

Maldives National Research and Monitoring Plan Guidance for Protected and Conserved Areas



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April, 2025

Citation:

Environmental Protection Agency and Ministry of Tourism and Environment (2025).
Maldives National Research and Monitoring Plan Guidance for Protected and
Conserved Areas.

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Acknowledgements:

The following organisations provided review for this document:

Joint Nature Conservation Committee (JNCC, UK)

Marine Management Organisation (MMO, UK)

EXECUTIVE SUMMARY

Protected and Conserved Areas (PCAs) are crucial for preserving biodiversity and promoting sustainable use of marine resources. When effectively managed, these areas contribute to healthier ecosystems by protecting habitats and endangered species, which in turn supports more robust fisheries. These improved environmental conditions provide numerous benefits to local communities, including enhanced food security through sustainable fishing practices and increased income opportunities from eco-tourism. By attracting visitors who are interested in exploring pristine marine environments, well-managed PCAs can also boost local economies and encourage conservation efforts. Monitoring and research programmes are essential for effective management of PCAs, providing evidence for the occurrence and magnitude of changes through time and space, and enabling assessment of these changes against known impacts or management actions.

A Research and Monitoring Plan (RMP) is a document which provides a standardised framework to aid environmental managers and scientists in developing these programmes. RMPs are developed alongside PCA-specific management plans, thus establishing clear links between PCA visions, the implementation of management actions, and the subsequent influence of management on the 'health' or 'condition' of protected species, habitats and human communities. A well-designed RMP will act as a 'blueprint' for the scientific activities needed to collect targeted scientific data and evidence for PCA effectiveness evaluations, allowing managers to responsively adapt management and maximise conservation benefits to both the environment and stakeholders.

The key function of an RMP is to collate and structure all relevant information on monitoring requirements for PCAs in a clear and central repository. This ensures that monitoring activities are closely linked to management actions and that responsibility for each element of the monitoring is understood by all participants. A well-designed RMP will also streamline the acquisition of 'research relevant' data through monitoring objectives, whilst identifying knowledge gaps where additional research projects could feed into long-term management.

This report presents guidance to facilitate the development of RMPs for PCAs for the Maldives. It firstly describes the importance of developing PCA-specific RMPs, then outlines the various governance roles and stakeholder engagement needed for effective PCA management. The report then explains how RMPs represent a component of a PCA management framework, then guides the reader through the various steps of developing an effective RMP for any PCA.

The establishment of a monitoring programme is central to an RMP - the report describes the attributes needed for an effective monitoring programme, and how to define monitoring objectives and activities for the various types of environmental and social monitoring. This guidance report then discusses how to identify research gaps and how these should be prioritised, how data should be managed and how the outcomes of research and monitoring programmes should be disseminated. Finally, this RMP guidance report describes how the outcomes of a monitoring programme are used as part of PCA assessment and evaluation, both as part of formal condition assessments and how they contribute to Protected Area Management Effectiveness (PAME) evaluations.

By providing a template for the establishment of an RMP for PCAs for the Maldives, this report aims to facilitate the RMP process, allowing the potential for a coherent network of PCA-specific RMPs to be developed for the Maldives.

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List of Acronyms

EPA	Environmental Protection Agency
IUCN	International Union for Conservation of Nature
MoTE	Ministry of Tourism and Environment
METT-4	Management Effectiveness Tracking Tool (version 4)
MPA	Marine Protected Area
OCP	Ocean Country Partnership Programme
OECM	Other Effective Area-based Conservation Measures
MMRI	Maldives Marine Research Institute
MNU	Maldives National University
NGO	Non-Governmental Organisation
PAME	Protected Area Management Effectiveness
PCA	Protected and Conserved Areas
RMP	Research and Monitoring Plan
SMART	Specific, Measurable, Attainable, Relevant, Time-bound
UNESCO	United Nations Educational, Scientific and Cultural Organisation

1 Introduction and scope

This document provides practical guidance on developing Research and Monitoring Plans (RMPs) for Marine Protected Areas (MPAs) and Other Effective area-based Conservation Measures (OECMs), hereafter collectively referred to as Protected and Conserved Areas (PCAs), in the Maldives.

This document should be considered a ‘living’ resource, to be updated as and when changes are made to PCA monitoring requirements and governance structures at the national scale.

1.1 What is an RMP?

Monitoring and research programmes are essential for effective PCA management, providing evidence for the occurrence and magnitude of changes through time and space, and enabling assessment of these changes against known impacts or management actions.

A Research and Monitoring Plan (RMP) is a document which provides a standardised framework to aid environmental managers and scientists in developing these programmes. RMPs are developed alongside PCA-specific management plans, thus establishing clear links between PCA visions, the implementation of management actions, and the subsequent influence of management on the ‘health’ or ‘condition’ of protected species, habitats and human communities. A well-designed RMP will act as a ‘blueprint’ for the scientific activities needed to collect targeted scientific data and evidence for PCA effectiveness evaluations, allowing managers to responsively adapt management and maximise conservation benefits to both the environment and stakeholders.

The present document can be used to aid the creation of standardised RMPs for both nationally designated MPAs and OECMs. It represents a partner document to the Maldives National Management Plan Guidance for Protected and Conserved Areas (MoCCEE, 2024) document.

The following sub-sections detail the importance of RMPs for PCA success, in addition to the governance structures that need to be in place and the stakeholder inputs required prior to developing an RMP. Section 2 describes the process of RMP development within a hierarchical PCA management framework, whilst Section 3 focuses on the development of research and monitoring plans. Section 4 discusses how the outputs of RMPs feed into PCA assessments and evaluations.

1.2 Why develop PCA-specific RMPs?

Successful PCA management depends on understanding whether (and to what degree) the implemented management actions have contributed towards achieving (or not achieving) the stated management objectives and overarching PCA vision. Dedicated PCA monitoring programmes collect data for a range of applications. These include increasing our understanding of ecosystems; demonstrating the impact of management actions to stakeholders and local communities; enabling managers to conduct evidence-based condition assessments (feeding into evaluations of management effectiveness); and, ultimately, improving management by learning from experience. This process, known as adaptive management, is illustrated in Figure 1.



Figure 1. PCA monitoring within a cycle of adaptive management.

Marine Protected Areas are crucial for preserving biodiversity and promoting sustainable use of marine resources. When effectively managed, these areas contribute to healthier ecosystems by protecting habitats and endangered species, which in turn supports more robust fisheries. These improved environmental conditions provide numerous benefits to local communities, including enhanced food security through sustainable fishing practices and increased income opportunities from eco-tourism. By attracting visitors who are interested in exploring pristine marine environments, well-managed MPAs can also boost local economies and encourage conservation efforts.

