# A Biogeographic Assessment of the Samoan Archipelago



Matthew Kendall and Matthew Poti (Editors)

Prepared by NOAA/NOS/NCCOS/CCMA Biogeography Branch with Support from NOAA's Office of National Marine Sanctuaries and Coral Reef Conservation Program

THOLEN CAND ATMOSPHERIC POMILIER POMILI

NOAA Technical Memorandum NOS NCCOS 132

Citation for the entire Document:

Kendall, M.S. and M. Poti (eds.), 2011. A Biogeographic Assessment of the Samoan Archipelago. NOAA Technical Memorandum NOS NCCOS 132. Silver Spring, MD. 229 pp.

Example citation for an individual chapter (example of Chapter 3: Currents and Larval Connectivity):

Kendall, M.S., M. Poti, T. Wynne, B. Kinlan, L. Bauer. 2011. Ocean Currents and Larval Transport Among Islands and Shallow Seamounts of the Samoan Archipelago and Adjacent Island Nations. In: Kendall, M.S. and M. Poti (eds.), 2011. A Biogeographic Assessment of the Samoan Archipelago. NOAA Technical Memorandum NOS NCCOS 132. Silver Spring, MD. 229 pp.

The graphic wrapped on the cover was created by Kang Sevao of American Samoa and used with permission here. This tapa design symbolizes the creation of land and sea. The processes of island formation and reef growth are central to understanding biogeography of the Samoan Archipelago.

Mention of trade names or commercial products does not constitute endorsement or recommendation for their use by the United States Government.

## A Biogeographic Assessment of the Samoan Archipelago

Prepared by: NOAA National Centers for Coastal Ocean Science (NCCOS) Center for Coastal Monitoring and Assessment (CCMA) Biogeography Branch 1305 East West Highway (SSMC-IV, N/SCI-1) Silver Spring, MD 20910 USA

July 2011

Editors

Matthew S. Kendall CCMA Biogeography Branch

Matthew Poti CCMA Biogeography Branch and Consolidated Safety Services, Inc.



NOAA Technical Memorandum NOS NCCOS 132

United States Department of Commerce	National Oceanic and Atmospheric Administration	National Ocean Service
Gary Locke	Jane Lubchenco	David Kennedy
Secretary	Administrator	Assistant Administrator

#### **ABOUT THIS DOCUMENT**

This assessment represents the continuation of ongoing partnerships between NOAA's National Centers for Coastal Ocean Science (NCCOS), Center for Coastal Monitoring and Assessment (CCMA), Biogeography Branch and the Office of National Marine Sanctuaries (ONMS) and Coral Reef Conservation Program (CRCP). The Biogeography Branch has applied a biogeographical approach to inform the management of marine resources within both coral reefs and National Marine Sanctuaries since 1998. To date, nine ONMS sites and most of the coral reef ecosystems in US states and territories have had some level of biogeographic characterization or mapping completed through these partnerships.

The results of this ecological characterization are available via website. For more information on this project and those in other ONMS and reef ecosystem locations please visit the Biogeography Branch webpage at http://ccma.nos.noaa.gov/about/biogeography/ or direct questions and comments to:

Chris Caldow, Biogeography Branch Chief National Oceanic and Atmospheric Administration 1305 East West Highway SSMC 4, N/SCI-1 Silver Spring, MD 20910 Phone: (301) 713-3028 Email: Chris.Caldow@noaa.gov

#### ACKNOWLEDGEMENTS

This particular work was jointly funded by ONMS, CRCP, and CCMA and was conducted in consultation with local scientists and managers. The assessment would not have been possible were it not for the joint funding commitment and generous in-kind contributions from regional partners including suggestions during project inception, sharing of key datasets, contributions of co-authors, and review of draft analyses and documents. Mark Monaco led initial development of the project. Jamie Higgins formatted and organized the figures, tables, images, and text into this document.

#### **EXECUTIVE SUMMARY**

This report examines the marine biogeography of the Samoan Archipelago (~14° S latitude along the international date-line) with a focus on regional ocean climate, connectivity among islands due to larval transport, distributions of reef fish and coral communities, and the extent of existing marine protected areas. Management decisions and prior assessments in the archipelago have typically been split along the international political boundary between the islands of Samoa and those of American Samoa despite their close proximity and shared resources. A key goal in this assessment was to compile data from both jurisdictions and to conduct the characterization across the entire archipelago. The report builds upon earlier assessments by re-analyzing and interpreting many pre-existing datasets, adding more recent biogeographic data sources, and by combining earlier findings into a multidisciplinary summary of marine biogeography.



**Image 1.** A coral reef in the National Park of American Samoa near Vatia. Photo credit: Matt Kendall, NOAA Biogeography.

The assessment is divided into 5 chapters and supporting appendices. Each chapter was written and reviewed in collaboration with subject matter specialists and local experts. In Chapter 1, a short introduction to the overall scope and approach of the report is provided. In Chapter 2, regional ocean climate is characterized using remote sensing datasets and discussed in the context of local observations. In Chapter 3, regional ocean currents and transport of coral and fish larvae are investigated among the islands of the archipelago and surrounding island nations. In Chapter 4, distinct reef fish and coral communities across the archipelago are quantified on the basis of overall biodiversity, abundance, and community structure. In Chapter 5, the existing network of MPAs in American Samoa is evaluated based on the habitats, reef fish, and coral communities that are encompassed. Appendices provide analytical details omitted from some chapters for brevity as well as supplemental datasets needed as inputs for the main chapters in the assessment. Appendices include an inventory of regional seamounts, a description of shore to shelf edge benthic maps produced for Tutuila, analytical details of reef fish and coral datasets, and supplemental information on the many marine protected areas in American Samoa.

The main objectives and some key findings of each chapter are as follows:

Chapter 1: Introduction

 Objectives were to introduce the physical setting of the archipelago and describe the scope and main components of the biogeographic assessment.

Chapter 2: Oceanography of the Samoan Archipelago

- Objectives were to summarize regional atmospheric and oceanographic conditions as well as trends in winds, waves, currents, sea surface temperature, chlorophyll, and sea surface height anomalies, and discuss potential influences they may have on biogeography of Samoan reef ecosystems.
- Ocean conditions in the region are characterized by small seasonal fluctuations and often much larger multiyear fluctuations in response to broad climatic cycles such as the Southern Oscillation/El Niño. The major source of variability is seasonal for winds, waves, and sea surface temperature whereas chlorophyll and sea surface height are affected more by interannual processes.

