

# PACIFIC CORAL REEF MONITORING ASSESSMENT



The Pacific BioScapes Programme is a European Union (EU) funded action, managed and implemented by the Secretariat of the Pacific Regional Environment Programme (SPREP). The Programme contributes to the sustainable development of Pacific Small Island Developing States through the implementation of 30 focused activities taking place across a diversity of ecosystems in 11 countries that will address critical issues concerning coastal and marine biodiversity, and ecosystem-based responses to climate change adaptation.

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### SPREP Library Cataloguing-in-Publication Data

Pacific coral reef monitoring assessment. Apia, Samoa : SPREP, 2026.

104 p. 29 cm.

ISBN: 978-982-04-1508-9 (ecopy)

1. Coral reefs and islands – Monitoring – Oceania. 2. Coral reef conservation – Oceania. 3. Coral reefs and islands – Research - Oceania. I. Pacific Regional Environment Programme (SPREP). II. Title.

593.60961

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Pacific Coral Reef Monitoring Assessment

### Document Control

#### Document Identification

Title	Pacific Coral Reef Monitoring Assessment
Project No	003745
Deliverable No	02
Version No	03
Version Date	6 February 2026
Customer	Secretariat of the Pacific Regional Environment Programme (SPREP)
Classification	None
Author	Dr Beth Toki, Lydia Tobin
Checked By	Dr David Rissik
Project Manager	Beth Toki

#### Amendment Record

The Amendment Record below records the history and issue status of this document.

Version	Version Date	Distribution	Record
01	23 December 2025	SPREP	PDF
02	30 January 2026	SPREP	PDF
03	06 February 2026	SPREP	PDF, DOC

# Executive Summary

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## Background

Coral reef ecosystems in the Pacific are among the most biodiverse globally, underpinning the livelihoods and cultural heritage of millions across the region. These reefs face multifaceted challenges, including climate change, local stressors, and resource constraints that hinder sustainable management. To contribute towards improved reef management in future, the Secretariat of the Pacific Regional Environment Programme (SPREP) contracted BMT to assess coral reef monitoring practices and needs across 11 Pacific Island Countries under the EU-funded Pacific Bioscapes Programme. This initiative seeks to strengthen national capacities for monitoring, data management, and reporting to enable evidence-based decision-making and improve resilience in marine ecosystems.

The assessment aligns with the Pacific Coral Reef Action Plan 2021–2030, supporting key action areas such as capacity building, habitat conservation, and research utilisation. Rather than imposing a uniform regional model, the recommendations emphasise tailored approaches that reflect national and sub-regional priorities and governance structures, particularly given responsibilities for reef monitoring and management can vary from community-led to government-driven systems. By enhancing fit-for-purpose monitoring frameworks, the initiative aims to increase informed decision-making and foster sustainable coral reef management across the Pacific Small Island Developing States.

## Approach

A consultative approach was adopted for the assessment, engaging national government representatives from 11 Pacific Island Countries, alongside selected coral reef monitoring stakeholders including NGOs, universities, and research institutions. While communities were not specifically targeted for consultation, national agencies and their partner organisations often accounted for community-based management and monitoring arrangements when providing inputs. Together, the inputs provide a regional perspective on monitoring capacities, governance structures, and aspirations for strengthening coral reef management.

While all countries had the opportunity to participate through an online survey and optional supplementary remote correspondence, five countries underwent more in-depth engagement through face-to-face meetings held between June and July 2025. These countries were Kiribati, Papua New Guinea, Republic of the Marshall Islands, Tonga and Vanuatu. Additional insights were gathered during a Pacific regional ReefCloud workshop hosted by the Australian Institute of Marine Science in Brisbane, Australia, in August 2025.

The assessment aimed to establish a regional understanding of current coral reef monitoring practices, including methodologies, data platforms, and stakeholder roles, while identifying gaps in capacity and integration. Specific objectives included evaluating government capabilities, recommending candidate countries for national monitoring programs, and developing actionable regional recommendations for SPREP and the Pacific Bioscapes Programme.

## Current Context and Challenges for Coral Reef Monitoring

Across the 11 Pacific Island Countries consulted, coral reef monitoring capacity and implementation varies significantly due to differences in governance, geography, strategic intention and resource availability. Current reef monitoring programs are not always designed to suit management needs in terms of direct coral reef conservation and management (i.e. can focus more directly on fisheries



management). The effectiveness of insights from monitoring being used to inform management and decision making is also variable between countries, with linkages to decision making most effective where strong communication and collaborative relationships exist between decision makers and those conducting the monitoring. There are also challenges in scaling up monitoring and addressing emerging needs or interests, which often are based on larger spatial scales as compared to present monitoring efforts.

While some nations maintain robust, long-term datasets, others face constraints such as limited funding, staffing shortages, and logistical challenges in accessing remote reefs. Community-based monitoring is widespread but often lacks standardisation and national resourcing, limiting data integration for informed decision-making, particularly in the context of aligning with national level decisions.

Monitoring techniques in the region predominantly rely on visual surveys using photo quadrats and transect methods, conducted in-person via SCUBA or snorkel (Figure 1). These approaches are favoured for their simplicity and low resource requirements. There is significant recent growth in the uptake of automated image annotation tools (e.g. CPCe, ReefCloud, CoralNet etc.) to facilitate the efficiency and accessibility of post-processing methods for the imagery collected from site through the application of machine learning. Other emerging technologies remain underutilised for application throughout the region, including both software and hardware technologies (e.g. ROVs/UAVs, drop or towed cameras, BRUVs, photogrammetry / photomosaics, remote sensing, environmental DNA (eDNA) etc.), in part due to limited awareness, training and resources. Data storage practices are inconsistent, with spreadsheets on local hard drives being most common, raising concerns about backup and accessibility. While some organisations use databases or cloud-based systems, broader adoption will be critical as data volumes grow with advanced monitoring techniques.

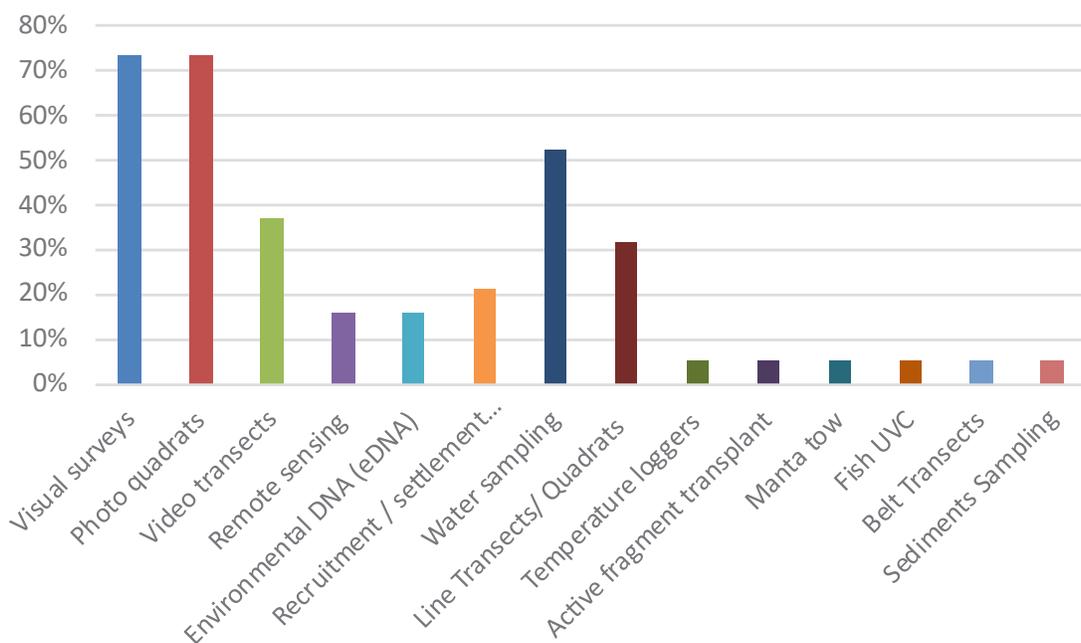


Figure 1. Reef survey methods used

Looking ahead, countries expressed clear aspirations to expand the spatial and temporal coverage of monitoring, integrate new technologies for data acquisition and management, and strengthen collaboration with national and international partners (Figure 2). These priorities underscore a regional

commitment to improving coral reef monitoring as a foundation for evidence-based management reef resilience. Achieving these goals will require targeted investment in capacity building, technology adoption, strategic policy or monitoring frameworks, and improved data-sharing to ensure that monitoring efforts translate into effective conservation and management of coral reef ecosystems.

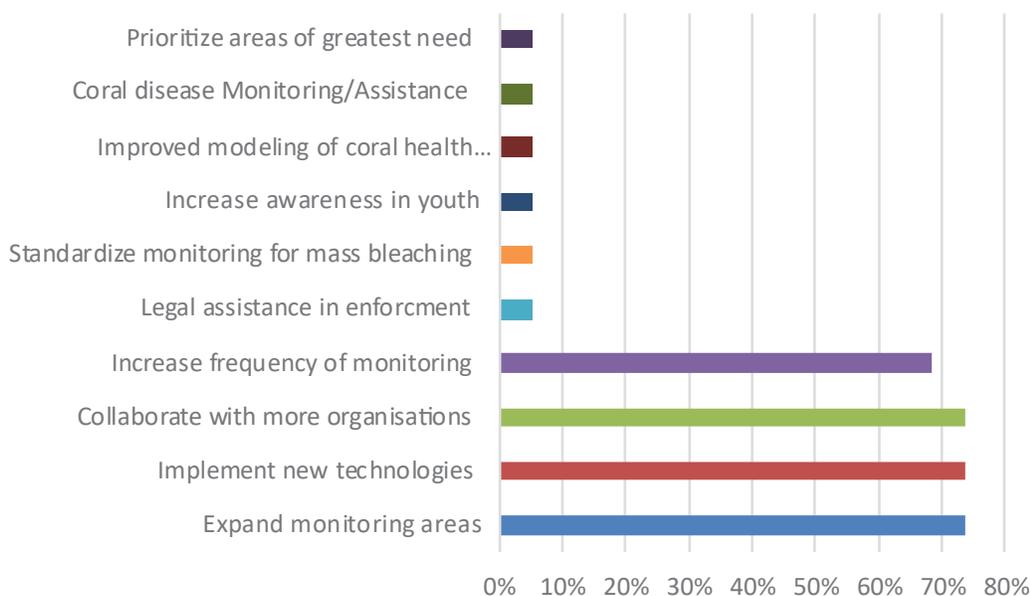


Figure 2. Future aspirations for coral reef monitoring

### Future Monitoring Needs

While significant challenges persist and governance structures vary between countries, common themes emerged across the region regarding future needs for improving coral reef monitoring. Countries identified the need to strengthen funding models, invest in training and capacity building, and establish standardised monitoring guidelines to ensure continuity and consistency. Enhanced collaboration, whether across government agencies, between governments and implementing partners, or at regional and international levels, was highlighted as critical, especially in the context of ensuring i) monitoring is designed to suit management needs, and ii) monitoring findings are accessible by reef managers and effectively used to inform decisions.

Additionally, there is growing interest in adopting new technologies, improving data sharing, and ensuring timely communication of monitoring results to decision makers. Barriers such as costs, limited awareness, and training gaps remain significant obstacles to technology uptake. Likewise, the ease of adopting new technologies and tools strongly influences the success of uptake by stakeholders. Ease of adoption therefore remains a critical requirement to facilitate new technological shifts away from historical approaches and avoid regression to old methods if new methods are perceived to be too complicated.

Addressing these needs at a national level is ambitious, particularly for resource-constrained countries, underscoring the importance of complementing national efforts with regional coordination and support. Regional initiatives can deliver cost efficiencies through shared databases, training programs, and funding advocacy, while fostering collaboration and knowledge exchange across jurisdictions. However, such efforts must remain flexible to accommodate diverse national objectives and governance structures, promote in-region capacity building, and leverage local expertise. These principles should guide the implementation of the actions recommended by this assessment for strengthening coral reef monitoring in the Pacific.



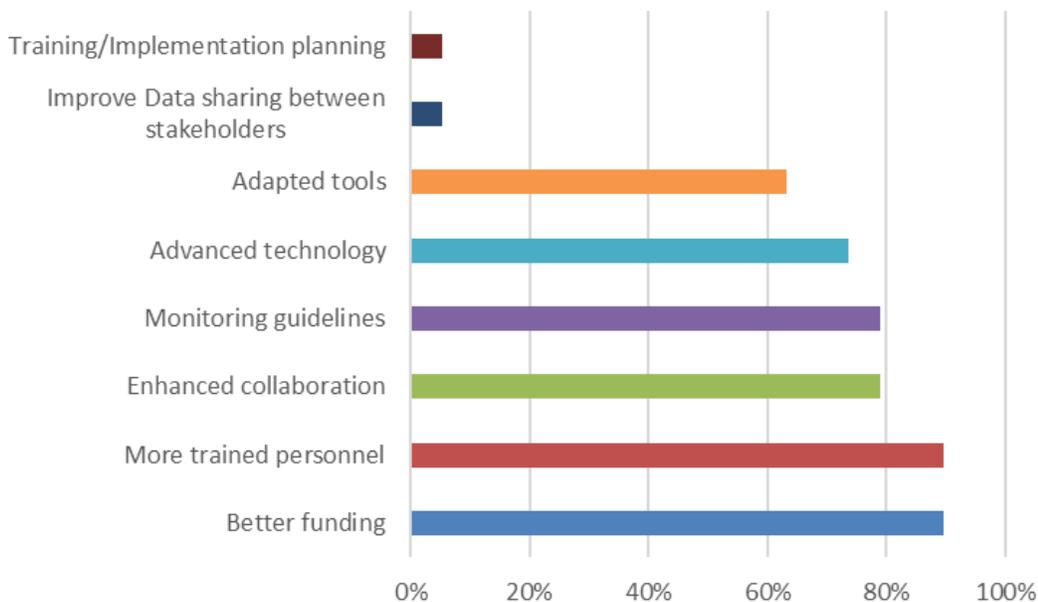


Figure 3. Key needs for improving coral reef monitoring

## Recommendations

Country-specific needs and recommended priority actions are set out for each country in Chapters 3 and 4 of this report. Across the 11 Pacific countries assessed, several key needs repeatedly emerged across the various need themes and are crucial for the region's success:

### *Training investment*

- Technical and scientific training to upskill and build institutional capacity
- Training and upskilling for communities and implementing partners

### *Enhanced collaboration*

- National collaboration
- Regional knowledge exchange
- International collaboration

### *Improved communication and data sharing*

- Improving communication and sharing of monitoring results
- Digital transformation of knowledge and data sharing

### *Development of monitoring guidelines*

- Expansion of guidelines and/or monitoring effort for countries with guidelines in place
- Development of guidelines for countries without these in place

### *Embracing technology*

- Leverage technological innovations
- Training to expedite uptake of technological tools

### *Improved funding*

- Support for budget security and cost-efficiencies.

For most of these common themes, there are opportunities for regionally coordinated action and strategic support. These are typically matters that would: benefit most from regional expertise; would be more cost-efficient to implement at a regional scale; and/or provide an avenue for value-add benefits to the region in terms of enhanced regional alignment and collaboration for resilient reef futures across the Pacific. The main exception is training/upskilling of local communities, NGOs or other local implementing partners, which is appropriate to be led at a national level. Priority actions that are recommended for regionally led implementation or support are listed in Chapter 4, along with a recommended prioritisation rating (low, medium, high) and an indicative timeframe for implementation (from present day). These recommendations are intended to be actionable and context-specific, recognising the diversity of environmental, cultural, and socio-economic conditions across the Pacific. A subset of the actions is listed below, specifically those identified as the ‘high priority’ actions for implementation in the immediate to short term (four action, Table 1) and medium term (five actions, Table 2). It is assumed that SPREP would be the focal point responsible for leading and coordinating regional actions.

**Table 1. High priority regional actions for implementation in immediate short term (next 1-2 years)**

<b>Recommended ‘HIGH PRIORITY’ regional actions (short term implementation)</b>	
1.	In tandem with actions about embracing technology, raise awareness of cost-efficiencies potentially derived from technological solutions.
2.	Host broad awareness training to raise awareness of the alternative hardware and software tools available (e.g. automated image annotation tools, map visualisation tools, remote sensing, QGIS, ReefCloud, CoralNet, CPCe software, photomosaic technology, eDNA, BRUVs, ROVs <sup>1</sup> , AUV <sup>2</sup> drop cameras etc.) and their potential applications in coral reef monitoring, including the advantages and disadvantages of each (e.g. costs, efficiencies, scientific bias/limitations, expertise required, transport and logistics, supplier support, maintenance and repairs etc.) and presenting example case studies from where the tools have been used previously for coral reef monitoring.
3.	Existing infrastructure is available via SPREP’s Pacific Environmental Data Portal, such that SPREP should continue working towards development (in liaison with countries) and roll-out of a Pacific Coral Reef Dashboard (including training), once there is confidence that the dashboard meets country needs
4.	For countries that have made new and significant progress in recent years to start to develop protocols for national coral reef monitoring (e.g. <b>Samoa, Vanuatu</b> ), offer support to finalise and commence implementation of national coral reef monitoring and/or broader reef management strategy that, among other management actions, sets out the objectives and aims of reef monitoring from the national perspective.



Table 2. High priority regional actions for implementation in medium term (next 2-5 years)

Recommended 'HIGH PRIORITY' regional actions (medium term implementation)	
1.	Investigate opportunities for potential cost-efficiencies by streamlining monitoring solutions regionally where appropriate. For example, finalise development and conduct roll out to countries of a Pacific Coral Reefs Dashboard through SPREP's Pacific Environment Data Portal.
2.	Support targeted training to promote and facilitate the uptake of new technological methods that countries decide to trial and/or incorporate directly into their monitoring regime. For example, if selected countries require training in automated image annotation, regional support could be provided in terms of identifying a suitable trainer and assisting to arrange training. Training should be delivered in a manner that ensures acquired technical skills are transferrable across brands to maintain robustness of capacity and continuity of reliable monitoring data long term (i.e. brand loyalty can present a risk to monitoring).
3.	Host workshops, mentorships, and/or exchange programmes focused on equipping local experts with skills in new monitoring tools and analytical techniques, and to increase the number of personnel with these skills. For skills relating to 'Embracing Technology' (refer above) this would be beneficial for all countries. Recent ReefCloud workshops for the Pacific provide an example model where similar training has successfully been delivered for one tool that is seeing increasing uptake in the Pacific (i.e. Pacific ReefCloud project's train the trainer model).
4.	Host workshops, mentorships, and/or exchange programmes focused on equipping local government staff and/or implementing partners (e.g. NGOs) with general skills and analytical techniques for coral reef monitoring. This is most pertinent for countries without an existing monitoring programme and/or those wanting to increase the number of personnel with these skills (i.e. identified as a priority need for FSM, Cook Islands, Solomon Islands, Samoa).
5.	Liaise with countries that have not progressed development of a formal or informal national coral reef monitoring guideline/framework (e.g. <b>PNG, Fiji, Solomon Islands, Cook Islands</b> ) to encourage and support development of these. Even if monitoring is primarily implemented by communities or other thirds parties, national guidelines set standardised procedures (including for data sharing) for better ensuring on-ground effort meets national needs and commitments. Such guidelines could be stand-alone, or be embedded within a national reef management strategy (e.g. National Coral Reef Action Plan, marine spatial planning, MPA initiatives) that, among other management actions, set out the objectives and aims of reef monitoring from the national perspective.

All recommended priority actions, both at the regional and country levels, should consider opportunities to incorporate traditional knowledge and practices to complement scientific approaches, and align with the Pacific Coral Reef Action Plan 2021-2030.

In addition to focusing only on improvement needs, it is recommended that there also be region-wide recognition that celebrates where monitoring is being done well and is addressing the needs of decision makers. A focus on positive recognition sustains and grows engagement, which is essential to successfully addressing all priority needs. This could take the form, for example, of developing a range of case studies that have the value-add of fostering knowledge sharing and implementation in other locations. Case studies could include the way in which data are collected and managed, the ways results are used to inform management and stakeholders, and how the results have helped to inform and achieve outcomes. For exceptional monitoring examples and role models, it is also worth considering nominating monitoring programs and/or personnel for environmental awards.



## Conclusion

While significant obstacles remain, there is clear momentum towards more integrated, resilient, and sustainable approaches to coral reef monitoring in the Pacific, with the goal of safeguarding the region's reef ecosystems for future generations. By investing in technical training, expanding monitoring to remote locations, harmonising protocols, embracing technology, and fostering collaboration, Pacific nations can build a resilient framework for robust reef knowledge and stewardship.

This assessment provides a foundation for future action, offering practical guidance to support next steps for working with countries to improve coral reef monitoring. Stakeholders are encouraged to use this report as a roadmap for collaborative action and continuous improvement, whereby future success will depend on sustained commitment, ongoing upskilling, sustained resourcing, and a shared vision for healthy, productive reef ecosystems across the Pacific.



## Acknowledgements

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The Secretariat of the Pacific Regional Environment Programme (SPREP), together with BMT, wish to thank the many representatives from the Pacific region who generously contributed their time and knowledge to inform this assessment through the consultation. In particular, those from the selected priority countries who hosted in-country meetings.

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Marshall Islands Environmental Protection Authority (RMI EPA)

Marshall Islands Marine Resources Authority (MIMRA)

Marshall Islands Conservation Society (MICS)

Nguna Pele Area Council

One Reef / MiCOAST Project

Palau Bureau of Environment

Palau International Coral Reef Centre (ICRC)

PNG Conservation and Environment Protection Authority (CEPA)

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# 1 Introduction

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## 1.1 Background

Coral reef ecosystems in the Pacific region are some of the world's most vibrant and diverse reefs, supporting the livelihoods and cultures of millions of people. The challenges facing these reefs are vast and complex, spanning climate change, local stressors, and limited resources to support sustainable management and ecosystem enhancement.

BMT was engaged by the Secretariat of the Pacific Regional Environment Programme (SPREP) to undertake an assessment of coral reef monitoring across the Pacific, in collaboration with selected SPREP member countries. The purpose of this assessment was to better understand the needs and aspirations of these countries in strengthening capacities for coral reef monitoring, data management, and reporting, particularly to enhance evidence-based decision-making for coral reef management.

This work was delivered under the European Union (EU)-funded Pacific Bioscapes Programme, managed by SPREP, which aims to support the sustainable development of Pacific Small Island Developing States (SIDS) by improving the management and use of marine and coastal resources. Covering 11 Pacific Island Countries, the programme encompasses 30 projects designed to build capacity for biodiversity management, strengthen climate resilience, and promote the conservation and sustainable use of marine and terrestrial ecosystems.

The assessment also aligns with the Pacific Coral Reef Action Plan 2021–2030, developed by SPREP in close consultation with Pacific Island Countries and Territories (PICTs) and partners. The Action Plan provides a framework for enhancing the resilience and prosperity of coral reef ecosystems in the region. Strengthening coral reef monitoring for decision-making contributes to several of the eight Action Areas identified in the Action Plan, particularly:

- Action Area 1 – Optimise Capacity Building
- Action Area 2 – Foster Traditional Knowledge and Practices
- Action Area 5 – Conserve Reef Habitat and Biodiversity
- Action Area 8 – Utilise Research and Monitoring

This assessment specifically aimed to assess and provide recommendations to better support the 11 Pacific Bioscapes programme countries (Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Republic of the Marshall Islands, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga and Vanuatu) towards improved and fit-for-purpose coral reef monitoring programmes and approaches. Instead of a regionally harmonised or replicable model, the overarching goal is to:

*Increase monitoring efforts that support and deliver informed decision-making for coral reef management, building on current practices and targeted approaches depending on national or sub-regional frameworks and capabilities.*

In this regard, it is important to note that coral reef governance and decision-making responsibilities can be held by different decision maker jurisdictions from country to country. In some countries for example, much of the responsibility for coral reef monitoring and management lies with local communities, often with local/international NGO partners, whereas in others National or Provincial governments are responsible for reef monitoring and management.



## 1.2 Approach

Our approach for the assessment focused on consulting directly with national government representatives from the selected Pacific countries, as well as with other key reef monitoring operators in those countries, particularly those operators recommended by and/or significantly collaborating with the national governments on coral reef monitoring. These primarily included local and international non-government organisations (NGOs), as well as universities and research institutions.

While the assessment broadly covered 11 countries, a more in-depth consultation was conducted for five (5) of these countries: **Kiribati, Papua New Guinea, Republic of the Marshall Islands, Tonga and Vanuatu**. For these five countries targeted face-to-face consultation meetings were held (June-July 2025) with key national government agencies/ministries and selected non-government parties. This was in addition to an online consultation survey that was distributed to each of the 11 countries, supplemented with remote correspondence when clarification was required.

Additional inputs and feedback were sourced through group discussions that were facilitated in a workshop setting, as part of a regional ReefCloud<sup>3</sup> workshop that was hosted for Pacific attendees by the Australian Institute of Marine Science in Brisbane (August 2025).

Specific objectives of the assessment were to:

- Better understand the current state of coral reef monitoring in each of the 11 countries, including key stakeholders and partners involved, tools, methodologies, techniques and data platforms implemented, the type of monitoring data collected, data sharing arrangements, data storage and reporting capacities, initiatives and programmes from government agencies and their partners.
- Better understand current capacities and capabilities of the government agencies in coral reef monitoring, highlighting gaps and needs towards informed decision-making processes and coral reef management policies.
- Recommend potential candidate countries where a national coral monitoring programme could be designed and implemented.
- Develop recommendations for SPREP and the Pacific Bioscapes Programme towards capacity development, data integration, and a regional coral reef data webpage, building on the Pacific Environment Data Portal (PEP) or other existing portals or platforms.

This report presents the findings of the assessment set out as follows:

- **Chapter 2: Current Coral Reef Monitoring Context in the Pacific** (including a regional overview and synopsis for each country)
- **Chapter 3: Future Monitoring Priorities** (including a regional overview and synopsis for each country)
- **Chapter 4: Summary of Findings and Priority Recommendations.**

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<sup>3</sup> Refer ReefCloud open access platform: <https://reefcloud.ai/>



## 2 Current Coral Reef Monitoring Context in the Pacific

### 2.1 Regional Overview

The following information is based on the inputs provided by the selected countries through the survey-based consultation process conducted for this assessment. More detailed country-specific information is presented in the following sections.

A total of 38 survey responses were received. In some instances, national focal points advised only one nominated government delegate would respond on behalf of all relevant government agencies for that country. A breakdown of survey respondent affiliation is provided, recognising that respondents from different sectors may bring both explicit biases (such as greater reporting of programs led by their own organisation, or limited awareness of initiatives led by others) and implicit biases (including more favourable views of programs or actions with which they are directly involved). Note that survey responses were predominantly provided by representatives of national government agencies (36%), NGO/civil society representatives (39%), and other government bodies (8%) (Figure 2.1). These ratios partly reflect the strong roles of both national governments and NGOs in coral reef monitoring and/or management in most of the selected countries, though noting that some parties are likely underrepresented, particularly universities and communities. Where communities have primary responsibility for coral reef monitoring and management, such as through community-based management arrangements, the national government responders took this into account. For example, by advising generally about priority needs for supporting communities with coral reef monitoring in their country.

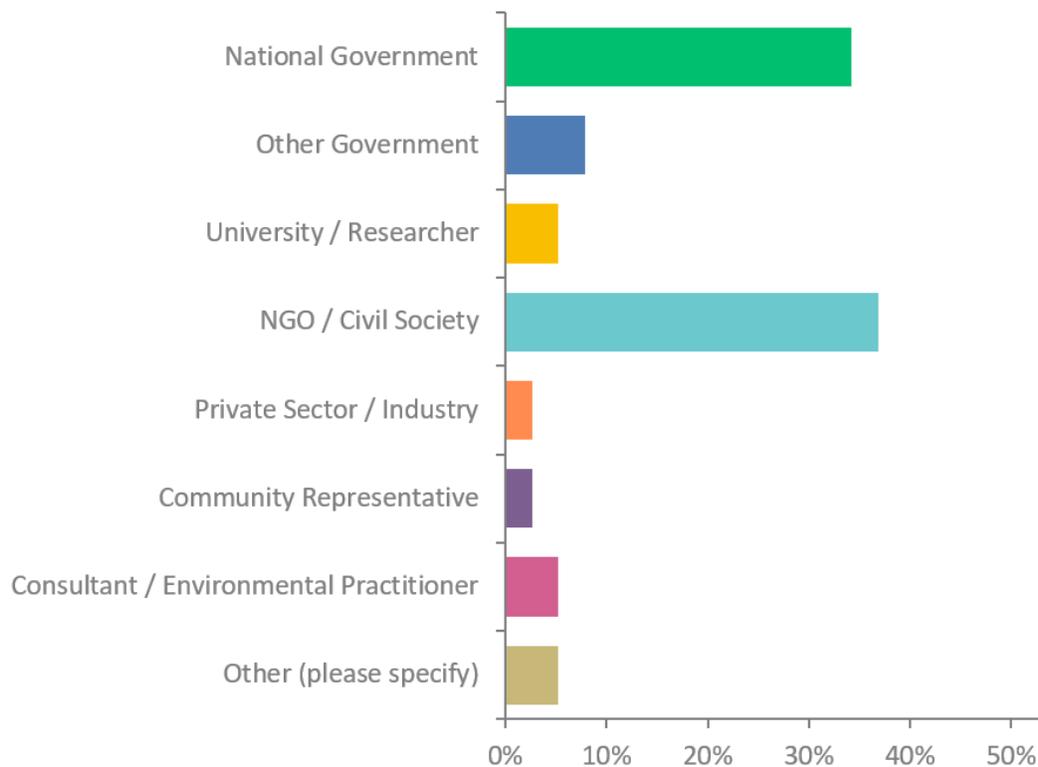


Figure 2.1 Affiliation of survey participants



Those respondents identifying as being affiliated with the 'Other' category can be considered as 'Private Sector / Industry' representatives as were associated with consulting or tourism.

## Regional Context

Across the countries consulted there exists a diverse range of coral reef management structures and monitoring capacities. These differences are largely driven by governance, geography and resource availability. While some nations maintain relatively robust and long-term reef monitoring datasets and established monitoring programmes, others face significant constraints related to funding, staffing, reef remoteness, and data integration issues. Community-based efforts are widespread and often form the backbone of reef stewardship, but many programs lack standardisation and nation-wide resourcing, limiting data availability for informed management decisions. Similarly, current reef monitoring programs are not always designed to suit management needs in terms of direct coral reef conservation and management (i.e. can focus more on fisheries, rather fisheries habitat). The effectiveness of linkages from monitoring to informing management and decision making is also variable between countries, with linkages to inform decisions most effective where there is strong communication and collaborative relationships between decision makers and those conducting the monitoring. There are also challenges in scaling up monitoring and addressing emerging needs or interests, which are often based on larger spatial scales.

Despite these differences, some key overarching themes were common throughout the region in the context of coral reef monitoring and management, particularly:

- A shared recognition of the importance of reef health and the urgency of climate-related impacts.
- Coral reefs nearer to human urban centres and settlements were generally more of concern, considered more degraded and more in need of management as compared to remote reefs.
- Remote reefs are typically the most poorly assessed by reef monitoring initiatives (i.e. least frequently included in monitoring), due largely to complex or costly logistics associated with traveling to survey these locations.
- Climate change was considered most likely to have the greatest overall impact on future coral reef health in the region, such that data relating to reef health in the context of climate change was perceived as highly desirable for supporting future reef management decisions.
- Local efforts to manage direct threats such as crown-of-thorns seastar (COTS, *Acanthaster planci*) outbreaks were generally successful and indicated a clear area where local management efforts have been successful at small spatial scales.
- There is significant room for improvement in terms of integrating findings from coral reef monitoring into government or community driven management actions, with consultation responders indicating such integration occurred (58%), only partially occurred (17%), or did not occur at all (25%).

To highlight the importance of coral reef monitoring and management, it is worth noting that almost 50% of the consultation survey responders indicated that there had been a decline in coral reef health in recent years (Figure 2.2). They typically perceive these changes to be attributed to a combination of one or more of the following factors: climate change, coastal development, pollution and/or overfishing (Figure 2.3).



