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Best Practice Guidelines

To mitigate impacts of oil & gas development on coral reef, sea turtles and marine mammals in the Northern Mozambique Channel

Fauna & Flora
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WCS

FONDS FRANÇAIS POUR L'ENVIRONNEMENT MONDIAL

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The Wildlife Conservation Society (WCS) was chartered by New York on April 26, 1895 as the New York Zoological Society, it was renamed WCS in 1993. WCS envisions a world where wildlife thrives in healthy lands and seas, valued by societies that embrace and benefit from the diversity and integrity of life on earth. WCS saves wildlife and wild places worldwide through science, conservation action, education, and inspiring people to value nature.

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Contents

Acronyms

ANL – Artificial Night Light

AR – Autonomous Acoustic Recorder

AUVs – Autonomous Underwater Vehicles

BBOP – Business and Biodiversity Offsets Programme

BES – Biodiversity and Ecosystem Services

CBD – Convention on Biological Diversity

CHM – Clearing House Mechanism

CPUE – Catch Per Unit Effort

CSBI – Cross Sector Biodiversity Initiative

EBSAs – Ecologically or Biologically Significant Areas

EIA – Environmental Impact Assessment

EMP – Environmental Management Plan

ESIA – Environmental and Social Impact Assessment

FF – Fauna & Flora

FPSO – Floating Production Storage and Offloading

GBIF – Global Biodiversity Information Facility

GPG - Fauna & Flora International's Good Practice Guidance

IBAT – Integrated Biodiversity Assessment Tool

ICCA – Indigenous and Community Conserved Areas

IFC – International Finance Corporation

IMMA – Important Marine Mammal Areas

IPBES- Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

ISRA – Important Sharks and Rays Areas

IUCN SSC – International Union for Conservation of Nature Species Survival Commission

KBA – Key Biodiversity Areas

KBF – Key Biodiversity Features

LNG/GNL – Liquefied Natural Gas (Gás Natural Liquefeito)

MBES – Multibeam Echo Sounder

MH – Mitigation Hierarchy

MMO – Marine Mammal Observer

MOF – Material Offloading Facilities

MPA – Marine Protected Areas

MSP – Marine Spatial Planning

NMC – Northern Mozambique Channel

NNL – No Net Loss

NORAD – Norwegian Agency for Development Cooperation

NPI – Net Positive Impacts

O&G – Oil & Gas

OECM/OMEC – Other Effective Area-Based Conservation Measures

PAM – Passive Acoustic Monitoring

PTS – Permanent Threshold Shift

RMU – Regional management units

SDG – Sustainable Development Goals

SEA – Strategic Environmental Assessment

SEL - Sound exposure level

SPL – Sound Pressure Level

SSS – Side Scan Sonar

TSS – Total Suspended Solids

TTS – Temporary Noise-Induced Threshold Shifts

UAVs – Unmanned Aerial Vehicles

WCS – Wildlife Conservation Society

WIO – Western Indian Ocean

WORMAS – World Register Of Marine Species

Executive Summary

The Northern Mozambique Channel (NMC) is renowned as one of the world's most biodiverse regions, serving as a biological reservoir for the entirety of the Eastern African coast. Its significance lies particularly in the rich ecosystems of coral reefs and associated marine life, making it a vital breeding and foraging ground for flagship marine species and migratory fauna.

However, this ecological asset is under threat from escalating human activities on land and at sea contributing to degradation. Decline and loss of marine and coastal biodiversity in this unique environment is already occurring, particularly from new infrastructure development and extractive industries. Recent discoveries of hydrocarbon account for more than 3.7 billion cubic meters of natural gas in the NMC, making it one of the largest gas fields in the world. While this discovery promises substantial economic growth, it also raises concerns about the potential environmental repercussions, posing risks to the health of the ecosystem and consequently, the livelihoods and well-being of local coastal communities.

In addition to the ecological consequences of exploration and extraction on the ecosystem, the burning of fossil fuels – including oil and gas – is the biggest contributor to climate change globally. Fauna & Flora advocates that in order to address the worst impacts of climate change for people and nature, it is critical for the world to phase out fossil fuels and rapidly transition to a low-carbon and nature positive economy. The energy sector (those companies that extract oil and gas as well as produce other forms of energy including renewables) must play a significant role in these global efforts, which necessitates transformation in their business models, and governments must regulate and enable these companies to do so.

In response to this tension between economic development and biodiversity conservation, Fauna & Flora has produced this practical guidance on best practices for minimizing and mitigating impacts on biodiversity and ecosystem services of the NMC. The document is designed for use by regulators responsible for planning and evaluation of Strategic Environmental Assessments (SEA), Environmental Impact Assessments (EIA) and Marine Spatial Planning (MSP) related to Oil & Gas (O&G) developments and associated infrastructure. These technical guidelines can also support industry professionals, Environmental and Social Impact Assessment (ESIA) practitioners, technical specialists, financial institutions and civil society groups. The report is based on a review of relevant international best practices for the O&G industry, emphasizing the rigorous application of the Mitigation Hierarchy (MH) to ensure biodiversity Not Net loss (NNL) outcomes or Net Positive Impacts (NPI) in marine environments.

Central to this guidance are three key biodiversity features: coral reefs, sea turtles and marine mammals. These features were previously prioritized through multi-stakeholder participatory exercises using a scoring process considering the ecological significance of these features within the Northern Mozambique Channel (NMC) and their susceptibility to impacts from the O&G industry.

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The document is structured into four main sections designed to address specific aspects of impacts mitigation and biodiversity conservation. The first section provides a concise overview of the document, its purpose, scope and structure. In addition, the section presents a compilation of existing resources on best practices to mitigate impacts in the O&G sector followed by a conceptualization of the Mitigation Hierarchy (MH) as a strategic tool designed to reduce impacts on biodiversity and to balance conservation with developmental needs. A brief description of the selection of biodiversity features part of this report is also introduced.

Sections 2, 3 and 4 provide specific guidelines for the prioritized biodiversity features. These sections are structured in a similar way starting with a brief description of the ecology and existing pressures of the feature followed then by concrete measures that O&G projects must address in response to an adequate application of the MH.

“While this discovery promises substantial economic growth, it also raises concerns about the potential environmental repercussions, posing risks to the health of the ecosystem and consequently, the livelihoods and well-being of local coastal communities.”

For coral reefs, the report emphasizes the importance of understanding their ecology to achieve effective conservation and management of these habitats given their vulnerability to changes in the local environment. This reinforces the need for proactive measures such as avoidance to ensure their persistence under developmental activities. This section highlights the role of Marine spatial planning use of Marine Protected Areas (MPAs) and Key Biodiversity Areas (KBAs) as the first step to avoid development within these sensitive ecosystems. A list of freely available spatial tools is also provided for guiding decisions during screening processes and project sites selection. Additionally, the guidance also provides a decision-making scheme O&G projects should follow to demonstrate impacts on coral reefs have been avoided as much as possible. When complete avoidance is not possible, decreasing the extent, magnitude and duration of project activities, and the use of inputs and outputs is the key to minimising the risk for negative impacts to coral reefs. In order to do that, understanding water movement through dispersion modelling (by understanding currents) is required, to understand fate and minimise impacts to coral reefs within the area of operations. This section recommends a series of habitat features and indicators to fully understand the potential impacts and design an effective monitoring and mitigation plan.

The first two steps of the MH (avoid and minimise) are of crucial importance given the low probabilities of restoring and/or offsetting coral reefs. Although it is possible to find positive results from experiences on coral transplanting, it is unlikely to achieve equivalent characteristics than the reefs impacted (e.g. percent coral cover, species diversity, mean colony height and coral colour/health).

The third section lists the five sea turtle species reported in the NMC, their life cycle and sensitive periods. These dynamics plus the existing pressures on sea turtles need to be considered to properly apply the MH and to address impacts on this biodiversity feature. Therefore, the section emphasizes the importance of spatial and temporal avoidance during different stages of O&G development. A set of baseline assessments are suggested and methodologies needed to inform a meaningful risk assessment and operational monitoring and mitigation practices included. For impact minimization, the report provides guidelines on preventative measure to reduce the duration, intensity, significance and/or extent of impacts to sea turtles that cannot be completely avoided. This includes minimization of impacts such as underwater noise, vessels movements, artificial light, and seismic surveys. Although restoration is not an applicable mitigation measure for affected sea turtle species, it is possible to implement restoration measures in sensitive or critical sea turtle breeding or foraging areas that were impacted or disturbed by the project footprint (e.g. seagrass beds, coral reefs, etc.). Likewise, offset activities can aim to generate gains by creating or restoring sea turtle habitats but also through conservation measures focused on avoiding adverted losses. Activities like removing or reducing existing or anticipated threats to sea turtles’ habitats or existing populations within the wider seascape of the Project can aim to achieve gains for sea turtle species.

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In the case of marine mammals, the fourth section focuses on the species which meet the Important Marine Mammal Areas (IMMA) criteria and are grouped into taxa as: Balean whales, Toothed whales (Odonotocetes) and dolphins, and sirenians (e.g. Dugong). For the first step of the MH, it is recommended an initial risk assessment to inform the project design and the need for additional baseline studies. In order to support the avoidance phase, It is recommended that regulators and project developers consult the IUCN SSC-WCPA Marine Mammal Protected Areas Task Force as well as the online IMMA e-Atlas which provide relevant information and spatial data about marine mammal habitats and species. Similarly, spatial and temporal considerations for migrant species are also specify in this section for the different phases and activities of an O&G project. Establishment of exclusion/safety zones is one of the key strategies highlighted to avoid impacts of physical injury (e.g. by detonations or vessels) or hearing impairments to marine mammals. For minimisation measures on marine mammals, the report provides a list of preventive activities the O&G projects must consider and include as part of the project impact assessment. Guidelines on minimisation measures of underwater noise, impacts by vessels, artificial night light, among other impact drivers are provided. Implementation of buffer distances, shut downs and ramp-up delays around exclusion/safety zones are also recommended to minimize the likelihood of impacts on marine mammals. The project also needs to develop a Marine Mammal and (Sea Turtle) Monitoring and Detection Plan as an instrument for adaptative management to take actions under scenarios where the likelihood of encountering whales is moderate to high.

As well as in the case of sea turtles, restoration is not an applicable mitigation measure for affected marine mammal species, excluding dugongs which are non-migratory, reliant and closely associated to seagrass habitat. In those cases, the EIA shall identify means to restore temporarily impacted or degraded seagrass habitat by the project. In the case of offset measures, the offsets shall aim to generate gains by creating or restoring marine mammals’ habitat, which in practicality is limited to Dugong, mangrove and seagrass habitat. It may include specific species focused actions to reduce effects through bushmeat hunting and harvesting, reduction of shipping collisions and bycatch, and protection of coastal or deep-water migratory pathways. Furthermore, if any local marine mammals action plan exists, the project should align as possible with priority actions. In any case, monitoring of marine mammals and enforcement of marine mitigation measures including offsets is typically costly. Therefore, project should ensure that adequate budget is set aside during project scoping, and includes local stakeholders for effective long-term success of any conservation actions.

The goal of this report is to inform and enable regulators to manage oil and gas development within the Northern Mozambique Channel with confidence. Technical training is required to familiarise regulators on the Mitigation Hierarchy and the technical tools available to avoid, minimise and restore harm before a proponent can rely upon offsets. It is an important step to achieving sustainable development within the biodiversity rich landscape.

Overview

Introduction

The Northern Mozambique Channel (NMC) covers an area of approximately 700,000 km2. It is among the world's richest regions for biodiversity. It serves as a biological reservoir for the entire Eastern African coast, in particular for coral reefs and associated ecosystems, and is an important breeding and foraging area for flagship marine and migratory species. Despite the critical importance of this environment, there are growing pressures from population growth, coastal infrastructure development and extractive industries. Recent discoveries of hydrocarbon account for more than 3.7 billion cubic meters of natural gas in the Mozambican NMC itself, making it one of the largest gas fields in the world, equivalent to 40 to 50 years of production. Similarly, in Tanzania and Mozambique where all major Oil & Gas companies operate, and new discoveries are expected. These recent discoveries of natural gas and oil in the region represent a potential for additional resources for the NMC, and therefore the region will probably experience a significant economic and even a higher population growth in the coming decades. This potential expansion of the economy can also come with threats to the health of environment, and consequently to the livelihood and well-being of coastal communities, which rely significantly on the services provided by coastal ecosystems for their livelihoods. It might indeed have negative impacts on fisheries resources, coastal protection, carbon sequestration and recreational functions underlying the tourism industry, and consequently on the livelihoods of people, particularly the poorest populations.

In addition to the ecological consequences of exploration and extraction on the ecosystem, the burning of fossil fuels – including oil and gas – is the biggest contributor to climate change globally. Fauna & Flora advocates that in order to address the worst impacts of climate change for people and nature, it is critical for the world to phase out fossil fuels and rapidly transition to a low-carbon and nature positive economy. The energy sector (those companies that extract oil and gas as well as produce other forms of energy including renewables) must play a significant role in these global efforts, which necessitates transformation in their business models, and governments must regulate and enable these companies to do so.

Given this context, the present report aims to provide pragmatic advice to practitioners working with marine oil and gas operations to help them identify, mitigate and manage impacts to biodiversity and ecosystem services with a particular focus on coral reefs, sea turtles and marine mammals as key biodiversity features given their importance within the NMC and globally. Whilst the intended audience is for government regulators responsible for planning and evaluation of Strategic Environmental Assessments (SEA), Environmental Impact Assessments (EIA), Environmental Management Plans (EMP), and Marine Spatial Planning (MSP), these technical guidelines can also support industry professionals, Environmental and Social Impact Assessment (ESIA) practitioners, BES specialists, financial institutions and civil society groups working with the oil and gas industry to adopt and deliver good practice in marine environmental stewardship.

The core of these tailored guidelines is the rigorous application of the Mitigation Hierarchy (MH), and it is based on a review of relevant international, regional & national best practices for the O&G industry. Whilst this report is not intended to be an exhaustive list of mitigation measures, it provides a series of criteria and illustrates how the steps of the MH work in place.

The report is structured as follows. The first section presents an overview of the scope of the guidelines. This includes the objectives and the intended audience of the report; a set of existing resources on good practices for oil and gas operations in marine environments, an introduction to the mitigation hierarchy as a central instrument for projects planning and development, and finally a brief description of the prioritization of biodiversity features included in the present report.

The three following sections are organized by biodiversity feature indicating how the different phases of the mitigation hierarchy needs to be applied taking into account the ecology of these features and their relationship with the environment. This section also includes orientation on data and measurements that need to be captured in baseline studies as well as in monitoring plans to assess the implementation of the Mitigation Hierarchy.

International Best Practices For Oil & Gas Operations In Marine Environments

For the purpose of this guidance, best practices are defined 'good practice' as policies, approaches and techniques that have proven to be effective in the realisation of desired outcomes (i.e. to avoid and minimise adverse impacts on biodiversity and ecosystem services (BES)). A wide range of good practice guidance documents exist for oil and gas operations in the marine environment. Below is a review of a selection of these, starting with a brief overview of Fauna & Flora's Good Practice Guidance (GPG) (2016) which itself provides a comprehensive overview of the relevant literature. This is not intended to be a comprehensive list and a wide range of other relevant materials are available.

Fauna & Flora's Good Practice Guidance (GPG)

The GPG is an essential reference for oil and gas operators, particularly those located in marine environments with high biodiversity value, where there are operational and stakeholder dependencies on ecosystem services, and where measures to avoid, minimise, restore and offset for impacts on BES are being applied to achieve no net loss or net gain outcomes.

The GPG provides pragmatic guidance for identifying, mitigating and managing risks and impacts on BES associated with intertidal through to deep water environments. All stages of the oil and gas project cycle are considered - from seismic surveys to decommissioning – as well as activities or developments directly linked to marine oil and gas operations, including shipping and ports.

The document does not address hydrocarbon spills and onshore developments as are dealt with in other existing guidance documents.

The GPG is underpinned by 10 core principles and an additional four principles specific to offsetting. These principles are to be applied together in a single, integrated approach. The document provides guidance on assessing impacts to BES, whether as part of a full ESIA process or as part of an internal risk assessment exercise.

The GPG describes potential adverse BES impacts and preventative mitigations (avoidance and minimisation – the first two steps in the mitigation hierarchy) at each phase in the oil and gas project cycle: seismic surveys, exploration drilling, field development, production and operations, and decommissioning. Ports and shipping are also assessed. For each phase of the project cycle, a table identifying activities, potential impacts for BES, and known avoidance and minimisation measures is presented. Remedial mitigations, in the form of restoration and offsetting (the last two steps in the mitigation hierarchy) are also discussed.

Biodiversity and ecosystem fundamentals: Guidance document for the oil and gas industry

Prepared by IPIECA (2016), Biodiversity and ecosystem services fundamentals: Guidance document for the oil and gas industry provides guidance for the management of BES impacts, dependencies, risks and opportunities in the oil and gas sector. It sets out a management framework comprised of six interrelated BES management practices along with an overview of tools for application within these practices, examples (case studies) of how these are being applied, and references for more detailed guidance.

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Cross-sector guide for implementing the mitigation hierarchy

Prepared by The Biodiversity Consultancy on behalf of the Cross-sector Biodiversity Initiative (2015), the Cross-sector guide for implementing the mitigation hierarchy provides practical guidance, approaches and examples to support operationalising the mitigation hierarchy effectively. It was developed with technical specialists in impact assessment, extractive industry experts and financial institutions, with feedback and input from the non-profit sector. The publication is aimed at environmental professionals working in, or with, extractive industries and financial institutions, who are responsible for overseeing the application of the mitigation hierarchy to biodiversity conservation, while balancing conservation needs with development priorities.

Strengthening implementation of the mitigation hierarchy: managing biodiversity risk for conservation gains

Strengthening implementation of the mitigation hierarchy: managing biodiversity risk for conservation gains (2015) was compiled by representatives of the international conservation community (BirdLife International, United Nations Environment Programme – World Conservation Monitoring Centre (UNEP-WCMC), the Royal Society for the Protection of Birds (RSPB) and Fauna & Flora) together with the University of Cambridge. Based on an assessment of case studies and regulatory review from nine regions, the publication considers the drivers for impact avoidance and identifies practical examples of avoidance measures from a range of sectors and geographies. Potential barriers to the widespread adoption of effective impact avoidance are highlighted and recommended actions to strengthen the application of the mitigation hierarchy and maximise impact avoidance potential are made.

Good Practices for the Collection of Biodiversity Baseline Data

Good Practices for the Collection of Biodiversity Baseline Data (2015) prepared for the Multilateral Financing Institutions Biodiversity Working Group and CSBI, summarises good practices for biodiversity baseline studies that allow biodiversity to be included effectively and fully in impact assessment and related management plans.

Good Practice for Biodiversity Inclusive Impact Assessment and Management Planning

The Good Practice for Biodiversity Inclusive Impact Assessment and Management Planning (2015) is a supplementary guidance document that complements reports and guidance on impact assessment published by a broad range of actors from government, industry and NGO sectors. It looks specifically at biodiversity risks and their respective management requirements, suggesting that projects should tailor the level of rigour applied in impact assessment and management planning according to the sensitivity of the site and the potential impact of the project.

CSBI Timeline Tool

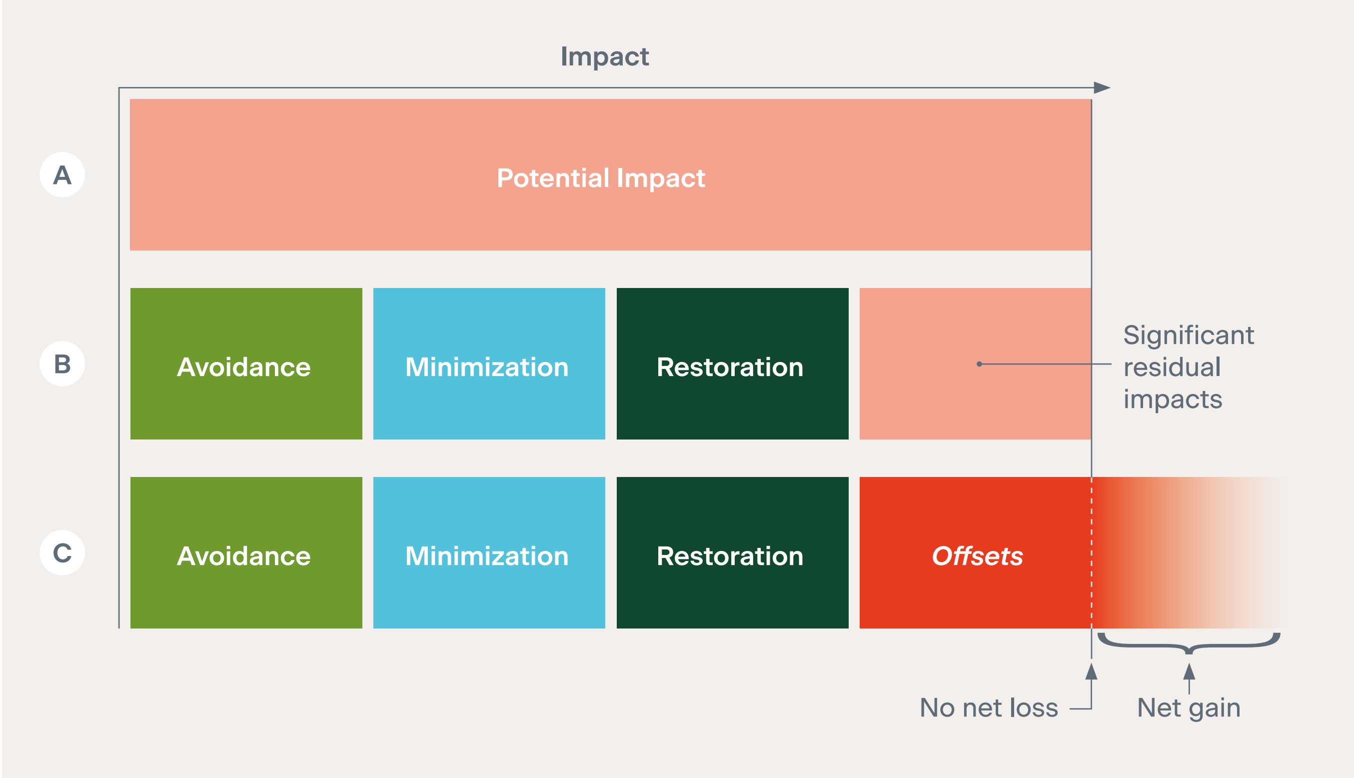
The Cross Sector Biodiversity Initiative (CSBI) Timeline Tool (2013) assists professionals planning extractive projects in coordinating project development calendars, biodiversity impact assessment and management schedules, and financial timelines milestones. It has been designed to present a roadmap to identify milestones and key interdependencies between project development schedules, financing timelines and the actions required to effectively apply the mitigation hierarchy. Whilst not being proscriptive, it recognises the operational challenges associated with identifying and mitigating biodiversity impacts.

Whilst the presented set of best practices compilations differ in level of complexity and focus of the analysis (e.g. terrestrial or marine ecosystems, type of industry, etc.), they all put the mitigation hierarchy at the centre of the project planning and implementation, and/or provide technical recommendations to specific phases within the mitigation hierarchy.

Introduction to the Mitigation Hierarchy

The Mitigation Hierarchy (MH) is a tool to decrease impacts to biodiversity and increase the sustainable management and use of living natural resources (see Figure 1). This is achieved by integrating a four-step process into the life cycle of a project, from initial inception to construction, throughout operations and finally during site decommissioning (CSBI, 2015). Originally adopted by the extractives and energy sectors (Aldrige et al. 2018), application of the Mitigation Hierarchy is currently expanding to other sectors, primarily through adoption within global target setting (e.g. the Science Based Targets Network) and reporting standards (e.g. the European Union's Corporate Sustainability Reporting Directive), and through Nature Positive ambition set forth in the Global Biodiversity Framework[1].

Figure 1. Application of the Mitigation Hierarchy showing no net loss and net gain. Net gain targets are preferred to reach our societal nature positive goals (from the CSBI 2015 guidance).



The aim of this tool is to balance conservation, and the retention of fundamental ecosystem services for local communities, with the need for development. It provides a structured way of accounting for gains and losses of biodiversity, by understanding the condition or state of biodiversity features within a landscape context and avoid impacts to threatened or irreplaceable species and ecosystems (Fauna & Flora, 2015). When metrics are applied, a quantified account of impacts can be recorded and used to measure success towards the specific biodiversity target set for the project (CSBI, 2015). Target setting is a critical element for success. In a traditional impact management approach, the main objective is to ensure at a minimum, No Net Loss or more preferred, Net Positive Impacts to biodiversity within an identified Area of Influence (AoI)[2] surrounding the project footprint (Sali, 2021). However, following the explicit call to action within the Kunming-Montreal Global Biodiversity Framework (KMGBF) to halt and reverse biodiversity loss and put nature on a path to recovery, new developments must prevent new impacts and set targets for Net Positive Impacts as part of the operation (Baggaley et al, 2023).

1. The Global Biodiversity Framework was signed by 196 Parties at the UN Convention of Biological Diversity in December 2022. It provides governments with 23 targets to integrate into national planning to curb biodiversity loss by 2030 and work toward a 2050 vision of 'Living in Harmony with Nature'. This has been deemed society's 'nature positive' goal and strives to ensure more nature exists in the future than there currently is (CBD. 2022)

2. The Area of Influence (AoI) is the area within which a project may potentially directly, indirectly, or cumulatively cause impacts.

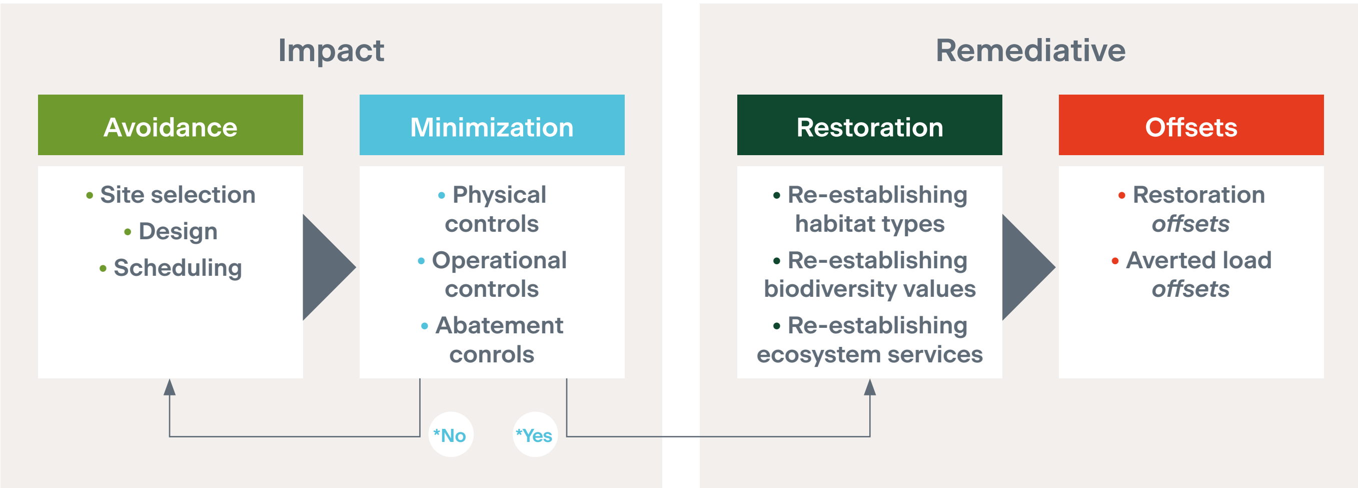
BOX 1: GOOD PRACTICE GUIDANCE FOR APPLYING THE MITIGATION HIERARCHY

- **Cross Sector Biodiversity Initiative. 2015. A cross-sector guide for implementing the Mitigation Hierarchy. CSBI.**
- **Business and Biodiversity Offsets Programme. 2012. Standard on Biodiversity Offsets. BBOP–Forest Trends.**
- **International Finance Corporation. 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Natural Resources. IFC.**

First and foremost, the MH focuses on 'prevention' of impacts to biodiversity and ecosystem services through 1) Avoidance and 2) Minimisation. It then encourages 'remediation' of impacts that occur during project development and operation through 3) Restoration and finally, when all previous steps are exhausted, 4) Offsetting (CSBI, 2015). Each of these steps will be described in detail below and later applied to the three biodiversity features that were selected for the NOCAMO project (see Figure 2).

