DRAFT FINAL REPORT

Assessment of the current and potential role of marine protected areas (MPA's) as management and conservation tools for fisheries management, with Plans for Adaptation.

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List of Acronyms

BCC – Benguela Current Convention

BCLME – Benguela Current Large Marine Ecosystem

CBD – Convention on Biological Diversity

CO_2 – Carbon Dioxide

CSC – Climate-smart conservation

CSIR – The Council for Scientific and Industrial Research

DFFE – Department of Forestry, Fisheries and the Environment

DMR – Department of Mineral Resources & Energy of South Africa

DOT – Department of Transport of South Africa

EbA – Ecosystem-based Adaptation

EBSA – Ecologically and Biologically Significant Area GEF – Global Environmental Fund

FOA – Fisheries Observer Agency of Namibia

INIPM – Ministry of Agriculture and Fisheries of Angola

IPBES – Intergovernmental Panel on Biodiversity and Ecosystem Services

IPCC – Intergovernmental Panel on Climate Change

IUCN – International Union for Conservation of Nature

IUU – illegal, unregulated and unreported

MARISMA – BCC Marine Spatial Management and Governance Programme

MCTA – Ministry of Culture, Tourism and Environment of Angola

MEFT – Ministry of Environment, Forestry and Tourism of Namibia

METT –Management Effectiveness Tracking Tool

MFMR – Ministry of Fisheries and Marine Resources of Namibia

MINTRANS – Ministry of Transport of Angola

MIREMPET – Ministry of Petroleum of Angola

MLRA –Marine Living Resources Act

MP – Management Plan

MPAs – Marine Protected Areas

MSP – Marine Spatial Planning

NCCSAP – National Climate Change Strategy and Action Plan

NEM PAA – The National Environmental Management: Protected Area Act

NNF – Namibia Nature Foundation

OA – ocean acidification

PAACZC – Adaptation Plan to Climate Change in the Coastal Zone of Angola

POPA – Planning Plan (Management) Fisheries and Aquaculture of Angola

RCP – Representative Concentration Pathway

SANParks – South African National Parks

SCP – Systematic conservation planning

SDG – Sustainable Development Goals

SST – sea surface temperature

SWOT – Strengths, Weaknesses, Opportunities and Threats

TAC – total allowable catch

TMNP – Table Mountain National Park

TNPMPA – Tsitsikamma National Park Marine Protected Area

UAN – Agostinho Neto University

UNFCCC – United Nations Framework Convention on Climate Change

UNiNBE – Universidade do Namibe

WWF – World Wide Fund for Nature

Executive summary

Participating countries of the Benguela Current Convention (BCC) are signatories of global commitments such as the Convention on Biological Diversity, the United Nations Framework Convention on Climate Change, the 2030 Agenda, and the Sustainable Development Goals. However, the potential impacts of climate change on the effectiveness of MPA have not been assessed in the BCLME region. This study aimed to evaluate the current and potential role of MPAs in the BCLME as fishery management and conservation tools and the impacts of forecasted climate change and variability on their effectiveness, including implications for local small-scale fishers and fishing communities. This study reviewed existing knowledge of MPAs in the region by incorporating a literature review (i.e. grey literature and peer-reviewed publications) and a content analysis to assess the current and potential future role of MPAs as management and conservation tools and the impacts of forecasted climate change and variability on their effectiveness. Once a draft document of compiled information was available, a diverse group of experts from each country was convened in a national virtual workshop, and then asked to provide feedback by e-mail on a draft version of the report aiming to determine how best to include climate change adaptation strategies into the design of existing and future MPAs. Results include tables of key fishery species at a country level (commercial and recreational) linked to protection in the MPAs, with possible adaptation and mitigation options, with background colour indicating a data quality score.

The content analysis and review of potential climate change impacts indicated several actions to improve the effectiveness of MPA's in the region and mitigate against climate change. These also included aspects such as the revision of management plans from each country's MPA to include a list of actions that can help improve the resilience of MPAs to climate change and making the management plans for all the MPAs in the region publicly available. The present report aims to highlight actions to improve the resilience of existing MPAs and ensure future MPAs (such as the one under development in Angola) account for the impacts of climate change. Improving the connectivity of the current network of MPAs is particularly important and should be discussed with academic experts, managers and other stakeholders to enhance resilience to climate change. The BCC has the potential to provide a platform for ongoing discussion with MPA practitioners and managers around all aspects of national and regional MPAs. Training of MPA practitioners could also be facilitated through this process and dedicated funding directed through the BCC.

1 Introduction

The ocean and its biodiversity provide fundamental ecosystem services for people and nations worldwide and essentially contribute to the livelihood, food security, cultural identity and national economy of coastal communities. Oceans also perform climate regulation by absorbing heat and the increased amounts of Carbon Dioxide (CO_2) resulting from anthropogenic activities (Bahri et al., 2018). Keeping the ocean's health through conservation management of its resources thus determines the balance between socio-economic development and ecosystem resilience.

The regulatory and productive role of the ocean is under threat due to climate change. The Intergovernmental Panel on Climate Change (IPCC) Assessment Report and the IPCC Special Report on the Ocean and Cryosphere in a Changing Climate estimate that change on the global atmospheric temperature will likely be between 1.5°–2.0°C and that global warming will continue beyond the 22nd century with irreversible effects of climate change for centuries to come. Predicted changes include impacts on the hydrological cycles and rainfall patterns, water temperature, oxygen content, ice coverage, sea level, ocean circulation and acidification, and primary production (Doney et al., 2012; Pörtner et al., 2014; Poloczanska et al., 2016; Bahri et al., 2018). These changes may incur shifts in distribution and migration and more negatively local or global extinction of economically important fishery species (Brander, 2010). The productive potential of the world's oceans is expected to decline between 7.0–12.1% of the total maximum fish catch potential under a 'business-as-usual' scenario of high greenhouse gas emissions, and 2.8–5.2% under a low emissions scenario. Shifts in fishery productivity may occur unevenly across the globe, with regional and local effects still unclear (Barange et al., 2018; Bahri et al., 2021). This will strongly affect the societies dependent on fisheries (Merino et al., 2010; Barange et al., 2014; Hoegh-Guldberg et al., 2014).

The effects of climate change may also negatively impact the fisheries sector in the Benguela Current Large Marine Ecosystem (BCLME), an upwelling rich region stretching along the coast of South Africa, Namibia, and Angola. The region encompasses one of the most productive ocean areas in the world and relies on the Global Climate Conveyor Belt. Its high level of primary productivity supports an important global reservoir of biodiversity and biomass of zooplankton, fish, sea birds and marine mammals as well as it holds rich deposits of precious minerals, and oil and gas reserves (BCLME Transboundary Diagnostic Analysis, 1999; Shannon et al., 2006). The BCLME thus represents a valuable fisheries resource to Angola, Namibia, and South Africa with an estimated annual landing of combined fisheries of the order of 1 million tons (Van den Lingen and Hampton, 2018). Previous studies have reviewed the observed and predicted impacts of climate change and conducted vulnerability assessments for species of ecological and economic importance and some of the main fisheries in the Benguela region (Hampton et al., 2017; Ortega-Cisneros et al., 2018; Cochrane et al., 2020). Effects of climate change in South Africa have been reported for sardine *(Sardinops sagax*) and anchovy *(Engraulis encrasicolus*) such as eastward shifts in distribution, and a south-eastward shift in the centre of gravity of round herring (*Etrumeus whiteheadi*) (DAFF, 2014). A reduction in west coast rock lobster *(Jasus lalandii*) growth accompanying an eastward migration during the 1980s, 1990s and mid-2000s has also been evidenced. With exception to anchovy, whose recruitment is unaffected by eastward shifts as juveniles concentrate off the west coast, these effects have considerably impacted the South African west coast fisheries. The environmental processes behind this are still not entirely known, but evidence suggests that it is due to increasing of the cross-shelf temperature gradient. There is currently a zero total allowable catch (TAC) for sardine in Namibia due to low abundance and anchovy disappeared under the effects of the Benguela Niño in 1994, while the cape horse mackerel *(Trachurus capensis)* has shifted southwards. Little is known about the effects of climate change in the Angolan stocks although changes in the migration patterns of sardine, and biomass and structure shifts of demersal species have been documented. Moreover, southwards shift in the distribution of the dusky kob *(Argyrosomus japonicus*) has been observed, this species has shown successful hybridization with

a conspecific in Namibia (Potts et al 2014; Van den Lingen and Hampton, 2018). Vulnerability assessments to climate change in Angola, Namibia and South Africa have also unveiled a high degree of vulnerability of fisheries in the region, particularly related to the artisanal and the semi-industrial small pelagic fishery in Angola, small pelagic, rock lobster and demersal trawl fishery in Namibia, whereas in South Africa the small scale fishery for line-and-net-fish, small pelagic, the inshore chokka squid (*Loligo reynaudii)* fishery and the west coast rock lobster fishery were the most vulnerable (van den Lingen and Hampton, 2018). A recent study on the small pelagic fishery highlighted that Angola and South Africa have moderate vulnerability to climate change whereas Namibia is highly vulnerable due to the reduced stocks of sardine and the lack of alternative fishery species (apart from horse mackerel) with adaptation potential rated as moderately negative for all three countries (Cochrane et al., 2020).

Under the predicted climate change scenarios, current fisheries management in the BCLME region may become obsolete requiring adaptation as the current management systems have been developed to face climate variability on fish abundance and distribution rather than being climate smart by incorporating proactive (planned) measures of climate adaptation. Climate-resilient fisheries management should rely on four key foundations to reduce the vulnerability of communities and take advantage of the effects of climate change (Bahri et al., 2021): efficient fisheries management, co-management, precautionary systems and adaptive management. Co-management of fishery resources improves resilience because it is more responsive and adaptive than centralized structures, intensify stakeholder participation and input into decision-making, modify rules to the local context, makes enforcement more effective when founded on a cooperative community-based framework, and promotes internalization of the rewards and penalties (Bahri et al., 2021). Marine Protected Areas (MPAs) have played a role as key instruments of fishery management by combining environmental conservation, climate resilience and the ecosystem approach to fisheries management. For instance, MPA networking has been successfully implemented in the Caribbean through the '*Managed Access*' programme that link expanded MPA networks to nationwide rights-based fisheries management by improving the catch statistics reporting and compliance of multi-species finfish fisheries (Rader et al., 2021). Benefits of MPAs as co-management and climate-resilient fishery management tools go beyond rebuilding of depleted stocks, promoting genetic diversity, and protecting essential ecosystems and their services thus acting as climate reserves by sequestering carbon, protecting the coast from extreme events and improving thermal tolerance of threatened fish species (Halpern, 2003; Lester et al., 2009; Harris and Lombard, 2018; Merwin et al., 2020). MPA networks are a cost-effective and low-tech tool offering local, regional and global mitigation and adaptation benefits, and should be incorporated into national climate change strategies (Harris and Lombard, 2018).

Adaptation strategies that can reduce the negative impacts of climate change and assist in developing adaptive capacity and resilience are seldom incorporated into MPA management plans and frameworks (Wilson et al., 2020), specifically their aims and objectives (Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES), 2019; Tittensor et al., 2019). Several conceptual frameworks have provided guidelines on how to include climate change adaptation into MPA design and management. Systematic conservation planning (SCP) is one of the most commonly used and implemented planning frameworks (Álvarez-Romero et al., 2018; Wilson et al., 2020), and has been used in South Africa (e.g. Algoa Bay, Algoa Bay Community of Practice Project funded by the National Research Foundation, 2019). Some of the advantages of the SCP approach include the capacity to account for multiple objectives, future scenarios and their uncertainties, and the incorporation of climate change adaptation (Kujala et al., 2013; Reside et al., 2018). Climate-smart conservation (CSC), another widely used planning framework, explicitly considers climate change in natural resource management by linking strategies to key climate impacts and vulnerabilities (Stein et al., 2014). Other planning frameworks include adaptation for conservation targets (Cross et al., 2012), portfolio decision analysis (Convertino and Valverde, 2013) and the International Union for the Conservation of

Nature (IUCN) cycle (Gross et al., 2016).

Out of 248 ecosystem types recognized in the BCLME region, 59% are not partially or fully protected (Holness et al., 2014). South Africa recently declared a network of 20 new MPAs aiming to reach 5.0% ocean protection and now it has 17 MPAs within the BCLME region. A partnership between the Department of Forestry, Fisheries and the Environment (DFFE) and the Council for Scientific and Industrial Research (CSIR) initiated a Coastal Vulnerability Study that aims to 1) provide base data to provinces for establishing their Coastal Management Lines, 2) develop Planning and Decision Support Tools, 3) Inundation modelling and 4) the Oceans and Coasts Information Management System (OCIMS). Namibia has a single MPA but it is dominated by a network of coastal protected areas (Holness et al., 2014). Identification and proclamation of MPAs in the country have been listed as one of the adaptive activities for the blue economy in the latest Nationally Determined Contribution (RoN, 2021) whereas Angola is expected to declare its first MPA along the coast of the Iona National Park in the Namibe Province in 2021. The region has implemented Marine Spatial Planning (MSP) as an integrated approach to reach economic development through promotion of the blue economy, contributing to improvements in the ocean governance and applying the ecosystem-based management through the BCC Marine Spatial Management and Governance Programme (MARISMA) (Finke et al., 2020). Systematic conservation planning through MPAs expansion has been integrated as a component of the MSP process. Ensuring that MPA networking in the BCLME is 'climate smart' will improve both fishery and MSP management and effectiveness in the region. The Southern African Development Community (SADC) also initiated a Marine Transfrontier Conservation Areas process. The first meeting for this process was held on 03 and 04 May 2022. SADC countries presented the potential low-hanging fruits for these initiatives. It was highlighted that the BCC cooperation with the Western member states could play a critical role in the process.

2 Objectives of this study

This study aimed to assess the current and potential future role of MPAs in the BCLME as fishery management and conservation tools and the impacts of forecasted climate change and variability on their effectiveness, including implications for local small-scale fishers and fishing communities. This report deals exclusively with MPAs declared by the national governments of the BCC countries (namely Angola, Namibia and South Africa) through their legislation. For South Africa, this includes MPAs declared through the National Environmental Management: Protected Areas Act. This study does not evaluate the role of other fisheries management strategies such as spatial or temporal fishing closures. While spatial closures potentially fall under specific MPA definitions such as the ones provided by the IUCN[1] and FAO[2], they were not considered in this study.

Moreover, this study aimed to evaluate the current and future role of MPAs in relation to climate change impacts. It is out of the scope of this study to evaluate the global commitments that the BCC countries has made with respect to MPA targets. These targets are chosen at the national or international level and must be discussed within each country and agree by the relevant stakeholders.

[1] IUCN definition of an MPA as "a *clearly defined geographical space, recognised, dedicated, and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values*"

[2] FAO defines an MPA in the following way (FAO, 2011): "any marine geographical area that is afforded greater protection than the surrounding waters for biodiversity conservation or fisheries management purposes will be considered an MPA"

Stakeholder engagement and consultation must take place at the initial stages of the planning process (FAO, 2011); as was the case when new MPAs were declared in South Africa in 2019, where extensive stakeholder consultation took place before the declaration of the MPAs. In this sense, this report does not attempt to make recommendations on the level of protection to be afforded by each national government, as the relevant stakeholders must agree on this in each country. The BCC commissioned this study to evaluate how climate change can potentially affect MPAs and did not imply that "MPAs are the appropriate go-to mechanism for adaptive fisheries management" as suggested by Industry stakeholders. Many adaptive management strategies under climate change have been implemented and suggested, which have been reviewed in Bahri et al., (2021).

3 Methodology

Study area

The Benguela upwelling system herein defined as the BCLME region is limited to the east by the Agulhas Bank in South Africa and extends to the north to the Cabinda Province in Angola. The BCLME countries are Angola, Namibia and South Africa.

Material and methods

This study reviewed existing knowledge of MPAs in the region by incorporating a literature review (i.e. grey and scientific literature), and a content analysis to assess the current and potential future role of MPAs as management and conservation tools and the impacts of forecasted climate change and variability on their effectiveness. The present report does not consider the potential effects of an extension of MPAs in the BCLME as it will be inappropriate to suggest MPA extension without extensive consulting with the relevant stakeholders. This report presents the results for the BCLME countries: Angola, Namibia and South Africa. This study was a desktop-based analysis with a timeline of four months spanning from August to November 2021.

