Biophysically special, unique marine areas of the Cook Islands

FINAL REPORT – 10 February 2021

Daniela M. Ceccarelli[1], Kate Davey[2], Keith Twyford[2], Hayley Weeks[2], Kelvin Passfield[3], Michael White[4], Hans Wendt[5], Gander Wainiqolo[5], John Kaitu'u[5], Miriam Burrah[5]

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[1] ARC Centre of Excellence for Coral Reef Studies, James Cook University and Marine Ecology Consultant
[2] Ridge to Reef (R2R) Project, Cook Islands National Environment Service (NES)
[3] Te Ipukarea Society, PO Box 649, Rarotonga, Cook Islands
[4] Honu Cook Islands, Omoka Village, Tongareva Atoll, Cook Islands
[5] International Union for the Conservation of Nature – Oceania Regional Office (IUCN-ORO)

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Acronyms

CBD – Convention on Biological Diversity
CITES – Convention on International Trade in Endangered Species
CMS – Convention on Migratory Species
DPS - Distinct Population Segments
EBSA – Ecologically or Biologically Significant Marine Areas
EEZ – Exclusive Economic Zone
ENSO - El Niño / Southern Oscillation
GEF - Global Environment Facility
IBA – Important Bird Areas
IMMA – Important Marine Mammal Area
IMSP - Island Marine Spatial Plan
IWC - International Whaling Commission
IUCN – International Union for the Conservation of Nature
IUCN ORO – IUCN Oceania Regional Office
KBA – Key Biodiversity Area
MMCO - Marae Moana Coordination Office
MoU – Memorandum of Understanding
MPA – Marine Protected Area
MSP – Marine Spatial Planning
NBSAP – National Biodiversity Strategy and Action Plan
NES - National Environment Service
NMMSP - National Marae Moana Spatial Plan
OPM - Office of the Prime Minister
RMU - Regional Management Unit
R2R – Ridge to Reef
SPC – Secretariat of the Pacific Community
SPREP – Secretariat of the Pacific Regional Environment Programme
SUMA – Special and / or Unique Marine Area
UNDP - United Nations Development Programme
UNESCO – United Nations Educational, Scientific and Cultural Organization
WCPFC – Western and Central Pacific Fisheries Commission

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Executive Summary

The biodiversity and productivity of the Cook Islands' marine ecosystems underpins the livelihoods, food security, wellbeing and culture of the people. The Cook Islands Ridge to Reef (R2R) project, funded by the UNDP Global Environment Facility (GEF) in partnership with the Cook Islands Government, aims to enhance the capacity of the Cook Islands to effectively manage its protected areas and sustainably manage its productive landscapes at local scales while considering food security and livelihoods. Since the R2R project was initially designed and commenced (July 2015), the Cook Islands Marine Park 'Marae Moana' has been extended to cover the entire Exclusive Economic Zone (EEZ) of 1.9 million km².

The Marae Moana Policy 2016-2020 and *Marae Moana Act 2017* provide the policy and legislative basis for Marine Spatial Planning (MSP) in the Marae Moana. MSP aims to balance the demands of human activities with the need to maintain the health of the ecosystems on which those activities depend. This involves an inter-sectoral and participatory public process of identifying, balancing and achieving economic, social and ecological objectives in a transparent and organised way.

One of the steps in the MSP process is to identify special, unique marine areas (SUMAs) and to determine their need for management or protection. On 15-16 July 2020, the Marae Moana Coordination Office (MMCO) together with R2R conducted a workshop to identify and map the special and/or unique marine areas of the Cook Islands. This report combines the workshop outcomes with a literature review describing and justifying the SUMAs and represents a non-binding information layer to be used for the MSP process.

The areas were described, justified and scored according to four criteria: geographic explicitness, justification, information sources and legal obligations associated with each site. Each site was described in as much detail as the available information sources allowed and was given a score out of 12. Sites were categorised as offshore or inshore (inshore was generally understood to include areas out to the edge of the shallow reef, and offshore areas were >12-200 nm from land) and scored separately to account for the different nature of offshore and inshore areas and the different amounts of information available for them. Through extensive background research and review, the workshop, and follow up discussions, seven offshore and 56 inshore SUMA sites were identified.

Inshore SUMA sites were scored individually, based on the merits of each site; offshore sites were also scored in this way, but scores were allocated with consideration of the general lack of knowledge available for those areas. This was to avoid bias towards nearshore/coastal sites because there is significantly more information available about the values of these sites than offshore areas. This means that the scores given for inshore and offshore SUMAs are not comparable.

Offshore SUMAs of the Cook Islands were predominantly defined by the complex geomorphology of the seabed and the high abundance of seamounts. The special features of the Cook Islands' offshore marine habitats are already globally recognised through the designation of five Ecologically or Biologically Significant Marine Areas (EBSAs) and an Important Marine Mammal Area (IMMA); these values were also reflected in the SUMAs chosen by workshop participants. The scores (between 4.5 and 9) given to these SUMAs reflects the lack of research conducted in the Cook Islands' offshore waters, especially its seamounts, for which many of the SUMAs were chosen. The highest scoring offshore SUMAs - Manihiki Plateau (Site O2), Northeastern Seamounts (O1) and the Marine Mammal Migratory

Pathways (O5) - scored highest (9/12 and 7.5/12 respectively), because there is relatively comprehensive research information available.

Many more inshore SUMAs were selected than offshore SUMAs, reflecting the greater familiarity with inshore environments around the islands. Inshore SUMAs received scores between 4 and 12, with half (28 of 56) receiving scores between 4 and 6. Reasons for lower scores included the selection for just one attribute (e.g. kai) and a lack of information about the attributes in the SUMA (e.g. Aitutaki – Tavaerua Tua, AIT8). High scores (between 10 and 12) were received by sites chosen for several attributes (e.g. Rarotonga Reef Flats, RAR2), geographically well-defined sites (e.g. Manihiki Lagoon, MAN1), and areas already acknowledged for their special, unique status (e.g. Suwarrow, SUW1). These higher scores mean that decisions about conservation measures or zones used to protect these areas can be made with greater confidence.

Some of the sites were given a special and/or unique status because of their remoteness (e.g. Tongareva – Flying Venus Reef, TON1). This was partly because geographic isolation often leads to unique assemblages, genetic distinctness and the presence of endemics, and/or because the remoteness itself has left their ecosystems relatively intact. Reefs located further offshore are considered of greater significance because the lack of exploitation and pollution makes them more diverse and resilient, with more abundant flora and fauna and intact food webs. Spatial planning can take this into account directly, but also in the context of connectivity, where intact coral reefs can act as sources of larvae to replenish degraded or more heavily used reefs; hydrodynamic modelling could help establish such linkages to further guide planning and management. In the Cook Islands, there is already some information available about the connectivity of the southern group of islands.

Future scoring systems could take into account levels of human use or impact, as this affects the intrinsic ecological value of a habitat, assemblage, population or ecosystem. This intrinsic ecological value is embedded within the ability of the system to function in a balanced and sustainable manner, and includes elements of assemblage structure and diversity, nutrient cycling, trophic linkages and the abundance of keystone species. Sometimes a single species (e.g. the presence of an apex predator) can indicate that these processes are likely to be intact. However, in the absence of existing information, only further surveys and research can confirm the special and/or unique nature of a site.

The identification and scoring of SUMAs is one of the key steps in the marine spatial planning process. SUMA identification also provides a baseline of information for other management measures such as permitting, licencing or for Environmental Impact Assessments, which may use SUMA designation as an input to conservation management decision making. Sites with higher scores can be seen as priority sites at a national level, while those with lower scores should be flagged for further research to confirm whether their low scores are based on lack of data or are otherwise confirmed as having less inherent value thus not considered a special, unique marine area.

1 Introduction

1.1 Project background

In the Cook Islands, the ocean and its resources provide the basis for people's culture, wellbeing, livelihoods, food security, and the economy of the country. The biodiversity and productivity of the Cook Islands' marine ecosystems underpins the resources that people rely on; protecting these ecosystems is paramount to ensuring their resilience in an uncertain future. The Cook Islands Ridge to Reef (R2R) project, which is funded by the UNDP and Global Environment Facility (GEF) in partnership with the Cook Islands Government, aims to enhance the capacity of the Cook Islands to effectively manage its protected areas. A further goal is for the Cook Islands to sustainably manage its productive landscapes at local scales while considering food security and livelihoods. This included the operationalisation of the Cook Island Marine Park (CIMP) and later the entire Exclusive Economic Zone, renamed as the Marae Moana, covering approximately 1.9 million km^2.

1.2 Policy and planning context

The *Marae Moana Act 2017* established the Marae Moana (also known as the Cook Islands Marine Park) within the waters of the Cook Islands and provides for its integrated management. Part 3 of the Act covers policy and spatial planning and specifies that regulations must be developed and in place to guide development of marine spatial plans (MSPs). The Act provides for two types of MSPs: a National Marae Moana Spatial Plan (NMMSP) and individual island marine spatial plans. To improve clarity and understanding, Twyford (2020a) proposed that these names are changed to offshore MSP (OMSP) and inshore MSP (IMSP).

The Act defines the NMMSP planning area as being 12 nautical miles (nm) from the baseline to the 200 nm mark of the Exclusive Economic Zone (EEZ). There isn't a specific legal definition of the geographic extent of IMSPs, however, it can be inferred from the Act that they cover internal waters (where they exist), and the territorial sea (from the baseline out to 12nm; Twyford, 2020a). Section 24 of the Act further establishes a "marine protected area" (MPA) zone of 50 nm around all 15 islands. Mining and large-scale fishing are prohibited in these areas (*Marae Moana Act, 2017*).

Marine Spatial Planning (MSP) is a practical way of balancing the demands of human activities with the need to maintain the health of the ecosystems on which those activities depend. This is especially important in Pacific Island countries where approximately 98 per cent of the area under each nation's jurisdiction is ocean (Seidel and Lal, 2010). Marine ecosystems are known to be in decline, mostly due to human activities, but there is recognition that it is possible to manage human activities to minimise many of these impacts. MSP involves an inter-sectoral and participatory public process of identifying, balancing and achieving economic, social and ecological objectives in a transparent and organised way.

The intended result of MSP is a zoning plan and management actions (or measures) that together spatially organise human activities. One of the key steps in the MSP process is to identify special, unique marine areas (SUMA) and to determine their need for management or protection (Ceccarelli et al., 2018; UNESCO, 2009).

This report describes the process and methodology used to identify, describe and rate SUMAs in the Cook Islands. The individual SUMAs are named, coded, justified, mapped, verified and scored in the results section of this report. The report represents one of many data layers that will inform the development of a marine spatial plan, and guide government decision-making about the types of ocean zones and level of protection that should be afforded to different parts of the Cook Islands' marine environment.

2 Methods

On 15 and 16 July 2020, a technical workshop was held to identify Special, Unique Marine Areas (SUMAs) in the Cook Islands (see workshop agenda in Appendix 2). For the purposes of this work, "Special" is defined as "better, greater, or otherwise different from what is usual; exceptionally good or pleasant" and "Unique" is defined as "being the only one of its kind; unlike anything else" (Oxford English Dictionary, 2018). The workshop explicitly focussed only upon ***biophysical values*** of the ***marine*** environment.

The Marae Moana Coordination Office together with Ridge to Reef conducted the workshop. The workshop objectives were to:

- Assess previous priority sites including Key Biodiversity Areas (KBAs), Important Bird Areas (IBAs), Ecologically or Biologically Significant Areas (EBSA), and ra'ui (traditionally managed areas)
- Review current information to identify inshore and offshore SUMA
- Identify and map the boundaries of inshore and offshore SUMA
- Update participants about the overall MSP process and R2R Project.

The Covid-19 global pandemic induced domestic and international travel restrictions, which meant that Pa Enua (Outer Island) participants and overseas-based experts were unable to be present in person. This necessitated a flexible approach to the workshop, whereby the Australia-based experts and outer island representatives were present through the online meeting platform Zoom, through which they contributed their presentations, guided the proceedings, participated in group discussions and answered questions.

2.1 Data gathering

The Government of the Cook Islands together with the International Union for the Conservation of Nature Oceania Regional Office (IUCN ORO) collated, assessed, prepared and mapped open source and freely available data on various aspects of the Cook Islands' marine environment (Appendix 3). During the two-day workshop these maps were available in electronic and printed format for the workshop participants. In total, there were 52 datasets covering natural risks, ocean uses, oceanography and biodiversity.

The information management package uploaded to Google Drive for stakeholders included:

1. A total of 52 spatial dataset categories according to the following thematic areas: bathymetry, biological, boundaries, economics, geography and oceanography.

2. Metadata (information about the spatial data) using the ANZLIC Metadata Profile[6] that is compliant with international (ISO 19115) standard and required by the Cook Islands Government as per the Spatial Information Management (SIM) Policy.
3. Open-source data that can be shared and distributed with relevant stakeholders.
4. A brief description of each dataset as part of the package on Google Drive.

These data, along with that produced following the workshop, have since been centrally stored within the Cook Islands Government geoportal housed at Infrastructure Cook Islands, to ensure safe storage and accessibility for future use.

2.2 Workshop and additional consultations

Forty-eight participants representing a range of Government ministries, NGOs, traditional leaders and individual experts were brought together to identify special and/or unique sites both in the inshore and offshore marine areas of the Cook Islands; five additional participants and two technical experts were present online, using Zoom (Appendix 1). These participants (and other contributors) have marine expertise in one or more of the following: inshore and offshore fish and other species, marine habitats and environments, high biodiversity areas, marine mammal areas, hydrology, oceanography, port works, fisheries and marine research.

As outlined in section 2.1, existing available data on the Cook Islands' corals, geomorphology and other key marine features were provided to the participants. These included maps outlining the current priority sites for conservation in the Cook Islands, such as Key Biodiversity Areas (KBAs), Important Bird Areas (IBAs), Ecologically or Biologically Significant Areas (EBSA), marine protected areas (MPAs) and ra'ui (traditionally managed areas).

Participants were divided into groups and asked to identify and define the Cook Islands' marine areas that were biologically and/or physically special and/or unique. In addition to the data described above, participants were provided with worksheets to complete for each identified site (Appendix 4), as well as maps of the Cook Islands at two scales: ocean-wide maps and "zoomed in" maps of each island. These were for participants to mark the geographic boundaries of the sites they had identified.

For each identified site, the workshop required participants to provide:

- a site name
- a geographic description of site location and boundaries.
- a justification. This may include information as to whether areas support, or are likely to support, rare, vulnerable or unusual habitats or species, threatened species, important life stages of key species, endemic species, physically or biologically outstanding attributes (e.g. unique geomorphology, high species diversity or high productivity).
- sources of information. These could be peer reviewed scientific papers, peer reviewed reports, other ("grey literature") reports, data or personal communications and traditional knowledge from participants or other expert sources.
- legal or other obligations to protect the site or species within the site.
- follow-up tasks required to finalise the description of the site.

[6] https://www.anzlic.gov.au

The workshop was followed by an extensive search for additional sources of information including from experts who were not able to attend the workshop. Information was collected through online libraries that linked to peer reviewed journals and online "grey" (unpublished) literature. Species-specific obligations were supplemented by compiling a list of species occurring in Cook Islands waters that are listed on national and international conservation registers (Appendix 5).

All spatial data and information collected during the workshop were digitized and a map of each identified site was created. A geographic boundary for each site was created in GIS from the minimum bounding geometry enclosing each site. The diagonal coordinates (latitudes/longitudes) generated from this process were used to identify the geographic boundaries for the Cook Islands' SUMAs.

2.3 Rating of the Cook Islands' special and/or unique marine areas

The Cook Islands have a vast range of marine biophysical features, some of which are well known and understood, some of which are special, some are unique, and some may require special consideration when planning for the optimal use and management of the Cook Islands' ocean. There is not equal justification for, or information about, the special and/or unique sites identified during the workshop and in this report.

Data from the workshop and other sources were used to systematically assess and score each site against the following criteria:

a. Geographic explicitness – how well-defined and well-justified are the boundaries of the site? This is a relative assessment. For most sites, the exact boundaries were not well known and so the maps provided are indicative only. As with all the sites in this report, more information may mean that site boundaries can be better defined in the future. For future planning purposes the more geographically explicit the boundaries are, the greater the chance of delivering an appropriate and effective management response.
   NOTE: All sites identified exclude land above the high-water mark. For example, if a site demarcates a ring around a fringing reef of an island, then the SUMA indicated in this report is understood to include only the entire marine environment within that ring up to high water mark but does not include the island itself. Exceptions are made for turtle and seabird nesting sites, and for coconut crab habitat; these species spend a significant portion of their lives in the sea and play a crucial role in land-sea connectivity.

b. Justification – how well, and in how much detail, can it be justified that the SUMA is, in fact, special and/or unique? Is there information available about the site itself or is there a need to infer it from information about similar areas or habitats? Scoring against this criterion refers to whether there is clear, abundant and convincing information to indicate whether the area is likely to support rare, vulnerable or unusual habitats or species, threatened species, endemic species, important life stages of key species, or physically or biologically outstanding attributes (e.g. unique geomorphology, high species diversity or high productivity). If the information provided is only generic to the type of site being described, and not specific to the Cook Islands, then the score under the criterion

"Justification" will be diminished by one-half to a whole of a point. In this instance, a half point will be subtracted from the score it might otherwise have received if there is not much information globally (e.g. many offshore, deeper water sites). A full point will be subtracted if, globally, there is a wealth of information and so the chances of having site-specific information is greater (e.g. coral reefs).

c. Information source(s) – this refers to information sources used to identify and justify the site, and whether they are websites, reports, legal documents, local knowledge or peer-reviewed scientific articles. The type of source determines how reliable and verifiable the information sources are. Information is more likely to be correct if it can be cross-referenced and triangulated via multiple information sources. Therefore, the overall score reflects both the type and the number of sources available. All the sites will have at least one, locally specific, expert source, namely, one of the workshop participants. For some sites, only generic sources will be available about the species or habitats in the SUMA; in these cases, the generic sources will be counted as per Table 1. For example, for the offshore, deeper water sites it is well understood that data are globally sparse and thus, for these sites, generic sources may be considered to count in this criterion. However, for globally well-studied habitats, such as coral reefs or mangroves, there will be thousands of generic sources; if we count these, each coral reef or mangrove SUMA will automatically receive the highest score. Therefore, for SUMAs containing globally well-studied species or habitats, only locally specific sources contribute to this criterion.

d. National and/or international obligations – does the area host species or habitats for which the country has international obligations (e.g. under Conventions) or national obligations (e.g. legal designation under legislation, regulations or bylaws), or customary approaches such as ra'ui? Coral reefs automatically host a large number of organisms (e.g. even the corals themselves), therefore scores are allocated only for the habitat itself, or for more specific organisms for which the SUMA was listed.

   Conventions, laws and policy (management instruments) apply differentially across SUMAs and impose different management obligations as follows:

   - Some Acts such as the *Marae Moana Act 2017* and *Marine Resources Act 2005* apply to all SUMAs.
   - In other cases individual sections of these Acts apply to specific SUMAs. All inshore SUMAs are covered by a Marine Protected Area as established under Section 24 of the *Marae Moana Act 2017*. Furthermore, Shark Conservation Regulations apply to all SUMAs where sharks are identified as a significant value.
   - In other instances, particular Regulations or bylaws apply to just one or a few SUMAs. For example, the Aitutaki Fisheries Protection By-Laws apply to just two SUMAs.

Appendix 6 provides a detailed description of the management obligations that apply across the entire Marae Moana (Cook Islands Marine Park). The management obligations that apply to each SUMA are listed under the management obligations section of each SUMA.

Each proposed SUMA was scored as relatively low (1), medium (2) or high (3) against each of the four criteria. SUMAs scoring highly against all criteria ranked higher overall. The scoring system used is described in Table 1. Three points are allocated as the top score for each of the four criteria; the information sources score is split into two components to reflect the type and number of sources. The highest total score possible is 12; the lowest is four.

Table 1. Scoring system for SUMAs identified through the expert workshop in the Cook Islands.

Criteria	Scoring descriptions	Score
Geographic explicitness	Boundaries are quite loosely defined	1
	Boundaries broadly match topographic or hydrodynamic features	2
	Boundaries exactly match the biophysical features identified as important	3
Justification	One or two reasons (e.g. presence of organisms) justifying the site, with generic information sources	1
	One or two reasons (e.g. presence of organisms) justifying the site, with site-specific information sources	1.5
	Three or four reasons justifying the site, with generic information sources	2
	Three or four reasons justifying the site, with site-specific information sources / five or more reasons justifying the site, with generic information sources	2.5
	Five or more reasons justifying the site, with site-specific information sources	3
Source type	Expert advice from workshop participants	0.5
	No peer reviewed papers are available but there are good reports available	1
	At least one peer reviewed scientific paper or report discusses this site (for inshore sites); for offshore sites, good peer-reviewed generic sources describe the main feature(s) of the site	1.5
Number of sources	One source	0.5
	Two to three sources	1
	Four or more sources	1.5
International/ national obligations	One species or habitat with obligations	1
	Two or three species and/or habitats with obligations	2
	More than three species and/or habitats with obligations	3

2.4 Layout of site information in report

For each SUMA identified in the workshop, the following information is provided:

- site name (for lesser-known types of habitats a broad definition of the habitat is provided)

- map
- summary table with the name and score of the site
- diagonal coordinates (latitudes/longitudes – see Section 2.2 for details)
- score and descriptive assessment against each of the four criteria.

In the following sections, results are grouped into offshore areas (Section 3) and inshore areas (Section 4). The sites for each section have been presented, roughly, from north to south.

3 Offshore biophysically special and/or unique marine areas

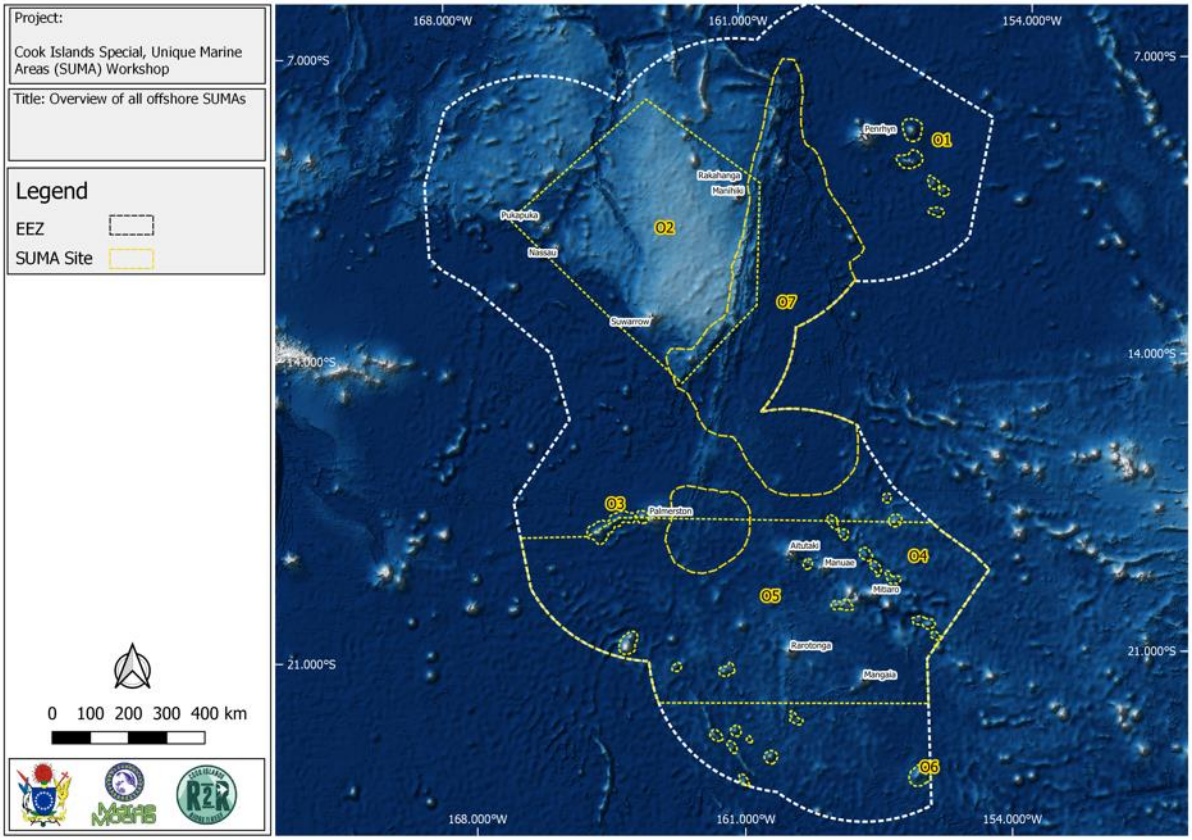


Figure 1. Overview of the Cook Islands' offshore SUMA sites.

3.1 Site O1: Northeastern Seamounts

Seamounts are a discrete (or group of) isolated landforms, being greater than 1,000 m in relief above the sea floor, and characteristically of conical form (IHO, 2008).

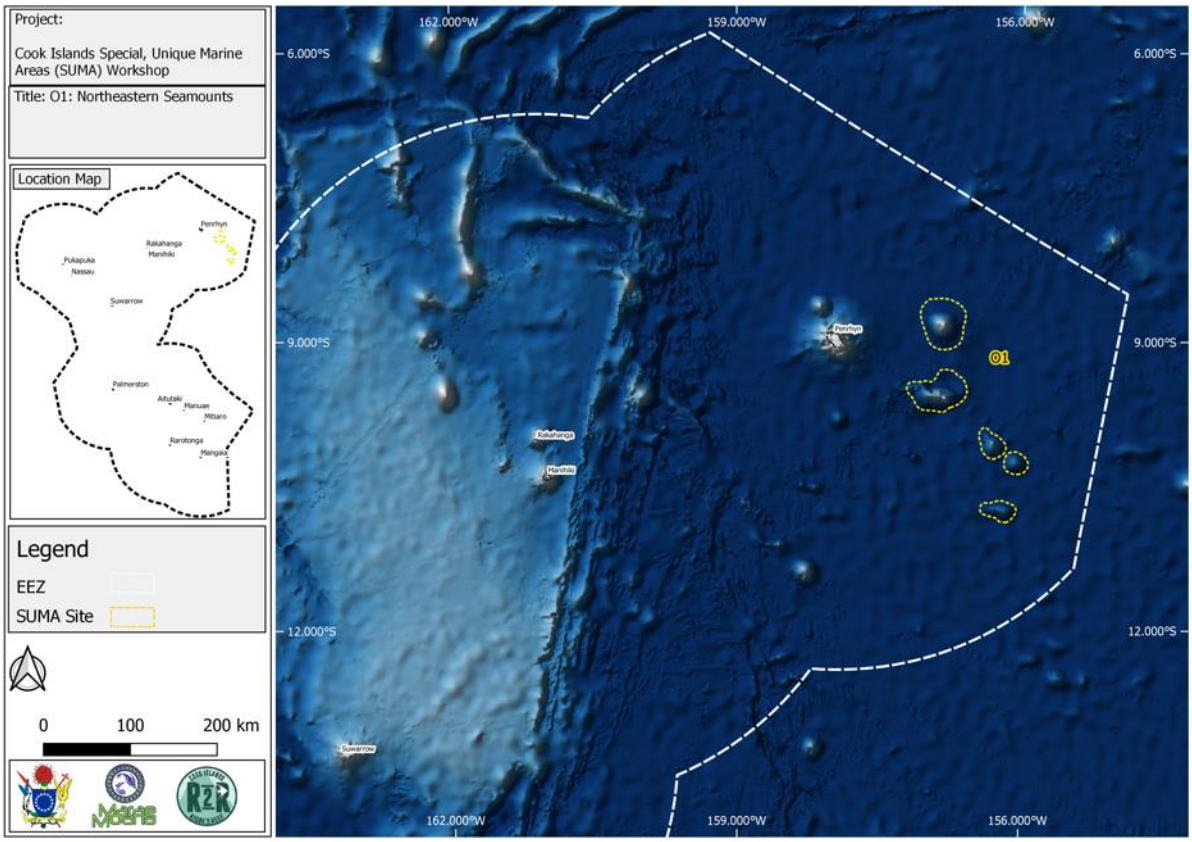


Figure 2. Site O1: Northeastern Seamounts.

Table 1. Site O1: Northeastern Seamounts

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Offshore sites	Northeastern Seamounts	O1	3	2	2	2	**9**

Geographic boundaries

Map	Latitude	Longitude	Points
	-8.5648048	-156.84779	O1 (A)
	-10.248141	-155.94447	O1 (B)
	-10.787724	-156.42846	O1 (C)

Geographic explicitness (score = 3):

The northeastern seamounts lie to the east of Tongareva and to the west of the Cook Islands EEZ boundary. This SUMA encompasses a cluster of six seamounts of varying morphologies (see Appendix 7 for details).

Justification (score = 2)

This SUMA was selected for its geomorphological complexity, especially its seamounts, as these deep-sea features are known for their potential to host high bioversity. The high abundance of seamounts in the Cook Islands stems from its position among a number of greater seamount chains, including the Cook-Austral-Island chain (Dickinson, 1998), the seamounts and islands rising from the Manihiki Plateau, and a number of isolated seamounts rising from deeper areas of the Penrhyn Basin (Summerhayes, 1967; Viso et al., 2005). More is known about the southern seamount chain (with Aitutaki on the western end), than about the northern seamounts; no studies were found describing the seamounts in this SUMA.

Harris et al. (2014) has classified the seamounts of the world based upon their physical parameters (e.g. depth of seamount base and summit, slope, size, height above seabed, shape of summit, etc). Globally, eleven types of seamounts occur (Harris et al., 2014); the Cook Islands has 128 seamounts in total representing all eleven types (Appendix 7). This SUMA contains five types of seamount, including the only seamount of Group 2 (large and tall with shallow peak, larger) within the EEZ (Appendix 7). Areas of complex geomorphology, such as those within this SUMA, are known as oceanic "hotspots" of life (Davoren, 2013), and are widely known to host higher biodiversity than surrounding waters, supporting rich benthic communities and attracting pelagic organisms (Letessier et al., 2019).

Many seamounts exhibit a "positive biological cascade" effect, with elevated levels of primary productivity leading to high concentrations of zooplankton, which in turn support a high abundance of benthic fauna and consequently large populations at higher trophic levels (Stone et al., 2004). Benthic taxa living on seamounts can include biogenic habitat-forming corals and sponges, anemones, crabs, sea stars, sea urchins, brittle stars, sea cucumbers, monoplacophorans and feather stars (Baker and Beaudoin, 2013; Clark et al., 2011; CSIRO, 2008; Sigwart et al., 2019). Seamounts often host deep-water species that are very slow-growing and long-lived (Stone et al., 2004). Combined with highly variable recruitment due to isolation and intermittent dispersal from other seamounts (if the species are not endemic to that seamount), this results in very delicate habitats vulnerable to over-exploitation, with poor recovery potential (Baker and Beaudoin, 2013; Stone et al., 2004). One of the seamounts in this SUMA has very high habitat suitability for cold-water corals (Davies and Guinotte, 2011). These habitat-forming corals can build extensive reef structures at depths of 1,000 – 2,000 m, thus they are an important habitat for a rich variety of seamount biota and are highly vulnerable to damage due to their extremely slow-growing life history (Fallon et al., 2014).

The deep-water seamount communities often have a high level of endemism and are likely to have different fauna on the leeward and windward sides (Marchese, 2014; Stone et al., 2004). Species may be restricted to a chain of seamounts, to a few adjacent seamounts (such as the seascape in this SUMA) or even to a single seamount (Stone et al., 2004). Rates of endemism vary, from a low of 5-9% up to 52% (Stone et al., 2004). Richer de Forges et al. (2000) found that adjacent seamounts in New Caledonia shared only 21% of species, and seamounts approximately 1,000 km apart shared only 4% of species. However, seamounts and seamount-like features (e.g. ridges) do not have to be isolated or large to support high levels of endemism. Work by Koslow et al. (2001) and Rowden et al. (2002) (both in Stone et al. (2004)) showed that even relatively small underwater hills (100 to 400 m above the seafloor) had rates of endemism of 15 to 35%. Work by Halafihi (2015) using chemical analysis of otoliths supports the premise of isolated populations on seamounts, finding genetically distinct populations of the flame snapper (*Etelis coruscans*) and crimson jobfish (*Pristipomoides filamentosus*) on seamounts in the north and south of Tonga.

Modelling found that the northern Cook Islands, including this SUMA, has very high historic catch rates (Sea Around Us Project, 2016), pelagic species richness (AquaMaps, 2014) and high values for indicators of primary productivity that favour aggregations of marine life (NASA, 2014; Oregon State University, 2017). This is likely to attract pelagic species such as tuna, deep-water snapper, sharks, whales and dolphins (Baker and Beaudoin, 2013; Morato and Clark, 2007; Stone et al., 2004). The seamounts, ridges and the seascapes between them, including shallower areas, have an important role for marine mammals during migration, breeding and feeding (Garrigue et al., 2015). The seamounts and ridges are also probably resting areas, navigational landmarks or even supplemental feeding grounds for whales (Garrigue et al., 2015). Telemetry studies have shown high levels of individual fidelity to specific sites, such as seamounts, by highly migratory marine species, and basin-wide movements can be directed towards these locations (Luschi, 2013). However, no research on marine mammals has been conducted within this SUMA.

How biodiversity and endemism vary on seamounts with parameters such as depth, surface productivity, temperature, substrate composition, organic flux to the seafloor, currents, oxygen level, latitude and other factors is unknown and unpredictable (Baker and Beaudoin, 2013; Stone et al., 2004). In Tonga, Halafihi (2015) found different chemical signatures in otoliths of juveniles and adults of the flame snapper and crimson jobfish, indicating that these deep-water fishes use different parts of a seamount at different life-stages. Species new to science continue to be discovered each time seamounts are sampled and, due to the longevity of many of those species, they may provide valuable information regarding the workings of the ocean and the source of some parts of life on Earth (CSIRO, 2008; Stone et al., 2004).

Type and number of sources (score = 2):

There was no information specific to the seamounts in this SUMA. General information about seamounts was used to infer the values likely to exist for this SUMA and include 17 peer-reviewed papers. Two additional peer-reviewed papers contained information about other seamounts in the Cook Islands. Five maps showed modelled values of productivity and biodiversity that included the general area around this SUMA.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Marine Resources Act 2005
- Environment Act 2003 potentially applies to all SUMAs

Commercial fishing is potentially undertaken in this offshore SUMA. There are multiple regulatory obligations on the Cook Islands Government and individual fishing enterprises that operate in this SUMA including:

- Marine Resources (Purse Seine Fishery) Regulations 2013
- Marine Resources (Large Pelagic Longline Fishery and Quota Management System) Regulations 2016
- Large Pelagic Longline Fishery Plan (2016)
- Cook Islands Shark Sanctuary and Marine Resources (Shark Conservation) Regulations 2012

- Sections 8 and 15 of the Purse Seine and Longline Fishery Regulations and Section 15 respectively that address protection of non-target species and mandate that commercial fishing must comply with various national plans of action including:
    - National Plan of Action for the Conservation and Management of Sharks (NPoA – Sharks) (MMR 2012)
    - Action Plan for Sea Turtle Mitigation (NPoA – Turtles) (MMR 2008)
    - National Plan of Action for Reducing Incidental Catch of Seabirds (NPOA-Seabirds) (MMR 2007)
- WCPFC Conservation and Management Measures (CMMs) that affect commercial fishing activities in the Cook Islands EEZ.

Marine mammals and some sharks found around seamounts are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

3.2 Site O2: Manihiki Plateau

An undersea plateau is a "a large, relatively flat elevation that is higher than the surrounding relief with one or more relatively steep sides" (IHO, 2008).

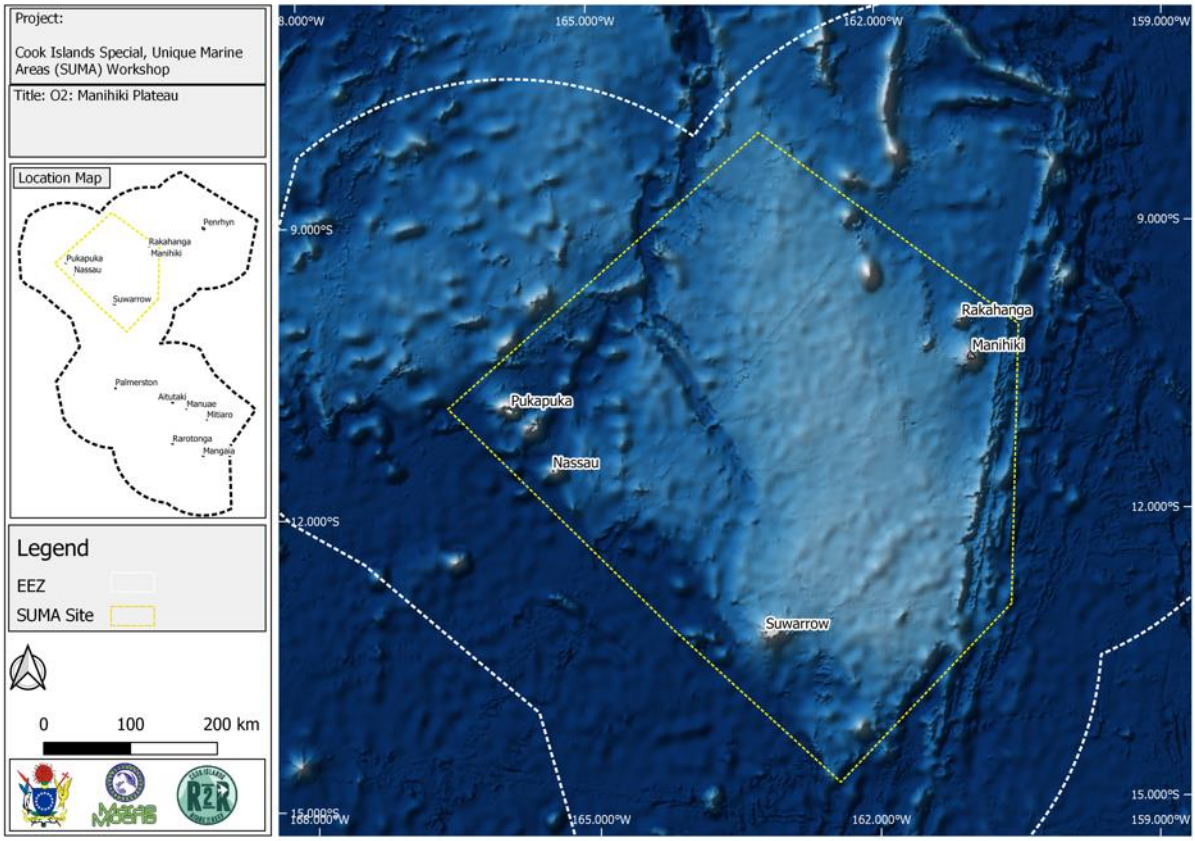


Figure 3. Site O2: Manihiki Plateau.

Table 2. Site O2: Manihiki Plateau

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Offshore sites	Manihiki Plateau	O2	2	2.5	2.5	2	**9**

Geographic boundaries:

Map	Latitude	Longitude	Points
	-8.081318	-163.20765	O2 (A)
	-13.001811	-160.58632	O2 (B)
	-10.893028	-166.50263	O2 (C)

Geographic explicitness (score = 2):

The Manihiki Plateau extends over 770,000 km^2, with an estimated volume of 8,800,000 km^3 and a crustal thickness of 15–25 km (Heezen et al., 1966). It supports numerous seamounts and extends across much of the Cook Islands' northern waters. It is bounded by the Tokelau Basin in the west, the Samoan Basin to the south, the Penrhyn Basin to the east, and the

Central Pacific Basin to the north. The SUMA encompasses the Plateau and the waters above it.

Justification (score = 2.5)

The Manihiki Plateau is characterised by high species richness and rich seabed mineral deposits (McCormack, 2016). The Manihiki Plateau is also an Ecologically and Biologically Significant Area (EBSA; CBD, 2015), as it meets criteria designed by the Convention of Biological Diversity (CBD) to identify areas that serve important purposes for the healthy functioning of ocean ecosystems[7]. The Manihiki Plateau was formed by volcanic activity 125 to 120 million years ago at the Tongareva Triple Junction plate boundary (Golowin et al., 2018; Pietsch and Uenzelmann-Neben, 2016). A thick layer of sediment up to 1 km deep covers some areas (Heezen et al., 1966), but in other areas deep-water currents sweep the basalt foundation bare (Bashah et al., 2020). A 2001 research expedition seeking seabed minerals recorded five phyla and eight biogroups of organisms on the plateau seabed, and confirmed traces of organisms (mounds, faeces, and trails) (Heezen et al., 1966). Abundant taxa included sponges, sea cucumbers, starfishes, isopods and polychaetes. Many of the macrobenthic organisms were thought to feed or otherwise rely on the manganese nodules on the seabed. Plankton and nekton (shrimps fishes and jellyfishes) were also recorded (Japan International Cooperation Agency Metal Mining Agency of Japan, 2001). Among the rare and unusual findings were an endemic brittle star recorded on the deep reef slope of Pukapuka Atoll, a rare species of cowrie (*Cypraea bernardi*) well outside its recorded depth range at 1,000m off Nassau Island, and an undescribed species of tilefish (*Malacanthus* sp.) endemic to the Cook Islands (Cook Islands Natural Heritage Trust 2007).

Polymetallic nodules have attracted attention due to their commercial potential. The nodules, which are especially abundant in the Cook Islands EEZ, are concretions of multiple metallic oxides that form very slowly (~ 2 mm per million years) around a central rock or piece of debris. The nodules absorb elements present in seawater and may contain over seventy elements, including practically all metals (Kingan, 1998). In the Cook Islands, the nodules are especially rich in cobalt; they appear to be especially abundant in the southern Penrhyn Basin (Hein et al., 2015; Kingan, 1998) and are also found in this SUMA (Heezen et al., 1966). The nodules and ecosystems they support are not well understood, but they are likely to be vulnerable to disturbance; once damaged, deep-water assemblages never recover (Chin and Hari, 2020).

In 2017, another expedition explored and mapped parts of the Manihiki Plateau, revealing previously unknown features and highlighting that there are still many knowledge gaps about the deep sea floor (NOAA, 2017). Cold-water corals were abundant in this area, suggesting that they may also occur in the SUMA (Bashah et al., 2020). Modelling found that the northern Cook Islands, including this SUMA, has very high historic catch rates of pelagic fish (Sea Around Us Project, 2016), pelagic species richness (AquaMaps, 2014) and high values for indicators of primary productivity that favour aggregations of marine life (NASA, 2014; Oregon State University, 2017). Fisheries catch composition data indicate an assemblage made up mostly of albacore (*Thunnus alalunga*, 79%), yellowfin (*Thunnus albacares*, 14%) and bigeye tuna (*Thunnus obsesus*, 5%), concentrated in the waters around this SUMA (MMR, 2019a). Blue marlin (*Makaira mazara*), swordfish (*Xiphias gladius*) and striped marlin (*Kajikia audax*) are the primary bycatch species., The most abundant sharks recorded from interactions with fishing vessels are blue sharks (*Prionace glauca*), oceanic whitetips

[7] https://www.cbd.int/ebsa

(*Carcharhinus longimanus*), bronze whalers (*Carcharhinus brachyurus*) and silky sharks (*Carcharhinus falciformis*).

This SUMA also contains 17 seamounts of seven types and five of the northern islands (Summerhayes, 1967) (Appendix 7). Dredged samples of the summit of a seamount 50 km west of Rakahanga Atoll recovered middle Eocene planktonic foraminifera embedded in burrowed limestone, and some of the limestone cobbles had manganese crusts; coralline fragments and more recent foraminifera were also recovered (Coulbourn and Hill, 1991). The values of seamounts in general and in the Cook Islands are described in Site O1: Northeastern Seamounts; these values are also expected to apply to this SUMA.

Type and number of sources (score = 2.5)

The Manihiki Plateau has been subject to a number of geological studies; six peer-reviewed articles, two reports and an online expedition report (NOAA) were reviewed for this SUMA. Apart from fisheries catch information, relatively little material was available to describe the values for which this SUMA was selected. Biological, ecological and minerals information was extracted from the EBSA website and report, the Biodiversity Database, and two general reports and a peer-reviewed paper on polymetallic nodules in the Cook Islands. References used to describe seamounts in Site O1: Northeastern Seamounts are also relevant here.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Marine Resources Act 2005
- Environment Act 2003 potentially applies to all SUMAs

Commercial fishing is potentially undertaken in this offshore SUMA. There are multiple regulatory obligations on the Cook Islands Government and individual fishing enterprises that operate in this SUMA including:

- Marine Resources (Purse Seine Fishery) Regulations 2013
- Marine Resources (Large Pelagic Longline Fishery and Quota Management System) Regulations 2016
- Large Pelagic Longline Fishery Plan (2016)
- Cook Islands Shark Sanctuary and Marine Resources (Shark Conservation) Regulations 2012
- Sections 8 and 15 of the Purse Seine and Longline Fishery Regulations and Section 15 respectively that address protection of non-target species and mandate that commercial fishing must comply with various national plans of action including:
    - National Plan of Action for the Conservation and Management of Sharks (NPoA – Sharks) (MMR 2012)
    - Action Plan for Sea Turtle Mitigation (NPoA – Turtles) (MMR 2008)
    - National Plan of Action for Reducing Incidental Catch of Seabirds (NPOA-Seabirds) (MMR 2007)
- WCPFC Conservation and Management Measures (CMMs) that affect commercial fishing activities in the Cook Islands EEZ.

Sharks found around seamounts are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

3.3 Site O3: Palmerston – Kona Reef

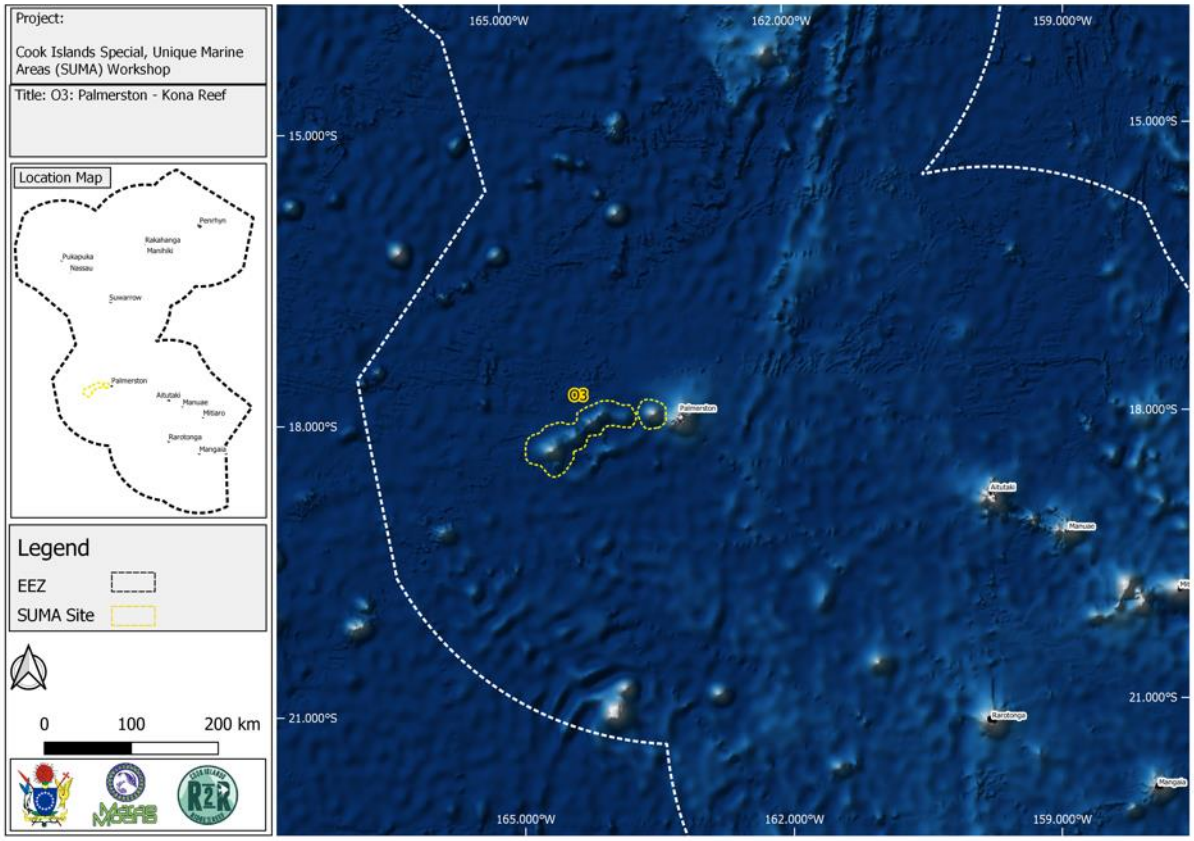


Figure 4. Site O3: Palmerston – Kona Reef

Table 3. Site O3: Palmerston – Kona Reef

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Offshore sites	Palmerston – Kona Reef	O3	1.5	1	1.5	2	**6**

Geographic boundaries:

Map	Latitude	Longitude	Points
	-17.949737	-163.31722	03 (A)
	-18.615064	-164.49204	O3 (B)
	-18.110917	-164.63523	O3 (C)

Geographic explicitness (score = 1.5):

Kona Reef is the name given to a cluster of six seamounts that appear to be a series of peaks along a ridge immediately to the west of Palmerston Island. The SUMA covers this area.

Justification (score = 1)

Kona Reef was identified (by expert and traditional knowledge, SUMA workshop) as providing important habitat for fishes, sharks and marine mammals. Of the six seamounts in this SUMA, five different types are represented (Appendix 7). One of them is thought to rise to less than 1,000 m from the surface, which is rare in the Cook Islands EEZ (CBD, 2015).

However, the position, measurements and depths of these seamounts still require some ground-truthing. The vicinity of these seamounts to each other and to Palmerston Island suggests a potentially favourable habitat for pelagic predators.

At least 25 species of sharks have been observed in the Cook Islands (Table 4), many of which are likely to frequent pelagic habitats or undertake long migrations. The Cook Islands has declared its waters a shark sanctuary (National Geographic, 2018), in recognition of the need to protect the ocean's top predators as part of safeguarding ecosystem health (Estes et al., 2011). Shark sanctuaries are recognised as one of the highly effective ways to ensure the protection of reef shark populations (MacNeil et al., 2020).

Sharks are important predators and high densities of sharks are considered a sign of a healthy marine ecosystem (Estes et al., 2011; Heupel et al., 2019; Roff et al., 2016). Top predators are typically the first to disappear under any degree of fishing pressure, as they are preferentially targeted by most fisheries and/or killed by fishermen when caught as by-catch (Friedlander and DeMartini, 2002; Graham et al., 2010; Hisano et al., 2011; Sandin et al., 2008). The high commercial value of apex predators, combined with their slow growth, long life, late maturity and low fecundity reduces productivity and inhibits recovery of exploited populations under continued fishing pressure (Collette et al., 2011; Pauly et al., 1998; Stevens et al., 2000). In some habitats, anthropogenic impacts have reduced the abundance of apex predators by 90 % or more (Myers and Worm, 2003). The removal of apex predators may result in trophic cascades, with repercussions throughout the food web, sometimes even affecting ecological primary producers such as phytoplankton or benthic communities (Estes et al., 2011). Areas with high local abundance of sharks, such as this SUMA (potentially), are becoming more valuable and protecting these areas would ensure that local food webs remain intact.

Table 4. Sharks and rays known to occur in Cook Islands waters

Scientific Name	Common Name	Habitat	IUCN Red List	Definitely confirmed/ documented	Source of record
Aetobatus ocellatus	Ocellated eagle ray	Reef	Vulnerable	x	1, 2
Alopias pelagicus	Pelagic thresher shark	Pelagic	Endangered	x	1, 2
Alopias superciliousus	Bigeye thresher shark	Pelagic	Vulnerable	x	2
Alopias vulpinus	Common thresher shark	Pelagic	Vulnerable	x	2
Carcharhinus albimarginatus	Silvertip shark	Epipelagic, but seen on reefs	Vulnerable	x	1, 2
Carcharhinus altimus	Bignose shark	Pelagic, but seen on reefs	Data Deficient		2
Carcharhinus amblyrhynchos	Grey reef shark	Reef	Near Threatened	x	1, 2
*Carcharhinus brachyurus**	Bronze whaler shark	Epipelagic	Near Threatened		2
Carcharhinus falciformis	Silky shark	Epipelagic, but seen near dropoffs	Vulnerable	x	1, 2
Carcharhinus galapagensis	Galapagos shark	Epipelagic, but seen on reefs	Least Concern		2
Carcharhinus longimanus	Oceanic whitetip shark	Epipelagic, but seen near dropoffs	Critically Endangered	x	1, 2
Carcharhinus melanopterus	Blacktip reef shark	Reef	Near Threatened	x	1, 2
Carcharhinus obscurus	Dusky shark	Epipelagic	Endangered	x	3
Carcharhinus wheeleri	Grey reef shark/ *wheeleri* subspecies	Reef	Near Threatened	x	3
Dasyatis kuhlii	Bluespotted maskray	Reef	Data Deficient	x	1, 2

Scientific Name	Common Name	Habitat	IUCN Red List	Definitely confirmed/ documented	Source of record
Echinorhinus cookei	Prickly shark	Pelagic bottom dweller	Data Deficient		1
Galeocerdo cuvier	Tiger shark	Epipelagic, but seen on reefs	Near Threatened	x	1, 2
Hexanchus griseus	Bluntnose sixgill shark	Pelagic bottom dweller	Near Threatened		2
Himantura fai	Pink whipray	Reef	Vulnerable	x	1, 2
Isurus oxyrinchus	Shortfin mako shark	Pelagic	Endangered	x	1, 2
Isurus paucus	Longfin mako shark	Pelagic	Endangered		2
Isistius brasiliensis	Cookiecutter shark	Pelagic, deep	Least Concern	x	1, 2
*Lamna nasus***	Porbeagle shark	Pelagic	Vulnerable		2
Mobula alfredi	Reef manta ray	Reef	Vulnerable	x	3
Mobula birostris	Giant manta ray	Epipelagic, but seen on reefs	Vulnerable	x	1, 2
Nebrius ferrugineus	Tawny nurse shark	Reef	Vulnerable	x	1
Negaprion acutidens	Sicklefin lemon shark	Reef	Vulnerable	x	1, 2
Prionace glauca	Blue shark	Pelagic	Near Threatened	x	1, 2
Rhincodon typus	Whale shark	Pelagic	Endangered	x	1, 2
Sphyrna lewini	Scalloped hammerhead shark	Epipelagic	Critically Endangered	x	1, 2
Sphyrna mokarran	Great hammerhead shark	Epipelagic	Critically Endangered	x	2
Sphyrna zygaena	Smooth hammerhead	Epipelagic	Vulnerable	x	2
Taeniurops meyeni	Round ribbontail ray	Reef	Vulnerable	x	1, 2
Triaenodon obesus	Whitetip reef shark	Reef	Near Threatened	x	1, 2
Zameus squamulosus	Velvet dogfish	Deep	Data Deficient		2

Source of record: 1. Cook Islands Biodiversity Database; 2. MMR Catch History; 3. J. Cramp pers. comm.
*Likely misidentified, this shark's range doesn't include Cook Islands
**Likely misidentified, this shark prefers cold/temperate waters and has not been recorded in the Pacific (with DNA confirmation)
Note: All species are listed on the IUCN Red List of Threatened Species and other international agreements. Information includes the current listing on the IUCN Red List of Threatened Species, whether the species has been documented or observed by J. Cramp during her shark research in the Cook Islands, and whether the species has been documented in the catch history curated by the MMR.

Seamounts, ridges and the seascapes between them, including shallower areas, have an important role for marine mammals during migration, breeding and feeding (Garrigue et al., 2015). The seamounts and ridges are also resting areas, navigational landmarks or even supplemental feeding grounds for whales (Garrigue et al., 2015). Telemetry studies have shown high levels of individual fidelity to specific sites, such as seamounts, by highly migratory marine species, and basin-wide movements can be directed towards these locations (Luschi, 2013). Humpback whales are known to use these seamounts as they travel northwest from the waters around Rarotonga (Nan Hauser, pers. comm.). Information about marine mammals in the Cook Islands is reviewed in Site O5: Marine Mammal Migratory Pathways.

Type and number of sources (score = 1.5)

Twelve peer-reviewed papers were used to describe the attributes of this SUMA from a global and regional perspective. Two websites supported the presence of marine mammals, sharks and abundant marine life on these seamounts. References used to describe seamounts in Site O1: Northeastern Seamounts are also relevant here.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Marine Resources Act 2005
- Environment Act 2003 potentially applies to all SUMAs

Commercial fishing is potentially undertaken in this offshore SUMA. There are multiple regulatory obligations on the Cook Islands Government and individual fishing enterprises that operate in this SUMA including:

- Marine Resources (Purse Seine Fishery) Regulations 2013
- Marine Resources (Large Pelagic Longline Fishery and Quota Management System) Regulations 2016
- Large Pelagic Longline Fishery Plan (2016)
- Cook Islands Shark Sanctuary and Marine Resources (Shark Conservation) Regulations 2012
- Sections 8 and 15 of the Purse Seine and Longline Fishery Regulations and Section 15 respectively that address protection of non-target species and mandate that commercial fishing must comply with various national plans of action including:
    - National Plan of Action for the Conservation and Management of Sharks (NPoA – Sharks) (MMR 2012)
    - Action Plan for Sea Turtle Mitigation (NPoA – Turtles) (MMR 2008)
    - National Plan of Action for Reducing Incidental Catch of Seabirds (NPOA-Seabirds) (MMR 2007)
- WCPFC Conservation and Management Measures (CMMs) that affect commercial fishing activities in the Cook Islands EEZ.

Marine mammals and sharks found around seamounts are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

3.4 Site O4: Ngaputoru Ridges and Seamounts

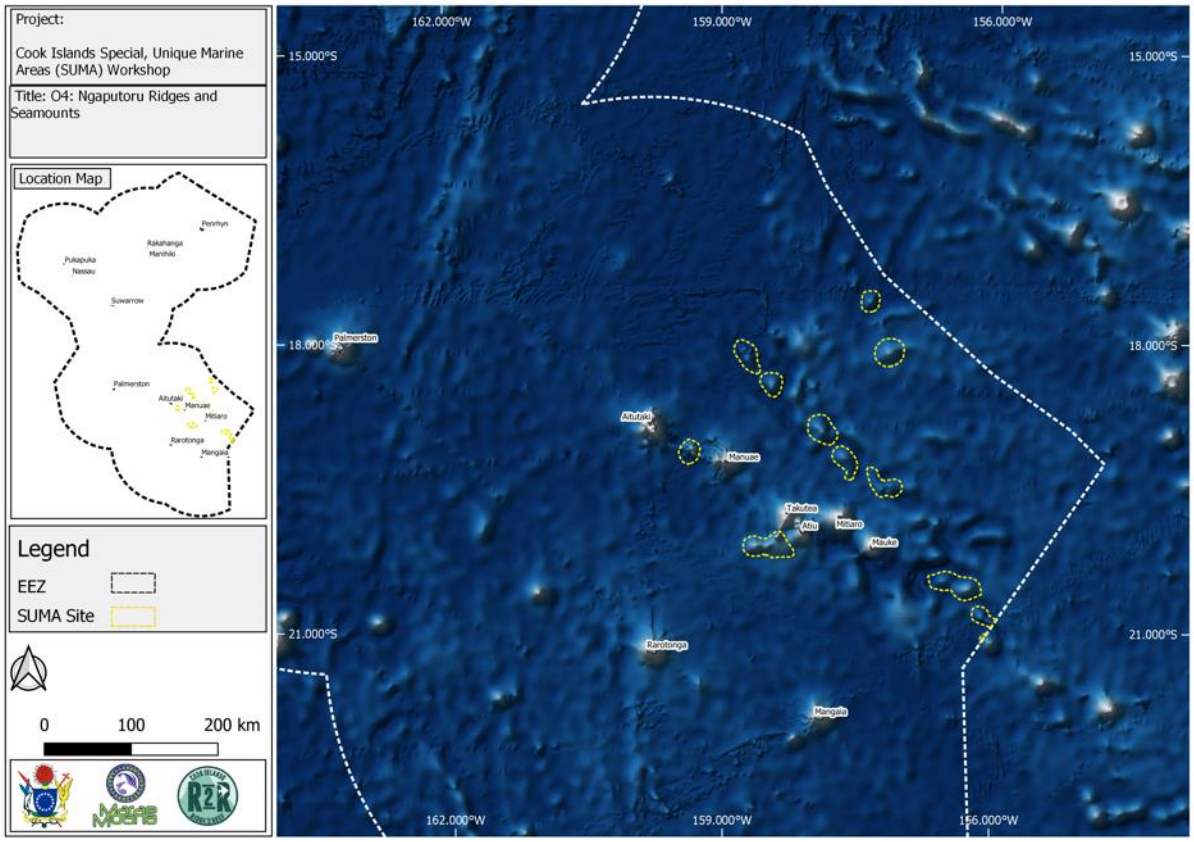


Figure 5. Site O4: Ngaputoru Ridges and Seamounts.

