NATIONAL COASTAL & MARINE SPATIAL BIODIVERSITY PLAN

VERSION 1.0 (BETA 2)

Securing South Africa's coastal and marine biodiversity to support economic development and sustainable resource use

NATIONAL COASTAL & MARINE SPATIAL BIODIVERSITY PLAN

VERSION 1.0 (BETA 2)

TECHNICAL REPORT

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Executive Summary

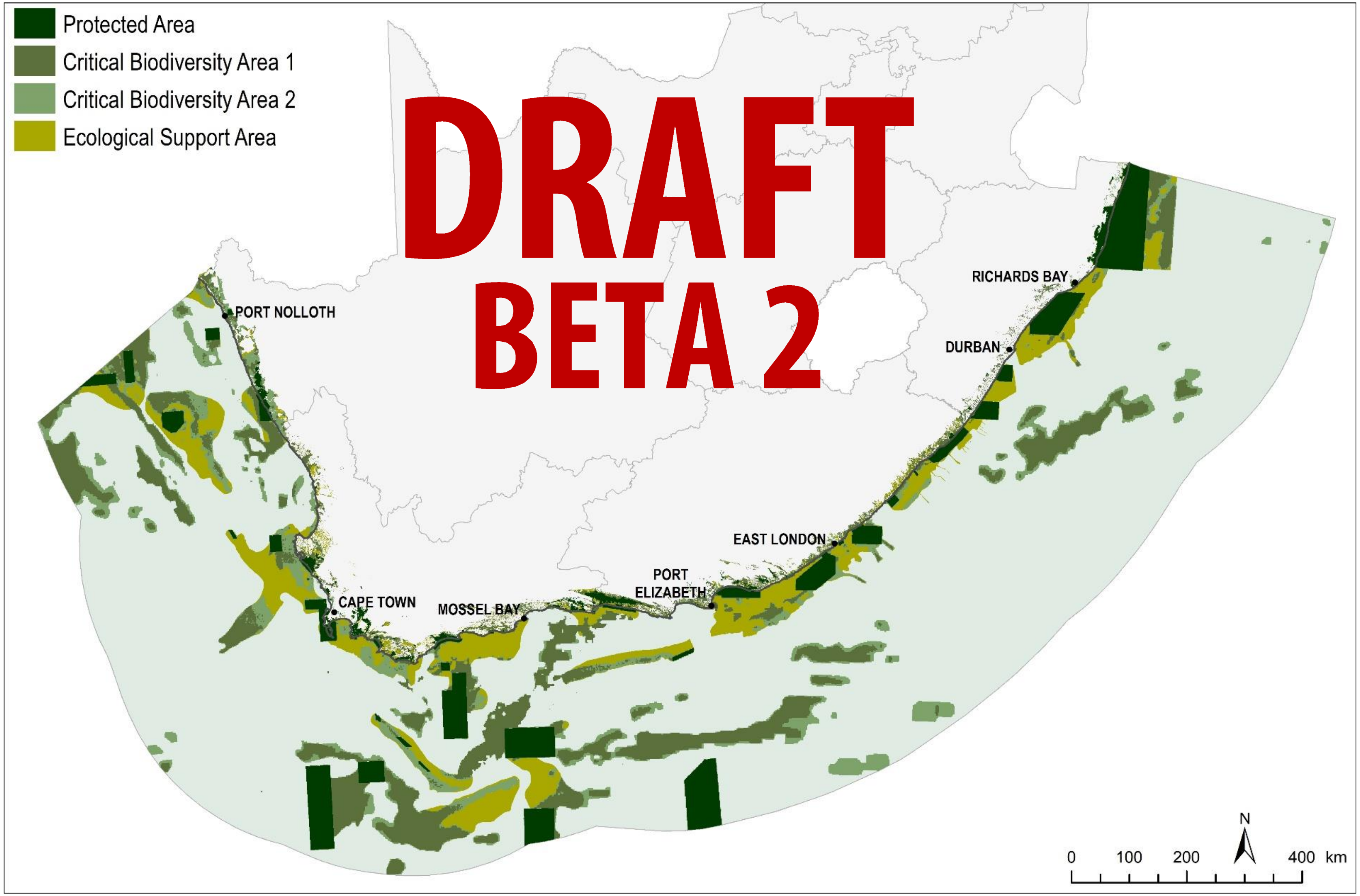
Maps of Critical Biodiversity Areas (CBA Maps) have been used successfully to inform land-use planning and land-based protected area expansion in South Africa for many years, and have been and continue to be one of the key tools for protecting terrestrial and inland water biodiversity, and supporting sustainable development. This report describes South Africa's first National Coastal and Marine Spatial Biodiversity Plan, comprising the National Coastal and Marine CBA Map and accompanying sea-use guidelines. The intent of this plan is to consolidate the biodiversity sector's spatial prioritisation of the South African coast and ocean to provide inputs into national Marine Spatial Planning (MSP) as well as other planning and decision-making processes. This is to ensure that marine biodiversity assets and ecological infrastructure are secured, and that development of the ocean economy is sustainable. It also includes contributions towards identifying focus areas for Marine Protected Area (MPA) expansion, which builds on work that supported the declaration of 20 new MPAs in 2019.

A CBA Map presents a spatial plan for the natural environment, designed to inform planning and decision-making in support of sustainable development. In terms of the Technical Guidelines for CBA Maps developed by the South African National Biodiversity Institute (SANBI 2017), CBA Maps must be developed using the principles of systematic biodiversity planning. These maps comprise three categories of biodiversity priority areas: Protected Areas, Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs), which are jointly important for the persistence of a viable representative sample of all ecosystem types and species, as well as the long-term ecological functioning of the landscape or seascape as a whole . The two other map categories are: Other Natural Areas (ONA) and No Natural Remaining (NNR).

This document presents the second beta version of the first National Coastal and Marine Spatial Biodiversity Plan for the coast and ocean around the South African mainland. Both the map and this technical report were developed in accordance with the Technical Guidelines for CBA Maps (SANBI 2017). Following an introduction, the coastal and marine environment in South Africa is defined and described. Background to systematic biodiversity planning is presented, as well as how this is applied in South Africa, including its application in compiling CBA Maps. The methodology for developing the National Coastal and Marine CBA Map is described, including descriptions of the planning domain, input layers, biodiversity targets, and analysis methods. A first draft of the spatial outputs and accompanying sea-use guidelines are presented and discussed.

Given that this is the first compilation of a National Coastal and Marine CBA Map and sea-use guidelines, attention is paid to data gaps and limitations that need to be addressed in the next iterations. The intention is to include a more comprehensive suite of input datasets, enhance conflict avoidance in the cost layer, and to engage more extensively with stakeholders on the sea-use guidelines in future versions. Progress has been made in many of these aspects in this second beta version, and will continue through the next iterations. For example, Beta 2 includes more than 50 additional biodiversity datasets, and the cost layer has been redefined to better avoid other activities. The final National Coastal and Marine Spatial Biodiversity Plan Version 1.0 will be released (on 26 February 2021). The work will continue thereafter to iteratively improve the National Coastal and Marine Spatial Biodiversity Plan over the next few years.

15 December 2020



National Coastal and Marine CBA Map Version 1.0 (Beta 2).

Contents

Acknowledgements

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In particular, we thank the biodiversity planners of South Africa who have developed a strong community of practice over the last two decades, and the scientists who contribute the foundational research to inform spatial assessments and plans. We are grateful to DEFF's National Marine Biodiversity Scientific Working Group, the National Ecologically or Biologically Significant Marine Areas (EBSA) Working Group, the Provincial and Metro Biodiversity Planning Working Group, and the participants of the Biodiversity Planning Forum who helped shape and review this work. We also thank the estuarine and inland water scientists for initial discussions around advancing and integrating spatial biodiversity priorities across realms. We are also grateful to everyone who attended the launch of the first beta version of the National Coastal and Marine Spatial Biodiversity Plan, and appreciate the comments, suggestions and feedback. Altogether, representatives from nearly 100 organisations have attended various presentations and discussions relating to this work.

Our sincerest thanks to those who have contributed spatial data to inform the National Coastal and Marine CBA Map.

We thank Dr Hedley Grantham (Wildlife Conservation Society) and Dr Kira Gee (Helmholtz-Zentrum Geesthacht) for serving as international reviewers of the National Coastal and Marine Spatial Biodiversity Plan Version 1.0 (Beta 1); we sincerely appreciate their careful consideration of the technical report and their insightful comments.

We welcome further engagement.

Supporting information

Annexure 1 Review to support the inclusion of climate change resilience and genetic connectivity in coastal and marine biodiversity plans for South Africa. This document, compiled by Tatjana Baleta, may be available on request to Prof. Kerry Sink (k.sink@sanbi.org.za).

1. Introduction

1.1. What is the National Coastal and Marine Spatial Biodiversity Plan?

This technical report presents the second beta version of the national Map of Critical Biodiversity Areas and Ecological Support Areas (CBA Map) and associated land- and sea-use guidelines for South Africa's coastal and marine environment. A CBA Map is a spatial plan for the natural environment, intended to inform planning and decision-making in support of sustainable development. It comprises a portfolio of biodiversity priority areas that are identified using principles of systematic biodiversity planning[1]. These priority areas are important for conserving a representative sample of ecosystems and species, for maintaining ecological processes, and for providing ecosystem services (SANBI 2016). The sea-use guidelines enhance the use of the CBA Map in a range of planning and decision-making processes by indicating the compatibility of various activities with the different biodiversity priority areas so that the broad management objective of each can be maintained. Together, the CBA Map and sea-use guidelines form a Spatial Biodiversity Plan, with the overall goal of safeguarding a sufficient, representative sample of coastal and marine biodiversity that can persist into the future, in support of sustainable economic development.

1.2. Why was the National Coastal and Marine Spatial Biodiversity Plan developed, and how is it envisaged to be used?

Operation Phakisa is a presidential initiative that was launched in 2014 to help fast-track implementation of the National Development Plan (Republic of South Africa 2014). More specifically, Operation Phakisa Oceans Economy aims to unlock the economic potential of South Africa's oceans (Department of Planning Monitoring and Evaluation 2015), with a view to accelerating diversification and intensification of activities in the country's coastal zone and oceans to grow the blue economy. Recognising the need to plan for these activities, South Africa is developing a national, multi-sector Marine Spatial Plan (MSP).

On land, the biodiversity sector's spatial input into multi-sectoral planning processes (equivalent to MSP) takes the form of a CBA Map (Botts et al. 2019). To date, CBA Maps have been compiled for the whole land-based portion of the country, as well as for the marine area adjacent to KwaZulu-Natal (Harris et al. 2012). However, the National Biodiversity Assessment 2018 (Skowno et al. 2019a), with its updated ecosystem maps and assessments, provided an opportunity for the first National Coastal and Marine CBA Map to be developed (Harris and Sink 2019). The CBA Map aims to consolidate several past and present spatial assessment and planning initiatives to provide a coherent map of the coastal and marine biodiversity priority areas in South Africa that require focused management measures to support sustainable development of the blue economy. These initiatives include: the most recent classification, mapping and assessment of coastal and marine biodiversity in South Africa (Harris et al. 2019a; Harris et al. 2019e; Sink et al. 2019f); previous and new work to support Marine Protected Area (MPA) expansion; identification, revised delineation and proposed management of Ecologically or

[1] In the academic literature, this is referred to as Systematic Conservation Planning (SCP). However, SCP is often interpreted as being about spatial prioritisation for protected area expansion only. Given the broader application of SCP in South Africa, where it is used to identify spatial priorities to inform land- or sea-use planning and decision-making, it is more appropriately referred to as systematic biodiversity planning.

Biologically Significant Marine Areas (EBSAs; MARISMA Project 2020c); and other spatial prioritisations done at local, provincial or other sub-national scales, e.g., Algoa Bay Systematic Conservation Plan (Algoa Bay Project 2019).

Given the strong conceptual parallels between land-use planning and Marine Spatial Planning (MSP), the National Coastal and Marine CBA Map is envisaged to inform MSP in an equivalent way to how land-based CBA Maps inform land-use planning, which takes place predominantly through Spatial Development Frameworks at national, provincial and local level. In other words, the intent of the National Coastal and Marine Spatial Biodiversity Plan (CBA Map and accompanying sea-use guidelines) is to amalgamate the biodiversity sector's spatial priorities to inform the multi-sectoral MSP process (Fig. 1), as per the MSP Act: No. 16 of 2018 (Republic of South Africa 2018), in the same way that CBA Maps with accompanying land-use guidelines inform Spatial Development Frameworks on land. In addition, Spatial Biodiversity Plans can inform and streamline environmental decision-making, including Environmental Impact Assessments, in the landscape and seascape. They also inform identification of focus areas for protected area expansion.

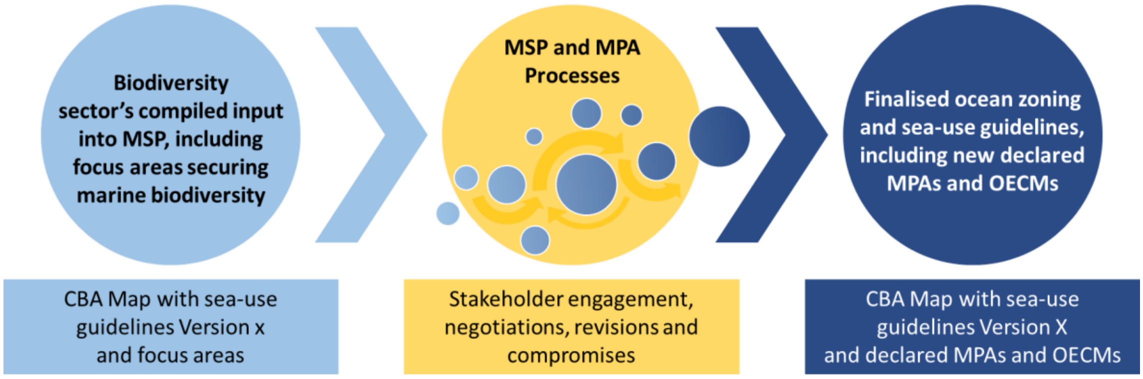


Figure 1. *Conceptual illustration showing how the biodiversity sector's input to the MSP process (including the CBA Map and associated sea-use guidelines Version x, and proposed focus areas for securing marine biodiversity in marine protected areas (MPAs) and other effective area-based conservation measures (OECMs), based on the CBA Map) are incorporated into the MSP and MPA processes. Through substantial stakeholder engagement and negotiations, the proposed biodiversity priority areas are expected to go through several iterations that aim to accommodate other sector's requirements as far as possible, recognising that it is likely that all sectors will need to make compromises to their initial priority areas during MSP negotiations. Once the country's ocean zoning and sea-use guidelines are finalised, new MPAs declared and OECMs established, a final version of the CBA Map and sea-use guidelines will be compiled. Note that the biodiversity priority areas in this latter version of the CBA Map will likely have straight boundaries that follow lines of latitude and longitude for easier implementation at sea, compared to the more organic boundaries in the initial versions.*

Another application of the National Coastal and Marine CBA Map is informing the recommended management of South Africa's Ecologically or Biologically Significant Marine Areas (EBSAs; see Box 3 in Section 4.2.1.2), which will be part of the biodiversity sector's integrated input into the MSP process. EBSAs were conceptualised by the Convention on Biological Diversity (CBD), initially as part of the work on approaches to promote international cooperation and coordination for the conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction. However, the value of identifying EBSAs in areas under national jurisdiction was recognised, and States were urged to do so at the 9th Convention of Parties (COP) in 2009 (decision IX/20). It was also noted that EBSAs may require enhanced conservation management measures (decision X/29) to secure their constituent marine biodiversity, and that this was a matter for States.

South Africa's EBSAs were adopted by the CBD at COP 12 in 2014. Under the current regional Marine Spatial Management and Governance (MARISMA) Programme (see Box 3 in Section 4.2.1.2), South Africa has revised its EBSAs and is preparing management recommendations for each one. It is proposed that EBSAs comprise two zones: a Biodiversity Conservation Zone and an Environmental Impact Management Zone, with recommendations for management per zone. There is alignment in the management objectives of CBAs and the Biodiversity Conservation Zone, and of ESAs and the Environmental Impact Management Zone (see Department of Environmental Affairs 2019; SANBI 2017; and Section 6 below). Therefore, the National Coastal and Marine CBA Map has been adopted as the tool by which South Africa's EBSAs are zoned for recommended inclusion in the national MSP processes. This careful and deliberate alignment of the National Coastal and Marine CBA Map and the EBSA zones is important for identifying a single, coherent portfolio of coastal and marine biodiversity priorities to inform multi-sectoral processes (see Box 3 in Section 4.2.1.2).

1.3. How does the National Coastal and Marine Spatial Biodiversity Plan fit into biodiversity assessment, planning and prioritisation in South Africa?

The National Biodiversity Assessment (NBA) is a primary tool for reporting on the state of biodiversity in South Africa. In this assessment, the threat status and protection level of all ecosystem types and a myriad of species is determined across the entire national territory in four realms: terrestrial, inland aquatic, estuarine and marine, with a cross-realm coastal integration (see Section 2.1). The foundational data (e.g., maps of ecosystem types) and headline indicators (e.g., Ecosystem Threat Status, and Ecosystem Protection Level) that are assessed for the NBA are key inputs into spatial biodiversity planning (Fig. 2). Ecosystem Threat Status gives an indication of the risk of ecosystem collapse, and Ecosystem Protection Level gives an indication of how well protected an ecosystem type is relative to its biodiversity target.

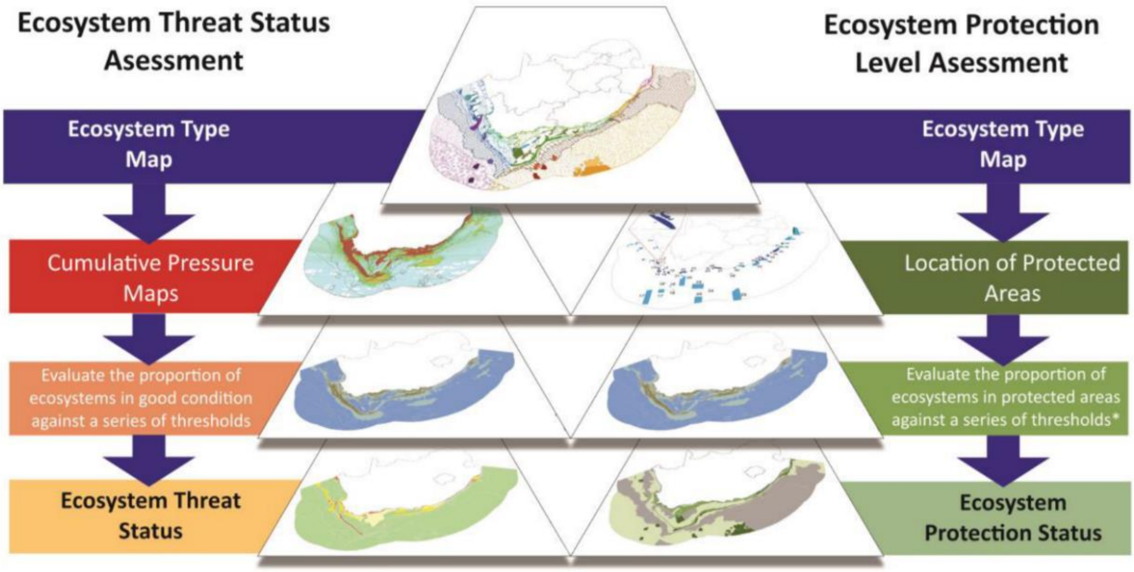


Figure 2. *Steps in assessing Ecosystem Threat Status and Ecosystem Protection Level. *Note the link between ecological condition and protection level: only natural habitat contributes to protection level targets. Figure from: Sink et al. (2019e).*

Spatial biodiversity planning uses a systematic approach to identify a portfolio of priority areas within which biodiversity needs to be secured, and also makes recommendations for conserving and managing those areas. In South Africa, CBA Maps and associated land- or sea-use guidelines are the typical spatial biodiversity planning products (Fig. 3). In the marine realm, EBSAs (see Box 3 in Section 4.2.1.2) are also a form of spatial biodiversity planning, with associated management recommendations. The National Coastal and Marine CBA Map has incorporated the EBSAs so that, as discussed above, there is a single consolidated input from the biodiversity sector into MSP and other multi-sector processes.

Outputs from both spatial biodiversity assessment and spatial biodiversity planning inform spatial biodiversity prioritisation (Fig. 3). The NBA identifies ecosystem types that are under-protected, and the headline indicators of Ecosystem Threat Status and Ecosystem Protection Level (Fig. 2) guide which ecosystem types are highest priority for protection. Spatial biodiversity planning gives the most efficient spatial configuration within which to meet targets for biodiversity. These inputs facilitate identification of focus areas for formal protection in MPAs, which can be explored further in multi-sector negotiations.

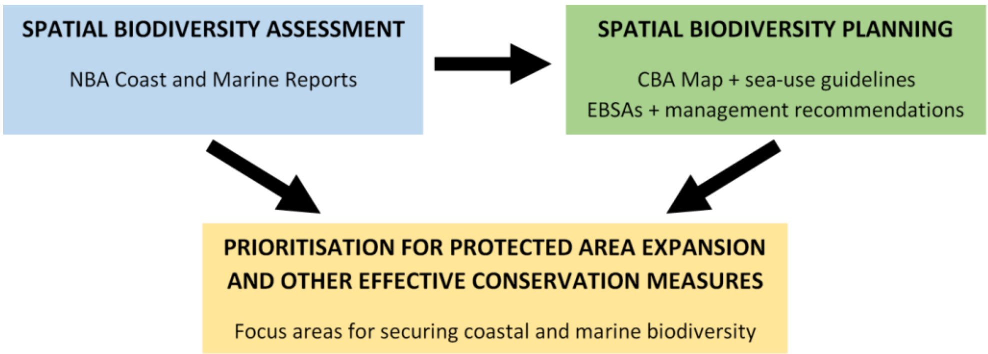


Figure 3. *Conceptual relationships among spatial biodiversity assessment, spatial biodiversity planning and spatial prioritisation in South Africa. (Note that the EBSAs and management recommendations are integrated into the CBA Map and aligned with the sea-use guidelines, respectively; they are not separate products)*

The value of taking this systematic, spatially explicit approach to biodiversity assessment, planning and prioritisation (Fig. 3) is exemplified by the recently declared MPAs in the Phakisa network. These MPAs were underpinned by the spatial biodiversity assessments undertaken in 2004 (Lombard et al. 2004) and 2011 (Sink et al. 2012) and a spatial biodiversity plan that led to the identification and prioritisation of focus areas for MPA expansion (Sink et al. 2011). The MPA network that was declared in 2019, after stakeholder consultation and negotiation, is highly efficient. It represents 87% of the 150 marine ecosystem types in just 5.4% of South Africa's mainland marine territory (Sink et al. 2019d)[2].

1.4. Intended users of the National Coastal and Marine Spatial Biodiversity Plan

This National Coastal and Marine Spatial Biodiversity Plan is intended to be used by managers and decision-makers in those national government departments whose activities occur in the coastal and marine space, e.g., environment, fishing, transport (shipping), petroleum, mining, and others. It is

[2] Note that further protection is required to afford protection to the remaining 13% of ecosystem types, and to further protect ecosystem types that are represented in MPAs but are still not yet 'Well Protected' (Sink et al. 2019c), and to reach South Africa's international obligation of protecting at least 10% of its marine territory.

relevant for the Marine Spatial Planning Working Group where many of these departments are participating in developing South Africa's emerging marine spatial plans. It is also intended for use by relevant managers and decision-makers in the coastal provinces and coastal municipalities, EIA practitioners, organisations working in the coast and ocean, civil society, and the private sector.

1.5. How this document is structured

Following this Introduction, the coastal and marine environment in South Africa is defined and described (Section 2). Background to systematic biodiversity planning is presented, as well as how this is applied in South Africa, including its application in compiling CBA Maps (Section 3). The methodology for developing the National Coastal and Marine CBA Map is described, including descriptions of the planning domain, input layers, biodiversity targets, and analysis methods (Section 4). A second draft of the spatial outputs (Section 5) and accompanying sea-use guidelines are presented and discussed (Section 6), and reference to the coastal land-use guidelines and links to integrated coastal zone management are made (Section 7). Given that this is the first compilation of a National Coastal and Marine CBA Map and sea-use guidelines, attention is paid to data gaps and limitations that need to be addressed in the next iterations of this Spatial Biodiversity Plan (Section 8, Appendix 2).

2. Coastal and marine biodiversity in South Africa

2.1. Defining the ecologically determined coastal zone and South Africa's marine territory

2.1.1. The coastal zone

The land-sea interface is a complex space in which to work, partly because of the myriad of definitions and delineations of "the coast" and "the coastline". A particular challenge has been the spatial misalignment of terrestrial, estuarine and marine maps along their seams within this coastal interface. Importantly, this precluded cross-realm analyses and accurate assessment of coastal biodiversity, and made it difficult to include biodiversity pattern and ecological processes meaningfully in spatial biodiversity plans. This was addressed in the NBA 2018 by integrating the national maps of ecosystem types in the terrestrial, estuarine and marine realms to form a single seamless map of ecosystem types for the first time (Harris et al. 2019a; Skowno et al. 2019a).

The first step toward achieving this seamless integration was to construct a conceptual framework (see Fig. 5 below) for dividing the land-sea interface using boundaries that marked an appropriate divide between the terrestrial and marine realms, and that best represented ecosystem types that occur across the ecotone (transitional zone) between land and sea. The seashore zone, comprising the backshore (foredunes) and shore (from the dune base to the back of the surf zone), was defined, with the backshore marking the seaward edge of the terrestrial National Vegetation Map (Dayaram et al. 2019) and the shore marking the landward edge of the map of marine ecosystem types (Sink et al. 2019a). Delineating the seashore required high-resolution mapping at a fine scale (<1:3000) (Harris et al. 2019a). Estuaries intersect the seashore zone all along the South African coastline, and these too needed to be seamlessly integrated as well (Harris et al. 2019a). In the map of estuarine ecosystem types, estuaries are delineated as the Estuarine Functional Zone (EFZ; Van Niekerk et al. 2019a). Where these intersect the seashore, the EFZ and backshore boundaries were aligned as necessary, and the seaward edge of the EFZ was extended to include the full extent of the shore zone (i.e., to the back of the surf zone). The result of digitizing the seashore (including estuarine shores) at such a high resolution was achieving accurate representation of these very narrow ecosystem types for the first time (Harris et al. 2019a), and facilitating the compilation of the seamless, integrated map of ecosystem types for the entire area under South Africa's national jurisdiction (Skowno et al. 2019a).

Once the maps of ecosystem types were seamlessly aligned, an ecologically determined coastal zone was identified (Harris et al. 2019a), comprising coastal ecosystem types from the terrestrial, estuarine and marine realms (Fig. 4). Inland aquatic features are not included in the ecologically determined coast at this time (Van Deventer 2019). The fundamental principle by which the ecologically determined coastal zone was identified was to select ecosystem types that had an influence from both land and sea (see Harris et al. 2019a for details). Therefore, vegetation types were considered coastal if they had >70% of their extent within 10 km of the dune base and/or the description of the vegetation type in the National Vegetation Map (Dayaram et al. 2019) mentioned a coastal affinity. The vegetation types that matched these criteria were included (full extent per vegetation type) to comprise the coastal terrestrial portion of the map. All estuaries were considered coastal, and were mapped and included as the estuarine functional zone (EFZ). And finally, all marine ecosystem types in the shore and inner shelf zones, and those further offshore that are influenced by outflow from rivers are included in the ecologically determined coastal zone: this is the coastal marine portion of the map (see Fig. 5 for a schematic representation).

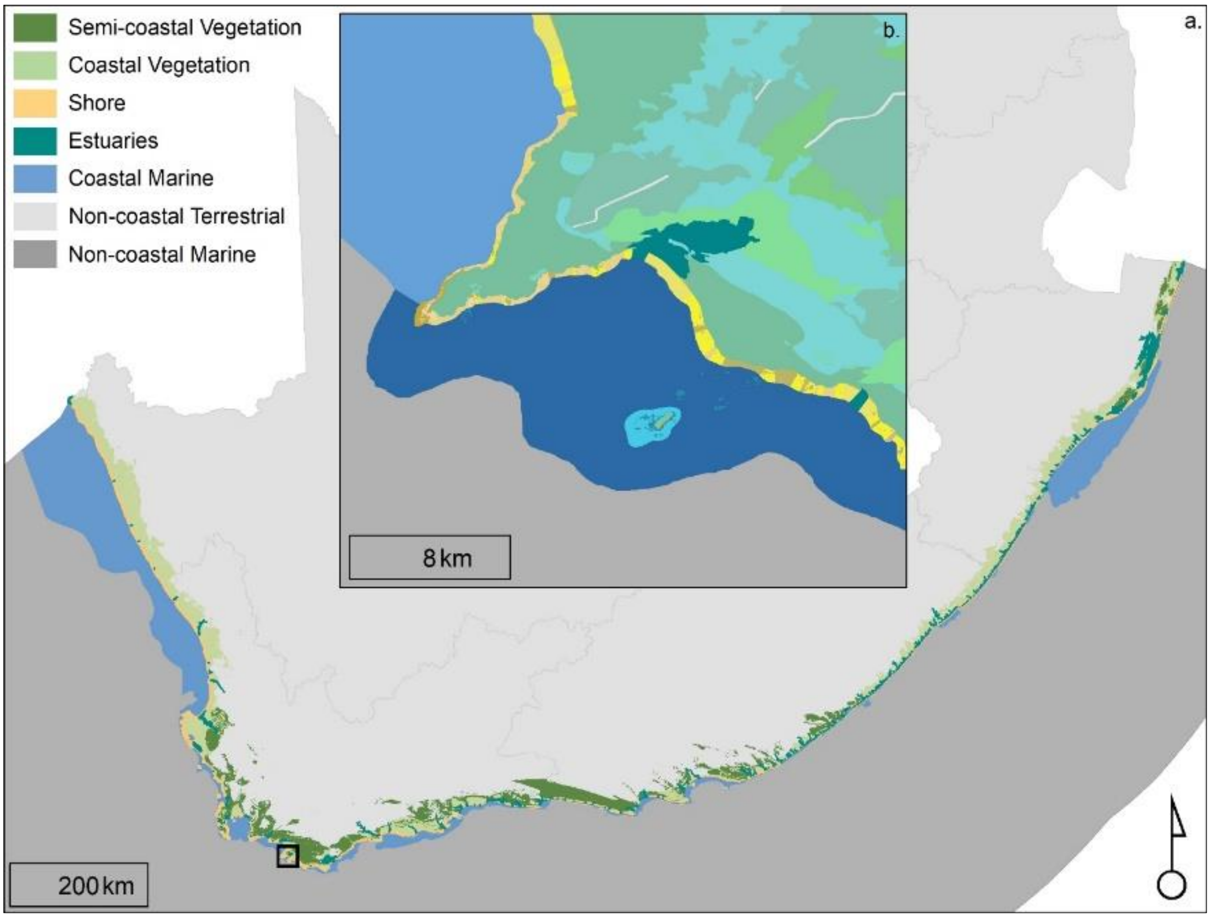


Figure 4. *(a) South Africa's ecologically determined coastal zone given in colour, with the adjacent land and sea shown in grey, showing the portions of the land (terrestrial vegetation types and estuaries) and sea (coastal marine ecosystem types) that comprise the coast. (b) Representing ecosystem types accurately in the coast, especially in the seashore zone, required high-resolution mapping (see Harris et al., 2019a). Note that the legend refers to panel a, with ecosystem types in panel b shown in shades of the same zone colours as in panel a.*

2.1.2. South Africa's marine territory

South Africa's marine territory comprises the territorial seas (extends to 12 nm offshore), and the Exclusive Economic Zone (EEZ; extending from 12 nm to 200 nm offshore) around the country's mainland and the Sub-Antarctic Prince Edward Islands (PEI). Note that in this report, reference to the country's marine territory refers only to that around the mainland. This is the same extent as the Marine Realm in the National Biodiversity Assessment 2018 (Sink et al. 2019f).

2.1.3. What areas are included in the National Coastal and Marine Spatial Biodiversity Plan?

The areas included in the National Coastal and Marine Spatial Biodiversity Plan, referred to as the planning domain, are the ecologically determined coastal zone and marine territory (Fig. 5). This Spatial Biodiversity Plan is explicitly for South Africa's mainland and excludes PEI. (See Lombard et al. (2007) for a systematic biodiversity plan for PEI that underpinned the declaration of the PEI MPA). It is recognised that the ecological definition of the coast is different to the definition of coastal zone in the Integrated Coastal Management Act (No. 24 of 2008; Republic of South Africa 2008). However, the former extent was chosen because an ecological coastal boundary is more appropriate than an administrative one to ensure adequate representation of biodiversity pattern and ecological processes across the land-sea interface. It is also noted that the planning domain covers the entire mainland area under the jurisdiction of the MSP Act (i.e., excluding PEI).

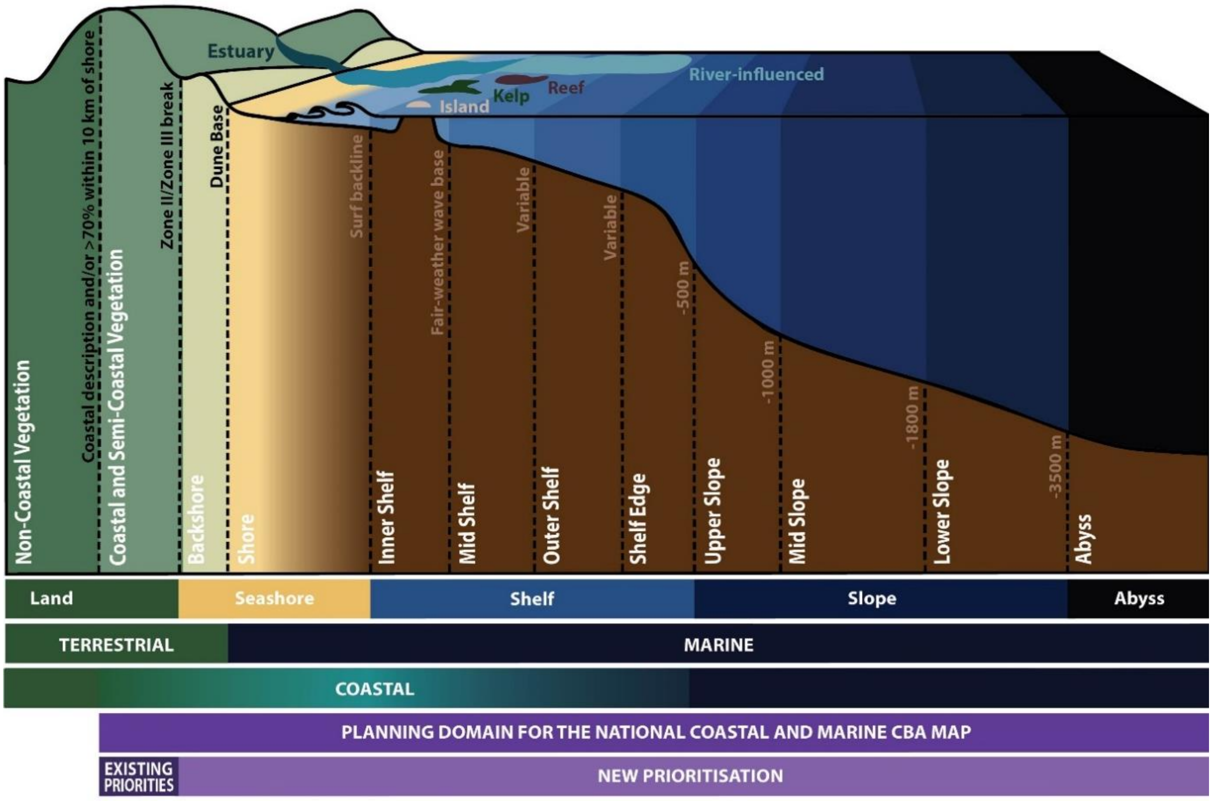


Figure 5. *The planning domain (extent of the National Coastal and Marine CBA Map) includes the coast and the full extent of the marine realm (marine territory). The coast comprises: terrestrial coastal and semi-coastal vegetation types, including those in the backshore; all estuaries; and all marine ecosystem types from the shore and inner shelf, and those ecosystem types that are river-influenced.*

No new planning was done for the land-based portion of the planning domain; only for the area that is seaward of the dune base (Fig. 5; see also Fig. 9 in Section 4.1). The biodiversity priority areas (protected areas, CBAs and ESAs) for the land-based portion of the ecologically determined coastal zone were taken directly from the existing provincial biodiversity plans for the four coastal provinces (Northern, Western and Eastern Cape, and KwaZulu-Natal), which have been developed by (or for) their respective provincial conservation authorities (see Section 4: Methods for details).

2.2. Biodiversity Profile of South Africa's coast and oceans

Coastal and marine biodiversity in South Africa is exceptional. As the southern tip of Africa, the country is influenced by three ocean basins, each with contrasting oceanographic conditions. The west coast is influenced by the Benguela Current that brings cold water from the western and southern portion of the South Atlantic Gyre, with characteristic upwelling in the region resulting in some of the highest marine primary productivity in the world. The east coast is bounded by the warm, fast-flowing Agulhas Current that sweeps warm tropical waters southward along the eastern seaboard. These two currents meet each other and brush past the northern extent of the Southern Ocean along the southern margin of the country.

These three ocean systems give rise to stark contrasts among ecosystems, communities and species on the cool temperate west coast, warm temperate south coast, and subtropical east coast, such that South Africa has 150 marine ecosystem types in 15 broad ecosystem groups. These groups are: Sandy Shores; Rocky and Mixed Shores; Islands; Bays; Kelp Forests; Shallow Reef; Shallow Soft Shelf; Shallow Rocky Shelf; Deep Soft Shelf; Deep Rocky Shelf; Slope; Plateau; Seamount; Canyon; and Abyss (Sink et al. 2019a). These are nested into five ecoregions (Fig. 6), some of which are split further into sub-regions. These ecoregions are: cool temperate Southern Benguela (Namaqua and Cape sub-regions); warm temperate Agulhas; subtropical Natal-Delagoa (Delagoa, KwaZulu-Natal Bight and KZN-Pondoland sub-regions); Southeast Atlantic; and Southwest Indian (Sink et al. 2019a). Although the South African territory includes the sub-Antarctic Prince Edward Islands (PEI) in the Southern Ocean, this report focuses on only the mainland coastal and marine environment and excludes PEI (see also Lombard et al. 2007).