Successful application ensures businesses are accounting for all impacts of a project, including direct, indirect and cumulative ones, and that opportunity costs and environmental trade-offs are considered early in project development (Alridge et al., 2018).

Figure 2. Broadscale steps to apply the Mitigation Hierarchy as preventative and remediative measures when designing and implementing a project (adapted from the CSBI 2015 guidance).



* Can potential impacts be managed adequately through remediative measures?

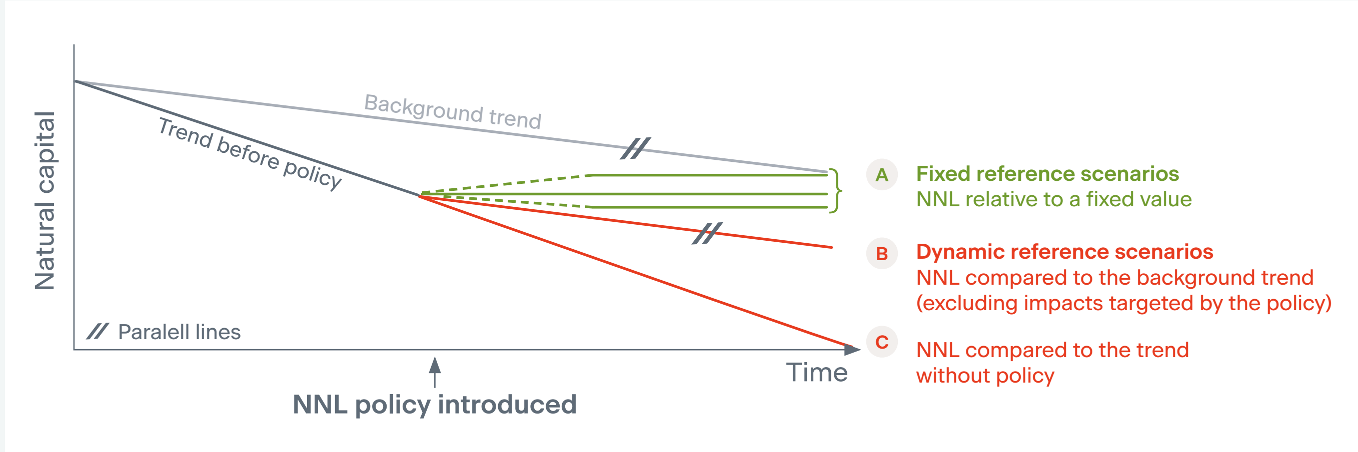
Metrics & Biodiversity Accounting

It is essential that the accounting of gains and losses includes both direct, indirect and cumulative impacts on biodiversity (Aldridge et al. 2018). Historically, metrics have focused on measuring vulnerable species or habitats. However, it is recognised that small, cumulative effects of project operations are affecting common species and ecosystems and are often unrecognised within the Environmental Impact Assessment or permitting phase of project licensing (Phalan et al. 2018).

International reporting standards are requiring companies to disclose on impacts to all material ecosystems and species affected by project activities, regardless of their threat status (UNEP-WCMC et al. 2022). This is because biodiversity loss is occurring globally and on average, all species have declined by 69% since 1970. This is primarily due to increased pressure on the natural environment (WWF, 2022). For this reason, it is recommended that companies measure material ecosystem condition and species threat status within their AoI to determine which a) are likely to be affected by the project and b) likely to affect project operations. This way of inward and outward thinking is referred to as 'double materiality' and ensures that a company thinks beyond its environmental dependencies and instead considers impacts to the surrounding landscape and local communities (TNFD, 2022, EFRAG 2022).

A comprehensive baseline is needed to understand the state of biodiversity prior to project development. A separate baseline is needed for each feature being monitored. This is required to record restoration and offsetting success, and work towards the NNL or NPI target in a quantified manner. Historically, different dynamic baseline scenarios have been required which assume a background trend of loss. It is recommended, however, that a transparent, 'fixed baseline scenario' be required by companies moving forward (Maron et al., 2018), as this ensures biodiversity gains are brought above the initial condition before operation (Figure 3; Booth et al. 2023).

Figure 3. Adapted from Maron et al. 2018 paper highlighting the different biodiversity outcomes, using 'fixed' vs. 'dynamic' baselines.



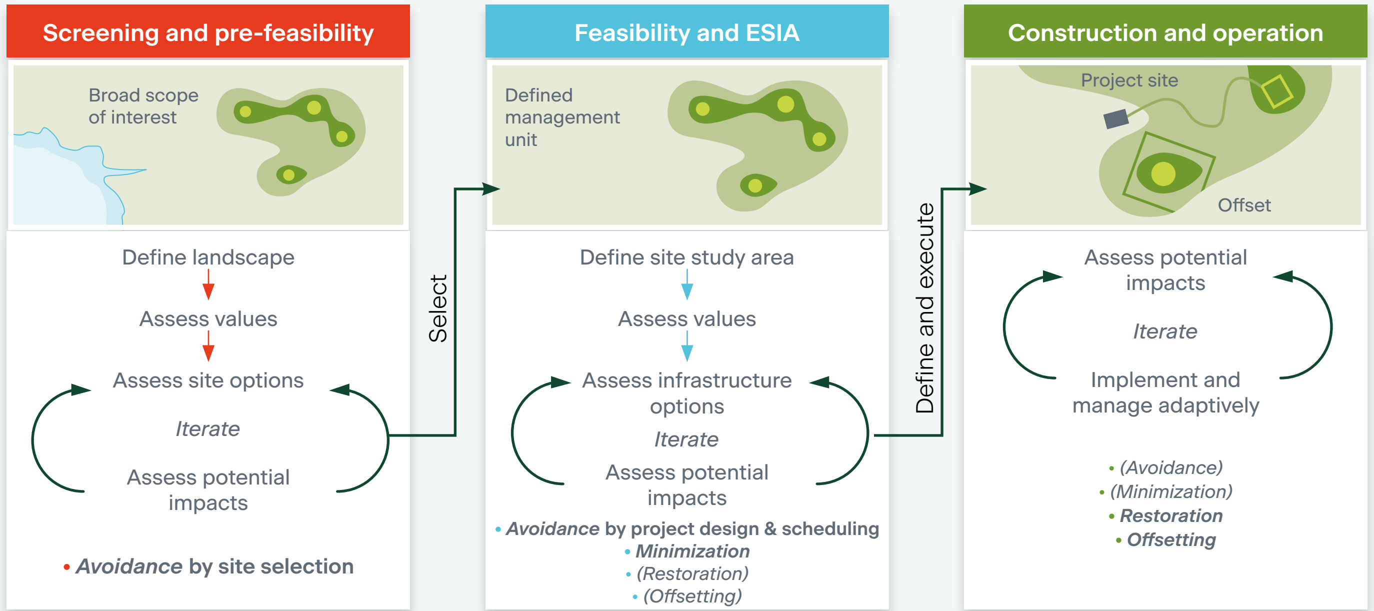
Four principles should be followed for long-term monitoring , as follows (adapted from Cote and Reynolds, 2006):

1. Measurements need to be related to the baseline survey and completed at the same sites > to monitor a change in condition of the marine environment
2. Sampling methods must use the same technique as the baseline survey
3. Sampling frequency should be randomised, to avoid accidental synchronisation with natural biological events.
4. Control sites are required to assess variances in the baseline condition against natural changes to the environment (see Figure 8 below as an example).

Applying the Mitigation Hierarchy

Although the process is visualised as linear, application of the MH is a cyclical process, that encompasses all phases of a project lifecycle, from inception to closure (see Figure 4). To ensure adequate application, effort should be focused on avoidance, to think through unacceptable opportunity costs and the trade-offs (CSBI, 2015) from a people and nature perspective.

Figure 4. Application of the Mitigation Hierarchy across three broad stages of the project lifecycle (from the CSBI 2015 guidance).



Each step is described briefly, below:

1) Avoidance

Avoiding impacts to areas of high biodiversity value is the most important step in the MH. Biodiversity loss is occurring at unprecedented rates, primarily through habitat conversion for economic development (Neugarten, 2023).Renewed focus on the first step of the MH is needed to discourage use of offsets (Phalan et al. 2018). This requires understanding of 'no go' areas through spatial planning and the use of global and regional biodiversity datasets.

Companies will seek government advice on areas of high biodiversity value that should not be operated within. Legal protection is the best way of ensuring this, and the identification of Key Biodiversity Areas (KBAs) utilising scientific criteria developed by IUCN. Supporting implementation is the Integrated Biodiversity Assessment (IBAT) tool, which allows users to access global biodiversity datasets as an initial risk screening process[3] by overlaying potential site footprints on these maps, to identify overlap and proximity to these areas. When available, regional datasets should be prioritised. By adding on a 50km buffer to the potential project site, an understanding of the species and ecosystems within this wider area is generated, and a landscape lens is incorporated.

Spatial avoidance is the most common tool to avoid physical impact to biodiversity. This requires companies to consider sensitive biodiversity features within the landscape and select a site to minimise harm. This step occurs during the pre-ESIA phase when multiple site options are still being assessed.

Temporal avoidance is also used, once an understanding of the species and habitats within a selected site are understood. Project activities should be scheduled when vulnerable species are least likely to be present and not going through sensitive life history traits such as migration, breeding or nesting. This often occurs during the Feasibility stage of an ESIA and requires an assessment on the biodiversity values of the site. Further spatial avoidance is possible, by considering the project design and specific location within the site. Table 1 summarises the phases of project development when this should occur and the most common methods of avoidance.

Table 1. Methods of avoidance prior to and during an ESIA (adapted from CSBI, 2015; World Bank 2016 & Sali et. al. 2021).

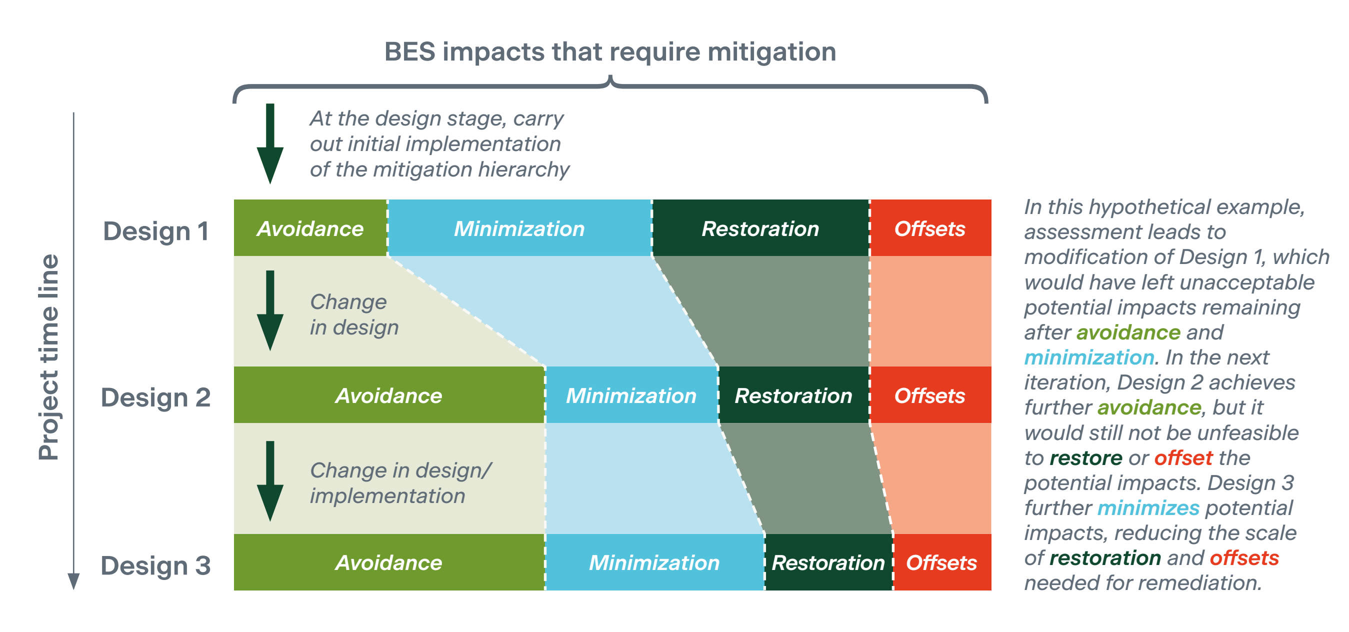
Pre-ESIA	During-ESIA
Physical avoidance	**Temporal avoidance**
• Site selection through spatial planning and overlay of potential site on geospatial maps to identify overlap and proximity to areas of high biodiversity value (e.g. site selection, project component placement, re-routing pipelines, during exploration)	• Schedule project activities to occur when species are least likely to be present by understanding life history characteristics and seasonal patterns (e.g. migration, breeding seasons and/or nesting season) and ecosystem functions (e.g. river flows, fruiting pattern, vegetation growth). This should be before both construction and operations.
	Physical avoidance
	• Modify project design using new technology and engineering solutions to decrease the risk of significant impact (e.g. by reducing light pollution to decrease impacts on birds). • Carefully locating infrastructure within the designated project area (micro-siting) to avoid areas of biodiversity importance.

Avoidance does not end after the ESIA phase. Adaptive management is required throughout the project lifespan, to avoid unanticipated impacts to biodiversity features that may not have been identified during the initial assessment and modify temporal measures over time.

3. IBAT allows the user to access three comprehensive biodiversity datasets including: the World Data Base on Protected Areas (including World Heritage Sites), Key Biodiversity Areas and the IUCN's Red List of Threatened Species.

Successful avoidance of biodiversity saves a company financial investment in the long-term and is a large incentive for action. By understanding high value biodiversity features within the landscape, companies can avoid impact and reduce their offsetting requirements. Therefore, the avoidance step should be utilised as early as possible in the project development phase, when changes to the site's location are still possible. To achieve this, it is essential that a company's engineering team works closely with the sustainability/environmental department to make sure a wider understanding of the ecology of the site is developed. Priority biodiversity features should be avoided from during the project design stage,prior and during the ESIA process. This will minimise compensation costs and ensure offsets are minimised (see Figure 5 below).

Figure 5. Minimisation of offsets required through increased application of avoidance planning during project development (from the CSBI 2015 guidance).



2) Minimisation

Minimisation is not as effective as avoidance, but it is the second preventative step of the MH and is considered project level conservation (Alridge, 2015). The objective is to decrease the duration, extent and intensity of potential impacts. This requires expert knowledge on the biodiversity features present to predict impacts and collaboration with project planners and engineers, to adapt design. Addressing the source of the impact and reducing the magnitude and extent is key (CSBI, 2015). Table 1 provides an overview of the three control options available:

Table 2. Three categories of minimisation techniques to reduce impacts to biodiversity at the site-level (CSBI, 2015; Sali et. al 2021).

Physical	Operational	Abatement
Further adaptation of project design once site is selected to minimise effects to the local landscape (e.g. utilise bubble curtains etc.).	Manage people's actions through operational controls (e.g. require machine shut off when not in use to reduce noise disturbance).	Decrease input and outputs required for project activities (e.g. decrease pollutants discharged to natural environment, decrease freshwater uptake etc).

Inclusion of local communities to generate ideas for minimising harm will spur innovation, help create jobs and increase local buy-in of the project. As shown in Figure 5 above, this is a second opportunity for a company to reduce the residual impacts of a project and decrease the cost of compensation through restoration[4] and offsets.

4. Note that countries will have their own regulation for offsetting and should always be deffered to when working with a corporate to decide the most appropriate offsetting project. For example, Mozambique does not allow 'averted loss offsets' (i.e. protecting existing habitat which may be lost) and instead requires a biodiversity gain.

3) Restoration

Restoration is the first 'remediation' mechanism of the MH and has less certainty of success than the previous two steps. Implementation requires a quantified baseline on the state of biodiversity within the assessment area, and reference sites to provide a realistic target (i.e. to define what 'state' you are working to restore towards). The ultimate goal is to repair degradation or damage caused by project activities within the AoI (either by direct or indirect impacts), and restore ecosystem condition (structure, function and composition) and species populations. This should be quantified using an appropriate biodiversity metrics for each feature. Ecological time lags will mean that target success is likely not possible within the lifespan of a project and requires time series data to plot recovery rates and the use of models to predict if/when 'success' will occur (CSBI, 2015).

Note that it is not always possible to restore certain biodiversity features, including vulnerable species and habitats. This would include critically endangered, endangered and vulnerable populations, and irreplaceable habitats such as the deep sea, and tundra landscapes. These features should always be avoided in Steps 1.

4) Offsetting

Offsets generate gains in biodiversity by creating or restoring habitat or protecting existing habitat which would have otherwise been lost. At all costs, offsetting should be considered a last resort before a project is approved. It is a timely and expensive compensation method with the lowest rates of success, which require sufficient technical capacity to regulate, administrate, monitor and apply best practice.

Offsets are already regulated in some countries and should be discussed with the right government authority to agree the location and type of offset required. The 'like-for-like' or 'like-for-better' principle applies, whereby the ecosystem type being impacted needs to be directly replaced. If this is not possible, or the habitat type is considered degraded, then an ecologically 'better' (i.e. more vulnerable, sensitive or valued ecosystem) should be compensated for. The concept of multipliers is used, to ensure adequate compensation is reached, and account for the uncertainty of success. The more rare, threatened or vulnerable a biodiversity feature is, the higher the multiple should be. These are developed and regulated at a national level, to incentivise avoidance.

An offset will require careful project design, testing and validation before it can be implemented. Gain/loss accounting using quantified metrics is needed to ensure direct and indirect impacts from the project are compensated for and real outcomes for biodiversity are achieved (CSBI, 2015). Biodiversity accounting is an evolving space but has been heavily used by the extractives and energy sectors, particularly in South Africa.

The Standard on Biodiversity Offsets was developed by the Business and Biodiversity Offsets Programme (BBOP) in 2012 and is considered an international standard. Additionally, the Impact Mitigation and Ecological Compensation Thematic Group (IMEC), part of the IUCN Commission on Ecosystem Management, is building upon BBOP and other initiatives towards improvements in best practice in the application of the mitigation hierarchy. This includes work to provide guidance on linking mitigation (including avoidance) and compensation efforts to global and jurisdiction-level biodiversity targets, and to related environmental and social science-based targets, with due consideration for indigenous peoples and other stewards of nature. These resources should be consulted when approving offsetting projects put forward by the proponent.

Despite the absence of legislation requiring NNL/NPI, regulators shall ensure that an EIA requires the implementation of the Mitigation Hierarchy, including the identification of residual adverse impacts and the implementation of Biodiversity Offsets when residual impacts occur.

With any offsetting measure, monitoring and oversight of offset implemenetation will be necessary to demonstrate permanence, equivalence and additionality against an established baseline or counterfacutal scenario for biodiversity. Monitoring measures are also an essential part of adaptive management to effectively adjust project implementation so as to improve on-the-ground outcomes towards achieving a Net Positive Impact or other conservation objectives (World Bank, 2016). The monitoring and evaluation framework as well as key performance indicators should be defined in the Biodiversity Offset Management Plan, found in the EMP. Monitoring indicators will be highly context dependent on the offsetting measure defined. As recommended by the World Bank (2016), in the case of offsets, it is recommended that regulators consider requesting a third-party panel - of technical experts of regulatory entities, but also from the major private EIA companies, NGOs and other specialist bodies, and academics - be responsible for the review of the offsetting progress towards its objectives.

Conclusion

It is essential that the MH and Net Positive Impact targets are woven into environmental legislation by making both mandatory. This is the main driver for increasing corporate accountability operating in the landscape and is a crucial mechanism to protect biodiversity at the national level (Alridge et al., 2018). Offsetting requirements are controversialas they enable companies to downgrade application of Steps 1 – 3 of the MH, without investing in Avoidance or Minimisation. It is important to create adequate multipliers that ensure additionality (Maron et al. 2018) to create a financial incentive to avoid areas of high biodiversity value and instead re-think project location and design. Multidisciplinary iterative work between project designers and environmental teams is essential to ensure feasible efficient solutions. It is suggested to work with local NGOs and civil society to advocate for the conservation and protection of species, including common ones (Phalan et al., 2015).

It is understood that application of the MH and accountability of implementation requires technical training. The first step is to integrate these principles within national policies to move away from voluntary application. Secondly, improved knowledge and mapping of high biodiversity value areas and the creation of 'No Go' areas for development, protected by legislation is essential. Technical tools/guidance adapted to the region/country's reality is essential, such as ecological condition metrics are also necessary. Consultation with local communities and Indigenous Peoples is a crucial element to ensure accurate representation of biodiversity and the services it provides (COMBO project, 2018). Capacity building will be required by national governments and practitioners in general to implement and enforce legislation as well as to adequately use data and apply the existing technical tools. Specifically for offsets, it is essential that the implementation mechanisms are operational and, preferentially, tested before implemented at scale.

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Marine Features Selected

The present guidance focuses on a set of marine biodiversity features previously selected through multi-stakeholder (government representatives, the private sector and civil society) participatory exercises in Mozambique, Madagascar and Tanzania. The objective was to identify priority biodiversity features, on one side subject to impacts from the O&G industry, but also of ecological significance within the NMC and of relevance as practical indicators for impacts quantification and monitoring.

The selection followed a stepwise scoring process to understand priorities for guidance development in relation to O&G developments. A range of global datasets covering biodiversity, habitat, geomorphology, and infrastructure were assessed to understand the presence and distribution of marine biodiversity features within the NMC. This information, and subsequent maps, were used to inform those completing a desktop review and workshop participants during an introductory presentation to local stakeholders. Additionally, a desktop review was completed to understand the marine features present within the NMC. High-level categories were used rather than individual species to allow for flexibility when implementing guidance at the national level. This would allow species to be selected that are relevant to the country and/or national priority when implementing the guidance that is to be developed for the channel and applied by Mozambique, Madagascar and Tanzania.

Three categories were used for the prioritization: O&G impacts, biodiversity significance and monitoring potential. In this case the selected features were those with higher exposure to pressures from the sector, ecological importance in the NMC and the suitability of these features to be used as marine indicators. The potential effects of oil & gas development were taken from FFI (2017)[5]. A table describing all phases and associated activities for the lifespan of a project was utilised (see Appendix 1). This table was then adapted to associate each activity with the most appropriate driver of biodiversity loss, as described by IPBES in the 2019 assessment report. Each feature was assessed against the activity and potential for biodiversity loss (see Appendix 2). A score of 1 indicated likely or no impact, 2 was for moderate impacts (e.g. degradation of habitat; impact on movement/spp. presence) and 3 was for high impact (e.g. habitat loss expected; species decline very high due to habitat loss/new infrastructure/assumed population decline). Note that scores are based on anticipated direct impacts only. Indirect impacts were outside the scope of this project.

To understand biodiversity significance of the features present within the NMC, 5 scoring criteria were developed (Table 3).

Table 3 Scoring criteria for biodiversity significance

Biodiversity Significance	Scoring criteria
IUCN Red-List Status (for species only)*scored by FF	**1 = Least concern** **2 = Near Threatened** **3 = Vulnerable, Endangered, Critically Endangered**
Anticipated marine distribution (for ecosystems only)*scored by FF	**1 = Coastal only** **2 = Intertidal** **3 = Intertidal or subtidal**
How important is this biodiversity feature for your country?	**1 = Low importance** **2 = Moderate importance** **3 = High importance**
Ecosystem service - provisional (e.g. economic benefits from fishing)	**1 = No commercial significance for coastal communities** **2 = Moderate commercial significance for coastal communities (1 country only)** **3 = High commercial significance for coastal communities (2 or more countries)**
Ecosystem service - cultural (e.g. valued by coastal communities)	**1 = No cultural significance** **2 = Moderate cultural significance (1 country only)** **3 = High cultural significance (2 or more countries)**

5. Fauna & Flora International (FFI). 2017. Biodiversity and Ecosystem Services: Good Practice Guidance for Oil and Gas Operations in Marine Environments. FFI: Cambridge U.K. Available from: www.fauna-flora.org

Potential for monitoring was evaluated based on 2 criteria categories. This included the usefulness of the feature as an indicator of change (i.e. would a decrease in presence indicate a wider change to ecosystem condition and/or function?). A score of 1 was given for low indication of change, 2 for moderate indication of change and 3 for high indication of change. Finally, participants were asked to provide a score from 1 to 3 based on the method most commonly used for monitoring the feature and how costly these methods are relative to one another. A score of 1 was given for expensive monitoring methods that are hard to bring to scale (e.g. diving and individual site-level surveys), 2 for moderately expensive survey methods (e.g. camera traps / underwater traps that require divers to install the equipment but are able to collect data passively) and 3 for the least expensive methods available (e.g. remote sensing / satellite data that allows monitoring to happen at scale). It is recognised that all methods mentioned require ground-truthing and some degree of on-the-ground survey collection.

For each category (O&G Impacts, Biodiversity Significance and Monitoring Potential), a total score was compiled using the following formula:

Cumulative score = [O& G Impacts + Monitoring Potential] **X**

[Biodiversity Significance]

Note that biodiversity significance was used as a multiplier, as the exercise is meant to identify features that are important for monitoring from a biodiversity perspective, with consideration to the impacts oil and gas development could have and the importance of each feature to local communities. The final scores were then used to select three biodiversity features as shown in Table 4 (Appendix 3).

Table 4 Selection of biodiversity features

Biodiversity feature	Overall ranking	Notes
Coral reef	**1**	Ranked 1st in Madagascar and Tanzania, 4th in Mozambique.
Marine mammals (e.g. humpback whale, Indo-Pacific humpback dolphin)	**2**	WCS and FF experts revised scores for Madagascar under biodiversity significance (ecosystem services) as they were abnormally low, misrepresenting the importance of marine mammals in the country's West coast. Ideally, the guidance developed might include some parts relating to dugongs, which ranked 1st in Mozambique, but low in the other 2 countries due to the absence of any identified viable population (contrary to Mozambique).
Sea turtles (e.g. hawskbill green)	**3**	Ranked 3rd in Mozambique and Tanzania, but 5th in Madagascar.

Biodiversity Feature 1: Coral Reefs

Introduction

Corals do not even cover 1% of the Earth's surface, but they are extremely diverse. In fact, they are dubbed the rain forests of the sea because of this immense diversity (Miththapala, 2008; NOAA, 2019). Their importance is vital for about 25% of the ocean's fish. Fishes and other organisms' shelter, find food, reproduce, and rear their young in the many nooks and crannies formed by corals.

The Northern Mozambique Channel (NMC) is home to 35% of the coral reefs of the entire Indian Ocean, and contains 16% of the world's coral reefs (Spalding et al. 2001, Obura et al. 2015, Obura et al, 2017). The NMC as part of the Western Indian Ocean (WIO) sub-region, includes parts of the Exclusive Economic Zones of Madagascar, Mozambique, Tanzania and France, and the whole of the Comoros, covering an area of approximately 450,000 km². *"The high and unique biodiversity of the NMC is hypothesised to be a result of high levels of connectivity due to the South Equatorial Current and Mozambique Channel eddies, the retention of species there due to its stable coastlines and marine climate, and an evolutionary history preserving unique relict species from the Tethys Sea some 25-40 million years ago".* Consequently, the northern Mozambique channel may be the second peak of shallow marine biodiversity in the world, after the Coral Triangle (Obura et al, 2015).