Table 5. Site O4: Ngaputoru Ridges and Seamounts

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Offshore sites	Ngaputoru Ridges and Seamounts	O4	2	1	1	1	**5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-18.014164	-158.82315	O4 (A)
	-18.019318	-157.0532	O4 (B)
	-21.11944	-156.14131	O4 (C)
	-20.186642	-158.765	O4 (D)

Geographic explicitness (score = 2)

Ngaputoru (or Nga Pu Toru) is the name given collectively to the islands of Atiu, Ma'uke, Mitiaro and Takutea. The islands and associated seamounts surrounding them lie in the easternmost part of the southern Cook Islands EEZ. This SUMA encompasses the seamounts and ridges offshore of the islands themselves.

Justification (score = 1)

This SUMA was chosen for its complex geomorphology and the role of seamounts in attracting aggregations of marine life. There are 14 seamounts in this area, representing five different morphotypes. The seamounts lie in depths of between 4,000 and 5,500 m and are mostly classified as small, with deep peak depths ranging from 1,000 to almost 4,000 m (Appendix 7). The Eclipse Seamount, which lies between Aitutaki and Manuae, is located in this SUMA (Summerhayes, 1967).

The islands and seamounts of the Ngaputoru form the northwestern end of the Cook-Austral Island volcanic seamount chain, which is 2,200 km long and extends from Macdonald Seamount in the southeast to Aitutaki Island in the northwest (Dickinson, 1998). This area is considered one of the geological hotspots of the South Pacific due to its historical and ongoing volcanic and tectonic activity (Wessel and Kroenke, 1997). The ecological and biological attributes that make seamounts hotspots of marine life are reviewed in Site O1: Northeastern Seamounts, and also apply to this SUMA. No further information was available about the seamounts and ridges in this SUMA.

Type and number of sources (score = 1)

Three peer-reviewed papers were used to define the geology of this SUMA, but no information was found to describe its biological and ecological attributes. References used to describe seamounts in Site O1: Northeastern Seamounts are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Marine Resources Act 2005
- Environment Act 2003 potentially applies to all SUMAs

Commercial fishing is potentially undertaken in this offshore SUMA. There are multiple regulatory obligations on the Cook Islands Government and individual fishing enterprises that operate in this SUMA including:

- Marine Resources (Purse Seine Fishery) Regulations 2013
- Marine Resources (Large Pelagic Longline Fishery and Quota Management System) Regulations 2016
- Large Pelagic Longline Fishery Plan (2016)
- Cook Islands Shark Sanctuary and Marine Resources (Shark Conservation) Regulations 2012
- Sections 8 and 15 of the Purse Seine and Longline Fishery Regulations and Section 15 respectively that address protection of non-target species and mandate that commercial fishing must comply with various national plans of action including:
    - National Plan of Action for the Conservation and Management of Sharks (NPoA – Sharks) (MMR 2012)
    - Action Plan for Sea Turtle Mitigation (NPoA – Turtles) (MMR 2008)
    - National Plan of Action for Reducing Incidental Catch of Seabirds (NPOA-Seabirds) (MMR 2007)
- WCPFC Conservation and Management Measures (CMMs) that affect commercial fishing activities in the Cook Islands EEZ.

Marine mammals and sharks found around seamounts are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

3.5 Site O5: Marine Mammal Migratory Pathways

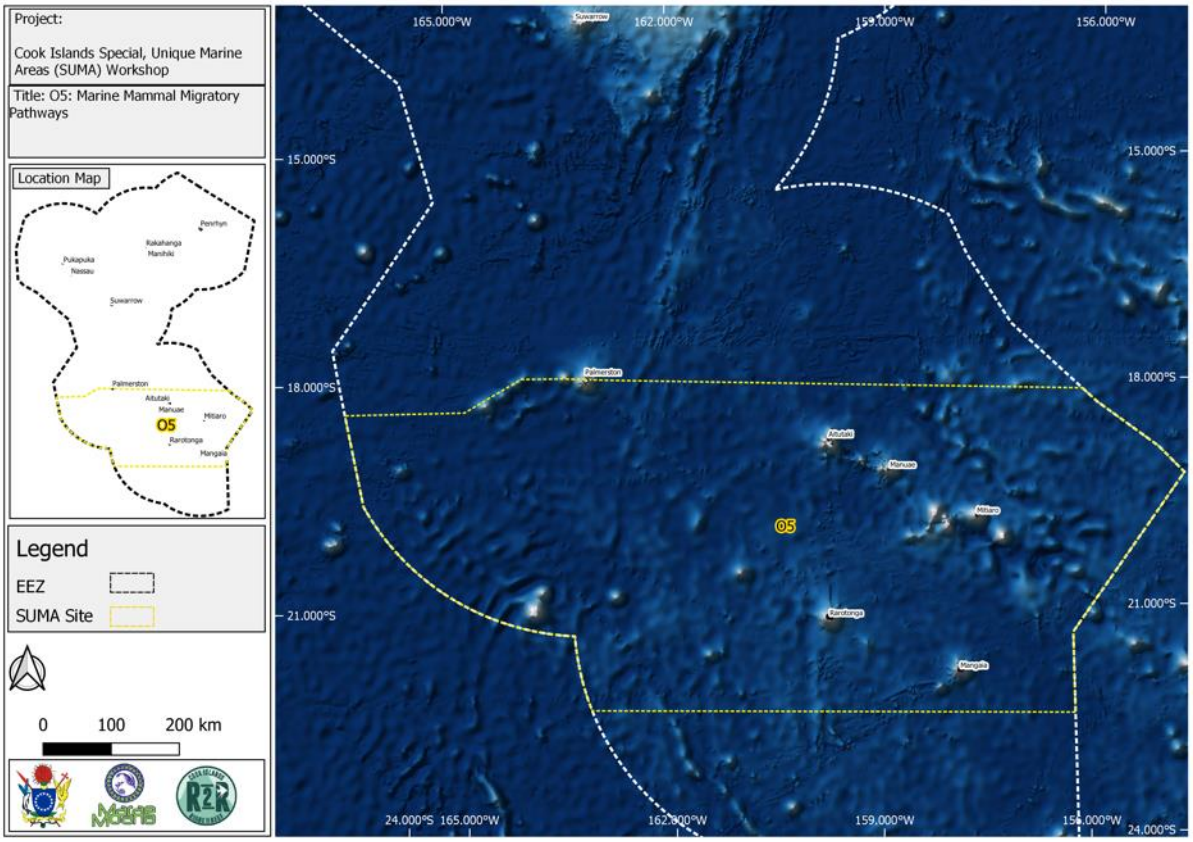


Figure 6. Site O5: Marine Mammal Migratory Pathways

Table 6. Site O5: Marine Mammal Migratory Pathways

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Offshore sites	Marine Mammal Migratory Pathways	O5	1	2.5	3	1	**7.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-18.012084	-164.05165	O5 (A)
	-18.167476	-156.25242	O5 (B)
	-22.474013	-156.26983	O5 (C)
	-21.433114	-163.39744	O5 (D)

Geographic explicitness (score = 1)

The broad area of ocean spanning from Palmerston Island at the northern end to Rarotonga at the southern end and extending between the Ngaputoru group of islands to the east and the western EEZ boundary is used by humpback whales during their migrations. The exact pathways are not well known, and northern waters may be used as well. However, the area

within the boundaries of this SUMA is known for its concentration of pathways used by tagged whales as they migrate west (Greenpeace International, 2015).

Justification (score = 2.5)

This SUMA was chosen due to the importance of these waters for marine mammals[8], especially for humpback whales (*Megaptera novaeangliae*) as they travel westwards from the southern Cook Islands (Figure 7). Humpback whales occur globally as a series of geographically and genetically distinct populations that migrate annually between Antarctic feeding grounds and low-latitude breeding areas. Oceania has the most endangered migratory population of humpback whales in the world (Derville et al., 2018). Connections between Antarctic feeding grounds and breeding areas in Oceania, and the degree of movement between different areas of the southwestern South Pacific, are not well known (Hauser et al., 2010; Pastene et al., 2013). Photo-identification studies suggest limited exchange between New Caledonia, Tonga, Vanuatu, the Cook Islands, and French Polynesia (Constantine et al., 2012). Humpback whales that frequent the Cook Islands are considered by the International Whaling Commission (IWC) to be part of Breeding Stock F (Garrigue et al., 2002); they are present in aggregations that appear to be small and transient, with connections primarily to Tonga, American Samoa and Samoa (Hauser et al., 2010).

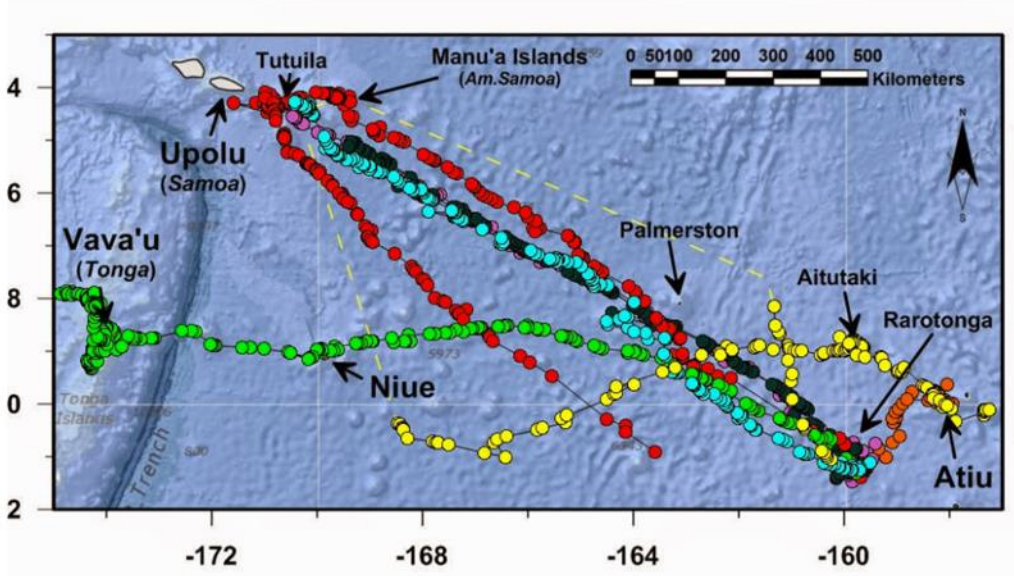


Figure 7. Migratory pathways of humpback whales tagged by Nan Hauser off Rarotonga. Each colour represents an individual humpback whale. Reproduced with permission from Nan Hauser.

This SUMA is also located within the Cook Islands Southern Group Important Marine Mammal Area (IMMA), listed for its breeding, calving and migrating populations of humpback whales, resident spinner dolphins (*Stenella longirostris*) and the general diversity of marine mammals (Marine Mammal Protected Area Task Force, 2020). During their work on humpback whales, Hauser and Clapham (2005) recorded 26 additional species of cetaceans, with others likely to occur here (Table 7). Research has shown that calving humpback whales and resident spinner dolphins are mostly found close to the islands (Hauser and Clapham, 2005). However, this SUMA specifically covers areas used during migration and may also include feeding areas of other cetaceans (Garrigue et al., 2002; Hauser et al., 2010; Olavarría et al., 2007).

[8] http://whaleresearch.org/

Humpback whale research has taken place for almost twenty years around Rarotonga, Aitutaki, Mangaia, Atiu and Palmerston, resulting in photo and genetic identification of individuals, acoustics, communication, behaviour, migration patterns, population identity and abundance (Hauser et al., 2010; Hauser and Clapham, 2005), as well as the development of novel methods to study whales (Hauser, 2020). Most observer effort has been focused around Rarotonga (Hauser, 2020).

Table 7. Whales and dolphins confirmed or likely to occur in the Cook Islands EEZ. Compiled by Nan Hauser, Centre for Cetacean Research and Conservation.

Scientific Name	Common Name	IUCN Status
Balaenoptera bonaerensis	Antarctic minke whale	Near threatened
Mesoplodon densirostris	Blainville's beaked whale	Data deficient
Balaenoptera musculus	Blue whale	Endangered
Tursiops truncatus	Bottlenose dolphin	Least concern
Balaenoptera edeni	Bryde's whale	Least concern
Delphinus delphis / frontalis	Common dolphin	Least concern
Ziphius cavirostris	Cuvier's beaked whale	Least concern
Balaenoptera acutorostrata	Dwarf minke whale	Least concern
Kogia simus	Dwarf sperm whale	Least concern
Pseudorca crassidens	False killer whale	Near threatened
Balaenoptera physalus	Fin whale	Vulnerable
Lagenodelphis hosei	Fraser's dolphin	Least concern
Megaptera novaeangliae	Humpback whale	Endangered
Orcinus orca	Killer whale	Data deficient
Peponocephala electra	Melon-headed whale	Least concern
Balaenoptera omurai	Omura whale	Data deficient
Lagenorhynchus australis	Peale's dolphin	Least concern
Feresa attenuata	Pygmy killer whale	Least concern
Kogia breviceps	Pygmy sperm whale	Least concern
Grampus griseus	Risso's dolphin	Least concern
Steno bredanensis	Rough-toothed dolphin	Least concern
Balaenoptera borealis	Sei whale	Endangered
Globicephala macrorhynchus	Short-finned pilot whale	Least concern
Physeter macrocephalus	Sperm whale	Vulnerable
Stenella longirostris	Spinner dolphin	Least concern
Stenella attenuata	Spotted dolphin	Least concern
Stenella coeruleoalba	Striped dolphin	Least concern

Type and number of sources (score = 3)

Marine mammals are well-studied in the Cook Islands, with dedicated scientists and long-term research programs resulting in 23 years of data collection led by Nan Hauser, Centre for Cetacean Research and Conservation. Over 60 documents have been produced about humpback whales and other fauna[9]; information for this SUMA was sourced from two websites, two reports and six peer-reviewed papers relating specifically to marine mammals in this area, and four peer-reviewed papers about the Oceania population of humpback whales more generally.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017

[9] whaleresearch.org/publications

- Marine Resources Act 2005
- Environment Act 2003 potentially applies to all SUMAs

Commercial fishing is potentially undertaken in this offshore SUMA. There are multiple regulatory obligations on the Cook Islands Government and individual fishing enterprises that operate in this SUMA including:

- Marine Resources (Purse Seine Fishery) Regulations 2013
- Marine Resources (Large Pelagic Longline Fishery and Quota Management System) Regulations 2016
- Large Pelagic Longline Fishery Plan (2016)
- Cook Islands Shark Sanctuary and Marine Resources (Shark Conservation) Regulations 2012
- Sections 8 and 15 of the Purse Seine and Longline Fishery Regulations and Section 15 respectively that address protection of non-target species and mandate that commercial fishing must comply with various national plans of action including:
    - National Plan of Action for the Conservation and Management of Sharks (NPoA – Sharks) (MMR 2012)
    - Action Plan for Sea Turtle Mitigation (NPoA – Turtles) (MMR 2008)
    - National Plan of Action for Reducing Incidental Catch of Seabirds (NPOA-Seabirds) (MMR 2007)
- WCPFC Conservation and Management Measures (CMMs) that affect commercial fishing activities in the Cook Islands EEZ.

The government declared the Cook Islands Whale Sanctuary in 2001, however there is no legislation or regulations to uphold this declaration. MMR intended to develop a National Plan of Action for the Conservation and Management of Cetaceans in the Cook Islands (NPOA-Cetaceans) in 2017, to enable the ministry and other government agencies to administer the Sanctuary[10]. However, this NPoA remains incomplete as at time of writing this SUMA Report.

All the marine mammals known from this SUMA are listed on the IUCN Red List of Threatened Species, and some are listed under the Convention on Migratory Species (CMS). The Memorandum of Understanding (MoU) for the Conservation of Cetaceans and their Habitats in the Pacific Island Region is a Multilateral Environmental Memorandum of Understanding (MoU) concluded under the auspices of the CMS in collaboration with the Pacific Regional Environment Programme (SPREP). The MoU provides an international framework for coordinated conservation efforts to improve the conservation status of the Pacific Islands cetaceans.

[10] https://www.mmr.gov.ck/legislation/

3.6 Site O6: Southern Cook Islands Seamounts

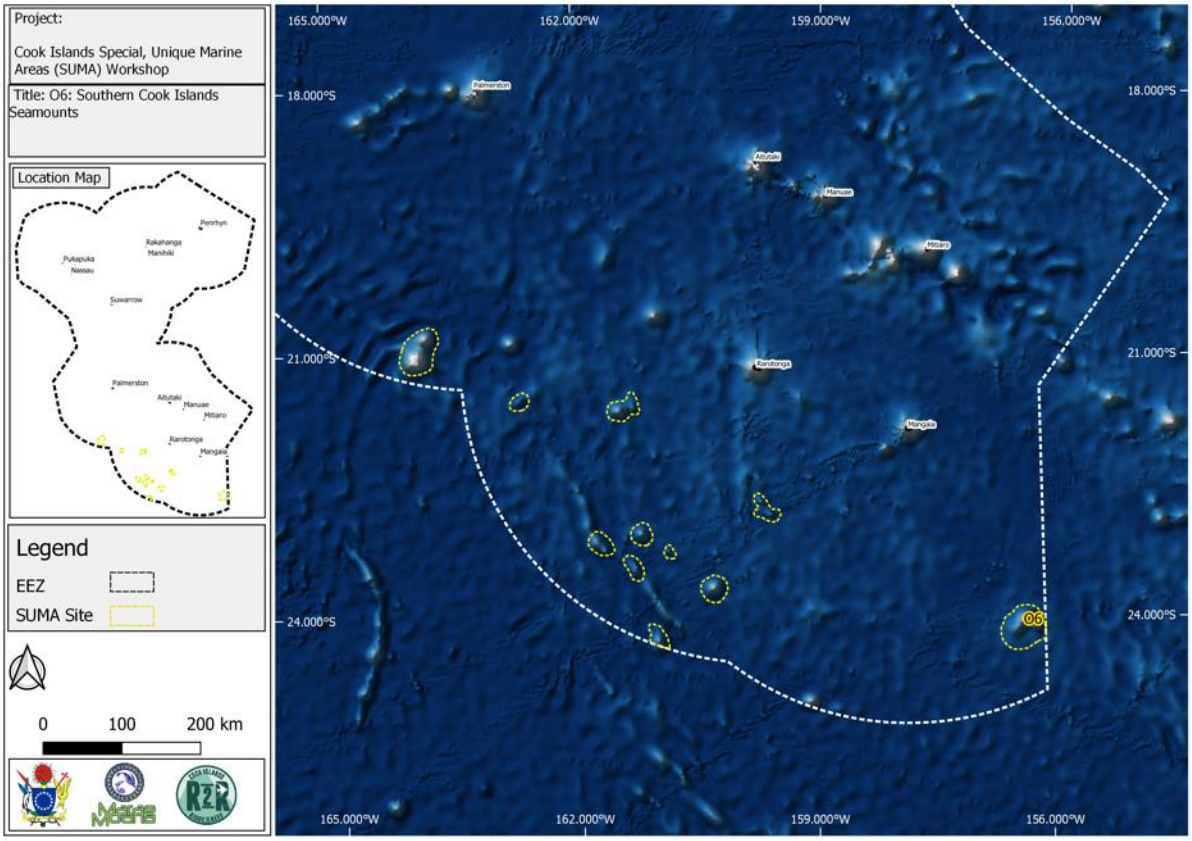


Figure 8. Site O6: Southern Cook Islands Seamounts

Table 8. Site O6: Southern Cook Islands Seamounts

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Offshore sites	Southern Cook Islands Seamounts	O6	1	1.5	1	1	**4.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-20.815209	-164.01319	A
	-22.674575	-159.78603	B
	-24.306018	-156.17295	C
	-24.373987	-161.13342	D

Geographic explicitness (score = 1)

This SUMA includes a cluster of seamounts along the southwestern portion of the Cook Islands EEZ.

Justification (score = 1.5)

The complex geomorphology of seamounts is key in attracting aggregations of marine life in the open ocean (expert and traditional knowledge, SUMA workshop). There are 13

seamounts in this area, representing six different morphotypes. The seamounts lie in depths of between 4,500 and 5,100 m and are mostly classified as small, with deep peak depths ranging from 1,500 to 3,600 m (Appendix 7). The exception is the EBSA-listed Ua Puaka'oa seamount complex, which is very large and potentially has a peak as shallow as 300 m (CBD, 2014). However, further assessment is required to ascertain the depth and dimensions of all the seamounts in this SUMA.

The islands and seamounts of the southern Cook Islands were formed by the same forces that created Rarotonga (Dickinson, 1998). This area is considered one of the geological hotspots of the South Pacific, due to its history and ongoing volcanic and tectonic activity (Wessel and Kroenke, 1997). The ecological and biological attributes that make seamounts hotspots of marine life are reviewed in Site O1: Northeastern Seamounts, and also apply to this SUMA. No further information was available about the seamounts and ridges in this SUMA.

Type and number of sources (score = 1)

Two peer-reviewed papers were used to define the geology of this SUMA, but no information was found to describe its biological and ecological attributes. One of the seamounts in the SUMA is listed as an EBSA, but information in the EBSA report (CBD, 2014) was inferred from other seamounts. References used to describe seamounts in Site O1: Northeastern Seamounts are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Marine Resources Act 2005
- Environment Act 2003 potentially applies to all SUMAs

Commercial fishing is potentially undertaken in this offshore SUMA. There are multiple regulatory obligations on the Cook Islands Government and individual fishing enterprises that operate in this SUMA including:

- Marine Resources (Purse Seine Fishery) Regulations 2013
- Marine Resources (Large Pelagic Longline Fishery and Quota Management System) Regulations 2016
- Large Pelagic Longline Fishery Plan (2016)
- Cook Islands Shark Sanctuary and Marine Resources (Shark Conservation) Regulations 2012
- Sections 8 and 15 of the Purse Seine and Longline Fishery Regulations and Section 15 respectively that address protection of non-target species and mandate that commercial fishing must comply with various national plans of action including:
    - National Plan of Action for the Conservation and Management of Sharks (NPoA – Sharks) (MMR 2012)
    - Action Plan for Sea Turtle Mitigation (NPoA – Turtles) (MMR 2008)
    - National Plan of Action for Reducing Incidental Catch of Seabirds (NPOA-Seabirds) (MMR 2007)
- WCPFC Conservation and Management Measures (CMMs) that affect commercial fishing activities in the Cook Islands EEZ.

Marine mammals and some sharks found around seamounts are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

3.7 Site O7: High-Density Nodule Fields

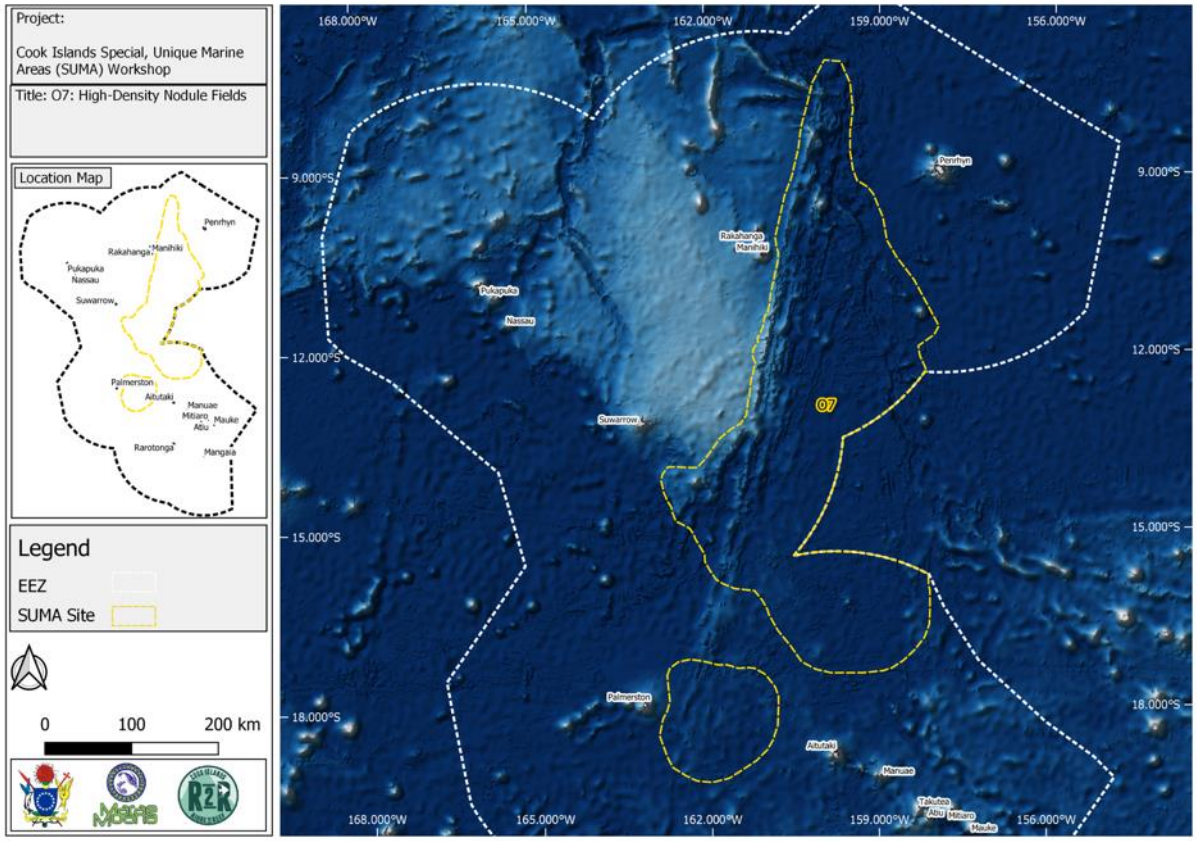


Figure 9. Site O7: High-Density Nodule Fields

Table 9. Site O7: High-Density Nodule Fields

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Offshore sites	High-Density Nodule Fields	O7	2	2.5	2	1	**7.5**

Geographic boundaries:

Map	Latitude	Longitude	Points
	-7.135944838	-159.9419254	A
	-15.86056221	-158.1441557	B
	-19.10623489	-162.6945391	C
	-14.01833386	-162.681649	D

Geographic explicitness (score = 2):

This non-contiguous SUMA incorporates two areas of the Cook Islands EEZ known for their high density of polymetallic nodules on the seabed; together they span 308,680 km^2. The larger, northern area extends from north of Aitutaki, between the eastern side of the Manihiki Plateau and the EEZ boundary, north to the deep ocean west of Tongareva (Penrhyn). The smaller, southern area lies between Palmerston and Aitutaki.

Justification (score = 2.5)

Polymetallic nodules have attracted attention due to their commercial potential. The nodules, which are especially abundant in the Cook Islands EEZ, are concretions of multiple metallic oxides that form very slowly (~ 2 mm per million years) around a central rock or piece of debris. The nodules absorb elements present in seawater and may contain over seventy elements, including practically all metals (Kingan, 1998). In the Cook Islands, the nodules are especially rich in cobalt; they appear to be especially abundant in the southern Penrhyn Basin (Hein et al., 2015; Kingan, 1998) and found in their highest densities throughout this SUMA (Heezen et al., 1966) (Figure 10). In fact, the Cook Islands EEZ is one of only four areas globally with high densities of nodules (McCormack, 2016). The nodules and ecosystems they support are not well understood, but they are known to be highly fragile and vulnerable to disturbance; once damaged, and like other deep-water assemblages may never fully recover (Chin and Hari, 2020; Simon-Lledó et al., 2019a; Vanreusel et al., 2016).

A 2001 research expedition seeking seabed minerals in the Cook Islands EEZ recorded five phyla and eight biogroups of organisms on the plateau seabed, and confirmed traces of organisms (mounds, faeces, and trails) (Heezen et al., 1966). Abundant taxa included sponges, sea cucumbers, starfishes, isopods and polychaetes. Many of the macrobenthic organisms were thought to feed or otherwise rely on the manganese nodules on the seabed (Chin and Hari, 2020).

Further information about ecological communities associated with polymetallic nodule fields can be inferred from research conducted in the Clarion-Clipperton Zone (CCZ), a ~6 million km^2 region between the Clarion and Clipperton Fracture Zones, in Areas Beyond National Jurisdiction (ABNJ) (high seas). Using a remotely operated vehicle, the ABYSSLINE Project estimated the presence of 229 different megafaunal morphotypes, with a megafaunal density of around 1.48 ind. m^{-2}, and seven new species and four new genera (Amon et al., 2016). Importantly, half of the morphotypes recorded occurred only on polymetallic nodules, and there was a positive correlation between megafaunal and nodule abundance (Amon et al., 2016). A different study in the CCZ using video transects found that epifaunal densities were more than double when nodule coverage was dense (>25 individuals per 100 m^2) versus sparse ≤10 individuals per 100 m^2). Some alcyonacean and antipatharian corals were virtually absent from nodule-free areas (Vanreusel et al., 2016) and the giant protists (xenophyophores) doubled with a very modest initial increase in nodule cover (from 1% to 3%) (Simon-Lledó et al., 2019c). Even small variations in nodule cover (1–20%) were related to changes in faunal abundance, the types of species present, and biodiversity (Simon-Lledó et al., 2019c). In the Peru Basin, nodules were found to offer a specific ecological niche (Simon-Lledó et al., 2019b), with hard substrate, high metal concentrations, and sessile fauna, that distinguished them from typical deep-sea benthos, and the nodule fields therefore host a different microbial community (Molari et al., 2020).

Research indicates that polymetallic nodule fields constitute a unique environment on deep seabeds, with a different, and often richer variety, of organisms than surrounding soft sediment habitats, including species that rely solely on the nodules for habitat and not found anywhere else in the world (Simon-Lledó et al., 2019c). Higher densities of nodules are associated with higher faunal densities, clearly supporting the special and unique status of this SUMA.

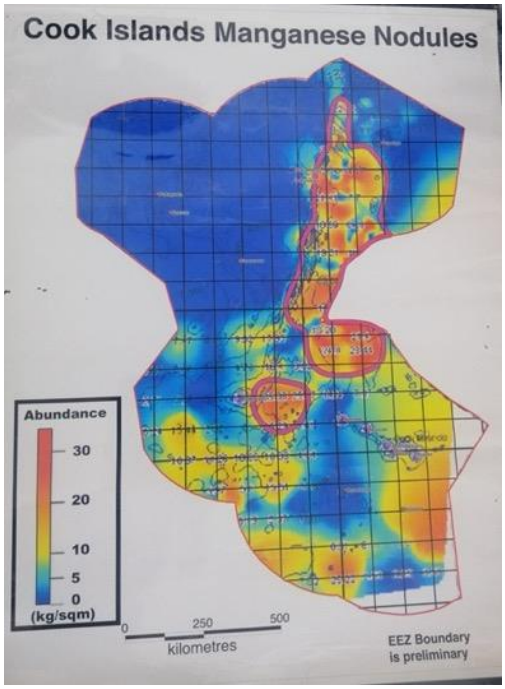


Figure 10. Abundance of manganese nodules in the Cook Islands EEZ, showing the areas with the highest densities. From McCormack (2016).

Type and number of sources (score = 2)

A number of documents describe the nodule fields of the Cook Islands EEZ, but most have little or no information about their biophysical values. The attributes of nodule fields relevant to this SUMA were described using eight peer-reviewed papers and three reports.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Marine Resources Act 2005
- Environment Act 2003 potentially applies to all SUMAs.

Seabed minerals exploration and mining will potentially be undertaken in this SUMA. These activities are regulated by a complex array of legislation[11] including:

- Seabed Minerals Act 2019 and Seabed Minerals Amendment Act 2020
- Seabed Minerals (Exploration) Regulations 2020
- Environment Act 2003. The National Environment Council (Council), established under the Act, acts as the permitting authority for seabed minerals activities.
- Draft Environment (Seabed Minerals Activities) Regulations 2020.

The Cook Islands is a contracting party to the United Nations Convention on the Law of the Sea. UNCLOS is international agreement which defines the rights and responsibilities of nations in their use of the world's oceans, establishing guidelines for businesses, the environment, and the management of marine natural resources. UNCLOS confers rights to natural resources and also imposes certain obligations. These obligations are couched in a

[11] https://www.sbma.gov.ck/laws

general duty owed to the international community to "protect and preserve the marine environment"[12].

Commercial fishing is undertaken in this offshore SUMA. There are multiple regulatory obligations on the Cook Islands Government and individual fishing enterprises that operate in this SUMA including:

- Marine Resources (Purse Seine Fishery) Regulations 2013
- Marine Resources (Large Pelagic Longline Fishery and Quota Management System) Regulations 2016
- Large Pelagic Longline Fishery Plan (2016)
- Cook Islands Shark Sanctuary and Marine Resources (Shark Conservation) Regulations 2012
- Sections 8 and 15 of the Purse Seine and Longline Fishery Regulations and Section 15 respectively that address protection of non-target species and mandate that commercial fishing must comply with various national plans of action including:
    - National Plan of Action for the Conservation and Management of Sharks (NPoA – Sharks) (MMR 2012)
    - Action Plan for Sea Turtle Mitigation (NPoA – Turtles) (MMR 2008)
    - National Plan of Action for Reducing Incidental Catch of Seabirds (NPOA-Seabirds) (MMR 2007)
- WCPFC Conservation and Management Measures (CMMs) that affect commercial fishing activities in the Cook Islands EEZ.

Marine mammals and some sharks found around seamounts are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

[12] https://www.sbma.gov.ck/laws

4 Inshore biophysically special and/or unique marine areas

4.1 Northern Cook Islands

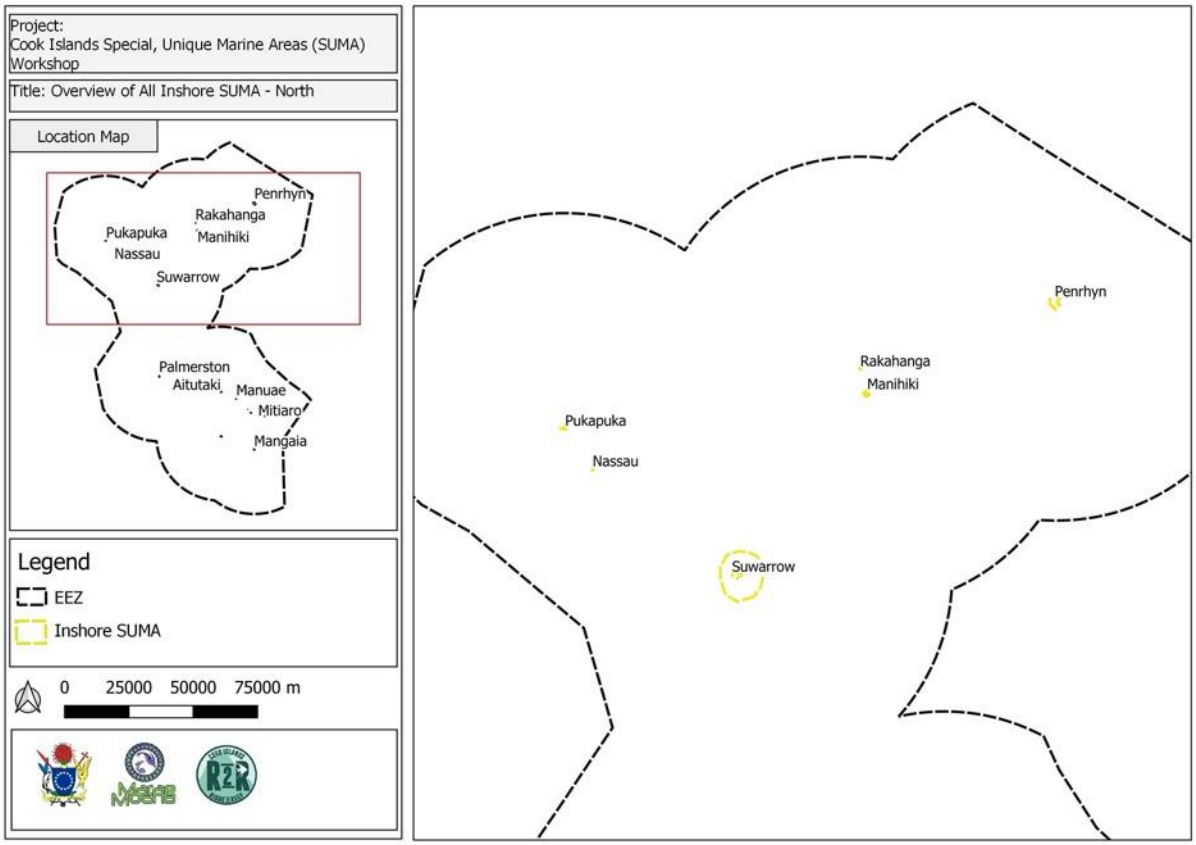


Figure 11. Overview of the northern Cook Islands' inshore SUMA sites.

4.1.1 Site TON1: Tongareva - Flying Venus Reef

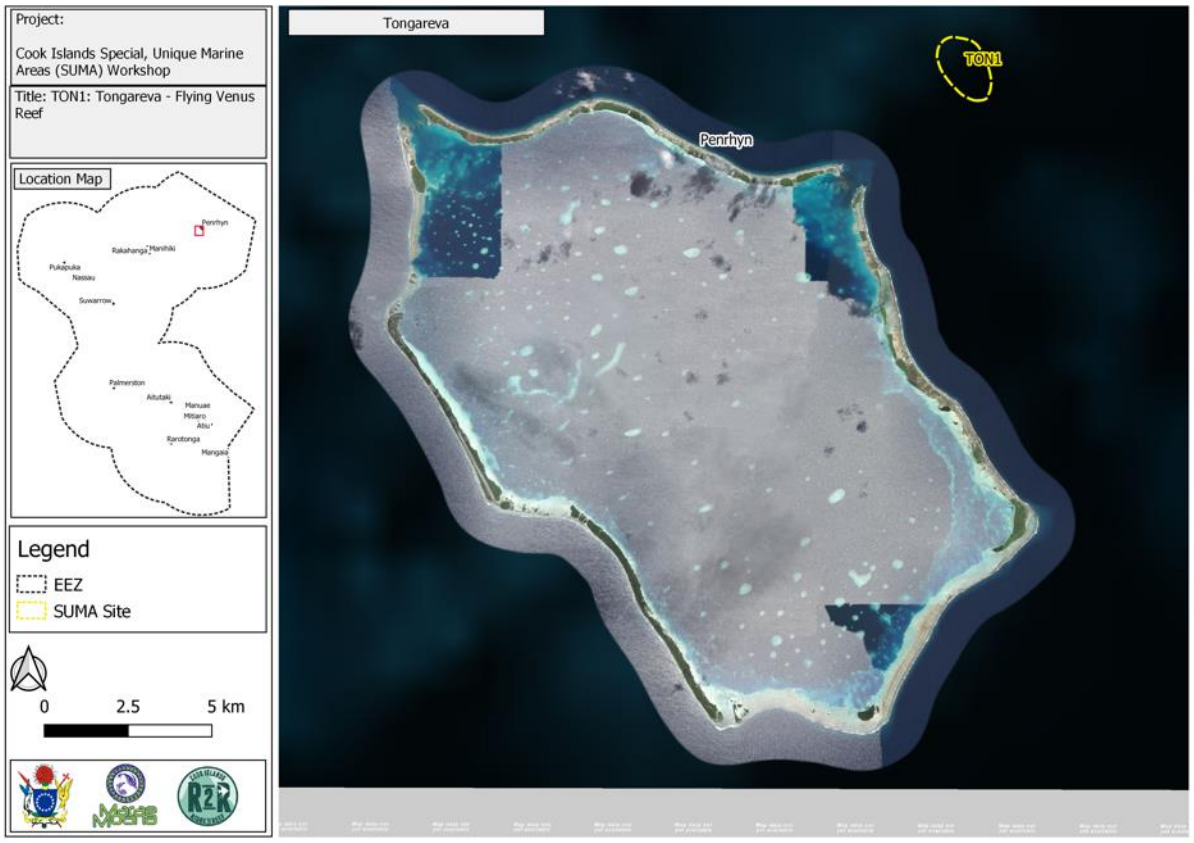


Figure 12. Site TON1: Tongareva - Flying Venus Reef.

Table 10. Site TON1: Tongareva - Flying Venus Reef

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Tongareva – Flying Venus Reef	TON1	1	1	2.5	1	**5.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-8.8994626	-157.90443	TON1 (A)
	-8.9160461	-157.8944	TON1 (B)

Geographic explicitness (score = 1)

Flying Venus Reef is a ridge of reef that lies to the northeast of the main atoll of Tongareva (also known as Penrhyn) and rises from over 1,000 m into shallow depths (5.6-9.4 m).

Justification (score = 1)

Flying Venus Reef was identified as a SUMA due to its high biodiversity. Globally, coral reefs are among the ecosystems most valued for their productivity, diversity, conservation and economic value. Human activities are degrading reefs worldwide, and resilient coral reefs

are becoming more important and valuable, as their ability to recover from natural and climate change induced disturbance events confers to them a role of refuges and sources of larvae that assist the recovery of more damaged reefs (Holbrook et al., 2016). Typically, coral reef resilience is expected to be higher on reefs further from human activities (França et al., 2020; McLean et al., 2016), with intact trophic structure, especially populations of predators and herbivores (Brewer et al., 2012; Holbrook et al., 2016; McLean et al., 2016), higher coral cover (Hughes, 2006), higher diversity (Ferrigno et al., 2016), greater structural complexity, deeper habitats acting as refuges, higher densities of juvenile corals and low nutrient loads (Graham et al., 2015). Remote and isolated coral reefs also have a greater likelihood of hosting unique assemblages, genetically distinct populations, or even endemic species (Hobbs et al., 2013; Hughes et al., 2002). The coral reef in this SUMA may have some of these attributes, due to its relative isolation from direct human influence.

Coral reefs in the Cook Islands are estimated to be home to up to 600 species of fish, 100 species of algae and 1,500 invertebrate species (MMR, 2000a). Some of the coral reefs in the Cook Islands, especially Rarotonga, have been studied during repeated surveys, while others have received less attention (Purkis et al., 2018; Rongo et al., 2017). Species richness is proportional to the generally declining values with increasing distance to the Coral Triangle epicentre of diversity in the Indo-Australian archipelago (MMR, 2000a). In 2013, indicators such as coral cover and fish biomass were comparable to those of other South Pacific Island countries (Purkis et al., 2018). Populations on islands separated from each other by 100 km or more, such as many of the Cook Islands reefs, are expected to be mostly reliant on self-seeding (Bay et al., 2017), although there is probably some connectivity between Tongareva and Flying Venus Reef. Patterns of gene flow tested with giant clams (*Tridacna maxima*) throughout the Pacific were consistent with extensive past dispersal of marine species from the Indo-Malay region, but dispersal was to some degree inconsistent with the directions of present-day ocean surface currents (Benzie and Williams, 1997).

Reefs have suffered from periodic crown-of-thorns starfish outbreaks and cyclones and, more recently, global heatwaves causing coral bleaching (Rongo and Dyer, 2015). Cyclones, which are closely linked to El Niño / Southern Oscillation (ENSO), are twice as prevalent in the southern Cook Islands as in the northern Cook Islands (de Scally, 2008). The northern Cook Islands were severely bleached during the 2015 / 2016 El Niño event (Rongo, 2016); in Tongareva, corals throughout the lagoon and shallow barrier reefs were severely bleached (White, 2016a, 2020). Shallow reef slope assemblages, especially in the northern Cook Islands, appear dominated by Pocilloporid corals (Rongo, 2016); these are often vulnerable to thermal bleaching. There also appeared to be a longitudinal effect of thermal stress, with impacts higher on Tongareva and declining toward Pukapuka (Rongo, 2016). Bleaching was recorded again in 2019, despite slightly cooler temperatures than those in 2016; this latest bleaching event was probably caused by high ultraviolet (UV) radiation (White, 2020). The eastern reef closest to Flying Venus Reef was not surveyed, but rough weather and lower temperatures were recorded than on lagoonal and western reefs, suggesting a lower likelihood of bleaching (White, 2019).

Reef fish abundance, biomass and species richness tend to be reflective of human use, with richer assemblages and higher predator abundance further from human populations (Purkis et al., 2018); fishing pressure on Flying Venus Reef is unknown. Biogeographically, fish assemblages on Cook Islands reefs are associated with French Polynesia and Pitcairn to form a “South Polynesia” region (Kulbicki, 2007). Species exist that are endemic to this region of the Pacific, including the damselfish *Dascyllus auripinnis* (Randall and Randall, 2001), the

blenny *Stanulus seychellensis*, the groupers *Epinephelus tuamotuensis* and *Odintanthias tapui*, the wrasses *Bodianus paraleucosticticus*, *Coris roseoviridis*, *Labropsis polynesica*, *Oxycheilinus lineatus*, *Pseudocheilinus citrinus* and *Cirrhilabrus claire*, the leatherjacket *Cantherhines longicaudus*, the angelfish *Centropyge boylei*, *C. nigriocellus* and *Genicanthus spinus*, and the squirrelfish *Sargocentron hormion* (Appendix 5).

Tongareva has the largest lagoon in the Cook Islands, well-flushed through a few wide passes. Trochus were introduced to the inner reef from Aitutaki in the 1980s and were well-established in some parts of the western reef in 1997 (Ponia et al., 1997). The lagoon passes are known to be spawning aggregation sites for groupers (MMR, 2000a). Forereefs were strongly impacted by the 2015/2016 El Niño event, with 60% bleaching and heavy mortality among Pocilloporid corals (Rongo, 2016); the effects of this bleaching event on Flying Venus Reef are unknown. Surveys of reefs on Tongareva Atoll have not included sites on the eastern forereef, which would be most representative of likely ecological communities on Flying Venus Reef.

Type and number of sources (score = 2.5)

There was no information available to describe Flying Venus Reef. Its values were inferred from eleven peer-reviewed papers on coral reefs in general, four reports and six peer-reviewed papers about coral reefs in the Cook Islands and four reports and two articles that had some information about coral reefs on Tongareva.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area (MPA) of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005
- Environment Act 2003 potentially applies to all SUMAs.

Other management obligations for this SUMA include:

- Penrhyn (Prohibition on Exportation of Paua) By-Laws 2007 prohibit the export of pasua (paua, giant clam) from Penrhyn. Although paua (paua; giant clams) are not specifically mentioned as a value, they are likely present in this SUMA.
- Although the island of Tongareva (and its internal waters) are not governed under the Environment Act 2003, this SUMA occurs within the territorial seas which does fall within the jurisdiction of the Act.
- This SUMA is important for coral reefs. Many of the species that live on coral reefs are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

4.1.2 Site TON2: Tongareva - Taruia Reef Pass

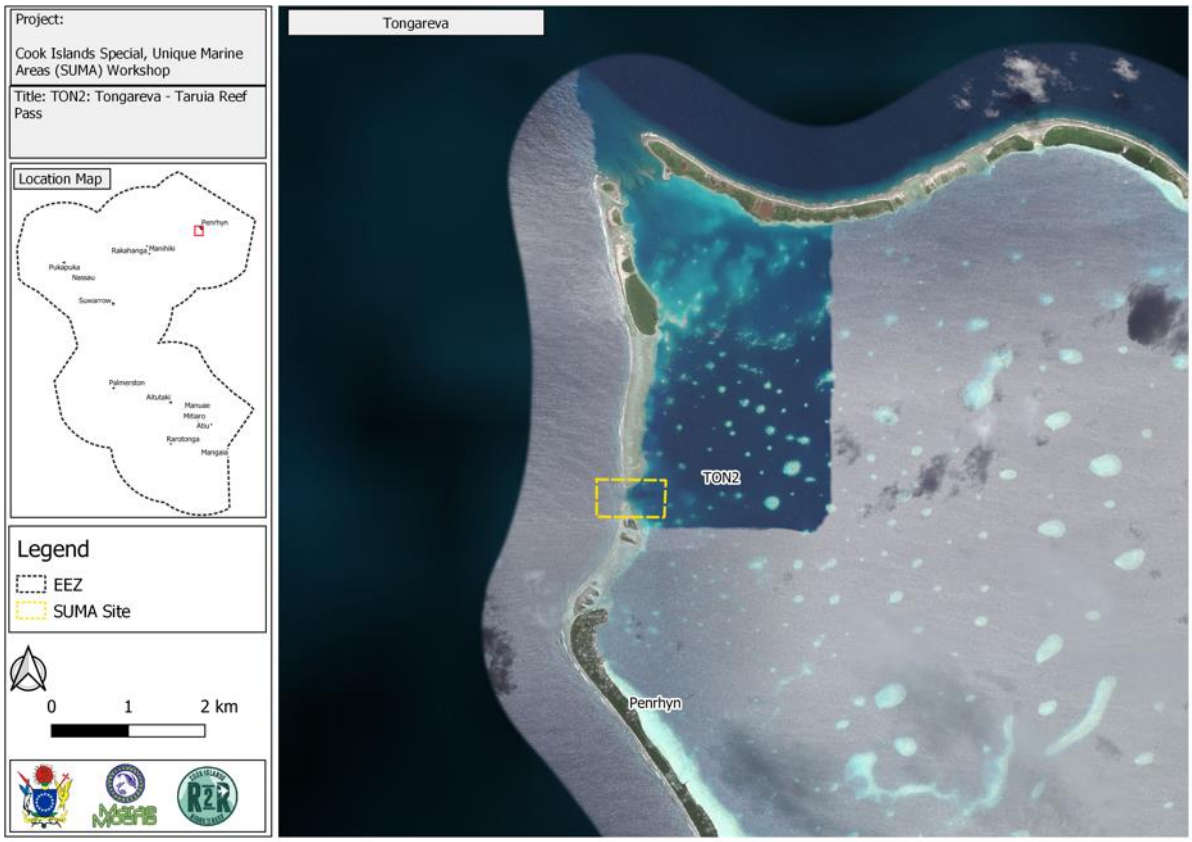
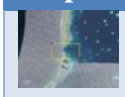


Figure 13. Site TON2: Tongareva - Taruia Reef Pass.

Table 11. Site TON2: Tongareva - Taruia Reef Pass

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Tongareva – Taruia Reef Pass	TON2	2	2.5	3	3	**10.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-8.9586254	-158.05306	TON2 (A)
	-8.9630682	-158.04503	TON2 (B)

Geographic explicitness (score = 2)

Taruia Reef Pass is the west-facing passage of Tongareva Atoll (Penrhyn). It measures approximately 400 m across and is up to 7 m deep. Winds are predominantly from the east, and water generally moves through the pass from east to west. This is one of three major passages for water exchange into and out of the lagoon, which measures 233 km^2.

Justification (score = 2.5)

Taruia Reef Pass was identified as a SUMA because of its aggregations of manta rays, sharks, frequent presence of Napoleon wrasse (*Cheilinus undulatus*) and spawning

aggregations of saddleback grouper (*Plectropomus laevis*) and camouflage grouper (*Epinephelus polyphekadion*). Forereefs around this atoll were strongly impacted by the 2015/2016 El Niño event, with 60% bleaching and heavy mortality among Pocilloporid corals, including at a site just south of the pass (Rongo, 2016). Tongareva has the largest lagoon in the Cook Islands and passes such as this one contribute to its flushing and to the movements of marine life between oceanic and lagoonal habitats. Green turtles (*Chelonia mydas*) are frequently observed mating in the pass, making this a critical turtle habitat (Dr. M. White, pers. obs.). Tidal currents are likely to enhance the movement of nutrients through the pass, providing a bottleneck where planktivorous species such as manta rays tend to aggregate to feed (Mourier, 2012).

Manta rays have not been specifically studied in the Cook Islands, but there are observations in the Tongareva lagoon passes (The Cook Islands Natural Heritage Trust, 2007). It is uncertain whether references to manta rays during the workshop were giant manta rays (*Mobula birostris*) or reef manta rays (*Mobula alfredi*), but both are thought to occur in the Cook Islands (White et al., 2018). Reef manta rays and spinner dolphins are often observed feeding directly outside the pass (Dr. M. White, pers. obs.). Their migratory lifestyle makes them highly susceptible to industrial fishing fleets and they are therefore of conservation concern (Appendix 5). As large planktivores, manta rays convert pelagic biomass into organic matter that can be used by benthic organisms, contributing to nutrient cycling on coral reefs (Peel et al., 2019). Recent research shows they also feed on mesopelagic zooplankton, creating a trophic link between deep and shallow waters (Burgess et al., 2016) and occupying a unique role among coral reef planktivores (Peel et al., 2019). Manta rays often decline in response to high fishing pressure, making their presence one of the signs of relatively intact food webs (Glynn, 2004). Studies of their movement patterns suggest a high tendency toward site fidelity (Peel et al., 2019), making protection at local feeding sites an effective conservation tool (Stewart et al., 2016).

Lagoon passes are also frequently used by sharks to travel between the lagoon and outer reef. Reef sharks are prominent predators on coral reefs, regulating prey populations, but their ecological roles have been found to be at a similar trophic level to most large predatory reef teleosts, such as groupers (Roff et al., 2016). Sharks and other predators often decline in response to high fishing pressure, making their presence one of the signs of relatively intact ecosystems (Glynn, 2004). Shark research was conducted on Tongareva Atoll in 2018/19 by NGO SharksPacific, which is believed to contain the highest densities of sharks in the Cook Islands[13] with abundant blacktip reef sharks (*Carcharhinus melanopterus*) in the lagoon[14]. The data relating to this research are expected to be published in 2021 (J. Cramp, pers. comm). General information about sharks in the Cook Islands is reviewed in Site O3: Palmerston – Kona Reef.

The Napoleon or humphead wrasse (*Cheilinus undulatus*) is thought to be rare in Tongareva (The Cook Islands Natural Heritage Trust, 2007), meaning that sites that provide favourable habitat are particularly important. The humphead wrasse is among the largest bony fishes found on Indo-Pacific coral reefs; it matures late (~ 6 years of age) and grows slowly, reaching over one meter in length (Taylor et al., 2018). Widespread population declines have been reported for this species across its range, resulting in its Endangered status, especially as localised conservation efforts have not always been successful (Hamilton et al., 2019; Sadovy

[13] https://sharkspacific.org/shark-island/
[14] http://www.cookislands.org.uk/

de Mitcheson et al., 2019). Population declines have been attributed to commercial fishing pressure to supply local, national and international markets (Lennox et al., 2019). Humphead wrasse are important predators of invertebrates, including crown-of-thorns starfish (Sadovy et al., 2003). The abundance and distribution of humphead wrasse on Tongareva Atoll are currently unknown, but this species is frequently seen in Tongareva (Dr. M. White, pers. obs.).

The lagoon passes on Tongareva are known to be spawning aggregation sites for groupers (MMR, 2000a), especially *Plectropomus laevis* (expert and traditional knowledge, SUMA workshop), *Epinephelus polyphekadion* and *Cephalopholis argus* (Passfield, 1996). Reef fishes breed by spawning, the release of gametes into the water for external fertilization; most species form aggregations to maximize the likelihood of success (Russell et al. 2014). Individuals often travel long distances to a particular site to spawn in high densities. This critical event can involve multiple species and occurs in conjunction with certain phases of the moon or tidal cycles, to further maximize the likelihood of fertilization (Domeier and Colin 1997). On Tongareva, *E. polyphekadion* are known to gather in the lagoon for two to three weeks before spawning and are targeted by subsistence fishers around lagoonal coral heads (Passfield, 1996). Spawning aggregations are essential for the future of fish populations and especially vulnerable to fishing, as the high density is an artificial and temporary phenomenon that aggregates individuals from a wide area. Targeting them for fishing rapidly depletes fish populations from a broad catchment (Abesamis et al., 2014). On the other hand, protecting multi-species spawning aggregation sites can help protect the spawning stocks of many species (Grüss et al., 2014).

Type and number of sources (score = 3)

Two reports, one peer-reviewed paper and two websites (Cook Islands Biodiversity Database and Sharks Pacific), provided some information about the attributes of this SUMA. The values for which it was chosen were further described using six peer-reviewed papers for manta rays, five peer-reviewed papers for humphead wrasse, and four peer-reviewed papers about spawning aggregations. References used for Site O3: Palmerston – Kona Reef also pertain to this SUMA, and an additional two peer-reviewed papers were used for sharks.

Obligations (score = 3)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area (MPA) of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- Penrhyn (Prohibition on Exportation of Paua) By-Laws 2007 prohibit the export of paua (paua, giant clam) from Penrhyn. Although paua (paua; giant clams) are not specifically mentioned as a value, they are likely present in this SUMA.
- Marine Resources (Shark Conservation) Regulations 2012 and the National Plan of Action for the Conservation and Management of Sharks in the Cook Islands (NPoA –

Sharks) (MMR 2012) are of particular relevance given the significance of sharks in this SUMA.

- Manta rays, sharks, humphead wrasse, groupers and many of the other species that live on coral reefs are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

Sharks are protected by the Cook Islands Shark Sanctuary, and spawning aggregations come under the Marine Resources Act 2005.

4.1.3 Site TON3: Tongareva - Northern Reef Pass

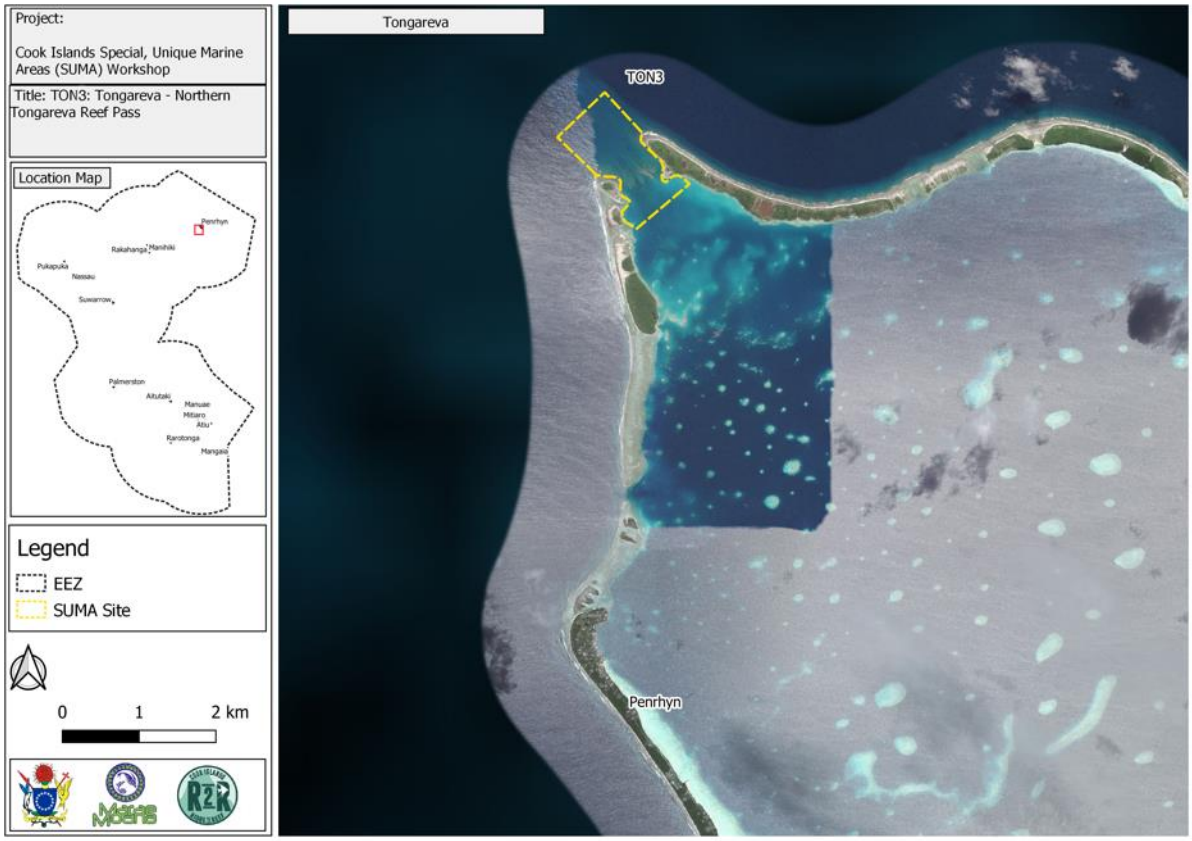


Figure 14. Site TON3: Tongareva - Northern Reef Pass.

Table 12. Site TON3: Tongareva - Northern Reef Pass

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Tongareva – Northern Reef Pass	TON3	2	1	2	2	**7**

Geographic boundaries

Map	Latitude	Longitude	Points
	-8.91317	-158.05222	TON3 (A)
	-8.923916	-158.04214	TON3 (B)
	-8.9292288	-158.04841	TON3 (C)
	-8.918481	-158.05783	TON3 (D)

Geographic explicitness (score = 2)

This SUMA is the northwest-facing passage of Tongareva (Penrhyn) Atoll, also known as Siki Rangi. It measures approximately 700 m across and is up to 10 m deep. This is one of three major passes for water exchange into and out of the lagoon, which measures 233 km^2.