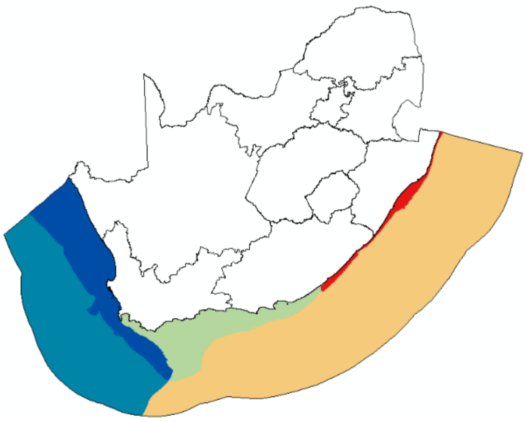


Figure 6. *Five marine ecoregions of South Africa (Sink et al., 2019a): Southern Benguela Shelf (dark blue), South East Atlantic (turquoise blue), Agulhas Shelf (green), Natal-Delagoa Shelf (red), and Southwest Indian (yellow).*

The contrasting ocean currents and differences in topography between the eastern and western portions of the country results in the bulk of South Africa's rain falling on the eastern half of the country. In turn, the vast majority of our 290 estuaries and 42 micro-estuaries are located on the east coast (Van Niekerk et al. 2019a). There are nine types of estuaries, ranging from fluvially dominated to small temporarily closed systems, and four bioregions (Cool Temperate, Warm Temperate, Subtropical, Tropical), giving a total of 22 estuarine ecosystem types, and a further nine micro-system (micro-estuary, micro-outlet, coastal waterfall) ecosystem types (van Niekerk et al. 2020).

South Africa is recognised as a megadiverse country (Mittermeier et al. 1997) because of its phenomenal species richness. Because of the contrasts in productivity and temperature between the west and east coasts, community biomass is generally higher on the west coast, and diversity is higher on the east coast (Bustamante and Branch 1996). Endemism, however, is often highest along the south coast. This is true of beach species and foredune plants (Harris et al. 2014), coastal fish (Turpie et al. 2000), and marine invertebrates (Awad et al. 2002), including decapods (Kensley 1981). Moreover, new species are continually being discovered the more we explore our oceans (e.g., Samaai et al. 2017). To date, it is estimated that South Africa's marine ecosystems support more than 13 000 species (Sink et al. 2019e), with estimates of marine endemism for different groups of taxa ranging between 26 and 33% (Awad et al. 2002; Costello et al. 2010; Gibbons 1999; Griffiths and Robinson 2016; Griffiths et al. 2010). Globally, South Africa is reported as having the third highest marine endemism (28%) after New Zealand (51%) and Antarctica (45%), as well as the third highest number of species per unit area after South Korea and China (Costello et al. 2010). In short, South Africa has a lot to celebrate in terms of its abundant biodiversity, and it is imperative to safeguard this national asset for the myriad of benefits it delivers to people, and as a legacy for future generations.

3. Systematic biodiversity planning: background and application in South Africa

3.1. What is a CBA Map?

A Map of Critical Biodiversity Areas and Ecological Support Areas (CBA Map) presents a spatial plan for the natural environment, designed to inform planning and decision-making in support of sustainable development. The map comprises three main sets of biodiversity priority areas: protected areas, Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) that are jointly "important for the persistence of a viable representative sample of all ecosystem types and species as well as the long-term ecological functioning of the landscape [and seascape] as a whole" (SANBI 2017). Areas not selected as biodiversity priorities are categorised as Other Natural Areas (ONA) or No Natural Remaining (NNR). SANBI has developed Technical Guidelines for CBA Maps (SANBI 2017, hereafter called the Technical Guidelines), which include a requirement for CBA Maps to be based on systematic biodiversity planning principles (see Section 3.3).

For South Africa's mainland, CBA Maps are compiled at a sub-national level, usually at provincial level, and in some cases for individual metropolitan areas. These CBA Maps and accompanying land-use guidelines provide the biodiversity sector's input into numerous multi-sectoral planning and assessment processes that relate to land-use planning and decision making, including municipal Integrated Development Plans and Spatial Development Frameworks. CBAs are also among the features that trigger environmental authorisation processes through the Environmental Impact Assessment Regulations, published under the National Environmental Management Act (No. 107 of 1998). Protected areas and CBAs also feature as part of the Natural Resource and Ecological Infrastructure subframe in the draft National Spatial Development Framework, which was published for public comment in early 2020. In short, CBA Maps are a powerful tool to include the biodiversity sector's spatial priorities into a range of planning, assessment and decision-making processes from the national to local level, with the ultimate intent of securing biodiversity assets and ecological infrastructure in support of long-term sustainable development (SANBI 2017).

To ensure consistency among CBA Maps produced by different planners for different areas and realms (terrestrial, inland aquatic, estuarine and marine), a set of Technical Guidelines was compiled to give clear instructions regarding the technical aspects of the process. For example, the Technical Guidelines state that CBA Maps must be designed from a minimum of four input layers: existing protected areas; ecosystem types; areas important for ecological processes; and a spatial assessment of ecological condition. Additional inputs, such as species of special concern, unique or special habitats or features, ecological infrastructure, and socio-economic constraints can add substantial value where these data are available. These input layers and data are used to prioritise portions of the landscape or seascape in a spatially efficient and connected network of sites that are representative of the biodiversity in the planning domain. This prioritisation is based on a systematic biodiversity plan, which in South Africa is most commonly undertaken using the decision-support tool, Marxan (Botts et al. 2019; see Box 1). The Technical Guidelines thus also provide guidance around target setting for the biodiversity features that are fed into the systematic biodiversity plan, indicating recommendations for the proportion of a feature's extent, number of occurrences, etc that is required to ensure sufficient representation and persistence of that feature. There are also clear instructions on how to translate the input layers and the outputs from the systematic biodiversity plan into the various types of biodiversity priority areas that comprise a CBA Map (Fig. 7).

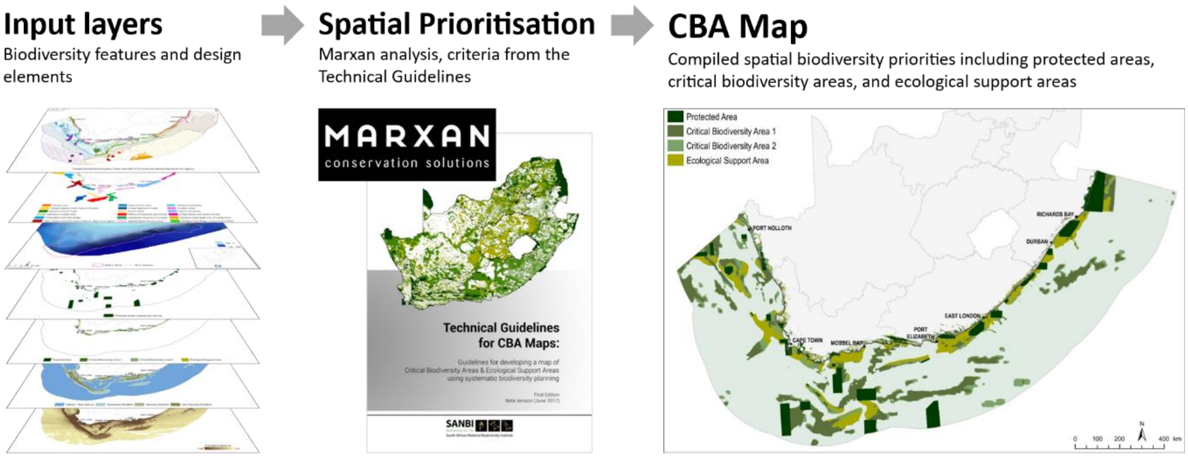


Figure 7*. Schematic diagram indicting the technical process of compiling a CBA Map.*

Table 1*. Definitions of biodiversity priority areas, including the management objective of each category (adapted from SANBI 2017). CBA: Critical Biodiversity Area; ESA: Ecological Support Area.*

Category	Definition	Broad management objective
Protected Areas	Protected areas declared or recognised in the National Environmental Management: Protected Areas Act (No. 57 of 2003)	As per each Protected Area Management Plan
CBA 1	Irreplaceable or near-irreplaceable sites where there are no other options to represent the features they contain in the planning area. Ideally these sites are natural or near-natural, but exceptions can be made if the only sites where a feature exists are degraded.	Must be kept in a natural or near-natural state
CBA 2	Sites that are the best option available for representing the features in a spatial prioritisation. Ideally these sites are natural or near-natural, but exceptions can be made if the only sites where a feature exists are degraded.	
ESA 1	Sites that are not CBAs but are still important for meeting targets for biodiversity and ecological processes. These sites must be in natural, near-natural or moderately modified ecological condition.	Must be kept in at least a functional state (ideally at least in a moderately modified ecological condition)
ESA 2	Sites that are not CBAs but are still important for meeting targets for biodiversity and ecological processes. These sites are generally in severely modified ecological condition.	

The identified biodiversity priority areas are divided among three main map categories: protected areas, CBAs and ESAs, with CBAs and ESAs each divided further into two sub-categories: CBA 1 and CBA 2; ESA 1 and ESA 2 (Table 1). The split between CBA classes is based on how irreplaceable the features are in the landscape or seascape, and the split between ESA classes is based on the ecological condition of the sites. However, these sub-category splits do not change the management objective of the main map category. It is emphasised that protected areas are a separate map category and are not a subset of CBAs or ESAs. Further, none of the map categories overlap: a site is allocated to only one map category.

3.2. Origins of systematic biodiversity planning

Historically, nature conservation reflected the thinking of the time: that humans were separate from the environment and so biodiversity was protected by fencing off areas of wilderness (Mace 2014). However, design and placement of land-based protected areas was often ad hoc, poorly accounted for biodiversity representation, largely comprised areas that were unsuitable for urban development or agriculture, and in hindsight, were very inefficient solutions (Pressey 1994). As the understanding of people's relationship with nature grew through time (Mace 2014), so too did methods for designing appropriate protected areas until, at the turn of the century, systematic conservation planning was formally defined (Margules and Pressey 2000). In this seminal paper, systematic conservation planning is defined as a six-stage process that aims to achieve representation and persistence of biodiversity in an efficient portfolio of priority areas that is in least conflict with competing uses and users, often with limited resources (Margules and Pressey 2000). These steps, as listed and described by Margules and Pressey (2000), are:

1. Compile data on the biodiversity of the planning region
2. Identify conservation goals for the planning region
3. Review existing conservation areas
4. Select additional conservation areas
5. Implement conservation actions
6. Maintain the required values of conservation areas

Although systematic conservation planning was initially used to design protected area networks, this has been extended to broader land-use planning (Botts et al. 2019). Given this broader application of systematic conservation planning in South Africa, it is more appropriately referred to as systematic biodiversity planning. Having tools such as systematic biodiversity planning available means that as spatial planning unfolds in the marine realm, the past inefficiencies in land-based protected area design can be avoided. This has already been demonstrated in South Africa: the new MPA network, designed with systematic biodiversity planning, represents 87% of the 150 ecosystem types in just 5.4% of the mainland marine territory (Sink et al. 2019d).

Initially, practitioners in South Africa (and globally) used custom algorithms to undertake systematic biodiversity planning until specialised software became available (Botts et al. 2019), with the most commonly used programmes including Marxan (Ball et al. 2009; see Box 1 below), C-Plan (Pressey et al. 2009) and Zonation (Moilanen et al. 2009a). In South Africa, Marxan is most commonly used (Botts et al. 2019), and is the algorithm used for this National Coastal and Marine Spatial Biodiversity Plan. Marxan is the abbreviation for *"marine reserve design using spatially explicit annealing"*, although it is commonly used beyond the marine realm. Using an algorithm to search the decision space is substantially more accurate and efficient compared to doing it by hand. Because a site can either be selected or not selected as a biodiversity priority area, a planning domain divided into 100 000 planning units can have 100 000^2 (10 billion) possible solutions. The National Coastal and Marine CBA Map had nearly four times as many planning units, where a planning domain with 400 000 planning units would have 160 billion possible solutions. The algorithm searches the decision space far quicker than is humanly possible to find the most efficient way to meet targets for all the biodiversity features in a configuration that is in least conflict with other activities.

Box 1. Technical explanation of Marxan

The minimum set problem formulation, in its simplest form, is defined in the equations below (Moilanen et al. 2009b):

$$\min \quad \sum_{i=1}^{N_s} c_i x_i$$

given the constraints that

$$\sum_{i=1}^{N_s} x_i r_{ij} \geq T_j \quad \text{for all features } j$$

$$\text{and} \quad x_i \in \{0,1\} \quad \text{for all sites } i$$

where N_s is the number of sites, c_i is the cost of site i, r_{ij} is the occurrence level of feature j in site i, and T_j is the target level for each feature j. The Boolean control variable x_i has value 1 for selected sites, and value 0 for sites not selected.

Marxan uses simulated annealing to solve this algorithm. It seeks to meet feature targets across the decision space with the least conflict to competing sectors or activities (cost) by evaluating different combinations of selected planning units. With each iteration in the routine, Marxan either selects or unselects a planning unit and evaluates if this improved or worsened the overall score, initially allowing increases in score to avoid falling in local minima such that the global minimum score can be found (or at least, closely approximated; Fig. 8). By including a penalty term for boundary length (the boundary length modifier), Marxan also has to trade off higher penalties for having fragmented solutions of very low cost and selecting planning units of higher cost but that comprise neat, compact selections.

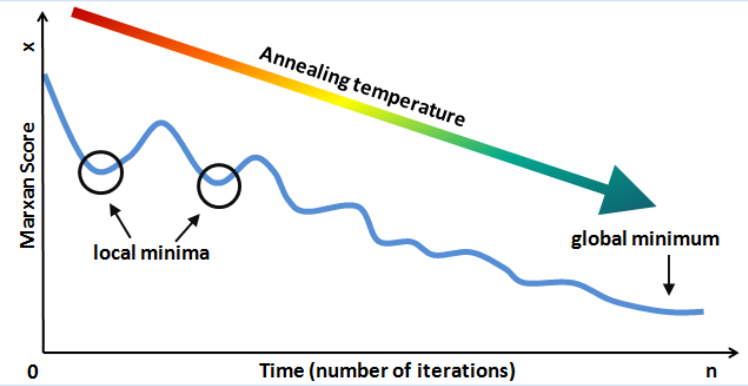


Figure 8. *Illustration of how the Marxan score (0 - x; blue line) could change over time (where time is measured as the number of iterations in the routine; 0 - n). The Marxan score decreases with every "good move", and increases with every "bad move". Early in the routine (when the annealing temperature is high), bad moves are accepted to prevent the algorithm from slipping into a local minimum, but fewer of these are allowed as the annealing temperature cools (coloured arrow). If the routine duration is long enough (user-defined number of iterations), then the solution should come close to achieving the global minimum. (Figure from Harris*

Given that Marxan is a minimum set algorithm, complementarity and efficiency are at its core. By the end of the routine, it selects a portfolio of sites such that user-defined biodiversity targets are met for all features at the lowest cost to competing activities and in the most efficient configuration. Calibrating parameters (see below) allows for optimal clustering of selected sites without large increases in cost for minimal improvements in clustering.

Note that the most recent developments in the international arena have been to implement systematic biodiversity planning in the statistical coding programme, R (R Core Team 2016), using integer linear programming (Beyer et al. 2016; Hanson et al. 2020) instead of simulated annealing. In this way, the global minimum is calculated rather than approximated (see Fig. 8), and processing time is faster. Future iterations of the Coastal and Marine CBA Map may include this approach once the new method has been mastered, particularly in terms of identifying the optimal sites for meeting biodiversity targets (i.e., CBA 2).

3.3. Principles and essential characteristics of systematic biodiversity planning

The Technical Guidelines highlight three principles of systematic biodiversity planning that need to be reflected in a CBA Map: representation, persistence and target setting (SANBI 2017). The principle of representation is that a sufficient sample of all biodiversity is selected for inclusion in the priority areas; and the principle of persistence requires maintaining the ecological processes for biodiversity to persist over time, particularly in the face of rapid global change. Fundamental to realising both principles is setting and achieving quantitative biodiversity targets for mapped (surrogates of) biodiversity pattern and ecological processes.

For the National Coastal and Marine CBA Map, representation was achieved by using the National Map of Marine Ecosystem Types (Sink et al. 2019a) as the surrogate for marine biodiversity, and setting quantitative biodiversity targets for all ecosystem types. Achievement of these targets was assessed as part of the methodology (see Section 4 below for more details, and Appendix 1). Further effort is needed to increase and consolidate species atlas data for future inclusion to support species representation in the Coastal and Marine Spatial Biodiversity Plan, especially for those taxa for which ecosystem types are not a good surrogate of their distributions.

Fully addressing the principle of persistence is a current limitation of the Plan, and an area requiring more research and engagement with the scientific community. Seascape connectivity is fundamentally different to landscape connectivity, and the approaches to defining and mapping ecological corridors on land are not necessarily applicable in sea. Marine ecological processes are currently accounted for by having higher biodiversity targets for special ecosystem types (i.e., types that are more diverse, more sensitive and have a disproportionately high contribution to ecological processes compared to other ecosystem types), such as canyons, seamounts and reefs. Ecological processes were also accounted for by including the full extent of Ecologically or Biologically Significant Marine Areas (EBSAs), many of which were delineated to include sites of key ecological processes (e.g., sites of importance for key life-history stages and areas of high productivity; Box 3 in Section 4.2.1.2). Detailed suggestions to address these limitations in the future are given at the end of the Methods (Section 4).

In implementing the three principles above, there are five essential characteristics of systematic biodiversity planning (listed below) that are required in a CBA Map (SANBI 2017).

1. **Complementarity and spatial efficiency** relate to selecting sites with complementary assemblages of biodiversity rather than hotspots of biodiversity to represent all species in the most compact, spatially efficient configuration. This was addressed by using Marxan to select the priority sites. As described above, Marxan accounts for these attributes by being a minimum-set algorithm and selecting the most efficient portfolio of planning units that meet feature targets. It achieves this by selecting complementary sites rather than all sites of highest diversity (i.e., 'hotspots' that, collectively, may not be representative of all biodiversity in the planning domain).

2. **Conflict avoidance** relates to meeting biodiversity targets in areas that avoid as much competing use for those same areas as possible. This was addressed by including a cost layer in the Marxan analysis, which is a map of cumulative pressures to (i.e., other activities in) the marine environment that was developed for the NBA 2018 (Majiedt et al. 2019; but see Section 8.1.1 for plans to enhance conflict avoidance in the cost layer through improved representation of high-value areas for other sectors). Marxan seeks to meet targets for the lowest cost, i.e., with the least conflict to existing uses and users of the marine environment, as far as possible. In some cases, avoiding conflict may not be possible, e.g., for rare or Critically Endangered features that are in an area of use by another sector.
3. **Connectivity** relates to the connectedness of the selected sites in a way that makes provision for species to move along geographic, climatic, productivity and oceanographic gradients. It is addressed by focussing on including networks of sites that could facilitate range shifts in species' distributions as they respond to climate change. As a first step, in addition to the existing MPA network, the entire EBSA network was included. MPAs and EBSAs are jointly considered to be connected networks of priority areas. It is recognised that the connectivity among these areas will need further testing, for example, in terms of species' dispersal distances (see Box 2 below). Notwithstanding, landscape-scale ecological corridors are appropriate and essential for the coast. Therefore, connectivity is addressed by including the existing land-based biodiversity priority areas (see Section 4.2.1), and edge-matching the coastal marine priority areas to ensure contiguous, land-sea, catchment-to-coast connectivity.[3]
4. The input layers are all based on quantitative data and have quantitative biodiversity targets, both of which follow the requirements and recommendations in the Technical Guidelines, with priority sites selected by the Marxan algorithm. Therefore, the selection of priority areas is objective, and **data driven**.
5. The prioritisation is made **explicit and repeatable** by detailing all steps taken during the planning process in this technical report.

[3] There are intended revisions of the National Estuary Biodiversity Plan (pending confirmation of funding) and the national map of Freshwater Ecosystem Priority Areas (FEPAs). Together with this Coastal and Marine CBA Map, the intention is to deliberately and explicitly edge-match priorities from freshwater catchments, through estuaries to offshore river-influenced marine ecosystem types, both up- and downstream, to enhance land-sea connectivity in the respective plans.

Box 2: Including connectivity in systematic biodiversity planning: brief overview of the literature

Connectivity is highlighted here because it underpins one of the requirements of a CBA Map: to include ecological corridors that facilitate metapopulation connectivity and species' range shifts as part of achieving persistence of biodiversity. However, connectivity in marine planning is different to that in terrestrial planning because the oceans are fundamentally more connected than the land because of the water medium. This has key implications for designing the required large-scale ecological corridors, as per the Technical Guidelines (SANBI 2017). After reviewing the scientific literature and discussing this issue with the broader biodiversity planning community in South Africa, it was decided that having a well-designed network of sites in the marine realm that could facilitate species' range shifts (e.g., be suitably sized and spaced) is more appropriate than including ecological corridors in the same way that they are delineated and included in terrestrial plans. As a first step, in addition to the existing MPA network, connectivity is addressed in this plan by including the entire EBSA network, recognising that this is an aspect of the CBA Map that needs testing and refinement (see also Annexure 1).

Including connectivity in biodiversity plans for the marine environment is an area of active research, globally. As noted above, the oceans are fundamentally more connected than is the terrestrial environment. Furthermore, the concept of designing corridors for maintaining ecological processes (e.g., animal migration routes, climate-change-adaptation corridors, connections between sites of importance for life-history stages) is also different because there are many activities that can block species movement on land, whereas in the sea, numerous activities may occur at the same place (e.g., shipping, longline fishing), and still be permeable enough to allow connectivity through the rest of the water column. It has thus been argued that accounting for connectivity in marine planning relates more to the sizing and spacing of protected areas in connected networks than including corridors *per se.*

Notwithstanding, there are several tools by which connectivity can be included. These tend to be data-intensive from sampling by electronic tracking (telemetry), capture-mark-recapture, *in situ* observations (e.g., visual surveys), stable isotope ratios, population genetics and passive acoustic monitoring (Dunn et al. 2019). Consequently, these are generally applied in marine plans covering a small planning domain or for specific taxa, e.g., for migratory or nomadic birds. For example, to include dynamic distributions of species requires sampling over the animals' full home range over multiple seasons and years (Runge et al. 2015). By modelling the distribution at multiple timesteps, critical areas in the home range can be identified and prioritized (Runge et al. 2015; Runge et al. 2016). From tracking data of migratory species, connectivity matrices can be compiled and summed to get a surface of relative importance for connectivity across the seascape for the migration (Beger et al. 2015). Currently, there are global efforts to synthesize information on animal movement to inform international marine policy that guides conservation, e.g., the MiCO system (Dunn et al. 2019; https://mico.eco).

Other options are to include spawning areas as biodiversity features with a buffer representing "fish spawning area catchments" and setting a target of 50% (Beger et al. 2015). This can be supplemented with larval dispersal models that account for pelagic larval duration, survival rates and behaviour (Beger et al. 2015) to determine how near to each other sites need to be for connectivity to be maintained. Most recent is the development of a new application called Marxan Connect (Daigle et al. 2020). It allows inclusion of different types of connectivity calculated from demographic data (e.g., dispersal models, tracking data) and/or landscape data (e.g., isolation by resistance). Options like this and other tools, such as using circuit theory to incorporate connectivity in spatial planning (Dickson et al. 2019), provide opportunities to strengthen inclusion of ecological connectivity in the Coastal and Marine CBA Map, depending on data availability as required by the different tools. These options will be explored in future iterations of the CBA Map.

4. Methods

This section explains the methods used to develop the National Coastal and Marine CBA Map Version 1.0 (Beta 2), including delineation of the planning domain and planning units; input layers and biodiversity targets; and details on technical methods and parameter calibrations. In Version 1.0 (Beta 2) of the National Coastal and Marine CBA Map, the focus has been on strengthening conflict avoidance in the cost layer, and including more biodiversity data (e.g., certain species' distributions) that are not adequately represented by ecosystem types. Next iterations will continue to strengthen these aspects, and well as include a more comprehensive suite of ecological processes (e.g., areas of high productivity, corridors for migratory species, etc; see Appendix 2 for a desktop analysis of proposed data to source and include in future iterations). As noted above (Section 1.1), the overall goal is to safeguard a sufficient, representative sample of coastal and marine biodiversity that can persist into the future, in support of sustainable economic development.

4.1. Planning domain

The planning domain for the National Coastal and Marine CBA Map includes the entire ecologically determined coastal zone and the mainland marine territory (Fig. 9; see also Section 2.1 and Fig. 5). However, no additional spatial prioritisation was done landward of the dune base. Rather, the existing biodiversity priority areas from the provincial biodiversity plans for the four coastal provinces were used (Fig. 5). Protected areas, CBAs and ESAs within the footprint of the ecologically determined coast were extracted and the protected areas and CBAs were included in the systematic biodiversity plan to ensure proper edge-matching across the land-sea interface as a design element (see Section 4.3).

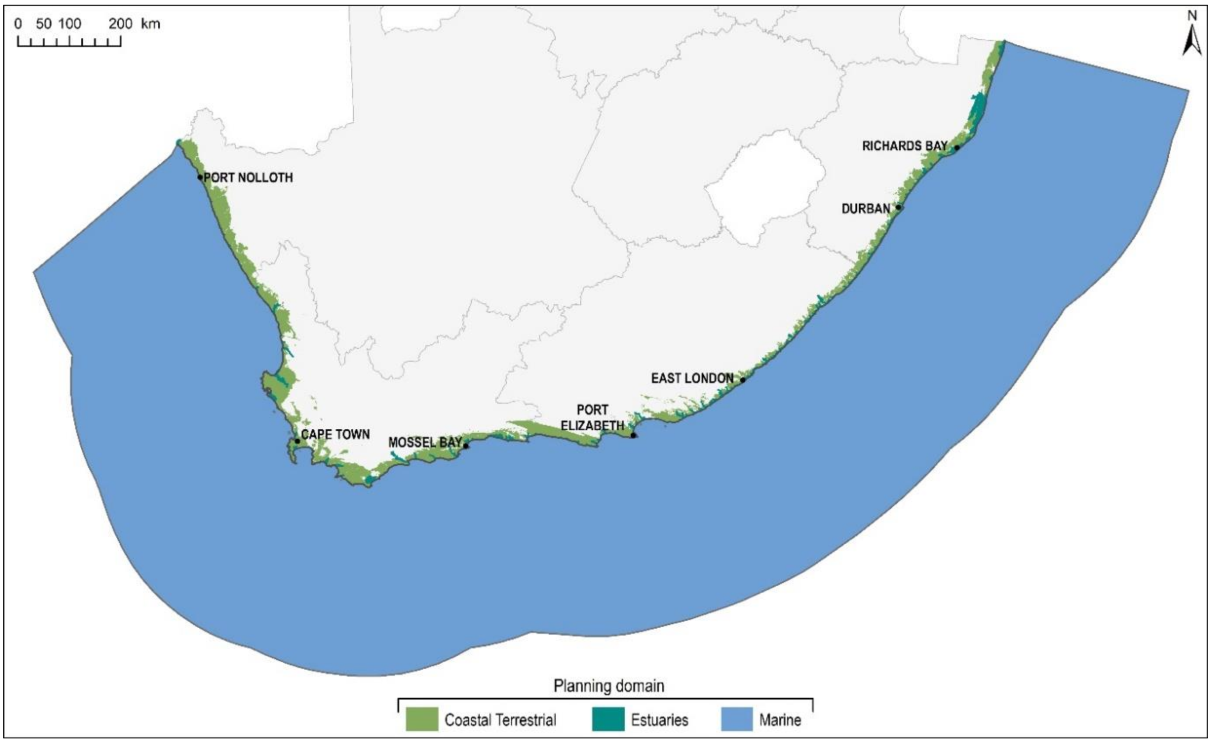


Figure 9. *Planning domain, including the coastal terrestrial area, estuaries, and the marine territory. Note, though, that new spatial priorities were identified in the marine territory only; existing biodiversity priority areas were included for the land-based portion of the National Coastal and Marine CBA Map. (Data source: Harris et al. 2019a; Sink et al. 2019a).*

4.2. Planning units

Previous spatial prioritisations for the marine realm used a 5' grid (e.g., Majiedt et al. 2013; Sink et al. 2011). Given improvements in the input data, especially fine-scale coastal ecosystem types, a 1' grid was used that extended 5 km inland (for aligning with terrestrial biodiversity priorities) and 5 km into Namibian waters (to align with their marine biodiversity spatial priorities). There is already transboundary protection between South Africa and Mozambique and so further alignment there was not considered necessary. Note that planning units outside of South Africa's marine territory (i.e., on land and in Namibia) were not included in the map of marine biodiversity priorities; they were used only as a design element to align priorities. The marine priorities were confined to the marine territory, and the land-based priorities were trimmed to the dune base to create a seamless CBA Map. This coastal integration will be improved in future iterations (see Section 8.2). As a step towards refining the land-sea integration of priority areas, the delineation of the 1-min grid units was intersected with the shore zone from the NBA 2018 Coast map to better attribute data to planning units in this very narrow zone, and either side of it (see also Section 8.2). Altogether, there are 387843 planning units in the National Coastal and Marine CBA Map Version 1, Beta 2.

4.3. Biodiversity input layers

The National Coastal and Marine CBA Map is built using a series of input layers in two classes: biodiversity features; and design elements. The biodiversity features include ecosystem types; species; unique or special habitats or features; culturally significant areas; ecological processes; ecological infrastructure; climate resilience; and existing priority areas. The design elements relate to edge-matching and aligning priority areas across land-sea and shared international boundaries; ecological condition; and known, fragile areas. The list of features included in the spatial plan is growing and the number of datasets in each of these categories that are used in the spatial biodiversity plan is expected to increase. See Appendix 2 for lists of all the features that are intended to be included in future iterations of the National Coastal and Marine CBA Map. The biodiversity input layers are each presented and briefly described below; the details on each dataset will be expanded in future iterations of the report.

A more comprehensive suite of biodiversity features will be included in the next iteration of the CBA Map (26 February 2021). To contribute data, see the EBSA Portal for options. Deadline for data submissions: 31 January 2021

4.3.1. Ecosystem types

4.3.1.1. Coastal and marine ecosystem types

Ecosystem types (Fig. 10) are one of the primary surrogates of biodiversity in systematic biodiversity plans (Botts et al. 2019). Updated maps of ecosystem types were created for all realms during the National Biodiversity Assessment 2018, allowing seamless integration of the maps across the land-sea interface for the first time (see also Section 2.1). This map thus represents the latest information in ecosystem classification for the entire country.

Altogether, there are 254 ecosystem types in the planning domain. This includes 79 coastal vegetation types; 25 estuary ecosystem types (including three micro-estuary types); and 150 marine ecosystem types. Full details on coastal and marine ecosystem classification are available in Harris et al. (2019a) and Sink et al. (2019a). See also Dayaram et al. (2019) for terrestrial vegetation, van Niekerk et al. (2020) for estuaries, and Van Deventer (2019) for an explanation of why inland aquatic features are not included in the coastal ecosystem map. Note, though, that because new prioritisations were done for just the marine component, only the 150 marine ecosystem types were included in the Marxan analysis; spatial priorities for the other 104 ecosystem types came from the existing land-based plans.

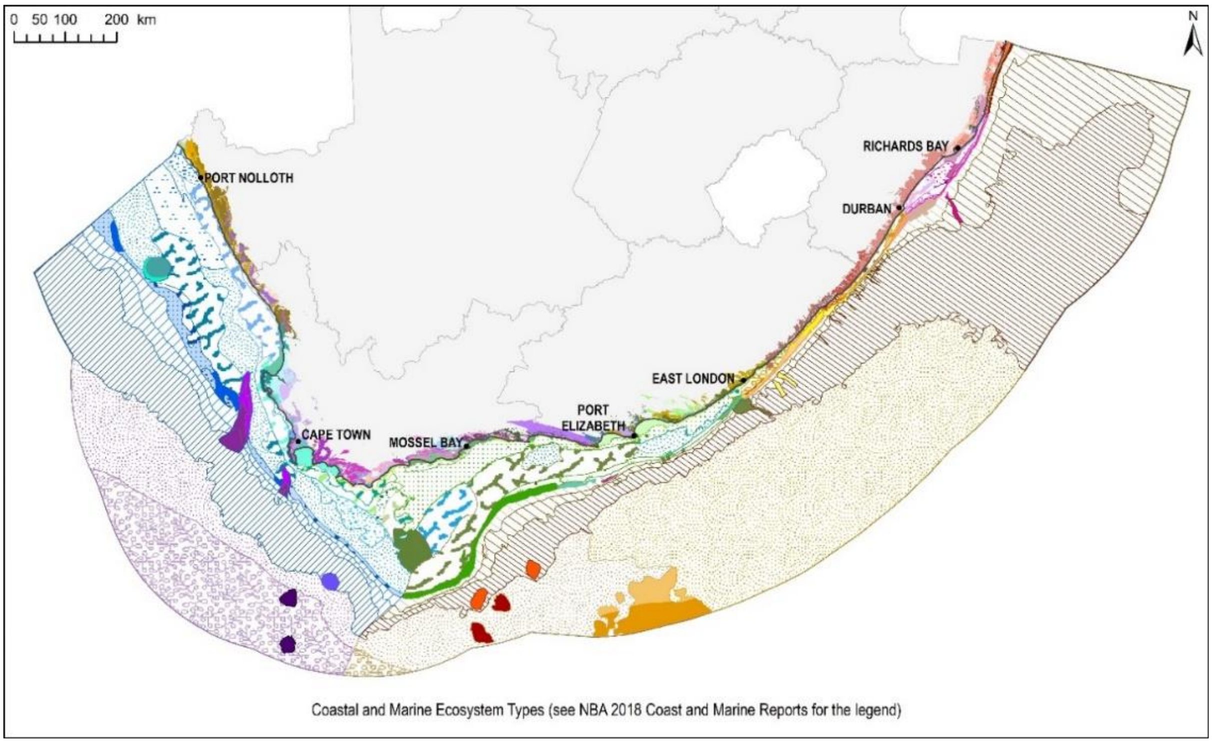


Figure 10. *National maps of coastal and marine ecosystem types. (Data source: Harris et al. 2019a; Harris et al. 2019b; Sink et al. 2019a).*

4.3.1.2. Pelagic ecosystem types

The pelagic bioregionalisation by Roberson et al. (2017) identified 16 different pelagic ecosystem types in South Africa based on sea-surface temperature, chlorophyll-*a*, net primary productivity, mean sea-level anomalies, seabed slope and depth. These 16 pelagic ecosystem types were included in the CBA Map.

4.3.2. Species

4.3.2.1. Turtles

Turtle information was included in three different categories: nesting grounds (digitized from information drawing from Harris et al. 2015; King 2019; Nel et al. 2013); internesting areas (Harris et al. 2015); and migration routes for loggerheads (*Caretta caretta*) and leatherbacks (*Dermochelys coriacea*) (Harris et al. 2018). Planned updates include adding in the latest tracking information to include data on green turtles, hawksbills, key turtle foraging areas, and the juvenile life-history stages.

4.3.2.2. Seabirds

Maps of seabird and shorebird distributions are in preparation by BirdLife South Africa and will be included in the next iterations of the CBA Map. Data included now are seabird colonies, and approximated foraging areas of four Endangered species: African Penguins, Cape Gannets, Cape Cormorants, and Bank Cormorants as used in Majiedt et al. (2013).

4.3.2.3. Cetaceans

Range maps of Indo-Pacific Humpback Dolphins, Heaviside's Dolphins, Indo-Pacific Bottlenose Dolphins, Southern Bottlenose Whales, Common Dolphins, Killer Whales, and Risso's Dolphins were included from Purdon et al. (2020a). The next iteration will include distributions of Dusky Dolphins, False Killer Whales (Purdon et al. 2020a), Sperm Whales, Bryde's Whales, Humpback Whales and Southern Right Whales (Purdon et al. 2020b).

4.3.2.4. Seals

Seal colonies were included in this iteration (Kirkman et al. 2013). In future, seal foraging areas will be included as well. This will draw from seal tracking work done at three of the colonies by Botha et al. (2020).

4.3.3. Unique or special habitats or features

4.3.3.1. Unique habitats or features

Mallory slope was identified as a unique geomorphic feature in South Africa's marine territory that is currently not represented in an MPA. It lies in the Agulhas-Falkland Fracture Zone and the escarpment slopes steeply, with a 3-km drop over 14 NM (Fig. 11).

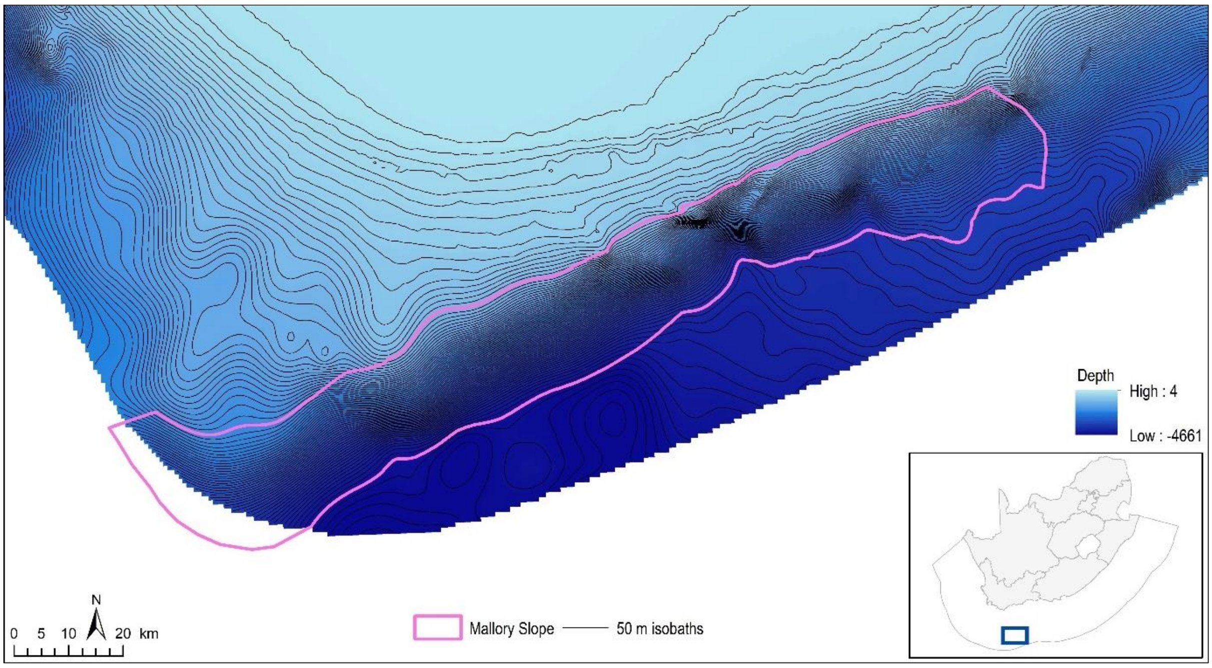


Figure 11. *Mallory slope was digitised by tracing the bathymetric contours at the top and bottom of the steep slope. Note the substantial decrease in depth (m) across the slope. (Bathymetry data source: De Wet 2012).*

Childs Bank is also a unique geomorphic feature in South Africa's marine territory. It was recently afforded protection in the new Childs Bank Marine Protected Area. *In situ* underwater observations, particularly from the ACEP projects, have discovered several unique or rare (as far as we know) features. These include anemone gardens, and rhodolith beds. The Alexandria dunefield is a unique coastal feature, located more on the land-based portion of the CBA Map. It is the largest mobile active dunefield in the southern hemisphere, and a salient feature of South Africa's seashore that also contains shell middens.

