Appendix A: Seamounts within the Exclusive Economic Zones of Samoa and American Samoa

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INTRODUCTION

Seamounts are underwater mountains of volcanic origin. They are often formed near mid-ocean ridges or subduction zones at the edges of tectonic plates but also occur over upwelling plumes ("hotspots") within plate boundaries (Wessel 2001). Like all geologic formations, seamounts change in shape and height over millions of years as a result of the gradual processes of volcanic growth upward out of the seafloor, growth of coral reefs if emergent or shallow enough, and eventually the processes of erosion and subsidence or sinking of the reshaped structure back into the seafloor. The Samoan Archipelago is part of a hotspot chain

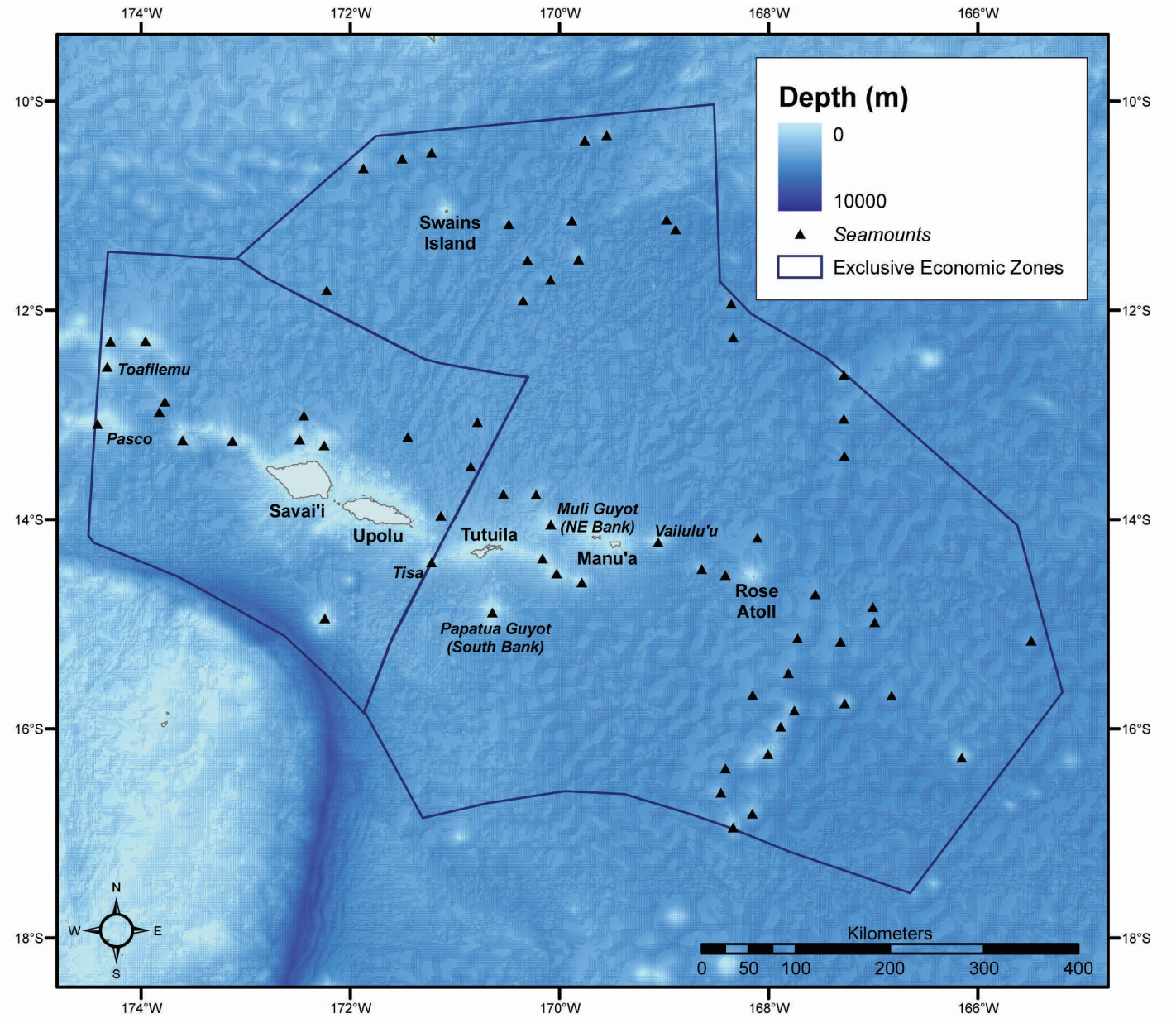

Figure A.1. Seamounts of the Samoan Exclusive Economic Zones.