Globally, coral reefs are extremely productive ecosystems and provide humans with many services, their importance is recognized as being ecological, economic, and societal benefits valued, globally, at about USD $9.8 trillion each year (Miththapala, 2008; de Groot et al., 2012; Costanza et al., 2014,). In the WIO region and NMC in particular, coral reefs provide crucial habitat for fishes and directly support the countries fisheries and tourism sectors, and provide essential income opportunities for local communities through subsistence fishing

Ecology

In scientific classification, corals fall under the phylum Cnidaria and the class Anthozoa. They are relatives of jellyfish and anemones (NOAA, 2024). Coral reefs are found, where the sea is shallow (less than 100m); where the sea is warm and are generally located within the latitude of 30°N to 30°S.

Corals are composed of colonies of polyps living within a calcium carbonate body structure. They are often carnivorous and capture particles using stinging cells called nematocysts (NOAA. 2024a). Corals also exhibit a symbiotic relationship with zooxanthellae, a type of single-celled algae that lives within the polyps of a coral colony. These algae are photosynthetic that help coral survive by producing oxygen, removing waste and providing the coral with key products to survive (e.g. glucose and amino acids; NOAA, 2024b). When the environmental parameters of corals are changed quickly a phenomenon called 'bleaching' occurs, whereby the algae are expelled from the coral and the colour is lost from the coral structure. Depending on the amount of bleaching, the health of the coral declines. When the coral is 100% bleached, it is considered dead. It's important to understand the natural environmental parameters reef building corals require for optimal health. This includes (from NOAA, 2010 and NOAA 2024b):

- High light penetration through the water column to allow algae to photosynthesize and provide coral with key products for growth and survival
- High dissolved oxygen within the sea water
- Low turbidity or suspended solids
- Low nutrient input
- Warm sea temperature, most often ranging from 18 - 30°C
- Open ocean salinity ranging from 33 – 36 parts per thousand (ppt)

Coral diversity is variable all over the world. The Western Indian Ocean (WIO) is considered one of the most diverse areas for coral in the world. A 2020 study identified >300 coral species within reefs off the coast of Mozambique (Obura, 2012). Relatively speaking this is extremely high (e.g. Hawaiin reefs have 45 – 52 species and the Caribbean is known to host >100 coral species; NOAA, 2010). Coral reefs are generally considered slow growing ecosystems, and avoidance of these habitat is the most effective measure to ensure sustainable development of the O&G industry. Understanding the coral types present within a reef is necessary to understand the implication of impact for restoration and offsetting. Generally, corals are so slow growing, that offsetting is unlikely to be successful within the lifespan of a project, if at all. Different types of corals exist, with different growth rates. A good grasp of the coral diversity should be obtained in the baseline study of an EIA (see Baseline section below). It is generally understood that (from NOAA, 2020):

- Branching corals grow faster than massive corals
- Stony corals can have many forms
  - Massive (growing up to ~1cm/year)
  - Branching (growing up to 20cm/year)
  - Plate-like
  - Finger-like
  - Encrusting
- Different forms of coral react differently to changes in the environment and would require the use of local specialists to identify potential effects of project activities
- Natural causes of death range from predation, competition, diseases and storms.

Corals undergo broadcast spawning (i.e. sending out sperm and/or fertilised eggs into the water column). Reef success is dependent on currents to disperse planktonic spores, larvae and juveniles (NOAA, 2020). This requires connectivity along coastlines, to ensure dispersal can reach different reef patches, and is an important consideration for marine spatial planning, particularly restoration and protection of existing reefs. Coral reproduction is generally an annual event. Abiotic factors influence when spawning happens for specific reefs include (from NOAA, 2020):

- Seasonal seawater temperature changes
- Lunar cycle (i.e. moon phases)
- Time of day

Pressures

Coral reefs are among the most threatened ecosystems on Earth (IUCN, 2017). Anthropogenic threats at all scales, including fishing, climate change, local to regional development and newly discovered natural gas fields are fuelling unprecedented development pressures (Obura et al, 2017; Obura et al, 2019; NOAA, 2024). Sea vessel presence and movements, anchoring vessels offshore, inorganic waste, physical disturbance from new facilities are a few common activities associated with new O&G developments that directly impact on vulnerable biodiversity such as coral reefs. Moreover, recent literature suggests that hard coral cover declined substantially across the region immediately after the 1998 bleaching event, and in the years since, average coral cover has remained at about 30%, which is 25% lower than pre-bleaching levels (Obura et al., 2017, Obura et al., 2019). These threats, combined with tropical storms, disease outbreaks, vessel damage, marine debris and invasive species, exacerbate each other and the damage to this special ecosystem.

When reviewing an EIA, specific pressures requiring particular attention include (Birrell et al, 2020 and NOAA, 2010):

- **Bleaching:** from climate change, and warming waters. Bleaching can be induced by acute temperature changes in the water column (e.g. heated wastewater)
- **Human population growth and in-migration:** to coastal areas (e.g. an indirect effect brought on by new work opportunities due to project development)
- **Artisanal fishing:** using destructive fishing methods such as beach seine, gill nets, or mosquito nets which can cause damage to habitats. These pressures often increase if in-migration results from project development.
- **Industry development:** on or near these sensitive habitats, including ports and O&G causing:
  – **Increased sedimentation:** from habitat disturbance causing reduced light penetration, smothering and/or burying of coral colonies.
  – **Increased nutrient levels**: from effluents, project activities can cause increased plankton and algal growth. This is most common in areas with low wave action such as lagoons. Growth smothers coral, decreases light penetration and the ability to broadcast spawn, decreasing reef health.
  – **Invasive alien species:** most often transported through ballast water, introduced species can outcompete and overgrow on native species within the reef system.
  – **Oil spills:** will negatively harm coral reefs through acute and chronic toxicity effects, particularly if the spill occurs during a reproduction period.
- **Crown thorn starfish:** increase in this predator can lead to significant reductions in live coral cover (e.g. 90% coral reduction experienced in Northern Mozambique on the border of Tanzania; damage to the Great Barrier Reef by this species could take 20 – 40 years to recover, Birrell et al. 2020).

Avoidance

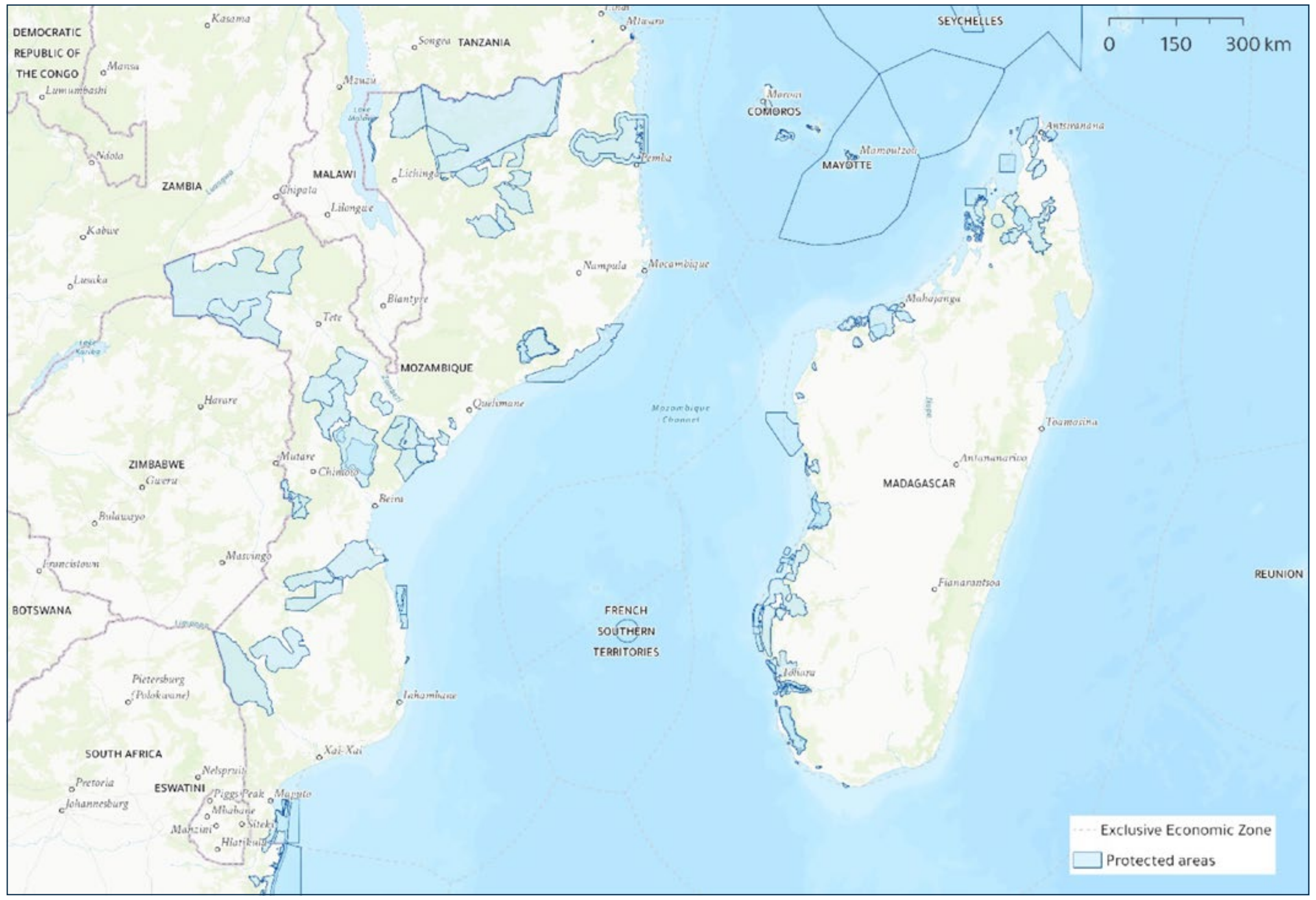
Coastal zone management is critical for reef protection, and avoidance is the most effective measure to deter negative impacts to this sensitive ecosystem. Proper avoidance has multiple benefits. It will decrease the residual impacts and requirement for restoration and offsetting and decreases conflict with local communities by ensuring development occurs in the most appropriate location (Côté and Reynolds, 2006). When damage occurs, it can take decades or centuries for reefs to recover and there is also a chance that damage may be permanent (NOAA, 2010).

Marine spatial planning, MPAs & KBAs

Utilising globally and nationally available tools for marine spatial planning is the first step to avoid development within these sensitive ecosystems. Utilising a comprehensive marine spatial plan can close funding gaps, meet climate change commitments and optimise marine areas for economic development and conservation. The first national marine spatial plan was developed by Mozambique in November 2021. Tanzania is currently planning for coastal urban resilience in Dar es Salaam (World Bank, 2022). Both should be consulted when determining where a new O&G field should be allowed to operate.

Identifying Marine Protected Areas (Figure 1) and Key Biodiversity Areas within marine and coastal environments is the first risk-screening step to be completed. Governments can access these databases online for free to ensure a proponent has adequately described these areas within the coastal and offshore environment.

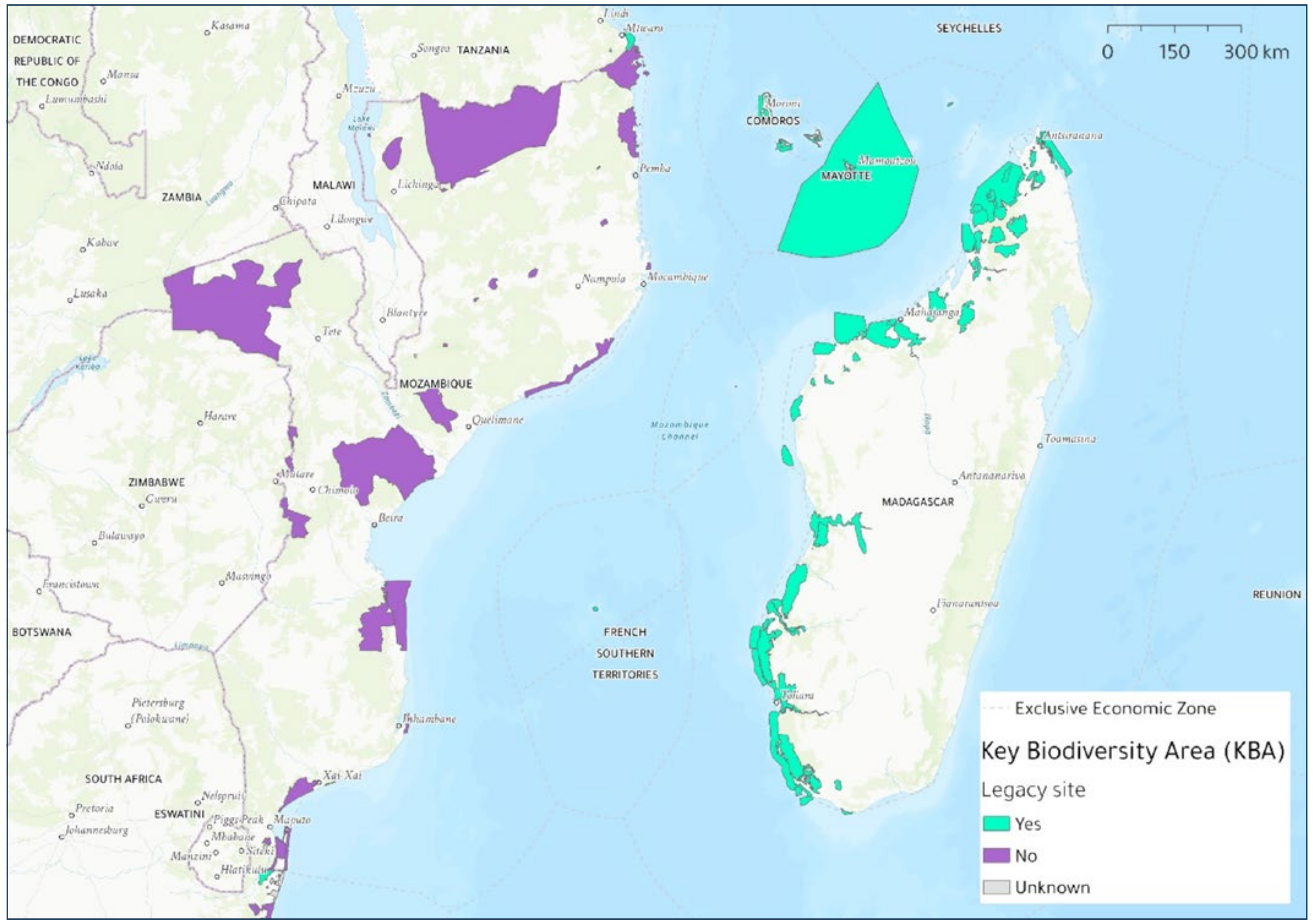
Figure 6 Protected Areas identified within the Northern Mozambique Channel (IBAT, 2024).



MPAs will have different levels of protection, governance structures and economic development rules depending on their protection status. A first step is understanding where MPAs exist, and then exploring how they are managed (IUCN, 2019). As of 2016, all IUCN designated MPAs (Categories I – VI) are considered 'no go' areas for industrial-scale activities that are environmentally damaging, including O&G. This was introduced at the World Conservation Congress in 2016, Motion 026 (IUCN, 2016a; IUCN 2016b) and is because MPAs play a critical role in addressing climate change through carbon storage/sequestration and by providing ecosystem services for adaptation. It is known that climate change and biodiversity loss are critically linked (World Bank, 2022) and requires holistic planning. ***The IUCN therefore calls on governments to prohibit extractive industries within MPAs, ICCAs[6], KBAs (Figure 7) and areas of high conservation value.***

6. Indigenous/community conserved areas and territories (ICCAs)

Figure 7 Legacy (turquoise) and Real (purple) Key Biodiversity Areas within the Northern Mozambique Channel (IBAT, 2024).



Key Biodiversity Areas (KBAs) are an emerging conservation planning tool, whereby sites contributing significantly to the global persistence of biodiversity are identified based on scientific/quantitative rather than political criteria (IUCN 2016c). Mozambique has identified and mapped KBAs within their national boundaries and as of April 2024 had officially recognised 30 KBAs of which 4 were marine. These KBAs are embedded in the national territorial development plan and national marine spatial plan as avoidance areas for development. They are also in the national legislation as avoidance areas and priority offset receiving sites. Therefore, these are meant to support marine spatial planning and conservation priorities and inform policies being developed for private sector development (WCS, 2021).

Below are tools freely available to all three countries as a first step screening process (Appendix 4):

1) **Allen Coral Atlas:** provides freely available maps of the world's coral reefs and allows users to monitor threats and provides actional data to better understand coastal ecosystems. This provides:
   - An interactive web tool to explore reef threats, reef habitat types, maritime boundaries and marine protected areas.
   - Users can overlay MPAs with benthic maps to understand where coral reefs, and seagrass overlap.
   - Note that the data is based off satellite imagery and is considered a first step in understanding what is potentially present at the site. Data will need to be ground-truthed using site-level surveys to determine actual reef presence.
2) **Protected Planet:** this is the leading World Database on Protected Areas and allows users to view all MPAs individually, by region or country.
   - Individual MPAs can be reviewed to understand their status, designation, IUCN Management Category and Governance Type.
3) **Integrated Biodiversity Assessment Tool:** a subscription-based service, companies are able to explore IBAT to understand sensitive habitats within a polygon (i.e. site assessment area) and buffer areas ranging from 5–50km. Access and technical support is provided free of charge to government officials regulating O&G development[7]. Users can identify the following within these areas:
   - Proximity or overlap with **MPA's** and **KBAs**
   - Proximity or overlap to **Critical Habitat** (as defined by IFC PS6)
   - Number of globally **threatened species** within the assessment area (based off the IUCN red-list)
   - It is recommended that companies purchase an IBAT subscription to adequately risk-screen against these sensitive habitats and species prior to investment and before exploration work begins on a proposed project. If not for capital gain, it is possible that access to IBAT may be granted for free (i.e. by governments) on a case-by-case basis.
4) National-level platforms also exist and should be consulted as it is likely the information is more rigorous and up to date. As an example, countries which have signed the Nairobi Convention[8] have detailed information about MPAs and a country profile page for:
   - Tanzania
   - Madagascar
   - Mozambique[9]

For example, marine spatial planning in Tanzania has focused on the development of Marine Parks and Marine Reserves based on a sustainable approach and to safeguard marine resources. Managed by the MPRU (Marine Parks and Reserves Unit) a participatory/co-management approach is used to engage local community members for decision-making, implementation and benefit sharing. To date, 18 formal MPAs (with IUCN Categories ranging from II – IV) exist totalling ~1% of the country's EEZ. O&G is considered an income opportunity within these areas, however, and will require careful mitigation planning to ensure biodiversity values are maintained and negative ecological impacts are avoided. The Mnazi Bay Ruvuma Estuary Marine Park (MBREMP; IUCN Category IV with an extent of 650km^2) for example, currently allows O&G exploitation and will require careful monitoring if biodiversity conservation is to be achieved (UNEP, 2021).

Avoidance Techniques for sites proposed in the marine environment

Figure 8 below provides a decision tool to help regulators understand if a proposed site should be allowed to operate in coastal and offshore environments. As mentioned above, risk screening should be completed to see if the site is located within a PA, KBA or OECM (Other Effective Area-based Conservation Measures). If the site is located within either of the protected areas, then the activity should not be allowed.

Assuming the site is located outside of an important area for biodiversity, the operator will need to investigate to see if any coral reefs are present within the footprint of operations and surrounding area. If coral reefs are present, it is not recommended that activities are allowed. If densities are low and mitigation techniques can be implemented to ensure risk of impact is low, then it may be possible to operate, in some instances (adapted from DFO, 2021).

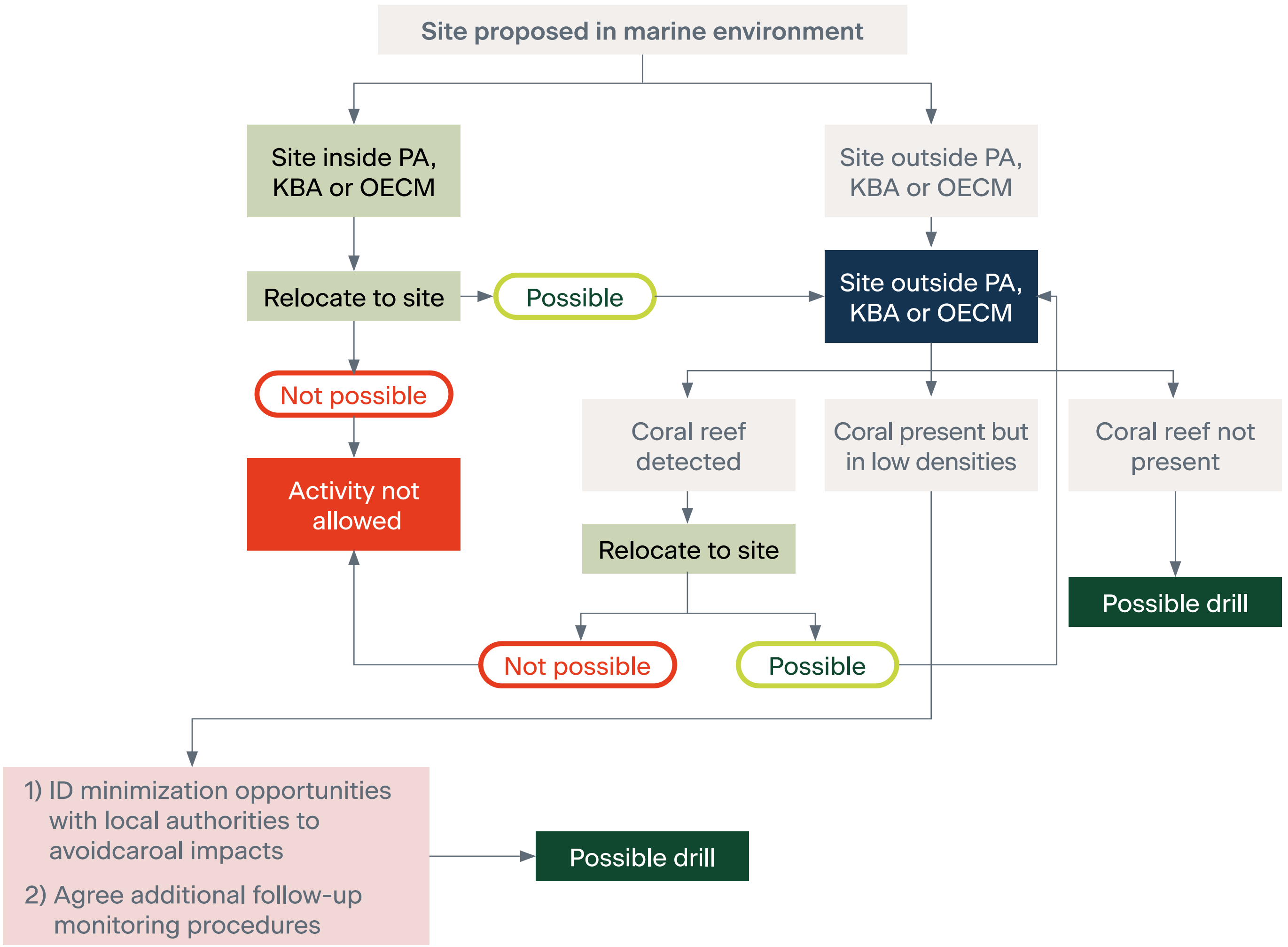
7. To gain free access contact IBAT using the following URL: https://www.ibat-alliance.org/contact-us

8. The Nairobi Convention requires countries to meet globally agreed marine conservation targets (SDG14/15) where by 2020, at least 10% of coastal and marine areas are conserved based on best available scientific information and be consistent with national and international law (UNEP, 2021).

9. The Mozambican Biodiversity Information System (SIBMOZ) is available at sibmoz.gov.mz and is part of the global information exchange network established under the Convention on Biological Diversity (CBD) (Clearing House Mechanism - CHM). Its aim is to provide relevant information on national biodiversity and facilitate technical and scientific cooperation, as well as the sharing of knowledge and data, facilitating the decision-making process and promoting the sustainable use of biodiversity in the country.

10. Other Effective Area-based Conservation Measures (OECMs) complement protected areas through sustained, positive conservation outcomes, even though they may be managed primarily for other reasons (UNEP-WCMC, 2024).

Figure 8 Decision tree to help regulators decide if a proposed site should be allowed to operate (adapted from DFO, 2021).



Avoidance after a project location is approved

Once a location has been chosen, project level avoidance techniques can be implemented to decrease the risk of affecting nearby coral communities. Physical disturbance from equipment being placed on the seafloor can cause damage to coral. Equipment/infrastructure being placed on coral reefs should be avoided at all costs. When working near a reef, efforts should be made to use floating equipment/infrastructure where possible, and when not possible, reduce the size of the object requiring contact with the sea floor. The following activities are likely to harm coral reefs and should be avoided as much as possible (adapted from DFO, 2021 and NOAA, 2010):

Vessel presence: an understanding of local MPAs, KBAs and sensitive habitats should be made prior to vessels entering the area. Captains should be provided with 'no-go' areas and requirements to anchor in a particular place.

Ballast water: to avoid transfer of invasive species during shipping, or in the event of a grounded vessel, ballast water released into the marine environment should be treated with ozone, chlorine or heated before being discharged. Heated water should cool before being released to avoid acute temperature changes to seawater.

Physical disturbance: damage through physical placement of equipment, including anchors. Equipment should utilise floating devices as much as possible. When not possible, footprint size should be minimised as much as possible. Anchorage/equipment should be placed in the same location to decrease the number of disturbance events.

Sedimentation: through anchoring activities, drilling, dredging etc. Dispersion models should be utilised to understand how far sediments will travel and in which directions, to avoid smothering of nearby reefs.

Chemical effects: release of chemicals into water column through use of cement, release of drill cuttings etc. Understanding of chemical type and concentration is required as travel distance will vary as will the toxic effect to various coral species. Cumulative impacts of chemicals can occur if wells are placed near one another.

BOX 2: Avoiding coral reef encroachment during LNG development, Yemen (YLNG, 2008)

The Yemen LNG Project required the construction of a gas liquefaction plant at Bal Haf Cape, Yemen. The LNG plant involved the construction of the following marine infrastructure: jetty for LNG Carriers loading and shipping; Material Offloading Facility (MOF) for tugboat mooring; sea water intake/outfall pipes; and shoreline protection for the onshore plant.

Site Screening and Selection
Detailed studies were conducted for three sites, to select a combination of a LNG plant location and pipeline route to transport the gas, which would optimize the economics of the project while minimizing its environmental and social impacts. The comparison of the three selected sites resulted in the final site selection of the best technical compromise with minimal dredging and the lowest capital investment.

Avoiding localized impacts by modifying the plant design
The Material Offloading Facilities (MOF) design considered different options to avoid as much as possible dredging volumes in coarser material, thus less prone to turbidity. Additionally, the selected alternative presented a lower impact on corals by reducing the project "footprint" and encouraging free flow of ocean currents.

Minimise

Because coral reefs are benthic, non-moving structures requiring specific environmental parameters for survival, it is important to ensure project construction and activities do not significantly change water quality parameters. Therefore, when complete avoidance is not possible, decreasing the extent, magnitude and duration of activities, and the use of inputs and outputs is the key to minimising the risk for negative impacts to coral reefs. Even if activities do not occur on a reef (as they never should), understanding water movement through dispersion modelling (by understanding currents) is key to minimising impacts to coral reefs within the area of operations.

Technical expertise is required to understand impact pathways and predict or model potential effects for both construction and operation phases of the project. It is important to specify the magnitude, likely length and risk level of each activity and its impact, with the aim of developing mitigation techniques to minimise risk. Criteria for each parameter are provided in Table 5 below. The higher the severity, duration and risk, the more attention is needed to minimise harm.

Table 5. Understanding severity, duration and risk of likely to environmental features, in the marine context impacts (adapted from Côté and Reynolds, 2006).