3.1 Literature review

The literature review was done following the three steps below:

STEP 1: A literature review of relevant government documents such as national policies and acts (i.e. Department of Forestry, Fisheries and the Environment- South Africa, Ministry of Environment, Forestry and Tourism and Regional Ministry of Environment and Tourism- Namibia, Ministry of Agriculture and Fisheries-Angola, National Parks, relevant Provincial departments) were conducted for each country to gather information on the history, purpose, legal status and effectiveness of MPAs in Angola, Namibia, South Africa. The search was done by directly accessing the government websites and/or through searches on the Ecolex website (https://www.ecolex.org/) and/or using the Google search engine. All data gathered for each country were compiled into **Appendix 1** for comparative purposes.

Additional documents such as management plans were reviewed through the search engine Google using the key words "management plan", "MPAs", "Angola", OR "Namibia" OR "South Africa" and the name of a specific MPA. This was accessed to gather relevant information, including MPAs aims and objectives, type, management authority, and frameworks that incorporate climate change initiatives. These initiatives may include an implementation plan, indicators, time frame, actions and strategies.

STEP 2: All data gathered for each country were compiled into **Appendix 1** for comparative purposes. The table was subdivided into three main topics: legal status, management plan and climate change framework. Each field within these topics are defined as follows:

1. Legal status:
- Protected area type: each MPA was classified according to the national documents (acts/policies) available relating to the MPAs declarations and regulations. For example, for South Africa the type of protected areas was based on the National Environmental Management: Protected Areas Act, 2003. These include special nature reserve, national parks, nature reserves, and protected environments as well as marine protected areas, World Heritage Sites, Forest nature reserves and forest wilderness areas, and Mountain catchment areas. Each MPA may have more than one classification as it may be declared in different acts throughout the years (e.g. MPAs and Sanctuary; MPA and Ramsar site).

- Type of zones: state what types and how many zones there are in the MPAs. The zones were classified as "controlled" or "restricted" zones. Please refer to Appendix 1 for the classification of MPAs following the criterions listed above and below.

- Location: state if the MPA is declared as "coastal", "offshore" or both.

- History: provide the date of declaration and implementation as provided in the national documents.

- Aims and objectives: state the specific purposes of the MPAs as described in the national documents and/or management plans (or elsewhere whenever available in the literature).

2. Management Plan (MP):
- Management authority: Name of the management authority as designated accordingly.

- MP status: Indicates if the MP is available (it has been prepared and published), unavailable (it has not been prepared/published) and/or under review (it is under review and open for comments, but it has not been published yet).

- Effectiveness: Indicates the effectiveness status of the MPA according to the WWF Management Effectiveness Tracking Tool (METT) available for the country (if any). For South Africa, it was based on the results of Adams and Kowalski (2021).

- Effectiveness indicators: Includes all priority indicators listed in the latest assessment of the effectiveness of the MPA according to the METT.

- Biodiversity indicators: List all biodiversity/environmental indicators (if any) that have been applied for monitoring in the MPA according to the MP or other sources.

3. Climate Change Framework:
- Climate change reporting: Indicates if there are mentions of climate change and/or its impacts on the MPA in the environment, communities, or management.

- Climate change framework included: States if the climate change framework is included or not in the MP of the MPA.

- Type of framework: Indicates what type of conservation framework was used in the MPA design (i.e. systematic conservation planning, climate-smart conservation).

- Climate change-related indicators: Lists all climate change-related indicators if included in the framework.

- Adaptive Climate: provide a list of strategies and actions that have been implemented for adaptation/mitigation of climate change effects in the MPA.

3.2 Content analysis

A content analysis was undertaken to determine if climate change is included in (a) international commitments in which the participating BCC countries are signatories, (b) national policies and other relevant legal documents (e.g. South African Marine Spatial Planning Act) and (c) MPAs documents (e.g. MPA management plans, regulations and acts, frameworks). Search words such as 'climate change', 'adaptation', 'environment', 'variability', 'impacts' and 'resilience' were used to identify direct references to climate change in these documents.

For the MPAs documents, the content analysis was restricted to the aims and objectives of the MPAs declarations, acts and management plans. Climate change information was also extracted from these documents, such as climate reporting (e.g. environmental impacts) and climate change frameworks of each MPA if available. Information was extracted from these documents to define their conservation goals and how future adaptation is required to be effective under the predicted impacts of climate change.

3.3 Climate impacts and vulnerability assessments

Previous studies including the outputs from previous BCC projects (e.g. Cochrane et al., 2020a,b) were used to estimate the predicted impacts of climate change on species and fisheries in the region. First, species of commercial, recreational and subsistence importance were selected for each country. A few species that have important ecological roles (i.e. provision of food, habitat and refugia) were also included in the assessment, for instance, mussels and coral reefs. Available information for the selected species was reviewed to determine their likely sensitivity and response to climate change impacts, management actions to improve species' resilience in the future were also included. The following information was gathered:

- *Distribution*: Species distribution highlighting if the species is endemic to the country or southern Africa.
- *Likely sensitivity to climate change*: A trait-based analysis estimated the likely sensitivity to climate change of 40 South African marine species using 14 attributes including abundance, distribution and phenology categories (Ortega-Cisneros et al., 2018b). These attributes include average age at maturity, stock status, capacity for larval dispersal, and environmental variables as a phenological cue for settlement or spawning (Pecl et al., 2014). The results of Ortega-Cisneros et al. (2018b) and Mason (2019) were used herein to classify the likely sensitivity of most South African marine species. If information was not available for a species, as it was the case for most species from Namibia and Angola, information on traits such as stock status, latitudinal coverage and environmental variables as a phenological cue for spawning and breeding were used to infer a species' likely sensitivity to climate change (Pecl et al., 2014).

- *Likely change due to climate*: Estimates the possible directional effect of climate change and provides an overall indication of whether the impacts of climate change are predicted to be negative, neutral, or positive for a species. A negative impact would involve a decrease in productivity or abundance or a contraction on a species' distribution, while a positive impact will result in increased productivity or abundance or an expansion on a species' distribution. Neutral impacts involved no changes on a species' productivity, abundance or distribution.

Experimental or modelling studies can be used to estimate the likely response of a species to climate change, if no information is available for a species, expert opinion was used to estimate a likely response. It is important to note that the uncertainty of this information is high. The uncertainty in the estimates was captured by using a data quality score (Hare et al., 2016), ranging from 0 (i.e. no available data) to 3 (indicating that there is adequate information for the species in the study area) (following Hare et al., 2016). For almost all species included in this assessment, the data quality score is 1 or based on expert opinion (Tables 4–6) unless experimental or modelling studies were available for the species indicating their likely response to the effects of climate change (i.e. increasing temperatures or decreased pH). This estimate complements the likely sensitivity to climate change estimate by indicating a possible direction on a species' response. For instance, the likely sensitivity indicates a species may have a relative low sensitivity to climate change but it does not indicate if the response, even if it is small, can be positive or negative or neutral. Importantly, the likely sensitivity does not capture the current or future exposure to climate change, and the trait-based assessment does not include the mechanistic understanding of a species response to environmental variables and can underestimate the sensitivity of a species. For example, small pelagics species and chokka squid scored a relatively low sensitivity in Ortega-Cisneros et al. (2018b) because of some of their life-history traits, however, a later vulnerability assessment (Cochrane et al., 2020a, b) adding information on exposure, adaptive capacity and socio-economic factors identified the small pelagic fishery as moderately vulnerable (see Ortega-Cisneros et al., 2018b for a discussion on the limitations of their study). Despite the limitations, information from Ortega-Cisneros et al. (2018b) was used in this study for South African species because it assessed 40 species using the same methods and assumptions and provides a comprehensive assessment of their likely sensitivity to climate change.

– *Possible MPA adaptation*: Wilson et al., (2020) conducted an extensive literature review to determine how to incorporate climate change adaptation into MPA planning. Based on 27 case studies, the authors found that the adaptation strategies incorporated into the design of existing or new MPAs were broadly classified into seven types:

1) Improve MPA resilience: Wilson et al. (2020) found that 45% of studies used resilience principles as the climate change adaptation strategy in MPA design. This included recommendations on MPA size and shape, representation and replication targets, protection of critical habitat areas, maintaining connectivity and ecosystem functioning.
2) Protect climate refugia: Climate refugia is defined as "slower changing areas where species, habitats or ecosystems may be more likely to persist" (Wilson et al., 2020 and references therein). Thirty-three percent of the studies used climate refugia as their main climate change adaptation strategy. Climate refugia can provide ecological benefits to a diverse number of species as conditions are not changing as well as allow species and ecosystems to slowly adapt to future changes (Wilson et al., 2020 and references therein).
3) Protect future habitat: Involves protecting future priority areas i.e. those that will harbour key species or habitats in the future. This is done using projections of a species or habitat distribution into the future.
4) Increase connectivity: This was found to be the most recommended climate change adaptation strategy but in practice only 23% of the studies increased connectivity as their adaptation strategy was constrained probably due to the data requirements associated with modelling connectivity.

5) Increase heterogeneity: Involves protecting areas across the full range of climate change impacts such as climate refugia, areas with high climate variability and high exposure.
6) Reduce other stressors (i.e., fishing): Involves implementing management actions that can reduce other stressors and minimize cumulative impacts on species and ecosystems.
7) Other methods (i.e. dynamic MPAs): This includes MPAs that can move in space and time to match environmental conditions or to move with species if they show distribution shifts due to climate change.

Possible adaptation options were provided for the selected species. If recommendations from previous studies gathered through the literature review were available, those were included in Tables 4-6. If no information was available, recommendations were provided by this study. The possible adaptation options listed in Tables 4-6 fall into one of the seven above-mentioned adaptation types from the classification in Wilson et al. (2020).

- *Other mitigation suggested*: Possible actions to strengthen the species' resilience to climate change and other stressors (i.e. overfishing, pollution). This can include improving monitoring, control and surveillance for a species, or addressing gaps in information. When available, management recommendations from previous studies were included in Tables 4–6.

- *Further MPA requirements*: Recommendations on how existing MPAs can be modified to improve the protection of a species or how the implementation of new MPAs can increase the level of protection of a species. Recommendations from previous studies were cited in Tables 4-6, if available. If no information was available, recommendations were provided by this study if considered necessary. For instance, need for future MPAs to protect a species and its habitat, or new reserves to protect key habitat types against trawling, oil, gas and mining. If information was available on how existing MPAs have benefited a species, those studies were cited in Tables 4-6.

- *MPA effectiveness and climate change scoring*: Each MPA has been scored from 0 (neutral = no change) to 2 (major change) to reflect the likely change in effectiveness status of the MPA against their current objectives. The current MPA objectives were evaluated and scored using the available information on climate change impacts in communities and fisheries within the MPA obtained in this report (section 4.4). The criteria are defined as follow:

    - NA (not available): no baseline information available on impacts in the community/fisheries and no social-economic objectives stated for the MPA
    - zero (0) score: no change = neutral effects on communities and/or fisheries
    - 1 score: moderate change = negative effects on either communities or fisheries
    - 2 score: major change= negative effects on both communities and fisheries

3.4 Stakeholder consultation

A group of experts from each country was contacted in 2021 during the drafting stage of this report by e-mail to gather information on availability of management plans and other matters such as expert feedback to determine how best to include climate change adaptation strategies into the design of existing and future MPAs. Extensive initial stakeholder consultation was out of the scope of this desktop analysis conducted from August to November 2021 due to COVID, budget and time constraints. A draft version of this report was presented to national stakeholders on a series of hybrid workshops in each BCLME country in May 2022 to gather their feedback on the draft report. The draft report was then disseminated to all stakeholders associated with Operation Phakisa in South Africa, and all comments incorporated. Stakeholder consultation is managed through the BCC office as the

consultancy hired to conduct this report do not have ethical clearance to conduct extensive stakeholder consultation.

4 Results

4.1 Background – MPAs and their current role in the BCLME

Thirty-four MPAs are distributed along the BCLME region. The oldest MPA in the region is the Tsitsikamma National Park Marine Protected Area (TNPMPA, South Africa) proclaimed in 1964 first as a park (the Tsitsikamma Coastal and Forest National Park). The TNMPA was declared later on when the marine section of the park (excluding the above De Vasselot marine area) became part of the park as published in the Government Gazette No. 21948, Notice 1429 of December 2000 under Section 43 of the Marine Living Resources Act 1998 (Act No. 18 of 1998). The MPA was re-proclaimed years later under Section 22A of the National Environmental Management: Protected Area Act (NEMPAA) Act N. 57 of 2003 in the Government Notice 1578 of the Government Gazette 40510.

Currently, there is no MPAs proclaimed in Angolan waters, but the country has been working on declaring its first MPA, the Iona Marine Protected Area. The future MPA will be part of the Iona National Park, which is the oldest park established in the country, first established as a reserve in 1937 (Decrete 2421 of 2 October 1937). This initiative is part of a Global Environmental Fund (GEF) funded project whose objective is "*to expand the protected area network into the marine environment through the creation of Angola's first marine protected area (MPA)*" and it will last till 2023 (GEF-60, 2017). Iona National Park is located at the southern portion of the country in the Namibe Province bounded by the Kunene River (border to Namibia) in the south and the Curoca Rivers in the north, and it is nested within the Kunene-Namibe Ecologically or Biologically Significant Area (EBSA) of the BCLME region, an important transboundary area between south Angola and Namibia. The new MPA will extend seawards along the coastline of the Iona National Park covering at least 150,000 hectares from south of the Tombua Bay to the Kunene River mouth adjacent to Namibia and transcending approximately 180 km in length of the Iona National Park coastline. Iona MPA has been chosen according to a set of criteria, including the '*opportunity for land-sea continuum in conservation management and transfrontier protected areas*'. The area is one of Angola's most productive fishing zones in which the artisanal, commercial and recreational sectors operate actively thus the reason to create the new MPA as a fishery management tool.

Furthermore, the country has four natural reserves or integral protected areas along the coastline that will be available for integration into the MPAs networking (GEF-60, 2017):

- Quiçama National Park– Luanda Province;
- Ilhéu dos Pássaros Natural Reserve– Luanda Province;
- Chimalavera Regional Natural Park– Benguela Province;
- Namibe Parcial Reserve– Namibe Province.

Additionally, three sites for habitat or species management have been defined as EBSA, namely Mussulo-Kwanza-Cabo Ledo Complex (Formerly Ramiros-Palmerinhas) in Luanda Province and the Longa coastline, and the Namibe (formerly Kunene-Tigres). Namibe EBSA comprises one offshore controlled zone, one coastal controlled zone and one coastal restricted zone. This protected area aims essentially "*to facilitate species management by protecting nursery areas for fish species and allowing stock recovery and enhancing intertidal and subtidal resource abundance in adjacent areas*". In Angolan marine waters, the main fisheries resources are generally classified into five groups: main: (i) small pelagic fish; (ii) large pelagic fish; (iii) demersal or bottom fish; (iv) crustaceans – deep-sea and coastal; (v) cephalopods (POPA, 2018-2022). These fisheries are very diversified, using multiple gears. It is indeed a concern to promote approaches to environmental sustainability and with emphasis on

fishing production main areas like south region of Angola. The set of adaptation measures identified for Angola also encompasses Ecosystem-based Adaptation (EbA), which is an approach to anticipate natural solutions leading to adaptation to climate change in different sectors. These types of measures consist mainly of restoration, conservation and sustainable use of ecosystems (RoA, 2019).

A single offshore MPA exists in Namibia, the Namibian Islands Marine Protected Area, declared in 2009 "*for the protection and regeneration of marine resources*". It comprises four restricted areas /zones that are managed by the Ministry of Fisheries and Marine resources (MFMR)/Ministry of Environment, Forestry and Tourism (MEFT) MFMR/MEFT. The restrictions include among others accessing without permit, commercial fishing activities, guano scraping, processing plant discharge, mining over-flight restrictions of a minimum altitude of 3000 feet/1000, access by vessels with a size of more than 500 Gross Registered Tonnage, and Anchoring. Namibia also has two Ramsar wetland biodiversity zones, Walvis Bay Lagoon and Sandwich Harbour, both declared in 1995. Additionally, seven coastal and offshore prohibited areas in respect of fishing for recreational purposes are distributed along the coast, two protected area for the protection of Rock Lobster stocks, two for hakes and one for Kabeljou/southern meagre (*Argyrosomus hololepidotus*). There are other 22 protected areas in Namibia, and this Namibia is the country with the largest network of protected areas within the BCLME region (Holness et al., 2014).