4.3.3.2. Special habitats or features

There are six different types of special habitats or features included in this iteration, located in the coastal zone and further offshore. The estuary mouths of flagship and non-flagship free-flowing rivers were included as special habitats. Their inclusion also contributes to improving alignment of priorities from catchments through to the coast, and strengthening connectivity between land and sea by including these "pinch-points" of connection. Whale-associated bays are special areas associated with supporting key life-history stages of whales, including foraging and nursery areas (see also Best 2000); further engagement with the marine mammal scientists is required to refine this layer. Whale-associated bays also contribute to societal benefits by underpinning some ecotourism ventures (i.e., whale-watching). Potential cold-water coral reefs and potential vulnerable marine ecosystems (VMEs) based on fragile and sensitive features or the presence of their indicator taxa (Atkinson and Sink 2018) were included. The distribution of these species was based on 10 years of DEFF demersal trawl surveys. Many of these species are particularly slow growing, and recovery from impacts is often notably slow. The features were identified based on ongoing visual survey work, largely from the ACEP cruises, with ongoing work to support the identification and management of VMEs in South Africa (Sink and Atkinson 2020).

4.3.4. Culturally significant areas

An initial, preliminary compilation of heritage-related data is included in this iteration of the CBA Map. These include locations of fish traps (including historical and currently used traps), as well as a compilation of key coastal sites. Examples of the latter are some of South Africa's coastal caves and archaeological sites, (e.g., Pinnacle Point, Blombos cave), shell middens (e.g., Paternoster Midden, Mussel Point), and sites with cultural and heritage value, e.g., Hole-in-the-wall, Gompho Rock, and Shaka's Rock. This work will be expanded through the CoastWise project, where more comprehensive maps of culturally significant areas will be developed.

4.3.5. Ecological processes

4.3.5.1. Productivity

Beaches with surf diatom accumulations are globally rare, and South Africa has several sites that support these accumulations, primarily along the south coast (Campbell 1996). Surf diatom accumulations contribute to particularly high productivity for those associated beach and surf-zone communities (Campbell 1987; Campbell and Bate 1988). Beaches with beach-cast kelp similarly have elevated productivity, with the wrack piles also playing a key role in carbon efflux (Coupland et al. 2007). Future iterations of the CBA map need to take upwelling explicitly into account as well, noting that it is partly accounted for in some of the EBSAs that rank high for productivity. Productivity was also included as part of the pelagic bioregionalisation and thus, the pelagic ecosystem types (Roberson et al. 2017).

4.3.5.2. Spawning, nursery and aggregation areas

Spawning and nursery areas are critically important for securing fishing and food-provisioning opportunities into the future. Such areas that were included in this iteration are the shores of estuaries ranked with DEFF's fish-nursery importance rating (Van Niekerk et al. 2019a; Van Niekerk et al. 2019b); squid spawning areas (Roberts et al. 2012); areas with high sardine and anchovy egg densities (Twatwa et al. 2005); Red Steenbras spawning areas; Wreck Fish aggregation sites; and Giant Guitarfish aggregation sites.

4.3.6. Ecological infrastructure

Ecological infrastructure (EI) plays a key role in delivering nature-based benefits to people. Two types of EI were included in this iteration: coastal protection EI, and recreational outdoor activities and sports events EI. This is based on novel techniques for mapping EI and quantifying associated ecosystem service demand, capacity, flow and delivery as part of a PhD thesis by Perschke (in prep).

4.3.7. Climate resilience

Algal dominated reefs have high contributions to carbon sequestration and thus contribute to climate resilience. Only a few localities where such reefs occur are known for South Africa, based on visual surveys, and these sites were all included as a first step toward including climate resilience in the CBA Map. Future iterations of the CBA Map will aim to strengthen climate resilience in the design.

4.3.8. Existing priorities

4.3.8.1. Ramsar sites

South Africa's Ramsar sites were included to encourage selection of these areas. All of these sites are land-based and/or are already located in protected areas, and thus served more as a design element to align priorities.

4.3.8.2. Important Bird and Biodiversity Areas

The confirmed marine IBAs were included to encourage selection of these key areas for seabirds and shorebirds. Most of these sites are land-based and/or are already located in protected areas, and thus – like Ramsar sites – served more as a design element to align priorities.

4.3.8.3. Network of Sites of Importance for Marine Turtles in the Indian Ocean – South-East Asia Region

iSimangaliso (previous Maputaland and St Lucia MPAs) was one of the first sites adopted into this network of sites of importance for turtles that was established by the Indian Ocean and South-East Asia Sea Turtle Memorandum of Understanding under the Convention on Migratory Species. iSimangaliso is recognised for its value for hosting nesting loggerhead (regionally Vulnerable) and leatherback (regionally Critically Endangered) turtles during the breeding season, as well as serving as foraging and nursery areas for green turtles and hawksbills.

4.3.8.4. Ecologically or Biologically Significant Marine Areas

There are 23 EBSAs that are wholly or partially under South African jurisdiction. Five of these EBSAs extend into the high seas, including one at Prince Edward Islands, and are not shown or considered here. Of the 18 other EBSAs, three are shared with neighbouring countries: two are shared with Namibia and one with Mozambique (Fig. 12). More details on EBSAs in South Africa are given in Box 3 below, but briefly, they are based on a previous systematic biodiversity plans, and have been refined since their original description and delineation based on new data (MARISMA Project 2020c). These areas were included as an input dataset because they are existing, recognised priority areas for coastal and marine biodiversity in South Africa, and thus need to be integrated into the CBA Map to form part of the single, coherent input from the biodiversity sector into multi-sector processes like MSP (see Fig. 1). Further, together with the MPAs, EBSAs represent a network of sites that are important for biodiversity, and contribute towards including connectivity in the CBA Map. They also encompass areas that are important for ecological processes, e.g., productivity and key life-history stages.

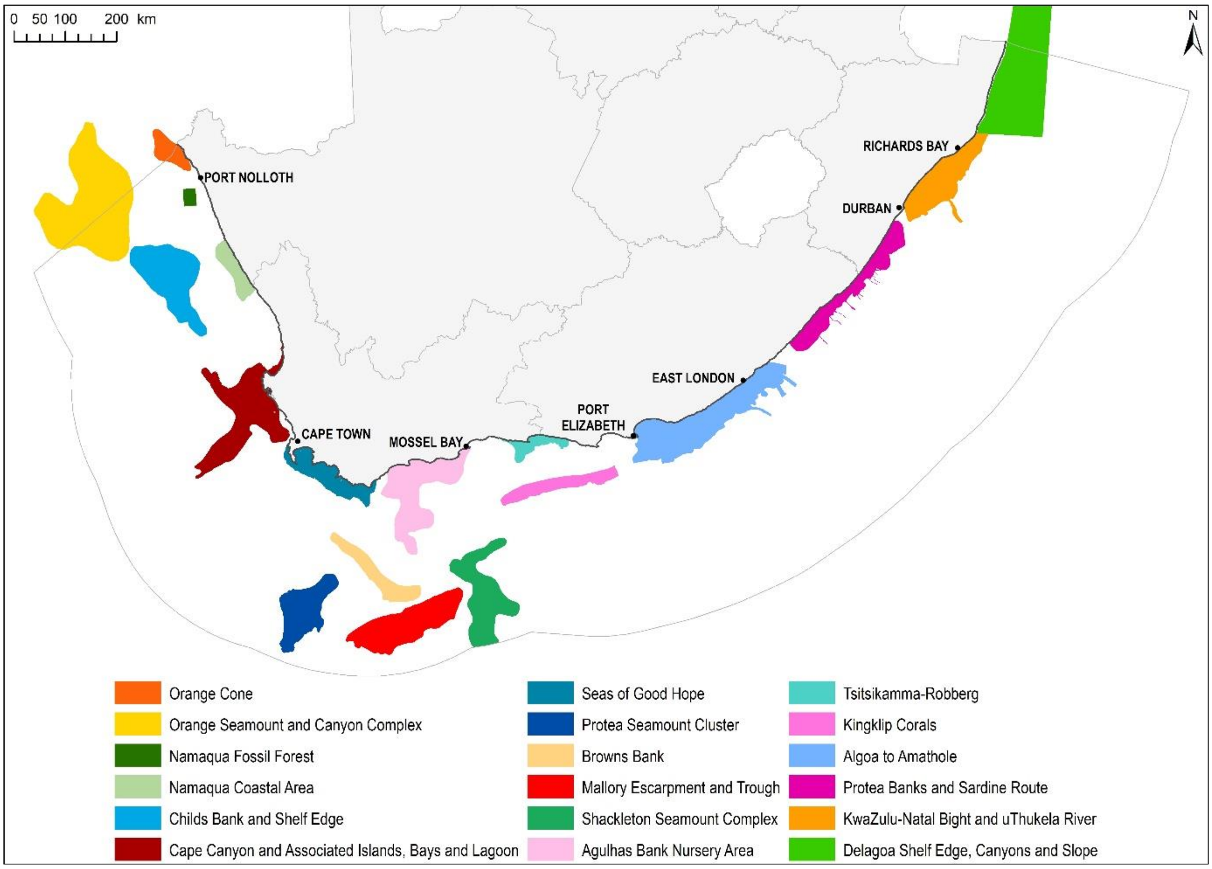


Figure 12. *Ecologically or Biologically Significant Marine Areas (EBSAs) in South Africa. Only those EBSAs that are entirely within South Africa's marine territory or are shared with neighbouring countries are shown. (Data source: MARISMA Project 2020a).*

Box 3. EBSAs in South Africa

Ecologically or Biologically Significant Marine Areas (EBSAs) were conceptualised by the Convention on Biological Diversity (CBD), initially as part of the work on approaches to promote international cooperation and coordination for the conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction. EBSAs are marine places that provide important services to one or more species or populations or to the ecosystem as a whole, compared to other surrounding areas or areas of similar ecological characteristics. To be inscribed as an EBSA, a site must meet at least one of the seven EBSA criteria set out by the CBD (UNEP-CBD 2009).

The Seven EBSA Criteria

1. Uniqueness or rarity
2. Special importance for life history stages of species
3. Importance for threatened, endangered or declining species and/or habitats
4. Vulnerability, fragility, sensitivity, or slow recovery
5. Biological productivity
6. Biological diversity
7. Naturalness

See the MARISMA EBSA Portal for more details on the criteria.

It was also noted that EBSAs may require enhanced conservation and management measures (decision X/29) to secure their constituent marine biodiversity, and that this was a matter for States.

The value of identifying EBSAs in areas under national jurisdiction was recognised, especially for helping countries guide efforts to achieve their Aichi targets. Therefore, States were urged to identify EBSAs at the 9th Convention of Parties (COP) in 2009 (decision IX/20). Through a series of regional workshops supported by the CBD, EBSAs were identified by evaluating sites against the seven EBSA criteria, and were delineated within country territories, in the high seas, and across boundaries (country-country, or country–high seas). Currently, 320 sites have been identified, globally (see CBD EBSA website).

South Africa's original EBSA network was identified at two regional workshops: The Southern Indian Ocean (UNEP/CBD/RW/EBSA/SIO/1/4) and South Eastern Atlantic (UNEP/CBD/RW/EBSA/SEA/1/4) Regional Workshops to Facilitate the Description of Ecologically or Biologically Significant Marine Areas in 2012 and 2013, respectively. South Africa's proposed sites were based largely on the focus areas for offshore MPAs that had been identified using systematic biodiversity planning (Sink et al. 2011). The proposed sites met the EBSA criteria and were adopted as EBSAs by the CBD at COP 12 in 2014. Although EBSAs are not legally binding, the CBD encouraged countries to co-operate regionally, and implement improved conservation and protection measures within EBSAs to secure the special biodiversity features for which they were identified.

Since then, the Benguela Current Commission (BCC) and its member states (Angola, Namibia and South Africa), in cooperation with GIZ on behalf of the German government, have been working on a regional Marine Spatial Management and Governance Programme (MARISMA; 2014-2020). The aim was to refine the boundaries of existing EBSAs and identify relevant new ones, assess their status and management requirements, and incorporate these into Marine Spatial Planning (MSP) processes in each country to support sustainable ocean use in the Benguela Current Large Marine Ecosystem (Harris et al. 2019c). This builds on a previous project to map biodiversity priority areas in this region (Holness et al. 2014).

The updated priority areas were identified using systematic biodiversity planning, with improved data based on new research (Kirkman et al. 2019). In South Africa, for example, the MARISMA Project has drawn heavily on the maps and assessments produced for the NBA 2018 (Harris et al. 2019a; Majiedt et al. 2019; Sink et al. 2019a; Sink et al. 2019c; Sink et al. 2019d). This application of systematic biodiversity planning in identifying EBSAs was also shown to strengthen and advance the EBSA process (Harris et al. 2019c). The updated biodiversity priority areas (Holness et al. 2014; Kirkman et al. 2019) helped to refine the boundaries of the existing EBSAs, and new priority areas that were identified were evaluated against the EBSA criteria, and those that met the criteria were included as proposed EBSAs (MARISMA Project 2020a). Both the revised and proposed EBSAs have been reviewed nationally and internationally, and at the time of writing, were in review with the Department of Environment, Forestry and Fisheries in preparation for submission to the CBD's Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA).

The updated EBSA network in South Africa comprises 23 EBSAs that are wholly or partly within the country's national jurisdiction. Six of these EBSAs were not revised in the MARISMA Project: the required regional engagement process was beyond the scope of the project because these EBSAs extend from South Africa's marine territory into areas beyond national jurisdiction (including one at Prince Edward Islands) or into Mozambique. (The five EBSAs that extend into the high seas can be viewed on the CBD EBSA website).

In terms of EBSA management and proposed inputs into the emerging national MSP processes, it is likely that EBSAs will comprise two zones: a Biodiversity Conservation Zone, and an Impact Management Zone. As noted in the main text, the management objectives of these two zones align with those of CBAs and ESAs respectively. In other words, the recommended management objective of the EBSA Biodiversity Conservation Zone is to secure marine biodiversity in a natural or semi-natural state, or as near to this state as possible; and of the EBSA Impact Management Zone is to manage impacts on key biodiversity features in a mixed-use area to keep key biodiversity features in at least a functional state. Therefore, delineation of the CBA Map categories inside EBSAs and the EBSA zones have been intentionally aligned and are identical; recognising that the EBSA zoning is currently under discussion, and any changes made will be incorporated in the next iteration of the National Coastal and Marine CBA Map. The careful and deliberate alignment of coastal and marine biodiversity priorities, underpinned by the same data and systematic planning and assessment processes that have been undertaken by the same team, has allowed a single, coherent portfolio of coastal and marine priorities to be identified that represent the biodiversity sector's input in multi-sectoral processes.

For detailed information about South Africa's EBSAs visit the EBSA Portal.

4.3.8.1. Shores/mouths of priority estuaries

The estuarine shores of the priority estuaries were included. The priority estuaries are those listed in Van Niekerk et al. (2019b), which is Appendix D of the NBA 2018 Estuarine Realm Assessment (Van Niekerk et al. 2019a). This is to facilitate alignment between estuarine and marine biodiversity priorities, and to include key "pinch points" of connectivity between land and sea.

4.3.8.1. Priority beaches

Harris (2012) identified a portfolio of sandy shores that were important for beach ecosystem types, beach macrofauna, phytoplankton and microphytobenthos, dune plants, and beach-associated vertebrates, based on a fine-scale systematic conservation plan specifically for beaches in South Africa. These areas were included as a feature to encourage Marxan to meet targets in these previously identified priority areas.

4.3.8.2. Algoa Bay fine-scale systematic conservation plan

A fine-scale systematic conservation plan was compiled for Algoa Bay, including 137 biodiversity features and fine-scale cost information, with broad stakeholder consultation (Algoa Bay Project 2019). This plan also sought to encourage selection of marine biodiversity priorities in areas that would also bring social benefits, e.g., to support ecotourism and recreational activities. It identified highest priority areas in natural or near-natural ecological condition that were inside MPAs and outside MPAs (Fig. 13).

Figure 13. *Fine-scale marine biodiversity priority areas identified for Algoa Bay. (Data source: Algoa Bay Project 2019).*

4.3.9. Design elements

4.3.9.1. Protected areas

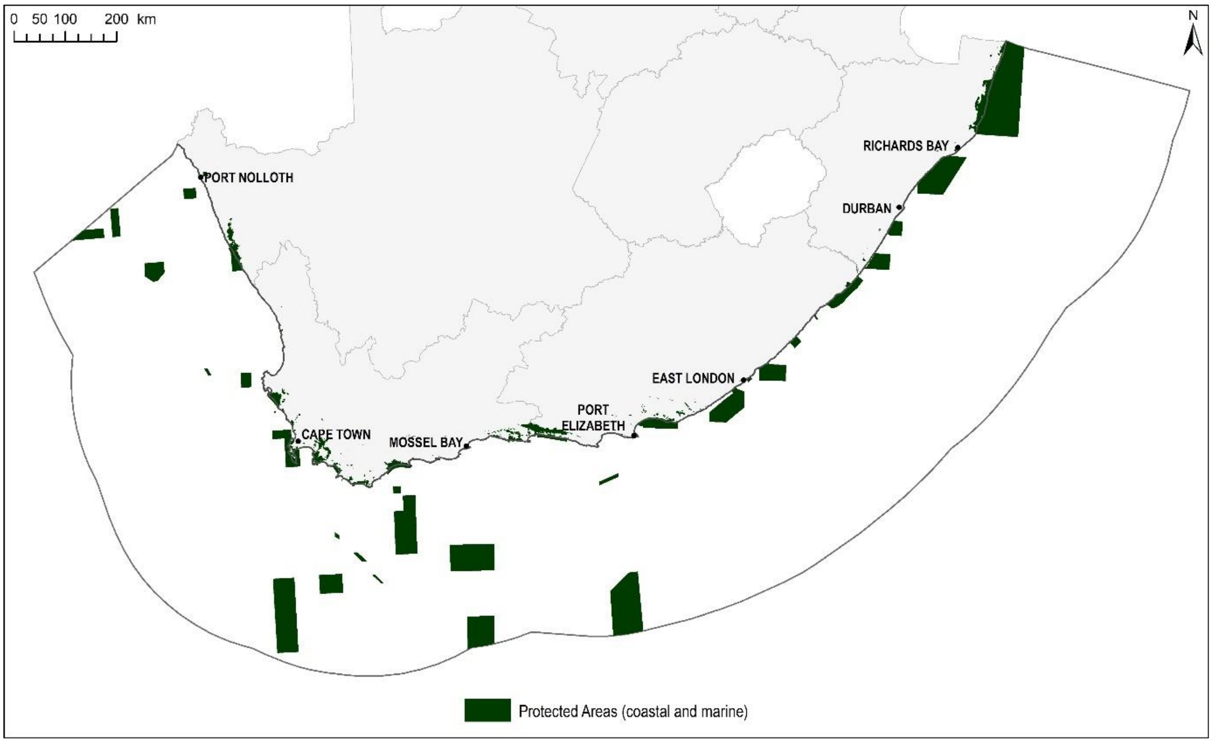


Figure 14. *Protected areas in the coastal and marine planning domain. (Data source: Skowno et al. 2019a, and SAPAD).*

There has been a notable recent expansion of South Africa's protected area estate, particularly in the marine realm with the declaration of 20 new MPAs in 2019. Full details about South Africa's protected areas can be found in the National Biodiversity Assessment 2018 (Sink et al. 2019d; Skowno et al. 2019b; Van Niekerk et al. 2019a). The protected areas included in this systematic biodiversity plan were extracted for the coastal and marine planning domain from the version of the protected areas map used in the NBA 2018 (Fig. 14). The new nature reserve at the Orange River mouth was also added from the South African Protected Areas Database (SAPAD).

4.3.9.2. Existing land-based biodiversity priority areas

Given the existing systematic biodiversity planning that has been done in the four coastal provinces (Northern, Western and Eastern Cape and KwaZulu-Natal), it was decided that the already identified biodiversity priority areas should be included in the National Coastal and Marine CBA Map for the coastal terrestrial portion of the map (Fig. 15). The intent is to align (edge-match) priorities where possible so that biodiversity can be secured cross-realm, with plans to advance this aspect explicitly in the next iterations of the National Coastal and Marine CBA Map (see Section 8.2).

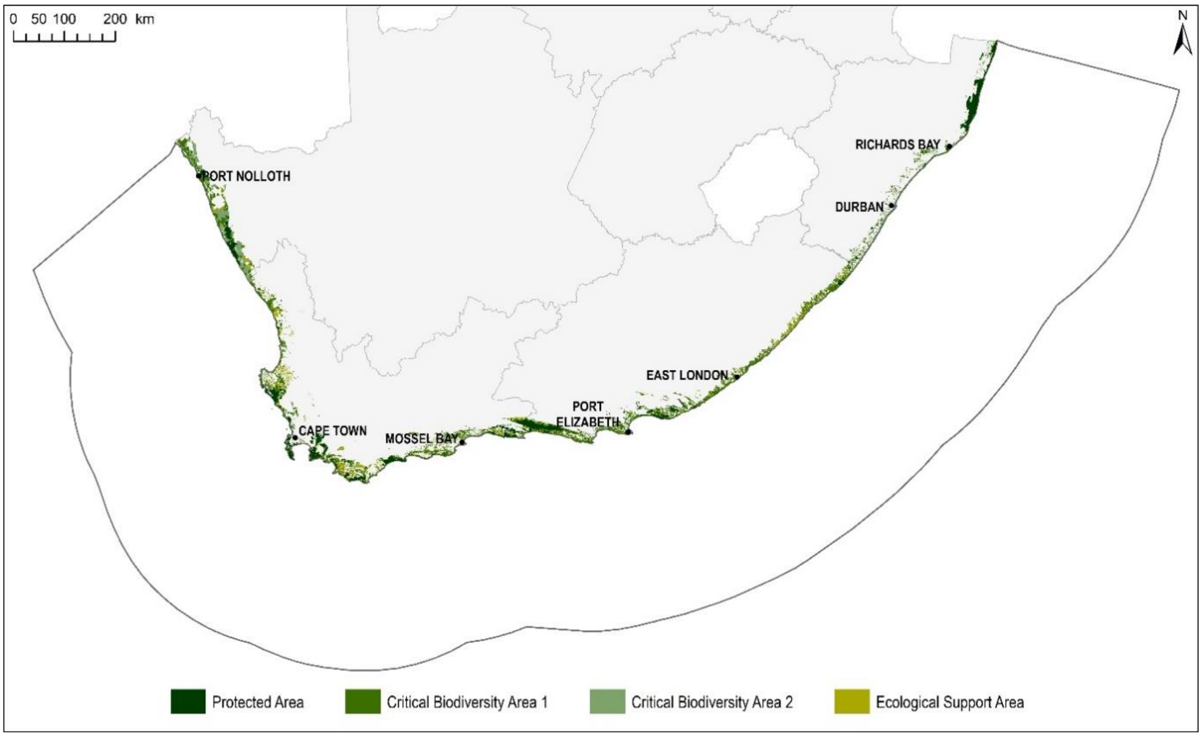


Figure 15. *Spatial biodiversity priority areas for the land-based portion of the coastal zone, which were extracted from the provincial biodiversity plans for the four coastal provinces. (Data source: Hawley et al. 2019; Holness and Oosthuysen 2016; KZN CBA Irreplaceable version 01022016 2016; KZN CBA Optimal version 03032016 2016; KZN ESA Species Specific version 11072016 2016; KZN ESA version 01022016 2016; Pence 2017; Pool-Stanvliet et al. 2017).*

4.3.9.3. Conservation Zones of transboundary EBSAs (in Namibia)

The Biodiversity Conservation Zones of the two transboundary EBSAs shared with Namibia were included on the Namibian side of the border to facilitate edge-matching of priorities on the South African side. These include two portions of the Orange Seamount and Canyon Complex EBSA, and the mouth of the Orange River in the Orange Cone EBSA.

4.3.9.4. Known, fragile areas: reef points and polygons

Finally known, fragile areas were included to encourage selection in areas that are otherwise undifferentiated. This was also important within bays because the new bay ecosystem types from NBA 2018 (Sink et al. 2019a) replaced the detailed delineations of the underlying ecosystem types from NBA 2011 (Sink et al. 2012), including reefs (but not replacing kelp ecosystem types).

4.3.9.5. Ecological condition

The map of ecological condition for the marine realm (Fig. 16) was used to encourage meeting targets in areas of the best-available ecological condition as far as possible. This map was generated as part of the National Biodiversity Assessment 2018 by doing a cumulative pressure assessment. Full details on how the map was generated are available in Sink et al. (2019c) based on pressure data compiled by Majiedt et al. (2019). In brief, the impact of ocean-based activities on marine biodiversity was determined (Fig. 36) by spatially evaluating the intensity of each activity and the functional impact to and recovery time of the underlying ecosystem types (Fig. 10). From this map of cumulative impact (Fig. 36), a map of ecological condition was generated based on the severity of degradation across the marine realm such that areas with negligible impacts are considered to be natural to near natural, and those that are intensively impacted are considered to be very severely modified. The map of marine ecological condition was used here by intersecting it with the map of ecosystem types (Fig. 10) to produce two input datasets that were included as design elements (see Table 3): one layer of areas where ecosystem types are in natural or near-natural ecological condition; and a second layer of areas where ecosystem types are natural, near-natural or moderately modified. By stacking up these two layers and the map of ecosystem types, it encourages Marxan to meet feature targets in areas of good ecological condition first (because it can meet features targets for all three layers simultaneously in those areas), then areas of fair (moderately modified) ecological condition are favoured (because it can meet targets for two of the three layers in those areas), and if targets for an ecosystem type are still not met, then the remaining portion will be met in areas of poor ecological condition.

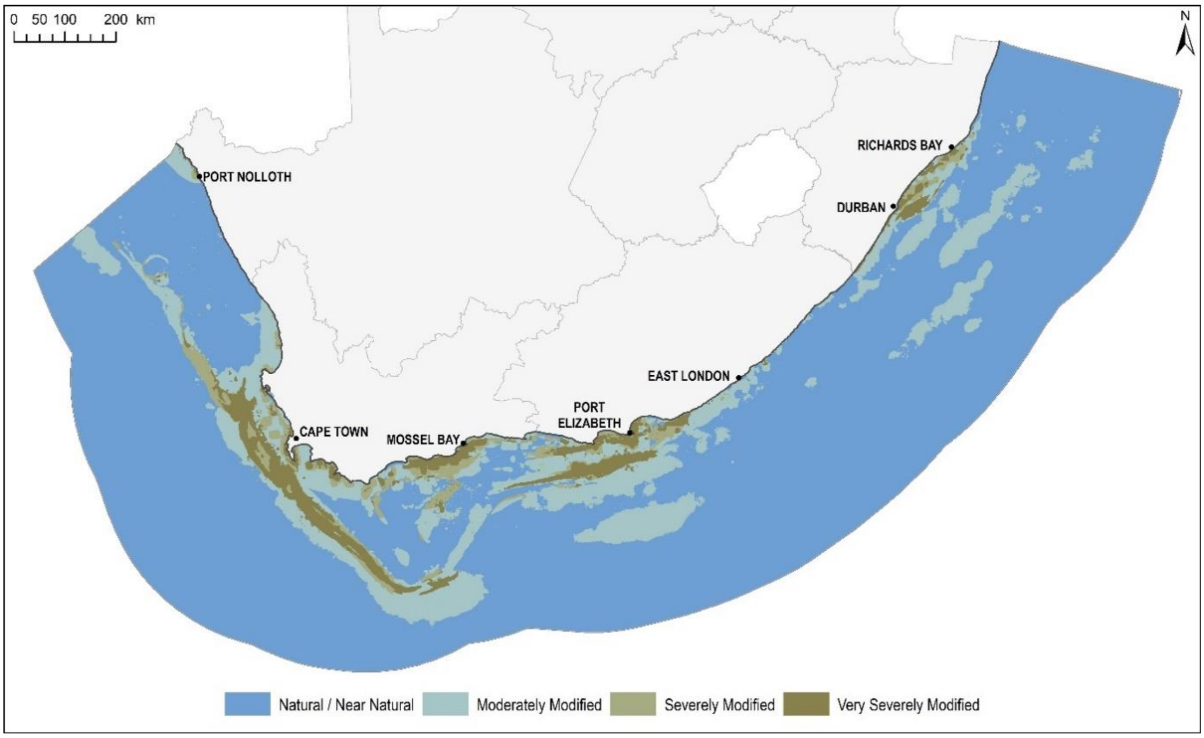


Figure 16. *Ecological condition of the marine realm. (Data source: Sink et al. 2019c)*

4.4. Cost

4.4.1. What is the cost layer?

Sectors are encouraged to review the data that are being used to represent their activities. We welcome engagement if any of the current data do not fully capture the areas that need to be avoided. We will include these in the next iteration of the CBA Map (26 February 2021). To contribute data, see the EBSA Portal for options. Deadline for data submissions: 31 January 2021

In the context of systematic biodiversity planning, cost can be defined in many ways but generally relates to the amount of competing interest or use of sites in the planning domain. It is included as a layer to encourage selection of biodiversity priorities in areas of low competing use to streamline negotiations and increase the likelihood of successful implementation of the spatial priorities; in this case, implementation of the National Coastal and Marine Spatial Biodiversity Plan through the MSP process. Sections 4.2.2–4.4.7 describe the data that were used to generate the cost layer, and Section 4.2.8 explains the method for integrating all the data into a single map and presents the final cost layer that was used in the Marxan analysis. Unless specified otherwise, the data included come from Chapter 4 of the NBA 2018 Marine Realm technical report (Majiedt et al. 2019). Descriptions of how the data were processed for inclusion in the cost layer are adapted from Appendix 2 of the NBA 2018 Marine Realm technical report (Sink et al. 2019f), with some additional explanations regarding the data used in this analysis.

4.4.2. Petroleum

Four layers were included in the map of petroleum activities: areas with production rights; areas identified as leads and prospects; and areas with exploration rights. Areas with production rights were assigned the highest avoidance value; areas identified as leads and prospects were given intermediate avoidance values; and areas with exploration rights assigned a lower avoidance value. This facilitated strong avoidance of the areas with highest confidence (i.e., those that are well delineated) where future petroleum activities are intended. These data were shared under a confidentiality agreement between the Petroleum Agency South Africa (PASA) and DEFF, and therefore are not shown here.

Cost element	Source data	Processing methodology
Petroleum activities	Data provided by the Petroleum Agency South Africa (PASA), with contributions from rights holders	• Areas with production rights were assigned the highest avoidance value (100) • Areas identified as leads or prospects were compiled into a single layer and the area calculated per polygon. The polygons were split into nine percentiles based on area, which were each assigned avoidance levels at intervals of 10, between 10–90. The smallest areas (i.e., with the most precise delineation and thus the highest confidence and intent of further petroleum activities) were assigned higher avoidance values (90), through to the largest polygons with lower specificity regarding future priority areas that got a lower avoidance value (10). • Areas with exploration rights were assigned an avoidance value of 5. • These three sets of polygons were compiled into a single shapefile, using the highest value per site. This was converted to a raster layer with 30 m x 30 m pixels, using a mean value per grid cell.

4.4.3. Mining

Areas of high value for mining were included as per the NBA 2018 map of mining intensity (Majiedt et al. 2019), where all areas that have been or are being mined were assigned the highest value for avoidance (Fig. 17). It is recognised that the current map is not fully representative of all areas of avoidance for mining (e.g., prospecting and new mining operations since the NBA 2018 map of mining activities was compiled), and engagements with this sector are planned to update the map.

Cost element	Source data	Processing methodology
Mining	Various SANBI datasets (including NBA 2011 data on mine points, mined polygons from industry, and the NBA 2018 landcover) were used to identify areas that are mined or within 500 m of a mine.	• Different mining layers combined into a single layer (120 m pixels). • 500 m buffer developed in a raster environment to identify any areas near mines. A value of 100 was coded to these areas, which is used as the level of avoidance.

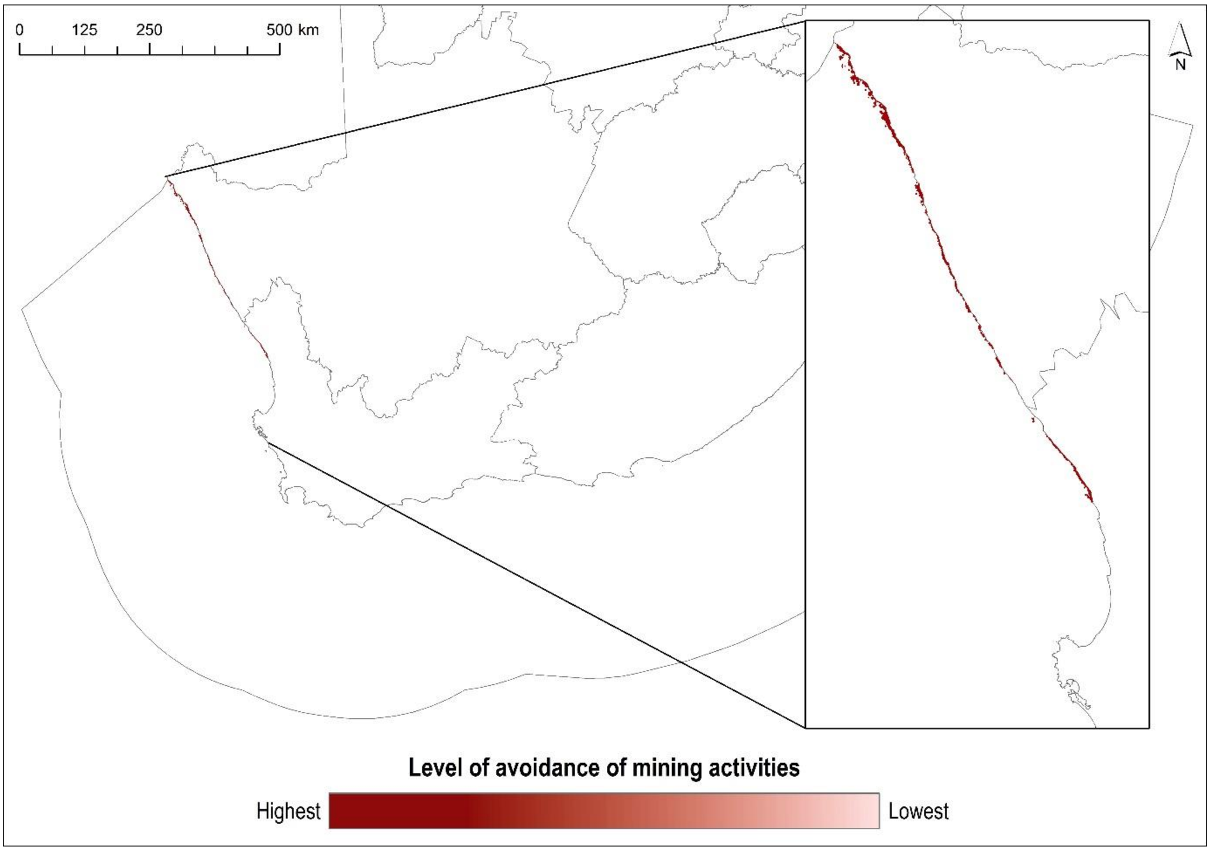


Figure 17. *Level of avoidance of mining activities as used in the CBA Map Version 1 (Beta 2).*

4.4.4. Fisheries

The specific small-scale and industrial fisheries sectors that were included explicitly in the cost layer include: demersal trawling (inshore and offshore); crustacean trawling; mid-water trawling; linefishing; demersal longlining; pelagic longlining; tuna pole fishing; purse seining (small pelagics fishery); gillnetting; beach seining; West Coast Rock Lobster harvesting; South Coast Rock Lobster harvesting; squid harvesting; oyster harvesting; and kelp harvesting. For each of these specific fisheries sectors, the map of intensity of fishing was taken from the NBA 2018 as the map of relative avoidance for each fishery, respectively.

4.4.4.1. Demersal trawling (inshore and offshore)

The data that are currently used to represent inshore and offshore demersal trawling (Fig. 18, 19) come from the NBA 2018 (Majiedt et al. 2019). However, we are aware of a new layer developed by Dr Jock Currie of trawl swept area ratios. Engagement is required to determine which map best represents the inshore and offshore demersal trawl sectors, and thus is preferred for inclusion in the cost layer.

Cost element	Source data	Processing methodology
Demersal inshore and offshore trawling	Raw data were received for the period 2008-2016 with start and end positions for each trawl event, alongside data for hours of trawling and total catch in kilograms. The offshore trawl sector was defined as trawl areas deeper than 100 m. Catch was recorded as the average annual take in kilograms and effort as hours of trawling.	• The data was cleaned to eliminate likely errors. The points that were removed were tracks on land, tracks over 50 km long, tracks where values had been rounded off in the underlying dataset and hence had integer start and end points. • A point density was calculated using a 120 m grid cell and evaluating all areas within 2.5 km of the cell. Values were calculated as a total per square kilometre. • Values were reclassified into 10 quantiles; the lowest intensity quantile (10%) was removed to eliminate remaining very low density and likely error areas. • Values were compared to other datasets such as known trawl footprints. • Values were modified using MPA boundaries (where there are trawl exclusions). • These intensity layers scaled 0-100 were used as the maps of relative avoidance of inshore and offshore demersal trawling.