Severity		Duration		Risk	
Low	Negligible effects to environmental element	**Short**	0 – 5 years	**Low**	High understanding of likelihood where impacts assumed to be minimal
Medium	Changes environmental element	**Medium**	5 – 15 years	**Medium**	Relatively moderate understanding of impact where damage is likely reversible
High	Severely alters natural process or social function	**High**	> 15 years	**High**	Uncertainty or low confidence levels in outcome, impacts are likely to be severe and irreversible with long term effects

Working in the marine environment, it becomes difficult to disaggregate the effects of project activities from natural changes to the local environment. To do so, it is recommended that feedback monitoring loops be developed, for reactive management during project construction and operations. This requires the use of multiple sampling techniques near a site and any coral reefs that may be affected. Selection of sampling techniques and the metrics used for monitoring will be context specific. It is recommended, however, that the chosen techniques can be quickly assessed in the field, without the use of statistical or laboratory analysis (Côté and Reynolds, 2006). Development of thresholds will help the operator understand if environmental changes could have negative effects on the reef. Thresholds should be developed based on local regulation, international standards and/or expert opinion. Examples of environmental factors for monitoring potential effects to coral reefs are mentioned in Table 6.

Table 6. Potential environmental factors for monitoring in the marine environment to mitigate impacts to coral reefs (adapted from Côté and Reynolds, 2006 and Birrell et al. 2020b).

Environmental Factor	Potential Effect to Coral Reef	Measurement Technique
Water quality; turbidity/ suspended solids	Increased sedimentation causing stress through decreased light levels and increased deposition on benthic organisms	Visibility from surface (in cm using Secchi disk)
Water quality; pollution levels (e.g. heavy metals)	Increased level of pollutant in the water column can cause stress to organisms if toxic	Water samples measuring specific pollution levels through laboratory analysis
Light penetration	Increased sedimentation causing poor light levels/ shading from infrastructure decreasing available light reaching sea floor	Watts/m^2 using light loggers
Dissolved oxygen	Deoxygenation causing increased coral bleaching and mortality	mg/L or ppm using dissolved oxygen meter
Sea temperature	Increased mortality from acute temperature rise causing bleaching	°C using thermistors

Seawater quality will need to be monitored to understand when project activities have changed from normal conditions. This can result from several oil & gas activities, including (but not limited to; Eni East Africa, S.p.A. 2015):

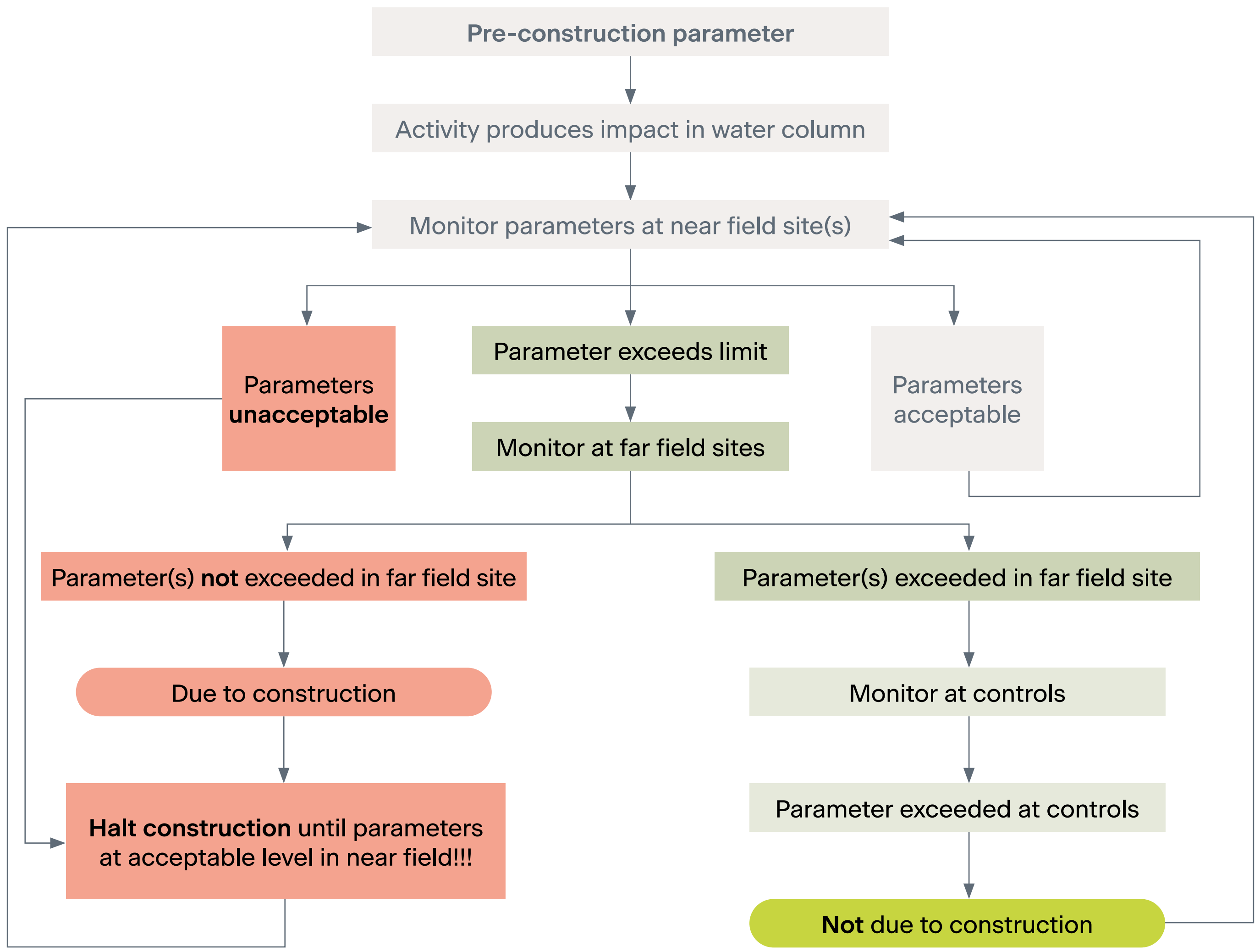
- **Drilling and installation:** discharge of cuttings when drilling production wells as they contain hydrocarbons and heavy metals that are toxic to reefs causing physical stress, and/or chronic/acute physiological affects
  – This can be mitigated by collecting and transporting the cuttings onshore by supply vessels for treatment and disposal (if the correct permits are acquired cuttings can be treated aboard drilling vessels and discharged to the sea
  – An oceanographic specialist is required to model potential locations where drilling may occur and anticipate the amount of sediment that will enter the water column (called Total Suspended Solids or TSS) and the thickness of the cuttings that would fall on the seafloor with the potential to smother benthic organisms. As an example of analysis, the maximum TSS (mg/L) should be estimated for each well proposed and compared against a known threshold to see if it falls within acceptable limits, and how quickly the concentration dissipates from the site (e.g. ambient seawater quality standards in Mozambique are established through Annex V of Decree 18/2004 (as amended by Decree 67/2010)).
  – In the absence of national standards, international standards should be adopted from *IFC's guidelines as applicable (e.g. IFC's guidelines for effluent discharges of hydrotest water at LNG Facilities* (IFC, 2007b)).
- **Operational phase:** water and effluent discharges. Water discharged to the sea should be cooled / warmed to ambient seawater temperature, to minimise risk of coral bleaching. Water should also be treated to remove possibility of invasive species transfer (e.g. through ballast water). Seasonal changes to temperature should be considered throughout the year. Modelling studies should be conducted to understand the thermal properties of water and effluent discharged into the marine environment (e.g. thermal properties, density etc.).
- **Unplanned events** – oil spills can have significant impacts on coral reefs. Proper oil spill response planning is required to understand how an oil spill is likely to affect nearby habitats, and what the appropriate response mechanisms should be **before** a project begins.

A flow diagram is provided in Figure 9, to monitor changes to the marine environment during construction and operations. Three types of sites will be required to compare against, and sampling values will need to be compared to a known threshold for the environmental factor being monitored. Samples will need to be collected at the field site where the activity is to occur (as close as feasible), at a far site that is still affected by the project, and a control where project activities will not affect the local environment. All three sites need to have similar environmental conditions.

When exceedances are recorded at the site or nearby site, comparison against a control site is necessary to understand if the values observed are due to project activities (e.g. increased sedimentation due to dredging), or due to natural changes in the local environment (e.g. increased sedimentation from a storm). The control site needs to be far enough away, that it is not influenced by the project. Therefore, if exceedances are NOT found at the control site, it is safe to assume the change is due to the project and all activities should cease. This is to allow water quality levels to return to normal and avoid impacts to the reef.

Additional mitigation measures should be explored as part of an adaptive management strategy. It is expected that the operator or a consultant complete measurement on a daily to weekly during construction, and then weekly-fortnight during operations. A third party should be involved to validate results, from either an academic institution or local NGO. The monitoring plan should be described before permitting is granted, at the tendering stage.

Figure 9. Flow diagram detailing example monitoring plan to determine when natural or project related environmental exceedances occur near coral reefs (adapted from Côté and Reynolds, 2006)



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Oil Spill Response Planning

Oil spills will adversely affect coral reefs. The severity of these impacts will depend on the type of oil released and its density. Oil products which are denser than seawater will settle on the coral as droplets, and directly affect health. Generally, intertidal corals are at a greater risk than deep water corals. Oil can bioaccumulate within the coral tissues and are slow to be removed (NOAA, 2010).

A comprehensive oil spill response plan will need to be developed as part of mitigation planning and presented within the EIA. This should include an understanding of the oil products that are likely to be exposed to the marine environment in the event of a spill, the current patterns of the area, and an understanding of the sensitive habitats within and adjacent (based on modelling of currents) to the project. The objective of the response plan is to minimize damage by considering the following (from NOAA, 2010):

- Physical impacts that may occur in the event of an accident (i.e. grounded ships)
- Ballast water that may be released to lighten a ship (and how to treat it)
- Hazardous cargo that may be transported near coral reefs. A response plan that prioritises action on the materials that are most likely to cause harm should be developed.
- Requirement for use of booms or skips and where they would be sourced from. This equipment needs to be used so that it does not cause further damage to the reef (e.g. through anchoring) and should be available before activities begin.
- Disposal planning for hazardous materials that are collected
  – In-situ burning of oil should be avoided in the vicinity of reefs where possible, as it substantially alters the water temperature and may cause oil to sink after cooling.
- Dispersant use should be considered as it combines with the oil, allows it to disperse from the site (along the sea surface) and generally biodegrades faster than untreated oil. Oceanic conditions need to be considered, to determine if this is an appropriate mitigation measure before dispersants are used.

Restore

As mentioned, the likelihood of restoration success for coral reefs is low and should be avoided at all costs. In the event of a spill, or where avoidance to physical impact is unavoidable, restoring reef health may be possible through coral transplanting, however the chance of success is low making it difficult for a company to achieve its NPI target.

Also note that restoration does not always count as a mechanism for reducing residual impacts that need to be compensated towards through offsetting. In some circumstances restoration is only feasible long after the impacts have occurred (e.g. decades). In these situations, it is not appropriate to rely on restoration as a mitigation option to reduce offsetting requirements. For instance, where the impact driver and its effects will last in perpetuity, or when short-term losses are not acceptable. In addition, the outcomes of restoration can be uncertain.

Recruitment onto reef frameworks is no longer considered a viable method, as larvae settlement is generally unsuccessful. Transplanting living corals has a higher change of success (NOAA, 2010). Preference is to transplant coral into low wave action areas, so disturbance is less likely. Soft corals are harder to relocate due to delicate holdfast tissues, compared to hard corals. Recovery can occur by reestablishing broken fragments or regenerating partially damaged colonies. Success will decrease if fleshy seaweeds settle instead of coral, particularly if the species is invasive, which is a trade-off for restoring low wave action areas. Generally, the more severe the disturbance, the longer the recovery time (NOAA, 2010).

Success of recovery is measured through percent coral cover, species diversity, mean colony height and coral colour/health. Disturbed areas should be compared to nearby areas that have not received the same disturbance (i.e. the identified control sites). Recovered reefs are likely to have different species compositions from the original site and reef structure is likely to change. What matters is that diversity of native species increases, to ensure reef resilience and re-establishment of ecosystem services crucial to the surrounding communities (NOAA, 2010). Local experts should be hired to help develop a restoration plan and carry out related activities. This could be through international projects or local NGOs, when available.

Offsetting

Whenever coral offsetting is proposed, justification needs to be provided with specifics on why avoidance, minimisation and restoration did not fully remove the likelihood of a residual impact. Reducing the residual impact as much as possible is an essential part of contributing to Nature Positive goals. Reductions in offsetting will help society maintain the natural ecosystems remaining on Earth, and ensure greater resilience to natural disasters.

BOX 3: National offsetting legislation

If countries have specific legislation, then it should be followed. For example:

Mozambique: Has a Biodiversity Offsets Directive as of 2022 (Ministerial Diploma 55/2022 of 19 May). There is an additional implementation manual for reference. The Norwegian Agency for Development Cooperation (NORAD) is supporting the National Directorate of Environment (DINAB) on developing an Environmental Oil & Gas guideline.

Madagascar: Does not currently have requirements for the proponent to implement offsets to compensate for negative project. Internationally funded projects may be required to follow principles set forth by the World Bank or International Finance Corporation's Performance Standard 6 (IFC PS6), which does require offsets. These standards should be followed in the absence of mandatory legislation.

Tanzania: Like Madagascar, Tanzania does not have offsetting requirements. Proponents should be encouraged to adopt the principles set forth by the World Bank and IFC PS6.

To predict potential impacts to coral reefs, expertise and knowledge on the local reef is needed to understand how it is likely to respond to project activities. Note that the assessment of loss will not necessarily be linear (i.e. where one unit of impact = x units of loss). Sometimes when certain thresholds are reached, the reef can decline more rapidly. This means that each unit of impact results in more units of loss in the KBF and the impact has greater significance. Sometimes, when the state of a coral falls below this threshold, the decline is irreversible. This is referred to as a 'tipping point' and should be avoided as impacts like these cannot be compensated for.

Potential steps to calculate residual impact include:

1) Examine each impact pathway in turn and assess whether impact drivers can be removed thus avoiding the resulting losses to the reef, or if it could be removed from the range of impact.
2) Then for those KBFs where avoidance was not possible, explore opportunities to minimise the effects of each impact pathway by reducing its effects on the KBF. This can include by adjusting the location, area, frequency, season of the impact. Prioritise impact drivers and KBFs as above.
3) Consider whether some restoration of KBFs is feasible (i.e. whether impacts will stop at some point during or after the project's life), if so incorporate restoration into operational plans. Next consider whether it is appropriate to consider this as a mitigation measure which reduces the residual impact of that feature, depending on whether the timeframe for restoration and certainty of restoration outcomes are acceptable.
4) Expert to re-assess the total potential loss for each KBF, given the revised set of impact pathways following avoidance, minimisation and any acceptable restoration gains. For anywhere losses are still predicted, record a justification for why the loss could not be avoided, minimised or restored. These remaining impacts will then need to be compensated for.

Data collected in the comprehensive baseline surveys will be used to understand the state of the reef before activities began. The same indicators and metrics (see 'Baselines & Monitoring' section above) should be used to monitor offsetting success. This is particularly important as offsets should always aim to rehabilitate 'like-for-like' ecosystems or 'like-for-better'. Because coral reefs are considered critically important, the same reef systems should be chosen for an offset. If it is the only reef system of its kind, development should not occur within its vicinity. Local consultation is key to understanding the ecosystem services provided by a reef, and how these may change when a project is introduced. These views should be integrated into offsetting decisions, particularly where and what project should be initiated. Condition metrics need to be incorporated into the baseline assessment and monitoring plan, to monitor offsetting progress. To understand ecosystem condition, metrics on structure, composition and function need to be included. Mozambique has developed condition metrics for coral reefs and should be consulted (Birrell et al., 2020b).

Uncertainties and the use of Multipliers

A biodiversity offset multiplier is a factor used in biodiversity offsetting schemes to ensure that the compensation provided for the loss of biodiversity adequately reflects the ecological value of the impacted area and the effectiveness of the offset actions. This multiplier is applied to the amount of habitat or biodiversity calculated by the residual impact quantification of a project, to determine the extent of compensatory actions required. The multiplier reflects the idea that the ecological value of impacted habitats or species may be greater than what is apparent from simple area (i.e. extent) calculations. It accounts for factors such as habitat quality, species rarity, connectivity, and ecosystem services provided by the impacted area. In addition, "additional uncertainties" can be accounted for by additional multipliers to create a total compensation goal. Multipliers should be used in the following situations:

- **Achieving biodiversity objectives:** multipliers are designed to ensure compensation meets landscape level conservation objectives. When development causes cumulative impacts, or to leverage conservation funding (e.g., higher multipliers for more threatened habitats, or to achieve net gains). If measures can help towards landscape level conservation objectives and have a high level of additionality within the project design, then a lower multiplier will be used than if the project has low additionality.
- **Limited information, or predictive power:** multipliers can be used to ensure NPI is achieved by accounting for uncertainties. This could be in a situation where there is limited information on either impacts or offsets, or predictions are uncertain. This could be very different depending on the ecosystem in question. Because coral reefs recover so slowly, they will have high uncertainties, and greater multipliers, than a fast-growing ecosystem such as a tropical forest.
- **Risk of failure:** multipliers used if conservation gains might not succeed. When ecological measures implemented under NPI to achieve biodiversity gains may not be successful (e.g., restoration measures might fail).
- **Temporal issues:** multipliers used to manage temporal challenges. When future biodiversity gains may need to be larger than realised current losses in order to account for:
  – Human time preferences (e.g., incorporate discount rates)
  – Time lags between impacts and gains
  – The degree of permanence that can be assured for offsets.
- **NPI accounting:** Multipliers used by regulators to ensure ecological equivalence.

Decisions on the application of multipliers should be made in collaboration with national governments and local biodiversity experts. As national multipliers do not currently exist within the Mozambique Channel, it is recommended that guidance be sought from countries which do, such as South Africa and Australia as they have extensive coral reef offsetting requirements.

BOX 4: Coral reef offsetting options in Australia (Reef Trust, 2021).

Australia is famed for its Great Barrier Reef and provides a multitude of ecosystem services to local communities including reduced impact from storm surges, fishing opportunities and tourism. Coastal development along the Australian coast has received ample attention and development of offsetting schemes has resulted. Below is an example offsetting strategy put forward to the Australian Government by Reef Trust as an Offsets Plan and Calculator. A similar tool could be developed for the Northern Mozambique Channel, to signify how companies would need to compensate for damage to coral reefs.

Impact Tiers and Proposed Actions

Severity of impacts is divided into 3 Tiers. As impacts increase so do the number of actions and cost required by the proponent:

TIER 1 **focuses on water quality impacts (sediment and nitrogen)**

TIER 2 **focuses on habitats (mangroves, seagrasses, shallow reefs and saltmarsh etc) and**

TIER 3 **focuses on specific species (e.g. bony fish, sharks, dolphins).**

Low level impacts require the proponent to fund restoration activities in the same catchment area where possible. Tier 2, if moderate, focus on restoration and threat abatement where as severe impacts requires proponent-negotiated ad hoc offsets on a case-by-case basis. Predicted impacts are categorised as follows:

A) Impacts to biodiversity due to water quality changes → Tier 1 Required

B) Impacts to biodiversity through direct removal of habitats and/or indirect impacts to habitats other than water quality impacts→ Tier 2 Required

C) Impact to biodiversity through removal of species and/or indirect impacts to species other than 1) water quality impacts or 2) habitat impacts → Tier 3 Required

Offset Costs

The tool provides a calculator to estimate costs and determine the financial liability of a proponent. Currently offset costs are available for sediment, nitrogen, mangrove, seagrass, shallow reef and saltmarsh. All other offsets require ad hoc estimates. As a comparison, risk-adjusted costs are provided as unit (e.g. ha for shallow reefs and saltmarsh and tonnes for suspended fine sediment) for each type of feature being compensated for. The restoration cost per unit for a salt mash is estimated to be $100, 818 AUD / ha and $2, 742, 928 AUD/ha for shallow reefs. The success rate multiplier for each is 1.6 therefore making the risk-adjust cost (as of 2016) $322,618 and $8,777,370, respectively. To understand the full cost of offsetting and the liability of the proponent, the number of units impacted will need to be added, multiplied by a time factor, with a 25% admin fee added on. For an example 4ha offset project, the total cost would be:

((($8,777,370*4) *1)*1.25) = $43.9 million AUD

**Note that costs are based on a median average in developed countries from a peer-reviewed global meta-analysis (Bayraktarov et al. 2016).*

Offsetting actions

Similar to restoration above, coral spawning on degraded reefs can increase reef condition. Programmes exist to rear coral larvae and transplant them onto artificial reefs. Ex-situ coral cultivation and transplanting them is becoming more prominent, particularly using heat resistant corals in warming waters. Cheaper efforts include rearing coral fragments in protected bays and planting them onto degraded reefs once grown.

Location considerations are important. Site selection should include consideration of (from Reef Trust, 2021):

- Within the same catchment area as the impacted site.
- If sites within the same catchment area are not available, then the same NRM region must be used.
- Considerations of connectivity and interdependencies with other ecosystems (e.g. seagrasses) need to be thought through.
- Consideration on how features will change after disturbance (i.e. through succession)
- How pre-existing human pressures will affect restoration success
- Planned conservation interventions and how these can be leveraged to increase the chance of success.

Note that the above information is based on inshore reef knowledge. Scientific understanding of impacts and recovery rates for deep reefs is much less studied (Reef Trust, 2021). Extreme caution should be made when permitting development in these areas.

Choice of offsetting actions will also depend on national legislation and requirements. These should be consulted, ideally in partnership between the proponent and national government, to choose the most appropriate actions.

Baselines & Monitoring

To fully understand potential impacts and design an effective monitoring and mitigation plan, a comprehensive baseline needs to be developed for the coral communities within the project's area of influence. Multiple factors need to be considered including; coral structure, benthic organisms and fish communities. Established through multiple surveys, experts are required to complete these surveys and ensure appropriate metrics are used and species are accurately identified.

Avoidance to coral reef habitats is the main mitigation measure for reducing impacts to this critical ecosystem. When a project is likely to move forward, and an EIA is being completed, a comprehensive baseline survey is required to understand the current extent and condition of the reefs within the surrounding area, that have the potential to be impacted by direct (e.g. project construction, shipping, anchoring and or port/pipeline development) and indirect effects (e.g. in-migration and an increased pressure on coastal fish and invertebrate communities due to subsistence fishing).

WCS has provided well developed guidance on the state of coral reefs in Mozambique (Birrell et al. 2020a) and monitoring techniques for coral reef communities within the Western Indian Ocean (Birrell et al. 2020b). A summary of these recommendations is provided below to indicate proponent expectation when submitting an EIA. Ideally, three aspects of a coral reef community should be surveyed, to understand the health of the reef and the species composition. This includes coral reef, macro algae/benthic organism surveys and reef fish surveys. Details on each are provided below.

Coral reef surveys

Multiple structures of coral reefs exist. They will occur at different depths and orientations, and a multitude of abiotic factors which will affect community structure and diversity. These must be considered to help identify appropriate sites that are comparable for long term monitoring, to understand impacts of a project.

Habitat features to consider (from Birrell et al. 2020b):

- Depth
- Reef zones: slope, crest, flat, back reef, lagoon, patch reef
- Reef types: points, pinnacles, reef channels, cleaning stations
- Turbidity and sediment loads, distance offshore or from source of sediment
- Reef substrate orientation
- Distance from human centre or fishing port as proxy for fishing intensity
- Tidal currents and water movement speeds
- Exposure to waves and wind

Once a site has been chosen for development, it will be important to gather baseline data to understand the condition of the reef before activities begin. There are a few considerations to be made, before deciding when/where to survey. As above, survey sites should be chosen in areas where direct and indirect effects are anticipated to occur. Similar sites should be chosen further from the site, to act as a control and be used to compare results over time. If it is found that the sites directly/indirectly affected by the project worsen over time, adaptative management strategies would need to be implemented to try and reduce pressures on the reef. See Table 7 for survey techniques and considerations:

Table 7 from Birrell et al. 2020 Guide Monitor Coastal Habitats (Corals and benthic organisms)

Potential indicators to understand state	• *Coral percentage cover (%) • Coral health (categorised based on bleaching; normal, pale, 0-20% bleached, 21-50% bleached etc.) • *Coral diversity • *Coral size-class distribution (abundance per size class; reproductive vs. immature colonies) • *Coral abundance (n/m²) • Abundance of key coral species (% cover; n/m²) • Abundance of coral predators (n/m²) • Abundance and diversity of coral diseases (% diseased colonies, n/m²) • *Coral recruitment rate (count/m²) • *Macroalgae % cover, density and diversity (% cover, n/m² diversity indices)
Survey methods: core monitoring	• Point Intercept Transects (PIT)/Line Intercept Transects (LIT) • Photo-quadrats • Visually assessed quadrats • Inclusion of metadata to describe condition/circumstances when each site was surveyed (e.g. survey name, date, time (start and end), observer, site name, GIS coordinates, transect number etc).
Survey methods: complementary monitoring	• General habitat mapping and ground truthing satellite / aerial images • Timed random search observations, preferably with photographic records, from a site with defined habitat characteristics (e.g. depth, reef zone). • Size class measurements in belt transects to provide insight to the demographic structure of a coral community. • Monitor environmental parameters: temperature, visibility, light intensity, rugosity and habitat complexity
Timing	• If monitored once, the hottest month of the year should be chosen (March & April) to allow monitoring for coral bleaching • Good light is needed for observations (7:30 – 16:30) • Snorkelling and diving are best at high or low tide. This is when water movement is the least and visibility is highest.

Monitoring – Fish Abundance

Coral reefs provide complex habitat for numerous species, including coastal fishes. The more diverse a reef habitat is, the greater resilience it will have to rebound after environmental and human-induced disaster. Understanding species composition, estimates on fish biomass and size class distribution can provide an indication on relative coral reef health. Local communities in the area rely on fish for subsistence and it is important that negative changes to reef health are not a result of economic development. In Table 8 below, proposed indicators and methods for measuring fish diversity within a coral reef are described.

Table 8 from Birrell et al. 2020 Guide Monitor Coastal Habitats

Potential indicators to understand state	• *Fish diversity • *Fish biomass per area (kg/ha) • *Fish size class distribution (kg/ha) • Biomass and diversity of key functional and trophic groups (kg/ha) • Herbivore diversity and biomass (diversity indices, relative abundance)
Survey methods: core monitoring	• Visual belt transect surveys (50m x 10m) to record fish abundance, diversity and biomass (using Fish allometric length-weight conversion of [W = a × TL × b])
Survey methods: complementary monitoring	• Non-baited video camera to monitor fish diversity and abundance (minimum 5m visibility required) • Timed swims • Stationary point counts • Manta tow
Timing	• Survey at same time as corals if surveying once/year • Seasonal surveys recommended to identify variation in presence and abundance (60 – 90 days apart) • Survey in middle of day (10:00 – 14:00) with good light • High tide required to observe feeding and predator presence • Consider lunar cycle as moon phase influences aggregation for spawning

*Recommended indicator

Biodiversity Feature 2: Sea Turtles

Introduction

Sea turtles, sometimes called marine turtles, are large migratory reptiles that inhabit tropical and subtropical seas throughout the world. These animals interact with a diverse array of marine plants and animals traveling to and from open ocean, seagrass meadows, mangrove swamps, coral reefs, among other ecosystems. Sea turtle species play a special role in their ecosystems by maintaining a balanced food web as top predators and providing food (eggs and hatchlings as prey) for other coastal animals, stimulating habitat formation and structure, and maintaining the health of marine habitats by facilitating nutrient turnover and succession, (FFI, 2017). These animals are considered one of the Northern Mozambique channel's (NMC) most valuable marine megafauna both ecologically, economically, culturally, and in terms of food security (Humber et al. 2015).