The majority (42 at total) of the MPAs of the region are declared within the South African territory, comprising coastal and offshore MPAs. Controlled and restricted zones are part of the zoning scheme of the MPAs in the country as set out in the NEMPAA Act N. 57 of 2003, in which fishing activities are regulated for protection and use of ecosystem services. According to the NEMPAA, a *"Controlled Zone"* is defined as an area where fishing or any other activity may take place if authorized in terms of the regulations as contemplated in terms of section 48A(2) whilst *"Restricted Zone"* is an area where no fishing may take place, but where any other activity may take place if authorized in terms of the regulations as contemplated in terms of section 48A(2) of the Act. In South Africa, the management of MPAs are undertaken by different authorities that have municipal, provincial, national and international jurisdictions such as South African National Parks (SANParks), iSimangaliso Wetland Park Authority , CapeNature, Ezemvelo KwaZulu Natal Wildlife, Nelson Mandela Bay Municipality and The City of Cape Town Municipality and co-managed by the DFFE. In the case of Marion Island, the management of the MPA is shared between France and South Africa.

The current role of the MPAs within the BBC region as fishery management and conservation tools is summarized in Table 2 below (full details in Appendix 1). The majority of the MPAs have been created and designed to protect specific habitats, species, fishery stocks and/or environments as well as to control fishery and tourism activities within their boundaries. Communities are rarely cited in the MPAs aims and objectives and thus BCC MPAs have not targeted social and economic development of the surrounding communities, with one exception in the Aliwal Shoal MPA.

Table 2. Summary information on the aims and objectives (purpose) of MPAs within the BCLME region as fishery management and conservation tools. GN: RSA Government Gazette Numbe

Name of MPA	Aims and objectives
Angola	
Mussulo-Kwanza-Cabo Ledo Complex (Formerly Ramiros-Palmerinhas) EBSA	a) establish the principles and rules for the conservation of flora and fauna in environmental conservation areas and their ecosystems. b) promote the sustainable management of flora and fauna in the areas involved so as to ensure balance with the protection of ecosystems and biological diversity; (c) to protect and regulate access to a scenic area which contributes to eco-tourism;(d) to protect the cultural heritage.
Longa Coastline EBSA	
Namibe (Formerly Kunene-Tigres) EBSA	a) establish the principles and rules for the conservation of flora and fauna in environmental conservation areas and their ecosystems. b) to conserve and protect threatened ecosystems;(c) to protect and regulate access to a scenic area which contributes to eco-tourism;(d) to protect the cultural heritage;(e) to facilitate species management by protecting nursery areas for fish species and allowing stock recovery and enhancing intertidal and subtidal resource abundance in adjacent areas; and(g) to protect and provide an appropriate reference environment for research and monitoring.
Namibia	
Namibian Islands' Marine Protected Area	a marine reserve for the protection and regeneration of marine resources
Mouth of Kunene River	Prohibited areas in respect of fishing for recreational purposes
10 North Torra Bay	Prohibited areas in respect of fishing for recreational purposes
10 km south of Torra Bay	Prohibited areas in respect of fishing for recreational purposes
Concrete beacon marked CCI	Prohibited areas in respect of fishing for recreational purposes
Southern limits of the quay in the harbour of Walvis Bay	Prohibited areas in respect of fishing for recreational purposes
Concrete beacon marked SV2	Prohibited areas in respect of fishing for recreational purposes
Plat 26	Prohibited areas in respect of fishing for recreational purposes
Area between RL 1 Danger Point and RL 2 situated at Douglas Point	Protection of Rock Lobster
Diaz Point to a point north of Lüderitz Bay	Protection of Rock Lobster
south of 25° S is 300 metres for wetfish trawlers and 350 metres for freezer trawlers; and	Conservation measures for hake

north of 25° S is 200 metres for wetfish and freezer trawlers.	Conservation measures for hake
the area of Pelican Point at 22 22 degrees 53.934 minutes South along the coastline to a concrete beacon marked SV 1 at 23 degrees 19.216 minutes South and extending to two nautical miles offshore from the high-water mark	Conservation measures for Kabeljou (Argyrosomus Hololepidotus)
Walvis Bay Lagoon	The Ramsar sites are declared under the Ramsar Convention of UNESCO as sites of international importance for conserving biological diversity
Sandwich Harbour	–
Area 0 to 200 m water depth	Protection of Juvenile fishes
South Africa	
Orange Shelf Edge	(a) To contribute to a national, regional and global representative system of marine protected areas by providing protection to benthic and pelagic ecosystems on the outer shelf, shelf edge and slope in this region;(b) to protect remnants of threatened seabed ecosystems particularly untrawled shelf edge areas;(c) to conserve and protect the biodiversity and ecological processes associated with these ecosystems;(d) to contribute to the conservation and protection of an area of importance for migratory species;(e) to facilitate species management by protecting components of aggregating areas for sharks and other species; and(f) to protect and provide an appropriate environment for research and monitoring particularly research on habitat impacts and recovery (GN39646).
Namaqua Fossil Forest	(a) to contribute to a national and global representative system of marine protected areas by providing protection to the benthic ecosystems of the inner shelf in this region;(b) to conserve and protect an in-situ fossilised forest and its associated cold water corals; and(c) to conserve and protect the biodiversity and ecological processes associated with these features (GN39646).
Namaqua National Park	(a) To contribute to a national and global representative system of marine protected areas by providing protection to the coastal and offshore benthic and pelagic ecosystems of the Namaqua region;(b) to conserve and protect threatened ecosystems;(c) to conserve and protect the biodiversity and ecological processes associated with these ecosystems;(d) to protect and regulate access to a scenic area which contributes to eco-tourism;(e) to protect the cultural heritage of archeological middens;(f) to facilitate species management by protecting nursery areas for fish species and allowing stock recovery and enhancing intertidal and subtidal resource abundance in adjacent areas; and(g) to protect and provide an appropriate reference environment for research and monitoring, including archaeological research, climate change research and research to assess biodiversity state and resource recovery (GN39646).

Childs Bank	(a) To contribute to a national and global representative system of marine protected areas by providing protection to the benthic ecosystems of the outer shelf and shelf edge of this region;(b) to conserve and protect the Childs Bank feature and associated ecosystems including cold water coral colonies;(c) to conserve and protect the biodiversity and ecological processes associated with these ecosystems; and(d) to protect and provide an appropriate reference environment for research and monitoring particularly research on fisheries impacts and recovery (GN39646).
Benguela Mud	(a) To contribute to a national and global representative system of marine protected areas by providing protection to benthic ecosystems on the outer shelf and shelf edge in this region;(b) to protect remnants of threatened seabed ecosystems particularly untrawled rocky habitat;(c) to conserve and protect the biodiversity and ecological processes associated with these ecosystems; and(d) to protect and provide an appropriate environment for research and monitoring (GN39646).
Cape Canyon	(a) To contribute to a national, regional and global representative system of marine protected areas by conserving and protecting a submarine canyon ecosystem and associated benthic and pelagic habitats in the southern Benguela region, including threatened ecosystem types;(b) to conserve and protect the ecological processes and ecologically sensitive biodiversity associated with these ecosystems, including protected and threatened species, thereby supporting eco-certification and its associated economic benefits;(c) to facilitate species management by protecting a feeding area for marine mammals and seabirds;(d) to support sustainable nature-based tourism opportunities in the area through the protection of marine wildlife; and(e)to protect and provide an appropriate environment for research and monitoring particularly research on ecosystem impacts and recovery, ecological function and marine mammals, and also to promote and contribute to environmental education (GN42478). (a) To contribute to a national and global representative system of marine protected areas by providing protection to the offshore benthic and pelagic ecosystems of this region;(b) to conserve and protect a submarine canyon ecosystem and other deep rocky habitats in the Benguela region;(c) to conserve and protect threatened ecosystems;(d) to conserve and protect the biodiversity and ecological processes associated with these ecosystems;(e) to facilitate species management by protecting a feeding area for marine mammals and seabirds;(f) to protect and regulate a scenic area which contributes to eco-tourism ;and(g) to protect and provide an appropriate environment for research and monitoring particularly research on ecosystem impacts and recovery, ecological function and marine mammals (GN39646).
Rocherpan	Conserve and maintain important marine, coastal, wetland, and terrestrial habitats important for bird conservation (objective 1), and provide opportunities for nature based tourism (objective 2) (Visagie and Saul 2014).
Malgas Island	Protect nationally and internationally important biodiversity areas, scenic areas and cultural heritage sites.· Prevent exploitation or occupation inconsistent with the protection of the ecological integrity of the area.· Allow spiritual, scientific, educational, recreational and tourism opportunities which are environmentally compatible.· Contribute to economic development (SANParks 2013).
Marcus Island	Protect nationally and internationally important biodiversity areas, scenic areas and cultural heritage sites.· Prevent exploitation or occupation inconsistent with the protection of the ecological integrity of the area.· Allow spiritual, scientific, educational, recreational and tourism opportunities which are environmentally compatible.· Contribute to economic development (SANParks 2013).

Jutten Island	Protect nationally and internationally important biodiversity areas, scenic areas and cultural heritage sites.· Prevent exploitation or occupation inconsistent with the protection of the ecological integrity of the area.· Allow spiritual, scientific, educational, recreational and tourism opportunities which are environmentally compatible.· Contribute to economic development (SANParks 2013).
Langebaan Lagoon	Protect nationally and internationally important biodiversity areas, scenic areas and cultural heritage sites.· Prevent exploitation or occupation inconsistent with the protection of the ecological integrity of the area.· Allow spiritual, scientific, educational, recreational and tourism opportunities which are environmentally compatible.· Contribute to economic development (SANParks 2013).
Sixteen-Mile Beach	Protect nationally and internationally important biodiversity areas, scenic areas and cultural heritage sites.· Prevent exploitation or occupation inconsistent with the protection of the ecological integrity of the area.· Allow spiritual, scientific, educational, recreational and tourism opportunities which are environmentally compatible.· Contribute to economic development (SANParks 2013).
Robben Island	(a) To contribute to a national and global representative system of marine protected areas by providing protection to coastal, island and offshore benthic and pelagic ecosystems in this region;(b) to conserve and protect threatened ecosystems;(c) to conserve and protect the biodiversity and ecological processes associated with these ecosystems;(d) to contribute to the conservation and protection of African penguin, bank and Cape cormorants and other threatened seabird and shorebird species;(e) to protect an area of significant cultural heritage, a scenic area with tourism value, a South African National Heritage site and a World Heritage Site; and(f) to facilitate species management by supporting fisheries recovery and enhanced species abundance in adjacent areas for west coast rock lobster, abalone and other overexploited species (GN 39646).
Table Mountain National Park	Protect and conserve marine ecosystems and populations of marine species; Protect the reproductive capacity of commercially important species of fish, including abalone, rock lobster and traditional linefish and to allow their populations to recover; Promote eco-tourism within the Marine Protected Area (GN26431). Protect areas of national and international important biodiversity, scenic areas and cultural heritage sites• prevent exploitation or occupation inconsistent with the protection of the ecological integrity of the area; allow spiritual, scientific, educational, recreational and tourism opportunities which are environmentally compatible; and contribute to economic development (SANParks 2015).
Helderberg	Biophysical Goals1. To protect the marine and estuarine ecosystems that are representative of the Agulhas bioregion and to maintain biodiversity and ecological functioning in these ecosystems;2. To protect depleted, endangered and endemic species and populations and to protect habitats which are important for the survival and revival of these species and populations;3. To contribute towards the long-term viability of marine fisheries. Socioeconomic Goals a) To promote non-consumptive, ecotourism opportunities; b) To provide opportunities for marine ecological research and monitoring of environmental effects of human activities on marine ecosystems;c) To facilitate the interpretation of marine ecosystems for the promotion of conservation among scholars and tourists; Governance Goals1. To reduce conflicts between competing users in the MPA and surrounding areas;2. To ensure that appropriate and effective legal structures are developed for protecting the biodiversity of the MPA and the activities that benefit from it;3. To fulfil South Africa's international commitment to marine protection in terms of international protocols and conventions (CCT unknown year).

Betty's Bay	Biophysical Goals1. To protect the marine and estuarine ecosystems that are representative of the south coast zone and to maintain biodiversity and ecological functioning in these ecosystems;2. To protect depleted, endangered and endemic species and populations and to protect habitats which are important for the survival and revival of these species and populations;3. To contribute towards the long-term viability of marine fisheries Socioeconomic Goals1. To promote non-consumptive, ecotourism opportunities;2. To provide opportunities for marine ecological research and monitoring of environmental effects of human activities on marine ecosystems;3. To facilitate the interpretation of marine ecosystems for the promotion of conservation among scholars and tourists; Governance Goals1. To reduce conflicts between competing users in the MPA and surrounding areas;2. To ensure that appropriate and effective legal structures are developed for protecting the biodiversity of the MPA and the activities that benefit from it;3. To fulfil South Africa's international commitment to marine protection in terms of international protocols and conventions (du Toit and Attwood 2009).
Walker Bay	to safeguard an area for whales to rest without being disturbed; to protect rocky and sandy shore habitats; to protect kelps forests (MPAs.org).
SE Atlantic Seamounts	(a) To contribute to a national and global representative system of marine protected areas by providing protection to the benthic and pelagic ecosystems of the slope and abyss of this region;(b) to conserve and protect seamount and associated ecosystems;(c)to conserve and protect the biodiversity and ecological processes associated with these ecosystems;(d) to conserve and protect an area of importance for migratory species including seabirds, turtles, sharks and other fish; and(e)to protect and provide an appropriate environment for research and monitoring particularly research on habitat description, habitat resilience, mapping and monitoring (GN 39646).
Browns Bank Corals	(a) To contribute to a national and global representative system of marine protected areas by providing protection to the benthic ecosystems of the shelf edge;(b) to conserve and protect cold water corals and associated ecosystems;(c) to conserve and protect the biodiversity and ecological processes associated with these ecosystems; and(d) to protect and provide an appropriate reference environment for research and monitoring particularly research on ecosystem description and assessment and fisheries impacts and recovery (GN 39646).
De Hoop	Biophysical 1. To protect marine ecosystems that are representative of the warm temperate south coast Hone and to maintain biodiversity and ecological functioning in these ecosystems. 2. To protect depleted, endangered and endemic species and populations and to protect habitats which are important for the survival and revival of these species and populations. 3. To contribute towards the long-term viability of marine fisheries. Socio-economic 4. To promote non-consumptive, ecotourism opportunities. 5. To provide opportunities for marine ecological research and monitoring of environmental effects of human activities on marine ecosystems. 9. To facilitate the interpretation of marine ecosystems for the promotion of conservation among scholars and tourists. Governance 7. To reduce conflicts between competing users in the MPA and surrounding areas.