- Executive Summary
- Nearly all aspects of ocean climate for the archipelago vary more significantly by latitude than by longitude such that all islands except Swains, ~400 km to the north of the archipelago, experience very similar conditions.
- The archipelago has relatively more stable oceanic conditions compared to latitudes to the north and south.
- Key climate related changes include gradual sea level rise as well as periodic low sea level events corresponding to El Niño and also rising surface water temperatures and the threat of coral bleaching.

Chapter 3: Ocean currents and larval transport among islands and shallow seamounts of the Samoan Archipelago and adjacent island nations.

- Objectives were to describe regional ocean currents, identify key sources and destinations of coral and fish larvae for each island, and understand the influence of various combinations of larval life history characteristics on larval connections.
- Major surface currents identified around the archipelago were the meandering westward flow of the South Equatorial Current (SEC) directly across the archipelago (13-19° S), the eastward flowing South Equatorial Counter Current (SECC) (8-12° S) that seasonally (October – April) bifurcates the surface flow of the SEC, and a regularly occurring eddy south of the archipelago centered at ~16° S and 172° W.
- A wide range of larval longevities (10 to 100 days), mortality rates (3-46 % daily mortality), and settlement zones (9 to 36 km from islands) were investigated.
- Major sources of larvae in the region are likely to be the large islands of Samoa, which contribute over twice as many larvae as the smaller islands of American Samoa.
- Current transport is primarily westward along the archipelago such that each island tends to seed its natal reefs (especially with short-lived larvae) and island neighbors to the west (especially with long-lived larvae). In addition, the north coasts of Samoa may seed the islands of American Samoa via the feedback loops connecting the SECC with the SEC for organisms with long larval durations.
- Current orientations and the long distance from upstream islands suggest the archipelago is heavily dependent on internal sources of larvae to sustain reef populations. Predicted connections among islands suggest potential benefits to coordinated management of marine resources and conservation planning between Samoa and American Samoa.

Chapter 4: Biogeographic assessment of fish and coral communities of the Samoan Archipelago.

- Objectives were to identify geographic patterns of hotspots, breakpoints, and spatial trends in reef fish and coral communities among and within islands of the archipelago.
- Analysis focused on six variables: coral cover, coral diversity, coral community structure, fish biomass, fish diversity, and fish community structure.
- Results from 8 studies were combined to determine regions with high, medium, and low values for each variable.
- 30 distinct biogeographic regions with distinct patterns in one or more variables were identified across the archipelago.
- 51 regional hotspots with relatively high values for particular fish or coral variables were identified.
- Regions that were hotspots for several variables were northern, northeastern, and southern Savai'i, Swains Island, Ofu and Olosega Islands, Aunu'u and the eastern tip of Tutuila, southwestern Tutuila, and the Fagamalo area of northwestern Tutuila.
- Regions that were not hotspots for any variables investigated included the Apolima Strait between Upolu and Savai'i, the north coast of Upolu, and parts of the northwest coast of Tutuila.
- Regions that were identified as having unique reef fish and/or coral communities included southern Savai'i, Pago Pago Harbor, Aunu'u, Rose Atoll, and Swains Island.

Chapter 5: The existing network of marine protected areas in American Samoa.

 Objectives were to characterize the reef fishes, corals, habitats, and other key features of each existing MPA, evaluate the distribution of MPA sites in the context of the biogeographic regions and ecological hotspots defined in Chapter 4, summarize the area of reef ecosystem that is currently protected, by bottom type and reef type, and identify potentially important areas not currently in the network. Unlike the other chapters, analysis was restricted to American Samoa due to the lack of needed input datasets for Samoa. Creation of benthic maps and GIS datasets of MPA boundaries and regulations should be a priority for conservation planning and resource management in Samoa.

- There are 23 MPAs in American Samoa managed by Territorial, Federal, or combined authorities.
- Only 8% of the potential coral reef ecosystem (defined as bottom regions less than 150 m deep) in American Samoa is within existing MPAs. Only 3% has complete no-take restrictions.
- Fourteen of the twenty ecologically distinct biogeographic regions identified around American Samoa include at least one MPA, leaving only six with no representation in the present MPA network.
- High-value regions (those that were hotspots for 3 reef fish/coral variables) represented in the existing MPA network include southwestern Tutuila, the Fagamalo area, and Ofu and Olosega Islands. High-value regions lacking an MPA in the network include Aunu'u, the eastern tip of Tutuila, and Swains Island.
- Regions not currently represented in the existing MPA network that have been identified as having unique reef fish and/or coral communities include only Swains Island and Aunu'u.
- A comprehensive and coordinated MPA network strategy based on the findings of this study and other information is needed to define and accomplish conservation and resource management goals across the entire archipelago.

#### EXECUTIVE SUMMARY TRANSLATED IN SAMOAN

#### **ΤΑLΑ 'ΟΤΟ'ΟΤΟ**

Translation provided by Veronika Mata'utia Mortenson. O lenei ripoti ua saunia faapitoa e su'esu'e ai le atoatoa o le olaga faa-natura o meaola o le sami i totonu o le atu-Samoa (~14° S o le ekueta, latalata i le laina o loo sui ai aso o le lalolagi) ma e patino lenei lomiga i tulaga o le tau, fesoota'iga ma isi atu-motu ona o feoa'iga o fua o i'a, faasoasoaina o nofoaga o i'a, ā'au ma 'amu, faapea ma le tulaga o loo iai nei nofoaga faasao o le sami. O Amerika Samoa ma Samoa Tuto'atasi o ni motu e tu lalata ma e masani i le fefa'asoa'i o le tamaoaiga faa-natura, peita'i, o faai'uga ma ni isi o su'esu'ega na faatino i totonu o le atu-Samoa ua le maua iai se maliega ona o le ese'esega o faiga-nuu ma faiga-mālo. O le faamoemoe maualuga o lenei ripoti o le tuufaatasia lea o ni faamaumauga ma faaiuga e uiga i le ola faa-natura i Amerika Samoa ma Samoa. O le oto'otoina o lenei lomiga na tuufaatasia mai i le anoano o su'esu'ega ua mae'a ona fa'asalalau, faapea le taumafaiga e tuu atu iai ma ni isi o faamatalaga lata mai e uiga i nofoaga o meaola o le sami.