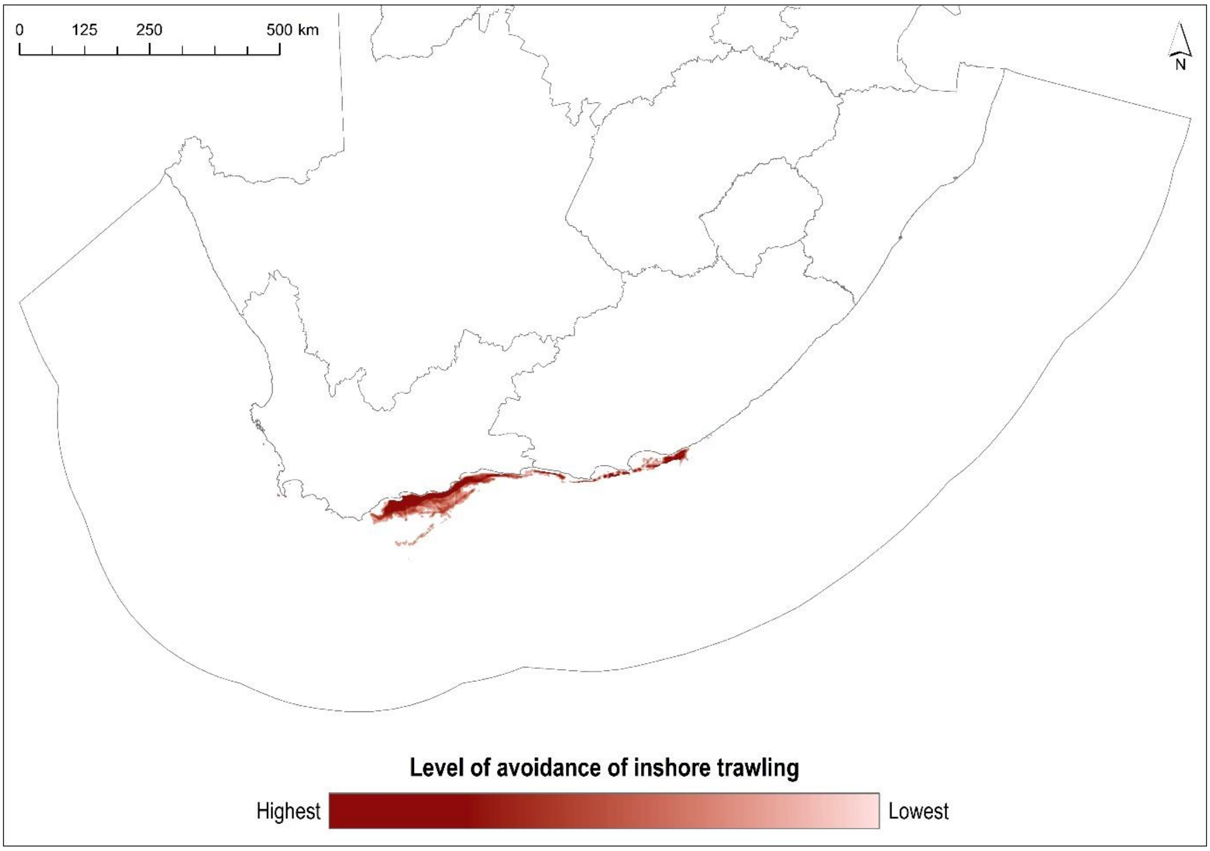


Figure 18. *Level of avoidance of inshore demersal trawling as used in the CBA Map Version 1 (Beta 2).*

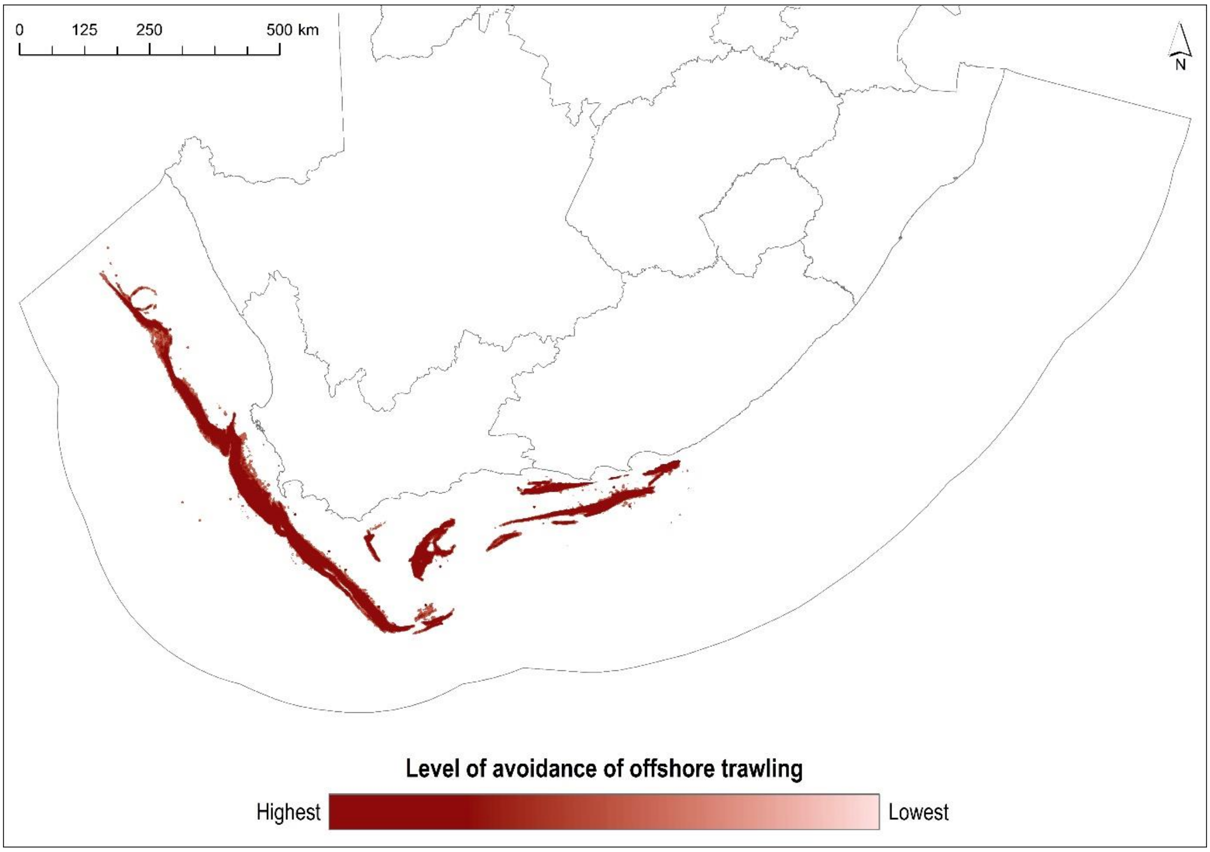
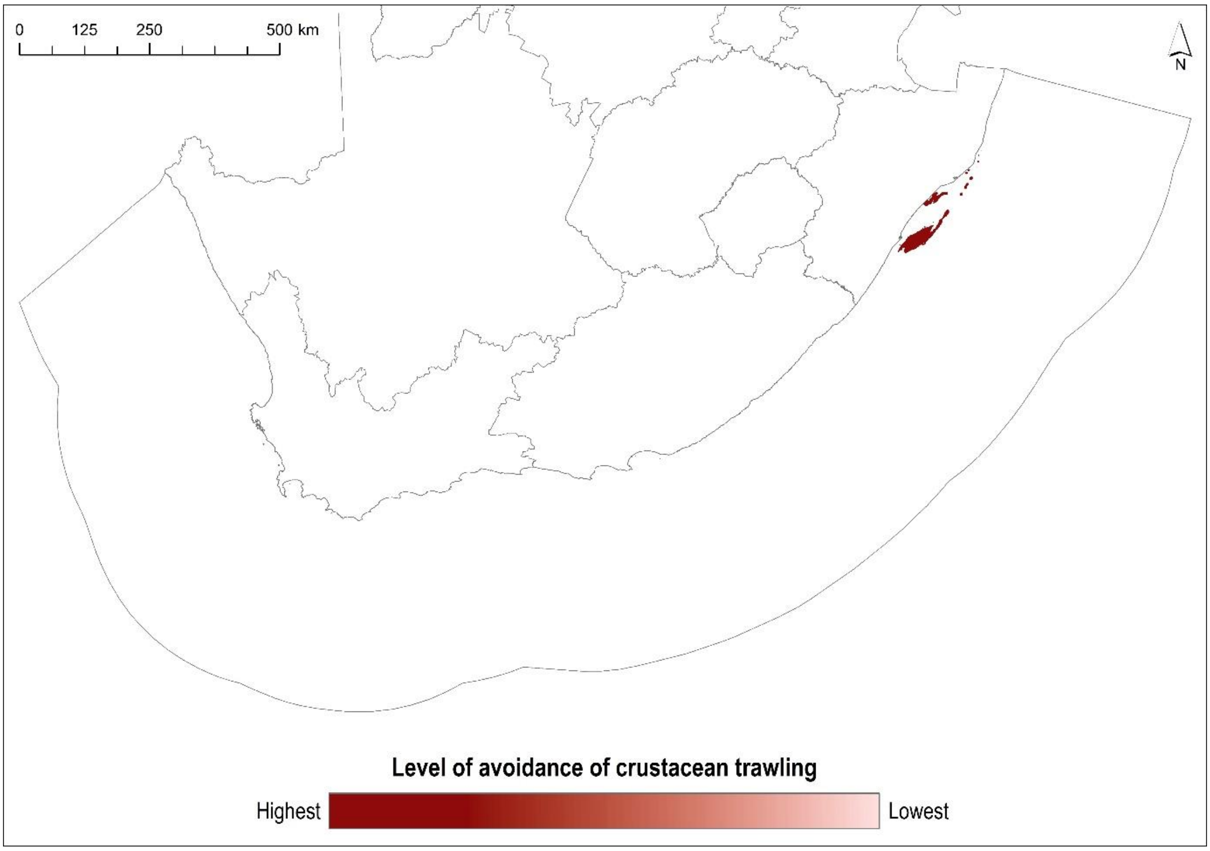


Figure 19. *Level of avoidance of offshore demersal trawling as used in the CBA Map Version 1 (Beta 2).*

4.4.4.2. Crustacean trawling

The data that are currently used to represent crustacean trawling (Fig. 20) come from the NBA 2018 (Majiedt et al. 2019).



Cost element	Source data	Processing methodology
Crustacean trawling	The NBA 2011 / OMPA crustacean trawl dataset for the period 2001-2005 was combined with more recent data for period 2006-2017. Catch was recorded as the average annual take in kilograms and effort as hours of trawling.	• Existing NBA 2011/OMPA data cleaning retained. • The following analysis was done separately on the NBA 2011 / OMPA crustacean trawl dataset for the period 2001-2005 and the more recent data for period 2006-2017. Results were combined in the final stage. • A point density was calculated using a 120 m grid cell and evaluating all areas within 2.5 km of the cell. Values were calculated as a total per square kilometre. • We assumed very low effort (under 25 h) were errors. This eliminated most points that were unlikely (e.g., on land or deep water). • Initial analysis classified the prawn trawl to ten quantiles. This was later revised to a binary footprint layer (trawled / not trawled) due to impacts of industry. • Values were modified using MPA boundaries (where there are trawl exclusions). • The footprint from the two datasets was combined and used to represent crustacean trawling, and was assigned an intensity, and thus avoidance level, of 100.

Figure 20. *Level of avoidance of crustacean trawling as used in the CBA Map Version 1 (Beta 2).*

4.4.4.3. Midwater trawling

The data that are currently used to represent midwater trawling (Fig. 21) come from the NBA 2018 (Majiedt et al. 2019).

Cost element	Source data	Processing methodology
Midwater trawling	Raw data were received for the period 2008-2016 with start and end positions for each trawl event, alongside data for hours of trawling and total catch in kilograms. Catch was recorded as the average annual take in kilograms and effort as hours of trawling.	• Point statistics on effort in hours per square kilometre were calculated (a cell size of 0.005° was used, with a 10-cell radius circular search area to determine effort). • We used the 100*n/n80 method to deal with a very skewed data distribution. • We removed very low intensity values under 1 which represent any cells with less than 1% of the level of effort of the n80 cell. • The map of intensity of fishing scaled 0-100 was used as the level of avoidance.

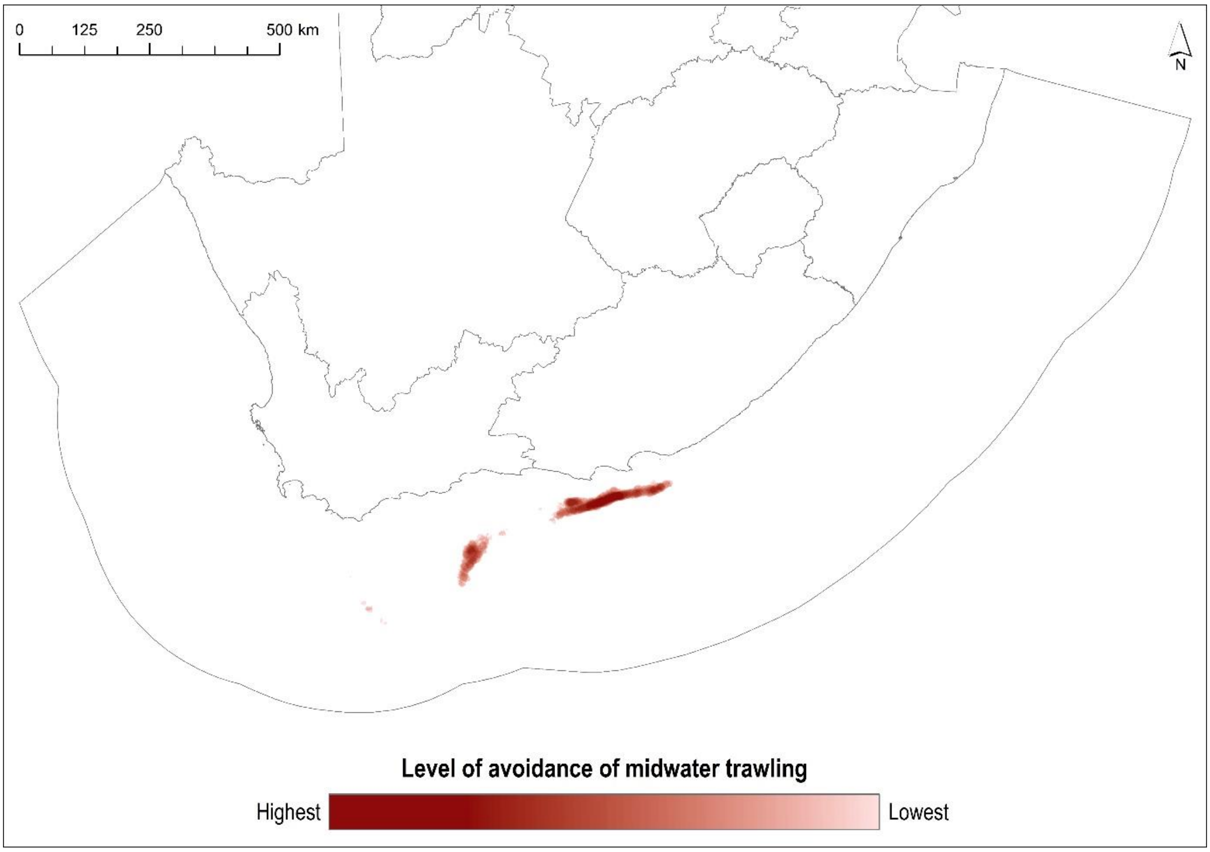


Figure 21. *Level of avoidance of midwater trawling as used in the CBA Map Version 1 (Beta 2).*

4.4.4.4. Linefishing

The data that are currently used to represent linefishing (Fig. 22) come from the NBA 2018 (Majiedt et al. 2019).

Cost element	Source data	Processing methodology
Linefishing (commercial and recreational boat-based fishing)	Point data were received for the period 2000-2016. This layer was also used as a proxy for recreational boat-based linefishing, as the patterns of use are similar to that of the commercial sector and data for actual catch by recreational fishermen were not available.	• Linefish data were summarised to centre points of a 5' grid. • All values within that grid were added up to give a total kg catch for the grid square. • All points with no catch were allocated a 0 kg catch. • A Natural Neighbour Interpolation was done to produce a smoothed continuous surface of estimated catch. • Very low values (under 100 kg for the entire period) were excluded. • Values were then reclassified into 10 quantiles. • Values were modified using MPA boundaries (where there are activity exclusions). • The map of intensity of fishing scaled 0-100 was used as the level of avoidance.

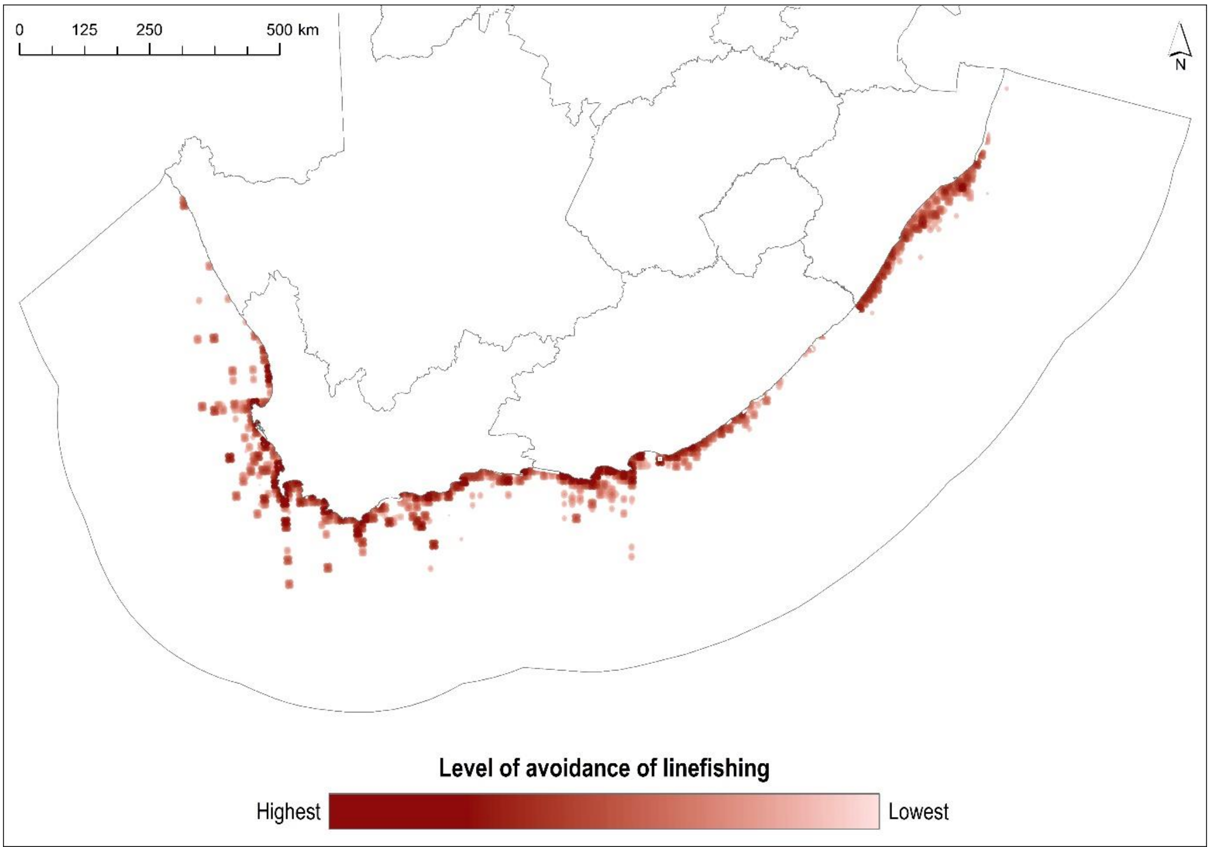


Figure 22. *Level of avoidance of linefishing as used in the CBA Map Version 1 (Beta 2).*

4.4.4.5. Demersal longlining

The data that are currently used to represent demersal (hake) longlining (Fig. 23) come from the NBA 2018 (Majiedt et al. 2019).

Cost element	Source data	Processing methodology
Demersal Longline	Point data of start and end positions was received from DAFF for the period 2000-2017, alongside number of hooks per line and the total catch in kilograms.	• Raw point data used for total catch of all species (largely hake and kingklip) • Data presented as annual average over the period 2000 to 2017. • A point density approach was used to add up all catch around an area. A 120m grid was used, with catches within 5000 m of each grid cell being aggregated for whole period. Values were calculated in catch / km^2. • Low values of under 1000kg/km^2 removed to deal with scatter of inaccurate points and eliminate very low use areas. • Due to an extremely skewed distribution, a 100* n/n_{70} method was used to deal with high values. The n_{70} value was 19 914 km^2. After the calculation, we reclassified values over 100 as 100. • Values were modified using MPA boundaries (where there are activity exclusions). • The map of intensity of fishing scaled 0-100 was used as the level of avoidance.

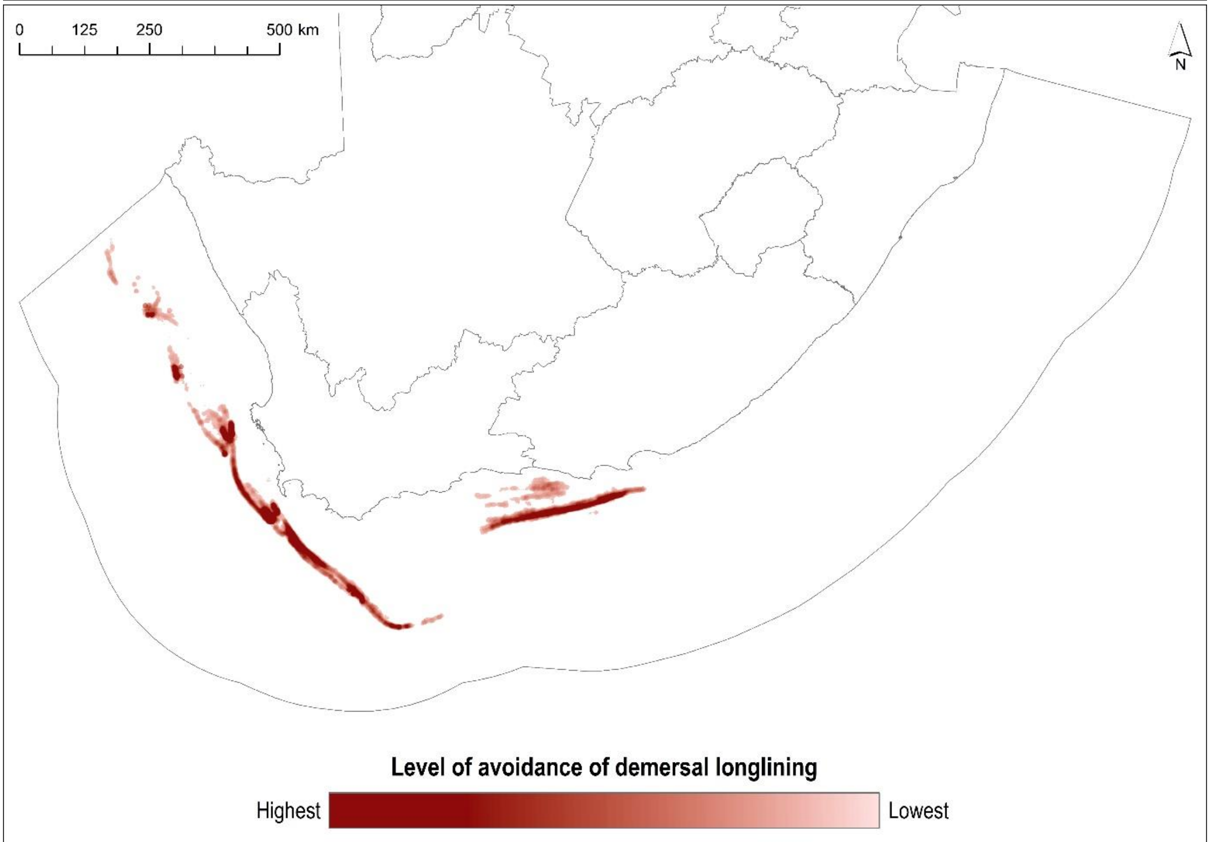


Figure 23. *Level of avoidance of demersal longlining as used in the CBA Map Version 1 (Beta 2).*

4.4.4.6. Pelagic longlining

The data that are currently used to represent pelagic longlining (Fig. 24) come from the NBA 2018 (Majiedt et al. 2019).

Cost element	Source data	Processing methodology
Pelagic Longline	Point data of start and end positions was received from DAFF for the period 2000-2016, alongside number of hooks per line and the total catch in kilograms.	• Base data with line hook numbers (effort) values associated with start and end points • A point density approach was used to add up all effort around an area. A 120m grid was used, with areas within 10 000m of a point being evaluated. • The effort was calculated in hooks/km^2. Low values of under 100 hooks/km^2 were removed to deal with scatter of inaccurate points and very low use areas. • Reclassified into 10 quantiles (given values from 10-100). • Values were modified using MPA boundaries (where there are activity exclusions). • The map of intensity of fishing effort scaled 0-100 was used as the level of avoidance.

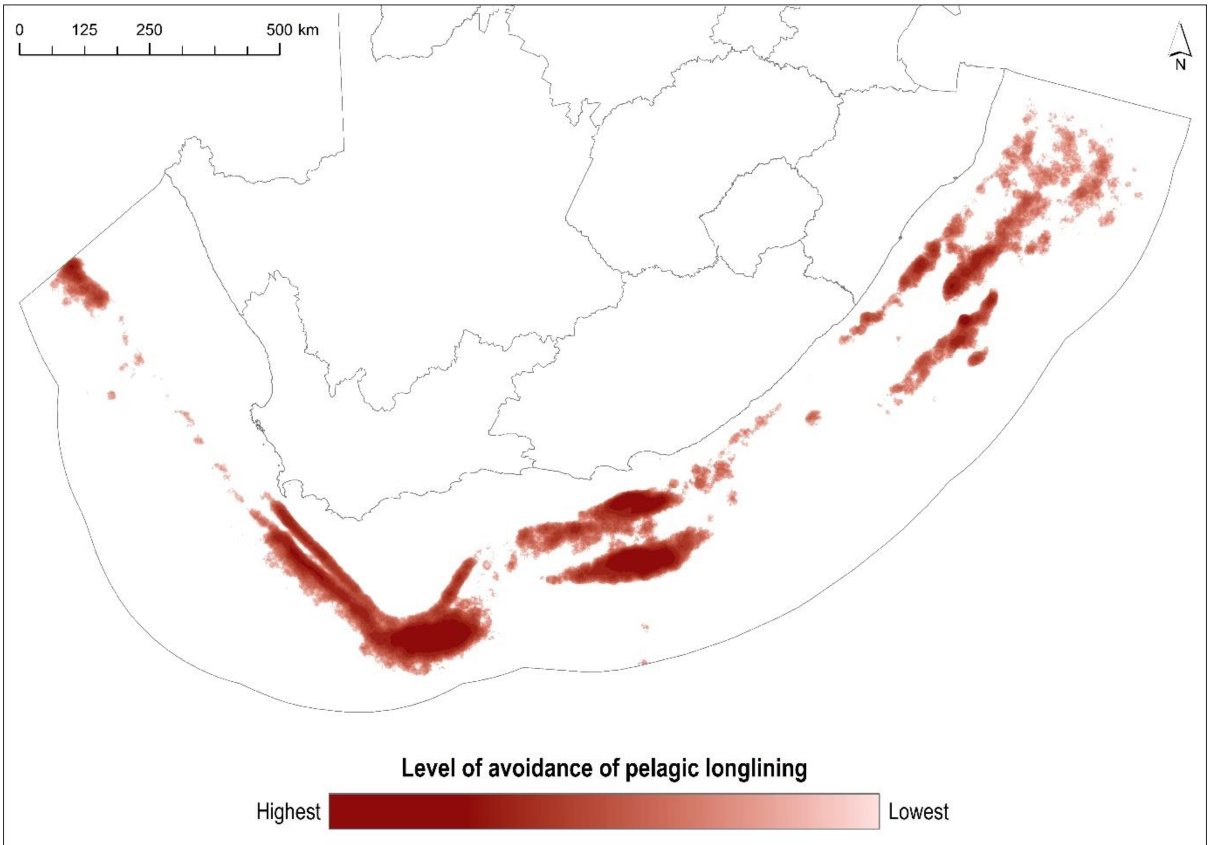


Figure 24. *Level of avoidance of pelagic longlining as used in the CBA Map Version 1 (Beta 2).*

4.4.4.7. Tuna pole fishing

The data that are currently used to represent tuna pole fishing (Fig. 25) come from the NBA 2018 (Majiedt et al. 2019).

Cost element	Source data	Processing methodology
Tuna Pole	Point data collated to a coarse 50-nm grid was received for the period 2007-2016.	• DAFF pole tuna catch data were collated by Capfish / SANBI • The reporting used very coarse grid squares of 50 nm. • We allocated the total catch records to a centroid for each grid square. Zero values were allocated to all non-fished grids squares. • A natural neighbours interpolation was undertaken for marine areas. • Extremely low values with under 10 000kg catch over the record period were excluded. • A modified $100*n/n_{99}$ method used to deal with skewed distributions. The n_{99} was 1 004 051. After the calculation values over 100 were reclassified as 100. • Values were modified using MPA boundaries (where there are activity exclusions). • The map of intensity of fishing scaled 0-100 was used as the level of avoidance.

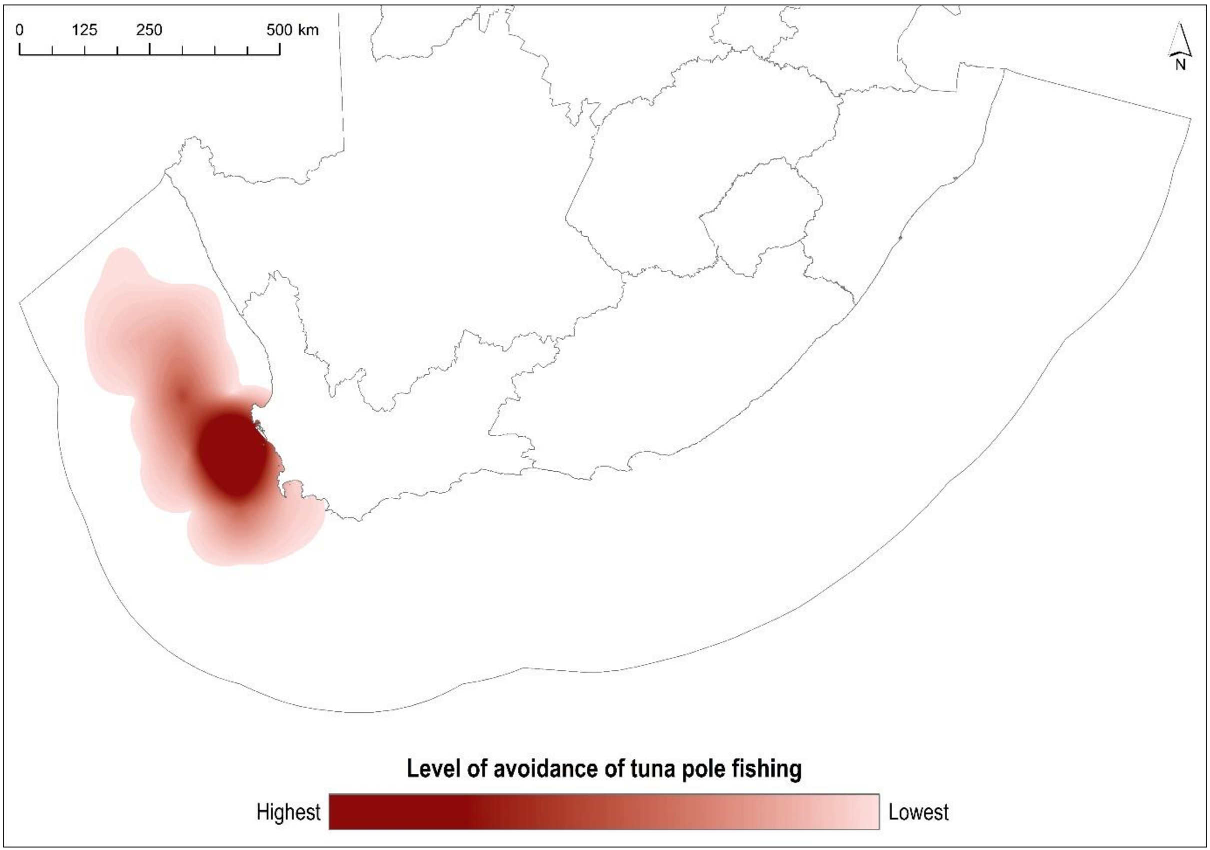


Figure 25. *Level of avoidance of tuna pole fishing as used in the CBA Map Version 1 (Beta 2).*

4.4.4.8. Purse seining (small pelagics fishery)

The data that are currently used to represent purse seining (i.e., the small pelagics fishery; Fig. 26) come from the NBA 2018 (Majiedt et al. 2019).

Cost element	Source data	Processing methodology
Small Pelagic Fishery	Data were received for the period 2000-2016 and calculated to a 5 min grid by CAPFISH (DAFF/CAPFISH/SANBI)	• A centroid was used for each grid square, with total catch values for the square being allocated to this centroid. A zero value was allocated to non-fished areas. • A natural neighbours interpolation was undertaken for marine areas. • Extremely low values with under 200kg catch over the record period were excluded. • Reclassified into 10 quantiles (given values from 10-100). • Values were modified using MPA boundaries (where there are activity exclusions). • The map of intensity of fishing scaled 0-100 was used as the level of avoidance.

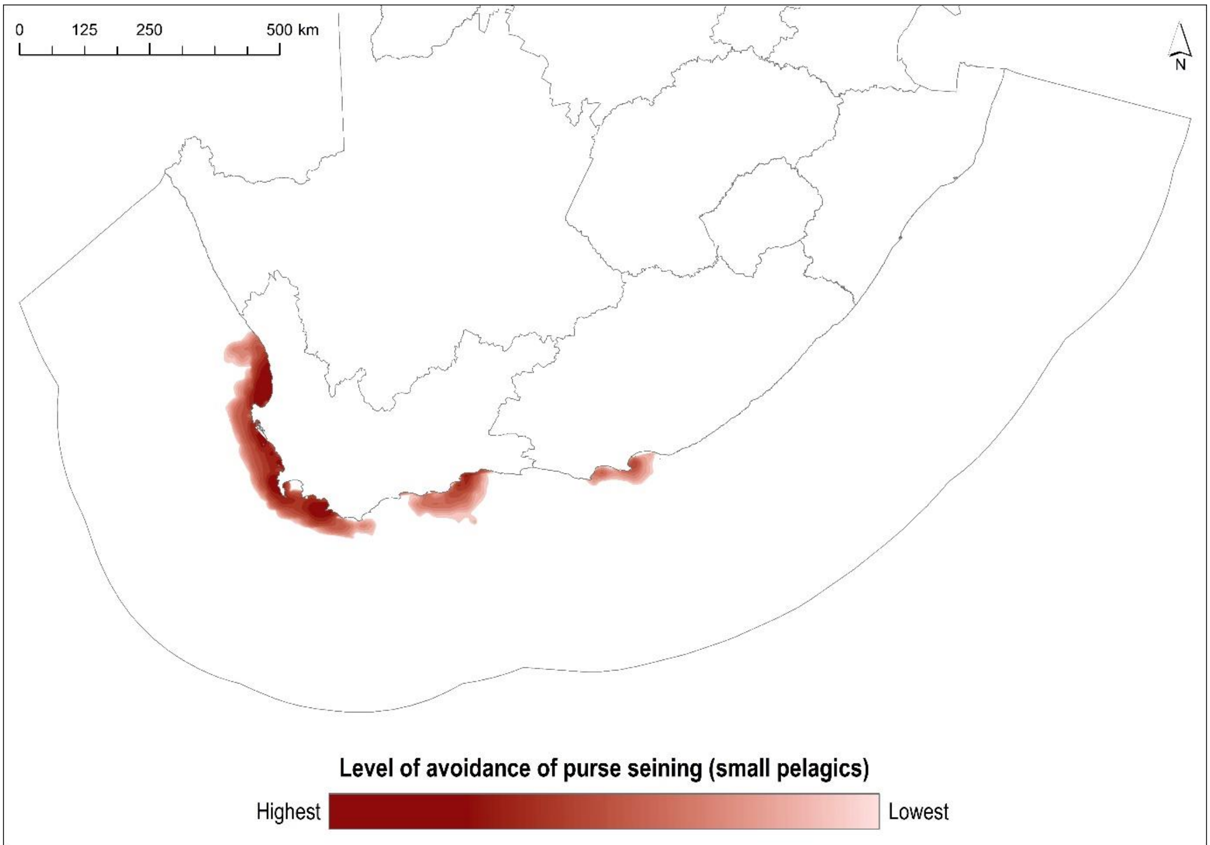


Figure 26. *Level of avoidance of purse seining (small pelagics fishery) as used in the CBA Map Version 1 (Beta 2).*

4.4.4.9. Gillnetting

The data that are currently used to represent gillnetting (Fig. 27) come from the NBA 2018 (Majiedt et al. 2019).

Cost element	Source data	Processing methodology
Netfishing: Gillnetting	Spatial distribution of rights per management sector for 2016/17.	• Spatial delineations of management zones for the gillnet sector with TAE (rights allocated) in 2016-17 for each area. Coverage extends from coastline seawards to the 50m depth contour. • Calculated as an intensity Gill net rights/km^2 over the period • A 100* n/n_{max} method used to benchmark values against the highest intensity of use. • Values were modified using MPA boundaries (where there are activity exclusions). • The map of intensity of fishing effort scaled 0-100 was used as the level of avoidance.