	8. To ensure that appropriate and effective legal structures are developed for protecting the biodiversity of the MPA and the activities that benefit from it. 9. To fulfil South Africa's international commitment to marine protection in terms of international protocols and conventions (CapeNature 2006)
Stilbaai	Protect and conserve the coastal environment and marine living resources that are found in and around the Marine Protected Area; protect the reproductive capacity of exploited species of fish, including shellfish, to allow their populations to recover and to contribute to the replenishment of adjacent areas; protect the nursery function of the Goukou estuary and the recruitment of estuarine-dependent fish into marine fisheries; and control other activities in the Marine Protected Area to reduce the risks of habitat degradation and to preserve the vywers, which have archaeological and cultural value (du Toit and Attwood 2008).
SW Indian Seamounts	(a) To contribute to a national and global representative system of marine protected areas by providing protection to the benthic and pelagic ecosystems of the shelf edge, slope and abyss of this region;(b) to conserve and protect rocky shelf edge, seamount and associated deep sea ecosystems;(c)to conserve and protect the biodiversity and ecological processes associated with these ecosystems;(d) to conserve and protect an area of life history importance for migratory species including seabirds, turtles, sharks and other fish; and(e) to protect and provide an appropriate environment for research and monitoring particularly research on ecosystem description, resilience and change (GN39646).
Goukamma	To conserve and manage biodiversity and natural processes representative of Southern Cape terrestrial and marine ecological systems; To improve the reach and quality of biodiversity management; To create environmental awareness; To expand and secure the conservation estate; To provide appropriate opportunities and facilities for recreation; To promote social and economic opportunities and sustainable utilisation; and To effectively conserve our cultural heritage attributes (Spencer et al. 2016)

Robberg	Biophysical 1. To protect marine ecosystems that are representative of the warm temperate south coast Hone and to maintain biodiversity and ecological functioning in these ecosystems. 2. To protect depleted, endangered and endemic species and populations and to protect habitats which are important for the survival and revival of these species and populations. 3. To contribute towards the long-term viability of marine fisheries. Socio-economic 4. To promote non-consumptive, ecotourism opportunities. 5. To provide opportunities for marine ecological research and monitoring of environmental effects of human activities on marine ecosystems. 9. To facilitate the interpretation of marine ecosystems for the promotion of conservation among scholars and tourists. Governance 7. To reduce conflicts between competing users in the MPA and surrounding areas. 8. To ensure that appropriate and effective legal structures are developed for protecting the biodiversity of the MPA and the activities that benefit from it. 9. To fulfil South Africa's international commitment to marine protection in terms of international protocols and conventions (Schutte-Vlok et al. 2006)
Tsitsikamma	(a) To contribute to a national and global representative system of marine protected areas by providing protection to the coastal and offshore benthic and pelagic ecosystems of the Agulhas Inshore Bioregion;(b) to conserve and protect threatened species and ecosystems;(c) to conserve and protect the biodiversity and ecological processes associated with these ecosystems;(d) to protect and regulate access to a scenic area which contributes to eco-tourism;(e) to protect the cultural heritage of the coastline;(f) to facilitate species management by protecting spawning stock and nursery areas for fish species and allowing stock recovery and enhancing intertidal and subtidal resource abundance in adjacent areas; and(g) to protect and provide an appropriate reference environment for research and monitoring where no fishing is allowed and for research to assess biodiversity status, the impact of limited recreational fishing access in controlled areas, and resource condition in areas where there is no access to resources (GN40510).
Agulhas Front	(a) To contribute to a national and global representative system of marine protected areas by providing protection to the benthic and pelagic ecosystems of the lower slope and abyss of this region;(b) to conserve and protect the biodiversity and ecological processes associated with these ecosystems;(c) to facilitate species management by protecting an area of life history importance to large pelagic fish; and(d) to protect and provide an appropriate environment for research and monitoring particularly research on habitat description, habitat resilience and climate change (GN39646).
Agulhas Mud	(a) to contribute to a national and global representative system of marine protected areas by providing protection to offshore benthic ecosystems on the shelf in this region;(b) to protect a threatened mud ecosystem;(c) to conserve and protect the biodiversity and ecological processes associated with this ecosystem; and(d) to protect and provide an appropriate reference environment for research and monitoring particularly research on habitat impacts and recovery (GN39646).

Agulhas Bank Complex	(a) To contribute to a national and global representative system of marine protected areas by providing protection to the offshore benthic and pelagic shelf ecosystems of the Agulhas Bank;(b) to conserve and protect rocky, gravel, sandy and pelagic habitats of the Agulhas Bank, which includes the Alphard Banks, parts of the 45 Mile Bank and parts of the 72 Mile Bank;(c) to conserve and protect threatened ecosystems and fish species;(d) to conserve and protect the biodiversity and ecological processes associated with the ecosystems in this area, which includes the nursery function of the Agulhas Bank;(e) to support the recovery of linefish by protecting important nursery, spawning, foraging, aggregation and refuge areas for overexploited linefish;(f) to facilitate species management and sustainable use of linefish and south coast rock lobster to enhance species abundance in adjacent areas; and(g) to protect and provide an appropriate environment for research and monitoring particularly research on ecosystem impacts and recovery, habitat requirements of south coast rock lobster and recovery of linefish (GN39646).
Port Elizabeth Corals	(a) To contribute to a national and global representative system of marine protected areas by providing protection to the benthic ecosystems of the shelf edge and slope of this region;(b) to conserve and protect cold water coral reefs and associated ecosystems;(c) to conserve and protect the biodiversity and ecological processes associated with these ecosystems; and(d) to protect and provide an appropriate reference environment for research and monitoring particularly research on fisheries impacts and recovery and kingklip spawning and nursery requirements (GN39646).
Sardinia Bay	–
Addo Elephant National Park	(a) To contribute to a national and global representative system of marine protected areas, by providing protection for species, habitats and ecosystem processes in a biodiversity hotspot, to form a contiguous conservation area between marine, estuarine and terrestrial habitats;(b) to facilitate fisheries management by protecting spawning stock, allowing stock recovery, enhancing stock abundance in adjacent areas, in particular linefish and abalone stocks ; allowing the development of sustainable aquaculture in a confined area; and(c) for the protection of fauna and flora or a particular species of fauna or flora and the physical features on which they depend, including the African Penguin and Cape Gannet (GN39646).
Amathole	(1) To protect and conserve the marine environment and marine biodiversity in the Amathole region (2) To provide a sanctuary for species impacted by boat-based exploitation (3) To provide benchmark areas for scientific research and monitoring aimed at the protection and conservation of biodiversity and ecosystems (4) To control activities in the Marine Protected Area to reduce the risks of habitat degradation (ECPTA 2021)
Amathole Offshore	(a) to contribute to a national and global representative system of marine protected areas by providing protection to the offshore benthic and pelagic outer shelf and slope ecosystems of the region;(b) to conserve and protect canyon, deep reef, cold water coral, sandy and pelagic habitats of this area;(c) to conserve and protect threatened ecosystems and fish species;(d) to conserve and protect the biodiversity and ecological processes associated with the ecosystems in this area;(e) to support the recovery of linefish by protecting spawning, nursery, foraging, aggregation and refuge areas for overexploited species;(f) to facilitate species management and sustainable use of linefish and south coast rock lobster and enhance species abundance in adjacent areas; and(g) to protect and provide an appropriate reference environment for research and monitoring particularly with regard to habitat recovery, fisheries recovery of

	linefish and habitat requirements of south coast rock lobster and climate resilience, and also to promote and contribute to environmental education (GN39646).
Dwesa-Cwebe	To contribute to a national and global representative system of marine protected areas, by providing protection for species, habitats and ecosystem processes in a biodiversity hotspot; To facilitate fisheries management by protecting spawning stock, allowing stock recovery, enhancing stock abundance in adjacent areas, in particular line fish and abalone stocks ; To protect the nursery function of the Mbashe estuary and the recruitment of estuarine dependent fish into marine fisheries; For the protection of fauna and flora or a particular species of fauna or flora and the physical features on which they depend; and Control other activities in the Marine Protected Area to reduce the risks of habitat degradation (mpaforum.org.za)
Hluleka	For the protection of marine fauna and flora and the physical features and natural processes on which they depend; To facilitate fishery management by protecting spawning stock, allowing stock recovery, enhancing stock abundance in adjacent areas as well as providing pristine communities for research; To diminish any conflict that arises due to competing users in that area (mpaforum.org.za).
Pondoland	Protect and conserve marine ecosystems and populations of marine species; Protect the reproductive capacity of commercially important species of fish, including shellfish, rock lobster and traditional line fish and to allow their populations to recover; Promote eco-tourism within the Marine Protected Area (mpaforum.org.za).
Trafalgar	to protect marine fossil deposits (Chadwick et al. 2014)
Protea Banks	(a) To contribute to a national and global representative system of marine protected areas by providing protection to the offshore benthic and pelagic ecosystems of this region;(b) to conserve and protect submarine canyons, deep reefs, cold water coral reefs and other habitats of the shelf edge and slope;(c) to conserve and protect threatened ecosystems;(d) to conserve and protect the biodiversity and ecological processes associated with these ecosystems such as the sardine run;(e) to protect a scenic area with significant eco-tourism opportunities;(f) to support the recovery of linefish and shark species by protecting spawning and other aggregations; and(g) to facilitate species management and sustainable use of linefish to enhance species abundance in adjacent areas (GN39646).

Aliwal Shoal	1. Protect the biodiversity at Aliwal Shoal and the surrounding areas. 2. Promote and manage a popular SCUBA diving destination. 3. Reduce conflict between competing users on Aliwal Shoal and surrounding areas. 4. Allow over-exploited populations of reef-fish to recover at Aliwal Shoal. 5. Encourage economic opportunities for previously disadvantaged communities in the vicinity of Umkomaas (DEA 2006) AND (a) To contribute to a national and global representative system of marine protected areas by providing protection to the coastal and offshore benthic and pelagic ecosystems of this region;(b) to conserve and protect threatened ecosystems;(c) to conserve and protect the biodiversity and ecological processes associated with these ecosystems, including the sardine run;(d) to protect and promote a scenic area and its associated eco-tourism opportunities;(e) to facilitate species management by supporting fisheries recovery and enhanced species abundance in adjacent areas for intertidal resources, linefish and sharks;(f) to facilitate marine and coastal species management by protecting spawning and other aggregations of marine fish species;(g) to support the recovery of linefish by protecting spawning, nursery, foraging, aggregation and refuge areas for overexploited species;(h) to conserve and protect an area of life history importance for migratory species including seabirds, turtles, sharks and other fish;(i) to facilitate species management and sustainable use of linefish and enhance species abundance in adjacent areas; and(j) to protect and provide an appropriate environment for research and monitoring particularly research on fisheries recovery of linefish (GN39646).
Uthukela Banks	(a) To contribute to a national and global representative system of marine protected areas by providing protection to coastal and offshore benthic and pelagic ecosystems of the Kwazulu-Natal Bight;(b) to conserve and protect coastal habitats including sandy beaches, rocky shores and estuaries as well as offshore habitats including the soft sediment and reef systems, submarine canyons, the shelf edge and slope ecosystems;(c) to conserve and protect the biodiversity and ecological processes associated with these ecosystems. This includes the connectivity, spawning area and nursery function of this area and the role of fresh water riverine input in these processes;(d) to conserve and protect threatened ecosystems and species;(e) to protect and regulate a scenic area which contributes to eco-tourism;(f) to facilitate species management by supporting fisheries recovery and enhanced species abundance in adjacent areas for linefish and sharks;(g) to facilitate marine and coastal species management by protecting spawning and other aggregations of marine fish species; and(h) to contribute to sustainable marine and coastal ecotourism through the zonation for activities which yield socio-economic benefits on the local and national scales (GN39646).
Isimangaliso	a) To contribute to a national and global representative system of marine protected areas, by providing protection for sites of special sensitivity and sites that are critically endangered; and by providing a large contiguous conservation area which links inshore marine habitats with those further offshore;b) to contribute to sustainable marine and coastal ecotourism through the zonation for activities which yield socio-economic benefits on the local and national scales;c) to facilitate fisheries management by protecting spawning stock, allowing stock recovery, and enhancing stock abundance in adjacent areas, in particular, for reef fish and large pelagic fish;d) for the protection of fauna and flora or a particular species of fauna or flora and the physical features on which they depend, including the canyons which constitute known and potential Coelacanth habitat, vulnerable benthic habitats, including cold water corals and areas which are important migratory corridors for humpback whales and whale sharks and breeding and foraging areas for several turtle species; and e) to provide reference sites for research, including areas in good ecological condition and areas which may show most clearly the impacts of climate change (GN39646).

Prince Edward Islands	(a) To contribute to a national and global representative system of marine protected areas, by providing protection for unique species, habitats and ecosystem processes including foraging grounds and shelf areas with increased nutrients (b) To provide scientific reference points that can Inform the management of the area and to be able to understand better the impacts of Climate Change on the whole Southern Ocean; (c) To facilitate integrated and ecologically sustainable management of marine resources of the area; and (d) To reduce the ecological impacts of fisheries and other extractive industries including effects on by-catch species such as albatrosses and petrels (GN36572) AND To ensure the long-term survival and maintenance of biological diversity, including genetic diversity, species diversity and the diversity of ecological processes; To minimise human interference with natural processes and the destruction or degradation of natural and historic features and objects; To encourage activities aimed at restoring and rehabilitating damage due to local human activities; To encourage research that will contribute to understanding effects of human-induced changes, including long term climate change; To encourage research and monitoring aimed at the conservation and management of the fauna and flora of the PEIs; To ensure that South Africa meets its obligations to, and the provisions of, all international agreements and conventions to which it is a signatory; To seek cooperation with all parties interested in the conservation of the Southern Ocean and its islands; To create an awareness of the value and fragility of the islands' ecosystems; To secure a favourable conservation status of species occurring naturally at the islands; To allow scientific research not in conflict with these objectives; To apply a risk-averse and cautious approach, taking into account the limits of current knowledge and the consequences of decisions and actions (DEA 2010).

4.2 National policies regulating MPAs in each country

In Angola, there is no specific policy regulating MPAs but as the country fosters the creation of a network of MPAs policy, institutional and legal frameworks are strengthened. Two main policies are available to provide the required legal framework for the creation of MPAs in the country:

1. *The Law of the Environmental Basis* n.o 5/98 *of 19 June 1998 (*in Portuguese *'Lei das Bases do Ambiente n.o 5/98 de 19 de junho de 1998')*

The above law establishes under Article 13 the creation of protected areas of regional, national, local and transboundary scales in Angola for conservation of both terrestrial and aquatic biodiversity, and under Article 25 it foresees the responsible and sustainable usage of its natural resources. The law defines protected area as "well defined spaces representing biomes or ecosystems for preservation and where natural resources exploitation are not allowed, except for ecotourism, environmental education and scientific investigation."

Classification of protected areas were later on published under the Decrete n.o 43/77 of 5 May ('*Decreto n.o 43/77 de 5 de Maio*' in Portuguese) but it did not include the definition of marine protected areas: national park, integral natural reserve, partial reserve, regional natural park, and special reserve.

2. *The Law of Biological Aquatic Resources Law* n.° 6-A/04 of 8 October *2004* ('*Lei dos Recursos Biológicos Aquáticos - Nova Lei da Pesca Lei n.° 6-A/04 de 8 de Outubro'* in Portuguese)

It establishes principles and objectives for the use of aquatic resources in the country and regulates fishery management in continental, coastal and offshore waters as well as scientific monitoring of the natural aquatic resources in Angola.

Article 65 of Section III of Chapter 1 recognizes marine protected areas as a tool for the conservation of aquatic natural resources and sets up a series of objectives under Article 78 which includes:
a) preservation of aquatic species, ecosystems and habitats and its biodiversity including recovering of species under threat and rehabilitation of degraded habitats; b) protection of cultural values, particularly aesthetics; c) recreational and tourism use; d) scientific investigation; e) contributing to the creation of protected areas networking.' The main aquatic protected areas are classified under Article 79 and comprises: integral aquatic natural reserves, aquatic national parks, aquatic natural reserves, partial reserves, and natural monuments.

For Namibia, Marine Resources Act 27 of 2000 (and its regulations) aims to conserve the marine ecosystem towards responsible utilization, conservation, protection, and promotion of marine resources on a sustainable basis in Namibia. It covers the general policy for conservation and control over marine resources, harvesting of marine resources, and fisheries management and control measures. Regulations relating to Namibian Islands' MPA Government Notice 316 of 2012 define the MPA and identify several zone restrictions and access permits.
The Convention on Wetlands is an intergovernmental treaty (Ramsar convention) for conserving and using wetlands and their resources.

In South Africa, the MPAs may have dual proclamation on national legislations with some of them being declared in one act and re-proclaimed in a different one. The main policies regulating fisheries and other activities within the MPAs in the country are:

1. The Marine Living Resources Act N.18 of 1998

The Marine Living Resources Act (MLRA) and its amendments is a pioneer on declaring and regulating the first South African MPAs under the Section 43. The main purposes of the Act was to

declare an area as a MPA "*(a) for the protection of fauna and flora or a particular species of fauna and flora and the physical features on which they depend", (b) to facilitate fishery management by protecting spawning stocks allowing stock recovery, enhancing stock abundance in adjacent areas, and provide pristine communities for research", or (c) to diminish any conflict that may arise from competing uses in the area"*.

2. The National Environmental Management: Protected Area Act (NEMPAA) (Act 57 of 2003)

Currently, MPAs are proclaimed under this Act but may have been proclaimed on another Act previously as well. The main objectives of this legislation are "*(a) to provide, within the framework of national legislation, including the National Environmental Management Act, for the declaration and management of protected areas; (b) to provide for co-operative governance in the declaration and management of protected areas; (c) to effect a national system of protected areas in South Africa as part of a strategy to manage and conserve its biodiversity; (d) to provide for a representative network of protected areas on state land, private land and communal land; (e) to promote sustainable utilization of protected areas for the benefit of people, in a manner that would preserve the ecological character of such areas; and (f) to promote participation of local communities in the management of protected areas, where appropriate".* NEMPAA also has set out a series of definitions and management regulations regarding protected areas in the country in order to apply a conservation approach other than the management of living resources.

Other important policies regulating fisheries and other activities within the MPAs in the country are the National Environmental Management Biodiversity Act, National Environmental Management Act, and the Constitution.