O su'esu'ega o loo i totonu o lenei Ripoti ua mafai ona vaevaeina i ni mataupu se 5, faapea ma ni isi o faamatalaga e sapasapai ai mataupu ta'itasi. O mataupu uma ua faamauina, na tusia ma iloiloina e ni isi ua atamai ma iai agavaa faapitoa i le aotelega o lenei tusiga. I le Mataupu 1, o le upu tomua e faailoa ai galuega ma tulaga i loo i totonu o le ripoti. O le Mataupu 2 o loo faamatala ai fesuisuiaiga o le tau, mai molimau a tagata lautele faapea ai ma ni isi o su'esu'ega faa-saienisi. I le Mataupu 3, o le gasologa o le āu ma le femālagaa'i o fua o 'amu ma i'a i le va o Samoa ma isi atu-motu. I le Mataupu 4, o le aofa'iga o i'a-ā'au ua lauiloa ma ituaiga 'amu ese'ese ua mafai ona faavasega i le anoanoa'i ma le felanulanua'i o ituaiga ese'ese. I le Mataupu 5, o le iloiloina o le fesootaiga o gataifale faasao i Amerika Samoa e afua mai lea i le mata'ituina o ituaiga i'a ese'ese ma ituaiga 'amu o loo maua ai. O isi Faamatalaga i le pito i tua o le Ripoti o loo auili'ili atu ai ni isi o mataupu taua. O loo aofia ai foi ma le faitau aofa'i o tama'i mauga o loo i le alititai, faapea faamatalaga o le faafanuaina o le talafatai e oo atu i le alititai, ma ni isi o faamatalaga e uiga i gataifale faasao i totonu o Amerika Samoa.

O le taula'iga ma vaega faapitoa o mataupu ta'itasi:

#### Mataupu 1: Upu Tomua

• O ta'iala, na faaogaina e faalauiloa ai tulaga o atu-motu ma sa faapea ona faaoga fo'i e faamatala ai le faasoasoaina o meaola i lea motu.

Mataupu 2: Su'esu'ega o le Sami i le atu-Samoa.

- Na faaogaina ta'iala e 'oto'oto ai tulaga o le 'ea ma le sami, faapea ma le tulaga o matagi, o galu, o le tafe o le āu, vevela ma le loloto o le sami e tau sa'ili ai fesoota'iga o nei mea uma i ā'au ma 'amu o le atu-Samoa.
- O le tulaga ole aga'i i luga ma lalo o le suasami ua mafai nei ona maitauina ona o le vevela o le kelope i le El Niño. O le mafua'aga 'autu o lenei lugā lalō e oso masina pe faa-vāimasina mo matagi, galu ma le vevela o le suasami, a o le a'afia o le maualuga masani o le suasami e oso faa-vāitausaga.
- Se'i vaganā ai le motu o Swains, ~400 km i mātu o le atu-Samoa, e toeitiiti lava tutusa tulaga o le tau i le sami o atu-motu uma e tu lalata i le ekueta.
- O le atu-Samoa e tutusa lelei tulaga o le sami i le itu i matū ma saute o le ekueta.
- O suiga ua tula'i mai i fesuiaiga o le tau e aofia ai le si'isi'i malie i luga o le maualuga masani o le suasami faapea ai ma le maualalo tele ona o le El Niño.

Mataupu 3: O āu o le sami ma le femalagaa'i o fua-o-i'a ma figota i le va o motu faapea tama'i mauga ua ola i le alititai.

- O le 'autū o lenei mataupu o le faamatalaina lea o le ala o āu o le sami, faailo mafua'aga taua o taunu'uga o le femalagaā'i o 'amu ma fua-o-i'a i le va o motu ta'itasi, ma le malamalama'aga i le feso'otaiga o meaola uma o le sami.
- O āu o le sami i totonu o atu-motu ua mafai ona faamau i tusitusiga e aofia ai le South Equatorial Current (SEC) ma e tafe aga'i i sisifo, o le South Equatorial Counter Current (SECC) (8-12° S) e tafe aga'i i sasa'e mai le masina o Oketopa – Aperila ma e vaelua e lenei āu le tafe a le SEC, ma ei totonu o le ~16° i Saute ma 172° i Sisifo.
- O le tele ma le umi o le olaga o fua o i'a (10 i le 100 aso), o le saoasaoa o le faatama'ia o fua-o-i'a (3-46 % i le aso), ma mea o loo ofaga ai (9 i le 36 km mai motu ta'itasi) sa mafai ona su'esu'eina.
- O le anoanoa'i o fua-o-i'a o loo masalomia e tele i motu tetele o Samoa Tuto'atasi, ma fa'aluaina i lo motu laiti o Amerika Samoa.
- O le malaga a fua-o-i'a e tele na aga'i atu i le itu i sisifo ma e 'umi lo latou ola i lo fua-o-i'a e aga'i atu i sasa'e.
   Ma o le isi, o le tafā-tai i matū o Samoa Tuto'atasi ua mafai ona faafailele ai fua-o-i'a ona toe taamilo mai lea ma aga'i mai i Amerika Samoa.
- Talu ai le mamao o motu, e iai le talitonuga e ao ona faamoemoe le atu-Samoa i fua-o-i'a nei aua le faatupula'ia ma le faaleleia o ā'au. O lenei fesootaiga i le atu-Samoa e aoga tele i le galulue fa'atasi o Samoa-na-lua i le faia lea o faaiuga ma ni maliega 'autasi – aua le puipuia atili o le tamaoaiga a Samoa Tuto'atasi ma Amerika Samoa.

Mataupu 4: Su'esu'ega o ituaiga i'a ma 'amu ese'ese i le atu-Samoa.

- O sini o nei su'esu'ega o le faailo lea o le anoanoa'i o 'auala ese'ese o loo lamatia ai le olaga o i'a ma 'amu i tafātai ma totonu o le atu-Samoa.
- O nei su'esu'ega na faapito i ni vaega se ono: aofa'iga o 'amu, ituaiga 'amu ese'ese, anoano o 'amu ese'ese i se nofoaga e tasi, o le aofa'iga o le mamafa o i'a i se nofoaga e tasi, ituaiga i'a ese'ese, ma le ituaiga nofoaga e ofaga ai i'a.
- O taunuuga o su'esu'ega e 8 na tuufaatasi e tau sa'ili ai poo fea vaega e maualuga, feololo ma maualalo.
- I totonu o le atu-Samoa, e 30 ni nofoaga na mafai ona faailoa ona o le ma'oti o le itua'iga e tasi pe sili atu fo'i.
- E 51 ni vaega vevela o le sami mai maugamu o loo mauluga ai le faitau aofa'i ma le aoga o i'a ma 'amu.
- O vaega vevela o le sami sa tele ai meaola ese'ese o matū, matū-i-sasa'e, ma sauté o Savai'i, Motu o Swains, Ofu ma Olosega, Aunu'u ma itu i sasa'e o Tutuila, faapea le itu i sauté-sisifo, ma Fagamalo.
- O isi nofoaga e le'i agava'a i vaega vevela o le sami e aofia ai le āva i Apolima i le va o Upolu ma Savai'i, le talafātai i matū o le motu o Upolu, ma ni vaega o le gataifale i matū-i-sasa'e o Tutuila.
- O ni isi nofoaga sa mafai ona iloa ai le tutasi o i'a-a'au ma 'amu ese'ese o Savai'i, Pago Pago, Aunu'u ma le Motu o Swains.