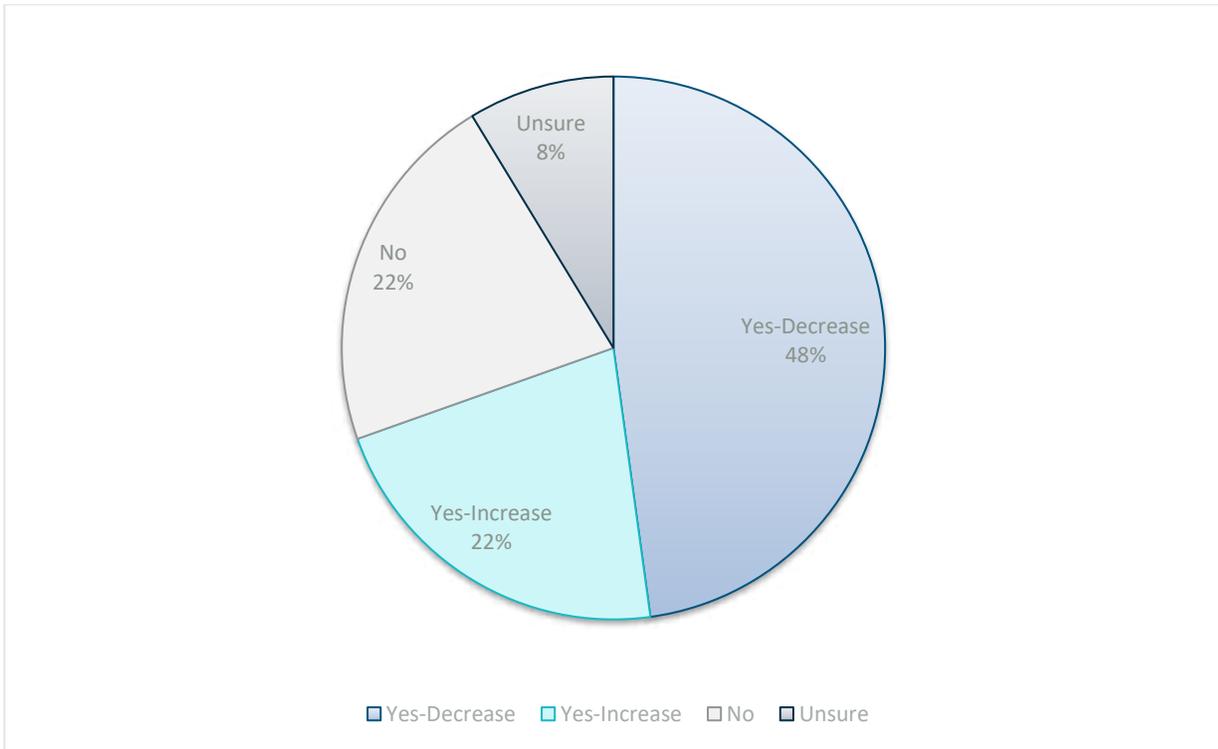


Figure 2.2 Proportion of responders indicating they had noted significant changes in coral reef health over the past few years

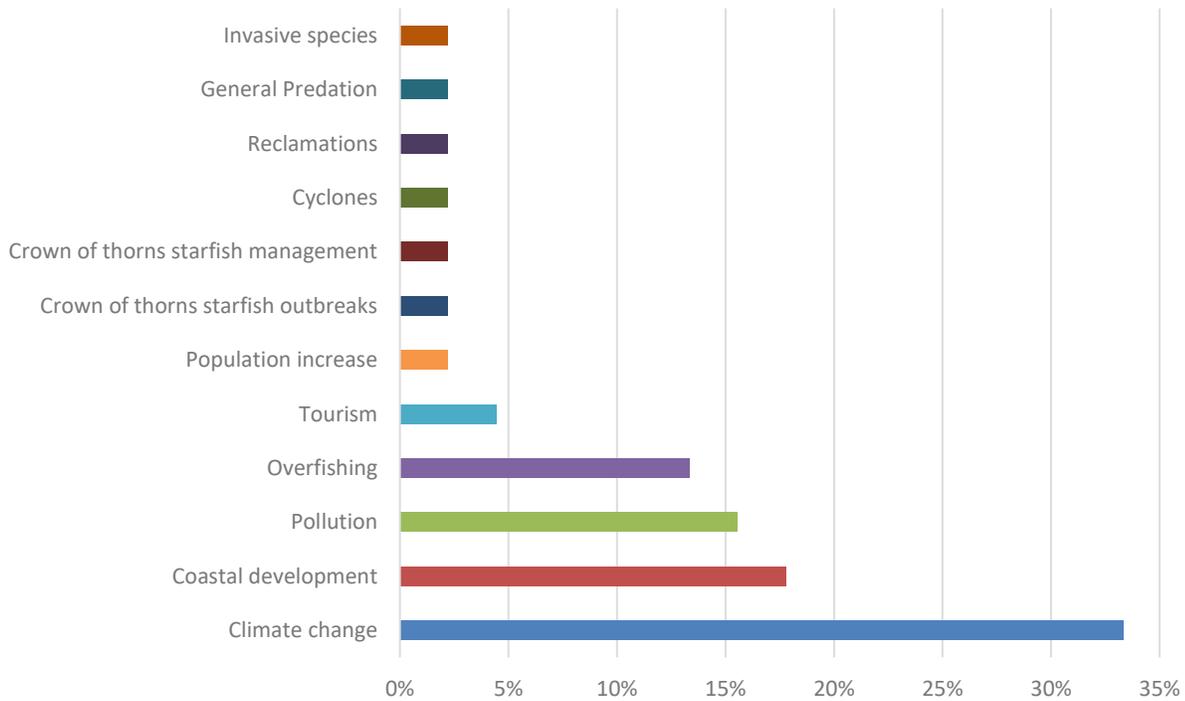


Figure 2.3 Primary contributor to changes in coral reef health



## Coral Reef Monitoring Techniques in the Region

In terms of the field survey techniques used for coral reef monitoring in the selected Pacific countries, visual surveys using photo quadrats are most commonly used. Transect methods, via either direct visual survey or video-based image capture are also used, as is water quality sampling (Figure 2.4). The prevalence of these methods can be attributed not only in the context of their appropriateness for assessing reef condition, but also owing to their relatively low barrier for uptake, training and implementation (i.e. snorkel-based implementation requires simple tools such as a PVC quadrat or tape measure, a note board and/or camera).

There is an emerging use of technological approaches to data acquisition in coral reef monitoring (e.g. remote sensing, environmental DNA (eDNA), photomosaic technology), although their application is not yet widespread in the Pacific region. Their limited uptake is partly linked to a lack of awareness around the existence and/or benefits of using such tools for coral reef monitoring, together with limited access to training, resources and laboratories.

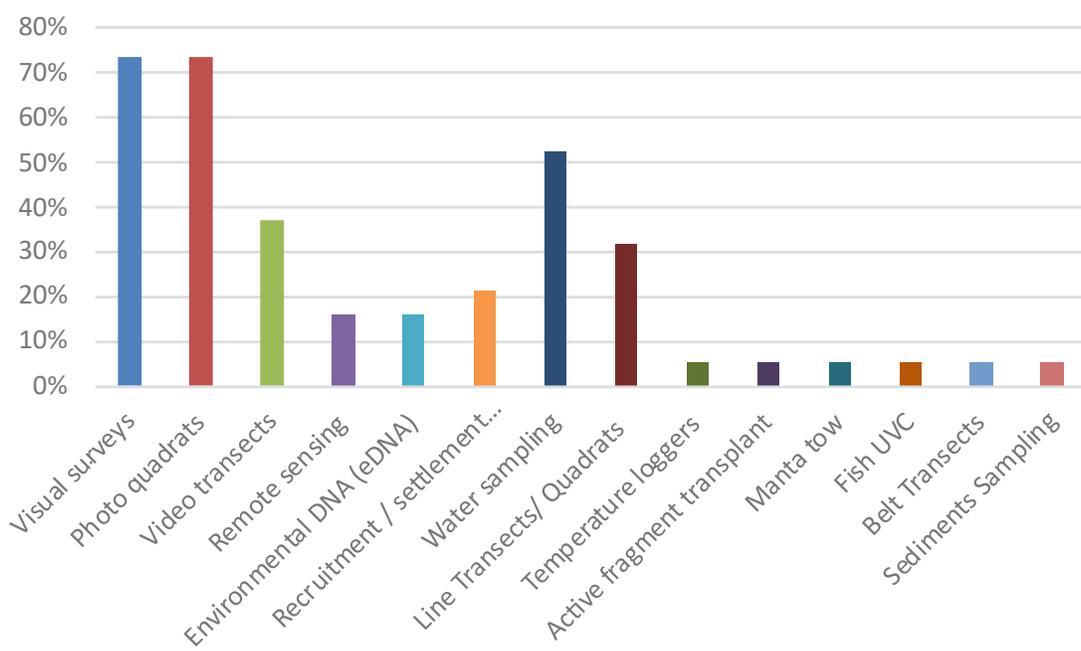


Figure 2.4 Reef survey methods used

Storage options used for data from coral reef monitoring are highly varied and typically lack consistency at national scales (i.e. between organisations operating within a country) or at regional scales (i.e. between countries). Spreadsheets stored on local hard drives remain the most common form of data storage (Figure 2.5). There is wide ranging familiarity of programs such as Microsoft excel and its spreadsheets are highly compatible with statistical software packages such as R Studio. However, solely relying on hard drive storage raises some concerns as it is unknown to what degree 'backup' copies are held or updated for contingency, and shareability is limited if access is only available to a few people.

In some instances, data is uploaded to databases (either organisational or regional databases) and there is a growing uptake of cloud-based data storage. The latter will become increasingly critical as technological shifts demand greater data storage capacities, due to larger file sizes and increasing uptake of data-heavy monitoring techniques (e.g. video, remote sensing etc.). In many instance data is stored

only by external/international partners (e.g. NGOs, universities). This poses a key risk where decision makers lack agency and access with regard to monitoring data, particularly in the longer term (e.g. data access may be lost altogether if an external organisation disbands, has significant staff turnover, or discontinues data storage facilities/programmes).

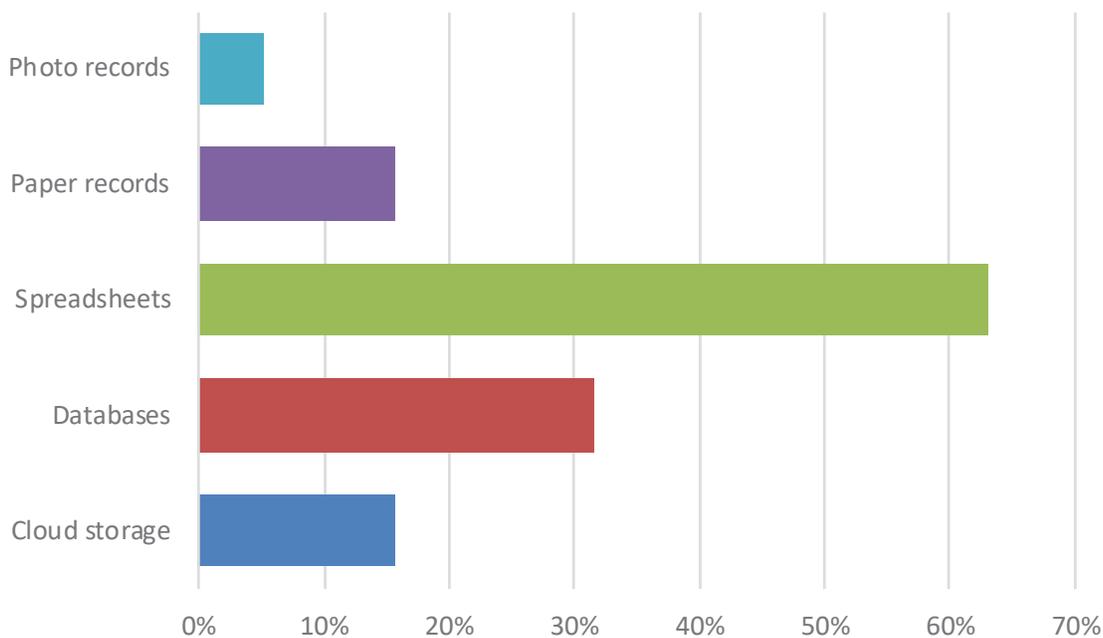


Figure 2.5 Reef data storage locations (note: 'spreadsheets' denotes standalone Excel files or similar stored on local drives, i.e. not integrated with database or cloud storage systems)

### Regional aspirations for improved coral reef monitoring

Survey responders were asked to indicate their: i) priority goals regarding their next steps for improving coral reef monitoring nationally; and ii) priority needs or mechanisms to achieve these goals. Overwhelmingly, the region indicated aspirations to (Figure 2.6):

- Increase the spatial extent of coral reef monitoring by expanding exiting monitoring efforts to include new monitoring locations
- Integrate new technologies to improve coral reef monitoring, either acquisition technologies (e.g. field survey or remote monitoring technologies) or technologies for data storage, analysis and/or sharing technologies
- Improve collaboration with relevant national or international organisations, including both government and non-government organisations
- Increase the temporal frequency of monitoring.

These priority goals and needs were reasonably consistent, regardless of the affiliation of the responder (i.e. government vs NGO etc.). There was however a slight trend for NGOs to primarily desire expanding the spatial or temporal coverage of monitoring (i.e. scale up the existing operations of the organisation), whereas government responders were more cognisant of the need to also improve collaboration and uptake of technologies.



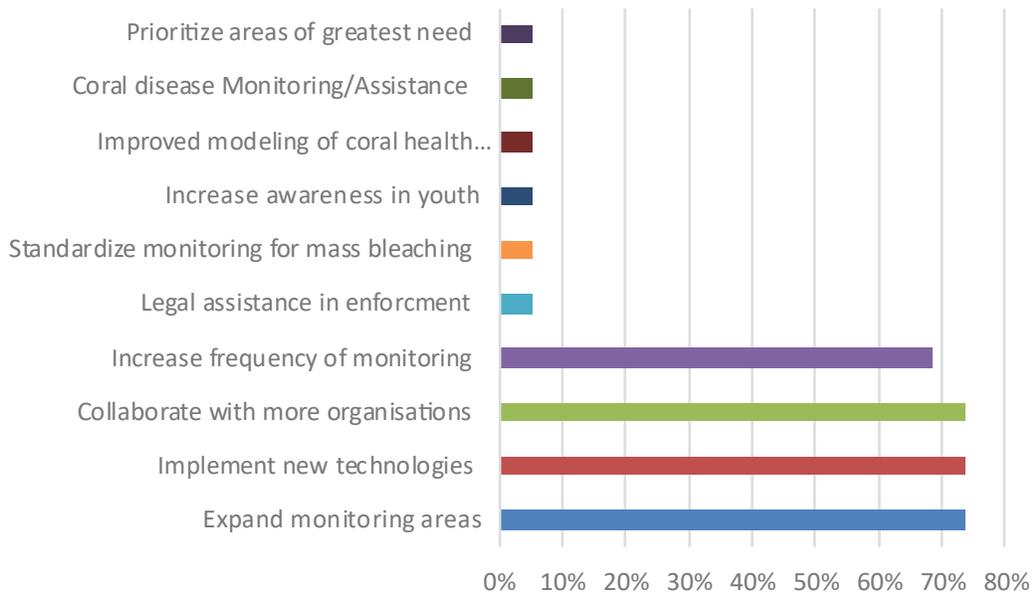


Figure 2.6 Future aspirations for coral reef monitoring

## 2.2 Tonga

Tonga's coral reef ecosystems include a diverse range of fringing, barrier and lagoon reefs, distributed across volcanic and limestone islands. Coral reef conservation in Tonga is driven by both local ecological assessments and a nationally scaled community-based management program. Between 2016 to 2019, ecological surveys of over 375 sites across Tongatapu, Ha'apai, and Vava'u (Figure 2.7) found that Tonga's coral reefs are increasingly impacted by climate-driven stressors, such as bleaching and cyclones, and by local pressures including overfishing and land-based pollution (Smallhorn-West et al., 2020). Live coral cover averaged just 18%, with southern reefs (e.g. Tongatapu) showing greater resilience compared to more degraded northern systems (e.g. Vava'u) (Smallhorn-West, 2019). Reef fish biomass can also be highly variable, with many areas classified as moderately to heavily exploited. In recent years, there has also been increasing observations at some sites of coral bleaching, macroalgae (where rainfall runoff results in spikes of nutrient inputs) and crown-of-thorns seastar (COTS). The latter have instigated management action by way of some manual COTS removal.

In response to such stressors, Tonga has implemented an expansive network of Special Management Areas (SMAs), rooted in co-management principles under the Fisheries Management Act 2002 (Gillett, 2010). Each SMA grants exclusive fishing rights to communities and requires the designation of no-take Fish Habitat Reserves (FHRs) (Ford-Learner et al., 2024). By 2019, more than 50 SMAs had been established nation-wide and there are now approximately 64 SMAs. While impact assessments of older SMAs indicate signs of fish recovery, particularly within FHRs, evidence of broader ecological improvement is mixed. Some areas show increases in fish size and abundance, but others demonstrate negligible changes. Additional on-site and off-site management interventions are also being considered (e.g. coral planting for direct reef enhancement, mangrove restoration to support water quality improvement). Reef monitoring effort remains unevenly distributed across sites and often lacks long-term follow-up data, limiting conclusions on overall effectiveness. For example, while baseline surveys are conducted when establishing and SMA, implementation of follow-up monitoring is not consistent, often constrained by staff capacity.

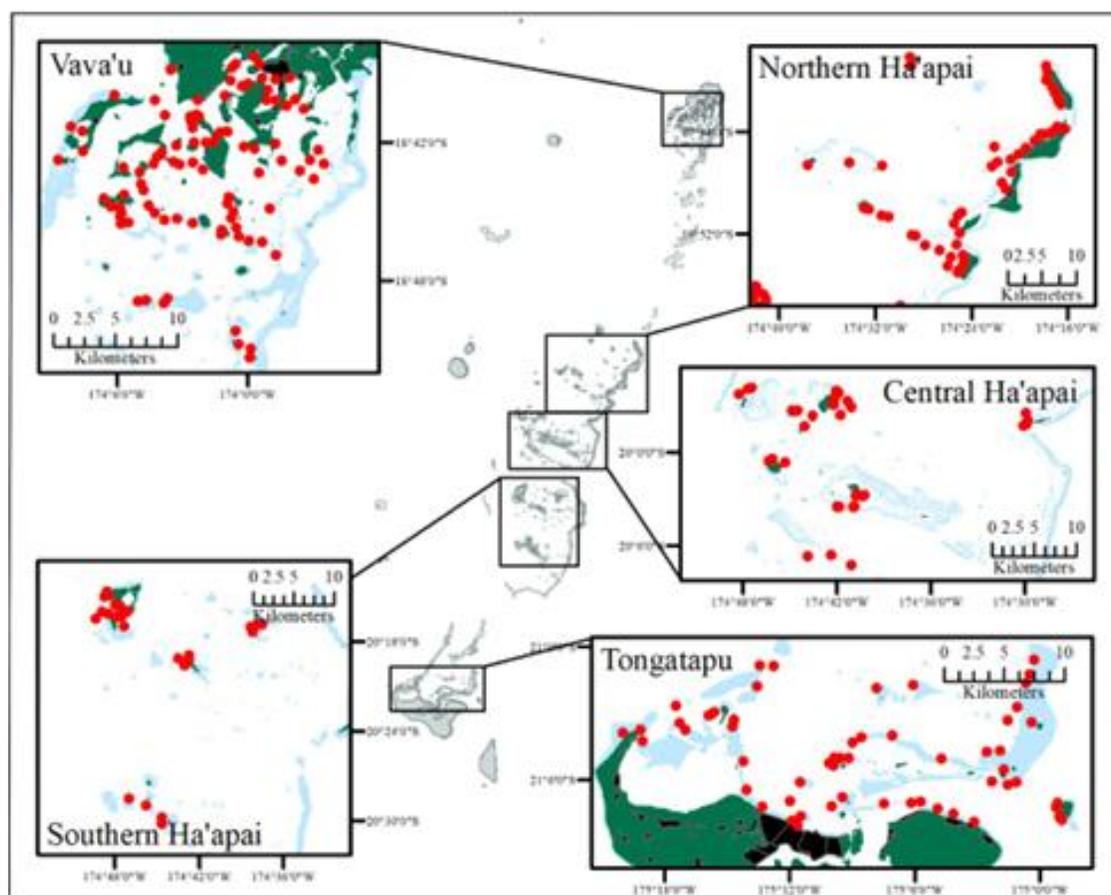


Figure 2.7 Map of Tonga showing the locations of coral reef survey sites (red dots), with land denoted by green, villages and urban areas by black, and coral reef habitat by blue (source: from Smallhorn-West, 2020b)

Coral reef monitoring in Tonga is currently executed through strong collaborative operations between the Department of Environment, Ministry of Fisheries and the non-government organisation (NGO) Vava'u Environmental Protection Association (VEPA), with support from James Cook University. It typically uses a rapid assessment methodology that evolved from BIORAP (rapid biodiversity assessment) initiatives, specifically SCUBA-based surveys for:

- Line-transect based monitoring of reef fish and invertebrates
- Point intercept transect monitoring for benthic biota (including corals)
- Photo quadrat based monitoring of corals to species (via ReefCloud for analysis).

This has been supplemented by related short-term coral reef survey programmes, such as the:

- Ridge to Reef Phase I and Phase II
- CITES<sup>4</sup> coral stock assessment (Tongatapu)
- Local NGO efforts (Vava'u coral reef monitoring by VEPA)
- International NGO surveys (e.g. Waitt Foundation in 2014 and 2022, Living Oceans Foundation 2020, Blue Nature Alliance)

<sup>4</sup> Convention on International Trade in Endangered Species of Wild Fauna and Flora



- International research, particularly James Cook University<sup>5</sup>
- Communities conducting local reef health monitoring with the support of external donors and parties.

Much of these efforts are typically concentrated around Tongatapu and Vava'u. In recent years there has also been much focus on the impacts of the Hunga-Tonga Hunga-Ha'apai volcano eruption, and subsequent tsunami, on coral reefs and their reef fish communities (e.g. increase in *Sargassum* spp. macroalgae, physical reef damage, substrate destabilisation through the presence of coral rubble, increase in urchin abundance etc.). Given the severity of this event in 2022, Tonga is highly cognisant of the extreme effects that acute natural hazard events (such as major volcanic eruptions) can have on their coral reef ecosystems.

With regard to data analysis and storage from the major government-led coral reef monitoring initiatives, it was indicated that data were generally recorded in spreadsheets, uploaded to either local hard drives or cloud storage, and shared with Government departments (Environment / Fisheries), funding partners, regional organizations and NGOs. This data is then analysed locally by government Fisheries or Environment staff (or their local contractor), or VEPA. Academic partner(s) at James Cook University have also led more detailed statistical analyses and data manipulation in recent years and frequently make their coral reef data publicly accessible via portals linked to scientific journal publications (e.g. ecological data hosted at <https://doi.pangaea.de>). Like most countries assessment, there was no specific mention of coral reef monitoring data being uploaded to the regional Pacific Environment Data Portal hosted by SPREP. Despite this, coral reef monitoring data is accessible by, and/or provided directly to, both government and community decision makers regarding reef management and conservation. This positive outcome results from the strong collaborative culture, open dialogue and sharing between data gathering efforts and governance.

### 2.3 Kiribati

In part due to Kiribati's vast geographical spread across the Gilbert, Phoenix and Line Islands groups, the coral reefs in Kiribati are recognised for their significant spatial extent and high biological diversity. Government led coral reef monitoring in Kiribati is conducted by the Ministry of Fisheries and Ocean Resources (MFOR) Coastal Fisheries Division, which has a particular remit for coral reef management (including through community-based management plans) in the context of sustainable coastal fisheries. This monitoring is conducted bi-annually and is concentrated in the Gilbert Islands (e.g. outer reefs of South Tarawa and Abaiang), given the operational constraints for monitoring the remote Phoenix and Line Islands.

Long-term coral reef monitoring began in the early 2000s, focusing primarily around Tarawa and Abaiang. While early studies found high coral cover (~55%) in North Tarawa and low cover (~20%) in South Tarawa, subsequent bleaching events (particularly in 2004) led to significant declines (Donner, 2007). However, reefs in South Tarawa have demonstrated notable resilience, largely due to the dominance of the bleaching-tolerant coral *Porites rus*, despite chronic water quality and sedimentation issues (Summers & Donner, 2022). Coral bleaching has also been reported anecdotally for various locations in Kiribati in the last two to three years. In contrast, outer atolls and less populated regions remain understudied, with limited consistent monitoring. This is partly due largely to the remoteness of reefs making ongoing surveys costly and logistically difficult, together with inconsistent methodology limiting long-term data comparisons.

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<sup>5</sup> Dr Patrick Smallhorn-West completed his PhD research on Tonga's coral reefs, including leading expeditions to study the impact of the Hunga Tonga–Hunga Ha'apai volcano on the coral reefs.



The government-led monitoring conducted bi-annually the Gilbert Islands (e.g. outer reefs of South Tarawa and Abaiang) is conducted in the form of SCUBA or snorkel based visual/camera surveys of coral cover and health, as well as monitoring reef fish communities. This includes point intercept transect monitoring and photo transects for benthic biota to track coral cover, coral health, species composition and benthic assemblages. Data is analysed using CPCe (Coral Point Count with Excel extensions) and stored locally by MFOR as Excel spreadsheets. Data acquired by international university researchers is often publicly available via data portals linked to scientific journals – for example, data from Cannon et al. 2021 accessible at <https://zenodo.org/records/4456048> (refer also Figure 2.8).

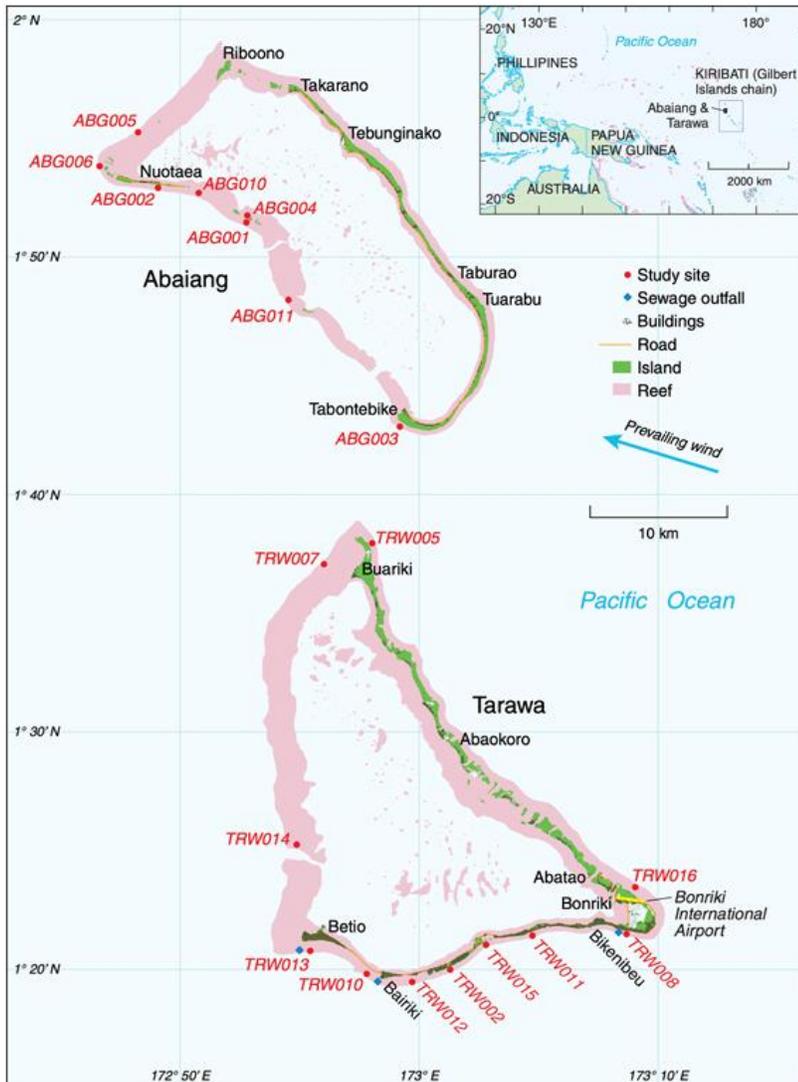


Figure 2.8 Map depicting the study sites for coral reef monitoring in Tarawa and Abaiang (Source: Cannon et al. 2021)

Additional coral reef surveys have been conducted by, or funded by, NGOs (e.g. Conservation International, Waitt Foundation) and research institutions, usually with a focus on marine protected areas (MPAs). This is especially true for the Phoenix Islands Protected Area (PIPA) established in 2008, and the Southern Line Islands Marine Protected Area (SLIMPA) established in 2018.

Note that by the time of its establishment, the Phoenix Islands Protected Area (PIPA) was reported to host over 200 coral species (including several new or undescribed species) and at least 518 reef fish species, with predictions of over 576 total fish species (Obura et al., 2002, Donner, 2007). The Gilbert Islands, including South Tarawa, have notably fewer coral species (~115), and reef health in these areas varies significantly due to population density and local anthropogenic pressures.

There is also some research being conducted in relation to heat tolerant coral species in the Line Islands, as well as isolated interests in biomedical-related research using corals. Some coral nursery work and associated monitoring has been attempted previously but is not presently active.

Additionally, the Environment and Conservation Division (ECD) at the Ministry of Environment, Lands and Agricultural Development (MELAD) has a wide-reaching remit relating to coral reef management, such as through the responsibilities of their Biodiversity and Climate Change Section, Environmental Data Section, marine spatial planning initiatives, and linkages to the outer islands Integrated Community Based Natural Resources Management Plans. As such, there is growing recognition of the importance of strengthening national coordination frameworks, data sharing and ongoing communications between ministries. Likewise, integrating scientific and traditional knowledge more directly into decision making would enhance adaptive reef governance in the face of climate change and population pressures.

## 2.4 Papua New Guinea

Papua New Guinea (PNG) is the largest of the Pacific Island nations in terms of land area, and lies within the Coral Triangle with approximately 13,840 square kilometres of coral reef habitat. This comprises extensive fringing and patch reefs, with barrier reef formations in areas such as Milne Bay and East Cape. Kimbe Bay alone hosts exceptional reef biodiversity with more than 400 coral species and at least 860 reef fish species (Chin et al. 2008).

Remote reef systems in PNG, particularly in Manus and New Ireland Provinces, remain in relatively good ecological condition. However, reefs adjacent to population centres show significant degradation, primarily from sedimentation, destructive fishing, mining, COTS outbreaks and land-based runoff (Moore et al. 2014; Chin et al. 2008; Flynn et al. 2004) (refer example survey sites shown in Figure 2.9). Monitoring in the northern Manus outer islands, including Ahus, Andra, Onetah and Ponam Islands revealed significant spatial variability in coral and fish community health (Moore et al. 2014). While some outer reefs retain moderate coral cover and diverse fish assemblages, back reef and lagoon zones are increasingly dominated by algae, sediment, and rubble, indicating chronic environmental stress.

Coral reef monitoring in PNG is a Provincial and/or community responsibility, rather than a national government responsibility. However, there is no overarching (e.g. national) strategy, coordination or incentivisation linked to the provincial or community remit for reef monitoring. Community-based management initiatives, often supported by NGOs (such as Sea Women of Melanesia (SWOM), Coral Sea Foundation, James Cook University, Hiri Coral, Kyeema and ENB Sea Keepers) and provincial fisheries authorities, thus play a central role in reef governance in PNG. Yet coral reef monitoring in the region remains difficult, largely due to the remoteness of many locations, lack of adequate funding and technical capacity to complete ongoing survey works. As such, the overall effectiveness of monitoring efforts can be severely constrained by limited resources, uneven distribution of monitoring effort, and external pressures (Moore et al. 2014; Chin et al. 2008).



