MARINE BIOREGIONS OF THE COOK ISLANDS

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Daniela M. Ceccarelli[1], Kate Davey[2] , Hayley Weeks[3] , Keith Twyford[2], Hans Wendt[4], Gander Wainiqolo[2], John Kaitu'u[4], Miriam Bhurrah[4]

1 ARC Centre of Excellence for Coral Reef Studies, James Cook University and Marine Ecology Consultant
2 Cook Islands Ridge to Reef Project, Rarotonga, Cook Islands
3 National Environment Service, Rarotonga, Cook Islands
4 Oceania Regional Office, IUCN (International Union for Conservation of Nature), Suva, Fiji

IMAGE: NATIONAL ENVIRONMENT SERVICE
COVER IMAGE: KIRBY MOREJOHN

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ACRONYMS

CIMP	Cook Islands Marine Park (synonymous with Marae Moana)
EBSA	Ecologically or Biologically Significant Marine Areas
EEZ	Exclusive Economic Zone
IBA	Important Bird Areas
IMSP	Island marine spatial plan
IUCN	International Union for the Conservation of Nature
IUCN ORO	IUCN Oceania Regional Office
MACBIO	Marine and Coastal Biodiversity Management in Pacific Island Countries
MMCO	Marae Moana Coordination Office
MMR	Ministry of Marine Resources
MPA	Marine Protected Area
MSP	Marine Spatial Planning
My	Million years
NMMSP	National Marae Moana spatial plan
NES	National Environment Service
nm	nautical miles
R2R	Ridge to Reef
SPREP	Secretariat of the Pacific Regional Environment Programme
SUMA	Special and / or unique marine area
UNDP	United Nations Development Programme

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IMAGE: KIRBY MOREJOHN

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IMAGE: ALISHA STREET | @myrarotonga | www.my-rarotonga.com

EXECUTIVE SUMMARY

The Cook Islands Government has declared almost their entire marine estate a multiple use marine park. Established under the *Marae Moana Act 2017*, the Marae Moana (also known as the Cook Islands Marine Park) has the primary purpose to 'protect and conserve the ecological, biodiversity, and heritage values of the Cook Islands marine environment'. The Act specifies various strategies to achieve this purpose including provision 'for a system of marine spatial planning, including zoning plans and management measures for marine-based activities'.

Marine spatial planning is a holisitic planning process that allocates the spatial distribution of human activities in marine areas to achieve ecological, economic and social objectives. To help deliver on the 'ecological' objectives, marine spatial planning provides a framework to design ecologically representative and well-connected systems of marine protected areas (MPAs). Networks of highly protected zones are the best conservation tool to protect marine biodiversity, ecological processes and ecosystem health.

Because of the extensive gaps in the available data on marine ecosystems, surrogates for biodiversity must be used in the design of representative networks of MPAs. Bioregionalisation, or the classification of the marine environment into spatial units that host similar biota, can serve this purpose and provide spatially explicit surrogates of biodiversity. In 2016, the MACBIO[5] Project undertook a study to develop draft reef associated and deepwater bioregions for the Southwest Pacific. The study aimed to develop bioregions that were at a scale useful for national planning, as a basis for the systematic identification of an ecologically representative system of MPAs.

An important subsequent step was that each Pacific Islands country would review and refine the resultant draft bioregions with their local marine experts prior to their use in planning. A workshop was held in Rarotonga on 16 July 2020 for the purpose of refining the Cook Islands bioregions.

In the Cook Islands, the review process led to the retention of the original 30 deepwater bioregions as identified by MACBIO, and the separation of six reef-associated marine bioregions into nine. The retention of the draft deepwater bioregions was based on the lack of detailed knowledge about these ecosystems. It was further acknowledged that more data exist for the Cook Islands deepwater bioregions than was used for the Southwest Pacific bioregionalisation, however there is currently limited capacity to analyse these data. Reef-associated bioregions were modified based on traditional knowledge, scientific data and an understanding of the geological history of different islands. The local experts identified this as the best information available, and acknowledged that there was limited experience in working with bioregional information and data, particularly for the deep offshore regions of the Cook Islands' Exclusive Economic Zone (EEZ).

The use of bioregions is just one of the important data layers used to identify an ecologically representative system of highly protected zones. To be truly ecologically representative and comprehensive, it is also important to consider any additional information about habitats, species and ecological processes.

5 Marine and Coastal Biodiversity Management in Pacific Island Countries - http://macbio-pacific.info/

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 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 Marae Moana (Cook Islands Marine Park - CIMP) , 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 (IMSPs).

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 these exist), and the territorial sea (from the baseline out to the 12 nm mark). Section 24 of the Act further establishes a "marine protected area" (MPA) of 50 nm around all 15 islands. Mining and large-scale fishing are prohibited in these areas. Twyford (2020) provides a detailed critique of the Act as it relates to marine spatial planning.

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 (Halpern et al., 2008). Marine ecosystems are known to be in decline, mostly due to human activities, but there is recognition that it is possible to manage such 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.

1.3 COOK ISLANDS MARINE BIOREGIONS PROJECT

The decline of marine biodiversity and ecosystem services is a worldwide problem and requires better management (Jackson et al. 2001, Worm et al. 2006, Mora 2008, Beger et al. 2015, Klein et al. 2015). This has been recognised globally and individual countries are attempting to address the problem through national efforts, multi- and bi-lateral initiatives and other agreements and commitments. For example, over 1,400 Voluntary Commitments to improve ocean management were made at the United Nations Ocean Conference in June 2017[6] . This includes at least 130 Pacific-specific targets. In order to achieve these targets, many nations are currently in the process of zoning their marine and coastal areas for better management and greater protection. The placement and effective designation of a national network ofmarine protected areas requires the full representation of marine biodiversity in highly protected zones, whilst considering socio-economic and cultural needs.

To help deliver on the objectives of Marae Moana, marine spatial planning provides a framework to identify 'ecologically representative' and well-connected systems of highly protected zones. Networks of highly protected zones are the best conservation tool to conserve marine biodiviersity, ecological processes and ecosystem health (Graham et al. 2011, Edgar et al. 2014, Green et al. 2014).

To develop an 'ecologically representative' network of protected zones within Marae Moana, it would be ideal to have perfect marine habitat and species data. However, this is rarely possible, and surrogates for biodiversity must be found. Bioregionalisation, or the classification of the marine environment into spatial units that host similar biota, can serve to provide spatially explicit surrogates of biodiversity for marine conservation and management (Fernandes et al. 2005, Last et al. 2010, Fernandes et al. 2012, Terauds et al. 2012, Foster et al. 2013, Rickbeil et al. 2014). Marine bioregions are useful because they offer insurance against ignoring parts of the ocean where data are incomplete or absent. Bioregions define areas with relatively similar assemblages of biological and physical characteristics without requiring complete data on all species, habitats and processes (Spalding et al. 2007). This means, for example, that seamounts within one bioregion will be more similar to each other than seamounts in another bioregion. Similarly, coral reefs within one bioregion will be more similar to each other than coral reefs in another bioregion.

Marine bioregions are useful because they offer insurance against ignoring parts of the ocean where data are incomplete or absent.

In 2018, the MACBIO[7] Project undertook a study to develop draft reef associated and deepwater bioregions for the Southwest Pacific (Wendt et al., 2018). The study aimed to develop bioregions that were at a scale useful for national planning, as a basis for the systematic identification of an ecologically representative system of marine protected areas.

6 oceanconference.un.org/ commitments

7 Marine and Coastal Biodiversity Management in Pacific Island Countries - http://macbio-pacific.info/

In developing the draft bioregionalisation, the authors of the study understood that local knowledge and expertise beyond available datasets is critical to ensuring the best possible outcome. Therefore, an important subsequent step was that each Pacific Islands country were advised to review and refine the resultant draft bioregions with their local marine experts prior to their use in planning.

Once bioregions are confirmed in the Cook Islands, an ecologically representative system of highly protected zones can then be built by including examples of every bioregion (and every habitat, where known) within the system. Defining bioregions across a country helps mitigate against ignoring habitats and ecosystems about which no or little data are available.

Networks of highly protected zones will be an important outcome of the marine spatial planning process as will the designation of other ocean zones that meet the social, economic and cultural objectives of Marae Moana.

The Cook Islands marine bioregionalisation project aims to:

- support marine spatial planning processes currently underway
- describe and present a revised set of marine bioregions
- provide a biological and environmental framework for identification of an ecologically representative system of highly protected zones within the Marae Moana.

Image: Kirby Morejohn

2 METHODS

2.1 SOUTHWEST PACIFIC MARINE BIOREGIONS – ANALYSIS AND RESULTS

The technical bioregionalisation analysis of the Southwest Pacific, including the Cook Islands, resulted in the identification of two broad groupings: reef-associated and deepwater bioregions. A detailed, peer-reviewed description of the methods can be found in Beger et al. (2019). A total of 262 deepwater bioregions and 102 reef-associated bioregions were defined. Most were contiguous but some had multiple, non-contiguous parts. Many deepwater bioregion boundaries extended beyond countries' EEZs and into areas beyond national jurisdiction (commonly called the 'high seas'). A majority of the deepwater bioregions share boundaries with neighbouring countries as do many reef-associated bioregions. Names and descriptions of bioregions are provided in Wendt et al. (2018). Note that whilst in-country knowledge of reef systems is relatively high, knowledge of the deep-sea environments is lower (Wendt et al. 2018).

Final numbers of bioregions per country is provided in Table 1. Because many bioregions cut across national boundaries they are listed in more than one country. The numbers of bioregions in the table reflect the technical results before the in-country expertise of the Cook Islands is used to refine and revise the bioregions. Bioregions of the Southwest Pacific are displayed in Figures 1 and 2.