Mataupu 5: O le feso'ota'iga o nofoaga faasao o le gataifale i Amerika Samoa.

• O le manulauti, o le faavasegaina lea o ituaiga i'a, 'amu, le mea o loo ofaga ai, ma isi faailo ua tāua mo Gataifale Faasao - i le faatusatusaina lea i eria o loo 'oā i le tamaoaiga e pei ona faailoa atu i le Mataupu 4. E le pei o isi Mataupu, sa tapula'a su'esu'ega i Amerika Samoa ona e le'i iai ni faamaumauga mai Samoa. O le fausiaina o ni ata ma faafanua o le alititai e tatau ona tapena iai Samoa, faapea ma ni faamaumauga (GIS) e iloa ai tonu tuā'oi ma tulafono i le puipuiina o le tamaoaiga.

- E 23 ni gataifale faasao o loo iai nei i Amerika Samoa, ma o loo pulea e le Teritori, Malo Feterale, ma isi pulega.
- Na o le 8% o ā'au (e faauiga o nofoaga o loo i le loloto e 150 m) i Amerika Samoa ei totonu o gataifale faasao. E na o le 3% e le mafai ona fagotaina.
- Mai i le sefulufa o nofoaga faapitoa ua mafai ona tāmau i faamaumauga i Amerika Samoa, o loo iai lava se Gataifale Faasao se tasi i totonu o lenei sefulufa, ma e ono e le o maua iai ni faamaumauga i le fesootaiga o gataifale faasao o loo iai nei.
- O nofoaga o loo maualuga le oā o puna'oa (le vaega sa 'avea ma tulaga vevela o le sami mo i'a ma 'amu ese'ese) i totonu o Gataifale Faasao e aofia ai le itu i saute-sisifo o Tutuila, Fagamalo, ma Ofu & Olosega. O nofoaga o loo maualuga ai puna'oa e le o mafai ona tuu i totonu o le fesootaiga o gataifale faasao a Amerika Samoa e aofia ai Aunu'u, le itu i sasa'e o Tutuila faapea ai ma le Motu o Swains.
- O nofoaga o loo tutasi ma tele ai le tamaoaiga, ma e le o iai i totonu o le li'o o Gataifale Faasao e aofia ai na'o le Motu o Swains ma Aunu'u.
- O loo mana'omia ni faamaumauga maumaututū e uiga i le fesootaiga o Gataifale Faasao, ina ia mafai ona aoga i le uiga ma ni taunuuga lelei o le faasao ma puipui atili o le tamaoaiga faa-natura i le atu-Samoa.



#### TABLE OF CONTENTS

CHAPTER 1 INTRODUCTION TO THE BIOGEOGRAPHIC ASSESSMENT	1
CHAPTER 2 OCEANOGRAPHY OF THE SAMOAN ARCHIPELAGO INTRODUCTION	3 3
DATA AND METHODS RESULTS	3 4
CONCLUSIONS	22 24
REFERENCES	25
CHAPTER 3: OCEAN CURRENTS AND LARVAL TRANSPORT AMONG ISLANDS AND SHALLOW SEAMOUNTS OF THE SAMOAN ARCHIPELAGO AND ADJACENT ISLAND NATIONS	27
	27
RESULTS AND DISCUSSION	
ACKNOWLEDGEMENTS	90 92
REFERENCES	93
CHAPTER 4: BIOGEOGRAPHIC ASSESSMENT OF FISH AND CORAL COMMUNITIES OF THE SAMOAN ARCHIPELAGO	97
INTRODUCTION	97 98
RESULTS	.104
ACKNOWLEDGEMENTS	.118
CHAPTER 5: THE EXISTING NETWORK OF MARINE PROTECTED AREAS IN AMERICAN SAMOA	123
	.123
RESULTS: BENTHIC HABITATS OF AMERICAN SAMOA	.125
RESULTS: MPA NETWORK ANALYSES	130 .174
CONCLUSIONS	.180 .182
REFERENCES	.183
APPENDIX A: SEAMOUNTS WITHIN THE EXCLUSIVE ECONOMIC ZONES OF SAMOA AND AMERICAN SAMOA	.189
APPENDIX B: SHORELINE TO SHELF EDGE BENTHIC MAPS OF TUTUILA, AMERICAN SAMOA APPENDIX C: FISH AND CORAL DATA PLOTS	.197
APPENDIX D: KEY ATTRIBUTES AND ACTIVITIES OF MPAS IN THE EXISTING NETWORK OF	225
	.220

List of Tab	les	
Table 2.1.	Original data sources.	4
Table 3.1.	Full factorial ANOVA on the effects of region, season, and ENSO status on median drifter heading	36
Table 3.2.	Full factorial ANOVA on the effects of region, season, and ENSO status on mean drifter speed	36
Table 3.3.	Islands, seamounts, or island groups used as source locations in simulations of regional larval	
	connectivity, their corresponding potential reef area (0-150 m shelf), number of virtual larvae	
	used in modeling, and the percentage of the simulated larval pool contributed by each source	42
Table 4.1.	List of datasets and variables used in the analysis.	100
Table 4.2.	Assigned breakpoints between low and medium (L $\rightarrow$ M) and medium and high (M $\rightarrow$ H) values for	
	each of the fish and coral variables by dataset	102
Table 4.3.	Hotspot analysis summary table.	113
Table 5.1.	Existing MPAs in American Samoa as of January 2011	126
Table 5.2.	Biogeographic regions, ecological hotspots, and overlap with existing MPAs.	176
Table 5.3.	Potential reef ecosystem area (km <sup>2</sup> ) by benthic structure type for existing MPAs.	179
Table A.1.	Locations and morphological characteristics of seamounts within the EEZ of American Samoa and	
	Samoa.	193
Table D.1.	General description of MPA implementation and management.	225
Table D.2.	Conservation focus and management practices.	226
Table D.3.	Biological and socio-economic monitoring/assessment and community involvement.	227
Table D.4.	Current and future projects.	228