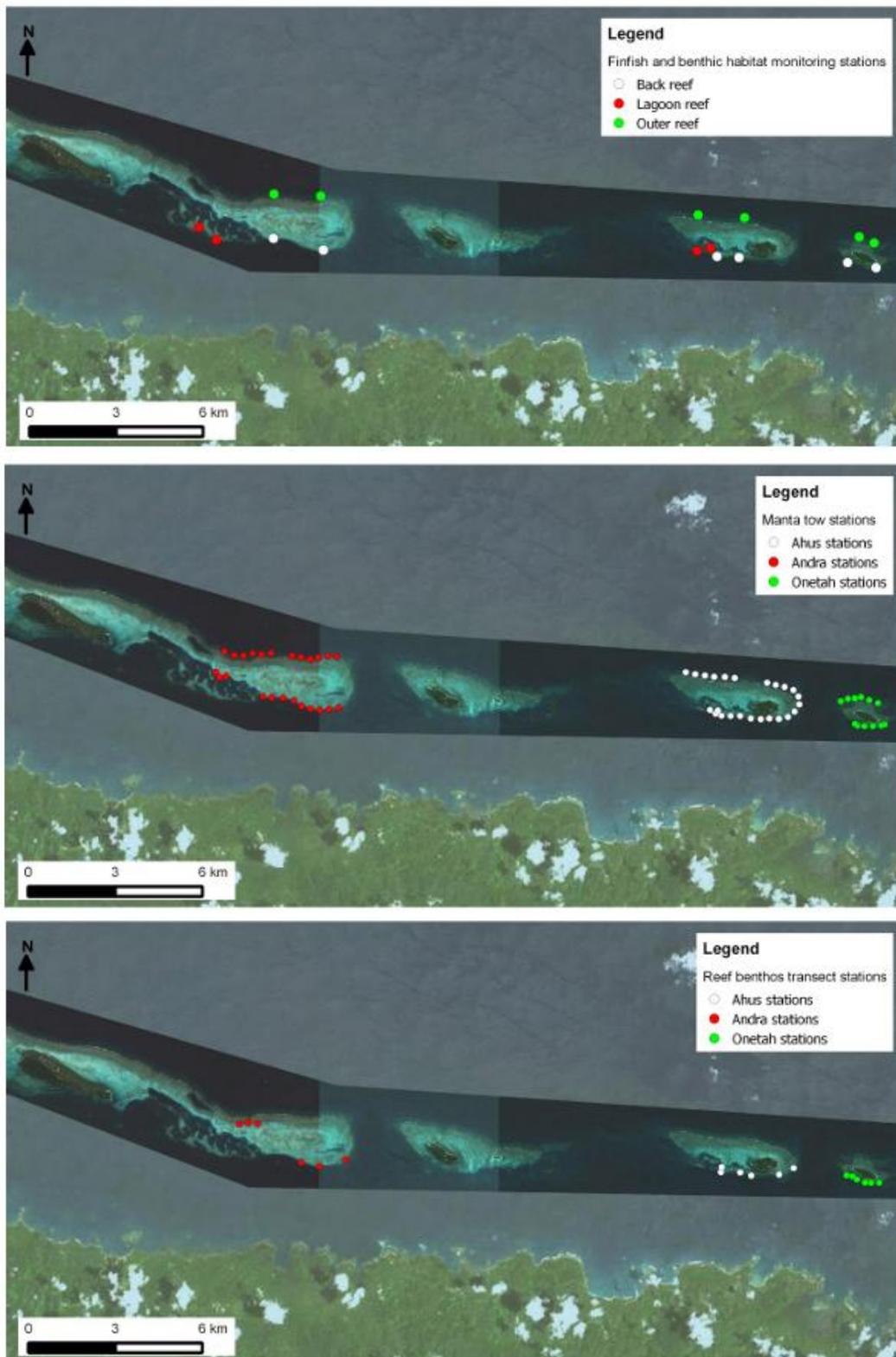


Figure 2.9 Survey locations for reef monitoring by Moore et al. (2014); top: finfish and benthic habitat monitoring stations; middle: manta tow survey locations; bottom: reef benthos transect stations

At Kimbe Bay, the NGO Mahonia Na Dari Research and Conservation (MND) and project partners (some now at James Cook University (JCU)) established a long-term monitoring program on inshore, mid-shelf and outer reefs, with annual fish and benthic surveys between 1997 and 2019. This is thought to be the only long-term, spatially structured monitoring program that exists in PNG and contributed data to several GCRMN reports. They also established (now ongoing through JCU) a long-term project in Kimbe Bay on reef fish population connectivity, monitoring sample populations of clownfish and using genetic parentage analysis to determine movements of larvae between islands/reefs.

Much of the present monitoring is concentrated on locally managed marine areas (LMMAs), particularly those at Kimbe Bay, Central Province and Milne Bay. The PNG Conservation and Environment Protection Authority (CEPA) has a memorandum of understanding in place with SWOM supporting SWOM's coral reef monitoring in LMMAs (i.e. ad hoc photo quadrats on snorkel, uploaded to ReefCloud to semi-quantitatively estimate benthic cover). NGO led monitoring takes place in two large MPAs at New Ireland, led by World Conservation Society (WCS), as well as at Manus Island, led by The Nature Conservancy (TNC). Example sites focused on by current coral reef management and/or monitoring include the following islands: Lelehudi, Keleton, Mahabalina, Wagawaga, Parimeta, Nuakata, Sebutuia, Fergusson, and Lovongai Islands; Murat local level government jurisdictions in New Ireland Province, East New Britain, Central, Kimbe, Milne Bay and Manus.

Such monitoring efforts have identified the recent mass bleaching event in PNG (worst bleaching on record to date), and increases in COTS at Kimbe Bay which instigated some management intervention. However, the disparate nature of existing monitoring effort means that there are usually limitations to understanding trends at a national scale, and therefore inform national level decision making. For example, monitoring frequency can range from monthly to annually (or longer), depending on the program. Likewise, monitoring, data analysis and data storage techniques are varied and not consistent, including various combinations of:

- Visual surveys and video/photo transects (e.g. to track one or more of coral cover, fish counts, benthic assemblage composition, coral health, coral bleaching, coral disease, reef fish communities and restoration success)
- Analysis tools and software packages such as TG6, TG7, R, Basecamp, Google earth, ReefCloud and the MERMAID<sup>6</sup> database, noting analysis is often outsourced to international partners.
- Databases and cloud storage are typically used to store data, which is then widely shared amongst research partners such as the Australian Institute of Marine Science (AIMS), Coral Sea Foundation (CSF), SWOM and Partner communities.

The many different organisations and communities involved in coral reef monitoring also means that sharing of relevant findings and data to national government is often slow or absent. Likewise, the decentralisation of efforts (particularly as the various NGOs and research institutions often act independently) does not foster streamlining of effort, nor collaboration and communication of goals. These were repeatedly identified as aspects of coral reef monitoring that need strengthening.

SWOM has been successful at rapidly increasing the spatial coverage and frequency of coral reef monitoring at some locations, including Kimbe Bay, Milne Bay and Port Moresby, covering 200 sites since 2021 and with aspirations to eventually cover 5000 sites. One challenge they identified that is somewhat unique to PNG (in the context of the countries included in this assessment) is a need to ensure the safety and personal security of monitoring personnel, particularly being a women-based organisation. Beyond this, costly logistics for accessing reefs located remote from urban centres presents a key challenge. They are also cognisant of their reliance on international parties for technical support.

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<sup>6</sup> <https://datamermaid.org/>



A new and evolving avenue for national government to potentially have more direct involvement in coral reef monitoring and management in PNG comes from a recent restructure of the National Fisheries Authority (NFA). Specifically, the recent creation of a new role at NFA that focuses on monitoring Coastal Ecosystems<sup>7</sup>. Coastal ecosystems in this regard include key habitats that are critical for sustaining coastal fisheries, e.g. seagrass, mangroves, coral reefs. While the new role is presently limited to one staff member, NFA has the benefit of having a well-established coastal fisheries monitoring network and procedure nationally (i.e. fisheries stock and catch monitoring through NFA's provincial offices), which could be leveraged as a foundation to expand monitoring to coastal habitats. NFA has also recently endorsed its first community level 'Ecosystem-based Management Plans' (as opposed to purely fisheries-based management plans), further highlighting NFA's current trend towards starting to mainstream a more holistic ecosystem-based fisheries management for coastal fisheries.

## 2.5 Vanuatu

Vanuatu comprises over 80 islands with approximately 4,110 square kilometres of coral reefs, featuring fringing, platform, ribbon reefs and atolls (Chin et al. 2011). These support an estimated 295 coral species, 469 reef fish species, and numerous invertebrates. While many reefs are thought to be in relatively good condition, Vanuatu's narrow coral reef ecosystems are vulnerable to both natural and anthropogenic stressors, particularly around more densely populated urban centres on Efate and Espiritu Santo. More remote or traditionally managed areas generally exhibit higher coral cover and fish abundance. Major stressors include cyclones, earthquakes, coastal fisheries, sedimentation, and occasional COTS outbreaks and coral bleaching.

Scientific monitoring of coral reefs has historically been sparse and focused mainly on sites that are shallow and accessible. A Reef Check training and survey effort in 2002 and 2004 helped build initial capacity for national monitoring, but long-term data remains limited. Surveys during this period showed considerable variability in reef condition, with live coral cover ranging from less than 5% in degraded sites like Luganville (degraded by a COTS outbreak at that time) to over 50% in healthier areas such as North Efate (Chin et al. 2011; Lovell et al. 2004). While Reef Check monitoring is thought to continue to varying degrees, there is no known communication or data sharing to the relevant government agencies, including the Ministry of Fisheries, Oceans and Maritime Affairs (MFOMA) and the Department of Environmental Protection and Conservation.

Despite increasing awareness and engagement through community-based management initiatives, reef monitoring efforts have historically been challenged by limited financial and institutional support. Both institutional support and funding have improved significantly in the last few years, most notably through a strong relationship between MFOMA and Waitt Foundation which provided capacity building for government staff and co-led the completion of Vanuatu's first national-scale coral reef assessment in 2023 (Government of the Republic of Vanuatu & Blue Prosperity Vanuatu, 2025, Figure 2.10). It is envisioned by the national government that this major achievement lays the foundation for an ongoing, national scale, and government-led monitoring programme for coral reefs in Vanuatu.

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<sup>7</sup> Ecosystems Monitoring Manager role at PNG's National Fisheries Authority



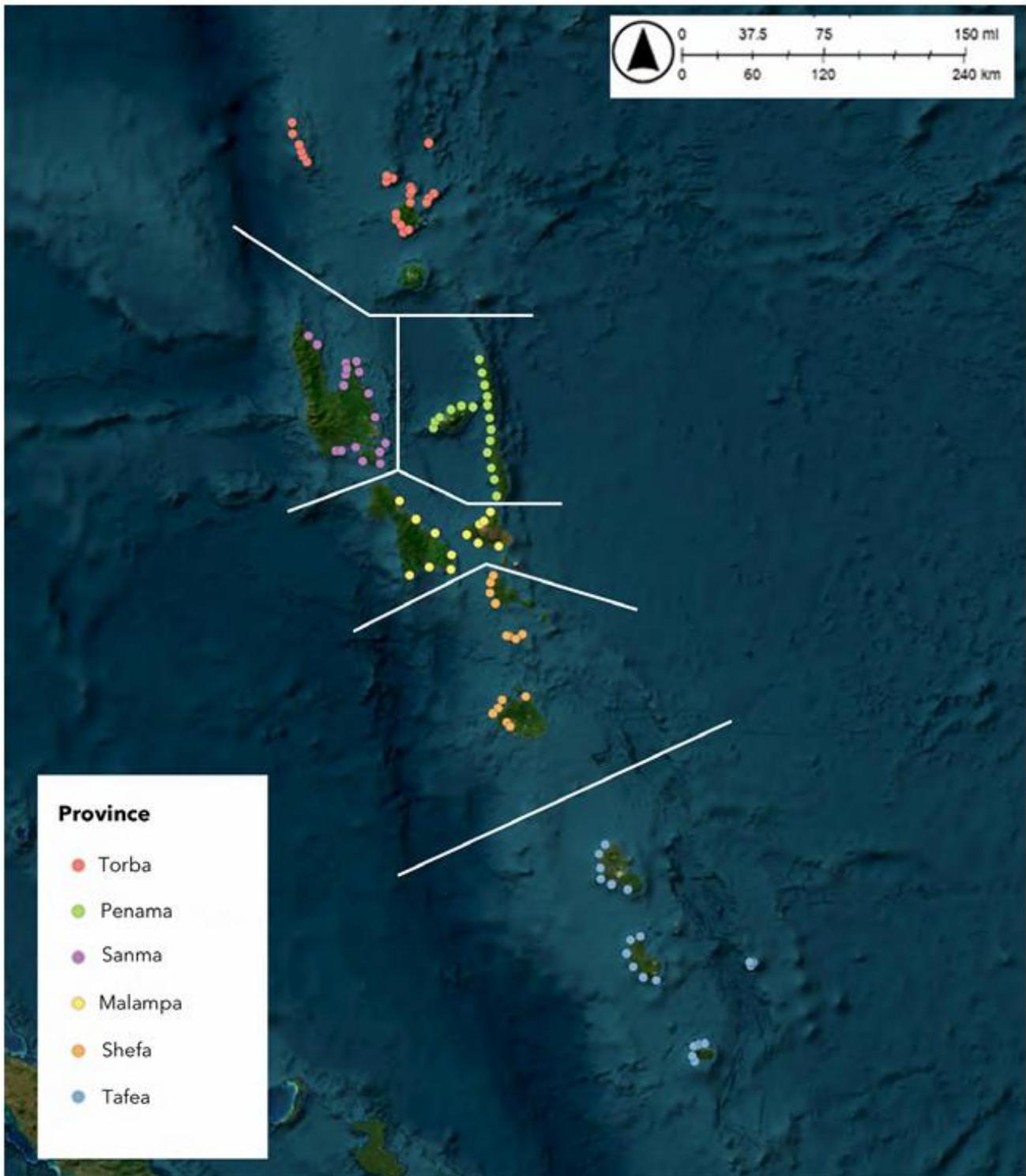


Figure 2.10 Survey site locations for the Blue Prosperity 2023 Vanuatu Coral Reef Study (source: Government of the Republic of Vanuatu & Blue Prosperity Vanuatu, 2025)

Local NGO's have also been a key actor in coral reef monitoring and management, especially at Efate. In particular, the Vanuatu Environmental Science Society (VESS) has been well organised in funding and coordinating local Efate volunteer efforts to monitor and control COTS outbreaks (e.g. Port Vila harbour), and implement coral reef restoration and translocation (e.g. at Iriki in relation to mitigating a new domestic wharf development). Smaller community-based NGOs and networks (TasiVanua and Nguna Pele

resource networks, C2O Consulting) have also contributed some smaller scale coral reef surveys or management. This includes, for example, reef monitoring using a Community Marine Monitoring Toolkit (Johnson et al., 2018), activities linked to ecotourism-associated reef restoration, and researching coral restoration methodologies. The Community Marine Monitoring Toolkit includes a module on 'Reef Health' for snorkel-based visual observations of reef physical structure (rugosity), diversity, bleaching and COTS. However, it is not known to have uptake by communities beyond the two initial TasiVanua and Nguna Pele community resource networks. Disruptions associated with the Covid-19 pandemic likely contributed to limiting further roll-out of this resource (e.g. travel limited for international trainers; communities affected by reduced tourism investing in time and effort elsewhere to sustain communities).

Excluding the recent MFOMA-led national coral reef assessment, coral reef monitoring methods have been highly varied. Information provided during the consultation for this assessment can be summarised as follows:

- Frequency of monitoring was defined as normally either seasonally or annually, with some programs being implemented on an ad-hoc basis.
- The primary monitoring techniques to date have been visual surveys and video/photo transects to monitor coral cover, benthic assemblage composition, coral predation, coral bleaching, coral disease, reef fish underwater visual census (UVC) and restoration success.
- The primary methods used for analysing data follow those set out in the Community Marine Monitoring Toolkit (for communities using this toolkit), image analysis from photo transects using ReefCloud, and rapid reef health surveys which are assessed manually or in a qualitative manner.
- Spreadsheets and cloud storage are used to store reef monitoring data, which is then distributed based upon the individual organisation's protocols. For example, Fisheries section of MFOMA keeping most fisheries data internally or sharing it with SPC or with GCRMN under a data sharing agreement; C2O Consulting data is publicly available on ReefCloud and is also shared with the Global Coral Reef Monitoring Network (via CRIOBE<sup>8</sup> and AIMS<sup>9</sup>) for respective status and trends reports.

A key issue affecting coral reef management at a national level is the decentralised nature of monitoring efforts leading to low oversight and awareness by national government regarding current reef monitoring efforts in Vanuatu, as well as limited sharing of data and knowledge from the various actors to national government. MFOMA's recent work delivering a national coral reef assessment (in partnership with Waitt Foundation<sup>10</sup>), is a significant step towards broad scale and coordinated national reef monitoring data. This would be complemented by strengthening communications and data sharing from local scale activities to national government.

The recent national coral reef assessment was co-designed as an extensive approach to assessing shallow coral reefs in a manner that minimises time in the field (i.e. rapid field methods that collect a lot of data at each site). The intention is that the approach can be repeated and used to inform management decisions about marine resources, such as the efficacy or need for conservation efforts (e.g. marine protected areas, locally managed marine areas, fisheries closures) and other marine interventions. It comprised surveys at 109 sites (each 10x10m, and typically lee fore reefs around 10m water depth) across 21 islands, with the following measured, assessed or acquired at each site (mostly via imagery that is post-processed off site):

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<sup>8</sup> Centre de Recherches Insulaires et Observatoire de l'Environnement

<sup>9</sup> Australian Institute of Marine Science

<sup>10</sup> Blue Prosperity Project



- Geo-referenced photomosaic
- Water temperature
- Reef fish abundance, diversity biomass, trophic groups
- Benthic composition using quadrats (e.g. hard coral, soft coral, turf algae, crustose coralline algae (CCA) etc.)
- Juvenile coral abundance
- Macroinvertebrate community
- Water quality (via isotopes in *Halimeda* sp. as a sewage indicator)
- Reef rugosity (via simulated chain transect from the photomosaic)

Field data was collected through a collaborative field campaign with national government and Waitt Foundation personnel. Much of the data processing and all statistical analyses were conducted overseas by Waitt Foundation or their international partners (including through the use of machine learning based imagery analysis), with reporting prepared collaboratively with national government. The report from this initial national monitoring (Government of the Republic of Vanuatu & Blue Prosperity Vanuatu, 2025) is publicly available online, and data is presented in the form of spatial map images on the website <https://www.blueprosperityvanuatu.org/>. It is an aspiration that the government and community are empowered to lead future repeats of this type of national assessment employing local resources, noting this would require investment in trained labour and tools/equipment for field surveys, as well as tools and trained personnel for data processing and reporting. While several staff with the relevant skills are present at MFOMA, they are heavily committed with similar work for fisheries management (i.e. their primary role).

Likewise, constraints to other monitoring efforts in Vanuatu are linked to limited technical capacity or high demand on the personnel with the technical skills (e.g. field survey skills, data analysis skills, and capacity for interpreting data outputs for management decisions), time and other resources, and access to remote sites (where most reefs are located). These were recognised as constraints across multiple jurisdiction levels, i.e. not only at government levels but also for local communities.

## 2.6 Republic of the Marshall Islands

The Republic of the Marshall Islands (RMI) consists of 29 coral atolls and 5 low-lying islands. There is conflicting estimates on the area of coral reef habitat, even among GCRMN sources, with the 2011 Status and Outlook Report for Coral Reefs of the Pacific stating 1,995 km<sup>2</sup> (Chin et al. (2011) and the more recent Status and Trends of Coral Reefs of the Pacific 1980 – 2023 stating 3,558 km<sup>2</sup> of coral reef extent (Wicquart et al., 2025). RMI's outer atolls such as Rongelap, Ailinginae, Bikini, and Namu remain comparatively pristine, with high coral cover, and abundant reef fish and predatory species such as shark (Beger et al. 2008, Figure 2.11). These are locations that are either remote, have very small human populations and/or are atolls where human access was restricted following historic nuclear testing. In contrast, reefs around populated centres like Majuro and Arno show evident degradation due to overfishing, land reclamation, pollution, limestone extraction and coral bleaching (Beger et al., 2008). This is evident through declines in large reef fish and coral health, particularly tabulate *Acropora* species, which have been heavily affected by white disease and thermal stress events (Beger et al. 2008).



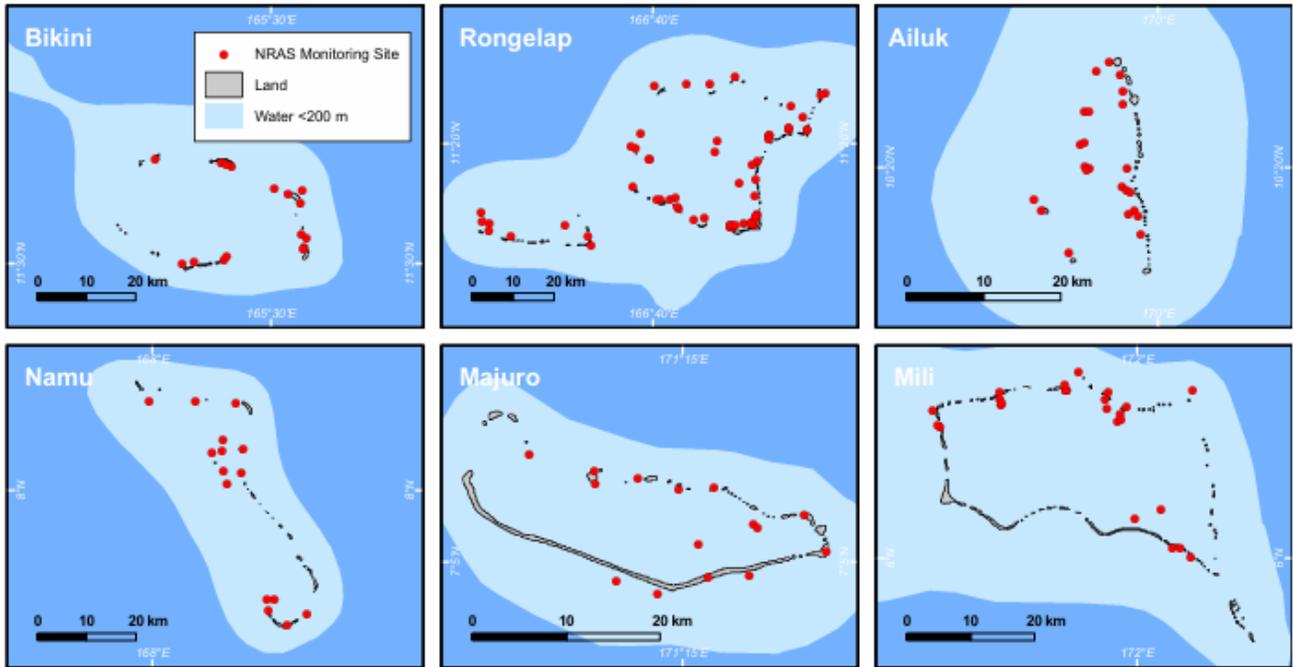


Figure 2.11 Map of the reef survey locations (Source: Berger et al., 2008)

Long-term coral reef monitoring has historically been limited, but there has been a significant increase in reef monitoring and related capacity building in recent years, expanding initially through combined efforts to establish baseline data across several atolls. This was associated with the National Natural Resources Assessments surveys, the Coastal Management Advisory Council (CMAC) aspirations, Marshall Islands Marine Resources Authority (MIMRA), Marshall Islands Conservation Society (MICS) and the College of the Marshall Islands.

Now the national government actively coordinates coral reef monitoring through the CMAC, MIMRA, and the Reimaanlok framework (i.e. RMI's national framework for the planning and establishment of community-based conservation areas) which aims to support whole of atoll conservation, including coastal fisheries management by communities (Reimaan National Planning Team, 2008). This centralised and coordinated network approach guides and supports reef monitoring activities, with implementation delivered through collaboration with reef monitoring partners, especially MICS, University of Guam, other NGOs (e.g. The Nature Conservancy TNC) and local communities. The collaborative and coordinated approach also fosters strong communication and information sharing at all jurisdiction levels, from communities to national government (Figure 2.12).



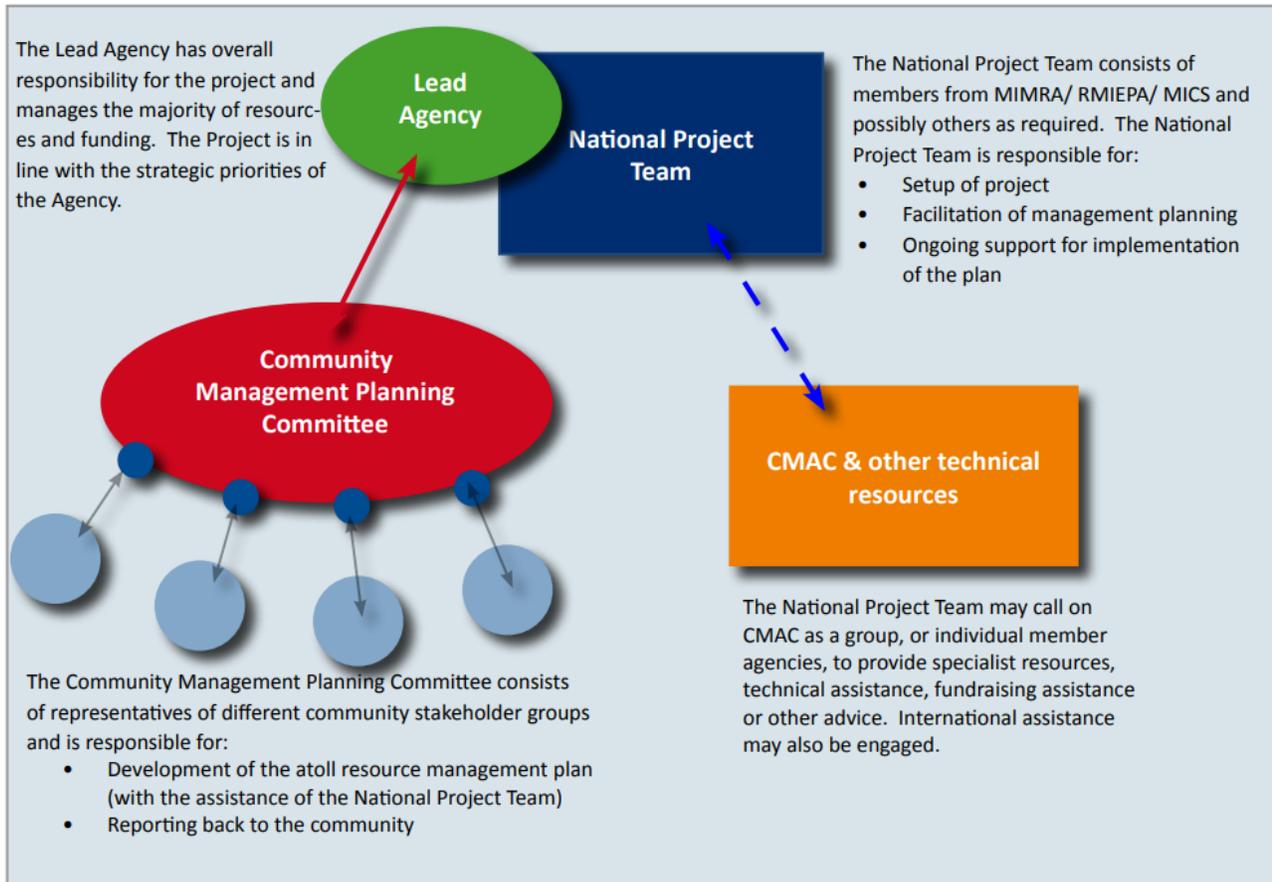


Figure 2.12 Organisational arrangements for developing a Community-Based Management Plan under the Reimaanlok Framework (source: Reimaan National Planning Team, 2008)

From a marine perspective, the primary focus of the marine monitoring component (within a community resource management plan) is to acquire reef data that informs communities for making decisions about their community-based conservation areas through the development of resource management plans, and for management of the Reimaanlok MPA (18,500 square miles at the Ratak chain of islands). This program is in the process of expanding to new Reimaanlok sites/communities through the introduction of a Community Marine Monitoring Toolkit, with monitoring intended to be either annual or seasonal depending on community wants for each location. Note that the communities are empowered to decide which components of the toolkit they will monitor (i.e. fish, benthic invertebrates, seagrass, macroalgae etc.).

Other recent coral monitoring programs are typically NGO led and include those associated with the new ‘Super Reefs’ project investigating thermal tolerant coral species at Majuro (i.e. propagation of heat resistant *Acropora* and *Porites*), annual monitoring of corals at 14 sites across Majuro, and recent initiatives by TNC under the Coral Research & Development Accelerator Platform (CORDAP) project<sup>11</sup>. The annual monitoring at Majuro comprises fish counts, benthic photographs and invertebrate counts. Coral bleaching has also been monitored over short timeframes when there are bleaching events (Fellenius, 2014; Beger et al. 2008). While some sites have shown partial recovery, recurrent bleaching and localised coral disease outbreaks can persist.

<sup>11</sup> <https://cordap.org/>

Coral reef monitoring in RMI primary employees point intercept transect and photo transect methods for assessing coral cover, benthic composition, coral health, bleaching and reef fish communities. Water quality is also sometimes monitored, particularly physicochemical parameters (e.g. temperature loggers in Majuro). Currently (and until capacity is strengthened locally, much of the data is sent to the University of Guam (Marine Laboratory) for analysis, with analyses using a combination of imagery post-processing and statistical tools/softs as appropriate, such as CPCe, Kobo Toolbox, R, Iksavea, Excel, FishKit, MC UVC protocols, ArcGIS, Backyard Buoy. The data is often stored via spreadsheets at the University of Guam, with interpreted results communicated to projects partners and national government (MIMRA, MICS, CMAC Marine Working Group, MC Marine Measures Group), who then communicate results to communities. For community-based management areas, there can be a lag of up to one year between data acquisition and presentation of the results by project partners back to communities. Like field surveys in many Pacific islands, the sharing of monitoring results with remote communities (as the decision makers for community-based management areas) can likewise be hampered by high travel costs.

Key project partners for coral reef monitoring in RMI indicated that the most pressing constraints and challenges for improving coral reef monitoring are:

- The remote location of many reefs and resultant cost-prohibitive travel logistics to conduct surveys, particularly SCUBA diving based surveys where the preference for safety reasons is to utilise a vessel equipped with a hyperbaric chamber.
- A limited number of certified SCUBA divers to perform monitoring surveys, especially at locations away from Majuro.
- A limited number of local in-country personnel skilled in data post-processing, data analysis and statistics, and scientific report writing.
- Insufficient financial support to upscale monitoring, and/or training of communities so that they can conduct monitoring themselves.

Despite these challenges, there is a strong desire across key actors to work together and expand the number of monitoring locations (including expanding the Reimaanlok model to urban areas), increase the uptake of community based monitoring through the Community Marine Monitoring Toolkit, implement new technologies, increase the frequency of monitoring, and increase collaboration with more organisations.

## 2.7 Fiji

Fiji's reef systems encompass approximately 6,700 square kilometres and include fringing reefs, barrier reefs, and atolls spread across more than 300 islands. These reefs lie within a high-diversity biogeographic region, supporting over 300 species of scleractinian corals and more than 1,200 reef-associated fish species. Fiji's reefs exhibit notable spatial variability in benthic composition and ecological status, influenced by both natural disturbance regimes and localised anthropogenic stressors (Beger et al., 2008, Wicquart et al., 2025).

Overall, the more remote reefs in less developed areas are typically in good condition and relatively resilient to natural hazards (e.g. cyclones) and coral bleaching. However, reefs near major population centres around Viti Levu and Vanua Levu are increasingly degraded due to overfishing, sedimentation, and nutrient enrichment. These sites often exhibit elevated macroalgal cover and reduced fish biomass, particularly of larger reef species.



Fiji maintains some of the most extensive reef monitoring programs in the Pacific, involving both government agencies, NGOs, local communities at Locally Managed Marine Areas (LMMAs), the private sector, and both local and international universities (e.g. University of the South Pacific, James Cook University). Key examples of significant reef monitoring programmes in Fiji include the:

- Coral Reef Rescue initiative led by the Wildlife Conservation Society (WCS)
- Lau Seascape rapid assessments
- Ongoing coral reef monitoring surveys by WCS, Conservation International and Reef Check Fiji
- Great Sea Reef monitoring through World Wildlife Fund (WWF)
- Reef Explorer monitoring of community managed areas
- Blue Prosperity Fiji coral reef surveys through Waitt Foundation (refer 2023 national expedition illustrated at Figure 2.13)
- Pacific Blue Foundation monitoring at Beqa and Yadua
- Monitoring by national government's Fisheries Research Division
- Various postgraduate research projects
- Coral bleaching and recovery surveys by Marine Ecology Consulting and Talanoa Consulting, including monitoring of reef systems that shifted from coral-dominated to algae-dominated reef systems following heat waves.

Much of the reef monitoring is concentrated around the two biggest islands, Viti Levu and Vanua Levu, as well as Malolo, Malomalo and Moturiki. These locations are monitored at various frequencies, typically ranging from monthly or quarterly to annually. Other sites such as Namena, Vatu-i-Ra, Bua and others (e.g. through WCS and Great Sea Reef initiatives) are also monitored but less frequently.