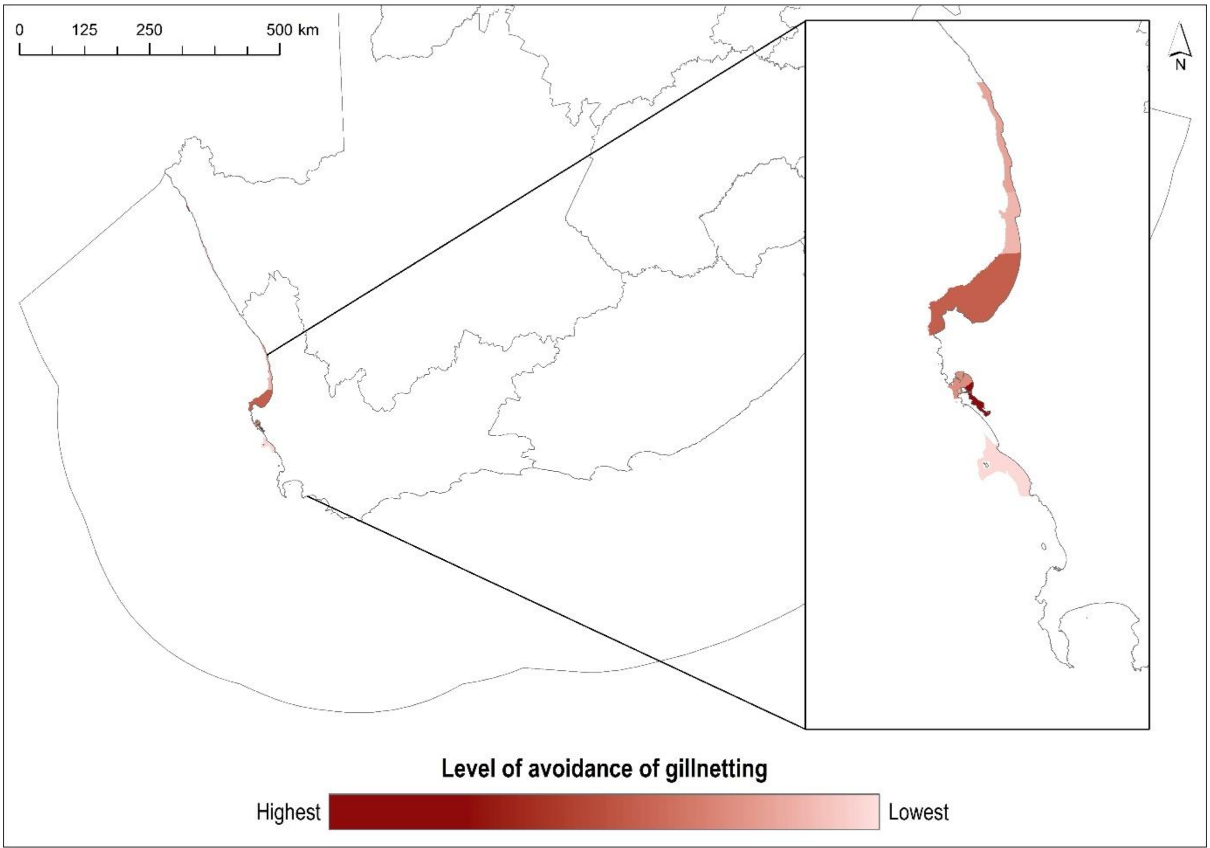


Figure 27. *Level of avoidance of gillnetting as used in the CBA Map Version 1 (Beta 2).*

4.4.4.10. Beach seining

The data that are currently used to represent beach seining (Fig. 28) come from the NBA 2018 (Majiedt et al. 2019).

Cost element	Source data	Processing methodology
Netfishing: Beach-seine	Spatial distribution of rights per management sector for 2016/17.	• Spatial delineations of management zones for the beach-seine sector with TAE (rights allocated) in 2016-7 for each area. Coverage extends from coastline seawards to the 10m depth contour. • Calculated as an intensity seine rights/km^2 over the period • A 100*n/nmax method used to benchmark values against the highest intensity of use. • Values were modified using MPA boundaries (where there are activity exclusions). • The map of intensity of fishing effort scaled 0-100 was used as the level of avoidance.

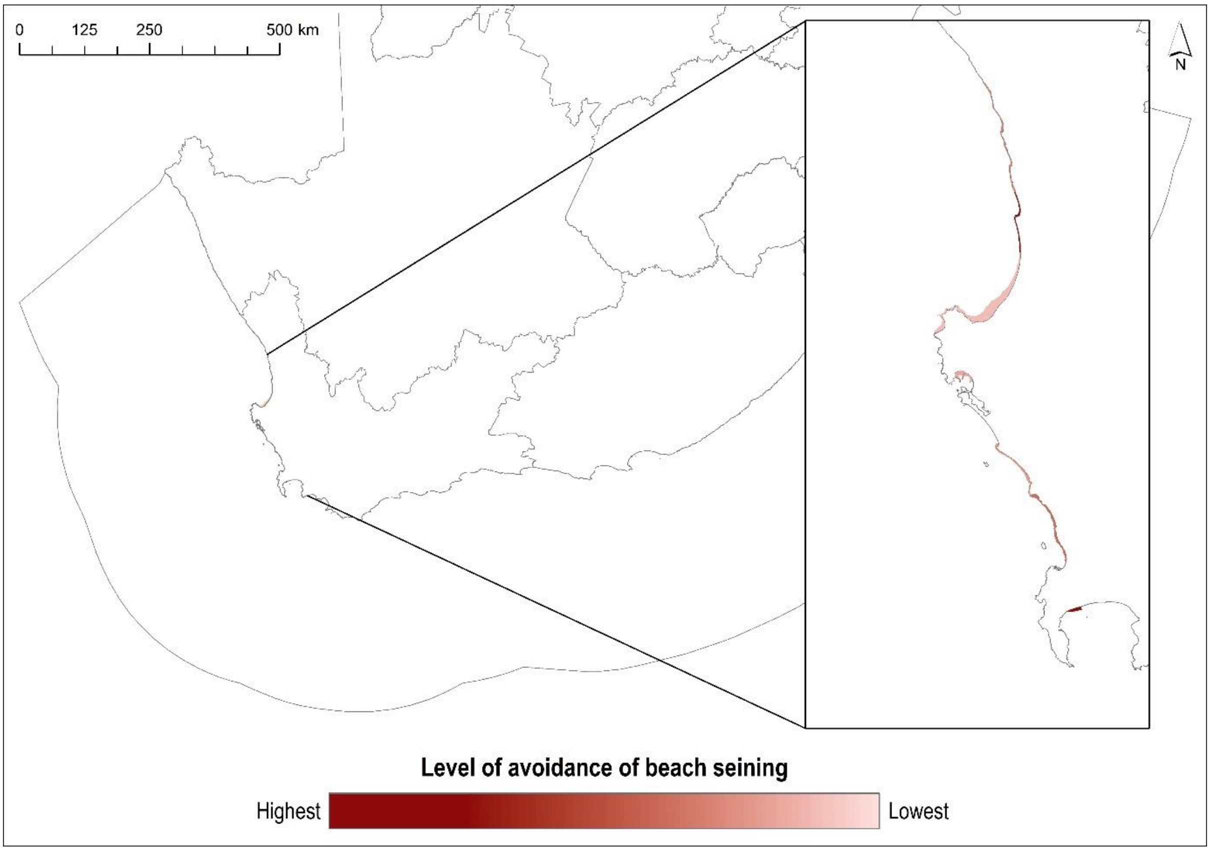


Figure 28. *Level of avoidance of beach seining as used in the CBA Map Version 1 (Beta 2).*

4.4.4.11. West Coast Rock Lobster harvesting

The data that are currently used to represent West Coast Rock Lobster harvesting (Fig. 29) come from the NBA 2018 (Majiedt et al. 2019).

Cost element	Source data	Processing methodology
West Coast Rock Lobster	West Coast Rock Lobster harvesting data was collated by for each concession area for the period 2006 to 2016	• Total catch for period for all types of rock lobster fishery were aggregated into the spatial delineations of management zones for the catch of West Coast rock lobster. • Coverage extends from coastline seawards to the 20m depth contour. • Calculated as an intensity measured in Total catch/km^2 over the period • A 100*n/n90 method used to deal with skewed distributions, with the n90 being 992.28. We reclassified any resulting values over 100 as 100. • Values were modified using MPA boundaries (where there are activity exclusions). • The map of intensity of harvesting scaled 0-100 was used as the level of avoidance.

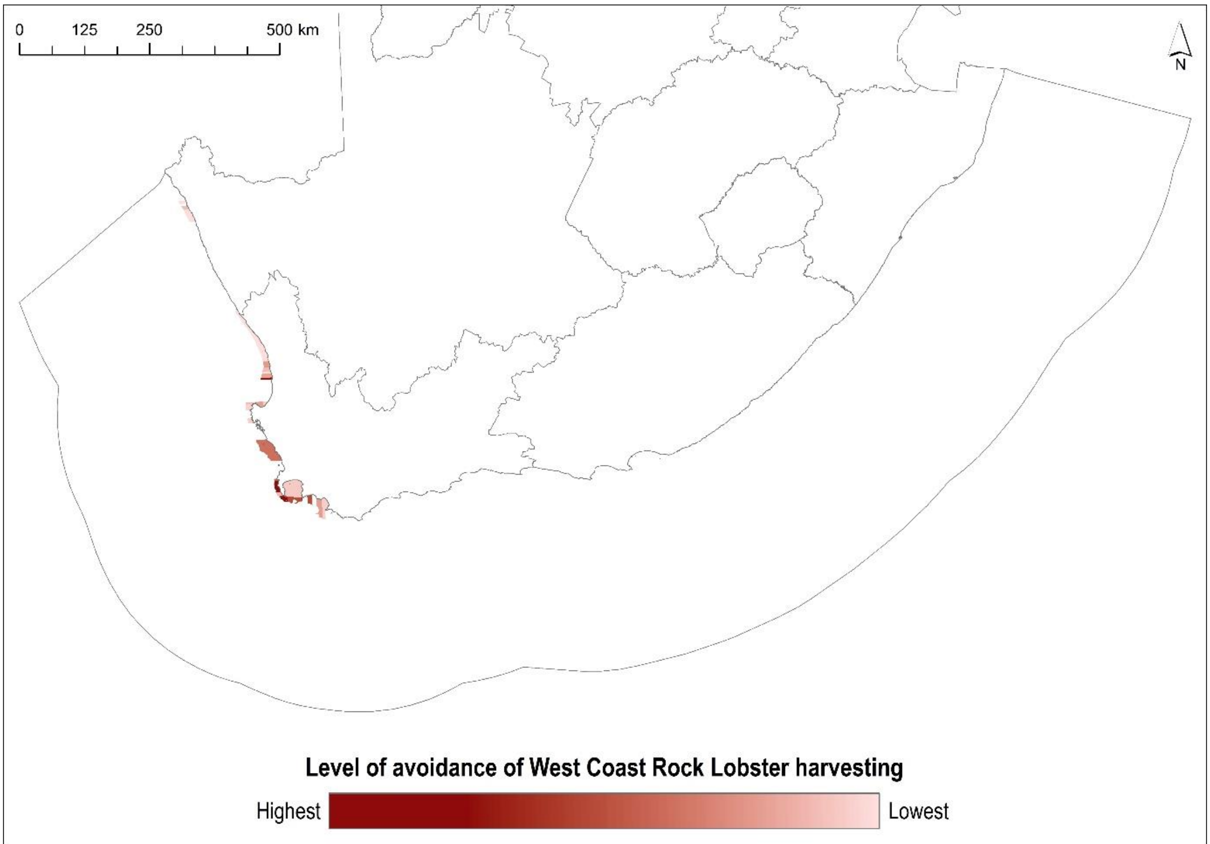


Figure 29. *Level of avoidance of West Coast Rock Lobster harvesting as used in the CBA Map Version 1 (Beta 2).*

4.4.4.12. South Coast Rock Lobster

The data that are currently used to represent South Coast Rock Lobster harvesting (Fig. 30) come from the NBA 2018 (Majiedt et al. 2019).

Cost element	Source data	Processing methodology
South Coast Rock Lobster	South Coast Rock Lobster harvesting data was collated by for each concession area for the period 2007 to 2016.	• A centroid was developed from the summary grid of total catch. A zero value was allocated to all non-fished grid cells. • A natural neighbours interpolation was undertaken for marine areas. • Extremely low values with under 713 kg catch over the record period were excluded. • A 100*n/n_{90} method used to deal with the skewed distribution of values, with n_{90} = 33 420. We reclassified any resulting values over 100 as 100. • Values were modified using MPA boundaries (where there are activity exclusions). • The map of intensity of harvesting scaled 0-100 was used as the level of avoidance.

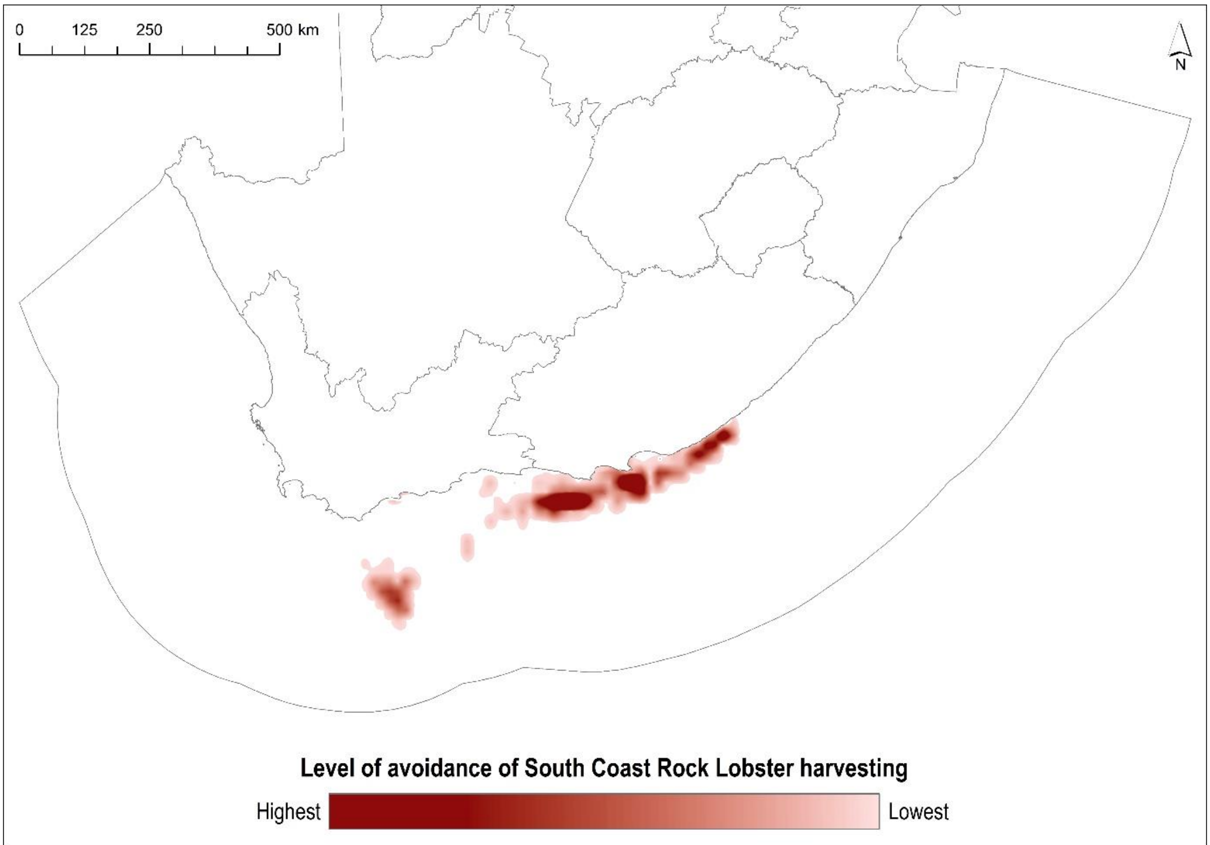


Figure 30. *Level of avoidance of South Coast Rock Lobster harvesting as used in the CBA Map Version 1 (Beta 2).*

4.4.4.13. Squid harvesting

The data that are currently used to represent squid harvesting (Fig. 31) come from the NBA 2018 (Majiedt et al. 2019).

Cost element	Source data	Processing methodology
Squid	Total catch values for the period 2012 - 2016 were collated and calculated into a 5min grid	• A centroid was developed from the summary grid of total catch for the period. A zero value was allocated to all non- fished grid cells. • A natural neighbours interpolation was undertaken for marine areas. • Extremely low values with under 10000kg catch over the record period were excluded. • Exclude values with under 10000kg catch • Values were reclassified into 10 quantiles (given values from 10-100). • Values were modified using MPA boundaries (where there are activity exclusions). • The map of intensity of harvesting scaled 0-100 was used as the level of avoidance.

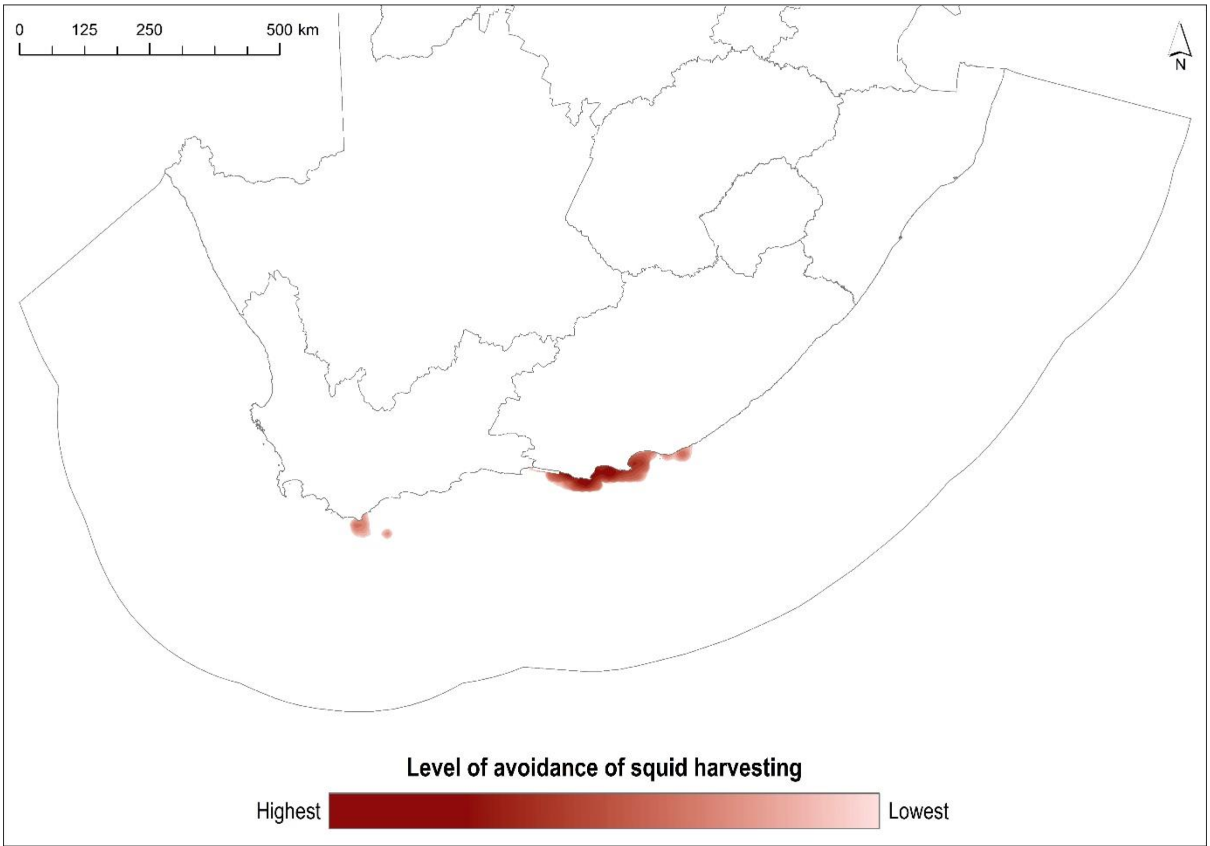


Figure 31. *Level of avoidance of squid harvesting as used in the CBA Map Version 1 (Beta 2).*

4.4.4.14. Oyster harvesting

The data that are currently used to represent oyster harvesting (Fig. 32) come from the NBA 2018 (Majiedt et al. 2019).

Cost element	Source data	Processing methodology
Oysters	Average number of oysters collected per year over the period 2000 to 2017 was collated per fishing area.	• Spatial delineations of management zones for the collection of oysters within the Southern Cape and KZN regions. Coverage extends from coastline seawards to the 10m depth contour. • Calculated as a fishing intensity measured in oysters/km^2 over the period • The 100* n/n_{90} method used to deal with skewed distributions, with n_{90} = 2008.16. We reclassified any resulting values over 100 as 100. • Values were modified using MPA boundaries (where there are activity exclusions). • The map of intensity of harvesting scaled 0-100 was used as the level of avoidance.

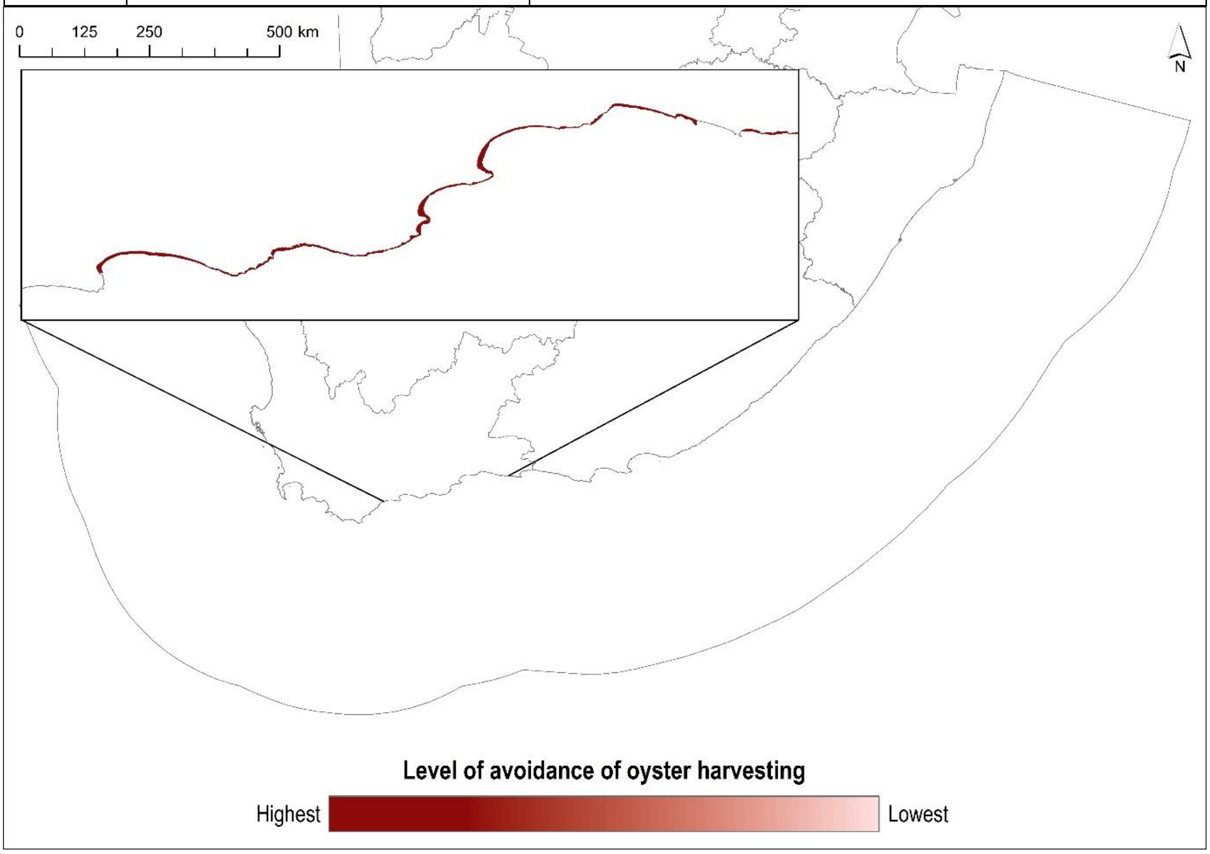


Figure 32. *Level of avoidance of oyster harvesting as used in the CBA Map Version 1 (Beta 2).*

4.4.4.15. Kelp harvesting

The data that are currently used to represent kelp harvesting (Fig. 33) come from the NBA 2018 (Majiedt et al. 2019).

Cost element	Source data	Processing methodology
Kelp Harvesting	Kelp harvesting data was collated for the period 2000- 2017 for each concession area. Based on expert input, the area of activity was mapped to the 10m depth bathy.	• The four types of kelp harvesting values were aggregated into a total take in kg. • Values were calculated as an intensity in kg/km^2 over the record period. • The 100*n/n_{90} method was used to deal with skewed distributions, with n_{90} = 29316. We reclassified any resulting values over 100 as 100. • Values were modified using MPA boundaries (where there are activity exclusions). • The map of intensity of fishing effort scaled 0-100 was used as the level of avoidance.

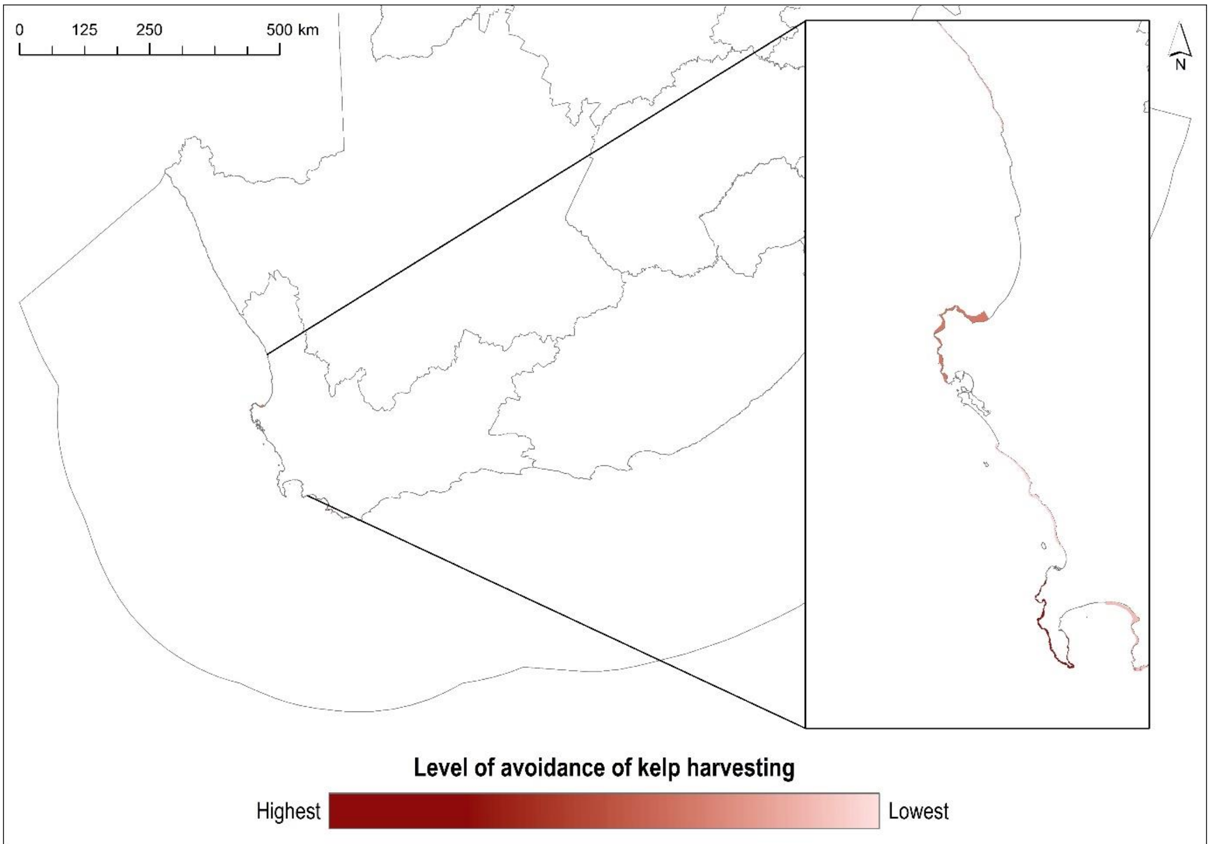


Figure 33. *Level of avoidance of kelp harvesting as used in the CBA Map Version 1 (Beta 2).*

4.4.5. Aquaculture

The data that are currently used to represent marine aquaculture (Fig. 34) come from the NBA 2018 (Majiedt et al. 2019). This layer may need to be supplemented with the identified aquaculture development zones as part of Operation Phakisa.

Cost element	Source data	Processing methodology
Sea-based Aquaculture	Data on the footprint of existing sea-based aquaculture was used.	• Sites were buffered by 1 km. • These areas are flagged as being within a mariculture impact footprint. A value of 100 was coded to these areas.

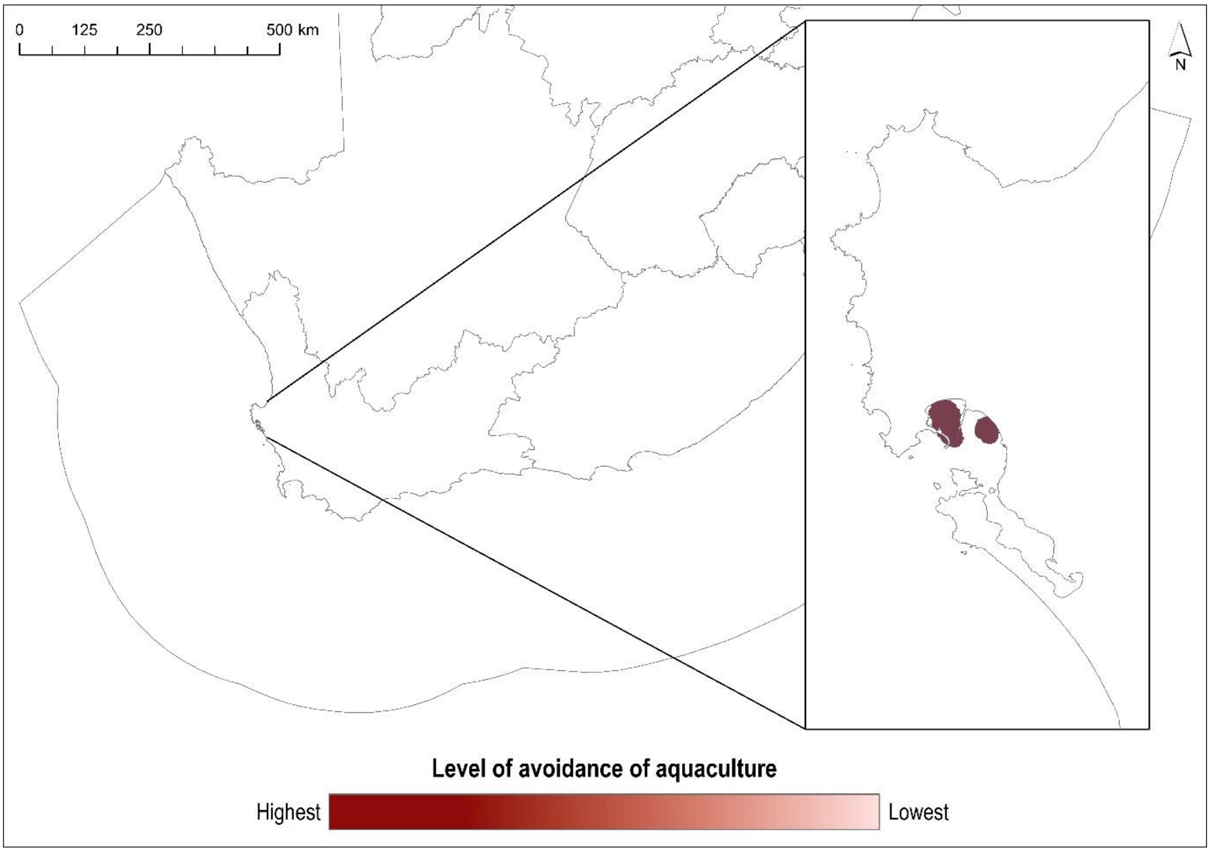


Figure 34. *Level of avoidance of marine aquaculture as used in the CBA Map Version 1 (Beta 2).*

4.4.6. Transport activities

The areas of avoidance for transport (Fig. 35) included a composite layer across the NBA 2018 maps (Majiedt et al. 2019) of shipping, ports and harbours, and dredge spoil dumping sites. To prioritise avoidance of shipping lanes and remove areas of very low intensity shipping from the transport layer, the raster values of the composite map were reclassified to scale the upper 50% of the data from 0–100.

Pressure Layers and cost element	**Source data**	**Processing methodology**
Shipping	Data for shipping was extracted from the global dataset published by Halpern et al. (2015).	• Global data were resampled to the SA EEZ. • The values were in SA were rescaled to South African range (0-100). • The 100*n/n_{90} method was used to deal with skewed distributions, with n_{90} = 72.29. We reclassified any resulting values over 100 as 100. • Very low values (0-3), were reclassified as 0
Port and harbour activities	Various data sources were combined to develop this layer: – NBA 2011 harbours mapped as part of coastal mapping – Port limits (Transport/SANBI) – Port infrastructure (Transport/SANBI) – Harbour points buffered by 1 km (SANBI mapped and verified)	• Point and infrastructure data were buffered by 1 km. • Port limits were not buffered. • Different port layers combined into a single layer (120 m pixels). • Note that the physical infrastructure impacts of a port are covered under coastal development.
Dumping of dredge material	Polygon data was received from the Navy National Hydrographics Office.	• Impacted areas treated as identical and coded into a dredge spoil footprint layer. • A value of 100 was coded to these areas.
Transport activities (cost element)	Shipping, port and harbour activities, and dumping of dredge material, as described above.	• A single raster of transport activities was compiled by taking the maximum value per pixel across the three layers above. • The raster values were reclassified so that the lower 50% of the values got a value of 0. The upper 50% of the data were divided into 20 percentiles, which was multiplied by 5 to scale the transport activities values 0–100.

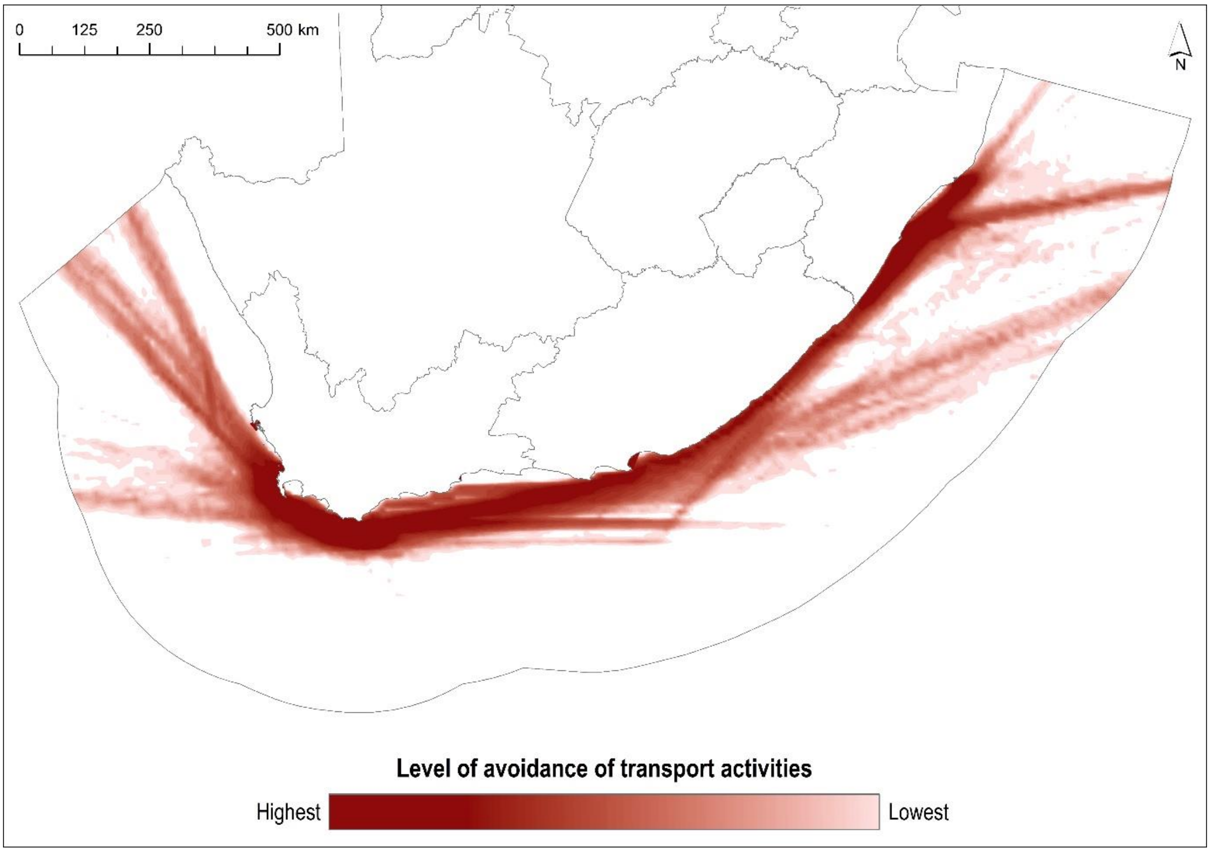


Figure 35. *Level of avoidance of transport as used in the CBA Map Version 1 (Beta 2).*

4.4.7. Cumulative impacts to marine biodiversity

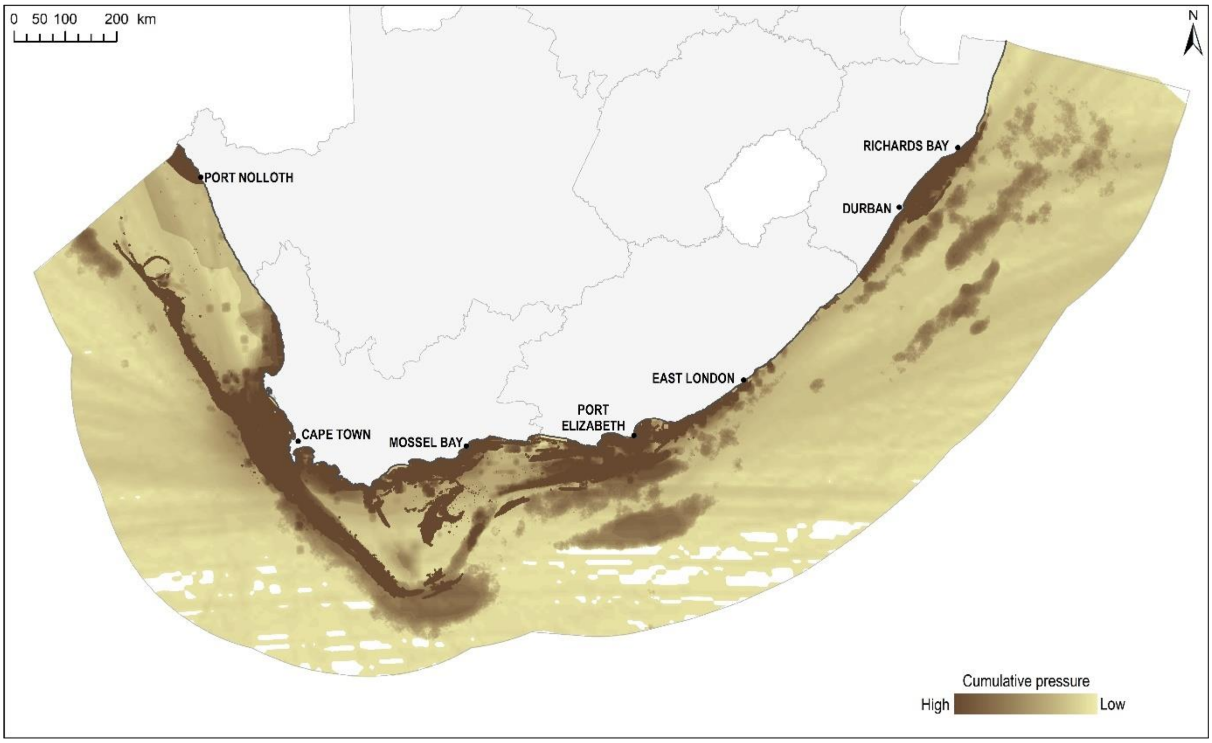


Figure 36. *Cumulative impact on marine biodiversity, based the intensity of all cumulative pressures and the sensitivity of the underlying ecosystem types to each of those pressures. (Data source: Sink et al. 2019c)*

The map of cumulative impacts on marine biodiversity (Fig. 36) is from the National Biodiversity Assessment 2018 (Sink et al. 2019c). It includes the data described in Sections 4.3.2–4.4.6, as well as other pressures, such as alien invasive species, freshwater-flow reduction, wastewater discharge and shark netting for bather protection. It also gives an indication of ecological condition because sites exposed to higher levels of pressure are likely to be more degraded than those areas exposed to lower levels of pressure. Note that this cumulative impact layer includes both current and historical activities, as well as legal and – in the case of abalone harvesting – illegal activities, to best capture the combination of current competing use and impact. For more details on the compilation of this layer, see Majiedt et al. (2019) and Sink et al. (2019c).