List of Figures		
Figure 1.1.	Samoan Archipelago study region.	1
Figure 2.1.	Wind direction measured by the QuikSCAT satellite.	5
Figure 2.2.	Path and intensity of cyclones passing through the EEZs of Samoa or American Samoa	
U	from 2000-2007	6
Figure 2.3.	Major surface currents of the Southern Pacific Ocean adapted from Tomczak and Godfrey (2003)	7
Figure 2.4.	Sea surface temperature data from CoRTAD presented as an average annual cycle	8
Figure 2.5	Sea surface temperatures from CoRTAD	9
Figure 2.6	Sea surface temperature and anomaly values from CoRTAD for the years 1985 to 2006	10
Figure 2.7	Sea surface temperature anomalies from CoRTAD during the month of July for the years 1997 to 2005	11
Figure 2.8	Sea surface temperature anomaly plots for warmest water month	12
Figure 2.0.	Bleaching alert time series from NOAA Coral Reef Watch	12
Figure 2.9.	Chlorenbull concentration estimated from SeeWiES and procented as an average appual evelo	17
Figure 2.10.	Chlorophyll concentration estimated from the SeaWiFS and presented as an average annual cycle	14
Figure 2.11.	Chlorophyll concentrations estimated from SeaWiFS Satellite.	10
Figure 2.12.	Chlorophyll concentrations estimated from SeaWiFS for the years 1997 to 2005	10
Figure 2.13.	Chiorophyli anomalies estimated from SeawiFS for June 2002 and April 2005	17
Figure 2.14.	Sea level values for Pago Pago, American Samoa from 1948 to 2008.	17
Figure 2.15.	Sea surface neight anomalies from AVISO are presented as an average annual cycle	18
Figure 2.16.	Sea surface height anomalies from AVISO	19
Figure 2.17.	Sea surface height anomalies from AVISO for the years 1993 to 2006	20
Figure 2.18.	Sea surface height anomalies from AVISO during the month of March for the years 1993 to 2006	21
Figure 2.19.	Linear regression of maximum monthly sea level deviation versus SOI during El Niño events	
	since 1954	22
Figure 2.20.	Sea Surface Temperature from CoRTAD at the intersection of 170° W longitude (the approximate	
	boundary between Samoa and American Samoa) and 0°, 5° S, 10° S, 15° S, 20° S, 25° S,	
	and 30° S latitude respectively	23
Figure 3.1.	Samoan Archipelago and surrounding islands depicted by the 9 km grid cells of the HYCOM	
	hydrodynamic model	28
Figure 3.2.	Example of regional current vectors.	30
Figure 3.3.	Tonga Trench Eddy.	30
Figure 3.4.	Example of typical drifter paths. January 2007 drifters shown	31
Figure 3.5.	Box plots of median current headings by region, season, and ENSO conditions based on drifter data	35
Figure 3.6.	Median current headings by season and region based on drifter data	36
Figure 3.7.	Box plots of median current speeds by region, season, and ENSO conditions based on drifter data	37
Figure 3.8.	Mean gross and net displacement of drifters after 10, 20, 30, 50, and 100 days,	37
Figure 3.9a.	Gross displacement of individual drifters as a frequency histogram after 10, 20, 30, 50 and	
U	100 davs at large.	38
Figure 3.9b.	Net displacement of individual drifters as a frequency histogram after 10, 20, 30, 50 and	
- <b>J</b>	100 days at large	39
Figure 3.10a.	Surface current patterns of the Samoan EEZs and surrounding region for October through April	40
Figure 3.10b.	Surface current patterns of the Samoan EEZs and surrounding region for May through September	40
Figure 3.11.	Proportion of virtual larvae in the study area that were started from each island, seamount	
· ·gai e ei · · ·	or island aroun	41
Figure 3 12	Cumulative connectivity 2004-2008	43
Figure 3 13	Transport of virtual larvae from Swains Island by model year	45
Figure 3 14	Position of virtual larvae from southern Savai'i for all model years by PLD	46
Figure 3 15	External larval supply and local larval retention at Savai'i-South as a function of PLD	-0
rigure e.re.	and mortality rate	47
Figure 3 16	Destinations (and sources) of simulated larvae originating from (arriving at) Savai'i-South	71
rigure 5.10.	for low medium, and high larval mortality rates	18
Eiguro 2 17	Position of virtual larvae from porthorn Savai'i for all model years by PLD	40 50
Figure 3.17.	External land a unply and local land retention at Savai'i North as a function of DLD and mortality rate	50
Figure 3.10.	External larval supply and local larval retention at Saval FNOrth as a function of FLD and montality rate	51
rigure 3.19.	Destinations (and sources) or simulated larvae originating from (arriving at) Saval I-North for IOW,	E 0
Eigure 2.00	Desition of virtual larvas from southern Lindu for all model years by DLD	JZ
Figure 3.20.	Position of virtual larvae from southern Upolu for all model years by PLD.	54
Figure 3.21.	External larval supply and local larval retention at Upolu-South as a function of PLD and mortality rate	55
rigure 3.22.	Destinations (and sources) of simulated larvae originating from (arriving at) Upolu-South for low,	
	medium, and high larval mortality rates.	56
Figure 3.23.	Position of virtual larvae from northern Upolu for all model years by PLD	58