The most effective monitoring plans are developed at the scale of each individual PCA, rather than using generic approaches. This enables alignment of monitoring questions and measured parameters with the PCA vision and management objectives at the correct spatial and temporal scales, and with respect to local knowledge, stakeholder usage and environmental conditions.

In addition to collecting evidence on ecosystem components for which the PCA has been established, the most efficient monitoring programmes also collect additional information which can feed into research projects and contribute to a greater understanding of the protected species and habitats, their wider ecological function, the environmental processes that support them and their socio-economic context.

The key function of an RMP is therefore to collate and structure all relevant information on monitoring requirements for each individual PCA in a clear and central repository. This ensures that monitoring activities are closely linked to management actions and that responsibility for each element of the monitoring is understood by all participants. A well-designed RMP will also streamline the acquisition of ‘research relevant’ data through monitoring objectives, whilst identifying knowledge gaps where additional research projects could feed into long-term management.

The guidance in this document will enable the development of RMPs that provide evidence to fulfil the following objectives:

- 1) Assess the overall condition of species and habitat ‘features’ for which the PCA has been a) legally designated (for MPAs), or b) identified as of conservation value (for OECMs);
- 2) Assess the distribution and intensity of threats to the features of the PCA;
- 3) Assess whether ecological and socio-economic management objectives have been achieved;
- 4) Assess the nature, magnitude and direction of changes in response to the implementation of PCA-specific management actions;
- 5) Inform the adaptive development and enhancement of management objectives and identify actions where required;
- 6) Improve understanding of the species and habitat features and their wider supporting environmental processes;
- 7) Where required, provide evidence to demonstrate that PCAs meet the inclusion criteria for international networks and certification schemes (e.g. UNESCO Biosphere Reserve and IUCN Green List status; further details are provided in Section 2).

1.3 Governance, roles and responsibilities

Strong, dedicated and focused leadership is integral to the effectiveness of research and monitoring programmes (Lindenmayer and Likens, 2010). Prior to developing an RMP, it is essential that governance structures, remits, roles and responsibilities of all parties involved in management, monitoring and research of the PCA are agreed and clear.

Individual governance roles related to the RMP include:

- Development of the RMP (and future updates)
- Monitoring of RMP delivery
- Conducting condition assessments
- Reviewing condition assessments
- Prioritising scientific research
- Permitting scientific research

Organisational flowcharts depicting roles, responsibilities and process flows in respect to the various stages of the adaptive management cycle should be added to the Management Plan and RMP documents for each PCA. Timelines detailing when involvement from each individual organisation is required should also be clearly highlighted in these flowcharts.

1.4 Stakeholder engagement

Alongside governance, it is important to consider stakeholder engagement strategies prior to development of an RMP. Good engagement with stakeholders provides transparency and

creates opportunities for relationship building to support buy-in, alongside maximising the input of PCA-specific and local knowledge to the RMP.

In a global study of MPA ‘success’ and ‘failure’, Giakoumi *et al.* (2018) found that stakeholder engagement was consistently the most important factor in the success of MPAs, and its absence was most often linked to their failure. The study authors advocated a dynamic dialogue-based engagement process, the format of which is likely to vary depending on the type and location of the PCA, as are the stakeholder groups consulted.

Dedicated workshops are effective for collating the views of larger groups of stakeholders (ideally mixed stakeholder groups to ensure a broad range of opinions and stimulate discussion), whilst targeted sessions with key stakeholders or small groups are required to gain a detailed understanding of scientific activities and research needs. A (not exhaustive) list of example stakeholder groups to consider during RMP development is provided in Table 1, and a PCA-specific list should be created and maintained for each RMP.

Gender Equality and Social Inclusion (GESI) considerations are critical in ensuring that stakeholder engagement processes are thorough, inclusive, and equitable. By integrating GESI principles, the diverse needs and perspectives of all stakeholders, particularly those who are marginalised or less obvious, are acknowledged and addressed. This ensures that their views are accounted for and incorporated into decision-making processes.

Marginalised stakeholders often include groups such as women, minorities, persons with disabilities, and economically disadvantaged individuals. These groups may face barriers to participation that prevent their voices from being heard in traditional stakeholder engagement processes. It is important to ensure their inclusion for several reasons, e.g., representation, equity and innovation.

To ensure that stakeholder engagement is accessible and equitable, several strategies can be employed. These include identifying barriers (e.g., language, physical accessibility, lack of information), providing support (e.g., translation services, transportation, childcare), and using multiple communication methods (e.g., online platforms, community meetings, and one-on-one interviews).

Finally, equitable engagement goes beyond simply inviting marginalised stakeholders to participate. It requires a deliberate effort to create an environment where their contributions are genuinely valued and considered such as actively implementing active listening, empowerment and transparency.

Table 1. Example stakeholder groups to consider in RMP consultations.

Stakeholder group	Example stakeholders
Government ministries	Ministry of Tourism and Environment (MoTE) Ministry of Fisheries and Ocean Resources Ministry of Cities, Local Government and Public Works
Government agencies	Environmental Protection Agency (EPA) Maldives Marine Research Institute (MMRI) Local Government Authority (LGA)
Councils	Atoll Councils Island Councils

Stakeholder group	Example stakeholders
	Women's Development Councils (WDCs)
On site PCA managers	e.g., Baa Atoll Biosphere Reserve Office
Scientific	Maldives National University (MNU) Foreign partner universities Research NGOs
Civil society organisations	Local NGOs (specific to atoll or island) Environmental NGOs
Local businesses	Resorts Dive centres Fishers
Local communities	Schools Community members

2 RMPs within the PCA management framework

Five different elements comprise the hierarchical framework proposed here to structure the development of RMPs: **1) overarching principles, 2) PCA 'features', 3) PCA vision, 4) management objectives, 5) management actions** (as detailed in the Maldives National Management Plan Guidance for Protected and Conserved Areas: MoCCEE, 2024).

These elements inform development of **monitoring objectives and research priorities** (see Section 3), which in turn feed into assessment processes. The list below provides details on each sequential element.

1) Overarching principles

For some types of PCA, such as those designated as UNESCO Biosphere Reserves or included on the IUCN Green List (or those aspiring to either status), several overarching principles will need to be built into the RMP to ensure that accreditation criteria are fully met. Specific monitoring and research requirements for UNESCO Biosphere Reserves and IUCN Green List PCAs are summarised in Table 2.

These overarching requirements reflect high-level best practice in PCA monitoring and should therefore underpin the development of RMPs for all PCAs, regardless of whether they are UNESCO or IUCN listed.

Table 2. Specific UNESCO Biosphere Reserve and IUCN Green List requirements relating to research and monitoring. Text in blue refers to sections in the associated source reference.