4.3 Content analysis of MPA documents

A) *International commitments*

Several international commitments were identified through the literature review, the content analysis indicated that biodiversity and climate change were included in most of these documents (Table 3).

Table 3. List of international commitments of relevance to MPAs in face of climate change scenarios. NA: not available.

Convention name	**Countries**	**Description of biodiversity and climate-related commitments**
Convention on Biological Diversity (CBD) 1992	all	*Aichi Target 11* By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes. *Aichi Target 15*

		By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.
United Nations Framework Convention on Climate Change (UNFCCC), 1994	all	*Art. 4 Section 1* (d) Promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol, including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems; (e) Cooperate in preparing for adaptation to the impacts of climate change; develop and elaborate appropriate and integrated plans for coastal zone management, water resources and agriculture, and for the protection and rehabilitation of areas, particularly in Africa, affected by drought and desertification, as well as floods;
Nairobi Convention, 2010	all	*Preamble* *Aware* of the impacts of climate change on marine and coastal environment resulting in, *inter alia,* sea-level rise, increase of sea water temperature, ocean acidification, weather and climate variability that affect or are likely to affect coastal communities;
IUCN World Parks Congress 2014 - The Promise of Sydney	Namibia and South Africa	*Namibia committed to:* A programme to intensively create awareness among the youth and to empower local people to be wildlife stewards through their role in managing and preserving natural systems and to put a stop to poaching in the country. *South Africa committed to:* - More than triple its ocean protection over the next ten years, from less than 0.5% to 5% of our Exclusive Economic Zone within Marine Protected Areas, to ensure environmental sustainability as MPAs deliver ecosystem services which underpin South African livelihoods, food security and ecotourism. - Use South Africa's unique geographical position to encourage the African region to create a network of marine protected areas to increase ecosystem resilience, maintain genetic biodiversity and the ability to cope with climate change.
United Nations Convention on	all	NA

the Law of the Sea, 1994		
The post 2020 Global Biodiversity Framework	all	*2030 Action Targets* *Target 3.* Ensure that at least 30 per cent globally of land areas and of sea areas, especially areas of particular importance for biodiversity and its contributions to people, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes. *Target 8.* Minimize the impact of climate change on biodiversity, contribute to mitigation and adaptation through ecosystem-based approaches, contributing at least 10 GtCO2e per year to global mitigation efforts, and ensure that all mitigation and adaptation efforts avoid negative impacts on biodiversity.
Paris Agreement, 2015	all	entire document
The 2030 Agenda and the Sustainable Development Goals (SDG)	all	*Goal 13 Climate Action* - Take urgent action to combat climate change and its impacts Target 13.2 - Integrate climate change measures into national policies, strategies and planning *Goal 14 Life Below Water* - conserve and sustainably use the oceans, sea and marine resources for sustainable development. Target 14.2 - By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans
African Convention on the Conservation of Nature and Natural Resources, 1968	all	NA

B) National legislations

The Contracting Parties of the BCC are committed to marine biodiversity conservation, sustainable use of the ocean services as well as climate change mitigation and adaptation which are reiterated in

several international conventions (Table 4). Some of these conventions have mentioned that both biodiversity conservation and environmental resilience are directly related to the efficient management of protected areas.

Each Contracting Party should attempt to amend and/or design their legal documents related to MPAs in the BCC region to integrate climate-related sections to address issues such as the impacts of climate change, adaptive strategies and mitigation actions as well as climate related implementation plans. An assessment of these documents has shown that the national documents relevant to MPAs (see Table 4) are far from addressing the international commitments related to climate change initiatives.

Table 4. List of relevant MPAs acts and regulations, and climate change policies and other national documents that are applied to the MPAs by country. Reference to climate change related issues are highlighted for each document whenever available. NA: not available.

Country	**Document name**	**Reference to climate-related issues**
Angola	Constitution of the Republic of Angola	NA
	Environmental Conservation Areas Law (amended) Law No. 8/20, Official Gazette No. 50)	NA
	Aquatic Biological Resources Law Law nº6-A/04	NA
	Planning Plan (Management) Fisheries and Aquaculture (POPA) 2018-2022	NA
	Annual Fisheries management measures to Marine and continental fisheries, Aquaculture and salt	NA
	Adaptation Plan to Climate Change in the Coastal Zone of Angola (RoA, 2019)	The fishing sector is moderately affected in the coastal zone of Namibe province. This report states that the fishing sector is moderately affected in the coastal zone of Namibe province and indicates that changes in the distribution of fish stocks are aggravated due to the influence of climate change on

Country	Document name	Reference to climate-related issues
		water bodies. The report points to the vulnerability of artisanal fishing communities due to the low socioeconomic status of these riverside populations.
Namibia	The Constitution of the Republic of Namibia	Article 95 The State shall actively promote and maintain the welfare of the people by adopting, inter alia, policies aimed at the following; (i) maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilization of living natural resources on a sustainable basis for the benefit of all Namibians, both present and future;
	Marine Resources Act, 2000 (Act 27 of 2000)	Exploratory right to harvest marine resources (34) (3) Notwithstanding the provisions of any other law, the Minister may require the applicant to carry out or cause to be carried out such. Environmental impact studies, as the Minister may consider necessary for the purposes of this Act.
	Environmental Management Act 7 of 2007	"assessment" means the process of identifying, predicting and evaluating - (a) the significant effects of activities on the environment; (b) the risks and consequences of activities and their alternatives and options for mitigation with a view to minimize the effects of activities on the environment and to maximize the benefits and to promote compliance with the principles set out in section
	Regulations relating to Namibian Islands' Marine Protected Area Government Notice 316 of 2012	NA
	National Policy on Climate Change for Namibia (2011)	Guiding principles for mainstreaming climate change into policies, legal framework and development planning and strategies that need to be followed in key sectors
	National Climate Change Strategy and Action Plan (NCCSAP)(2013-2020)	To operationalize and implement the National Climate Change Policy

Country	Document name	Reference to climate-related issues
South Africa	Constitution of the Republic of South Africa (No 108 of 1996)	NA
	National Environmental Management Act (No 107 of 1998)	Definitions **1. (**1) In this Act. unless the context requires otherwise_ (xxiv) "pollution'. means any change in the environment caused by— (i) substances; (ii) radioactive or other waves; or (iii) noise, odours, dust or heat. emitted from any activity, including the storage or treatment of waste or substances, construction and the provision of services, whether engaged in by any person or an organ of state, where that change has an adverse effect on human health or well-being or on the composition. resilience and productivity of natural or managed ecosystems, or on materials useful to people, or will 5 have such an effect in the future; (iii)
	Marine Living Resources Act No 18 of 1998 (Amended in 2000, 2014)	NA
	National Environmental Management: Protected Areas Act 57 of 2003 (Amended 2004, 2009, 2013, 2014)	NA
	World Heritage Convention Act (No 49 of 1999)	Fundamental Principles Section 4 Art. (2) For the purposes of this Act, sustainable development of World Heritage Sites includes that— (h) negative impacts on the environment and on the environmental rights of the people must be anticipated and prevented, and where they cannot be prevented, must be mitigated;

Country	Document name	Reference to climate-related issues
	National Environmental Management: Biodiversity Act 10 of 2004	NA
	The National Environmental Management: Integrated Coastal Management Act, 2008 (Act No. 24 of 2008). (Amended 2014).	Chapter 3 Section 28 (3) When determining or adjusting the coastal boundary of the coastal protection zone the MEC must take into account: (d) the potential for the number and severity of natural disasters to increase due to the effects of global climate change and other impacts on the environment, and the importance of taking preventive measures to address these threats; Determining and adjusting coastal boundaries of coastal protection zone Sect 28 Determining and adjusting coastal boundaries of coastal protection zone (3) When determining or adjusting the coastal boundary of the coastal protection zone the MEC must take into account— (d) the potential for the number and severity of natural disasters to increase due to the effects of global climate change and other impacts on the environment, and the importance of taking preventive measures to address these threats;
	Marine Spatial Planning Act (No 16 of 2018)	National Working Group Section 9. 2 The National Working Group is a technical group responsible for— (b) developing draft marine area plans by using the information from the vi) environmental change impacts;
	Environment Conservation Act, 1989 (Amended 1993, 2003, 2004)	NA
	White Paper On The National Climate Change Response	entire document

Country	Document name	Reference to climate-related issues
	Climate Change Bill, Government Gazette 41689 of 2018	entire document
	National Framework on Marine Spatial Planning in South Africa, 2017	entire document

B) ***MPAs documents***

Reference to climate change in MPA documents and management plans from the BCLME region is limited to South Africa (Table 2, Appendix 1). Out of the 42 MPAs that are declared in the South African territory only four of them stated "*climate change*" in their aims and objectives: Namaqua National Park, Amathole Offshore MPA, iSimangaliso MPA, and Prince Edward Islands MPA. Climate information in this case are exclusively referred as part of the scientific purpose and/or monitoring of the marine ecosystem and biodiversity of the MPAs. For example, one of the iSimangaliso MPA aims and objectives is "*to provide reference sites for research, including areas in good ecological condition and areas which may show most clearly the impacts of climate change*".

The impacts of climate change in the related ecosystems of MPAs and its surrounding areas were mentioned in the management plans of Nine South African MPAs: Table Mountain National Park (TMNP), Betty's Bay, Stilbaai, Robberg, Addo Elephant National Park, Amathole, Aliwal Shoal and iSimangaliso. Addo Elephant National Park, Rocherpan and Robberg, however, only generally cited climate change as a possible threat according to the Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis undertaken in their respective effectiveness assessments. The most cited climate change impacts in these MPAs are increase in SST, sea level rise, decrease of rainfalls, increase in salinity, high incidence of extreme events, and strong ocean currents. Coral bleaching and mobile dunes are also mentioned in the management plan of the iSimangaliso MPA. Reference to the climate change impacts in the management of the protected areas was not included in the management plans of all the MPAs assessed here and only one (iSimangaliso) has stated possible impacts in the community, including erosion, water quality and quantity, infrastructure damage, and exposure to climate-related diseases.

No climate change frameworks have been incorporated into the management plans of the South African MPAs so far, with the exception of Table Mountain National Park, Tsitsikamma MPA as part of the Garden Route National Park and iSimangaliso MPA. Climate change is addressed in the 'Functional Ecosystem Programme' of the entire TMNP and not under the MPA programme as part of the sub-objective "*To understand climate change in the Park"* in which related actions are listed and planned for implementation. iSimangaliso management plan is the only one that aligns back to the aims and objectives of the MPA in supporting monitoring and research on climate change. The management plan of this MPA also provides a few climate change indicators for monitoring such as underwater temperature and salinity in specific areas of the MPA. Climate adaptation measures are cited as well, for instance, restoration of the Lake St Lucia estuarine system, interconnection of wetlands and dune rehabilitation at Sodwana and St Lucia, removal of infrastructure in vulnerable areas, raising of roads to prevent flooding during times of heavy rain, and water supply to dry areas during droughts.

4.4 Present and future impacts of climate change to MPAs

Cochrane et al. (2020), using information on several environmental drivers from forecasts of future trends, provided a summary of likely climate-driven changes in sea level rise, extreme events, sea surface temperature (SST), ocean productivity, acidification, deoxygenation and salinity for each of the Benguela countries. From all the environmental drivers analysed in the above-mentioned study, SST showed marked differences between the average conditions from the historical (1956–2005) and future periods (2006–2055). Importantly, the degree of warming varied among the BCLME with slightly higher SST increases forecasted for the coastal waters off southern Angola, northern and central Namibia, and the east coast of South Africa. In terms of primary productivity, upwelling indices from 1979–2014 indicated that there has a been significant increase in total cumulative upwelling and the number of upwelling days off the Agulhas Bank but a reduction off the northern Benguela from 2009–2014 (Lamont et al., 2018). A reduction of approximately 0.07 to 0.1 pH units was predicted for the BCLME under Representative Concentration Pathway (RCP) 8.5 scenario by 2050. It is noteworthy that the decrease in pH is expected to be slightly higher off the Agulhas Bank than the west coast of South Africa. Experimental studies on the effects of ocean acidification are restricted to a few species of commercial and recreational importance in South Africa (i.e. West coast rock lobster, blacktail, dusky kob and red roman). Previous studies have found that the pH predicted by 2090 under RCP 8.5 will negatively affect the growth, development and metabolic responses of larval dusky kob (*A. japonicus*) (Mpopetsi, 2019). Early postflexion stage of blacktail (*Diplodus capensis*) exposed to pH treatments ranging from local conditions to future ocean acidification (OA) scenarios indicated no impact of future OA on metabolic or feeding rates, with only slight increases in swimming speed and distance under decreased pH (Edworthy, 2020). However, red roman (*Chrysoblephus laticeps*) showed sensitivity to lower pH (0.4 pH units decrease) during the preflexion and flexion stages in terms of metabolic and growth rates (Muller et al., 2020). In terms of invertebrates, adult West Coast rock lobster, on experimental treatments, showed to fully compensate for exposure to low pHs by protecting oxygen carrying capacity of haemocyanin (Knapp et al., 2016). Abalone *(Haliotis midae*) exhibited metabolic shifts to utilize more energy-efficient mechanisms of adenosine triphosphate generation under OA treatments (Carroll & Coyne, 2021). The authors concluded that abalone as other molluscs exhibit a complex array of overlapping functions of both the stress and immune response systems.

An assessment of the likely sensitivity to climate change of 40 priority species selected based on their ecological, socio-economic and/or recreational importance in the southern Benguela system identified the white steenbras (*Lithognathus lithognathus*), soupfin shark (*Galeorhinus galeus*), St Joseph (*Callorhinchus capensis)* and abalone (*Haliotis midae*) as potentially the most sensitive species to climate-change impacts (Ortega-Cisneros et al., 2018b). The study also found that most species with a high or medium sensitivity were those with depleted stock status and/or endemic to southern Africa and highlighted the urgent need to improve the control of illegal, unregulated and unreported (IUU) fishing and to ensure that the MPA network functions effectively to protect resident species.

Tables 5–7 provide a list of the main fishery species for each BCC country, their likely response to climate change, linked to possible adaptation options that can be incorporated on the management of existing MPAs. Overall, very few species were predicted to be positively impacted by climate change, however, the uncertainty on the estimates of likely change due to climate have high uncertainty as they were mostly based on expert opinion with the exception of a few species. Most of the possible MPA adaptation options were targeted at reducing other stressors (following Wilson et al., 2020) such as fishing and protecting the habitat of key species.

In terms of socio-economic impacts of MPAs, Mann-Lang et al. (2021) conducted a review of the declarations of the 41 MPAs around mainland South Africa and of literature on socio-economic effects of South African MPAs. These authors gathered 31 of the 41 declaration notices, 60% of these

declarations corresponded to the MPAs declared in 2019. The objectives of all the MPAs with available declarations were analysed and classified into nine social and economic objectives to then determine if an MPA included social or economic objectives. The categories included fisheries sustainability and resource recovery, conflict management, nature-based tourism and associated benefits, environmental education, cultural and marine heritage, research and monitoring among others. The authors found that all MPAs included at least one of their nine social or economic objectives, with six MPAs having a single social objective. The Aliwal Shoal MPA had eight out of nine social and economic objectives, with 'provision of research and monitoring opportunities' and 'environmental education' being the most common objectives. It was noted that many of the social and economic objectives of the MPAs are not clear and do not have associated indicators to measure effectiveness.

One of the findings from Mann-Lang et al. (2021) is that research on the effects of MPAs on South African people and communities is limited (Table 8). Both positive and negative effects of MPAs on people have been documented, benefits include capacity building, employment opportunities, spill over of fish into adjacent exploited areas, ecosystem services and cultural and spiritual values. Overall, the authors highlighted that there is limited information to assess the effectiveness of MPAs in a socio-economic context. Some of their recommendations included to 'determine current and possible future social and economic effects, ensuring indicators are identified to test effectiveness', 'develop clear, carefully considered, and assessable ecological, socio-economic and governance objectives for each of South Africa's MPAs', 'identify and implement innovative opportunities to enhance tangible benefits associated with MPAs to build support for the MPA', 'identify and source baseline data to track MPA effectiveness in a socio-economic context and the achievement of objectives', among others (Mann-Lang et al., 2021, p. 381).