List of Figures	e (cont.)	
Figure 3.24.	External larval supply and local larval retention at Upolu-North as a function of PLD and mortality rate	. 59
Figure 3.25.	Destinations (and sources) of simulated larvae originating from (arriving at) Upolu-North for low,	
-	medium, and high larval mortality rates.	60
Figure 3.26.	Position of virtual larvae from Tutuila for all model years by PLD.	62
Figure 3.27.	External larval supply and local larval retention at Tutuila as a function of PLD and mortality rate	63
Figure 3 28	Destinations (and sources) of simulated larvae originating from (arriving at) Tutuila for low	
1 19410 0.201	medium, and high larval mortality rates	64
Figure 3 29	Position of virtual larvae from South Bank for all model years by PLD	66
Figure 3 30	External larval supply and local larval retention at South Bank as a function of PLD and mortality rate	00
Figure 3.30.	Destinations (and sources) of simulated larvae originating from (arriving at) South Bank for low	07
Figure 5.51.	Destinations (and sources) of simulated larvae originating from (arriving at) South Bank for low,	60
<b>E</b> iaura 2.20	Desition of virtual larvas from East Dank for all model years by DLD.	00
Figure 3.32.	Position of virtual larvae from East Bank for all model years by PLD.	70
Figure 3.33.	External larval supply and local larval retention at East Bank as a function of PLD and mortality rate	71
Figure 3.34.	Destinations (and sources) of simulated larvae originating from (arriving at) East Bank for low,	
	medium, and high larval mortality rates.	72
Figure 3.35.	Position of virtual larvae from Northeast Bank for all model years by PLD	74
Figure 3.36.	External larval supply and local larval retention at Northeast Bank as a function of PLD and	
	mortality rate.	75
Figure 3.37.	Destinations (and sources) of simulated larvae originating from (arriving at) Northeast Bank	
	for low, medium, and high larval mortality rates	76
Figure 3.38.	Position of virtual larvae from Manu'a for all model years by PLD	78
Figure 3.39.	External larval supply and local larval retention at Manu'a as a function of PLD and mortality rate	79
Figure 3.40.	Destinations (and sources) of simulated larvae originating from (arriving at) Manu'a for low.	
<b>J</b>	medium, and high larval mortality rates.	80
Figure 3.41.	Position of virtual larvae from Rose Atoll for all model years by PLD	82
Figure 3 42	External larval supply and local larval retention at Rose Atoll as a function of PLD and mortality rate	83
Figure 3 43	Destinations (and sources) of simulated larvae originating from (arriving at) Rose Atoll for low	00
1 igure 0.40.	medium, and high larval mortality rates	84
Eiguro 2 14	Position of virtual larvas from Swains Island for all model years by PLD	-00
Figure 3.44.	External larval supply and local larval rotantian at Swains Island as a function of DLD and	00
Figure 3.45.	External larval supply and local larval retention at Swallis Island as a function of PLD and	07
<b>Figure 0.40</b>	montainy rate.	87
Figure 3.46.	Destinations (and sources) of simulated larvae originating from (arriving at) Swains Island for low,	~~
	medium, and high larval mortality rates.	88
Figure 4.1.	Datasets and corresponding survey sites included in the analyses.	99
Figure 4.2.	Biogeographic regions (Bioregions) assigned based on analyses of fish and coral data	105
Figure 4.3.	Coral cover at survey sites across Samoa and American Samoa.	106
Figure 4.4.	Coral richness at survey sites across Samoa and American Samoa	107
Figure 4.5.	Summary of Bioregions sharing similar coral communities and those with unique coral	
	communities as identified from the MDS analyses.	108
Figure 4.6.	Fish biomass at survey sites across Samoa and American Samoa.	109
Figure 4.7.	Fish richness at survey sites across Samoa and American Samoa.	. 111
Figure 4.8.	Summary of Bioregions sharing similar fish communities and those with unique fish communities	
-	as identified from the MDS analyses.	.112
Figure 4.9.	Fish and coral hotspots by Bioregion.	.114
Figure 5.1.	Existing MPAs in American Samoa as of January 2011.	127
Figure 5.2.	Density of pigs (pigs/km <sup>2</sup> ) in piggeries by watershed for Tutuila and Manu'a watersheds	127
Figure 5.3.	(a) Proportion of mapped benthic structure types in American Samoa overall. (b) Proportion of	
	coral reef and hardbottom in each reef zone	129
Figure 5.4	Benthic habitat (by structure type) and fish and coral survey data within Alega Private	120
rigare 0.4.	Marine Reserve	130
Figuro 5 5	(a) Proportion of benthic structure types in Alega Drivate Marine Deserver (b) Proportion of soral	150
rigure 5.5.	(a) Froportion of benunc structure types in Alega Frivate Manne Reserve. (b) Proportion of Coral	121
	Field and narobolion in each reel zone.	131
Figure 5.6.	Fish and coral data collected in Alega Private Marine Reserve.	131
Figure 5.7.	Bentnic nabitat (by structure type) and fish and coral survey data within the Alofau CFMP reserve	132
Figure 5.8.	(a) Proportion of benthic structure types in the Alotau CFMP reserve. (b) Proportion of coral reef	
	and hardbottom in each reef zone.	133
Figure 5.9.	Fish and coral data collected in the Alofau CFMP reserve.	133
Figure 5.10.	Benthic habitat (by structure type) and fish and coral survey data within the Amanave CFMP reserve	134