[1] NOAA/NOS/NCCOS/CCMA/Biogeography Branch and Consolidated Safety Services, Inc., Fairfax, VA, under NOAA Contract No. DG133C07NC0616
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that extends from the volcanically active Vailulu'u seamount in the east to west of the island of Savai'i (Hart et al. 2006) and includes examples of many stages in the seamount life cycle. The region also includes many seamounts not associated with the Samoan hotspot (Figure A.1).

Seamounts are not only interesting features geologically as described above, but also biologically in that they represent oases of biodiversity relative to the comparatively barren ocean and seafloor surrounding them. Seamounts offer an array of habitat opportunities, current fields, and depth zones for plankton, fish and corals to occupy, they play a role as "stepping stone" features connecting populations of reef fish and corals between islands, are known gathering sites for many pelagic fish species, and consequently are popular destinations for fishing and scientific study (Rogers 1994).

The scientific definition of a seamount has evolved over time (Staudigel et al. 2010) and has variously been based on some minimum height above the seafloor, gravity anomalies of even fully subsided or buried seamounts, and has included emergent islands by some definitions. In this assessment seamounts are defined as totally submerged but extending a minimum of 150 m above the seafloor. The objective of this appendix is to provide a characterization of seamounts within the Exclusive Economic Zones (EEZs) of Samoa and American Samoa. Of particular importance are those shallow enough to be colonized by reef fish and corals.

METHODS

Seamounts are typically mapped using sonar and satellite altimetry. While sonar based mapping is the most direct method and provides detailed resolution, it is expensive and generally limited in spatial coverage. Satellite altimetry in contrast, which can be used to detect seamounts indirectly due to variations in the Earth's gravity field (Wessel 2001, Wessel et al. 2010), is available at a global scale but is comparatively coarse resolution.

Two datasets were used to characterize seamounts in the Samoan Archipelago. The Global Seamount Census (Wessel 2001, Wessel et al. 2010) is a global database of ~12,000 seamount features from satellite-derived bathymetry (Smith and Sandwell 1997). The Seamount Biogeosciences Network provides a characterization for ~1,800 seamounts worldwide, including available multibeam data, relevant literature, and morphological characteristics (Koppers et al. 2010a). Seamounts from both sources were plotted and examined in concert with available bathymetry datasets. Three bathymetry data sources were used