Country name	Number of deepwater bioregions	Number of shared deepwater bioregions	Number of reef-associated bioregions	Number of shared reef-associated bioregions
American Samoa	9	9	2	2
Cook Islands	**30**	**27**	**6**	**4**
Fiji	23	23	12	3
French Polynesia	52	23	16	5
Kiribati	54	47	11	2
Marshall Islands	34	19	9	2
Micronesia	41	32	19	4
Nauru	6	6	1	1
New Caledonia	31	24	8	1
Niue	6	6	2	2
Palau	19	18	4	0
Samoa	6	6	1	1
Solomon Islands	33	26	19	6
Tokelau	8	8	2	2
Tonga	35	27	4	3
Tuvalu	13	13	4	3
Vanuatu	20	18	7	3
Wallis and Futuna	9	9	3	3

Table 1: Number of draft deepwater and reef-associated bioregions described in Southwest Pacific Island countries and territories

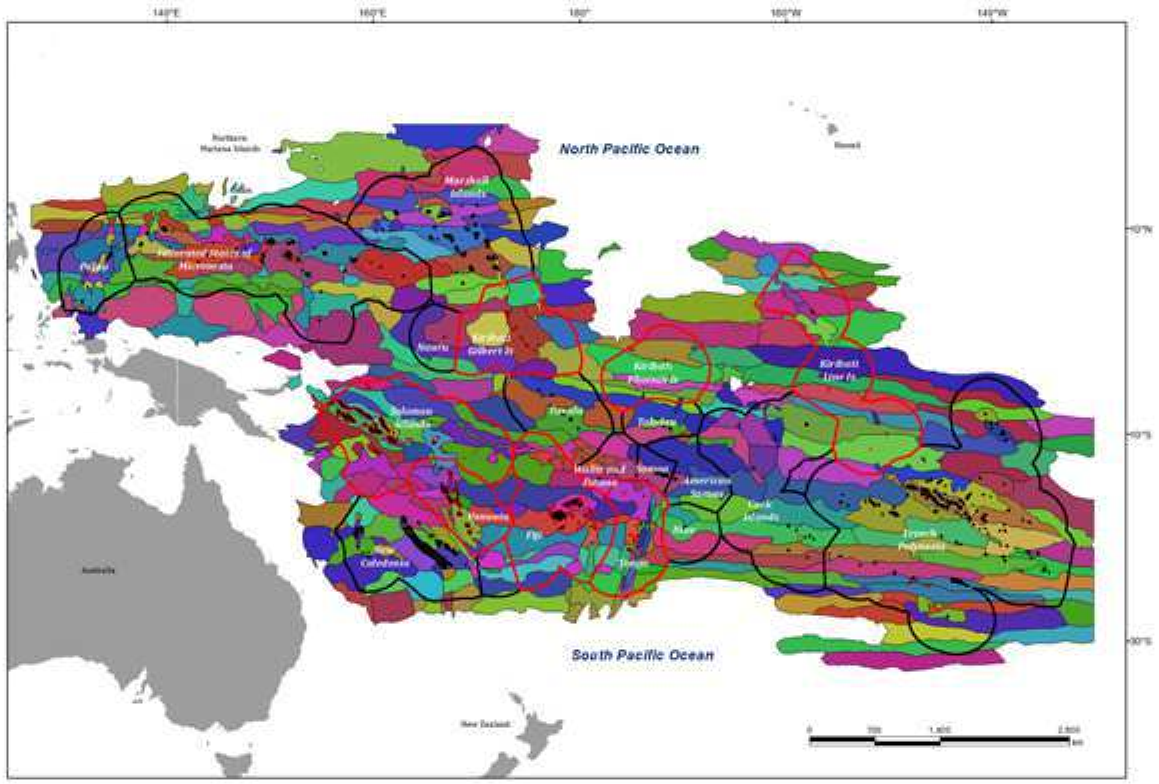

Figure 1: Draft deepwater bioregions for the Southwest Pacific.

The different coloured areas represent different bioregions. Because the available colour palette was not sufficient, some different bioregions may appear to be the same colour.

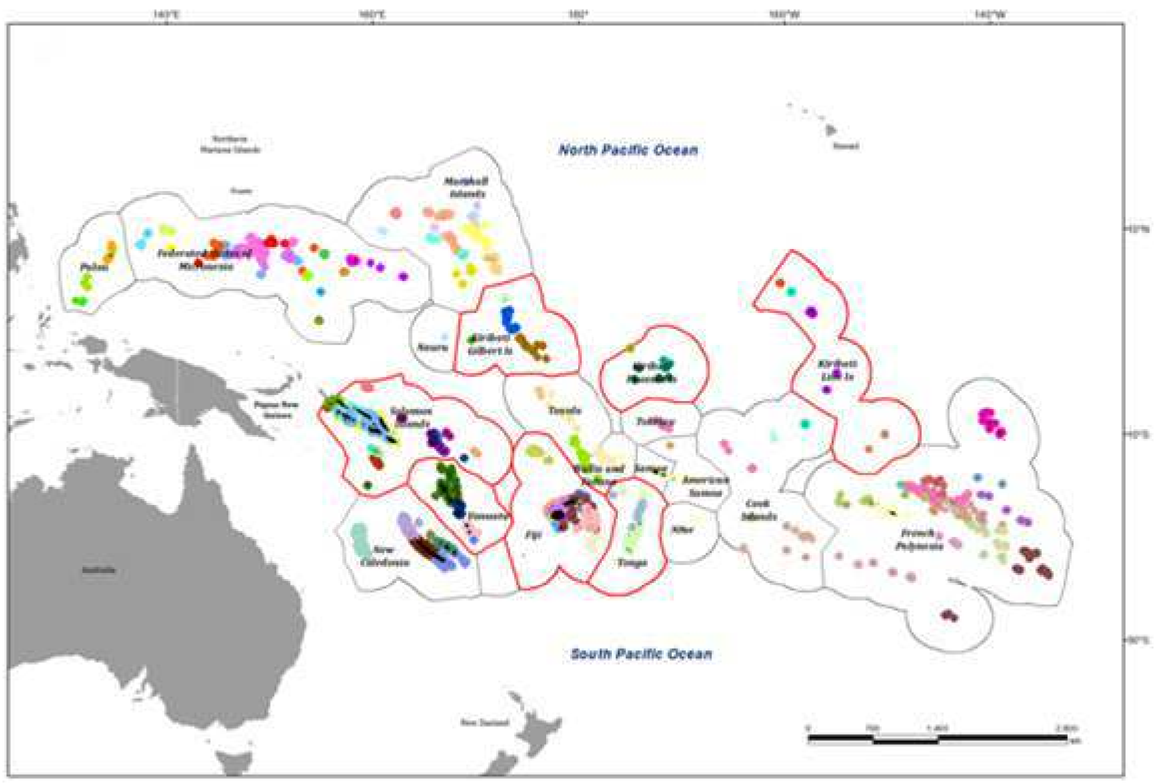

Figure 2: Draft reef-associated bioregions for the Southwest Pacific

Reef areas are exaggerated in this figure for ease of viewing. The different coloured areas represent different bioregions. Because the available colour palette was not sufficient, some different bioregions may appear to be the same colour.

2.2 COOK ISLANDS MARINE BIOREGIONS WORKSHOP

The workshop to refine the draft bioregions in the Cook Islands was hosted and chaired by the Ridge to Reef Project (R2R) and the Marae Moana Coordination Office (MMCO). It occurred on 16 July 2020 in Rarotonga, Cook Islands. Because of domestic and international travel restrictions imposed during the global Covid19 pandemic, some participants were present through the "zoom" online meeting platform, including Cook Islands' outer island representatives and international expertise. The aim of the workshop was to gather marine expertise in the Cook Islands to review and refine the draft bioregions. The workshop agenda (Appendix 1) was circulated to all participants (Appendix 2) and clarified with a Powerpoint presentation at the start of the workshop (Appendix 3).

The workshop initially reviewed the reef-associated bioregions, since it was understood that these areas were more familiar to, and better understood by, the participants. Then the participants reviewed the deepwater bioregions. Participants were asked to consider location, boundaries, name and description of each bioregion.

The format in which the information was gathered from participants can be seen in Appendix 4. The 40 participants (Figure 3) were divided into working groups. A GIS technician was present to assist, and each working group had a rapporteur and a facilitator.

Figure 3. Workshop participants during the 2020 review of the Cook Islands bioregions

Supporting material was made available to the workshop participants including maps of the draft bioregions (at various scales) for each working group to annotate and hardcopy maps of biophysical data posted on a "resource wall" (see Appendix 5). The biophysical data were also available in a GIS for those specifically interested, and have been stored within the Cook Islands geoportal housed at Infrastructure Cook Islands (ICI) following Cook Islands spatial data policy[8]. Two types of data were included in developing the bioregions, and other biophysical data not used to develop the bioregions but still useful to inform the refinement of the Cook Islands bioregion boundaries and descriptions.

The participants were assigned to working groups in two ways: people with more knowledge about a particular area were allocated to the group dealing with that area; people with more general knowledge chose which group they could work with. Some participants were extremely knowledgeable about more than one area and were asked to move around the groups that were working on specific geographies.

8 Cook Islands Spatial Information Management Policy 2020
https://www.maraemoana.gov.ck/wp-content/uploads/2020/08/SIM-Policy-FINAL-21022020.pdf

3 RESULTS

3.1 SOUTHWEST PACIFIC MARINE BIOREGIONS - COOK ISLANDS DRAFT BIOREGIONS

At Cook Islands national level, the MACBIO technical analysis (refer Wendt et al., 2018) resulted in the identification of six draft reef-associated marine bioregions and 30 draft deepwater bioregions (see Figure 4 and Figure 5 respectively).