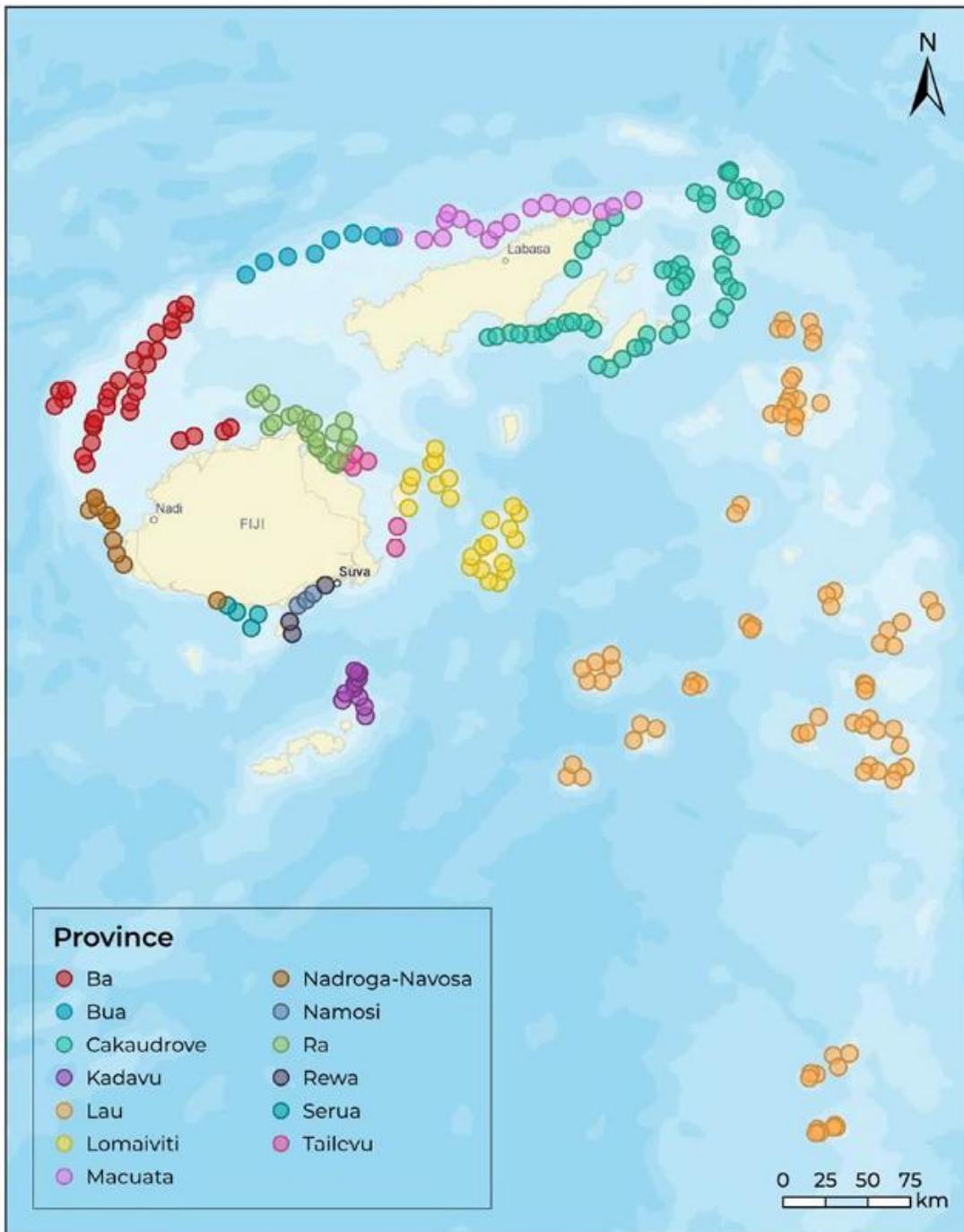


Figure 2.13 Blue Prosperity Fiji coral reef survey sites colour coded by province (Source: Government of the Republic of Fiji & Blue Prosperity Fiji, 2025)

Monitoring techniques vary depending on the objectives of the monitoring, but most commonly include underwater visual surveys, photo quadrats, video transects and remote sensing. Water sampling for both physicochemical parameters (e.g. temperature loggers) and potential contaminants (e.g. nutrients, *E.coli*<sup>12</sup>), as well as eDNA<sup>13</sup> are also used. Fisheries-based data is also acquired, such as quantitative catch-per-unit-effort (CPUE) data and information from community logbooks.

<sup>12</sup> *Escherichia coli* (*E. coli*) bacteria

<sup>13</sup> Environmental DNA



The resulting raw monitoring data is most commonly stored as spreadsheet files on local networks or hard drives for use in statistical analyses, and sometimes uploaded to databases managed by international organisations/NGOs. Monitoring data and/or results are most commonly shared to government by organisations that have a strong local/permanent presence in Fiji (e.g. locally registered NGOs and private sector operators). Communication of monitoring data and results to the government from the research community, especially international researchers, and organisations without a strong in-country presence rarely occurs.

Monitoring results are then integrated into reef management decisions at either national government or community levels, as appropriate. Related management uses include, for example, defining benchmarks or performance indicators for evaluating conservation or restoration interventions, compliance monitoring for developments, developing or implementing adaptation plans, informing decisions about MPAs and LMMAs, and refining the Reefs of Hope Ocean Decade Actions.

While coral reef monitoring in Fiji is extensive and varied, it would benefit from improved national-level coordination and communication. Data quality and continuity vary greatly, such that national-scale assessments are limited by inconsistent sampling design and comparability for trend analyses. Without robust, accessible data on catch composition and reef condition, management remains largely precautionary. Community-based marine resource monitoring remains central to management efforts, supported by the LMMA network, and has empowered many communities to act as stewards of their reef resources. However, local capacity constraints remain, such as in relation to too few trained personnel (particularly in reference to taxonomic identification of data), data standardisation, limited analytical capacity, and disruptions to community buy-in linked to shifting social dynamics.

There are also aspirations by key monitoring partners to grow and improve existing reef monitoring programmes by expanding the spatial coverage (i.e. number of monitoring locations), implement new technologies, move towards more standardised methods nationally (where appropriate) through the development of clear monitoring guidelines, and increase the frequency of monitoring.

By integrating local knowledge with scientific support, stabilising funding mechanisms, and strengthening communication with management decision makers, Fiji has the potential to strengthen reef resilience in the face of expanding human and climate pressures. It will also require continued investment in LMMAs, simplified monitoring tools, and targeted capacity-building, which will be critical for scaling up effective monitoring adaptive reef management.

## 2.8 Samoa

In Samoa the coral reef systems fringe the high volcanic islands of Upolu and Savai'i, covering approximately 1,000 square kilometres and comprising primarily fringing and patch reefs. These habitats support moderate coral diversity (~200 species) and high reef fish biomass (Beger et al. 2008). However, significant structural degradation has occurred since the 1998 mass bleaching event, exacerbated by cyclones, COTS, and chronic anthropogenic pressures such as eutrophication and overfishing (Beger et al.; 2008). This has persisted since, with low live coral cover at many sites, particularly near urban centres like Apia (Wicquart et al., 2025). In such areas, benthic communities are increasingly dominated by turf algae and macroalgae, reflecting altered ecosystem functioning and trophic structures (e.g. reduced herbivory). Some localised recovery has been observed (e.g. coral recruitment and improved structural complexity) where stressors are managed.

Reef monitoring has typically been concentrated on the northeastern coasts of Upolu and Savai'i islands (Figure 2.14), with other locations only captured in one or fewer monitoring events. The eastern coasts of both islands are underrepresented in monitoring, with no known monitoring to date.



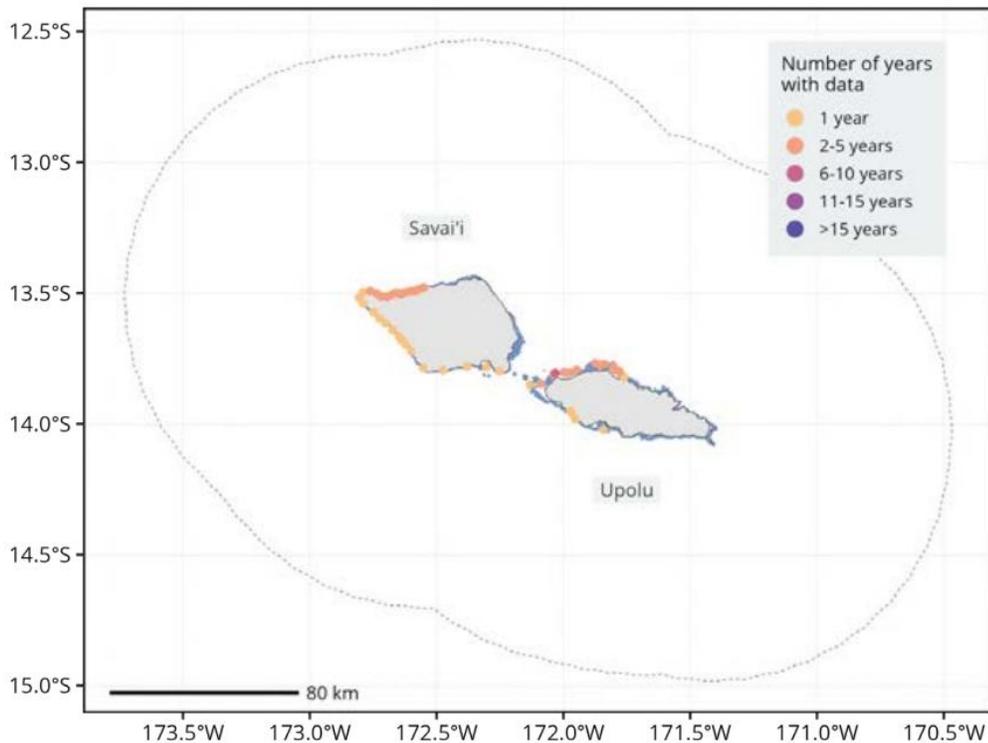


Figure 2.14 Distribution of benthic cover monitoring sites across Samoa, with colour scale indicating the number of years with data (Source: Wicquart et al., 2025)

National reef monitoring is led by the Ministry of Natural Resources and Environment (MNRE) and Ministry of Agriculture and Fisheries (MAF), with support from international organisations. While long-term datasets exist for selected MPAs and high-use reefs, the coverage of monitoring remains spatially and temporally limited. To date, most coral reef monitoring relies on visual observations, with limited functional or biogeochemical indicators. Community-based monitoring also occurs and gradually expanded since 2003 under the Global Coral Reef Monitoring Network (GCRMN)<sup>14</sup> and SocMon<sup>15</sup> frameworks, enhancing local stewardship despite ongoing capacity constraints.

More recent monitoring efforts include the monitoring at Aleipata MPA (Upolu Island) led by the Ministry of Natural Resources & Environment (MNRE) and SPREP in partnership with AIMS. It combines traditional ecological knowledge with modern technology like ReefCloud and BRUVs<sup>16</sup> to assess coral health and fish populations. This and other recent monitoring centres around photographing underwater photo quadrats, with the images being uploaded to ReefCloud for postprocessing and analysis. This method is used to assess coral cover, species composition, coral health and coral bleaching. The data are stored via ReefCloud's cloud storage system, with outputs then distributed to government (MAF, MNRE) and stakeholders. While there are typically intentions to monitor reefs annually, sometimes it occurs less frequently (e.g. every three years), depending on the availability of funding.

Samoa's robust village governance systems, legal commitment to conservation, and active participation in regional initiatives (e.g., SPREP, ICRI) provide a strong foundation for future reef management. However, long-term monitoring improvements and sustainable reef management will require improved monitoring design, integrated coastal planning, and targeted climate adaptation measures. Other constraints identified for improved coral reef monitoring include ongoing and sufficient financial support,

<sup>14</sup> <https://gcrmn.net/>

<sup>15</sup> <https://www.socmon.org/>

<sup>16</sup> Baited Remote Underwater Videos



the number of skilled personnel available to support monitoring efforts (i.e. in the field and with data processing and reporting), the limited application of advanced technologies, lack of standardised monitoring guidelines, and limited awareness of additional collaborative opportunities to access additional international support.

Despite this, there are ambitious aspirations to expand the spatial extent of reef monitoring (i.e. increase the number of monitoring locations), apply new technologies and increase the frequency of monitoring.

To this end, Samoa is soon to release their new integrated 'National Coral Reef Monitoring Programme' to better inform the management of Samoa's coral reefs and associated fisheries. The national programme will support Samoa Ocean Strategy's priorities: to improve research and data collection and monitoring; and, to strengthen the effectiveness of coastal management using traditional knowledge, innovation, and marine science. Designed in collaboration with SPREP and AIMS, the programme aims to:

- Expand the area and frequency of monitoring efforts
- Explore new techniques/technologies
- Improve data sharing between government ministries, stakeholders and NGO's.
- Strengthen the collaboration to better evaluate the status and trends of Samoa's coral reefs
- Improve research, data collection and monitoring
- Strengthen the effectiveness of coastal management using traditional knowledge, local involvement, innovation (i.e. applying advanced scientific techniques and utilising publicly available tools such as ReefCloud), and marine science.

In addition to local partners and stakeholders, the development of the programme has also been supported by international partners such as SPREP, AIMS and GCRMN. The Accenture Foundation supports the use of ReefCloud in Samoa via AIMS.

## 2.9 Solomon Islands

The Solomon Islands comprises approximately 6,750 square kilometres of coral reef habitat, primarily fringing reefs associated with high volcanic islands. Located within the Coral Triangle marine region, the Solomon Islands supports very high biodiversity with over 500 hard coral species and a rich diversity of reef-associated fauna (Green et al., 2006; Chin et al., 2011).

Similar to other Pacific countries, live coral cover is typically greatest in less disturbed areas, with variability driven by localised anthropogenic stressors such as sedimentation, nutrient input, and fishing pressure (Chin et al., 2011). The remote sites retain structural integrity and exhibit higher recruitment rates, indicating resilience under reduced local stress. In contrast, at nearshore reefs adjacent to urban centres (e.g., Honiara, Gizo) macroalgae tends to be more dominant, with reduced coral cover, and declining structural complexity (Albert et al., 2012). Jejevo Lagoon, for example, exhibited low coral cover (~22.7%) and elevated turbidity (~32 NTU), likely due to upland logging and subsequent runoff (Albert et al., 2012). Recent global bleaching events in the region (from 2011-2016) had also led to extensive coral decline particularly in the Bali Barat National Park which saw a 44% decline in live coral cover during the January 2016 bleaching events (Denley et. al. 2020).



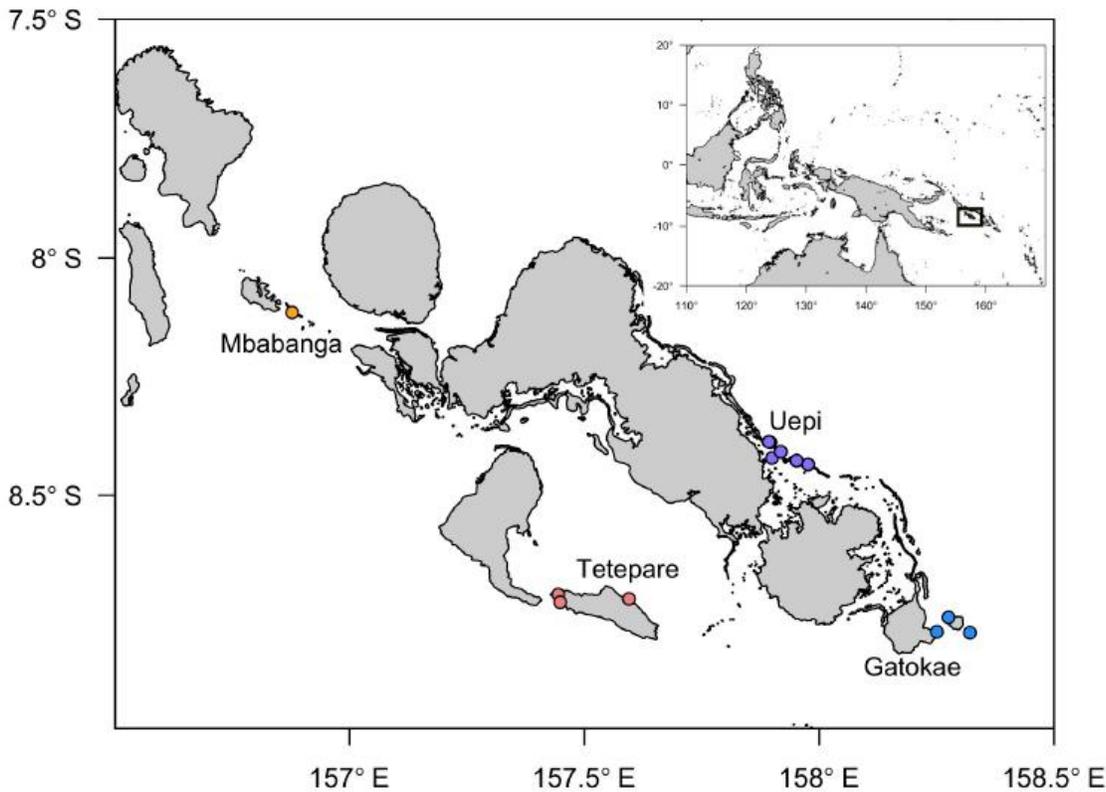


Figure 2.15 Site locations for the Denley et al. (2020) Survey located over 4 islands: Mbabanga (orange dots), Tetepare (pink dots), Uepi (purple dots), Gatokae (blue dots)

From a national government perspective, the primary agency responsible for coral reef management in the Solomon Islands is the Ministry of Fisheries and Marine Resources (MFMR), with collaboration and support provided by the Ministry of Environment, Climate Change, Disaster Management and Meteorology (MEDCM), and NGO and research institute partners (e.g. WCS, TNC). Presently, the primary coral reef monitoring underway identified by the national government is the Coral Reef Rescue project, including monitoring of coral restoration work (replanting) by the MFMR's Community-Based Resource Management division.

More broadly, coral monitoring and research has historically been disproportionately spread, with effort geographically concentrated in Western, Isabel and Guadalcanal Provinces. Monitoring has also occurred at Three Sister Islands, Marau, and Rennell Island, and there has been increasing effort in the last two years at Central Province. The latter is a current focus for WCS, given the very limited attention in the past. Community-based approaches are widely used but lack standardisation for upscaling at a national scale (Govan, 2011; Green et al., 2006). Data are largely limited to benthic cover, fish counts, and habitat structure.

Monitoring techniques vary, with the most common being visual observations and photo quadrats. Video transects and water sampling are also being used. Together, these methods are used to collect data on coral cover, coral health, coral bleaching, fish species composition, water quality, and restoration success. Annual surveys are the most common monitoring frequency, although some monthly to seasonal monitoring can occur. The primary tools and software used for data processing and analysis indicated to be Mermaid, R Studio software and Microsoft Excel. Data resulting from monitoring by the national government, or their primary implementation partners, is typically stored as spreadsheet files on local networks or hard drives. Hardcopy (paper) records are also commonly stored by local implementing partners.



The most common line of information sharing to inform management decisions is in the context of community-based management areas, where the community is at the core of, or closely involved with, both reef monitoring and management decisions. Data sharing and interpretation in these instances may be facilitated by government or NGOs partners. Data sharing and communication with national government is somewhat limited, mainly occurring via government monitoring initiatives and major NGO initiatives where the NGO has a strong in-country presence. Data sharing and communication with national government is less common where surveys or analyses are conducted by parties (e.g. research institutions, international NGOs) without a strong and permanent in-country presence.

Strengthened data integration, standardised monitoring, and expanded co-management is seen as critical for improving coral reef management in the Solomon Islands. From the national government's perspective, achieving this will require the following challenges to be overcome:

- A lack of awareness, capacity and equipment for local communities to lead monitoring across the network of community-based management areas
- Funding constraints for training in all technical aspects required for effective coral reef monitoring, including for newer techniques such as eDNA sampling and photomosaic technology
- The need to expand the spatial extent of monitoring (i.e. number of monitoring locations), apply new technologies, increase the frequency of monitoring
- The need to enhance collaboration and sharing of monitoring results, preferably via a shared data platform where all monitoring data can be stored and managed (and accessed to inform management decisions, including development permitting).

## 2.10 Cook Islands

Across the Cook Islands 15 islands there is approximately 528 square kilometres of coral reefs, predominantly fringing systems around Rarotonga, Aitutaki, and the northern atolls. The more remote northern islands, such as Manihiki, Palmerston and Pukapuka retain high coral cover, structural complexity, and abundant reef fish populations (Chin et al., 2011; Purkis et al., 2018; Loya et al., 2019). As part of a global reef expedition, the Khaled Bin Sultan Living Oceans Foundation conducted habitat mapping of reefs at some of the remote islands (Purkis et al., 2018), which provided some of the first detailed and large scale reef data (reef extent) for some of the islands in the Cook Islands (Figure 2.16).



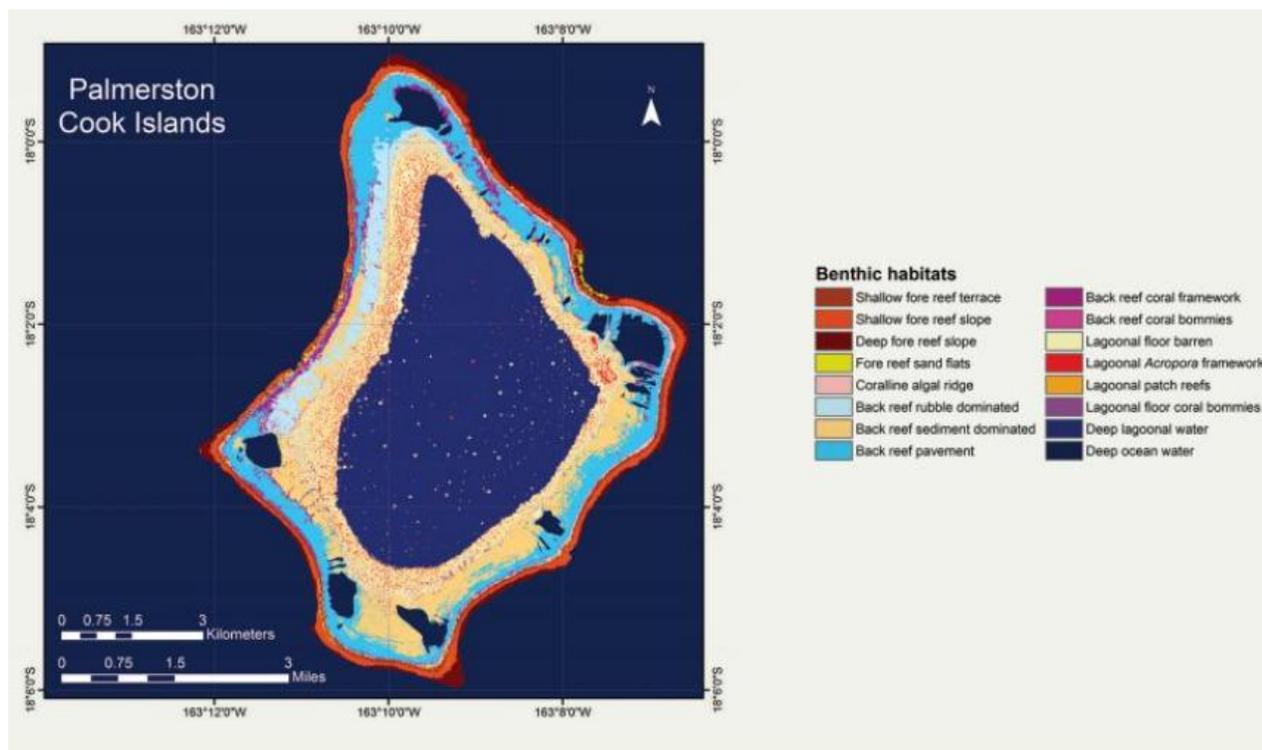


Figure 2.16 Habitat Mapping for Palmerston Island in the Cook Islands (Source: Purkis et al., 2018)

Reefs at the more populated islands, especially Rarotonga, show signs of ecological stress, including declining live coral cover, macroalgal proliferation, and reduced herbivore and carnivore fish biomass, all of which is to a combination of natural hazards (e.g. tropical cyclones) and human impacts such as eutrophication, fishing pressure, coastal development and direct physical disturbance (Chin et al., 2011).

Formal long term monitoring efforts are limited at present, although the Marae Moana marine park, National Environment Service (NES), Ministry of Marine Resources (MMR), customary marine tenure, local expertise and regional partnerships, together offer a strong governance platform for future initiatives. Key coral reef monitoring activities to date include:

- Monitoring efforts at Rarotonga and Aitutaki led by the national government (NES/MMR) and partners to survey benthic cover, fish biomass and/or COTS (including monitoring COTS eradication), though noting standardised long-term protocols across sites can be limited (Rongo et al. 2013, Loya et al., 2019).
- Local NGO monitoring/training (e.g. by Kōrero O Te 'Ōrau), including local NGO coral restoration (i.e. transplantation/nursery) projects that are then monitored
- Two-yearly monitoring at one site by CRIOBE.

Key local implementing partners include Kōrero O Te 'Ōrau, GROW Aitutaki, Dive Rarotonga and Ocean Toa.



Figure 2.17 Example site survey locations for the Cook Islands, survey sites are represented by yellow dots; Left: Takutea, Right: Atiu (source: Rongo et al., 2013)

The abovementioned monitoring (with the exception of CRIOBE monitoring) is conducted at varying extended intervals, such as annually to every 5-years or more. No short-term monitoring frequencies were reported during consultation. It was indicated that inhabited islands in the southern Cook Islands are surveyed approximately every 5 years, but that surveys are conducted less frequently in the northern islands. The Cook Island is also the only country consulted that mention they have some monitoring of mesophotic reefs (i.e. reefs deeper than 40-60 m), as compared to monitoring elsewhere assumed to be shallow water reefs.

Most effort is concentrated around Rarotonga and Aitutaki, largely due to the ease of accessibility (i.e. population centres, accessible islands, and availability of vessels and SCUBA diving services). Operations at the other islands can be cost-prohibitive, given their remoteness and/or lack of local diving services.

Monitoring techniques likewise vary, with the most survey methods being SCUBA-based visual surveys and photo quadrats. It was indicated that eDNA, coral recruitment/ settlement monitoring, and water sampling has also been used. The data collected has been used to assess overall benthic cover including live hard/soft coral, coral bleaching, dead coral, invertebrate densities, reef fish densities/communities, COTS density and eradication success, and coral restoration effectiveness. Monitoring data is stored in spreadsheets for use in statistical analysis, saved on local hard drives. Varying combinations of analysis tools are used to assess the data, depending on which project partner is leading analyses, but typically include CPCe, Excel, R Studio, PRIMER<sup>17</sup> and/or SPSS<sup>18</sup>.

Sharing of data and information can be dependent on the monitoring partners involved. For example, data and/or monitoring results will be shared with, or stored by, national government if they are a project partner. Sharing of independent monitoring or reef research is less common or may experience a time lag. While there is some monitoring and sharing of data, it is generally thought that this has limited uptake to inform government decisions or community-driven actions about coral reef conservation. Exceptions include COTS eradication efforts and coral restoration/nursery initiatives.

<sup>17</sup> <https://www.primer-e.com/software>

<sup>18</sup> <https://www.ibm.com/products/spss-statistics>

Since data limitations constrain knowledge and management, it is recognised that improved monitoring will be critical to sustaining reef resilience. In particular, improving the spatial extent and temporal frequency of monitoring, standardising monitoring techniques, and improving community involvement and traditional knowledge. This will require some challenges to be addressed, particularly:

- Limited availability of dedicated and sustained funding
- An absence of clear monitoring guidelines and commitment to coordinated coral reef monitoring
- Poor data and information sharing at times
- Too few skilled local personnel and/or training opportunities, particularly in coral taxonomy and statistical analysis
- High costs involved with monitoring remote islands.

### 2.11 Federated States of Micronesia

Owing to its vast expanse across four states (Yap, Chuuk, Pohnpei, Kosrae) and ~1.6 million square kilometres of ocean, the Federated States of Micronesia (FSM) host approximately 5,000 square kilometres of coral reefs, including fringing, barrier, atoll, and patch reefs. The reefs support >300 coral species and >1,200 reef fish species (Chin et al., 2011; George et al., 2008).

Remote reefs, especially in outer Yap, Chuuk and Kosrae, maintain relatively intact reef ecosystems with high live coral cover, healthy fish assemblages, and minimal coral bleaching and disease (George et al., 2008). In contrast, reefs adjacent to the population centres of Kolonia (Pohnpei), Weno (Chuuk), and Tofol (Kosrae) show degradation from sedimentation, land clearing, coastal development and nutrient inputs (George et al., 2008). Traditional governance structures, localised management, and regional conservation initiatives offer a strong basis for adaptive reef management, provided they are supported by improved data systems and improved implementation capacity for both monitoring and management.

Coral reef monitoring is conducted by government agencies, NGOs and academic partners, with the following organisations are most involved in reef monitoring or management:

- National Oceanic Resource Management (NORMA) - Division of Marine Resources Management
- Department of Resources and Development – Marine Division
- Conservation Society of Pohnpei (refer historical monitoring locations at Figure 2.18)
- Yap Community Action Plan
- Kosrae Conservation and Safety Organisation
- Kosrae Island Resource Management Authority
- Chuuk Conservation Society.

Sites in Kosrae and Pohnpei have long-term data, while outer islands remain under-surveyed. Community participation is expanding via Reef Check and LMMA networks, but standardised methods and spatial coverage remain limited (Chin et al., 2011). The key large scale monitoring programme underway at present in FSM is the centralised Micronesia Coral Reef Monitoring (MCRM) programme. It focuses on ongoing monitoring at 21 coral reef monitoring sites around Yap's main island, as well as sites at Pohnpei, and a few sites on Chuuk and Kosrae, and involves on-site data collection by local monitoring teams.



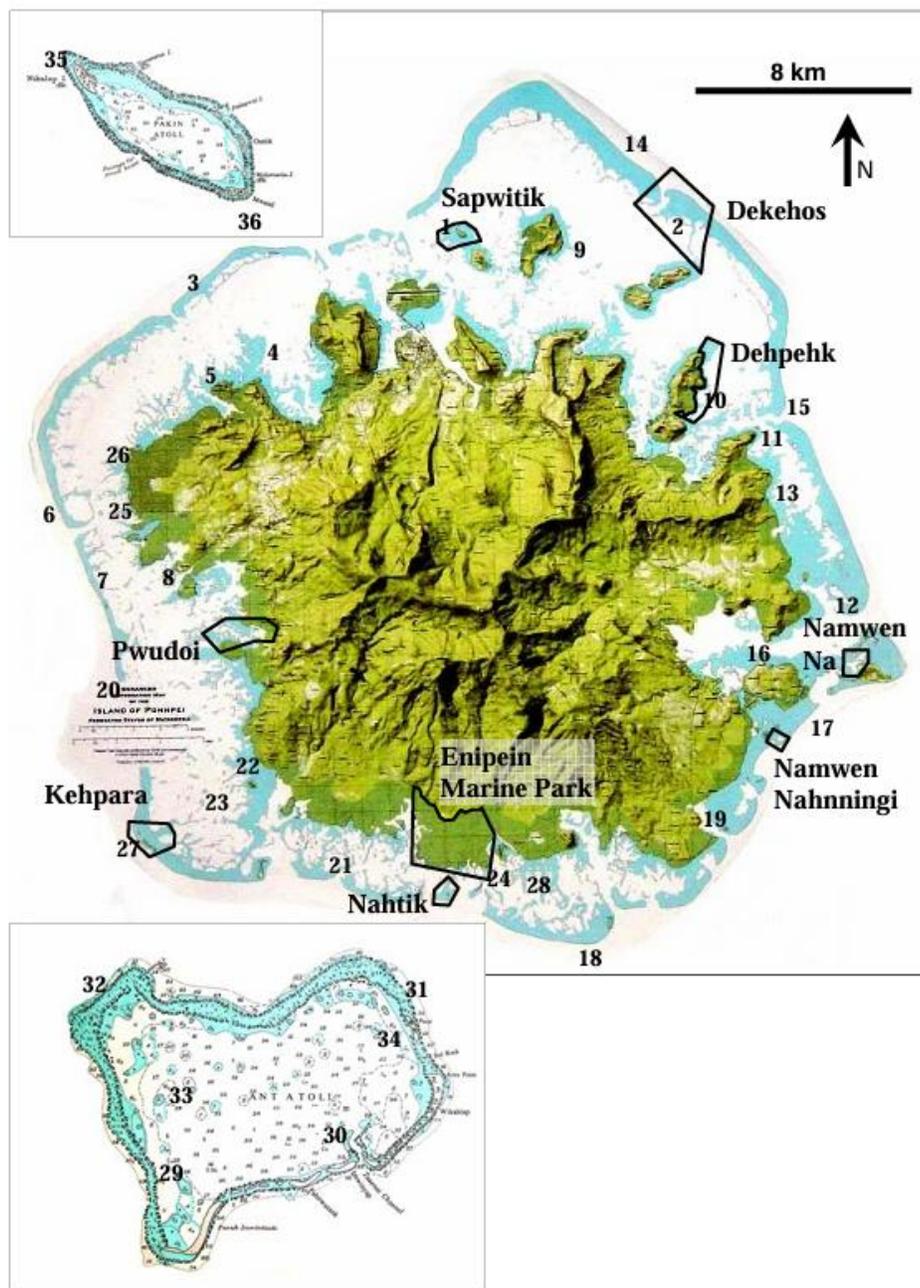


Figure 2.18 Survey sites (36) for the Coral Rapid Ecological Assessment across Pohnpei island, Ahnd and Pakin atolls (source: Conservation Society of Pohnpei, 2006).

These sites are monitored annually using of methods aligned with Reef Check and similar protocols. Specifically, monitoring techniques primarily include visual surveys and photo quadrats to assess coral cover, composition and health; fish populations; and epibenthic invertebrates. Other smaller coral reef monitoring initiatives encompass recruitment/ settlement, water quality, line transects and manta tow sampling methods. Common data processing and analysis tools include CPCe, CoralNet, Excel and R Studio. Increasingly, software tools such as Photomosaic technology (via Scripps Institution of Oceanography) and Viscore (point-based visual analytics) are being applied where appropriate to a monitoring programme and its objectives/methodology.