Of seven occurring species of sea turtles, five occur within and along the coastline of the NMC: the green turtle *(Chelonia mydas)*, loggerhead *(Caretta caretta)*, hawksbill *(Eretmochelys imbricata)*, Olive ridley *(Lepidochelys olivacea)* and leatherback *(Dermochelys coriacea)*.

Life cycle and sensitive time periods

Sea turtles have a complex life cycle. Baby turtles (or hatchlings) start out as eggs that are laid in nests on sandy beaches. Once hatched the hatchlings head directly for the open ocean. Post-hatchlings are understood to follow several years of passive pelagic migration, however their specific whereabouts are widely unknown. Large numbers of young or juvenile and sub-adult turtles are typically found along coastal foraging grounds for most of the year. Once they are fully grown, adult turtles migrate back to where they were born from the open ocean to the shallow coastal zone for foraging and reproduction. Adult females will mate with multiple males and then when ready, the climb up onto the nesting beach to lay their eggs, starting the cycle again.

In the NMC, sea turtle species exhibit a variety of movement behaviours, such as, seasonal or multiyear residency, site fidelity, as well as highly migratory strategies, moving to and from nesting and feeding grounds north and southward along the continental coastline, and to and from nesting beaches and pelagic foraging. Spatial variation differs regionally and between different genetic stocks or regional management units (RMU) for each sea turtle species (Williams, *et al.,* 2017). Within the channel, their migration patterns criss-cross the channel due to oceanographic conditions and mixing.

Most sea turtles return to their beach of birth during the mating season. Males and females congregate offshore mating for several months and may mate with several partners depending on the species. Afterwards, only the females come to shore to nest, typically at night. Females dig deep holes along a sandy beach before depositing their eggs, covering their nests and returning to sea. Eggs can incubate before hatchlings emerge for 45-80 days. During the nesting period, female turtles, and her eggs and hatchlings are most sensitive to poaching threats, and disturbance from coastal light and noise.

Adult, subadult and juvenile sea turtles can regularly be seen in the NMC year-round, however species and interspecies female nesting behaviour shows great temporal and spatial variability. Generally, nesting in this area is reported to occur between October to July for all species, however, comparison of rookeries and studies demonstrate species and interspecies nesting variation that is associated to location as well as environmental factors that affect foraging areas (Dalleau, M., *et al,* 2012; Fernandes et al., 2016; Pilcher & Williams, 2018; refer to Table 9 below for reproductive variability of each species).

Species

Five species have been reported in the NMC: *Chelonia mydas* (green turtle), *Caretta caretta* (loggerhead), *Eretmochelys imbricata* (hawksbill), *Lepidochelys olivacea* (Olive ridley), and *Dermochelys coriacea* (leatherback) (see **Appendix 5** for a detailed description). These species can be found throughout the NMC; however, it nests outside this section of the Mozambique channel farther south along the sandy beaches of the southern coast of Mozambique and coast of South Africa (Lockhart, G.G *et al,* 2014; Pilcher NJ & J Williams, 2018, van De Geer, *et al.*, 2022). Post nesting leatherbacks leaving the southern Maputal and rookery of Mozambique follow 3 distinct migratory corridors, with only one corridor crossing the NMC heading northward closely following the Mozambique coast, settling for extended periods in central Mozambique in the shallow coastal zones of Sofala Bank.[11]

Table 9 Summary table of NMC sea turtle threat status and reproduction traits

Species	Scientific name	Threat status	Nesting period	Egg clutch size	Clutches per season
Green	*Chelonia mydas*	EN *Southwest Indian RMU: LC*	All year round, with main nesting season between February and July.	75-200	1-9
Loggerhead	*Caretta caretta*	VU *Southwest Indian RMU: NT*	Oct to Feb	110-130, multiple times	2-5
Hawksbill	*Eretmochelys imbricata*	CR *Southwest Indian RMU: not assessed*	October to February	140	3-5
Olive ridley	*Lepidochelys olivacea*	VU *West Indian RMU: not assessed*	October to February	100-110	1-3
Leatherback	*Dermochelys. coriacea*	VU *Southwest Indian RMU: CR* *Northeast Indian RMU: DD*	November to March	50-170	5-7

Note: Data in table sourced from the Animal Diversity Web (online; Myers et al, 2024), the IUCN Red List of Threatened Species (IUCN, 2024) Fernandes et al (2016) and Pilcher & Williams (2018)

11. The other two migratory corridors head southwards to the Indian ocean, and another continuing west to the Atlantic ocean

Pressures

All five species are threatened according to the International Union for Conservation of Nature (IUCN), listed as either vulnerable, endangered, or critically endangered worldwide (IUCN, 2024). Regionally, the main threats to sea turtles are mortality and injury by accidental capture by commercial and artisanal fisheries in fishing gear (known as bycatch), from gillnets, longlines and trawling, and direct mortality from unsustainable harvesting of nesting turtles and eggs for traditional protein source, medicinal and ornamental use, and international wildlife trade. Furthermore, its populations are in decline from habitat degradation at nesting beaches and foraging areas from coastal developments (see Table 10 for sea turtles sensitive locations), increased effluent and water pollution, plastic ingestion and suffocation, disease (i.e. Fibropapilloma) and disruption to behaviour from increased coastal light sources (Pilcher NJ & J Williams, 2018; Williams et al., 2019; Rakotonirina and Cooke, 1994).

Table 10 Summary of commonly occurring species by country and its known sensitive locations. Each species is identified as exhibiting behaviours along each country's marine and terrestrial coastline, which include nesting, foraging, and transient.

Country	Most common species	Sensitive locations and habitats
Madagascar	Green (few nesting) Hawksbill (few nesting sites)	• Barrier reefs provide important feeding grounds for both juvenile and adult sea turtles • Few Hawksbill and Green nesting sites at Nosy Iranja
Tanzania	Green turtle (nesting, abundant) Hawksbill (nesting) Loggerhead (foraging and transient)	• Tanzania harbours extensive seagrass beds and coral reefs • Common nesting of green turtle, • Hawksbill nesting sites restricted to coastal islands • most important current C. mydas nesting sites in Tanzania are found in the districts of Kigamboni, Pangani, and Mafia • hawksbill nesting sites along coastal islands • Coastal waters are critical developmental grounds for juvenile green turtles and subadults, while Zanzibar supports E. imbricata juveniles • C. mydas foraging hotspot - Rufiji Delta-Mafia Channel Complex • southern Tanzania is an important foraging ground for C. caretta • Tanzania coastline is a frequent migratory pathways for loggerhead
(Northern) Mozambique	Green turtle (nesting) Hawksbill (nesting) Leatherback (transient)	• Soft and plate corals, rocky reefs and mixed coral and microalgae • Vamizi island is most important nesting site for *C. mydas* and *E. imbricata* in Mozambique • Qurimbas Archipelago supports smaller clutches (<100) for *C. mydas* and *E. imbricata* • Mozambique coastline to northern Mozambique supports major migratory corridor for *D. coriacea*

Note: Published literature and long-term monitoring have identified these species as nesting along beaches, foraging along recognized coastal habitats, and transient referring to known migration pathways along its coastline. Each represent significant risk to sea turtle impacts by oil and gas development.

These species are fully protected by national laws (in all three countries), and by international treaties such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)[12] and Convention on the Conservation of Migratory Species of Wild Animals (CMS). Tanzania, Madagascar and Mozambique are also signatories to the Sodwana Declaration and the Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia (IOSEA MoU)[13], the latter being an instrument of the CMS.

For all best practice mitigation measures, it is recommended that regulators and project developers consult the IUCN Species Survival Commission (SSC) Marine Turtle Specialist Group (see **Appendix 4** for available databases), especially when a project is impacting critical sea turtle habitat.

Avoidance

Depending on the stage and context of the EIA in review, government regulators should ensure that all best practice avoidance measures are incorporated for various stages of O&G development. Mitigation measures should ensure that sensitive and critical habitat for sea turtles are spatially avoided (i.e. nesting beaches and foraging zones) and sensitive breeding and reproductive seasons are temporally avoided (Table 10). More details are provided in the following paragraphs.

Scoping

Before any practices are begun, an initial risk assessment of the general nature of the project activity (i.e. seismic survey, construction, operations, shipping) and the local environment is necessary to help determine the scale and magnitude of impact. This involves assessing the type, scale, duration, and specifics of the proposed project, as well as, in this case the sea turtle species and their critical habitats potentially affected within the survey area. This initial risk assessment informs planning and design of the Project and need for additional baseline studies.

The baseline assessment of the EIA shall incorporate this risk assessment, review of existing data and additional field studies. Robust field assessments should survey and inventory nesting beaches and offshore feeding grounds using standardised techniques for aerial, boat, in-water (scuba or snorkelling) and ground surveys, as applicable. However, surveys should apply location- specific methods that accurately reflect the offshore environments unique conditions. Furthermore, timing of surveys should align with peak abundance and sensitive time periods of sea turtles (e.g. peak nesting between October and July), and at minimum cover two periods or seasons, depending on metric and species target. Standard research and monitoring methods for sea turtles in both offshore (in-water) and onshore (nesting) are summarized in Table 11.

12. All sea turtles are listed on Appendix I of CITES

13. The MoU provides a framework through which States of the region, as well as other concerned States, can work together to conserve and replenish depleted marine turtle populations for which they share responsibility. It includes a comprehensive region-wide plan containing 24 programmes and 105 specific activities which aim to reverse the decline of marine turtle populations throughout the region. https://www.cms.int/iosea-turtles/fr/signatories-range-states

Table 11 Standard research and monitoring methods for sea turtles

Target	Method	Technique	Description	Indicator
Offshore/ in water for foraging individuals	Non-transect (Catch per unit effort)	Netting	Placement of floating turtle nets or large turtle seine in a set depth and duration	Abundance, diversity, size
		Standard swim snorkelling	Along the edge of or across a coral reef habitat or seagrass bed	Abundance, diversity, size, extent of suitable habitat
		Standard boat-based searching	Visual observation from boat along an area of habitat or multiple habitats	Abundance, diversity, size, extent of suitable habitat
Offshore/ in water for foraging individuals	Transect based methods (Catch per Unit Effort)	Aerial drone surveying techniques	Visual observation of large area and several habitats	Abundance, size, extent of suitable habitat
		Boat-based surveying	Boat based observers count turtle observations along pre-defined transects across a study area	Abundance, diversity, extent of suitable habitat
Onshore	Beach nesting	Transect based method	Walking set transects along coastal beach front for sea turtle nesting evidence (tracks, nests, adult emergence)	Nesting events, nesting success, poaching rate, abundance and diversity (female only), extent of suitable nesting habitat
	Turtle bycatch surveys	Interviews	Interviewing of fishers across local study area to gather perception on bycatch rates, hotspots and gear used, as well as capture and release incidents	Poaching rate from by-catch, mortality, suitable habitat
Onshore and offshore	Capture-Mark-Recapture	Metal flipper and PIT tags	Additional method of tagging individuals with unique tag identifier that can be done with beach transects or boat surveys	Abundance, diversity, size population size estimate, survival, spatial behaviour

Planning and design of avoidance measures to mitigate disturbance of habitat and species

For appropriate planning and assessment of impacts, an EIA shall identify presence, and distribution of sea turtles in the AOI/study area within the baseline assessment chapter. The baseline assessment shall have incorporated a combination of desktop review, field assessments and stakeholder consultation. The level of risk of a Project and data availability typically will dictate the extent and degree of field work for sea turtles required.

Baseline assessments should include the following to inform a meaningful risk assessment and operational monitoring and mitigation practices.

- Incorporation of existing databases, regional species assessments, relevant peer reviewed published scientific articles, and other relevant information
- Global, regional and local mapping databases shall be incorporated to inform distribution of sea turtles, and sensitive habitat (e.g. nesting) of sea turtles. A useful online database of sea turtles and their nesting habitat in the region can be identified using State of the World's Sea Turtles (SWOT) Mapping Application.
- Assessment of physical and biological environment
- Robust field ecological assessments shall identify and incorporate the following:
  – Key threatened and priority species at global, regional and local scale, their presence, abundance and distribution
  – Sensitive habitat critical for reproduction (nesting and inter-nesting), foraging and movement
  – Habitat use and spatial distribution identifying density of individuals in associated sensitive habitat (density of nesting events, density of individuals
  – Quality, degree of threat, and vulnerability of sea turtle habitat to establish "no go" areas of avoidance
  – Apply appropriate and standardised methodologies for assessing sea turtles and their key habitats by qualified specialists
    - Methodologies may include aerial, boat, and ground surveys or a combination.
    - Target appropriate seasons and multiple seasons, at minimum two seasons to capture peak nesting and outside of nesting to capture other behaviours (e.g. foraging and migration; refer to Table 12)
- Assessment of additional stressors (beyond Project) and human activities - O&G exploration and development, Shipping traffic, fishing, construction, naval activity, acoustic research activities
- Exposure analysis using models and algorithms to assess impacts of pollutants, noise, sedimentation, among others.

Table 12 Methodologies for assessing sea turtles and their habitats

Type	Timing	Indicators
Onshore coastal foot surveys	Nesting season only	Nesting behaviour, levels of poaching, abundance (of females)
Offshore coastal surveys by boat, in-water, or aerial	Two seasons at minimum Peak nesting (October – July) and outside of nesting season	Nesting behaviour, levels of poaching, foraging and resting distribution, abundance

EIAs must incorporate spatial avoidance measures of critical foraging and key breeding habitat which may occur from impacts of seismic surveys, exploratory drilling, shipping (sea vessel presence, movement and anchoring), port construction, field development, operations and decommissioning.

- All <u>infrastructure, anchoring of vessels offshore and operations</u> shall avoid areas near the coast and sensitive areas, such as Marine Protected Areas (MPA), critical habitat for sea turtles (i.e. nesting beaches and foraging areas – seagrass beds and coral reefs)
  – Seagrass beds and coral reefs in any state of conservation should always be categorized as critical habitat, with beds and corals in a good state of conservation should be considered "No Go" areas
  – Utilize predictive forecasting models to select a placement and design of jetty and port infrastructure that does not cause erosion of nesting sand beaches
- Avoid detonations during reproductive seasons
- Avoid illuminating nesting beaches and surface of water with night lighting

EIA shall identify sensitive time periods for key species and the EMP shall incorporate temporal avoidance measures during sensitive periods.

- Exploratory <u>seismic surveys, construction, and other noise generating activities</u> shall avoid sensitive breeding periods for sea turtles from October to July

Hearing effects and physical impairments by increased underwater noise

Increased underwater sound may be caused by seismic surveys, drilling, pile-driving, dredging, shipping, among other construction activities.

Sea turtles exhibit behavioural changes and/or avoidance within a localized area around an operating seismic survey vessel. There are very few data on temporary hearing loss and no data on permanent hearing loss or injury in sea turtles exposed to air source pulse; However, PTS thresholds of 204 dB SEL cum and 232 dB peak have been proposed (NMFS, 2018). The limited available data indicate that the frequency range of best hearing sensitivity of sea turtles extends from ~100–700 Hz overlaps with the frequencies produced by air source pulses.

To avoid impacts by underwater noise an EIA shall include the following information and measures.

- Underwater sound modelling of the source impact should be utilized to measure and predict the received noise with various propagation conditions to understand receiving area and quality of habitat and establish exclusion zones.
  – Water depth, bottom type, sound generating activity, and volume should be factored into the sound model to determine the size of the exclusion zone.
  – Models should incorporate various times of the year to determine maximum zones of PTS and TTS injury thresholds for sea turtle species.
- At minimum, the EMP should establish turtle exclusion radius from the centre of the source noise impact.
  – Qualified marine observers should conduct visual monitoring with appropriate sighting technology within the exclusion (on deck and/or underwater) to ensure no visual detection of sea turtles within the exclusion zone 30 min preceding the start of the noise generating activity.
  – If a sea turtle is sighted within or approaching the relevant exclusion zone, noise sources should not be activated until the animal has left the zone, or 30 minutes has passed, and the animal had not been re-sighted
  – To prevent a startle response, undertake observations around noise generating impulsive operations (e.g. pile driving) prior to commencement of work. If species are observed within a site-specific exclusion zone, delay commencement until individuals clear the area.
- Only commence surveys during daylight hours when visual mitigation is possible.
- Avoid noisy construction activities such as pile driving for port infrastructure, dredging, drilling during sensitive mating and breeding between October and July
- Avoid dredging and extracting construction materials from the sea floor nearby to seagrass and coral reef habitat

Seismic exploration surveys

Seismic air sources have a low probability of directly harming most marine life, except at close range where physical hearing impairment or entanglement can occur to sea turtles. For this reason, avoidance measures to exclude and detect sea turtles occurring near the air source array is critical to avoid exposing them to sound pulse and proximity.

The EIA shall identify the entire Project area in which seismic air source arrays will be activated to establish appropriate avoidance strategies and designs. Reproduction areas for sea turtles shall be delineated and avoided. It is expected that significant population level adverse effects on any marine species shall be avoided and sea turtles (and marine mammals) listed as endangered or threatened should not be displaced during breeding, nesting, and foraging nor diverted from known migration routes.

- An alternative analysis that considers location, time, and design for sea turtles shall be evaluated before conducting a seismic survey
- Sea turtle species likely to be present in the survey areas should be identified. Plan surveys to avoid areas and periods of high abundance and key seasons
- Seismic survey lines should be designed based on spatial density maps of aggregation and feeding areas by season

- Dates and timeline of seismic survey activity should be planned during off peak seasons of reproduction.
- Once critical avoidance zones for sea turtles are identified, a buffer zone should be established to ensure that operating survey vessels do not enter the vicinity; this should include foraging and reproductive zones
- Exclusion zones around seismic surveys should be established at a minimum of 500 m for all marine fauna species.

Injury and mortality by detonation

During construction of offshore infrastructure, detonations can cause **physical injury and mortality** to nearby sea turtle species of concern and other marine taxa.

To avoid impacts of physical injury (including hearing) and mortality by detonations an EIA shall include the following information and measures

- Conduct pre-detonation searches for sea turtles at least 1 hour before any type of detonation. Visual above water and underwater (snorkelling or scuba) monitoring should be conducted by a trained marine observer in the mitigation zone and should continue until the observer advises that the mitigation zone is clear.
- Plan the sequence of multiple explosive charges so that, where possible, smaller charges are detonated first to maximise a 'soft-start' effect.
- Implement an exclusion zone and safety zone to avoid physical injury and hearing impairments to sea turtles
  – Identify the radii distance of the safety zone to prevent serious injury or mortality, with a buffer added to account for animal movement towards the zone itself
  – Default mitigation zone for marine observation mitigation should be 1km, measured from the explosive source, 360 degrees circular coverage.
- Only commence explosive detonations during the hours of daylight and good visibility (observers should be able to monitor the full extent of the mitigation zone). If sea turtles (or other marine mammals) are observed, delay detonation (dedicated and trained marine observers should carry out observations). Delay should last for at least 30 minutes of a sea turtle leaving the mitigation zone

BOX 3: Example of mitigation measures for sea turtles

Avoidance

- Vessel operators and contractors will implement vessel strike avoidance protocols to reduce the potential for vessel strike, including establishing an incident register. When turtles are seen ahead of a vessel, procedures to avoid collision should be adopted. These should include the reduction of vessel speed and maintaining a steady course. Erratic changes of direction should be avoided.
- Vessel operators and contractors will log all incidents/ interactions with marine mammals and reptiles (in addition to observations recorded in the marine fauna register

Minimization

- Operation of high-speed typical crew boat operations not planned to occur during night and will be minimised during low light conditions
- The speed of vessels should be kept to a minimum, consistent with operational and safety constraints. A maximum speed of 10 kts should be implemented for all vessels
- Vessel traffic at night will be minimised
- Lighting will be reduced on marine infrastructure including avoiding use of unnecessary lighting, shading light spill and downward lighting.

Minimise

After all avoidance measures are taken to reduce impacts to sea turtles and priority species, measures designed to further reduce impacts should be established in the EIA. This section focuses upon preventative measure to reduce the duration, intensity, significance and/or extent of impacts to sea turtles that cannot be completely avoided.

Underwater noise

Underwater noise should be restricted, and where noise cannot be avoided, relevant mitigation measures should be implemented to ensure a reduction or mitigation of anthropogenic marine noise. Permanent and threshold shifts (PTS and TTS) to sea turtles (and marine mammals) shall be modelled based on activity (i.e. seismic, dredging, drilling and pile driving) to determine distances of exclusion zones and mitigation measures.

- Establish auditory exclusion zones during drilling, pile driving and seismic surveys (at minimum 500 m from the source or as determined by TTS). A marine observer shall spot for turtles' sightings within the auditory exclusion area and halt the noise-generating activities when turtles are sighted.
  – Physical barriers should be considered such as floating silt curtains or mesh fences, which can be installed at distances determined by sediment plume model, while observers can monitor the additional distance determined by threshold shift.
  – Observer monitoring can be done above water by observers on deck, drones or underwater with SCUBA, autonomous underwater vehicles (AUVs), among others.
- Underwater noise monitoring through passive acoustic monitoring (PAM) or autonomous acoustic recorder (AR) devices can be utilized in different scenarios to ensure thresholds are followed and equipment is adjusted when necessary to remain under TTS. However, environmental factors, such as depth and pressure, can reduce the effectiveness of acoustic devices, therefore additional types of technology should also be considered by specialists.
- Alternative survey methods may include remote sensing. Optical remote sensing methods may be employed in shallow water where water clarity is sufficient around 25 m. For deeper waters, active acoustic remote sensing such as sidescan sonar systems (SSS), and multi-beam echo sounders (MBES) could be considered.
- During seismic and dredging activities, operators shall slowly increase activity over a period of 30 minutes. Pile driving shall implement sound mitigation measures such as soft starting to gradually increase hammer power, which would minimise noise disturbance to a behavioural response of deterrence rather than permanent hearing effects
- Bubble curtains and other noise mitigation measures shall be considered to reduce underwater noise to sea turtles

BOX 4: Noise minimisation measures for sea turtles

Sea turtles are especially sensitive to low sound frequencies, with maximum sensitivity at or below 400 Hz; for perspective, humans hear sounds ranging from 20 Hz to 20,000 Hz (SWOT). Anthropogenic noise that overlaps with the hearing range of sea turtles includes noise produced by vessels which has the most energy between 10 Hz and 1000 Hz, airgun seismic surveys with most energy between 5 and 300 Hz, and pile driving, involved in constructions with most energy between 100 and 1000 Hz. Anticipated noise within these frequencies should be given particular attention for developing a robust mitigation plan, that ensures turtles do not come into the vicinity of the noise source and techniques are applied to minimise the duration of the operation as much as possible. The proponent should provide a plan that explains the anticipated noise source, and how project planning has been modified to reduce impact to sea turtles

Vessels (and aircraft)

Impacts by industrial vessels that can be minimized through preventative measures include shipping collisions, underwater noise and artificial night light.

To minimize impacts of accidental collisions by vessels an EIA shall include the following measures.

Vessel (and aircraft) movement should be restricted from moving within and around defined coastal sensitive areas for sea turtles, major migratory routes or other known high concentrations of turtles.

- Design narrow corridors for vessel and helicopter routes to minimize disturbance and collision risk
- Ensure EMP includes vessel strike avoidance plan and protocols to reduce the potential for strikes with sea turtles (and other marine megafauna)
- Limit vessel speeds along neritic (coastal) zones and nearby sensitive area to <10 knots, when less than 2.5 m limit speed to <4 knots per hour or similar. Vessels should also follow safety speed limits accordance to safety requirements near project infrastructure.
- Limit number of vessels engaged in offshore operations
- Vessels should implement a sea turtle (and marine mammal) avoidance protocols which restricts operators from coming within 100 m of sightings.

To minimize impacts of underwater noise caused by propellers and thrusters, as well as additional machinery, an EIA shall include the following measures:

- Use PAM to monitor ship noise
- Implement noise reduction measures, such as non-essential equipment shut down
- Ensure gradual start-up of engines and thrusters where possible, to provide opportunity for species to take evasive action
- Ensure good propeller design, including large diameter, slow turning props (reduced cavitation), as well as blade shapes optimised to flow conditions, increased skew, and hull modifications to improve flow conditions
- Utilize cold ironing, shore connection, or alternative maritime power (AMP), when ships are at berth
- Monitor acoustic noise levels using hydrophones and PAM from offshore vessels to ensure limits are below TTS

Artificial night light (ANL)

ANL from construction and operational vessels, drill rigs, LNG FPSO, coastal infrastructure and offshore anchored vessels can impact sea turtles may cause disorientation during migrations, disturbance and behavioural impacts on adults and hatchlings.

ANL shall be restricted to only light which is necessary for security and safety. An EIA and its ESMS shall include measures to develop and implement a light management plan for coastal and offshore infrastructure to minimize artificial night time lighting disturbance and disorientation impacts on sea turtles. Measures can include the following:

- Utilizing long wavelength light (yellow to red; or above 560 nanometers). Low-pressure sodium- vapour lighting is the purest yellow light source and commercially available.
- Install lights with directional lighting to illuminate rigs and vessels as necessary, low in height, and with light shielding such as hoods to minimize light cast upwards and outwards
- Install lights with motion-sensitive switches to turn off unnecessary artificial night light, considering safety and security
- Develop and implement a coastal light monitoring plan at sensitive beach nesting locations

BOX 5: Turtles and artificial light sensitivity

Sea turtles do have colour vision and can sense the shorter, near-UV light wavelengths emitted from the stars and moon that humans do not see. Hatchlings use those dim light cues to crawl toward the sea from the nest, and adult females respond to such cues during nest site selection (SWOT vol XVIII)”]. For this reason, lighting on nesting beach habitat should be always be avoided and coastal infrastructure, such as ports and jetties, shall minimize safety and security lighting as possible

Seismic surveys

The following minimization measures should be incorporated as part of the EIA and EMP to further reduce impacts from seismic surveys on sea turtles

- Reduce potential for entanglement of sea turtles in the seismic equipment and acoustic receivers by including no tangle gear attached to the streamers
- A 40-km geographic separation distance should be utilized between simultaneously operating seismic surveys to minimize cumulative impacts of increased underwater sound
- dentify maximum allowable sound exposure levels from seismic surveys for: (1) protected species, (2) any other species, i.e., allowable exposure may vary by level of regulatory protection. Determine power-down and/or shut-down criteria based on identified maximum allowable exposure levels for sea turtle and more vulnerable groups (i.e. low frequency cetaceans) based on expert opinion, available literature, and sound exposure models
- Each seismic survey and operational procedures should be designed to include the following

  – use the minimum amount of energy necessary to achieve operational objectives;

  – minimize the proportion of the energy that propagates horizontally; and

  – minimize the amount of energy at frequencies above those necessary for the purpose of the survey

  – Consider the use of alternative technologies such as marine vibrators instead of air sources to decrease source level (e.g. 50-100 dB)

  – Establish a safety zone which is a circle with a radius of at least 500 m as measured from the centre of the air source array(s)

The implementation of shut downs and ramp-up delays for sea turtles detected within an exclusion/ safety zone serves to minimize the likelihood of hearing impairment and disturbance.

- Establish an **exclusion/safety zone** – Sound propagation models should be used to establish safety zones for sea turtles (and marine mammals) during the planning stage of a seismic survey where applicable

  – The zone should be the most precautionary of a 500 m radius or a radius determined using sound propagation models based on best available data and science for a pre-determined acoustic threshold. Water depth, bottom type, and array volume all influence the size of the zone.

- Develop and implement a **Sea Turtle (and Marine Mammal) Monitoring and Detection Plan**, which includes the following:

  – If marine fauna are likely to be present in an area, only commence surveys using Marine Observers (MO). MOs should be trained and qualified, when on duty sole task is to observer for marine fauna (sea turtles and marine mammals), positioned at the highest safe lookout with no obstruction to 360 degrees visibility around the vessel, access to high-quality optical equipment, and with two observers at minimum on the source vessel

  – MOs should be independent and should have the authority to suspend surveys immediately.