List of Fig	gures (cont.)	
Figure 5.	(a) Proportion of benthic structure types in the Amanave CFMP reserve. (b) Proportion of coral	
	reef and hardbottom in each reef zone	. 135
Figure 5.	12. Fish and coral data collected in the Amanave CFMP reserve.	. 135
Figure 5.	<b>13.</b> Benthic habitat (by structure type) and fish and coral survey data within the Amaua and	
	Auto CFMP reserve.	. 136
Figure 5.	(a) Proportion of benthic structure types in the Amaua and Auto CFMP reserve. (b) Proportion	
	of coral reef and hardbottom in each reef zone.	. 137
Figure 5.	<b>15.</b> Fish and coral data collected in the Amaua and Auto CFMP reserve	. 137
Figure 5.	6. Benthic habitat (by structure type) within the Aoa CFMP reserve	. 138
Figure 5.	(a) Proportion of benthic structure types in the Aoa CFMP reserve. (b) Proportion of coral reef	
	and hardbottom in each reef zone.	. 139
Figure 5.	<b>8.</b> Benthic habitat (by structure type) within the Aua CFMP reserve	. 140
Figure 5.	<b>9.</b> (a) Proportion of benthic structure types in the Aua CFMP reserve. (b) Proportion of coral reef	
	and hardbottom in each reef zone.	. 141
Figure 5.2	20. Benthic habitat (by structure type) and fish and coral survey data within the Fagamalo CFMP	
	reserve	. 142
Figure 5.2	21. (a) Proportion of benthic structure types in the Fagamalo CFMP reserve. (b) Proportion of coral	
	reef and hardbottom in each reef zone	. 143
Figure 5.2	22. Fish and coral data collected in the Fagamalo CFMP reserve.	. 143
Figure 5.2	23. Benthic habitat (by structure type) and fish and coral survey data within the Fagamalo No-Take MPA	. 144
Figure 5.2	(a) Proportion of benthic structure types in the Fagamalo No-Take MPA. (b) Proportion of coral	
	reef and hardbottom in each reef zone	. 145
Figure 5.2	<b>25.</b> Comparison of fish and coral data collected in the Fagamalo No-Take MPA to data from all	
	of American Samoa	. 145
Figure 5.2	26. Benthic habitat (by structure type) within the Leone Pala SMA.	. 146
Figure 5.2	27. Proportion of benthic structure types in the Leone Pala SMA.	. 147
Figure 5.2	28. Benthic habitat (by structure type) and fish and coral survey data within the Masausi CFMP reserve	. 148
Figure 5.2	<b>29.</b> (a) Proportion of benthic structure types in the Masausi CFMP reserve. (b) Proportion of	
	coral reef and hardbottom in each reef zone.	. 149
Figure 5.3	<b>30.</b> Fish and coral data collected in the Masausi CFMP reserve	. 149
Figure 5.3	<b>31.</b> Benthic habitat (by structure type) and fish and coral survey data within the Matu'u and	
	Faganeanea CFMP reserve	. 150
Figure 5.3	<b>32.</b> (a) Proportion of benthic structure types in the Matu'u and Faganeanea CFMP reserve.	
	(b) Proportion of coral reef and hardbottom in each reef zone.	. 151
Figure 5.	<b>33.</b> Fish and coral data collected in the Matu'u and Faganeanea CFMP reserve.	. 151
Figure 5.	34. Benthic habitat (by structure type) and fish and coral survey data within the Nu'uuli Pala SMA	. 152
Figure 5.3	<b>35.</b> (a) Proportion of benthic structure types in the Nu'uuli Pala SMA. (b) Proportion of coral reef and	
	hardbottom in each reef zone.	. 153
Figure 5.	<b>36.</b> Benthic habitat (by structure type) and fish and coral survey data within the Otu Vaoto Marine Park	. 154
Figure 5.3	<b>37.</b> (a) Proportion of benthic structure types in the Ofu Vaoto Marine Park. (b) Proportion of coral reef	
	and hardbottom in each reef zone.	. 155
Figure 5.	<b>38.</b> Fish and coral data collected in the Ofu Vaoto Marine Park.	. 155
Figure 5.	<b>39.</b> Benthic habitat (by structure type) within the Pago Pago Harbor SMA.	. 156
Figure 5.4	(a) Proportion of benthic structure types in the Pago Pago Harbor SMA. (b) Proportion of coral	4
<b>F</b> 1	reet and hardbottom in each reet zone.	. 157
Figure 5.4	H. Benthic habitat (by structure type) and fish and coral survey data within the Poloa CFMP reserve	. 158
Figure 5.4	(a) Proportion of benthic structure types in the Poloa CFMP reserve. (b) Proportion of coral reef	450
	and hardbottom in each reef zone.	. 159
Figure 5.4	<b>13.</b> Fish and coral data collected in the Poloa CFMP reserve.	. 159
Figure 5.4	<ul> <li>Bentriic nabitat (by structure type) within the Sallele CEMP reserve.</li> <li>(a) Dreparties of beathie structure types in the Osilele OSMD reserve.</li> </ul>	. 160
rigure 5.4	io. (a) Proportion of benthic structure types in the Sallele CHMP reserve. (b) Proportion of coral reef	101
	and nardbottom in each reet zone.	100
Figure 5.4	<b>HO.</b> Benunic nabitat (by structure type) and tish and coral survey data within the Vatia CFMP reserve	. 162
rigure 5.4	(a) Proportion of benthic structure types in the vatia CEMP reserve. (b) Proportion of coral reef	400
<b>F</b> ierry <b>F</b>	and naropottom in each reet zone.	. 163
Figure 5.4	<b>IV.</b> FISH and coral data collected in the vatia CFMP reserve.	. 163
Figure 5.4	Benthic habitat (by structure type) and fish and coral survey data within Fagatele Bay NMS	. 164
Figure 5.	<b>bu.</b> (a) Proportion of benthic structure types in Fagatele Bay NMS. (b) Proportion of coral reef and	405
	naradottom in each reet zone.	. 165

List of Figures	e (cont.)	
Figure 5.51.	Comparison of fish and coral data collected in Fagatele Bay NMS to data from all of American Samoa.	. 165
Figure 5.52.	Benthic habitat (by structure type) and fish and coral survey data within the Ofu Unit of the	
	National Park.	. 166
Figure 5.53.	(a) Proportion of benthic structure types in the Ofu Unit of the National Park. (b) Proportion of	
	coral reef and hardbottom in each reef zone.	. 167
Figure 5.54.	Comparison of fish and coral data collected in the Ofu Unit of the National Park to data from all	
	of American Samoa	. 167
Figure 5.55.	Benthic habitat (by structure type) and fish and coral survey data within the Ta'u Unit of the National Park.	. 168
Figure 5.56.	(a) Proportion of benthic structure types in the Ta'u Unit of the National Park. (b) Proportion of coral	400
	reet and hardbottom in each reet zone.	. 169
Figure 5.57.	Comparison of fish and coral data collected in the Ta'u Unit of the National Park to data from all	400
Eiguro E EQ	OF AMERICAN Samoa	. 169
Figure 5.56.	the National Park	170
Eiguro 5 59	(a) Proportion of benthic structure types in the Tutuila Unit of the National Park (b) Proportion	. 170
rigure 5.59.	of coral reef and hardbottom in each reef zone	171
Figure 5.60	Comparison of fish and coral data collected in the Tutuila Unit of the National Park to data from	
rigare 0.00.	all of American Samoa	171
Figure 5.61.	Mapped benthic habitat (by structure type) and fish and coral survey data within Rose Atoll MNM	. 172
Figure 5.62.	(a) Proportion of mapped benthic structure types in Rose Atoll MNM. (b) Proportion of coral reef	–
0	and hardbottom in each reef zone.	. 173
Figure 5.63.	Comparison of fish and coral data collected in the Rose Atoll MNM to data from all of	
-	American Samoa.	. 173
Figure 5.64.	(a) Proportion of the total potential reef ecosystem area around American Samoa by benthic	
	structure type for the entire suite of existing MPAs and for the rest of American Samoa. (b) Proportion	n
	of the total potential reef ecosystem with no-take restrictions and with other fishing restrictions	. 174
Figure 5.65.	(a) Proportion of coral reef habitat by benthic structure type for the entire suite of existing MPAs	
	and for the rest of American Samoa. (b) Proportion of coral reef habitat with no-take restrictions	
	and with other fishing restrictions.	. 175
Figure 5.66.	Distribution of existing MPAs relative to the locations of significant ecological features, including	
	Bioregions that are holspots for three lish/coral variables (Chapter 4) and the mesopholic coral	177
Eiguro 5 67	Properties of potential roof access stem area by bothic structure type for each existing MPA	. 1//
Figure 5.67.	Seamounts of the Samoan Exclusive Economic Zones	180
Figure A 2	Frequency distribution of seamounts within the Samoan and American Samoan FE7 based on	. 103
rigare A.z.	a) depth of seamount top and b) height	190
Figure A.3.	Vailulu'u Seamount, the active hotspot for the Samoan Island Chain	. 191
Figure A.4.	Papatua Guvot (South Bank).	. 191
Figure A.5.	Tulaga (East Bank).	. 192
Figure A.6.	Muli Guyot (NE Bank).	. 192
Figure A.7.	Pasco Seamount	. 192
Figure A.8.	Toafilemu Seamount.	. 192
Figure B.1.	Cross section of Zones.	. 198
Figures C.1-31	. Bar graphs depicting the distribution of percent coral cover (C.1-8), coral richness (C.9-15),	
	fish biomass (C.16-23), and fish richness (C.24-31) for each of the studies.	. 205
Figure C.32.	MDS plots based on coral community data for sites in each of the American Samoa studies.	. 221
Figure C.33.	MDS plots based on fish community data for sites in each of the American Samoa studies	. 222
Figure C.34.	MDS plots based on coral and tish community data for sites in each of the Samoa studies	223

