Grey tailed tattler	Tringa brevipes	CE	M, MI	\checkmark		3	CoastKit, SNES, NatureKit
219	10154	Birds	Shorebirds	Wood sandpiper	Tringa glareola	EN	M, MI	✓		1	SNES
220	10156	Birds	Shorebirds	Wandering tattler	Tringa incana		M, MI	\checkmark		1	SNES
221	10158	Birds	Shorebirds	Common greenshank	Tringa nebularia	EN	M, MI	\checkmark		3	CoastKit, NatureKit
222	10159	Birds	Shorebirds	Marsh sandpiper	Tringa stagnatilis	EN	M, MI	\checkmark		3	SNES, NatureKit
223	4625	Marine fish	Elasmobranchii	Fiddler ray	Trygonorrhina dumerilii				✓	3	(Graf 2023)
224	NA	Marine mammals	Cetacean	Spotted bottlenose dolphin	Tursiops aduncus		С	\checkmark		1	SNES
225	11617	Marine mammals	Cetacean	Burrunan dolphin	Tursiops australis	CE	С	\checkmark		2	CoastKit, VBA
226	11612	Marine mammals	Cetacean	Bottlenose dolphin	Tursiops truncatus str		С	\checkmark		1	SNES
227	4826	Marine fish	Syngnathiformes	Hairy pipefish	Urocampus carinirostris		М	\checkmark		1	SNES
228	4828	Marine fish	Syngnathiformes	Mother-of-pearl pipefish	Vanacampus margaritifer		М	\checkmark		1	SNES
229	4829	Marine fish	Syngnathiformes	Port Phillip pipefish	Vanacampus phillipi		М	✓		1	SNES
23 0	530182	Marine fish	Syngnathiformes	Long-nosed pipefish	Vanacampus poecilolaemus		М	\checkmark		1	SNES
231	10160	Birds	Shorebirds	Terek Sandpiper	Xenus cinereus	EN	M, MI	√		3	SNES, NatureKit
232	11587	Marine mammals	Cetacean	Cuvier's beaked whale	Ziphius cavirostris		С	√		1	SNES
233	NA	Listed communities		Giant Kelp Marine Fore	sts of Southeast Australia		EN	✓		1	SNES

234	NA	Listed communities		Littoral Rainforest and Coastal Vine Thickets of East Australia	-	Œ	~					1	SNES
235	NA	Listed		River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria	C	Œ	~					1	SNES
236	NA	Listed communities		The assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community	E	EN	✓					1	SNES
237		Key ecological features		Bonney coast upwelling				\checkmark	1	SNES			
238		Key ecological features		East of Eden upwelling				~	1	SNES			
239	NA	Listed communities		Port Phillip Bay Entrance Deep Canyon Marine Community	Listed		✓				2	Co	astKit
24 0	NA	Listed communities		San Remo Marine Community	Listed		\checkmark				2	Cod	astKit
241	NA	Listed communities		Western Port Bryozoan Reef Community	Listed		✓				2	Co	astKit
242		Marine habitats	Littoral rock (ba1)	ba1.1 High energy littoral rock					✓			3	CoastKit
243		Marine habitats	Littoral rock (ba1)	ba1.2 Moderate energy littoral rock					✓			3	CoastKit
24 4		Marine habitats	Littoral rock (ba1)	ba1.3 Low energy littoral rock					~			3	CoastKit
245		Marine habitats	Littoral sediment (ba2)	ba21 Littoral coarse sediment					√			3	CoastKit
24 6		Marine habitats	Littoral sediment (ba2)	ba2.2 Littoral sand					√			3	CoastKit
247		Marine habitats	Littoral sediment (ba2)	ba2.3 Littoral mud					√			3	CoastKit
248		Marine habitats	Littoral sediment (ba2)	ba2.5 Saltmarsh and reedbeds					~			3	CoastKit
24 9		Marine habitats	Littoral sediment (ba2)	ba2.7 Littoral sediment seagrass					✓			3	CoastKit
25 0		Marine habitats	Infralittoral rock (ba3)	ba3.1 High energy infralittoral rock					✓			3	CoastKit
251		Marine	Infralittoral rock	ba3.2 Moderate energy infralittoral rock					✓			3	CoastKit
252		Marine	Infralittoral rock	ba3.3 Low energy infralittaral rock					√			3	CoastKit
253		Marine habitats	Circalittoral rock (ba4)	ba4.1 High energy open-coast circalittoral rock					~			3	CoastKit
254		Marine habitats	Circalittoral rock (ba4)	ba4.2 Tide-swept channels of circalittoral rock					~			3	CoastKit
255		Marine habitats	Sublittoral sediment (ba5)	ba5.1 Sublittoral coarse sediment					√			3	CoastKit
256		Marine habitats	Sublittoral sediment (ba5)	ba5.2 Sublittoral sand and muddy sand					✓			3	CoastKit
257		Marine habitats	Sublittoral sediment (ba5)	ba5.3 Sublittoral mud					✓			3	CoastKit