Sharing of monitoring data and/or results is common. Data from the MCRM programme is uploaded to the public-facing Micronesia Coral-Reef Monitoring database, managed by the Pacific Environment Data Portal. The information is then integrated into wider management decisions, although the exact mechanisms for this are not formalised. Monitoring data from other initiatives may be stored locally by the leading in-country partner, or internationally in instances where overseas partners have led the analysis of monitoring data (i.e. international University partners).

FSM has aspirations to further embed the MCRM programme by eventually incorporating additional sites with locally-led monitoring personnel, as well as improve the flow of information to the national and state governments from smaller decentralised reef monitoring initiatives. Key issues to overcome in this regard include:

- Sourcing increased and sustained funding dedicated to coral reef monitoring (e.g. increased labour support, personnel training, equipment purchase and maintenance)
- Enhancing collaboration and communications between non-government actors and national/state governments
- Improved awareness of options for applying advanced technologies.

## 2.12 Palau

Palau contains approximately 1,000-1,200 square kilometres of coral reef habitat, comprising barrier reefs, fringing and patch reefs, atolls, and distinctive ecosystems such as marine lakes. Its reefs are among the most biodiverse in the Pacific, hosting over 400 coral species and 1,300 reef fish species (Berger et al., 2008, Wicquart et al., 2025).

Reefs exhibit high structural complexity and ecological integrity, as observed by robust monitoring by the Palau International Coral Reef Center (PICRC) and other monitoring groups (e.g. CRRF). The good condition of coral reefs in Palau is attributed to effective management, relatively low terrestrial runoff in many areas, and a relatively small human population density in proximity to much of the reef extent. Long-term datasets include benthic cover, fish biomass, and water quality, supporting adaptive management across various reef types and zones, as well as observations and modelling of calcification declines.

Despite strong governance and conservation frameworks, climate-induced stressors present major risks. Severe bleaching events in 1998 and subsequent years significantly reduced coral cover and reef calcification rates. Net ecosystem calcification in Palau's Southern Lagoon fell by 50% post-1998 and continued to decline through 2015, indicating limited recovery (Lentz et al., 2020). Nevertheless, Palau maintains relatively high reef resilience. Protected areas such as the Rock Islands Southern Lagoon (a UNESCO World Heritage Site) remain ecological strongholds. The national outlook is comparatively positive, supported by high management capacity, ecosystem heterogeneity, and robust datasets, although future impacts from ocean warming and acidification remain critical concerns (Chin et al., 2011).

At present, the main coral reef monitoring in Palau include:

- Ongoing coral reef monitoring surveys and water temperature monitoring conducted by the Palau International Coral Reef Centre (PICRC, refer Figure 2.19)
- Metocean monitoring conducted by the Coral Reef Research Foundation (CRRF) Palau.



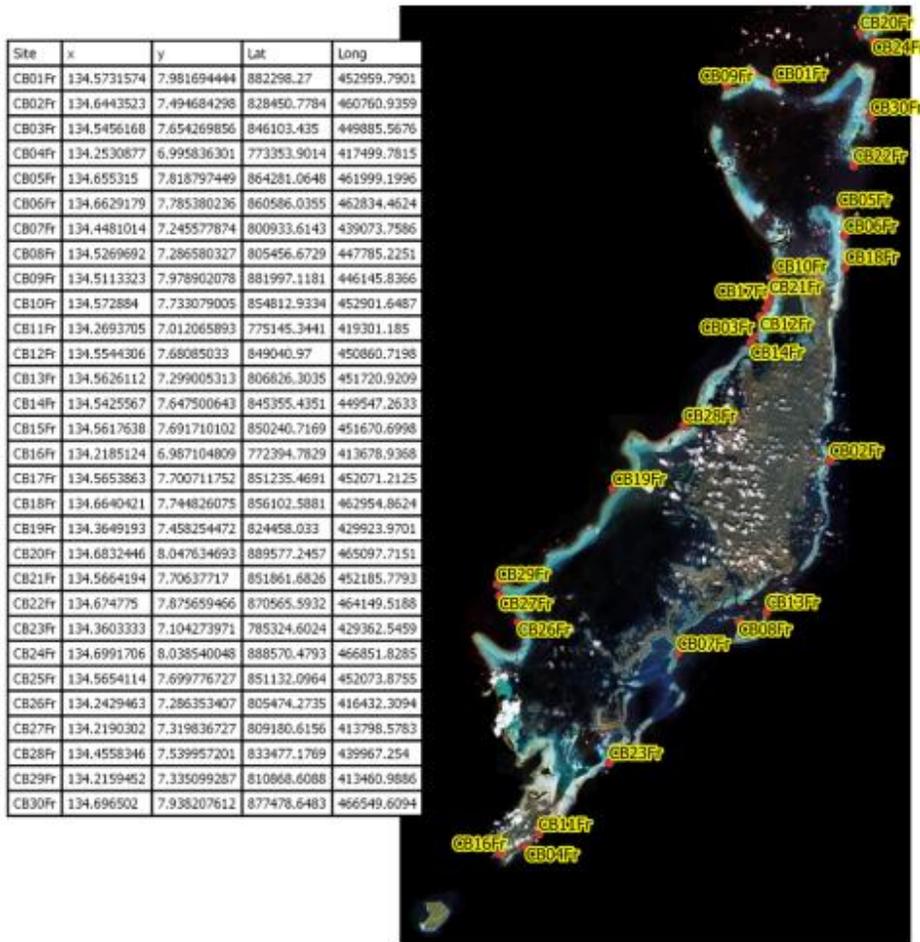


Figure 2.19 Coral survey sites for PICRC’s most recent bleaching survey (source: Biondi et al. 2023)

The PICRC monitoring focuses spatially on the eastern outer reefs, three patch reefs, five inner reefs, six western outer reefs and MPAs. Each of these sites was monitored every two years until 2022, after which it was decided to reduce the monitoring frequency to every four years. The field techniques utilise a primarily use underwater visual surveys using photo quadrats (i.e. an underwater camera mounted to a PVC quadrat frame) to monitor coral cover and condition (e.g. bleaching), fish biomass, epibenthic invertebrate communities and habitat condition. CRRF’s metocean monitoring uses loggers deployed for periods of continuous monitoring of physicochemical parameters including salinity, temperature, pH, oxygen and nutrients. Other smaller reef monitoring programmes (e.g. as associated with shorter programmes such as research projects) incorporate coral recruitment/ settlement monitoring, eDNA sampling of reef biodiversity and/or remote sensing.

Data post-processing and analyses typically use either CPCe software or ReefCloud, together with Excel and R Studio. In Palau, remote sensing analyses are usually conducted using QGIS. Data and monitoring results are then generally shared across government agencies and project partners according to defined agreements for a monitoring programme, as well as through regional and Micronesian partnerships where appropriate. National government then integrates monitoring findings into wider environmental management decision making.

Future plans for the national coral monitoring included expanding the spatial coverage, applying new technologies as they arise, and increased training for numerical modelling to better understand key drivers of coral condition such as coral recruitment, disease and marine heat waves. A challenge for

expanding the spatial coverage to understudied southwestern states (e.g. Hatohebei, Sonsorol) is the prohibitive field costs associated with their remote distance and high transportation costs for regular monitoring. Despite, the presence of a specialised coral research centre in Palau, a lack of technical capacity (i.e. number of skilled personnel with up-to-date training) remains another key challenge for improving coral reef monitoring in Palau.



## 3 Future Monitoring Needs

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### 3.1 Regional Overview

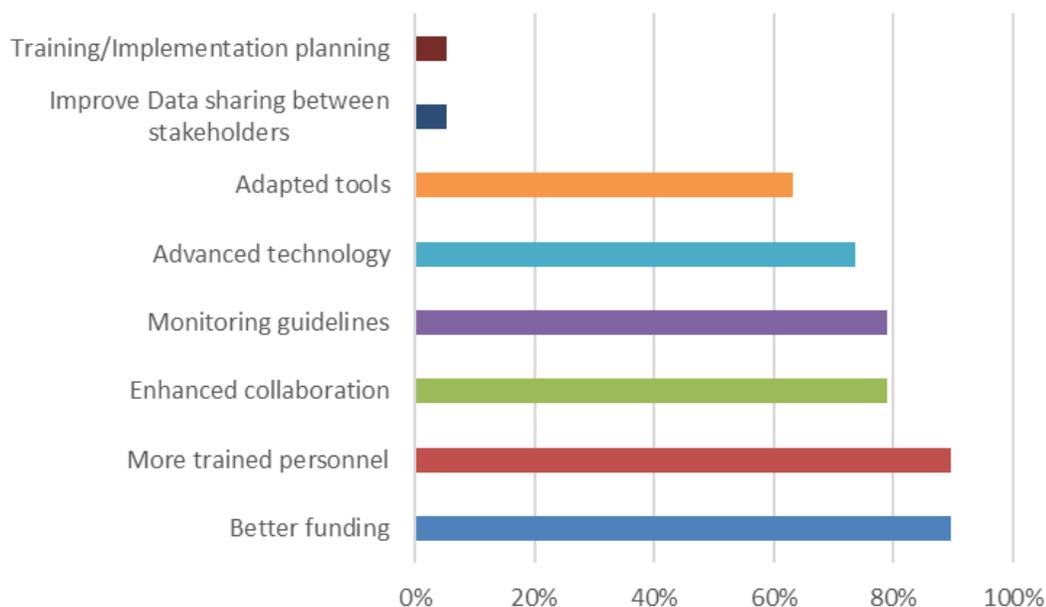
Robust monitoring strategies are required to sustainability manage coral reefs against the backdrop of the multiple threats they face, including direct or indirect human disturbance, natural hazards and climate change. This is particularly challenging for the Pacific countries where many reefs are not monitored such that significant data gaps persist, and where governance structures and/or limited communication of monitoring results limit the uptake of monitoring data for informing decision making, especially at a national scale.

Each country is at a different stage in its maturation of coral reef monitoring and has differing governance arrangements, such that specific needs can vary from country to country. However, a variety of similar issues and common themes did emerge between the countries in terms of key challenges that need to be addressed to achieve their aspirations and goals for improved coral reef monitoring, and its uptake in reef management. Specifically, most of the countries indicated that they would need to focus their efforts on three or more of the following themes to improve coral reef monitoring in the future (Figure 3.1):

- **Fund monitoring:** improving funding models for coral reef monitoring and/or determine more cost-efficient monitoring methods.
- **Training investment:** investing in capacity building, specifically increasing training of the personnel for conducting coral reef monitoring and reporting.
- **Development of monitoring guidelines:** establishing standardised monitoring guidelines and/or frameworks at a national level (noting that having documented processes assists with continuity of monitoring when there is staff/personnel turnover).
- **Enhanced collaboration:** noting that this looks different for each country. For example, in some countries the focus may be on strengthening cross-agency collaboration at a national government level. At others there is already excellent national government collaboration, such that there is a desire to focus more on government—NGO collaboration, or national—provincial government collaboration and/or regional and international collaborations. Regardless enhanced collaboration is critical in the context of ensuring monitoring is designed to suit management needs, and can be effectively used to by reef managers to inform decisions.
- **Embracing technology:** advancing the uptake and application of novel and technological approaches to coral reef monitoring. There is a growing awareness among some countries that there are barriers to their uptake of new technologies, such a lack of awareness about technology options and their advantages/disadvantages, perceived or actual cost-prohibitive concerns, current training limitations etc.
- **Improved communication and data sharing:** greater communication to government and community decision makers of the results from coral reef monitoring, and improved sharing and accessibility of data. A large proportion of monitoring data is held by non-decision makers, and in many instances held only by international organisations (e.g. NGOs, Universities). This poses a key risk where decision makers lack agency and access with regard to monitoring data, particularly in the longer term (e.g. data access may be lost altogether if an external organisation disbands, has significant staff turnover, or discontinues data storage facilities/programmes).

These are listed in Table 3.1, along with example solutions for addressing the challenges.





**Figure 3.1 Key needs for improving future coral reef monitoring**

Addressing all of these efforts at a national level is ambitious and, particularly for the countries with few resources, would benefit greatly from regional support. Regional coordination and support, where appropriate, can also foster enhanced collaboration among the communities of practice across the region and deliver cost-efficiencies such as through regional approach to databases, training, and funding advocacy. Coordinated regional efforts also have great potential to support improvements in coral reef monitoring and management. However, it was strongly advised that any regional initiatives should:

- Recognise the diversity of needs across the Pacific
- Be flexible in supporting the potentially differing objectives of coral reef monitoring between countries (and therefore potential desire for different indicators, metrics, methods and frequency etc.)
- Foster socialisation of lessons learned and monitoring results across various jurisdictional levels within a country, and across the Pacific region
- Encourage leveraging of expertise from within the region, including capacity building in-region preferentially over reliance on international expertise.

Consideration of regional coordination and initiatives should be broader than the context of the 11 countries included in this assessment. Coral monitoring programmes are well established in other parts of the Pacific, particularly French Polynesia, New Caledonia, Northern Marianas Islands, Guam and Hawaii. Any regional initiatives or new communities of practice would therefore benefit from the inclusion of these Pacific territories/states to maximise the exchange of knowledge, expertise and solutions.

inputs of what is happening in the French and US territories where and how this could best contribute towards a regional community of practice.

The following sections present the needs identified by each country for improving their coral reef monitoring and strengthening management, supplemented with insights drawn from literature review, meetings and workshops conducted as part of this assessment.

Chapter 4 then highlights key priorities and recommendations, particularly in a regional context.



Table 3. 1 Key need themes for future coral reef monitoring in the Pacific, together with preliminary example solutions for addressing each

Key need theme	Preliminary potential solution examples
<p><b>Fund monitoring:</b> address insufficient funding, which leads to the inability of coral reef monitoring to initiate consistent survey efforts, particularly for remote reefs that are particularly costly to access</p>	<ul style="list-style-type: none"> <li>Improving funding models, including consideration of sustainable financing or sourcing external funding</li> <li>Investigate and apply more cost-effective monitoring strategies, such as remote sensing technologies or utilising local labour for field surveys</li> <li>Advocate to elevate the importance of funding robust coral reef monitoring</li> <li>Dedicated funding for monitoring programs to assess the current and ongoing state of coral reefs, including allocations remote reefs</li> <li>Support with introductions to prospective donors and/or grant writing assistance</li> </ul>
<p><b>Embracing technology:</b> Advancing the uptake and application of novel and technological approaches for coral reef monitoring to improve or expand monitoring</p>	<ul style="list-style-type: none"> <li>Investigate survey technologies that may be adopted to improving monitoring, such as remote sensing using satellite imagery, aerial or underwater drone-based surveys, eDNA, coral tissue sampling, photomosaic technology</li> <li>Investigate technologies for data post-processing and analyses, including web/online, cloud-based and other software</li> <li>Consider needs for long term data storage and back-up, particularly as imagery and other data is regularly increase in file size (e.g. cloud storage and online databases)</li> <li>Raise awareness of potential technologies available, including their advantages and limitations, through communication networks or training</li> <li>Understanding financial risk and/or gains associated with new approaches, software and equipment</li> <li>Invest in research and development tailored to national needs</li> </ul>
<p><b>Training investment:</b> reflecting a need for more trained personnel to conduct surveys (i.e. skills in survey methods, SCUBA diving, equipment use and maintenance, GIS, community engagement etc.), data processing (GPCE, ReefCloud, QGIS etc.), and analysis, and reporting, and/or upskilling of existing personnel to ensure their expertise remain relevant</p>	<ul style="list-style-type: none"> <li>Specific training programs delivered to meet the training needs, either locally led or with regional/International support (as applicable)</li> <li>Succession planning to support continuity of monitoring even when there is turnover of personnel (i.e. by ensuring skills and knowledge are not limited to a few personnel)</li> <li>Sponsor scholarships or internship opportunities for local university students</li> <li>Ongoing professional development</li> </ul>



Key need theme	Preliminary potential solution examples
<p><b>Development of monitoring guidelines:</b> establishing standardised monitoring guidelines and/or frameworks at a national level to ensure monitoring meets the needs to inform management decisions, noting that it can be difficult to compare findings across time, locations or programmes if guidelines are not available and followed</p>	<ul style="list-style-type: none"> <li>• Development of a national reef management strategy, such as a National Coral Reef Action Plan that, among other management actions, sets out the objectives and aims of reef monitoring</li> <li>• Development of coral reef monitoring guidelines or framework</li> <li>• Clearly set out standardised monitoring procedures required for acquiring data that is targeted and sufficiently robust for information decision making</li> <li>• Ensure monitoring guidelines (or similar) are communicated and used to decide survey permits/approvals for monitoring if applicable</li> <li>• Use guidelines to set out expectations for communicating results and data sharing</li> </ul>
<p><b>Improved communication and data sharing:</b> greater communication to government and community decision makers of the results garnered from coral reef monitoring</p>	<ul style="list-style-type: none"> <li>• Foster and schedule communications in an appropriate format and timeframe</li> <li>• Define reporting responsibilities, including within an adaptive management framework for coral reef management</li> <li>• Host coral reef events to provide a local platform for multiple actors to connect and share insights from monitoring and management interventions</li> <li>• Improve data shareability and accessibility by uploading data into a database that is fit-for purpose, hosted either locally and/or regionally</li> </ul>
<p><b>Enhanced collaboration:</b> strengthening partnerships to facilitate improved coordination, awareness, information sharing and learnings in relation to coral reef monitoring, as appropriate to local governance structures</p>	<ul style="list-style-type: none"> <li>• Strengthening cross-agency collaboration at a national government level</li> <li>• Strengthening government-NGO collaboration</li> <li>• Strengthening collaboration between governance jurisdictions, i.e. national-provincial collaboration and/or government-community collaboration</li> <li>• Facilitating regional and international collaboration, such as through a regional network that offers mentoring, non-financial support, camaraderie and greater exchange of ideas for the community of practice (e.g. such as via a social media networks or online education platforms that are accessible by relevant local actors)</li> </ul>



### 3.2 Tonga

Future coral reef monitoring in Tonga would benefit from broader geographic coverage, stronger coordination, and improved continuity of long-term data collection. The 2016–2019 ecological survey reported low average coral cover (18%) and variable fish biomass, with southern reefs demonstrating greater resilience compared to more degraded northern sites such as Vava'u. However, monitoring efforts remain uneven, with a disproportionate focus on Vava'u and limited attention to wider community-based reef assessments. Survey feedback also highlighted potential governance challenges, with multiple agencies identified as leads for coral management. This suggests a need for clearer institutional roles and more cohesive oversight across Special Management Areas (SMAs).

Continuity of coral reef monitoring faces significant cost challenges, particularly for vessel charters, SCUBA equipment, transportation, and essential equipment. There is a strong desire to upgrade to higher-quality imaging equipment and explore innovative technologies like underwater drones and remotely operated vehicles (ROVs), provided they align with national monitoring objectives and remain cost-effective. Training government staff in remote sensing and boat-based towed video methods is a priority to enhance efficiency, alongside interest in emerging approaches such as environmental DNA (eDNA), gene-editing technologies and photomosaic technology. Addressing delays in follow-up monitoring at Special Management Areas (SMAs) requires additional trained personnel, while diver training remains a critical gap for meeting workplace health and safety standards, noting that in-country providers for Rescue Diver certification are currently unavailable.

To strengthen monitoring capacity, targeted training programs are needed to build expertise in advanced technologies, including cloud-based and machine-learning image processing, eDNA applications, and remote sensing techniques. Establishing an integrated database and web portal accessible to agencies, communities, and partners would improve data management and align reporting with multilateral agreements, replacing the current reliance on physical hard drives.

Further, developing a national coral reef management action plan would help to standardise monitoring protocols, clarify responsibilities and foster integrated collaboration. Additionally, investing in community-led monitoring initiatives are critical steps toward overcoming challenges related to coordination, consistency, and resource limitations. Likewise, investment in coral restoration and reef habitat enhancement trials is seen as an opportunity to engage communities more actively in reef stewardship, fostering a holistic approach to conservation and resilience.

Of all the key needs, it was emphasised that the following were critical:

- Financial support is essential for sustaining monitoring efforts and identified it as the greatest risk to program continuity
- Enhanced collaboration and data sharing, and the adoption of new tools and technology as key requirements for improving coral reef monitoring in the future.



Table 3.2 Key needs for Tonga

Theme	National context
Improved funding	<ul style="list-style-type: none"> <li>• Costs for vessel charter, SCUBA equipment, transportation, and equipment purchase (e.g. cameras) are already challenging</li> <li>• Essential for continuity of monitoring</li> <li>• Desire to upgrade cameras to better quality equipment</li> </ul>
Advanced technology	<ul style="list-style-type: none"> <li>• Investigating options to acquire and start to use underwater drone / remote operated vehicle (ROV) technology, where affordable and suitable to national monitoring objectives</li> <li>• Interest for government staff to receive training on remote sensing and boat-based towed video methods for coral reef monitoring (i.e. in the context of exploring potential cost-effective monitoring methods)</li> <li>• Appetite to explore eDNA and photomosaic technology</li> </ul>
Training investment	<ul style="list-style-type: none"> <li>• Follow-up monitoring at SMAs often delayed due to limited staff availability (i.e. time capacity), such that additional trained national government staff beneficial</li> <li>• Identified diver training as a critical gap for ensuring adequate WHS standards (e.g. minimum certification and insurance implications) are met for government SCUBA diving personnel, i.e. would like all government divers to be certified to Rescue Diver, however there is no training provider available in-country</li> <li>• Specific training programs desirable to allow for greater understanding of new and emerging reef monitoring technology such as cloud-based/machine-learning image processing, eDNA, remote sensing, photomosaic technology</li> </ul>
Improved communication and data sharing	<ul style="list-style-type: none"> <li>• Desires an integrated database and web portal / dashboard that all agencies, communities and implementing partners can access (data currently stored on physical hard drives), preferably aligned with reporting needs under multilateral agreements</li> <li>• Training around data management and access required</li> </ul>
Development of monitoring guidelines	<ul style="list-style-type: none"> <li>• Standardised monitoring protocols would be beneficial and facilitate collaboration</li> </ul>
Enhanced collaboration	<ul style="list-style-type: none"> <li>• Looking to invest in more coral restoration and reef habitat enhancement trials to get communities more actively involved in coral reefs</li> </ul>

### 3.3 Kiribati

In Kiribati, future coral reef monitoring would benefit from improved consistency, broader geographic coverage, and greater integration of local knowledge. To date, long-term monitoring has been concentrated in South Tarawa and Abaiang, leaving many other atolls largely under-surveyed. Historical data reveal a stark contrast in coral cover between North and South Tarawa, with the latter demonstrating resilience to chronic stressors due to the dominance of *Porites rus* (Summers & Donner, 2022). However, persistent challenges such as bleaching, pollution, and sedimentation continue to impact reef health. Fragmented monitoring methodologies, combined with limited funding that restricts surveys to bi-annual intervals, further constrain the ability to track ecological change over time. While the Phoenix Islands Protected Area (PIPA) offers protection for remote reefs, enforcement remains limited elsewhere, and traditional management systems have weakened despite the continued presence of valuable local



ecological knowledge within fishing communities. Coral reef monitoring in Kiribati also faces significant challenges due to the high cost of accessing most reef sites, limiting national government efforts primarily to the Gilbert Islands.

Investing in expanding rapid or remote monitoring methods across priority target locations will be a key step in addressing these challenges. While likely to be constrained by funding or resources in the immediate term, increased investment in the longer term to enable more frequent and geographically comprehensive monitoring, particularly in underrepresented remote islands, would help close critical data gaps. Limited awareness of emerging technologies also underscores the need for investment in modern monitoring tools and targeted training programs.

Building capacity in advanced methods such as cloud-based image processing, eDNA analysis, photomosaic technology and remote sensing is essential to improve efficiency and data quality. Additionally, developing a shared web-based database or dashboard would enable better data management and facilitate timely sharing of monitoring results to inform decision-making for growing industries such as bone fishing tourism, wreck diving, and surfing. This could include, for example, a centralised, shared Excel-based system (aligned with current practices) or a regionally tailored web-based dashboard could support data entry, data visualisation, and coordination among government agencies and partners.

Strengthening institutional collaboration and community engagement is a key priority. Regular communication and information sharing between MELAD and MFOR will enhance coordination and ensure monitoring aligns with national conservation and marine resource management objectives. Establishing clear guidelines and a comprehensive national Coral Reef Action Plan would provide strategic direction, set monitoring goals, and promote cross-agency collaboration. Developing a national coral reef coordination plan would help clarify institutional roles and standardise monitoring methods across regions. This plan could build on lessons from the Phoenix Islands Protected Area Management Plan (2015–2020), which provides a proven framework for effective reef governance.

Finally, integrating scientific techniques (e.g. point-intercept transects, photo transects, CPCe analysis) with community-based knowledge into a unified monitoring framework would strengthen adaptive management and long-term reef stewardship, particularly in the context of limited resources and climate-driven stressors. Incentives for community participation, coupled with continued investment in research on thermal-tolerant coral species, will support resilience-building efforts. These measures collectively aim to secure sustainable monitoring practices and improve reef management outcomes across Kiribati.

**Table 3.3 Key needs for Kiribati**

Theme	National context
Improved funding	<ul style="list-style-type: none"> <li>• Access to most reefs is cost-prohibitive, such that national government monitoring primarily restricted to the Gilbert Islands</li> <li>• Limited tools and equipment, such that there is a desire to invest in monitoring tools and equipment</li> </ul>
Embracing technology	<ul style="list-style-type: none"> <li>• Limited awareness of new tools and technologies - specific training programs desirable to allow for greater understanding of new and emerging reef monitoring technology such as cloud-based/machine-learning image processing, eDNA, photomosaic technology and remote sensing.</li> <li>• Desire a shared web-based database portal or dashboard to share monitoring data and results</li> </ul>



Theme	National context
	<ul style="list-style-type: none"> <li>• Interest in continuing to support investment in further research and development relating to thermal-tolerant coral species (such as those identified in the Line Islands)</li> </ul>
Training investment	<ul style="list-style-type: none"> <li>• Only a few personnel local personnel (e.g. MFOR staff) are adequately training to conduct coral reef monitoring, which presents a key risk to continuity of monitoring</li> <li>• Specific training programs required to allow for greater understanding of new and emerging reef monitoring technology such as eDNA, photomosaic technology and remote sensing</li> </ul>
Enhanced collaboration	<ul style="list-style-type: none"> <li>• A key priority is to strengthen regular collaboration and information sharing between MELAD and MFOR on coral reef matters, i.e. improving collaboration and communication between national government ministries</li> <li>• A need to continue exploring incentivisation options to foster community participation in reef monitoring</li> </ul>
Monitoring guidelines	<ul style="list-style-type: none"> <li>• Would be beneficial to development a national reef management strategy, such as a National Coral Reef Action Plan that, among other management actions, sets out the objectives and aims of reef monitoring</li> <li>• Clear monitoring guidelines to better facilitate cross-collaboration between agencies and better ensure national monitoring efforts met the needs of all relevant national government agencies</li> </ul>
Improved communication data sharing	<ul style="list-style-type: none"> <li>• A key priority is to strengthen regular collaboration and information sharing between MELAD and MFOR on coral reef matters, i.e. improving collaboration and communication between national government ministries</li> <li>• Kiribati indicated that it is important that monitoring results are shared to better inform management decisions relating to emerging/growing industries, such as bone fishing tourism, plane wreck sight-seeing and surfing</li> </ul>

### 3.4 Papua New Guinea

Papua New Guinea (PNG) would benefit from refining its coral reef monitoring and management approaches to address well-documented threats and persistent data gaps. While remote reefs remain in relatively good condition, those near population centres or downstream of industrial activities (e.g. mining, land clearing, coastal development), are under significant pressure. Long-term studies in PNG have shown that sedimentation and turbidity both coastal and catchment activities can substantially reduce coral cover and species richness, with lasting impacts on reef structure and ecological function. However, consistent and standardised monitoring across PNG remains limited, leaving reef health poorly understood in many regions.

Coral reef monitoring in Papua New Guinea is highly decentralised, creating significant challenges for national oversight and data integration. To address the monitoring challenges, PNG could adopt a nationally tailored monitoring framework that can be utilised by the provinces, communities or National Fisheries Authority (NFA) for monitoring implementation. This may include developing national reef health indicators and promoting the use of low-cost, standardised techniques (e.g. benthic video transects) to track reef condition and trends over time. Integrating traditional ecological knowledge with scientific approaches within a national coral reef management or monitoring framework would further support adaptive management, particularly in under-surveyed areas vulnerable to both climate change and localised human stressors. Local operators have already demonstrated willingness to adopt new technologies such as ReefCloud when trained, but awareness and training through a coordinated



approach is required to ensure the use of these and other monitoring methods are applied in a manner that facilitates scientifically robust outputs

There is an urgent need to strengthen data-sharing mechanisms, as reports from third-party operators are often delayed or not shared at all, limiting the government’s ability to make informed decisions. Establishing a centralised data-sharing platform, modelled on successful regional databases, would improve transparency and collaboration among communities, government agencies, and NGOs. Such a platform could also help reduce the fragmentation of efforts, which has been reported as a challenge when NGOs operate independently without clear communication of objectives.

Building technical and organisational capacity at the provincial level is a priority to enable community-led monitoring and ensure sustainability. As mentioned in Section 2.4, the new role at NFA that focuses on monitoring coastal ecosystems could be leveraged by utilising NFA’s established coastal fisheries monitoring network and procedures to grow nationally coordinated coral reef monitoring across the provinces. This is aligned with NFA’s growing focus on more holistic ecosystem-based fisheries management for coastal fisheries. Strengthening collaboration between NFA, CEPA, and monitoring practitioners will help align efforts not only with these NFA management priorities, but also national priorities associated with development applications, MPAs, biodiversity and climate resilience. For example, providing clear national guidance on monitoring standards will support consistent practices that meet reporting obligations under multilateral agreements and inform national-scale reef management.

Further, expanding community-based monitoring and strengthening the capacity of implementing partners through training, data management tools, and sustained funding for regular monitoring would enhance program resilience. It is noted that training should consider not only technical training, but also non-technical training to support the longer-term sustainability of emerging local partners/NGOs (e.g. training in leadership, accounting, grant writing).

**Table 3.4 Key needs for Papua New Guinea**

Theme	National context
Improved communication data sharing	<ul style="list-style-type: none"> <li>From the perspective of national government, there is an urgent need to strengthen sharing of data and reports from third parties, and decentralised approach to monitoring means that national government currently has little oversight and power to enforce sharing agreements from the many reef monitoring operators</li> <li>There is often a very delayed time lag between monitoring and sharing of data to national government, and commonly data is not shared with government at all</li> </ul>
Improved funding	<ul style="list-style-type: none"> <li>While there are many organisations involved in coral reef monitoring in some form, there remains a need for improved funding if coordination and expansion of monitoring is to be improved - for example, to facilitate access to boats, cover the costs of security for monitoring teams, invest in training of personnel, and cover the costs of transport to remote reefs</li> </ul>
Embracing technology	<ul style="list-style-type: none"> <li>Local operators have proven to be open to, and adopt relatively rapidly, the uptake of new technologies when they are trained and aware of the benefits (e.g. ReefCloud), however there is often limited awareness of other new technologies (e.g. drones) that could also be applied and/or awareness of opportunities to apply technology tools such as ReefCloud in a manner that provides more scientifically robust monitoring outputs</li> </ul>
Training investment	<ul style="list-style-type: none"> <li>Improving technical capacity on the ground (i.e. in the provinces) is considered a priority for facilitating Provincial and community-led reef monitoring</li> <li>Local NGOs expressed a need for training in non-technical areas to ensure the longevity and sustainability of the organisations that are implementing</li> </ul>



Theme	National context
	<p>monitoring, including training in areas such as leadership, accounting, human resources and grant writing</p> <ul style="list-style-type: none"> <li>Continued investment in and upskilling of NFA's coastal ecosystems monitoring initiatives</li> </ul>
Enhanced collaboration	<ul style="list-style-type: none"> <li>Improved collaboration between CEPA and those conducting monitoring would help to ensure monitoring is suitable for informing national government management decisions relating to development applications, MPAs, high biodiversity areas and climate change</li> <li>Continue to enhance collaboration between CEPA and NFA to identify and pursue opportunities to leverage NFAs existing monitoring network (but expanding to facilitate coral reef monitoring)</li> <li>There is a need to incentivise partners in the provinces to take on responsibility for coral reef monitoring, such as through employment and training opportunities</li> <li>It was indicated that it would be beneficial to establish platforms where local organisations and personnel conducting reef monitoring can share knowledge and learn from one another</li> </ul>
Development of monitoring guidelines	<ul style="list-style-type: none"> <li>Given the decentralised nature of coral reef monitoring in PNG, clear guidance from national government would be useful for encouraging monitoring practitioners and communities to conduct monitoring in a manner that benefits the needs of national government (e.g. reporting on multilateral agreements, national-scale decision making about reef management, supporting sustainable coastal fisheries etc.)</li> </ul>

### 3.5 Vanuatu

Vanuatu's coral reefs support high biodiversity across a range of reef types but remain vulnerable to both climate-induced impacts (e.g. cyclones, bleaching) and localised pressures such as sedimentation, overfishing, and coastal development. While earlier efforts such as Reef Check surveys in 2002–2004 helped build baseline knowledge and local capacity, long-term datasets remain limited, particularly in remote or traditionally managed areas. Previous surveys have shown considerable variability in reef condition, with some urban-adjacent sites reporting live coral cover below 5%, compared to over 50% in healthier northern reefs. Other smaller scale monitoring efforts, including those led by TasiVanua, the Nguna Pele network, and C2O Pacific, have been largely concentrated in accessible regions.