### Introduction to the Biogeographic Assessment

Matthew S. Kendall<sup>1</sup>

This report provides an assessment of the marine biogeography of the Samoan Archipelago with a focus on oceanography, reef fish, and coral communities. Biogeography examines the distribution of biota and their habitats as well as the environmental factors that have shaped them. Biogeographic characterizations are among the basic information inputs required not only for making informed management decisions but also building public support for them.

The Samoan Archipelago lies in the South Pacific Ocean along ~14° S latitude at the international date-line (Figure 1). The archipelago is comprised of a chain of volcanic islands, seamounts, and coral atolls and is divided into two countries: Samoa and American Samoa. The much larger islands of Savai'i and Upolu comprise



Figure 1.1. Samoan Archipelago study region.

most of the independent nation of Samoa, formerly called Western Samoa. American Samoa (a Territory of the United States) is made up of the comparatively medium sized island of Tutuila, the smaller islands of the Manu'a group, and the two small, remote coral atolls of Swains Island and Rose Atoll that are not derived from the same volcanic hotspot as the rest of the island chain.

Many prior assessments have touched on the biogeography of either Samoa or American Samoa and are cited throughout this document. The present report builds upon these earlier assessments by combining and re-analyzing their original datasets, adding more recent biogeographic data sources, and by combining and re-interpreting their individual findings into a multidisciplinary summary of marine biogeography.

Despite their close proximity and shared resources, management decisions and prior assessments in the region have typically been split along the international political boundary between Samoa and American Samoa. In contrast, a key goal in this assessment was to compile data from both areas and to conduct the characterization across the entire archipelago. Results of the assessment are intended partly to support the "2 Samoa's Initiative", a recent cooperative agreement between the two jurisdictions that seeks to foster improved collaboration, coordination, and information exchange on natural resource management and other topics. The Governments of Samoa and American Samoa should be contacted directly for more information on the current status of this unfolding initiative.

Of note, much of the data used in this assessment was collected prior to the September 2009 tsunami that devastated some shallow water and low lying segments of the archipelago. Most parts of this assessment however, were conducted at a broad analysis scale and the types of data used were not highly sensitive to this significant and anomalous natural disturbance. For more information on tsunami impacts, interested readers are directed to specific studies that were conducted to evaluate the extent and severity of damage due to that event.

A key application intended for the report is to provide guidance in the ongoing development of a network of Marine Protected Areas (MPA) in the Samoan Archipelago. The region is already home to a diversity of MPAs implemented at various levels of government from individual villages and communities to federally protected areas of international significance. Many of the different MPAs in the network were created through independent processes for different objectives but each contributes to the mosaic of marine resource management in the region. Understanding what fish, coral, and habitat resources this diverse network of MPAs collectively encompasses is a key objective of this work and is critical for understanding the scope of current protection and thoughtfully designing additional network elements.



**Image 2.** Reef fish sold in a local grocery. Photo: Matt Kendall, NOAA Biogeography.

As a result of discussions with project partners in the design phase of the assessment, this report

focuses on corals and reef fish, transport of their larvae, and the reef habitats where they live. Additional aspects of biogeography that are not included in this assessment but are important to the region and Samoan culture include sea birds, cetaceans, deep coral habitats, and pelagic fish communities to name but a few. Including these resources was beyond the scope of our assessment although they have been investigated in several individual studies that should be consulted for more information.

The assessment is divided into 5 chapters with supporting appendices. Each chapter was based on compilation of multiple pre-existing datasets, original analysis, and discussion that has not been previously published. Each chapter was written or reviewed in collaboration with subject matter specialists and local experts. Here in Chapter 1, the overall scope and approach of the report is introduced. In Chapter 2, regional ocean climate is characterized including wind and wave climate, sea surface temperature, primary productivity, and sea level fluctuations. The focus is on the spatial and temporal patterns and trends in ocean climate that may affect marine biogeography. In Chapter 3, regional ocean currents and transport of coral and fish larvae are investigated among the islands of the archipelago as well as the surrounding island nations. The degree of self seeding versus dependency on outside sources of fish and coral larvae for maintaining each islands reef ecosystem is quantified. Major and secondary sources of larvae for each island are discussed in terms of resilience of reefs to disturbance. In Chapter 4, the reef fish and coral communities of the archipelago are quantified on the basis of overall biodiversity, abundance, and community structure. Biogeographic trends, breakpoints, and hotspots are identified among and within each of the islands in the archipelago. In Chapter 5, we summarize the existing network of MPAs in American Samoa based on their habitats, reef fish, and coral communities. Presently protected features are compared to regional resources, and remaining gaps in resource protection are highlighted. Appendices include analytical details omitted from some chapters for brevity as well as important secondary analytical products needed as inputs for the main chapters in the assessment. This includes an inventory and summary of regional seamounts needed for the larval connectivity chapter (Chapter 3), analytical details of the reef fish and coral datasets (Chapter 4), a description of the shore to shelf edge benthic maps created and used for the MPA network analysis (Chapter 5), and supplemental information on the many marine protected areas in American Samoa (Chapter 5).