Designation	Requirement	Source
UNESCO Biosphere Reserve	Management is based on a continuous cycle of planning, implementation, monitoring and evaluation. Monitoring and evaluation should form an integral part of the management plan and should be adequately resourced. <i>Section 199.</i>	UNESCO (2021) Technical Guidelines for

	<p>Indicators (data collected as part of monitoring) should be quantified and accompanied by benchmarks. The indicators need to be linked to the goals and objectives to give an indication of whether the medium and long-term goals of the biosphere reserve are likely to be achieved. <i>Section 199.</i></p>	Biosphere Reserves (technical-guidelines-2021.pdf)
	<p>According to the attributes and specificities of a biosphere reserve, it is necessary for managers to choose, from the time of nomination, a set of data for progressive monitoring. <i>Section 271.</i></p>	
	<p>Monitoring should be sufficient to answer the questions in the UNESCO Periodic Review Form. <i>Section 265.</i></p>	
IUCN Green List	<p>Procedures are in place to ensure that results from monitoring, evaluation and consultation are used to inform management and planning processes including the establishment of goals and objectives. <i>Good Governance, Criterion 1.3.</i></p>	IUCN & WCPA (2017) IUCN Green List of Protected and Conserved Areas (V1.1) (IUCN Green List Standard Version 1.1 - 25 September 2018 update 0.pdf)
	<p>For each of the major site values identified (<i>under Criterion 2.1</i>), a monitoring system is in place and a set of performance measures has been defined and documented, which provides an objective basis for determining whether the associated value is being successfully protected. <i>Effective Management, Criterion 3.7.</i></p>	
	<p>A threshold level has been specified and assessed in relation to each set of performance measures that relates to natural values, that if achieved, is considered to demonstrate objectively that the associated major site value is being successfully conserved. <i>Effective Management, Criterion 3.7.</i></p>	

2) PCA ‘features’

The fundamental basis of any PCA-specific Management Plan and accompanying RMP is comprised by the ‘features’ for which the PCA has been designated or selected to protect¹. This term relates to specific environmental elements of conservation importance that have been formally highlighted as requiring protection via establishment of a PCA.

3) The PCA ‘vision’

As detailed in the Maldives National Marine Protected Areas Management Plan Guidance (MoCCEE, 2024), the PCA vision describes the kind of PCA the Management Plan is seeking to achieve in the long-term. This provides the focus or direction for management objectives.

4) Management objectives

These are specific high-level statements of intent, which link to the overarching PCA vision. These objectives should be Specific, Measurable, Achievable, Relevant and Time-bound (SMART) and used as a basis upon which to develop specific management actions.

5) Management actions

Management objectives should be accompanied by a more detailed set of specific management actions that need to be implemented to achieve them. The management actions in turn provide the framework for development of monitoring objectives and research priorities (Section 3).

Figure 2 shows where each of the five elements listed above, as well as subsequent monitoring objectives and research priorities, and assessment processes, sit within the cycle of adaptive PCA management of an MPA. Those elements highlighted in red are covered by the RMP and are described in the following section (Section 3).

Adaptive monitoring and management of OECMs generally follows the same underlying principles as those for MPAs, although it is inherently less onerous and generally managed by a single organisation. The broad process for OECMs, indicating where the RMP fits within the process, is presented in Figure 3.

¹ ‘Features’ are encompassed as part of the wider ‘values’ of the PCA (as defined in the Maldives National Management Plan Guidance for Protected and Conserved Areas (MoCCEE, 2024) but are distinguished as specific ecological elements for which the PCA has been formally designated or selected.

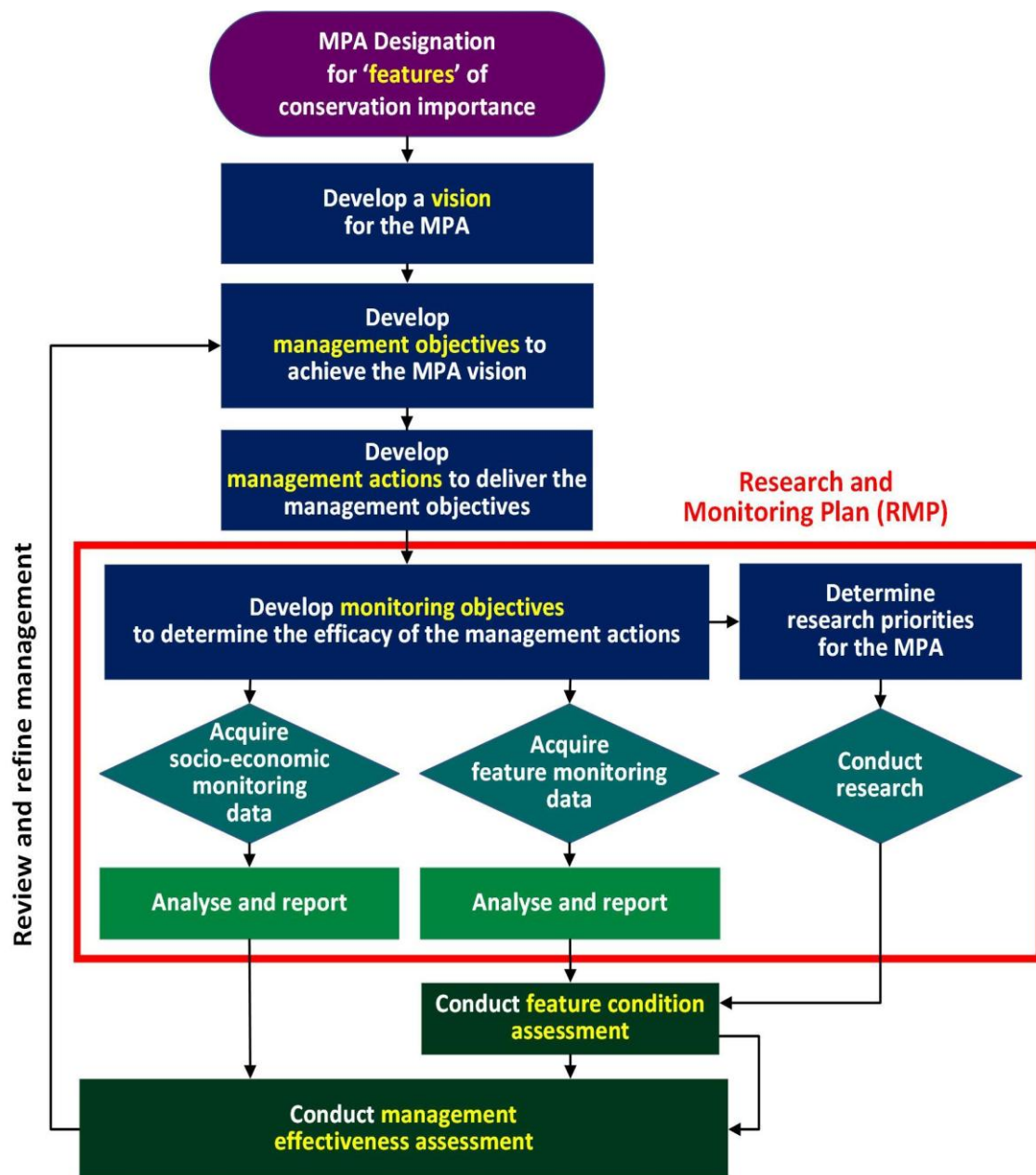


Figure 2. A hierarchical framework of objectives, actions and processes within an adaptive management cycle for MPAs, with the scope of the Research and Monitoring Plan (RMP) highlighted by the red box.