Vanuatu has since made significant gains in recent years in its approach to national coral reef monitoring, most notably through enhanced collaboration with international experts and donor(s) to implement a national coral reef survey and report (Government of the Republic of Vanuatu & Blue Prosperity Vanuatu, 2025). This survey was co-designed and co-implemented by the National Government and Waitt Foundation, with a key focus on incorporating of local capacity building for national government staff during the survey process (i.e. strengthening institutional capacity). Several years of relationship building between the partners was required to build trust, and co-design a program that was fit for government management needs. A high proportion of the survey team was national government staff, with training and guidance from international partners. Government staff were also involved in the reporting process. The National Government has committed to continuing this national scale monitoring in future (time frame to be determined, but potentially every five years). This represents a step-change from the previous monitoring initiatives that were more piecemeal by nature. As such, the key need for Vanuatu now is to maintain this positive momentum in a manner that eventually transitions to an ongoing monitoring programme that the government and/or communities are empowered to deliver autonomously (i.e. locally led and without the risk of having to rely on external partners). Waitt Foundation have committed to



ongoing support and capacity building during the transition. This would solidify the current monitoring foundation, ensuring integrated and relevant coral reef data is available at a national scale to support MFOMA’s relevant decisions regarding managing and conserving marine resources.

To support this and future improvement of coral reef monitoring and management, a sustainable and integrated approach to coral reef monitoring is essential. This requires strategic funding that supports the entire lifecycle of monitoring activities, including assets, vessels, diving equipment, field labour, and advanced technologies for data processing and reporting. Current government budgets enable monitoring at a few selected sites annually; however, there is a strong aspiration to expand this to permanent monitoring across six Provinces or implement a rotational system to broaden coverage. Embedding institutional learnings (e.g. expanding knowledge to operational staff to ensure ready use of learnings in everyday operations) from recent national surveys and leveraging innovative technologies to address data gaps—such as shallow-water habitats critical for local fisheries and deeper reef profiles—will further strengthen monitoring effectiveness.

Building national capacity remains the priority, with a focus on empowering government staff and communities to lead locally driven monitoring initiatives. This includes maintaining momentum from recent institutional strengthening efforts, fostering partnerships with regional and international organisations, and utilising available supports to embed best practices. Flexibility to engage short-term labour through university partnerships, coupled with improved communication and data-sharing between government agencies, communities, and external actors, will enhance collaboration. Ultimately, it is hoped that an integrated national approach that combines scientific and community-based methods will enable timely detection of threats such as coral bleaching, disease, and cyclones, and provide reef managers with actionable alerts to trigger rapid interventions when necessary.

**Table 3.5 Key needs for Vanuatu**

Theme	National context
Improved funding	<ul style="list-style-type: none"> <li>• Sustainable funding for a holistic and integrated monitoring approach, rather than piecemeal reef monitoring, including funding to continue national scale monitoring of coral reefs</li> <li>• Strategic funding across the life-span of monitoring, i.e. across assets, vessel, diving equipment, field labour, field equipment (e.g. cameras, GPS’s), high-specification computers for processing big data, reporting, training and recruitment</li> <li>• Existing government business plan budget established for monitoring at several coral reef sites each year, with a desire for funding to upscale this to permanent monitoring sites across six Provinces or, alternatively, rotate the sites that are monitored from year to year</li> </ul>
Embracing technology	<ul style="list-style-type: none"> <li>• Continue embedding institutional learnings from the technologies used over the last few years in the national coral reef survey</li> <li>• Consider whether technologies can be applied to address current data gaps, such as assessments in shallow waters 0-5m deep (i.e. habitat for local fisheries interests pertaining to green turban snail and trochus), and for reefs deeper than 10m (i.e. the approximate depth profile for the recent national survey)</li> </ul>
Training investment	<ul style="list-style-type: none"> <li>• Capacity building with a focus on empowering government staff and communities to deliver locally led coral reef monitoring for the nation, particularly building off momentum of the last few years to embed and expand the institutional capacity strengthening achieved during delivery of the recent national coral reef survey</li> </ul>



Theme	National context
	<ul style="list-style-type: none"> <li>Flexibility to acquire short-term labour support for field surveys, such as students through university memorandums of understanding (MoU) as per programme with James Cook University</li> </ul>
Enhanced collaboration	<ul style="list-style-type: none"> <li>Continue to build long-term partnerships with regional and international partners</li> <li>Utilise available regional and international supports to embed capacity building and work towards locally-led coral reef monitoring</li> </ul>
Monitoring guidelines	<ul style="list-style-type: none"> <li>Aspiring to an integrated national approach to coral reef monitoring, including integration of community and scientific approaches</li> <li>Consider monitoring needs in the context of detecting threats/impacts (e.g. COTS, coral bleaching and disease, cyclones and earthquakes), recovery of reefs to impacting events, and informing threat management and mitigation</li> <li>Develop best approach for Vanuatu with regarding to establishing monitoring in a manner that provides timely alerts to reef managers when there are impacting events, such that alerts can trigger rapid intervention responses if necessary</li> </ul>
Improved communication and data sharing	<ul style="list-style-type: none"> <li>Well established and effective communications between national government agencies</li> <li>Opportunities to strengthen communication and data sharing with communities and other actors (e.g. international organisations) conducting coral reef initiatives in Vanuatu</li> </ul>

### 3.6 Republic of the Marshall Islands

Sustained investment in proven national mechanisms, particularly CMAC and the Reimaanlok Framework, should remain a priority, with a view to expanding their geographic reach across additional atolls and adapting a Reimaanlok-style program for major urban areas. Strengthened technical capacity and continued support for emerging community-based approaches is also vital. Specifically, continued rollout and embedding of the Community Marine Monitoring Toolkit will further empower local stewardship, provided it is complemented by short- to medium-term support for training, transport, tools, and reliable communications. To strengthen national research capacity and operational reach, stakeholders should continue assessing the feasibility of a dedicated research vessel under sustainable financing and cost-recovery models, while also advancing cost-effective approaches for remote reef monitoring that are less reliant on diving (e.g. remote sensing, drone mapping, AUVs, and other remote imagery methods).

Building capability at scale requires targeted training for both practitioners and community members. Priorities include structured programs to drive uptake of new Marine Monitoring Toolkits, addressing the shortage of trained divers that limits the scope and frequency of survey efforts, and strengthening the availability of trained personnel within key national implementing partners (government and non-government). The latter involves expanding training opportunities across the monitoring lifecycle, from monitoring design to data acquisition, analysis, and scientific reporting to improve the quality and consistency of reef assessments. In addition to monitoring reef health, biodiversity and fisheries values, community monitoring could encompass surveillance of priority threats (e.g. COTS outbreaks, declines in giant triton and Napoleon wrasse) and inform associated management decisions.



Given collaboration between national partners is already very strong, enhancement of collaboration at this level requires better resourcing of partner organisations that are currently stretched across multiple commitments (i.e. growing internal resources). Specifically, key delivery partner organisations (e.g. MICS) have only two or three key staff, who are trying to deliver multiple major environmental projects so are severely constrained by human resources. Likewise, stronger alignment of international partners and donors with local needs, rather than solely regional or global agendas, would support efficiencies in-country for delivering national priorities. In this regard, international NGOs and researchers should be encouraged to liaise more closely with CMAC before deciding and progressing work programs in RMI.

Improved regional and international collaboration could also be facilitating through regional partnerships and by aligning with platforms like the Global Coral Reef Monitoring Network (GCRMN) to enhance data integration and promote shared learning. This should start by specifically targeting those international organisations already conducted reef monitoring or research in RMI (e.g. University of Guam, TNC). At the community level, continuing to support and scale up the Community Marine Monitoring Toolkit could also provide a valuable pathway for increasing local stewardship and ensuring long-term monitoring coverage in outer atolls. That being said, incentivisation mechanisms may be needed to deepen community buy-in and ownership over the long term, and could include training, employment, travel, networking, and/or an inter-island network of trained community participants as appropriate.

To ensure monitoring meaningfully informs management, methods and objectives should be reviewed to address both national decision needs and local conservation priorities beyond coastal fisheries. This includes complementary metocean monitoring such as the ‘Backyard Buoy’ programme, as well as ongoing engagement in thermo-tolerant coral research (e.g. new Super Reefs programme) that are already underway to inform strategies for managing reef resilience in a changing climate. The community monitoring toolkit, while valuable for locally chosen metrics, should be complemented by efforts to close data gaps necessary for national reporting and permitting, including RMI EPA processes (e.g. development assessment and earthmoving permits) amid limited compliance capacity on outer islands. Urban monitoring should be tailored to local pressures such as nutrient inputs and macroalgal/turf algal proliferation, with objectives differentiated by location akin to atoll-specific plans. Shortening the turnaround between field monitoring and community reporting, potentially by leveraging transport logistics of non-environment agencies, and fostering cross-atoll and regional knowledge exchange through learning platforms or communities of practice will enhance consistency, insight generation, and timely management action.

**Table 3.6 Key needs for the Republic of the Marshall Islands**

Theme	National context
Improved funding	<ul style="list-style-type: none"> <li>• Support continued funding of CMAC and the Reimaanlok Framework as proven national mechanisms for working towards coordinated coral reef conservation and management nationally, and seek to build on the success of these by investing further to expand to more atolls</li> <li>• Continue to invest in rolling out and embedding the use of the community monitoring toolkit</li> <li>• Investigate opportunities to sponsor a program for major urban areas that is similar to Reimaanlok, but tailored to the needs and governance systems of urban areas</li> <li>• Long term aspiration to empower communities to take on the responsibility of coral reef monitoring requires short to medium term investment in training communities, transport, tools and communications (e.g. Starlink is not yet available everywhere and is at the discretion of local government)</li> <li>• Continued investigation into viability of a dedicated national research vessel (i.e. sustainable financing and cost-recovery options whereby vessel is also</li> </ul>



Theme	National context
	used for commercial activities such as research time for international non-government researchers or ecotourism)
Embracing technology	<ul style="list-style-type: none"> <li>Investigate cost-effect options for monitoring remote reefs, including exploring methods that are not reliant on diving (e.g. remote sensing, drone mapping, AUV and other remote imagery acquisition techniques techniques)</li> <li>Continue engagement in research and development relating to the Super Reefs project (or similar thermo-tolerant coral research) to support decisions around managing for resilient reefs</li> </ul>
Training investment	<ul style="list-style-type: none"> <li>Specific training programs to allow for greater uptake of new Marine Monitoring Toolkits</li> <li>Incorporate training for communities about threats they can conduct surveillance monitoring for (e.g. increase in COTS, reductions of giant triton or Napoleon wrasse numbers)</li> </ul>
Enhanced collaboration	<ul style="list-style-type: none"> <li>Strong centralised structure and network well established, though may be opportunities to better streamline ways of working between organisations to further improve collaboration</li> <li>For international partners and donors, encourage stronger alignment with local needs, not only regional/global aspirations of the organisation</li> <li>Investigate incentivisation opportunities to promote community buy-in and ownership of monitoring in the long term (e.g. engagement, training, travel, networking and employment opportunities, establishment of an inter-island network between atolls for trained community participants)</li> <li>Excellent collaboration exists between key implementing partners, but resourcing can be constrained when partners take on multiple commitments, such that improved resourcing would contribute to enhancing collaboration further</li> </ul>
Monitoring guidelines	<ul style="list-style-type: none"> <li>Community monitoring toolkit provides a framework and guidance for monitoring where communities decide which reef metrics they choose to monitor, however need to determine whether data gaps for informing national decisions also need to be addressed</li> <li>Review monitoring methods and objectives to ensure adequate for informing local coral management and conservation decisions (i.e. not only coastal fisheries management)</li> <li>In urban areas, consider monitoring needs in relation local management issues such as nutrient inputs and proliferation of macroalgae and turfing algae (could a Reimaanlok-type model be tailored to urban needs and governance systems?)</li> <li>Consideration of monitoring objectives in urban areas and how these may differ between locations (similar to how the management plans for different atolls each have different objectives)</li> </ul>
Improved communication and data sharing	<ul style="list-style-type: none"> <li>Consideration of coral reef knowledge needs in RMI EPA decisions relating to development assessment and permitting (e.g. preliminary environmental assessment, earthmoving permits etc.), and noting that EPA does not have capacity to conduct compliance monitoring at the outer islands</li> <li>For outer islands where management decisions are made locally, there is a need to reduce the turn-around time between monitoring and report the results to communities, noting face-to-face updates are financially constrained (are</li> </ul>



Theme	National context
	<p>there opportunities to leverage transport activities of other non-environmental agencies?)</p> <ul style="list-style-type: none"> <li>• Establishment of an inter-island network between atolls for trained community participants</li> <li>• Support sharing of learning and cross-pollination of ideas between regional/Micronesian practitioners (i.e. combining data across multiple countries/programmes could yield more insights), which could be achieved through a regional learning platform or an online community of practice for those on the ground to support each other</li> </ul>

### 3.7 Fiji

Given the number of parties involved in coral reef monitoring in Fiji, a key focus going forward is the need to continue working towards streamlining these significant efforts in a coordinated manner to better inform and address national coral reef priorities. There have been significant gains in recent years including, for example:

- Fiji is working towards developing a National Coral Reef Action Plan(s) to support coral reef conservation
- Expedited collaboration through regional resilience initiatives (e.g. Great Barrier Reef Foundation and partners hosting Pacific Coral Reef Action Accelerator Program workshop(s) in Fiji; the Drawaqa Marine Conservation Trust as a Pacific Reef Resilience Hub; WCS as the Fiji's lead for WWF's Coral Reef Rescue Initiative). The focus of these collaborative efforts has been intervention actions to enhance the resilience of coral reefs and their communities. Regardless, they provide momentum in Fiji's national networking and community of practice collaboration, which can be leveraged to also work towards streamlined and coordinated monitoring of coral reefs across Fiji.

The development of the National Coral Reef Action Plan provides a platform by which some of the concerns about monitoring that were raised by stakeholders can be explored and addressed. Most notably, reviewing the adequacy of current monitoring approaches for:

- Establishing standardised monitoring protocols (e.g. national monitoring guidelines) to improve consistency across sites and programs.
- Tracking trends and changes in the community composition of coral communities, noting that ecological phase shifts have been documented in response to mass bleaching events (i.e. differing responses between coral genera, such as pioneer species initiating the process of reef recovery and ecological succession after major events). This is a different approach to methods that track only coral cover, with the resultant information helpful to understand reef recovery and stress/resilience, which can be then inform management decisions.
- Monitoring coral reefs in a future climate, particularly in the context of future marine heat waves, increasing sea temperature, extreme weather events and ocean acidification. As well as understanding climate change effects to reefs and ensuring monitoring methods are resilient in a changing climate, this is also relevant in the context of future-proofing restoration, adaptation and conservation initiatives.
- Monitoring, and potentially forecasting, COTS outbreaks in a manner sufficiently timely to inform decisions about early intervention responses.



Increasing collaboration between agencies/practitioners, coupled with improved data sharing frameworks, was also identified as a need to help ensure that monitoring informs adaptive management more effectively. Likewise, continued support to integrate local knowledge with scientific input remains key to sustaining Fiji's reef ecosystems under increasing anthropogenic and climatic pressure. On the scientific aspects there is a desire for greater funding to support internal training, scientific research, and technical capacity. For community aspects, continued investment in Locally Managed Marine Areas (LMMAs) and simplified monitoring tools that are aligned with the Fiji's LMMA network could help scale up community engagement and enhance resilience.

Embracing technology was not specifically identified as a key need by Fijian representatives at this time. In part, this is likely attributed to a relatively high number of experts who are up to date with technology options and/or the present national focus being on more strategic coral reef matters.

**Table 3.7 Key needs for Fiji**

Theme	National context
Improved funding	<ul style="list-style-type: none"> <li>• Ensure continued funding to realise development of National Coral Reef Action Plan (including actions specific to reef monitoring)</li> <li>• Desire to increase the funding needed to support technical training and ensure adequate local expertise continues, specifically regarding the scientific aspects of reef monitoring (e.g. monitoring design, data acquisition, data analysis, reporting)</li> <li>• Continued investment in Fiji's LMMA network and simplified monitoring tools to foster growth in community engagement</li> </ul>
Training investment	<ul style="list-style-type: none"> <li>• Desire to increase the funding needed to support technical training and ensure adequate local expertise continues, specifically regarding the scientific aspects of reef monitoring (e.g. monitoring design, data acquisition, data analysis, reporting)</li> <li>• Training of communities as a component of growing LMMA network and community involvement in reef monitoring</li> </ul>
Enhanced collaboration	<ul style="list-style-type: none"> <li>• Maintain recent momentum in national collaboration around strategic coral reef initiatives, and leverage these to addresses reef monitoring</li> <li>• Streamline monitoring efforts across multiple monitoring parties, such that monitoring is more coordinated across Fiji</li> <li>• Continue working towards developing a National Coral Reef Action Plan to facilitate and guide the above, and collaboration between monitoring practitioners and decision makers</li> </ul>
Improved communications and data sharing	<ul style="list-style-type: none"> <li>• Given the number of parties involved in coral reef monitoring in Fiji, an improved data sharing framework/tool will be highly beneficial in facilitating coordinated sharing of knowledge and learnings (including sharing monitoring outcomes with various decision makers and in the context of adaptive management)</li> <li>• Continue working towards developing a National Coral Reef Action Plan to facilitate and guide the above</li> </ul>
Monitoring guidelines	<ul style="list-style-type: none"> <li>• Continue working towards developing a National Coral Reef Action Plan to support coral reef conservation</li> <li>• Streamline existing monitoring efforts in a coordinated manner to better inform and address national coral reef priorities</li> </ul>



Theme	National context
	<ul style="list-style-type: none"> <li>Review the adequacy of current monitoring approaches (in the context of informing reef management) and develop standardised monitoring guidelines that address key gaps</li> <li>Ensure future monitoring is 'climate-smart'</li> <li>Ensure continued integration of traditional and scientific knowledge</li> </ul>

### 3.8 Samoa

Samoa's strong village governance system, legal frameworks, and regional participation (e.g. SPREP, ICRI) provide a solid foundation for adaptive reef management. However, improved integration of ecological monitoring into coastal planning, greater methodological standardisation, and targeted climate resilience initiatives are necessary to support long-term reef sustainability.

In recognition of these pressing needs, Samoa has already commenced the process of designing an integrated national coral reef monitoring programme. This programme has been developed as part of the ReefCloud project piloted in Samoa with AIMS, SPREP and CI (from 2021 to 2023). Development of the draft national monitoring programme was one of the key deliverables of this project (where MNRE and MAF were involved). It is intended to standardise data collection for inter-operability of reporting outputs across the various local monitoring efforts. This will ease comparisons of monitoring results and trends between the initiatives of different monitoring organisations (e.g. MAF, MNRE) to better understand the status and trends of Samoa's coral reefs and reef fisheries. It will also support the Samoa Ocean Strategy by better facilitating the sharing of reliable and up-to-date data on the status of coral reefs, and be used to inform the management of Samoa's coral reefs and associated fisheries.

In the interim, Samoa will continue to rely on the support of NGOs and international organisations to support coral reef monitoring and management through training, financial contributions, and the provision of skilled personnel to enhance local capacity and effectiveness during monitoring operations. Going forward, it was indicated that investment in human, financial and technical resources is required to realise the country's aspirations for improving national coral reef monitoring. Specifically, there has been significant training on ReefCloud in recent times (led by Ministry of Agriculture and Fisheries, and Ministry of Natural Resources and Environment), and ongoing opportunities to embed the application of ReefCloud are required to maximise the full potential of ReefCloud in data analysis and information sharing.

Table 3.8 Key needs for Samoa

Theme	National context
Improved funding	<ul style="list-style-type: none"> <li>Secure and upscale funding sourced locally and internationally to support training needs and skilled labour to conduct monitoring ( as well as hardware/equipment needs for monitoring and data analysis)</li> <li>Mainstream annual government budget allocation to support the implementation of the national coral reef monitoring plan</li> </ul>
Embracing technology	<ul style="list-style-type: none"> <li>Opportunities to continue solidify the uptake of ReefCloud and embed its application across relevant stages of reef monitoring</li> </ul>
Training investment	<ul style="list-style-type: none"> <li>Opportunities to continue solidify the uptake of ReefCloud and embed its application across relevant stages of reef monitoring</li> <li>Training needs as set out in the national coral monitoring plan (when complete)</li> </ul>

Theme	National context
Enhanced collaboration	<ul style="list-style-type: none"> <li>• Maintain collaborative network in a manner that builds on the momentum of recent national workshops about coral reefs (i.e. workshops pertaining to national coral monitoring plan, ReefCloud, traditional knowledge etc.)</li> <li>• Realise collaboration during integrated monitoring</li> <li>• Enhance collaboration with local communities/villages, including in relation to both access permission to monitoring sites, and to involve community representative directly in reef monitoring process or part thereof</li> </ul>
Improved communications and data sharing	<ul style="list-style-type: none"> <li>• Commence planning for implementation of the national coral reef monitoring programme to start to facilitate the sharing of reliable and up-to-date data</li> <li>• Opportunities to continue embed the uptake of ReefCloud to realise its full potential in data analysis and information sharing</li> <li>• Liaison with local communities to ascertain what their needs and expectations are regarding improved communications and data sharing</li> </ul>
Monitoring guidelines	<ul style="list-style-type: none"> <li>• Finalise national coral reef monitoring programme</li> <li>• Commence planning for implementation of the national coral reef monitoring programme intended to standardise and integrate local monitoring efforts</li> </ul>

### 3.9 Solomon Islands

Representatives for the Solomon Islands indicated that regular and ongoing coral reef monitoring is essential, particularly considering perceived declines of coral reef health nationally. Therefore, in a move to strengthen coral reef monitoring in the Solomon Islands, stakeholders are already exploring options for establishing a dedicated marine research institute locally (i.e. through the Solomon Islands National University (SINU)). This is viewed as a valuable long-term investment to:

- Grow and strengthen local capacity
- Train the next generation of local marine scientists and technicians
- Foster improved collaboration between local researchers and decision makers, as well as between local and international researchers, noting stronger partnerships with government, NGOs, and researchers was emphasised as critical for coordinated monitoring and building long-term capacity
- Attract and host international coral experts
- Create a national hub for research and data management.

Such as venture will require both financial and technical support, and the Solomon Islands is actively seeking opportunities and/or partners to secure this support.

Beyond a national research facility, other key needs in the Solomon Islands revolve around awareness, monitoring robustness, data storage, funding and accessing remote reefs. For example, it was recognised that a more robust approach to coral reef monitoring and decision making is required, and that the approach must be practically applicable to both the large area of coral reef habitat and remote locations of many reefs.

While communities play an essential role in reef stewardship, sustained support and training are needed to maintain effective community-based monitoring. Additionally, awareness raising to increase appreciation of the importance of coral reef data will be valuable for fostering engagement by local communities and, at government levels, contribute to securing funding. Reliable and adequate funding was identified as a need to:



- Address limitations in resources and technical capacity (e.g. invest in training, additional monitoring personnel, equipment purchasing and maintenance)
- Enable consistent and long-term monitoring with coverage across a greater geographic area
- Enable monitoring of remote locations and the country’s hundreds of islands.

Data management is another challenge that needs to be addressed. Given monitoring efforts are often fragmented across various agencies and NGOs, data management, storage and sharing is likewise fragmented and decentralised. Similarly, the different actors often use different methods, such that spatial or temporal comparisons for informing reef management decisions can be challenging. Together this means that there is limited integration of coral reef data into broader policy or permitting frameworks. The national government desires a centralised national data depository where all coral reef monitoring and survey data can be stored and managed. This data depository should host monitoring data from all applicable sources (e.g. government and NGO monitoring, researchers, communities) to submitted or uploaded. Critically, the system could be linked to government permitting systems to ensure ease of access to reef information by regulators and other government decision makers.

Regarding training, the following were identified as key training needs:

- Training for communities, noting having more trained community members involved in coral reef monitoring means more consistent monitoring data can be collected and across a greater geographic area
- Technical training for government staff, noting data analysis training was specifically identified
- Training in tools like MERMAID and ReefCloud
- Training in newer marine technologies and methods that are somewhat unfamiliar locally, such as eDNA monitoring, remote sensing and photomosaic technology.

Finally, standardising monitoring protocols and broadening geographic coverage would be beneficial for then implementing an initial national baseline survey, from which ongoing monitoring events can follow. Note that any development of standardised monitoring methods should consider both traditional and emerging technologies/methods (e.g. remote sensing, eDNA), then apply the methods that are most suitable and feasible in the Solomon Islands context.

Table 3.9 Key needs for Solomon Islands

Theme	National context
Improved funding	<ul style="list-style-type: none"> <li>• Identify reliable adequate funding opportunities and/or partners to secure establishment of a national marine research institute, which could provide a centralised hub for new and future programs (e.g. future Coral Reef Rescue work) and facilitate the alignment of international initiatives with the Solomon Islands’ Ocean12 Committee and national ocean policy</li> <li>• Build on current monitoring funding and support for monitoring to better address underrepresented coral reefs (e.g. remote reefs)</li> <li>• Invest in training, additional monitoring personnel (professionals and communities), equipment purchasing and maintenance</li> </ul>



Theme	National context
Embracing technology	<ul style="list-style-type: none"> <li>Investigate emerging technologies for monitoring coral reefs and integrate into future standardised monitoring protocols where appropriate for achieving monitoring objectives</li> </ul>
Training investment	<ul style="list-style-type: none"> <li>Continue exploring options to establish a dedicated marine research institute locally as a focal point for training and capacity building, including training marine scientists and technicians (in both field and data analysis skills)</li> <li>Invest in training and awareness for communities to enhance monitoring capacity across a greater geographic area</li> <li>Conduct training to increase uptake and application of software tools and technologies that support monitoring (e.g. MERMAID, ReefCloud, remote sensing, eDNA, photomosaic technology etc.)</li> </ul>
Enhanced collaboration	<ul style="list-style-type: none"> <li>Continue exploring options to establish a dedicated marine research institute locally to foster enhanced collaboration</li> <li>Foster improved collaboration between local researchers and decision makers, as well as between local and international researchers</li> <li>Foster engagement by local communities</li> </ul>
Improved communications and data sharing	<ul style="list-style-type: none"> <li>Continue exploring options to establish a dedicated marine research institute locally as a hub facilitating communications and data management</li> <li>Investigate options for hosting and implementing a centralised national data management and storage system that can be accessed by both government and non-government monitoring personnel and decision makers (including permitting regulators)</li> </ul>
Monitoring guidelines	<ul style="list-style-type: none"> <li>Work towards commencing regular, coordinated and ongoing coral reef monitoring</li> <li>To facilitate the above, establish standardising monitoring protocols and broaden geographic coverage, noting that the current variation in methods used by multiple organisations/projects limits spatial and temporal insights</li> <li>Develop standardised monitoring methods by considering both traditional and emerging technologies for monitoring coral reefs, and ensuring the approach is practically applicable to both the large area of coral reef habitat and remote locations of many reefs</li> </ul>

### 3.10 Cook Islands

Coral monitoring in the Cook Islands tends to be associated with that for relatively small-scale management interventions such as coral restoration/gardening, and COTS surveillance and eradication. It tends to be linked to short term funding opportunities and implemented by NGOs, the private sector and researchers, in collaboration with the national government.

Future reef management in the Cook Islands would benefit from improved data quality through standardised coral monitoring across a wider geographic area. Given the relatively small number of islands (and reef area) as compared to most other Pacific countries included in this assessment, the Cook Islands lends itself well to the introduction of a nation-wide coral reef monitoring programme. Expanding the frequency and geographic range of monitoring and aligning these efforts with national conservation targets (e.g. under Marae Moana and NES) may help translate monitoring into management more effectively. While there are some challenges regarding the number of trained personnel in-country and costs of accessing the more remote northern islands, such a programme could be scaled to focus more



intensely on the reefs most at risk or need of management (e.g. those in proximity to high use areas), and less intensely on reefs less at risk.

It is envisioned that such a programme could be led by national government, with implementation support from local communities, NGOs and the private sector (e.g. vessel charter and diving/tourism businesses), assuming there is adequate remuneration and/or other means of incentivisation to promote mutually beneficial partnerships. This type of model would build on existing collaboration and relationships, but endeavour to realise a more coordinated monitoring effort while utilising the expertise and enthusiasm available among civil society.

Such a programme, or other efforts to improve coral reef monitoring in the Cook Islands would require dedicated technical, financial, logistical and training support to address existing barriers. For example:

- Increasing the number of personnel/staff trained and available to conduct monitoring, noting that both government and non-government personnel have many commitments outside of coral reef monitoring/management so are presently significantly time-limited
- Logistical support for remote islands and those without suitable support services (e.g. vessel, diving support) to accommodate coral reef monitoring
- Targeted support for monitoring in the northern group islands, including travel subsidies and equipment for remote fieldwork
- Awareness and training in non-diver based monitoring methods, particularly in the context of facilitating monitoring in locations that are challenging to access or unsafe for diving
- Training in coral taxonomy and data analysis
- Increasing the technical integration of tools like CPCe, R, and PRIMER – while already utilised to some extent, further uptake could be supported through regional partnerships.

In the Cook Islands there is an active focus on raising awareness of youth (e.g. school children, university students) about environmental matters, including in relation to the marine environment and coral reef monitoring. This helps to foster a culture of awareness, stewardship and encourage school children to consider tertiary training and careers in environmental fields. Investing in continuing this is a means of contributing to shoring future capacity and capability.

Similarly, there is existing non-government training initiatives and local private investment in coral initiatives (e.g. coral gardening/restoration, training youth and communities), which could be grown with adequate support to complement government initiatives. These are important because greater public awareness and cross-institutional collaboration are recognised as key to strengthening reef stewardship across the Cook Islands.

It is noted that data usage is presently inconsistent, with some datasets shared across sectors and others withheld, such that monitoring results are not yet being used effectively to inform decision-making or guide community action. Increased implementation of data sharing agreements would be beneficial in this regard. While there is presently no centralised data storage relating to coral reef information, any future movement towards centralised national/regional data storage would be encouraged to be accessible to non-government stakeholders, even if only in a read-only functionality. This recognises the active role of civil society, traditional leaders and communities in informing management decisions, such as through their roles on Technical Working Groups or similar, responding to public submissions (including marine developments), and environmental permitting (e.g. National Environment Council).



Table 3.10 Key needs for the Cook Islands

Theme	National context
Improved funding	<ul style="list-style-type: none"> <li>• Source sustainable funding to increase the number of personnel/staff trained and available to conduct monitoring</li> <li>• Dedicate funding to ensure adequate remuneration and/or other means of incentivisation to promote mutually beneficial partnerships</li> <li>• Secure funding to support logistics for monitoring remote islands and monitoring equipment</li> </ul>
Embracing technology	<ul style="list-style-type: none"> <li>• Increase awareness and training in non-diver based monitoring methods, particularly in the context of facilitating monitoring in locations that are challenging to access or unsafe for diving</li> <li>• Support further technical integration of tools like CPCe, R, and PRIMER</li> </ul>
Training investment	<ul style="list-style-type: none"> <li>• Increasing the number of personnel/staff trained and available to conduct monitoring</li> <li>• Training in coral taxonomy and data analysis</li> <li>• Training to support further technical integration of tools like CPCe, R, and PRIMER</li> <li>• Continue to foster a culture of awareness, stewardship and encourage students to consider tertiary training and careers in marine science</li> </ul>
Enhanced collaboration	<ul style="list-style-type: none"> <li>• Ensure adequate remuneration and/or other means of incentivisation to promote mutually beneficial partnerships</li> <li>• Celebrate existing collaboration and relationships, recognising the expertise and enthusiasm among civil society</li> <li>• Support existing non-government initiatives and private investment in coral reefs (e.g. coral gardening interventions and associated monitoring) that complement government initiatives, promote civil stewardship and implement some management interventions</li> </ul>
Improved communications and data sharing	<ul style="list-style-type: none"> <li>• Implement data sharing agreements between government and non-government actors</li> <li>• Consider moving towards centralised national/regional data storage, if accessible to non-government stakeholders (at least for read-only functionality)</li> </ul>
Monitoring guidelines	<ul style="list-style-type: none"> <li>• Work towards introducing a nation-wide coral reef monitoring programme to improve data quality through standardised coral monitoring across a wider geographic area</li> <li>• Expand the frequency monitoring (as well as spatial coverage)</li> <li>• Align coral reef monitoring efforts with national conservation targets</li> </ul>

### 3.11 Federated States of Micronesia

Continued support of the Micronesia Coral Reef Monitoring (MCRM) initiative was highlighted as key to ongoing coordination and collaboration regarding coral reef monitoring in the Federated States of Micronesia (FSM). This programme operates across states, with state resource departments, local NGOs (e.g. Conservation Society of Pohnpei, Chuuk Conservation Society) and community organisations



playing important roles. It also includes an online database that hosts reef monitoring data, with findings being used to define local coral reef management decisions.