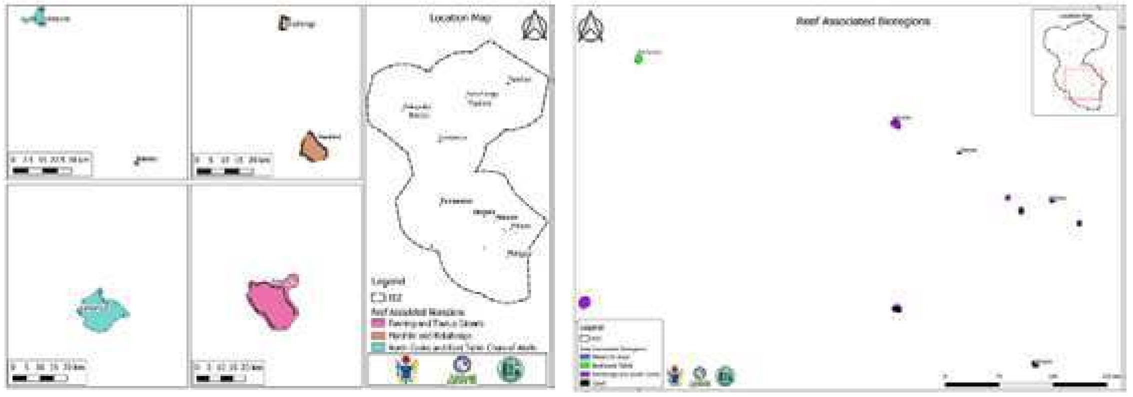

Figure 4. Draft reef-associated bioregions of the Cook Islands

Notes: Left panel: northern islands; right panel: southern islands.
These were the outcome of the MACBIO technical analysis (Wendt et al., 2018). Each colour represents a different marine bioregion.

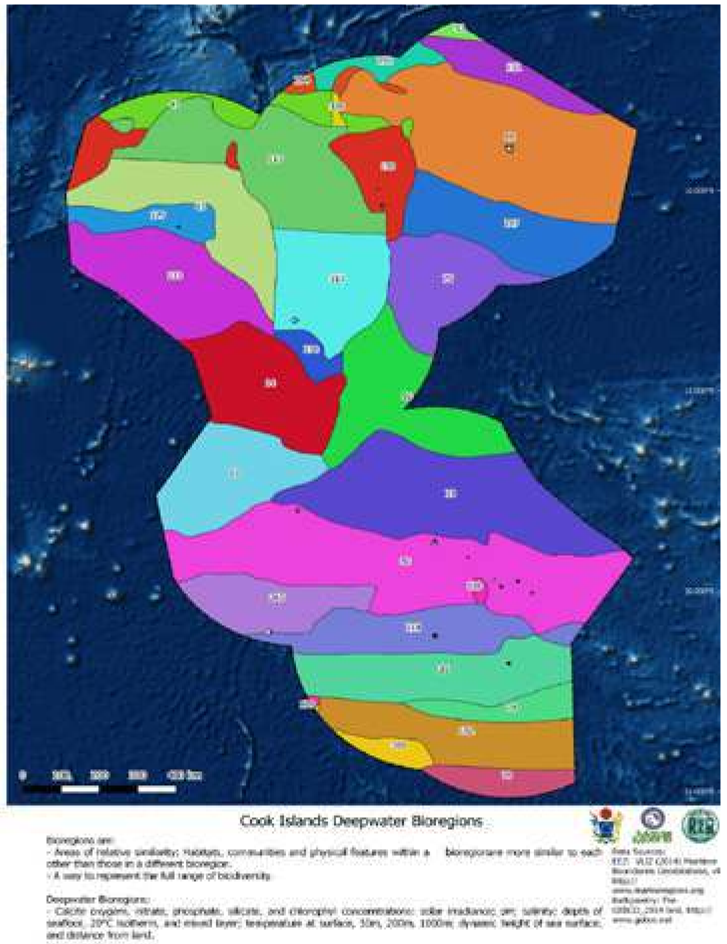

Figure 5. Draft deepwater bioregions of the Cook Islands

Note: these were the outcome of the MACBIO technical analysis (Wendt et al., 2018). Each colour and code represents a different marine bioregion.

The authors of the original study knew however, that this process would be incomplete without local input. An important subsequent step was to refine the draft bioregions with inputs from marine experts in the Cook Islands prior to their use in national planning.

The following section describes the process and outcomes of the Cook Islands workshop, and follow-up discussions and research, during which the marine bioregions of the Cook Islands were finalised for use.

3.2 REVISED BIOREGIONS FOR THE COOK ISLAND

3.2.1 Reef-associated bioregions

Through the Southwest Pacific bioregional identification process, the reefs of the Cook Islands were designated into bioregions that spanned whole islands and groups of islands, and in some cases reflected the geological continuation of island or seamount chains beyond the Cook Islands' EEZ. This resulted in six draft reef-associated bioregions, which often grouped Cook Islands reefs with those in French Polynesia.

Comments received from workshop participants suggested the following amendment to the reef-associated bioregions:

1. In the Northern Group, Rakahanga and Manihiki are currently listed under the same reef-associated bioregion; these should be considered separately as they have different ecological assemblages and systems. Productivity and species diversity are thought to be much lower in the Rakahanga Lagoon than in Manihiki (George and Story 2014).
2. In the Southern Group, Rarotonga, Mangaia and the Ngaputoru group (Atiu, Mitiaro, Ma'uke and Takutea) have very different geological histories. Rarotonga is a young (1.5My) volcanic island which formed its own volcanic hotspot and is not related to neighbouring hotspot chains. Mangaia and the Ngaputoru group are raised limestone islands and significantly older than Rarotonga. Mitiaro, Aitutaki, Atiu and Ma'uke formed from the Arago hotspot (situated south of Rurutu, an island in French Polynesia), whereas Mangaia formed from the MacDonald hotspot, east of Rapa in the far south of French Polynesia. Aitutaki is an 'almost atoll', with volcanic characteristics like Rarotonga and atoll characteristics like the northern group.
3. In the Southern Group, the allocation of Mitiaro as a different bioregion from the rest of the Ngaputoru was questioned. It was recommended that Mitiaro be grouped with the other Ngaputoru islands.
4. Where individual islands are clearly associated with island or seamount chains that extend beyond the Cook Islands EEZ, bioregion names were modified to reflect both the entire chain and the name of the island(s) within the EEZ that makes part of the chain.

Based on this feedback, the following nine reef-associated bioregions were recommended:

Northern Cook Islands:

1. Penrhyn (Tongareva) Atoll (renamed from Fanning and Tautua Islands)
2. Rakahanga Atoll
3. Manihiki Atoll
4. Nassau, Pukapuka and Suwarrow (renamed from North Cooks and East Tahiti Chain of Atolls)

Southern Cook Islands:

5. Northwest Tahiti and Palmerston Atoll (renamed from Northwest Tahiti)
6. Rarotonga
7. Mangaia
8. Ngaputoru: Atiu, Mitiaro, Mauke and Takutea
9. Aitutaki, Manuae and Southern Shelf.

The final reef-associated bioregions for the Cook Islands are shown in Figure 6 and described in Table 2.

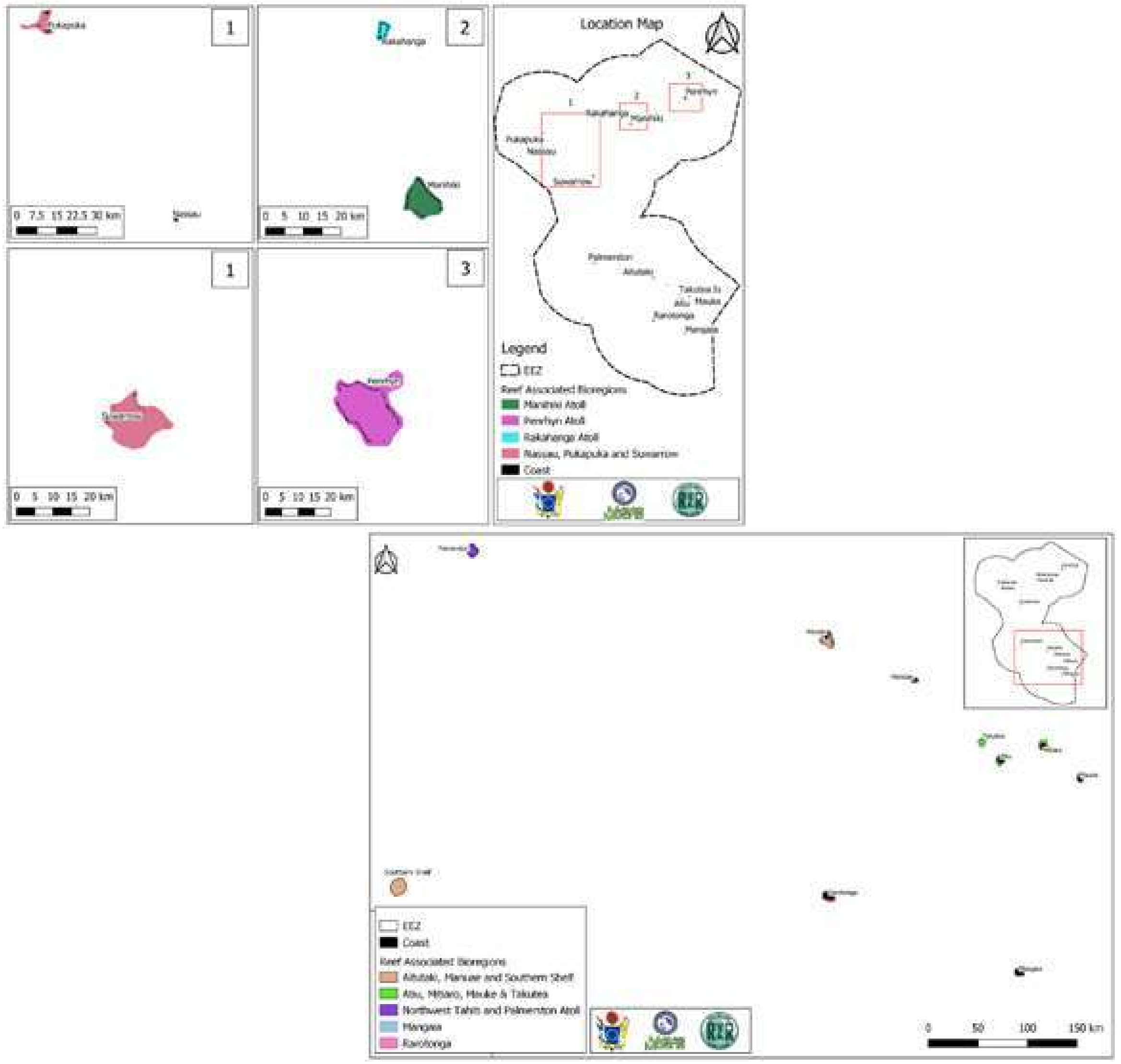

Figure 6. Revised reef-associated bioregions of the Cook Islands.