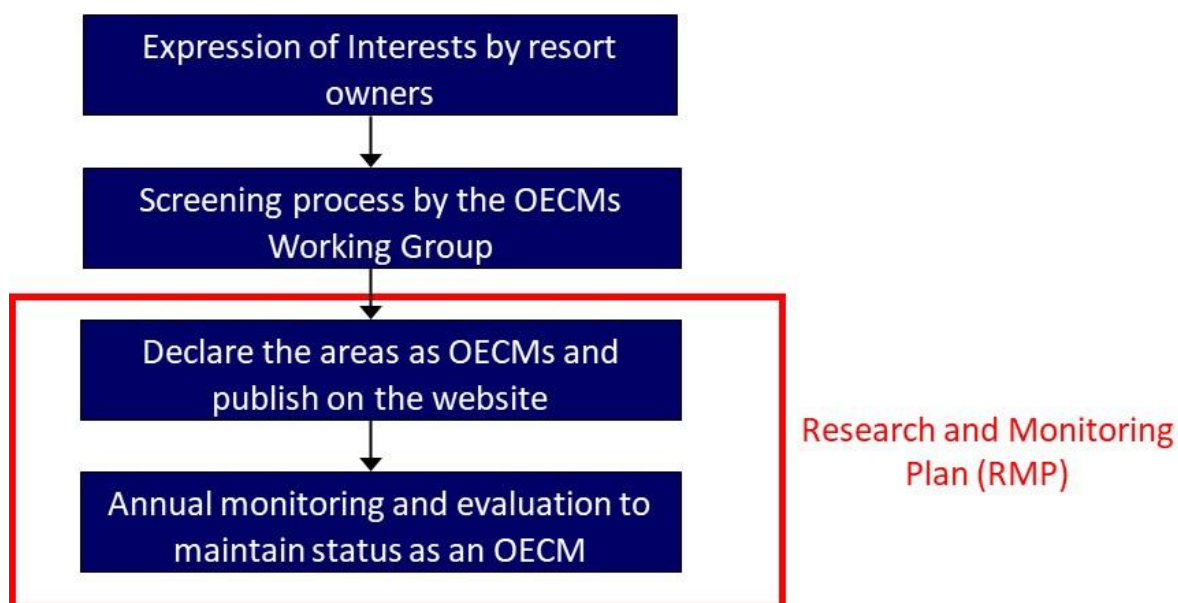


Figure 3. The simplified framework for an adaptive management plan for OECMs, with the scope of the Research and Monitoring Plan (RMP) highlighted by the red box.

3 Developing the RMP

3.1 What makes an effective monitoring programme?

Various studies have identified important characteristics of effective monitoring programmes (Lindenmayer and Likens, 2010; Addison, 2011; Parry *et al.*, 2012; Giakoumi *et al.*, 2018; Noble-James *et al.*, 2018; Noble-James *et al.*, 2023; Turrell, 2018; Hayes *et al.*, 2019).

A selection of the key characteristics advocated by these authors is provided below and should be incorporated into RMPs wherever possible.

- **Solid governance structures and strong leadership:** their importance for the success of monitoring programmes cannot be overstated. This is particularly crucial where (such as in Maldives) multiple organisations work together to manage, monitor, assess and evaluate PCAs. Clear and sustained remits are critical to deliver results efficiently in such partnerships, with each organisation being given a distinct role in the various stages of the adaptive management cycle (as per Section 1.3).
- **‘Good questions and evolving questions’** are at the heart of good science and are therefore essential for effective monitoring (Lindenmayer and Likens, 2010). Clarity on exactly what is being asked about the PCA and its features is critical for developing unambiguous and quantifiable monitoring objectives.
- **A hierarchy of objectives** (ideally SMART) should be clearly presented as part of the RMP, to ensure complete linkage between the goals of the PCA and the data collected to evaluate whether they have been achieved.

- **Indicators explicitly linked to management actions** are required to determine their effectiveness. As will be discussed in Section 3.3.3, good indicator metrics should fulfil various criteria, centred around feasibility and responsiveness to management actions.
- **Adequate and stable funding and resources** are required, matched to the specific monitoring objectives and indicator metrics for the PCA in question and being available within an appropriate timeframe. As questions evolve through the process of evaluation and adaptive management, there should be flexibility in the activities that can be funded and resourced.
- **Well-developed partnerships** between government organisations and with scientific stakeholders (such as NGOs and universities) will support the long-term stability of monitoring programmes in terms of personnel, skillsets, funding and equipment.
- **A commitment to regular and appropriately timed evidence collection** allows timely responses to threats and changes to management measures if necessary. The regularity of monitoring activities should be informed by the timeframe within which a detectable response to management measures is expected, in addition to the frequency and intensity of pressures.
- **Appropriate and statistically robust sampling designs** are crucial for detecting responses in selected indicator metrics to management actions against a background of ‘noise’ or natural variation. There is no ‘one-size-fits-all’ approach to PCA monitoring (Lindenmayer and Likens 2010; Noble-James *et al.*, 2023). Sampling strategies should be designed at the scale of each individual PCA, with respect to the specific features protected, local environmental conditions, management actions implemented, indicator metrics selected, and methods, equipment, funds and resources available.
- **Data management and availability:** data acquired from PCAs should ideally be made available for general use in future assessments and research projects (e.g. via a central database), in line with the ‘collect once, use many times’ principle.
- **Regular and accessible reporting of results** for a varied range of audiences (e.g. scientists, managers and community members) is a crucial step in delivering the evidence generated by an effective monitoring programme. Regular analysis of data and reporting facilitates scrutiny by the public and timely use by managers.
- **Condition assessment** is the final critical step in delivering an effective monitoring programme, in which all evidence on the designated features and the pressures potentially impacting them are analysed and interpreted collectively, to determine whether the conservation-focused management objectives have been achieved.