  – A combination of tools (not limited to MOs) may be required to achieve the desired target probabilities of detection, these can include other detection technology such as RADAR, active sonar, thermal Infrared and aerial surveys.

- Conduct **visual and acoustic pre-seismic shooting** search for marine fauna of the exclusion zone and adjacent waters before a soft-start or ramp up technique is undertaken (see next bullet below). A search should be conducted 30 minutes before firing of the seismic source. If marine fauna are detected within 500m of the centre of the airgun array, delay the soft-start of the seismic sources until they are more than 500m away from the source and implement at minimum a 20-minute delay from the time of the last sighting or detection within 500m to commencement of the soft-start.

  – Visual Monitoring of the exclusion zone should be conducted by a qualified MO for the entire 30 minutes preceding the start of the air source array

  – When a marine fauna is sighted within or approaching the relevant exclusion zone, air sources should not be activated until the animal had left area, or 30 minutes had passed, and the animal had not been re-sighted

  – If firing of the airguns has stopped and not restarted for at least 10 minutes then a pre-shooting search and 20-minute soft-start should be carried out.

- Use **soft-start/ramp-up** techniques for surveys whereby the noise volume is slowly built up over a period of (e.g.) 20-30 minutes to give marine life more chance to move away. The air source array should be gradually ramped up preferably starting with the smallest air source and the gradual addition of other air sources until full volume is reached over a period of time. To the extent practical in the planning stages of a seismic survey, a ramp-up protocol shall determine project-specific incremental increase of sound source level.
- Immediate **Shut-down of Air Source Array**(s) any time a marine fauna (endangered, threatened) is detected within the exclusion/safety zone. This should be followed by a 30- minute all-clear period and then a standard, full ramp up
- During **line Changes and Maintenance Shut-downs**, air sources should be shut down during line changes and ramp-up's should be implemented after periods of single air source use during line changes

Turbidity

During dredging and drilling turbidity may impact areas of high density or sensitive habitat for sea turtles. The following minimization measures should be incorporated as part of the EIA and EMP to further reduce impacts.

During dredging and drilling turbidity to critical sea turtle habitat shall be minimized

- Turbidity and sedimentation plumes caused by dredging and drilling discharge should be modelled and incorporate as part of the impacts chapter of the EIA to minimize possible impacts to sensitive sea turtle ecosystems and their function, such as coral reefs.
- Prior to dredging and discharging drill cuttings and mud, the project shall model sediment plume to minimize sedimentation of critical habitat area sand consider relocation of dredged material to avoid critical areas. When dredge material is not contaminated, it can be considered for terrestrial land fill, road development, among others.
- Establish turtle exclusion zones with mesh fences and observers watching for turtle sightings during dredging for coastal infrastructure
- Utilize turtle exclusion devices and other specialised equipment when dredging
- When dredging and drilling, establish floating silt curtain for dredging and discharges of drilling mud and cuttings to minimize sedimentation nearby to critical sea turtle habitat. For dredging, silt curtains should be maintained until suspended solids concentration is equal to or below baseline turbidity threshold.
- Monitor for turtle entrapment within construction site and implement sea turtle rescue plan

Offshore disturbances

EIA and the ESMP shall incorporate mitigation measures to reduce mortality, injury and disturbance to sea turtles applicable to all offshore vessels and floating storage and regasification units

- All vessels shall comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of waste generated on board vessels
- Monitor for presence and movements of turtles (using observers on ships) so that collisions with vessels can be avoided. This mitigation action will only be effective for vessels capable of rapid manoeuvres (e.g. vessels of a few thousand GT or less)
- All vessels should implement a waste management plan that includes guidance for marine debris awareness
- Develop and implement maritime waste and effluent management plan, prohibit dumping of waste in open ocean. Vessels shall abide by MARPOL Annex V[14], which seeks to eliminate and reduce the amount of garbage being discharged into the sea from ships.
- Ensure that floating storage and regasification units include grates to avoid uptake of sea turtle hatchlings with water uptake
- Seismic vessels shall utilise turtle guards on seismic streamer tail buoys to minimize risk of entanglement.

14. https://www.imo.org/en/ourwork/environment/pages/garbage-default.aspx

Waste and effluent management

EIA and the ESMP shall incorporate waste management plans for onshore to minimize physical and chemical waste from polluting the ocean and causing mortality and injury to sea turtles

- All onshore areas should implement a waste management plan that includes guidance for marine debris awareness
- For coastal port infrastructure, develop and implement effluent and stormwater management plan
- Conduct routine water quality assessment from treated effluent discharge points
- Implement routine beach and coastal clean-up (i.e. plastics initiative) involving staff and local coastal communities in the AOI
- Develop and implement land-based waste and effluent management plan, prohibit dumping of waste in open ocean

Unintended exploitation from population influx

In accordance with national and international laws protecting sea turtles from exploitation, projects may cause an influx in population and workforce to the area and may indirectly increase poaching threats. An EIA should identify this threat and implement mitigation measures to reduce poaching pressure.

- Design and implement a bushmeat action plan for sea turtles, which includes

  – Collect, develop and disseminate sensitization/education materials to local coastal communities on sea turtle threat status, legal protection, ecological importance and unsustainable exploitation of sea turtles

  Conduct employee and contractor sensitization campaigns regarding conservation status, legal protection and ecological importance of sea turtles

  Prohibit employees and contractors from fishing and hunting on port infrastructure and all operational vessels.

  Prohibit employees and contractors from harvesting or purchasing protected species (e.g. sea turtle eggs and sea turtles)

  Include measures in employee and contractor code of conduct and disciplinary policy

  Monitor and report incidents of illegal take, trafficking incidents, and turtle mortality
- Implement a beach and coastal long-term monitoring program and patrol for sea turtles with the direct participation and employment of coastal local communities

Accidental events

In cases of unplanned events, especially regarding unexpected oil spills, all projects and vessels shall have an emergency oil spill plan and procedure.

Restore

Regulators shall ensure that all spatial and temporal avoidance measures have been incorporated in an EIA and its ESMP to evade significant impacts to sensitive and critical habitats for sea turtles such as coral reefs, sea grass meadows, nesting beaches, and major migratory routes. After the avoidance and minimisation measures have been implemented, there may be some unavoidable impacts to these habitats, in this context, an EIA shall quantify the amount of area impacted.

Restoration refers specifically to area measures of returning an ecosystem to its former natural condition and to restoring ecological function; therefore, restoration is not an applicable mitigation measure for affected sea turtle species. In any case, restoring sensitive or critical sea turtle breeding or foraging areas **that were impacted or disturbed by the project footprint can be restored. An EIA shall identify means to restore temporarily impacted or degraded areas by the project.**

Restoration actions that can be considered for sea turtle species include the following:

- Restoration of seagrass bed
- Restoration of coral reef (see above)
- Restoration of degraded mangrove forests
- Restoration of sandy beach coastline – replace eroded or removed sand, re-vegetate, where appropriate, frontal dunes at nesting beaches, with indigenous flora as far as possible, remove installed access points, and to restore appropriate beach temperature regimes

Offsetting

As the three governments of the NMC do not have a pre-designed offset or compensation bank, the residual impact assessment of the EIA shall include conservation measures to offset adverse residual impacts to sea turtles. In practice, the appropriate offsetting mechanism for impacts to sea turtles shall be designed and implemented with participation and consultation of local and national government ministries, sea turtle experts and local conservation institutions. In the case of Mozambique, offsets shall follow national follow national legislation (Ministerial Diploma 55/2019) and its implementation manual.

Furthermore, it is important to highlight that there are numerous key challenges for implementing offsets based on the key offset principles in a marine enviroment with wide ranging species (Jacob et al 2020). Even so, offsets can aim to generate gains by creating or restoring sea turtle habitat or may include specific species focus actions to reduce bushmeat hunting, creation of rookeries to increase hatching success and survival, among others.

The Marine Turtle Conservation Strategy and Action Plan for the Western Indian Ocean[15] and the Conservation and Management Plan (CMP) broadly include key sea turtle conservation topics, such as reducing mortality, improving understanding of ecology, and increasing public awareness and participation[16] that should be undertaken with any sea turtle offsetting measure. Furthermore, if any local Sea turtle action plan exists, the project should align as possible with priority actions.

In this section examples are provided for which can be considered for the design and planning of offsets to compensate for residual impacts that could not be avoided or minimized. However, the actual work of designing and conserving these offset projects and areas lies outside the scope of this guidance.

Possible offsets which should be considered for sea turtle species gains may include restoration,ecosystem enhancements, and protection . In practice, the type of offset(s) to be implemented shall abide by the national legislation.[17]

15. IUCN East Africa Regional Office and IUCN/SSC Marine Turtle Specialist Group. 1996. A Marine Turtle Conservation Strategy and Action Plan for the Western Indian Ocean https://portals.iucn.org/library/sites/library/files/documents/1996-047.pdf

16. Efforts may involve organising beach clean-ups, establishing marine sanctuaries, conducting regular beach patrols and creating conservation and research programs with the local community.

17. In the case of Mozambique, averted loss offsets are not permitted.

Restoration offsets include manipulating the physical, chemical, or biological characteristics of the habitats mentioned above (e.g. seagrass, mangrove, coral reef, and coastal beach) to enhance natural functions or sea turtle species population in an existing habitat. Stakeholder consultation with government and non-government conservation organizations should be conducted to identify degraded priority areas in need of restoration in the wider seascape of the Project.

Outside of restoration actions, offsetscan aim to acheive gains for sea turtle species by removing or reducing exisitng or anticipated threats to its habitats or existing populations within the wider seascape of the Project. These offset actions may include but are not limited to the following:

- Supporting technical and financial capacity of a marine protected area and its management to reduce impacts to sea turtles and stabilize or increase resident and migratory population size. Measures may include

  – Establishing or enhancing hatcheries/rookeries

  – Enhancing or supporting nesting beach patrol efforts

  – Support spatial planning involving stakeholders, and local communities in particular, 1) to protect nesting beaches from degradation due to coastal development, including sand mining, beachfront construction, destruction and alteration of coastal vegetation, and 2) to identify and protect important foraging areas requiring seasonal or permanent closure for fisheries

  – With the appropriate authorities, support the development and implementation of a local or national sea turtle recovery plan if not available

- Extend spatial protection measures through comprehensive regional MPA network to undisturbed critical or priority sea turtle habitat patches and transform them into formally protected areas. This includes Locally Managed Marine Areas.

  – Offset sites that could achieve multi-species conservation targets, including species other than turtles, should be prioritized.

- Managing threats to sea turtle species

  – supporting the establishment of controlled-fishing zones, or development of local sustainable harvesting systems

  – changing fishing practices to reduce bycatch of marine turtles

  – Reducing or managing threats to important ecological corridors

Lastly, as most offsets require gains on the ground, policy advocacy to change threats and pressures to sea turtles cannot be considered as an offset yet this action is highly encouraged as an additional conservation action by a project. Policy advocacy can include mitigating threats and improving longline fishing practices, alternative gear type, and temporary season closures to reduce bycatch on sea turtles.

Baselines and Monitoring

The baseline field assessments conducted as part of the EIA baseline inform the impact and therefore the consideration of a biodiversity offset. However, when data metrics are poor and do not provide a sufficient estimate of the significant adverse impact to sea turtles, which is often the case, additional field data should be collected to inform offset design.

Baseline and long term monitoring assessments for offset areas should align with sea turtle population metrics utilised during baseline field assessments, yet it is critical that these metrics be able to measure the quantity of losses, and gains to sea turtles. Commmonly accepted metrics to quantify gains and losses to species include population metrics, whereas suitable habitat can be a surrogate measure (Table 13).

Table 13 Common metrics for sea turtle species within a projects study area

Metric	Descriptor
Abundance	Nesting observations in the study area per species; Catch per unit effort (CPUE) in the coastal marine environment
Nesting events	Number of nesting events per season
Nesting success	Percentage of nesting events per season compared to total number of emergences
Hatchling emergence	Total number of nesting emergences
Sea turtle diversity	Number of sea turtle species recorded in the study area per season (offshore on onshore)
Extent of suitable habitat (area and condition qualifier)	Nesting habitat Foraging seagrass habitat Foraging coral reef habitat
Distribution	Area utilized for foraging, nesting, migration, and resting
Poaching rate	Percentage and number of poaching events (nest and adult females) recorded in the study area per season Percentage and number of poaching events from by catch events

Biodiversity Feature 3: Marine Mammals

Introduction

Marine mammals are classified into four different taxonomic groups: cetaceans (whales, dolphins, and porpoises), pinnipeds (seals, sea lions, and walruses), sirenians (manatees and dugongs), and marine fissipeds (polar bears and sea otters) (NOAA 2019).

These species provide vital marine ecosystem services at various levels. As apex and meso-predators across a number of food webs they affect community structure and dynamics; and as grazers impact seagrass systems and nutrient cycling. Therefore, the loss of vulnerable marine megafauna has potential consequences for ecosystem structure and function, with implications and impacts across multiple spatiotemporal scales (Temple et al. 2017).

The shores and coastal waters of the Western Indian Ocean (WIO) are recognized globally for their biological richness, natural beauty and high ecological and socio-economic value. 34 species of marine mammals, particularly the dugong, some species of whale and dolphin are part of the main marine biodiversity features of the region WW. In early December 2019, scientists announced the approval of 37 new "Important Marine Mammal Areas" (IMMAs) in the Western Indian Ocean. Important Marine Mammal Areas (IMMAs), defined as discrete portions of habitat, important to marine mammal species, that have the potential to be delineated and managed for conservation (IUCN-MMPATF 2019).

Within the NMC, there are four identified IMMAs for which details can be found in Appendix 5. These IMMA s have been identified as supporting areas that contain A) habitat important for the survival and recovery of threatened and declining species, B) small and resident populations, and important aggregations of a marine mammal species, C) key life cycle activities (reproduction, foraging, and migration), and D) high diversity of marine mammals. Similarly, several KBA[18]s in the region are triggered by marine mammals such as the North Salary MPA and Barren Islands MPA off the coast of western Madagascar. The species which meet these criteria are the focus of this guidance and are grouped into taxa as: Balean whales, Toothed whales (Odonotocetes) and dolphins, and sirenians (e.g. Dugong; refer to Appendix 5).

Threats to marine mammals are largely the result of human impacts, including incidental capture in fishing gear, habitat destruction, poaching, pollution and collisions with ships (NOAA, 2019). Specifically, from offshore industries, pressures on marine mammals include bycatch, prey depletion, underwater noise, habitat degradation, and collision with static or moving objects. This exposure of marine megafauna, such as cetaceans, to many human pressures is causing the decline of populations or the extinction of several species over the last few centuries (Pimiento et al., 2020) and leads to multiple disruptions of ecological processes, such as changes in the behaviour of marine animals (Rodríguez et al 2023). In the Western Indian Ocean, there are reports of bycatch of dugongs and dolphins (Humpback and bottlenose), primarily in gillnet and trawl fisheries.

18. https://www.keybiodiversityareas.org/

Avoidance

It is recommended that regulators and project developers consult the IUCN SSC-WCPA Marine Mammal Protected Areas Task Force, especially when a project is impacting critical marine mammal habitat. Mitigation measures should ensure that sensitive and critical habitat for marine mammals are spatially mapped and avoided (i.e. migratory corridors) and sensitive breeding and reproductive seasons are temporally avoided. More details are provided in the following paragraphs.

Scoping

Before any practices are begun, an initial risk assessment of the general nature of the project activity (ie. seismic survey, construction, operations, shipping) and the local environment is necessary to help determine the scale and magnitude of impact. This involves assessing the type, scale, duration, and specifics of the proposed project, as well as, in this case the marine mammals species and their critical habitats potentially affected within the survey area. This initial risk assessment informs planning and design of the Project and need for additional baseline studies.

The baseline assessment of the EIA shall incorporate this risk assessment, review of existing data and additional field studies.

Planning and design of avoidance measures to mitigate disturbance of habitat and species

An EIA shall identify the presence and distribution of marine mammals in the study areas/AOI within the baseline chapter. The baseline assessment shall have incorporated a combination of desktop review, field assessments and stakeholder consultation. The level of risk of a Project and data availability typically will dictate the extent and degree of field work for sea turtles required.

Baseline assessments for marine mammals should include the following to inform meaningful risk assessment and operational monitoring and mitigation.

- Incorporation of existing databases, regional species assessments, relevant peer reviewed published scientific articles, and other relevant information.
- Global, regional and local mapping databases shall be incorporated to inform distribution and sensitive habitat of resident and migratory marine mammals (Appendix 4). The online IMMA[19] e-Atlas provides quick access to information about marine mammal habitats and species with the option to view fact Sheets and to download shapefiles.
- Assessment of physical and biological environment
- Robust field ecological surveys shall identify and incorporate the following
  – Key threatened and priority species at global, regional and local scale, their presence, abundance and distribution
  – Resident and migratory species and behaviours
  – Sensitive habitat critical for reproduction (e.g. breeding, calving and nursing), foraging and movement
  – Habitat use and spatial distribution for migration, breeding, calving, nursing and foraging, identifying density of individuals in associated sensitive habitat
  – Quality, degree of threat, and vulnerability of marine mammals' habitat to establish "no go" areas of avoidance
  – Ecological interactions and drivers influencing the distribution and density of the prey of key species
  – Hearing sensitivities of marine mammal species
  – Apply appropriate and standardised methodologies for assessing marine mammals and their key habitats by qualified specialists
    - Methodologies may include aerial (aircraft or drone)/vessel/shore-based visual surveys, infrared, socio-ecological interviews, acoustic surveys, satellite tracking, or a combination.
    - Multiple surveys should be conducted at different time periods for both resident and migratory species
    - For migratory species, field surveys should target appropriate seasons during peak migration times or during seasons of peak aggregations for breeding, calving, nursing or foraging of priority species. Refer to Table 14 for details on migrant species peak abundance.
- Other stressors and human activities: O&G exploration and development, Shipping traffic, fishing, construction, naval activity, acoustic research activities
- Exposure analysis using models and algorithms to assess impacts of pollutants, noise, sedimentation, among others.

Acoustic exposure modelling tools should be utilized to identify sound impact zones and minimization measures of overall exposure to sound. These should account for species presence, group structure, and baseline behaviour, and animal movement and response, to estimate average and maximum noise exposure within survey area, accounting for species-specific hearing abilities (e.g., frequency-weighting functions).

Table 14 Spatial and temporal avoidance considerations for migrant species within the NMC

Migrant Species	Location	Time	Sensitivity
Humpback, *Megaptera novaeangliae*	Coastal waters of **Mozambique** extending to the northern border with Tanzania	Peak abundance: July and August	Mating, calving and nursing grounds
	Coastal shallow waters of western coast of **Madagascar**	May- November	Mating, calving and nursing
Antarctic blue whale, *Balaenoptera musculus intermedia*	Northern Mozambique Channel Specifically, *Northwest Madagascar and Northeast Mozambique channel* IMMA	VU Southwest Indian RMU: NT	Oct to Feb
Pygmy blue whale, *Balaenoptera musculus brevicauda*	*Northwest Madagascar and Northeast Mozambique channel* IMMA	CR Southwest Indian RMU: not assessed	October to February
Fin whale, *Balaenoptera physalus*	Deep offshore waters of Nosy be, **Madagascar**	VU West Indian RMU: not assessed	October to February
Sperm whales, *Physeter macrocephalus*	Deep water offshore of Northwest Madagascar and *Northeast Mozambique channel* IMMA	VU Southwest Indian RMU: CR Northeast Indian RMU: DD	November to March

19. IMMAs are defined as discrete portions of habitat, important to marine mammal species, that have the potential to be delineated and managed for conservation. https://www.marinemammalhabitat.org/

EIAs must incorporate spatial avoidance of critical foraging and key breeding habitat which may occur from impacts of seismic surveys, exploratory drilling, shipping (sea vessel presence, movement and anchoring), port construction, field development, operations and decommissioning.

- All infrastructure, anchoring of vessels offshore and operations shall avoid migration, breeding, calving, and important feeding areas for marine mammals. These may include:
  – Seagrass meadows where Dugongs frequent for foraging (E.g. the west coast of Madagascar)
  – Coastal areas of high prey productivity where dolphin species will aggregate for foraging
  – Migrant corridors and winter resident areas as identified in Table 14.
- Avoid detonations during sensitive marine mammal periods
  – Determine what marine mammal species are likely to be present in the detonation area and assess if there are any seasonal considerations that need to be taken in to account, e.g. migration, breeding and calving
- Vessel traffic and helicopter routes shall avoid high density coastal habitat and sensitive reproductive areas for marine mammals
  – Vessel traffic shall avoid areas of underwater canons which are important for sperm whales.

EIA shall identify sensitive time periods for key species and the EMP shall incorporate temporal avoidance measures during sensitive periods for migration, breeding, and calving.

- Seismic surveys, and noise generating activities during construction (e.g. dredging) shall avoid migratory and breeding seasons to avoid masking whale singing, navigation, reproductive success, mortality and injury, and adverse impacts to this population

Hearing effects and physical impairments by increased underwater noise

Sound is an important sensory modality for marine mammals, and the bandwidth of range of acoustic frequencies is wide and varies between species. Increased underwater sound may have an effect on marine mammals when it is in the shared frequency range of their hearing and vocalization. Increased underwater sound may be caused by seismic surveys, drilling, pile-driving, dredging, shipping, among other construction activities.

Marine mammals use acoustic cues to avoid approaching boats, communicate, navigate, reproduction and forage. Acoustic masking[20] may have a wide range of potential repercussions across marine animal taxa, by influencing their behaviour, their capacity to effectively communicate or their ability to hear information pertinent to their long-term survival and health, such as for orientation (Cholewiak).

Temporary threshold shift (TTS), as well as permanent threshold shift (PTS) represent the most common hearing effect of acute and chronic high-level acoustic stimulation. TTS is the mildest form of hearing impairment that can occur during exposure to a strong sound. It is a temporary phenomenon, and is not considered to represent physical damage or "injury". Rather, the onset of TTS has been considered an indicator that, if the animal is exposed to higher levels of that sound, physical damage (PTS) is ultimately a possibility (Moulton et al 2020).

Noise exposure criteria proposed by Southall et al (2019) to predict the onset of auditory effects of TTS and PTS in marine mammals are presented in Table 15 and Table 16 below. Different thresholds have been provided for the various hearing groups, including low-frequency cetaceans (e.g., baleen whales), high-frequency cetaceans (e.g., most odontocetes or toothed whales), very high-frequency cetaceans, which are not relevant for the NMS, and sirenians (e.g. dugongs).Table 15 and Table 16 present impulsive noise (e.g. pile driving, geophysical seismic surveys, explosives) and continuous non-impulsive noise (i.e. long duration noises, such as vessels and dredging) categories, respectively. These thresholds are recommended guideline that can serve as the basis to establish exclusion zones for sources of significant underwater noise. The largest distance of criteria (SEL or Peak SPL) can be used as the safety radius.

20. Acoustic masking can occur when an extraneous sound covers or 'masks' a desired signal, making the latter more difficult to detect.

To avoid impacts by underwater noise an EIA shall include the following information and measures.

- Underwater sound modelling of the source impact should be utilized to measure and predict the received noise with various propagation conditions to understand receiving area and quality of habitat and establish exclusion zones.

  – Water depth, bottom type, sound generating activity, and volume should be factored into the sound model to determine the size of the exclusion zone.

  – Models should incorporate various times of the year to determine SPL peak injury thresholds (PTS onset) for marine mammals species.
- At minimum, the EMP should establish a 500 m minimum exclusion radius from the centre o the source noise impact.

  – Qualified marine mammal observers (MMOs) should conduct visual and acoustic monitoring of the exclusion to ensure no visual detection of marine mammals within the exclusion zone 30 min preceding the start of the noise generating activity.

  – If a marine mammal is sighted within or approaching the relevant exclusion zone, noise sources should not be activated until the animal has left the zone, or 30 minutes has passed, and the animal had not been re-sighted

  – To prevent a startle response from marine fauna, undertake observations around noise generating impulsive operations (e.g. pile driving) prior to commencement of work. If species are observed within a site-specific exclusion zone, delay commencement until individuals clear the area.

Only commence surveys during daylight hours when visual mitigation is possible.

Table 15 TTS- and PTS-onset thresholds for marine mammals exposed to non-impulsive noise. Exposure criteria are given in in frequency weighted sound exposure level (SEL, given in units relative to 1 µPa2-s) (Southall et al 2019)

Marine mammal hearing group	Taxa	Genera (or species) included	TTS onset: SEL (weighted)	PTS onset: SEL (weighted)
Low-frequency cetaceans	baleen whales	Balaenopteridae: Fin whale *(Balaenoptera physalus),* Blue whale (B. *musculus*), *Ziphius* spp	179 dB	199 dB
High-frequency cetaceans	Most odontocetes	Physeteridae (Physeter); Delphinidae (Orcinus) Delphinidae (Globicephala spp., *Peponocephala*, Pseudorca, *Sotalia* spp., Sousa spp., *Stenella* spp., , Tursiops spp.)	178 dB	198 dB
Very high frequency cetaceans	Subset of odontocetes	NA		
Sirenians	Sirenians	Dugongs *(Dugong dugong)*	186 dB	206 dB

Table 16 TTS- and PTS-onset thresholds for marine mammals exposed to impulsive noise: SEL thresholds in dB re 1 μPa2 s under water and peak SPL thresholds in dB re 1 μPa under water (Southall et al 2019)

Marine mammal hearing group	Taxa	TTS onset: SEL (weighted)	TTS onset : Peak SPL (unweighted)	PTS onset: SEL (weighted)	PTS onset: Peak SPL (unweighted)
Low-frequency cetaceans	baleen whales	168	213	183	219
High-frequency cetaceans	Most odontocetes	170	224	185	230
Very high frequency cetaceans	Subset of odontocetes	140	196	155	202
Sirenians	Dugongs	175	220	190	226

Seismic exploration surveys

Seismic air sources have a low probability of directly harming most marine life, except at close range where physical injury can occur. For this reason, avoidance measures to exclude and detect marine mammals occurring near the air source array is critical to avoid exposing them to sound pulse.

The EIA shall identify the entire Project area in which seismic air source arrays will be activated to establish appropriate avoidance strategies and designs. Migration, breeding, calving, and important feeding areas for marine mammals shall be delineated and avoided. It is expected that significant population level adverse effects on any marine species shall be avoided and marine mammals (and sea turtles) listed as endangered or threatened should not be displaced during breeding, feeding and nursing nor diverted from known migration routes.

One of the most common behavioural responses is displacement for most marine mammals, and at least localized avoidance of air source arrays. Furthermore, the spectrum of seismic airguns overlaps with vocalizations causing communication masking (Nowacek 2007). Baleen whales estimated hearing range overlaps with the highest peaks of the power spectrum of seismic air source arrays and are known to exhibit behavioural response and changes after exposure to the noise. Toothed whales (ie. sperm whale and delphids) reactions to large arrays for air sources are variable. Dolphins (Delphinus spp) have been documented to produce less vocalizations during active seismic survey air source arrays (200 Hz).

Therefore, EIAs must incorporate spatial avoidance of critical foraging and key breeding habitat. If a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant (ie. greater risk of reduced reproductive success; Nowacek et al. 2015). Baleen whales, such as humpbacks, generally avoid operating air sources, therefore migrational corridors (e.g. coastline of Mozambique) shall be mapped to understand timing of impact.

To avoid impacts of increased underwater noise by seismic surveys an EIA shall include the following information and measures

- Pre-seismic survey studies should be conducted for threatened listed species if the seismic survey area overlaps the distributional range of a threat-listed species and finer-scale distributional patterns are not well known. These studies would assess for the occurrence of species and increase the understanding of the likelihood of displacing or diverting individuals. Each survey must be designed to avoid

  – displacing an individual marine mammal (or sea turtle) of a species listed as endangered or threatened from breeding, feeding or nursing;

  – diverting migrating marine mammal listed as endangered or threatened on from a known migration route or corridor;

- displacing a group of breeding, feeding or nursing marine mammals, that would cause significant adverse effects;

  – diverting marine mammals from known migration routes or corridors if it is known there are no alternate migration routes or corridors, or that if by using those alternate migration routes or corridors, the group of marine mammals would incur significant adverse effects.