Information on the socio-economic impacts of climate change in South Africa is scarce in comparison to ecological information (Cochrane et al., 2020b, 2020a). The same is observed for Angola and Namibia. For South Africa, the limited evidence indicates that the observed impacts of climate change on fishing communities include increased wind intensity and speed, changes in wind direction and increased frequency of harmful algal blooms. These result in a lower number of days at sea and reduced safety at sea, but also on reduced catches and unavailability of fish to the fishers since fish move offshore as reported by small-scale fishers in St. Helena Bay during a rapid vulnerability assessment (Sowman et al., 2019). Shorter fishing seasons and changes on the start time of the fishery were also reported (Sowman et al., 2020a), resulting in lower income or lack of a food source for small-scale fishers. Unavailability of fish due to environmental changes such as temperature has also been reported by the small pelagics fishery, with the associated increase in fishing costs (Cochrane et al., 2020b, 2020a). Other predicted social impacts of climate change in South Africa include mismatch of Territorial Use Rights for Fishing and species distribution, increase in unemployment and compliance issues, damage to coastal infrastructure and changes in food security, nutritional content of species and food supply (van der Lingen and Hampton, 2018; Cochrane et al., 2020b, 2020a; Ortega-Cisneros et al., 2021). The adaptation options developed by small-scale fishers include training, access to loans, development of co-ops and diversification of livelihoods (Table 8). In this regard, MPAs can benefit communities through capacity building, increased employment opportunities and fish abundance

Table 5. List of key South African fishery species (commercial and recreational) linked to MPAs, with possible adaptation and mitigation options. Names highlighted in bold indicate that species is endemic to South Africa. Information on distribution was gathered from previous studies (i.e. Mann, 2013, Ortega-Cisneros et al., 2018 and references therein). See section 2.3 for an explanation of the likely sensitivity to climate change and likely change due to climate. The background colour indicates the data quality score, provided as a measure of uncertainty in the estimates. Red= no data, Orange = expert opinion, Yellow = limited data and Green= adequate data.

Distribution	**Fishery species**	**Likely sensitivity to climate change**	**Likely change due to climate**	**Possible MPA adaptation**	**Other mitigation suggested**	**Further discussions required with multi-stakeholders and approaches – e.g.MPA managers, Government Fisheries agency; all regulations and permit conditions.**
southern Angola to KwaZulu-Natal on the east coast of South Africa	Shallow-water hake *Merluccius capensis*	Low	Neutral	Agulhas mud and Agulhas Bank Complex MPAs aim to protect habitats previously disturbed by trawling and oil exploration. Agulhas Mud MPA also supports the hake fishery eco-certification	Continue hake management through Operational Management procedures. Strengthen cooperative management of deep-water hake with Namibia	
Cape Frio, Namibia, to Agulhas Bank, and eastwards to East London, South Africa	Deep-water hake *Merluccius paradoxus*	Medium-low				
Bergen, Norway, to East London, South Africa	Anchovy *Engraulis encrasicolus*	Medium-low	Negative (Raybaud et al., 2017; Ortega-Cisneros et al., 2018a; Cochrane et al.,	Continue the experimental closure to purse-seine fishing around	Continue the joint Operational Management Procedure for anchovy and	

			2020b)	penguin breeding grounds to increase the availability of fish within a suitable foraging range of the penguins	sardine, keeping risk to acceptable levels and integrating ecosystem considerations	
Indo-Pacific: southern Africa to eastern Pacific	Sardine *Sardinops sagax*	Low	Negative (Cochrane et al., 2020b)	Continue spatial management for directed sardine Total allowable catch, with a maximum % of directed TAC to be caught west of 20°E		
Angola, South Africa	Chokka squid *Loligo reynaudii*	Low	Neutral to Positive (Doubleday et al., 2016)	Tsitsikamma MPA and other local reserves protect some of the spawning area	Closed season during the spawning season	Further protection of spawning area through temporal dynamic MPAs as one management tool
Orange River Mouth to KwaZulu-Natal	**White steenbras** *Lithognathus lithognathus*	High	Negative (threatened, estuarine-dependent phase and endemic)	MPAs and Estuarine Protected areas (EPAs) considered a very important methods to protect this species (Bennett, 2012)	Improved monitoring, surveillance and enforcement of management actions (Bennett, 2012)	Additional protection of estuarine and nearshore habitat for this species along its distribution range (Bennett, 2012)
St Helena Bay to Port St Johns, South Africa	**Abalone** *Haliotis midae*	High	Negative (heavily depleted, additional stressors	Improve abalone restocking programs, Stronger focus on	Expand ranching operations. Improve	Enhance Monitoring, Surveillance and Compliance within MPAs

			as illegal fishing and overfishing)	reducing illegal fishing.	monitoring, surveillance and compliance.	
East London to north of Walvis Bay, Namibia	West coast Rock lobster *Jasus lalandii*	Medium-high	Negative (Depleted to heavily depleted, Strong correlation with environmental variables, climate-driven distribution shifts)	Stronger focus on reducing illegal fishing	Improve monitoring, surveillance and compliance	
Yyzerfontein (90 km north of Cape Town, west coast) to Transkei (east coast)	**Panga** *Pterogymnus laniarius*	Medium-low	Neutral (No known correlation with environmental variables, however, it is an endemic species)	Protection of its habitat (deep, low and high profile reefs) and nursey area on the Central Agulhas Bank	Conduct a stock assessment for this species and determine stock status.	
Namibia to KwaZulu-Natal	St Joseph *Callorhinchus capensis*	High	Negative (no additional stressors, summer breeding season, endemic)	Stronger focus on IUU fishing (Shark Expert Panel, 2020).	Improved monitoring, surveillance and enforcement of compliance (Shark Expert Panel, 2020).	Conserve critical habitats for feeding or reproduction of sharks. Align fishing and tourism regulations and discuss the use of MPAs to prevent and reduce conflict between shark fisheries and ecotourism operators (Shark Expert Panel, 2020).
Globally distributed in temperate waters. In SA, from East London to at least northern Namibia	Soupfin shark *Galeorhinus galeus*	High	Negative (depleted stock status and pupping season in austral spring)			

Cape Agulhas, Western Cape, to St Lucia, KwaZulu-Natal	**Black musselcracker** *Cymatoceps nasutus*	Medium-high	Negative (Spawning takes place between May–Oct in Transkei waters but highly resident and vulnerable status)	Improve protection of reefs (suitable habitat) on the south west coast since evidence suggests there is a disjunct adult population (Murray et al., 2014, 2019)	Increase Monitoring, Control and Surveillance on the Wildcoast, particularly Mdumbi area. Further studies on adult movement (Murray et al., 2019)	A well-designed no take MPA network (Murray et al., 2019) is proposed and requires discussion on future protection for this species.
from Namibia to Port St Johns, SA, but very rare on the west coast.	**Red roman** *Chrysoblephus laticeps*	Medium-low	Neutral (near threatened, endemic but weak correlation with environmental variable)	No take MPAs considered very effective in protecting this species (Götz and Kerwath, 2013 and references therein)	Improve monitoring, surveillance and compliance of management actions (size and bag limits) (Götz and Kerwath, 2013)	Model-based predictions of red roman' distribution suggest that its habitat is likely to persist until 2100 with a slight contraction at the western and eastern edges (Duncan et al., 2020)
Cape Point in Western Cape to Thukela River in KwaZulu-Natal	White musselcracker *Sparodon durbanensis*	Medium-low	Neutral (near threatened, endemic, spawning migration but weak correlation with environmental variable)	Extremely important trophy fish for recreational and spearfishery. Size limit and closed season have been suggested as management actions for this species (Potts and Mann, 2013).	-	No take MPAs covering the near-shore environment are suggested to be suitable for this species (Potts and Mann, 2013). This needs to be discussed with all stakeholders and approaches
In SA, from Cape Point, to southern Mozambique.	Dusky kob *Argyrosomus japonicus*	Medium-low	Negative (collapsed, juvenile estuarine-	Improve management status of estuarine habitats	Improved monitoring, surveillance and	Additional protection of estuarine and nearshore habitat for this species along

Most abundant from Cape Agulhas to northern KwaZulu-Natal			dependent, resident, spawning migration)	in terms of pollution and freshwater inflow	enforcement of compliance of management actions (bag and size limits)	its distribution range (Childs, 2013).
Evidenc	Geelbek *Atractoscion aequidens*	Medium-low	Negative (collapsed, spawning migration)	Reduction in fishing effort, i.e. important target of the commercial and recreational linefishery, and bycatch of the inshore demersal trawl fishery (Attwood et al., 2011)	Accounting for linefish dependency on small pelagics fisheries management, strong geelbek–sardine interaction, sardine biomass EoCA as a strong predictor of geelbek CPUE on the southwest coast (Parker et al., 2020)	Migratory species, however, spatial or temporal closures of spawning grounds may benefit the species (Kerwath and Winker, 2013).
southern Mozambique to Struisbaai, South Africa	**Bronze bream** *Pachymetopon grande*	Medium-low	Negative (highly resident, Summer spawner, temperature will influence onset of spawning)	Reduction in fishing effort i.e. Important target on the recreational shore-based fishery and spearfishery (Mwale and Cowley, 2013)	MPAs considered one of the most effective methods to protect bronze bream (Buxton and Clarke, 1992; Cowley et al., 2002)	Suitable network of MPAs along the distribution of endemic SA species like bronze bream (Mwale and Cowley, 2013)
West coast of Africa to southern Mozambique	Leervis *Lichia amia*	High	Negative (collapsed, estuarine-dependent)	Reduction in fishing effort. i.e. recreational trophy fish, specially during winter and spring	Improved monitoring, surveillance and enforcement of compliance of	Additional protection of estuarine habitats can provide protection for juveniles (Smith, 2008)

				season (spawning) in KZN (Mann and Potts, 2013)	management actions (Smith, 2008)	
Global, particularly in temperate waters	Common octopus *Octopus vulgaris*	Medium-low	Positive	Experimental fishery. Protected in no take MPAs	-	Needs to be discussed – there has bene a suggestion to close whale's feeding grounds to octopus fishing since it has been reported to negatively impact whales due to entanglement.
Endemic to southern Africa from northern Namibia to southern Transkei	Silver Kob *Argyrosomus inodorus*	Medium-low	Neutral (but near threatened, endemic)	Important target of the commercial skiboat fishery. Bycatch of inshore trawlers in the Southeast coast. Higher monitoring and enforcement for the trawl and recreational fisheries (Donovan, 2010)	Legislation changes and reduction in commercial effort has resulted in increased Catch per Unit Effort (CPUE) after 2002	No evidence of MPA effectiveness for this species since most coastal MPAs do not cover its offshore distribution (Donovan and Kerwath, 2013).
Endemic, False Bay to St. Lucia	Red Steenbras *Petrus rupestris*	High	Negative (collapsed, although species has affinity for warmer KZN waters)	Improve enforcement of management actions. Moratorium on catches set in November 2012 (Mann and Kerwath, 2013).	-	Tsitsikamma and De Hoop MPAs offered protection to juvenile steenbras. Pondoland, Dwesa-Cwebe and Amathole MPAs provide protection for adults (Mann and Kerwath, 2013), as well, as the new network of offshore MPAs off the Agulhas Bank.

Endemic to SA: Found from KZN to Cape Point, rarely caught in KZN but has been found in Richards Bay	**Dageraad** *Chrysoblephus cristiceps*	Medium-low	Negative (critically endangered, resident and endemic)	Effort reduction. Minimum size limit 40 cm TL, 1 pppd for commercial and recreational bag limit imposed in April 2005 (Donovan 2010)	Improved monitoring and enforcement of compliance of management actions implemented in 2005 (Buxton and Mann, 2013)	Tsitsikamma, De Hoop, and MPAs off East London and Transkei protect a portion of the stock (Buxton and Mann, 2013 and references therein).
Endemic, Cape Point to East London	Red stumpnose *Chrysoblephus gibbiceps*	Medium-low	Negative (but overexploited, resident and endemic)	Effort reduction. 1 pppd for subsistence and recreational bag limit (Wilke and van Zyl, 2013)	Stock assessment studies for this species considered a high research priority (Wilke and van Zyl, 2013)	De Hoop and Tsitsikamma provide protection for this species (Wilke and van Zyl, 2013 and references therein)
Circumglobal. along the whole SA coast but rarely Cape Point and northern Namibia but not in Saldanha Bay	Elf/shad *Pomatomus saltatrix*	Moderate	Neutral (but overexploited)	Re-evaluate closed season keeping in mind the migratory nature of the species (Maggs and Mann, 2013).	Improved monitoring and enforcement of compliance of management actions (Maggs and Mann, 2013).	Migratory species, but evidence from Langebaan and De Hoop MPAs suggest MPAs can provide protection for this species (Maggs and Mann, 2013).
Southern Angola to southern Mozambique (two disjoint populations)	Blacktail *Diplodus capensis*	Medium-high	Neutral (but resident and endemic to southern Africa)	Current management actions (incl. no take MPAs) seem to be adequate sustaining the population (Mann and Dunlop, 2013).	Improve monitoring of catch and effort in the shore fishery (Mann and Dunlop, 2013).	No take MPAs (with inshore habitats) along the south and east coast of SA protect blacktail due to its resident nature (Mann and Dunlop, 2013 and references therein).
Mediterranean Sea, eastern	Smoothhound shark	Medium-low	Neutral (but resident)	Implement maximum size	Determine fishery-independent	Offshore MPAs were suggested as a management

Atlantic and southwest Indian Ocean. Found along the entire South African coast south of Durban, to Namibia	*Mustelus mustelus*			restrictions and area closures (da Silva and McCord, 2013)	biomass, stock identity and habitat use (da Silva and McCord, 2013)	action to protect this species (da Silva and McCord, 2013). The new offshore MPAs are likely to provide protection for this species.
Global, warm temperate to subtropical areas	Bronze whaler *Carcharhinus brachyurus*	Medium-low	Neutral (but present in subtropical and tropical areas)	Highly vulnerable to fishing pressure. Monitor and managed the population as an 'isolated" population based on female dispersal studies (Wintner and Dudley, 2013)	Improve species identification in the collection of catch data (Wintner and Dudley, 2013)	Limited information on MPA effectiveness, MPAs situated in parturition areas likely to protect juveniles (Wintner and Dudley, 2013).
Endemic to southern Africa, from central Transkei region of South Africa to southern Angola, but excluding west coast of South Africa	**Spotted gully shark** *Triakis megalopterus*	Medium-high	Negative (threatened, resident and endemic)	Highly vulnerable to overfishing. Precautionary management is recommended (Smale and da Silva, 2013)	Improved species identification in the collection of catch data. This species is confused with *Mustelus* spp, which are a commercial target (Smale and da Silva, 2013).	No take MPAs with suitable inshore reef habitats provide protection to this species due to its resident nature (Smale and da Silva, 2013)
Angola to northern KZN	Blue stingray *Dasyatis*	Medium-low	Neutral	Late maturity and low fecundity make	Discard of inshore trawlers (Smale	Protected in a number of no-take MPAs on the east coast

	chrysonota			this species vulnerable to overexplotation, precautionary management was advised (Ebert and Cowley 2009)	2009)	of SA
North Sea to SA, also off Kenya	Eagle ray *Myliobatis aquila*	Low	Neutral	Monitor bycatch in trawl and beach seine fisheries (WC) (Dunlop and Mann, 2013)	-	Little evidence of MPA protection for this species in the literature (Dunlop and Mann, 2013)
Indo-Pacific	Blacktip reef shark *Carcharhinus limbatus*	Low	Neutral to positive (warm-temperature, subtropical and tropical waters)	Highly vulnerable to overexplotation and other additional stressors since it inhabits inshore areas as juvenile and adult.	-	Protection for this species in Aliwal shoal MPA and other MPAs in the eastern side of SA.
Distributed in the Atlantic Ocean: Africa, Europe and South America	Brown mussel *Perna perna*	Medium-low	Neutral	Overexploited on the southeast coast of South Africa (Macala and McQuaid, 2017)	Improved monitoring and enforcement of compliance of management actions	-
from Namibia to the vicinity of Cape Agulhas, South Africa	Seaweeds *Ecklonia maxima*, *Laminaria pallida*, others	Medium-low	Neutral to negative (*Ecklonia maxima* show very poor growth at temperatures of 22.5 °C or higher)	Improve protection of kelp forests along the South African coast	-	-

Table 6. List of key Namibian fishery species (commercial and recreational) that are linked to the conservation in MPAs, with possible adaptation and mitigation options. See section 2.3 for an explanation of the likely sensitivity to climate change and likely change due to climate. The background colour indicates the data quality score, provided as a measure of uncertainty in the estimates. Red= no data, Orange = expert opinion, Yellow = limited data and Green= adequate data.