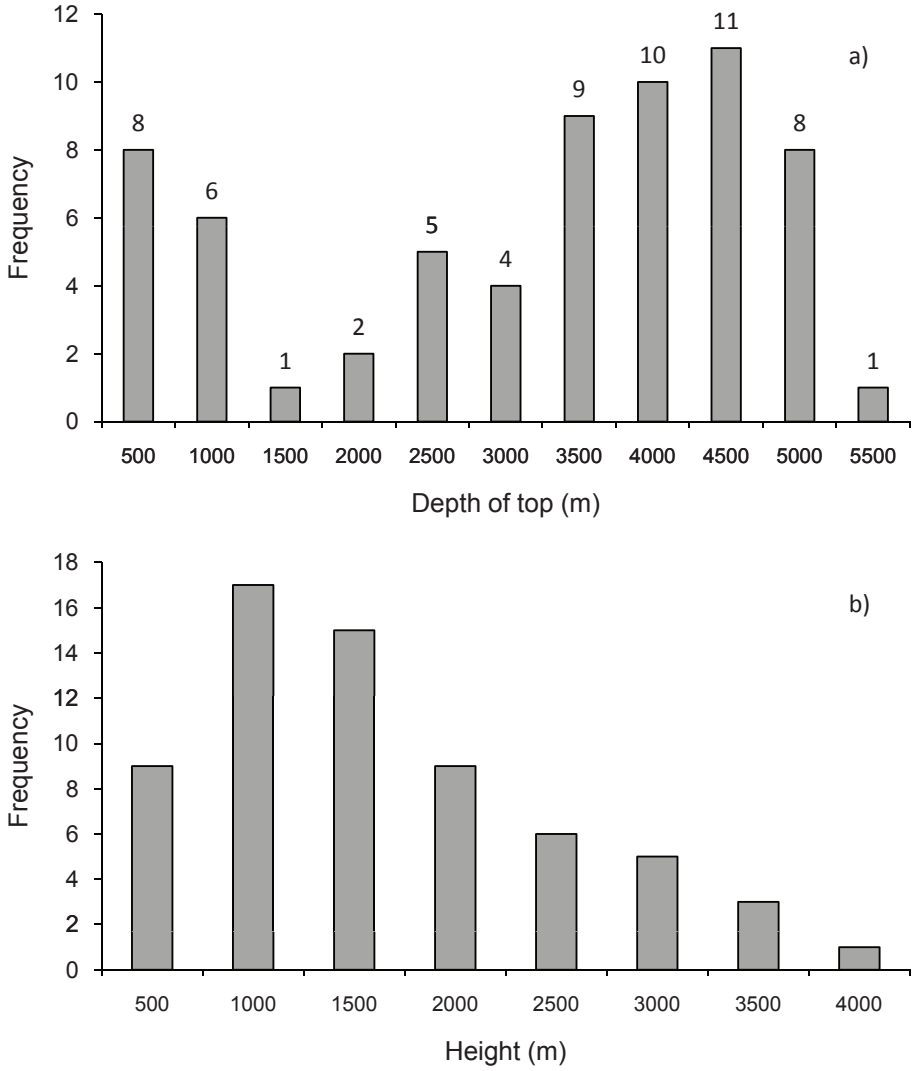

Figure A.2. Frequency distribution of seamounts within the Samoan and American Samoan EEZ based on a) depth of seamount top and b) height.

to obtain complete coverage of the study region. High resolution (5-40 m) bathymetry based on multibeam sonar was obtained from the Pacific Islands Benthic Habitat Mapping Center (http://www.soest.hawaii.edu/pibhmc.htm) for three seamounts: Vailulu'u, Muli (locally known as Northeast Bank) and Tulaga (Two-Percent Bank). Moderate resolution (180 m) bathymetry from merged multibeam and satellite data were downloaded from Koppers et al. (2010a). Last, one-minute bathymetry estimated from satellite altimetry, ship depth soundings, and other sources (http://topex.ucsd.edu, Smith and Sandwell 1997), was used where the two finer resolution datasets lacked coverage.

In many cases, seamount locations disagreed slightly between the two data sources and were therefore moved slightly in this characterization to more precisely identify the approximate peak of each seamount based on bathymetry. A few features from the satellite derived dataset (Wessel et al. 2010) lacked significant bathymetric relief and were removed. These features may have been gravity anomalies representing "buried" seamounts (Wessel 2001, Wessel et al. 2010). Additional features not included in either seamount dataset were identified within the EEZs of Samoa and American Samoa based on the bathymetry. Summary information for each seamount feature was compiled including peak coordinates, depth of peak, and total height above the seafloor. The depth of the peak and base of the seamount was estimated in ArcGIS and the height was calculated as the difference between these estimates. Seamounts are summarized in tabular form, as histograms based on peak height and depth, and in map format for both the region and as individual maps for features with potential reef communities.

RESULTS AND DISCUSSION

A total of 65 seamount features were identified; 48 within the EEZ of American Samoa, 16 within the EEZ of Samoa, and one, Tisa Seamount situated on the EEZ boundary (Figure A.1; Table A.1). Approximately 20 of the seamounts in the study area are derived from the Samoan hotspot and lie along the axis of the archipelago. This group includes many of the largest and shallowest seamounts in the region. In addition, there are two groups of smaller seamounts in the southeastern and northern regions of the American Samoa EEZ.