Justification (score = 1)

The northern reef pass of Tongareva Atoll was chosen by workshop participants for its shark aggregations and the importance of the seaward area as an upwelling site and tuna habitat. Tongareva has the largest lagoon in the Cook Islands and passes such as this one contribute to its flushing and to the movements of marine life between oceanic and lagoonal habitats. Tidal currents are likely to enhance the movement of nutrients through the pass, providing a bottleneck where planktivorous species feed, attracting higher-order predators such as tuna and sharks. Much of the information presented in Site TON2: Tongareva - Taruia Reef Pass also pertains to this SUMA.

Lagoon passes are often used by sharks to travel between the lagoon and outer reef. Shark research was recently conducted on Tongareva Atoll, which is believed to be the "sharkiest island" in the Cook Islands[15] with abundant blacktip reef sharks (*Carcharhinus melanopterus*) in the lagoon[16]. General information about sharks in the Cook Islands is reviewed in Site O3: Palmerston – Kona Reef.

The most common tuna species in the Cook Islands are albacore, yellowfin and skipjack tuna (*Thunnus alalunga*, *T. albacares* and *Katsuwonus pelamis*), targeted by the Western and Central Pacific fisheries (MMR, 2000a). Bigeye tuna (*Thunnus obesus*), blue marlin (*Makaira nigricans*), striped marlin (*Kajikia audax*) and swordfish (*Xiphias gladius*) and a number of pelagic shark species are also found in Cook Islands waters (MMR, 2019a). The northern part of the EEZ appears to be more productive than the southern part, especially in recent years (MMR, 2019a). Movements of pelagic species can be influenced by large-scale oceanographic patterns; over the last four decades sea surface temperatures in the Cook Islands have risen by ~0.1–0.3 °C per decade, and sea level by ~2–3 cm per decade (Harrison and Carson, 2013). The species most abundant around Tongareva Island, and therefore probably occurring in this SUMA, are yellowfin tuna, which are proportionally more abundant than in other areas (MMR, 2019a).

Type and number of sources (score = 2)

References used to describe Site TON2: Tongareva - Taruia Reef Pass, and for sharks in Site O3: Palmerston – Kona Reef, are also relevant here. General information on tuna and other pelagic predators in the Cook Islands was sourced from two reports and one peer-reviewed paper, and from references used in Site O2: Manihiki Plateau.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area (MPA) of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

[15] https://sharkspacific.org/shark-island/
[16] http://www.cookislands.org.uk/

- Penrhyn (Prohibition on Exportation of Paua) By-Laws 2007 prohibit the export of paua (paua, giant clam) from Penrhyn. Although paua (paua; giant clams) are not specifically mentioned as a value, they are likely present in this SUMA.
- Marine Resources (Shark Conservation) Regulations 2012 and the National Plan of Action for the Conservation and Management of Sharks in the Cook Islands (NPoA – Sharks) (MMR 2012) are of particular relevance given the significance of sharks in this SUMA.
- Sharks and many of the other species that live on coral reefs are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

4.1.4 Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua

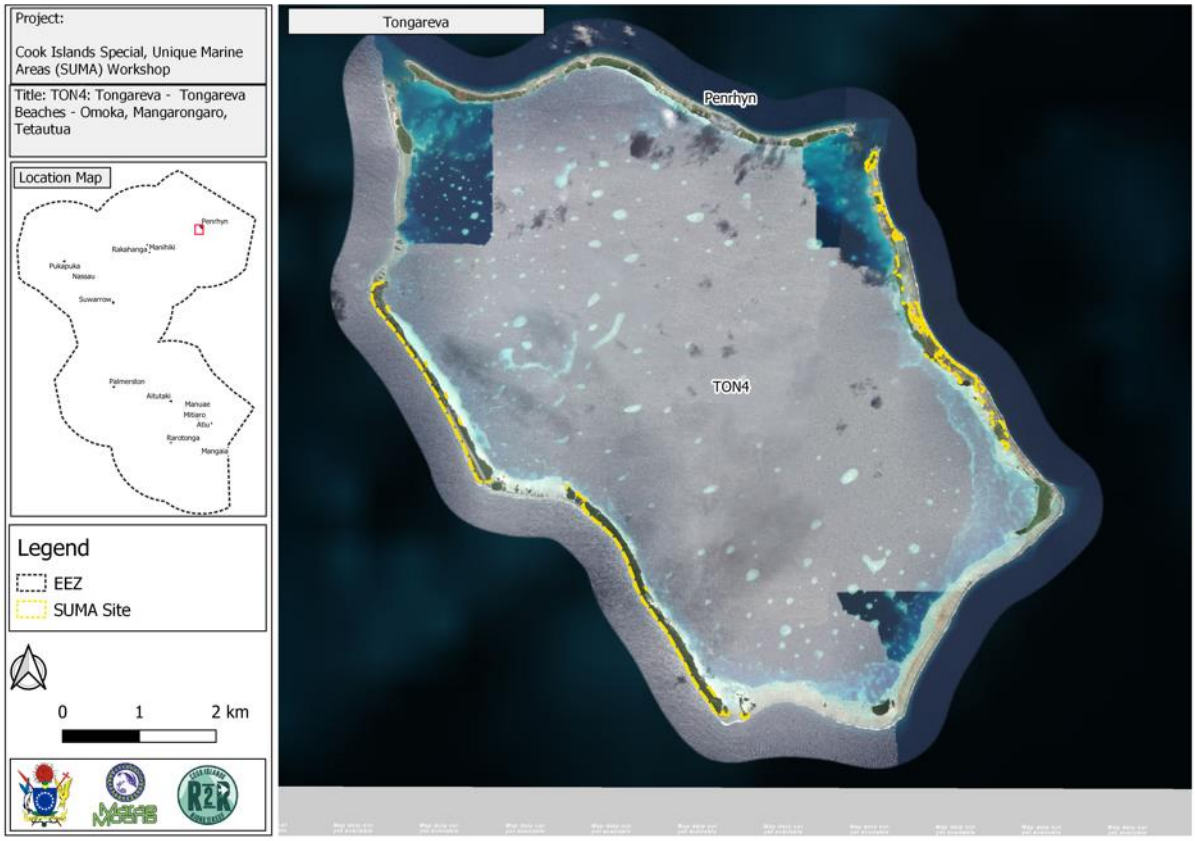
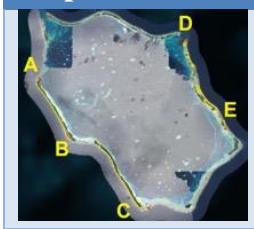


Figure 15. Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua.

Table 13. Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Tongareva Beaches – Omoka, Mangarongaro, Tetautua	TON4	2	2.5	3	2	**9.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-8.9739763	-158.05316	TON4 (A)
	-9.0243855	-158.0255	TON4 (B)
	-8.9407255	-157.9277	TON4 (C)
	-9.0159306	-157.89374	TON4 (D)
	-9.0837857	-157.95933	TON4 (E)

Geographic explicitness (score = 2)

This SUMA focuses on the ocean-side beaches of Tongareva (Penrhyn) Atoll where turtles are known to nest. Mangarongaro motu is the most important site. Two others are near Omoka and Tetautua villages.

Justification (score = 2.5)

The beaches that make up this SUMA have been identified as turtle nesting sites (traditional and expert knowledge, SUMA workshop). Although the scope of this report is below the high-water mark, turtles play important ecological roles in linking land and sea, and their nesting sites are therefore considered here. Uninhabited Mangarongaro Motu at the southwestern corner of the atoll is the primary nesting site at this atoll (White, 2012a, 2014a, 2014b; White et al., 2020). A survey conducted there in 2011 identified 525 turtle nests, with the majority of the nests laid among vegetation within 1-15 metres of the top of leeward, sandy beaches (White, 2012b). Annual surveys from 2011 to 2014 documented between 98 and 551 nests on Mangarongaro (White, 2014b); over 1,000 nests per annum were laid between 2017 and 2019 (White et al., 2020).

In most places around the world, including at Palmerston Atoll (see Site PAL1: Palmerston, Cook and Primrose Island Beaches), green sea turtle nesting is distinctly seasonal, but on Mangarongaro Motu successful nesting was documented every month between August 2014 and April 2020; this makes it the most important green sea turtle rookery in the central South Pacific (Mast et al., 2020; White, 2014a; White et al., 2020). All nesting occurs on the ocean side of the islets; juvenile development occurs year-round in the lagoon and on outer reefs. Mating occurs in Taruia Passage and some lagoonal areas of Tongareva, including at Omoka wharf (White, 2014b, 2012b).

White et al. (2014b) identified the highest nest densities in areas where there are gaps (ava) in the reef flat and beach rock that allow ease-of-access to the beach for nesting females and access to the sea for the hatchlings. Given the high-energy oceanic environment and extensive reef development, the physical attributes of important nesting sites identified by White (White, 2012b, 2012a) may be common in the Cook Islands. Lower numbers of turtle nests were identified at the other beaches in this SUMA (White, 2014b).

In 2015, Tetautua had four nests (two females laid two each); these were the first in 30 years, perhaps evidence of natal homing by a previous cohort reaching maturity (White, 2016b). In 2016, an El Niño year, Molokai (Motu Unga in the northwestern part of the atoll) had 18 nests, then 45 more in 2017, but none were recorded before or since (Dr. M. White, pers. obs. 2020). Tokerau (Pahonu) and Ruahara (both northern motu) have approximately 10 nests every 3-5 years. Omoka beach rarely has nests due to greater human presence, but in 2007 the entire beach was used for nesting (Mataora Marsters pers. comm. 2013, cited in White 2016b). The southwestern corner of the runway on Moana Nui is sandy and occasionally has nests (Dr. M. White pers. obs. 2020).

Seminoff et al. (2015) confirmed that the global green turtle (*Chelonia mydas*) population can be divided into 11 Distinct Population Segments (DPS). Each DPS is genetically unique, so the loss of any population segment represents significant loss of planetary genetic diversity. DPSs are markedly separated from each other as a consequence of ecological, behavioural and oceanographic factors, and based on genetic and morphological evidence. Tongareva is in the Central South Pacific DPS (Seminoff et al., 2015). White (2016a) provides the first genetic evidence from live green turtles at Tongareva. Five DNA samples were collected and analysed at the NOAA laboratory in San Diego. Mitochondrial DNA (mtDNA) revealed shared haplotypes with the following:

- Haplotype CmP65 ~ shared with Samoa (sample was two hatchlings from the same nest).
- Haplotype CmP77 ~ shared with Federated States of Micronesia (FSM) (juvenile).

- An Eastern Pacific haplotype, possibly Galapagos (juvenile; Dr. Peter Dutton pers. comm. 2015).
- A novel haplotype (juvenile).

Mangarongaro beach has other attributes, including a near-pristine leeward reef (Dr. M. White, pers. obs.). The turtles emerge over the drop-off to reach the beach. The reef-top is typically 20-50 metres wide and in many places there is a coral barrier up to 1 m in height adjacent to the shore. On high-energy nights waves carry turtles directly to the back of the beach, leaving a short crawl (1-5 metres) before finding suitable depth of sand or coral rubble for oviposition. The nesting zone is 8 km long and a few metres wide.

These islands are also habitat for thousands of tupa (land crabs) (*Cardisoma carnifex*, see Site PAL3: Palmerston North Islet and Marion's Bank for more information) and seabirds (see also Site PUK4: Pukapuka Seabird Colonies). Bristle-thighed curlews (*Numenius tahitiensis*) are present on the Mangarongaro beach throughout the year, using this area for foraging, courtship and mating (Dr. M. White pers. obs. 2020). No nests have been found, as this species are thought to nest only in Alaska. White fairy terns (*Gygis alba*) are also present throughout the year and nest in the trees along the back of the beach; turtle nests are often laid under their trees (Dr. M. White pers. obs. 2020; see also Site AIT7: Aitutaki - Moturakau and Rapota). White-tailed tropicbirds (*Phaeton lepturus*), normally a cliff-nesting species, nest in the taller trees, red-tailed tropicbirds (*Phaeton rubricauda*) nest under bushes, black noddies (*Anous minutus*) are colonial nesters in some trees and brown noddies (*Anous stolidus*) nest all along Mangarongaro. Brown noddies frequently associate with white terns to drive away frigatebirds hunting for unattended chicks. Both species of frigatebird (*Fregata minor* and *Fregata ariel*) nest in the coconut trees and boobies (*Sula sula*, *Sula dactylatra* and *Sula leucogaster*) nest on or under large trees at southern end. Wandering tattlers (*Heteroscelus incanus*) often forage along reef drop-off, and sooty terns (*Onychoprion fuscatus)* typically nest on very remote motu.

Sea turtles are long-lived, late-maturing, air-breathing marine reptiles, laying their soft-shelled eggs on land. They are found throughout the tropics and in some temperate places, and have changed little in 300 million years (FitzSimmons et al., 1995). All seven species are in decline globally and on the IUCN Red List of Threatened Species (IUCN, 2020). Six species use the Pacific Ocean: hawksbill turtle (*Eretmochelys imbricata*), green turtle (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*), loggerhead turtle (Caretta caretta) and leatherback turtles (*Dermochelys coriacea*); Kemp's ridley turtles (*Lepidochelys kempii*) inhabit the Caribbean (IUCN, 2020; Marquez, 1990). Four species of marine turtle have been recorded within the Cook Islands EEZ: green turtle, hawksbill turtle, loggerhead turtle and leatherback turtle (White, 2012a).

In the Cook Islands, green turtles are most common throughout the northern atolls, although they are also present on some of the southern islands. Hawksbills appear to be more common in the southern Cook Islands than the northern islands; in Rarotonga, in-water assemblages comprise 67% green turtles and 33% hawksbills (White, 2013). Loggerhead turtles have been reported only from Palmerston Atoll and are not known to nest in the Cook Islands (Bill Marsters pers. comm. 2010, cited in White 2012a). The presence of leatherback turtles is only known from bycatch in offshore industrialised fisheries (P. Maru pers. comm. 2010, cited in White 2012a). Flatback turtles (*Natator depressus*) may be occasional vagrants to the Cook Islands, however only rare sightings and anecdotal records exist[17].

[17] https://www.honucookislands.com/sea-turtles.php

Sea turtles spend most of their life cycle in the ocean, but females must go ashore for egg-laying, preferring clean, isolated, sandy beaches. They require access from the ocean onto a suitable beach and need to be undisturbed, preferably in darkness, for 60-90 minutes, while they dig a nest and deposit eggs, before returning to the sea (Miller, 1997). Turtle eggs provide nutrient-deficient beaches with an increased concentration of high-quality nutrients, which stabilise dunes and encourage the growth of vegetation (Hannan et al., 2007). In the Cook Islands, nesting information is based exclusively on green turtles (McCormack, 2005a; White, 2012b, 2014a)

Green turtles are endangered (Seminoff, 2004) and highly migratory, using a variety of habitats during their lifetime (Hirth, 1997). Early development occurs in the open ocean, after which turtles recruit to neritic developmental areas rich in seagrass and/or marine algae where they forage and grow until maturity (Musick and Limpus, 1997). Upon attaining sexual maturity, both male and female green turtles undertake breeding migrations between foraging grounds and nesting areas every few years (Carr, 1987, 1986; Hirth, 1997). At Tongareva Atoll, green turtles are present throughout the year (White, 2014a; White et al., 2020). McCormack (2005b) noted that adult green turtles in Melanesia forage on seagrasses and seaweeds. The older portions of sea grass blades are often overgrown with microorganisms, epiphytes, algae, invertebrates and fungi, so sea turtle grazing helps to maintain the health of seagrass beds (Jackson, 2001). Seagrasses are absent from the Cook Islands (Ellison, 2009), suggesting that green turtles are more reliant on seaweeds growing on the reefs.

Hawksbill turtles are critically endangered (Mortimer and Donnelly, 2008) and are omnivorous in the Indo-Pacific, feeding on sessile reef animals, especially sponges and algae (McCormack, 2005a); this algal grazing helps to maintain coral reef health. Hatchlings disperse in oceanic gyres before settling into a neritic habitat; some individuals may remain near their nesting habitat (Bowen and Karl, 1997). They are typically slow to mature, requiring a minimum of 30-35 years before reaching breeding age (Limpus, 1992), and are the most solitary of nesters. On Tongareva Atoll, they have been observed five times since 2012 (White et al., 2020).

Loggerhead turtles are broadly distributed throughout the subtropical and temperate regions of the Mediterranean Sea and Pacific, Indian, and Atlantic Oceans. The global population is comprised of 10 subpopulations or RMUs (regional management units) that vary widely in population size, geographic range, and population trends (Wallace et al., 2011, 2010). The global assessment is “Vulnerable” (Casale and Tucker, 2017), however the South Pacific subpopulation is Critically Endangered (Limpus and Casale, 2015). They are highly migratory, using open ocean development grounds for around 16 years (Bolten and Witherington, 2003). They are carnivorous, feeding primarily on benthic invertebrates such as crabs and shellfish, but are known to eat jellyfish. Loggerhead turtles reach sexual maturity when they are 30-40 years old (Avens and Snover, 2013).

Leatherback turtles are listed as vulnerable (Wallace et al., 2013) and are distributed circumglobally, with foraging ranges that extend from tropical to temperate and sub-polar latitudes; there are seven RMUs (Wallace et al., 2010). These are deep diving animals feeding predominantly on jellyfish, salps and siphonophores (Eckert et al., 2012). Leatherback turtles in the Cook Islands are within the geographic range of the West Pacific Ocean subpopulation (Wallace et al., 2013). Despite areas of overlap in distribution with the

East Pacific subpopulation, the West Pacific subpopulation is genetically distinct from all other leatherback subpopulations (Dutton et al., 1999), and it occupies broad foraging and migratory habitats (Benson et al., 2011). Based on long time-series datasets of abundance—i.e. annual counts of nesting females and nests—this West Pacific leatherback subpopulation has declined 83% during the past three generations. Major threats to this subpopulation include direct harvest of females and eggs, low hatching success and fisheries bycatch (Wallace et al., 2013). The most important nesting sites for the West Pacific leatherback subpopulation are located at Papua Barat (province of Indonesia), Papua New Guinea, and the Solomon Islands, and to a lesser extent in Vanuatu. Leatherback turtles are not known to nest in the Cook Islands.

Interaction between humans and turtles span millennia (Allen, 2007), including widespread egg-take and use for meat, oil, leather, household artefacts (carapace as bowls), tools (bones carved into fish-hooks, spoons etc.), jewellery, artwork (e.g. Japanese bekko 'tortoiseshell'), 'sympathetic magic' (where one thing is believed to cause another: e.g. a juvenile turtle's carapace may confer longevity), and traditional medicine (e.g. curing menstrual problems or sexual impotence). Cultural or spiritual connections are known in many parts of the world including Polynesian navigators using migratory pathways of sea turtles during oceanic vaka voyages. Sea turtles are also threatened by climate change, fisheries and plastic pollution. At Tongareva, White (White, 2016b) taught school children the turtle's life cycle (Te Orohanga) as a way to reach parents (Evans et al., 1996). Most communities recognize that this traditional food is endangered and have started to implement various conservation measures (McCormack, 2005a). Forty years ago, most egg-clutches were eaten in the Cook Islands (White, 2012a); at Tongareva only two nests were harvested in the past decade (one on 13 August 2011 and one on 27 October 2015). The understanding of the value, vulnerability and conservation needs of sea turtles on Tongareva makes it more likely for turtles to persist in this SUMA.

Type and number of sources (score = 3)

Information used to describe the abundance and nesting activities of marine turtles was sourced from six peer-reviewed papers, one report and the IUCN website. There has been some turtle research in the Cook Islands; two websites and three reports were used here. This SUMA has had the benefit of nesting surveys and information on this was sourced from two reports, one article, three peer-reviewed papers and a website (www.seaturtlestatus.org).

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area (MPA) of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- Penrhyn (Prohibition on Exportation of Paua) By-Laws 2007 prohibit the export of paua (paua, giant clam) from Penrhyn. Although paua (paua; giant clams) are not specifically mentioned as a value, they are likely present in this SUMA.

- All marine turtle species and many seabird species are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS). Hawksbill turtles are critically endangered (CR), green turtles are endangered (EN), olive ridley, loggerhead and leatherback turtles are vulnerable (VU), and flatback turtles are data deficient (DD). The Cook Islands is also a Party or Signatory to several international agreements for marine turtle conservation, protection and management, including the Convention on Biological Diversity. Ra'ui is a traditional form of management in the Cook Islands that involves periodic harvesting closures of specific areas or resources, and applies to turtles in some areas, including Tongareva.

4.1.5 Site MAN1: Manihiki Lagoon

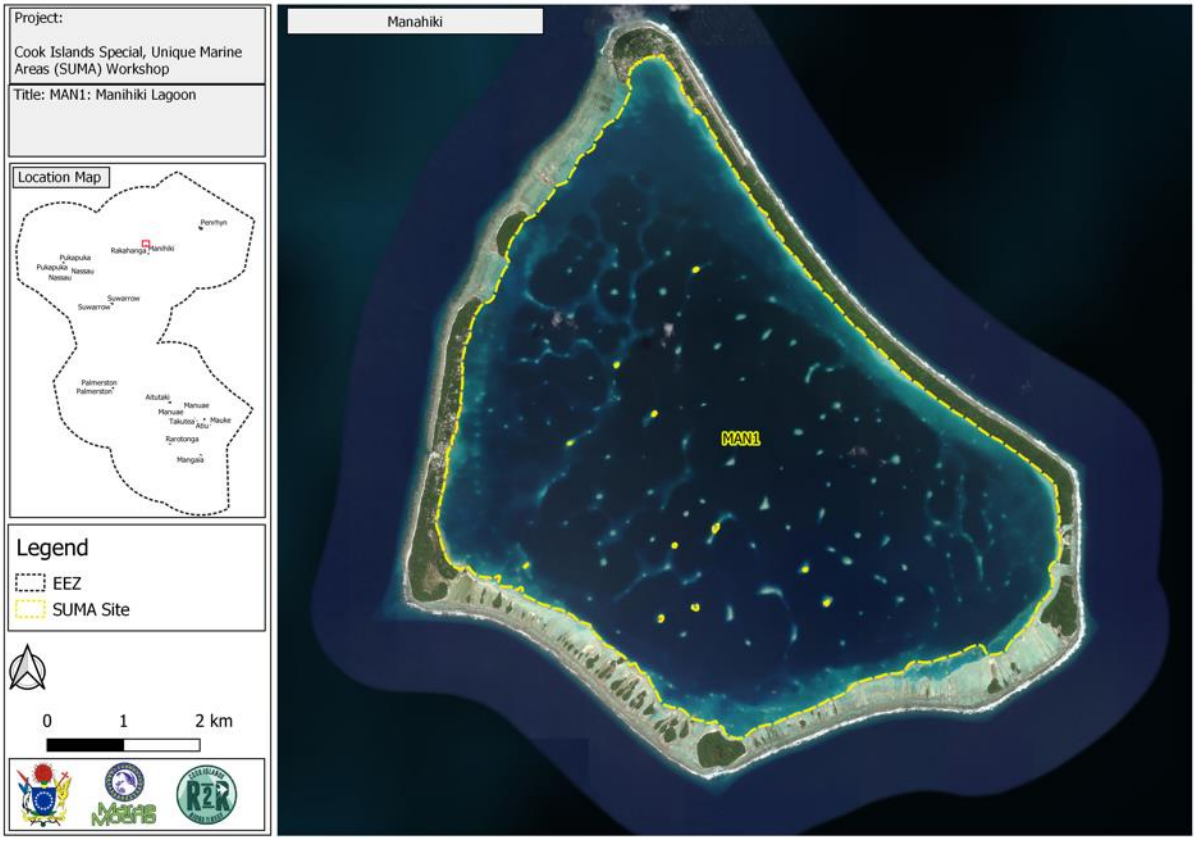


Figure 16. Site MAN1: Manihiki Lagoon

Table 14. Site MAN1: Manihiki Lagoon

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Manihiki Lagoon	MAN1	3	3	3	3	**12**

Geographic boundaries

Map	Latitude	Longitude	Points
	-10.374341	-161.00714	MAN 1 (A)
	-10.447334	-161.01324	MAN 1 (B)
	-10.438129	-160.95752	MAN 1 (C)

Geographic explicitness (score = 3)

This SUMA encompasses the lagoonal and inner reef areas of Manihiki Atoll, covering an area of approximately 45 km^2. The lagoon is enclosed and is 70 m deep at its deepest point, with patch reefs and sandy areas.

Justification (score = 3)

Workshop participants chose this lagoon for a number of values including spawning areas for groupers near the passes, reef sharks and humphead wrasse, areas of high biodiversity around coral outcrops (kaoa), and populations of valuable invertebrates, especially *Asaphis* spp.

bivalves (kai) and tridacnid clams (paua). Black pearl oysters are farmed in the lagoon (Ponia et al., 2000); there have been concerns about the effects of the farms on water quality, as the lagoon is mostly enclosed (Anderson, 1998). Water quality assessments in 2009 found no obvious increases in nutrients or suspended solids, however high bacterial concentrations were noted (SPREP, 2018). Manihiki's coral reefs were strongly impacted by the 2015/2016 El Niño event, especially in shallow forereef areas (Rongo, 2016). Massive corals in the lagoon were only partially bleached, including the species *Plerogyra sinuosa*, which to date has not been observed elsewhere in the Cook Islands (Rongo, 2016). Atoll lagoons can be highly diverse and in many cases host assemblages that are unique, even when compared to forereef communities of the same atoll (Job and Ceccarelli, 2012; Skinner et al., 2020).

Early research in Manihiki Lagoon documented the abundant coral pinnacles, lagoon hydrology, fluctuations in water chemistry, and the flora and fauna (Bullivant and McCann, 1974). They recorded 30 species of scleractinian corals, two species of sipunculid worms, 49 genera of gastropods, 33 genera of bivalves, 39 species of crabs (some unidentified), 25 species of echinoderms and 103 species of fishes. The checklists produced by these early studies could prove useful in follow-up research to assess changes in lagoonal assemblages.

For general information about sharks and their presence and abundance in the Cook Islands, see Site O3: Palmerston – Kona Reef. Atoll lagoons are known to be important habitats for reef sharks and other predators (Skinner et al., 2020). The marbled grouper *Epinephelus polyphekadion* and honeycomb grouper *E. merra* were once abundant in Manihiki and use the lagoon passes to spawn; populations are thought to have declined in recent years (Rongo and Dyer, 2015). Manihiki Atoll has been identified as a marine Key Biodiversity Area (KBA), and two additional species of grouper, *Epinephelus lanceolatus* and *Plectropomus laevis*, are listed as trigger species (Evans, 2012). Humphead wrasse (*Cheilinus undulatus*) are also thought to be abundant in the deeper areas of the lagoon. For general information about the importance of spawning aggregations and humphead wrasse, see Site TON2: Tongareva - Taruia Reef Pass.

The most recent assessments of macroinvertebrates found few species of sea cucumbers, and although densities of lollyfish (*Holothuria atra*) were around the regional average, the population was dominated by small individuals (George and Story, 2014). There were moderate densities of black lip pearl oysters and these were especially abundant in the lagoon (George and Story, 2014). In 1985, 400 adult trochus were introduced to Manihiki although current densities are low (George and Story, 2014).

Manihiki has been known to have a high abundance of tridacnid clams (*Tridacna maxima*), thought to be due to effective management through ra'ui (Butler, 2017a). The most recent resource assessment found that clam densities had declined dramatically since the previous survey in 2002, but were generally larger (George and Story, 2014). Many were affected by bleaching during the marine heatwave of 2015/2016 (Rongo, 2016). Giant clams (family Tridacnidae) are widely distributed across coral reefs of the Indo-Pacific (Wells, 1997). Ecologically, giant clams are valuable to reef ecosystems by providing food for predators, scavengers and opportunistic feeders; their shells and mantles provide habitat and topographic complexity; they act as reservoirs of zooxanthellae (*Symbiodinium* spp.); and they filter nutrients from the water (Neo et al., 2015). There are twelve species of giant clams that vary in their geographic distribution, with *Tridacna maxima* having the largest geographical range (bin Othman et al., 2010) and *T. gigas* currently found only in Australia and the Solomon Islands, with relict populations remaining elsewhere (Wells, 1997).

Giant clams are heavily exploited in the Cook Islands, as they are considered a delicacy on many islands (MMR, 2000a). Only two species are known to occur naturally, *T. maxima* and *T. squamosa*; other species have been introduced from Australia to Aitutaki with varying degrees of success (MMR, 2000b). A number of life history traits make giant clams vulnerable to overexploitation, including late sexual maturity, a sessile adult phase, broadcast spawning and very high mortality during early life stages (Neo et al., 2015). In many Pacific Island countries and territories, giant clams form part of traditional diets and local economies (Gillet and Tauati, 2018). Common regulatory measures in giant clam fisheries include minimum legal size limits, daily bag limits or catch quotas, and no-take marine reserves (Gilbert et al., 2005; Gomez and Mingoa-Licuanan, 2006; Teitelbaum and Friedman, 2008). A recent meta-analysis indicated that populations of *Tridacna maxima* closest to dense human populations were at greatest risk, but reefs near land areas with low human population densities did not always have high clam densities (Van Wynsberge et al., 2013). Giant clam densities can also vary according to broad reef types; highest densities are found on semi-closed atolls, open atolls and continental reefs (Van Wynsberge et al., 2013).

Type and number of sources (score = 3)

A number of sources described this SUMA directly: an early peer-reviewed study documented marine ecosystems in the lagoon, one report had information about coral reefs, two reports about invertebrates, one about fish, one described Manihiki Lagoon as a KBA and two peer-reviewed papers described the pearl oyster farms. Giant clams were further documented more generally using nine peer-reviewed papers, atoll lagoon assemblages were characterised using a report and a peer-reviewed paper, and two reports described clams for the Cook Islands. References used to describe sharks for Site O3: Palmerston – Kona Reef and groupers and humphead wrasse for Site TON2: Tongareva - Taruia Reef Pass are also relevant here.

Obligations (score = 3)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Manihiki and its internal waters as provided for under the Environment (Application to Manihiki) Order 2012. This SUMA includes a large area of internal waters.
- Marine Resources (Shark Conservation) Regulations 2012 and the National Plan of Action for the Conservation and Management of Sharks in the Cook Islands (NPoA – Sharks) (MMR 2012) are of particular relevance given the significance of sharks in this SUMA.
- Manihiki (Natural Resources) By-Laws 2003 provide for the management of natural resources on the island of Manihiki and in its lagoon and surrounding waters. The bylaws place restrictions on the harvest of pearl shell and pearl farming and restrict gear that may be used for fishing.

- The Manihiki Lagoon was set aside for the purposes of research through an Island Council Resolution (Saul and Tiraa, 2004).
- National ban on the international export of all paua (giant clams).

4.1.6 Site MAN2: Manihiki - Porea Ra'ui

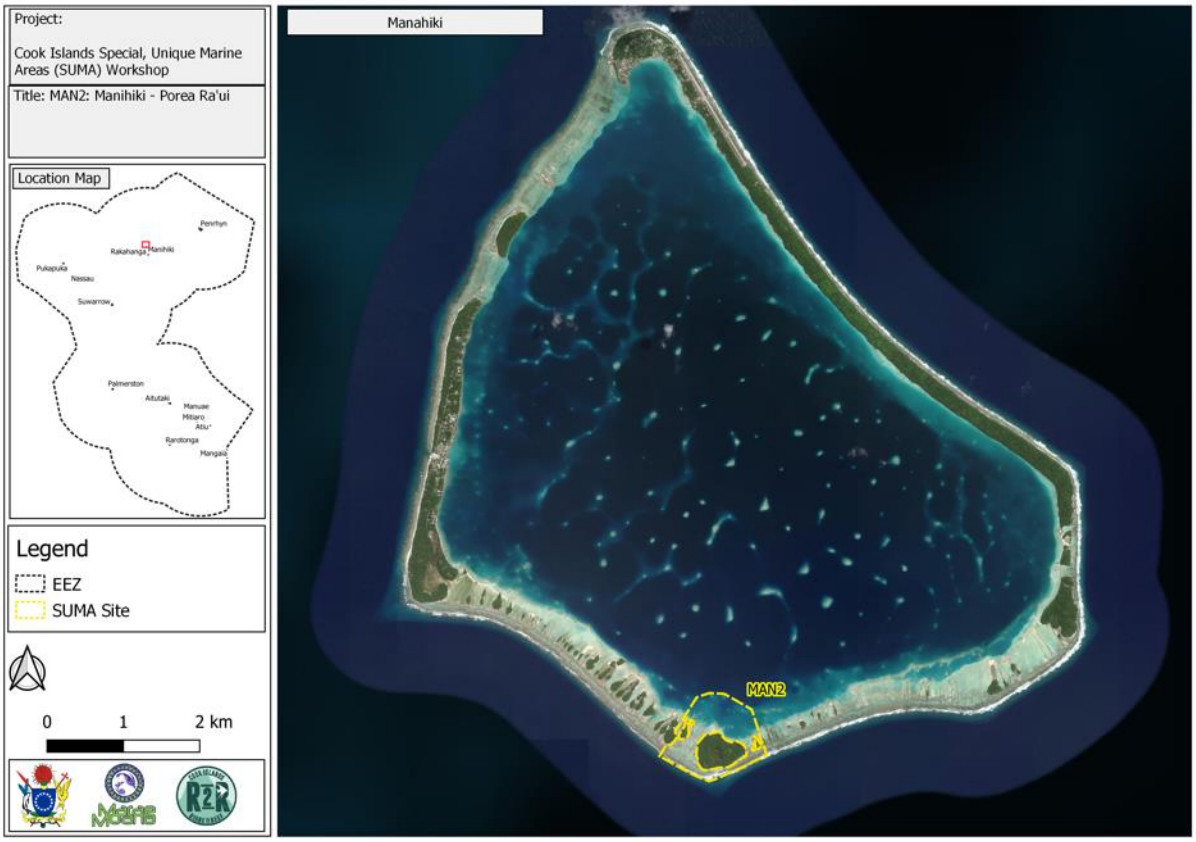


Figure 17. Site MAN2: Manihiki - Porea Ra'ui.

Table 15. Site MAN2: Manihiki - Porea Ra'ui

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Manihiki – Porea Ra'ui	MAN2	3	2	3	2	**10**

Geographic boundaries

Map	Latitude	Longitude	Points
	-10.453344	-160.99843	MAN 2 (A)
	-10.461014	-161.00662	MAN 2 (B)
	-10.460956	-160.99317	MAN 2 (C)

Geographic explicitness (score = 3)

Porea is the southern island of Manihiki Atoll, measuring approximately 0.25 km^2. Marine habitats around the island include exposed outer reef to the south, reef flats to the east and west, and saltmarsh and lagoonal habitat to the north. The SUMA is the marine ra'ui around Porea Island.

Justification (score = 2)

This SUMA was chosen as habitat for spawning milkfish (*Chanos chanos*) and closer to shore and on the beaches for coconut crabs (*Birgus latro*). It is protected under the customary

management practice of ra'ui (NES, 2012a). The milkfish is one of the most important species in Pacific Island aquaculture (Izumi and Basco, 2014; MMR, 2000a), and its ecology is one of continuous migration (Bagarinao, 1994), with an important role in linking the food webs of inshore and offshore marine habitats. The Porea ra'ui includes customary managed milkfish ponds (Evans, 2012; Saul and Tiraa, 2004; SPREP, 2018). At very high tides, milkfish fry and fingerling naturally enter shallow areas of the salt-marsh lakes to feed and are then caught and transferred to stock inshore ponds. On Manihiki, the ra'ui dictates that the animals must grow to an adequate size before harvesting, which is only performed during traditional ceremonies or when VIPs visit the island (Terekia, 1988).

Manihiki is not generally listed as one of the islands with a large population of coconut crabs, but they are found on Porea and protected under ra'ui (MMR, 2000a). Coconut crabs are highly prized throughout the Pacific, including in the Cook Islands. They are the largest terrestrial arthropod in the world and can weigh up to 4kg. Their reproductive cycle includes a marine larval phase and they act as scavengers on beaches and in intertidal areas as adults (Drew et al., 2010). Its well-developed lungs and independence from the marine environment as an adult make it unique among crustaceans. Pacific and Indian Ocean populations are genetically distinct (Lavery et al., 1996). Recruitment is likely to be limited, making intact populations difficult to find (Drew et al., 2010). They are vulnerable to overexploitation, and because of their popularity as a food source, they have disappeared almost entirely from some areas (Lavery et al., 1996). In areas where they are hunted, the crabs remain hidden during the day and forage at night (Matamaki et al., 2016).

Currently there are approximately 50 marine areas under some form of management or protection in the Cook Islands, including ra'ui (Twyford, 2020b). Twyford (2020b) provides an overview of the system of ra'ui in place across the Cook Islands and a proposed definition as:

Ra'ui is the traditional custom of imposing a restriction on certain activities in a certain area for a certain time and purpose as determined by a traditional leader or leaders of a village area (MMR, 2000a; Twyford, 2020b).

The *Marine Resources Act* devolved much of the responsibility for coastal fisheries management to island councils, and designated some fisheries to be managed in consultation between the Ministry of Marine Resources and the island council (Adams, 1998). With the exception of the main island of Rarotonga, the governance system of each of the Cook Islands consists of a mayor and an island council. The mandate of island councils, according to the Island Government Act 2012–13, is the local governance and the promotion of social, economic, culture and environmental well-being for its communities. The island council is therefore responsible for the management of the island's resources (Hoffmann, 2002a), and for developing local regulations to address environmental issues, such as the import and protection of species (both terrestrial and marine), area and seasonal restrictions (ra'ui), controls on methods for harvesting resources, waste disposal, controls for domestic animals, and management of the foreshore environment (Matamaki et al., 2016). Some Islands have agreed to be covered by the Environment Act (Aitutaki; Atiu and Takutea; Mitiaro; Mauke; Manihiki). and for some of these, Island Environment Regulations are in place (Atiu and Takutea; Mitiaro). Rarotonga is covered differently (see below); other islands have not yet opted in.

A total of 22 ra'ui sites were listed in 2017 (Butler, 2017a), but this may have changed since then, given the often temporary nature of ra'ui (Twyford, 2020b). Monitoring of the effectiveness of ra'ui is rarely conducted, but reports exist for the Rarotonga ra'ui, where between 1998 and 2002 densities of commercially important invertebrates increased inside the ra'ui, and species richness either increased or remained stable (Raumea et al., 2000; Saywood et al., 2002). Across the Cook Islands, surveys show that the effectiveness of ra'ui in restoring depleted populations is variable, and depends on the objectives of the ra'ui, the specific management practices implemented, and compliance.

The Cook Islands' network of protected and other managed areas, including ra'ui and nationally managed marine protected areas (MPAs), are important components of promoting the national goal of biodiversity conservation (Butler, 2017a). Locally managed marine areas such as ra'ui can be highly successful because place-based knowledge gathered over generations informs day-to-day decision-making and extends beyond ecological knowledge; it encompasses language, resource use and management, systems of classification (including biota and biophysical conditions), social interactions, cultural practices, and spirituality (Mackey and Claudie, 2015).

Additionally, they can be implemented immediately, without lengthy consultations. As with managed areas everywhere, however, their success relies on compliance with the rules set out for them. In the Pacific, traditional socio-cultural management frameworks are increasingly recognised as a crucial element in ecosystem management and marine spatial planning, especially in the context of adaptation to climate change (Warwick et al., 2017). Successfully managed areas typically host a high abundance of fishes and invertebrates that are ecologically, economically and culturally important. Evidence for significant fishery benefits such as increased landings or catch per unit effort is scarcer, as it usually takes a number of years of effective management for such benefits to be measurable (Russ and Alcala, 2004).

Type and number of sources (score = 3)

Four reports contained information about this SUMA. Its values were further inferred from two peer-reviewed papers and one report about milkfish, three peer-reviewed papers about coconut crabs, three peer-reviewed papers about marine protected areas in general, and seven reports and two peer-reviewed papers about ra'ui in the Cook Islands.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Manihiki and its internal waters as provided for under the Environment (Application to Manihiki) Order 2012. This SUMA falls within Manihiki internal waters.
- Manihiki (Natural Resources) By-Laws 2003 provide for the management of natural resources on the island of Manihiki and in its lagoon and surrounding waters. The

bylaws place restrictions on the harvest of pearl shell and pearl farming and restrict gear that may be used for fishing.

- The Manihiki Lagoon was set aside for the purposes of research through an Island Council Resolution (Saul and Tiraa, 2004).
- National ban on the international export of all paua (giant clams).
- This SUMA is protected under customary laws, or ra'ui. Island by-laws state that coconut crabs, clams and lobster cannot be exported and must be consumed only on the island (NES, pers. comm.).
- Milkfish and coconut crabs are listed on the IUCN Red List of Threatened Species.

4.1.7 Site MAN3: Eastern Manihiki

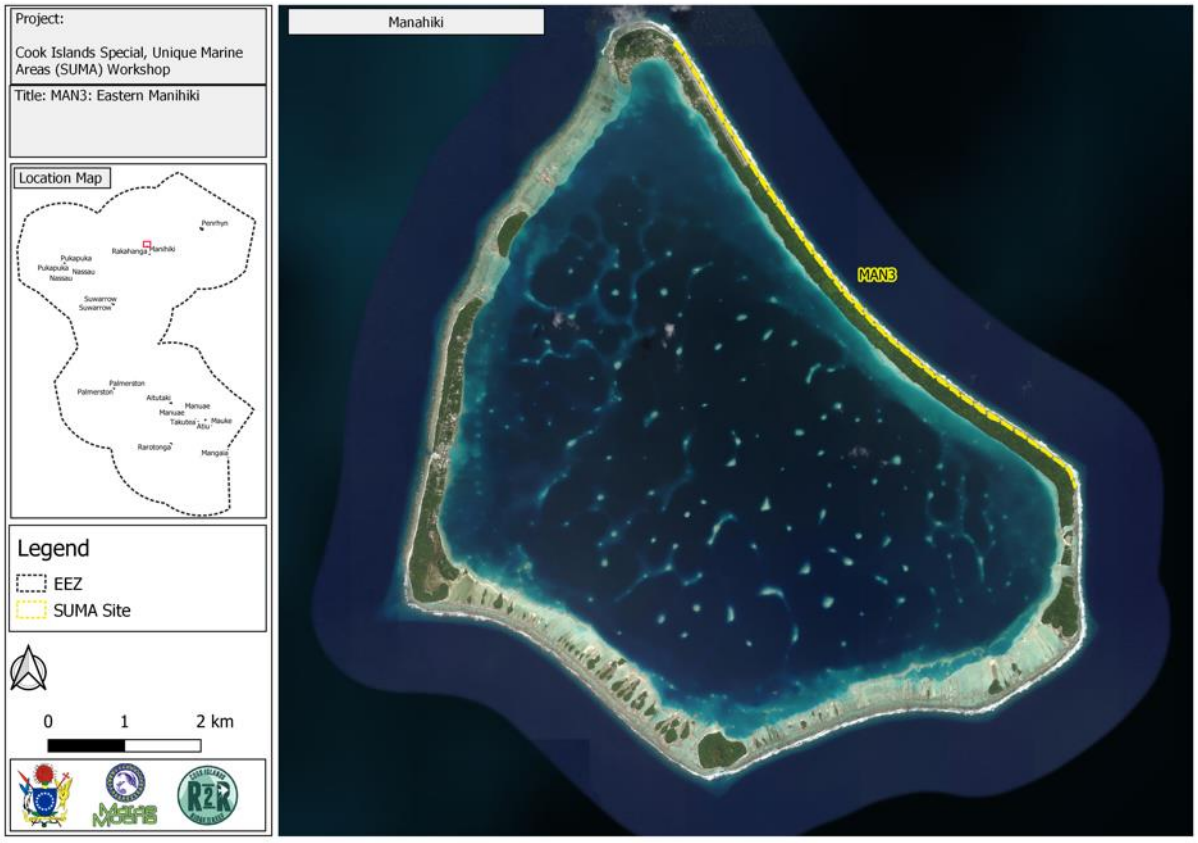


Figure 18. Site MAN3: Eastern Manihiki

Table 16. Site MAN3: Eastern Manihiki

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Eastern Manihiki	MAN3	2	1	1	1	**5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-10.372441	-161.00416	MAN 3 (A)
	-10.401724	-160.98463	MAN 3 (B)
	-10.428083	-160.95438	MAN 3 (C)

Geographic explicitness (score = 2)

This SUMA covers the seaward beach along the eastern island of Manihiki Atoll, measuring approximately 7.5 km.

Justification (score = 1)

Workshop participants chose this beach because it provides habitat for coconut crabs (*Birgus latro*). Manihiki is not generally listed as one of the islands with a large population of coconut crabs, but they are found on Porea motu/island and the eastern shores and protected under ra'ui (MMR, 2000a). Coconut crabs are highly prized throughout the Pacific, including

in the Cook Islands. Information reviewed about coconut crabs for Site MAN2: Manihiki - Porea Ra'ui is also relevant here. There was no further information available for coconut crabs in this SUMA.

Type and number of sources (score = 1)

References reviewed about coconut crabs for Site MAN2: Manihiki - Porea Ra'ui also pertain to this SUMA. No additional information was available.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Manihiki and its internal waters as provided for under the Environment (Application to Manihiki) Order 2012. The island, beaches and internal waters of this SUMA are therefore under the coverage of the Act.
- Manihiki (Natural Resources) By-Laws 2003 provide for the management of natural resources on the island of Manihiki and in its lagoon and surrounding waters. The bylaws place restrictions on the harvest of pearl shell and pearl farming and restrict gear that may be used for fishing.
- Coconut crabs are listed on the IUCN Red List of Threatened Species and on Manihiki Atoll are protected under ra'ui and cannot be exported.

4.1.8 Site MAN4: Manihiki - Ngake Reef

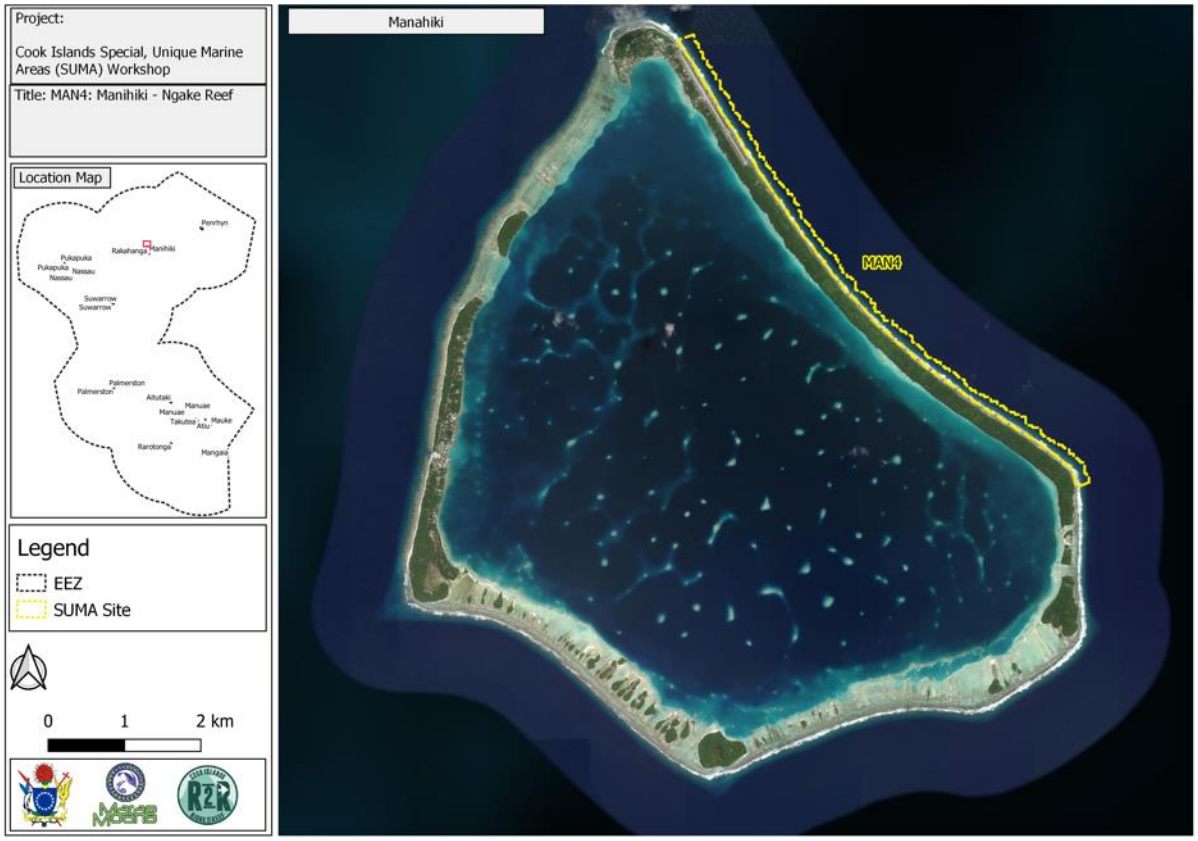
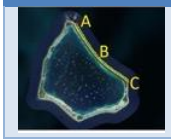


Figure 19. Site MAN4: Manihiki - Ngake Reef

Table 17. Site MAN4: Manihiki - Ngake Reef

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Manihiki – Ngake Reef	MAN4	1	2	2	2	**7**

Geographic boundaries

Map	Latitude	Longitude	Points
	-10.371533	-161.00184	MAN 4 (A)
	-10.402301	-160.98176	MAN 4 (B)
	-10.428073	-160.95415	MAN 4 (C)

Geographic explicitness (score = 1)

Ngake Reef, or "eastern reef", is the seaward forereef of Manihiki Atoll. The SUMA covers the reef habitats along approximately 7.5 km^2 of the northeast facing edge of Manihiki.

Justification (score = 2)

This exposed reef front was identified as having high coral cover and providing habitat for sharks, rays, dolphins and whales (traditional and expert knowledge, SUMA workshop). The reef flat is narrow and the slope is steep, with spurs, grooves and surge channels (Bullivant and McCann, 1974). Manihiki coral reefs were strongly impacted by the 2015/2016 El Niño

event, especially in shallow forereef areas, which were dominated by small, robust colonies typical of high-energy reef fronts (Rongo, 2016). The composition and coral cover of this area is currently unknown; further information about coral reefs in general, and in the Cook Islands, is reviewed in Site TON1: Tongareva - Flying Venus Reef.

The steep and exposed aspect of this reef front is expected to promote high water movement and productivity, which attracts predators and megafauna such as sharks, rays and marine mammals. There was no information about sharks and rays specifically for Manihiki Atoll, but information for the Cook Islands was reviewed in Site O3: Palmerston – Kona Reef and Site TON2: Tongareva - Taruia Reef Pass; there are indications of declining reef sharks in the southern Cook Islands, but not in the northern Cook Islands (Rongo and Dyer, 2015).

Research on whales and dolphins in the northern Cook Islands has been rare and is not well-documented. For general information about marine mammals in the Cook Islands, see Site O5: Marine Mammal Migratory Pathways. Some islands have resident populations of spinner dolphins (*Stenella longirostris*) (Marine Mammal Protected Area Task Force, 2020) and traditional knowledge suggests they occur in this SUMA.

Type and number of sources (score = 2)

One peer-reviewed paper and one report had information about coral reef structure in this SUMA;. one report and one website were used to infer additional information. References used to describe coral reefs for Site TON1: Tongareva - Flying Venus Reef, sharks and rays in Site O3: Palmerston – Kona Reef and Site TON2: Tongareva - Taruia Reef Pass and marine mammals in Site O5: Marine Mammal Migratory Pathways are also relevant here.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Manihiki and its internal waters as provided for under the Environment (Application to Manihiki) Order 2012. This SUMA comprises nearshore reefs of Manihiki (internal waters hence under the Environment Act 2003) and potentially extends into the adjoining territorial seas (also within the jurisdiction of the Act).
- Manihiki (Natural Resources) By-Laws 2003 provide for the management of natural resources on the island of Manihiki and in its lagoon and surrounding waters. The bylaws place restrictions on the harvest of pearl shell and pearl farming and restrict gear that may be used for fishing.
- Marine Resources (Shark Conservation) Regulations 2012 and the National Plan of Action for the Conservation and Management of Sharks in the Cook Islands (NPoA – Sharks) (MMR 2012) are of particular relevance given the significance of sharks in this SUMA.
- Sharks, rays, marine mammals and coral reefs are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

4.1.9 Site RAK1: Rakahanga Lagoon

Figure 20. Site RAK1: Rakahanga Lagoon

Table 18. Site RAK1: Rakahanga Lagoon

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Rakahanga Lagoon	RAK1	2	2	2	2	**8**

Geographic boundaries

Map	Latitude	Longitude	Points
	-9.9982708	-161.09357	RAK1 (A)
	-10.018496	-161.08319	RAK1 (B)
	-10.025639	-161.09699	RAK1 (C)

Geographic explicitness (score = 2)

The Rakahanga lagoon SUMA covers approximately 12 km^2 of the inner reef and lagoon habitats of Rakahanga Atoll. The lagoon has a maximum depth of 33 m.

Justification (score = 2)

Workshop participants designated terrestrial areas as SUMAs for Rakahanga, but that is beyond the scope of this report. Rakahanga Lagoon has been identified as a KBA and SUMA

values are therefore taken from KBA trigger species, these being the giant grouper *Epinephelus lanceolatus* and green turtle *Chelonia mydas* (Evans, 2012). The whole lagoon area is a marine ra'ui for paua (clams) and parau (pearl oysters); harvesting of fish is allowed (Munro, 2018; SPREP, 2018). There are additional ra'ui on Rakahanga that span both terrestrial and marine habitats, but their exact location is unclear. Lagoon habitats often host different species assemblages from those on surrounding reefs, further adding to their importance and level of uniqueness (Job and Ceccarelli, 2012; Skinner et al., 2020).

Rakahanga coral reef communities were strongly impacted by the 2015/2016 El Niño event, with 80% bleaching and heavy mortality among Pocilloporid corals, especially in shallow forereef areas (Rongo, 2016). Coral cover was generally highest on shallow reef slopes, while deeper reef slopes and lagoon areas were more depauperate (Rongo, 2016). Assessments of macroinvertebrates found few species of sea cucumbers; although densities of lollyfish (*Holothuria atra*) were three times the regional average, the population was dominated by small individuals (George and Story, 2014). There were moderate densities of black lip pearl oysters, few clams and no trochus (George and Story, 2014). When part of the lagoon was closed off by a causeway in 2005, milkfish, tilapia, freshwater eels and trevally began breeding there (NES, 2012b). However, the enclosed and relatively shallow nature of the lagoon has led to water quality issues in the past (Rongo and Dyer, 2015), and to relatively depauperate flora and fauna.

Green turtle nests have been observed in Rakahanga (Balazs, 1995; MMR, 2000a), with at least four nests surveyed as part of the Cook Islands Turtle Project (White, 2011). Information on sea turtles in general, and for the Cook Islands in particular, is reviewed in Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua.

Type and number of sources (score = 2)

The values of this SUMA were described using ten reports; references used to review turtles in the Cook Islands for Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua are also relevant here.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- Turtles are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).
- The Cook Islands is also a Party or Signatory to several international agreements for marine turtle conservation, protection and management, including the Convention on Biological Diversity.
- Ra'ui is a traditional form of management in the Cook Islands that involves periodic harvesting closures of specific areas or resources, and applies to turtles in some areas, and to the Rakahanga lagoon.

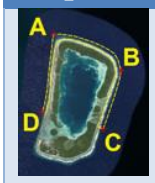
4.1.10 Site RAK2: Rakahanga Forereef Ra'ui

Figure 21. Site RAK2: Rakahanga Forereef Ra'ui

Table 19. Site RAK2: Rakahanga Forereef Ra'ui

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Rakahanga Forereef Ra'ui	RAK2	1.5	2	2	2	**7.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-9.9933102	-161.09856	RAK2 (A)
	-10.006511	-161.07478	RAK2 (B)
	-10.02712	-161.08128	RAK2 (C)
	-10.020856	-161.10294	RAK2 (D)

Geographic explicitness (score = 1.5)

This SUMA encompasses coral reef habitats around the northern half of Rakahanga Atoll, including reef flats, reef crests and slopes.

Justification (score = 2)

Workshop participants designated terrestrial areas as SUMAs for Rakahanga, but that it beyond the scope of this report. The whole of Rakahanga and surrounding waters has been

identified as a KBA, and SUMA values are therefore taken from KBA trigger species, the giant grouper *Epinephelus lanceolatus* and green turtle *Chelonia mydas* (Evans, 2012). The whole lagoon area is a marine ra'ui for paua (clams) and parau (pearl oysters), protection is thought to extend to forereef habitats (Munro, 2018; SPREP, 2018). There are additional ra'ui on Rakahanga that span both terrestrial and marine habitats, but their exact location is unclear.

Outer reef communities of Rakahanga are expected to have higher abundance and diversity than the lagoon, which has suffered from poor water quality (see Site RAK1: Rakahanga Lagoon). Rakahanga coral reef communities were strongly impacted by the 2015/2016 El Niño event, with 80% bleaching and heavy mortality among Pocilloporid corals, especially in shallow forereef areas (Rongo, 2016). Coral cover was generally highest on shallow reef slopes, while deeper reef slopes and lagoon areas were more depauperate (Rongo, 2016). Assessments of macroinvertebrates found few species of sea cucumbers; although densities of lollyfish (*Holothuria atra*) were three times the regional average, the population was dominated by small individuals (George and Story, 2014). There were moderate densities of black lip pearl oysters, few clams and no trochus (George and Story, 2014).

Green turtle nests have been observed in Rakahanga (Balazs, 1995; MMR, 2000a), with at least four nests surveyed as part of the Cook Islands Turtle Project (White, 2011; White and Galbraith, 2013). Southern, eastern and northern beaches were considered suitable for nesting (White and Galbraith, 2013). Information on sea turtles in general, and for the Cook Islands in particular, is reviewed in Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua. Green turtles are likely to use the coral reef habitats in this SUMA to shelter and rest.

Type and number of sources (score = 2)

The values of this SUMA were described using eight reports and one peer-reviewed article. References used to review turtles in the Cook Islands for Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua are also relevant here.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- Turtles are listed on the IUCN Red List of Threatened Species, and turtles are listed under the Convention on Migratory Species (CMS).
- The Cook Islands is also a Party or Signatory to several international agreements for marine turtle conservation, protection and management, including the Convention on Biological Diversity.
- Ra'ui is a traditional form of management in the Cook Islands that involves periodic harvesting closures of specific areas or resources, and applies to turtles in some areas, and to the Rakahanga lagoon.

4.1.11 Site PUK1: Pukapuka Southern Lagoon

Figure 22. Site PUK1: Pukapuka Southern Lagoon

Table 20. Site PUK1: Pukapuka Southern Lagoon

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Pukapuka Southern Lagoon	PUK1	1	1	2	1	**5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-10.907732	-165.84217	PUK1 (A)
	-10.909103	-165.83818	PUK1 (B)
	-10.911627	-165.84176	PUK1 (C)

Geographic explicitness (score = 1)

This SUMA is a small portion of the southern end of the Pukapuka lagoon, approximately 0.1 km^2 in area, where milkfish breed.

Justification (score = 1)

Workshop participants identified this area as being significant for milkfish (*Chanos chanos*), an important aquaculture resource in the Cook Islands (Izumi and Basco, 2014; MMR, 2000a). Milkfish are known to be present in Pukapuka, albeit not in high numbers (Terekia, 1988). The islet of Motu Ko and its immediate marine area is managed under ra'ui (Evans,

2012; Munro, 2018). At very high tides, milkfish fry and fingerling naturally enter enclosed and shallow habitats, such as this part of the Pukapuka lagoon (Terekia, 1988). Information reviewed about milkfish for Site MAN2: Manihiki - Porea Ra'ui is also relevant here.

Type and number of sources (score = 2)

Four reports and one peer-reviewed paper were available to describe milkfish and their presence in Pukapuka, and the Pukapuka ra'ui. References used for Site MAN2: Manihiki - Porea Ra'ui are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The islet of Motu Ko and its immediate marine area is managed under ra'ui (Evans, 2012; Munro, 2018).
- Milkfish are managed under ra'ui on Pukapuka. They are listed as Least Concern on the IUCN Red List of Threatened Species.