3.2 Reviewing the *status quo*

Prior to developing monitoring objectives, any existing monitoring structures, activities, and outputs should be reviewed by MPA managers and key scientific stakeholders.

The following questions can be used to help ascertain what is working well, where improvements could be made, and where gaps exist in the current monitoring activities:

- Which monitoring activities are ongoing and who is conducting them?

- Are the current monitoring objectives and activities (if any) fit for purpose to demonstrate that the PCA vision and management objectives have been achieved?
- Are current governance structures, roles and responsibilities clearly defined?
- Are current scientific partnerships working well?
- How are monitoring data currently analysed, reported and communicated?
- Are existing data sufficient for inclusion in a long-term monitoring time-series?
- How are monitoring data managed and are they disseminated for wider use?
- What are the key constraints of, and limitations on, current monitoring?
- Are current resources (e.g., funds, personnel, skillsets and equipment) sufficient to deliver the monitoring evidence required?
- If additional activities are needed, are resources available to implement them? If not, where might resources be found? Where might partnerships help create efficiencies?

3.3 Defining monitoring objectives and activities

As discussed in Section 2, the PCA vision informs management objectives, which in turn are used to develop specific management actions. Monitoring objectives should then be explicitly and closely linked to these management actions.

The following questions summarise the main considerations for developing monitoring objectives and activities, with relevant sub-sections within this document signposted.

- Which broad types of monitoring are required? (Section 0)
- Which monitoring objectives will provide evidence of the effectiveness of the management actions? (Section 3.3.2)
- Which indicator metrics will be used? (Section 3.3.3)
- How will the indicators be evaluated, i.e., how will thresholds, benchmarks or trends be used to determine whether the PCA features are 'healthy' or in 'good condition'? (Section 3.3.4)
- How will the data be collected? (Section 3.3.5)
- Who will collect the data and how frequently? (Section 3.3.6)

3.3.1 Types of monitoring

PCA monitoring is classed here into five broad 'types' which can be used to structure the development of monitoring objectives:

- **Feature monitoring** of the designated or selected PCA features (e.g., the direct 'health' or 'condition' of manta ray populations).
- **Environmental monitoring** of parameters that are likely to influence the condition of the PCA features. Wherever possible (particularly if requiring little additional effort or

resource), collection of environmental monitoring data should be aligned to the requirements of future or ongoing research projects (e.g., investigation of climate change impacts).

- **Pressure monitoring** of anthropogenic impacts to the PCA features (e.g., commercial and recreational activities, pollution).
- **Socio-economic monitoring** of both positive and negative impacts of PCA management objectives and actions on the economy and society. Socio-economic monitoring should combine feature, environmental and pressure monitoring with data on the local socio-cultural context to ensure that social and economic impacts of the PCA do not undermine its long-term goals (e.g., thematic natural capital accounting).
- **Safety monitoring** of human activities within the MPA. This type of monitoring may be required in relation to the management of ecotourism activities, such as snorkelling with megafauna.

Depending on the PCA in question, it is likely that elements of each monitoring type will be needed to gain a holistic understanding of the effects of management. Where resources and funds are limited, expert judgement will be needed to balance them, based on which are most critical for assessing PCA effectiveness.

3.3.2 Defining monitoring objectives

Monitoring objectives should be defined as clear and concise statements of intent, which give direction to subsequent monitoring activities and parameters to be measured. They should link directly back to the management actions and should focus on providing evidence for whether management actions have succeeded in achieving the desired outcomes of the PCA.

Wherever possible, MPA-specific monitoring objectives should also integrate objectives of wider monitoring or environmental surveillance programmes (e.g., national pollution and emergency monitoring) and standardise data collection protocols across the board. Such integration is critical to ensuring a consistent sampling approach, thus producing data which can be used to answer a range of questions at different scales and to maximise limited resources.

Depending on the type of PCA or PCA features, overarching national guidance requirements or protocols may need to be incorporated into the monitoring objectives (see Table 3). It should be noted that these requirements should be considered a foundation upon which to develop objectives at the MPA scale. The protocols should not limit the scope of data collection activities as long as the required parameters are included within them.

Table 3. National monitoring guidelines, requirements and protocols.

Habitat / Species / PCA	Source
Available	
Coral reefs	The Coral Database (The Coral Database Protocols)
Seagrass	The Maldives Seagrass Monitoring Network

	Monitoring Methods (Maldives Seagrass Monitoring Network Monitoring Methods)
Mangroves, wetlands and island vegetation	<p>Mangroves of the Maldives: a review of their distribution, diversity, ecological importance and biodiversity of associated flora and fauna (Cerri <i>et al.</i>, 2024:Mangroves of the Maldives: a review of their distribution, diversity, ecological importance and biodiversity of associated flora and fauna Aquatic Sciences)</p> <p>Dryden and Basheer (2020). Guidelines for coral reef and small island vegetation surveys in the Maldives. 20220413-pub-guidelines-for-coral-reef-and-small-island-vegetation-in-the-maldives-2021.pdf</p>
Sharks	Under the mandate of the Fisheries Act of the Maldives (Fisheries Act of the Maldives 14- 2019 English Version-1718880127733.pdf)
Cetaceans	Under the mandate of the Fisheries Act of the Maldives (Fisheries Act of the Maldives 14- 2019 English Version-1718880127733.pdf)
Manta rays	<p>Manta ray mooring line entanglement protocol (Manta Mooring Line Entanglements — Manta Trust)</p> <p>How to swim with Manta rays (How to Swim with Manta Rays)</p> <p>Maldives Conservation Research Programme (Maldives Manta Conservation Programme)</p>
Whale sharks	Various MWSRP guidance documents including a whale shark photo identification manual, a photo identification software set-up manual, and a MWSRP network portal manual. These can be obtained through direct communication with the MWSRP.
Sea turtles	Olive Ridley Project. Sea Turtle Code of Conduct 2018 (Code-of-Conduct-Sea-Turtles-Olive-Ridley-Project.pdf)
OECMs	Guideline for Recognising Areas as Other Effective Area-based Conservation Measures (OECMs) in Areas Leased for Tourism Operations (MoCCEE Guideline for Recognising Areas as Other Effective Area-based Conservation Measures (OECMs) in Areas Leased for Tourism Operations)
Socio-economic	<p>Maldives Statistics Act 16/2021 (MaldivesStatisticsAct-EnglishTranslation.pdf [<i>English translation</i>])</p> <p>The National Strategy for the Development of Statistics 2021-2030 (NSDS-Maldives.pdf)</p> <p>The Global Socioeconomic Monitoring Initiative for Coastal Management (SocMon ICRI)</p>
In development / to be developed	
Harvested species	To be developed (including reef fish, octopus and molluscs; Ministry of Fisheries)

Rays	National management plan in development (EPA)
Seabirds	In development (EPA in collaboration with JNCC, UK)
Benthic habitats (non-reef)	To be developed
Water column	To be developed

3.3.3 Selecting indicator metrics and supporting parameters

Once monitoring objectives have been defined, the next stage is the selection of indicator metrics to inform on whether the management actions have been successful (in both environmental and socio-economic contexts).