  – overlapping entirely with the range of a sensitive resident marine mammals' population (e.g. Omura's whale)

  – high quality sensitive foraging and breeding areas which may cause significant population level adverse effects, especially for periods of long-term displacement or repeated events.

- Predictive noise propagation or exposure models should determine extent of underwater sound to inform avoidance measures

  – Refer to Table 15 for non impulsive noise thresholds which may be used to establish exclusion and safety zones for marine mammals and use of MMOs

  – Utilize 160 dB, or as determined by specialist, to guide predictions of behavioural responses of groups of marine mammals to alter design of seismic line surveys

- Seismic survey lines should be designed based on spatial density maps of aggregation and feeding areas by season
- An alternative analysis that considers location, time, and design for marine mammals shall be evaluated before conducting a seismic survey
- Marine mammal species likely to be present in the survey areas should be identified. Plan surveys to avoid areas and periods of high abundance and key seasons
- Dates and timeline of seismic survey activity should be planned during off peak seasons for migratory marine mammals' aggregations. Survey shall avoid peak season abundance of migratory times, breeding, calving and nursing areas.
- Once critical avoidance zones for marine mammals are identified, a buffer zone should be established to ensure that operating survey vessels do not enter the vicinity
- Exclusion zones should be established at a recommended distance minimum of 500 m for all mammal species, 1 km for species of concern without young, and 1.5 km radius for species of concern with young. The acoustic source must be shut down if any marine mammals enter the relevant mitigation zones.

Vessels

Industrial vessels can cause **continuous non-impulsive underwater** noise at low frequency levels which can mask acoustic cues and vocalization of some low frequency cetaceans, such as baleen whales. Large vessels have been documented to mask humpback and fin whale song by 85-90% (Cholewiak et al).

To avoid impacts of increased underwater noise by vessels an EIA shall design vessel routes to avoid areas of known high concentration of marine mammals.

Vessel traffic should include recommendations from published guidance from the Quieter Western Indian Ocean Project (QWIO). At the time of the writing of this guidance, QWIO was conducting a scientific assessment of underwater noise from shipping and maritime services and its effects on marine mammals and sea turtles in the Western Indian Ocean, and - in consultation with the private sector and the authorities concerned – developing concrete and practical measures to avoid and minimise impacts associate with marine traffic that are accepted by regional governments, ship owners, the ports concerned and relevant international authorities.[21]

21. https://programs.wcs.org/qwio/About

Injury and mortality by detonation

During construction of offshore infrastructure, detonations can cause **physical injury and mortality** to nearby marine mammals species of concern and other marine taxa.

To avoid impacts of physical injury (including hearing) and mortality by detonations an EIA shall include the following information and measures

- Implement an exclusion zone and safety zone for marine mammals with MMOs to avoid physical injury and hearing impairments to marine mammals.

  – Identify the radii distance of the safety zone to prevent serious injury or mortality, with a buffer added to account for animal movement towards the zone itself

  – Default mitigation zone for marine mammal observation mitigation should be 1km, measured from the explosive source, 360 degrees circular coverage. This radius can be increased/decreased if there is supporting evidence to do so following consultation with the appropriate marine mammals' specialist.

- Only commence explosive detonations during the hours of daylight and good visibility (observers should be able to monitor the full extent of the mitigation zone). If marine mammals are observed, delay detonation (dedicated and trained marine mammal observers should carry out observations). Delay should last for at least 30 minutes of a marine mammal leaving the mitigation zone

  – In darkness or low visibility, use PAM to detect marine species in the exclusion zone and within 500 m. Use Active Acoustic Monitoring (AAM) to supplement visual observations and PAM as mitigation measures. Small hand-deployable units for detecting dolphin and porpoise clicks are good in shallow water, whereas larger units deployed by large vessels with the ability to record high-frequency bandwidths should be considered for deep water.[22]

22. Sousa-lima et al (2013) provide an inventory of acoustic autonomous recorders and there limitations in various marine situations. Link

Minimise

After all avoidance measures are taken to reduce impacts to marine mammals and priority species, measures designed to further reduce impacts should be established in the EIA. This section focuses upon preventative measure to reduce the duration, intensity, significance and/or extent of impacts to marine mammals that cannot be completely avoided.

Underwater noise

Underwater noise should be restricted, and where noise cannot be avoided, relevant minimisation measures should be implemented to ensure a reduction of anthropogenic marine noise.

Impacts from underwater noise can be minimized through monitoring with the use of hydrophones to record background baseline noise levels and Project associated high noise impact generating activities such as pile driving, drilling, dredging and seismic surveys.

- Underwater noise monitoring through passive acoustic monitoring (PAM) or autonomous acoustic recorder (AR) devices can be utilized in different scenarios to ensure thresholds are followed and equipment is adjusted when necessary to remain under TTS. However, environmental factors, such as depth and pressure, can reduce the effectiveness of acoustic devices, therefore additional types of technology should also be considered by specialists.
- Alternative survey methods may include remote sensing. Optical remote sensing methods may be employed in shallow water where water clarity is sufficient around 25 m. For deeper waters, active acoustic remote sensing such as sidescan sonar systems (SSS), and multi-beam echo sounders (MBES) could be considered.
- SEL values should be calculated over the entire duration of a discrete noise exposure or over multiple repeated noise exposures that occur in sufficiently rapid succession.
- Noise levels should be monitored for exceedance of pre-defined thresholds, when exceedances occur modifications to equipment or design shall be implemented

Injury and mortality by detonation

During construction of offshore infrastructure, detonations can cause **physical injury and mortality** to nearby marine mammals species of concern and other marine taxa.

To minimize impacts of physical injury (including hearing) and mortality by detonations an EIA shall include the following information and measures

- Pre-detonation searches for marine mammals at least 1 hour before any type of detonation. Visual and acoustic monitoring should be conducted by a trained marine mammal observer in the mitigation zone and should continue until the observer advises that the mitigation zone is clear.
- Plan the sequence of multiple explosive charges so that, where possible, smaller charges are detonated first to maximise a 'soft-start' effect.
- In the case of repeated detonations (e.g. excavations), however, the effects on animals outside the injury/mortality zone should also be monitored.

Vessels

Impacts by industrial vessels that can be minimized through preventative measures include shipping collisions, underwater noise and artificial night light (see section Artificial night light (ANL)).

To minimize impacts of accidental collisions by vessels an EIA is recommended to include the following measures

- Monitor for presence and movements of marine mammals (and sea turtles) using Marine Mammal Observers (MMO) on ships, and/or acoustic monitoring devices to minimize potential for collisions. This mitigation action will only be effective for vessels capable of rapid manoeuvres (e.g. vessels of a few thousand GT or less)

- Limit speed of vessels to 10 knots when nearshore to coastal sensitive habitats. When less than 2.5 m in depth, limit speed to <4 knots per hour or similar. Vessels should also follow safety speed limits accordance to safety requirements near project infrastructure.
- Limit speed of all vessels to 10 knots when in proximity to migration corridor and during seasonal peak migration.
- Shipping routes shall be restricted to narrow routes to avoid significant overlap with near-coastal zone habitat for Indian Ocean humpback, dolphin, Indo-Pacific bottlenose dolphin and dugong.
- Develop and implement a clear, structured communication and response plan for struck or stranded marine mammals.

To minimize impacts of underwater noise caused by propellers and thrusters, as well as additional machinery, an EIA is recommended to include the following measures:

- Use PAM to monitor ship noise.
- Implement noise reduction measures, such as non-essential equipment shut down
- Ensure gradual start-up of engines and thrusters where possible, to provide opportunity for species to take evasive action.
- Ensure good propeller design, including large diameter, slow turning props (reduced cavitation), as well as blade shapes optimised to flow conditions, increased skew, and hull modifications to improve flow conditions.
- Utilize cold ironing, shore connection, or alternative maritime power (AMP), when ships are at berth
- Monitor acoustic noise levels using hydrophones and PAM from offshore vessels to ensure limits are below non-impulsive continuous noise thresholds (refer to table x).

Aircraft (fixed wing and helicopter)

Noise and disturbance to marine mammals by routine aircraft flights can be minimized through preventative measures, which may include the following:

- Minimize noise disturbance by prohibiting aircraft from circling or hovering over marine mammals or sites identified as sensitive for marine mammals unless essential for safety purposes.

Artificial night light (ANL)

ANL from construction and operational vessels, drill rigs, LNG FPSO, coastal infrastructure and offshore anchored vessels can impact marine mammals may cause disorientation during migrations, disturbance and behavioural impacts on species and its prey.

An EIA and its ESMS shall include measures to develop and implement a light management plan for coastal and offshore infrastructure to minimize ANL. It is recommended that a light management plan include the following as feasible:

- ANL shall be restricted to only light which is necessary for security and safety.
- As recommended for sea turtles, longer wavelength lighting (above 560 nm) is recommended as a precaution. No guidance is provided for marine mammals.
- Install lights with directional lighting to illuminate rigs and vessels as necessary, low in height, and with light shielding such as hoods to minimize light cast upwards and outwards
- install lights with motion-sensitive switches to turn off unnecessary artificial night light, considering safety and security.

Seismic surveys

The following minimization measures should be incorporated as part of the EIA and EMP to further reduce impacts from seismic surveys on marine mammals.

- Use active acoustic sonar equipped with transducer operating frequency above 200kHz[23] to minimise interference with marine mammals.

23. The level of sound from 200 kHz echo sounders are within the hearing range of some marine mammals and above the thresholds for hearing of many marine mammals, but well below the levels that might cause physical injury.

- Reduce potential for entanglement of marine animals in the seismic equipment and acoustic receivers by including no tangle gear attached to the streamers.
- A 40-km geographic separation distance should be utilized between simultaneously operating seismic surveys to minimize cumulative impacts of increased underwater sound
- Identify maximum allowable sound exposure levels from seismic surveys for: (1) protected species, including more vulnerable types of individuals (e.g., mother-calf pairs); (2) any other species, i.e., allowable exposure may vary by level of regulatory protection. Determine power-down and/or shut-down criteria based on identified maximum allowable exposure levels for cetacean groups based on expert opinion, available literature, and sound exposure models
- For resident populations of marine mammals, such as Omura's Whale in and other dolphins, where overlap may be significant if entire exploratory block is in coastal water neritic habitat, minimization efforts will be critical

  – The EIA should differentiate between what may be harmless, short-term responses to a sound from responses that could have an adverse impact on resident populations

  – In areas closest to high density areas and sensitive habitat, limit surveys to periods when sound propagation is lowest.

- Each seismic survey and operational procedures should be designed to include the following

  – use the minimum amount of energy necessary to achieve operational objectives;

  – minimize the proportion of the energy that propagates horizontally; and

  – minimize the amount of energy at frequencies above those necessary for the purpose of the survey

  – Consider the use of alternative technologies such as marine vibrators instead of air sources to decrease source level (e.g. 50-100 dB)

  – Establish a safety zone which is a circle with a radius of at least 500 m as measured from the centre of the air source array(s)

The implementation of shut downs and ramp-up delays for marine mammals detected within an exclusion/safety zone serves to minimize the likelihood of hearing impairment considering onset of permanent and temporary threshold shifts (PTS, TTS) in marine mammal hearing.

- Establish an **exclusion/safety zone** – Sound propagation models should be used to establish safety zones for marine mammals during the planning stage of a seismic survey where applicable

  – The zone should be the most precautionary of a 500 m radius or a radius determined using sound propagation models based on best available data and science for a pre-determined acoustic threshold. Water depth, bottom type, and array volume all influence the size of the zone.

  – Exclusion zones should consider 500 m at minimum; however, the presence of certain species, potential risk of adverse impacts, and the output of the array may justify the safety zone to be extended to 3 km. High-frequency cetaceans typically require a larger exclusion zone (e.g. 1500 m)

  – a minimum 500 m zone around air source arrays is likely sufficient to minimize exposure to air source pulses which may result in permanent auditory damage to most marine mammal species

- Develop and implement a **Marine Mammal and (Sea Turtle) Monitoring and Detection Plan**, which includes the following:

  – If marine mammals are likely to be present in an area, only commence surveys using Marine Mammal Observers (MMO). MMOs should be trained and qualified, when on duty sole task is to observer for marine mammals, positioned at the highest safe lookout with no obstruction to 360 degrees visibility around the vessel, access to high-quality optical equipment, and with two observers at minimum on the source vessel

  – MMOs should be independent and should have the authority to suspend surveys immediately.

  – If carrying out seismic surveys in darkness or low visibility, use a Passive Acoustic Monitoring device (PAM) to detect marine mammals likely to be present in the area. PAM operatives must be experienced and should assess any acoustic detections and determine if there are likely to be marine mammals within 500 m of the source. If present, the operation should be suspended.

– The use of PAM should be considered in areas where the likelihood of encountering whales is moderate to high. PAM should be used when the seismic survey area occurs in Critical Habitat for a vocalizing cetacean, observers should watch for vocal signatures or other recognition criteria that would trigger a shut down of the air sources. Environmental factors, such as depth and pressure, can reduce the effectiveness of acoustic devices, therefore additional types of technology should also be considered by specialists. Alternative survey methods may include remote sensing. Optical remote sensing methods may be employed in shallow water where water clarity is sufficient around 25 m. For deeper waters, active acoustic remote sensing such as sidescan sonar systems (SSS), and multi-beam echo sounders (MBES) could be considered.

– A combination of tools (not limited to MMOs and PAM) may be required to achieve the desired target probabilities of detection, these can include other detection technology such as RADAR, active sonar, thermal Infrared and aerial surveys.

- Conduct **visual and acoustic pre-seismic shooting** search for marine mammals of the exclusion zone and adjacent waters before a soft-start or ramp up technique is undertaken (see next bullet below). A search should be conducted 30 minutes before firing of the seismic source or 60 minutes if surveying where deep diving mammals are likely to be present (in deep waters >200m). If marine mammals are detected within 500m of the centre of the airgun array, delay the soft-start of the seismic sources until they are more than 500m away from the source and implement at minimum a 20-minute delay from the time of the last sighting or detection within 500m to commencement of the soft-start.

  – Visual Monitoring of the exclusion zone should be conducted by a qualified MMO for the entire 30 minutes preceding the start of the air source array

  – When a marine mammal is sighted within or approaching the relevant exclusion zone, air sources should not be activated until the animal had left area, or 30 minutes had passed, and the animal had not been re-sighted

  – If firing of the airguns has stopped and not restarted for at least 10 minutes then a pre-shooting search and 20-minute soft-start should be carried out.

- Use **soft-start/ramp-up** techniques for surveys whereby the noise volume is slowly built up over a period of (e.g.) 20-30 minutes to give marine life more chance to move away. The air source array should be gradually ramped up preferably starting with the smallest air source and the gradual addition of other air sources until full volume is reached over a period of time. To the extent practical in the planning stages of a seismic survey, a ramp-up protocol shall determine project-specific incremental increase of sound source level.
- Immediate **Shut-down of Air Source Array**(s) any time a marine mammal (endangered, threatened), or other marine mammals (and sea turtle) is detected within the exclusion/safety zone. This should be followed by a 30- minute all-clear period and then a standard, full ramp up.
- During **line Changes and Maintenance Shut-downs**, air sources should be shut down during line changes and ramp-up's should be implemented after periods of single air source use during line changes.
- During operations in low visibility, cetacean detection technology such as PAM should be used during periods of poor visibility (when safety/exclusion zone not entirely visible). Use of a longer hydrophone array may be required to increase detection probability of low–frequency calls by baleen whales, namely blue and fin whales.
- Specific protocols for shut-down, ramp up, and among others, are provided to vessel teams in advance of operations with clear communication lines and stop work authority defined.

Turbidity

During dredging and drilling turbidity may impact areas of high density or sensitive habitat for marine mammals. The following minimization measures should be incorporated as part of the EIA and EMP to further reduce impacts from seismic surveys on marine mammals.

- Turbidity and sedimentation plumes caused by dredging and drilling discharge should be modelled and incorporate as part of the impacts chapter of the EIA to minimize possible impacts to sensitive sea areas, such as seagrass meadows for dugongs or high prey density areas for dolphins.
- the Project shall model sediment plume to minimize sedimentation of critical habitat areas and consider relocation of dredged material to avoid critical areas. When dredge material is not contaminated, it can be considered for terrestrial land fill, road development, among others.
- Utilize exclusion zones and MMOs to observe for marine mammals during dredging for coastal infrastructure.
- When dredging and drilling, establish floating silt curtain for dredging and discharges of drilling mud and cuttings to minimize sedimentation nearby to sensitive areas. For dredging, silt curtains should be maintained until suspended solids concentration is equal to or below baseline turbidity threshold.

Waste and effluent management

Improper disposal of hazardous, organic and inorganic waste from coastal infrastructure and offshore vessels can pollute the ocean causing injury and mortality to marine mammals. The EIA and EMP shall incorporate a waste and effluents management plan for onshore coastal infrastructure and offshore vessels to minimize pollution.

- All onshore areas and vessels should implement a waste management plan that includes guidance for marine debris awareness
- All vessels shall comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of waste generated on board vessels
- For coastal port infrastructure, develop and implement effluent and stormwater management plan
- Conduct routine water quality assessment from treated effluent discharge points
- Implement routine beach and coastal clean-up (i.e. plastics initiative) involving staff and local coastal communities in the AOI
- Develop and implement land-based waste and effluent management plan, prohibit dumping of waste in open ocean

Unintended exploitation from population influx

In accordance with national and international laws protecting marine mammals from exploitation, projects may cause an influx in population and workforce to the area and may indirectly increase poaching threats. An EIA should identify this threat and implement minimization measures to reduce hunting of marine mammals and unintended by catch from artisanal fisheries.

- Design and implement a bush meat action plan for aquatic bushmeat which includes all products sourced from wild aquatic megafauna (e.g. Dugong). Measures must be context specific but might include the employment of beach patrols/eco guards and raising awareness that the harvest of certain marine species is illegal.
- Prohibit fishing and hunting on all project facilities and for all staff and contractors. Prohibit employees and contractors from harvesting or purchasing protected species products. This should be communicated in a site induction and included in the disciplinary policy.
- Apply restrictions and enforce speed limits for recreational vessels, especially in shallow water
- Raise awareness among all construction staff and contractors on environmental sensitivity and legal protection of biodiversity and local environment.

Accidental events

In cases of unplanned events, especially regarding unexpected oil spills, all projects and vessels shall have an emergency oil spill plan and procedure.

Restore

Regulators shall ensure that all preventative avoidance and minimization measures have been incorporated in an EIA and its EMP to evade significant impacts to sensitive and critical habitats for marine mamamsls such as sea grass meadows or mangroves for dugongs. After these mitigation measures have been implemented, there may be some unavoidable impacts to these habitats, in this context, an EIA shall quantify the amount of area impacted.

Restoration refers specifically to measures of returning an ecosystem to its former natural condition and to restoring ecological function; therefore, restoration is not an applicable mitigation measure for affected marine mammal species, excluding dugongs which are reliant and closely associated to seagrass habitat. An EIA shall identify means to restore temporarily impacted or degraded areas by the project if applicable.

Offsetting

As the three governments of the NMC do not have a pre-designed offset or compensation bank, the residual impact assessment of the EIA shall include conservation measures to offset adverse residual impacts to marine mammals. In practice, the appropriate offsetting mechanism for impacts to marine mammals shall be designed and implemented in accordance to national legislation on offsets[24], and with participation and consultation of local and national government ministries, marine mammals experts, international and national conservation NGOs and other local conservation institutions.

Furthermore, it is important to highlight that there are numerous key challenges for implementing offsets based on the key offset principles in a marine environment with wide ranging species (Jacob et al 2020).

Even so, Marine Spatial Planning exercises at appropriate national or regional levels should be undertaken to identify appropriate offset receiving sites and also priority sites for conservation and thus no-go for developments. In this practice, governance can also be improved and made more efficient by moving away project offsetting to offset banking at regional scale for aggregated offsets (Jacobs et al, 2020)

The offsets shall aim to generate gains by creating or restoring marine mammals' habitat, which in practicality is limited to Dugong mangrove and seagrass habitat, or may include specific species focus actions to reduce bushmeat hunting and harvesting, reduction of shipping collisions and bycatch, and protection of coastal or deep-water migratory pathways, among others. Furthermore, if any local marine mammals action plan exists, the project should align as possible with priority actions.

In this section examples are provided for which can be considered for the design and planning of offsets to compensate for residual impacts that could not be avoided or minimized. However, the actual work of designing and conserving these offset projects and areas lies outside the scope of this guidance.

Possible offsets which should be considered for marine mammal species gains may include restoration actions (when applicable), ecosystem enhancements and protection. In practice, the type of offset(s) to be implemented shall abide by the national legislation[25].

Restoration offsets are limited to residual impacts to dugongs, as restoration of open water habitats is not practical. For dugongs, restoration offsets can include manipulating the physical, chemical, or biological characteristics of seagrass and mangrove habitats to enhance natural foraging and resting habitat for dugong population. Stakeholder consultation with government and non-government conservation organizations should be conducted to identify degraded priority mangrove and seagrass bed areas in need of restoration in the wider seascape of the Project.

Protection or ecosystem enhancements can aim to achieve gains for marine mammals species by removing or reducing existing or anticipated threats to its habitats or existing populations within the wider seascape of the Project. These offset actions may include but are not limited to the following:

- Effective management and limited resources support which can support national biodiversity strategy and action plans, as well as Global Biodiversity framework goals (ie. 30 x 30 targets)

  – Supporting the establishment or extension and management of coastal and marine protected areas which support coastal, shelf and deep water areas for priority impacted marine mammal species.

  – Extend spatial protection measures through comprehensive regional MPA network to priority marine mammals areas and/or transform them into formally protected areas. This includes Locally Managed Marine Areas.

  – reduce the rate of seascape-scale biodiversity loss by contributing to specific national or regional biodiversity protected targets, providing a clear and transparent basis for compensation

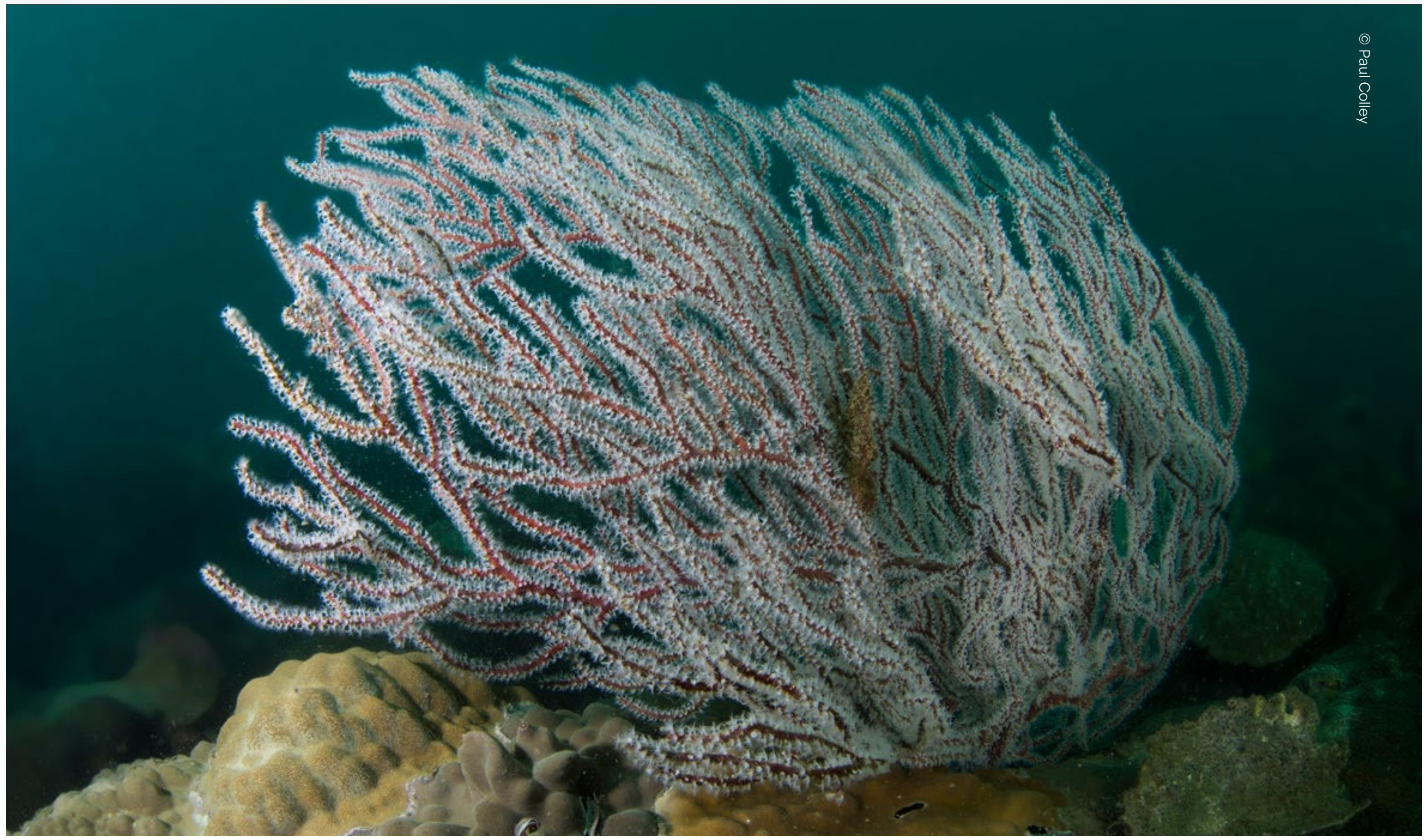
- Support spatial planning involving stakeholders, and local communities in particular, to protect IMMAs and other priority sites from degradation due to coastal offshore development, shipping and fisheries
- With the appropriate authorities, support the development and implementation of a local or national marine mammal (or species) action plan, if not in existence
- Supporting local communities to improve marine resource management avoiding targeted marine mammal catches or by-catch.
- Implementing upstream pollution and sedimentation controls to improve water quality for marine mammal species utilizing coastal marine ecosystems
- Manage existing threats to marine mammals

  – Reducing or managing existing threats to important ecological corridors

  – supporting the establishment of controlled-fishing zones, or development of local sustainable harvesting systems

Offsets for wide-ranging marine species, which are often threatened across their range, may also require "mobile offsets" that aim to tackle a number of impacts at different seasons in order to be effective. However, these types of offsets require considerable stakeholder consultation across jurisdictions. Furthermore, offset sites that could achieve multi-species conservation targets, including species other than turtles, should be prioritized.

Lastly, as most offsets require gains on the ground, policy advocacy to change threats and pressures to marine mammals cannot be considered as an offset yet this action is highly encouraged as an additional conservation action by the Project. Policy advocacy can include mitigating threats and improving longline fishing practices, alternative gear type, and temporary season closures to reduce bycatch on dolphins and other whales.



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24. In the case of Mozambique, offsets shall follow national follow national legislation (Ministerial Diploma 55/2019) and its implementation manual.
25. In the case of Mozambique, averted loss offsets are not permitted.

Baselines and monitoring

The baseline field assessments conducted as part of the EIA baseline inform the impact and therefore the consideration of a biodiversity offset. However, when data metrics are poor and do not provide a sufficient estimate of the significant adverse impact to marine mammals, additional field data should be collected to inform offset design.

Typical metrics for marine mammals species with a projects study area may include but are not limited to those listed in Table 17 with methods described in Table 18.