4.1.12 Site PUK2: Pukapuka - Reef East of Toka

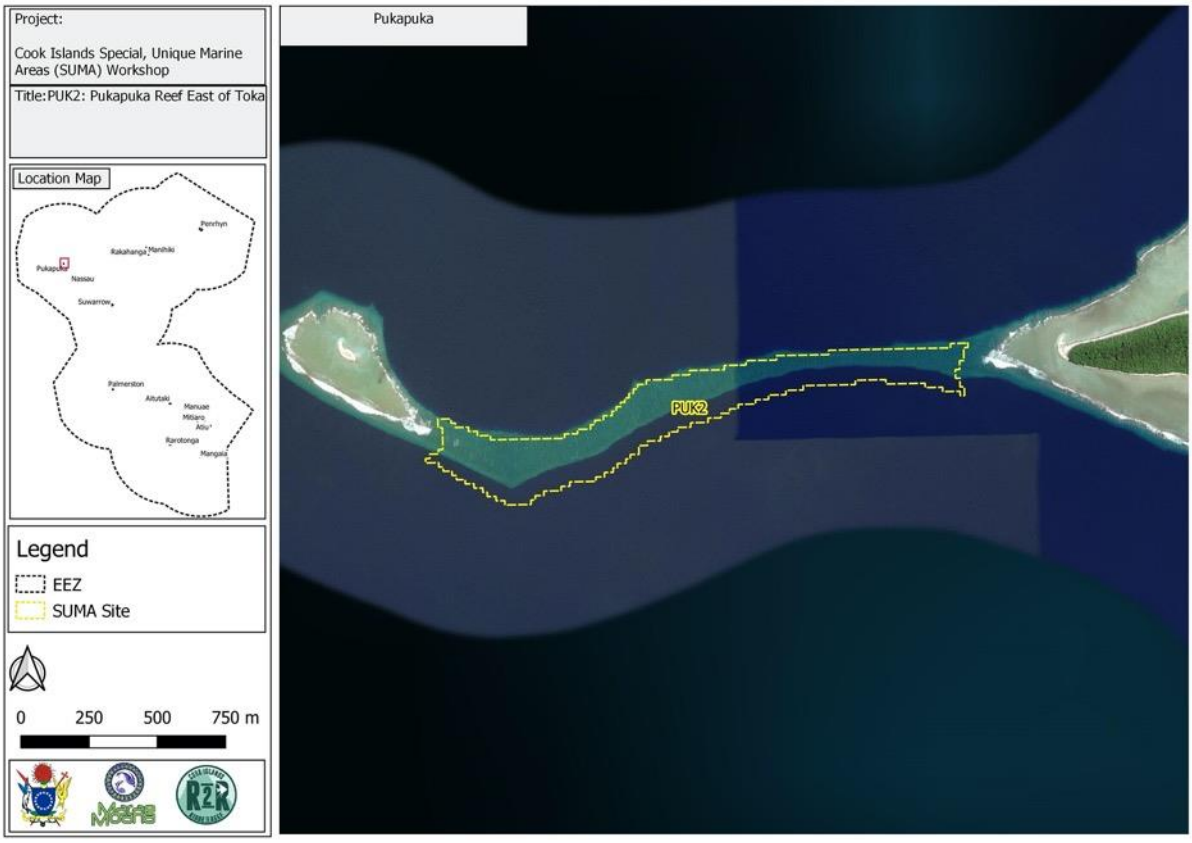
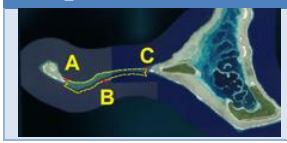


Figure 23. Site PUK2: Pukapuka - Reef East of Toka

Table 21. Site PUK2: Pukapuka - Reef East of Toka

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Pukapuka – Reef East of Toka	PUK2	3	1.5	1	1	**6.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-10.89673	-165.9187	PUK2 (A)
	-10.892759	-165.8852	PUK2 (B)
	-10.897591	-165.90279	PUK2 (C)

Geographic explicitness (score = 3)

This SUMA is a submerged reef connecting Toka to Motu Kotawa, approximately 7 km long and between 200 and 500 m wide. It drops off steeply on both sides.

Justification (score = 1.5)

This reef was selected as a SUMA because it provides habitat for breeding tiger sharks (*Galeocerdo cuvier*). These iconic predators use coral reef, coastal and oceanic habitats, and can undertake extensive migrations (Domingo et al., 2016). Unlike reef sharks, which share a similar trophic position with groupers and other more generalist predators, tiger sharks

operate at a number of trophic levels, from true apex predators to scavengers (Ferreira et al., 2017). Their feeding activities directly regulate populations of prey, and their presence can significantly change prey behaviour and thereby indirectly affect seascape ecology (Wirsing et al., 2007). Tiger sharks have low reproductive output (Whitney and Crow, 2007), making protection of breeding and nursery areas, such as this SUMA, potentially critical to conservation strategies (Holland et al., 2019). Breeding and pupping areas for tiger sharks are also a key knowledge gap in tiger shark research (Holland et al., 2019). Other sharks that may frequent this SUMA, and were listed as trigger species for Pukapuka as a KBA, are the whale shark (*Rhincodon typus*), oceanic whitetip shark (*Carcharhinus longimanus*) and thresher shark (*Alopias pelagicus*) (Evans, 2012). Based on offshore fisheries records, oceanic whitetip sharks are common in the Cook Islands EEZ (MMR, 2019a), but their presence in this SUMA is unknown.

The whale shark is the world's largest extant fish species, with an average length of approximately 9.8m and a maximum recorded length of over 18m (Colman, 1997; McClain et al., 2015). They are filter-feeders that prey on plankton, small fish, squid and eggs released by fishes, corals and other invertebrates during mass spawning events (Compagno, 1984). Their distribution is likely to be temperature limited, as they are rarely sighted in surface temperatures of less than 21°C (Colman, 1997). They are known to occur in both oceanic and coastal waters and have been recorded from 124 countries worldwide (Chen and Phipps, 2002).

Whale sharks are highly migratory, covering vast ocean distances and transiting among national jurisdictions. A recent study used satellite tagging and tracking technology to document a 20,000 km migration of a female whale shark from the eastern Pacific (Panama) to the western Pacific (Mariana Trench) over 841 days (Guzman et al., 2018). Whale sharks can also display significant variability in their movement patterns, and tend to seasonally aggregate in key locations for feeding and/or mating (Froese and Pauly, 2019). Genetic studies indicate a lack of population genetic structure among sampled whale sharks in the Indian and Pacific basins, suggesting a single meta-population and no limitation on dispersal throughout the Indo-Pacific region (Castro et al., 2007).

Whale sharks are sighted relatively frequently in the western and central Pacific regions, particularly in the Bismarck and Solomon Seas (Harley et al., 2013). Although there are several reports of whale shark sightings by both locals and tourists in the Cook Islands, there are no official records listed on FishBase (Froese & Pauly 2019, https://www.fishbase.se/summary/2081#). The Cook Islands are within the documented range of whale sharks and there is little doubt that they occasionally transit through the Cook Islands EEZ. They may potentially attend specific feeding sites in the Cook Islands such as those with significant upwelling of nutrient-rich waters, high plankton and nekton aggregations, or where reef fishes aggregate to spawn; this suggests that this SUMA is a favourable location. Further information about sharks in the Cook Islands is reviewed in Site O3: Palmerston – Kona Reef.

Type and number of sources (score = 1)

General information about tiger sharks was gathered from five peer-reviewed papers. Because the whale shark is a trigger species for Pukapuka as a KBA, information was also reviewed for this species, using four peer-reviewed papers, three reports and the FishBase website. Interactions between sharks and fisheries, which can confirm their presence within

parts of the EEZ, were recorded from one report. References reviewed for Site O3: Palmerston – Kona Reef are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- Although the island of Pukapuka (and its internal waters) are not governed under the Environment Act 2003, this SUMA extends into the adjoining territorial seas which does fall within the jurisdiction of the Act.
- Marine Resources (Shark Conservation) Regulations 2012 and the National Plan of Action for the Conservation and Management of Sharks in the Cook Islands (NPoA – Sharks) (MMR 2012) are of particular relevance given the significance of sharks in this SUMA.
- Sharks are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

4.1.13 Site PUK3: Pukapuka Beaches

Figure 24. Site PUK3: Pukapuka Beaches

Table 22. Site PUK3: Pukapuka Beaches

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Pukapuka Beaches	PUK3	2	1	1	1	**5**

Geographic boundaries

Map	Latitude	Longitude	Label
	-10.846264	-165.83387	PUK3 (A)
	-10.913293	-165.83119	PUK3 (B)
	-10.893145	-165.87954	PUK3 (C)

Geographic explicitness (score = 2)

This SUMA encompasses the beaches of Pukapuka's islets. It includes the south-facing beach of Motu Kotawa and the seaward beaches of Pukapuka and Motu Ko.

Justification (score = 1)

The beaches of Pukapuka Atoll are known nesting sites for green turtles (SPREP, 2018). The turtles that nest here have been grouped with nesting stock from Samoa and America Samoa (known as the Western Polynesia stock), separate from other Cook Islands nesting aggregations (SPREP, 2018). They may be genetically distinct from other nesting

aggregations, even within the Cook Islands (White, 2012b). Turtles on Pukapuka are protected through ra'ui (White, 2012b). Information about turtles in general, and for the Cook Islands, is reviewed in Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua.

Type and number of sources (score = 1)

Two reports had some information about nesting turtles on Pukapuka beaches. Furthermore, references used to describe turtles in Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- All marine turtle species are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).
- The Cook Islands is also a Party or Signatory to several international agreements for marine turtle conservation, protection and management, including the Convention on Biological Diversity.
- Ra'ui is a traditional form of management in the Cook Islands that involves periodic harvesting closures of specific areas or resources and applies to turtles in some areas.

4.1.14 Site PUK4: Pukapuka Seabird Colonies

Figure 25. Site PUK4: Pukapuka Seabird Colonies

Table 23. Site PUK4: Pukapuka Seabird Colonies

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Pukapuka Seabird colonies	PUK4	2	1	1.5	1	**5.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-10.91103	-165.84487	PUK4 (A)
	-10.909545	-165.83252	PUK4 (B)
	-10.915126	-165.83827	PUK4 (C)

Geographic explicitness (score = 2)

This SUMA spans the south-facing beach of Motu Ko on Pukapuka, along with associated vegetation where seabirds nest, rest and breed. It covers an area of approximately 1.4 km^2.

Justification (score = 1)

The beach and associated vegetation at the southern end of Pukapuka Atoll provides important habitat for colonies of nesting seabirds (MMR, 2000a; Passfield and Rongo, 2011). Species documented as using this SUMA include masked booby (*Sula dactylatra*) and frigatebirds (*Fregata* spp.) (McCormack, 2002; traditional knowledge).

The Cook Islands supports at least 30 seabird species and twelve land bird species, six of which are endemic (BirdLife International, 2020; Jones, 2001); this SUMA review is restricted to seabirds (Table 24). Of the 30 seabird species that occur in the Cook Islands, nine are classified as vulnerable (VU) on the IUCN Red List.

Table 24. Seabirds recorded in the Cook Islands.

Species name	Common name	Family	IUCN Red List Category
Anous stolidus	Brown Noddy	Laridae (Gulls, Terns, Skimmers)	LC
Anous minutus	Black Noddy	Laridae (Gulls, Terns, Skimmers)	LC
Procelsterna cerulea	Blue Noddy	Laridae (Gulls, Terns, Skimmers)	LC
Ardenna bulleri	Buller's Shearwater	Procellariidae (Petrels, Shearwaters)	VU
Ardenna pacifica	Wedge-tailed Shearwater	Procellariidae (Petrels, Shearwaters)	LC
Fregata minor	Great Frigatebird	Freagatidae (Frigatebirds)	LC
Fregata ariel	Lesser Frigatebird	Freagatidae (Frigatebirds)	LC
Gygis alba	Common White Tern	Laridae (Gulls, Terns, Skimmers)	LC
Onychoprion fuscatus	Sooty Tern	Laridae (Gulls, Terns, Skimmers)	LC
Phaethon lepturus	White-tailed Tropicbird	Phaethontidae (Tropicbirds)	LC
Phaethon rubricauda	Red-Tailed Tropicbird	Phaethontidae (Tropicbirds)	LC
Procellaria parkinsoni	Black Petrel	Procellariidae (Petrels, Shearwaters)	VU
Procelsterna cerulea	Blue-grey Noddy	Procellariidae (Petrels, Shearwaters)	LC
Pterodroma brevipes	Collared Petrel	Procellariidae (Petrels, Shearwaters)	VU
Pterodroma cervicalis	White-necked Petrel	Procellariidae (Petrels, Shearwaters)	VU
Pterodroma cookii	Cook's Petrel	Procellariidae (Petrels, Shearwaters)	VU
Pterodroma heraldica	Herald Petrel	Procellariidae (Petrels, Shearwaters)	LC
Pterodroma leucoptera	White-winged Petrel	Procellariidae (Petrels, Shearwaters)	VU
Pterodroma neglecta	Kermadec Petrel	Procellariidae (Petrels, Shearwaters)	LC
Pterodroma nigripennis	Black-winged Petrel	Procellariidae (Petrels, Shearwaters)	LC
Pterodroma solandri	Providence Petrel	Procellariidae (Petrels, Shearwaters)	VU
Puffinus lhierminier	Audubon's Shearwater	Procellariidae (Petrels, Shearwaters)	LC
Sterna lunata	Spectacled tern	Laridae (Gulls, Terns, Skimmers)	LC
Sterna sumatrana	Black-naped Tern	Laridae (Gulls, Terns, Skimmers)	LC
Sula sula	Red-footed Booby	Sulidae (Gannets, Boobies)	LC
Sula leucogaster	Brown Booby	Sulidae (Gannets, Boobies)	LC
Sula dactylatra	Masked Booby	Sulidae (Gannets, Boobies)	LC
Thalassarche impavida	Campbell Albatross	Diomedeidae (Albatrosses)	VU
Thalassarche eremita	Chatham Albatross	Diomedeidae (Albatrosses)	VU
Thalasseus bergii	Greater Crested Tern	Laridae (Gulls, Terns, Skimmers)	LC

Seabirds are a taxonomically diverse group of nearly 350 species (around 3.5% of all bird species globally) that depend on the marine environment for at least part of their life cycle. Seabirds are typically apex predators within oceanic food webs and they are key indicators of ecosystem health (Croxall et al., 2012). In general, seabirds live longer, breed later and have

fewer young than most land birds. Most species nest in colonies that vary in size from a few dozen birds to millions. Many species undertake long-distance annual migrations, crossing the Equator or in some cases circumnavigating the Earth (Schreiber and Burger, 2011).

In island ecosystems, seabird breeding colonies play a crucial role in the transport of macro and micronutrients, and other materials from the sea to the land through guano, egg shells, feathers, fish scraps and dead birds (Otero et al., 2018; Sánchez-Piñero and Polis, 2000). This source of nutrients, primarily nitrogen and phosphorous, drives the production and enrichment of island soils, which in turn provides resources to terrestrial plants and animals and facilitates the development of ecological communities and the human communities that rely upon them (Cushman, 2013; Otero et al., 2018). Furthermore, seabird guano has been shown to be an important source of nitrogen for reef-building corals on remote islands of Oceania (Lorrain et al., 2017).

The status of the world's seabirds has deteriorated over recent decades due to human activities in the marine environment. Approximately half (47%) of all seabird species are known or expected to be experiencing population declines. Furthermore, nearly one-third (28%) of seabirds are globally threatened, 10% are near threatened, and a further 5% are critically endangered and slipping close to extinction (BirdLife International, 2012; IUCN Red List). Key threats to seabird populations include the introduction of invasive animal and plant species (e.g. rats), degradation of nesting sites, marine plastics and pollution, direct harvest for food and feathers, commercial fishing through competition for available fish and mortality in fishing gears, and the cumulative effects of climate change, including ocean warming, sea-level rise, increasing frequency and severity of storms, and changes in ocean circulation and food resource availability (Croxall et al., 2012; Serratosa et al., 2020).

There is a growing need to identify candidate locations and establish marine protected areas (MPAs) for the conservation and sustainability of marine species, including seabirds. For seabirds, typical candidate locations for MPAs include those near breeding colonies, offshore foraging areas, inshore habitats for wintering species, and migratory bottlenecks (Thaxter et al., 2012). Over the past three decades Birdlife International (https://www.birdlife.org/) has developed and applied a global network of Important Bird Areas (IBAs) that aim to protect and restore key nesting and foraging sites.

Type and number of sources (score = 1.5)

There was little detailed information on the seabirds in this SUMA; the presence of nests here was confirmed in three reports. A further four peer-reviewed papers and two books provided background information on seabirds; one report and the BirdLife International website were used to list seabird species in the Cook Islands.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- Seabirds and their nests on Pukapuka are protected under ra'ui.
- All species are listed on the IUCN Red List of Threatened Species, and many are also listed under the Convention on Migratory Species (CMS).

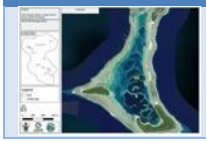
4.1.15 Site PUK5: Pukapuka Ra'ui

Figure 26. Site PUK5: Pukapuka Ra'ui

Table 25. Site PUK5: Pukapuka Ra'ui

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Pukapuka Ra'ui	PUK5	3	2	3	1	**9**

Geographic boundaries

Map	Latitude	Longitude	Points
	-10.891101	-165.86763	PUK5 (A)
	-10.853864	-165.84563	PUK5 (B)
	-10.909641	-165.83843	PUK5 (C)

Geographic explicitness (score = 3)

The marine ra'ui area of Pukapuka Atoll covers the entire lagoon, spanning approximately 6.6 km^2 of marine habitats. The triangular-shaped lagoon is completely enclosed and includes back reef, sandy seabed and coral outcrops. The lagoon is about 8 km long and 3-5 km wide.

Justification (score = 2)

The marine resources in the Pukapuka lagoon are closely linked to the condition of lagoon and reef ecosystems. A recent survey (Rongo 2016) recorded two species of coral in the Pukapuka lagoon that have not been reported elsewhere in the Cook Islands (*Stylophora*

pistillata and *Pavona decussata*, with the latter unaffected by coral bleaching). Pukapuka's coral reefs were impacted by the 2015/2016 El Niño event, but bleaching was less severe than on reefs further east such as Tongareva (Rongo, 2016). Furthermore, lagoonal corals were more resistant to bleaching than corals on the forereef (Rongo, 2016) perhaps due to past adaptation to greater temperature fluctuations in the enclosed lagoon (Bay et al., 2017). At the northern end of the lagoon, coral communities included healthy colonies of *Pocillopora damicornis* which were heavily bleached on islands further east. *Pavona decussata* was also abundant in this area (Rongo, 2016).

Marine invertebrates such as clams are scarce in the lagoon, having declined as a result of overharvesting and changes in lagoon flow due to harbour development (Passfield and Rongo, 2011). Humphead wrasse (*Cheilinus undulatus*) are thought to occur on the reefs of Pukapuka (Evans, 2012).

Ra'ui arrangements in Pukapuka target the protection of coconut crabs, turtles and seabirds, and a ban on spearfishing to protect groupers (Butler, 2017a; MMR, 2000a; Saul and Tiraa, 2004). Land and sea ra'ui areas together cover 450 hectares (SPREP, 2018). General information about the system and benefit of ra'ui in the Cook Islands was reviewed in Site MAN2: Manihiki - Porea Ra'ui.

Type and number of sources (score = 3)

Six reports and one peer-reviewed paper had information about ra'ui, coral reefs and a few of the marine resources of Pukapuka. References describing ra'ui in Site MAN2: Manihiki - Porea Ra'ui are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- Many marine species in Pukapuka are managed under ra'ui to facilitate sustainable use.
- Many of the coral reef species present in this SUMA are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

4.1.16 Site NAS1: Southern Nassau Turtle Sites

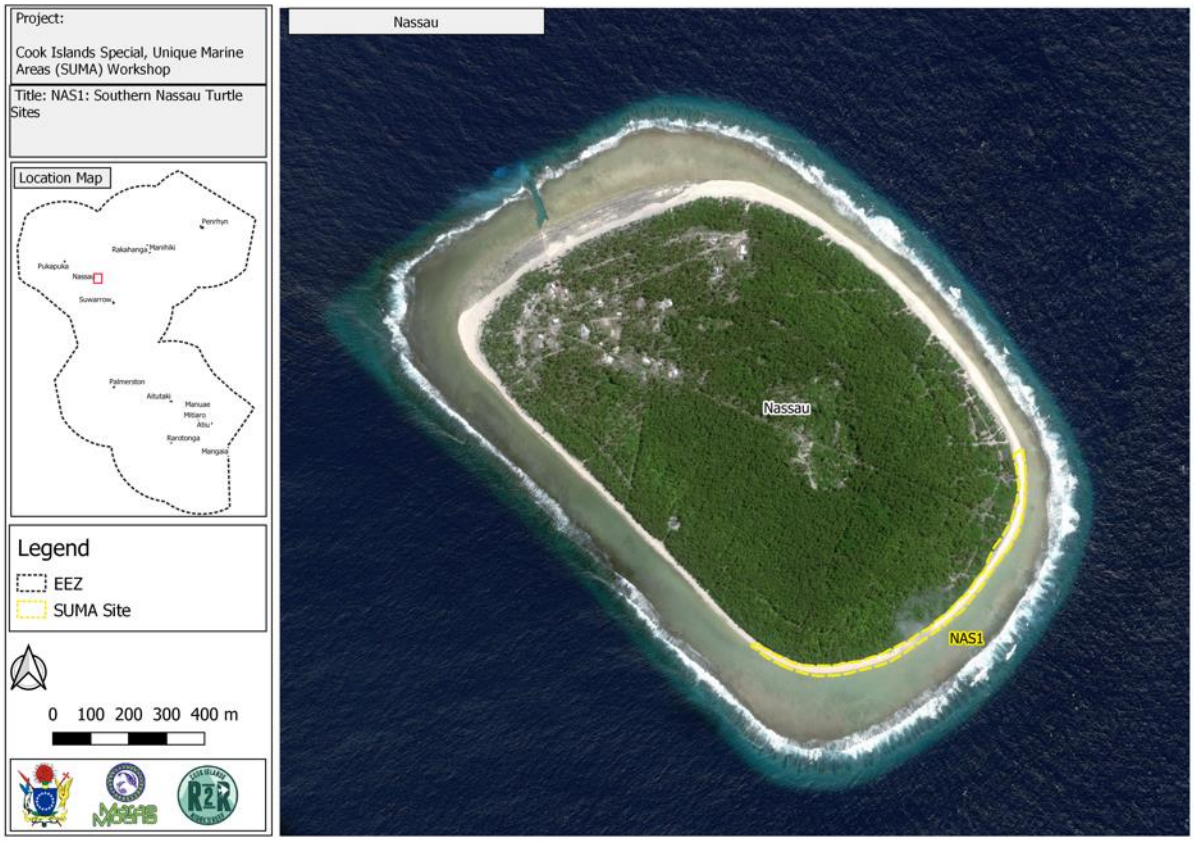


Figure 27. Site NAS1: Southern Nassau Turtle Sites

Table 26. Site NAS1: Southern Nassau Turtle Sites

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Southern Nassau Turtle Sites	NAS1	2	1.5	1	1	**5.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-11.561484	-165.40848	NAS 1 (A)
	-11.565125	-165.4098	NAS 1 (B)
	-11.565863	-165.41492	NAS 1 (C)

Geographic explicitness (score = 2)

This SUMA is the southern beach of Nassau Island, a sand cay with a surrounding beach and a narrow fringing reef. Facing southeast, the beach is approximately 8 km long and only 20 m wide.

Justification (score = 1.5)

Workshop participants chose this beach as a SUMA due to its nesting green turtles, which are thought to belong to the Northern Cook Islands nesting stock (Evans, 2012; MMR, 2000c; SPREP, 2018; White, 2011). A rapid assessment survey of the whole Nassau coastline

recorded six nests; three were on the northern and northeastern beaches, which consist mainly of coral fragments, two on the sandier eastern beach and one on the southern beach (White, 2011). Nests were usually laid in, or close to, the vegetation behind the beach.

Information about turtles in general, and for the Cook Islands, is reviewed in Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua.

Type and number of sources (score = 1)

Nesting turtles on Nassau Island were described using four reports. References reviewed for Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- All marine turtle species are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS). The Cook Islands is also a Party or Signatory to several international agreements for marine turtle conservation, protection and management, including the Convention on Biological Diversity.
- Ra'ui is a traditional form of management in the Cook Islands that involves periodic harvesting closures of specific areas or resources and applies to turtles in some areas.

4.1.17 Site NAS2: Northern Nassau Reef

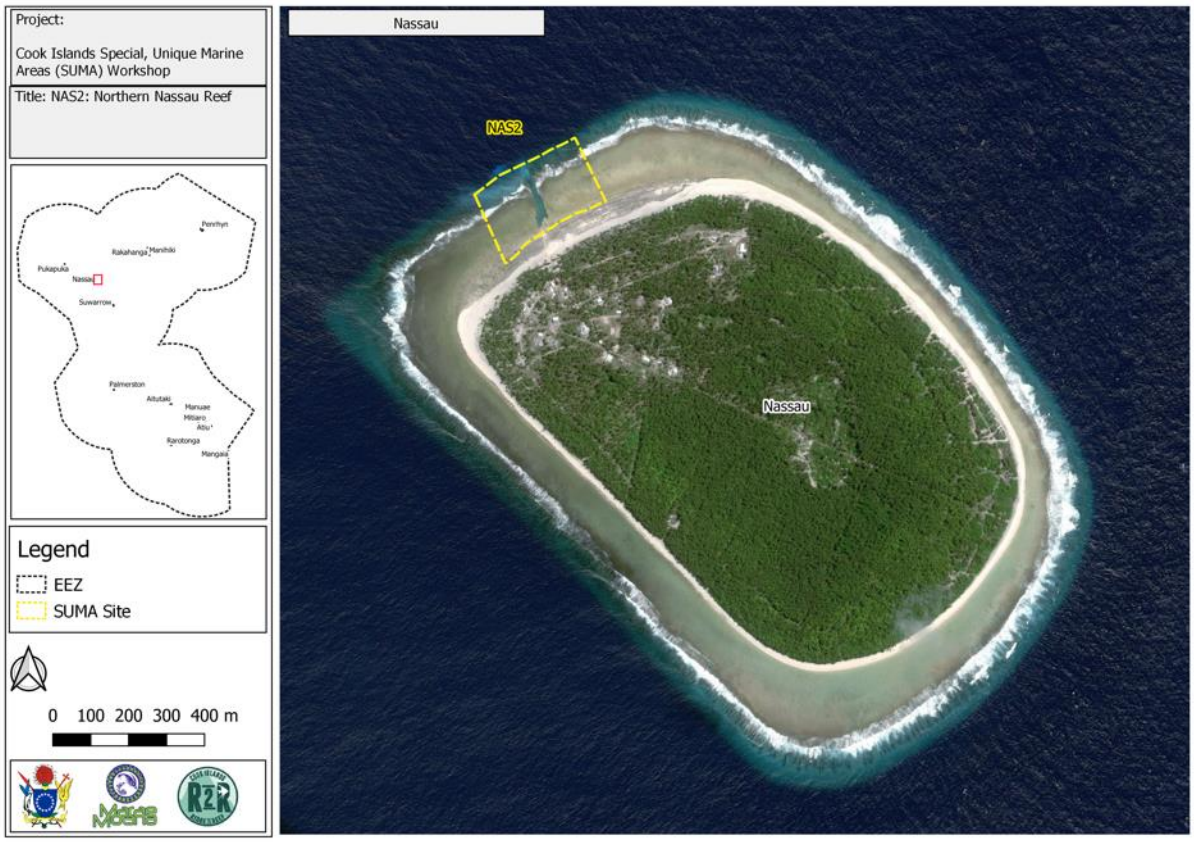


Figure 28. Site NAS2: Northern Nassau Reef.

Table 27. Site NAS2: Northern Nassau Reef

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Northern Nassau Reef	NAS2	1	1	1	1	**4**

Geographic boundaries

Map	Latitude	Longitude	Points
	-11.5537	-165.41891	NAS 2 (A)
	-11.55666	-165.42065	NAS 2 (B)

Geographic explicitness (score = 1)

This SUMA is a small portion of reef on the north-facing side of Nassau Island, including reef flat, crest and slope.

Justification (score = 1)

The reef on the northern side of Nassau Island is thought to be favourable habitat for lobsters (*Panulirus* spp.) and red snapper (*Lutjanus bohar*), which are prized throughout the Cook Islands (MMR, 2000a). The presence of these species suggests that this area is likely to be productive, and both species contribute significantly to the trophic ecology of coral reefs. Lobster are important detritivores and are prey for large groupers which are rare on degraded

or exploited reefs (Frisch and Hobbs, 2012). Large snapper are important reef predators (Boaden and Kingsford, 2015; Sandin et al., 2008). Lobsters are protected under ra'ui on Nassau Island (Munro, 2018).

Nassau reefs are thought to have suffered bleaching along with the other reefs from the northern group, but no surveys were conducted there (Rongo, 2016). Tema Reef, offshore from Nassau, is an isolated reef that may contribute to the larval replenishment of Nassau's fringing reefs after disturbance (Passfield and Rongo, 2011; White, 2011).

Type and number of sources (score = 1)

The values of the site were inferred from two reports on northern Cook Islands reefs, an unpublished list of ra'ui, one report on lobsters in the Cook Islands, and three peer-reviewed paper about lobsters and reef predators in general.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- Lobsters are listed on the IUCN Red List of Threatened Species.
- Ra'ui is a traditional form of management in the Cook Islands that involves periodic harvesting closures of specific areas or resources and applies to lobsters in some areas.

4.1.18 Site NAS3: Southeastern Nassau Ra'ui Area

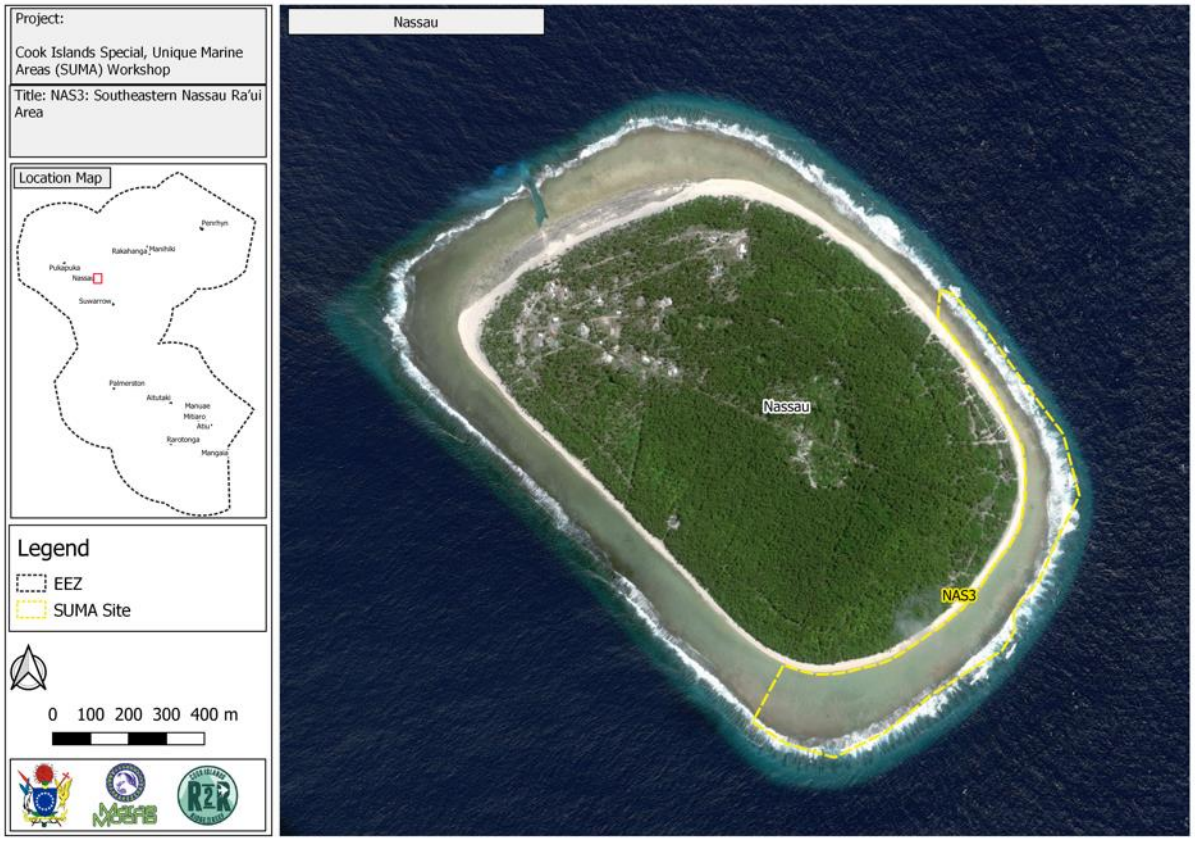


Figure 29. Site NAS3: Southeastern Nassau Ra'ui Area.

Table 28. Site NAS3: Southeastern Nassau Ra'ui Area

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Southeastern Nassau Ra'ui Area	NAS3	3	1	1	1	**6**

Geographic boundaries

Map	Latitude	Longitude	Points
	-11.557498	-165.41016	NAS 3 (A)
	-11.566147	-165.40887	NAS 3 (B)
	-11.566357	-165.41415	NAS 3 (C)

Geographic explicitness (score = 3)

This SUMA encompasses the fringing reef flat, crest and slope under ra'ui on the southeastern side of Nassau Island.

Justification (score = 1)

The western side of Nassau Island is managed under ra'ui, with a 6-12 month rotation of various fishing and hunting arrangements, especially for coconut crabs, lobster and red-footed booby (Munro, 2018). Across the Cook Islands, surveys show that the effectiveness of ra'ui in restoring depleted populations is variable and depends on the objectives of the ra'ui,

the specific management practices implemented, and compliance (Matamaki et al., 2016). There was no information on the state of resources specific to the ra'ui in this SUMA. General information about ra'ui in the Cook Islands is reviewed in Site MAN2: Manihiki - Porea Ra'ui.

Type and number of sources (score = 1)

Although the Nassau marine and terrestrial ra'ui are mentioned in an unpublished list by the National Environment Service, there was no information specific to the state of the habitats or resources. One further report was used to explain the factors leading to the success or otherwise of ra'ui. References used to describe the system of ra'ui in general for Site MAN2: Manihiki - Porea Ra'ui are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- This SUMA is protected under customary laws, or ra'ui. Coconut crabs, lobster and red-footed booby are three of the species subject to ra'ui on Nassau Island. The harvest of coconut crab is prohibited anywhere on the island and only opened up to the community when the Aronga Mana or Leaders decide, on the grounds of their apparent abundance and only for very special occasions. The ra'ui for coconut crabs can be in place for a period up to 3 or 4 years. The harvest of lobsters is restricted to areas outside the ra'ui
- All species protected under ra'ui in this SUMA are also listed on the IUCN Red List of Threatened Species.

4.1.19 Site NAS4: Nassau Beaches

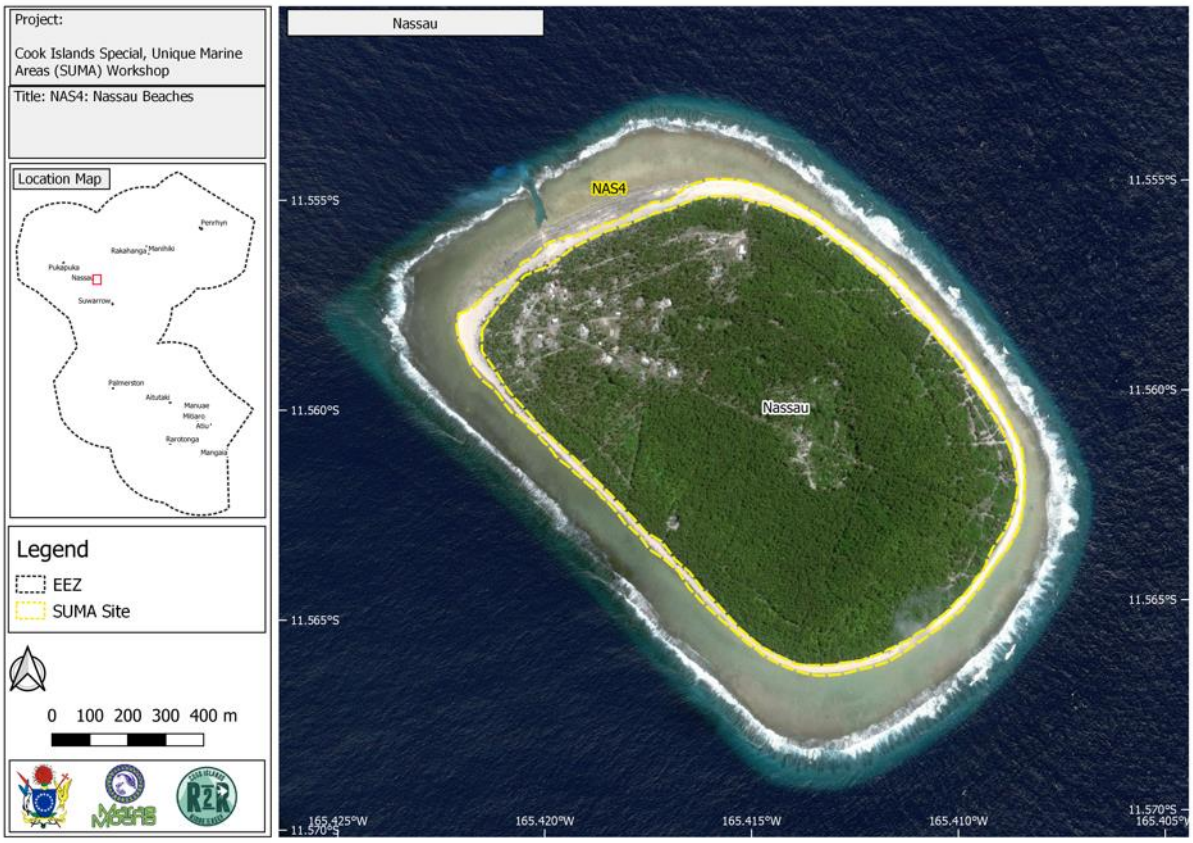


Figure 30. Site NAS4: Nassau Beaches

Table 29. Site NAS4: Nassau Beaches

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Nassau Beaches	NAS4	2	1	1	1	**5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-11.557798	-165.4218	NAS 4 (A)
	-11.562938	-165.40831	NAS 4 (B)
	-11.555158	-165.41503	NAS 4 (C)
	-11.565898	-165.41466	NAS 4 (D)

Geographic explicitness (score = 2)

This SUMA captures the entire beach around Nassau Island, from the vegetation line to the low water mark.

Justification (score = 1)

Workshop participants chose this SUMA to include all the beach areas used by coconut crabs on Nassau Island. There is no other information about coconut crabs on Nassau Island,

except that they are managed under ra'ui (Munro, 2018). Information reviewed about coconut crabs for Site MAN2: Manihiki - Porea Ra'ui is also relevant here.

Type and number of sources (score = 1)

The management of coconut crabs under ra'ui on Nassau Island was confirmed from an unpublished list from the National Environment Service. References about coconut crabs reviewed for Site MAN2: Manihiki - Porea Ra'ui are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- Coconut crabs are listed on the IUCN Red List of Threatened Species. On Nassau Island they are also protected under ra'ui.

4.1.20 Site SUW1: Suwarrow

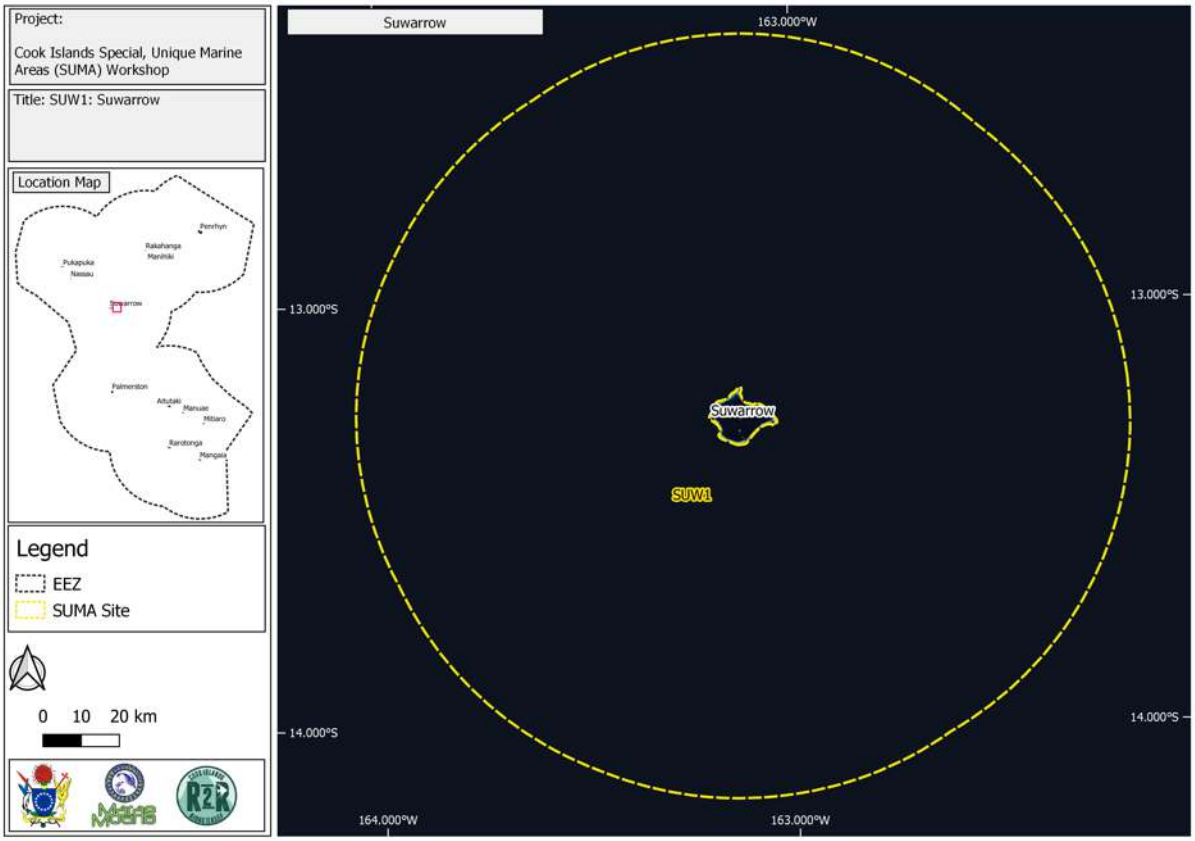


Figure 31. Site SUW1: Suwarrow

Table 30. Site SUW1: Suwarrow

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – northern group	Suwarrow	SUW1	3	3	2.5	3	**11.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-12.367805	-163.11452	SUW1 (A)
	-14.176395	-163.1483	SUW1 (B)

Geographic explicitness (score = 3)

Suwarrow Atoll is located approximately 800 km northwest of Rarotonga in the Northern Cook Islands. Suwarrow has 30 motu (islets) and a coral reef fringing a lagoon with a total area of approximately 97 km^2. This SUMA coincides with the marine areas of the KBA and National Park, and extends to 50 nm from the atoll itself, which means that it is also a MPA under Marae Moana 2017 out to this same point (50nm)

Justification (score = 3)

Suwarrow Atoll and the surrounding waters have been protected as a National Park since 1978; it is the oldest and largest terrestrial protected area in the Cook Islands and is under the jurisdiction of the National Environment Service (NES) (SPREP, 2018). Suwarrow meets the global IUCN definition of a protected area and is one of only two that extend across island and marine environments (Takutea is the other) (Twyford, 2020b). The legal status of Suwarrow remains a matter of some conjecture, although it would seem that the national park designation remains, and that this designation extends into the surrounding marine area and out to 12nm (Twyford, 2020b).

Suwarrow is a KBA and also has two of the nine designated Important Bird Areas (IBAs) in the Cook Islands, one for the motu and one for the marine waters[18]. The National Park supports important nesting sites for seabirds and turtles. There are extensive coral reefs fringing the atoll and patch reefs throughout the lagoon that support abundant invertebrate, fish and shark populations.

Suwarrow is uninhabited except for two NES rangers (caretakers) that are stationed at Anchorage Island for approximately six months of the year outside of cyclone season. The caretakers are responsible for monitoring visiting yachts, ensuring the protection of the environment and maintaining their small accommodation on Anchorage Island (NES, 2020).

Suwarrow Atoll is a critically important seabird nesting site for the Cook Islands and the Oceania region (BirdLife International, 2020). It supports at least 14 seabird species including over one percent of the global population of sooty tern (*Onychoprion fuscatus*) and red-tailed tropicbird (*Phaethon rubricauda*) and approximately 13% of the world's lesser frigatebirds (*Fregata ariel*) (BirdLife International, 2020; Jones, 2001). The atoll also supports locally significant colonies of red-footed boobies, great frigate birds, masked boobies and brown boobies (BirdLife International, 2020). Suwarrow is also a wintering site for the bristle-thighed curlew which migrates from Alaska (Jones, 2001). Motu Tou is an important nesting site for black noddy terns and they were the dominant species during a nesting survey in 2000 (Jones, 2008). However, an infestation of rats was found at Motu Tou during the 2008 bird nesting survey and no noddy terns were observed nesting there at that time (BirdLife International, 2020).

The large spatial extent of this SUMA reflects the foraging ranges of the seabird species present. For example, the marine IBA for Suwarrow allows for a radius of 140 km from the nesting site to cover the foraging range of lesser frigatebirds. Female magnificent frigatebirds (*Fregata magnificens* – not present on Suwarrow) that are provisioning chicks travel 55 km and males range out to 156 km (Soanes et al., 2016) and it can be inferred that other frigatebirds will forage similar distances. Generally, conservation initiatives for seabirds use the distance from the nest within which 1% of the global population forages. This would result in a foraging range with a radius of 140 km from Suwarrow. However, although this kind of scale cannot be adequately covered by site-based conservation measures, it justifies the 50 nm MPA around the islands currently in place under the *Marae Moana Act 2017* (M. O'Brien, Conservation International, pers. comm.).

Green turtles (*Chelonia mydas*) are known to nest on beaches at Suwarrow Atoll. However, lower numbers of turtles are known to nest here than at the primary nesting sites at Tongareva Atoll and Palmerston Atoll in the northern and southern Cook Islands respectively (Balazs,

[18] http://datazone.birdlife.org/site/ibacritglob

1995; Rudrud, 2010; White, 2012b). Green turtle populations were decreasing globally when they were last assessed in 2004 (Seminoff, 2004). Information about green turtles in the Cook Islands reviewed in Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua is also relevant here.

Suwarrow also supports large populations of coconut crabs (NES, 2020). The Suwarrow National Park provides no-take protection for this highly prized food species and it is possible that Suwarrow is providing a regionally significant source of coconut crab larvae for the replenishment of populations throughout the Cook Islands. Information about coconut crabs in the Cook Islands reviewed in Site MAN1: Manihiki Lagoon is also relevant here.

The waters and coral reefs fringing Suwarrow Atoll have been designated as a no-take marine reserve since the National Park was declared in 1978. Baseline surveys of Suwarrow's coral reef fishes were conducted in the early 1980s (Grange and Singleton, 1985), however there have been no systematic marine surveys undertaken to assess the biodiversity and condition of the coral reefs in recent years. There are no known endemic coral reef species at Suwarrow. Information about coral reefs in the Cook Islands reviewed in Site TON1: Tongareva - Flying Venus Reef is also relevant here.

Current evidence suggests that Polynesian seafarers from Samoa and Tonga had discovered and colonised the Cook Islands, Tahiti, Tuamotus and Marquesas by 1190 – 1290 A.D. (Wilmshurst et al., 2011). These seafarers introduced domesticated root crops such as sweet potato, along with chickens and pigs to many islands throughout the Pacific. These domesticated plants and animals have become naturalised to the Pacific Islands and continue to provide an important food source for local people. Pacific rats (*Rattus exulans*), also known as Polynesian or little rats, originate from southeast Asia and Melanesia and are likely to be one of the first introduced invasive species to many Pacific Islands, including the Cook Islands (Thomson et al., 2014). Pacific rats are a significant predator of birds, reptiles and insects, as well as consuming seeds and fruits. They have been implicated in many of the native bird and insect extinctions that occurred throughout Oceania (Atkinson and Atkinson, 2000). Native species had evolved in the absence of mammals and were unable to successfully adapt to the predation pressure posed by the introduced rat (Amos et al., 2014). Pacific rats were noted to be present on Anchorage Island at Suwarrow by early European visitors in the 1800s (Jones, 2001). In the 1940s, Coastwatchers that were stationed at Suwarrow, introduced pigs and chickens to Anchorage Island. Cats were also introduced to Anchorage Island in an attempt to control Pacific rat numbers (Jones, 2001). Rats prey upon seabird eggs and chicks and pose a major threat to the important seabird rookeries at Suwarrow Atoll. If not controlled or preferably eradicated, rats could seriously undermine the viability of seabird nesting at Suwarrow and degrade the environmental values of the National Park.

A control program using cereal bait pellets laced with Brodifacoum (an anticoagulant poison) is being conducted at Suwarrow in an attempt to eradicate rats. There have been three rounds of bait deployments in 2003, 2013 and 2018. The task of eradicating rats from Suwarrow's Motus remains a work in progress; there is no current report on the success of the eradication program (Te Ipukarea Society, 2014).

Type and number of sources (score = 2.5)

Four websites, five reports and three peer-reviewed papers contributed information about the attributes of Suwarrow Atoll. References used to review information in Site TON1:

Tongareva - Flying Venus Reef, Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua and Site MAN1: Manihiki Lagoon are also relevant here.

Obligations (score = 3)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- In the marine area, two designations exist: (a) Suwarrow Marine Protected Area, effectively a zone established under the Section 24 of the Marae Moana Act, that extends from the coastline to 50 nm; and (b) Suwarrow National Park that includes the "superjacent waters in the territorial sea" which is interpreted to mean the marine area surrounding the island, from the coastline to 12 nm. Designation as a national park under this arrangement needs further consideration and resolution (refer Twyford 2020b).
- Many of the species that live on Suwarrow Atoll are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

4.2 Southern Cook Islands

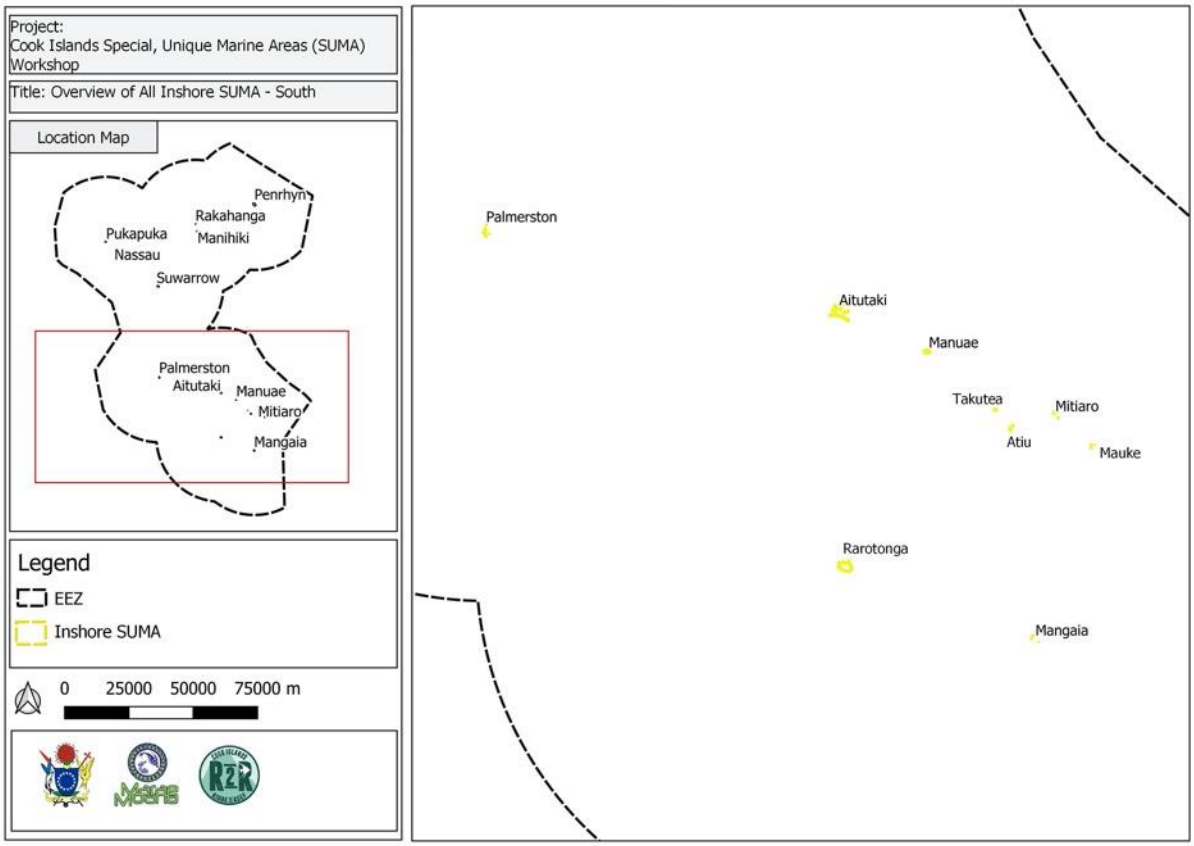


Figure 32. Overview of the southern Cook Islands inshore SUMAs.

4.2.1 Site PAL1: Palmerston, Cook and Primrose Island Beaches

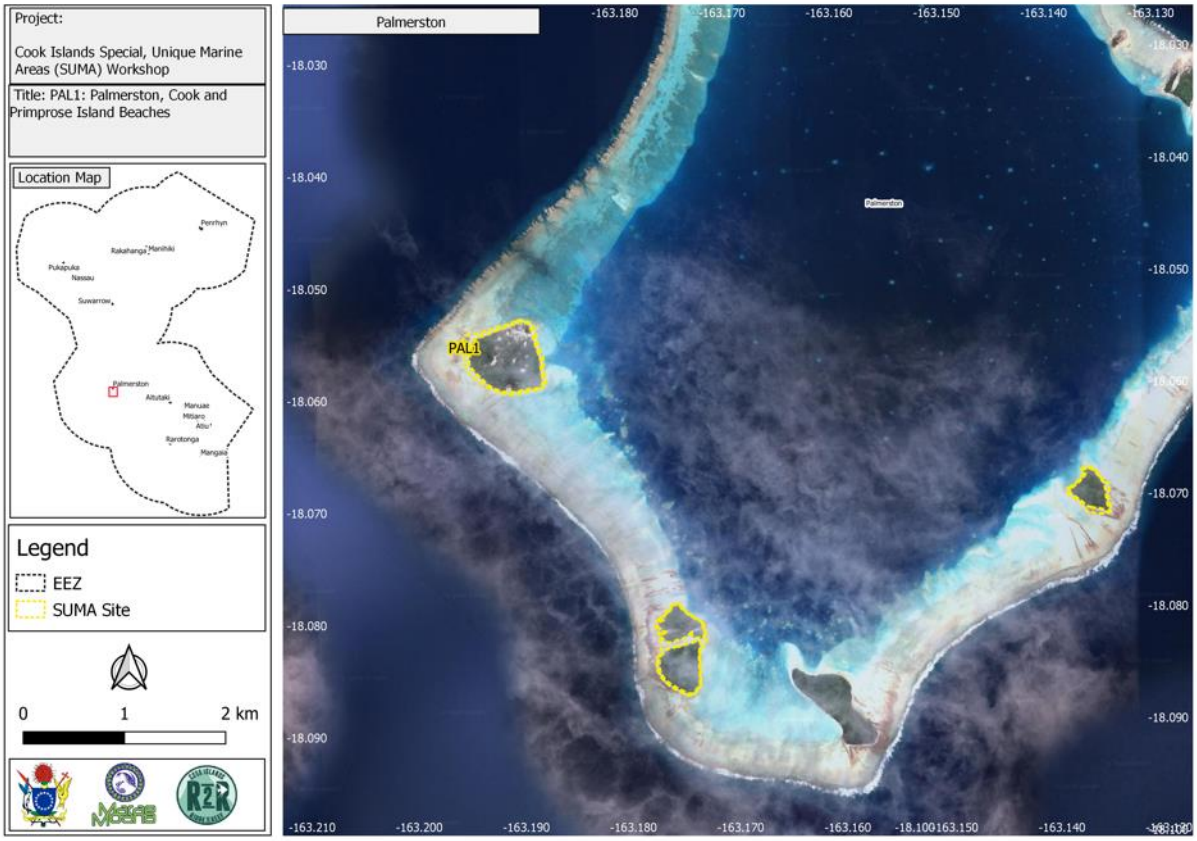


Figure 33. Site PAL1: Palmerston, Cook and Primrose Island Beaches

Table 31. Site PAL1: Palmerston, Cook and Primrose Island Beaches

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Palmerston, Cook and Primrose Island Beaches	PAL1	2	1.5	2	1	**6.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-18.068945	-163.13487	PAL 1 (A)
	-18.069578	-163.13887	PAL 1 (B)
	-18.087039	-163.17414	PAL 1(C)
	-18.078913	-163.17591	PAL 1 (D)
	-18.05912	-163.18732	PAL 1 (E)
	-18.054527	-163.19459	PAL 1 (F)

Geographic explicitness (score = 2)

This SUMA encompasses the beaches of Palmerston Atoll, particularly the portions of beaches on Palmerston, Cook and Primrose Islands where turtle nests are found.

Justification (score = 1.5)

This SUMA was identified for its importance to nesting turtles, with an estimate of 100 nests per year (SPREP, 2018). The beaches of Palmerston Atoll are also important habitat for coconut crabs (*Birgus latro*; see also Site MAN2: Manihiki - Porea Ra'ui) (Kora and Munro, 2020). Palmerston Atoll is the primary green turtle nesting site in the southern Cook Islands (Balazs, 1995). Reports from the 1960s and 1970s refer to Palmerston Atoll as an important nesting location for green turtles in the Pacific, although no indications of numbers of nesting females were provided (Balazs, 1995). Surveys undertaken from 1972-77 found that the number of turtle nests declined from 30 or 40 to fewer than 10 (Helfrich, 1974). There is evidence of a link between green turtles on Palmerston and other Pacific Island nations; in 2000, Hauser and Peckham (N. Hauser, pers. comm.) reported that a green turtle tagged on Palmerston had arrived in Fiji after 52 days.

In November 2000, a 25-night survey at Cook Islet found only seven turtles (CCRC, 2004); this plus detection of few turtle nests at other Palmerston Atoll beaches indicated much lower nesting rates than previously reported. These results were corroborated by Palmerston fishermen who noted low numbers of nesting turtles during the 2000 season (CCRC, 2004). A survey conducted in December 2010 at Palmerston Islet identified three nests laid in the vegetation at the back of the leeward beach (White, 2011). In 2012 the atoll was surveyed more extensively and 185 nests were confirmed (White, 2012c).

Little is known about the peak nesting period for green turtles in the Cook Islands (White, 2012b). It is expected that the primary egg-laying period is between September and April, however it is possible that there are differences in timing between northern and southern islands (White, 2012b). There are reports of loggerhead turtles at Palmerston Atoll, but no evidence that they nest in the Cook Islands (SPREP, 2018). Green and loggerhead turtles were two of the trigger species for the designation of Palmerston Atoll as a KBA (Evans, 2012). Information about turtles in general, and for the Cook Islands, is reviewed in Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua.

Type and number of sources (score = 2)

Information about nesting turtles in this SUMA was gleaned from one peer-reviewed paper, six reports and one website. References reviewed for Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- All marine turtle species are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS). The Cook Islands is also a Party or Signatory to several international agreements for marine turtle conservation, protection and management, including the Convention on Biological Diversity.

- Ra’ui is a traditional form of management in the Cook Islands that involves periodic harvesting closures of specific areas or resources and applies to turtles in some areas.

4.2.2 Site PAL2: Western Palmerston Outer Reef Slope

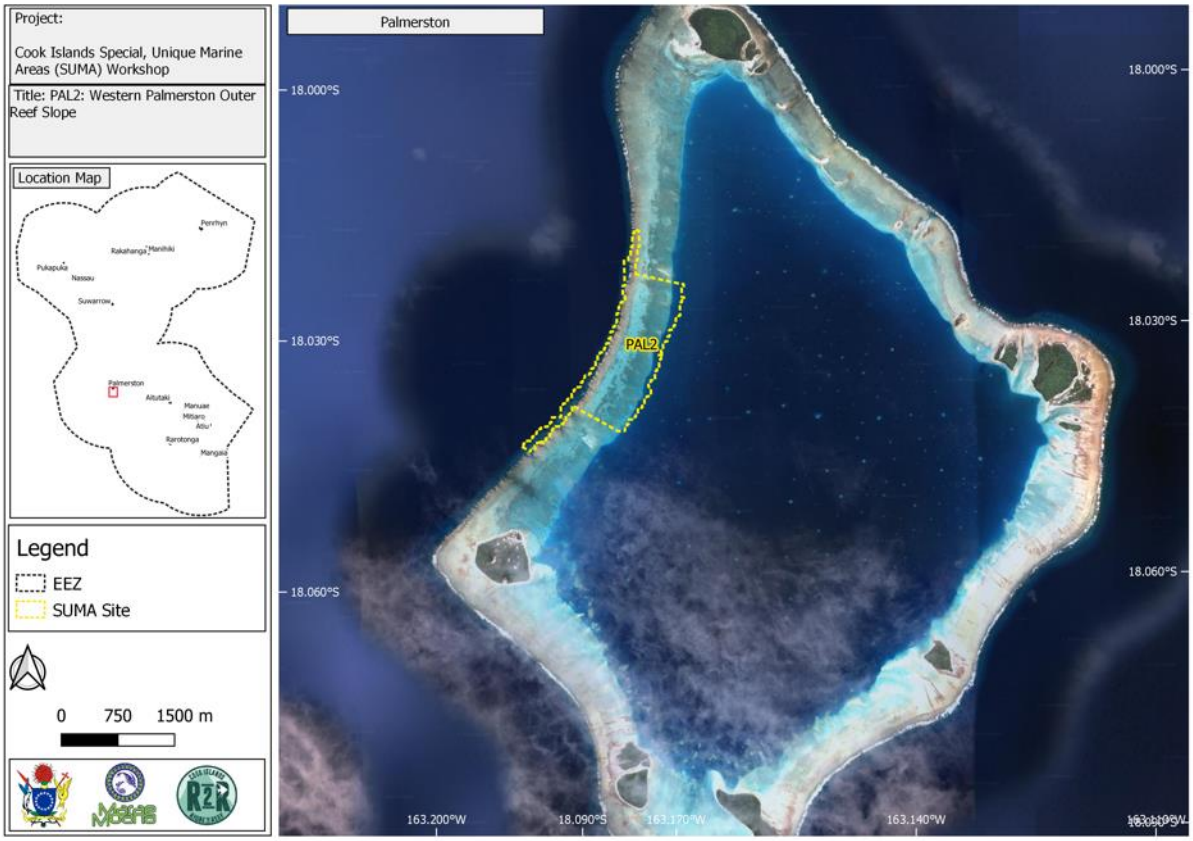


Figure 34. Site PAL2: Western Palmerston Outer Reef Slope

Table 32. Site PAL2: Western Palmerston Outer Reef Slope

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Western Palmerston Outer Reef Slope	PAL2	2	1.5	2	1	**6.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-18.017853	-163.173	PAL 2 (A)
	-18.038512	-163.18182	PAL 2 (B)

Geographic explicitness (score = 2)

This SUMA covers the reef flat and outer reef slope of the western side of Palmerston Atoll. It extends approximately 3 km north from Palmerston Islet and drops steeply into deep water. In shallower waters there are breaks in the reef (big tonu ava and small tonu ava) that contribute to habitat complexity.