Top panel: northern islands; bottom panel: southern islands.

Bioregion name	Description
Penrhyn (Tongareva) Atoll	Makatea type island isolated from the rest of the southern group of islands. Narrow fringing reefs and steep slopes. Small and relatively flat habitat, likely to support small and vulnerable populations.
Manihiki Atoll	Atoll with a large, deep lagoon, flushed only across the reef tops at high tide and through small reef channels. Located on the southern end of the Manihiki Plateau. Potential for connectivity with Rakahanga Atoll.
Rakahanga Atoll	Atoll with a shallow, turbid lagoon, flushed only across the reef tops at high tide and through small reef channels, northern part drying during low tides. Located on the southern end of the Manihiki Plateau. Potential for connectivity with Manihiki Atoll.
Nassau, Pukapuka and Suwarrow	Atolls and islands set in a southeast to northwest chain, set along the southwest-facing side of the Manihiki Plateau.
Northwest Tahiti and Palmerston Atoll	Atoll with a large, deep lagoon, flushed only across the reef tops at high tide and through small reef channels. Arises independently from deep waters. Highly isolated.
Aitutaki, Manuae and Southern Shelf	Almost-atoll (Aitutaki) and atoll (Manuae) at the northwestern end of the Cook-Austral Island chain of seamounts. Rich in biodiversity. Potential for connectivity in a northwest to southeast direction, making these two islands possible source reefs.
Atiu, Mitiaro, Mauke & Takutea	Collectively known as Ngaputoru, these are makatea type islands with an upraised limestone shelf, narrow fringing reefs and steep slopes. Small and relatively flat habitat, likely to support small and vulnerable populations.
Rarotonga	High island isolated from the rest of the southern group of islands. Narrow fringing reefs and a small lagoon encircling the island, deep channels connecting shallow habitats to the open ocean on all sides of the island.
Mangaia	Makatea type island isolated from the rest of the southern group of islands. Narrow fringing reefs and steep slopes. Small and relatively flat habitat, likely to support small and vulnerable populations.

Table 2. Names and descriptions of revised reef-associated bioregions of the Cook Islands

3.2.2 Deepwater bioregions

The workshop did not make suggestions for amendments to deepwater bioregions from the regional study. A common response from workshop participants was that not enough information was currently known to confidently confirm or suggest amendments to the draft deepwater bioregions. No changes were therefore made and the draft deepwater bioregions were accepted as final (Appendix 6).

The final deepwater bioregions are shown in Figure 7; full descriptions are in Appendix 6.

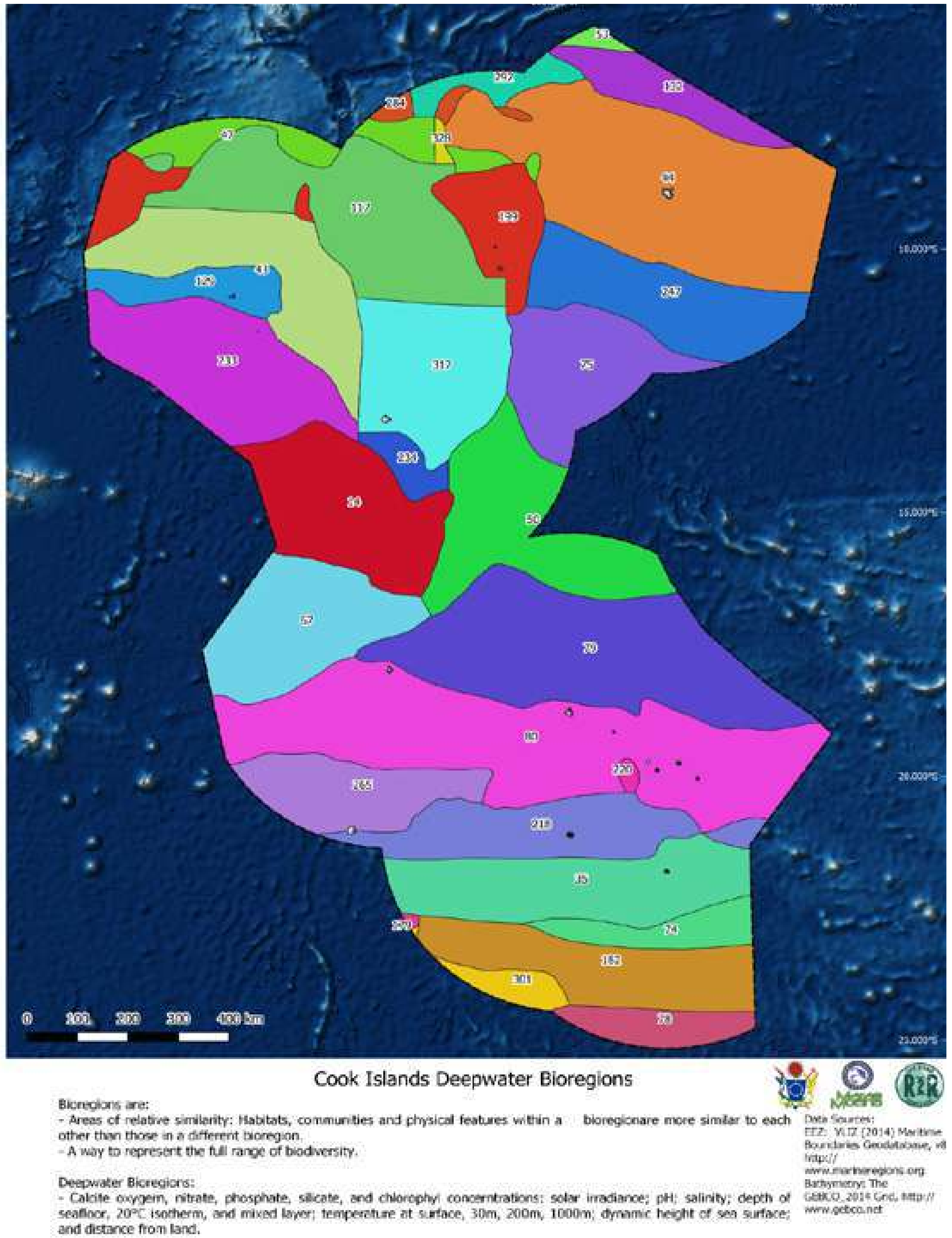

Figure 7. Final deepwater bioregions of the Cook Islands.

4 CONCLUSIONS

After review by workshop participants, it was decided to make some changes to the reef-associated bioregions and retain the boundaries and descriptions of the 30 deepwater bioregions. It is acknowledged that marine data for the Cook Islands remain imperfect and the boundaries and descriptions of bioregions will be subject to further review and change as more data become available.

Workshop participants commented that little biological information was considered in the design of the draft deepwater bioregions. Species and habitat data such as fisheries, marine mammal migratory pathways and deep-sea benthos have been collected since the draft bioregions were designed in 2016; any future review and analysis of regional bioregions could incorporate these additional data. The workshop also noted that, given the large number of seamounts in the Cook Islands EEZ, bioregions could be revisited according to the peak depths and other geomorphological attributes of seamounts.

Some workshop participants also commented that the MACBIO report (Wendt et al., 2018) used data from only four of the 15 Cook Islands, from a few key surveys, to inform the reef-associated bioregion analysis. Data exist for at least 10 of the other islands. Future efforts to further refine the reef-associated bioregions for the Cook Islands will benefit from using these data.

The Cook Islands is made up of islands with distinct geomorphology and well-documented geological histories; recent biophysical data are available for many areas. There are a large number of active scientific research programs by government and non-government organisations; the knowledge generated by these research activities assisted in the refinement of reef-associated bioregions. The reef-associated bioregions were therefore re-grouped according to a combination of geological, geomorphological and biological characteristics.

The final marine bioregions as identified in this report now form a more robust and technically sound input to offshore and inshore marine spatial planning decisions in the Cook Islands.