The characteristics of indicator metrics will vary between the different types of monitoring (Section 3.3.1), but they should be selected for their capacity to ‘respond’ to management actions, providing a clear ‘signal’ against a background of natural variation (e.g., within species populations, assemblages, habitats and environments). In this way, indicator metrics are distinct from any measured parameters (e.g., environmental) which do not provide direct information about the condition of the PCA features being monitored, although such parameters may be important to understand trends and patterns in the indicator metrics themselves.

For example, an indicator metric for the condition of a manta ray population might be the number of individual manta rays recorded in a season, whilst supporting environmental parameters measured to help explain variation in the indicator metric might include sea-surface temperature, turbidity levels and plankton biomass. Once indicators have been selected, any supporting environmental parameters should also be specified alongside them.

Hiddink (2020) produced a set of criteria which can be used to assess whether metrics can be considered effective ‘state’ indicators (Table 4). Here ‘state indicator’ refers to the subject(s) of conservation-focused management objectives (e.g., manta rays), as opposed to ‘pressure indicators’, which measure the degree of threat to them (e.g., number of snorkellers in the water, direct contacts or boat strikes).

As detailed in Table 4, proposed ‘state’ indicator metrics should be tightly linked to the expected outcomes of management actions (particularly in terms of ‘Sensitivity’, ‘Responsiveness’ and ‘Specificity’), and should be documented within each RMP alongside the additional supporting parameters required to investigate trends and patterns in the state indicator metrics.

Table 4. Criteria for the selection of ‘state’ indicators (Hiddink, 2020; adapted from ICES, 2005, and Rice and Rochet, 2005).

Criteria	Description
Concreteness	Indicator represents a directly observable and measurable property of physical/biological world rather than reflecting abstract properties which can only be estimated indirectly
Theoretical basis	Link between pressure and indicator based on well-defined and validated theoretical links

Criteria	Description
Public awareness	Public understanding of the indicator is consistent with its technical meaning. Nature of what constitutes 'serious harm' is widely shared
Cost	Monitoring is through measurement tools that are widely available and inexpensive to use
Measurement	Indicator is measurable in practice and in theory, using existing instruments, monitoring programmes and analytical tools, and on the timescales needed to support management. Minimal or known bias and signal should be distinguishable from 'noise'
Historical data	Supported by a wealth of data and/or time-series data to aid interpretation of trends and to allow a realistic setting of objectives
Sensitivity	Trends should be sensitive to changes in the ecosystem state, pressure, or response that the indicator is intended to measure
Responsiveness	Indicator is responsive to effective management and provides rapid and reliable feedback on the consequences of management
Specificity	Indicator responds to the properties they are intended to measure, rather than to other factors and/or it should be possible to disentangle the effects of other factors from the observed response

There is a large body of literature concerning the socio-economic impacts of MPAs, including recommendations for socio-economic indicators of success (Gallacher *et al.*, 2016; Mann-Lang *et al.*, 2021; Leleu *et al.*, 2012; Ban *et al.*, 2019) and frameworks for integrating economic impacts into existing national accounting (King *et al.*, 2023). Socio-economic indicators recognise that the ecological benefits of MPAs alone are insufficient to ensure positive socio-economic outcomes from conservation (Pascual *et al.*, 2016). Instead, the identification and quantification of ecosystem benefits of PCAs can help provide an evidence base for long-term financing through blended and sustainable finance mechanisms.

Depending on the features of the PCA, some indicator metrics and supporting parameters may have been pre-specified in national guidelines or protocols (see Table 3).

3.3.4 Setting benchmarks, thresholds and target trends

Ideally each indicator should be accompanied by benchmarks or thresholds, i.e., points of reference beyond which a change through time can be considered to indicate either meeting or failing to meet a management objective. Examples include the number of manta rays considered to constitute a 'healthy' or 'unhealthy' population; or the concentration of a specific contaminant in sediment samples beyond which infauna could be adversely impacted.

In many cases the exact, appropriate benchmarks and thresholds will not be clear, often due to a limited understanding of habitat or species ecology. Also, in the case of socio-economic indicators, it may be challenging to define exact 'cut-offs' for PCA success, particularly if there are perceived conflicts between social and environmental management objectives. In such instances, managers and scientists may instead deem it more appropriate to specify a target trend direction. For example, this could be an increase in manta ray numbers; a decrease in the number of manta ray touch infractions; or a decrease in the level of a contaminant. Expert

judgement must then be used to determine whether the observed changes constitute success or failure of management.

3.3.5 Sampling methods and designs

Once monitoring objectives, indicators and supporting parameters have been defined, sampling methods must be selected and sampling designs developed.

This topic is exceptionally broad and can be complex, depending on the features and management objectives of the PCA. It is beyond the scope of this document to provide a comprehensive overview of sampling methods and design, instead this section summarises the main considerations required. Detailed guidance on principles of monitoring sampling design, useful references and details on lessons learned can be accessed in Noble-James *et al.* (2018; 2023). Although these publications focus on benthic habitats, many of the general principles and theory can be translated to other ecosystem components.

No two PCAs are the same, therefore, it is important that sampling designs are created for each individual PCA, with respect for the unique characteristics of each (whilst incorporating elements of national requirements where needed; Table 3).

A wide range of methods can be used for the various types of PCA monitoring activity. Wherever possible the selection should be primarily based on the most effective method(s) to quantitatively measure the selected indicators and supporting parameters, although equipment availability and funds will also clearly influence these decisions. If possible, it is strongly advised to create a habitat map of the PCA, to focus the development of the sampling design and reduce 'noise' in the data. A summary of the most widely used monitoring and mapping methods is presented in Table 5.

Table 5. A summary of widely used methods for collection of monitoring and mapping data.