Table 17 Typical metrics for marine mammals species baseline assessments

Metric	Descriptor	Survey method
Relative abundance & relative density	Observations in the study area per species; these can be by visual observation or acoustic detection. Catch per unit effort (CPUE) in the coastal marine environment	Boat, aerial, acoustic
Diversity	Number of species recorded in the study area per survey effort or per time period	Boat, aerial, acoustic
Group size and composition	Estimated number of individuals in a group, sex and age, presence of calves	Boat, aerial,
Habitat occupancy	Occupied marine habitat based on distribution and behaviour	Satellite telemetry, PAM, aerial, boat
Extent of suitable habitat	Extent of good quality seagrass habitat for dugongs	Aerial surveys, boat surveys
Prey abundance	Number of specific prey species for target marine mammals	Interviews, targeted prey counts
Noise levels (dB)	Underwater noise levels in study area	PAM
Communication prevalence	Frequency range (Hz), length, temporal and spatial variation in vocalizations of marine mammals species occurring in the study areas	PAM
Poaching rate	Percentage and number of poaching events (ie. for dugongs) recorded in the study area per season Percentage and number of poaching events from by catch events (ie. for all coastal species)	Fishers surveys at shipping landings
Stranding and mortality rate	Number of stranding events or carcasses found along coastline per time period	Foot surveys, aerial surveys

Baseline and long-term monitoring assessments for offset areas should align with marine mammals' population metrics utilised during baseline field assessments. Standard research and monitoring methods for marine mammals are summarized in Table 18.

Robust field assessments should focus survey effort on areas of known marine mammals' presence around the coastline, islands, coastal shelf, deep water and inside and outside of the lagoons. Standardized survey techniques may include visual surveys by aerial or boat with photo-identification, acoustic surveys, satellite tagging and socio-ecological interviews. Furthermore, timing of surveys should align with peak abundance and sensitive time periods of marine mammals (e.g. peak migrations or calving periods), and at minimum cover two periods or seasons per year, depending on metric and species target.

Monitoring of marine mammals and enforcement of marine mitigation measures including offsets is typically costly. Therefore, project should ensure that adequate budget is set aside during project scoping, and includes local stakeholders for effective long-term success of any conservation actions.

Table 18 Methods of baseline assessments for marine mammals

Target	Method	Technique	Description	Indicator
All marine mammals	Non-transect opportunistic (Catch per unit effort)	Passive acoustic surveys	Acoustic records are recorded using autonomous hydrophones attached to a buoy and anchor system at defined locations. Noise level and vocalizations are identified after collection. New technology also allows for near real-time data collection from devices while underwater. Good for long-term monitoring	Rel abundance and diversity, communication prevalence, noise levels, habitat occupancy
		Aerial Unmanned aerial vehicles (UAVs)	Visual observation with UAVs of large areas from defined height with mounted camera and ground control system	Rel abundance, diversity, group size and composition, extent of suitable habitat, habitat occupancy, and behaviour Also photographic evidence can document occurrence of previous collisions and other injuries
		Standard opportunistic boat-based searching with marine observer	Visual observation from boat along coastal, shelf or deep offshore marine habitat	Relative abundance, relative diversity, groups size and composition, behaviour and location Also photographic evidence can document occurrence of previous collisions and other injuries
	Capture-Mark-Recapture	Satellite telemetry tagging	After capturing a marine mammals, Satellite-Relayed Data Logger (SRDLs) tags are attached to record an individual's location, speed, dive depth, and temperature of surrounding water. Good for long-term monitoring and research	Rel. abundance, density, diversity, habitat occupancy, spatial behaviour
	Transect based methods (Catch per Unit Effort	Aerial Unmanned aerial vehicles (UAVs)	Visual observation with UAVs of pre-determined transects from defined height with mounted camera and ground control system	Relative abundance, relative diversity, group size and composition, extent of suitable habitat, habitat occupancy, and behaviour Also photographic evidence can document occurrence of previous collisions and other injuries
		Boat-based searching with marine observer	Visual observation from boat along coastal, shelf or deep offshore marine habitat along pre-defined transects	Relative abundance, relative diversity, groups size, number of calves, behaviour and location Also photographic evidence can document occurrence of previous collisions and other injuries
Marine mammals impacted by poaching and by catch (ie. dugongs, dolphins)	Interview	Hydrophones attached to a boat	Acoustic records are recorded while dragged behind a boat. Noise level and vocalizations are identified after collection.	Real abundance and diversity, communication prevalence, noise levels, habitat occupancy
		Socio-ecological Interviews	Interviewing of fishers across local study area to gather perception on bycatch rates, hotspots and gear used, as well as capture and release incidents	Poaching rate from by-catch, mortality, suitable habitat

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Appendix

Appendix 1 O&G activities breakdown and biodiversity pressures categories

Project Phase	Oil & Gas Activity	Direct Pressure on Biodiversity
Shipping	Sea vessel presence and movement	Species and habitat disturbance – vessel presence; surface
	Ship and boat wash (waves created by vessel movement)	
	Anchoring	Species and habitat disturbance – vessel presence; sea floor
	Noise	Species and habitat disturbance – noise
	Lighting	Species and habitat disturbance - light
	Ballast water	Introduction of alien species
	Biofoulants (species attached to vessel hulls) on sea vessels	
	Hazardous, inorganic and organic wastes	Pollution - aquatic pollution (excl. oil)
	Gaseous sea vessel emissions	Pollution - atmospheric emissions
Port construction and operation	Construction of port infrastructure	Land/sea use change
	Dredging of sediment and disposal of spoil	
	Lighting	Species and habitat disturbance - light
	Construction vessels	Species and habitat disturbance – vessel presence; surface
	Ship and boat wash	
	Shipping	NA - see 'shipping' activity for breakdown of potential effects
	Anchoring	Species and habitat disturbance – vessel presence; sea floor
	Dredging of sediment and disposal of spoil	Species and habitat disturbance - sedimentation
	Noise	Species and habitat disturbance – noise
	Hazardous materials	Pollution - aquatic pollution (excl. oil)
	Influx of construction workforce (people)	NA – indirect impact
	Decreased access to marine resources	NA – indirect impact
Seismic surveys	Airguns	Species and habitat disturbance – noise
	Acoustic receivers (streamers)	Species and habitat disturbance – vessel presence; surface

Project Phase	Oil & Gas Activity	Direct Pressure on Biodiversity
Exploration drilling	Temporary drill rig	Land/sea use change
	Anchors	Species and habitat disturbance – vessel presence; sea floor
	Shipping	
	Artificial lighting used on rig.	Species and habitat disturbance - light
	Machinery, propellers and thrusters in exploratory drilling	Species and habitat disturbance – noise
	Helicopters for transportation to and from drill rig.	
	Cooling water	Species and habitat disturbance – warm water (temporary)
	Ballast water exchange from drill rig	Introduction of alien species
	Biofoulants on drill rigs.	
	Use of drilling muds, fluids, cuttings and cement	Pollution - aquatic pollution (excl. oil)
	Hazardous, inorganic and organic waste	
Field development (i.e. construction)	Physical disturbance and presence of permanent subsea infrastructure	Land/sea use change
	Laying of the pipeline, ancillary drilling, positioning anchors and cables	
	Dredging of sediment and disposal of spoil	
	Drilling	NA - see 'drilling' activity for breakdown of potential effects
	Construction vessels	Species and habitat disturbance – vessel presence; surface
	Shipping	NA - see 'shipping' activity for breakdown of potential effects
	Noise	Species and habitat disturbance – noise
	Lighting	Species and habitat disturbance – light
	Dredging of sediment and disposal of spoil	Species and habitat disturbance – sedimentation
	Hazardous materials (including chemicals for pipeline maintenance)	Pollution - aquatic pollution (excl. oil)
	Influx of construction workforce	NA – indirect impact

Project Phase	Oil & Gas Activity	Direct Pressure on Biodiversity
Production / operations	Construction of petroleum and LNG terminals	Land/sea use change
	Presence of subsea infrastructure (risers, flowlines, umbilical, Christmas tree)	
	Lighting	Species and habitat disturbance - light
	Shipping	Species and habitat disturbance – vessel presence; surface
	Water uptake and discharge from floating Storage and Regasification Units	Introduction of alien species
	Generation of hazardous, organic and inorganic waste	Pollution - aquatic pollution (excl. oil)
	Production of natural gas	NA – indirect impact
	Influx of construction workforce	NA – indirect impact
Decommissioning	Decommissioning of pipelines and protective infrastructure	Land/sea use change
	Decommissioning of subsea facilities	
	Lighting	Species and habitat disturbance - light
	Noise	Species and habitat disturbance - noise
	Shipping	NA - see ‘shipping’ activity for breakdown of potential effects
	Removal and disposal of hazardous waste	Pollution - aquatic pollution (excl. oil)
	Lack of decommissioning plans in line with legislation.	NA – indirect impact

Appendix 2 O&G activities and potential for biodiversity loss by feature

Project Phase	Direct Pressure on Biodiversity	Potential Max Score	Mangrove	Seagrasses (*e.g. Thalassia emprichii, Syringodium isoetifolium*)	Coastal wetland	Coral reef	Marine mammals (*e.g. humpback whale, Indo-Pacific humpback dolphin*)	Sharks/ Rays (*e.g. whale shark, saw shark, viola shark*)	Sea turtles (e.g.)	Sea birds (*e.g. sooty tern, roseate tern*)	Dugong (*Dugong dugon*)	Pelagic fishes (*e.g. pelagic fishes Yellowfin/ Bigeye/ Skipjack Tuna*)	Coastal fishes/ invertebrates (*e.g. shrimp*)
Shipping	Species and habitat disturbance – vessel presence; surface	3											
	Species and habitat disturbance – vessel presence; sea floor	3											
	Species and habitat disturbance – noise	3											
	Species and habitat disturbance - light	3											
	Introduction of alien species	3											
	Pollution - aquatic pollution (excl. oil)	3											
	Pollution - atmospheric emissions	3											
Port construction and operation	Land/sea use change	3											
	Species and habitat disturbance - light	3											
	Species and habitat disturbance – vessel presence; surface	3											
	Species and habitat disturbance – vessel presence; sea floor	3											
	Species and habitat disturbance - sedimentation	3											
	Species and habitat disturbance – noise	3											
	Pollution - aquatic pollution (excl. oil)	3											
Seismic surveys	Species and habitat disturbance – noise	3											
	Species and habitat disturbance – vessel presence; surface	3											
Exploration drilling	Land/sea use change	3											
	Species and habitat disturbance – vessel presence; sea floor	3											
	Species and habitat disturbance - light	3											
	Species and habitat disturbance – noise	3											
	Species and habitat disturbance –warm water (temporary)	3											
	Introduction of alien species	3											
	Pollution - aquatic pollution (excl. oil)	3											
Field development (i.e. construction)	Land/sea use change	3											
	Species and habitat disturbance – vessel presence; surface	3											
	Species and habitat disturbance – noise	3											
	Species and habitat disturbance – light	3											
	Species and habitat disturbance – sedimentation	3											
	Pollution - aquatic pollution (excl. oil)	3											

Project Phase	Direct Pressure on Biodiversity	Potential Max Score	Mangrove	Seagrasses *(e.g. Thalassia emprichii, Syringodium isoetifolium)*	Coastal wetland	Marine mammals *(e.g. humpback whale, Indo-Pacific humpback dolphin)*	Sharks/ Rays *(e.g. whale shark, saw shark, viola shark)*	Sea turtles (e.g.)	Sea birds *(e.g. sooty tern, roseate tern)*	Dugong *(Dugong dugon)*	Pelagic fishes *(e.g. pelagic fishes Yellowfin/ Bigeye/ Skipjack Tuna)*	Coastal fishes/ invertebrates *(e.g. shrimp)*
Production / operations	Land/sea use change	3										
	Species and habitat disturbance - light	3										
	Species and habitat disturbance – vessel presence; surface	3										
	Introduction of alien species	3										
	Pollution - aquatic pollution (excl. oil)	3										
	Species and habitat disturbance – noise	3										
	Pollution - aquatic pollution (excl. oil)	3										
Decommissioning	Land/sea use change	3										
	Species and habitat disturbance - light	3										
	Species and habitat disturbance - noise	3										
	Pollution - aquatic pollution (excl. oil)	3										

Appendix 3 Selection of priority biodiversity features

	Impacts O&G		Composite indicator					
			Mozambique		Madagascar		Tanzania	
Biodiversity Features	Score	Ranking	Score	Ranking	Score	Ranking	Score	Ranking
Coral reef	102	5	1060	4	1188	1	1296	1
Marine mammals *(e.g. humpback whale, Indo-Pacific humpback dolphin)*	105	1	1177	2	888	3	981	5
Sea turtles *(e.g. hawskbill green)*	103	3	1166	3	763	5	1070	3
Seagrasses *(e.g. Thalassia emprichii, Syringodium isoetifolium)*	97	6	981	7	918	2	1030	4
Artisinal fishery/mariculture spp. *(e.g. shrimp)*	103	3	954	6	864	4	1090	2
Sharks/Rays *(e.g. whale shark, saw shark, viola shark)*	78	9	972	5	664	6	924	6
Dugong *(Dugong dugon)*	105	1	1308	1	540	9	642	9
High-seas fisheries *(e.g. pelagic fishes Yellowfin/Bigeye/ Skipjack Tuna)*	80	8	830	8	581	7	840	7
Sea birds *(e.g. sooty tern, roseate tern)*	88	7	828	9	460	11	744	8
Mangrove	52	11	522	10	522	10	522	11
Coastal wetland	53	10	290	11	570	8	590	10

Appendix 4 Global and regional databases available for marine biodiversity features

Biodiversity feature	Dataset	Scope	Description	Link
General	Global Patterns of Marine Biodiversity	Global	The dataset shows the global patterns of marine biodiversity (species richness) across 13 major species groups ranging from zooplankton to marine mammals (11,567 species in total)	https://data.unep-wcmc.org/datasets/17
General	Copernicus	Global	Copernicus offers ocean hindcast (historical) and forecast data. Data comes from satellites, in-situ (direct ocean sampling), and numerical models that cover the global ocean.	https://marine.copernicus.eu/
General	PANGAEA	Global	PANGAEA services are generally open for archiving, publishing, and re-usage of data in the field of earth sciences, mainly dedicated to data of oceanographic ecological surveys	https://www.pangaea.de/?t=Oceans
General	World Register of Marine Species (WORMS)	Global	The Aphia platform is an infrastructure designed to capture taxonomic and related data and information, and includes an online editing environment. It is the core platform that underpins the World Register of Marine Species (WoRMS) and all its related global, regional and thematic species databases.	https://www.marinespecies.org/index.php
General	Global Biodiversity Information Facility (GBIF)	Global	International network and data infrastructure funded by the world's governments and aimed at providing open access to data about all types of life on Earth.	https://www.gbif.org/
General	Ecologically or Biologically Significant Areas (EBSAs)	Global	The EBSAs are special areas in the ocean that serve important purposes, in one way or another, to support the healthy functioning of oceans and the many services that it provides.	https://www.cbd.int/ebsa/
General	IUCN Red List	Global	The IUCN Red List of Threatened Species contains global assessments for more than 157,100 species. More than 83% of these (>130,500 species) have spatial data.	https://www.iucnredlist.org/resources/spatial-data-download
General	Key Biodiversity Areas (KBA)	Global	The KBA Programme supports the identification, mapping, monitoring and conservation of KBAs to help safeguard the most critical sites for nature	https://www.keybiodiversityareas.org/
General	Bio-Oracle	Global	Essential physical, chemical, biological and topographic data layers with global extent and uniform resolution for modelling the distribution of marine biodiversity.	https://bio-oracle.org/index.php
General	Protected Planet	Global	World Database on Protected Areas and allows users to view all MPAs individually	https://www.protectedplanet.net/en/
General	Integrated Biodiversity Assessment Tool (IBAT)	Global	Geographic information about global biodiversity	https://www.ibat-alliance.org/?locale=en
General	Important Sharks and Rays Areas (ISRAs)	Global	Similar objective as the IMMAs, the ISRAs identifies the areas critical for the conservation of elasmobranchs	https://sharkrayareas.org/e-atlas/
Coral reefs	Allen Coral Atlas	Global	Freely available maps of the world's coral reefs and allows users to monitor threats and provides actional data to better understand coastal ecosystems.	https://allencoralatlas.org/atlas/#6.14/-15.8746/42.1500
Coral reefs	NOAA Deep-Sea Coral & Sponge Map Portal	Global	NOAA's National Centres for Environmental Information (NCEI), including the US National Oceanographic Data Centre, manages one of the largest archives of atmospheric, coastal, geophysical, and oceanic research in the world.	https://www.ncei.noaa.gov/maps/deep-sea-corals/mapSites.htm
Marine mammals and sea turtles	Ocean Biodiversity Information System (OBIS)	Global	OBIS-SEAMAP consists of a diverse database accumulating data from surveys, satellite telemetry, acoustic monitoring, Photo-ID, and citizen science of marine megavertebrates.	https://seamap.env.duke.edu/
Marine mammals	Important Marine Mammal Areas (IMMAs)	Global	Input of marine mammals into existing national and international conservation tools with respect to marine protected areas, including Ecologically or Biologically Significant Areas (EBSAs) under the Convention on Biological Diversity (CBD), and Key Biodiversity Areas (KBAs) identified through the IUCN Standard (Weaver and Johnson, 2014; IUCN, 2016).	https://www.marinemammalhabitat.org/immas/
Sea turtles	The State of the World's sea turtles (SWOT)	Global	The database contains thousands of sea turtle nesting data records and sea turtle telemetry tracks worldwide.	https://www.seaturtlestatus.org/online-map-data
Sea turtles	ShellBank	Global	DNA-based traceability toolkit that tracks and traces marine turtle populations globally	https://shellbankproject.org/
Sea turtles	SEATURTLE.ORG	Global	Repository of research and conservation efforts in the sea turtle community.	http://www.seaturtle.org/
General	WIOMPAN interactive map of MPAs and OECMs in the WIO	Western Indian Ocean	This interactive map provides a wide range of data for WIO Marine Protected Areas (MPAs) and Other effective area-based conservation measures' (OECMs). It features maps of MPAs and OECMs in the WIO region.	https://wiomsa.org/wiompan/interactive-map/
General	Mozambique Biodiversity Information System (SIBMOZ)	Mozambique	Provides relevant information on national biodiversity and facilitate technical and scientific cooperation, as well as the sharing of knowledge and data, facilitating the decision-making process and promoting the sustainable use of biodiversity in the country	https://sibmoz.gov.mz/

Chelonia mydas (green turtle)

The green turtle is considered a good indicator of coral reef and seagrass bed health. It primarily feeds off of red and green algae from seagrass meadows, as well as salt water marsh wetland plants. As an adult, it is exclusively herbivorous and in size can reach up to 100-120 cm in length. Globally, the species population is declining, and classified as Endangered (EN) according to the IUCN Red List (Seminoff, J.A., 2023), whereas within the NMC Southwest Indian Regional Management unit (RMU; or genetic subpopulation), it is considered to have an increasing population and listed as Least Concern (LC; Bourjea & Dalleau, 2023).

In the three countries of the NMC, the green turtle is the most abundant and widespread species. It nests commonly along sandy beaches of Tanzania, followed by the northern coast of Mozambique and less so in Madagascar (Lockhart, G.G et al., 2014;). Continental coastal waters are important for its migratory and foraging habitat. Major migratory pathways have been documented from southern Tanzania and Northern Mozambique across the channel towards northern Madagascar and following inshore routes between nesting and foraging sites along the continental coast.

Caretta caretta (loggerhead)

The loggerhead is primarily a shallow water species traveling long distances along coastal regions, preferring rocky and muddy substrates over a sandy one. It occupies three different ecosystems during their lives: the terrestrial zone, the oceanic zone, and the "neritic" zone or coastal zone. This species is omnivorous yet primarily feeds on crustaceans and shellfish, followed by invertebrates such as, sponges, jellyfish and occasionally algae, and can reach up to 1.5 m as an adult (Rowley, S.J., 2005). Globally, it is classified as Vulnerable (VU) according to IUCN Red List (Casale & Tucker, 2017) whereas in the NMC, the Southwest Indian RMU is Near Threatened (NT) and its population is increasing (Nel & Casale, 2015).

Currently, there are no major nesting rookeries in NMC. The South West Indian Ocean Loggerhead subpopulation is known to nest along the southeast African seaboard with about 80% of the nests in South Africa, and 20% of the nests in southern Mozambique, with a few sporadic nesting events in southern Madagascar (van De Geer et al., 2022; Lockhart, G.G et al., 2014). Despite this, tag returns confirm that southern Tanzania is an important foraging ground for loggerheads. Major migratory routes of post nesting females have been recorded from South Africa and Mozambique moving north along the continental coast until settling at foraging sites and moving west to the west coast of Madagascar and the Seychelles (van De Geer et al., 2022)

Eretmochelys imbricata (hawksbill)

Hawksbill are commonly found along hard-bottomed coral reef habitats, containing sponges and shoals at depths up to 20 m. This species primarily feeds on sponges, however shows omnivorous behaviour eating fish, molluscs, algae and other sea plants and animals. It is a relatively small turtle reaching up to 87 cm in length. Globally, it is classified as Critically Endangered (CR) with a decreasing population trend according to IUCN Red List (Mortimer & Donnelly, 2008). Within the NMC, its Southwest Indian RMU has not been assessed.

Along the NMC, a small number (<10) of hawksbill nests have been recorded recently along the coastal islands of Tanzania, and similarly in northern Mozambique (<10) with fewer in NW Madagascar at Nosy Iranja Kely (Lockhart, G.G et al., 2014; van De Geer, et al., 2022). Hawksbill migratory routes are less known in this area; however, routes have been identified from Seychelles to southern Tanzania and Northern Mozambique (van De Geer et al 2022).

Lepidochelys olivacea (Olive ridley)

Olive ridley prefers shallow coastal water within 15 km of shore. It is primarily carnivorous feeding on invertebrates, jellyfish, snails, shrimp and crabs but also has been known to feeds on algae. Adults are relatively small reaching up to 75 cm in length. Globally, it is classified as VU with a decreasing population trend according to IUCN Red List (Abreu-Grobois & Plotkin, 2008), whereas the NMC West Indian RMU has not been assessed. They are considered the most abundant sea turtle in the world, yet one of the lesser abundant of the five species in this region.

The species has no known large (>100 clutches per year) nesting sites in the NMC or West Indian Ocean (van De Geer, et al., 2022). Similarly, there is little data on migration patterns to identify clear migratory pathways in this channel, although it is observed along the continental coasts and reported by fishermen occasionally as accidental by catch in gillnets. It has few (<10) documented nesting occurrences in central Mozambique (van De Geer, et al 2022). Previously, the species was widespread along the northern coasts of Mozambique, yet no reports of current nesting in this area exist. In the 1970s, the species nested on Maziwe island of Tanzania, yet due to erosion the island is currently submerged during high tide and unsuitable for nesting.

Dermochelys coriacea (leatherback)

Leatherback are primarily found in the open ocean and considered a deep-diving turtle, diving more than a kilometre deep. However, these species also forage along the coast; it feeds predominately on jellyfishes, salp[26] and gelatinous invertebrates and is the largest sea turtle species, reaching a length of 2.13 m. Globally, the species is classified as VU on the IUCN Red List (Wallace, Tiwari, & Girondot, 2013) with a decreasing population trend. However, the NMC supports two RMU for leatherbacks, the Southwest Indian RMU listed as CR (Wallace, Tiwari, & Girondot, 2013a), and the Northeast Indian RMU listed as data deficient (DD; Tiwari, Wallace, & Girondot, 2013).

26. Salp or salpa is a barrel-shaped, planktonic tunicate in the family Salpidael.

Appendix 6 Important Marine Mammal Areas (IMMAs) in the NMC

Taxa	Common name	Scientific	IUCN	Habitat	Madagascar	Mozambique	Tanzania	NMC
Baleen whales	**Antarctic blue whale**	*Balaenoptera musculus intermedia*	CR	Deep offshore	Migrant for breeding off NW Madagascar during austral winter from May to September	ND	ND	NMC likely hosts breeding season aggregation and winter destination
	Humpback	*Megaptera novaeangliae*	LC	Coastal waters for breeding grounds, yet mainly in continental shelf waters (Clapham et al, 2002).	Migrates from the Antarctic feeding grounds to coastal Madagascar in May for reproduction	The coastal waters (20-200 m isobaths) of Mozambique are utilised as a mating, calving and nursery ground between July and November each year	Coastal waters of Tanzania from June to November each year (Fleming et al, 2011)	Likely a migration route on the northern part of the channel (Obura et al, 2015)
	(SWIO) Pygmy blue whale	*Balaenoptera musculus brevicauda*	EN	Sub Antarctic zone of the southern Indian Ocean and south-western Pacific Ocean. Breeds in the Indian and South Atlantic oceans, travelling south to above the Antarctic to feed	There is a likely summer feeding region on the Madagascar Ridge (Best et al. 2003).	ND	ND	Migratory route during the austral summer (Anderson et al, 2012, Cerchio et al. 2018)
	Omura's whale	*balaenoptera omurai*		shallow-water shelf habitat with sea surface temperature between 27.4°C and 30.2°C (Cerchio et al, 2015)	Resident, non-migratory population, in the area year-round in NW Madagascar Fragmented and isolated population from global range. Primarily during the months of October through December	Aggregations are regularly seen feeding on patches of krill, or producing a chorus of song display, in the Nosy Be region,	ND	Resident
	Fin whale	*Balaenoptera physalus*	VU		Acoustically detected off northwest Madagascar during the austral winter (Cerchio et al. 2018).	ND	ND	year-long acoustic monitoring in the deep offshore waters off the Nosy Be region indicates presence of fin whales from early August to mid-September (Cerchio et al 2018c).
Toothed whales *Large toothed whales*	**Sperm whales**	*Physeter macrocephalusmacrocephalus*	VU	Offshore deep waters				Regularly encountered deep offshore in the NMC, over the slope habitat during aerial surveys and visual. At the 2000 m depth contour around Nosy Be acoustic monitoring produced numerous detections.
Toothed whales *Delphinids*	**Coastal ocean dolphin species:**	*Sousa plumbea,*	EN	Coastal habitats that include mangroves, rocky reefs, lagoons and shallow, protected bays. Preference appears to be for water shallower than 25 m in depth, 2-3 km from shore	Resident	Resident	Resident	in the southwest coast of Madagascar are highly impacted (where active hunting occurs), whereas population(s) in the northwest appear to be healthier and more abundant (Razafindrakoto 2004).
		Tursiops aduncus	NT	Shallow coastal waters on the continental shelf or around oceanic islands. In some locations, they occur relatively far from shore, yet, in the shallow waters of reef banks (Kiszka 2012)	Native	Native	Resident (Pemba, no NMC)	Resident (Mayotte)
	Coastal ocean dolphin species:	*Stenella attenuata*	LC	Waters with a sharp thermocline at depths of less than 50 m, surface temperatures over 25°C, and salinities less than 34 parts per thousand (Perrin and Hohn 1994). commonly occur in multispecies aggregations including Spinner Dolphins (Stenella longirostris) and Yellowfin Tuna (Thunnus albacares) (Perrin 2018).	Resident	Resident	Resident	Resident
	Coastal ocean dolphin species:	*Stenella longirostris*	LC	High seas and in inshore waters associated with islands or banks	Resident	Resident	Resident	Resident
	Coastal ocean dolphin species:	*Peponocephala electra*	LC	deep oceanic waters. They can be common around some oceanic islands where ocean bottom topography is steep. They are primarily distributed in waters ranging from 300 to 2,000 meters in depth (Brownell et al. 2009; Kiszka et al. 2009).	Resident	Resident	Resident	Resident
Sirenians	**Dugong**	*Dugong dugon*	VU	regular presence during the Austral winter, and thus breeding habitat (Cerchio et al. 2018)				Historically widespread throughout Madagascar. Data suggest that the northwest of Madagascar may constitute a range where a remnant viable population remains, but is still under hunting and bycatch pressure and likely in decline

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