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6 APPENDICES

APPENDIX 1 – WORKSHOP AGENDA

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 2 - BIOREGIONS		
TIME	**Item**	**PRESENTERS**
9:00 am	Opening Prayer	
9:05 am	Agenda #1: Welcome and Agenda ahead	Maria Tuoro Marae Moana Director
9: 20 am	Agenda #2: What are bioregions and how do they help us protect biodiversity?	Kate Davey MSP Team Leader Ridge to Reef
9:40 am	Agenda #3: Reviewing Bioregions – task ahead	Dr Dani Ceccarelli Marine Ecologist and SUMA Specialist
10:00 am	MORNING TEA	
10:20 am	Agenda #4: ACTIVITY: Reef Associated Bioregions Deep water Bioregions	Gander Wainiqolo, GIS Coordinator, Marae Moana
12:00 pm	Report Back	Group presenters
12:30 pm	Agenda #5: Next steps closing remarks	Maria Tuoro Marae Moana Director
12:45 pm	END	
1:00 pm	LUNCH	

APPENDIX 2 – 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
Exceive Papa	OPM/CCCI	Climate Change Intern	exceive.papa@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
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
Kate Davey	Australia	R2R Consultant	katedaveyau@gmail.com
Daniela Ceccarelli	Australia	R2R Marine Ecologist	dmcecca@gmail.com

APPENDIX 3 – WORKSHOP PRESENTATION

Workshop:
Marine Bioregions
for the Cook Islands

Agenda #1: Welcome

Director, Marae Moana Coordination Office
Office of the Prime Minister

Workshop Agenda

9:00	Opening Prayer
9:05	Welcome Remarks
9:20	What are bioregions and how do they help us protect biodiversity?
9:40	Reviewing Bioregions – task ahead
10:00	**MORNING TEA**
10:20	ACTIVITY – Reviewing Bioregions
12:00	Report Back
12:30	Next Steps and closing
1:00pm	**LUNCH**

Agenda #2: What are bioregions and how do they help us protect biodiversity?

MSP Team Leader
Ridge to Reef Project

Old approach to protect biodiversity

- Only protects areas where we **know** there is high biodiversity
- Protect areas with **known** endemic or threatened species

NOW we know

- Protecting these areas is important BUT not enough to protect the ecosystems AND
- We have imperfect information about these anyway

New approach to protect biodiversity

Ecologically **representative** network of marine protected areas

- Convention on Biological Diversity (CBD)
- Includes examples of **all** habitat types

We don't have complete information about biodiversity in the marine environment so how do we choose "ecologically representative" areas to protect?

Solution: use bioregions

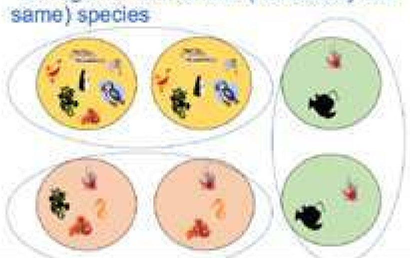
- It is a value-neutral way to describe the entire marine environment of Cook Islands.
- Bioregions can be described using comprehensive layers of environmental data: surrogates for imperfect biological information.
- Every part of Cook Islands marine environment belongs to one bioregion or another.
- No bioregion is more important than any other.

But what are bioregions?

- Areas that are similar
  - Habitats, communities, and physical features within a bioregion (e.g. seamounts, coral reefs, fish, invertebrates) are more similar to each other than those same features in a different bioregion.
- A way to represent the full range of biodiversity
- A classification of habitat and environmental types

Example of Species Assemblages

"Bioregions" with similar (not exactly the same) species



Bioregions as a planning tool

If one objective is an ecologically representative network of marine protected areas covering a minimum percentage, say 20% of the marine environment with the goal of enhancing biodiversity

......

Then having 20% of each bioregion included in a protected area/s will help meet that objective.

Bioregions of the SW Pacific

In 2015 - The MACBIO project (GIZ, SPREP and IUCN) undertook bioregionisation for the SW Pacific to allow for Pacific Island Countries to do national scale marine planning and management.

2 Types of Bioregions

1. Deep water bioregions
2. Reef-associated bioregions (shallow)

Draft Bioregions of the Cook Islands

- 30 Deepwater Bioregions in Cook Islands

Reef-associated (shallow) bioregions

6 reef-associated bioregions in Cook Islands

Agenda # 4: Reviewing draft bioregions for the Cook Islands

Marine Ecologist and Bioregion Specialist
Ridge to Reef Project

Suggestion:
Each group - take one region only

Each Group must nominate

Each Group must nominate:

- Facilitator
- Note taker

Note: Please swap tables if you have broad knowledge of the Cook Islands.

Resources

Resources:

a) Resource wall (hard copy maps posted on the wall
b) Hard copy maps and input forms on tables to guide discussions

Reminder – your task
Review the draft bioregion boundaries and descriptions

For each reef-associated and deepwater bioregion consider:

1. Boundaries and location of the bioregions - do any boundaries need to change? Do any bioregions need to be merged or split?
2. Names for the bioregions - provide your own locally relevant.
3. Description of the bioregions – review & add to the deepwater bioregion descriptions; create descriptions for the reef-associated bioregions
4. **BEGIN with Reef Bioregions and then move to Deepwater Bioregions**

Agenda # 4 Next steps

- Digitise the boundary changes
- Verify clarity about suggested bioregion name changes and descriptions
- Prepare bioregions report for Cook Islands
- Distribute draft report back to participants

Summary of 2 Day Workshop

- Provided an overview of Marine Spatial Planning and projected timelines
- Identified Inshore Special, Unique Marine Areas (SUMA)
- Reviewed draft Bioregions for the Cook Islands

Meitaki mo'ota for all you hard work and commitment

Data Contributors

APPENDIX 4 – WORKSHOP INFORMATION GATHERING

COOK ISLANDS BIOREGIONS WORKSHEET

<table>
<tr><td>Group/table #</td><td>Facilitator:</td><td>Rapporteur:</td></tr>
<tr><td rowspan="2">Group Members (names)</td><td colspan="2">Bioregions numbers:</td></tr>
<tr><td colspan="2">General Location:</td></tr>
<tr><th>Task</th><th colspan="2">Additional Information</th></tr>
<tr><td>Description of the bioregions – review & add to any of the deepwater bioregion descriptions; create descriptions for the reef-associated bioregions</td><td colspan="2"></td></tr>
<tr><td>Boundaries and location of the bioregions - do any boundaries need to change? Do any bioregions need to be merged or split? Draw any suggested boundary changes onto the map.</td><td colspan="2"></td></tr>
<tr><td>Name for the bioregions- suggest your own locally relevant.</td><td colspan="2"></td></tr>
</table>

Questions to Consider when answering

Reef Associated Bioregions description

(a) Can you identify the environmental conditions/characteristics that are similar within the bioregions i.e current strength, proximity to land, rivers, wind, habitat/community types, localised upwellings etc

(b) Identify parts of the bioregion that do not make sense (ie look like they don't share the same environmental conditions)

Boundaries

(a) Looking at the bioregion boundaries – does the bioregion capture the correct features? Should it be moved towards or away from reefs/rivers etc?

Deepwater Bioregions description

(a) Briefly view the 'summary' provided for the deep-water bioregions. - Can you see any patterns or major influences? i.e., chlorophyll, sea surface temperature, mixed layer depth, bathymetry

(b) Are there any bioregions that stand out or that you can provide any further comments/ details on (geomorphology, productivity)?

Boundaries

(a) Looking at the bioregion boundaries – does the bioregion capture the correct features? Should it be moved towards or away from reefs?

APPENDIX 5 – DATA AVAILABLE TO WORKSHOP PARTICIPANTS

List of bioregions maps, resource wall and e-copy maps and GIS data

Note: RED fonts include data that were used to derive the draft bioregions. The fonts in black indicate data that were NOT used to derive bioregions but directly related to the environmental conditions and biological information including on how species are distributed in the ocean.

Bioregions maps used for feedback

1. Deepwater bioregions map at EEZ scale
2. Shallow reef-associated bioregions map

Resource wall (hard copy maps posted on the walls)

1. Cook Islands bathymetry – used in developing bioregions
2. Cook Islands silicate concentration – used in developing bioregions
3. Cook Islands sea surface temperature – used in developing bioregions
4. Cook Islands chlorophyll a concentration – used in developing bioregions
5. Cook Islands mixed layer depth – used in developing bioregions
6. Cook Islands nitrate concentration in the ocean – used in developing bioregions
7. Cook Islands dissolved oxygen – used in developing bioregions
8. Cook Islands photosynthetically available radiation – used in developing bioregions
9. Cook Islands phosphate concentration – used in developing bioregions
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 and has since been centrally stored on the Cook Islands geo portal housed at Infrastructure Cook Islands (ICI) in line with Cook Islands spatial data policy.

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 – used in developing bioregions
   b. Temperature at 1000 meters depth – used in developing bioregions
   c. Temperature at 200 meters depth – used in developing bioregions
   d. Temperature at 30 meters depth – used in developing bioregions
   e. Depth of 20 degree isotherm – used in developing bioregions
   f. Mixed layer depth – used in developing bioregions
   g. Salinity – used in developing bioregions
   h. pH – used in developing bioregions
   i. Photosynthetically available radiation – used in developing bioregions
   j. Nitrate – used in developing bioregions
   k. Calcite – used in developing bioregions
   l. Silicate – used in developing bioregions
   m. Phosphate – used in developing bioregions
   n. Depth – used in developing bioregions
3. Bio-physical data
   a. Chlorophyll-a concentration – used in developing bioregions
   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 6 – DESCRIPTION OF THE FINAL DEEPWATER BIOREGIONS OF THE COOK ISLANDS

Descriptions of bioregions are not constrained to national boundaries, and therefore most of these descriptions relate to entire bioregions which may span across two or more EEZs.