This proven national platform provides a sounds basis for ongoing improvements in coral reef monitoring, noting there is a desire to:

- Expand geographic coverage of monitoring by increasing the number of monitoring sites, with particular emphasis on monitoring remote, underrepresented islands (e.g. remote islands of Yap State)
- Adopt advanced technologies via onboarding of progressive personnel and enhancing cross-institutional collaboration.

A need for funding continuity was also identified as a priority to support:

- Holistic monitoring that meets its objectives, including inclusion of monitoring to evaluate success or otherwise of reef management interventions
- Ongoing technical training of monitoring personnel, particularly skilled data analyst and divers, to help facilitate more regular monitoring (and seeking regional/international trainers when needed)
- Ensure sufficient personnel (i.e. increased staff numbers) are available to implement monitoring, including for data acquisition, data analysis and reports, and maintenance of MCRM online database
- Procurement and maintenance of equipment needed for monitoring.

Separately, effective collaboration and communication of monitoring outcomes should continue to be promoted to ensure decision makers are accessing shared data platforms for evidence-based management decisions. Likewise, ongoing leverage FSM's strong tradition of local stewardship will remain important for future coral reef monitoring and management.

**Table 3.11 Key needs for the Federated States of Micronesia**

Theme	National context
Improved funding	<ul style="list-style-type: none"> <li>• Investment in ongoing technical training of monitoring personnel, particularly skilled data analyst and divers</li> <li>• Ensure sufficient personnel (i.e. increased staff numbers) are available to implement monitoring</li> <li>• Secure sufficient funding to ensure procurement and maintenance of equipment needed for monitoring</li> </ul>
Embracing technology	<ul style="list-style-type: none"> <li>• Work towards incorporating advanced technologies into the MCRM initiative where appropriate (i.e. build into future evaluation and improvement process for the programme)</li> </ul>
Training investment	<ul style="list-style-type: none"> <li>• Ongoing technical training of monitoring personnel, noting skilled data analysts and divers needed</li> <li>• Training to ensure sufficient personnel (i.e. increased staff numbers) are available to implement monitoring</li> </ul>
Enhanced collaboration	<ul style="list-style-type: none"> <li>• Celebrate and promote cross-institutional collaboration, and identify opportunities to improve collaboration</li> <li>• Provide ongoing support and recognition for local stewardship</li> </ul>



Theme	National context
Improved communications and data sharing	<ul style="list-style-type: none"> <li>Foster ongoing communication of monitoring outcomes to ensure decision makers are accessing shared data platforms for evidence-based management decisions</li> </ul>
Monitoring guidelines	<ul style="list-style-type: none"> <li>Continued support of the Micronesia Coral Reef Monitoring (MCRM) initiative and associated online database</li> <li>Work towards expanding geographic coverage of monitoring by increasing the number of monitoring sites, with particular emphasis on monitoring remote, underrepresented islands</li> <li>Continue to foster holistic monitoring that meets its objectives, including inclusion of monitoring to evaluate success or otherwise of reef management interventions</li> </ul>

### 3.12 Palau

Palau's coral reef monitoring is relatively comprehensive, supported by the Palau International Coral Reef Centre (PICRC) and the Coral Reef Research Foundation (CRRF). It monitors a wide range of reef types using a range of methods and fosters excellent internal and regional collaboration. These exiting monitoring efforts require ongoing support, including technical, financial and human resource/labour support, particularly if the monitoring was to be expanded to address present gaps in the geographic extent of monitoring data. Currently, the ecological monitoring done by PICRC only covers Babeldaob and the southern states of Palau, but does not include the Southwestern states of Hatohebei, Sonsorol etc. due to distance and prohibitive transportation costs (i.e. remote locations). Inclusion of these remote areas, at least occasionally or via remote data acquisition methods, is desirable for a more holistic understanding of reef status and better integration of monitoring findings into management.

The existing monitoring provides a sounds basis for ongoing improvements in coral reef monitoring, noting support would be required in terms of:

- Funding or training to expand geographic coverage, including of remote reefs
- Access to specialist scientific expertise (e.g. advice on new technology or hardware that could be incorporated)
- Supporting investment in training local personnel in the application of tools such as QGIS, ReefCloud and CPCe software
- Access to hydrodynamic/ecological modelling expertise to better understand recruitment of corals (e.g. source reef locations), and access to coral expertise who can provide specialist knowledge about other indicators (e.g. coral disease)
- Bolstering on-island technical capacity
- Improved funding for transportation and equipment.

Together, addressing these needs would support the continuous improvement of Palau's strong reef monitoring framework.



Table 3.12 Key needs for the Palau

Theme	National context
Improved funding	<ul style="list-style-type: none"> <li>• Funding needed to expand geographic coverage, including of remote reefs</li> <li>• Improved funding required for transportation and equipment, especially in relation to remote reefs</li> </ul>
Embracing technology	<ul style="list-style-type: none"> <li>• A need to expand local awareness around newer tools and their applications (e.g. QGIS, ReefCloud, CPCe software, photomosaic technology, eDNA, remote sensing etc.)</li> </ul>
Training investment	<ul style="list-style-type: none"> <li>• Invest in training local personnel in the application of tools such as QGIS, ReefCloud and CPCe software</li> <li>• Training with regard to how best to practicably expand geographic coverage, including of remote reefs</li> <li>• Access to specialist scientific expertise to train local experts about new tools</li> </ul>
Enhanced collaboration	<ul style="list-style-type: none"> <li>• Celebrate excellent existing collaboration</li> <li>• Access desired to hydrodynamic/ecological modelling expertise to better understand recruitment of corals indicators such as coral disease, which would help with informing management decisions</li> </ul>
Improved communications and data sharing	<ul style="list-style-type: none"> <li>• Excellent local communication, though could be improved for remote locations</li> <li>• A desire to more external experts for continuous upskilling of local personnel and to enable sharing of lessons learned from outside Palau</li> </ul>
Monitoring guidelines	<ul style="list-style-type: none"> <li>• Expand monitoring to better remote reefs, including the Southwestern states of Hatohebei, Sonsorol etc.</li> <li>• Inclusion of above remote areas, at least occasionally or via remote data acquisition methods</li> </ul>



## 4 Summary of Findings and Priority Recommendations

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### 4.1 Context and Key Challenges

Approaches to coral reef monitoring vary between the Pacific countries included in this assessment and each country is at a different stage in the maturity and evolution of its reef monitoring. While some of the countries have established national coral reef monitoring programmes (e.g. Tonga, Palau, RMI, FSM) and others have made significant recent advances towards coordinated and standardised monitoring (e.g. Samoa, Vanuatu), others have yet to progress to this stage or lack sufficient oversight of monitoring efforts to ensure monitoring data is adequate and available to support reef management decision makers. All the countries face varying degrees of challenges to improving coral reef monitoring to support reef management and conservation.

Current reef monitoring programs are not always designed to suit management needs in terms of direct coral reef conservation and management (i.e. can focus more on fisheries, rather fisheries habitat). The effectiveness of linkages from monitoring to informing management and decision making is also variable between countries, with linkages to inform management decisions most effective where strong communication and collaborative relationships exist between decision makers and those conducting the monitoring.

There are also challenges in scaling up monitoring and addressing emerging needs or interests, which often are based on larger spatial scales. Overall, the current landscape reveals significant systemic challenges in coordinated coral reef monitoring and communication of monitoring results across the region. Many countries lack the technical capacity to effectively manage, analyse, and report on environmental data, or monitoring results fail to be available to decision makers in a timely manner. These, together with governance constraints, limit the ability of coral reef monitoring to be used for informing reef management decisions.

Even when data is available, it is not being leveraged to its full potential for informed decision-making. This underutilisation is compounded by fragmented efforts, where limited coordination exists between government agencies and different monitoring groups/organisations. This disconnection hinders the development of cohesive strategies and reduces the overall impact of monitoring initiatives.

Further, many countries continue to operate in national silos, with little visibility of activities occurring in neighbouring jurisdictions. This isolation underscores the need for stronger cooperation and coordination at both regional levels. Establishing consistent standards and increasing the frequency of monitoring at a national level should be prioritised where practicable to ensure data comparability and reliability. Addressing these challenges through improved collaboration, capacity building, and standardised approaches will be critical to strengthening coral reef monitoring and supporting informed reef management across the Pacific.

Likewise, stronger regional coordination (including through SPREP and other regional actors) could play a pivotal role in aligning government efforts and fostering collaboration. There is also a pressing need to bridge the gap between academic training and professional practice. Early-career professionals often lack structured pathways for mentorship and applied experience, resulting in a loss of valuable capacity within the region. Targeted programs that focus on closing this loop, retaining skills, and embedding expertise within Pacific communities are essential to ensure sustainable capacity building and long-term resilience.



For countries where coral management is predominantly under the jurisdiction of local communities, there is also a need for improved two-way communication between communities and national government, i.e. ensuring monitoring outputs to filter to the right levels for supporting both communities and national commitments. Such communications need to be in a useful and functional format for the target audience. For example, while interactive online dashboards are increasingly common, some communities/managers may prefer information to be shared via workshops or community meetings, especially if this format can provide the value add of also building capacity at the same time.

In brief, Pacific nations confront a variety of geographical, technical, and institutional challenges in their efforts to monitor coral reefs. These include, among others:

- Limited access to dedicated and specialist scientific and technical expertise in-country to effectively manage, analyse, and report on environmental data, noting the importance of ongoing training, mentoring and retention
- The need for enhanced collaboration with external experts and neighbouring countries
- Insufficient awareness, training opportunities and resources for local practitioners
- Gaps in monitoring spatial coverage, either for remote or inaccessible coral reefs or where improved resolution is desirable at specific target locations (e.g. high risk reefs)
- Fragmented data sharing and communication between practitioners, agencies and regional networks, limiting the ability to leverage monitoring to its full potential for informed decision-making
- Governance structures that can limit influence on community/provincial programmes for adequately supporting national aspirations and commitments (e.g. sometimes monitoring is focused more on informing fisheries management and catch limits, rather than informing habitat management actions and conservation)
- Limitations on the ability of government to be aware of activities led by external (e.g. international) practitioners/organisations, influence the monitoring agenda by such parties and/or enforce data sharing agreements
- Technology is rapidly becoming adopted for image analysis, but less so for field data acquisition (i.e. monitoring surveys are typically SCUBA- or snorkel-based monitoring methods)
- Limited guidance on standardised and coordinated monitoring to guide monitoring that benefits national priorities and conservation/management decisions across various jurisdictional levels

Addressing these challenges requires coordinated approaches that are strategic in addressing national needs, leverage local and international expertise and support, and integrates traditional knowledge with scientific innovation.

## 4.2 Priority Needs and Recommended Actions for each Country

It is unlikely that all key needs for a country can be implemented immediately (i.e. due to limitations in resources etc.). Instead, priority needs and actions must be identified to guide investment in the most impactful actions for building capacity, enhancing collaboration, and advancing monitoring practices across the Pacific countries. Priority needs can be considered from both the perspective of each country, noting priority needs can vary between countries, as well as a from a regional perspective across all countries. Country level priorities are outlined here, while regional priorities are addressed in the following section.

Table 4.1 summarises the priority needs and recommended key actions for each country, based on the assessment findings set out in Chapter 3 but prioritised in terms of factors such as: impact and value add benefit, implementation feasibility, likelihood of success and relative affordability. These needs and actions are those that go above and beyond the status quo, i.e. it is assumed that current initiatives,



collaboration and funding already underway will continue as a minimum going forward. Whilst more impactful and/or urgent, priority needs are not intended to detract from the other key needs set out for each country in Chapter 3. Rather, the other key needs should continue to be considered in parallel where practicable or scheduled for later timeframes.



Table 4.1 Summary of priority needs and actions for each country

Country	Priority Need Themes	Recommended Priority Actions for Each Country
Tonga	Training investment, embracing technology, improve communications	<ul style="list-style-type: none"> <li>Seek regional support to implement training to address safety concerns and increase the number of trained government personnel (i.e. currently limited by staff availability)</li> <li>Explore technology options (hardware and software) to facilitate more time/cost efficient monitoring</li> <li>Operationalise an integrated database and web portal for sharing monitoring outcomes</li> </ul>
Kiribati	Improved communication and collaboration, embracing technology, monitoring guidelines	<ul style="list-style-type: none"> <li>Explore technology options for cost effective monitoring across remote reefs</li> <li>Host regular cross-agency forums or working groups to facilitate improved interagency collaboration and communication in relation to coral reef monitoring and management</li> <li>Establish formal national reef monitoring guidelines that can either be integrated with existing marine conservation initiatives (e.g. marine spatial planning, marine protected areas) or stand alone, and capture methods for Phoenix and Line Island groups (noting most monitoring presently only in Gilbert Islands group).</li> </ul>
Papua New Guinea	Enhanced collaboration, improved communication of data, embracing technology	<ul style="list-style-type: none"> <li>Improve collaboration and data sharing between CEPA and those conducting monitoring at provinces/communities</li> <li>Enhance collaboration between CEPA and NFA to pursue opportunities to leverage NFAs existing fisheries monitoring network (but expanding to facilitate coral reef monitoring and reporting)</li> <li>Raise awareness on the range of technological solutions for increasing monitoring coverage, and promote uptake of best option(s), i.e. ensure not overly reliant one tool</li> </ul>
Vanuatu	Embracing technology, improved funding, monitoring guidelines	<ul style="list-style-type: none"> <li>Leverage existing long-term partnerships with international partners to strengthening in-country capacity, with a view empowering independent and locally led delivery of coral monitoring in the longer term</li> <li>Continue embedding institutional technical learnings from the recent national coral reef survey within national government agency/ies, and leverage these learnings to develop timely alerts to reef managers when there are impacting events requiring management intervention</li> <li>Establish a sustainable funding mechanism, building on existing government business plan for commencing ongoing monitoring at several coral reef sites each year</li> </ul>
Republic of the Marshall Islands	Improved funding, embrace technology, training investment	<ul style="list-style-type: none"> <li>Build on the success of the Reimaanlok Framework and CMAAC collaboration by investing further to expand similar to more atolls and urban areas</li> </ul>

Country	Priority Need Themes	Recommended Priority Actions for Each Country
Fiji	Enhanced collaboration, monitoring guidelines, Improved communications and data sharing	<ul style="list-style-type: none"> <li>• Train, empower and incentivise communities to take on the responsibility of coral reef monitoring</li> <li>• Investigate more cost-effective options for monitoring remotes atolls and reefs, preferably through adopting technological solutions (though noting RMI also investigating options for potentially acquiring a dedicated and sustainably financed national research vessel)</li> </ul>
Samoa	Monitoring guidelines, enhanced collaboration, improved funding	<ul style="list-style-type: none"> <li>• Maintain recent momentum in national collaboration around strategic coral reef initiatives, and leverage these to address and streamline reef monitoring needs for informing management</li> <li>• Continue working towards developing a National Coral Reef Action Plan to facilitate and guide the above, better coordinate monitoring, and address the adequacy of current monitoring approaches (in the context of national reef management priorities)</li> <li>• Establish a data sharing framework/tool (via national or regional host) to better coordinated the sharing of data, knowledge and learnings</li> </ul>
Solomon Islands	Improved funding, training investment, monitoring guidelines	<ul style="list-style-type: none"> <li>• Finalise the National Coral Reef Monitoring Plan in preparation, which is intended to standardise and integrate local monitoring efforts, then commence implementation of the plan</li> <li>• Maintain and build on recent collaborative efforts about strategic matters for coral reefs, and enhance collaboration with local communities/villages (e.g. access permission, training, community data needs and expectations)</li> <li>• Mainstream and upscale ongoing funding allocation to support the implementation of national coral reef monitoring, including supporting training, equipment, software and data management etc.</li> </ul>
Cook Islands	Monitoring guidelines, improved funding, training investment	<ul style="list-style-type: none"> <li>• Identify reliable adequate funding opportunities and/or partners to secure establishment of a national marine research institute focusing on coral reefs, and as a hub for technical training, technology, communication, collaboration, and data management in collaboration with national government</li> <li>• Develop standardised monitoring methods by considering both traditional and emerging technologies, and ensuring the approach is practically applicable to both the large area of coral reef habitat and remote locations</li> <li>• Invest in training and awareness for communities to foster community engagement, build skills and enhance monitoring capacity across a greater geographic area</li> </ul>



Country	Priority Need Themes	Recommended Priority Actions for Each Country
Federated States of Micronesia	Monitoring guidelines, training investment, embrace technology	<ul style="list-style-type: none"> <li>• Source funding to increase the number of personnel/staff trained and available to conduct monitoring and analyses (in either government or non-government organisations) and/or ensure adequate remuneration for attracting monitoring partners (e.g. NGOs, consultants)</li> <li>• Secure funding to support logistics for monitoring remote islands and monitoring equipment</li> </ul>
Palau	Monitoring guidelines, embrace technology, improved funding	<ul style="list-style-type: none"> <li>• Work towards expanding geographic coverage of the Micronesia Coral Reef Monitoring (MCRM) initiative by increasing the number of monitoring sites, with particular emphasis on remote or underrepresented islands</li> <li>• Training to ensure sufficient personnel (i.e. increased staff numbers) are available to implement monitoring, noting skilled data analysts and are divers needed</li> <li>• Work towards incorporating advanced technologies into the MCRM initiative where appropriate (i.e. build into future evaluation and improvement process for the programme)</li> </ul>
		<ul style="list-style-type: none"> <li>• Expand monitoring to better include remote reefs, including the Southwestern states of Hatohobei, Sonoroi etc., at least occasionally or via remote data acquisition methods</li> <li>• Increase local awareness and training around newer tools and their applications (e.g. QGIS, ReefCloud, CPCE software, photomosaic technology, eDNA, remote sensing etc.)</li> <li>• Secure funding to invest in training around technological monitoring options and to expand geographic coverage of monitoring</li> </ul>

### 4.3 Regional Priorities for Supporting Improved Coral Reef Monitoring

In addition to a country-specific view of priority needs, it is useful to also consider needs in terms of regional priorities. Specifically, priority actions necessary to strengthen coral reef monitoring in the Pacific by addressing common themes that would benefit from regional support from SPREP and/or other regional CROP agencies or organisations. Further, a regional approach to addressing needs can, where appropriate, add value in terms of more cost-effective and far-reaching implementation; support facilitating access to experts, partners and funding; and enhanced regional alignment and collaboration for resilient reef futures across the Pacific.

Across the 11 Pacific countries assessed, several key needs repeatedly emerged across the various need themes and are crucial for the region's success:

#### *Training investment*

- Technical and scientific training to upskill and build institutional capacity:- there is a pressing need for workshops, mentorships, and exchange programmes focused on equipping local experts with skills in new monitoring tools and analytical techniques, and to increase the number of personnel with these skills.
- Training and upskilling for communities and implementing partners:- where coral reef monitoring is primarily conducted by communities and/or NGOs (e.g. Cook Islands, Fiji, RMI, PNG, Solomon Islands), the backbone of sustainable monitoring is well-trained and engaged on-ground partners, such that training of monitoring partners is required to realise the vision of expanding the spatial or temporal coverage of monitoring efforts. This highlights the importance then of key programs such as the ReefCloud ToT programme which focuses on training local CSOs and NGOs and providing adequate tools and resources.

#### *Enhanced collaboration*

- National collaboration:- celebrating and enhancing existing collaborative networks in-country is vital for fostering engagement of project implementation partners, fostering cross-agency dialogue in countries where this needs strengthening (e.g. Fiji, Kiribati, PNG), improving coordination of monitoring to better streamline effort, ensuring monitoring is designed to suit management needs, and that monitoring findings are effectively used by reef managers to inform decisions.
- Regional knowledge exchange:- sharing knowledge across the Pacific region through a dedicated community of practice will foster engagement, facilitate the sharing of lessons learned between countries, bring in fresh perspectives and expertise, and enable countries to work collaborate on aligning in-country effort with regional needs.
- International collaboration:- while the long-term goal is for all Pacific countries to be fully empowered and independent to conduct effective coral reef monitoring that is locally led, there is a role for continuing to ally with international partners to: provide ongoing upskilling and awareness as best practice and technologies evolve globally; identify and secure financial and in-kind support, enable two-way dialogue for the betterment of coral reef conservation and management globally.

#### *Improved communication and data sharing*

- Improving communication and sharing of monitoring results:- is critical if monitoring is to be effectively used to inform reef conservation and management decisions. While information sharing is strong in some countries (e.g. RMI, Tonga, Vanuatu, FSM, Palau), it is limited in others. With the exceptions of FSM and Palau, digital transformation for data sharing is long overdue (refer below). Enhanced collaboration will also contribute to improving communication and knowledge sharing.



- Digital transformation of knowledge and data sharing:- improved communication infrastructure and integrated data-sharing platform(s) are needed to foster information/data flow and transparency for reef management. Open data sharing is preferable, in a manner that is secure, accessible for key stakeholders, enables interoperable repositories, and is fit-for-purpose. There are options to host data sharing either locally and/or regionally, depending on country preferences (including maintenance etc.). Increase agency and custodianship where monitoring data, is held by external/internal organisations (e.g. formalise data sharing agreements and data transfer mechanisms).

#### *Development of monitoring guidelines:*

- Expansion of guidelines and/or monitoring effort for countries with guidelines in place: - several countries have monitoring guidelines already in place, either formally or informally (i.e. Tonga, Kiribati, RMI, FSM, Palau). For these countries there is a need to build on this proven success to expand monitoring effort to also include underrepresented locations. The underrepresented locations are typically locations that are geographically remote or otherwise challenging in terms of physical access and operations (e.g. cost-prohibitive). As such, there is a need to reassess monitoring protocols to determine if alternative methods and technologies (i.e. not relying on SCUBA or snorkel) can be applied appropriately to fill monitoring gaps. Programs targeted at providing an overview of designing monitoring programs and conducting assessments such as Reefresilliance.org are also key in expanding monitoring efforts to underrepresented locations. This guidance is provided for developing routine, responsive, and participatory monitoring programs as well as assessing and monitoring reef resilience and socio-economic conditions.
- Development of guidelines for countries without these in place: - some countries (i.e. Samoa, Vanuatu) have made significant progress in recent years to start to develop protocols for national coral reef monitoring. In these instances, finalisation and implementation of protocols for national coral reef monitoring will signify a step-change towards a sound foundation for ongoing monitoring that is coordinated and linked to agency decision makers. The remaining countries (PNG, Fiji, Solomon Islands, Cook Islands) would strongly benefit from developing national monitoring guidelines. Even if the intent is that monitoring is primarily implemented by communities, NGOs or other thirds parties, national guidelines set expectations and responsibilities for better ensuring on-ground effort meets national needs and commitments. Such guidelines could be stand-alone, or be embedded within a national reef management strategy, such as a National Coral Reef Action Plan that, among other management actions, sets out the objectives and aims of reef monitoring.

Note: As an alternative to the above, a single set of coral reef monitoring guidelines could be developed for the Pacific region, so long as there is in-built flexibility for countries to choose which component of the guidelines they choose to adopt for meeting their management needs and objectives, local governance structure and monitoring approach. National implementation plans could then be developed, based on applying selected guidelines for each country to suit their management needs.

#### *Embracing technology:*

- Leverage technological innovations: - coral reef monitoring data acquisition methods across all 11 countries typically rely heavily (exclusively in many instances) on traditional manual surveys relying on SCUBA- or snorkel-based labour on site. While these methods remain appropriate in many instances, they also have many limitations (e.g. labour intensive, can only cover small site areas, limited by time underwater, limited by weather and access, logistics can be costly, potential visual biases etc.). There is a need to raise awareness of the alternative technological tools available and their potential applications in coral reef monitoring. These tools include both hardware and software, and, following better awareness and exposure, should be considered as options for complementing existing methods as appropriate to address data gaps and introduce efficiencies. There is an



opportunity for this to be done cost-effectively in a whole of Pacific manner, with different countries being able to access information that is relevant to them.

- Training to expedite uptake of technological tools:- following awareness and the identification of preferred technological tools to complement monitoring, there will be a need for targeted training and support to facilitate their uptake and application. For software in particular, it is important to understand that there are a range of of-the-shelf tools/brands for each use case (e.g. automated image annotation, map visualisation, remote sensing etc.), each with advantages and disadvantages, and that countries need not be bound to a particular brand. Rather, training should be delivered in a manner that ensures acquired skills are transferrable across brands (for example, in case a product becomes unavailable, unsupported, or discontinued) to maintain robustness of capacity and continuity of reliable monitoring data.

#### *Improved funding*

- Support for budget security and cost-efficiencies:- funding is a cross-cutting theme that affects almost all other priority needs and actions. In recognising that Pacific countries have multiple funding needs across many other environmental and non-environmental priorities, it acknowledged that budgets constraints will remain an ongoing challenge. Still, there are options to provide support for those working to improve coral reef monitoring, such as identifying cost-efficiencies (e.g. technological solutions, streamlining solutions regionally where appropriate), providing guidance for preparing business cases and grant application, and facilitating introductions with prospective financial and/or in-kind donors.

For most of these common themes, there are opportunities for regionally coordinated action and strategic support. These are typically matters that would benefit from regional expertise, would be more cost-efficient to implement at a regional scale and/or provide an avenue for value-add benefits to the region. The main exception is training/upskilling of local communities, NGOs or other local implementing partners, which should remain driven by the national level. Priority actions that are recommended for regionally led implementation or support are listed below in Table 4.2, along with prioritisation (low, medium, high) and an indicative timeframe for implementation (from present day). It is assumed that SPREP would be the focal point responsible for leading and coordinating regional actions as the CROP Agency charged with supporting implementation of the Pacific Coral Reef Action Plan 2021-2030.

Note that these recommended regional actions are in alignment with delivering tasks set out under action areas in the Pacific Coral Reef Action Plan 2021-2030, namely:

- Action Area 1: Optimise Capacity Building
- Action Area 4: Streamline Regional and Local Collaboration
- Action Area 8: Utilise Research and Monitoring

All recommended priority actions, both at the regional and country levels, should consider opportunities to incorporate traditional knowledge and practices to complement scientific approaches, foster reef stewardship, and align with the following from the Pacific Coral Reef Action Plan 2021-2030:

- Action Area 2: Foster Traditional Knowledge and Practices.

Finally, in addition to focusing only on monitoring gaps and improvement needs, it is recommended that there also be region-wide recognition that celebrates where monitoring is being done well and is addressing the needs of decision makers. A focus on positive recognition sustains and grows engagement, which is essential to successfully addressing all priority needs. This could take the form, for example, of developing a range of case studies that have the value add of support knowledge building



and implementation in other areas. Case studies could include the way in which data are collected and managed, the ways results are used to inform management and stakeholders, and how the results have helped to inform and achieve outcomes. For exceptional examples and role models, it is also worth considering nominating monitoring programs and/or personnel for environmental awards.

#### 4.4 Risks, Constraints, and Assumptions

Expanding or changing coral reef monitoring programs across Pacific Island countries and territories is constrained by a combination of staffing, funding, and logistical challenges. Many programs operate with limited permanent staff and rely on short-term or project-based funding, which can affect continuity, consistency, and long-term planning. Geographic remoteness, dispersed islands, and weather-related access constraints further limit the frequency and spatial coverage of monitoring, often biasing data toward more accessible sites.

A significant risk is the reliance on external NGOs or research organisations for data collection and analysis. While this can provide critical technical expertise, it also introduces vulnerabilities related to funding continuity, staff turnover, and alignment with national priorities. Data ownership, standardisation, and long-term accessibility may be compromised where monitoring is externally driven rather than embedded within national institutions.

The introduction of new or expanded monitoring approaches—such as increased use of remote sensing or environmental DNA (eDNA)—brings additional capability and infrastructure risks. These methods require specialised training, consistent protocols, and, in the case of eDNA, access to laboratory facilities and reliable sample handling and transport systems. Limited in-country laboratory capacity in many Pacific nations increases dependence on overseas facilities, with associated cost, regulatory, and turnaround-time risks. Changes in methodology also risk reducing comparability with existing datasets unless carefully managed through calibration or phased transitions.

Many proposed enhancements implicitly assume stable funding, retention of trained staff, access to technical support, and sufficient institutional capacity to adopt new approaches. If these assumptions are not met, the effectiveness and sustainability of strengthened monitoring programs may be limited. Recognition of risks supports more realistic recommendations, including phased implementation, pilot studies, hybrid monitoring approaches, and targeted investment in local capacity building.