258		Marine	Sublittoral	ba5.4 Sublittoral					\checkmark		3	CoastKit
		habitats	sediment (ba5)	mixed sediments								
259		habitats	sediment (ba5)	rhodolith bods					\checkmark		3	CoastKit
26		Maurine	Sediment (bd3)	har C Cublitteral								
20		habitate	sediment (ba5)	biogenic reefs					\checkmark		3	CoastKit
0		Marino	Sublittoral	biogenic reels								
261		habitats	sediment (ba5)	ba5.7 Sublittoral seawe	ed on sediment				√		3	CoastKit
262		Marine	Sublittoral	ba5.8 Sublittoral					✓		3	CoastKit
202		habitats	sediment (ba5)	seagrass beds							0	
263		Marine habitats	Sublittoral sediment (ba5)	ba5.b Non-reef sedimer	nt epibenthos				\checkmark		3	CoastKit
26 4		Marine fish	Teleost	Yellow-eye mullet	Aldrichetta forsteri					✓	0	
265	15250	Marine invertebrates	Echinoderms	Brittle star	Amphiura triscacantha	EN		\checkmark			0	
266	4651	Marine fish	Eels	Short-finned eels	Anguilla australis					✓	0	
267		Marine fish	Eels	Lonafin eel	Anauilla reinhardtii					✓	0	
268	15251	Marine	Echinoderms	Sea cucumber (5251)	Apsolidium densum	EN		✓			0	
260		Invertebrates Marine	Fabinadorma	Sog oueumber	Appolidium faloonorgo	CE					0	
209		invertebrates	Echinoderms	Sed cucumber	Apsoliaium raiconerae	CE		v			0	
270	15252	Marine invertebrates	Echinoderms	Sea cucumber (5052)	Apsolidium handrecki	EN		\checkmark			0	
271		Marine fish	Teleost	Mulloway	Argyrosomus japonicus					✓	0	
272		Marine fish	Teleost	Australian salmon	Arripis trutta, A. truttaceus					✓	0	
273	15096	Marine	Cnidarian	Brackish jellyfish	Australomedusa baylii	EN		✓			0	
274	15254	Marine	Mollusc	Port Phillip chiton	Bassethullia glypta	CE		✓			0	
075		Marino fich	Sharks	(5254) Propzo whalor	Carebarbinus brachyurus					1	0	
275		Marine	51101 K3	BIOIIZE WIIGIEI	curcharninas brachyaras					•	0	
276		invertebrates	Echninoderms	Sea urchin	Centrostephanus rodgersii					√	0	
277		Marine fish	Teleost	Banded morwong	Cheilodactylus spectabilis					\checkmark	0	
278	15257	Marine invertebrates	Echninoderms	Brittle star species	Clarkcoma australis	CE		✓			0	
279	6017	Birds	Seabirds	Amsterdam albatross	Diomedea amsterdamensis		EN, M, MI	✓			0	
28		Marine								,		
0		invertebrates	Echninoderms	Sea urchin	Heilocidaris erythrogramma					\checkmark	0	
281		Marine fish	Teleost	Southern garfish	Hyporhamphus melanochir					\checkmark	0	
282	5053	Marine fish	Teleost	Empire gudgeon	Hypseleotris compressa	CE		✓			0	
283	100270	Marine invertebrates	Crustaceans	Southern rock lobster	Jasus edwardsii					✓	0	
284	4689	Marine fish	Syngnathiformes	Australian whitebait	Lovettia sealii	CE		✓			0	
285		Marine invertebrates	Cephalopoda	Octopus	Macroctopus maorum					√	0	

286	11590	Marine mammals	Cetacean	Blainville's beaked whale	Mesoplodon densirostris		С	~			0
287	15256	Marine invertebrates	Crustaceans	Ghost shrimp (Michelea species 5256)	Michelea microphylla	CE		✓			0
288	5029	Marine fish	Teleost	Flatback mangrovegoby	Mugilogobius platynotus	EN		~			0
289		Marine fish	Teleost	Bluethroat and purple wrasse	Notolabrus tetricus and. fucicola				√		0
29 0		Marine invertebrates	Crustaceans	Sand crab	Ovalipes australiensis					✓	0
291	15258	Marine invertebrates	Echninoderms	Sea cucumber (5258)	Pentocnus bursatus	VU		Y			0
292	10093	Birds	Seabirds	Light-mantled sooty albatross	Phoebetria palpebrata	CE	M, MI	Y			0

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