4.4.8. Compilation of the cost layer

In this iteration, cost per planning unit was defined as follows, using three equally weighted components (all scaled 0–100; i.e., total potential cost per site is 0-300), the first two of which specifically regard conflict avoidance:

Cost = [sum of avoidance across cost elements[4]] + [max of avoidance across cost elements[5]] + [sum of cumulative impact across all pressures]

[4] Cost elements are: petroleum, mining, transport, specific fisheries sectors (see Section 4.4.4), and marine aquaculture.

In the first component, the sum of avoidance per cost element facilitates minimizing overall conflict with other sectors in the ocean space, i.e., areas that are important (and ideally need to be avoided) for five other overlapping cost elements will be avoided more strongly than areas that are important (and ideally need to be avoided) for only one cost element. The cost values were summed across all cost elements and scaled 0-100 using 25 percentiles, and multiplying the output by 4 to get a value range of 0-100.

In the second component, the level of highest avoidance across all cost elements was used per site. In other words, regardless of how many cost elements there are at a site, the highest value across all cost elements was used as the cost value for that site. This means that, for example, areas of the highest level of avoidance for mining will be avoided as equally as areas of highest level of avoidance for petroleum, demersal trawling, beach seining, etc. Because all of the cost elements were scaled 0-100, and this cost component was compiled as the maximum value across all cost elements, this map was already scaled 0-100 and no further processing was needed.

In the third component, areas of highest cumulative impact to marine biodiversity were avoided, based on the intensity of current and historical pressures combined with the functional impact to and recovery time of the underlying ecosystem types. The data for the third component is the NBA 2018 cumulative pressure assessment, outlined in Chapters 4 and 7 of the marine technical report (Majiedt et al. 2019; Sink et al. 2019c). As noted above, it captures and represents both current use by other sectors and degradation of marine biodiversity, both of which should be avoided where possible when selecting biodiversity priority areas. The cost values from the cumulative impact map were scaled 0-100 using 25 percentiles, and multiplying the output by 4 to get a value range of 0-100.

These three components were summed as per the equation above to product the final cost layer. The areas of highest cost, which the Marxan algorithm will avoid more strongly, are concentrated on the shelf and shelf edge, especially to the southwest and southeast of the country, and around the KZN Bight. These areas are all associated with major ports in Cape Town, Port Elizabeth, and Durban, respectively. The abyssal areas around the southern margin of the EEZ support very few ocean-based activities, and consequently, have a very low cost and level of avoidance. Transport impacts from shipping are the primary driver of cost in these areas.

It is important to keep in mind that the cost layer is an information product that facilitates the algorithm choosing areas of lower cost where there is a choice between two areas of equivalent biodiversity value. However, **even areas of high cost (high level of avoidance) will be selected if that is the only option available for meeting biodiversity targets for particular features. For example, if a Critically Endangered ecosystem type occurs only in areas with lots of other activities (i.e., high cost), those areas will still be selected as a biodiversity priority area. It will then be identified as a site where MSP negotiations will need to be focussed and decisions made whether to safeguard the highly threatened biodiversity or to prioritise economic development.** See also Section 8.1.1.

4.5. Biodiversity targets

Biodiversity targets (Table 2) were set for all the biodiversity features, guided by recommendations for target setting by Porter et al. (2011), dedicated target discussions held during sessions of the Biodiversity Planning Forum and the National Biodiversity Assessment, targets used in previous marine systematic biodiversity plans (Majiedt et al. 2013; Sink et al. 2011), and guidance in the Technical Guidelines. There are six very large offshore ecosystem types that are each larger than 5000 km^2 in total extent, which got a 10% target. A 20% area target was set for all the small to medium-sized ecosystem types. An additional 20% target was added to those ecosystem types that are considered to be more diverse, more sensitive and contribute disproportionately to ecological processes, such that those were included with a 40% target (see Table 2).

Species feature targets varied, such that discrete, important sites for threatened species, e.g., turtle nesting grounds and seabird colonies, got high targets (90%) and modelled species distributions (e.g., for the cetaceans) got low targets 15%. The unique and special features generally have high targets (80-100%) because there are very few known localities for those features, with larger features getting intermediate targets (45-60%). Culturally significant areas also got high targets (90%) because the areas are small, discrete localities of high societal importance that should be kept in a natural to near-natural state. Targets for ecological processes were scaled by size, with smaller areas receiving higher targets (90–40%) and larger features getting lower targets (15%). Only one site is known for Red Steenbras spawning, and so it got a target of 100%. Coastal ecological infrastructure (EI) was included with a 60% target, which is commonly used for EI. Only three localities are known for algal dominated reefs, so this feature was included with a 100% target given their key value for carbon sequestration. Internationally recognised sites of importance (e.g., Ramsar sites, IBAs) were given a target of 100% because they are reasonably small areas that are mostly on land and/or are already in protected areas. EBSAs, however, were included with a 50% target per EBSA and 60% across the whole EBSA network because these are areas that are previously identified as priorities that take into account features such as top predator distributions, and ecological process features, e.g., productivity. They are thus an additional surrogate for biodiversity, ecological processes, and to some degree, ecological connectivity. Other previous prioritisations got a range of targets. Priority beaches got the lowest target (50%) because it is included to encourage selection in these previously identified areas, and the fine-scale Algoa Bay systematic conservation plan got a 100% target given the plethora of high-resolution datasets (biodiversity features and cost) that have more detail than national-scale planning.

Several other input layers were included as design elements (Table 3). Three features were included to edge-match and align priorities. Existing protected areas and the Namibian EBSA Conservation Zones that touch the South African border were locked into the planning units (i.e., hardwired into the final selection). The former are existing areas that are already contributing to meeting biodiversity targets, and the latter will encourage Marxan to align priorities across the border with Namibia. The natural (good ecological condition) and natural/moderately modified (good and fair ecological condition) portions of each ecosystem type were included as a design element to encourage Marxan to meet feature targets in the best available ecological condition. To do this, the full extent of each ecosystem type was used with the 20% (or 10%, 40%) target to determine an area (km^2) target per ecosystem type. Then, the proportion of the natural and natural/moderately modified portions of the ecosystem types that gave the same area as the overall target of 20% (or 10%, 40%) were determined and applied. Including ecological condition as a design element in this way encourages the algorithm to meet targets first in areas that are natural or near-natural, then in areas that are moderately modified, and only then in areas of poorer ecological condition, such that the most intact sites are preferably chosen to represent each biodiversity feature. Finally known, fragile areas were included to encourage selection in areas that are otherwise undifferentiated. This was also important within bays because these new bay ecosystem types from NBA 2018 (Sink et al. 2019a) replaced the detailed delineations of the underlying ecosystem types from NBA 2011 (Sink et al. 2012), including reefs.

Table 2. *Summary table of the biodiversity features included in the National Coastal and Marine CBA Map Version 1.0 (Beta 2), the feature target, and reference to the dataset.*

Feature		Target (%)	Reference
Ecosystem types			
Ecosystem types	Marine ecosystem types (x 150 types) • Large ecosystem types (>5000 km^2) • Small to medium-sized ecosystem types (<5000 km^2) • Special ecosystem types[5] important for key ecological processes: *corals, reefs, reef mosaics, kelp beds, fluvial fans, seamounts, and canyons*	 10 20 40	Sink et al. (2019a); Harris et al. (2019a)
	Pelagic ecosystem types (x 16 types), all >5000 km^2	10	Roberson et al. (2017)
Species			
Turtles	Turtle nesting grounds	90	Harris et al. (2015); Nel et al. (2013); King (2019)
	Loggerhead internesting areas	60	Harris et al. (2015)
	Leatherback internesting areas	60	
	Loggerhead migration corridors	20	Harris et al. (2018)
	Leatherback migration corridors	20	
Seabirds	Seabird colonies	90	Dr Stephen Kirkman (DEFF, unpublished data); Sherley et al. (2020); Sherley et al. (2019); Sherley et al. (2017); Crawford et al. (2016), and using Geody to identify specific localities as needed
	Cape Gannet foraging areas (overall)	50	Majiedt et al. (2013)
	Cape Gannet foraging areas (x 4 areas)	30	
	Bank Cormorant foraging areas (overall)	50	
	Bank Cormorant foraging areas (x 5 areas)	30	
	Cape Cormorant foraging areas (overall)	50	
	Cape Cormorant foraging areas (x 4 areas)	30	
	African Penguin foraging areas (overall)	50	
	African Penguin foraging areas (x 5 areas)	30	
Cetaceans	Bottlenose whale distribution	15	Purdon et al. (2020a)
	Common dolphin distribution	15	

[5] Special ecosystem types are those that are more diverse, more sensitive and have a disproportionately high contribution to ecological processes compared to other ecosystem types.

Feature		Target (%)	Reference
	Humpback dolphin distribution	15	
	Heaviside dolphin	15	
	Killer whale distribution	15	
	Risso's dolphin distribution	15	
	Bottlenose dolphin distribution	15	
Seals	Seal colonies	75	Kirkman et al. (2013)
Unique or special habitats or features			
Unique features	Mallory slope (feature)	60	Digitized from De Wet (2012)
	Childs bank (feature)	80	Majiedt et al. (2013)
	Alexandria dunefield	80	Extracted from Harris et al. (2019a)
	Anemone gardens	90	ACEP Deep Secrets, unpublished data
	Rhodolith beds	90	ACEP Imida, unpublished data; Adams et al. (2020)
Special features	Estuary mouths of flagship free-flowing rivers	100	Nel et al. (2011a); Nel et al. (2011b); extracted from Harris et al. (2019a)
	Estuary mouths of non-flagship free-flowing rivers	60	(Nel et al. 2011a); (Nel et al. 2011b); extracted from Harris et al. (2019a)
	Potential cold-water coral reefs	90	ACEP Deep Secrets, unpublished data
	Potential VME indicator species	60	Sink and Atkinson (2020)
	Potential VME features	45	Extracted from Sink et al. (2019a)
Culturally significant areas			
Heritage sites	Fish traps	90	SAHRA (2020)
	Initial compilation of culturally significant sites, e.g., caves and archaeological sites (e.g., Pinnacle Point, Blombos cave), middens, Hole-in-the-wall, Gompho Rock, Shaka’s Rock	90	Harris et al. (2019d), Algoa Bay Project (2019), and personal knowledge
Ecological processes			
Productivity	Beaches with surf diatom accumulations	40	Campbell (1996)
	Beaches with beach-cast kelp	40	Harris (2012)
Nursery, spawning and aggregation areas	Estuary fish nursery importance (shores/mouths)	40	Van Niekerk et al. (2019b) in Van Niekerk et al. (2019a)
	Squid spawning areas	25	Digitized from Roberts et al. (2012)
	Anchovy nurseries (high egg densities)	15	Digitized from Twatwa et al. (2005)
	Sardine nurseries (high egg densities)	15	
	Red steenbras spawning areas	100	Prof. Kerry Sink (SANBI, unpublished data)
	Wreck fish aggregation sites	90	ACEP Imida, unpublished data
	Giant guitarfish aggregation sites	90	Prof. Kerry Sink (SANBI, unpublished data)
	Whale-associated bays (overall)	60	Extracted from Sink et al. (2019a)
	Whale-associated bays (x 4 bays)	30	

Feature		Target (%)	Reference
Ecological infrastructure			
Coastal ecological infrastructure	Coastal protection EI	60	Perschke (in prep)
	Recreational outdoor activities and sports events EI	60	
Climate resilience			
Carbon sequestration	Algal dominated reefs	100	ACEP Imida, unpublished data
Existing priorities			
Recognised sites	Ramsar sites	100	Ramsar website
	Important Bird and Biodiversity Areas	100	Confirmed sites from BirdLife's Marine IBA website
	SA site (iSimangaliso) in the Network of Sites of Importance for Marine Turtles in the Indian Ocean – South-East Asia Region	100	IOSEA website
	Ecologically or Biologically Significant Marine Areas (whole network)	60	MARISMA Project (2020a)
	Individual Ecologically or Biologically Significant Marine Areas (x 18)	50	MARISMA Project (2020a)
Previous prioritisations	Priority beaches	50	Harris (2012)
	Shores/mouths of priority estuaries	75	Van Niekerk et al. (2019a)
	Algoa Bay fine-scale systematic conservation plan	100	Algoa Bay Project (2019)

Table 3. *Summary of the design elements and their application in the spatial plan.*

Feature		Application	Reference
Design elements			
Edge-matching and priority alignment	Coastal (land-based) and marine protected areas	Hardwired into the final selection	Skowno et al. (2019b); Sink et al. (2019d)
	Terrestrial CBAs	Target of 80% selection for planning units within 1 km of dune base that comprise at least 66% CBA	Holness and Oosthuysen (2016); Pence (2017); Hawley et al. (2019); KZN CBA Irreplaceable version 01022016 (2016); KZN CBA Optimal version 03032016 (2016).
	Conservation Zones of transboundary EBSAs (in Namibia)	Hardwired into the final selection	MARISMA Project (2020b)
Ecological condition	Marine ecosystem types in natural to near-natural ecological condition	% extent required to meet the target of the ecosystem type (if possible)	Sink et al. (2019a); Sink et al. (2019c)
	Marine ecosystem types in natural, near-natural or moderately modified ecological condition		
Known, fragile areas	Reef points	Included with a 40% target	Sink et al. (2011); Majiedt et al. (2013)
	Reefs and hard grounds polygons	Included with a 15% target	Sink et al. (2012)

4.6. Analysis

4.6.1. Marxan parameter calibrations

The **number of iterations** is important to calibrate because it ensures that the length of the annealing routine is long enough to find the global minimum (see Box 3), and thus, the most optimal solution. This parameter was calibrated by running 10 runs of the same scenario, each time increasing the number of iterations by an order of magnitude until more iterations did not improve the solutions (in terms of lowering cost and boundary length). Solutions became less costly and more efficient (shorter boundary length) from 100 million iterations, to 1 billion iterations, after which (10 billion iterations), only marginal improvements were made (Fig. 38).

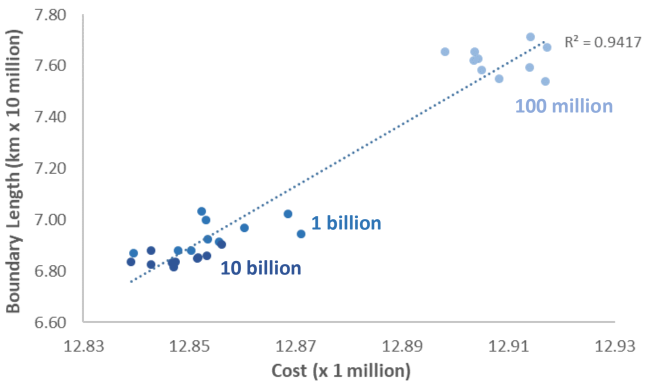


Figure 38. *Calibration of the number of iterations (value labels), with the value selected at the point beyond which adding more iterations did not lower boundary length (km) and cost (dimensionless index) any more than the previous number of iterations tested.*

Next, the **boundary length modifier** (blm) was calibrated as a trade-off between solution clustering and cost (Fig. 39). The more clustered the solutions are, the better it is for implementation because it means that adjacent planning units are selected in fewer, more discrete clumps rather than having many selected planning units scattered through the planning domain. However, if the blm is set too high, it means that areas of high cost can be selected purely to keep the selected area highly clustered and compact, and are not always essential for meeting biodiversity targets. Thus, the optimum blm value is that which maximizes clustering for only marginal increases in cost. To find this value, the standard method for calibrating blm was used, following recommendations in the Marxan Good Practices Handbook (Ardron et al. 2010) and User Manual (Game and Grantham 2008). A run of 10 billion iterations was run for five scenarios, where blm = 0.000, 0.005, 0.010, 0.025, 1.00, and all other inputs kept constant. The boundary length lowered rapidly with a small increase in blm (0.005), for only a small change in cost. However, between blm =0.010–0.025, the improvements in solution clustering were lower, but cost increased. Beyond this (blm =0.025–1.000), there were low changes in boundary length, and dramatic increases in cost. Therefore, a blm of 0.010 was used. Strictly speaking, the most optimal blm value is a bit higher (at a tangent to the curve). However, a

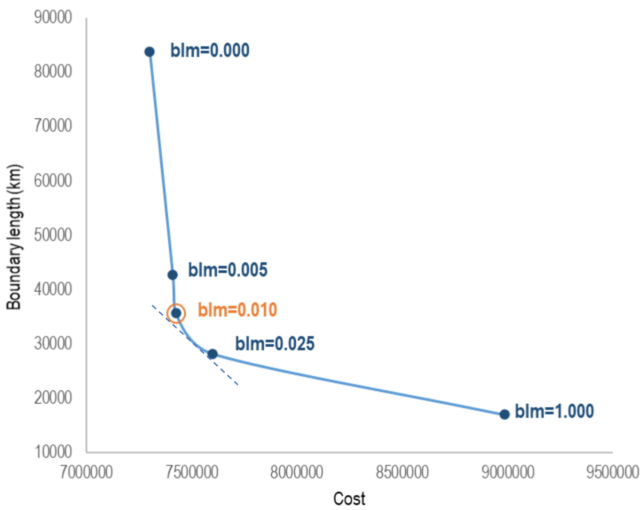


Figure 39. *Calibration of the boundary length modifier (value labels on the chart), with the value selected (orange circle) just above an approximate tangent to the fitted curve (dashed line), which is the point beyond which more solution clustering (lower boundary length) gave a rapid increase in solution cost.*

value of 0.01 is a good trade-off between solution clustering and cost, and by being a bit lower than optimal, it trades off marginal gains in solution clustering for slightly higher conflict avoidance, which is important for implementation, especially in an MSP context. This blm value of 0.010 was used for the rest of the scenarios.

The last parameter that requires calibration is the **species penalty factor** (spf). This parameter increases the penalty value for not meeting a feature's target, making it "worse" for the algorithm to triage a feature's target than to select sites of high cost in order to meet the feature's target. The spf was set to 1 for all features. After the algorithm was run, the outputs were reviewed to determine which features did not meet their targets, and thus, which features required an increase in the spf. However, targets for all biodiversity features (Table 2) were met at a 95% level in the final selection. Therefore, there was no need to increase the spf.

4.6.2. Marxan analysis and compilation of the CBA Map

We ran two consecutive scenarios of the Marxan, each with 100 runs of the algorithm, using the input settings, data and targets described above. Results from the first scenario, were plotted (Fig. 40) as the selection frequency (number of times a planning unit was selected out of the 100 runs of the algorithm) versus the area of that selection (cumulative summed area of the planning units selected at that selection frequency threshold). This graph (Fig. 40) excludes MPAs, which have a 100% selection frequency because they are automatically selected as part of the design criteria. The areas selected 100% of the time in scenario 1 (i.e., in all 100 runs) comprised 9.04% of the marine territory. Areas selected 90% of the time comprised 11.19% of the marine territory.

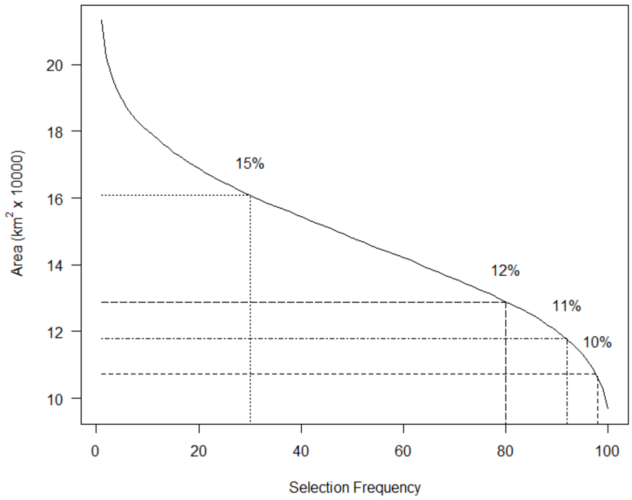


Figure 40. *The proportion (percentage) of the total area selected per selection frequency threshold.*

The areas selected at the 90% selection frequency threshold (i.e., 90–100% selection) were "locked in" to the design, and Marxan was run in a second scenario, with the same settings as before. We iteratively tested at which selection frequency all feature targets (Table 2) were met in the second scenario. All feature targets were met at a 95% level at a selection frequency of 28%, which comprises 14.62% of the marine territory (Fig. 41).

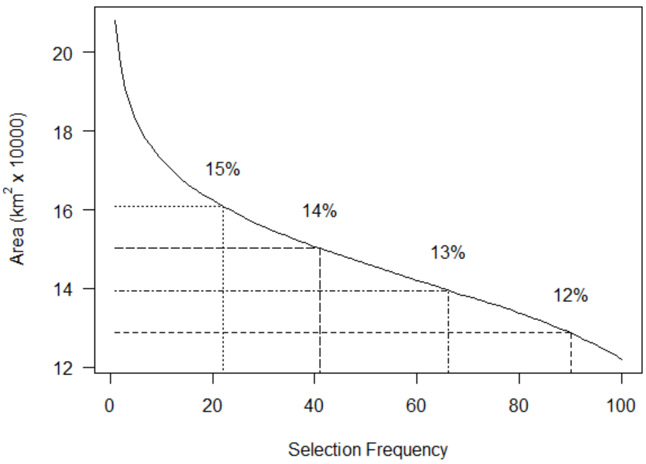


Figure 41. *The proportion (percentage) of the total area selected per selection frequency threshold.*

CBA 1s are the irreplaceable to near-irreplaceable areas, with the recommendation in the Technical Guidelines that the former are the sites with 100% selection frequency, and the latter have a high selection frequency that can be in the range of 80-90%. Given the extent of the area selected at a selection-frequency threshold of 100% (Fig. 40), we used this threshold to define the CBA 1s. CBA 2s are the "best design" sites that are required to meet feature targets but have degree of negotiability in their location. We used the areas selected in the second scenario (that were not already selected as CBA 1s) to define the CBA 2s. This included the 2.15% of the marine territory identified in the first scenario (90–99% selection frequency, "locked in" to the second scenario), as well as an additional 3.43% identified in the second scenario, to give a total CBA 2 extent of 5.58% of the marine territory.

As for the first beta version of the National Coastal and Marine CBA Map, the marine ESAs were the areas of EBSAs that are not already selected as MPAs or CBAs. Note that in this iteration, no distinction is made between ESA 1 and 2. The CBA Map categories and criteria for including areas in each of the categories is summarised in Table 4.

Table 4. *Summary of CBA Map categories and features in the National Coastal and Marine CBA Map Version 1.0 (Beta 2).*

Category	Description
Protected Area	• Marine Protected Areas and coastal land-based protected areas
Critical Biodiversity Area 1	• Irreplaceable to near-irreplaceable sites (100% selection frequency in Marxan scenario 1) • Existing CBA 1 for the coastal terrestrial portion of the planning domain
Critical Biodiversity Area 2	• Best design sites (sites selected at the 90–99% selection frequency in Marxan scenario 1, and 28–100% in Marxan scenario 2) • Existing CBA 2 for the coastal land-based portion of the planning domain
Ecological Support Area	• EBSAs outside of MPAs and not already selected as CBAs • Existing ESAs for the coastal land-based portion of the planning domain

5. National Coastal and Marine CBA Map

Considering only the marine territory, MPAs comprise 5.4%, CBA 1s comprise 9.04%, CBA 2s comprise 5.58%, and ESAs comprise 6.09% of the extent. This means that 26.11% of the marine component of the CBA Map is in one of the CBA Map categories (Figure 42). There are many priority areas for biodiversity along the South African coast, and on the Agulhas Bank where ecosystem type heterogeneity and diversity are high (Fig. 43), especially along the east coast, and at the ecoregional (biogeographic) breaks (refer to Fig. 6). The slope and abyssal ecosystem types on the western and eastern flanks of the EEZ are large and relatively uniform, with some of the new species information (and spatial efficiency and cost) guiding selection in these areas. Many of the biodiversity targets

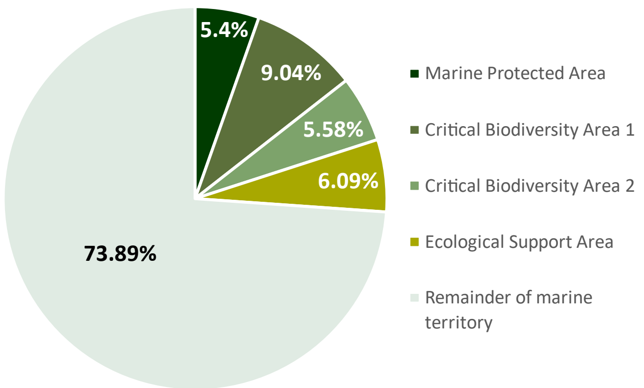


Figure 42. *Proportions of South Africa's mainland marine territory in each of the CBA Map categories.*

are met inside the EBSAs, which is expected because these are priority areas that have been identified in previous systematic assessments.

For users of the National Coastal and Marine Spatial Biodiversity Plan, CBAs 1 and 2 and ESAs 1 and 2 are identical because the management objective is the same in each case. Thus, there is only one set of management recommendations for all CBAs and for all ESAs in the sea-use guidelines (see Section 6). However, it is useful to show the map categories separately for CBAs in the CBA Map (Fig. 43) in this technical report because the detail can be useful for internal sector-based decisions, e.g., offsets. They can also be useful for multi-sector negotiations because CBA 1 indicates irreplaceable or near-irreplaceable sites that are required to meet biodiversity targets with limited, if any, option to meet targets elsewhere, whereas CBA 2 indicates optimal sites that generally can be adjusted to meet targets in other areas, although that may come at higher cost to other sectors. Displaying all categories of biodiversity priority also provides transparency for both internal and multi-sector processes, which is important and good practice for decision-making.

As discussed in Section 3.1, there are typically two additional CBA Map categories that are shown: Other Natural Areas (ONAs) and No Natural Remaining (NNR). The Technical Guidelines define NNR areas are those that are “already severely or irreversibly modified by intensive land [or sea] uses”. Because of differences in how marine ecological condition is analysed compared to that for terrestrial systems, and because of the three-dimensional nature of the ocean, it is seldomly true that severely modified marine habitat has NNR. It is recognised that this is a technical discussion point that needs more attention, and perhaps the only NNR areas in a marine context are ports, harbours, coastal development and other hard infrastructure (including seawalls, breakwaters, etc) below the dune-base line (see Fig. 5 for delineation of the realms). Until this is finalised, these map categories are not displayed in the National Coastal and Marine CBA Map, recognising that the land-based ONAs and NNR are also not displayed, although they have been identified and mapped in the respective provincial plans.

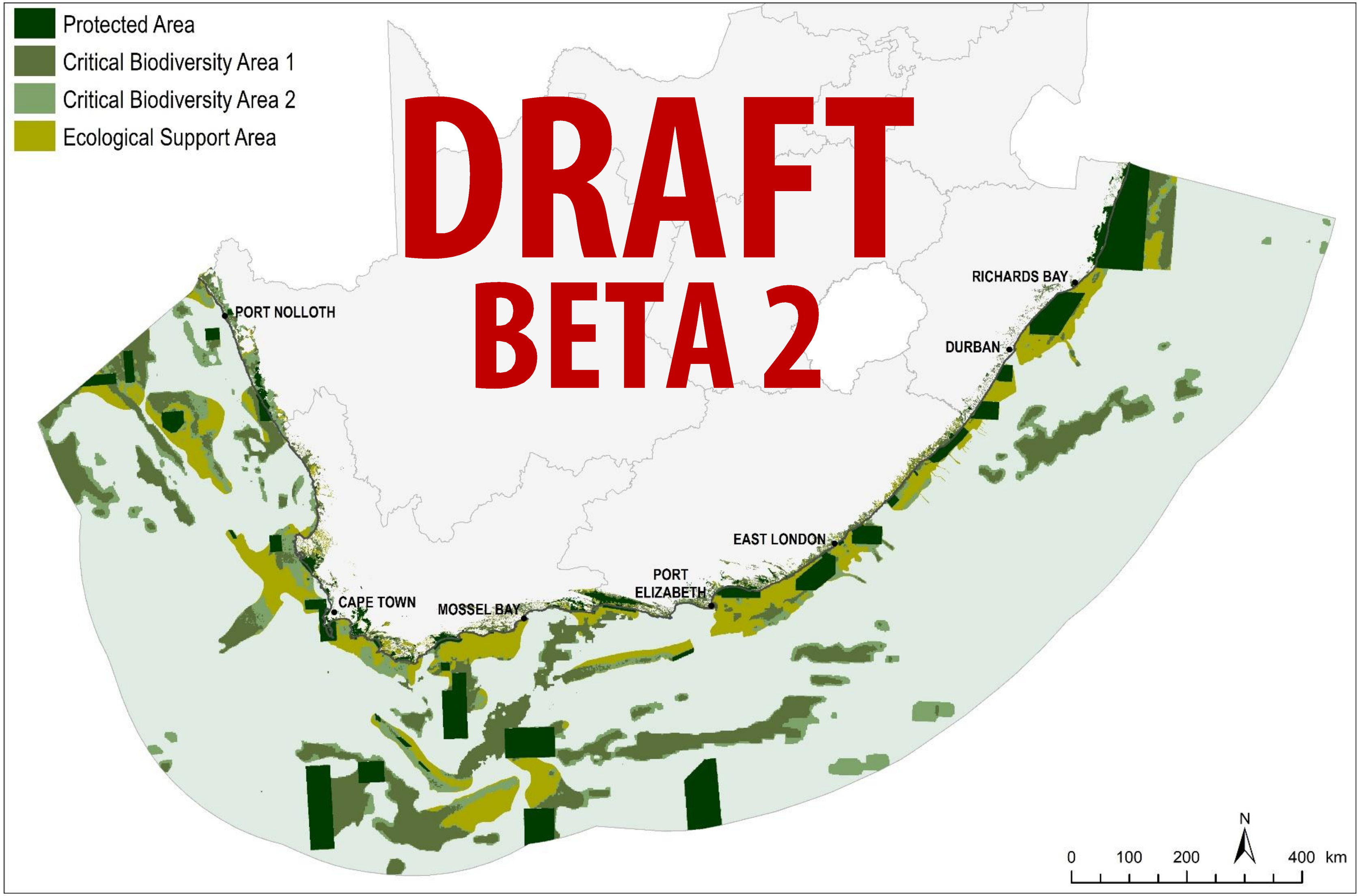


Figure 43. *National Coastal and Marine CBA Map Version 1.0. (Beta 2)*

6. Sea-use guidelines

This section and the following section respectively provide the sea-use and land-use guidelines to accompany the National Coastal and Marine CBA Map. These guidelines enhance the use of the CBA Map in a range of planning and decision-making processes, including Environmental Impact Assessments (EIAs), Marine Spatial Planning (MSP), and Integrated Coastal Zone Management (ICZM). Although the land-use guidelines are well established from a long history in compiling land-based plans, the sea-use guidelines are presented here for the first time, and are a draft that will require further engagement (see Section 8.4, Fig. 1, and Fig. 44). The MSP process, currently underway in terms of the Marine Spatial Planning Act (Act No. 16 of 2018), is a key focus of the sea-use guidelines.

6.1. Approach to compiling the sea-use guidelines and links with the MSP process

As explained in the Introduction, the National Coastal and Marine CBA Map and sea-use guidelines form the basis for the biodiversity sector's input into, *inter alia*, the multi-sectoral MSP process. Current proposed zones for MSP are being developed (e.g., The Approach to a Spatial Management System for South Africa's Marine Planning Areas; Department of Environmental Affairs 2019), with the Conservation Zones likely to comprise a Strict Biodiversity Conservation Zone (including Marine Protected Areas, and Other Effective Area-Based Conservation Measures (OECMs) as two separate types), and an Environmental Impact Management Zone. Protected areas will be managed according to their gazetted regulations. The intention is that the CBA Map (CBAs and ESAs) and sea-use guidelines inform the MSP Conservation Zones and management regulations, respectively (Fig. 44).

Each CBA Map category has a desired management objective (as explained in Section 3.1 and summarised in Table 1): CBAs (1 and 2) need to be kept natural or near-natural; and ESAs (1 and 2) need to be kept at least functional, where further deterioration in ecological condition is ideally avoided. This means that activities within these areas need to be managed in a way that the management objective can be maintained. To do this, each activity needs to be assessed in terms of its compatibility with the management objective of CBAs and ESAs. The outcome of this assessment is that an activity is either compatible, conditionally compatible, or not compatible with the management objective of the CBAs and ESAs. The compilation of compatibility assessments for all activities form the sea-use guidelines that accompany the CBA Map (Fig. 44).

The CBA Map and sea-use guidelines (jointly, the National Coastal and Marine Spatial Biodiversity Plan) are then included in the MSP process as part of the biodiversity sector's input into the multi-sector negotiations. There are likely to be both spatial and regulation adjustments that are made iteratively to the CBA Map and sea-use guidelines through the MSP stakeholder engagement and negotiation processes (see also Fig. 1). For example, where areas of conflict are identified, potential spatial adjustments to the biodiversity priority areas could be explored to try find alternative areas in which to meet targets, target achievement could be re-evaluated, specific sites could be considered for exceptions to the management regulations, etc. The results of the MSP process will be fed back to the latest version of the CBA Map to ensure alignment. Similarly, the activity compatibilities in the sea-use guidelines will inform the MSP regulations for activities. One finalised, the MSP regulations will be fed back into the latest version of the sea-use guidelines so that they match the national MSP (Fig. 44). Descriptions of the environmental zones in the national MSP and recommended links to the CBA Map are given in Table 5.