Location	Code	Name	Countries	Summary description
DW	**14**	American Samoa - Cook Islands Abyssal Mountains	ASM,COK,WSM,TON	Forms on the northern tip of the Tonga EEZ on a basin and abyssal mountain. Sea surface temperature is high; chlorophyll-a concentrations, 20°C isotherm and the deepwater temperature are low. Mixed layer depth, salinity and pH levels, nitrate and solar irradiance are moderate. Calcite is low and variable and dissolved oxygen concentrations are low and stable. Strong sea surface currents generally from the Northeast. Contains 5 seamounts type 2 (small with deep peak, most common type); 5 seamounts type 3 (intermediate size, large tall and deep); 3 seamounts type 7 (small and short with very deep peaks, shortest); 5 seamounts type 8 (small and short with very deep peaks, deepest type); 2 seamounts type 10 (large and tall with shallow peak: shallow); contains 1 active, confirmed hydrothermal vent. The upper depth is 5000m and the lower depth is 5500m.
DW	**35**	South Polynesian Range	COK,PYF,TON,NIU	Dominated by slope from ridges, and plateaus sloping towards the trench. Sea surface temperature is moderate. chlorophyll-a concentrations, 20°C isotherm and deepwater temperature are low. Salinity, pH levels, nitrate and solar irradiance are moderate. Mixed layer depth is moderate. Calcite is low and variable and dissolved oxygen concentrations are low and stable. Strong sea surface currents generally from the north. Contains 1 seamount type 3 (intermediate size, large tall and deep); 1 seamount type 6 (very large and tall with low escarpment); 2 seamounts type 7 (small and short with very deep peaks, shortest); 1 seamount type 8 (small and short with very deep peaks, deepest type); 1 seamount type 11 (intermediate size, largest basal area and deepest peak depth). Includes 3 blind canyon types. The upper depth is 4500m and the lower depth is 5500m.
DW	**43**	Cook Island - Tokelau Sea Mounts	WLF,ASM,COK,TKL	Bioregion falls mostly within Tokelau and the Cook Islands. Dominant feature is seamounts. Other features include abyssal features (hills, plains and mountains). SST high and stable, chlorophyll-a concentration is low and variable, salinity is low, dissolved oxygen is low and stable, deep water temperature is moderate, 20°C isotherm is moderate, mixed layer depth is moderate, solar irradiance is moderate, pH level is low, silicate level is low, phosphate level is low, nitrate level is moderate, calcite is low and variable. Contains 4 seamounts type 1 (small with deep peak, short with moderately deep peak); 12 seamounts type 2 (small with deep peak, most common type); 1 seamount type 7 (small and short with very deep peaks, shortest); 1 seamount type 10 (large and tall with shallow peak: shallow); 4 seamounts type 11 (intermediate size, largest basal area and deepest peak depth). The upper depth is 3500m and the lower depth is 4500m.

Location	Code	Name	Countries	Summary description
DW	**44**	Cook Island - Kiribati Abyssal Range	COK,KIR	Thin and pointed bioregion that falls mainly within the Phoenix and Line islands (Kiribati) and the Cook Islands. Dominated by abyssal hills with seamounts formed on top of abyssal mountains. Other features include a trough, ridges and escarpments. Sea surface temperature is high and stable. Chlorophyll-a concentrations are low to moderate. Dissolved oxygen, phosphorous, solar irradiation, pH, nitrate levels are moderate. Salinity levels are high, and silicate and calcite levels are low. Temperatures at depth are quite high. Mixed layer and 20°C isotherm are deep. Contains 10 seamounts type 2 (small with deep peak, most common type); 6 seamounts type 3 (intermediate size, large tall and deep); 2 seamounts type 7 (small and short with very deep peaks, shortest); 10 seamounts type 8 (small and short with very deep peaks, deepest type); 2 seamounts type 9 (Large and tall with shallow peak, larger); 9 seamounts type 10 (large and tall with shallow peak: shallow); 4 seamounts type 11 (intermediate size, largest basal area and deepest peak depth). The upper depth is 4500m and the lower depth is 5500m.
DW	**47**	Cook Islands, Tokelau - High Seas Sea Mounts	COK,TKL	This bioregion falls mostly in the high seas but cuts through Tokelau and the Cook Islands EEZs. Mostly dominated by seamounts and abyssal hills and mountains. Other features include a plateau, trough, ridge and escarpments. Sea surface temperature is moderate and stable. Chlorophyll-a concentrations are low. Very deep mixed layer and a more shallow 20°C isotherm. 1000m temperature is low. Temperature at 200m is high and stable. Silicate, nitrate, dissolved oxygen, calcite, and phosphorous levels are low. Salinity is high. Solar irradiation and pH are high to moderate. Contains 1 seamount type 1 (small with deep peak, short with moderately deep peak); 8 seamount type 2 (small with deep peak, most common type); 1 seamount type 3 (intermediate size, large tall and deep); 1 seamount type 7 (small and short with very deep peaks, shortest); 1 seamount type 8 (small and short with very deep peaks, deepest type); 3 seamount type 10 (large and tall with shallow peak: shallow); 3 seamount type 11 (intermediate size, largest basal area and deepest peak depth). The upper depth is 3500m and the lower depth is 5000m.
DW	**50**	French Polynesia & Cook Islands - High Seas Abyssal Range	COK,PYF	Most of the bioregion falls within the French Polynesia EEZ but also cuts through Cook Islands and the high seas. Dominant features are abyssal hills and mountains with seamounts. Other features include a basin, escarpment, plateau and ridge. SST is moderate and stable, chlorophyll-a concentrations are low. Calcite, solar irradiance, phosphorous, silicate, and nitrate levels are low. Dissolved oxygen, salinity, and pH levels are high. Temperature at 200m is high, while at 1000m it is moderate and variable. Mixed layer is deep; 20°C isotherm is shallow and variable. Contains 4 seamounts type 1 (small with deep peak, short with moderately deep peak); 3 seamounts type 2 (small with deep peak, most common type); 5 seamounts type 3 (intermediate size, large tall and deep); 1 seamount type 4 (small with deep peak, most isolated type); 3 seamounts type 7 (small and short with very deep peaks, shortest); 5 seamounts type 8 (small and short with very deep peaks, deepest type); 7 seamounts type 10 (large and tall with shallow peak: shallow); 1 seamount type 11 (intermediate size, largest basal area and deepest peak depth). Includes 2 blind canyon types. The upper depth is 4000m and the lower depth is 5000m.

Location	Code	Name	Countries	Summary description
DW	**53**	Starbuck and high seas	COK,KIR	Falls within the Line Islands Group EEZ (Kiribati) and the high seas. Mostly abyssal features (hills, plains and mountains) including seamounts. Other minor features include a basin, ridge and escarpment. Sea surface temperature is moderate and stable. Chlorophyll-a concentrations are moderate. Shallow 20°C isotherm and deep mixed layer. Moderate 1000m temperature and high 200m temperature. Salinity, solar irradiance, nitrate, dissolved oxygen, and phosphorous levels are high. pH, silicate, and calcite levels are low. Contains 4 seamounts type 2 (small with deep peak, most common type); 3 seamounts type 3 (intermediate size, large tall and deep); 1 seamount type 6 (very large and tall with low escarpment); 2 seamounts type 7 (small and short with very deep peaks, shortest); 3 seamounts type 8 (small and short with very deep peaks, deepest type); 3 seamounts type 10 (large and tall with shallow peak: shallow); 2 seamounts type 11 (intermediate size, largest basal area and deepest peak depth). The upper depth is 4500m and the lower depth is 5500m.
DW	**67**	American Samoa Basin and North Tonga Trench	ASM,COK,WSM,TON,NIU	Contains the Tonga Trench and abyssal hills and cuts through Tonga, Niue and American Samoa. Sea surface temperature is high, chlorophyll-a concentrations, 20°C isotherm and the deepwater temperature are low. Mixed layer depth, salinity and pH levels, nitrate and solar irradiance are moderate. Calcite is low and variable and dissolved oxygen concentrations are low and stable. Strong sea surface currents generally flow from the northeast. Contains 8 seamounts type 2 (small with deep peak, most common type); 2 seamounts type 3 (intermediate size, large tall and deep); 1 seamount type 7 (small and short with very deep peaks, shortest); 3 seamounts type 8 (small and short with very deep peaks, deepest type); 3 seamounts type 10 (large and tall with shallow peak: shallow); 2 seamounts type 11 (intermediate size, largest basal area and deepest peak depth). The upper depth is 5000m and the lower depth is 5500m.
DW	**74**	Moses Reef and Austral Seamounts	COK,PYF	Contains mainly abyssal features (plains, hills and mountains) with seamounts. Runs across the Cook Islands and French Polynesia. SST is low and stable, chlorophyll-a concentrations are generally low. Salinity is high and dissolved oxygen is low and variable. Temperature at 1000m is low and 20°C isotherm is deep, mixed layer depth is moderate. pH is low. Silicate, phosphate, nitrate and calcite are moderate. Contains 6 seamounts type 2 (small with deep peak, most common type); 3 seamounts type 3 (intermediate size, large tall and deep); 1 seamount type 7 (small and short with very deep peaks, shortest); 3 seamounts type 8 (small and short with very deep peaks, deepest type); 2 seamounts type 10 (large and tall with shallow peak: shallow); 1 seamount type 11 (intermediate size, largest basal area and deepest peak depth). The upper depth is 4000m and the lower depth is 5000m.