Distribution	**Fishery species**	**Likely sensitivity to climate change**	**Likely change due to climate**	**Possible MPA adaptation**	**Other mitigation suggested**	**Further discussions required with multi stakeholders and approaches – e.g.MPA managers, Government Fisheries agency; all regulations and permit conditions.**
southern Angola to KwaZulu-Natal on the east coast of South Africa	Shallow-water hake *Merluccius capensis*	Low	Neutral	-	Continued management as per the Marine Resources Act of 2000	*Further protection of habitats disturbed by trawling and other activities like mining, petroleum industry*. Discussion of stakeholders required.
Cape Frio, Namibia, to Agulhas Bank, and eastwards to East London, South Africa	Deep-water hake *Merluccius paradoxus*	Medium-low	Neutral	-		

East London to north of Walvis Bay, Namibia	Rock Lobster *Jasus lalandii*	High	Negative as depth distribution of rock lobster varies seasonally in response to dissolved oxygen concentrations at the bottom	MPA implementation included the protection of Rock Lobster	Continued management as per the Marine Resources Act of 2000	Further protection of area that may be impacted by deep sea mining as rock lobster feed mainly in the rocky subtidal zone
Found in Namibia, Angola, and South Africa. Namibia has about 60% of the population on twenty–six colonies along the coastline	Cape fur seals *Arctocephalus pusillus pusillus*	Low	Neutral	MPA implementation included the protection of some seals colonies	Continued management as per the Marine Resources Act of 2000	-
Indo-Pacific: southern Africa to eastern Pacific	Sardine *Sardinops sagax*	High	Negative (Cochrane et al., 2020b)	-	Continued management as per the Marine Resources Act of 2000	Protection of the Spawning areas
From around Tomboa in Southern Angola and throughout Namibia (Krakstad 2001)	Horse Mackerel *Trachurus capensis*	Low	Negative	-	Continued management as per the Marine Resources Act of 2000	Protection of the nursery areas that are found further south around 24°S60
From Cape Frio up to the Kei	Silver kob *Argyrosomus*	Medium	Negative as of Silver kob in	MPA implemented for the protection of	Continued management as per the Marine	

River on the east coast of South Africa (Griffiths and Heemstra, 1995)	*inodorus*		catches declines in northern Namibia, where water temperatures are higher, and the species is not known to occur in Angola (Griffiths and Heemstra, 1995	fish species including silver Kob	Resources Act of 2000	
Co-occuring with silver kop off Namibia (Holtzhausen, et.al 2001)	Dusky kob *A. japonicus*	Medium	Neutral	MPA implemented for the protection of fish species including dusky kob	Continued management as per the Marine Resources Act of 2000	Protection of nursery are a
Rio Longa, in Angola, to Cape Town, South Africa (Man et. Al 2014)	West Coast steenbras *Lithognathus aureti*	High	Negative IUCN red listed threatened species	-	Continued management as per the Marine Resources Act of 2000	Spawning and Sanctuary area protection.
Southern Africa coast and most abundant species caught by rock-and-surf anglers along the Namibian coast (Penrith and Loutit 1982)	Galjoen *Dichistius capensis*	High	Negative	-	Continued management as per the Marine Resources Act of 2000	Spawning and Sanctuary area protection.

Southern Angola to southern Mozambique (two disjoint populations)	Blacktail *Diplodus sargus*	High	Negative	Management actions implemented in SA, including MPAs seem to be adequate sustaining the population (Mann and Dunlop, 2013).	Continued management as per the Marine Resources Act of 2000	Spawning and Sanctuary area protection.
The distribution of *L. vomerinus* extends from northern Namibia (21°S) to Durban, South Africa (Leslie 1990)	Monkfish (*Lophius spp*.)	Low	Neutral	-	Continued management as per the Marine Resources Act of 2000	-
Entire Benguela coast, where it occurs intertidally (Hockey & Schurink, 1992)	Mediterranean mussel *Mytilus galloprovincialis*	Low	Neutral	Invasive species in many parts of the world	Continued management as per the Marine Resources Act of 2000	-
West coast of Southern Africa (Branch et al. (2016)	Black mussel *Choromytilus meridionalis*	Low	Neutral	-		-
West and East coast of southern Africa (Branch et al. (2016)	Brown mussel *Perna perna*	Medium-low	Neutral	-		-

Table 7. List of key fishery species (commercial and recreational) from Angola that are linked to protection in future MPAs, with possible adaptation and mitigation options. Names highlighted in bold indicate that species is endemic. Note not all estuarine targeted species are shown here and should be considered as information becomes available; also some marine mammals have been included here due to high sensitivity with mining operations. See section 2.3 for an explanation of the likely sensitivity to climate change and likely change due to climate. The background colour indicates the data quality score, provided as a measure of uncertainty in the estimates. Red= no data, Orange = expert opinion, Yellow = limited data and Green= adequate data.

Distribution	**Species**	**Likely sensitivity to climate change**	**Likely change due to climate**	**Possible MPA adaptation**	**Other mitigation suggested**	**Further discussions required with multi stakeholders and approaches – e.g.MPA managers, Government Fisheries agency; all regulations and permit conditions.**
West Atlantic along coastline Namibe, Angola	West African geryon *Chaceon maritae*	High	Negative (Vulnerable)	Implement MPA to protect species from habitat destruction, pollution, climate change, oil spills and ingestion of marine debris such as micro plastics	Improve monitoring, surveillance and enforcement of management actions	Improve MPA resilience

Distribution	**Species**	**Likely sensitivity to climate change**	**Likely change due to climate**	**Possible MPA adaptation**	**Other mitigation suggested**	**Further discussions required with multi stakeholders and approaches – e.g.MPA managers, Government Fisheries agency; all regulations and permit conditions.**
All Eastern Atlantic along coastline Angola	West coast Spiny lobster *Palinurus gilchristi*	Medium-high	Negative (Depleted to heavily depleted, Strong correlation with environmental variables, climate-driven distribution shifts)	Stronger focus on reducing illegal fishing. Implement MPA to protect species from habitat destruction, pollution, climate change, oil spills and ingestion of marine debris such as micro plastics	Improve monitoring, surveillance	Improve MPA resilience
All Eastern Atlantic along coastline Senegal to Angola	Red squat lobster *Scyllarides herklotsii*	Medium	Negative (Depleted to heavily depleted, Strong correlation with environmental variables, climate-driven distribution shifts)	Implement MPA to protect species from habitat destruction, pollution, climate change, oil spills and ingestion of marine debris such as micro plastics marine debris such as micro plastics	Improve monitoring, surveillance	Improve MPA resilience

Distribution	**Species**	**Likely sensitivity to climate change**	**Likely change due to climate**	**Possible** **MPA adaptation**	**Other mitigation suggested**	**Further discussions required with multi stakeholders and approaches – e.g.MPA managers, Government Fisheries agency; all regulations and permit conditions.**
All Eastern Atlantic along coastline Angola from	Blue shark *Prionacea glauca*	High	Negative	Implement MPA to protect species and habitat from habitat destruction, pollution, climate change, oil spills and ingestion of marine debris such as micro plastics (Couturier et al. 2012). Stronger focus on illegal, unregulated and unreported fishing	-	Increase connectivity and reduce other stressors, or other methods (i.e. dynamic MPAs).
All Eastern Atlantic along coastline Angola from	Shortfin mako shark *Isurus oxyrinchus*	-	Negative *Vulnerable*	Implement MPA to protect species and habitat from habitat destruction. Stronger focus on illegal, unregulated and unreported fishing	Improve monitoring, surveillance and enforcement of management actions	Increase connectivity and reduce other stressors, or other methods (i.e. dynamic MPAs).
All Eastern Atlantic along	Oceanic whitetip shark	-	Negative *Vulnerable*	Implement MPA to protect species and habitat from habitat destruction.	Improve monitoring, surveillance and enforcement of	Increase connectivity and reduce other stressors, or other

Distribution	**Species**	**Likely sensitivity to climate change**	**Likely change due to climate**	**Possible MPA adaptation**	**Other mitigation suggested**	**Further discussions required with multi stakeholders and approaches – e.g.MPA managers, Government Fisheries agency; all regulations and permit conditions.**
coastline Angola from	*Carcharhinus longimanus*			Stronger focus on illegal, unregulated and unreported fishing	management actions	methods (i.e. dynamic MPAs).
All Eastern Atlantic along coastline Angola from Cabinda to Namibe	Chilean devil ray *Mobula tarapacana*	High	Negative (Vulnerable)	Implement MPA to protect species and habitat from habitat destruction. Stronger focus on illegal, unregulated and unreported fishing	Improve monitoring, surveillance and enforcement of management actions	Increase connectivity and reduce other stressors, or other methods (i.e. dynamic MPAs).
All Eastern Atlantic along coastline Angola from Cabinda to Namibe	Devil fish *Mobula mobular*	High	Positive (Endangered)	Stronger focus on illegal, unregulated and unreported fishing	Improve monitoring, surveillance and enforcement of management actions	Increase connectivity and reduce other stressors, or other methods (i.e. dynamic MPAs).
All Eastern Atlantic along coastline Angola from	Lesser Guinean devil ray *Mobula rochebrunei*	High	Positive (Vulnerable)	Stronger focus on illegal, unregulated and unreported fishing	Improve monitoring, surveillance and enforcement of management actions	Increase connectivity and reduce other stressors, or other methods (i.e.

Distribution	**Species**	**Likely sensitivity to climate change**	**Likely change due to climate**	**Possible MPA adaptation**	**Other mitigation suggested**	**Further discussions required with multi stakeholders and approaches – e.g.MPA managers, Government Fisheries agency; all regulations and permit conditions.**
Cabinda to Namibe						dynamic MPAs).
Globally distributed in temperate waters and Namibe	Copper shark *Carcharhinus brachyurus*	High	Negative (threatened)	Stronger focus on illegal, unregulated and unreported fishing	Improved monitoring, surveillance and enforcement of management actions	Additional protection of estuarine and nearshore habitat for this species along its distribution range.
Globally distributed in temperate waters and Namibe	Western angelshark *Squatina ocelatta*	High	Positive (no for biological data and water temperature vulnerability)	Stronger focus on illegal, unregulated and unreported fishing	Improved monitoring, surveillance and enforcement of compliance	Conserve critical habitats for feeding or reproduction of sharks. Align fishing and tourism regulations and use MPAs to prevent and reduce illegal fishing
Globally distributed in temperate waters and Namibe	Tope shark *Galeorhinus galeus*	High	Negative (depleted stock status and pupping season in austral spring)			

Distribution	**Species**	**Likely sensitivity to climate change**	**Likely change due to climate**	**Possible MPA adaptation**	**Other mitigation suggested**	**Further discussions required with multi stakeholders and approaches – e.g.MPA managers, Government Fisheries agency; all regulations and permit conditions.**
Mauritania to Namibia	Scalloped hammerhead *Sphyrna lewini*	High	Negative (depleted stock status and pupping season in austral spring)	Stronger focus on reducing illegal fishing.	Improve monitoring, surveillance and compliance.	Surveillance and Compliance within MPA's
Mauritania and the Canary Islands to Angola	Canary tonguesole *Cynoglossus canariensis*	High	Neutral (shows habitat specificity)	Implement an MPA dedicated to protect the mud habitats that this species inhabits	Need dedicated assessment for the species	MPA to protect other important grounds
Mainly Central Atlantic (from France to Angola)	Solea *Solea senegalensis*	Moderate to high	Neutral (shows habitat specificity)	Implement an MPA dedicated to protect the mud habitats that this species inhabits	Conduct a stock assessment for this species and determine stock status	MPA to protect other important grounds
Southern Atlantic Angola to Namibia (Benguela Current)	Dusky kob *Argyrosomus coronus*	Medium-low	Negative (Near Threatened, endemic, resident, warm-temperate waters, summer and autumn spawning)	Reduction in fishing effort	Monitoring and assessment for species An increase in fishing effort suggest that management interventions are required such as bag	Surveillance and Compliance within planned MPA's. Protection of estuarine and nearshore habitat for this species

Distribution	Species	Likely sensitivity to climate change	Likely change due to climate	Possible MPA adaptation	Other mitigation suggested	Further discussions required with multi stakeholders and approaches – e.g.MPA managers, Government Fisheries agency; all regulations and permit conditions.
					and size limits	(Particularly the Kunene region) along its distribution range.
Southern Angola to KwaZulu-Natal on the east coast of South Africa	Shallow-water hake *Merlucius capensis*	Low	Neutral	Implement an MPA to protect habitats previously disturbed by trawling and oil exploration.	-	Further protection of habitats disturbed by trawling and other activities like mining, petroleum industry
West coast of Africa to southern Mozambique	Leervis *Lichia amia*	NA	Negative (collapsed, estuarine-dependent)	Reduction in fishing effort. i.e. recreational trophy fish, especially during winter and spring season (spawning) in (Estuaries Kwanza and Cunene)	Improved monitoring, surveillance and enforcement of compliance of management actions (Smith, 2008)	Additional protection of estuarine habitats can provide protection for juveniles (Smith, 2008) Protection within the range of the species in the south of

Distribution	Species	Likely sensitivity to climate change	Likely change due to climate	Possible MPA adaptation	Other mitigation suggested	Further discussions required with multi stakeholders and approaches – e.g.MPA managers, Government Fisheries agency; all regulations and permit conditions.
						Angola – planned Iona National Park marine section will be very important.
Bergen, Norway, Angola, to East London, South Africa	Anchovy *Engraulis capensis*	Medium-low	Negative (Cochrane et al., 2020; Ortega-Cisneros et al., 2018; Raybaud et al., 2017)	-	Improved monitoring, surveillance and enforcement of compliance of management actions (Smith, 2008)	Consider some offshore areas for protection.
Indo-Pacific: southern Africa to eastern Pacific	Sardine/Pilchard *Sardinops sagax*	Low	Negative (Cochrane et al., 2020)	Reduction in fishing effort from industrial and semi-industrial fisheries.		
All Atlantic, Angola coast	Humpback whale	Medium	Negative	Adopt measures to reduce the impact of vessel routes,	Monitor population	Further protection of habitats disturbed by

Distribution	**Species**	**Likely sensitivity to climate change**	**Likely change due to climate**	**Possible** **MPA adaptation**	**Other mitigation suggested**	**Further discussions required with multi stakeholders and approaches – e.g.MPA managers, Government Fisheries agency; all regulations and permit conditions.**
	Megaptera novaeangliae			fishing nets		fisheries and other activities like mining, petroleum industry Increase connectivity and reduce other stressors, or other methods (i.e. dynamic MPAs).
All Atlantic, Angola Coast	False killer whale *Pseudorca crassidens*	Medium	Negative	Adopt measures to reduce the impact of vessel routes, fishing nets	Monitor population	Further protection of habitats disturbed by fisheries and other activities like mining, petroleum industry Protect climate refugia Increase connectivity and reduce other stressors, or other methods (i.e.