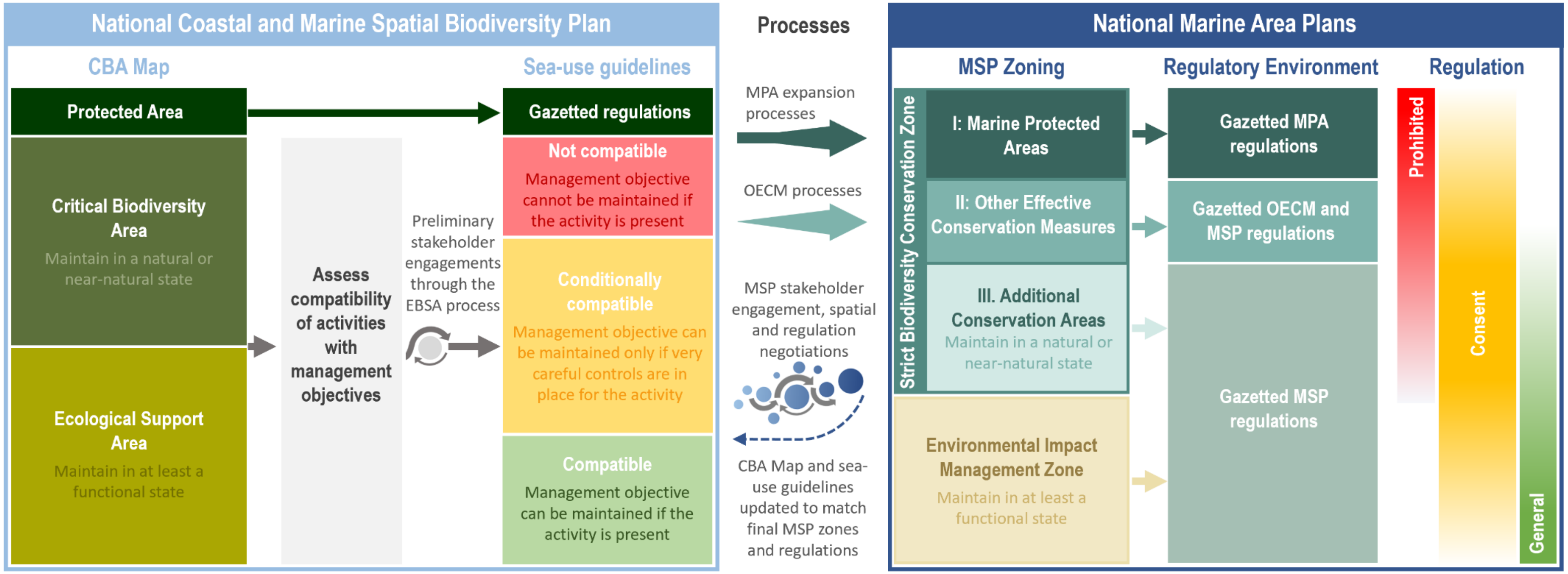


Figure 44. *Schematic diagram illustrating that the National Coastal and Marine Spatial Biodiversity Plan (comprising the Map of Critical Biodiversity Areas and Ecological Support Areas (CBA Map) and sea-use guidelines) will inform the Marine Area Plans, and will be iteratively adjusted through the MSP stakeholder engagement processes. The resulting MSP Zones and management regulations will be fed back into National Coastal and Marine Spatial Biodiversity Plan so that the CBA Map matches the MSP Zoning, and the sea-use guidelines match the MSP regulations. The process for deriving the sea-use guidelines is also shown, indicating that it is based on an assessment of activity compatibility with the management objective of the CBAs (maintain in a natural or near-natural state) and ESAs (maintain in at least a functional state). Note that MPA expansion (focusses on Critical Biodiversity Areas) will also take place and be incorporated into the MSP and revised CBA Map.*

Table 5. *Overview of the environmental zones in the national marine spatial plan, proposed broad spatial regulations and explanation.*

Type of zone	Sub-category	Spatial regulations	Justification
Strict Biodiversity Conservation Zones	**Zone I: Marine Protected Areas**	Marine Protected Areas (MPAs) declared under NEMPA and primarily managed as per their gazetted NEMPA MPA regulations. Activities that are not permitted in the regulations will not be allowed to take place in these areas.	In Strict Biodiversity Conservation Zones, key biodiversity features will be maintained in a natural or semi-natural state, or as near to this state as possible, through strict place-based protection measures with associated regulation of human activities. Areas identified as CBAs need to be managed by place-based regulations informed by the rationale for their selection as CBAs. These will include designated MPAs (Strict Biodiversity Conservation Zone I) and OECMs (Strict Biodiversity Conservation Zone II) and areas that are neither MPAs nor OECMs but nevertheless require strict conservation management measures (Strict Biodiversity Conservation Zone III) regulated in terms of the Marine Area Plan. Additional areas for MPAs would be informed by the National Protected Areas Expansion Strategy (particularly the protection targets), MPA focus areas, Protected Area implementation feasibility, and alignment with other sectors. The MPA gazetting process requires additional consultation and public participation steps (beyond the MSP process) to meet the requirements of the Protected Areas Act. OECMs are controlled under appropriate specific legal mechanisms that control key pressures/impacts on biodiversity over the long term and achieve sustained and effective contribution to in situ conservation, though this does not have to be the primary objective of these areas. Areas would be controlled under appropriate specific legal mechanisms in addition to the regulations as per the legally binding Marine Area Plans. Zone III: Additional Conservation Areas are controlled by the regulations as per the legally binding Marine Area Plans which are informed by the requirements to protect the features which underpin their original selection as CBAs.
	Zone II: Other Effective Area-Based Conservation Measures	Other Effective Area-Based Conservation Measures (OECMs) are specified under various other legal means (i.e. not NEMPA) but nevertheless have an effective long term biodiversity outcome. These areas are managed through these other legal means and by the Marine Area Plan and its regulations. These areas will be managed by place-based regulations informed by their underlying environmental values. Activities that are not permitted in the regulations and/or area management plan will not be allowed to take place in these areas.	
	Zone III: Additional Conservation Areas	These are remaining areas identified as CBAs which are not in Zone I or II, and will be managed by the Marine Area Plan and its regulations informed by the rationale for their selection as CBAs. Activities that are not permitted in the area management plan will not be allowed to take place.	
Environmental Impact Management Zone		These are areas identified as Ecological Support Areas in the CBA map. These areas will be managed by place-based regulations informed by the rationale for their selection. Activities that are not permitted in the regulations and/or area management plan will not be allowed to take place.	In Environmental Impact Management Zones), negative impacts of human activities on key biodiversity features are managed and minimised to maintain the features in at least a functional state and/or to allow the area to improve in ecological condition.

6.2. Sea-use guidelines

As noted above, the sea-used guidelines are a compilation of activity compatibilities with the CBAs and ESAs (Fig. 44). This evaluation of activity compatibility was based on the ecosystem-pressure matrix from the NBA 2018 marine assessment (Sink et al. 2019c), and applied the principles tabulated below (Table 6). The cross-walk from the CBA Map categories to high-level MSP zones is given (Table 7, see also Table 5), also showing which MSP zones could be broadly compatible with the desired management objective for each CBA Map category.

Table 6. *Principles for assessing compatibility of activities within the Critical Biodiversity Areas and Ecological Support Areas, and recommendations for management of those activities*

Type of activity	**Critical Biodiversity Areas** *Compatibility with the management objective to: keep the site in a natural / near-natural state*	**Ecological Support Areas** *Compatibility with the management objective to: keep the site in at least a functional state*
Activities that would (or could) result in Severe or Very Severe degradation over broad areas	**Not compatible** Management recommendations: The activity should not be permitted to occur in this area because it is not compatible with the management objective. If it is considered to be permitted as part of compromises in MSP negotiations, it would require alternative CBAs and/or offsets to be identified. However, if this is not possible, it is recommended that the activity remains prohibited within the CBA.	**Conditionally compatible** Management recommendations: Careful regulations and controls over and above the current general rules and legislation would be required to be put in place to avoid unacceptable impacts on biodiversity features. Examples of such regulations and controls include: avoiding intensification or expansion of current impact footprints; exclusions of activities in portions of the zone; additional gear restrictions; temporal closures of activities during sensitive periods for biodiversity features; etc.
Activities that would (or could) result in Severe or Very Severe degradation of localised sites	**Conditionally compatible** Management recommendations: Careful regulations and controls over and above the current general rules and legislation would be required to be put in place to avoid unacceptable impacts on biodiversity features. Examples of such regulations and controls include: avoiding intensification or expansion of current impact footprints; exclusions of activities in portions of the zone; additional gear restrictions; temporal closures of activities during sensitive periods for biodiversity features; etc.	**Conditionally compatible** Management recommendations: Careful regulations and controls over and above the current general rules and legislation would be required to be put in place to avoid unacceptable impacts on biodiversity features. Examples of such regulations and controls include: avoiding intensification or expansion of current impact footprints; exclusions of activities in portions of the zone; additional gear restrictions; temporal closures of activities during sensitive periods for biodiversity features; etc.
Activities that would (or could) result in or contribute to Moderate degradation	**Conditionally compatible** Management recommendations: Careful regulations and controls over and above the current general rules and legislation would be required to be put in place to avoid unacceptable impacts on biodiversity features. Examples of such regulations and controls include: avoiding intensification or expansion of current impact footprints; exclusions of activities in portions of the zone; additional gear restrictions; temporal closures of activities during sensitive periods for biodiversity features; etc.	**Compatible** Management recommendations: Activities should be allowed and regulated by current general rules. Notwithstanding, there should still be duty of care, possibly requiring monitoring and evaluation programmes, to avoid unintended cumulative impacts to the biodiversity features for which this area is recognised.
Activities that would (or could) result in low to very low degradation and/or are not managed by biodiversity zones	**Compatible** Management recommendations: Activities should be allowed and regulated by current general rules. Notwithstanding, there should still be duty of care, possibly requiring monitoring and evaluation programmes, to avoid unintended cumulative impacts to the biodiversity features for which this area is recognised.	**Compatible** Management recommendations: Activities should be allowed and regulated by current general rules. Notwithstanding, there should still be duty of care, possibly requiring monitoring and evaluation programmes, to avoid unintended cumulative impacts to the biodiversity features for which this area is recognised.

Table 7. *Overview of CBA Map categories, desired state and recommended MSP Zones that are broadly compatible with the desired state. The boldfaced MSP zone is the one that is informed by the CBA Map category for each row.*

CBA Map Category	Description	Desired state / management objective	Recommended MSP Zones
Protected Areas	Areas that are formally protected in terms of the National Environmental Management: Protected Areas Act (No. 57 of 2003)	As per each Protected Area Management Plan	**Strict Biodiversity Conservation Zone I: Marine Protected Areas** Additional broad compatibility with: Marine Tourism; Heritage Protection; Fisheries Resource Protection
Critical Biodiversity Areas	Areas that must remain in natural or near-natural ecological condition in order to meet biodiversity targets	Maintain in natural or near-natural ecological condition	**Strict Biodiversity Conservation Zone (to be split into appropriate Zones I-III based on the MPA expansion process, OECM process, and MSP)** Additional broad compatibility with: Marine Tourism; Heritage Protection; Fisheries Resource Protection
Ecological Support Areas	Areas that must remain in at least moderately modified ecological condition in order to meet biodiversity targets, support ecological functioning, or deliver ecosystem services; further deterioration in ecological condition must be avoided	Maintain in at least a functional state, avoiding further deterioration in ecological condition where possible.	**Environmental Impact Management Zone** Additional broad compatibility with: Marine Tourism; Heritage Protection; Commercial Fishing; Small Scale/Subsistence Fishing; Fisheries Resource Protection; Aquaculture Development; Renewable Energy; Military; Maritime Transport; Underwater Infrastructure

More detail is provided on specific activities in each MSP zone that are likely to be compatible or incompatible with the management objectives for CBAs and ESAs (Table 8). Activities are classified into those that are compatible (Y for Yes), those that are incompatible (N for No), and those that may be compatible subject to certain conditions (C for Conditional). For example, CBAs should be maintained in a natural or near-natural state, which means that low-impact tourism activities such as scuba diving are likely to be compatible with CBAs, whereas other activities such as mining operations are unlikely to be compatible with CBAs because such activities degrade the natural state. As mentioned above, the CBA Map categories are reduced to two: CBAs and ESAs because the management objective for CBA 1 and 2 is the same (to maintain biodiversity in a natural or near-natural state, or as near to this state as possible); likewise for ESA 1 and 2 (to keep biodiversity in at least a functional state).

Note that these guidelines (Table 8) set out the minimum recommendations for management of activities. The recommendations do not override existing controls on an activity (e.g., gillnetting) or where prohibitions are already in place (e.g., ammunition dumping). Further, the ideal position is if improved place-based protection within biodiversity priority areas is pursued. This may require additional MPA declaration or expansion, implementation of other effective area-based conservation measures (OECMs), and sector-specific regulations, particularly in CBAs.

Table 8. *List of all sea-use activities, grouped by their broad sea use and Marine Spatial Planning (MSP) Zones, and scored according to their compatibility with the management objective of Critical Biodiversity Areas (CBA) and Ecological Support Area (ESA). Once finalised in the MSP process, CBAs will get the same delineation as the Strict Biodiversity Conservation Zone II; and ESAs will get the same delineation as the Environmental Impact Management Zone. Activity compatibility is given as Y = yes, compatible, C = conditional or N = not compatible.*

Broad sea use	Associated MSP Zones	Associated sea-use activities	MPA	CBA	ESA
Recreation and tourism	Marine Tourism Zone	Beach visiting, recreation, non-motorised water sports	Sea-use activities as per gazetted MPA regulations	Y	Y
		SCUBA diving		Y	Y
		Shark cage diving		Y	Y
		Whale watching		Y	Y
		Motorised water sports (e.g., jet skis)		C	Y
		Recreational boat-based linefishing		C	Y
		Recreational shore-based linefishing		C	Y
		Spearfishing		C	Y
		Shark control		C	Y
Heritage	Heritage Conservation Zone	Shipwrecks		Y	Y
		Sites of historic importance		Y	Y
		Sites of land- or seascape value		Y	Y
Fisheries	Priority Fishing Zone	Crustacean trawling		N	C
		Demersal inshore trawling		N	C
		Demersal offshore trawling		N	C
		Abalone harvesting		C	Y
		Commercial linefishing		C	Y
		Demersal hake longlining		C	Y
		Kelp harvesting		C	Y
		Midwater trawling		C	Y
		Beach seining		C	Y
		Gillnetting		C	Y
		Oyster harvesting		C	Y
		Pelagic longlining		C	Y
		Small pelagics fishing		C	Y
		South coast rock lobster harvesting		C	Y
		Squid fishing		C	Y
		Tuna pole fishing		C	Y
		West coast rock lobster harvesting		C	Y
	Small Scale/Subsistence Fishing Zone	Subsistence fishing		C	Y
	Fisheries Resource Protection Zone	Resource protection		Y	Y
Aquaculture	Priority Mariculture Zone	Sea-based aquaculture		C	Y
Mining	Mining Zone	Mining: prospecting (non-destructive)		C	Y
		Mining: prospecting (destructive, localised impact, e.g., bulk sampling)		C	C
		Mining: mining construction and operations		N	C
Petroleum	Petroleum Zone	Petroleum: exploration (non-destructive)		C	Y
		Petroleum: exploration (destructive, localised impact, e.g., exploration wells)		C	C
		Petroleum: production		N	C
Renewable Energy	Renewable Energy Zone	Renewable energy installations		C	Y
Defence	Military Practice Zone	Missile testing grounds		C	Y
		Training and practice areas		Y	Y
	Disused Ammunition Dumping Areas	Ammunition dumping site (*disused)		N*	N*
Transport	Maritime Transport Zone	Shipping lanes (including port approach zones)		Y	Y
		Ports and harbours		N	C
		Dumping of dredged material		N	C
		Anchorage areas		C	Y
		Bunkering		C	Y
Infrastructure	Underwater Infrastructure Zone	Undersea cables		C	Y
		Seawater inlets		C	Y
		Pipelines		C	Y
	Land-based Infrastructure Zone	Coastal development (including piers, breakwaters, and seawalls)		N	C
Disposal	Disposal Zone	Waste-water		C	Y

The sea-use guidelines presented here (Tables 7 and 8) are a revised draft. They build on the proposed management recommendations from preliminary stakeholder engagement through the EBSA process. The draft above still requires further engagement with stakeholders to refine and improve what is proposed (Fig.1, Fig. 44). The MSP process is required to include robust stakeholder engagement and negotiations among sectors, which is likely where most of these discussions will take place, but we welcome preliminary engagements with sectors who feel that their ocean-based activities are not adequately represented in the guidelines (e.g., some of the activities may need to be split into their respective components if it is sensible for the management recommendations to be different for those different components).

7. Coastal land-use guidelines and integrated coastal zone management

The coastal land-based biodiversity priority areas are from the existing provincial plans. Therefore, for the land-use guidelines accompanying the land-based portion of the National Coastal and Marine CBA Map, see the respective provincial spatial biodiversity plans (Table 9). In the next iterations of the National Coastal and Marine Spatial Biodiversity Plan, a focus will be on improving the land-sea integration (Section 8.2). This may also require, *inter alia*, some cross-checks between the land- and sea-use guidelines to ensure that transitional systems (e.g., beaches and dunes) are appropriately managed across the land-sea interface (see Section 8.4), in accordance with the National Environmental Management: Integrated Coastal Management Act No. 24 of 2008.

Table 9. *References and links to the coastal provincial plans and land-use guidelines*

Province	Reference	Website
Northern Cape	Holness and Oosthuysen (2016)	http://bgis.sanbi.org/Projects/Detail/203
Western Cape	Pool-Stanvliet et al. (2017)	http://bgis.sanbi.org/Projects/Detail/194
Eastern Cape	Hawley et al. (2019)	http://bgis.sanbi.org/Projects/Detail/233
KwaZulu-Natal	Escott et al. (2016)	http://bgis.sanbi.org/Projects/Detail/22

8. Current limitations and plans and recommendations for future work

This section describes the current recognised limitations in the National Coastal and Marine Spatial Biodiversity Plan, and proposes ways to address these. Future improvements can be achieved by including a variety of new datasets (Section 8.1), revising some of the technical aspects in the methods (Section 8.2) and related prioritisations (Section 8.3), and refining the sea-use guidelines (Section 8.4). Recommendations for revisions to the Technical Guidelines are also given (Section 8.5). Some progress has been made to address some of these aspects, which will continue through the upcoming revisions of the Spatial Biodiversity Plan: the final Version 1 to be released on 26 February 2021; and Version 2 to be released approximately around the end of 2022, or early 2023. Once more engagement and a broader suite of biodiversity data have informed the updated CBA Map and it is accepted as the consolidated spatial priorities of the biodiversity sector, it will be the Coastal and Marine Biodiversity Sector Plan.

A more comprehensive suite of biodiversity features and any updated cost information will be included in the next iteration of the CBA Map (26 February 2021). To contribute data, see the EBSA Portal for options.

Deadline for data submissions: 31 January 2021

8.1. Additional data

The intent is that the National Coastal and Marine Spatial Biodiversity Plan is always based on the best-available information, which will necessitate iterative refinements over time to incorporate new data and updates from stakeholder negotiations in the MSP Process (Figs. 1, 43). Numerous datasets have been identified for inclusion in future iterations of the National Coastal and Marine CBA Map (see Appendix 2), with this Beta 2 version including more than 50 biodiversity input datasets with close to 100 additional features than did Beta 1. We will continue to add more data through the upcoming iterations. Experts are welcomed to provide additional data. The South African Marine Science Symposium (SAMSS) provides an important forum for engagement with the marine science community. A workshop is planned for the upcoming symposium, where building the science base for assessment, planning and management in the coastal and marine environment will be discussed (see Appendix 3). This will provide a key opportunity to review available datasets and to discuss future research priorities. Further, DEFF's Marine Information Management System (MIMS: http://data.ocean.gov.za), which is still under development, will be an important source of datasets and will facilitate access to the data needed for future iterations.

8.1.1. Unmapped areas of high cost

The revised method for mapping cost (level of avoidance of other activities) proposed at the end of Beta 1 has been implemented in Beta 2. We used the data from the NBA 2018 (Majiedt et al. 2019; Sink et al. 2019c) as the best available data for representing cost; however, we do recognise some shortcomings. For some activities (e.g., some fisheries), the areas of current highest use are their areas of high value, and thus the current intensity of use is a good metric for the level of avoidance in spatial prioritisation for marine biodiversity. However, for other activities, this is not the case, especially for new, emerging and expanding activities, e.g., petroleum, mining, aquaculture, new fisheries, and renewable energy. Some initial engagements have been undertaken to change the level of avoidance from current and historical use to better capture areas of intended activities in the short to medium term. For example, engagement with petroleum rights holders and the Petroleum Agency South Africa has reframed the map of avoidance of petroleum activities from avoiding only existing well heads, to avoiding (at different levels) production rights, leads and prospects, and exploration rights as well. Furthermore, current intensity of use may also have changed for some activities since compilation of the maps for the NBA 2018 and need to be updated. Work is planned to refine and validate priority areas for the sectors represented in the cost layer for the next iterations. The need for updated and improved data was highlighted in the research priorities and priority actions reflected in the NBA 2018 Marine assessment report (Sink et al. 2019b). It is our intention to combine efforts and use this opportunity to update the pressure layers for the next NBA, and improve the cost layer for future iterations of the CBA Map.

The intent of all these engagements and updates is to further refine compilation of a cost layer for the next iterations of the CBA Map that best avoids areas of high value to other ocean-based activities (i.e., high conflict) as far as possible, while still meeting biodiversity objectives. In this way, MSP negotiations can be limited to only those areas that are legitimately contested space; it would eliminate unnecessary conflict and streamline any decision-making, declaration of protected areas and other implementation. Therefore, continued development of the fine-scale map showing areas of high value for other activities that can be included in future versions of this CBA Map will be to the benefit of both these activities and the biodiversity sector.

It is also important to note that this is not the stakeholder engagement process mandated to be part of the MSP process. These are preliminary engagements undertaken by the biodiversity sector as an additional step to compile an input for the MSP process that has highest likelihood of implementation and requires least multi-sector negotiation because it has already taken into account the areas of importance for other users, as far as possible. It is anticipated that the MSP stakeholder engagement process will require further modifications to biodiversity spatial priorities and/or regulations, and will require compromises to be made by all sectors, before the national MSP is finalised.

Further engagement to refine the input cost data, where necessary, is encouraged

Any sectors that feel the maps in Section 4.4.2–4.4.6 do not adequately represent their activities – particularly if any areas are missing – are encouraged to contact us and provide the additional data required to improve the avoidance. We note that these maps have not yet made the adjustments to the areas available for different activities since the new MPAs came into effect in 2019. These adjustments will be made for the next iteration, but did not affect the current analysis because the MPAs are included in the analysis as existing biodiversity priority areas.

8.1.2. Species data

This Beta 2 version contains a number of the most readily accessible species datasets, and further inclusion of species data will continue through the next iterations. There would also likely need to be a **workshop to determine which species are not adequately represented by their associated ecosystem types and need to be included as separate features**. Species that require particular attention are rare, threatened or protected species, indicator species of vulnerable marine ecosystems, species of commercial importance, and any other species of special concern. Inclusion of fish species is also a key priority for the next iterations. It is important to recognise that some species requirements may be better addressed under their Biodiversity Management Plans, and that modelled species' distributions should be included only where confidence in the map is high. Migratory species may be useful in terms of incorporating ocean connectivity into the prioritisation. The species included in the latest versions of the National Coastal and Marine CBA Map will also be reviewed and discussed at the next SAMSS.

8.1.3. Ecological corridors

The Technical Guidelines place strong emphasis on ecological corridors, especially for ESAs, and it is one of the required minimum input datasets. This is because ecological corridors are an important component of a CBA Map; their inclusion makes provision for unimpeded movement of species through the land- or seascape as they adapt to changing conditions, thus allowing shifts in species' distributions, helping to safeguard their persistence. This is particularly important in terms of climate change. One key difference between terrestrial and marine planning is that there are many land-uses that potentially block landscape connectivity, e.g., built-up areas; but this is not the case in the marine environment. There are very few activities that present a physical barrier to species movement in the sea because it is inherently more connected than is the land because of the water medium.

There needs to be **engagement with the marine scientific community to determine what these ecological corridors might be, and how they could be mapped**. Possible options that could be explored are:

- Aggregating tracking data from migratory marine species to determine seascape-level migratory pathways
- Mapping the "centre of gravity" of ocean currents
- Identifying any known areas of larval dispersal
- Identifying key areas of land-sea connectivity that are not accounted for in edge-matching the terrestrial, inland aquatic, estuarine and marine prioritisations
- Including climate refugia and corridors or networks of sites for species adaptation and range shifts along thermal gradients (see Annexure 1 and Appendix 2).

As described in Box 2 above (Section 3.3), there are many tools to incorporate connectivity in the marine realm that can be explored: the key challenge is data availability at a national scale. **The connectivity of the network of selected sites should also be tested.**

8.1.4. Ecological infrastructure and ecological processes

Ecological infrastructure refers to "naturally functioning ecosystems that generate or deliver valuable services to people. It is the nature-based equivalent of built infrastructure, and is just as important for providing services and underpinning economic development" (SANBI 2016). Ecological infrastructure can be included as a biodiversity feature in a systematic biodiversity plan, where this information exists.

There is **current work being undertaken to map coastal and marine ecological infrastructure** (e.g., strategic fisheries resource areas, coastal protection), and to explore novel approaches to target setting for these features. Some of these datasets have been completed and included in this iteration; the other map products will be included in the next versions of the National Coastal and Marine CBA Map as soon as the data are available.

The inclusion of large-scale ecological processes in the National Coastal and Marine CBA Map is currently limited. Areas that are important for key ecological processes will need to be mapped and included as biodiversity features. An initial set of ecological processes that could be included in future iterations have been listed in Appendix 2; these will be discussed at the next SAMSS.

8.2. Planning-unit size and coastal integration

The planning units for the previous version of the Coastal and Marine CBA Map comprised a 1' grid; however, these 1' grid cells were too large to be appropriate planning units for the fine-scale ecosystem types closer to shore, and hardwiring in land-based protected areas, for example, sometimes resulted in areas on the inner shelf being selected. This was addressed in this iteration by intersecting the 1' grid with the shore zone from Harris et al. (2019a), which meant that land-based priorities remained coded to the land-based planning units (Fig. 45). **Improved refinement of land-sea integration will be undertaken in the CoastWise project.**

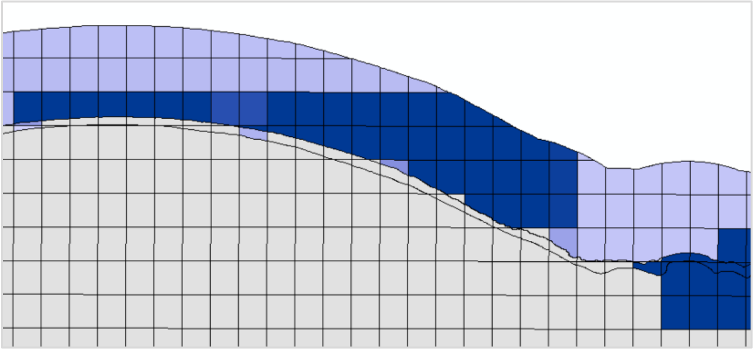


Figure 45. *Intersecting the 1′ planning unit grid with the shore zone facilitated improved accuracy in coding data to planning units at the land-sea interface. Planning units are outlined in black and coloured by selection frequency, showing protected areas (100% selection frequency) in dark blue, other selections in lighter shades of blue, and no selection as grey.*

8.3. Estuary priorities

A National Estuary Biodiversity Plan that identifies priority estuaries has been compiled by the estuarine scientific community (Turpie et al. 2012). However, these priorities **need to be brought into the CBA Map Framework**. The set of priority systems also needs to be revised in light of the updated estuarine ecosystem classification and condition assessment (Van Niekerk et al. 2019a; van Niekerk et al. 2020). Consequently, a project is planned to update the National Estuary Biodiversity Plan through the Coastwise project, pending finalisation of the contract. After some preliminary consultation, a target-based approach using systematic biodiversity planning that addresses representation, persistence, complementarity, and spatial efficiency was identified as the best way to identify CBAs and ESAs for estuaries.

In developing the **updated National Estuary Biodiversity Plan**, additional alignment is also planned with the freshwater (National Freshwater Ecosystem Priority Areas Project version 2: NFEPA2) and marine (Coastal and Marine CBA Map) spatial prioritisations, both upstream and downstream. In other words, where there are river-influenced marine ecosystem types that are identified as CBAs, this may cascade upstream into the estuary and catchment because maintaining river-influenced marine biodiversity and ecological processes will likely depend on maintaining healthy rivers and estuaries. Similarly, where there are priorities in either the catchment or estuary, this could cascade priorities downstream, e.g., by prioritising estuaries and beaches downstream of the flagship or free-flowing rivers, which we have implemented in the Beta 2 version. This catchment-to-coast connectivity is vital for supporting many species that use more than one realm through their lifecycle, including species of commercial importance.

8.4. Sea-use guidelines

The sea-use guidelines presented here are a **revised draft that can serve as a basis for discussions**. It is anticipated that this aspect will be advanced through other initiatives. Although these have been discussed in two national workshops in terms of EBSA management, much more negotiation and engagement with stakeholders and the marine science community is required. In particular, the formal engagements and negotiations among sectors through the MSP process will play a key role in advancing the sea-use guidelines from recommendations on compatibility to management regulations per MSP Zone. It is also noted that the next iteration that will include an improved land-sea coastal integration may require a careful look at the land- and sea-use guidelines for the transitional ecosystems that span both the terrestrial and marine realms, e.g., beaches and dunes, to ensure alignment between the two sets of guidelines for appropriate management of these ecosystems. This would also need to be considered in terms of the National Environmental Management: Integrated Coastal Management Act, No. 24 of 2008 (Republic of South Africa 2008).

8.5. Revisions to the Technical Guidelines for CBA Maps

Given that the Technical Guidelines for CBA Maps (SANBI 2017) have been developed for land-based biodiversity planning (including terrestrial as well as inland aquatic features, like rivers and wetlands), it is not always clear how to apply the detailed aspects of the guidelines in the marine realm. The experience of developing this Coastal and Marine CBA Map should inform a **revision of the Technical Guidelines** to make them more applicable to all realms.

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Appendix 1: Verification of target achievement

To verify if the biodiversity targets are met, the area of each biodiversity feature (Table A1.1) that is included in MPAs or CBAs (CBA 1 or CBA 2) was calculated. The summed percentage extent in the MPA and CBA categories was compared against the target. All features met their biodiversity targets at a 95% level, with the exception of three features that met their targets at 89%. Given that all three of these are threatened features (two Endangered ecosystem types, and one foraging area of the Endangered Cape Gannet), target achievement will need to be improved in the next iteration. Note that only the marine ecosystem types and estuarine shores are reported here; the land-based features will be reported in future iterations after the coastal integration is better addressed.

Table A1.1. *List of biodiversity input features, NBA 2018 Ecosystem Threat Status (ETS; grey where not applicable), area within Marine Protected Areas (MPAs) or Critical Biodiversity Areas (CBAs), full feature extent (km^2), percentage of the feature in MPAs or CBAs, and the biodiversity target per feature (see Table 2 of the main text) is presented. Target achievement is determined by comparing the proportion of the feature in an MPA or CBA, with the biodiversity target. The target is considered "met" if the proportion of the ecosystem type in a PA and CBA is within 5% of the target. ETS data from Sink et al. (2019c) and Van Niekerk et al. (2019a), based on the criteria for the IUCN Red List of Ecosystems: LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered; CR = Critically Endangered. The extent of the ecosystem types is from Sink et al. (2019a). ESA = Ecological Support Area.*

Feature		NBA 2018 ETS	Area within MPAs or CBAs (km^2)	Feature extent (km^2)	Percent in MPAs or CBAs (%)	Target (%)	Target met
Ecosystem types							
Ecosystem types (NBA 2018)	Agulhas Basin Abyss	LC	15899.1	56942.8	0.3	0.1	Met
	Agulhas Basin Complex Abyss	LC	757.7	3747.7	0.2	0.2	Met
	Agulhas Blues	NT	2244.1	8379.6	0.3	0.2	Met
	Agulhas Boulder Shore	NT	1.1	1.6	0.7	0.2	Met
	Agulhas Coarse Sediment Shelf Edge	VU	942.6	3990.5	0.2	0.2	Met
	Agulhas Dissipative Intermediate Sandy Shore	LC	74.4	116.4	0.6	0.2	Met
	Agulhas Dissipative Sandy Shore	NT	15.2	25.1	0.6	0.2	Met
	Agulhas Exposed Rocky Shore	VU	68.1	89.5	0.8	0.2	Met
	Agulhas Exposed Stromatolite Rocky Shore	VU	6.1	8.3	0.7	0.2	Met
	Agulhas Inner Shelf Mosaic	VU	1024.4	1853.6	0.6	0.2	Met
	Agulhas Inner Shelf Reef	LC	15.7	17.7	0.9	0.2	Met

Feature	NBA 2018 ETS	Area within MPAs or CBAs (km²)	Feature extent (km²)	Percent in MPAs or CBAs (%)	Target (%)	Target met
Agulhas Intermediate Sandy Shore	LC	7.1	14.5	0.5	0.2	Met
Agulhas Island	VU	6.4	6.4	1.0	0.2	Met
Agulhas Kelp Forest	VU	10.0	12.3	0.8	0.2	Met
Agulhas Lower Canyon	LC	881.4	1152.5	0.8	0.2	Met
Agulhas Mid Shelf Mosaic	NT	1800.8	3632.6	0.5	0.2	Met
Agulhas Mid Shelf Reef	VU	43.5	51.9	0.8	0.2	Met
Agulhas Mixed Shore	NT	147.2	188.1	0.8	0.2	Met
Agulhas Muddy Mid Shelf	CR	337.7	1732.4	0.2	0.2	Met
Agulhas Muddy Outer Shelf	NT	368.8	1278.0	0.3	0.2	Met
Agulhas Plateau	LC	1194.0	5469.1	0.2	0.2	Met
Agulhas Reflective Sandy Shore	VU	0.6	0.9	0.7	0.2	Met
Agulhas Rocky Outer Shelf	LC	1885.7	4214.8	0.4	0.2	Met
Agulhas Rocky Plateau	LC	2334.8	8592.9	0.3	0.2	Met
Agulhas Rocky Shelf Edge	LC	2499.3	5233.0	0.5	0.2	Met
Agulhas Sandy Inner Shelf	VU	314.0	521.5	0.6	0.2	Met
Agulhas Sandy Mid Shelf	NT	5917.7	20233.1	0.3	0.2	Met
Agulhas Sandy Outer Shelf	VU	1745.8	7058.5	0.2	0.2	Met
Agulhas Sheltered Rocky Shore	EN	0.7	1.3	0.5	0.2	Met
Agulhas Stromatolite Mixed Shore	VU	4.5	8.4	0.5	0.2	Met
Agulhas Upper Canyon	VU	54.7	102.0	0.5	0.2	Met
Agulhas Very Exposed Rocky Shore	VU	7.3	9.1	0.8	0.2	Met
Agulhas Very Exposed Stromatolite Rocky Shore	NT	0.7	1.3	0.5	0.2	Met
Aliwal Shoal Reef Complex	VU	5.2	5.2	1.0	0.2	Met
Alphard Bank	LC	31.9	31.9	1.0	0.2	Met
Amathole Hard Shelf Edge	VU	468.7	468.7	1.0	0.2	Met
Amathole Lace Corals	NT	67.8	131.6	0.5	0.2	Met
Browns Bank Rocky Shelf Edge	CR	832.0	2164.1	0.4	0.2	Met

Feature	NBA 2018 ETS	Area within MPAs or CBAs (km^2)	Feature extent (km^2)	Percent in MPAs or CBAs (%)	Target (%)	Target met
Cape Basin Abyss	LC	5980.5	57855.0	0.1	0.1	Met
Cape Basin Complex Abyss	LC	8811.5	73071.6	0.1	0.1	Met
Cape Bay	EN	129.4	254.4	0.5	0.2	Met
Cape Boulder Shore	VU	2.1	2.6	0.8	0.2	Met
Cape Exposed Rocky Shore	VU	21.4	28.9	0.7	0.2	Met
Cape Island	EN	3.0	3.0	1.0	0.2	Met
Cape Kelp Forest	VU	8.1	9.8	0.8	0.2	Met
Cape Lower Canyon	VU	1307.2	2838.1	0.5	0.2	Met
Cape Mixed Shore	VU	22.6	33.7	0.7	0.2	Met
Cape Rocky Inner Shelf	VU	403.7	473.6	0.9	0.2	Met
Cape Rocky Mid Shelf Mosaic	VU	2341.2	3904.9	0.6	0.2	Met
Cape Sandy Inner Shelf	VU	246.6	526.2	0.5	0.2	Met
Cape Sheltered Rocky Shore	EN	0.7	1.5	0.5	0.2	Met
Cape Upper Canyon	EN	770.4	2394.8	0.3	0.2	Met
Cape Very Exposed Rocky Shore	NT	0.5	0.5	1.0	0.2	Met
Central Agulhas Outer Shelf Mosaic	LC	553.0	2452.9	0.2	0.2	Met
Childs Bank Coral	VU	428.3	505.5	0.8	0.2	Met
Childs Bank Plateau	LC	1161.4	1620.3	0.7	0.2	Met
Cool Temperate Arid Predominantly Closed	EN	0.7	1.2	0.6	0.2	Met
Cool Temperate Estuarine Lake	EN	4.9	5.1	0.9	0.2	Met
Cool Temperate Large Fluvially Dominated	EN	2.7	3.4	0.8	0.2	Met
Cool Temperate Large Temporarily Closed	CR	4.5	4.9	0.9	0.2	Met
Cool Temperate Micro-estuary		1.0	1.0	1.0	0.2	Met
Cool Temperate Predominantly Open	EN	1.6	1.7	1.0	0.2	Met
Cool Temperate Small Fluvially Dominated	LC	0.0	0.0	1.0	0.2	Met
Cool Temperate Small Temporarily Closed	EN	1.9	2.1	0.9	0.2	Met
Delagoa Deep Shelf Edge	LC	605.4	605.4	1.0	0.2	Met

Feature	NBA 2018 ETS	Area within MPAs or CBAs (km^2)	Feature extent (km^2)	Percent in MPAs or CBAs (%)	Target (%)	Target met
Delagoa Lower Canyon	LC	33.6	33.6	1.0	0.2	Met
Delagoa Mixed Shore	LC	28.7	28.7	1.0	0.2	Met
Delagoa Rocky Mid Shelf	LC	23.0	23.0	1.0	0.2	Met
Delagoa Sandy Inner Shelf	LC	172.7	172.7	1.0	0.2	Met
Delagoa Sandy Mid Shelf	LC	274.2	274.2	1.0	0.2	Met
Delagoa Shelf Edge	LC	189.8	189.8	1.0	0.2	Met
Delagoa Upper Canyon	LC	13.6	13.6	1.0	0.2	Met
Delagoa Very Exposed Rocky Shore	LC	0.3	0.3	1.0	0.2	Met
Durnford Inner Shelf Reef Complex	EN	339.0	460.5	0.7	0.2	Met
Durnford Mid Shelf Reef Complex	VU	346.4	431.8	0.8	0.2	Met
Eastern Agulhas Bay	VU	759.5	1631.2	0.5	0.2	Met
Eastern Agulhas Outer Shelf Mosaic	LC	10499.1	25966.2	0.4	0.2	Met
False and Walker Bay	VU	934.9	1681.2	0.6	0.2	Met
Kei Fluvial Fan	EN	42.9	49.0	0.9	0.2	Met
Kei Reef Mosaic	EN	82.3	93.7	0.9	0.2	Met
Kingklip Koppies	VU	576.4	642.9	0.9	0.2	Met
Kingklip Ridge	EN	103.6	103.6	1.0	0.2	Met
Kosi Coral Community	LC	8.0	8.0	1.0	0.2	Met
KZN Bight Deep Shelf Edge	EN	485.6	1761.2	0.3	0.2	Met
KZN Bight Mid Shelf Mosaic	EN	94.9	534.7	0.2	0.2	Met at 89%
KZN Bight Mid Shelf Reef Complex	EN	5.6	23.0	0.2	0.2	Met
KZN Bight Muddy Inner Shelf	VU	328.7	328.7	1.0	0.2	Met
KZN Bight Muddy Shelf Edge	VU	273.2	515.7	0.5	0.2	Met
KZN Bight Outer Shelf Mosaic	VU	243.1	655.8	0.4	0.2	Met
KZN Bight Sandy Inner Shelf	EN	75.7	145.9	0.5	0.2	Met
Leadsman Coral Community	LC	12.5	12.5	1.0	0.2	Met
Namaqua Exposed Rocky Shore	VU	27.3	42.5	0.6	0.2	Met