Justification (score = 1.5)

The reef off western Palmerston Atoll was chosen because it provides favourable habitat for coral trout, or tonu (*Plectropomus laevis*); this habitat comprises large and small breaks in the reef (ava) that create structural complexity and provide shelter for fish (traditional

knowledge, SUMA workshop). Generally, reefs that support healthy populations of these predators are in good condition, with high coral cover, high structural complexity and high prey density. Compared with other carnivorous fish species at Palmerston, coral trout has been recorded in high densities and may be abundant because a history of ciguatera has limited its exploitation (Pinca et al., 2009; Preston et al., 1995). *Plectropomus* species are important predators in coral reef environment, playing a role that is sometimes as important as that of reef sharks (Barley et al., 2020). Predators such as *Plectropomus laevis* can drive ecological assemblages and processes, both through direct consumption and non-consumptive effects such as fear-based behaviour changes. Studies have shown that they can even affect herbivory patterns through this indirect influence, by shaping where and how much herbivorous prey can feed (Bauman et al., 2019).

The atoll is made up of a fringing reef surrounding a large lagoon (Purkis et al., 2018), roughly trapezoidal in shape, with an 11 km north-south axis and 8.5 km from east to west. The lagoon is largely enclosed and on average 20 m deep with a maximum depth of over 30 m (Pinca et al., 2009). There are six islets located on the reef rim, along with numerous smaller motus and sand cays (Preston et al., 1995). The fringing reef has an estimated perimeter length of 29.8 km and much of the reef flat dries at low spring tides (Preston et al., 1995). The crest is elevated and heavily cemented by crustose coralline algae such as *Porolithion* and *Lithothamnion* (Preston et al., 1995). In 2013, the coral reefs of Palmerston Atoll were found to be in good condition with high coral cover (~50%) and a diverse assemblage of algae and invertebrates (Purkis et al., 2018). The survey of fish assemblages reported high biomass compared with Aitutaki and Rarotonga, with a higher proportion of fishes in larger size classes (Purkis et al., 2018).

Finfish were also surveyed on the western outer reef in 2009 (Pinca et al., 2009) and in nearshore habitats in 2018 (MMR, 2019b). In 2009, compared to other reef habitats, outer reefs had the highest coral cover (33%) and displayed the highest density (0.7 fish per m^2) and biodiversity (39 species per transect). The predominant fish species were the surgeonfishes *Ctenochaetus striatus*, *Acanthurus achilles*, *Naso lituratus*, *A. nigrofuscus* and *A. nigricans*; the parrotfishes *Chlorurus sordidus*, *Scarus altipinnis* and *Chlorurus microrhinos*; and the black-saddled coral grouper *Plectropomus laevis* (Pinca et al., 2009). In 2018, the average density of finfish was 167 individuals per100 m^2 in the fore reef habitat, and 29 individuals per 100 m^2 in the back reef habitat. Species richness in the fore reef habitat was comparable to the 2009 surveys, with 33 species per transect, but on the back reef it was much lower at 11 species per transect. The surveyed areas closest to this SUMA were found to have high density and species richness (MMR, 2019b).

Type and number of sources (score = 2)

Four reports had information about the outer reefs of Palmerston Atoll, in some cases with data collected at or near this SUMA. One of the reports had information about coral trout/tonu (*Plectropomus laevis)*. Two recent peer-reviewed articles were used to describe the ecological importance of *P. laevis* on coral reefs.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017

- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- Groupers and many other coral reef organisms are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

4.2.3 Site PAL3: Palmerston North Islet and Marion's Bank

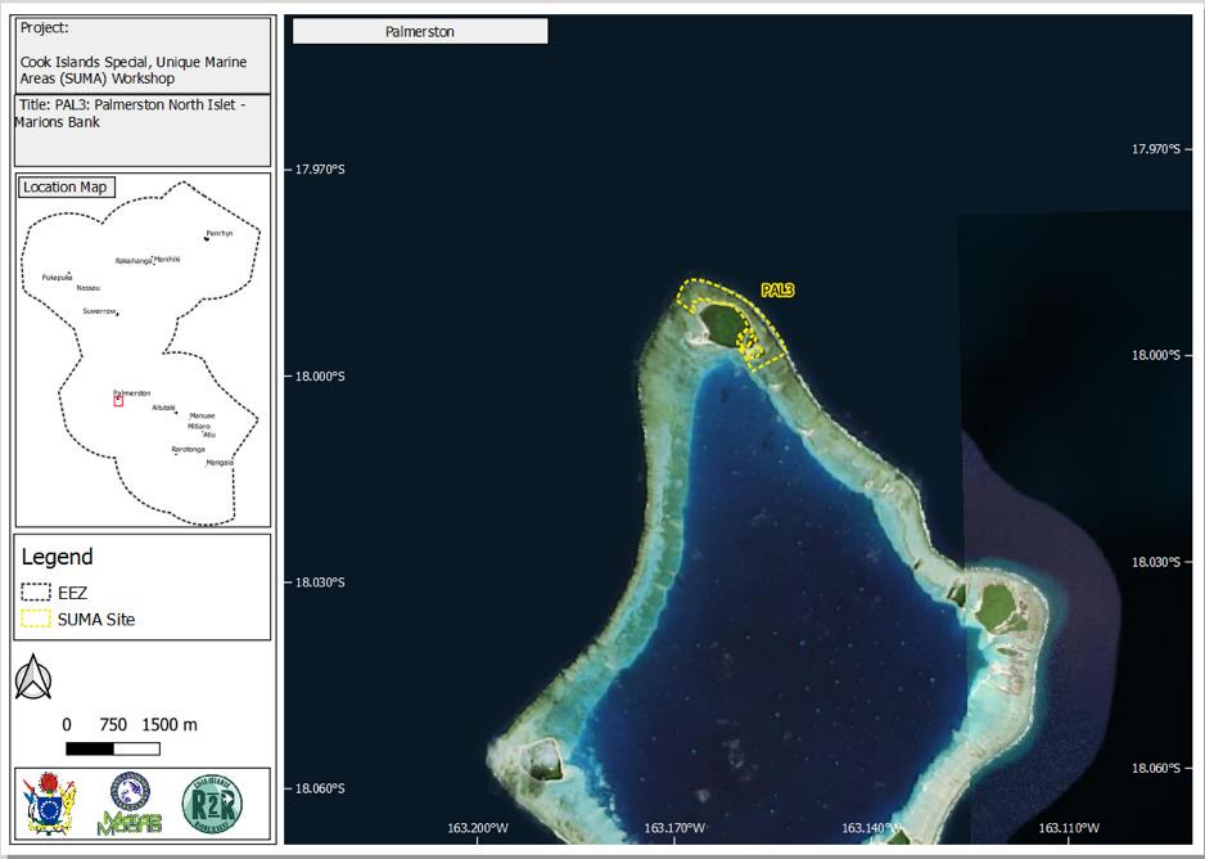


Figure 35. Site PAL3: Palmerston North Islet and Marion's Bank.

Table 33. Site PAL3: Palmerston North Islet and Marion's Bank

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Palmerston North Islet and Marion's Bank	PAL3	1	2	2	2	**7**

Geographic boundaries

Map	Latitude	Longitude	Points
	-17.987346	-163.16583	PAL3 (A)
	-17.998439	-163.15159	PAL3 (B)

Geographic explicitness (score = 1)

This SUMA includes the beach and reef flat habitats around the northern side of North Islet on Palmerston Atoll and Marion's Bank, a smaller, detached islet to the southeast of North Islet.

Justification (score = 2)

The reef flat around North Islet provides habitat for turtles and has abundant invertebrates including ka'i (*Asaphis violascens*), ungakoa (*Ceraesignum maximum*, formerly *Dendropoma maxima*) and tupa (*Cardisoma carnifex*). Turtle nests have been surveyed on Palmerston (see Site PAL1: Palmerston, Cook and Primrose Island Beaches), but there was no evidence of nests in this SUMA (White, 2012c). This area may be a transiting or resting place for turtles.

Information about turtles in general and for the Cook Islands is reviewed in Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua.

A 2013 survey found the reef in this area of Palmerston to be in good condition (Purkis et al., 2018). Invertebrate surveys recorded thirty-four species or species groupings (groups of species within a genus) including six bivalves, 12 gastropods, eight sea cucumbers, three urchins, two sea stars and two lobsters (Pinca et al., 2009). They noted that the intertidal coral rocks around the northern end of the Atoll were known for the collection of ka'i (Pinca et al., 2009). The presence of ka'i and tupa in general was also noted in earlier resource assessments (Preston et al., 1995).

Ka'i (*Asaphis violacens*) is subject to overexploitation in the Cook Islands and areas where populations persist are becoming more valuable. This clam burrows deeply and is found in very shallow intertidal habitats (Paulay, 1987). This makes it highly tolerant of large environmental fluctuations, but densities can be driven by shifts in the structure of the sediment (Kurihara et al., 2001). On Palmerston, ka'i were surveyed in 1988 on the eastern point of the reef; densities were not reported (Preston et al., 1995).

Ungakoa (*Ceraesignum maximum)* are vermetid molluscs that appear and behave like tube-dwelling polychaete worms, producing a similar thin, hard tube that coils around a hard object (Bruckner, 2015). However, like snails, they have a triple-layered shell with a glossy inner surface, a pair of tentacles, a small foot and a thin operculum attached to the foot that is used to seal the shell opening (Bruckner, 2015). To feed, they secrete a mucus net that can be up to several meters long, which traps plankton detritus and is then retracted (Lasi and Kronen, 2008). They also breed this way, which explains their propensity to aggregate. They are also highly prized and on other islands have been subject to resource assessments (Lasi and Kronen, 2008). In the Cook Islands, ungakoa are commonly embedded in massive coral colonies, especially *Porites*; several dozen can colonise a single coral (Bruckner, 2015). They can slow down the growth of coral hosts and in areas subject to high sedimentation can trap sediment that damages and smothers coral tissue (Zill et al., 2017). However, they are themselves sensitive to environmental stress; areas where high coral cover and high densities of ungakoa coexist could be inferred to have good water quality and generally favourable environmental conditions.

Tupa (*Cardisoma carnifex*), much like coconut crabs, spend time on land and in the sea, creating trophic links between these two habitats (see Site MAN2: Manihiki - Porea Ra'ui). They are nocturnal scavengers and use marine environments for reproduction; their burrows contribute to the aeration of island sediments (Yaldwin and Wodzicki, 1979).

Whilst these species have not been directly assessed on North Islet, traditional knowledge indicates the presence of healthy populations, which suggests that habitats in this SUMA are in good condition.

Type and number of sources (score = 2)

Invertebrate populations, reef condition and nesting turtles on Palmerston Atoll were mentioned in three reports. The invertebrate species for which this SUMA was chosen were described using one website and one peer-reviewed paper about the Cook Islands, and four additional peer-reviewed papers for general information. References about turtles in general and on Palmerston Atoll were reviewed for Site TON4: Tongareva Beaches - Omoka,

Mangarongaro, Tetautua and Site PAL1: Palmerston, Cook and Primrose Island Beaches, and are also relevant here.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- Turtles and many coral reef organisms are and listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS). These species are also managed under ra'ui in many areas of the Cook Islands.

4.2.4 Site PAL4: Palmerston - Reef off Cook Islet

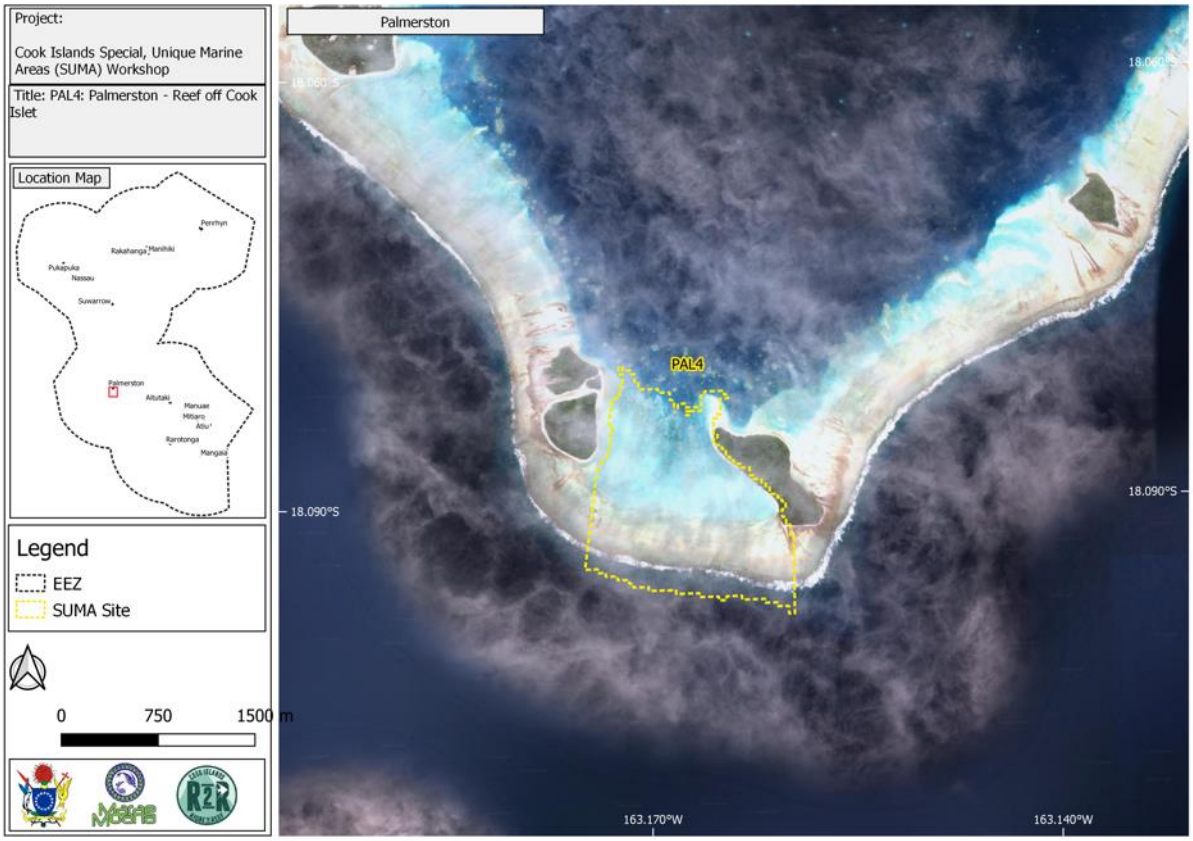


Figure 36. Site PAL4: Palmerston - Reef off Cook Islet

Table 34. Site PAL4: Palmerston - Reef off Cook Islet

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Palmerston – Reef off Cook Islet	PAL4	1.5	1	1	1	**4.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-18.080532	-163.1718	PAL 4 (A)
	-18.097934	-163.15924	PAL 4 (B)

Geographic explicitness (score = 1.5)

This SUMA is the tract of reef just east of Cook Islet. Measuring approximately 1.4 km^2, it contains reef flat, back reef and forereef habitats, including two gullies or breaks (big onu ava and small onu ava).

Justification (score = 1)

This SUMA was chosen for the breaks or gullies in the reef where turtles (onu) are said to rest. Turtles often rest after laying eggs, travelling or feeding; green turtles and at least one hawksbill turtle have been observed resting in this area (White, 2012c). In-water surveys confirmed that this was one of the primary resting areas for turtles on Palmerston Atoll

(White, 2012c). Reef-top gaps such as these also provide opportunities for turtles to emerge from the sea, as large waves can carry them to shore through the channel (White et al., 2020).

Information about turtles in general, and for the Cook Islands, is reviewed in Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua; further information is reviewed for Palmerston Atoll in Site PAL1: Palmerston, Cook and Primrose Island Beaches.

Type and number of sources (score = 1)

One report and one article confirmed the local knowledge about the importance of this SUMA for resting turtles. Additionally, references used for Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua and Site PAL1: Palmerston, Cook and Primrose Island Beaches are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- All marine turtle species are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS). The Cook Islands is also a Party or Signatory to several international agreements for marine turtle conservation, protection and management, including the Convention on Biological Diversity.
- Ra'ui is a traditional form of management in the Cook Islands that involves periodic harvesting closures of specific areas or resources and applies to turtles in some areas.

4.2.5 Site PAL5: Palmerston Western Lagoon Coral Heads

Figure 37. Site PAL5: Palmerston Western Lagoon Coral Heads

Table 35. Site PAL5: Palmerston Western Lagoon Coral Heads

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Palmerston Western Lagoon Coral Heads	PAL5	1.5	1	1.5	1	**5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-18.024888	-163.16772	PAL 5 (A)
	-18.071294	-163.17607	PAL 5 (B)

Geographic explicitness (score = 1.5)

This SUMA (approximately 2.6 km$^{2)}$ covers the western portion of the Palmerston Lagoon and comprises sandy lagoon floor, numerous coral heads and back reef area.

Justification (score = 1)

The western lagoon habitats of Palmerston Atoll were chosen because they host numerous coral outcrops that support abundant flora and fauna, especially fish species such as taraki (striped large-eye bream *Gnathodentex aureolineatus*) and taiva (one-spot snapper *Lutjanus*

monostigma). Large schools of these species tend to be indicative of reef habitats that are productive and in good condition. Live coral cover in 2009 was 20% (Pinca et al., 2009). The biomass, size and size ratio of finfish in the shallow lagoon reefs were higher than in both back- and outer-reef habitats, but density and species richness were intermediate. Taraki and taiva were not among the most abundant species; this may be because they tend to occur in localised schools near coral heads (Preston et al., 1995); catch data showed that taiva was caught in high abundance in the past (Pinca et al., 2009).

Predatory fishes, including snappers and emperors, have been found to be more abundant on Palmerston than Aitutaki and Rarotonga (Purkis et al., 2018). Fish assemblages in Palmerston lagoon have been dominated by grazing fishes in the past (Preston et al., 1995). Some species are known to form spawning aggregations in the lagoon, including the parrotfish *Scarus schlegeli* and the rabbitfish *Siganus argenteus* (Preston et al., 1995). However, later surveys documented a sharp decline in parrotfish abundance and a generally depauperate fish community (Pinca et al., 2009).

Type and number of sources (score = 1.5)

There was little information on the species for which this SUMA was chosen or about the exact condition of the habitats. Two reports about taraki and taiva on Palmerston and one about coral reef condition of Palmerston in general were used to describe this SUMA.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- Many coral reef species are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

4.2.6 Site AIT1: Aitutaki - Ootu Lagoon Area

Figure 38. Site AIT1: Aitutaki - Ootu Lagoon Area

Table 36. Site AIT1: Aitutaki - Ootu Lagoon Area

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Aitutaki – Ootu Lagoon Area	AIT1	2	2.5	2	2	**8.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-18.850584	-159.77475	AIT1 (A)
	-18.830495	-159.77228	AIT1 (B)
	-18.849566	-159.75728	AIT1 (C)

Geographic explicitness (score = 2)

The Ootu Peninsula on Aitutaki Island encloses an area of shallow lagoon spanning approximately 2 km^2. In the northern apex of the lagoon, between the Ootu Peninsula and the mainland, small streams and freshwater runoff drain into a swampy estuarine area. The SUMA includes soft-sediment lagoonal habitats and coral outcrops between the lagoon apex and Vaipeka Wharf.

Justification (score = 2.5)

This portion of the Aitutaki Lagoon is protected as a longstanding ra'ui (McCormack, 2002; Morejohn et al., 2019). It is known as a milkfish breeding area and important habitat for mud crabs (*Scylla serrata*) and varo, or mantis shrimp (*Lysiosquilla maculata*) (traditional knowledge, SUMA workshop). Aitutaki is one of the few southern group islands where milkfish occur and are caught (Terekia, 1988). A number of fishes are thought to use this area as a nursery ground, and the presence of milkfish in the Ootu lagoon was confirmed in early surveys (Adams et al., 1999). Information reviewed about milkfish for Site MAN2: Manihiki - Porea Ra'ui is also relevant here.

In the western Pacific, areas such as this lagoon would be colonised by mangroves, however these are absent from the Cook Islands (Ellison, 2009). Instead, the vegetation is predominantly pandanus (*Pandanus tectorius*), hibiscus (*Hibiscus tiliaceus*), Scaveola scrub (*Scaveola sericea*), coconut (*Cocos nucifera*) and marsh grass (*Paspalum vaginatum*) (Passfield 1993, cited in Adams et al 1999). This brackish environment is thought to be unique in the Cook Islands. The presence of mud crabs is also unique in the Cook Islands, as they are found only here and in the Avana Harbour area of Rarotonga (Adams et al., 1999, 1996). Boundary areas between intertidal and reef flat habitats are especially important during moulting, indicating the importance of habitats such as Ootu lagoon for mud crabs at this physically vulnerable life stage (Mirera, 2017). Mud crab densities in the intertidal region of Ootu from mark and recapture observations has been estimated at 108 adults per km^2 and 294 juveniles per km^2 (Adams et al., 1999). Mud crabs have a complex life cycle and perform an important role in estuarine environments as major benthic predators, feeding on gastropods, crustaceans, and molluscs (Alberts-Hubatsch et al., 2016).

Varo, or mantis shrimps, are thought to occur elsewhere in the Cook Islands, but their presence has been confirmed only in the Ootu lagoon (MMR, 1993). *Lysiosquillina maculata* is the largest species of the order Stomatopoda and their most distinctive feature is the second pair of thoracic appendages that have long spine blades. These mantis shrimps live in burrows on sand and mud banks from the intertidal down to the reef crest, and each burrow is usually inhabited by a pair of mantis shrimps. They feed on small fish, crustaceans and other invertebrates, killing their prey with an extremely rapid extension and retraction of the "knife" (MMR, 1993). In shallow and intertidal habitats such as this SUMA, where food webs are likely to be simple, they probably perform the role of apex predators, making them important regulators of ecological processes.

In addition to the presence of valued species, recent surveys by Morejohn et al. (2019) covering sites across the Aitutaki lagoon and reefs found the highest invertebrate densities in this area.

Type and number of sources (score = 2)

Ten reports contributed information about this SUMA and the values it was selected for. Additionally, two peer-reviewed papers were consulted to describe the ecological importance of mud crabs. References used for milkfish in Site MAN2: Manihiki - Porea Ra'ui are also relevant here.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017

- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Aitutaki and its internal waters as provided for under Section 4(2). This SUMA is within internal waters.
- The Aitutaki Fisheries Protection By-Laws 1990 regulate harvest of specific inshore marine species of Aitutaki and Manuae islands.
- The Aitutaki and Manuae bonefish fishery has been designated under the Marine Resources (Aitutaki and Manuae Bonefish Fishery) (Amendment) Regulations 2016.
- The Ootu lagoon is protected under ra'ui, which covers 220 ha (Butler, 2017b; Passfield and Rongo, 2011; Rasmussen, 2016).
- Milkfish are listed on the IUCN Red List of Threatened Species.

4.2.7 Site AIT2: Aitutaki - One Foot Island Area

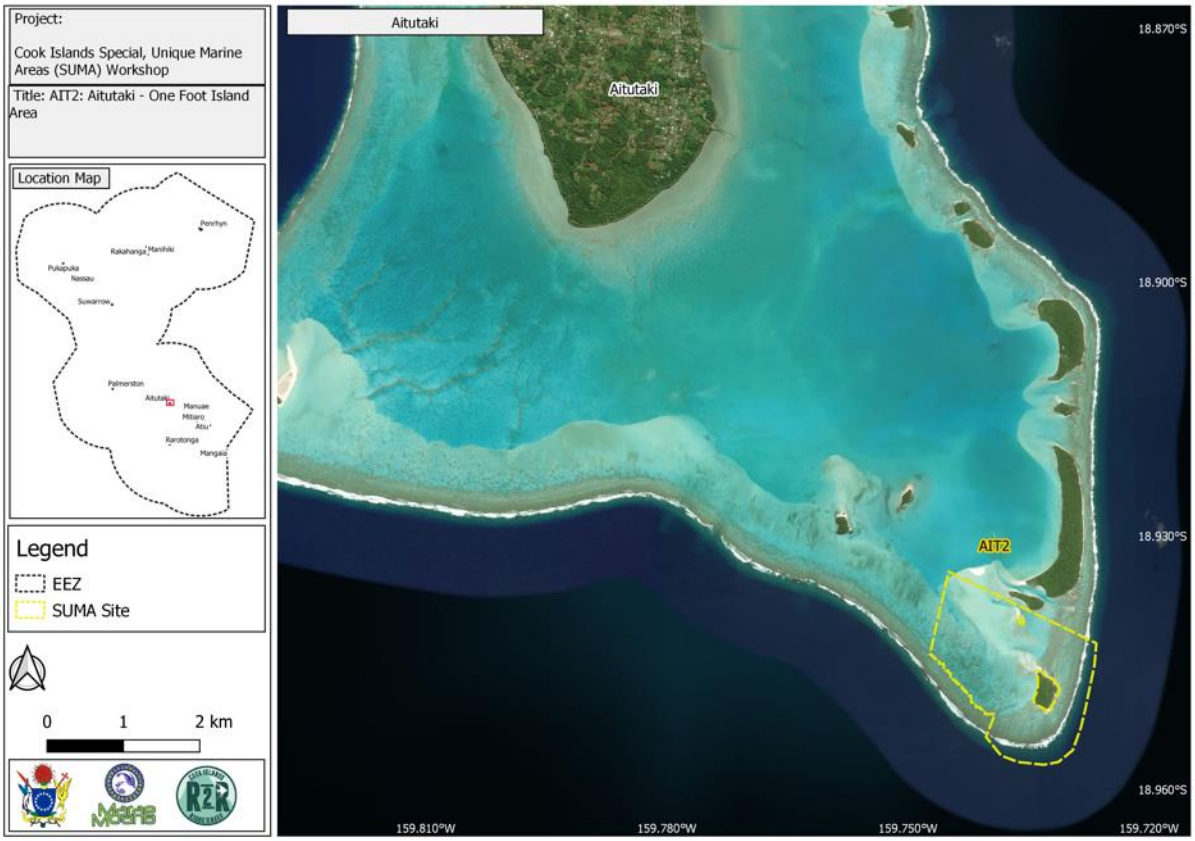
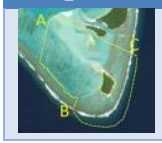


Figure 39. Site AIT2: Aitutaki - One Foot Island Area.

Table 37. Site AIT2: Aitutaki - One Foot Island Area

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Aitutaki – One Foot Island Area	AIT2	2	1.5	2	2	**7.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-18.934089	-159.74479	AIT 1 (A)
	-18.953655	-159.74023	AIT 2 (B)
	-18.942635	-159.72645	AIT 2 (C)

Geographic explicitness (score = 2)

This SUMA lies around One Foot Island (Motukitiu) at the southeastern point of Aitutaki lagoon. It includes the island's beaches, reef flats and lagoon areas and covers around 2 km^2.

Justification (score = 1.5)

This SUMA was chosen because of its value as a nursery area for giant clams, a nesting area for boobies and habitat for coconut crabs. This area is protected under ra'ui (Evans, 2012; MMR, 2000a) and was mapped by Morejohn et al. (2019). In the late 1980s, a clam hatchery was established on Aitutaki and clams were placed throughout the lagoon to mature. Clam

species from other countries have also been introduced: *T. squamosa*, *T. derasa*, *T. gigas* and *Hippopus hippopus* (MMR, 2000b, 1993). However, early declines were documented, from ~ 4 clams per m^2 in 1987 to ~ 0.5 clams per m^2 (5,000 per hectare) in 1993, and a reduction in shell size (Adams et al., 1999). A broad-scale survey in 2009 reported ~ 150 *T. maxima* per hectare (Pinca et al., 2009); this is substantially lower than the 1993 estimates. Recent invertebrate surveys by Morejohn et al. (2019) that included sites within this SUMA reported *T. maxima* densities of between 2.5 and 5 individuals per 100 m^2 (250 to 500 individuals per hectare).

Aitutaki is not noted as one of the islands with large populations of coconut crabs (MMR, 2000a), which makes areas where they exist of particular local importance, as well as subject to pressure. Aitutaki is an Important Bird Area specifically for boobies (Evans, 2012) and Motukitiu itself is important for seabirds (K. Passfield, pers. obs.); however there is no specific information about boobies nesting in this SUMA.

Information reviewed about clams, seabirds and coconut crabs for Site MAN1: Manihiki Lagoon, Site PUK4: Pukapuka Seabird Colonies and Site MAN2: Manihiki - Porea Ra'ui is also relevant here.

Type and number of sources (score = 2)

One report included surveyed sites within this SUMA. Clams on Aitutaki Island were described in five reports; one additional report documented Aitutaki as an Important Bird Area. References reviewed about clams, seabirds and coconut crabs for Site MAN1: Manihiki Lagoon, Site PUK4: Pukapuka Seabird Colonies and Site MAN2: Manihiki - Porea Ra'ui is also relevant here.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Aitutaki and its internal waters as provided for under Section 4(2). This SUMA is within internal waters.
- The Aitutaki Fisheries Protection By-Laws 1990 regulate harvest of specific inshore marine species of Aitutaki and Manuae islands. These state that: no one may take more than 20 paua (clams); international exports are banned; shells taken out of Aitutaki must be larger than 75 mm; paua is banned from sale within Aitutaki except by special permit and are normally taken only for home consumption or special occasions.
- The Aitutaki and Manuae bonefish fishery has been designated under the Marine Resources (Aitutaki and Manuae Bonefish Fishery) (Amendment) Regulations 2016.
- Seabirds, clams and coconut crabs are listed on the IUCN Red List of Threatened Species, and many are also listed under the Convention on Migratory Species (CMS).

4.2.8 Site AIT3: Aitutaki - Arutanga Passage

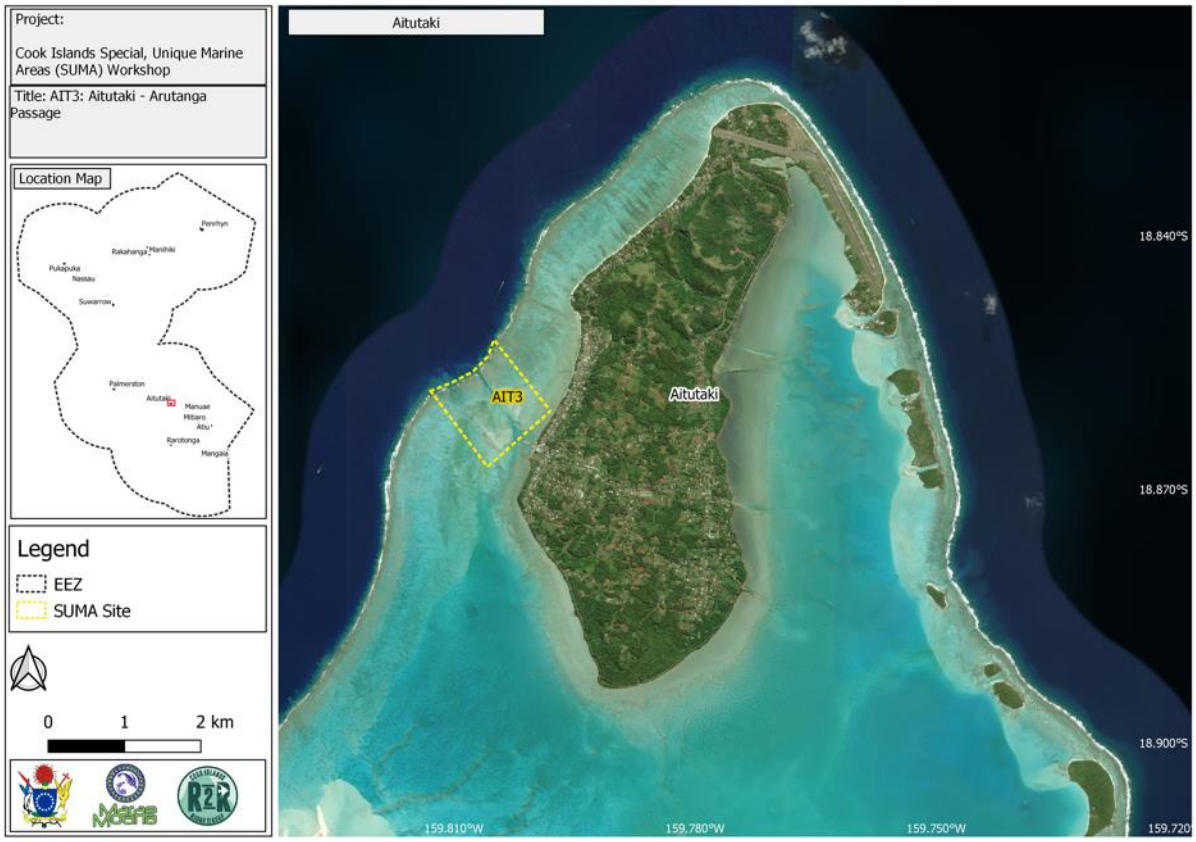


Figure 40. Site AIT3: Aitutaki - Arutanga Passage.

Table 38. Site AIT3: Aitutaki - Arutanga Passage

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Aitutaki – Arutanga Passage	AIT3	2	1	1.5	1	**5.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-18.851891	-159.80475	AIT 3 (A)
	-18.857922	-159.81263	AIT 3 (B)
	-18.866943	-159.80562	AIT 3 (C)
	-18.86037	-159.79774	AIT 3 (D)

Geographic explicitness (score = 2)

Arutanga passage is a channel in the reef that runs for 2.5 km from Arutanga on the western side of Aitutaki to the open ocean. This SUMA includes the channel and the reef flat habitats immediately surrounding it.

Justification (score = 1)

This SUMA was chosen as an important area for sea grapes, or rimu / remu (*Caulerpa racemosa*). In the Cook Islands, they are found primarily on Aitutaki, Rarotonga, Atiu and Mangaia (MMR, 1993). In recent years, reports suggest that Aitutaki is the only island where they are harvested (Rongo and Dyer, 2015). Seaweeds of this group can reproduce sexually, in a manner similar to spawning in corals, or vegetatively, which may be an adaptation to less favourable environments (MMR, 1993). There is thought to be some cultivation of sea grapes on Aitutaki (MMR, 1993), and harvesting takes place primarily around the Arutanga area (Adams et al., 1999).

Type and number of sources (score =1.5)

Two reports mentioned sea grapes in Aitutaki, and one additional report referred to the Arutanga area as being important habitat for them.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Aitutaki and its internal waters as provided for under Section 4(2). This SUMA is within internal waters.
- The Aitutaki Fisheries Protection By-Laws 1990 regulate harvest of specific inshore marine species of Aitutaki and Manuae islands.
- The Aitutaki and Manuae bonefish fishery has been designated under the Marine Resources (Aitutaki and Manuae Bonefish Fishery) (Amendment) Regulations 2016.

4.2.9 Site AIT4: Aitutaki - Tarava

Figure 41. Site AIT4: Aitutaki - Tarava.

Table 39. Site AIT4: Aitutaki - Tarava

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Aitutaki – Tarava	AIT4	2	2	2	2	**8**

Geographic boundaries

Map	Latitude	Longitude	Points
	-18.892455	-159.81331	AIT 4 (A)
	-18.917546	-159.81478	AIT 4 (B)

Geographic explicitness (score = 2)

This SUMA covers approximately 3 km^2 of the lagoon area south of Taravao District. The habitats are complex and comprised of channels, sandy lagoon floor, and abundant coral heads and outcrops.

Justification (score = 2)

Workshop participants identified this SUMA because of its spawning aggregation of unicornfish (*Naso unicornis*), giant clam nursery and settlement habitat for humphead wrasse (*Cheilinus undulatus*). The Maina lagoon ra'ui coincides with this SUMA (Morejohn et al., 2019; Passfield and Rongo, 2011; Rasmussen, 2016).

A 2009 survey found 18% coral cover on lagoonal reefs of Aitutaki, which included some sites within this SUMA. They reported particularly high biomass and abundance of the surgeonfishes *Acanthurus triostegus*, *Ctenochaetus striatus*, *Naso lituratus* and *N. unicornis* and the parrotfishes *Scarus altipinnis* and *Chlorurus sordidus* (Pinca et al., 2009). Two areas around this SUMA have been used as fish feeding stations to attract fish for tourists to view; recent work has questioned the ecological impacts of this practice (Prinz et al., 2020). The research found that carnivores and omnivores were disproportionately attracted to the feeding stations and may skew the trophic composition of fish assemblages at a local scale. Labrids (wrasses) were especially abundant during feeding times and this increased abundance persisted after feeding ceased, which may have long-term consequences on the reef fish community (Prinz et al., 2020). Additionally, macroalgal browsers (unicornfish *Naso lituratus* and *N. unicornis*) tended to flee during bread feeding events, but returned shortly afterwards (Prinz et al., 2020).

Unicornfish are known to move and spawn in large schools, forming spawning aggregations in some lagoonal areas (for more information on spawning aggregations, see Site TON2: Tongareva - Taruia Reef Pass). Coral reef herbivores are important for the maintenance of coral dominance (Cheal et al., 2010), especially species such as unicornfish that are able to consume fleshy macroalgae (Loffler et al., 2014). They therefore contribute to coral reef health and resilience (Holbrook et al., 2016); areas where they are still abundant are becoming more valuable as fishing depletes their numbers elsewhere. Reef surveys in 2013 found high macroagal cover in Aitutaki (Purkis et al., 2018). This adds to the importance of protecting spawning herbivores in this SUMA.

In the late 1980s, a clam hatchery was established on Aitutaki and clams were placed throughout the lagoon to mature. The reefs in this area were chosen for some of these clam translocations and clams (primarily *Tridacna maxima*) remain abundant here (MMR, 2000a). Surveys in 2018 reported intermediate densities of ~6 individual T. maxima per 100 m^2, which was approximately half the density as was found in other parts of Aitutaki (Morejohn et al., 2019). General information about giant clams was reviewed in Site MAN1: Manihiki Lagoon and is also relevant here.

Humphead wrasse have been documented in Aitutaki lagoon (Pinca et al., 2009) and were said to have been responsible for ciguatera poisoning in the past (Adams et al., 1999; Evans, 2012), but have not been recorded specifically in this SUMA. For general information about the ecological importance of humphead wrasse, see Site TON2: Tongareva - Taruia Reef Pass.

Type and number of sources (score = 2)

There were three reports and one peer-reviewed paper about the species of interest within or near this SUMA. Information about clams and general reef condition in Aitutaki was gathered from three reports; three-peer-reviewed papers provided general background on the importance of herbivorous fishes. References reviewed for humphead wrasse, spawning aggregations and clams more generally in Site TON2: Tongareva - Taruia Reef Pass and Site MAN1: Manihiki Lagoon are also relevant here.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Aitutaki and its internal waters as provided for under Section 4(2). This SUMA is within internal waters.
- The Aitutaki Fisheries Protection By-Laws 1990 regulate harvest of specific inshore marine species of Aitutaki and Manuae islands. These state that: no one may take more than 20 paua (clams); international exports are banned; shells taken out of Aitutaki must be larger than 75 mm; paua are banned from sale within Aitutaki except by special permit and are normally taken only for home consumption or special occasions.
- The Aitutaki and Manuae bonefish fishery has been designated under the Marine Resources (Aitutaki and Manuae Bonefish Fishery) (Amendment) Regulations 2016.
- Many reef fishes are listed on the IUCN Red List of Threatened Species.

4.2.10 Site AIT5: Southern Aitutaki Reef

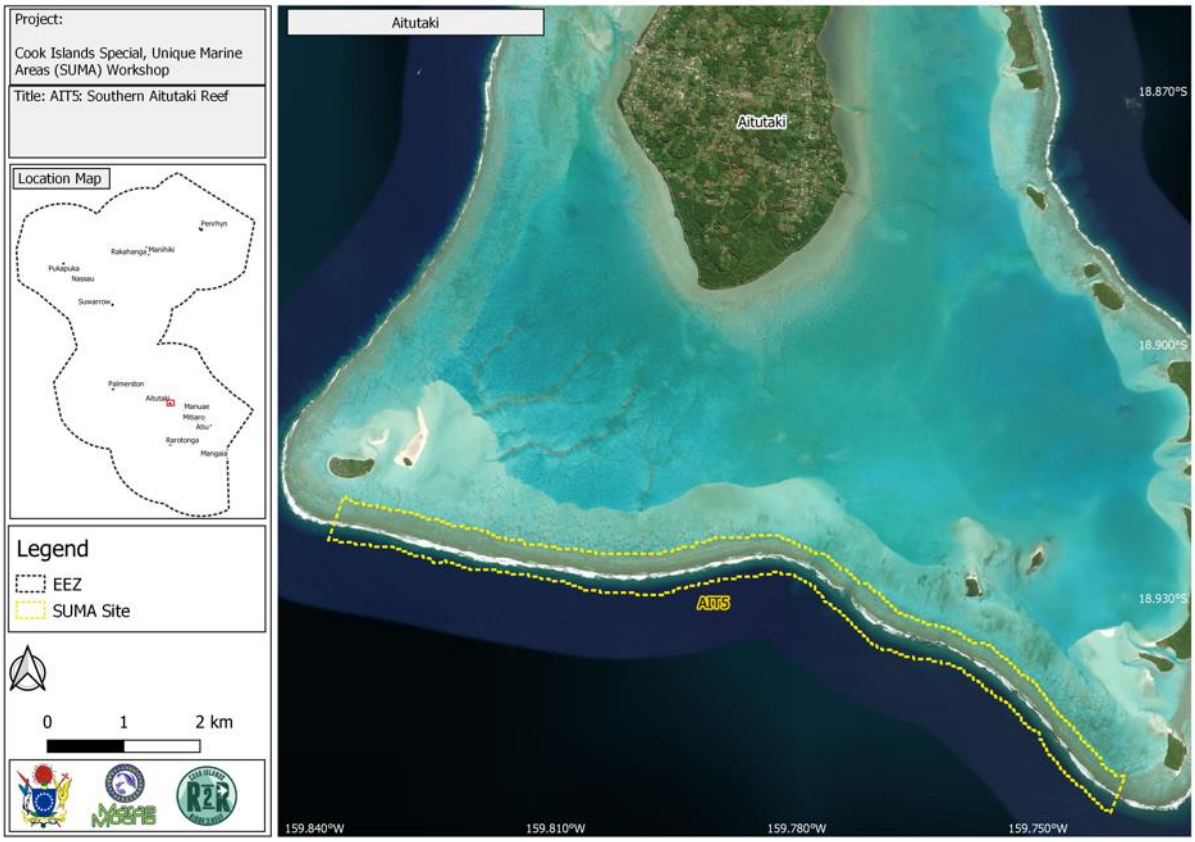


Figure 42. Site AIT5: Southern Aitutaki Reef.

Table 40. Site AIT5: Southern Aitutaki Reef

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Southern Aitutaki Reef	AIT5	2.5	2.5	3	3	**11**

Geographic boundaries

Map	Latitude	Longitude	Points
	-18.922616	-159.8381	AIT 5 (A)
	-18.922574	-159.78581	AIT 5 (B)
	-18.937029	-159.76536	AIT 5 (C)
	-18.950962	-159.73909	AIT 5 (D)

Geographic explicitness (score = 2.5)

This SUMA extends along the length of the outer south-facing reef of Aitutaki Island. It is approximately 13 km long and includes exposed reef crest and slope, reef flat and back reef habitats.

Justification (score = 2.5)

This SUMA was selected for its abundance of marine life, including aggregation and potential breeding areas for oceanic whitetip sharks, scalloped and great hammerheads, silky sharks, spotted eagle rays, reef and giant manta rays, high densities of humphead wrasse, frequent sightings of whales and dolphins, and on the reef flat and back reef, trochus, clams, giant worm snails (ungakoa) and turban snails (ariri, or *Turbo setosus*). This SUMA also coincides with three marine ra'ui, one across the reef (Taketake Ra'ui, where no netting is allowed to protect spawning species) and two around Maina Island (Passfield and Rongo, 2011; Rasmussen, 2016).

Aitutaki's coral reefs have suffered bleaching and crown-of-thorns outbreaks (Adams et al., 1996) and were still in an early stage of recovery in 2015, with shallow areas recovering more rapidly than deeper slopes (Purkis et al., 2018; Rongo et al., 2013a). Aitutaki is currently experiencing another crown-of-thorns outbreak (NES, pers. comm.) and coral cover remains low (Morejohn et al., 2019). Coral diversity and cover also tended to be higher on the windward than the leeward reefs, as the latter were more affected by agricultural run-off (Hoffmann, 2002b). Based on the prevailing direction of ocean currents, Aitutaki may be a source reef for islands to the southeast, both in terms of larvae and pathogens (Rongo et al., 2013a).

Elasmobranch species recorded around Aitutaki include silvertip sharks (*Carcharhinus albimarginatus*), grey reef sharks (*C. amblyrhynchos*), blacktip reef sharks (*C. melanopterus*), whitetip reef sharks (*Triaenodon obesus*) and spotted eagle rays (Adams et al., 1999; MMR, 1993). Oceanic species are likely to occur in deeper water where the reef drops off steeply. Anecdotal evidence suggests a recent increase in large pelagic sharks , perhaps because their prey has been depleted by industrial fishing and they are venturing closer to the islands to feed (Rongo and Dyer, 2015). There was no additional information on sharks in this SUMA; sharks are reviewed more extensively for the Cook Islands in Site O3: Palmerston – Kona Reef.

Aitutaki has been one of the areas where humpback whale research has occurred, and their use of habitats offshore and close to the reef has been confirmed (Hauser and Clapham, 2005). There is no other direct information about marine mammals on Aitutaki, or in this SUMA in particular, but marine mammals in the Cook Islands are reviewed in Site O5: Marine Mammal Migratory Pathways.

Humphead wrasse have been documented in Aitutaki lagoon (Pinca et al., 2009), and were said to have been responsible for ciguatera poisoning in the past (Adams et al., 1999; Evans, 2012), but no records exist for them in this SUMA apart from traditional knowledge presented at the SUMA workshop. For general information about the ecological importance of humphead wrasse, see Site TON2: Tongareva - Taruia Reef Pass.

Trochus (*Rochia nilotica*) has been introduced to the Cook Islands numerous times and from various countries (MMR, 1993). The first introduction was in 1957 (Table 41) and consisted of 280 individuals from Fiji which were placed on the barrier reef at Akaiama motu on Aitutaki (Nash et al., 1994). Trochus shells have a high unit value, are non-perishable compared with most other reef resources, but are vulnerable to periodic overfishing (Nash et al., 1994). Juveniles are found in shallow reef flat habitats and adults preferentially occur along highly dynamic, structurally complex reef crests (Seinor et al., 2020). Adult trochus are grazers, performing an important ecological role by keeping algal biomass low on structurally complex reef crests (Villanueva et al., 2013). Trochus surveys in 1993 included three sites in

this SUMA, with a total estimated favourable trochus habitat of over 100 hectares and an estimated population size of 106,704 trochus, with a high proportion of large individuals (Nash et al., 1994). A more recent assessment recorded between 27 and 860 trochus per hectare across all Aitutaki sites, depending on the survey method, with high densities in this SUMA (Pinca et al., 2009).

Table 41. Trochus introductions to the Cook Islands.

Island Name	Type	Reef	Year	N.	Status in 1993	Success
Northern Group						
Tongareva	Atoll	Barrier/bench	1985	440	Present	?
Manihiki	Atoll	Barrier/bench	1985	400		
			1986	1,040	Common	Yes
Rakahanga	Atoll	Barrier/bench	1985	690		
			1986	1,050	Common	?
Pukapuka	Atoll	Barrier/bench	1986	1,220	Common	?
Suwarrow	Atoll	Barrier	1985	460		
			1986	1,000	Common	?
Southern Group						
Aitutaki	Almost atoll	Barrier/bench	1957	280	Abundant	Yes
			1983	200	Common	Yes
Rarotonga	High	Fringe/bench	1983	300	Rare/Extinct	No
Mangaia	Makatea	Bench	1982	300	Rare/Extinct	No
Atiu	Makatea	Bench	1983	300	Rare/Extinct	No
Mauke	Makatea	Bench	1982	300	Rare/Extinct	No
Mitiaro	Makatea	Bench	1981	500	Unknown	Unknown
Manuae	Atoll	Barrier/bench	1986	600	Present	Yes
Palmerston	Atoll	Barrier	1981	2,000		
			1982	1,000	Common	Yes

Source: MMR (1993)

In the late 1980s, a clam hatchery was established on Aitutaki and clams were placed throughout the lagoon to mature (MMR, 2000a). The reefs in this area, however, are thought to host wild clam populations, likely to be *Tridacna maxima*. In fact, a 2018 survey found that both the ra'ui sites and the unregulated control sites in this SUMA had among the highest densities (14-16 individuals per 100 m^2) of clams in Aitutaki (Morejohn et al., 2019). This may indicate that cultured and translocated populations are breeding successfully, and that recruitment is taking place on the local reefs. General information about giant clams was reviewed in Site MAN1: Manihiki Lagoon and is also relevant here.

Giant worm snails, or ungakoa (*Ceraesignum maximum*, formerly *Dendropoma maxima*), are vermetid molluscs that are highly sought after for food in the Cook Islands (Lasi and Kronen, 2008). They are sensitive to overexploitation and environmental stress; areas where high coral cover and high densities of ungakoa coexist could be inferred to be in good condition. General information about ungakoa in the Cook Islands is reviewed in Site PAL3: Palmerston North Islet and Marion's Bank.

Sea urchins (*Echinometra mathaei*) and giant worm-snails (*Ceraesignum maximum*) were among the dominant invertebrates in a recent survey (Rongo et al., 2013a). A sea cucumber survey recorded ten species, which was a higher species richness than on other surveyed

islands (Raumea et al., 2013). Surveys indicated that the abundances of all but the lollyfish *Holothuria atra* were low (Pinca et al., 2009).

Turban snails, or ariri (*Turbo setosum*), are also commonly targeted by subsistence fisheries in the Cook Islands (MMR, 1993). They are found on reef edges and reef flats in the active surf zone, and have been documented in Aitutaki (MMR, 1993); the most recent available survey found that they were uncommon (Pinca et al., 2009).

Type and number of sources (score = 3)

A large amount of information pertaining to the values for which this SUMA was chosen has been reviewed for other sites: Site O5: Marine Mammal Migratory Pathways (marine mammals), Site O3: Palmerston – Kona Reef (sharks and rays), Site TON2: Tongareva - Taruia Reef Pass (humphead wrasse and manta rays), Site MAN1: Manihiki Lagoon (clams) and Site PAL3: Palmerston North Islet and Marion's Bank (ungakoa). The references used for those sites are also relevant here. Additionally, 10 reports and three peer-reviewed papers provided insights into Aitutaki and this SUMA.

Obligations (score = 3)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Aitutaki and its internal waters as provided for under Section 4(2). This SUMA is within internal waters. This SUMA also extends into the adjoining territorial seas which also fall within the jurisdiction of the Act.
- The Aitutaki Fisheries Protection By-Laws 1990 regulate harvest of specific inshore marine species of Aitutaki and Manuae islands. These state that: no one may take more than 20 paua (clams); international exports are banned; shells taken out of Aitutaki must be larger than 75 mm; paua are banned from sale within Aitutaki except by special permit and are normally taken only for home consumption or special occasions.
- The Aitutaki and Manuae bonefish fishery has been designated under the Marine Resources (Aitutaki and Manuae Bonefish Fishery) (Amendment) Regulations 2016.
- This area is protected under a number of ra'ui, which covers most of the organisms for which this SUMA was chosen. The trochus fishery is managed more strictly in Aitutaki than elsewhere.
- Sharks and marine mammals are protected under the Cook Islands Shark Sanctuary and listed on the IUCN Red List of Threatened Species, and many are also listed under the Convention on Migratory Species (CMS).

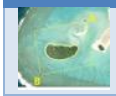
4.2.11 Site AIT6: Aitutaki - Maina Island

Figure 43. Site AIT6: Aitutaki - Maina Island.

Table 42. Site AIT6: Aitutaki - Maina Island

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Aitutaki – Maina Island	AIT6	3	1	1	2	**7**

Geographic boundaries

Map	Latitude	Longitude	Points
	-18.908894	-159.831	AIT 6 (A)
	-18.917868	-159.83893	AIT 6 (B)

Geographic explicitness (score = 3)

This SUMA includes the beach and marine areas around Maina Island, close to the Maina lagoon ra'ui and the Maina long reef ra'ui. This also partially overlaps with previous SUMA AIT5.

Justification (score = 1)

This area was chosen as a SUMA because of its nesting turtles and seabirds. Egg-laying has been confirmed for green turtles (*Chelonia mydas*) at Aitutaki and tagged hawksbill turtles have been tracked to the vicinity of the island (White, 2012b). Whether turtles nest on Maina Island is not confirmed. Aitutaki is an Important Bird Area (Evans, 2012), but only one report

indicated that red tailed tropic birds (tavake) nest on Maina Island (NES, 2019). Information about turtles and seabirds in general, and for the Cook Islands, is reviewed in Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua and Site PUK4: Pukapuka Seabird Colonies.

Type and number of sources (score = 1)

Two reports mentioned nesting turtles and seabirds in Aitutaki, and references reviewed for Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua and Site PUK4: Pukapuka Seabird Colonies are also relevant here.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Aitutaki and its internal waters as provided for under Section 4(2). This SUMA is within internal waters.
- The Aitutaki Fisheries Protection By-Laws 1990 regulate harvest of specific inshore marine species of Aitutaki and Manuae islands.
- The Aitutaki and Manuae bonefish fishery has been designated under the Marine Resources (Aitutaki and Manuae Bonefish Fishery) (Amendment) Regulations 2016.
- All marine turtle species are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS). The Cook Islands is also a Party or Signatory to several international agreements for marine turtle conservation, protection and management, including the Convention on Biological Diversity.
- Ra'ui is a traditional form of management in the Cook Islands that involves periodic harvesting closures of specific areas or resources and applies to turtles in some areas.

4.2.12 Site AIT7: Aitutaki - Moturakau and Rapota

Figure 44. Site AIT7: Aitutaki - Moturakau and Rapota.

Table 43. Site AIT7: Aitutaki - Moturakau and Rapota

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Aitutaki – Moturakau and Rapota	AIT7	2	1	1	1	**5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-18.922075	-159.74518	AIT 7 (A)
	-18.93187	-159.76315	AIT 7 (B)

Geographic explicitness (score = 2)

Moturakau and Rapota Islands are two small islands on the southern side of Aitutaki lagoon. The SUMA covers approximately 2 km^2 and includes the marine habitats surrounding the two islands.

Justification (score = 1)

Workshop participants identified these two islands and the surrounding marine habitats as hosting populations of kakaia, or white terns (*Gygis alba*). They are known to occur on

Aitutaki[19], and as resident birds of the Cook Islands, do not migrate[20]. Therefore, the role seabirds generally play as apex predators and agents of connectivity between marine and terrestrial habitats is likely to take place at this SUMA (see Site PUK4: Pukapuka Seabird Colonies). This SUMA also coincides with a known bonefish spawning site (Morejohn et al., 2019).

Type and number of sources (score = 1)

Two websites were used to infer the presence of white terns on Aitutaki. Additionally, references used to describe seabirds in Site PUK4: Pukapuka Seabird Colonies are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Aitutaki and its internal waters as provided for under Section 4(2). This SUMA is within internal waters.
- The Aitutaki Fisheries Protection By-Laws 1990 regulate harvest of specific inshore marine species of Aitutaki and Manuae islands.
- The Aitutaki and Manuae bonefish fishery has been designated under the Marine Resources (Aitutaki and Manuae Bonefish Fishery) (Amendment) Regulations 2016. This SUMA includes the Takitaki spawning area as identified under the Regulations.
- White terns are listed as Least Concern on the IUCN Red List of Threatened Species.

[19] http://cookislands.bishopmuseum.org/
[20] https://www.iucnredlist.org

4.2.13 Site AIT8: Aitutaki - Tavaerua Tua

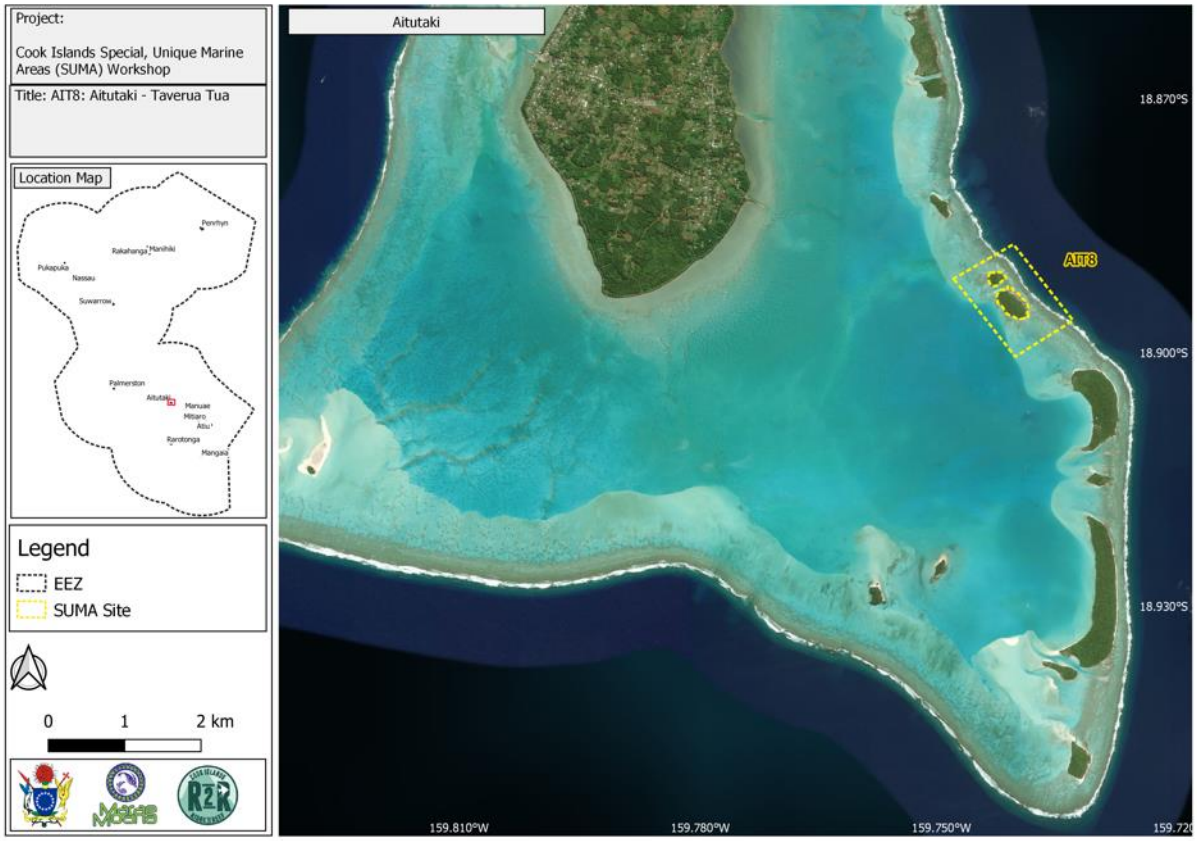
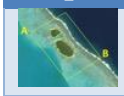


Figure 45. Site AIT8: Aitutaki - Tavaerua Tua.