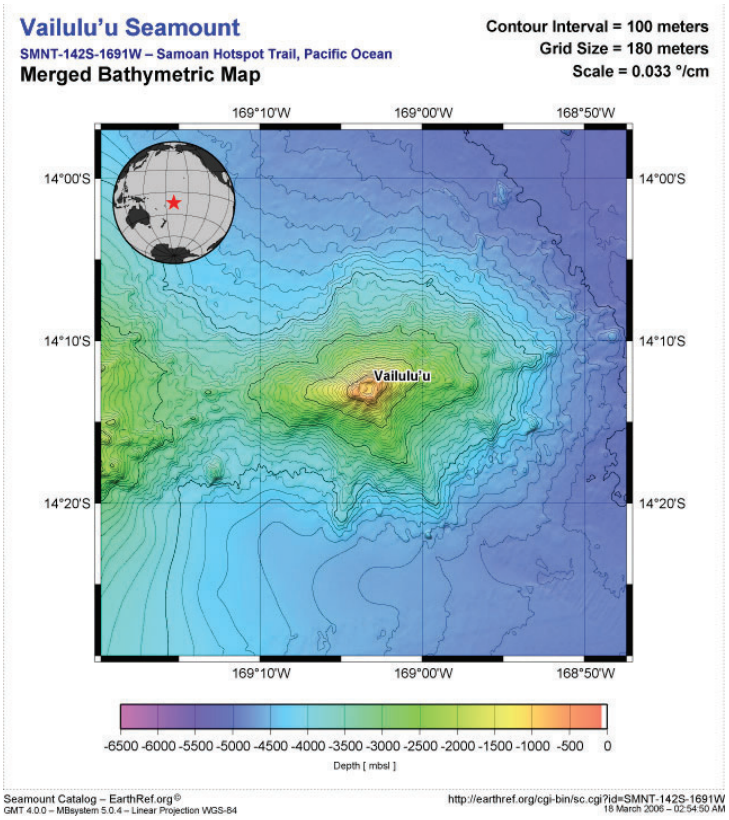

Figure A.3. Vailulu'u Seamount, the active hotspot for the Samoan Island Chain.

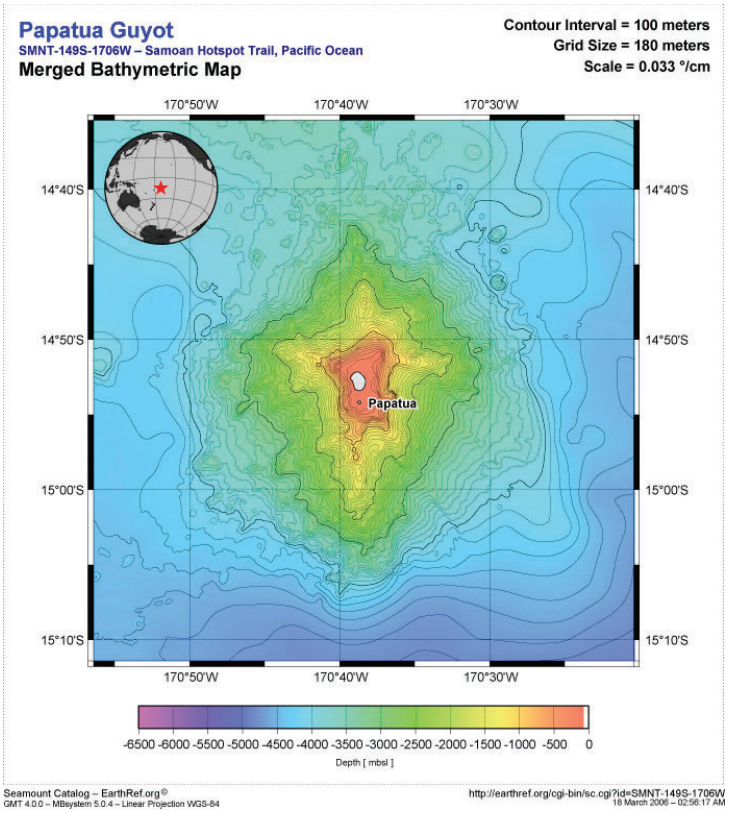

Figure A.4. Papatua Guyot (South Bank).

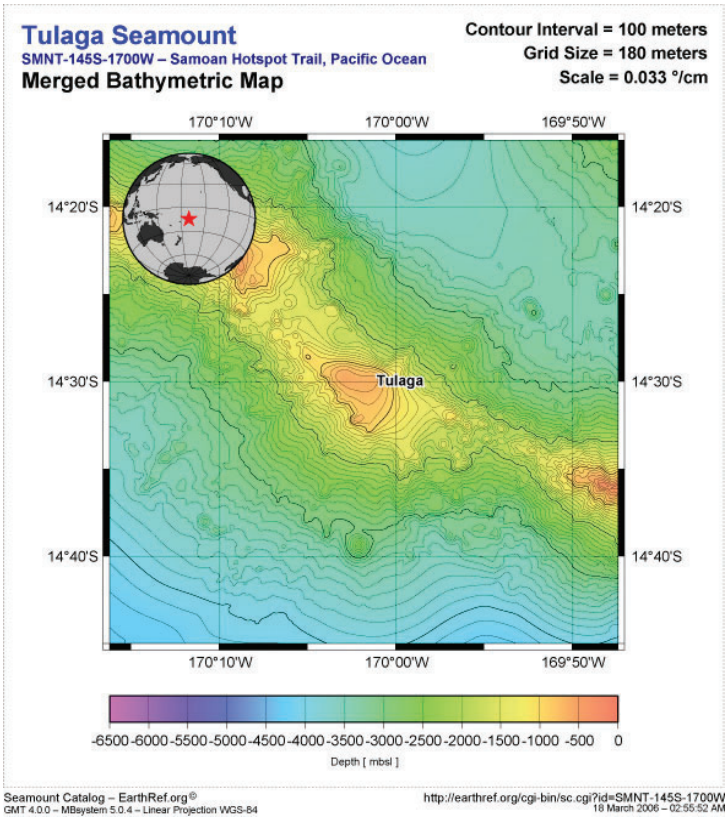

Figure A.5. Tulaga (East Bank).