Location	Code	Name	Countries	Summary description
DW	**75**	Line, Cooks and French Polynesia High Seas	COK,PYF,KIR	Contains basins and abyssal features with very few seamounts. Runs across the Cook Islands, Line Islands Group - Kiribati and French Polynesia. Sea surface temperature is high and stable. Chlorophyll-a concentrations are low. Calcite, solar irradiance, phosphorous, silicate, and nitrate levels are low. Dissolved oxygen, salinity, and pH levels are high. Temperature at 200m is high, while at 1000m it is moderate and variable. Mixed layer is deep; 20°C isotherm is shallow and variable. Contains 1 seamount type 3 (intermediate size, large tall and deep); 2 seamounts type 4 (small with deep peak, most isolated type); 3 seamounts type 7 (small and short with very deep peaks, shortest); 4 seamounts type 8 (small and short with very deep peaks, deepest type); The upper depth is 4500m and the lower depth is 5500m.
DW	**78**	South Fabert and McGee Seamount	COK,PYF,TON	Small bioregion with canyons, ridges, plateau and slope. Non-contiguous and falls within Tonga, Cook Islands and French Polynesia EEZ. Sea surface temperature is low and stable; chlorophyll-a concentrations, 20°C isotherm and the deepwater temperature are moderate. Salinity and pH levels are high. Nitrate and solar irradiance are moderate to low. Mixed layer depth and calcite are moderate and variable. Dissolved oxygen concentrations are moderate and stable. Strong sea surface currents generally flow from the northwest. Contains 1 seamount type 2 (small with deep peak, most common type); 1 seamount type 4 (small with deep peak, most isolated type); 1 seamount type 7 (small and short with very deep peaks, shortest); 2 seamounts type 11 (intermediate size, largest basal area and deepest peak depth). Includes 2 blind canyon types. The upper depth is 4500m and the lower depth is 5000m.
DW	**79**	Northwest Niue and north Arutanga (Cooks)	ASM,COK,PYF,TON,NIU	Non-contiguous bioregion which contains plateau, ridges and abyssal mountains. Sea surface temperature is high, chlorophyll-a concentrations, 20°C isotherm and the deepwater temperature are low. Mixed layer depth, salinity and pH levels, nitrate and solar irradiance are moderate. Calcite is low and variable and dissolved oxygen concentrations are low and stable. Strong sea surface currents generally flow from the northeast. Contains 1 seamount type 1 (small with deep peak, short with moderately deep peak); 3 seamounts type 2 (small with deep peak, most common type); 4 seamounts type 3 (intermediate size, large tall and deep); 1 seamount type 5 (intermediate size, small, moderately tall and shallowest peak depths of this group); 1 seamount type 7 (small and short with very deep peaks, shortest); 3 seamounts type 8 (small and short with very deep peaks, deepest type); 1 seamount type 9 (Large and tall with shallow peak, larger); 6 seamounts type 10 (large and tall with shallow peak: shallow); 1 seamount type 11 (intermediate size, largest basal area and deepest peak depth). Includes 1 blind canyon type. The upper depth is 4500m and the lower depth is 5000m.

Location	Code	Name	Countries	Summary description
DW	**80**	Capricorn and Eclipse Deep	COK,PYF,TON,NIU	Contains the biggest seamount: "the Capricorn Seamount", and the Eclipse Seamount within the Cook Islands, and lies on an abyssal hill and trench. Sea surface temperature is high, chlorophyll-a concentrations, 20°C isotherm and the deepwater temperature are low. Salinity is variable. and pH levels, nitrate and solar irradiance are moderate. Mixed layer depth is low. Calcite is low and variable and dissolved oxygen concentrations are low and stable. Moderate sea surface currents generally flow from the north-northeast. Contains 1 seamount type 1 (small with deep peak, short with moderately deep peak); 2 seamounts type 2 (small with deep peak, most common type); 4 seamounts type 3 (intermediate size, large tall and deep); 7 seamounts type 7 (small and short with very deep peaks, shortest); 4 seamounts type 8 (small and short with very deep peaks, deepest type); 1 seamount type 9 (Large and tall with shallow peak, larger); 6 seamounts type 10 (large and tall with shallow peak: shallow); 2 seamounts type 11 (intermediate size, largest basal area and deepest peak depth). Includes 2 blind canyon types. The upper depth is 4000m and the lower depth is 5500m.
DW	**117**	Northern Cooks Plateau	COK	Contains plateaus on the eastern side with few large seamounts. A trough runs through the center of the bioregion and deep abyssal hills and mountains lie to the west. The bioregion falls within the Cook Islands. SST is moderate and stable. Chlorophyll-a concentrations are low. Very deep mixed layer and a more shallow 20°C isotherm. 1000m temperature is low. Temperature at 200m is high and stable. Silicate, nitrate, dissolved oxygen, calcite, and phosphorous levels are low. Salinity is high. Solar irradiation and pH are high to moderate. Contains 3 seamounts type 1 (small with deep peak, short with moderately deep peak); 2 seamounts type 2 (small with deep peak, most common type); 1 seamount type 3 (intermediate size, large tall and deep); 1 seamount type 5 (intermediate size, small, moderately tall and shallowest peak depths of this group); 1 seamount type 10 (large and tall with shallow peak: shallow); 3 seamounts type 11 (intermediate size, largest basal area and deepest peak depth). The upper depth is 2500m and the lower depth is 4000m.
DW	**129**	Funafuti, Tokelau and Tema Deep (Cooks)	TUV,WLF,ASM,COK,TKL	Contains small to medium size deep seamounts formed on abyssal mountains. Seamounts have steep escarpments. SST is high and stable, chlorophyll-a concentrations are low. Very deep mixed layer and a more shallow 20°C isotherm. 1000m temperature is low. Temperature at 200m is high and stable. Silicate, nitrate, dissolved oxygen, calcite, and phosphorous levels are low. Salinity is high. Solar irradiation and pH are high to moderate. Contains 15 seamounts type 2 (small with deep peak, most common type); 3 seamounts type 3 (intermediate size, large tall and deep); 1 seamount type 7 (small and short with very deep peaks, shortest); 3 seamounts type 8 (small and short with very deep peaks, deepest type); 4 seamounts type 10 (large and tall with shallow peak: shallow); 3 seamounts type 11 (intermediate size, largest basal area and deepest peak depth). Includes 2 blind canyon types and 4 shelf incising canyon types. The upper depth is 4000m and the lower depth is 5000m.

Location	Code	Name	Countries	Summary description
DW	**132**	Penrhyn Basin	COK,PYF,KIR	Mostly abyssal hills and plains with a basin. SST is high to moderate and stable. Chlorophyll-a concentrations are moderate. Shallow 20°C isotherm and deep mixed layer. High temperature at 1000m and 200m depths. Salinity, solar irradiance, nitrate, dissolved oxygen, and phosphorous levels are moderate to high. pH, silicate, and calcite levels are low. Contains 1 seamount type 2 (small with deep peak, most common type); 1 seamount type 3 (intermediate size, large tall and deep); 1 seamount type 7 (small and short with very deep peaks, shortest); 3 seamounts type 8 (small and short with very deep peaks, deepest type); 4 seamounts type 10 (large and tall with shallow peak: shallow); 2 seamounts type 11 (intermediate size, largest basal area and deepest peak depth). The upper depth is 5000m and the lower depth is 5500m.
DW	**179**	Southern Niue and High Seas	COK,TON,NIU	Mostly dominated by abyssal plains and hills with a basin. Other features include an escarpment and ridges. SST is low and stable; chlorophyll-concentrations, 20°C isotherm and the deepwater temperature are moderate. Salinity and pH levels are high. Nitrate and solar irradiance are moderate to low. Mixed layer depth and calcite are moderate and variable. Dissolved oxygen concentrations are moderate and stable. Strong sea surface currents generally flow from the northwest. Intersects 1 seamount type 11 (intermediate size, largest basal area and deepest peak depth). The upper depth is 5000m and the lower depth is 6000m.
DW	**182**	Fabert and McGee Seamount	COK,PYF,TON	Small bioregion with canyons, ridges, plateau and slope. SST is low and stable; chlorophyll-concentrations, 20°C isotherm and the deepwater temperature are moderate. Salinity and pH levels are high. Nitrate and solar irradiance are moderate to low. Mixed layer depth and calcite are moderate and variable. Dissolved oxygen concentrations are moderate and stable. Strong sea surface currents generally flow from the northwest. Contains 2 seamounts type 2 (small with deep peak, most common type); 2 seamounts type 3 (intermediate size, large tall and deep); 2 seamounts type 8 (small and short with very deep peaks, deepest type); 3 seamounts type 11 (intermediate size, largest basal area and deepest peak depth). Includes 7 blind canyon types and 1 shelf incising canyon type. The upper depth is 4500m and the lower depth is 5000m.
DW	**199**	Manihiki and Tokelau to South Phoenix	ASM,COK,TKL,KIR	Non-contiguous region with mostly seamounts and plateaus in the east. SST is high and stable. Chlorophyll-a concentrations are low. Very deep mixed layer and a more shallow 20°C isotherm. 1000m temperature is low. Temperature at 200m is high and stable. Silicate, nitrate, dissolved oxygen, calcite, and phosphorous levels are low. Salinity is high. Solar irradiation and pH are high to moderate. Contains 2 seamounts type 1 (small with deep peak, short with moderately deep peak); 4 seamounts type 2 (small with deep peak, most common type); 1 seamount type 5 (intermediate size, small, moderately tall and shallowest peak depths of this group); 2 seamounts type 10 (large and tall with shallow peak: shallow); 5 seamounts type 11 (intermediate size, largest basal area and deepest peak depth). The upper depth is 3500m and the lower depth is 5000m.