Table 44. Site AIT8: Aitutaki - Tavaerua Tua

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Aitutaki – Taverua Tua	AIT8	1	1.5	1.5	1	**5**

Geographic boundaries

Map	Latitude	Longitude	Point
	-18.89112	-159.74817	AIT 8 (A)
	-18.896113	-159.73332	AIT 8 (B)

Geographic explicitness (score = 1)

Tavaerua Tua is a small area of Aitutaki's eastern reef, encompassing two islets (Tanaerua iti and Tavaerua) and an area of shallow reef flat.

Justification (score = 1.5)

Workshop participants identified this site as a settlement area for ka'i, or *Asaphis violascens*. This species was recorded in Aitutaki in early surveys (MMR, 1993), and they are managed under ra'ui across Aitutaki (Adams et al., 1999; MMR, 2000c). Ka'i is often subject to overexploitation in the Cook Islands and areas where populations persist are becoming more valuable. No documents were found that provided additional information about ka'i

populations in Aitutaki, or within this SUMA. However, this general area is also known as a bonefish nursery and translocation site for trochus, and both species are protected under ra'ui (Morejohn et al., 2019).

Type and number of sources (score = 1.5)

Three reports included some information about the presence of ka'i in Aitutaki, and one report describes the ra'ui status of this SUMA. References used to describe ka'i in Site PAL3: Palmerston North Islet and Marion's Bank are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Aitutaki and its internal waters as provided for under Section 4(2). This SUMA is within internal waters.
- The Aitutaki Fisheries Protection By-Laws 1990 regulate harvest of specific inshore marine species of Aitutaki and Manuae islands.
- The Aitutaki and Manuae bonefish fishery has been designated under the Marine Resources (Aitutaki and Manuae Bonefish Fishery) (Amendment) Regulations 2016.
- Ka'i are managed under ra'ui.

4.2.14 Site MAE1: Manuae Enclosed Lagoon

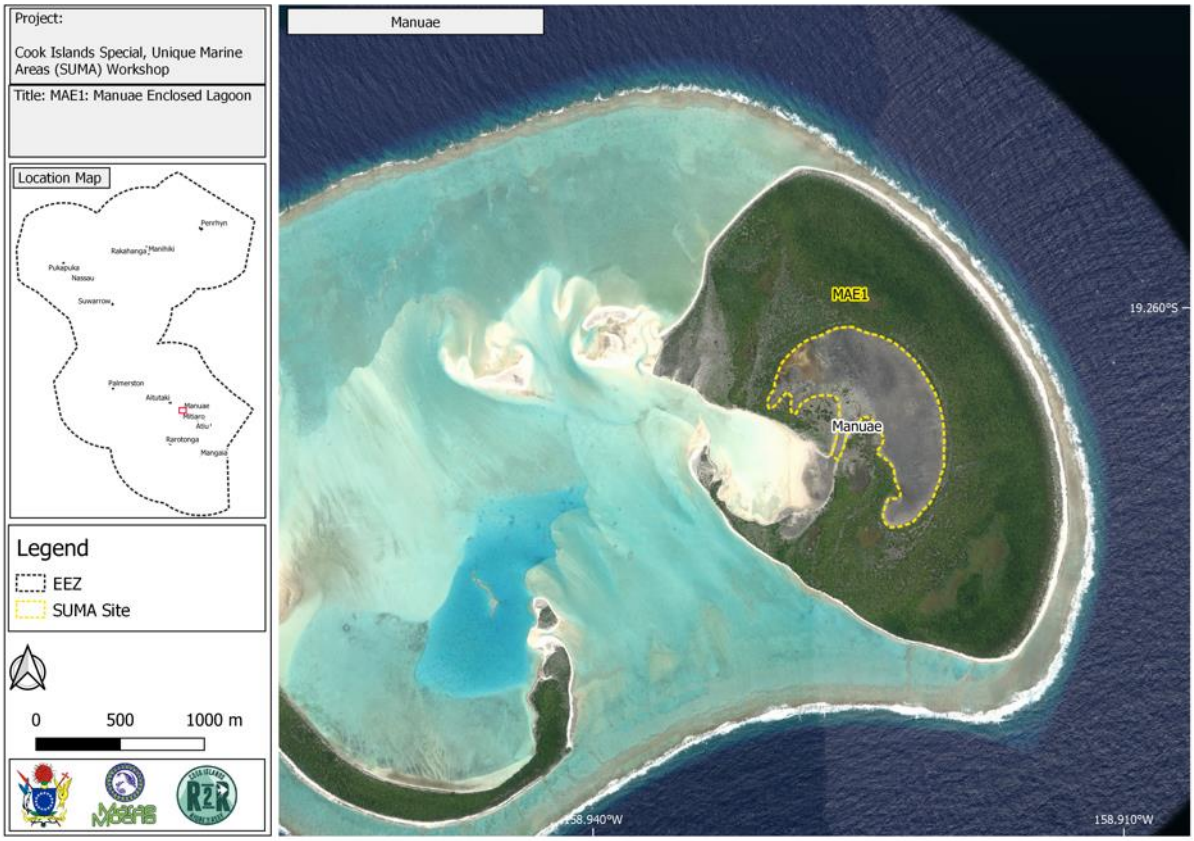


Figure 46. Site MAE1: Manuae Enclosed Lagoon.

Table 45. Site MAE1: Manuae Enclosed Lagoon

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Manuae Enclosed Lagoon	MAE1	3	2	1	1	**7**

Geographic boundaries

Map	Latitude	Longitude	Points
	-19.265126	-158.92821	MAE 1 (A)
	-19.26151	-158.92397	MAE 1 (B)
	-19.271761	-158.92326	MAE 1 (C)

Geographic explicitness (score = 3)

Manuae Atoll is situated on the peak of a submerged volcano rising from a depth of 4,000 m. It includes two uninhabited horseshoe-shaped islets, Manuae to the west and Te Au O Tu to the east, an enclosed lagoon, extensive reef flat and slope habitats. The eastern islet has a kidney-shaped saltpan area with channels into the lagoon; the SUMA includes all of this habitat.

Justification (score = 2)

This area was selected as a SUMA because of its unique ecosystem as an intertidal mud flat, which is rare in the Cook Islands. A resource survey that included a subtidal site just west of this SUMA recorded a diverse coral assemblage, including *Acropora*, submassive, encrusting and soft corals. Turf algae, *Halimeda* and clams were also common (Ponia, 1998). Eleven fish families were recorded in the broader lagoon area; close to this site common species were the lined bristletooth (*Ctenochaetus striatus)*, convict surgeonfish (*Acanthurus triostegus)*, Achilles tang (*Acanthurus achilles)*, garfishes, squirrelfishes, goatfishes and snapper (Ponia, 1998). Urchins, clams and lollyfish (*Holothuria atra*) were found in high densities at this site (Ponia, 1998).

Due to the global significance of Manuae, Saul and Tiraa (2004) proposed that the whole island, lagoon and surrounding seas be designated as a wildlife sanctuary or national park. They also suggested a community trust approach, as used for Takutea, to address long-standing land tenure disputes.

Type and number of sources (score = 1)

No information was found to describe this particular area of the Manuae lagoon and intertidal habitats. One report provides results from a resource assessment that included one site just west of the SUMA, and one report mentions the global significance of Manuae in general.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Aitutaki and its internal waters as provided for under Section 4(2); it is unclear whether Maunuae and its internal waters are likewise covered by the Act (Aitutaki and Manuae are generally considered "paired" with the latter under direct management of Aitutaki authorities).
- The Aitutaki Fisheries Protection By-Laws 1990 regulate harvest of specific inshore marine species of Aitutaki and Manuae islands.
- The Aitutaki and Manuae bonefish fishery has been designated under the Marine Resources (Aitutaki and Manuae Bonefish Fishery) (Amendment) Regulations 2016.

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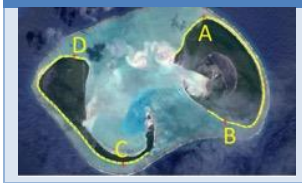
4.2.15 Site MAE2: Manuae Beaches

Figure 47. Site MAE2: Manuae Beaches.

Table 46. Site MAE2: Manuae Beaches

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Manuae Beaches	MAE2	2	1	1.5	1	**5.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-19.252486	-158.92872	MAE 2 (A)
	-19.277679	-158.92322	MAE 2 (B)
	-19.261801	-158.96184	MAE 2 (C)
	-19.287958	-158.94924	MAE 2 (D)

Geographic explicitness (score = 2)

This SUMA covers the seaward beaches of Manuae and Te Au O Tu on Manuae Atoll.

Justification (score = 1)

Workshop participants identified Manuae's beaches as providing habitat for nesting turtles. Nesting on Manuae's beaches has been confirmed in the past (MMR, 2000a; Morejohn et al., 2019; SPREP, 2018). and turtles that nest here belong to the Southern Cook Islands nesting

stock (White, 2012b). Green turtle nests were recorded on both islets, amounting to 57 nests on both islets (Morejohn et al., 2019). Information about turtles in general, and for the Cook Islands, is reviewed in Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua.

Due to the global significance of Manuae, Saul and Tiraa (2004) proposed that the whole island, lagoon and surrounding seas be designated as a wildlife sanctuary or national park. They also suggested a community trust approach, as used for Takutea, to address long-standing land tenure disputes.

Type and number of sources (score = 1.5)

Five reports mentioned nesting turtles on Manuae Atoll, one of which had quantitative information. References reviewed for Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Aitutaki and its internal waters as provided for under Section 4(2); it is unclear whether Maunuae and its internal waters are likewise covered by the Act (Aitutaki and Manuae are generally considered "paired" with the latter under direct management of Aitutaki authorities).
- The Aitutaki Fisheries Protection By-Laws 1990 regulate harvest of specific inshore marine species of Aitutaki and Manuae islands.
- The Aitutaki and Manuae bonefish fishery has been designated under the Marine Resources (Aitutaki and Manuae Bonefish Fishery) (Amendment) Regulations 2016.
- All marine turtle species are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS). The Cook Islands is also a Party or Signatory to several international agreements for marine turtle conservation, protection and management, including the Convention on Biological Diversity.

4.2.16 Site MAE3: Manuae Lagoon, Reef and Drop-off

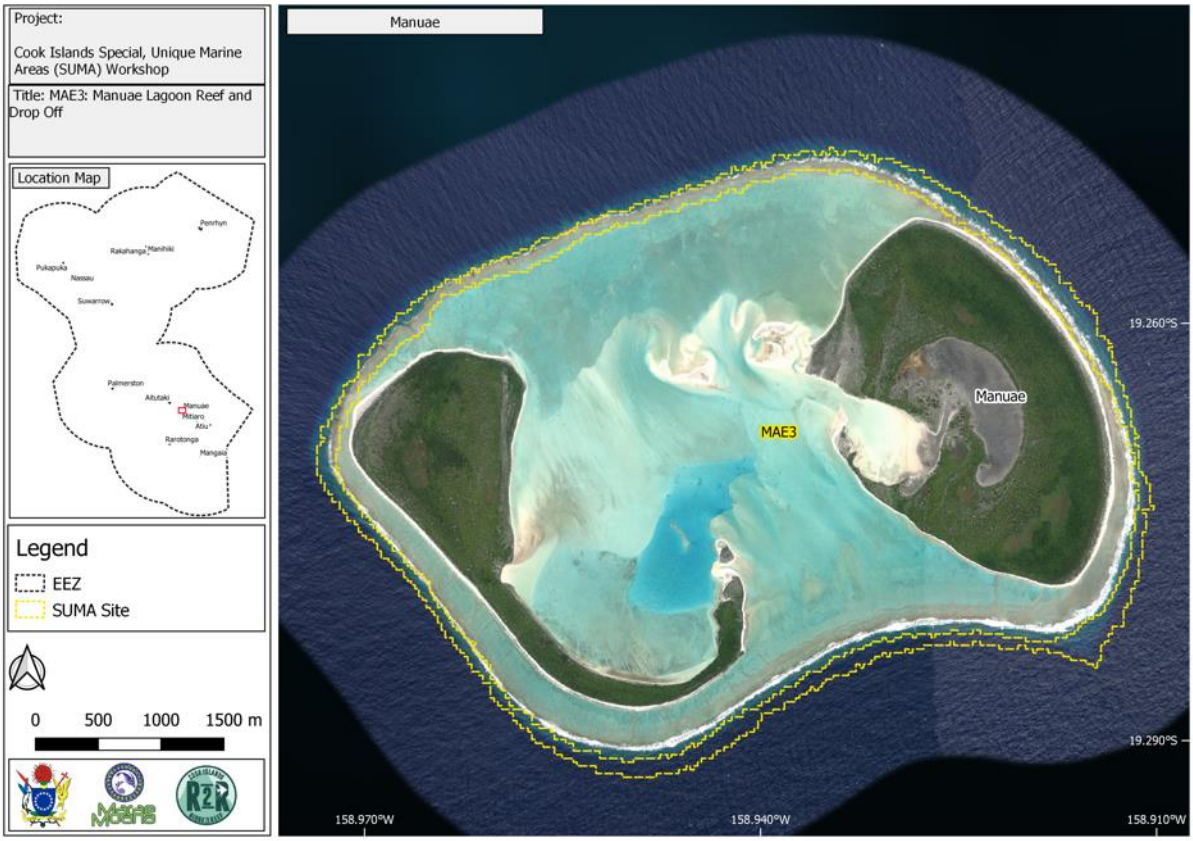


Figure 48. Site MAE3: Manuae Lagoon, Reef and Drop-off.

Table 47. Site MAE3: Manuae Lagoon, Reef and Drop-off

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Manuae Lagoon, Reef and Drop-off	MAE3	3	2	2	2	**9**

Geographic boundaries

Map	Latitude	Longitude	Points
	-19.251994	-158.95163	MAE 3 (A)
	-19.290224	-158.95704	MAE 3 (B)
	-19.271499	-158.91051	MAE 3 (C)

Geographic explicitness (score = 3)

This SUMA encompasses lagoon, reef and reef slope (drop-off) habitats of Manuae Atoll. The lagoon is 13 km² in size, shallow, completely enclosed and subject to large shifting sand banks. A coral reef surrounds the atoll, with a wide reef flat and a steep slope.

Justification (score = 2)

This SUMA was chosen for its vibrant, diverse and productive marine habitats that support a variety of species, many of which have become rare or overexploited in other areas (Morejohn et al., 2019). Several types of fishes (bonefish, milkfish, parrotfish and trevallies)

and invertebrates (clams and ariri) are abundant here (expert and traditional knowledge, SUMA workshop). In 2013, Manuae coral communities on the steep reef slopes were found to have high (28-41%) coral cover, which represented an increase from previous surveys and was high compared to other southern Cook Islands reefs. There was equivalent cover of crustose coralline algae and *Halimeda* spp. (Rongo et al., 2013a). Slopes were dominated by a few species, especially the branching *Acropora schmitti* and the plate-forming *Astreopora expansa*; the latter appears unique to a few islands in the southern Cook Islands (Rongo et al., 2013a). Surveys also recorded 66 fish species with a variety of trophic groups, from large schools of predatory trevallies to planktivorous *Pseudanthias* spp. (Rongo et al., 2013a). Early surveys recorded eleven fish families in the lagoon; common species were the lined bristletooth (*Ctenochaetus striatus)*, convict surgeonfish (*Acanthurus triostegus)*, Achilles tang (*Acanthurus achilles)*, garfishes, squirrelfishes, goatfishes and snapper (Ponia, 1998). More recent surveys included outer reef slope areas and recorded 85 taxa, and densities that ranged between 1,862 and 2,220 individuals per 100 m^2 on the leeward and windward sides of the reef, respectively (Morejohn et al., 2019). The lagoonal areas between Arekai and Ruakau, with abundant patch reef habitat, and reef slope areas from the southern leeward side of Motu Manuae and the southern windward side of Motu Te Au Outu, were noted as being particularly diverse and productive (Ponia, 1998).

The Manuae lagoon has had significant populations of milkfish (*Chanos chanos*) and bonefish (Albulidae) (Terekia, 1988) and large schools of trevallies (*Caranx sexfasciatus*) in the past (Ponia, 1998; Rongo et al., 2013b). These surveys found that parrotfish were less abundant than other grazers such as surgeonfish. Information reviewed about milkfish for Site MAN2: Manihiki - Porea Ra'ui is also relevant here.

This is known as the only area in the southern Cook Islands with relatively intact populations of giant clams (particularly *Tridacna maxima*). The average density of *T. maxima* on the reef varied from 8 to 36 individuals per 100 m^2 (Rongo et al., 2013a). Macroinvertebrate communities were otherwise dominated by the sea urchin *Echinometra mathaei* (Rongo et al., 2013a). Other invertebrates recorded around the forereef habitats of Manuae were the giant worm-snail (*Ceraesignum maximum*), Christmas-tree worm (*Spirobranchus* spp.), spider conch (*Lambis lambis*), esculator urchin (*Echinostrephus aciculatus*), and common reef octopus (*Octopus cyanea*) (Rongo et al., 2013a). General information about giant clams was reviewed in Site MAN1: Manihiki Lagoon and is also relevant here.

Due to the global significance of Manuae, Saul and Tiraa (2004) proposed that the whole island, lagoon and surrounding seas be designated as a wildlife sanctuary or national park. They also suggested a community trust approach, as used for Takutea, to address long-standing land tenure disputes.

Type and number of sources (score = 2)

There was little specific information about the species that characterise this SUMA, but more general information about Manuae's reefs was gleaned from three reports. References used for milkfish and clams in Site MAN2: Manihiki - Porea Ra'ui and Site MAN1: Manihiki Lagoon are also relevant here.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017

- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Aitutaki and its internal waters as provided for under Section 4(2).
- The Aitutaki Fisheries Protection By-Laws 1990 regulate harvest of specific inshore marine species of Aitutaki and Manuae islands.
- The Aitutaki and Manuae bonefish fishery has been designated under the Marine Resources (Aitutaki and Manuae Bonefish Fishery) (Amendment) Regulations 2016.
- Milkfish, parrotfish and clams are listed on the IUCN Red List of Threatened Species.

4.2.17 Site TAK1: Takutea Reefs

Figure 49. Site TAK1: Takutea Reefs

Table 48. Site TAK1: Takutea Reefs

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Takutea Reefs	TAK1	2	2	2	2	**8**

Geographic boundaries

Map	Latitude	Longitude	Points
	-19.811893	-158.29902	TAK1 (A)
	-19.807917	-158.28413	TAK1 (B)
	-19.817403	-158.28429	TAK1 (C)

Geographic explicitness (score = 2)

Takutea, one of the islands of the Nga Pu Toru group in the southern Cook Islands, is a small uninhabited island 1.22 km^2 in size. It is a sand cay and has a narrow fringing reef with a circumference of 6 km that slopes steeply into deep waters. This SUMA encompasses the reef habitats on the western and eastern ends of the island.

Justification (score = 2)

Takutea has a narrow and shallow fringing reef flat, often exposed during low tide, with low coral cover (~22% in 2013 and 7% in 2018) and a dominance of abiotic hard substratum that

has yet to be colonised, or pavement (MMR, 2019c; Rongo et al., 2013a). Because the island is uninhabited, the reef is thought to host abundant flora and fauna that has become rare elsewhere due to exploitation (expert and traditional knowledge, SUMA workshop). The two areas of the Takutea reef included within this SUMA are known to host high densities of tridacnid clams, or paua (P. Rakanui, pers. comm.). Takutea has been designated as a wildlife sanctuary since 1903, and re-established in 1950 (McCormack, 2002; Saul and Tiraa, 2004). It is protected as a no-take area and is also a KBA and IBA (Evans, 2012; Rasmussen, 2016).

Structural complexity around the reef is low and invertebrate and fish community composition and abundance appeared to be driven by the varying complexity of leeward and windward habitats (Rongo et al., 2013a). Poor habitat complexity often leads to depauperate coral communities, especially on isolated reefs where many organisms rely on self-seeding or long-range vagrants from distant upsteam sources (Graham and Nash, 2013). Coral communities on the steep reef slopes are dominated by a few robust species, including the plate-forming coral *Astreopora expansa*, which appears unique to a few islands in the southern Cook Islands (Rongo et al., 2013a). The populations of coral reef organisms here are thought to be vulnerable to exploitation, due to the small size of the habitat (MMR, 2000a).

Early surveys recorded 17 species of commercially important invertebrates, which is considered to be relatively high diversity compared to islands where more fishing occurs (Ponia et al., 1998b). The distribution of invertebrate species is thought to be affected by environmental factors, with larger populations in semi-exposed areas than in sheltered or exposed aspects (Ponia et al., 1998b). Recently, 1,049 individuals from 17 invertebrate taxa were recorded at four sites around Takutea, especially on the southern side, including abundant clams (*Chama pacifica*, paua kura, and *Tridacna* spp., paua) and giant worm snails (*Ceraesignum maximum*, ungakoa) (MMR, 2019c).

Type and number of sources (score = 2)

Three reports provided details about coral reefs in Takutea and one peer-reviewed paper was consulted for ecological background. Five reports mentioned that Takutea is a wildlife sanctuary. References used to describe coral reefs for the Cook Islands in Site TON1: Tongareva - Flying Venus Reef and paua in Site MAN1: Manihiki Lagoon are also relevant here.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- From 1903-1950, Takutea was a sanctuary under individual ownership. In 1950, Takutea was vested by court order in the board of trustees that includes most of the Aronga Mana of Atiu. Takutea has been declared a “community conserved area under the management and control of the Trustees of Takutea” (section 4 of *Environment (Atiu and Takutea) Regulations 2008*). The *Regulations 2008* specify that "Takutea"

means the island of Takutea and includes the waters within 12 nautical miles. Covering the entire island (120ha) and adjoining waters, Takutea is the oldest protected area in the Cook Islands; meets the global IUCN definition of a protected area; and one of only two that extend across island and marine environments (Suwarrow is the other) (Twyford 2020b).

- The Regulations effectively establish a “no take” reserve over the island and marine waters; fishing is prohibited “within 5 nm of the reef” (and potentially to 12 nm depending on how the Regulations are interpreted). This arrangement puts in place stronger protections and management than the Section 24 zone (full details are in Twyford 2020b).
- Many of the species that live on coral reefs are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

4.2.18 Site TAK2: Takutea Beaches

Figure 50. Site TAK2: Takutea Beaches

Table 49. Site TAK2: Takutea Beaches

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Takutea Beaches	TAK2	2	2.5	2	2	**8.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-19.812262	-158.29778	TAK2 (A)
	-19.807509	-158.28615	TAK2 (B)
	-19.8165	-158.28333	TAK2 (C)

Geographic explicitness (score = 2)

Takutea is a sand cay island and has a narrow surrounding beach. This SUMA encompasses the entire beach around Takutea Island.

Justification (score = 2.5)

The beaches of Takutea Island have been recorded as a turtle and seabird nesting area (expert and traditional knowledge, SUMA workshop). The turtles that nest here belong to the Southern Cook Islands nesting stock (SPREP, 2018; White, 2012b). Nesting has been reported in the past (MMR, 2000a) and green turtles are one of the trigger species for Takutea

as a KBA (Evans, 2012), but their current status in unknown (White, 2012b). Hawksbill turtles may also be present in the waters around the island (White, 2012b). Information about turtles in general, and for the Cook Islands, is reviewed in Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua.

Takutea is the most important seabird breeding island in the southern Cook Islands (Brider, 2019). It was designated as a wildlife sanctuary mainly for the red-footed boobies and globally significant populations of red-tailed tropicbirds (Butler, 2017a) and large populations of coconut crabs (McCormack, 2002; Saul and Tiraa, 2004). It is also a layover site for migratory species such as the bristle-thighed curlew (*Numenius tahitiensis*; K. Passfield, pers. obs.). It is protected as a no-take area and is also a KBA and IBA (Evans, 2012; Rasmussen, 2016).

Takutea has the largest nesting colony of red-tailed tropicbirds (*Phaethon rubricauda*, Tavake) in the Cook Islands. The island hosts nesting great frigatebirds (*Fregata minor*, Kōta'a), brown booby (*Sula leucogaster*, Kena) and red-footed booby (*Sula sula*, Toroā); the masked booby (*Sula dactylatra*, Lulu) is assumed to nest occasionally in very small numbers (Table 50). Seven species are known to nest on Takutea, three of which do not nest anywhere else in the Southern Cook Islands (Brider, 2019). Recent surveys found reductions in nesting Tavake and Kena compared to earlier reports, and Lulu and Kōta'a Nui were absent (Table 50). Foraging ranges for these seabirds are taken into account in Site TAK3: Takutea Seabirds. Further information about seabirds in the Cook Islands was reviewed in Site PUK4: Pukapuka Seabird Colonies.

Table 50. Results of repeated monitoring of nesting seabirds on Takutea. Reproduced from Brider (2019).

Species	Nest Count		
	2019 (Aug)	1990 (Sept)	1989 (May)
Red-tailed tropicbird - Tavake	438	≈2000	≈900
Brown booby - Kena	6	18	22
Masked booby - Lulu	9	0	0
Brown noddy - Kōta'a Nui	5	0	0
Black Noddy - Rakia	0	3	26

Type and number of sources (score = 2)

Three reports mentioned the presence of turtles in Takutea, but there was no further information about nesting activities or numbers. Five reports mentioned that Takutea is a wildlife sanctuary. One report had results of recent seabird surveys. References used for Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua and Site PUK4: Pukapuka Seabird Colonies to describe turtle and seabird nesting in the Cook Islands are also relevant here.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.

- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- From 1903-1950, Takutea was a sanctuary under individual ownership. In 1950, Takutea was vested by court order in the board of trustees that includes most of the Aronga Mana of Atiu. Takutea has been declared a “community conserved area under the management and control of the Trustees of Takutea” (section 4 of *Environment (Atiu and Takutea) Regulations 2008*). The *Regulations 2008* specify that "Takutea" means the island of Takutea and includes the waters within 12 nautical miles. Covering the entire island (120ha) and adjoining waters, Takutea is the oldest protected area in the Cook Islands; meets the global IUCN definition of a protected area; and one of only two that extend across island and marine environments (Suwarrow is the other) (Twyford 2020b).
- The Regulations effectively establish a “no take” reserve over the island and marine waters; fishing is prohibited “within 5 nm of the reef” (and potentially to 12 nm depending on how the Regulations are interpreted). This arrangement puts in place stronger protections and management than the Section 24 zone (full details are in Twyford 2020b).
- All marine turtle species and many of the seabird species present are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS). The Cook Islands is also a Party or Signatory to several international agreements for marine turtle conservation, protection and management, including the Convention on Biological Diversity.

4.2.19 Site TAK3: Takutea Seabirds

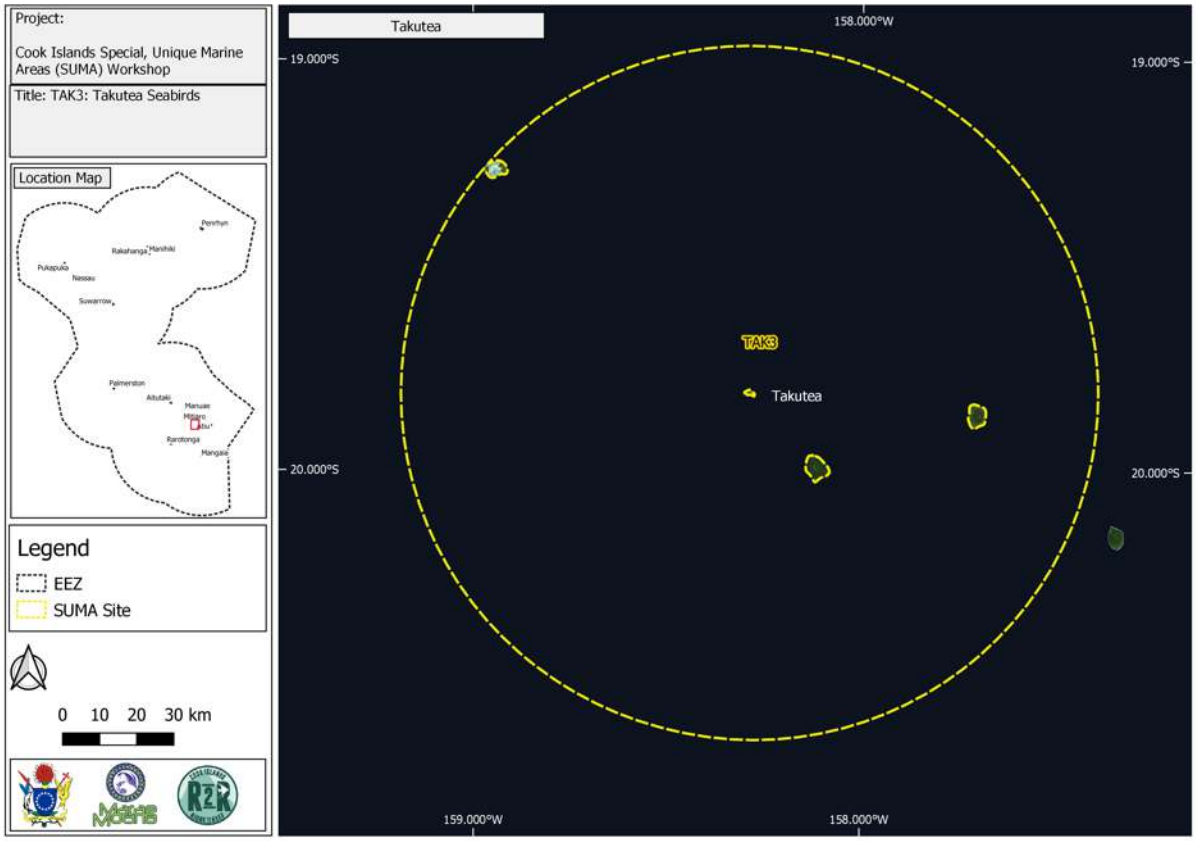
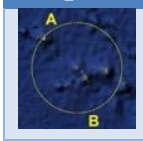


Figure 51. Site TAK3: Takutea Seabirds

Table 51. Site TAK3: Takutea Seabirds

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Takutea Seabirds	TAK3	3	2	1.5	2	**8.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-19.811933	-158.3011	TAK3 (A)
	-19.805129	-158.28738	TAK3 (B)
	-19.821248	-158.27647	TAK3 (C)

Geographic explicitness (score = 3)

Takutea, one of the islands of the Nga Pu Toru group in the southern Cook Islands, is a small uninhabited island 1.22 km^2 in size. This SUMA extends out to 50 nautical miles to capture whale habitat and the foraging ranges of seabirds (see Site TAK2: Takutea Beaches).

Justification (score = 2)

The deeper areas off the Takutea reef are habitat for nursing humpback whales (Passfield and Rongo, 2011); they are regularly encountered all around the island (P. Rakanui, Pers. comm.). This SUMA is also the marine extension for Site TAK2: Takutea Beaches, a

globally important nesting area for the red-tailed tropicbird . Red-tailed tropicbirds forage exclusively over the ocean, alternating between short (~25 km) and long (~100 km) distances. Generally, conservation initiatives for seabirds use the distance from the nest within which 1% of the global population forages (Thaxter et al., 2012). This would result in a foraging range with a radius of 240 km from Takutea. Although this kind of scale cannot be adequately covered by site-based conservation measures, it justifies the 50 nm MPA around the islands currently in place under the Marae Moana Act 2017 (M. O'Brien, Conservation International, pers. comm.).

Type and number of sources (score = 1.5)

Five reports mentioned that Takutea is a wildlife sanctuary and one report mentioned that whales may use this area. References used to describe marine mammals and seabirds in Site O5: Marine Mammal Migratory Pathways and Site TAK2: Takutea Beaches are also relevant here.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- From 1903-1950, Takutea was a sanctuary under individual ownership. In 1950, Takutea was vested by court order in the board of trustees that includes most of the Aronga Mana of Atiu. Takutea has been declared a "community conserved area under the management and control of the Trustees of Takutea" (section 4 of *Environment (Atiu and Takutea) Regulations 2008*). The *Regulations 2008* specify that "Takutea" means the island of Takutea and includes the waters within 12 nautical miles. Covering the entire island (120ha) and adjoining waters, Takutea is the oldest protected area in the Cook Islands; meets the global IUCN definition of a protected area; and one of only two that extend across island and marine environments (Suwarrow is the other) (Twyford 2020b).
- The Regulations effectively establish a "no take" reserve over the island and marine waters; fishing is prohibited "within 5 nm of the reef" (and potentially to 12 nm depending on how the Regulations are interpreted). This arrangement puts in place stronger protections and management than the Section 24 zone (full details are in Twyford 2020b).
- Many of the species that live on coral reefs are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).
- All marine turtle species and many of the seabird species present are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS). The Cook Islands is also a Party or Signatory to several international agreements for marine turtle conservation, protection and management, including the Convention on Biological Diversity.

4.2.20 Site TAK4: Takutea Shoal

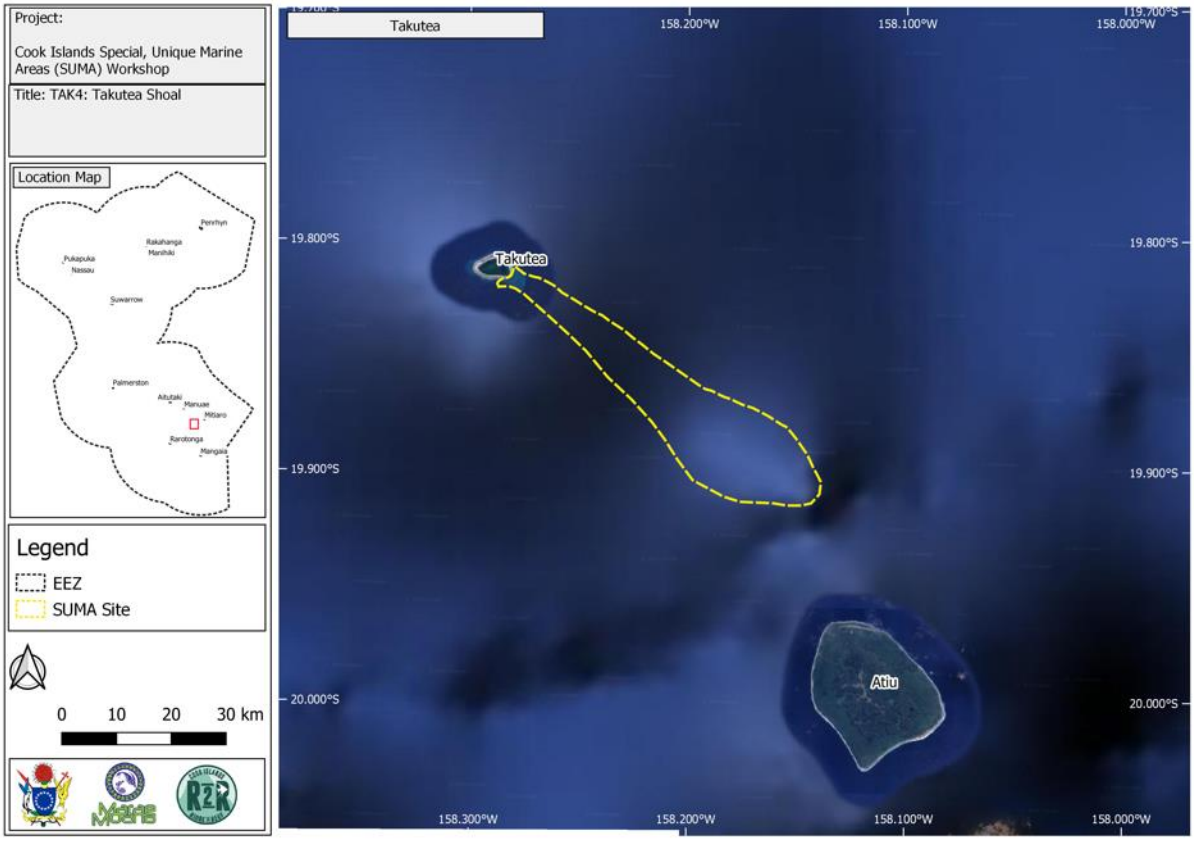
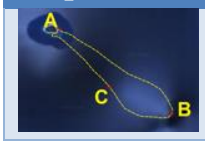


Figure 52. Site TAK4: Takutea Shoal.

Table 52. Site TAK4: Takutea Shoal

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Takutea Shoal	TAK4	1	1	1	1	**4**

Geographic boundaries

Map	Latitude	Longitude	Points
	-19.812055	-158.27946	TAK4 (A)
	-19.910079	-158.13942	TAK4 (B)
	-19.879155	-158.21639	TAK4 (C)

Geographic explicitness (score = 1)

The ocean between Takutea and Atiu is characterised by a relatively shallow shoal that links the two islands, visible at low tide in very calm weather. The SUMA includes the shoal and the waters above it.

Justification (score = 1)

The shallow shoal habitat between Takutea and Atiu is known to be highly productive, attracting high densities of fish (P. Rakanui, pers. comm.). As an extension of the Takutea reef, it is likely to have similar attributes (MMR, 2019c; Rongo et al., 2013a) and to host reef

assemblages typical of highly exposed reefs. Surveys also recorded 55 fish species from 17 families, with a lower proportion of pomacentrids than on other southern Cook Islands reefs, and regular sightings of large snapper (Rongo et al., 2013a). Fish density was highest on the southern side of the island during recent surveys (MMR 2019).

Although no specific information was available to describe this shoal, it may have high value as a connectivity pathway between the Takutea and Atiu fringing reefs. The value of coral reefs globally, and for the Cook Islands in particular, are also described in Site TON1: Tongareva - Flying Venus Reef; Takutea's coral reefs are further described in Site TAK1: Takutea Reefs.

Type and number of sources (score = 1)

The importance of this shoal habitat was identified through traditional knowledge (P. Rakanui) and inferred from information about the reefs around Takutea. References used in Site TON1: Tongareva - Flying Venus Reef and Site TAK1: Takutea Reefs are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- From 1903-1950, Takutea was a sanctuary under individual ownership. In 1950, Takutea was vested by court order in the board of trustees that includes most of the Aronga Mana of Atiu. Takutea has been declared a "community conserved area under the management and control of the Trustees of Takutea" (section 4 of *Environment (Atiu and Takutea) Regulations 2008*). The *Regulations 2008* specify that "Takutea" means the island of Takutea and includes the waters within 12 nautical miles. Covering the entire island (120ha) and adjoining waters, Takutea is the oldest protected area in the Cook Islands; meets the global IUCN definition of a protected area; and one of only two that extend across island and marine environments (Suwarrow is the other) (Twyford 2020b).
- The Regulations effectively establish a "no take" reserve over the island and marine waters; fishing is prohibited "within 5 nm of the reef" (and potentially to 12 nm depending on how the Regulations are interpreted). This arrangement puts in place stronger protections and management than the Section 24 zone (full details are in Twyford 2020b).
- This SUMA extends into the adjoining territorial seas which also fall within the jurisdiction of the Environment Act. The area beyond 12nm is outside the governance of the *Environment (Atiu and Takutea) Regulations 2008* but still under the general auspices of the Environment Act).
- Many of the species that live on coral reefs are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

- All marine turtle species and many of the seabird species present are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS). The Cook Islands is also a Party or Signatory to several international agreements for marine turtle conservation, protection and management, including the Convention on Biological Diversity.

4.2.21 Site ATI1: Atiu – Northwestern Reef Breaks

Figure 53. Site ATI1: Atiu – Northwestern Reef Breaks

Table 53. Site ATI1: Atiu – Northwestern Reef Breaks

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Atiu – Northwestern Reef Breaks	ATI1	2	1.5	1	1	**5.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-19.964269	-158.13529	ATI 1 (A)
	-19.981161	-158.14564	ATI 1 (B)
	-20.009001	-158.14083	ATI 1 (C)

Geographic explicitness (score = 2)

Atiu is in the Southern Cook Islands and part of the Nga Pu Toru island group, which consists of Takutea, Atiu, Mauke and Mitiaro. The reef habitats on the western and northern sides of Atiu include a reef flat and a steep reef slope. The SUMA covers the natural breaks in the reef across the northwestern aspect of the reef.

Justification (score = 1.5)

The reef breaks in this SUMA have historically served as flying fish (maroro) spawning aggregation sites where artisanal fishers targeted their catches (P. Rakanui, pers. comm.).

These aggregations no longer occur in Atiu; Mitiaro is the only island that still hosts these aggregations (see Site MIT1: Mitiaro - Maroro Tu).

The reef in this area has relatively low coral cover (10-20 %), with benthic communities dominated by crustose coralline algae and limestone pavement (Rongo et al., 2013a). Fish density and species richness were relatively high (Rongo et al., 2013a), suggesting the potential for this area to be productive and therefore attract feeding pelagic fishes and marine mammals. Shallow water surveys reported few invertebrates (MMR, 2019c), but an unusually high abundance of the black teatfish (*Holothuria whitmaei)* was recorded on the deeper reef slope on this side of the island (Rongo et al., 2013a).

Type and number of sources (score = 1)

The habitat condition of the SUMA was inferred from two reports and the historical aggregation of flying fish was contributed through traditional knowledge. References reviewed for Site MIT1: Mitiaro - Maroro Tu are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The island of Atiu, its territorial seas and internal waters fall under the jurisdiction of the *Environment (Atiu and Takutea) Regulations 2008*). The Regulations establish protections for coconut crabs, crayfish, flying fish, koperu (mackerel), birds and turtles, and specify restrictions on fishing methods and gear type; as per Section 3 of the Regulations these restrictions apply to the island of Atiu and the waters within 12nm of the coast.
- Some traditional rules apply to the fishing of maroro, including social observances (e.g. a curfew) and fishery regulations (e.g. the maroro cannot be sold).

4.2.22 Site ATI2: Atiu - Proposed Rimu and Pa'ua Ra'ui

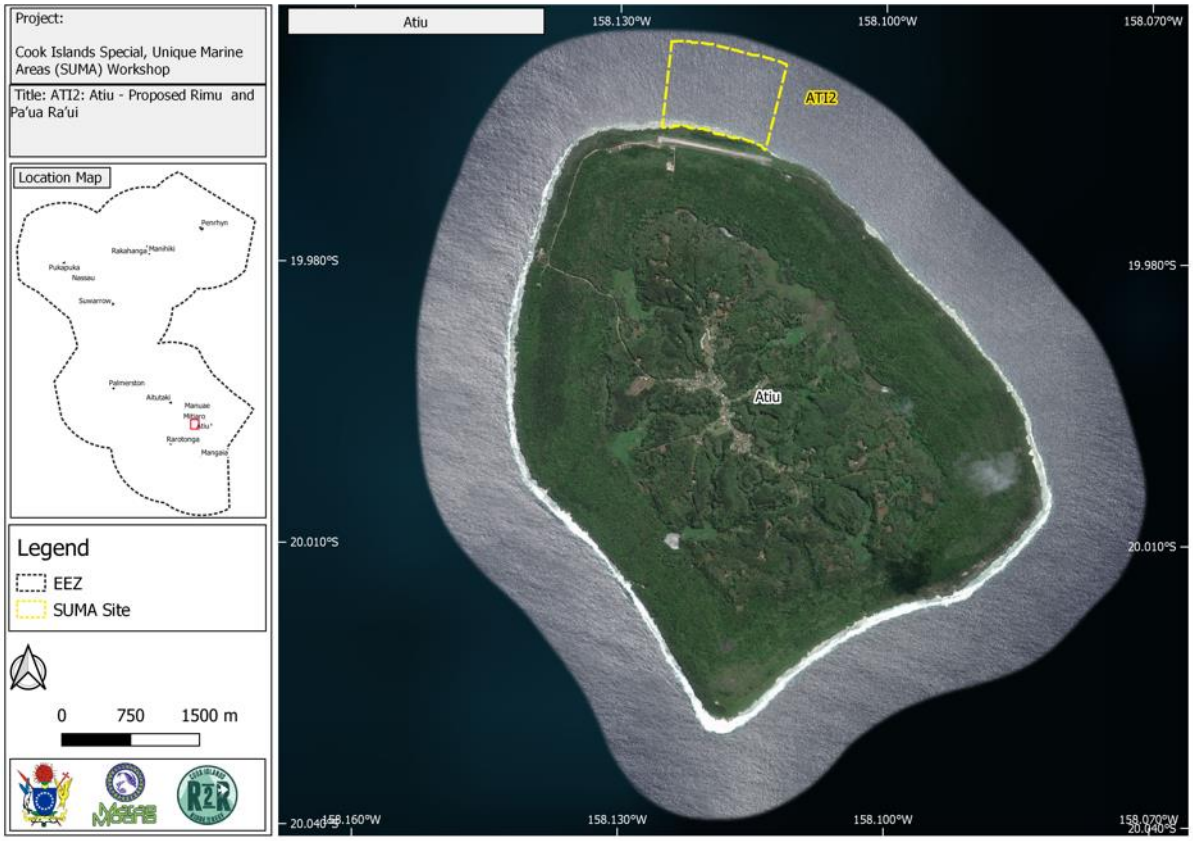


Figure 54. Site ATI2: Atiu - Proposed Rimu and Pa'ua Ra'ui.

Table 54. Site ATI2: Atiu - Proposed Rimu and Pa'ua Ra'ui

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Atiu – Proposed Rimu and Pa'ua Ra'ui	ATI2	2	1	1	2	**6**

Geographic boundaries

Map	Latitude	Longitude	Points
	-19.956439	-158.12431	ATI 2 (A)
	-19.967915	-158.11367	ATI 2 (B)

Geographic explicitness (score = 2)

This SUMA incorporates the shallow reef habitats within a small area (0.2 km^2) on the northern tip of Atiu Island.

Justification (score = 1)

This area is a proposed ra'ui for the management and protection of rimu / remu (sea grapes, *Caulerpa racemosa*) and paua (tridacnid clams). This area has been known for relatively high coral cover (~25%), compared to other reef locations around the island (Rongo et al., 2013a). Atiu is listed as one of the islands where remu has been collected in the past (MMR, 1993; Rongo and Dyer, 2015), but current abundance is unknown. Pa'ua were included in a 1998

resource assessment, but were not particularly abundant at the northern site (Ponia et al., 1998c). *Tridacna squamosa*, which are usually much less abundant than the more common *T. maxima*, were also recorded on Atiu; surveys found the dominant invertebrates were sea urchins (Rongo et al., 2013a). MMR (2019) recorded no sightings of paua at this site.

General information about remu and giant clams was reviewed in Site AIT3: Aitutaki - Arutanga Passage and Site MAN1: Manihiki Lagoon, and is also relevant here.

Type and number of sources (score = 1)

Three reports contained some information about coral reef condition and clams in the vicinity of this SUMA, and two additional reports provided some information about the presence of rimu on Atiu. References reviewed for Site AIT3: Aitutaki - Arutanga Passage and Site MAN1: Manihiki Lagoon are also relevant here.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The island of Atiu, its territorial seas and internal waters fall under the jurisdiction of the *Environment (Atiu and Takutea) Regulations 2008*). The Regulations establish protections for coconut crabs, crayfish, flying fish, koperu (mackeral), birds and turtles, and specify restrictions on fishing methods and gear type; as per Section 3 of the Regulations these restrictions apply to the island of Atiu and the waters within 12nm of the coast.
- Clams are also protected under ra'ui; there is a ban on international export.

4.2.23 Site ATI3: Atiu Deeper Waters

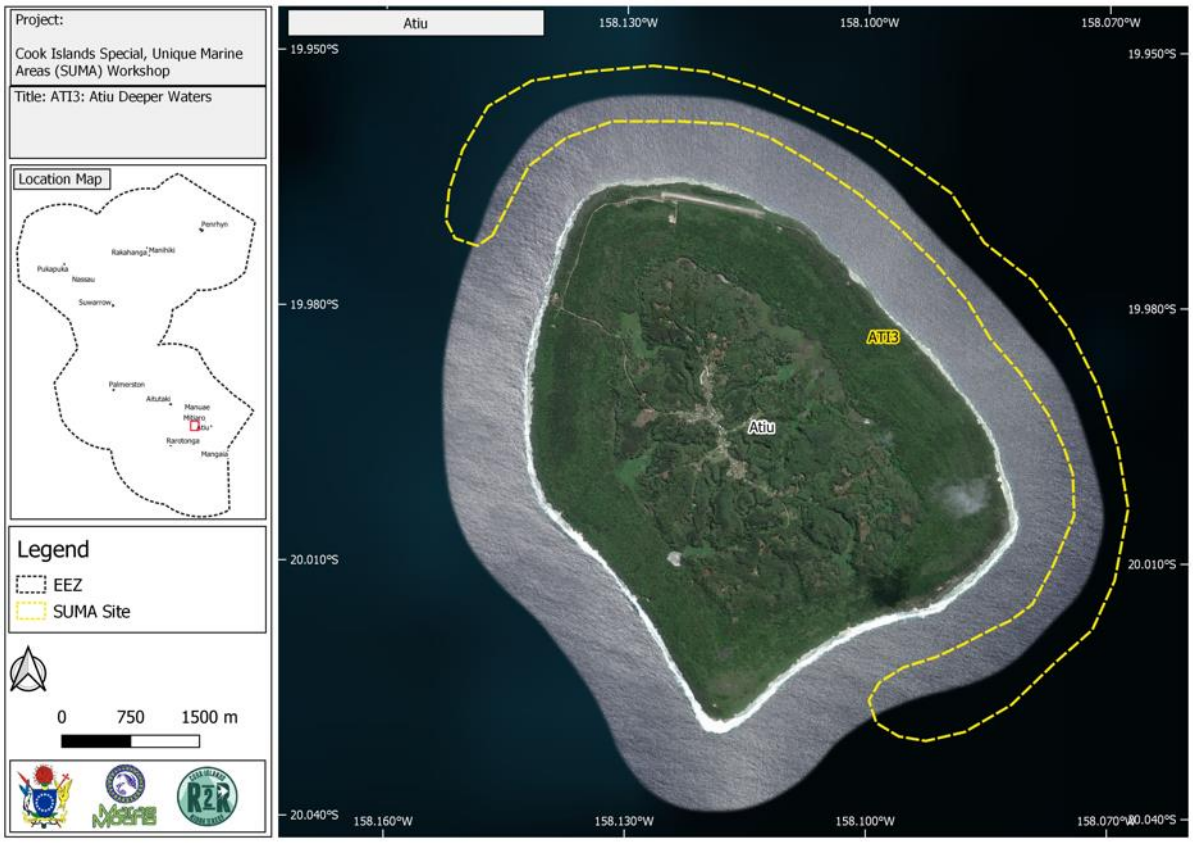


Figure 55. Site ATI3: Atiu Deeper Waters

Table 55. Site ATI3: Atiu Deeper Waters

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Atiu Deeper Waters	ATI3	2	2	2	2	**8**

Geographic boundaries

Map	Latitude	Longitude	Points
	-19.966511	-158.1522	ATI 3 (A)
	-19.95858	-158.11699	ATI 3 (B)
	-19.984344	-158.07392	ATI 4 (C)
	-20.030424	-158.09588	ATI 4 (D)

Geographic explicitness (score = 2)

This SUMA incorporates the deep waters seaward of the reef surrounding Atiu, on the southern, eastern and northern sides of the island.

Justification (score = 2)

This site was identified as habitat for whales, dolphins and turtles travelling to nesting sites on the island (traditional and expert knowledge, SUMA workshop). Atiu is also listed as a

KBA and an IBA (Evans 2012). Humpback whales are regularly reported off the coast of Atiu by pilots flying between islands (Hauser and Clapham, 2005). This area is included in the Southern Cook Islands IMMA, indicating a likelihood that one or more species of marine mammal frequent the waters around Atiu (Marine Mammal Protected Area Task Force, 2020).

Hawksbill and green turtles use marine habitats around Atiu and green turtles are thought to nest on the beaches (Evans, 2012), but there are no documents confirming this. Satellite tagging revealed that hawksbill turtles probably travel to Atiu to feed, as well as to other islands in the Nga Pu Toru group (White, 2012b). Information about marine mammals and turtles in general, and for the Cook Islands, is reviewed in Site O3: Palmerston – Kona Reef and Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua. MMR (2019) also report that finfish densities were highest within this SUMA (Tepari Aniu) than the other side of the island.

Type and number of sources (score = 2)

Whales, dolphins and turtles in this area were mentioned in three reports, and the habitat condition of the SUMA was inferred from two reports. References reviewed for Site O5: Marine Mammal Migratory Pathways and Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua are also relevant here.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The island of Atiu, its territorial seas and internal waters fall under the jurisdiction of the *Environment (Atiu and Takutea) Regulations 2008*). The Regulations establish protections for coconut crabs, crayfish, flying fish, koperu (mackeral), birds and turtles, and specify restrictions on fishing methods and gear type; as per Section 3 of the Regulations these restrictions apply to the island of Atiu and the waters within 12nm of the coast.
- This SUMA extends into the adjoining territorial seas which also fall within the jurisdiction of the Environment Act. The area beyond 12nm is outside the governance of the *Environment (Atiu and Takutea) Regulations 2008* but still under the general auspices of the Environment Act).
- All the marine mammals and turtles in the Cook Islands are listed on the IUCN Red List of Threatened Species, and some are listed under the Convention on Migratory Species (CMS). The Cook Islands is also a Party or Signatory to several international agreements for marine turtle conservation, protection and management, including the Convention on Biological Diversity.
- Ra'ui is a traditional form of management in the Cook Islands that involves periodic harvesting closures of specific areas or resources and applies to turtles in some areas.

4.2.24 Site ATI4: Eastern Atiu – Tepari

Figure 56. Site ATI4: Eastern Atiu – Tepari

Table 56. Site ATI4: Eastern Atiu – Tepari

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Eastern Atiu - Tepari	ATI4	2	1	1	2	**6**

Geographic boundaries

Maps	Latitude	Longitude	Points
	-19.960972	-158.11036	ATI 4 (A)
	-19.981104	-158.09556	ATI 4 (B)
	-19.98886	-158.08073	ATI 4 (C)

Geographic explicitness (score = 2)

The eastern side of Atiu Island, facing the prevailing southeasterly trade winds, has steep cliffs and a narrow fringing reef descending abruptly into deep waters. This SUMA includes the highly exposed waters across the reef and over the drop-off.

Justification (score = 1)

The Tepari area of Atiu is dominated by steep cliffs and a narrow reef facing the prevailing weather. Very rough weather conditions are typically experienced during six months of the year (January to June, P. Rakanui, pers. comm.). The topography results in high ecological productivity and impeded human access, meaning that the reduced fishing effort leads to a build-up in fish biomass and abundance that has become rare in heavily fished areas. The natural protection afforded by the physical geography and weather serves to replenish fish stocks. Recent finfish surveys reported the highest densities for the island (304 individuals per 100 m^2) in this SUMA (MMR, 2019c). The site is also known as a haven for sharks (P. Rakanui, pers. comm.)

Type and number of sources (score = 1)

Traditional knowledge and one report provided information about the primary attributes of this SUMA.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The island of Atiu, its territorial seas and internal waters fall under the jurisdiction of the *Environment (Atiu and Takutea) Regulations 2008*). The Regulations establish protections for coconut crabs, crayfish, flying fish, koperu (mackeral), birds and turtles, and specify restrictions on fishing methods and gear type; as per Section 3 of the Regulations these restrictions apply to the island of Atiu and the waters within 12nm of the coast.
- Many sharks and coral reef fishes are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).
- A ra'ui is in place stipulating that the fish caught on this side of the island may not be eaten on site.

4.2.25 Site MIT1: Mitiaro - Maroro Tu

Figure 57. Site MIT1: Mitiaro - Maroro Tu

Table 57. Site MIT1: Mitiaro - Maroro Tu

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Mitiaro – Maroro Tu	MIT1	1.5	1.5	1.5	1	**5.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-19.836963	-157.70725	MIT 1 (A)
	-19.843504	-157.72171	MIT 1 (B)
	-19.862126	-157.72077	MIT 1 (C)

Geographic explicitness (score = 1.5)

This SUMA encompasses the waters off the northwestern coastline of Mitiaro, one of the Nga Pu Toru group of islands in the southern Cook Islands. The site extends along approximately 3.4 km of coastline and 500 m out to sea.

Justification (score = 1.5)

As the SUMA name suggests, this site is the location of a flying fish (maroro) spawning aggregation (maroro tu). Three species of flying fish have been positively identified from the Cook Islands; *Cheilopogon atrisignis*, *C. unicolor* (also known as *C. antoncichi*) and

Cypselurus poecilopterus (MMR, 1993). Flying fish feed on zooplankton and are important prey for pelagic predators such as tuna and dolphins (Van Noord et al., 2013). Their movements between coastal spawning and oceanic feeding grounds create a trophic link between coastal and oceanic habitats. Mitiaro is one of the few islands in the Cook Islands where flying fish aggregate to spawn close to the coast, and are targeted by traditional canoe fishing methods (MMR, 2000a). The spawning aggregation occurs between July and December off the northern coast of the island, often in conjunction with rough weather (Climate Change Cook Islands, 2015; Te Ipukarea Society, 2015a). There are concerns about the reduction of these spawning aggregations on other islands (Rongo and Dyer, 2015), making the aggregation on Mitiaro especially important.

Mitiaro lacks a lagoon and has narrow fringing reefs with steep outer reef slopes (George and Kea, 2014), which may create the conditions favourable for pelagic fish spawning aggregations. The steep reef slopes were found to have high (24-42%) coral cover and a coral community dominated by a few species, especially the plate-forming coral *Astreopora expansa* on exposed slopes and *Pocillopora* spp. on the leeward side (Rongo et al., 2013a). The *A. expansa* thickets appear unique to a few islands in the southern Cook Islands (Rongo et al., 2013a). Algal cover was low and coral cover was reported to have increased between 2002 and 2013; some mortality was noted around the harbour entrance (Rongo et al., 2013a). Gastropod molluscs (*Drupa* spp.) were among the most common invertebrates in early surveys (Ponia et al., 1998a) and sea urchins (*Echinothrix diadema*) appeared dominant in more recent assessments (Rongo et al., 2013a). Surveys also recorded 62 fish species with a dominance of pomacentrids and unexpectedly low numbers of scarids (Rongo et al., 2013a).

Type and number of sources (score = 1.5)

Three reports and one website described the phenomenon of maroro tu on Mitiaro, and one confirmed that the aggregation occurs around the location of this SUMA. Additionally, two reports were used to characterise Mitiaro's coral reefs, and one peer-reviewed paper provided background on the trophic ecology of flying fish.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The island of Mitiaro, its territorial seas and internal waters fall under the jurisdiction of the *Environment (Mitiaro) Regulations 2008*). The Regulations establish protections for coconut crabs, crayfish, flying fish, milkfish, birds and turtles, and specify restrictions on fishing methods and gear type; as per Section 3 of the Regulations these restrictions apply to the island of Mitiaro and the waters within 12nm of the coast. Section 8 has protections for spawning flying fish and is directly relevant to SUMA MIT1.
- Some traditional rules apply to the fishing of maroro, including social observances (e.g. a curfew) and fishery regulations (e.g. the maroro cannot be sold).

- This area is also protected under ra’ui.

4.2.26 Site MIT2: Mitiaro Deep Waters

Figure 58. Site MIT2: Mitiaro Deep Waters

Table 58. Site MIT2: Mitiaro Deep Waters

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Mitiaro Deep Waters	MIT2	1	1	1	1	**4**

Geographic boundaries

Maps	Latitude	Longitude	Points
	-19.837534	-157.68282	MIT 2 (A)
	-19.850764	-157.67811	MIT 2 (B)
	-19.890444	-157.68284	MIT 2 (C)
	-19.899144	-157.66994	MIT 2 (D)

Geographic explicitness (score = 1)

This SUMA includes two areas of approximately 0.8 km^2 off the northeastern and southeastern coast of Mitiaro. These areas are in deep water, beyond the reef drop-off.

Justification (score = 1)

These areas were chosen as SUMAs for their value as tuna fishing grounds. The most common tuna species in the Cook Islands are albacore, yellowfin and skipjack tuna (*Thunnus*

alalunga, *T. albacares* and *Katsuwonus pelamis*), targeted by the Western and Central Pacific fisheries and coastal fishing communities (MMR, 2000a). Species caught artisanally are skipjack and dogtooth tuna (*Gymnosarda unicolor*). The numbers and sizes of tuna around all the islands have been declining in recent years (Rongo and Dyer, 2015). The fishery in this SUMA uses traditional methods to avoid the overexploitation that has occurred elsewhere (Te Ipukarea Society, 2015b). The species composition and abundance of tuna in the SUMA is unknown, but the fact that fishers target tuna here indicates places of high localised productivity (MMR, 1993); this inference is reinforced because deep waters (>150 m) occur very close to the shallow reef.

Type and number of sources (score = 1)

One video had information about tuna fisheries in Mitiaro. There was no further information about tuna in this SUMA, but more general information about tuna in the Cook Islands was found in three reports.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The island of Mitiaro, its territorial seas and internal waters fall under the jurisdiction of the *Environment (Mitiaro) Regulations 2008*). The Regulations establish protections for coconut crabs, crayfish, flying fish, milkfish, birds and turtles, and specify restrictions on fishing methods and gear type; as per Section 3 of the Regulations these restrictions apply to the island of Mitiaro and the waters within 12nm of the coast.
- Some traditional rules apply to the fishing of maroro, including social observances (e.g. a curfew) and fishery regulations (e.g. the maroro cannot be sold).
- Most tuna species are listed on the IUCN Red List of Threatened Species.