Distribution	**Species**	**Likely sensitivity to climate change**	**Likely change due to climate**	**Possible** **MPA adaptation**	**Other mitigation suggested**	**Further discussions required with multi stakeholders and approaches – e.g.MPA managers, Government Fisheries agency; all regulations and permit conditions.**
						dynamic MPAs).
All Atlantic, Angola Coast	Atlantic humpbacked dolphin *Sousa teuszii*	Medium	Negative (endangered)	Adopt measures to reduce the impact of vessel routes, fishing nets	Monitor population	Further protection of habitats disturbed by fisheries and other activities like mining, petroleum industry Protect climate refugia Increase connectivity and reduce other stressors, or other methods (i.e. dynamic MPAs).
Senegal south to Angola, including Cape Verde Islands, São Tomé and Principe. In	Giant African threadfin *Polydactylus quadrifilis*	Low	Neutral (not overfished-Bédia et al.2020)	Intensive recreational fishing specifically targeting this species (Kirkman and Nsingi, 2019; Butler et al.2020). Increase connectivity and reduce	Management measures for recreational fishers, no retention of threadfin allowed.	Protection of some of the key distribution areas. Many species use the Kwanza estuary as a breeding area or as

Distribution	Species	Likely sensitivity to climate change	Likely change due to climate	Possible MPA adaptation	Other mitigation suggested	Further discussions required with multi stakeholders and approaches – e.g.MPA managers, Government Fisheries agency; all regulations and permit conditions.
Angola at the mouth of the rivers Kwanza, Keve and Cunene.				other stressors.		refugia. Illegal fishing occurs in the area using nets at the entrance of the river mouth.
West Atlantic and East Atlantic from Ireland and western France south to Angola, including Azores, Madeira and São Tomé and Principe. Also introduced in the Eastern Pacific. In Angola at the mouth of the rivers Kwanza, Keve and Cunene.	Atlantic Tarpon *Megalops atlanticus*	Low	Neutral to Positive (threatened species)	Intensive recreational fishing specifically targeting this species (Kirkman and Nsingi, 2019; Butler et al. 2020).	Habitat loss and degradation are threats to Flat species like the tarpon. Thus, research that addresses habitat and spatial components are essential to inform conservation. Spatial management, whereby important habitats are protected, is arguably the best conservation approach (Adams et al. 2019).	Data that address abiotic factors such as habitat coverage (e.g. mangroves) or water quality are required for environmental monitoring of this species (Adams et al. 2019). Protection of key habitats. Increase connectivity and reduce other stressors. Many species use these estuaries as a breeding area or as

Distribution	Species	Likely sensitivity to climate change	Likely change due to climate	Possible MPA adaptation	Other mitigation suggested	Further discussions required with multi stakeholders and approaches – e.g.MPA managers, Government Fisheries agency; all regulations and permit conditions.
						refugia. Illegal fishing occurs in the area using nets at the entrance of the river mouth.
Circumglobal. In Angola at the mouth of the rivers Kwanza, Keve and Cunene.	Shad *Pomatomus saltatrix*	Low	Neutral to Positive (vulnerable species)	Intensive recreational fishing targets this species (Kirkman and Nsingi, 2019; Potts et al. 2009).	–	Increase connectivity and reduce other stressors. Many species use this estuary as a breeding area or as refugia. Illegal fishing occurs in the area using nets at the entrance of the river mouth.
Angola South coastline	Oyster *Ostrea* spp	Low	Neutral	-	Improve monitoring, surveillance and enforcement of management actions	-
Namibe coastline	Mussel *Mytilus mytilus*	Medium-low	Neutral			

Distribution	Species	Likely sensitivity to climate change	Likely change due to climate	Possible MPA adaptation	Other mitigation suggested	Further discussions required with multi stakeholders and approaches – e.g.MPA managers, Government Fisheries agency; all regulations and permit conditions.
All Angolan coast	Coral *Eunicella* sp	High	Negative	Sustaining and restoring coral reefs. Long-term investments could be made for their preservation	-	Protection of corals through implementing new MPAs including offshore ones to protect deep-sea corals since destructive human impact offers no sustainable protection against global change-induced threats.
All Angolan coast	Leptogorgia (Gorgonia, Sea Fan)	High	Negative			
Namibe coastline	Deep-sea coral *Lophelia pertusa*	High	Negative	Expected deoxygenation of 2% along the Atlantic continental margins until 2100 (Sweetman et al. 2017) by itself might not exert a serious threat to *L. pertusa*, except for already hypoxic settings like the Angolan margin		

adjacent to the MPA. However, this will not be possible if MPAs are not managed in a collaborative and inclusive manner involving all relevant stakeholders (including local communities) to develop solutions, determine socio-economic impacts of MPAs, obtain community support and improve management effectiveness (Mann-Lang et al., 2021).

Climate change may also have effects beyond the environment and communities within or surrounding the boundaries of the MPAs of the BCLME region. This includes changes in the status of the MPA and their effectiveness as the aims and objectives will likely be obsolete in the future if adaptive management is not considered. Each MPA has been scored against its current objectives and the forecasted impacts of climate change in communities within and/or surrounding the MPA. The majority of the MPAs of the BCC region have not been designed or created to meet socio-economic objectives; thus, assessing the impacts of climate change in the MPA effectiveness is currently not possible. Although baseline information is available for some MPAs, the majority have been scored as 1 (medium change) due to the lack of socio-economic objectives.

Table 8. List of predicted impacts of climate change in communities within/surrounding MPAs in the BCC region. Mitigation and adaptation measures that are recommend to support resilience of people and activities are also provided. Scoring on the status change of MPA effectiveness under the effects of climate change is also provided. Here, scoring is available only for MPAs with available baseline information.

Description of the impact	**Location**	**Name of nearby MPA/ reserve/ or other**	**Mitigation measures**	**Adaptation measures**	**Source**	**MPA effectiveness and CC** **Scoring**
Angola						
Movement of key marine species out of the area of Namibe/Tombwa	Southern Angola from Namibian border (Kunene)	Proposed Iona Park marine section	Transboundary protection of species moving into Namibian waters	Possible aquaculture opportunities for fishing communities of Namibe and Tombwa	Potts et al., 2013, 2014	–
Change in salinity, temperature and deoxygenation. Shifts in the Angola-Benguela front possibly influence the distribution of sardine			Strengthen management of small pelagic species and others of artisanal and commercial importance	Ensure greater awareness on climate change and improve information sharing/communication Need to set a total allowable catch/quota for the artisanal fisheries sector Need to diversify and target other fish species	Van der Lingen and Hampton, 2018, Cochrane et al, 2020a,b	-
Namibia						

Temperature, dissolved Oxygen and sea current regime can have negative impacts on resource abundance and availability	Luderitz	NIMPA	MPA implementation included the protection of Rock Lobster	-	Iitembu et.al 2021.	1
Shifts in the Angola-Benguela front possibly influence the distribution of sardine and can result in reduced fishing days.	Angola-Benguela front	NIMPA	Continuation of the moratorium	-	Kainge et.al, 2020.	2
Reduced coastal upwelling intensity could have disastrous effects on established fisheries. Valuable commercial stocks are likely to be reduced permanently.		NIMPA	Continued management of the resources as per Marine Resources Act 2000	-	Reid et.al., 2008.	1
More frequent and severe Benguela El Niño events would cause rapid population fluctuations, lowering productivity, reducing safe levels of exploitation and	Northern Benguela		Continued management of the resources as per Marine Resources Act 2000	-	Reid et al., 2008.	1

increasing the risk of collapse.						
South Africa						
• Weather unpredictable • Rough seas linked to increasingly strong winds • Drop in water temperature • Variability in geelbek abundance • Easterly wind makes water cold reducing chokka catch as chokka prey less mobile • Change in summer winds since 2015	Humansdorp	Tsitsikamma MPA	• Increased government support • Establish effective communication channels between government and communities • Reduce conflicts with other sectors (i.e. mining) • Improve participatory processes and consultation	• Developing alternative livelihoods through accessing SSF rights • Developing the co-operative • Accessing funds to kick start business operations • Training to equip the co-op board and members with necessary skills • Developing and operating chokka and line-fish fisheries • Business plan for the co-op	Sowman et al., 2020c	1
• Change in weather conditions i.e. fogs, currents, winds and storms	Hondeklip Bay	Namaqua National Park		• Access alternative coastal resources such as kelp that are less weather dependent • Collecting oyster and abalone as a food source • Apply to DAFF for access to other coastal resources	Sowman et al., 2020b	1

				• Data collection of catches to assist with management especially for the new co-op • Training in financial management to learn how to cope through the year		
• Changes in winds resulting in fewer sea days and colder waters • Changes in seasons, currents, occurrence of algal blooms • Reduced catches and fish resources (i.e. crayfish) • Fish further offshore >20km • Increased operating costs • Reduced safety at sea	St. Helena Bay	Malgas Island, Marcus Island, Langebaan Lagoon and Sixteen Mile Beach		• Training and skills development to support small business development and marketing of products • Development of local products and increased access to markets for these products • Fisher-scientist knowledge exchange workshop where small-scale fishers and ocean, atmosphere and marine scientists can exchange knowledge on climate variability and change in the BCLME • Building capacity to establish and operate a co-operative	Sowman et al., 2019; Cochrane et al., 2020a,b	2
• Changing weather (winds, sea state, sea temperature and currents)	Struisbaai	De Mond nature reserve		• Make use of technology to manage fishing activity with unpredictable weather • Implement a cold-chain and quality control system and	Sowman et al., 2020a	2

● Unpredictable weather ● Shorter fishing season, also starting later ● Changing migration patterns of key species ● Safety at sea concerns				maximise on market opportunities and undervalued species ● Developing a local fisher association ● Attending a learnership ● Explore a preferential access area for local small-scale fishers ● Enhance fisher knowledge and input in national fishing regulations through fisher-scientist exchanges ● Revisit the use of chukkies for tourism opportunities i.e. fishing day trips ● Upgrade and repair Struisbaai harbour to manage sand build-up and allow for easier launching of vessels		

5 Stakeholder consultations

Due to budget and time constraints, selected experts were invited to provide feedback on a draft version of this report during the drafting stage (August to November 2021). These consultations were conducted by e-mail, and were restricted to stakeholders known to the consultancy as their personal information was available to them. Personal information on other relevant stakeholders was not available to the consultancy as it is protected by the Protection of Personal Information Act (POPIA Act). Hybrid workshops were organized by the BCC and took place in each BCLME country in May 2022. The feedback of stakeholders was incorporated into the present report. The BCC also emailed the document to a broad stakeholder group, changes and additions were made from comments received. The consultations with local stakeholders are the responsibility of the BCC and not of the consultancy as ethical clearance is needed to approach stakeholders. It was not possible within the scope of work to hold meetings with the communities bordering or participating in activities within the MPAs, but it is suggested that this is an essential component for future work. Before any definitive action is taken, meetings with the small-scale fishing communities, the industrial fishing sector and other relevant stakeholders (using this document to facilitate discussion) are necessary to discuss the way forward.

6 Discussion and concise recommendations

In all three BCC countries, namely Angola, Namibia and South Africa, the establishment of MPAs follows the static design incorporating connected networks. MPA design may influence differently on the biomass, catch and revenue of fishery species under the climate change scenario as species distributions shift to other areas. Ecosystem modelling has shown that dynamic single MPAs outperformed dynamic or static networks of MPAs. Different designs perform equitably on catch and revenue when no MPAs are implemented under climate change, suggesting that MPAs could be beneficial regardless of the design but dynamic MPAs may benefit specific species (Cashion et al., 2020). Considering species interactions (e.g. predator-prey) and the effects of released fishing pressure within and around the MPA are recommended to be incorporated into the MPAs objectives during the design process (Cashion et al., 2020).

Designing MPAs and the expansion strategies also should consider the connectivity between the MPAs in a network for better ecological effectiveness (Kirkman et al., 2021). Ocean connectivity supports evolutionary processes that are key to marine species maintenance and evolution such as genetic connectivity and diversity, gene flow, larval dispersal, and population dynamics and migration. Thus, MPA connectivity may play a role in climate change adaptation of marine species if sizing and spacing between MPAs are considered. In South Africa, only 41% of the MPAs are located within a 20km and 32% within 10km radius, which in turn are not effective in promoting larval dispersal, organismal distribution and self-replenishment as it does not rely on the recommended distance of 15-20km radius (Kirkman et al., 2021). Importantly, there is recent evidence of increased metabolic scope for some species found within MPAs, in relation to those in open fishing areas, and this provides importance evidence of the importance of complete protection of the biodiversity in some areas (Warren Potts, Rhodes University, pers com).

In terms of effectiveness, Kirkman et al., 2021 in a review of 140 publications looking at the ecological effectiveness of MPAs found that most publications reported positive ecological effects of MPAs including increases in the abundance, size, growth rate and reproductive output of species. This is in line with previous studies, which also reported benefits of MPAs including spillover effects (Goñi et al., 2010), increases in yield (Kerwath et al., 2013), increases in the metabolic scope of fish (Duncan et al., 2019), among others. Kirkman et al. (2021) acknowledged that there are gaps in information with

some MPAs such as Sardinia Bay, Malgas, Marcus and Jutten Islands reporting no published studies of their effectiveness. This was also the case for taxa such as invertebrates, with most studies focusing on fish species. The authors also highlighted that most studies have focused on abundance and biomass responses with less studies evaluating the effects of MPAs on age, growth rate, condition indices, reproductive output and mortality. Industry stakeholders from SAPFIA and SADSTIA highlighted that the effectiveness criteria used by Kirkman et al. (2021) is not representative as these authors "simply consider comparisons of abundance inside versus outside MPAs" and that "It is necessary to show that the net sustainable yield to the fishery has increased as a result of the MPA". It is advised that discussions are established between the different branches of DFFE, industry and small-scale fisheries stakeholders to reach consensus on what indicators need to be selected to determine the ecological and socio-economic effects of MPA. This must be combined with tailored monitoring programmes to ensure information is collected to calculate those indicators. Previous studies have used methods such as bioeconomic and population models to evaluate MPA effects (Nickols et al., 2019; Ovando et al., 2021), the latter study highlighted that effect sizes of < 30% were difficult to detect.

In order to facilitate the development of intervention measures, the BCC is in a good position to attract and direct funding into ongoing discussions, negotiations, and training in the case of both existing and proposed MPAs. In this way National priorities are realised, regional expertise is shared, and the possibility of transboundary MPAs can be discussed in a suitable forum. This process has been started by the SADC in May 2022.

Our content analysis and review of potential climate change impacts for the most important commercial and recreational fisheries species in the Benguela countries as well as in the communities within and surrounding the MPAs indicate that the following actions should improve the effectiveness of MPAs in the region:

- Identify how climate change can potentially impact the conservation and other goals of each MPA to determine if its effectiveness would be compromised in the future.
- Agree on indicators to determine the ecological and social effectiveness of MPAs. These discussions should include all relevant stakeholders, including DFFE, academia, SANBI, commercial, recreational and small-scale fishers.
- Foster research on socio-economic impacts of MPAs in the region to get buy-in from local communities and develop baseline data to determine MPA effectiveness in the future. This study and previous research has shown there is very limited information on socio-economic impacts of climate change and MPA effects
- Determine the social and economic impacts of implementing MPAs, this should be done in consultation with interested stakeholders as it was done to prepare the ground to promulgate the new offshore MPAs in 2019. This is also advised by the FAO guidelines on MPAs (2011) which indicates that early involvement of stakeholders in the MPA planning process is crucial.
- Revise MPA management plans to ensure they include clear and measurable socio-economic objectives, linked to indicators;
- Revise or facilitate MPA management plans to include a list of actions that can help improve the resilience of MPAs to climate change. A number of recommendations and adaptation options were provided in Tables 5-7.
- Conduct vulnerability assessments for species of ecological, economic and cultural importance in the region. While a few studies have been conducted in South Africa, more studies using state of the art climate projections are needed to estimate species' vulnerability and distribution shifts as a result of climate change in the BCLME;
- Using trait-based assessments or other rapid methods to estimate species vulnerability and distribution shifts due to climate change, as a starting point.

- The possibility of improving the connectivity of the current network of MPAs should be discussed with academic experts, managers and other stakeholders to improve its resilience to climate change;
- Make the management plans for all the MPAs in the region publicly available;
- Improved monitoring, surveillance and enforcement of management actions is needed for most species in the commercial and recreational fisheries sectors. This is line with the findings of the State of MPA area management in South Africa, which indicated that some of the problems affecting MPAs are a lack of effective law enforcement, monitoring to inform adaptive management, and adequate cultural heritage management (Adams & Kowalski, 2021);
- The need for adequate funding and human and financial capacity was also highlighted as one of the main issues affecting MPAs in South Africa (Adams & Kowalski, 2021). While this study did not explore those aspects, it is important to highlight that MPAs will not be managed as effectively as needed without proper funding and capacity.
- A capacity and needs assessment commissioned by the BCC identified that knowledge on Marine Spatial Planning was one of the key skills to improve the capacity of government officials in the three BCC countries. Therefore, the BCC Climate Change and Capacity Building and Training Programme is advised to discuss possible synergies to implement training in the region.
- For new MPAs, it is recommended that frameworks such as systematic conservation planning or climate-smart conservation are used to design the MPAs. Climate change considerations should be included following best practices. The development of MPA objectives and evaluation of impacts of climate change must be conducted using both local knowledge and quantitative data ensuring ecological and socio-economic aspects of the MPAs are included. Moreover, climate change should be included within the MPAs aims and objectives and the new MPAs should include a climate change adaptation framework. The MPA objectives must be linked to indicators, which have been agreed with all relevant stakeholders and fulfil best practices for indicators (i.e. SMART). This is particularly relevant for Angola as no MPAs are implemented yet.
- The BCC could provide a platform of ongoing discussion with MPA practitioners and managers around all aspects of national and regional MPA's. This is particularly important in terms of the current planned introduction of MPA's in the region. Training of MPA practitioners could also be facilitated through this process and through dedicated funding directed through the BCC.

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