Purpose	Method or source
Feature monitoring	Diver or snorkeller observations
	Underwater still and video cameras (e.g., towed, drop, baited, sediment profiling)
Environmental monitoring	Dredges and scientific trawls (only where absolutely necessary and where it can be demonstrated these will result in no/low negative impact on environment)
Supporting parameters	Remotely Operated Vehicles (ROVs) and Autonomous Underwater Vehicles (AUV)
	Sediment samplers (grabs, cores)
	Water samplers and sensors
	Plankton samplers
	DNA or eDNA sampling
Mapping	Acoustic methods for subtidal regions (e.g., multi-beam echosounder, side scan sonar)
	Optical methods for terrestrial, intertidal and shallow subtidal regions (e.g., drone imagery, Light Detection and Ranging (LIDAR))

Purpose	Method or source
	Satellite data (free low-resolution / paid high-resolution imagery and environmental data)
Pressure monitoring	Direct observations by surveyor / enforcement personnel
	Remote observations (e.g., enforcement cameras, Vessel Monitoring Systems (VMS), Automated Identification Systems (AIS))
	Model outputs (e.g., contaminant dispersal model)
Socio-economic monitoring*	In person or online surveys/questionnaires. Such surveys can address wide ranging objectives, commonly used to measure attitudes and preferences (e.g., surveys of local/tourist views or perceptions and willingness to pay)
	Other in person methods, such as unstructured interviews, deliberative methods and Q-methodology
	Citizen science and methods utilising social media

* Guidelines for socio-economic monitoring in South Asia are accessible via [The Global Socioeconomic Monitoring Initiative for Coastal Management \(SocMon\)](#).

Once the sampling methods have been established, the sampling design will dictate where, when and how often the sampling will be conducted. The development of a time-series sampling design involves numerous considerations which will vary based on the PCA features, monitoring objectives and methods. Table 6 contains basic questions to guide this process.

Table 6. Basic questions to guide sampling design for time-series monitoring.

Monitoring type	Questions
Feature / Environmental / Pressure (see Noble-James <i>et al.</i> , 2018)	<ul style="list-style-type: none"> • Does the sampling design need to be comparable with previous monitoring datasets? • Which time(s) of the year is optimal for investigating the selected indicators? How frequently should sampling occur? • Which hypotheses will be tested? • Which type and size of sampling unit should be used to sample the indicators? • How should sampling effort be partitioned (e.g., between different zones or habitats)? • What sample size is required to detect the required degree of change (or ‘effect size’) in the selected indicators with sufficient statistical power (in the context of natural variation)? • Which spatial sampling pattern should be used? • How often should sampling be conducted and by whom?
Socio-economic	<ul style="list-style-type: none"> • What baseline data are available? • In absence/in addition to a baseline, is a counterfactual reference available? • When should sampling take place to account for seasonal variation in resource use? • What impacts are being measured? • What is the spatial scale of sampling? Are we concerned with general societal impacts or local impacts? • What frequency of sampling is required to detect changes in the chosen indicators? • Will time-series data use the same individuals over time? If so, how do we minimise drop-outs? • Who should collect the data? What impact will different methods/interviewers have on the data collected? • How will the sampling design impact other uses of the monitoring data?

3.3.6 Clearly linking management and monitoring

A clear and transparent way to demonstrate the close linkage of monitoring to the Management Plan is through tabulating management actions and using them to systematically populate information on monitoring types, objectives, indicators and activities. This tabulation exercise is also useful to highlight where any gaps exist in ‘*status quo*’ monitoring and to understand where research projects are required to inform long-term monitoring guidance. An

example management objective and accompanying management action with linked monitoring details is presented in Table 7.

Table 7. An example management objective with a linked management action and example monitoring details.*

Management Objective	Management Action	Monitoring type	Monitoring Objective	Indicators/ Parameters	Threshold / benchmark / trends	Method/s	When and how often?	Responsibility
By 2028, the population size and distribution of manta rays is maintained at current levels or has increased	Develop and implement a long-term monitoring programme to understand manta ray populations in the context of environmental parameters and anthropogenic pressures	Feature monitoring	Collect data to monitor manta ray populations	No. of sightings	Increasing	On-boat observations and Remote Underwater Video systems (RUVs)	Once weekly	PCA-specific
				No. of individuals	Increasing			
				No. of new individuals	Increasing			
				Male : female ratios	Stable			
		Pressure monitoring	Collect data to monitor anthropogenic pressures on manta ray populations	No. of anthropogenic sub-lethal injuries	Decreasing	On-boat observations and Remote Underwater Video systems (RUVs)	Once weekly	PCA-specific
				Number of observed distance infractions	Decreasing			
				Number of observed touch infractions	Decreasing			
				Contaminants	Decreasing	Sediment sampling, water sampling and sensors	Once quarterly	PCA-specific
				Microplastics	Decreasing			
		Environmental monitoring	Collect data to monitor environmental parameters to support interpretation of status and trends of the manta ray populations.	Temperature	n/a	Sediment sampling, water sampling and sensors	Once quarterly	PCA-specific
				Salinity	n/a			
				Turbidity	n/a			
				Hydrodynamics	n/a			
				Nutrients	n/a			
				Zooplankton	n/a			
				Phytoplankton	n/a			
By 2028, local communities' awareness and understanding of the MPA has improved	Undertake a public engagement campaign to increase levels of knowledge and interest in the MPA amongst the local community using innovative, accessible, equitable and participatory approaches.	Socio-economic monitoring	Collect data to monitor trends in local adult and child understanding of the values of the MPA and why its management is important	Various socio-economic metrics (e.g., % of population aware of MPA values, by age group and gender, will vary substantially depending on the MPA)	Increasing	Surveys Questionnaires Focal groups	Once annually	PCA-specific

*** Please note that this table only includes example details to illustrate how to populate the fields and does not describe fully developed monitoring requirements to address the management actions. Additional indicators / parameters are likely to be required and temporal aspects of monitoring will be defined by local ecology, the equipment used and the resources available.**

3.4 Developing research priorities

3.4.1 Collating ideas

The first stage of developing coherent research priorities to underpin the RMP should be to collate high-level research ideas and questions (adding to those already identified in the management action tabulation exercise; Table 7). These can later be shaped into fully formed scientific hypotheses and studies to support the aims of the PCA.

Gaps in understanding of the relevant species, habitats, local environmental conditions and the distribution and impact of pressures will be revealed via literature reviews. Compilation of all relevant literature in a bibliography is recommended to allow quick and easy access to key publications and data sources. Bibliographies should provide a rapid overview of a) work already done in and around the PCA, and b) relevant work which may not be PCA-specific but which can help understand the features of the PCA. Reviewing and compiling the available evidence collected thus far helps avoid future duplication of effort and to understand whether additional work is needed to expand on questions or hypotheses already investigated.

Consultations with key stakeholders (e.g., via workshops, meetings and questionnaires) will also reveal research priorities and knowledge gaps to feed into the RMP. Although this engagement process may primarily focus on capturing the views of PCA managers and scientific stakeholders, other stakeholders such as resort personnel, fishers, recreational users and island citizens are also likely to provide valuable observations and ideas to this process.