4.2.27 Site MAK1: Ma'uke Marine Ra'ui

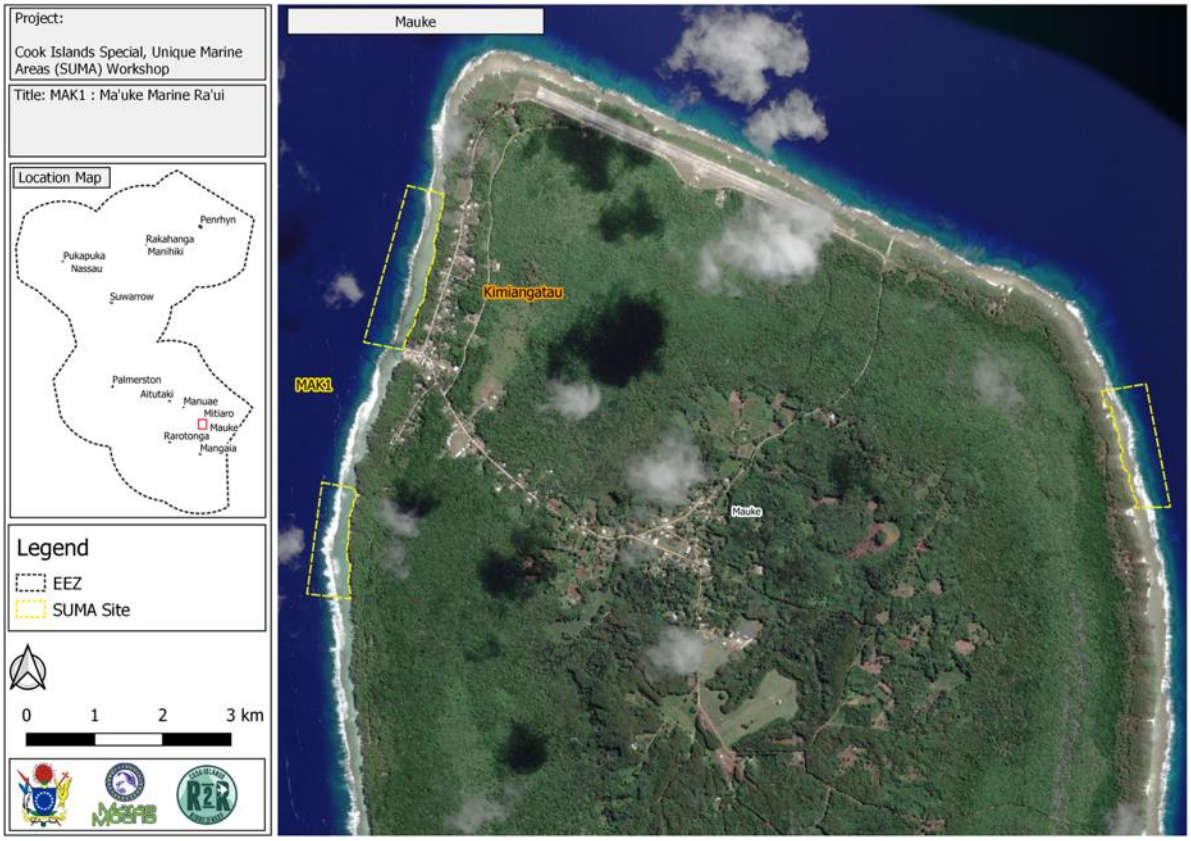


Figure 59. Site MAK1: Ma'uke Marine Ra'ui

Table 59. Site MAK1: Ma'uke Marine Ra'ui

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Ma'uke Marine Ra'ui	MAK1	2	1.5	2	1	**6.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-20.152327	-157.32106	MAK 1 (A)
	-20.147143	-157.32443	MAK 1 (B)
	-20.145485	-157.35835	MAK 1 (C)
	-20.137965	-157.35822	MAK 1 (D)
	-20.151847	-157.36068	MAK 1 (E)
	-20.156704	-157.36292	MAK 1 (F)

Geographic explicitness (score = 2)

Ma'uke is a raised coral island (makatea) with a narrow fringing barrier reef and is one of the Nga Pu Toru group of islands in the southern Cook Islands. This SUMA covers three ra'ui areas on the reefs; one on the eastern side and two on the north-western side.

Justification (score = 1.5)

The three coral reef ra'ui provide protection for exploited species (expert and traditional knowledge, SUMA workshop). Ma'uke lacks a lagoon and has narrow fringing reefs with steep outer reef slopes (George and Kea, 2014). Baseline assessments of invertebrate populations recorded 14 species of commercial and subsistence interest, with a dominance of muricid gastropods (Ponia and Raumea, 1998). Invertebrate abundance was generally low compared to other islands where assessments have been conducted. There was a general lack of sea cucumbers and an unexpected absence of the usually abundant sea urchin *Echinometra mathaei* (Ponia and Raumea, 1998). Densities of important fisheries species such as paua (clams), ungakoa (giant worm snail) and ariri (rough turban shell) were low at the most recent survey (George and Kea, 2014). A site at Anaue, in or near the northern ra'ui, reported eleven species of commercially and artisanally important invertebrates, including some clams (Ponia and Raumea, 1998). There was a zonation across the reef flat with cone snails and sea cucumbers increasing towards the reef crest and gastropods such as *Drupa* spp. and *Morula* spp. most abundant on the mid reef flat (Ponia and Raumea, 1998). Further information on coral reef species is scarce, but there have been reports of increasing reef sharks and declining flying fish around the island (Rongo and Dyer, 2015).

Information on ra'ui in Ma'uke is more scattered. A small area of the reef at Anai'o was placed under ra'ui in 2009 and a number of species increased in frequency as a response, however, the ra'ui was lifted a year later (George and Kea, 2014). The Biodiversity Strategy and Action Plan refers to plans to preserve paua and ature (bigeye scad) from Taunganui Harbour to Hyde Park, and restricted net-fishing in Taunganui Harbour (McCormack, 2002). Reports to the Convention of Biological Diversity state that a portion of the Ma'uke lagoon area is protected under ra'ui but do not specify the location (Passfield and Rongo, 2011). Rasmussen (2016) and Butler (2017) list Patito Iniao as a marine reserve measuring 23 hectares; this overlaps with one of the west-facing SUMAs. Further general information on ra'ui in the Cook Islands is provided in Site MAN2: Manihiki - Porea Ra'ui.

Type and number of sources (score = 2)

Six reports on ra'ui on Ma'uke Island and one report on general reef condition were consulted for this SUMA. Refences used to describe ra'ui in Site MAN2: Manihiki - Porea Ra'ui are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Mauke and its internal waters as provided for under the Environment (Application to Mauke) Order 2012. This SUMA falls within internal waters.
- This SUMA is protected under customary laws, or ra'ui. The use of underwater breathing apparatus (SCUBA), poisons or stupefying substances to harvest marine resources is forbidden under ra'ui.
- Many reef species are listed on the IUCN Red List of Threatened Species.

4.2.28 Site MAK2: Ma'uke Western Beaches

Figure 60. Site MAK2: Ma'uke Western Beaches.

Table 60. Site MAK2: Ma'uke Western Beaches

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Ma'uke Western Beaches	MAK2	2	1	1.5	1	**5.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-20.161904	-157.36052	MAK 2 (A)
	-20.183268	-157.35039	MAK 2 (B)
	-20.174053	-157.35763	MAK 2 (C)

Geographic explicitness (score = 2)

Ma'uke has a land area of 18.4 km^2 and is surrounded by beaches on all sides. This SUMA includes the beach on the western side of the island.

Justification (score = 1)

This SUMA was chosen as nesting habitat for green turtles (SPREP, 2018), which belong to the Southern Cook Islands nesting stock (White, 2012b). Surveys conducted on Ma'uke in 2012 found ten beaches that were considered suitable for nesting (Bradshaw and Bradshaw, 2012), but no nests were recorded on the beaches in this SUMA. Across the whole island,

there were 17 individual signs of nesting activities on four different beaches (Bradshaw and Bradshaw, 2012).

Ma'uke is listed as a KBA, with green turtles and hawksbill turtles as trigger species (Evans, 2012). Information about turtles in general, and for the Cook Islands, is reviewed in Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua.

Type and number of sources (score = 1.5)

Four reports contained information about turtles on Ma'uke. References used to review turtles in the Cook Islands for Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Mauke and its internal waters as provided for under the Environment (Application to Mauke) Order 2012. This SUMA falls within internal waters.
- All marine turtle species are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS). The Cook Islands is also a Party or Signatory to several international agreements for marine turtle conservation, protection and management, including the Convention on Biological Diversity.
- Ra'ui is a traditional form of management in the Cook Islands that involves periodic harvesting closures of specific areas or resources and applies to turtles in some areas.

4.2.29 Site RAR1: Rarotonga Passages - Rutaki, Papua and Avaavaroa

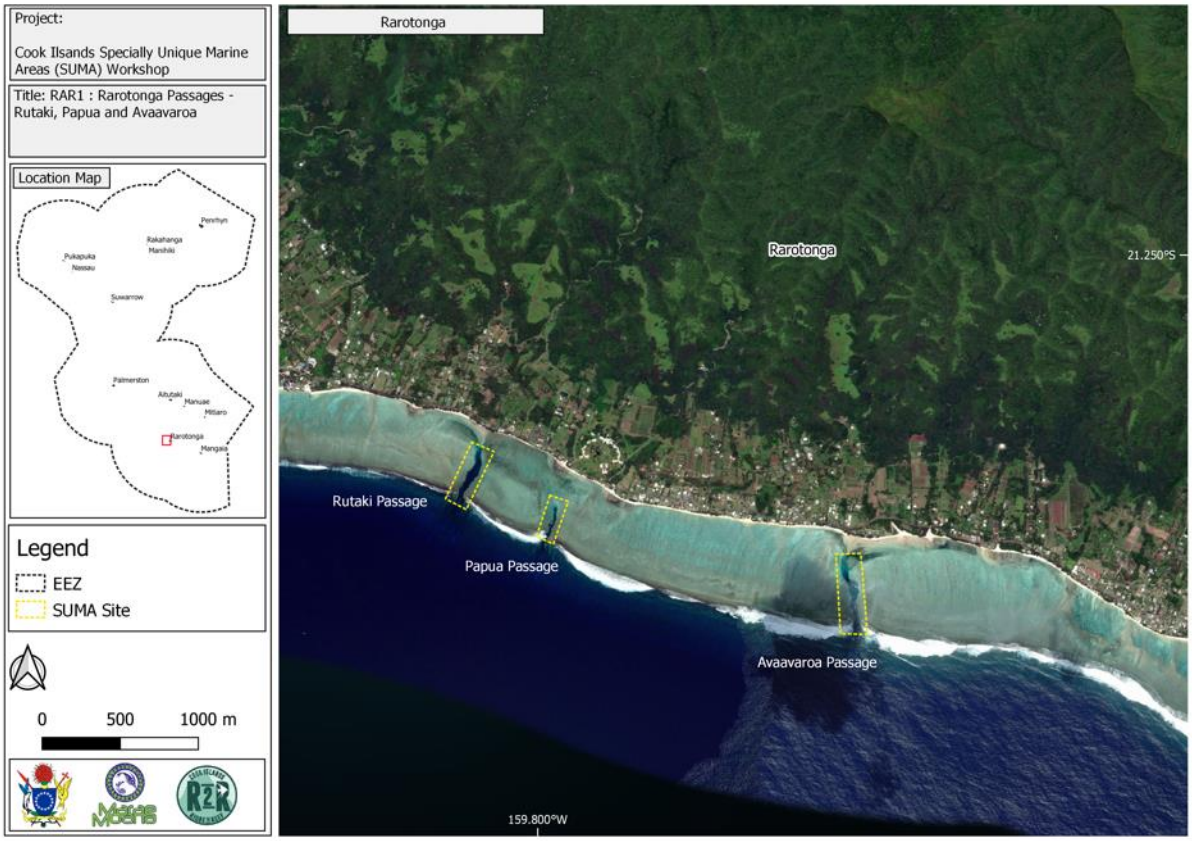


Figure 61. Site RAR1: Rarotonga Passages - Rutaki, Papua and Avaavaroa.

Table 61. Site RAR1: Rarotonga Passages - Rutaki, Papua and Avaavaroa

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Rarotonga Passages – Rutaki, Papua and Avaavaroa	RAR1	3	1	1	2	**7**

Geographic boundaries

Map	Latitude	Longitude	Points
	-21.260609	-159.80395	RAR1 (A)
	-21.266521	-159.79894	RAR1 (B)
	-21.267156	-159.77997	RAR1 (C)

Geographic explicitness (score = 3)

Rarotonga is the largest of the Cook Islands, a high island with a wide fringing reef and a small lagoon. The oval-shaped island measures 11 km from east to west and a maximum of 8 km from north to south. It is the main population centre and administrative centre of the Cook Islands. On the southern side of Rarotonga Island are three channels, or passages, that link the island to the open ocean. Their names (and depths), from west to east, are Rutaki (20-29 m), Papua (18 m) and Avaavaroa (12-24 m), and this SUMA covers all three passes.

Justification (score = 1)

The three reef passages provide habitat for hawksbill turtles (*Eretmochelys imbricata*) and ocellated eagle rays (*Aetobatus ocellatus*) (K. Morejohn and J. Cramp, pers. comm.). Green turtles have also been recorded using the passages (Butler, 2017a) and juvenile hawksbill turtles are known to forage on the reefs around Rarotonga (White, 2012b). Papua Passage in particular has had numerous records of both species of turtles since the 1990s (White, 2012b), using the passage for resting, cleaning and foraging (White, 2013). Information about turtles in general, and for the Cook Islands, is reviewed in Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua.

The passes experience strong currents and have walls of varying steepness that start just below the surface. Divers report sightings of whitetip reef sharks, grey reef sharks, turtles and eagle rays, as well as resident fishes and moray eels. Eagle rays may school in the passes, with groups of 40 or more (Adventure Cook Islands, 2019). The use of the passages by eagle rays indicates a clear link between oceanic and reef-associated habitats (Peel et al., 2019).

Descriptions of Papua Passage highlight a u-shaped gully with a sandy floor at its landward end, a steep-sided ravine and a series of narrows and wider areas (White, 2013). Reef surveys in the vicinity of the passes showed recovering hard and soft coral communities between 2006 and 2016, with relatively high coral species richness and a shift towards larger colonies in recent years (Rongo et al., 2017).

Type and number of sources (score = 1)

Four reports, one peer-reviewed paper and a SCUBA diving website provided information about turtles, rays and coral reef condition in this SUMA. One peer-reviewed paper provided background on the trophic ecology of rays. References used for Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua are also relevant here.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Rarotonga and its internal waters as provided for under Section 4(2). This SUMA is within internal waters.
- Marine Resources (Shark Conservation) Regulations 2012 and the National Plan of Action for the Conservation and Management of Sharks in the Cook Islands (NPoA – Sharks) (MMR 2012) are of particular relevance given the significance of sharks in this SUMA.
- All marine turtle species and ocellated eagle rays are listed on the IUCN Red List of Threatened Species, and turtles are listed under the Convention on Migratory Species (CMS). The Cook Islands is also a Party or Signatory to several international agreements for marine turtle conservation, protection and management, including the Convention on Biological Diversity.

4.2.30 Site RAR2: Rarotonga Reefs

Figure 62. Site RAR2: Rarotonga Reefs

Table 62. Site RAR2: Rarotonga Reefs

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Rarotonga Reefs	RAR2	3	3	3	2	**11**

Geographic boundaries

Map	Latitude	Longitude	Points
	-21.263783	-159.82196	RAR2 (A)
	-21.191793	-159.7996	RAR2 (B)
	-21.241211	-159.71978	RAR2 (C)
	-21.281706	-159.75671	RAR (D)

Geographic explicitness (score = 3)

Rarotonga is a high island in the southern Cook Islands with a narrow fringing reef and a small and shallow lagoon, with the outer reef sloping evenly. This SUMA includes the entire fringing reef around the Rarotonga coastline.

Justification (score = 3)

The Rarotonga reef flats were chosen as a SUMA because of their high coral diversity and populations of tridacnid clams (paua), although currently populations are low (NES, pers. comm.). This SUMA also coincides with the Rarotonga marine KBA (Evans, 2012). Rarotonga has had the benefit of multiple coral reef surveys since the early 1990s, although much of the recent survey effort has taken place on the reef slopes. There are also multiple ra'ui, which collectively cover about 10 % of the lagoon and reef system (Figure 63) (Raumea et al., 2013). In the early 2000s, the slopes were dominated by turf algae, and soft coral cover was greater than hard coral cover; hard corals showed a declining trend (Lyon, 2003). Since the crown-of-thorns outbreak in 1995-2001 coral communities have recovered; mean coral cover was ~1% in 2006, ~5% in 2009, 8% in 2011, 16% in 2014, and 26% in 2016 (Rongo et al., 2017). There was also a significant increase in larger colonies in 2016 when compared with 2006 (Rongo et al., 2017). Separate surveys that visited different sites recorded 22% coral cover in 2007 (Pinca et al., 2009) and 34% coral cover in 2013 (Purkis et al., 2018), indicating that coral communities around the Rarotonga reefs are likely to be highly variable at small spatial scales. Coral diversity recorded during the most recent documented survey was highest at the northern sites, with 27 species at each of the sites and a diversity index (H') of between 2.6 and 2.8 (Rongo et al., 2017). Unfortunately, Rarotonga reefs are currently experiencing another crown-of-thorns outbreak (NES, pers. comm.).

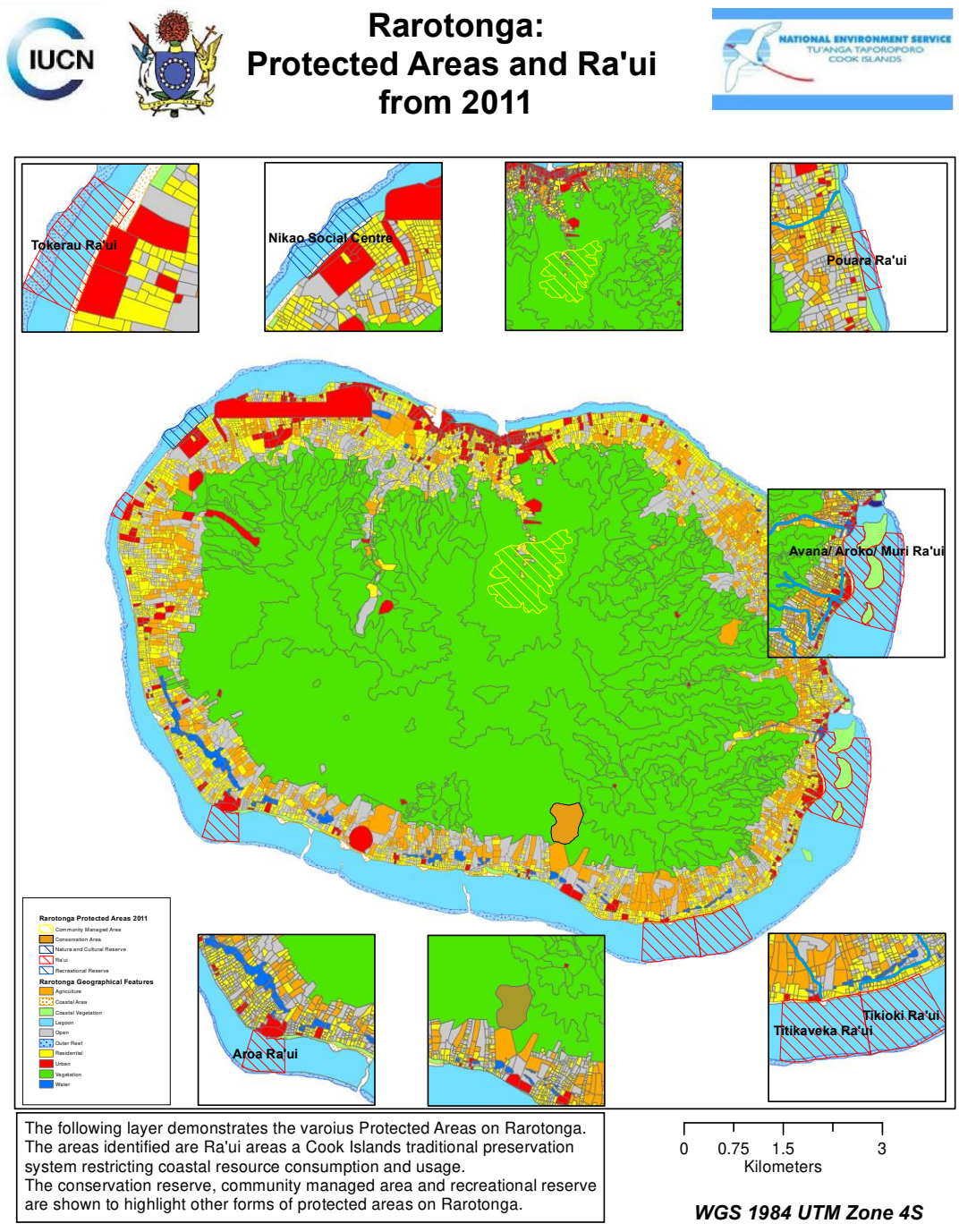


Figure 63. Rarotonga ra'ui as of 2011. See also Rasmussen (2016)

Coral reef fish assemblages changed from a dominance of acanthurids and scarids in 2006 (Pinca et al., 2009), probably not fished and therefore abundant in the past due to the risks of ciguatera poisoning if consumed, to a more varied taxonomic assemblage in 2016 (Rongo et al., 2017). An island-wide estimate of 182 species of fish and an average of 133.8 individuals per 100 m^2 was recorded in 2013 (Purkis et al., 2018). Differences between reef flat and reef slope communities were reported by Pinca et al. (2009); reef flats had higher biomass (210 g per m²), size (20 cm FL - fork length, from the front of the head to the fork in the tail) and

size ratios (64%), while reef slopes had higher species richness (31 species per transect). An increase in coral-dependent chaetodontids (butterflyfishes) and pomacentrids (damselfishes) has occurred in parallel with the coral recovery noted above (Rongo et al., 2017). A number of reef fish species that are thought to have a very restricted range, and may even be endemic to the Cook Islands, have been recorded on Rarotonga's reefs (Evans, 2012). On deeper reefs, exploratory mesophotic research has discovered 12 new species on the Rarotonga slope, and further exploration is likely to reveal further new records (Pyle, 2000).

It is thought that coral reef disturbances that cause coral mortality such as storms, bleaching events and crown-of thorns outbreaks lead to increased cover of algae, which can, in turn, drive an increase in the density of herbivorous fishes such as striated surgeonfish *Ctenochaetus striatus* that transfer ciguatoxins into the food web (Rongo and van Woesik, 2013a). This may be further exacerbated by sewage and terrigenous run-off (Hoffmann, 2002b). Damage has been caused by crown-of-thorns outbreaks, cyclones and bleaching events, some of which take place on the reef flat during extreme low tides (Rongo et al., 2017; Rongo and van Woesik, 2013b). In 2013, sites in good condition (higher coral cover, higher abundance of key invertebrates) were concentrated on the northern part of the island (Purkis et al., 2018). In 2016, coral cover had increased across most sites, with northern areas still showing relatively high coral cover and species diversity; unfortunately, 80% of corals were lost during the 2017 bleaching event (Rongo et al., 2017). Species response models using genomics predict that corals on Raratonga's reefs, adapted to relatively cool waters, have the ability to adapt to warmer oceans, but only under mild carbon emission scenarios (Bay et al., 2017).

Giant clams (only *Tridacna maxima*, primarily small individuals and low densities) and trochus have been recorded in past surveys (Pinca et al., 2009). Recent estimates suggest that populations of clams have remained mostly stable (Rongo et al., 2017). Common macroinvertebrates in Rarotonga are the sea urchin *Echinometra* spp., trochus and the giant worm snail *Ceraesignum maximum* (Raumea et al., 2000; Rongo et al., 2017). Sea cucumber assemblages were dominated by lollyfish (*Holothuria atra)* and surf redfish (*Actinopyga mauritiana)* (Raumea et al., 2013). General information about coral reefs and giant clams was reviewed in Site TON1: Tongareva - Flying Venus Reef and Site MAN1: Manihiki Lagoon and is also relevant here.

Monitoring of the effectiveness of ra'ui is rarely conducted, but reports exist for the Rarotonga ra'ui, where between 1998 and 2002 densities of commercially important invertebrates increased inside the ra'ui, and species richness either increased or remained stable (Raumea et al., 2000; Saywood et al., 2002). Noteworthy changes documented in 2002 at individual ra'ui sites were up to a five-fold increase in the density of lollyfish or rori toto (*Holothuria atra*), a 4.5-fold increase in snakefish or matu rori (*H. leucospilota*), a 25-42% increase in kina (the sea urchin *Echinometra* spp.), a 78% increase in greenfish or rori matie (*Stichopus chloronotus*), a twelve-fold decrease in vana (the sea urchin *Echinothrix diadema*) and a fivefold increase in trochus (Saywood et al., 2002). In one of the ra'ui there was a dramatic increase in the herbivorous drummer *Kyphosus cinerascens* (Raumea et al., 2000). Several ra'ui around Rarotonga resulted in an increase in the density of clams (Raumea et al., 2000). However, these early benefits appear to have been eroded in the following years, as more recent assessments indicate a decline in food species (Butler, 2017a).

Type and number of sources (score = 3)

Ten reports and one peer-reviewed paper provided descriptions of the coral reefs and clam populations in Rarotonga. Additionally, references on coral reefs and giant clams reviewed in Site TON1: Tongareva - Flying Venus Reef and Site MAN1: Manihiki Lagoon are also relevant here.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Rarotonga and its internal waters as provided for under Section 4(2). This SUMA is within internal waters.
- This SUJMA encompasses seven of Rarotonga's ra'ui; these aim to manage and protect coral reef habitats and species.
- Many of the species that live on coral reefs, including clams, are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

4.2.31 Site RAR3: Rarotonga - Muri Lagoon at Avana Harbour

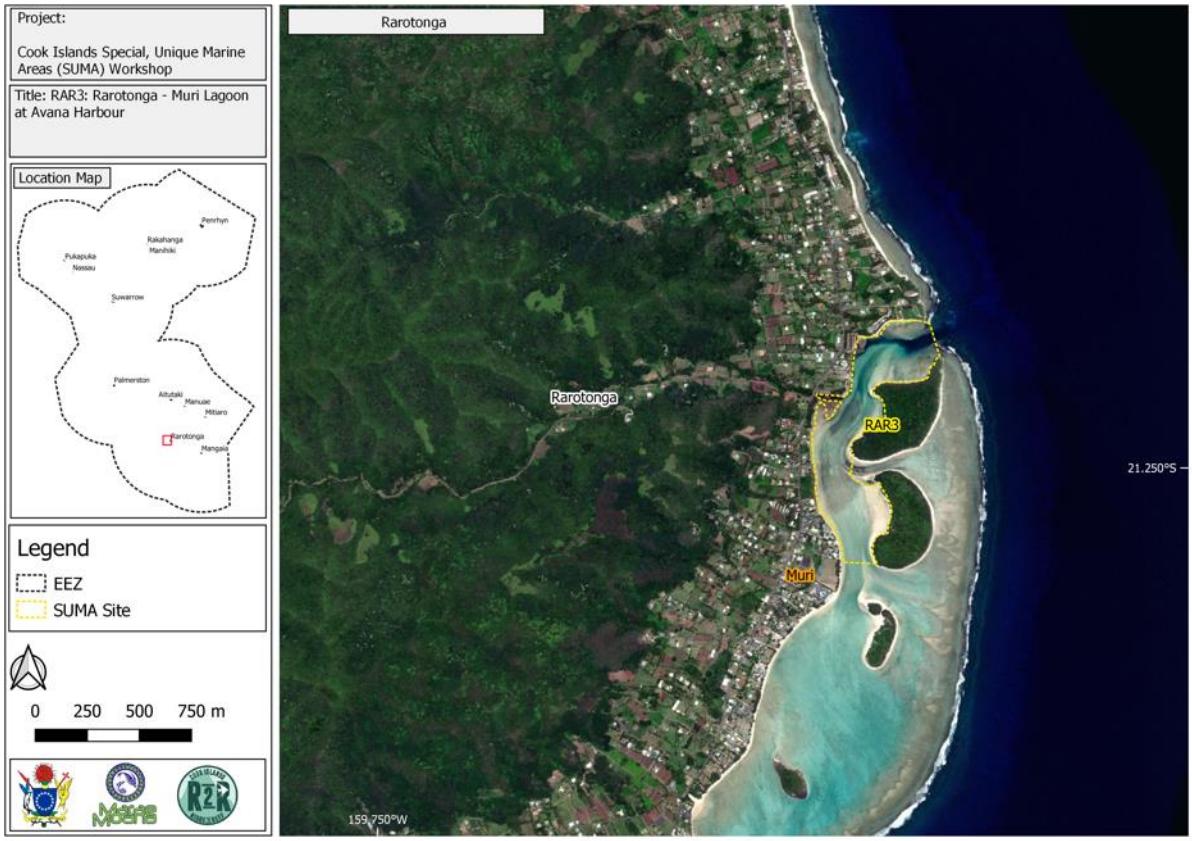


Figure 64. Site RAR3: Rarotonga - Muri Lagoon at Avana Harbour

Table 63. Site RAR3: Rarotonga - Muri Lagoon at Avana Harbour

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Rarotonga – Muri Lagoon at Avana Harbour	RAR3	2	1	1	0.5	**4.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-21.243649	-159.72437	RAR3 (A)
	-21.253812	-159.72841	RAR4 (B)
	-21.246713	-159.72957	RAR4 (C)

Geographic explicitness (score = 2)

Muri Lagoon on the southeastern side of Rarotonga Island is 1.75 km^2 in area and the largest part of the lagoon on the island. This SUMA incorporates the inshore portion of the lagoon, around Avana Harbour.

Justification (score = 1)

The shallow and muddy habitats in the lagoon are home to a large population of fiddler crabs; this is unique in the Cook Islands (traditional and expert knowledge, SUMA workshop). The common fiddler crab on Rarotonga and Aitutaki is the narrow-front *Uca tetragonon* which

excavate burrows in the sediment, sometimes with chimneys (MMR, 2000a). Crabs of the genus *Uca* are widely distributed in sheltered coastal environments such as bays, coastal lagoons, mangroves and river mouths (Costa and Soares-Gomes, 2009). They can occur in dense populations and play an important role as sediment bioturbators through their digging activity, and by the consumption of organic matter (Genoni, 1991). Their digging activity brings organic matter to the sediment surface, stimulating nutrient cycling by enhancing microbial growth (Genoni, 1991). They also contribute to intertidal food webs as prey for several species of fishes, birds, mammals and other crabs (Hemmi, 2005).

Water quality in the lagoon is influenced by a number of factors including runoff, groundwater and open ocean water (Tait et al., 2014). Coral cores show a sharp increase in nitrogen enrichment caused by agriculture since the 1980s (Erler et al., 2018). Since some of this nutrient enrichment enters the lagoon through groundwater, there may be a time lag between any efforts to address agricultural practices and changes in water quality (Erler et al., 2018; Tait et al., 2014). Agricultural runoff is further compounded by wastewater systems in the vicinity of the lagoon; together, these inputs have resulted in increased terrestrial sediment and seaweed growth (Mei Te Vai Ki Te Vai, 2020).

The Aroko ra'ui, which covers the general area around this SUMA, has resulted in a general increase in invertebrate richness . The species that benefited most from the closures in the early 2000 were avake, vana (both sea urchins), etu (sea stars), karikao (turban snails), paua (clams) and ungakoa (worm snail) (Raumea et al., 2000). The effects of the ra'ui may also have been beneficial for other species such as fiddler crabs.

Type and number of sources (score = 1)

There were no documents specifically reporting on fiddler crabs in Muri Lagoon. Two peer-reviewed papers and one website were used to describe water quality in the lagoon, and one report and three peer-reviewed papers described fiddler crabs in general and confirmed their presence in Rarotonga. One report listed the Muri Lagoon area as a ra'ui, and an additional report described changes to species in the area due to the ra'ui.

Obligations (score = 0.5)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Rarotonga and its internal waters as provided for under Section 4(2). This SUMA is within internal waters.
- No documented evidence was found of obligations pertaining to fiddler crabs. However, this area is under ra'ui (Passfield and Rongo, 2011), which may include fiddler crabs.

4.2.32 Site RAR4: Rarotonga Surrounding Waters

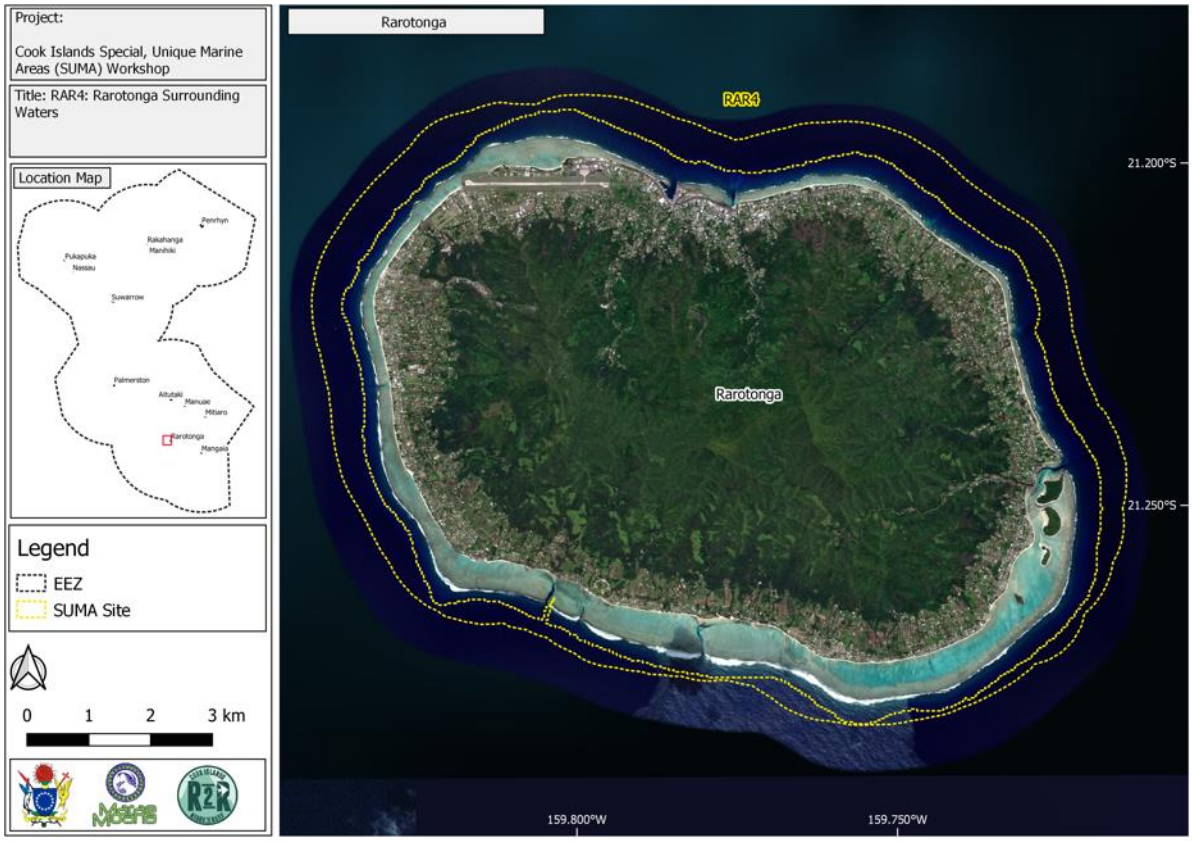


Figure 65. Site RAR4: Rarotonga Surrounding Waters

Table 64. Site RAR4: Rarotonga Surrounding Waters

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Rarotonga Surrounding Waters	RAR4	1.5	3	3	2	**9.5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-21.218593	-159.84087	RAR4 (A)
	-21.19466	-159.75109	RAR4 (B)
	-21.259987	-159.71659	RAR4 (C)
	-21.273036	-159.79593	RAR4 (D)

Geographic explicitness (score = 1.5)

This SUMA is the deeper waters immediately surrounding the Rarotonga reef edge, up to 1 km out to sea.

Justification (score = 3)

The ocean beyond the Rarotonga reef drop-off is important habitat for humpback whales, resident spinner dolphins, sharks and rays (N. Hauser and J. Cramp, pers. comm.). Research

on marine mammals in the Cook Islands is conducted by the Center for Cetacean Research and Conservation (CCRC), founded in 1994 by Dr. Nan Hauser. The affiliated venture, Cook Islands Whale Research Project, investigates all species of whales and primarily focuses on the Oceania populations of humpback whales (Hauser, 2020). Research topics and methods include population identity, photo ID, acoustics, genetics, stable isotopes, blue carbon, satellite tagging, migration and navigation, infrared, and surface and underwater behaviour. Other species are tagged opportunistically[21].

In the waters of this SUMA, eight humpback whales were satellite-tagged in 2006 and 2007, allowing their movements, including to Antarctic feeding grounds, to be recorded (Hauser et al., 2010). Using sound analysis software, four new humpback whale songs were discovered that had emerged in a population in eastern Australia, and gradually spread east. Within two years of the new song's creation, it had been passed through the Cook Islands and was being sung by whales in French Polynesia (Hauser et al., 2010).

Rarotonga is located within the Cook Islands Southern Group Important Marine Mammal Area (IMMA) and these waters have provided most of the knowledge about marine mammals in the Cook Islands (Marine Mammal Protected Area Task Force, 2020). Humpback whale calves are born between early June and late October, close to the shores of all the islands in the IMMA, including Rarotonga (Hauser and Clapham, 2005). Calves have also been observed mingling with the resident pods of spinner dolphins that occur around the southern islands of Rarotonga, Mangaia and Palmerston[22]. Although humpback whales constitute the highest number of records, there have been high counts of other marine megafauna, especially dolphins and sharks, recorded by Nan Hauser and colleagues (Figure 66).

Shark tagging has also been conducted by J. Cramp (Sharks Pacific) throughout 2018-2020, with research data expected to be published in 2021, providing further information about shark movement in this SUMA (NES, pers. comm.).

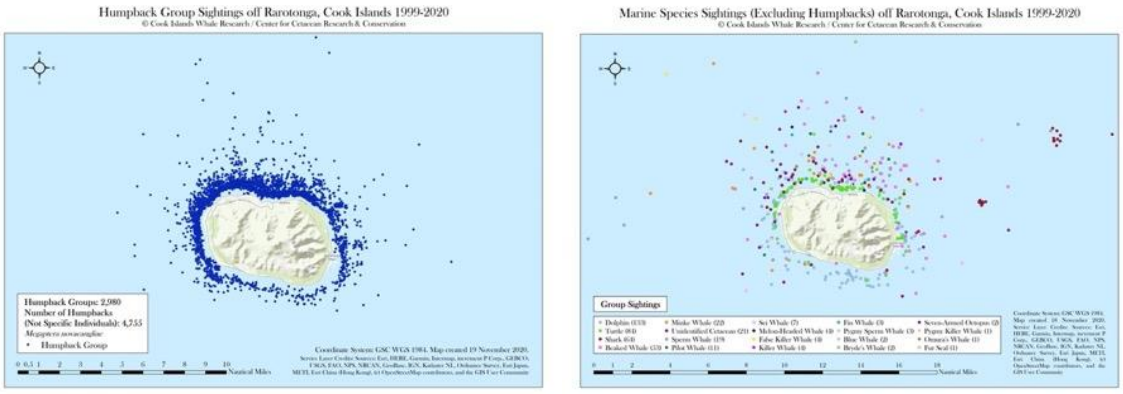


Figure 66. Combined sightings over 20 years of surveys by Nan Hauser and colleagues; humpback whales (left panel) and other marine fauna (right panel). Reproduced with permission from Nan Hauser.

[21] http://whaleresearch.org/

[22] Cook Islands Whale Research Annual Reports, 1998 to 2016, cited in https://www.marinemammalhabitat.org/portfolio-item/cook-islands-southern-group/

Type and number of sources (score = 3)

Most of the research on whales and dolphins in the Cook Islands takes place in this SUMA, resulting in a large body of work summarised on http://whaleresearch.org/. Key references used in this SUMA overlap with those reviewed in Site O5: Marine Mammal Migratory Pathways.

Obligations (score = 2)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- This SUMA falls within the territorial seas which remain under the general auspices of the Environment Act 2003.

- Marine Resources (Shark Conservation) Regulations 2012 and the National Plan of Action for the Conservation and Management of Sharks in the Cook Islands (NPoA – Sharks) (MMR 2012) are of particular relevance given the significance of sharks in this SUMA.
- All the marine mammals and sharks known from the SUMA are listed on the IUCN Red List of Threatened Species, and some are listed under the Convention on Migratory Species (CMS).

4.2.33 Site RAR5: Rarotonga Sand River

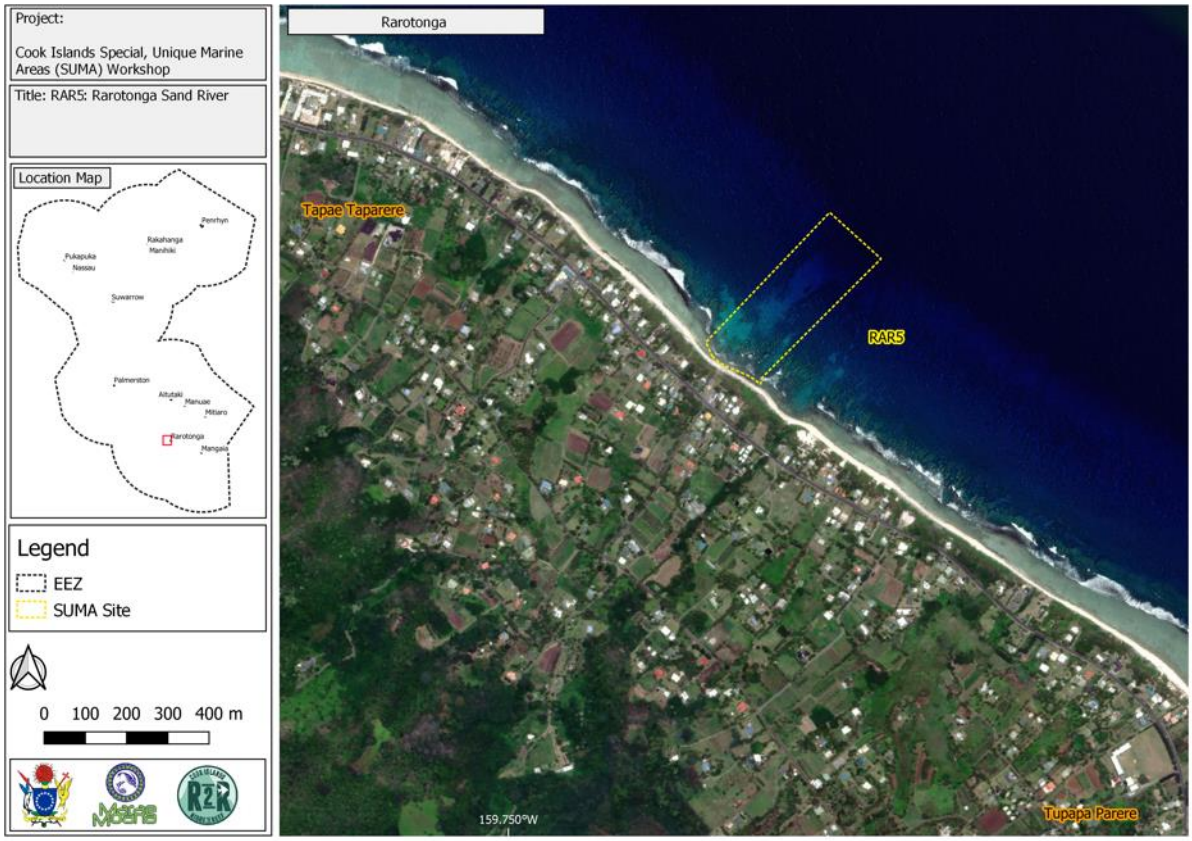


Figure 67. Site RAR5: Rarotonga Sand River.

Table 65. Site RAR5: Rarotonga Sand River

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Rarotonga Sand River	RAR5	3	1	1	1	**6**

Geographic boundaries

Map	Latitude	Longitude	Points
	-21.208971	-159.74533	RAR5 (A)
	-21.207166	-159.74123	RAR5 (B)

Geographic explicitness (score = 3)

This site on the northeastern coast of Rarotonga includes a "river" of sand (named the Tupapa Sandriver) that runs from the coast onto the reef and continues down the reef slope. It is surrounded by coral reef.

Justification (score = 1)

This SUMA was identified for its importance as a geomorphological feature. SCUBA diving sites describe it as "a sand channel with reef on both sides that starts in the surf zone and extends into the abyss" (https://www.adventurecookislands.com). There are coral reef features on both sides of the sand channel. Rongo et al. (2017), surveying a site close to the sand river (Kiikii),

reported an increase in coral cover and a decline in turf cover in recent years, with coral cover around 23% in 2016, up from ~10% in 2002 (Lyon, 2003). A separate survey at a site further west in 2013 reported a dominance of *Porites* and relatively low species richness (Purkis et al., 2018). In 2016 coral diversity was relatively high and coral assemblages had a high proportion of large colonies. However, relatively high cover of macroalgae was highlighted as a cause for concern (Rongo et al., 2017).

Type and number of sources (score = 1)

A number of recreational diving websites (one was used as a reference, since all held similar information) described the sand river. Three coral reef survey reports described research done at or near the site.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Rarotonga and its internal waters as provided for under Section 4(2). This SUMA is within internal waters.
- Many coral reef organisms are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

4.2.34 Site RAR6: Rarotonga Northern Beach

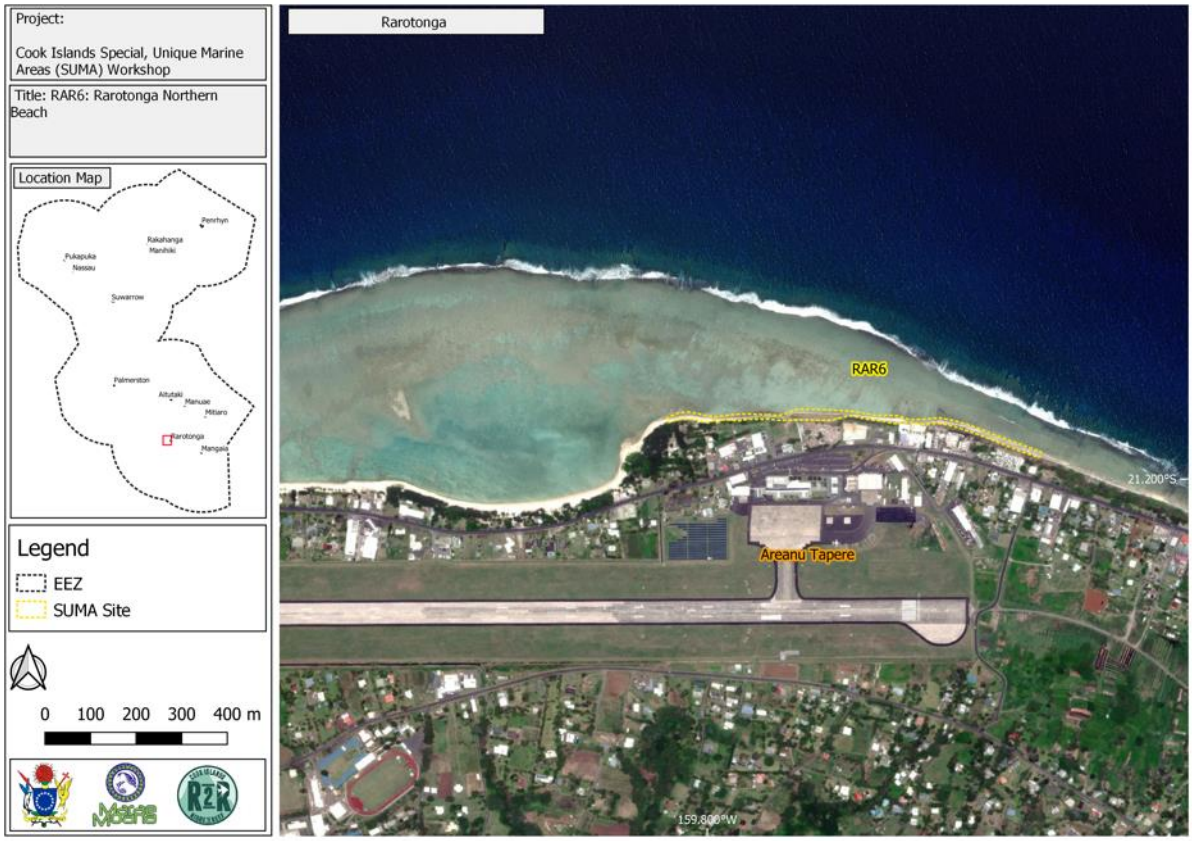


Figure 68. Site RAR6: Rarotonga Northern Beach

Table 66. Site RAR6: Rarotonga Northern Beach

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Rarotonga Northern Beach	RAR6	1	1	1	1	**4**

Geographic boundaries

Map	Latitude	Longitude	Points
	-21.198746	-159.80081	RAR6 (A)
	-21.198648	-159.79674	RAR6 (B)
	-21.199446	-159.7929	RAR6 (C)

Geographic explicitness (score = 1)

This SUMA is a small area of beach on the northern coast of Rarotonga, in line with the eastern end of the runway.

Justification (score = 1)

This site incorporates a turtle nesting beach (traditional and expert knowledge, SUMA workshop). Green turtles are thought to historically nest on Rarotonga and a 2015 survey found 15 out of 30 km of beach habitat suitable for nesting (Ischer et al., 2015). This beach was deemed suitable for nesting, although evidence of nesting has not been observed (White,

2013). The proximity to streetlights and the airport runway inhibit successful nesting (Dr. M. White, pers. obs. 2020). Information about turtles in general, and for the Cook Islands, is reviewed in Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua.

Type and number of sources (score = 1)

One report and one peer-reviewed paper provided some information about the possibility of turtles nesting on Rarotonga. Additionally, references reviewed for turtles in Site TON4: Tongareva Beaches - Omoka, Mangarongaro, Tetautua are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- The Environment Act 2003 applies to the island of Rarotonga and its internal waters as provided for under Section 4(2). This SUMA is within internal waters.
- All marine turtle species are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS). The Cook Islands is also a Party or Signatory to several international agreements for marine turtle conservation, protection and management, including the Convention on Biological Diversity.
- Ra'ui is a traditional form of management in the Cook Islands that involves periodic harvesting closures of specific areas or resources and applies to turtles in some areas.

4.2.35 Site MAG1: Mangaia Western Reefs

Figure 69. Site MAG1: Mangaia Western Reefs

Table 67. Site MAG1: Mangaia Western Reefs

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Mangaia Western Reefs	MAG1	2	1	1	1	**5**

Geographic boundaries

Map	Latitude	Longitude	Points
	-21.896887	-157.94153	MAG1 (A)
	-21.90809	-157.95597	MAG1 (B)
	-21.92852	-157.9599	MAG1 (C)

Geographic explicitness (score = 2)

Mangaia is an upraised coral island (52 km^2) in the southern Cook Islands with a narrow fringing reef, several narrow channels and a steep outer slope. This SUMA is the portion of the reef facing northwest, approximately 3.5 km long and extending 1 km out to sea.

Justification (score = 1)

The northwest-facing coastline of Mangaia island was noted for its coral reefs (traditional and expert knowledge, SUMA workshop). Research along the northern edge discovered that nutrient supply to ancient reefs was provided by a combination of upwelling and from island-

induced nitrogen (N_2) fixation. In contrast modern reefs receive nitrogen primarily through the groundwater discharge from the island (Erler et al., 2019). More generally, the coral reefs around Mangaia have low coral cover (~8%), especially on the western side, with a dominance of abiotic limestone pavement (Pinca et al., 2009). They support at least six sea cucumber species, with some species (e.g. greenfish *Stichopus chloronotus*) absent, but a presence of the commercially valuable surf redfish *Actinopyga mauritiana*, prickly redfish *Thelenota ananas* (Pinca et al., 2009) and black teatfish *Holothuria whitmaei* (Raumea et al., 2013). Other invertebrates include low densities of giant clams *Tridacna maxima* and *T. squamosa*, and few trochus (Pinca et al., 2009).

Reef fish surveys have found the community dominated by grazing surgeonfish, most probably due to the low diversity of habitats found around the island (Pinca et al., 2009). Archaeological studies show a decline in fish size and a shift in resource use to lower trophic levels (Butler, 2001), indicating a long-term overexploitation of higher trophic levels known as "fishing down the food web" (Pauly and Palomares, 2005).

A number of species are listed as triggers for the Mangaia Island KBA: the coral *Acropora palmerae*, the groupers *Epinephelus lanceolatus* and *Plectropomus laevis*, the sharks *Isurus oxyrinchus* and *Rhincodon typus*, and the blue whale *Balaenoptera musculus*; the latter is likely to occur further offshore (Evans 2012).

For more information about the value of coral reefs globally, and their characteristics in the Cook Islands, see Site TON1: Tongareva - Flying Venus Reef.

Type and number of sources (score = 1)

Mangaia's coral reefs are described in three reports and one peer-reviewed paper, ra'ui are mentioned in one report and a list of potential species of conservation interest are listed on one additional report. An additional peer-reviewed paper supported the indications of long-term exploitation of coral reef fishes. References used to characterise coral reefs in the Cook Islands in Site TON1: Tongareva - Flying Venus Reef are also relevant here.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- This SUMA transcends internal waters (under management of Island Government) and extends into the territorial seas which fall within the jurisdiction of the Environment Act (even though the island of Mangaia has not opted into the Environment Act).
- There is a ban on international export of clams.
- Many of the species that live on coral reefs are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).
- There are a number of ra'ui around Mangaia's coral reefs (Butler, 2017a).

4.2.36 Site MAG2: Mangaia - Saragossa Shipwreck

Figure 70. Site MAG2: Mangaia - Saragossa Shipwreck

Table 68. Site MAG2: Mangaia - Saragossa Shipwreck

Geographic Cluster	Site Name	Site Code	Score by criteria				
			Geographic	Justification	Source	Obligations	Total
Inshore sites – southern group	Mangaia – Saragossa Shipwreck	MAG2	3	1	1	1	**3**

Geographic boundaries

Map	Latitude	Longitude	Points
	-21.956021	-157.88988	MAG 2 (A)
	-21.958423	-157.8865	MAG 2 (B)

Geographic explicitness (score = 3)

This SUMA is the site of the Saragossa shipwreck, off Tamarua Village on the southern coast of Mangaia.

Justification (score = 1)

The Saragossa shipwreck provides habitat for a high abundance of fishes (traditional and expert knowledge, SUMA workshop), on a reef with otherwise mediocre habitat complexity (Pinca et al., 2009). Across Mangaia's coral reefs, the density (0.8 fish per m^2), diversity and biomass of finfish was relatively low, but average size was high (17 cm FL); fish density was higher on the southeastern side of the island, which may include this SUMA. Herbivores

(mostly surgeonfishes) dominated the assemblage and the lack of carnivores was thought to be driven by the mostly flat substrate (Pinca et al., 2009). Where the habitat is generally flat, structures that enhance complexity can attract a large variety of demersal and pelagic fishes, a premise that has led to the deliberate use of shipwrecks as artificial reefs in other parts of the world (Becker et al., 2017; Sreekanth et al., 2019). It can therefore be inferred that this SUMA, by virtue of its enhanced structural complexity, is likely to be a fish hotspot on Mangaia's reefs.

Type and number of sources (score = 1)

One report provided some information about reef fishes surveyed on Mangaia's reefs but did not include descriptions of the fish assemblage around the wreck. Two peer-reviewed papers provided some background on the effect of shipwrecks on fish assemblages.

Obligations (score = 1)

Instruments that specify management obligations for this SUMA are detailed in Appendix 6 and include:

- Marae Moana Act 2017
- Section 24 of the Marae Moana Act established a marine protected area of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands; this SUMA falls within a Section 24 MPA.
- Marine Resources Act 2005.

Other management obligations for this SUMA include:

- Many of the species that live on coral reefs are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).

5 Discussion

Workshop participants with follow-up consultations and research identified 63 special, unique marine areas (SUMAs), of which seven were offshore and 56 were inshore sites (Table 69). Sites identified by the expert workshop as SUMAs were given scores between 4 and 12. This scoring system was conducted systematically, albeit subjectively, and is designed to be used as a guide for future planning. While all sites are considered to be Special, Unique Marine Areas, sites chosen for more than one biophysical attribute or value generally received higher scores, as a significant proportion of the final score for each site reflects the amount and type of knowledge available for the attributes identified at that site, as well as the attributes themselves. Lower-scoring sites may benefit from further research before definitive decisions are made about their protection or management. Because the highest scoring sites have a more robust information base, these areas can be prioritised for management or conservation with greater confidence. Furthermore, the scoring system is based upon information available at the time of writing and, as more information is gathered, the score of any site may change.

Offshore SUMAs of the Cook Islands were predominantly defined by the complex geomorphology of the seabed and the high abundance of seamounts. The special features of the Cook Islands' offshore marine habitats are already recognised globally through the designation of five EBSAs and an IMMA; these special features were also reflected in the SUMAs chosen by workshop participants.

The scores received by offshore SUMAs were relatively low - from 4.5 to 9 - compared with similar reports for offshore SUMAs in other countries (e.g. Tonga, where the lowest offshore score was 6, or the Solomon Islands, where an offshore SUMA scored 11.5). This reflects the lack of documented research conducted in the Cook Islands' offshore waters, and especially on its seamounts, for which many of the SUMAs were chosen. The Manihiki Plateau, Northeastern Seamounts and Marine Mammal Migratory Pathways SUMAs scored highest and did so because there was research to support the presence and abundance of pelagic species and whales, respectively. The scores assigned for offshore SUMAs are not comparable with those for inshore SUMAs as there is generally less information about offshore environments.

Many more inshore SUMAs were selected than offshore SUMAs, reflecting the greater familiarity with inshore environments around the islands than with offshore marine habitats. More than one SUMA was identified for every island except Suwarrow, where the entire National Park (which encompasses the island and surrounding marine area) was designated as a SUMA, given the unique nature of this large no-take area in the Cook Islands. Inshore SUMAs received scores between 4 and 12, with almost half receiving scores between 4 and 6. Reasons for lower scores included the selection of SUMAs for one attribute (e.g. fiddler crabs in Site RAR3) and a lack of information about the attribute in the SUMA (e.g. Site AIT8 Aitutaki – Taverua Tua). These lower scores can help guide the prioritisation of sites for further surveys and research.

Sites with fish aggregating devices (FADs), chosen for their contribution to fisheries rather than their biophysical attributes, were removed from the report after further consultation.

There were six inshore SUMAs with high scores (between 10 and 12). These were tracts of reef chosen for several attributes (e.g. Site AIT5 - Southern Aitutaki Reef, Site RAR2 - Rarotonga Reef Flats), geographically well-defined sites (e.g. Site TON2: Tongareva - Taruia Reef Pass, Site MAN1: Manihiki Lagoon), and areas already protected because their special, unique status has already been confirmed (e.g. Site MAN2: Manihiki – Porea Ra'ui, Site SUW1: Suwarrow). Additionally, these sites have been subject to direct research documenting the attributes for which they were chosen. The Cook Islands inshore environment is especially research-rich, which is not always the case in Pacific Island countries, and local and traditional knowledge and stewardship of marine ecosystems is high. These higher scores mean that decisions about conservation measures or zones used to protect or improve management of these areas can be made with greater confidence.

Some of the sites were given a special and/or unique status because of their remoteness (e.g. Site TON1: Tongareva – Flying Venus Reef). This was partly because geographic isolation often leads to unique assemblages, genetic distinctness and the presence of endemics, and/or because the remoteness itself has left their ecosystems relatively intact. It is the reefs further offshore that are considered particularly special because the lack of exploitation and pollution makes them more diverse and resilient, with more abundant flora and fauna and intact food webs. Marine spatial planning can take this into account in two ways: firstly directly, through inclusion in highly protected MSP zones, and secondly through recognition of connectivity, where intact coral reefs act as sources of larvae to replenish degraded reefs; hydrodynamic modelling could help establish such linkages to further guide planning and management. In the Cook Islands, there is already some information available about the connectivity of the southern group of islands.

Future scoring systems could consider levels of human use or impact, as this affects the intrinsic ecological value of a habitat, assemblage, population or ecosystem. This intrinsic ecological value is embedded within the ability of the system to function in a balanced and sustainable manner, and includes elements of assemblage structure and diversity, nutrient cycling, trophic linkages and the abundance of keystone species. Sometimes a single species (e.g. the presence of an apex predator) can indicate that these processes are likely to be intact. However, in the absence of existing information, only further research can confirm the special and/or unique nature of a site.

The identification and scoring of SUMAs is one of the key steps in marine spatial planning. Identification of SUMAs also provides important information for other management purposes such as permitting, licencing and Environmental Impact Assessments. Sites with higher scores can be seen as priority sites at a national level, while those with lower scores should be flagged for further research.