Location	Code	Name	Countries	Summary description
DW	**218**	Rarotonga and the Byus Seamount	COK,PYF	Long, thin bioregion with deep seamounts formed on abyssal habitats scattered across the bioregion with steep escarpments. SST is low and stable, chlorophyll-a concentrations are generally low. Salinity is high and dissolved oxygen is low and variable. Temperature at 1000m and 20°C isotherm are deep, mixed layer depth is moderate. pH is low. Silicate, phosphate, nitrate and calcite are moderate. Contains 2 seamounts type 2 (small with deep peak, most common type); 6 seamounts type 3 (intermediate size, large tall and deep); 1 seamount type 6 (very large and tall with low escarpment); 4 seamounts type 7 (small and short with very deep peaks, shortest); 3 seamounts type 8 (small and short with very deep peaks, deepest type); 3 seamounts type 10 (large and tall with shallow peak: shallow); 2 seamounts type 11 (intermediate size, largest basal area and deepest peak depth). The upper depth is 4500m and the lower depth is 5000m.
DW	**220**	Nukutipipi Deep	COK,PYF	Mostly abyssal hills and two seamounts. SST low and stable, chlorophyll-a concentrations are generally low. Salinity is high and dissolved oxygen is low and variable. Temperature at 1000m and 20°C isotherm are deep, mixed layer depth is moderate. pH is low. Silicate, phosphate, nitrate and calcite are moderate. Contains 1 seamount type 1 (small with deep peak, short with moderately deep peak); 3 seamounts type 3 (intermediate size, large tall and deep); 1 seamount type 7 (small and short with very deep peaks, shortest). The upper depth is 4000m and the lower depth is 4500m.
DW	**233**	Swains Atoll and Nassau Island Deep	WLF,ASM,COK,WSM,TKL	Mostly seamounts, abyssal features (plains, hills and mountains), a basin and steep escarpments. SST is moderate and stable, chlorophyll-a is low and variable, salinity is low, dissolved 0xygen is low and stable, deep water temperature is deep, 20°C isotherm is deep, mixed layer depth is medium, solar irradiance is high, pH level is low, silicate level is moderate, phosphate level is moderate, nitrate level is moderate, calcite is low. Contains 1 seamount type 1 (small with deep peak, short with moderately deep peak); 18 seamounts type 2 (small with deep peak, most common type); 4 seamounts type 3 (intermediate size, large tall and deep); 1 seamount type 7 (small and short with very deep peaks, shortest); 13 seamounts type 8 (small and short with very deep peaks, deepest type); 6 seamounts type 10 (large and tall with shallow peak: shallow); 1 seamount type 11 (intermediate size, largest basal area and deepest peak depth). Includes 7 blind canyon types and 1 shelf incising canyon type. The upper depth is 4500m and the lower depth is 5500m.

Location	Code	Name	Countries	Summary description
DW	**234**	Wallis, Samoa and American Samoa	WLF,ASM,COK,WSM,TON	Includes medium size seamounts, northern parts of the Tonga Trench, and ridges that form the base of American Samoa with lots of canyons. Sea surface temperature is high, chlorophyll-a low and variable, salinity is low, dissolved oxygen is low and stable, deep water temperature is deep, 20°C isotherm is deep, mixed layer depth is medium, solar irradiance is high, pH level is low, silicate level is moderate, phosphate level is moderate, nitrate level is moderate, calcite is low. Contains 1 seamount type 1 (small with deep peak, short with moderately deep peak); 7 seamounts type 2 (small with deep peak, most common type); 9 seamounts type 3 (intermediate size, large tall and deep); 1 seamount type 7 (small and short with very deep peaks, shortest); 1 seamount type 8 (small and short with very deep peaks, deepest type); 2 seamounts type 9 (Large and tall with shallow peak, larger); 10 seamounts type 10 (large and tall with shallow peak: shallow); 1 seamount type 11 (intermediate size, largest basal area and deepest peak depth). Includes 16 blind canyon types and 12 shelf incising canyon types. The upper depth is 2000m and the lower depth is 5000m.
DW	**247**	Flint and Vostok Islands Deep	COK,PYF,KIR	Contains many smaller seamounts formed on abyssal mountains, steep escarpments and underlying basins. Sea surface temperature is high and stable. Chlorophyll-a concentrations are low. Calcite, solar irradiance, phosphorous, silicate, and nitrate levels are low. Dissolved oxygen, salinity, and pH levels are high. Temperature at 200m is high, while at 1000m it is moderate and variable. Mixed layer is deep; 20°C isotherm is shallow and variable. Contains 9 seamounts type 2 (small with deep peak, most common type); 5 seamounts type 3 (intermediate size, large tall and deep); 2 seamounts type 4 (small with deep peak, most isolated type); 1 seamount type 7 (small and short with very deep peaks, shortest); 5 seamounts type 8 (small and short with very deep peaks, deepest type); 2 seamounts type 9 (Large and tall with shallow peak, larger); 7 seamounts type 10 (large and tall with shallow peak: shallow); 4 seamounts type 11 (intermediate size, largest basal area and deepest peak depth). The upper depth is 4500m and the lower depth is 5500m.
DW	**265**	Tonga Ridge, Beveridge Reef Deep and west Cooks	COK,TON,NIU	Deep bioregion with mostly abyssal hills and plains extending towards the Tonga Trench and ridges. SST is moderate, chlorophyll-a concentrations, 20°C isotherm and the deep water temperature are low. Salinity, pH levels, nitrate and solar irradiance are moderate. Mixed layer depth is moderate. Calcite is low and variable and dissolved oxygen concentrations are low and stable. Strong sea surface currents generally flow from the north. Contains 1 seamount type 2 (small with deep peak, most common type); 4 seamounts type 3 (intermediate size, large tall and deep); 1 seamount type 6 (very large and tall with low escarpment); 4 seamounts type 7 (small and short with very deep peaks, shortest); 2 seamounts type 8 (small and short with very deep peaks, deepest type); 2 seamounts type 10 (large and tall with shallow peak: shallow); 1 seamount type 11 (intermediate size, largest basal area and deepest peak depth). The upper depth is 5000m and the lower depth is 5500m.

Location	Code	Name	Countries	Summary description
DW	**284**	North Cooks, Line and High Seas	COK,KIR	Contain seamounts, ridges, a trough, plateau and abyssal hills and mountains. SST is moderate and stable. Chlorophyll-a concentrations are moderate. Shallow 20°C isotherm and deep mixed layer. High temperature at 1000m and 200m depths. Salinity, solar irradiance, nitrate, dissolved oxygen, and phosphorous levels are moderate to high. pH, silicate, and calcite levels are low. Contains 2 seamounts type 1 (small with deep peak, short with moderately deep peak); 3 seamounts type 2 (small with deep peak, most common type); 4 seamounts type 3 (intermediate size, large tall and deep); 1 seamount type 5 (intermediate size, small, moderately tall and shallowest peak depths of this group); 1 seamount type 7 (small and short with very deep peaks, shortest); 5 seamounts type 10 (large and tall with shallow peak: shallow); 1 seamount type 11 (intermediate size, largest basal area and deepest peak depth). The upper depth is 3000m and the lower depth is 4500m.
DW	**292**	Gardner Island and North Cooks Boarder	COK,KIR	A two-part bioregion with troughs, seamounts, ridges, a basin and abyssal mountains and hills featured on the eastern side. The western part mostly includes deep abyssal habitats with seamounts. SST is high and stable. Chlorophyll-a concentrations are moderate. Dissolved oxygen, phosphorous, solar irradiation, pH, nitrate levels are moderate. Salinity levels are high, and silicate and calcite levels are low. Temperatures at depth are quite high. Mixed layer depth and 20°C isotherm are deep. Contains 7 seamounts type 2 (small with deep peak, most common type); 1 seamount type 3 (intermediate size, large tall and deep); 2 seamounts type 7 (small and short with very deep peaks, shortest); 7 seamounts type 10 (large and tall with shallow peak: shallow); 5 seamounts type 11 (intermediate size, largest basal area and deepest peak depth). The upper depth is 4000m and the lower depth is 5500m.
DW	**301**	South Tonga Eastern Lookout, South Cooks and High Seas	COK,TON	Contains the deep Tonga Ridge, abyssal hills and seamounts on abyssal mountains. SST is low and stable; chlorophyll-concentrations, 20°C isotherm and deep water temperature are moderate. Salinity and pH levels are high.Nitrate and solar irradiance are moderate to low. Mixed layer depth and calcite are moderate and variable. Dissolved oxygen concentrations are moderate and stable. Strong sea surface currents generally flow from the northwest. Contains 2 seamounts type 2 (small with deep peak, most common type); 1 seamount type 7 (small and short with very deep peaks, shortest); 3 seamounts type 8 (small and short with very deep peaks, deepest type); 11 seamounts type 11 (intermediate size, largest basal area and deepest peak depth). The upper depth is 5000m and the lower depth is 6000m.
DW	**317**	Suwarrow Atoll Deep	COK	Mostly composed of a plateau with ridge. SST is moderate and stable, chlorophyll-a concentrations are low. Calcite, solar irradiance, phosphorous, silicate, and nitrate levels are low. Dissolved oxygen, salinity, and pH levels are high. Temperature at 200m is high, while at 1000m it is moderate and variable. Mixed layer is deep; 20°C isotherm is shallow and variable. Contains 1 seamount type 2 (small with deep peak, most common type); 1 seamount type 3 (intermediate size, large tall and deep); 1 seamount type 7 (small and short with very deep peaks, shortest); The upper depth is 2500m and the lower depth is 3500m.

Location	Code	Name	Countries	Summary description
DW	**328**	North Cooks Spot	COK	Mostly abyssal hills. SST is high and stable. Chlorophyll-a concentrations are low. Very deep mixed layer and a more shallow 20°C isotherm. 1000m temperature is low. Temperature at 200m is high and stable. Silicate, nitrate, dissolved oxygen, calcite, and phosphorous levels are low. Salinity is high. Solar irradiation and pH are high to moderate. Contains 1 seamount type 10 (large and tall with shallow peak: shallow); 1 seamount type 11 (intermediate size, largest basal area and deepest peak depth). The upper depth is 3500m and the lower depth is 4500m.