3.4.2 Developing research questions

Once ideas have been collated, managers and scientists should work together to develop them into a list of fully developed scientific questions and hypotheses. At this point, two outputs should be generated: 1) a list of standalone future research questions and study ideas, and 2) a set of additional 'research-relevant' parameters to add to the combined management actions and monitoring table (e.g., Table 7). As mentioned in Section 1.2, a well-designed RMP will streamline the acquisition of such data through ongoing monitoring. Therefore, opportunities to 'add value' by simultaneously collecting data to feed into research projects should be incorporated into the planned monitoring activities.

Once a coherent list of standalone research questions and studies has been devised, opportunities are increased for strategic engagement with new and existing partners (e.g., Maldivian Government agencies, MNU, international universities, NGOs).

Prioritisation of these studies (according to the urgency with which the information is needed to understand condition of the PCA features) will allow PCA managers to guide affiliated scientific organisations and potential new collaborators to investigate the topics which will most benefit the management of the PCA and, ultimately, the conservation of its features.

3.5 Data, reporting and publication

3.5.1 Data

In line with any programme or initiative involving the acquisition, analysis, interpretation and storage of data (ecological, socio-economic), all data should be correct, well-managed, easily accessible (with appropriate restrictions where necessary), and should always be accompanied by the relevant metadata detailing, for example, what the data refer to, how collected and by whom and when, who is responsible for the data, etc.

At the time of writing this guidance, the EPA plan to develop and implement a centralised database and accompanying data standardisation protocols, within which all forms of monitoring data, including ecological, environmental and socio-economic data will be held.

3.5.2 Reporting

Reporting requirements are to be specified in the management plans and RMPs of individual MPAs, with reports being provided to the EPA. As specified by MoCCEE (2022), OECM managers must submit an annual report detailing monitoring activities and outcomes (Table 3).

3.5.3 Accessibility of information

Data interpretations must accompany the delivery of raw data, both for MPAs and OECMs. Data accessibility to the public would be in written report form, however, access to specific raw data can be requested.

3.5.4 Peer-reviewed publications

Publication in peer-reviewed publications based on PCA-scale research and monitoring is encouraged wherever possible. This facilitates easier access of information to wider communities and demonstrates greater rigour in evidence interpretation and giving appropriate recognition to Maldivian science in both domestic and international realms.

4 Assessment and evaluation

As presented in Figure 2, environmental and socio-economic monitoring and research results will feed into the next stages of the adaptive management cycle for MPAs – the condition assessment and Protected Area Management Effectiveness (PAME) evaluation – using the Management Effectiveness Tracking Tool version 4; METT-4.

4.1 Condition assessment

The condition assessment using the METT-4 PAME evaluation tool involves asking a series of questions covering all aspects of management effectiveness. Among these questions, those specifically relating to PCA condition are as follows:

- Q35. What is the condition of the important natural values of the protected area as compared to when it was first designated?
- Q36. What is the condition of the important cultural values of the protected area as compared to when it was first designated?
- Q37. Has the status of key indicator species changed over the last five years?
- Q38. Has the status of habitats changed over the last five years?

Condition assessments draw together all available evidence from environmental monitoring and research activities to answer the above questions.

These assessments investigate whether and/or how the PCA features have changed, and whether they are considered to be in ‘good condition’ (or equivalent terminology, such as ‘healthy’ or ‘favourable status’) following implementation of management actions. This is the point at which indicator metrics are evaluated against the target thresholds, benchmarks and trend directions. If the indicator metrics have not performed as expected, then an investigation of supporting parameters and environmental and pressure data may provide an understanding as to why this might have been the case.

Formal condition assessments should be conducted at least every five years, within a timeframe designed to feed into the PAME evaluation cycle and subsequent review of Management Plans (see the Maldives National Management Plan Guidance for PCAs; MoCCEE, 2024). It should however be noted that – dependent on the nature of the PCA features and the intensity of the pressures to which they are exposed – it may be necessary to conduct informal condition assessments more regularly to inform interim evaluations of management. For example, an informal assessment of manta ray population condition is conducted annually at Hanifaru Bay MPA to allow any changes to management (primarily related to tourism) to be implemented the following season.

There is no ‘correct’ way to conduct a condition assessment; the method and assessment criteria will vary dependent on the species, habitats, the pressures to which they are exposed and the type of PCA. For each PCA, the method should be discussed and agreed between the governing bodies and the key scientific stakeholders.

Condition assessments can be either qualitative or quantitative (Addison *et al.*, 2017). Qualitative condition assessments, using expert judgement, are conducted when limited or no monitoring data are available. However, expert judgement can be subject to a range of biases, such as linguistic uncertainty and overconfidence (Burgass *et al.*, 2017; Burgman *et al.*, 2011), and highly subjective estimates of environmental condition can vary considerably between individuals (Burgman *et al.*, 2011). The subjective nature of qualitative condition assessments means that the resultant accuracy and repeatability of these PAME evaluations can be compromised, and they may have limited comparability through space and time (Addison *et al.*, 2017).

Quantitative condition assessments are a viable alternative in situations where adequate scientific evidence is available (e.g., long-term monitoring data), and where research has provided a good understanding of ecosystem processes and dynamics (i.e., to justify the selection of environmental indicators and numerically defined condition categories) (Addison *et al.*, 2017). Such assessments remove the subjectivity of relying on expert judgement, improve repeatability over time and help condense complex monitoring information into standardised, transparent and easily communicated formats by which to communicate management outcomes (Cook *et al.*, 2014). Generic statistical and numerical guidance to aid analysis of quantitative data for condition assessments can be found in the UK 'Monitoring guidance for marine benthic habitats' (Noble-James *et al.*, 2018).

Where sufficient monitoring data are available, the five-yearly condition assessment should ideally be quantitative. It is, however, recognised that for many Maldives PCAs data are currently very limited, and managers may need to resort to a qualitative assessment.

4.2 Protected Area Management Effectiveness (PAME) evaluation

When a condition assessment has been conducted, the results will be combined with socio-economic monitoring information (together with a wide range of information on the various aspects of the PCA) to feed into the five-yearly PAME evaluation.

The PAME evaluation will help PCA managers to measure and understand the impact of management actions and track progress towards achievement of PCA goals and objectives, to document achievements, to identify and (if necessary) to set new management actions aimed at improving the future performance of the PCA.

Further details on the PAME evaluation process for Maldives PCAs can be found in the Maldives National Management Plan Guidance for Protected and Conserved Areas (MoCCEE, 2024).

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