Table 69. Summary of special and/or unique marine areas.

SUMAs are presented in order of highest to lowest overall scores. Offshore and inshore sites are rated and ranked separately.

Inshore/ Offshore	North/ South	Island	Code	Name	Geographic explicitness	Justification	Sources	Obligations	Total score
Offshore	North	na	O1	Northeastern Seamounts	3	2	2	2	9
Offshore	North	na	O2	Manihiki Plateau	2	2.5	2.5	2	9
Offshore	Both	na	O7	High-Density Nodule Fields	2	2.5	2	1	7.5
Offshore	South	na	O5	Marine Mammal Migratory Pathways	1	1.5	3	1	6.5
Offshore	South	na	O3	Palmerston - Kona Reef	1.5	1	1.5	2	6
Offshore	South	na	O4	Ngaputoru Ridges and Seamounts	2	1	1	1	5
Offshore	South	na	O6	Southern Cook Islands Seamounts	1	1.5	1	1	4.5
Inshore	North	Manihiki	MAN1	Manihiki Lagoon	3	3	3	3	12
Inshore	North	Suwarrow	SUW1	Suwarrow	3	3	2.5	3	11.5
Inshore	South	Aitutaki	AIT5	Southern Aitutaki Reef	2.5	2.5	3	3	11
Inshore	South	Rarotonga	RAR2	Rarotonga Reef Flats	3	3	3	2	11
Inshore	North	Tongareva	TON2	Tongareva - Taruia Reef Pass	2	2.5	3	3	10.5
Inshore	North	Manihiki	MAN2	Manihiki - Porea Ra'ui	3	2	3	2	10
Inshore	North	Tongareva	TON4	Tongareva Beaches - Omoka, Mangarongaro, Tetautua	2	2.5	3	2	9.5
Inshore	South	Rarotonga	RAR4	Rarotonga Surrounding Waters	1.5	3	3	2	9.5
Inshore	North	Pukapuka	PUK5	Pukapuka Ra'ui	3	2	3	1	9
Inshore	South	Manuae	MAE3	Manuae Lagoon Reef and Drop Off	3	2	2	2	9
Inshore	South	Aitutaki	AIT1	Aitutaki - Ootu Lagoon Area	2	2.5	2	2	8.5
Inshore	South	Takutea	TAK2	Takutea Beaches	2	2.5	2	2	8.5
Inshore	South	Takutea	TAK3	Takutea Seabirds	3	2	1.5	2	8.5
Inshore	North	Rakahanga	RAK1	Rakahanga Lagoon	2	2	2	2	8

Inshore/ Offshore	North/ South	Island	Code	Name	Geographic explicitness	Justification	Sources	Obligations	Total score
Inshore	South	Aitutaki	AIT4	Aitutaki - Tarava	2	2	2	2	8
Inshore	South	Atiu	ATI3	Atiu Deeper Waters	2	2	2	2	8
Inshore	South	Takutea	TAK1	Takutea Reefs	2	2	2	2	8
Inshore	North	Rakahanga	RAK2	Rakahanga Forereef Ra'ui	1.5	2	2	2	7.5
Inshore	South	Aitutaki	AIT2	Aitutaki - One Foot Island Area	2	1.5	2	2	7.5
Inshore	North	Manihiki	MAN4	Manihiki - Ngake Reef	1	2	2	2	7
Inshore	North	Tongareva	TON3	Tongareva - Northern Reef Pass	2	1	2	2	7
Inshore	South	Aitutaki	AIT6	Aitutaki - Maina Island	3	1	1	2	7
Inshore	South	Manuae	MAE1	Manuae Enclosed Lagoon	3	2	1	1	7
Inshore	South	Palmerston	PAL3	Palmerston North Islet - Marions Bank	1	2	2	2	7
Inshore	South	Rarotonga	RAR1	Rarotonga Passes - Rutaki, Papua and Avaavaroa	3	1	1	2	7
Inshore	North	Pukapuka	PUK2	Pukapuka Reef East of Toka	3	1.5	1	1	6.5
Inshore	South	Mitiaro	MIT1	Mitiaro - Maroro Tu	2	1.5	2	1	6.5
Inshore	South	Palmerston	PAL1	Palmerston, Cook and Primprose Island Beaches	2	1.5	2	1	6.5
Inshore	South	Palmerston	PAL2	Western Palmerston Outer Reef Slope	2	1.5	2	1	6.5
Inshore	North	Nassau	NAS3	Southeastern Nassau Ra'ui Area	3	1	1	1	6
Inshore	South	Atiu	ATI2	Atiu Proposed Rimu and Paua Ra'ui	2	1	2	1	6
Inshore	South	Atiu	ATI4	Eastern Atiu - Tepari	2	1	1	2	6
Inshore	South	Mangaia	MAG2	Mangaia - Saragossa Shipwreck	3	1	1	1	6
Inshore	South	Rarotonga	RAR5	Rarotonga Sand River	3	1	1	1	6
Inshore	North	Nassau	NAS1	Southern Nassau Turtle Sites	2	1.5	1	1	5.5
Inshore	North	Pukapuka	PUK4	Pukapuka Seabird Colonies	2	1	1.5	1	5.5
Inshore	North	Tongareva	TON1	Tongareva - Flying Venus Reef	1	1	2.5	1	5.5
Inshore	South	Aitutaki	AIT3	Aitutaki - Arutanga Passage	2	1	1.5	1	5.5

Inshore/ Offshore	North/ South	Island	Code	Name	Geographic explicitness	Justification	Sources	Obligations	Total score
Inshore	South	Atiu	ATI1	Atiu - Northwestern Reef Breaks	2	1.5	1	1	5.5
Inshore	South	Ma'uke	MAK1	Ma'uke Marine Ra'ui	1.5	1.5	1.5	1	5.5
Inshore	South	Mitiaro	MIT2	Mitiaro Deep Waters	2	1	1.5	1	5.5
Inshore	North	Manihiki	MAN3	Eastern Manihiki	2	1	1	1	5
Inshore	North	Nassau	NAS4	Nassau Beaches	2	1	1	1	5
Inshore	North	Pukapuka	PUK1	Pukapuka Southern Lagoon	1	1	2	1	5
Inshore	North	Pukapuka	PUK3	Pukapuka Beaches	2	1	1	1	5
Inshore	South	Aitutaki	AIT7	Aitutaki - Moturakau and Rapota	2	1	1	1	5
Inshore	South	Aitutaki	AIT8	Aitutaki - Taverua Tua	1	1.5	1.5	1	5
Inshore	South	Mangaia	MAG1	Mangaia Western Reefs	2	1	1	1	5
Inshore	South	Manuae	MAE2	Manuae Beaches	2	1	1	1	5
Inshore	South	Palmerston	PAL5	Palmerston Western Lagoon Coral Heads	1.5	1	1.5	1	5
Inshore	South	Palmerston	PAL4	Palmerston - Reef off Cook Islet	1.5	1	1	1	4.5
Inshore	South	Rarotonga	RAR3	Rarotonga - Muri Lagoon at Avana Harbour	2	1	1	0.5	4.5
Inshore	North	Nassau	NAS2	Northern Nassau Reef	1	1	1	1	4
Inshore	South	Ma'uke	MAK2	Ma'uke Western Beaches	1	1	1	1	4
Inshore	South	Rarotonga	RAR6	Rarotonga Northern Beach	1	1	1	1	4
Inshore	South	Takutea	TAK4	Takutea Shoal	1	1	1	1	4

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7 Appendices

Appendix 1. List of workshop participants

SUMA & Bioregions Workshop attendence list

Wednesday 15th & Thursday 16th July 2020

Name	*Organisation*	*Position*	*Email*
Ben Ponia	OPM	Chief of Staff	ben.ponia@cookislands.gov.ck
Mia Teaurima	OPM	Director - Island Governance	mia.teaurima@cookislands.gov.ck
Kevin Iro	OPM/MMCO	MM Ambassador	kevin.iro@cookislands.gov.ck
Maria Tuoro	OPM/MMCO	Director	maria.tuoro@cookislands.gov.ck
Gander Wainiqolo	OPM/MMCO	GIS Officer	gander.wainiqolo@cookislands.gov.ck
Isaac Glassie Ryan	OPM/CCCI	Climate Change Adviser	isaac.glassie-ryan@cookislands.gov.ck
Ana Tiraa	MFEM/DCD	Accredited Entity Adviser	ana.tiraa@cookislands.gov.ck
Tessa Vaetoru	MFEM/DCD	Development Programme Manager	tessa.vaetoru@cookislands.gov.ck
Koroa Raumea	MMR	Director - Inshore	K.Raumea@mmr.gov.ck
Kirby Morejohn	MMR	Marine Scientist	K.Morejohn@mmr.gov.ck
Lara Ainley	MMR	Marine Scientist	L.Ainley@mmr.gov.ck
Latishia Maui-Mataora	MMR	Senior Offshore Fisheries Officer	L.Maui@mmr.gov.ck
Saiasi Sarau	MMR	Offshore Fisheries Officer	s.sarau@mmr.gov.ck
Chris Brown	SBMA	Adviser	chrisgbrown@live.co.uk
Rima Browne	SBMA	GIS Specialist	rima.browne@cookislands.gov.ck
Louisa Karika	NES	Deputy Director	louisa.karika@cookislands.gov.ck
Elizabeth Munro	NES	Senior Biodiversity Officer	elizabeth.munro@cookislands.gov.ck
Moana Tetauru	NES	Media Officer	moana.tetauru@cookislands.gov.ck
Ben Maxwell	NES	Compliance Officer	ben.maxwell@cookislands.gov.ck
Hayley Weeks	NES	PMU Manager	hayley.weeks@cookislands.gov.ck
Muraai Herman	NES	Project Officer	muraai.herman@cookislands.gov.ck
Debora Mataio	NES	Admin & Finance Officer	debora.mataio@cookislands.gov.ck
John Hosking	MOT	Secretary	john.hosking@cookislands.gov.ck
Tuariki Henry	CIP	Captain	tuariki.henry@police.gov.ck
John Teaurima	CIP	Engineer	
Mark Te Kani	NZ Navy		
Vaipo Mataora	ICI	Director	vaipo.mataora@cookislands.gov.ck
Mark Te Kani	CIP	Maritime Surveillance Advidor	mark.tekani@police.gov.ck
Junior Ngatokorua	MOT	Director of Maritime	junior.ngatokorua@cookislands.gov.ck
Nicholas Henry	MOT	Maritime Officer	nicholas.henry@cookislands.gov.ck
John Teaurima	CIP	Maritime Surveillance Unit	john.teaurima@police.gov.ck
Teanau Rani	MOT	Aviation Officer	teanau.rani@cookislands.gov.ck
Simiona Teiotu	MOT	Aviation Security	simiona.teiotu@cookislands.gov.ck
Marah Tairi	MOT	Maritime Division	marah.tairi@cookislands.gov.ck
John Jessie	CIPA	Harbour Master	john.jessie@cookislands.gov.ck
Joseph Brider	CINHT	Project Officer	jobridy@gmail.com

SUMA & Bioregions Workshop attendence list

Wednesday 15th & Thursday 16th July 2020

Name	***Organisation***	***Position***	***Email***
Tupuna Rakanui	HOA	Clerk	punarakanui@gmail.com
Makitua Boaza	HOA	Project Officer	makituaboaza.hoa@gmail.com
Noeline Brown	Koutu Nui		brownenoeline@gmail.com
Imogen Ingram	Koutu Nui		imogenpuaingram@gmail.com
Kelvin Passfield	TIS	Director	kelvin.passfield@gmail.com
Kate McKessar	TIS	Coordinator	te.ipukarea.society.inc@gmail.com
Teina McKenzie	TIS	President	mackteina@gmail.com
Jess Cramp	Sharks Pacific	Founder/Director	jesscramp@mac.com
Stan Wolfgramme	Te Ara	Director, TeAra Museum	stan@tearacimce.co.nz
Nooroa Tou (Bim)	CIVS	CEO Ports Authority	nooroa.tou@cookislands.gov.ck
Nan Hauser	CIWR	Researcher	info@whaleresearch.org

Pa Enua and international participants (by Zoom)			
Arthur Neale	Palmerston	Executive Officer	exo.pamati@gmail.com
Ant Vavia	Mitiaro	PhD candidate	maria.tuoro@cookislands.gov.ck
Royston Jones	Mauke	Executive Officer	royston.jones@cookislands.gov.ck
Basilio Kaokao	Mauke	Director, Mauke Infrastructure	maukeaorangi@gmail.com
Charlie Rani	Mitiaro	Executive Officer	charlie.rani@cookislands.gov.ck
Dr. Daniela Ceccarelli	Australia	Consultant	dmcecca@gmail.com
Kate Davey	Australia	Consultant	katedaveyau@gmail.com

Appendix 2. Agenda for the Workshop on Biophysically Special, Unique Marine Areas in the Cook Islands

AGENDA

BIOPHYSICALLY SPECIAL, UNIQUE MARINE AREAS & BIOREGIONS

of the

Cook Islands

VENUE: Crown Beach Resort

DATE: 15 -16 July 2020

Workshop objectives:

1. To identify inshore and offshore, biophysically Special, Unique Marine Areas (SUMAs) &
2. Review draft inshore and offshore Bioregions for the Cook Islands

	DAY 1 – SPECIAL UNIQUE MARINE AREAS	
TIME	**Item**	**PRESENTERS**
8.30 am	Registration and coffee/tea	All
9:00 am	Opening Prayer	
9:05 am	Agenda # 1: Welcome Remarks	Mr. Ben Ponia Chief of Staff Office of the Prime Minister
9:15	Agenda # 2: Introduction, Agenda overview	Maria Tuoro Marae Moana Director
9:25 am	Agenda # 3: Background - MSP in the Cook Islands and how this workshop's outputs will contribute.	Maria Tuoro Marae Moana Director
9:45 am	Agenda # 4: What is Marine Spatial Planning?	Kate Davey MSP Team Leader Ridge to Reef
10:00 am	MORNING TEA	

	DAY 1 – SPECIAL UNIQUE MARINE AREAS	
10:30 am	Agenda # 5: Identifying Special, Unique Marine Areas for Marae Moana. • Justification - amount, detail and nature • Geographic explicitness • Source types and number • National/international obligations • Present preliminary draft SUMAs • Workshop process for identification of biophysically special, unique marine areas Overview of existing data (coral reefs, bathymetry, geomorphology, EBSA, species richness, productivity, important bird areas, etc.)	Dr Dani Ceccarelli Marine Ecologist and SUMA Specialist Gander Wainiqolo, GIS Coordinator, Marae Moana
11:15am	Agenda # 6: ACTIVITY: Assessment of biophysically special, unique marine areas INSHORE: Group 1: Aitutaki and Manuae Group 2: Palmerston Group 3: Rarotonga Group 4: Mauke, Mitiaro, Aitu & Takutea (Nga Pu Toru) Group 5: Mangaia Group 6: Pukapuka and Nassau Group 7: Rakahanga and Manihiki Group 8: Penrhyn and Suwarrow	Hayley Weeks | Manager, Project Management Unit (PMU) All participants
1:15 pm	LUNCH	
2:15 pm	Feedback from groups(5-10m min each)	Group presenters
2:45 pm	Agenda # 7: ACTIVITY: Assessment of biophysically special, unique marine areas OFFSHORE: Offshore Northern (2 x Groups) Offshore Southern (2 Groups)	All participants
3:30 pm	AFTERNOON TEA (served during activity)	
4:00 pm	Feedback from groups (5-10m min each)	Group presenters
4:30 pm	Agenda # 8: Next Steps and Closing Remarks	Maria Tuoro Marae Moana Director
	END	

Appendix 3. Biophysical data available during the workshop

Note: All datasets are open access.

Resource wall (hard copy maps posted on the walls)

1. Cook Islands bathymetry
2. Cook Islands silicate concentration
3. Cook Islands sea surface temperature
4. Cook Islands chlorophyll a concentration
5. Cook Islands mixed layer depth
6. Cook Islands nitrate concentration in the ocean
7. Cook Islands dissolved oxygen
8. Cook Islands photosynthetically available radiation
9. Cook Islands phosphate concentration
10. Cook Islands marine species richness all species from aquamaps
11. Cook Islands benthic marine species richness from aquamaps
12. Cook Islands pelagic marine species richness from aquamaps
13. Cook Islands cold water corals
14. Cook Islands coral species richness
15. Cook Islands currents
16. Cook Islands cyclone tracks
17. Cook Islands downwelling diffuse attenuation coefficient
18. Cook Islands downwelling eddy frequency
19. Cook Islands ecologically and biologically significant areas (EBSA)
20. Cook Islands important bird areas (IBAs)
21. Cook Islands front count
22. Cook Islands geomorphology
23. Cook Islands hydrothermal vents
24. Cook Islands mangroves, reefs
25. Cook Islands particulate organic carbon flux
26. Cook Islands reefs at risk
27. Cook Islands seamounts and seamount morphology classification
28. Cook Islands historic tsunami location
29. Cook Islands upwelling
30. Cook Islands ocean productivity

E-copy of data in GIS files

All of the hardcopy maps listed above were also available on the GIS. In addition, the following data were available on the GIS.

1. Base layers
    a. Cook Islands Provisional EEZ
    b. Cook Islands Coastlines
    c. Bathymetry data
    d. Underwater feature names

2. Environmental variables
    a. Sea surface temperature
    b. Temperature at 1000 meters depth
    c. Temperature at 200 meters depth
    d. Temperature at 30 meters depth
    e. Depth of 20 degree isotherm
    f. Mixed layer depth

g. Salinity
h. pH
i. Photosynthetically available radiation
j. Nitrate
k. Calcite
l. Silicate
m. Phosphate
n. Depth

3. Bio-physical data
    a. Chlorophyll-a concentration
    b. Geomorphological features
        i. Shelf classification (high, medium, low)
        ii. Escarpment
        iii. Basin
        iv. Bridge
        v. Guyot
        vi. Seamount
        vii. Rift valley
        viii. Trough
        ix. Ridge
        x. Spreading ridge
        xi. Terrace
        xii. Trench
        xiii. Plateau
        xiv. Abyssal classification (mountain, hill, plain)
        xv. Slope
        xvi. Hadal

Appendix 4. Workshop Site Response Sheet

Group/table #	Facilitator:	Rapporteur:
Group members (names)	Site name and or number:	
	Description/location:	
Criteria	**Additional Information**	
Justification - Why is this site biophysically special and/or unique? Consider if there are: – rare, vulnerable or unique habitats or species – species of concern – important life stages of key species (feeding, aggregation, breeding, nesting, migration), – physically or biologically outstanding attributes e.g. unique geomorphology or high species diversity – habitats of high complexity or size – This workshop we are not identifying culturally important sites.		
Geographic explicitness – Please be as specific as possible when defining the boundaries. – Clearly defined boundaries means that better decisions can be made about the area that is special and/or unique.		
Source Type. *Is the information:* – Traditional (TK) – Reports – Websites – Peer-reviewed papers – etc.		
International/National **Obligations** (CITES, IUCN Red List, Cook Islands Threatened Species Act, ra'ui, etc)		

Appendix 5: List of species known to occur in the Cook Islands with international and national obligations.

The species list was generated through a country- and region-specific search of Species + (www.speciesplus.net) and the IUCN Red List of Threatened Species (www.iucnredlist.org), cross-checked with the Cook Islands Biodiversity Database (cookislands.bishopmuseum.org). This table was used to verify the obligations for each site, where particular species were known to occur at the site. The distribution of each species is based on current listings and may be subject to change. CITES: The Convention on International Trade in Endangered Species of Wild Fauna and Flora; CMS: Convention on Migratory Species; IUCN: International Union for the Conservation of Nature; WCPFC CMM: Western and Central Pacific Fisheries Commission Conservation and Management Measures; DD: Data Deficient; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CE: Critically Endangered; CD: Conservation Dependent. To access the table, see https://www.maraemoana.gov.ck/downloads/.

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Appendix 6: Management obligations that apply in the Marae Moana (Cook Islands Marine Park)

1. Marae Moana Act 2017

1.1 General provisions

The Marae Moana Act 2017 established the Marae Moana (Cook Islands Marine Park), and its primary purpose is to protect and conserve the ecological, biodiversity, and heritage values of the Cook Islands marine environment [Section 3(1)]. The Act has a range of other purposes that may apply, consistent with the primary purpose. One such purpose is assisting the Cook Islands to meet its international responsibilities under the Convention on the Conservation of Biological Diversity (CBD) [Section 3(2d)].

Section 5 of the Act defines a series of ecologically sustainable use principles including the principle of protection, conservation, and restoration whereby areas within the Marae Moana should be protected, and their biodiversity conserved, for their cultural and natural heritage value.

Application to SUMAs:

- All offshore and inshore SUMAs.

1.2 Section 24 Marine Protected Area

Section 24 of the Act established a marine protected area (MPA) of 50 nautical miles (measured from the baseline) around all islands of the Cook Islands. The purpose of these MPAs is to protect the pelagic, benthic, coral reef, coastal, and lagoon habitats of the Marae Moana. All seabed minerals activities and large-scale commercial fishing are prohibited, but other ecologically sustainable uses are permitted in these areas.

Coral reefs are not specifically mentioned or protected in the Act. Section 24 MPAs cover inshore waters around every island (out to 50nm) and therefore the vast majority of the Cook Islands coral reefs (certainly all the inshore reefs) are in a MPA where seabed mining and large-scale fishing activities are prohibited.

Application to SUMAs:

- All inshore SUMAs.

2. Marine Resources Act 2005

2.1 General provisions

The Marine Resources Act 2005 provides for the conservation, management and development of marine resources and related matters, including the protection and conservation of the natural resources of the Cook Islands fishery waters. Under this Act, a fishery can be designated, and regulations can be passed to manage the designated fisheries. Designated fisheries include longline fishery, purse seine fishery and bonefish fishery.

Because of Section 24 MPAs (under the Marae Moana Act) around each of the 15 Cook Islands, large-scale commercial fishing is effectively limited to those waters of the EEZ between 50-200

nm. Potentially all the offshore SUMAs (sites O1-O7), in part or in whole, are subject to commercial fishing.

There are multiple regulatory obligations on the Cook Islands Government and individual fishing enterprises that operate in these SUMAs including:

- Marine Resources (Purse Seine Fishery) Regulations 2013
- Marine Resources (Large Pelagic Longline Fishery and Quota Management System) Regulations 2016
- Large Pelagic Longline Fishery Plan (2016)
- Cook Islands Shark Sanctuary and Marine Resources (Shark Conservation) Regulations 2012.

Section 8 of the Purse Seine Fishery Regulations addresses protection of non-target species and mandates that the following plans must be complied with:

- National Plan of Action for Reducing Incidental Catch of Seabirds (NPoA-Seabirds) (MMR, 2007)
- National Plan of Action for Sea Turtle Mitigation (NPoA – Turtles) (MMR, 2008)
- Regional Action Plan for Sea Turtle By-Catch Mitigation (Cameron and Preston, 2008)
- National Plan of Action for the Conservation and Management of Sharks (NPoA – Sharks) (MMR, 2012)
- Other measures in the Regulations.

Section 15 of the Longline Fishery Regulations addresses protection of non-target species and mandates that commercial longline fishing must comply with:

- National Plan of Action for Reducing Incidental Catch of Seabirds (NPoA-Seabirds) (MMR 2007)
- National Plan of Action for Sea Turtle Mitigation (NPoA – Turtles) (MMR 2008).

Application to SUMAs:

- All offshore and inshore SUMAs, in particular Offshore SUMA O1-7 where commercial fishing is undertaken.

2.2 Cook Islands Shark Sanctuary

In 2012 the Cook Islands declared all its marine estate (1.997 million sq. km) as a shark sanctuary[23]. Within its borders, all shark fishing and the sale or possession of shark products is banned. The Marine Resources (Shark Conservation) Regulations 2012 were established under the Marine Resources Act 2005 to put this declaration into effect.

[23] The Regulations and Cook Islands NPoA-Sharks uses the term "shark" to refer to all species of sharks, skates, rays and chimaeras.

The sanctuary protects sharks from targeted fishing and aims to prevent the possession, sale, and trade of shark parts and products. Heavy fines can be imposed on violators found with any part of a shark onboard their vessel[24].

The National Plan of Action for the Conservation and Management of Sharks in the Cook Islands (NPoA – Sharks) (MMR 2012) aims to promote a rational approach to the conservation and management of shark resources in order to maintain stocks at sustainable levels and protect the biological diversity of the marine environment. The plan applies to commercial and artisanal fishing in the waters of the Cook Islands (as well as high seas and distant water fisheries). It also describes the legal and administrative frameworks (international and national) governing fisheries involving sharks.

The Plan specifies a range of management strategies that include: strict protection of CITES-listed species; protection of reef species through area closures; a ban on shark finning requiring that whole shark carcasses are retained; a list of other species for which retention is prohibited; a prohibition on shark targeting; restrictions on use of gear; observer coverage level targets; improved reporting of catch and biological data; commercial licence conditions; and other measures (MMR 2012).

In 2008 the WCPFC designated a number of species as "key shark species". Once designated as key sharks, these are the subject of study under the WCPFC's Shark Research Plan. Country convention members are required to report catch and effort information and support research efforts on those species. Initially the list included blue shark, oceanic whitetip shark, mako sharks and thresher sharks. Silky, porbeagle (south of 30oS), hammerhead sharks (winghead, scalloped, great, and smooth) and whale sharks were added later (Brouwer & Harley 2015).

Many of the species listed in the NPoA are reef-associated or otherwise do not interact with the main commercial fisheries in the Cook Islands (ie. the longline and purse seine fisheries). Some of the WCPFC 'key shark species' are known to interact with the longline fishery in Cook Islands waters (MMR 2012).

Application to SUMAs:

- Offshore SUMAs O1-7.
- Those inshore SUMAs with sharks as an identified value.

2.3 Reducing by-catch of seabirds and turtles

Global concern about the impact of longline fishing on seabirds resulted in the development and adoption of the International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries (IPOA-Seabirds). The IPOA – Seabirds forms the basis to the Cook Islands National Plan of Action for Reducing Incidental Catch of Seabirds (NPOA-Seabirds). The Cook Islands Government has decided that the NPOA-Seabirds should cover all fisheries – not just longlining - in which Cook Islands is involved (MMR 2007).

In 2008, the Cook Islands developed an Action Plan for Sea Turtle Mitigation (NPoA – Turtles) with the objective to reduce the impacts of fishing for highly migratory fish species on sea turtles (MMR 2008). The Plan applies to fishing vessels operating in the Cook Islands offshore tuna

[24] https://www.mmr.gov.ck/shark-sanctuary/

fishery and the high seas and supports the Regional Action Plan for Sea Turtle Mitigation implemented by FFA member countries.

The Regional Plan has three high-level, regional strategies to mitigate the risk of sea turtle by-catch:

- Undertake collection and monitoring of fishery data to improve understanding of the nature, scope and scale of sea turtle/ tuna fishery interactions in order to develop appropriate responses.
- Conduct research and investigations to obtain information that cannot be acquired through monitoring, and test possible mitigation measures.
- Introduce mitigation measures to encourage/ require that fishers take steps to reduce (a) turtle/fishery interactions and (b) mortality rates resulting from such interactions (MMR 2008).

A series of national actions are described to support these regional strategies.

Application to SUMAs:

- Offshore SUMA O1-7.

2.4 Export of pa'ua (giant clams)

In 2020, the Cook Islands placed a ban on the international export of all paua (giant clams). (MMR 2020). Although not a party to CITES, a CITES permit was previously issued to allow people to export paua. Those permits will no longer be issued due to the state of paua populations in the Cook Islands. This ban will remain in place for at least the next five years. Whilst this action doesn't prevent domestic consumption, it prevents the large number of international exports that were previously occurring.

Application to SUMAs:

- Those inshore SUMA with pa'ua as an identified value.

3. Cook Islands Whale Sanctuary

The government declared the Cook Islands Whale Sanctuary in 2001, however there is no legislation or regulations to uphold this declaration. MMR intended to develop a National Plan of Action for the Conservation and Management of Cetaceans in the Cook Islands (NPOA-Cetaceans) in 2017, to enable the ministry and other government agencies to administer the Sanctuary[25]. However, this NPoA remains incomplete as at time of writing this SUMA Report.

Application to SUMAs:

- Offshore O5, if the Whale Sanctuary was legislated and/or regulated.

4. Environment Act 2003

[25] https://www.mmr.gov.ck/legislation/

The Environment Act 2003 potentially applies to many but not all SUMAs: both activity and geographic provisions of the Act must be triggered for the Act to apply.

4.1 Activity-based provisions

The Act is triggered when a proposed activity 'causes or is likely to cause significant environmental impacts' (refer Section 36 of the Act). An environmental impact assessment and project permit are required in these circumstances.

The Act also requires written consent of the permitting authority for specific activities '…of concern' (i.e. excavation, dredging, etc; Section 50-51 refer). Written consent of the permitting authority is required for activities in 'specific areas of concern', which include:

- Protection of foreshore and Cook Island waters (Section 50) (emphasis added). From the perspective of the marine environment, the emphasis of Section 50 is on excavation, removal of aggregate (soil, sand, gravel, rock, coral, etc), dredging, infrastructure construction, dredge spoil disposal, removal of vegetation.
- Pollution of Cook Island waters and inland waters (Section 51) (emphasis added).

Under Section 12(f), Island Environment Authorities (IEAs) have responsibility to determine applications for permits and consents for the purposes of sections 36 (environmental impact assessments), S50 (protection of foreshores and Cook Islands waters), S51 (pollution), S57 (excavations), and S58 (wetlands).

Section 20 states that the 'National Environment Council (is) to act as permitting authority for any part of the Cook Islands other than Rarotonga or an Outer Island'. In practice, this is interpreted as being matters triggered by Section 36 and/or "specific areas of concern" (Sections 50, 51, 57, 58) where located in the territorial seas and the EEZ.

4.2 Geographic coverage

The geographic coverage of the Act is complex: it is NOT national in its coverage. Section 4(1) states that the Act 'applies throughout the Cook Islands (including the territorial sea and exclusive economic zone) except as otherwise provided by subsection (2)'. Section 4(2) specifies that 'This Act shall apply to the islands of Rarotonga, Atiu and Aitutaki but shall not apply to any Outer Island unless otherwise specified by the Queen's Representative by Order in Executive Council'.

In these instances, the 'island' (defined as the island *per se* and internal waters)[26] are governed by an Island Environment Authority (IEA). Takutea is also covered although under different administrative arrangements (discussed elsewhere).

Table 1 summarises the geographic coverage of the Act to islands and the legislative instrument.

[26] Section 12(1) specifies that: "It shall be the function of each Island Environment Authority in respect of *its island* to…" (emphasis added).
Section 2 defines *island* as Rarotonga or any outer island, and its internal waters. However for those islands with Environment Regulations (Mitiaro, Atiu, Takutea) define the geographic extent of such Regulations as including waters to 12 nm. This may represent a conflict between the Act and Regulations.

Table 1. Geographic coverage of the Environment Act and the legislative instrument

Island	Instrument		
	Act	Order	Regulations
Rarotonga (note 1)	Section 4 (2)		
Aitutaki (note 1)	Section 4 (2)		
Manuae (note 1, 2)	Section 4 (2)		
Atiu	Section 4 (2)		Environment (Atiu and Takutea) Regulations 2008 (note 3)
Takutea (note 1, 2)	Section 4 (2)		Environment (Atiu and Takutea) Regulations 2008 (note 3)
Mitiaro		Environment (Application to Mitiaro) Order 2004	Environment (Mitiaro) Regulations 2008 (note 3)
Mauke		Environment (Application to Mauke) Order 2007 (note 1)	
Manihiki		Environment (Application to Manihiki) Order 2012 (note 1)	

Notes.

1. For those islands covered by the Act and currently without any Regulations – Rarotonga, Aitutaki, Manuae (see note 2 also), Mauke, Manihiki - the geographic coverage of the Act is the island and its internal waters.
2. Even though they are separate islands, Part III, Article 27(1)(a) of the Constitution of Cook Islands recognises Manuae and Takutea as part of Aitutaki and Atiu respectively.

Therefore, although not specifically identified in the Act, both Manuae and Takutea are covered by the Act.

3. For those islands covered by the Act and with Regulations – Atiu, Takutea, Mitiaro - the geographic coverage of the Regulations is the island, its internal waters, and the adjacent territorial seas (to 12nm).

Therefore, the Act applies to:

- The islands of Rarotonga, Aitutaki, Atiu (and Manuae and Takutea[27]) and their inland waters [Section 4(2)].
- Outer islands that have 'opted in', currently, these are the islands of Mitiaro, Mauke and Manihiki, and their internal waters.
- The territorial seas and EEZ of the Cook Islands (Section 4 of the Act refers).

The Act does not apply to those outer islands (and their inland waters) that have not opted in namely: Penrhyn, Rakahanga, Pukapuka, Nassau, Palmerston, and Mangaia. The Act specifically does not apply to Suwarrow Island and its internal waters. Despite these exclusions, the majority of Marae Moana falls within the jurisdiction of the Environment Act. Sections 36, 50, 51 and 57 would apply to specific activities that might be proposed in the majority of SUMAs. Only those SUMAs that were entirely in the internal waters of the islands of Penrhyn, Rakahanga, Pukapuka, Nassau, Palmerston, Suwarrow and Mangaia (TON2-4, RAK1-2, PUK1, PUK3-5, NAS1-4, PAL1-5, SUW1, MAG1-2) are <u>not</u> under the jurisdiction of the Act.

Application to SUMAs:

- All SUMA apart from those that are entirely in the internal waters of the islands of Penrhyn, Rakahanga, Pukapuka, Nassau, Palmerston, Suwarrow and Mangaia (TON2-4, RAK1-2, PUK1, PUK3-5, NAS1-4, PAL1-5, SUW1, MAG1-2).

4.3 Limitations

The scope of the Environment Act 2003 and the functions of the implementation bodies (National Environment Council, IEAs) does include some general and wide-ranging powers and duties for the protection, conservation and management of the environment, including Cook Islands waters. However, these functions are not as clearly spelt out as they might be (ComSec 2017).

The Environment Act 2003 has no definition of biodiversity (although the 'environment' is defined) and no mechanism for overall management and conservation of biodiversity other than through management plans (NES 2020). Section 37 allows for development of management plans for areas on an island and for internal waters. Such management plans can be prepared for many purposes including the protection, conservation and management of wildlife, protected

[27] Refer to Table 1 for explanation of situation concerning Manuae and Takutea

species and their habitats; wetlands; forests; and internal waters. However this provision has not yet been used.

Furthermore, the Act does have provision for designation of 'protected species' (both terrestrial and marine) and protection of such species and their habitat (Section 55), however this provision has not been used.

Section 70 allows for regulations to be made recognising components of biodiversity, namely:

- Designation of animals and plants as protected species.
- Providing for the protection, conservation and management of wildlife and/or protected species.
- Providing for the preservation, protection and conservation of trees and the prevention and control of vegetation clearing.

Such regulations have not been developed and this poses major limitations to effective environmental management and compliance (Tonkin & Taylor 2020).

A permit under the current legislation is required only if activities have significant adverse impacts or are included as a "specific area of concern" (i.e. excavation, dredging, etc). Therefore, small to medium sized projects are not covered by the Environment Act, although these may still affect the environment (Tonkin & Taylor 2020).

5. Seabed Minerals Act 2019

Seabed minerals exploration and mining will potentially be undertaken in some of the offshore SUMAs. These activities are regulated by a complex array of legislation[28] including:

- Seabed Minerals Act 2019 and Seabed Minerals Amendment Act 2020
- Seabed Minerals (Exploration) Regulations 2020
- Environment Act 2003. The National Environment Council (Council), established under the Act, acts as the permitting authority for seabed minerals activities.
- Draft Environment (Seabed Minerals Activities) Regulations 2020.

Application to SUMAs:

- Offshore O1-7, and in particular O7 which coincides with the highest density nodule fields, which are anticipated to be most commercially attractive and viable for seabed mining.

6. Aitutaki and Manuae

6.1 Aitutaki Fisheries Protection By-Laws

Fisheries regulations are in place to manage inshore marine species of Aitutaki and Manuae islands. The Aitutaki Fisheries Protection By-Laws 1990 regulate harvest of *Tridacna* spp., *Arca* spp. and *Turbo* spp. in lagoon waters and to a distance of 200 m beyond the outer reef edge on both islands. The bylaws establish daily harvest and size limits; the sale and removal of these species from their place of collection is prohibited, although permits may be issued by the Aitutaki Island Council which allow harvests greater than the daily bag limit and/or less than the

[28] https://www.sbma.gov.ck/laws

minimum size limit as well as export. The bylaws prohibit the export of giant clams from Manuae (Morejohn et al. 2019).

Application to SUMAs:

- Aitutaki AIT1-8
- Manuae MAE1-3

6.2 Bonefish Fishery

The Aitutaki and Manuae bonefish fishery has been designated under the Marine Resources (Aitutaki and Manuae Bonefish Fishery) (Amendment) Regulations 2016. The regulations aim to establish an ecologically sustainable fishery for bonefish (*Albula glossodonta*) on both islands. The regulations identify spawning and nursery sites and restrict fishing to other designated areas and under conditions (fishing licenses, requirements for guides, gear restrictions and ban on export).

Bonefish nursery and spawning areas as identified under the fishery are shown in the figure below.

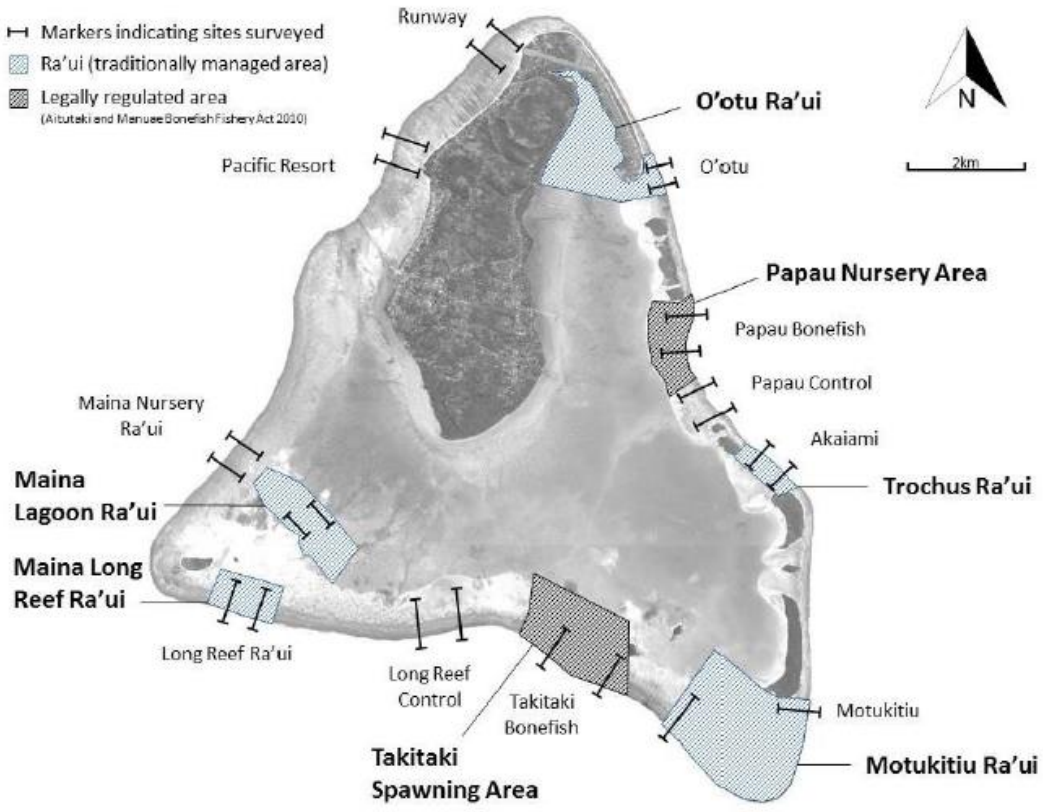

Fig. 1. Aitutaki survey sites. Map source: Google DigitalGlobe.

Source: Morejohn et al. 2019

Application to SUMAs:

- Aitutaki AIT1-8; AIT7 includes Takitaki spawning area
- Manuae MAE1-3

7. Manihiki

Manihiki (Natural Resources) By-Laws 2003 provide for the management of natural resources on the island of Manihiki and in its lagoon and surrounding waters. The bylaws place restrictions on the harvest of pearl shell and pearl farming, and restrict gear that may be used for fishing

Application to SUMAs:

- Manihiki MAN1-4

8. Tongareva (Penrhyn)

Penrhyn (Prohibition on Exportation of Paua) By-Laws 2007 prohibit the export of paua (paua, giant clam) from Tongareva (Penrhyn).

Application to SUMAs:

- Tongareva TON1-4: although paua (paua) are not specifically mentioned as values in these sites, clam species are likely present.

9. Atiu

The Environment (Atiu and Takutea) Regulations 2008 establish protections for coconut crabs, crayfish, flying fish, koperu (mackerel), birds and turtles, and specify restrictions on fishing methods and gear type; as per Section 3 of the Regulations these restrictions apply to the island of Atiu and the waters within 12nm of the coast.

Application to SUMAs:

- Atiu ATI1-3

10. Takutea

From 1903-1950, Takutea was a sanctuary under individual ownership. In 1950, Takutea was vested by court order in the board of trustees that includes most of the Aronga Mana of Atiu. Takutea has been declared a “community conserved area under the management and control of the Trustees of Takutea” (section 4 of *Environment (Atiu and Takutea) Regulations 2008*). The *Regulations 2008* specify that "Takutea" means the island of Takutea and includes the waters within 12 nautical miles. Covering the entire island (120ha) and adjoining waters, Takutea is the oldest protected area in the Cook Islands; meets the global IUCN definition of a protected area; and one of only two that extend across island and marine environments (Suwarrow is the other) (Twyford 2020b).

The Regulations effectively establish a “no take” reserve over the island and marine waters; fishing is prohibited “within 5 nm of the reef” (and potentially to 12 nm depending on how the Regulations are interpreted). This arrangement puts in place stronger protections and management than the Section 24 zone under the Marae Moana Act (full details are in Twyford 2020b).

Application to SUMAs:

- Takutea TAK1-4

11. Suwarrow

On 29 June 1978, "Suwarrow Islands and its superjacent waters in the territorial sea of the Cook Islands" were declared a national park pursuant to Section 11(1) of the Conservation Act 1975. The legal status of Suwarrow remains a matter of some conjecture, although it would seem that the national park designation remains (Twyford 2020b).

In the marine area, two designations exist:

- Suwarrow Marine Protected Area, effectively a zone established under the Section 24 of the Marae Moana Act, that extends from the coastline to 50 nm.
- Suwarrow National Park that includes the "superjacent waters in the territorial sea" which is interpreted to mean the marine area surrounding the island, from the coastline to 12 nm. Designation as a national park under this arrangement needs further consideration and resolution (refer Twyford 2020b).

Application to SUMAs:

- Suwarrow SUW1

12. Mitiaro

The Environment (Mitiaro) Regulations 2008 establish protections for coconut crabs, crayfish, flying fish, milkfish, birds and turtles, and specify restrictions on fishing methods and gear type; as per Section 3 of the Regulations these restrictions apply to the island of Mitiaro and the waters within 12nm of the coast. Section 8 has protections for spawning flying fish and is directly relevant to SUMA MIT1.

Application to SUMAs:

- Mitiaro MIT1-2

13. WCPFC Conservation and Management Measures (CMMs)

As a party to the Convention for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (WCPF Convention), the Cook Islands has adopted a number of Conservation and Management Measures (CMMs) that affect commercial fishing activities in its EEZ. These CMMs (WCPFC, 2020) include:

- CMM2006-04: Striped Marlin
- CMM2009-03: Swordfish
- CMM2011-03: Purse seine fishing & cetaceans
- CMM2015-02: South Pacific Albacore
- CMM2018-01: Bigeye, yellowfin, skipjack tuna
- CMM2018-03: Seabirds
- CMM2018-04: Sea Turtles
- CMM2019-02: Pacific Bluefin Tuna
- CMM2019-04: Sharks.

These CMMs are binding decisions on member countries and are important management obligations for commercial fishing in offshore SUMAs (O1-7).

Application to SUMAs:

- Offshore O1-7 in the context of commercial fishing.

14. International and regional agreements

- Marine species of conservation significance, including many of the species that live on coral reef, are listed on the IUCN Red List of Threatened Species and the Convention on Migratory Species (CMS).
- The Memorandum of Understanding (MoU) for the Conservation of Cetaceans and their Habitats in the Pacific Island Region is a Multilateral Environmental Memorandum of Understanding (MoU) concluded under the auspices of the CMS in collaboration with the Pacific Regional Environment Programme (SPREP). The MoU provides an international framework for coordinated conservation efforts to improve the conservation status of the Pacific Islands cetaceans.
- The Cook Islands is a Party or Signatory to several international agreements for marine turtle conservation, protection and management, including the Convention on Biological Diversity.
- The Cook Islands is a contracting party to the United Nations Convention on the Law of the Sea. UNCLOS is international agreement which defines the rights and responsibilities of nations in their use of the world's oceans, establishing guidelines for businesses, the environment, and the management of marine natural resources. UNCLOS confers rights to natural resources and also imposes certain obligations. These obligations are couched in a general duty owed to the international community to "protect and preserve the marine environment"[29].

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Appendix 7: Seamounts of the Cook Islands, including geomorphological characteristics and location within Offshore SUMAs.

Seamount ID	Map ID	SUMA	Area (km2)	Height (m)	Peak depth (m)	Distance to nearest seamount (km)	Escarpment (deg)	Morphotype	Description
S8898	1	O3	520.61	1057	4006	23.37	18.18	7	Group 5: small and short with very deep peaks, shortest
S8899	2	O3	645.26	3427	1859	21.73	70.90	3	Group 3: intermediate size, large tall and deep
S8900	3	O3	699.43	2828	2395	21.73	47.75	11	Group 3: intermediate size, largest basal area and deepest peak depth
S2174	4	O6	683.07	2487	2494	173.09	88.61	4	Group 4: small with deep peak, most isolated type
S2226	5	O6	773.38	2496	2522	88.72	83.15	2	Group 4: small with deep peak, most common type
S2244	6	O6	1868.70	3099	1542	25.82	46.15	11	Group 3: intermediate size, largest basal area and deepest peak depth
S2262	7	O6	909.17	2871	2031	73.25	63.70	11	Group 3: intermediate size, largest basal area and deepest peak depth
S2283	8	O6	556.86	1819	3172	43.24	63.42	8	Group 5: small and short with very deep peaks, deepest type
S2286	9	O6	190.62	1654	3111	42.12	49.80	8	Group 5: small and short with very deep peaks, deepest type
S2294	10	O6	720.76	2057	3092	51.87	78.45	2	Group 4: small with deep peak, most common type
S2297	11	O6	616.24	2293	2426	42.12	72.28	2	Group 4: small with deep peak, most common type
S2312	12	na	690.80	1487	3564	119.92	57.07	8	Group 5: small and short with very deep peaks, deepest type
S2342	13	na	434.81	3098	1636	32.00	89.20	3	Group 3: intermediate size, large tall and deep
S2368	14	O6	956.66	2406	2249	120.87	68.26	11	Group 3: intermediate size, largest basal area and deepest peak depth
S2369	15	O6	419.63	1510	3374	75.59	38.25	7	Group 5: small and short with very deep peaks, shortest
S2373	16	na	842.94	1461	3163	60.92	27.13	7	Group 5: small and short with very deep peaks, shortest
S2398	17	O4	525.95	2481	2223	35.86	96.04	3	Group 3: intermediate size, large tall and deep
S2412	18	O5	632.18	2676	2337	75.59	94.29	3	Group 3: intermediate size, large tall and deep
S2417	19	O4	559.04	1379	3462	34.58	62.53	8	Group 5: small and short with very deep peaks, deepest type
S2438	20	O4	705.35	2023	3002	28.48	70.69	2	Group 4: small with deep peak, most common type
S2465	21	O4	750.00	2295	1818	27.14	34.59	1	Group 4: small with deep peak, short with moderately deep peak
S2484	22	O5	476.39	1193	3931	59.50	64.89	8	Group 5: small and short with very deep peaks, deepest type
S2486	23	O5	1485.47	1697	3146	93.91	31.08	7	Group 5: small and short with very deep peaks, shortest
S2500	24	O4	773.41	1106	3592	56.31	38.36	7	Group 5: small and short with very deep peaks, shortest
S2517	25	O4	672.04	1453	3262	41.96	60.93	8	Group 5: small and short with very deep peaks, deepest type
S2521	26	O5	616.44	2513	2556	74.51	87.07	2	Group 4: small with deep peak, most common type
S2533	27	O4	866.40	1917	3009	41.96	58.05	8	Group 5: small and short with very deep peaks, deepest type
S2558	28	O4	537.85	1855	3080	42.49	83.23	2	Group 4: small with deep peak, most common type

Seamount ID	Map ID	SUMA	Area (km2)	Height (m)	Peak depth (m)	Distance to nearest seamount (km)	Escarpment (deg)	Morphotype	Description
S2591	29	O4	743.24	1476	3707	42.49	54.53	8	Group 5: small and short with very deep peaks, deepest type
S2597	30	O4	870.89	1387	3275	63.05	40.76	7	Group 5: small and short with very deep peaks, shortest
S2608	31	O3	2235.46	4206	1004	32.80	40.69	10	Group 2: large and tall with shallow peak: shallow
S2609	32	O3	891.34	3707	980	30.30	75.50	10	Group 2: large and tall with shallow peak: shallow
S2640	33	O4	435.74	1594	3496	63.05	85.76	2	Group 4: small with deep peak, most common type
S2654	34	na	433.57	2847	2578	21.92	82.68	2	Group 4: small with deep peak, most common type
S2710	35	na	526.72	1934	3720	28.58	69.20	8	Group 5: small and short with very deep peaks, deepest type
S2715	36	na	386.36	1330	4368	28.58	72.93	8	Group 5: small and short with very deep peaks, deepest type
S2741	37	na	613.80	2129	3495	49.96	88.53	2	Group 4: small with deep peak, most common type
S2748	38	na	499.62	1192	4446	65.08	42.55	7	Group 5: small and short with very deep peaks, shortest
S2764	39	na	624.37	3002	2539	31.62	98.51	3	Group 3: intermediate size, large tall and deep
S2780	40	na	354.25	2245	3308	31.62	80.80	2	Group 4: small with deep peak, most common type
S2790	41	na	439.99	1167	4430	44.16	49.24	8	Group 5: small and short with very deep peaks, deepest type
S2811	42	na	703.69	1710	3812	29.42	69.66	8	Group 5: small and short with very deep peaks, deepest type
S2822	43	na	455.07	2003	3416	77.91	60.75	8	Group 5: small and short with very deep peaks, deepest type
S2842	44	na	859.90	2971	2371	57.29	95.21	3	Group 3: intermediate size, large tall and deep
S2912	45	O2	989.02	3344	1192	39.50	78.70	3	Group 3: intermediate size, large tall and deep
S2916	46	O2	459.93	1575	2508	44.64	33.36	7	Group 5: small and short with very deep peaks, shortest
S2923	47	na	784.17	1659	3911	40.01	44.83	7	Group 5: small and short with very deep peaks, shortest
S2939	48	na	268.52	1248	4411	40.01	36.50	7	Group 5: small and short with very deep peaks, shortest
S2991	49	na	1075.73	2364	3113	25.03	59.38	8	Group 5: small and short with very deep peaks, deepest type
S3021	50	na	1084.88	2060	3576	131.03	66.33	8	Group 5: small and short with very deep peaks, deepest type
S3051	51	na	705.54	2474	3078	86.95	94.90	2	Group 4: small with deep peak, most common type
S3052	52	na	626.84	1637	3840	83.69	62.28	8	Group 5: small and short with very deep peaks, deepest type
S3066	53	na	1543.18	5502	237	92.87	63.68	10	Group 2: large and tall with shallow peak: shallow
S3110	54	na	644.62	1997	3457	40.08	86.35	2	Group 4: small with deep peak, most common type
S3120	55	na	591.32	1248	3844	21.31	54.59	8	Group 5: small and short with very deep peaks, deepest type
S3121	56	na	497.69	1900	3818	41.94	75.07	8	Group 5: small and short with very deep peaks, deepest type
S3147	57	na	464.48	1885	3645	42.49	70.70	8	Group 5: small and short with very deep peaks, deepest type
S3150	58	na	560.56	2650	3136	28.35	84.84	2	Group 4: small with deep peak, most common type
S3158	59	na	636.54	1727	3590	33.59	40.60	7	Group 5: small and short with very deep peaks, shortest

Seamount ID	Map ID	SUMA	Area (km2)	Height (m)	Peak depth (m)	Distance to nearest seamount (km)	Escarpment (deg)	Morphotype	Description
S3164	60	na	747.61	3835	1140	41.74	98.02	3	Group 3: intermediate size, large tall and deep
S3192	61	na	511.48	2386	2922	41.74	74.79	2	Group 4: small with deep peak, most common type
S3193	62	na	439.61	1828	3760	25.62	72.64	8	Group 5: small and short with very deep peaks, deepest type
S3201	63	na	837.77	1796	3691	26.06	77.21	2	Group 4: small with deep peak, most common type
S3203	64	na	378.03	2059	3204	83.10	68.34	8	Group 5: small and short with very deep peaks, deepest type
S3207	65	na	1142.18	4568	92	7.11	92.24	10	Group 2: large and tall with shallow peak: shallow
S3218	66	na	599.82	2636	2547	36.22	79.58	2	Group 4: small with deep peak, most common type
S3219	67	O1	722.90	1501	3855	57.72	67.49	8	Group 5: small and short with very deep peaks, deepest type
S3227	68	na	788.19	1937	3347	35.56	73.60	2	Group 4: small with deep peak, most common type
S3234	69	na	541.95	1746	3103	54.19	81.67	2	Group 4: small with deep peak, most common type
S3243	70	na	484.46	1727	3762	77.89	80.74	8	Group 5: small and short with very deep peaks, deepest type
S3261	71	O2	623.34	2352	2571	35.70	74.88	2	Group 4: small with deep peak, most common type
S3264	72	na	279.60	1283	3031	26.49	75.69	2	Group 4: small with deep peak, most common type
S3267	73	O2	461.90	1981	1426	48.45	52.67	1	Group 4: small with deep peak, short with moderately deep peak
S3272	74	O1	564.97	1696	3731	35.44	79.96	2	Group 4: small with deep peak, most common type
S3282	75	na	1574.44	3461	1324	50.67	73.90	10	Group 2: large and tall with shallow peak: shallow
S3286	76	na	1060.86	1835	2979	35.70	73.23	2	Group 4: small with deep peak, most common type
S3292	77	na	340.80	2750	3800	20.01	73.23	2	Group 4: small with deep peak, most common type
S3296	78	na	595.53	1408	2803	26.49	68.76	2	Group 4: small with deep peak, most common type
S3302	79	O1	742.22	2677	2589	35.44	80.51	2	Group 4: small with deep peak, most common type
S3303	80	na	762.65	1750	2361	50.67	66.34	1	Group 4: small with deep peak, short with moderately deep peak
S3304	81	na	33.06	1210	4923	20.01	77.79	8	Group 5: small and short with very deep peaks, deepest type
S3325	82	na	593.12	1351	4047	76.73	63.88	8	Group 5: small and short with very deep peaks, deepest type
S3342	83	na	2522.44	2988	1274	63.60	38.63	11	Group 3: intermediate size, largest basal area and deepest peak depth
S3347	84	na	1157.78	2368	2547	37.80	61.01	11	Group 3: intermediate size, largest basal area and deepest peak depth
S3363	85	O2	817.08	3037	99	68.09	98.19	3	Group 3: intermediate size, large tall and deep
S3367	86	O1	1271.26	5210	985	28.16	84.72	10	Group 2: large and tall with shallow peak: shallow
S3373	87	na	2427.73	5115	1486	46.38	85.79	10	Group 2: large and tall with shallow peak: shallow
S3384	88	na	614.22	2154	2311	32.17	64.19	1	Group 4: small with deep peak, short with moderately deep peak
S3387	89	O2	1478.15	2721	2129	47.66	40.57	11	Group 3: intermediate size, largest basal area and deepest peak depth
S3391	90	na	563.30	1870	2352	24.38	67.59	2	Group 4: small with deep peak, most common type

Seamount ID	Map ID	SUMA	Area (km2)	Height (m)	Peak depth (m)	Distance to nearest seamount (km)	Escarpment (deg)	Morphotype	Description
S3401	91	na	884.96	1367	2824	87.06	55.68	1	Group 4: small with deep peak, short with moderately deep peak
S3409	92	O2	711.96	2598	1381	46.22	81.31	5	Group 3: intermediate size, small, moderately tall and shallowest peak depths of this group
S3412	93	na	1247.04	2166	2478	30.62	68.75	2	Group 4: small with deep peak, most common type
S3420	94	O2	600.05	2043	2906	71.58	68.44	2	Group 4: small with deep peak, most common type
S3428	95	O1	2446.05	4755	756	69.00	43.11	9	Group 2: Large and tall with shallow peak, larger
S3431	96	na	1099.45	5381	81	33.59	67.49	10	Group 2: large and tall with shallow peak: shallow
S3438	97	O2	1560.17	2357	1652	46.22	51.65	11	Group 3: intermediate size, largest basal area and deepest peak depth
S3453	98	O2	1676.91	4158	1677	104.33	85.57	10	Group 2: large and tall with shallow peak: shallow
S3454	99	O2	1251.24	3933	18	5.28	84.30	10	Group 2: large and tall with shallow peak: shallow
S3469	100	O2	1181.91	1446	3059	69.17	13.89	7	Group 5: small and short with very deep peaks, shortest
S3470	101	na	1445.68	2052	2423	28.09	47.47	11	Group 3: intermediate size, largest basal area and deepest peak depth
S3497	102	na	379.84	1718	2613	18.25	80.35	2	Group 4: small with deep peak, most common type
S3534	103	O2	1054.93	2864	2372	33.87	87.90	3	Group 3: intermediate size, large tall and deep
S3570	104	O2	2616.72	4046	598	67.79	78.76	10	Group 2: large and tall with shallow peak: shallow
S8611	105	O6	719.70	2496	2228	25.82	52.09	11	Group 3: intermediate size, largest basal area and deepest peak depth
S8815	106	O5, O6	1017.50	3374	2653	22.47	70.30	11	Group 3: intermediate size, largest basal area and deepest peak depth
S8818	107	O4	559.31	1601	3915	28.48	53.40	8	Group 5: small and short with very deep peaks, deepest type
S8838	108	O5	381.70	1040	4104	59.50	23.23	7	Group 5: small and short with very deep peaks, shortest
S8842	109	O4	517.31	3893	1003	41.37	77.95	3	Group 3: intermediate size, large tall and deep
S8879	110	O4	492.08	2831	1533	27.14	96.24	3	Group 3: intermediate size, large tall and deep
S8901	111	O3	736.25	2412	2820	23.34	71.49	2	Group 4: small with deep peak, most common type
S8909	112	na	318.17	1508	3965	21.92	72.74	8	Group 5: small and short with very deep peaks, deepest type
S8951	113	na	383.20	1305	4282	29.42	49.68	8	Group 5: small and short with very deep peaks, deepest type
S8974	114	na	594.53	2135	2932	39.50	78.26	2	Group 4: small with deep peak, most common type
S8992	115	O2	247.27	1871	3113	21.74	92.82	2	Group 4: small with deep peak, most common type
S8993	116	O2	454.09	2676	2420	21.74	90.29	2	Group 4: small with deep peak, most common type
S9053	117	na	398.73	1042	3974	21.31	52.82	8	Group 5: small and short with very deep peaks, deepest type
S9065	118	na	395.29	1786	3917	25.62	67.32	8	Group 5: small and short with very deep peaks, deepest type
S9066	119	na	374.43	2502	3133	28.35	74.88	2	Group 4: small with deep peak, most common type
S9067	120	na	551.77	1723	3706	26.06	78.83	2	Group 4: small with deep peak, most common type

Seamount ID	Map ID	SUMA	Area (km2)	Height (m)	Peak depth (m)	Distance to nearest seamount (km)	Escarpment (deg)	Morphotype	Description
S9094	121	na	794.48	2069	2736	37.80	64.60	2	Group 4: small with deep peak, most common type
S9100	122	O1	1008.75	2660	3335	28.16	46.53	11	Group 3: intermediate size, largest basal area and deepest peak depth
S9104	123	na	481.90	1686	2651	24.38	82.79	2	Group 4: small with deep peak, most common type
S9121	124	na	341.68	1761	2836	21.35	73.10	2	Group 4: small with deep peak, most common type
S9122	125	na	655.50	1584	2815	21.35	42.97	1	Group 4: small with deep peak, short with moderately deep peak
S9133	126	na	319.28	2050	2553	18.25	83.02	2	Group 4: small with deep peak, most common type
S9167	127	O2	755.06	3344	2069	33.87	91.54	3	Group 3: intermediate size, large tall and deep
S10003	128	O5, O6	8282.17	1729	4437	9.60	3.43	6	Group 1: very large and tall with low escarpment

Source: xxxx