Feature	NBA 2018 ETS	Area within MPAs or CBAs (km^2)	Feature extent (km^2)	Percent in MPAs or CBAs (%)	Target (%)	Target met
Namaqua Kelp Forest	VU	4.9	7.4	0.7	0.2	Met
Namaqua Mid Shelf Fossils	LC	20.1	20.1	1.0	0.2	Met
Namaqua Mixed Shore	VU	35.2	60.7	0.6	0.2	Met
Namaqua Muddy Mid Shelf Mosaic	LC	3001.5	11762.5	0.3	0.2	Met
Namaqua Muddy Sands	LC	2773.8	12168.9	0.2	0.2	Met
Namaqua Sandy Inner Shelf	LC	282.0	760.2	0.4	0.2	Met
Namaqua Sandy Mid Shelf	LC	602.9	2853.2	0.2	0.2	Met
Namaqua Sheltered Rocky Shore	VU	1.0	1.2	0.8	0.2	Met
Namaqua Very Exposed Rocky Shore	VU	1.8	3.1	0.6	0.2	Met
Natal Boulder Shore	VU	0.2	0.3	0.6	0.2	Met
Natal Deep Shelf Edge	LC	541.3	1377.2	0.4	0.2	Met
Natal Delagoa Dissipative Intermediate Sandy Shore	LC	22.5	32.9	0.7	0.2	Met
Natal Delagoa Dissipative Sandy Shore	NT	0.6	0.7	0.9	0.2	Met
Natal Delagoa Intermediate Sandy Shore	NT	36.5	52.1	0.7	0.2	Met
Natal Delagoa Reflective Sandy Shore	VU	5.0	9.4	0.5	0.2	Met
Natal Exposed Rocky Shore	NT	21.8	31.5	0.7	0.2	Met
Natal Lower Canyon	LC	899.4	1481.4	0.6	0.2	Met
Natal Mixed Shore	VU	40.5	69.5	0.6	0.2	Met
Natal Upper Canyon	LC	57.0	83.1	0.7	0.2	Met
Natal Very Exposed Rocky Shore	NT	0.6	1.0	0.6	0.2	Met
Orange Cone Inner Shelf Mud Reef Mosaic	EN	224.1	511.0	0.4	0.2	Met
Orange Cone Muddy Mid Shelf	EN	474.1	1925.4	0.2	0.2	Met
Port St Johns Inner Shelf Mosaic	VU	43.9	48.5	0.9	0.2	Met
Port St Johns Muddy Mid Shelf	VU	109.4	124.8	0.9	0.2	Met
Port St Johns Muddy Shelf Edge	VU	111.7	129.4	0.9	0.2	Met
Protea Mid Shelf Reef Complex	EN	15.5	15.5	1.0	0.2	Met
Sodwana Coral Community	LC	6.0	6.0	1.0	0.2	Met

Feature	NBA 2018 ETS	Area within MPAs or CBAs (km^2)	Feature extent (km^2)	Percent in MPAs or CBAs (%)	Target (%)	Target met
Southeast Atlantic Lower Slope	LC	18126.6	86412.9	0.2	0.2	Met
Southeast Atlantic Mid Slope	LC	3944.2	18140.1	0.2	0.2	Met
Southeast Atlantic Seamount	LC	1576.3	1576.3	1.0	0.2	Met
Southeast Atlantic Slope Seamount	LC	887.9	887.9	1.0	0.2	Met
Southeast Atlantic Upper Slope	LC	5289.3	15242.1	0.3	0.2	Met
Southern Benguela Dissipative Intermediate Sandy Shore	LC	21.3	51.5	0.4	0.2	Met
Southern Benguela Dissipative Sandy Shore	LC	14.9	26.2	0.6	0.2	Met
Southern Benguela Intermediate Sandy Shore	NT	17.9	32.3	0.6	0.2	Met
Southern Benguela Muddy Outer Shelf Mosaic	LC	1147.5	5574.4	0.2	0.2	Met
Southern Benguela Muddy Shelf Edge	EN	146.0	814.0	0.2	0.2	Met at 89%
Southern Benguela Outer Shelf Mosaic	LC	4433.5	19508.7	0.2	0.2	Met
Southern Benguela Reflective Sandy Shore	EN	4.9	10.5	0.5	0.2	Met
Southern Benguela Rocky Shelf Edge	VU	501.3	2380.7	0.2	0.2	Met
Southern Benguela Sandy Outer Shelf	LC	9002.6	36057.1	0.2	0.2	Met
Southern Benguela Sandy Shelf Edge	VU	1554.7	7397.9	0.2	0.2	Met
Southern Benguela Shelf Edge Mosaic	LC	486.7	2181.8	0.2	0.2	Met
Southern KZN Inner Shelf Mosaic	EN	178.9	258.9	0.7	0.2	Met
Southern KZN Mid Shelf Mosaic	EN	522.8	989.6	0.5	0.2	Met
Southern KZN Shelf Edge Mosaic	NT	396.8	669.6	0.6	0.2	Met
Southwest Indian Lower Slope	LC	23612.8	197988.1	0.1	0.1	Met
Southwest Indian Mid Slope	LC	15548.7	78270.7	0.2	0.1	Met
Southwest Indian Seamount	LC	2043.6	2072.4	1.0	0.2	Met
Southwest Indian Slope Seamount	LC	667.9	1614.4	0.4	0.2	Met
Southwest Indian Upper Slope	LC	5939.9	17527.2	0.3	0.2	Met
St Helena Bay	VU	430.1	980.8	0.4	0.2	Met
St Lucia Mid Shelf Mosaic	LC	4.8	4.8	1.0	0.2	Met
St Lucia Sandy Inner Shelf	LC	93.4	120.0	0.8	0.2	Met

Feature	NBA 2018 ETS	Area within MPAs or CBAs (km^2)	Feature extent (km^2)	Percent in MPAs or CBAs (%)	Target (%)	Target met
St Lucia Sandy Mid Shelf	VU	308.2	646.8	0.5	0.2	Met
Subtropical Estuarine Bay	CR	0.1	0.1	1.0	0.2	Met
Subtropical Estuarine Lake	EN	1.0	2.2	0.4	0.2	Met
Subtropical Large Fluvially Dominated	EN	3.3	3.3	1.0	0.2	Met
Subtropical Large Temporarily Closed	EN	5.5	9.8	0.6	0.2	Met
Subtropical Micro-estuary		1.3	1.7	0.8	0.2	Met
Subtropical Predominantly Open	EN	6.6	6.9	1.0	0.2	Met
Subtropical Small Temporarily Closed	VU	6.3	8.3	0.8	0.2	Met
Trafalgar Reef Complex	EN	38.5	58.7	0.7	0.2	Met
Transkei Basin Abyss	LC	21861.8	210710.4	0.1	0.1	Met
Tropical Estuarine Lake	VU	1.3	1.3	1.0	0.2	Met
uThukela Canyon	NT	237.6	417.8	0.6	0.2	Met
uThukela Mid Shelf Mosaic	VU	734.7	789.4	0.9	0.2	Met
uThukela Mid Shelf Mud Coarse Sediment Mosaic	VU	1348.7	1348.7	1.0	0.2	Met
uThukela Outer Shelf Muddy Reef Mosaic	VU	514.8	531.8	1.0	0.2	Met
Warm Temperate Estuarine Bay	VU	0.2	0.2	1.0	0.2	Met
Warm Temperate Estuarine Lake	EN	1.0	1.5	0.7	0.2	Met
Warm Temperate Large Fluvially Dominated	VU	0.7	0.7	1.0	0.2	Met
Warm Temperate Large Temporarily Closed	VU	7.9	13.3	0.6	0.2	Met
Warm Temperate Micro-estuary		1.1	2.2	0.5	0.2	Met
Warm Temperate Predominantly Open	VU	9.1	12.4	0.7	0.2	Met
Warm Temperate Small Fluvially Dominated	LC	0.7	0.7	1.0	0.2	Met
Warm Temperate Small Temporarily Closed	LC	5.7	8.8	0.6	0.2	Met
Western Agulhas Bay	EN	220.0	819.7	0.3	0.2	Met
Western Agulhas Outer Shelf Mosaic	VU	1275.0	2786.5	0.5	0.2	Met
Wild Coast Inner Shelf Mosaic	VU	232.9	253.0	0.9	0.2	Met
Wild Coast Mid Shelf Mosaic	LC	1366.8	2385.9	0.6	0.2	Met

Feature		NBA 2018 ETS	Area within MPAs or CBAs (km^2)	Feature extent (km^2)	Percent in MPAs or CBAs (%)	Target (%)	Target met
	Wild Coast Shelf Edge Mosaic	LC	705.3	1435.2	0.5	0.2	Met
Pelagic ecosystem types	Pelagic1		18177.7	68516.8	0.3	0.1	Met
	Pelagic2		22044.3	143759.7	0.2	0.1	Met
	Pelagic7		952.4	9553.8	0.1	0.1	Met
	Pelagic9		16939.8	54853.6	0.3	0.1	Met
	Pelagic10		9916.5	63702.6	0.2	0.1	Met
	Pelagic11		13085.3	97880.0	0.1	0.1	Met
	Pelagic13		7155.3	71586.0	0.1	0.1	Met
	Pelagic21		7240.5	59193.7	0.1	0.1	Met
	Pelagic23		31531.6	125395.1	0.3	0.1	Met
	Pelagic38		8750.4	28793.3	0.3	0.1	Met
	Pelagic39		4897.3	30738.8	0.2	0.1	Met
	Pelagic40		11991.1	22474.4	0.5	0.1	Met
	Pelagic41		16956.6	169665.9	0.1	0.1	Met
	Pelagic45		10100.2	31400.8	0.3	0.1	Met
	Pelagic47		12295.9	53721.6	0.2	0.1	Met
	Pelagic48		9239.9	30774.3	0.3	0.1	Met
Species							
Turtles	Turtle nesting grounds		14.9	14.9	1.0	0.9	Met
	Loggerhead internesting areas		255484.9	255544.5	1.0	0.6	Met
	Leatherback internesting areas		337752.7	450073.0	0.8	0.6	Met
	Loggerhead migration corridors		3585986.1	6798590.3	0.5	0.2	Met
	Leatherback migration corridors		2471051.7	10307333.8	0.2	0.2	Met
Seabirds	Seabird colonies		18.8	19.8	0.9	0.9	Met
	Cape Gannet foraging areas (overall)		1774.1	3310.6	0.5	0.5	Met
	Cape Gannet foraging area1		180.1	674.1	0.3	0.3	Met at 89%

Feature		NBA 2018 ETS	Area within MPAs or CBAs (km^2)	Feature extent (km^2)	Percent in MPAs or CBAs (%)	Target (%)	Target met
	Cape Gannet foraging area2		1034.1	1484.0	0.7	0.3	Met
	Cape Gannet foraging area3		323.0	452.3	0.7	0.3	Met
	Cape Gannet foraging area4		236.8	700.2	0.3	0.3	Met
	Bank Cormorant foraging areas (overall)		938.8	1416.3	0.7	0.5	Met
	Bank Cormorant foraging area1		121.6	253.9	0.5	0.3	Met
	Bank Cormorant foraging area2		188.6	300.0	0.6	0.3	Met
	Bank Cormorant foraging area3		180.6	311.4	0.6	0.3	Met
	Bank Cormorant foraging area4		370.7	400.3	0.9	0.3	Met
	Bank Cormorant foraging area5		77.3	150.7	0.5	0.3	Met
	Cape Cormorant foraging areas (overall)		8244.8	14918.2	0.6	0.5	Met
	Cape Cormorant foraging area1		1212.8	2359.3	0.5	0.3	Met
	Cape Cormorant foraging area2		1971.5	3202.6	0.6	0.3	Met
	Cape Cormorant foraging area3		4142.6	6926.7	0.6	0.3	Met
	Cape Cormorant foraging area4		917.9	2429.6	0.4	0.3	Met
	African Penguin foraging areas (overall)		5056.4	9121.5	0.6	0.5	Met
	African Penguin foraging area1		1560.7	3135.3	0.5	0.3	Met
	African Penguin foraging area2		397.4	852.4	0.5	0.3	Met
	African Penguin foraging area3		764.9	1667.0	0.5	0.3	Met
	African Penguin foraging area4		542.8	883.7	0.6	0.3	Met
	African Penguin foraging area5		1790.6	2583.1	0.7	0.3	Met
Cetaceans	Bottlenose whale distribution		110996.1	708217.8	0.2	0.2	Met
	Common dolphin distribution		214024.4	675729.9	0.3	0.2	Met
	Humpback dolphin distribution		28400.6	51569.0	0.6	0.2	Met
	Heaviside dolphin		35816.8	109819.2	0.3	0.2	Met
	Killer whale distribution		166477.3	815981.3	0.2	0.2	Met
	Risso's dolphin distribution		177546.0	738811.3	0.2	0.2	Met

Feature		NBA 2018 ETS	Area within MPAs or CBAs (km^2)	Feature extent (km^2)	Percent in MPAs or CBAs (%)	Target (%)	Target met
	Bottlenose dolphin distribution		22753.5	39611.9	0.6	0.2	Met
Seals	Seal colonies		2.8	2.9	0.9	0.8	Met
Unique or special habitats or features							
Unique features	Mallory slope (feature)		2665.5	3441.5	0.8	0.6	Met
	Childs bank (feature)		1211.1	1449.2	0.8	0.8	Met
	Alexandria dunefield		142.0	142.3	1.0	0.8	Met
	Anemone gardens		1.0	1.0	1.0	0.9	Met
	Rhodolith beds		5.0	5.0	1.0	0.9	Met
Special features	Estuary mouths of flagship free-flowing rivers		40.2	40.7	1.0	1.0	Met
	Estuary mouths of non-flagship free-flowing rivers		53.9	67.2	0.8	0.6	Met
	Potential cold-water coral reefs		224.0	236.0	0.9	0.9	Met
	Potential VME indicator species		162.0	258.4	0.6	0.6	Met
	Potential VME features		13003.5	22853.8	0.6	0.5	Met
Culturally significant areas							
Heritage sites	Fish traps		0.4	0.5	0.9	0.9	Met
	Initial compilation of culturally significant sites, e.g., caves and archaeological sites (e.g., Pinnacle Point, Blombos cave), middens, Hole-in-the-wall, Gompho Rock, Shaka's Rock		36.0	40.0	0.9	0.9	Met
Ecological processes							
Productivity	Beaches with surf diatom accumulations		38.0	76.0	0.5	0.4	Met
	Beaches with beach-cast kelp		96.3	167.9	0.6	0.4	Met
Nursery, spawning and aggregation areas	Estuary fish nursery importance (shores/mouths)		842.0	1230.0	0.7	0.4	Met
	Squid spawning areas		536.1	1765.1	0.3	0.3	Met
	Anchovy nurseries (high egg densities)		36759.9	129817.9	0.3	0.2	Met
	Sardine nurseries (high egg densities)		33945.6	131080.3	0.3	0.2	Met
	Red steenbras spawning areas		1.0	1.0	1.0	1.0	Met
	Wreck fish aggregation sites		1.0	1.0	1.0	0.9	Met

Feature		NBA 2018 ETS	Area within MPAs or CBAs (km^2)	Feature extent (km^2)	Percent in MPAs or CBAs (%)	Target (%)	Target met
	Giant guitarfish aggregation sites		17.0	17.0	1.0	0.9	Met
	Whale-associated bays (overall)		1792.0	2803.0	0.6	0.6	Met
	Whale-associated bays1		752.1	1003.0	0.7	0.3	Met
	Whale-associated bays2		105.1	118.8	0.9	0.3	Met
	Whale-associated bays3		231.5	558.7	0.4	0.3	Met
	Whale-associated bays4		703.4	1122.6	0.6	0.3	Met
Ecological infrastructure							
Coastal ecological infrastructure	Coastal protection EI		5.6	9.2	0.6	0.6	Met
	Recreational outdoor activities and sports events EI		106.4	142.2	0.7	0.6	Met
Climate resilience							
Carbon sequestration	Algal dominated reefs		3.0	3.0	1.0	1.0	0.0
Existing priorities							
Recognised sites	Ramsar sites		1518.2	1518.9	1.0	1.0	Met
	Important Bird and Biodiversity Areas		1198.1	1201.7	1.0	1.0	Met
	SA site (iSimangaliso) in the Network of Sites of Importance for Marine Turtles in the Indian Ocean – South-East Asia Region		1021.2	1021.2	1.0	1.0	Met
	Ecologically or Biologically Significant Marine Areas (whole network)		105851.8	170005.3	0.6	0.6	Met
	Orange Seamount and Canyon Complex		6453.1	8801.7	0.7	0.5	Met
	Orange Cone		718.4	1224.9	0.6	0.5	Met
	Protea Seamount Cluster		9015.1	9019.5	1.0	0.5	Met
	Kingklip Corals		2890.4	5442.5	0.5	0.5	Met
	Protea Banks and Sardine Route		4855.4	9344.8	0.5	0.5	Met
	Algoa to Amathole		10108.5	19622.4	0.5	0.5	Met
	KwaZulu-Natal Bight and uThukela River		5302.5	10578.8	0.5	0.5	Met
	Namaqua Fossil Forest		810.5	831.6	1.0	0.5	Met

Feature		NBA 2018 ETS	Area within MPAs or CBAs (km^2)	Feature extent (km^2)	Percent in MPAs or CBAs (%)	Target (%)	Target met
	Namaqua Coastal Area		2788.1	3507.2	0.8	0.5	Met
	Childs Bank and Shelf Edge		7137.8	13586.7	0.5	0.5	Met
	Browns Bank		3337.2	5657.7	0.6	0.5	Met
	Seas of Good Hope		3670.8	6745.5	0.5	0.5	Met
	Agulhas Bank Nursery Area		6950.1	13620.0	0.5	0.5	Met
	Shackleton Seamount Complex		8000.3	11932.2	0.7	0.5	Met
	Cape Canyon and Surrounding Islands, Bays and Lagoon		8965.6	16584.7	0.5	0.5	Met
	Delagoa Shelf Edge, Canyons and Slope		15876.4	17950.1	0.9	0.5	Met
	Mallory Escarpment and Trough		7780.1	13072.9	0.6	0.5	Met
	Tsitsitsikamma-Robberg		1347.8	2639.3	0.5	0.5	Met
Previous prioritisations	Priority beaches		193.8	264.9	0.7	0.5	Met
	Shores/mouths of priority estuaries		1465.0	1929.0	0.8	0.8	Met
	Algoa Bay fine-scale systematic conservation plan		668.0	668.0	1.0	1.0	Met

Appendix 2: Proposed datasets to source and include in the next iterations of the National Coastal and Marine CBA Map

Table A2.1. *Compilation of proposed datasets to source and include in the next iterations of the National Coastal and Marine CBA Map. CR=Critically Endangered; EN=Endangered; VU=Vulnerable; DD=Data Deficient. Items that are shaded in light blue were included in this analysis.*

Biodiversity Features	Detailed information	Threat status	Reference
Ecosystems			
Ecosystem types	Marine Ecosystem Types		Sink et al., 2019a
	Coastal Ecosystem Types		Harris et al., 2019
	Ecosystem types in good ecological condition		Sink et al., 2019a,b
	Ecosystem types in good or fair ecological condition		Sink et al., 2019a,b
Pelagic bioregionalisation	Pelagic bioregions		Roberson et al., 2017; Sink et al., 2011
Species			
Cetaceans	Indo-Pacific humpback dolphin *Sousa chinensis* (modelled)	VU	Purdon et al., 2020
	Heaviside's dolphin *Cephalorhynchus heavisidii* (modelled)	NT	Purdon et al., 2020
	Dusky dolphin *Lagenorhynchus obscurus* (modelled)	LC	Purdon et al., 2020
	Indo-Pacific bottlenose dolphin *Tursiops aduncus* (modelled)	NT	Purdon et al., 2020
	Southern bottlenose whale *Hyperoodon planifrons* (modelled)	LC	Purdon et al., 2020
	Common dolphin *Delphinus delphis* (modelled)	LC	Purdon et al., 2020
	False killer whale *Pseudorca crassidens* (modelled)	NT	Purdon et al., 2020
	Killer whale *Orcinus orca* (modelled)	DD	Purdon et al., 2020
	Risso's dolphin *Grampus griseus* (modelled)	LC	Purdon et al., 2020
	Bryde's whale	LC	To be sourced
	Southern right whale	LC	To be sourced
	Sperm whale		
	Humpback whale	LC	To be sourced
Seals	Seal colonies	LC	Kirkman et al., 2013
	Seal foraging areas	LC	Botha et al., 2020
Shorebirds	Distributions of shore birds		To be provided by BirdLife South Africa
Seabirds	Colonies of threatened colonial seabirds	EN	DEA Unpublished data; Crawford et al., 2016; Sherley et al., 2017, 2019, 2020
	Other key seabird data (distributions, foraging areas, etc)		To be provided by BirdLife South Africa Contact: Alistair McInnes

Biodiversity Features	Detailed information	Threat status	Reference
	Preliminary inclusion of threatened seabird foraging areas (to be replaced with data from BirdLife)	EN	Majiedt et al., 2013
Turtles	Turtle nesting sites	NT, CR	King 2019; Harris, 2012; Harris et al., 2019
	Loggerhead internesting areas	NT	Harris et al., 2015
	Leatherback internesting areas	CR	Harris et al., 2015
	Loggerhead and leatherback foraging areas	NT, CR	Harris et al., 2018
	Loggerhead migration routes	NT	Harris et al., 2018
	Leatherback migration routes	CR	Harris et al., 2018
	Foraging areas of non-nesting species (green turtles; hawksbills) and juveniles/subadults	All species are threatened	Data to be shared by DEFF and the aquaria
Sharks and rays			To be sourced (e.g., KZN Sharks Board, DEFF, shark scientists, OCEARCH white shark tracking data, Wild Oceans shark conservation planning outputs)
Other top predator foraging and breeding sites?			To be sourced
Fish	Distributions of key species		To be sourced
Fish assemblages	Community distributions		Fish Atlas Data (Colin Attwood)
Harvested species	Black musselcracker	VU	Murray et al., 2019
	Other species		To be sourced
Plants	Locations of threatened and not protected coastal plant species		SANBI
Key habitats and features			
Unique features	Mallory slope		Extracted from: De Wet 2012
	Alexandria dunefield		Extracted from: Harris et al., 2019
	PE Ridge		Extracted from: Sink et al., 2019a
	Cold ridge		To be sourced
	Namaqua Fossil Forest		Extracted from EBSA map and marine map of ecosystem types
	Childs Bank		Majiedt et al., 2013
	Anemone gardens		ACEP Deep Secrets, unpublished data
	Rhodolith beds		ACEP Imida, unpublished data; Adams et al., 2020
	Others (check EBSA Uniqueness criterion for features)		To be sourced
Special features	Estuary mouths of flagship and non-flagship free-flowing rivers		Nel et al., 2011a, b

Biodiversity Features	Detailed information	Threat status	Reference
	Potential cold-water coral reefs		
	Potential Vulnerable Marine Ecosystems, indicator species and features		Sink & Atkinson 2020
Other priorities			
Sites of importance	Ramsar sites		Ramsar: https://www.ramsar.org/wetland/south-africa
	Important Bird Areas		BirdLife South Africa
	Important Marine Mammal Areas		https://www.marinemammalhabitat.org/immas/
	EBSAs		MARISMA project: https://cmr.mandela.ac.za/EBSA-Portal
	IOSEA Marine Turtle Site of Importance		IOSEA: https://www.cms.int/iosea-turtles/sites/default/files/basic_page_documents/IOSEA_Site_Network-ISimangaliso_SouthAfrica.pdf
Previous priorities	Beach priorities		Harris 2012
	Dune priorities		Tinley 1985
	Algoa Bay Systematic Conservation Plan		Algoa Bay Project 2019
	Priority estuaries		Van Niekerk et al 2019, including Turpie et al., 2012; to be updated
	Freshwater ecosystem priority areas		Plan in revision; in communication with the planners to align priorities; in this iteration, inclusion of the estuary mouths of free-flowing rivers
Previous priorities considered, but recognised as superseded and not included	Coastal fish priority areas (identified prior to declaration of the new MPAs)		Turpie et al., 2000
	NPAES 2016 (marine areas were the Phakisa MPAs that have since been declared)		DEA 2016
	NSBA 2004		Lombard et al., 2004
	KZN SEA Plan		Harris et al., 2012
	Offshore MPA Project (OMPA)		Sink et al., 2011
	West Coast Plan		Majiedt et al., 2013
	Agulhas Plan		Clark & Lombard 2007
Culturally significant areas			
Culturally significant areas	Key cultural sites: e.g., Shaka's Rock; Hole in the Wall; Sulphur Springs; Gompho Rock; archaeological sites, coastal caves, middens		To be expanded; also mapping of Cultural Significant Areas in the CoastWise project
	Shipwrecks		To be provided by SAHRA
	Durban Bluff Whale Heritage Site		To be sourced
	Fish traps		SAHRA, 2020

Biodiversity Features	Detailed information	Threat status	Reference
	Others		Possible sites from emerging work on this subject (by Sizo Sibanda and the CoastWise project team)
Areas important for ecological processes, ecological infrastructure, and climate resilience			
Climate change refugia	Upwelling areas		Lourenço et al., 2016
	Seamounts		Tittensor et al., 2010
	Areas spanning a range of climate futures (high change, medium change, no change)		To be sourced (see Tittensor et al., 2019 for review)
	Transition zones across biogeographic breaks and depth zones		Sink et al., 2019a; De Wet 2012
	Areas adjacent to low-lying inland areas without infrastructure that coastal habitats can expand into as sea levels rise		To be sourced
Climate resilience	Carbon sequestration (algal dominated reefs)		ACEP Imida, unpublished data. To be expanded to include more features.
Productivity	Beaches with surf diatom accumulations		Campbell 1996; extracted from Harris et al., 2019
	Beaches with beach-cast kelp		Harris 2012
	Upwelling cells		Hutchings et al., 2009
Other oceanography features			To be discussed with oceanographers (or built into a revised pelagic bioregionalization). Also: Hutchings et al., 2009; Kirkman et al., 2016
Adaptation and resilience	Areas of high genetic diversity		To be sourced
	Centres of endemism		To be sourced
Connectivity	Particle modelling		Collaboration in discussion
Ecological infrastructure	Coastal protection		Myriam Perschke PhD (in prep)
	Recreational outdoor activities and sports events		Myriam Perschke PhD (in prep)
	Strategic fisheries priority areas		To be sourced
Spawning and nursery areas	Sardine spawning areas		Twatwa et al., 2005; McGrath 2017, McGrath et al., 2020
	Anchovy spawning areas		Twatwa et al., 2005
	Hake spawning (2 species)		Jansen et al., 2015
	Hake nurseries		To be sourced
	Chokka/Squid spawning areas		Downey-Breedt et al., 2016; Lipiński et al., 2016
	Chokka/Squid nursery areas		To be sourced
	Other		Hutchings et al., 2002
	Whale-associated bays		Extracted from Sink et al., 2019a; to be confirmed with marine mammal scientists

Biodiversity Features	Detailed information	Threat status	Reference
Spawning and aggregation areas	Red Steenbras, Wreck fish; Giant guitarfish		Prof. Kerry Sink (SANBI, unpublished data); ACEP Imida, unpublished data
	Others		To be sourced
Protected Areas			
	Existing land-based protected areas and marine protected areas		Sink et al., 2019c; Skowno et al., 2019
Ecological Condition			
	Ecological condition		Sink et al., 2019b
Other data			
	Military restricted areas		To be sourced
	Known, fragile areas (reef points an polygons)		Sink et al., 2011, 2012; Majiedt et al., 2013; to be refined for the next iteration with assistance from Tamsyn Livingstone

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Appendix 3: List of meetings, workshops and work sessions held to inform and review the National Coastal and Marine Spatial Biodiversity Plan

The following meetings, workshops and work sessions were held over the period October 2018 to December 2020, to help draft the National Coastal and Marine CBA Map criteria, identify relevant data sets, and review the approach and progress. An overview of main areas of discussion and the organisations represented at each workshop or work session are provided.

Table A3.1. *Summary of meetings, workshops and work sessions held to inform and review the National Coastal and Marine Spatial Biodiversity Plan, and the organisations represented at each event*

Date	Workshop or work session	Overview	Organisations represented
19 – 22 June 2018	Biodiversity Planning Forum, Cape St Francis	Plenary session: Coastal and marine biodiversity assessment and planning: Towards ocean use guidelines. The aim of the session was to review progress and develop plans for a first National Marine Critical Biodiversity Areas (CBA) map that identifies and communicates different categories of priority areas to inform Marine Spatial Planning. Presentations and discussions informed work to identify new focus areas for Marine Protected Areas, Strategic Fisheries Areas, Coastal Ecological Infrastructure and other Ecological Support Areas. A presentation that reviewed the legal and policy framework opened the session and provincial planners shared lessons from provincial biodiversity planning. Challenges and opportunities in developing an integrated Lessons from good practice in land use guidelines helped inform the plans for ocean use guidelines.	BirdLife South Africa; CapeNature; Capricorn Marine Environmental (Pty) Ltd; CEN; Conservation Outcomes; CSIR; DAFF; DEA; DEA (Botswana); DPME; Eastern Cape DEDEAT; Eastern Cape Parks and Tourism Agency; Endangered Wildlife Trust; EOH; eThekweni Municipality; Ezemvelo KZN Wildlife; Free State DESTEA; Freshwater Consulting; Gauteng DARD; Greater Letaba Municipality; Independent consultants; IUCN SSC; JRC, European Commission; Kruger2Canyons Biosphere; Limpopo LEDET; Mondi Ltd; Mpumalanga DARDLEA; Nelson Mandela University; North West READ; North West University; Northern Cape DENC; Overberg Renisterveld Conservation Trust; Resilience Environmental Advice; SAEON; SANBI; SANCCOB; SANParks; Scherman Colloty and Associates; Stellenbosch University; University of Botswana; University of Cape Town; University of KwaZulu-Natal; University of the Free State; University of the Western Cape; Wildlands Conservation Trust; WWF South Africa.

Date	Workshop or work session	Overview	Organisations represented
30 October – 1 November 2018	Provincial and Metro Biodiversity Planning Working Group	A dedicated session discussed the development of a national CBA Map for the marine environment for inclusion into the NBA. The team producing the plan shared proposed approach and progress to date. Planners endorsed the proposed approach and discussion centred on connectivity, climate resilience and improved coastal integration in the longer term.	CapeNature; CSIR; Eastern Cape Parks and Tourism Agency; EOH; Ezemvelo KZN Wildlife; Free State DETEA; Gauteng DARD; Limpopo EDET; Mpumalanga TPA; Nelson Mandela University; North West DEDECT; Northern Cape DENC; SANBI; SANParks.
6 December 2018	Marine Biodiversity Working Group	Review of approach, discussion on best ways to align with provincial priorities and to incorporate climate resilience, social benefits, and connectivity. The proposed approach and targets were endorsed. Additional data sets that can be used to support species inclusion in future iterations (2021/2022) were identified with follow up data provided by Alison Kock (SANParks). The value of the CBA Map in supporting future priority areas for MPA expansion (next 5% target) was recognised. The importance of spatial alignment between CBAs, EBSAs and future MPA expansion priorities was emphasised.	Cape Nature; DEA; DENC; Eastern Cape Parks and Tourism Agency; SAEON; SAIAB; SANBI; SANParks; University of Cape Town.
29 May 2019	National EBSA Working Group Meeting, Cape Town	The National Coastal and Marine Critical Biodiversity Areas Map was presented and an explanation of how this aligned with the proposed EBSA Conservation and Impact Management Zones, and that the CBA Map was proposed to be used as the basis for EBSA zoning, with a first draft of the EBSA zoning presented for discussion.	Anchor Environmental Consulting; BirdLife; Cape Research and Diver Development; De Beers; DEA; IOI; Nelson Mandela University SANBI; SAEON; SANCCOB; SANParks.

Date	Workshop or work session	Overview	Organisations represented
4 – 7 June 2019	Biodiversity Planning Forum, Alpine Heath Resort, KwaZulu-Natal. Work session: Coastal and Marine Critical Biodiversity Area Map	The National Coastal and Marine Critical Biodiversity Areas Map and associated sea-use guidelines was presented. The presentation was given in plenary with an open invitation to discuss it in a later work session that addressed: • Interrogation of the CBA Map • Edge-matching progress and challenges • Links among the prioritisation processes (CBAs, EBSAs, KBAs) • Sea-use guidelines and links to MSP • MPAs	AES; African Conservation Centre (Kenya); Amphibian and Reptile Conservation Trust; Anchor Environmental; AWARD; BBreedlove (Pty) Ltd; BirdLife South Africa; Cape Analytical Services Laboritories (Pty) Ltd; CapeNature; CBD Focal Point Assisstants (Cameroon); CBD Secretariat; City of Cape Town; College of Science and Technology; CSIR; DAFF; DEA; DEA (Botswana); DEA (Malawi); Eastern Cape Parks and Tourism Agency; Eco-Pulse Consulting; Endangered Wildlife Trust; ESRI South Africa; eThekweni Municipality; Ethiopia; Ezemvelo KZN Wildlife; Gauteng DARD; Independent consultants; Institute for Natural Resources; Johannesberg City Parks and Zoo; KBA Secretariat; Land use and Spatial Planning Department (Ghana); Limpopo EDET; Malawi University of Science and Technology; Ministry of Environmnet and Tourism (Namibia); Mpumalanga TPA; National Environment Management Authority (Uganda); Nelson Mandela University; North West READ; Northern Cape DENC; Rhodes University; SANBI; SANParks; Southern Connections; The Cirrus Group; The Msunduzi Municipality; UNEP-WCMC; University of Botswana; University of Cape Town; University of Kent; University of the Free State; Western Cape Department of Agriculture; Wildlands Conservation Trust; Wildlife Conservation Society; WWF South Africa.
29 – 31 October 2019	Provincial and Metro Biodiversity Planning Working Group, Malibu Country Lodge, Pretoria	Review of process and outputs with positive feedback from participants. Suggestion that this work is fed into EIA screening tools as the presented work is a significant advancement on what is currently used in for example EIAs. Provincial planners recommended that provincial priorities are not used to seed coastal priorities as the work under review represents an improvement on the 2011 work. Further improvement and discussion with coastal planners recommended building on planned improvements through the CoastWise project. EKZNW requested 3 new national layers: MPA boundaries, MPA zones and a national fine-scale bathymetry layer. Birdlife expressed willingness to provide bird data for future iterations.	BirdLife; CapeNature; CES; CSIR; DEFF; Eastern Cape Parks and Tourism Agency; Ezemvelo KZN Wildlife; Free State DETEA; Gauteng DARD; Independent consultants; Limpopo EDET; Mpumalanga TPA; Nelson Mandela University; North West DEDECT; Northern Cape DENC; Resilience Environmental Advice; SANBI.

Date	Workshop or work session	Overview	Organisations represented
12 February 2019	National EBSA Working Group Meeting, Cape Town	The National Coastal and Marine Critical Biodiversity Areas Map was presented, as well as the revised EBSA zoning based on the CBA Map and taking into account feedback from the meeting on 29 May 2019. The proposed management regulations (the principles of which underpin the sea-use guidelines) were also presented for discussion.	BirdLife; Cape Research and Diver Development; DAFF; De Beers; DEA; Environmental consultants; I&J Limited; IOI; KZN Sharks Board; Lwandle Technogies (Pty) Ltd.; Nelson Mandela University; SANBI; SAEON; SANCCOB; SANParks; SAPFIA; Stellenbosch University; Two Oceans Aquarium; University of the Western Cape; Wildlife Conservation Society
13 February 2020	Marine Biodiversity Working Group, Cape Town	Alignment of EBSAs and other spatial tools such as Critical Biodiversity Areas was emphasised to ensure consolidated biodiversity input into MSP and other multi-sector processes. The revised proposed zoning of EBSAs was presented showing alignment of the broad management of objectives of the EBSA zones with that of CBAs and ESAs. Proposed management recommendations for the two EBSA zones were also presented. Recommendation for a special session to obtain further inputs and identify key data layers to improve the National Coastal and Marine Spatial Biodiversity Plan at the South African Marine Science Symposium.	CapeNature; DEFF; DENC; Nelson Mandela University; SANBI; WWF
May, July, September 2020	Virtual meetings	Virtual meetings with PASA and the individual petroleum rights holders regarding the specific priority areas for the petroleum industry, and engagement over the sea-use guidelines. The meetings were initially part of engagements regarding the EBSA zoning and management recommendations, but expanded to include the broader priorities for inclusion in the National Coastal and Marine Spatial Biodiversity Plan.	Africa Energy; DEFF; Impact Africa; New age; NMU; Petroleum Agency South Africa; PetroSA; Shell; Sunbird Energy; Total.
22 October 2020	Virtual online information sharing session	Virtual information sharing session on Marine Spatial Biodiversity Priorities as an input for Marine Spatial Planning. All meeting content (agenda, videos and pdfs of the presentations) is available on the EBSA Portal.	143 participants from a range of government departments, industries, NGOs, consultancies, and universities (including scientists, and social scientists).

Date	Workshop or work session	Overview	Organisations represented
10 November 2020	Virtual meeting of the Provincial and Metro Biodiversity Planning Working Group	The National Coastal and Marine Spatial Biodiversity Plan Version 1 Beta 1 was presented and was received with very positive feedback. Some of the technical aspects were discussed, e.g., technical options for enhancing land-sea alignment of priorities in the coastal zone based on how some of the land-based planners have edge-matched priorities across provincial boundaries.	BirdLife South Africa; CapeNature; CSIR; DEFF; Department of Environment and Nature Conservation; DESTEA; Eastern Cape Parks and Tourism Agency; Ezemvelo KZN Wildlife; FS DESTEA; Gauteng Department of Agriculture and Rural Development; Independent consultant; MTPA; NC Department of Agriculture, Environmental Affairs, Rural Development & Land Reform; Nelson Mandela University; NWDEDECT; SANBI; SANParks.
Postponed due to Covid-19	South African Marine Science Symposium: Workshop.	Building the science base for assessment, planning and management in the coastal and marine environment: EBSAs, CBA Map, and MSP. Planned discussions on current progress and future intentions in: (1) the foundational map of marine ecosystem types; (2) Ecologically or Biologically Significant Marine Areas; (3) the National Coastal and Marine Spatial Biodiversity Plan and (4) Marine Spatial Planning. Identification of where existing marine science can support these initiatives; current research priorities; and what collaborative groups need to be established to work on key systems.	Expected: Marine scientists from academic institutions, NGOs, provincial and national government departments