Table 4.2 Regional priorities for supporting improved coral reef monitoring

Theme	Need	Recommended Regional Actions	Prioritisation and Indicative Implementation Timeframe From Now
Improved funding	<ul style="list-style-type: none"> <li>Support for budget security and cost-efficiencies</li> </ul>	<p>Provide support to assist countries with identifying cost-efficiencies, and with mainstreaming and upscaling ongoing funding allocation, including:</p> <ul style="list-style-type: none"> <li>In tandem with actions about embracing technology, raise awareness of cost-efficiencies potentially derived from technological solutions.</li> </ul>	<p><b>High (1-2yrs)</b></p>
		<ul style="list-style-type: none"> <li>Investigate opportunities for potential cost-efficiencies by streamlining monitoring solutions regionally where appropriate. For example, finalise development and conduct roll out to countries of a Pacific Coral Reefs Dashboard through SPREP's Pacific Environment Data Portal.</li> </ul>	<p><b>High (2-5yrs)</b></p>
		<ul style="list-style-type: none"> <li>Providing guidance or training for preparing business cases and writing grant applications.</li> </ul>	<p><b>Low (2-5yrs)</b></p>
		<ul style="list-style-type: none"> <li>Based on global case studies, investigate potential alternative and sustainable financing models and mechanisms, and expose/introduce countries to these. They include, for example, incentivised or regulated levies (e.g. ecotourism fees), public-private-partnerships (PPP), blue bonds, debt-for-nature swaps, reef insurance etc.</li> </ul>	<p><b>Medium (2-5yrs)</b></p>
Embracing technology	<ul style="list-style-type: none"> <li>Leverage technological innovations</li> </ul>	<ul style="list-style-type: none"> <li>Facilitate introductions with prospective financial and/or in-kind donors (e.g. foreign aid, NGOs, philanthropic organisations etc.);</li> </ul>	<p><b>Medium (ongoing)</b></p>
		<p>Provide awareness and training to countries about potential technological monitoring solutions for improved efficiencies and more robust datasets (e.g. covering geographically remote reefs) including:</p> <ul style="list-style-type: none"> <li>Host broad awareness training to raise awareness of the alternative hardware and software tools available (e.g. automated image annotation tools, map visualisation tools, remote sensing, QGIS, ReefCloud, CoralNet, CPCE</li> </ul>	<p><b>High (1-2yrs)</b></p>

Theme	Need	Recommended Regional Actions	Prioritisation and Indicative Implementation Timeframe
	<p><b>Training investment</b></p> <ul style="list-style-type: none"> <li>Technical and scientific training to upskill and build institutional capacity</li> </ul>	<p>software, photomosaic technology, eDNA, BRUVs, ROVs<sup>19</sup>, AUV<sup>20</sup> drop cameras etc.) and their potential applications in coral reef monitoring, including the advantages and disadvantages of each (e.g. costs, efficiencies, scientific bias/limitations, expertise required, transport and logistics, supplier support, maintenance and repairs etc.) and presenting example case studies from where the tools have been used previously for coral reef monitoring.</p> <ul style="list-style-type: none"> <li>Support targeted training to promote and facilitate the uptake of new technological methods that countries decide to trial and/or incorporate directly into their monitoring regime. For example, if selected countries require training in automated image annotation, regional support could be provided in terms of identifying a suitable trainer and assisting to arrange training. Training should be delivered in a manner that ensures acquired technical skills are transferrable across brands to maintain robustness of capacity and continuity of reliable monitoring data long term (i.e. brand loyalty can present a risk to monitoring).</li> </ul> <p>Facilitate technical training for training needs where regional coordination or support is appropriate (e.g. institutional strengthening and/or instances where similar training needs have been identified by multiple countries), and enable career pathways and professional development to retain local expertise, including through:</p> <ul style="list-style-type: none"> <li>Host workshops, mentorships, and/or exchange programmes focused on equipping local experts with skills in new monitoring tools and analytical techniques, and to increase the number of personnel with these skills. For skills relating to 'Embracing Technology' (refer above) this would be beneficial for all countries. Recent ReefCloud workshops for the Pacific provide an example model where similar training has successfully been delivered for one</li> </ul>	<p><b>High (2-5yrs)</b></p> <p><b>High (2-5yrs)</b></p> <p><b>High (2-5yrs)</b></p>

<sup>19</sup> Remotely Operated Vehicle

<sup>20</sup> Autonomous Underwater Vehicle



Theme	Need	Recommended Regional Actions	Prioritisation and Indicative Implementation Timeframe From Now
		<ul style="list-style-type: none"> <li>• Host workshops, mentorships, and/or exchange programmes focused on equipping local government staff and/or implementing partners (e.g. NGOs) with general skills and analytical techniques for coral reef monitoring. This is most pertinent for countries without an existing monitoring programme and/or those wanting to increase the number of personnel with these skills (i.e. identified as a priority need for FSM, Cook Islands, Solomon Islands, Samoa).</li> <li>• As a potential alternative to the above, or to complement the above, consider assisting countries identify postgraduate scholarship opportunities for technical training in related marine science methods (i.e. tertiary professional development opportunities).</li> <li>• Where appropriate (during development of national reef management plans or similar), encourage countries to factor in succession planning for institutional capabilities. For example, encouraging countries to enable sponsor scholarships or internships for aspiring marine science young professionals, followed by work pathways being made available for graduates with relevant skills.</li> </ul>	<p><b>High (2-5yrs)</b></p> <p><b>Low (ongoing)</b></p> <p><b>Medium (ongoing)</b></p>
<b>Enhanced collaboration</b>	<ul style="list-style-type: none"> <li>• Regional knowledge exchange</li> <li>• International collaboration</li> </ul>	<p>Coordinate a regional 'Community of Practice' and encourage mutually beneficial regional, national and international partnerships, including through:</p> <ul style="list-style-type: none"> <li>• Create and host a facility for a Pacific 'Community of Practice' for coral reef monitoring practitioners (e.g. government staff, NGOs, other implementing partners, universities and community representatives conducting monitoring). Communities of Practice act as informal, social learning environments where members can exchange insights, improve their practice, and drive innovation to share knowledge. It will foster engagement, facilitate national and regional collaboration, and give practitioners access to fresh perspectives and expertise via a peer network. A social media group/page or mobile app is most</li> </ul>	<p><b>Medium (1-2yrs)</b></p>

Theme	Need	Recommended Regional Actions	Prioritisation and Indicative Implementation Timeframe
		<p>likely to be the platform format that is most accessible by a diverse range of practitioners, including those in remote locations.</p> <ul style="list-style-type: none"> <li>Identify and facilitate new partnerships with international partners (i.e. introductions between prospective partners and countries) to provide ongoing upskilling and awareness as best practice and technologies evolve globally; identify and secure financial and in-kind support, enable two-way dialogue for the betterment of coral reef conservation and management globally. This could leverage existing global reef networks (e.g. GCRMN<sup>21</sup>, ICRI<sup>22</sup>), multilateral agencies, prospective donors/funds (e.g. Global Fund for Coral Reefs) and NGOs which operate in some parts of the Pacific but not in others (e.g. WCS, TNC, GBRF<sup>23</sup>, WWF, Conservation International, international universities etc.)</li> </ul>	<p><b>Medium (1-2yrs)</b></p>
<p><b>Improved communication and data sharing</b></p>	<ul style="list-style-type: none"> <li>Improving communication and sharing of monitoring results</li> <li>Digital transformation of knowledge and data sharing</li> </ul>	<p>Develop and operationalise a digital data hub for the region that meets country needs for storing, sharing and accessing coral reef monitoring data, specifically noting:</p> <ul style="list-style-type: none"> <li>Existing infrastructure is available via SPREP's Pacific Environmental Data Portal, such that SPREP should continue working towards development (in liaison with countries) and roll-out of a Pacific Coral Reef Dashboard (including training), once there is confidence that the dashboard meets country needs. Consideration should be given to the following: <ul style="list-style-type: none"> <li>Open data sharing is preferable, in a manner that is secure, accessible for key stakeholders, enables interoperable repositories, and is fit-for-purpose.</li> </ul> </li> </ul>	<p><b>High (1-2yrs)</b></p>

<sup>21</sup> Global Coral Reef Monitoring Network

<sup>22</sup> International Coral Reef Initiative

<sup>23</sup> Great Barrier Reef Foundation

Theme	Need	Recommended Regional Actions	Prioritisation and Indicative Implementation Timeframe
		<ul style="list-style-type: none"> <li>- Design should be sufficiently flexible to meet differing needs between countries (i.e. different countries may have different monitoring objectives, data needs and/or methods).</li> <li>- A country-specific dashboard could be tailored to the bespoke needs of each country.</li> <li>- Spatial data views (e.g. via SeaSketch<sup>24</sup> or similar) would likely be useful for informing reef management and conservation decisions (e.g. environmental permitting).</li> </ul>	<p>Prioritisation and Indicative Implementation Timeframe From Now</p>
<p><b>Monitoring guidelines</b></p>	<ul style="list-style-type: none"> <li>• Expansion of guidelines and/or monitoring effort for countries with guidelines in place</li> <li>• Development of guidelines for countries without these in place</li> </ul>	<p>Support the development or expansion of monitoring guidelines as applicable to build on and complement existing monitoring, and ensure monitoring is purpose driven to suit the needs of decision makers, including:</p> <ul style="list-style-type: none"> <li>• For countries with existing formal or informal monitoring guidelines (e.g. <b>Tonga, Kiribati, RMI, FSM, Palau</b>) encourage and provide support to expand monitoring effort/methods to also include underrepresented locations (e.g. remote reefs) by reassessing monitoring protocols to determine if alternative methods and technologies will suffice to fill data gaps.</li> <li>• For countries that have made significant progress in recent years to start to develop protocols for national coral reef monitoring (e.g. <b>Samoa, Vanuatu</b>), offer support to finalise and commence implementation of national coral reef monitoring and/or broader reef management strategy that, among other management actions, sets out the objectives and aims of reef monitoring from the national perspective.</li> <li>• Liaise with countries that have not progressed development of a formal or informal national coral reef monitoring guideline/framework (e.g. <b>PNG, Fiji, Solomon Islands, Cook Islands</b>) to encourage and support development of</li> </ul>	<p>Medium (2-5yrs)</p> <p>High (1-2yrs)</p>

<sup>24</sup> <https://www.seasketch.org/>



Theme	Need	Recommended Regional Actions	Prioritisation and Indicative Implementation Timeframe
		<p>these. Even if monitoring is primarily implemented by communities or other thirds parties, national guidelines set standardised procedures (including for data sharing) for better ensuring on-ground effort meets national needs and commitments. Such guidelines could be stand-alone, or be embedded within a national reef management strategy (e.g. National Coral Reef Action Plan, marine spatial planning, MPA initiatives) that, among other management actions, set out the objectives and aims of reef monitoring from the national perspective.</p> <p>Notes:</p> <ul style="list-style-type: none"> <li>- As an alternative to the above, a single set of coral reef monitoring guidelines could be developed for the Pacific region, so long as there is in-built flexibility for countries to choose which component of the guidelines they choose to adopt for meeting their management needs and objectives, local governance structure and monitoring approach. National implementation plans could then be developed, based on applying selected guidelines for each country to suit their management needs.</li> <li>- Monitoring guidelines for countries with community driven monitoring should consider including guidelines on how to understand and work appropriately with communities, including supporting appropriate monitoring, analysis and decision making.</li> <li>- Monitoring guidelines should consider need and/or feasibility of including monitoring of non-reef metrics (e.g. metocean, human use, socio-economic data etc.) if useful to inform reef management and conservation (e.g. manage impacts or forecast potential future impacts).</li> </ul>	<p><b>High (2-5yrs)</b></p>

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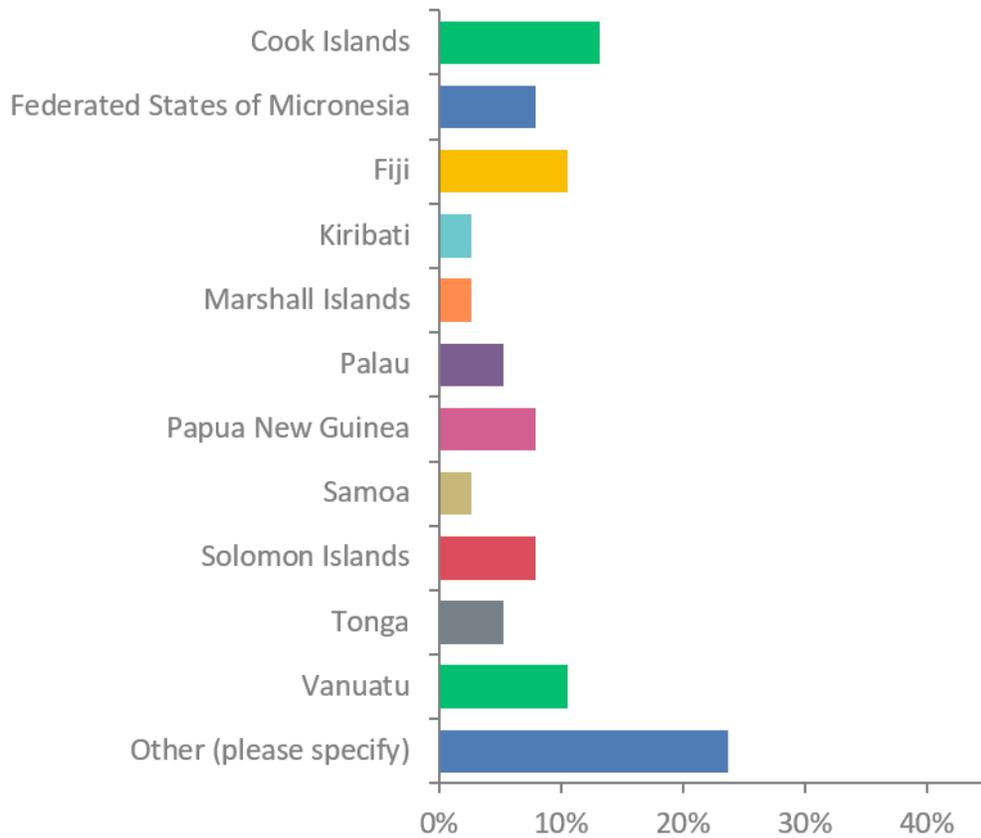
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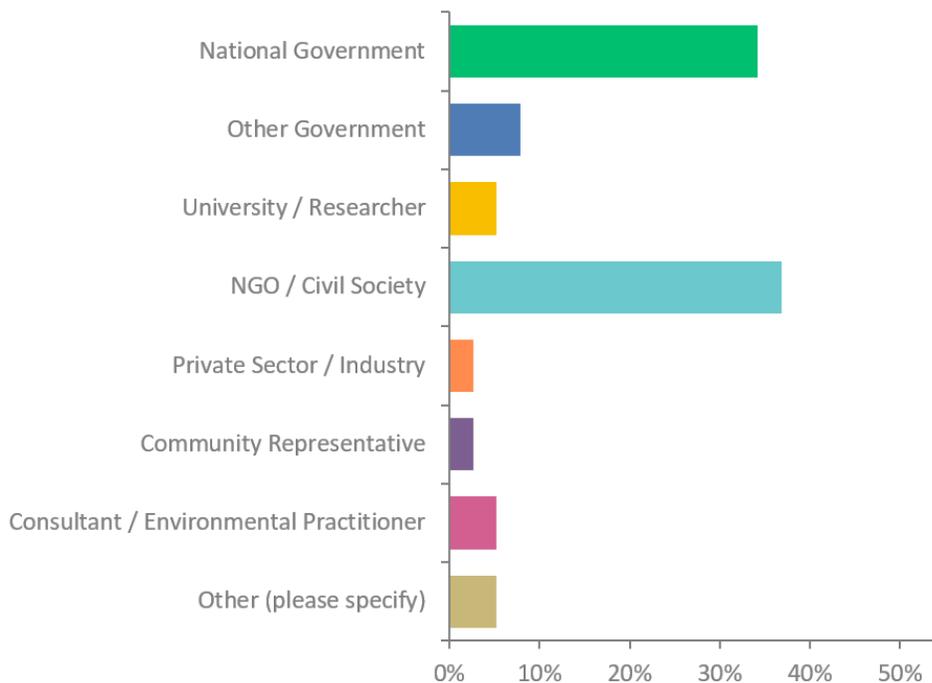
## Annex A Summary of Selected Consultation Survey Responses



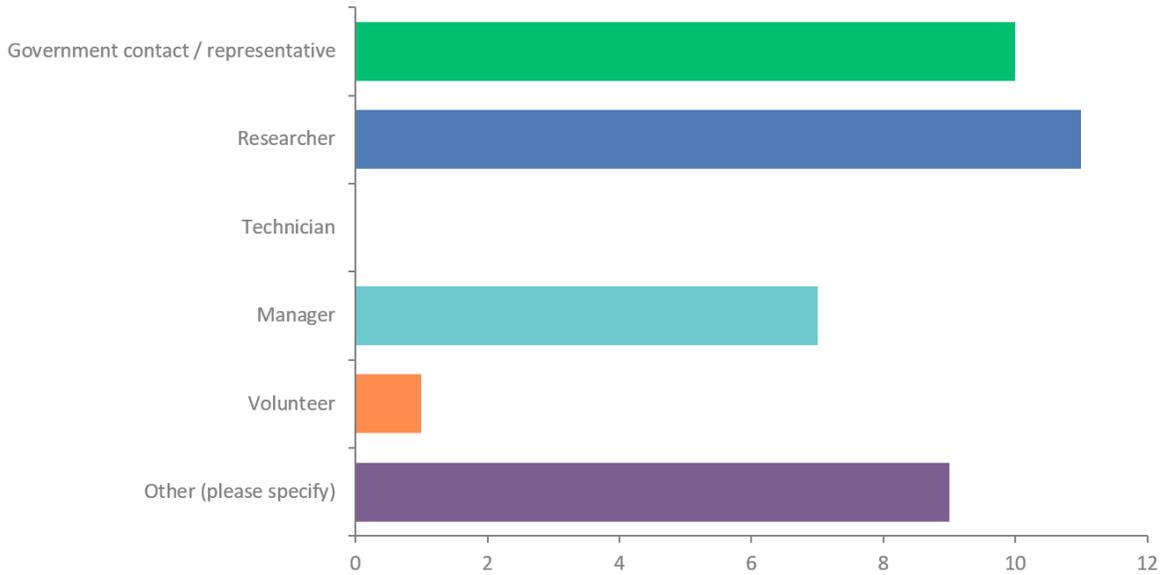
## A.1 Which country are you from?



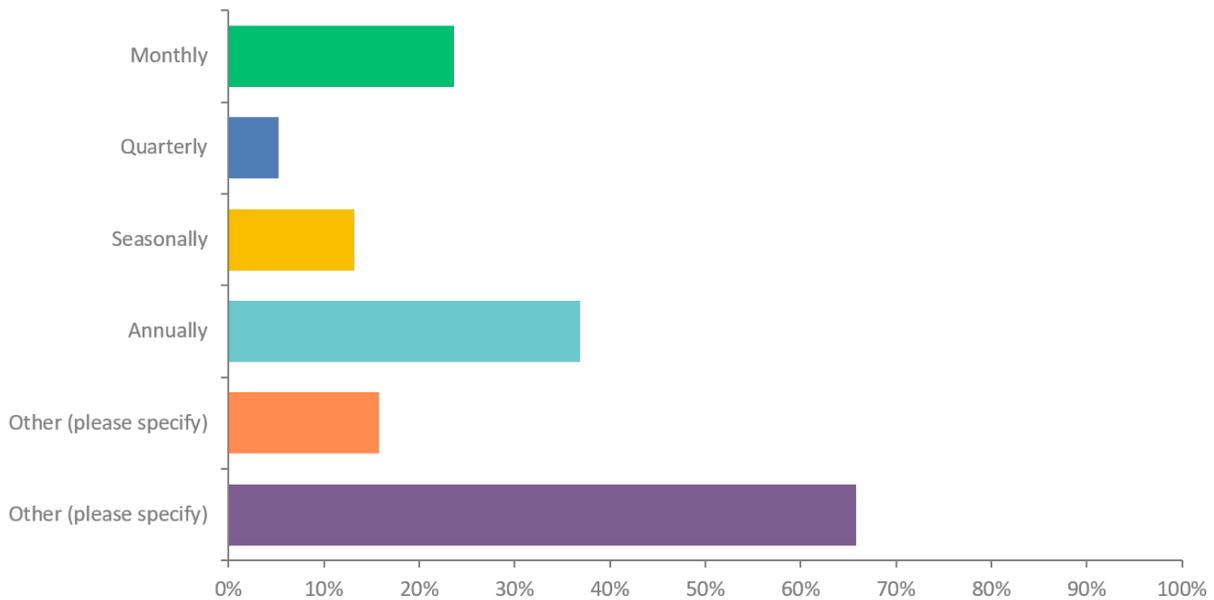
## A.2 What is your affiliation?



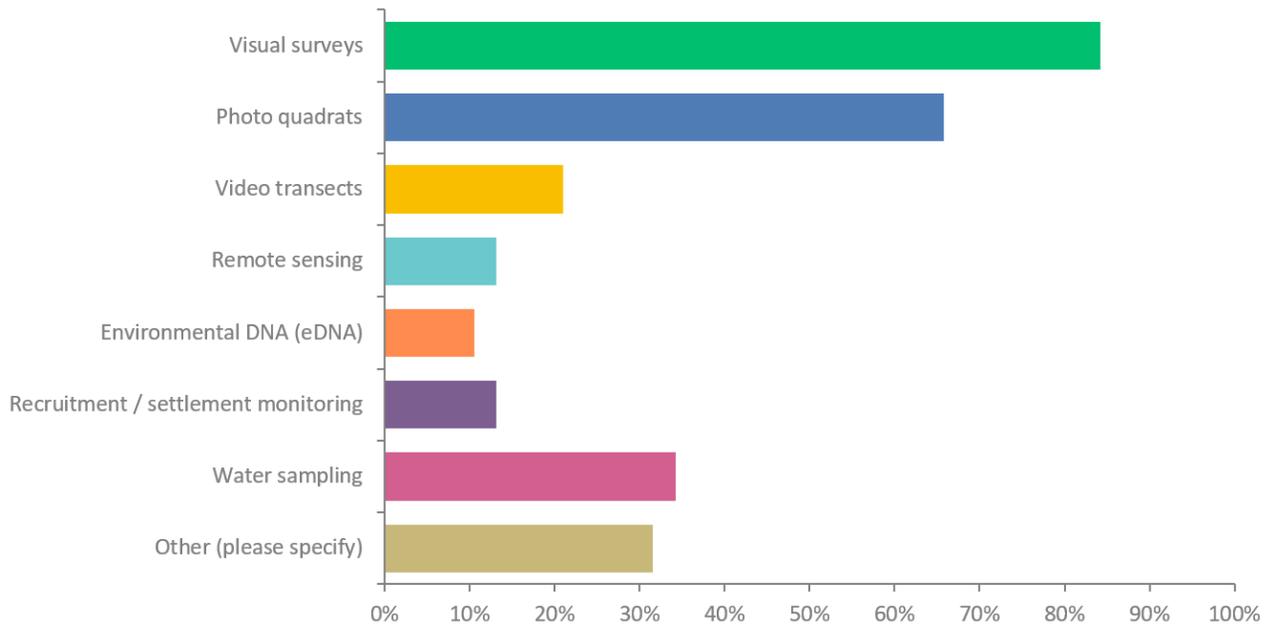
### A.3 What is your role in coral reef monitoring?



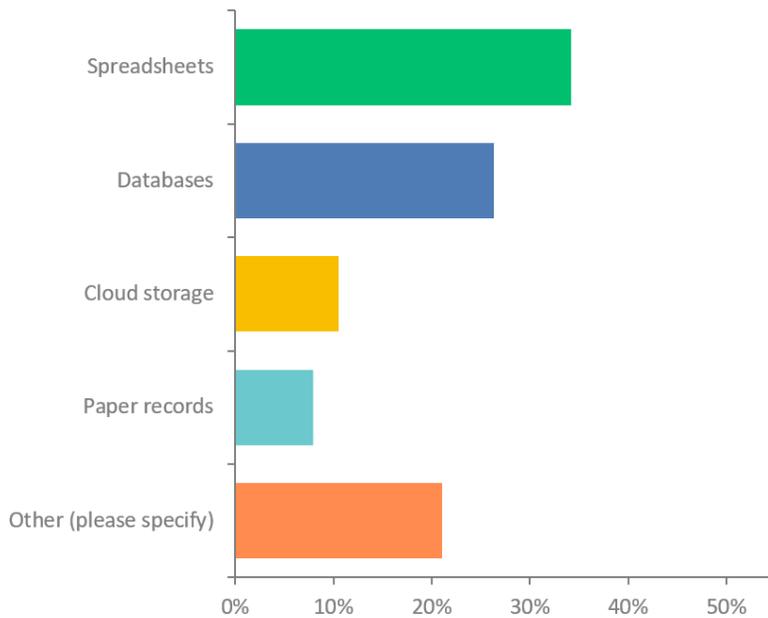
### A.4 For the coral reef monitoring you are aware of, what is the frequency of monitoring (e.g. monthly, yearly, intermittently)?



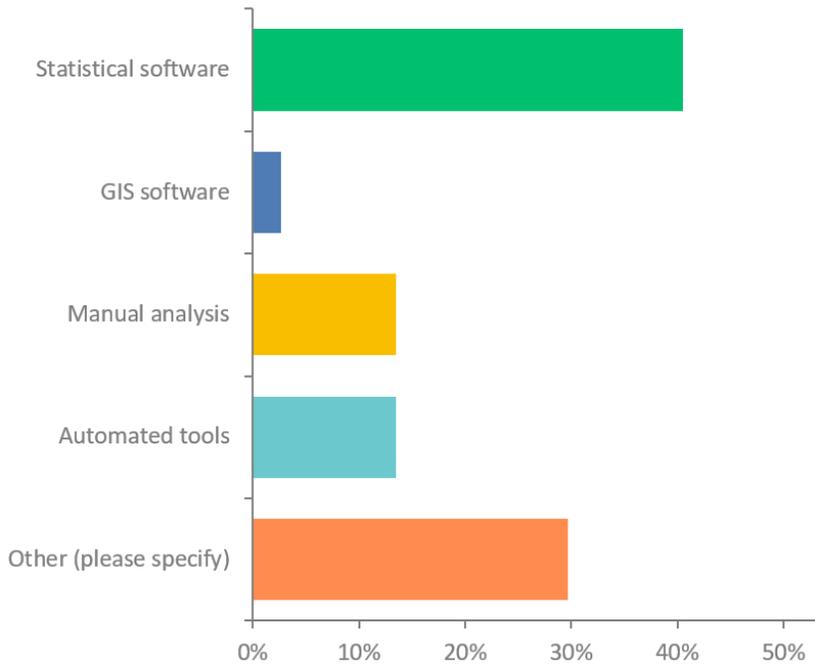
### A.5 For the coral reef monitoring you are aware of, which survey methods are employed?



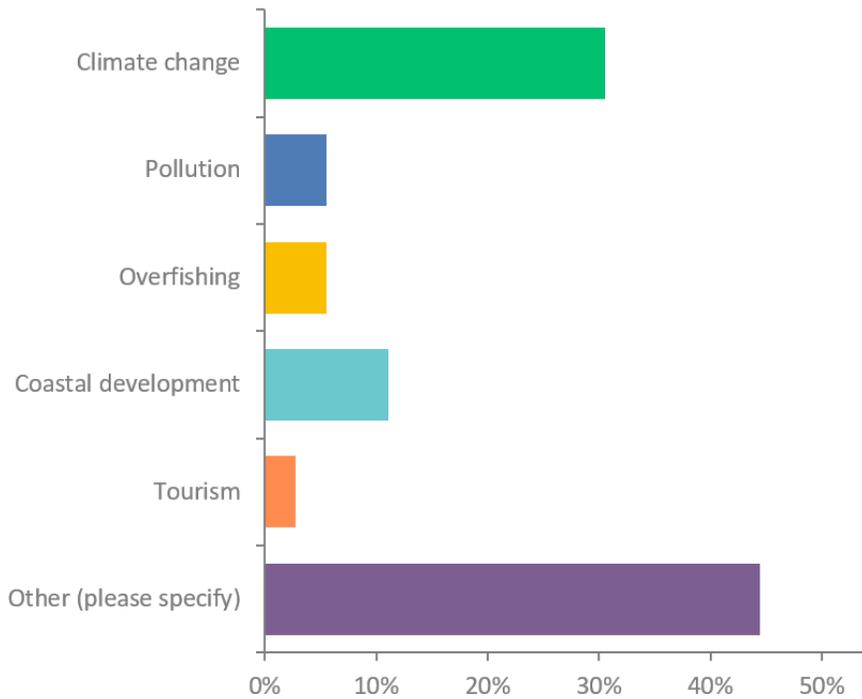
### A.6 How do you store and manage the data collected from coral reef monitoring?



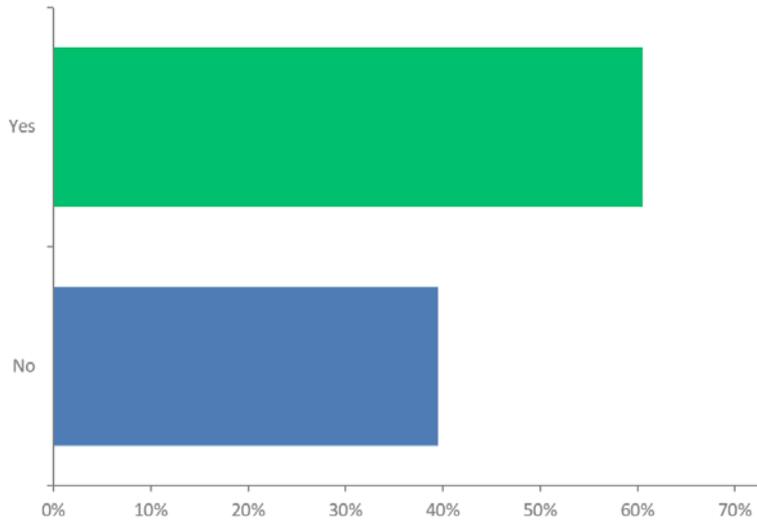
### A.7 How do you analyse the data collected from coral reef monitoring?



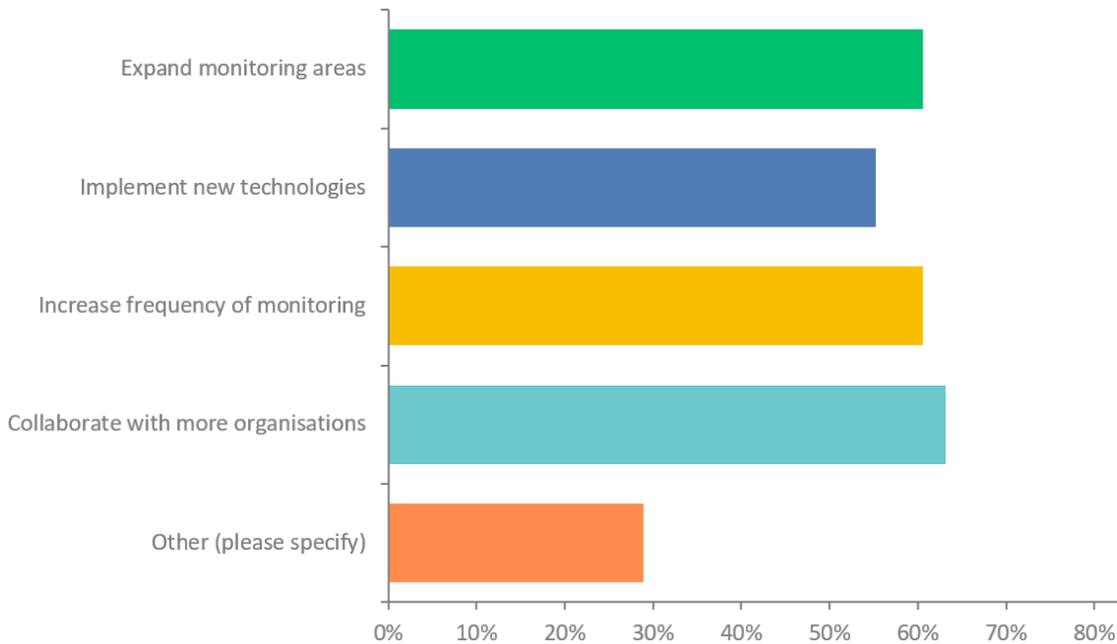
### A.8 Which factor(s) do you believe are primarily contributing to coral reef degradation you have observed?



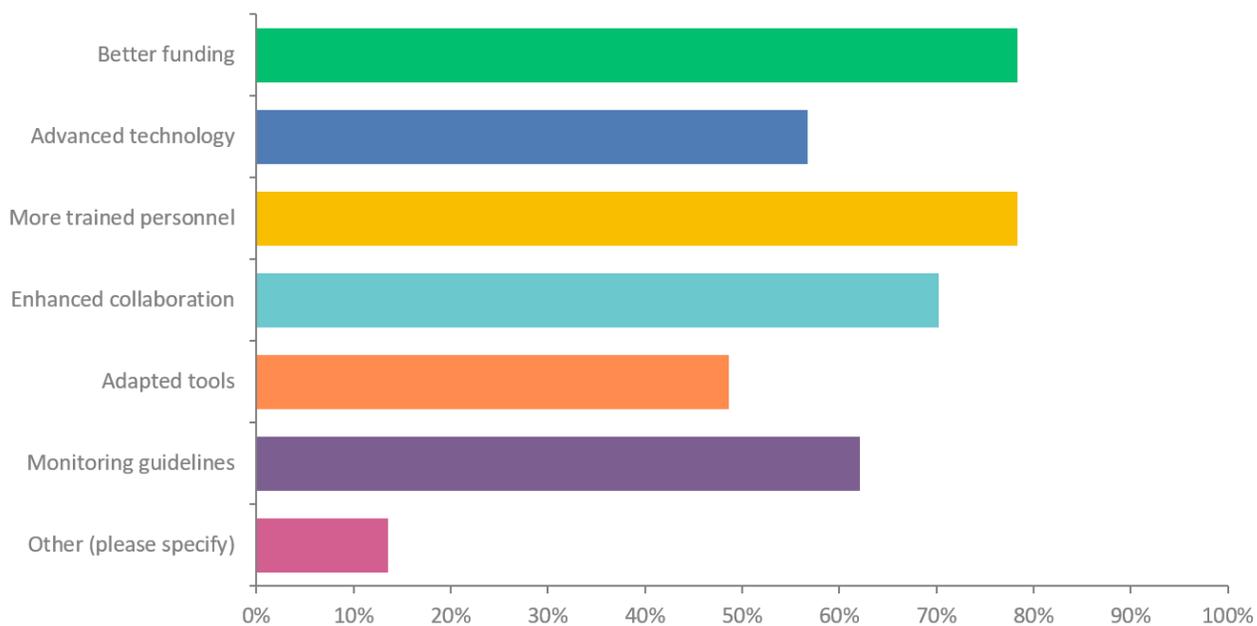
### A.9 Are you aware of the Global Coral Reef Monitoring Network (GCRMN)?



### A.10 What are your future plans or goals for coral reef monitoring? Select all that apply.



## A.11 How do you think coral reef monitoring can best be improved in the future? Select all that apply



## Annex B Copy of Consultation Survey

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Q1

What is your name?

Q2

Which country are you from?

Q3

What is your affiliation?

Q4

What is your role/position?

Q5

Do you agree to be contacted to discuss your responses in further detail if required?

Q6

If you agree to be contacted, please provide contact email address and phone number:

Q7

What is your role in coral reef monitoring?

Q8

For your country, which existing coral reef monitoring initiatives (e.g. activities or programmes) are you aware of?

Q9

Which organisations are actively leading coral reef monitoring in your country?

Q10

Which coral locations (e.g. islands/reefs) are currently monitored on an ongoing basis?

Q11

For the coral reef monitoring you are aware of, what is the frequency of monitoring (e.g. monthly, yearly, intermittently)? Select all that apply.

Q12

For the coral reef monitoring you are aware of, which survey methods are employed? Select all that apply.



Q13

For the coral reef monitoring you are aware of, which parameters are monitored (e.g. coral cover, species composition, benthic assemblage composition, coral health, coral bleaching, coral disease, water quality, reef fish communities, reproductive or restoration success, socio-economic data, etc.)?

Q14

Which tools, software or technologies do you use for data collection and analysis?

Q15

How do you store and manage the data collected from coral reef monitoring?

Q16

How do you analyse the data collected from coral reef monitoring?

Q17

For the coral reef monitoring you are aware of, who has access to and uses the data and/or monitoring results?

Q18

Is the data used to inform government decisions or community-driven actions about coral reef conservation?

Q19

Is the data shared with any scientific institutions or partners?

Q20

What are the main challenges your country faces for monitoring coral reefs?

Q21

Have you noticed any significant changes in coral reef health over the past few years? If so, please describe.

Q22

If so, which factor do you believe is primarily contributing to these changes?

Q23

Do you collaborate with other organisations or institutions for coral reef monitoring? If yes, please specify.

Q24

Are you aware of the Global Coral Reef Monitoring Network (GCRMN)?



Q25

What kind of support (e.g. financial, technical, human resources) do you need to improve your monitoring efforts?

Q26

Are you aware of NGOs or local communities conducting community-based or participatory monitoring of coral reefs in your country?

Q27

What are your future plans or goals for coral reef monitoring? Select all that apply.

Q28

How do you think coral reef monitoring can best be improved in the future? Select all that apply

Q29

Do you have any additional comments or suggestions regarding coral reef monitoring? Please feel free to add any comments and information regarding your specific needs and context.