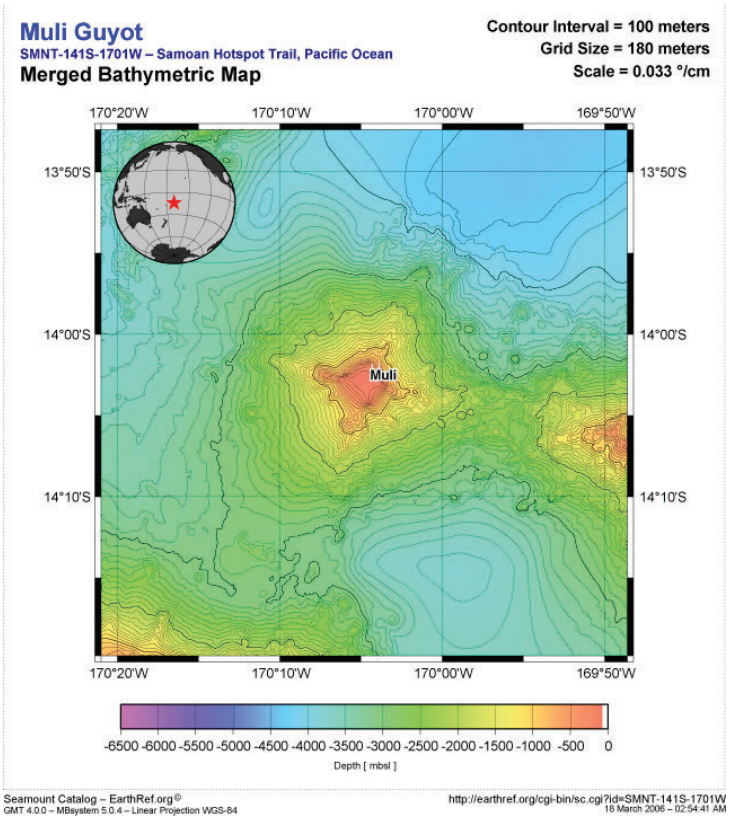

Figure A.6. Muli Guyot (NE Bank).

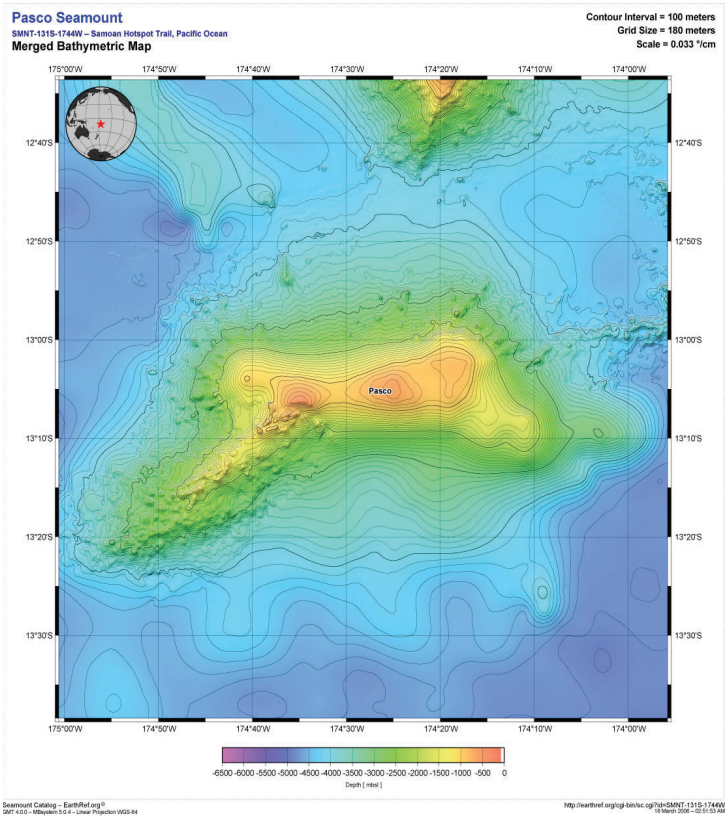

Figure A.7. Pasco Seamount.

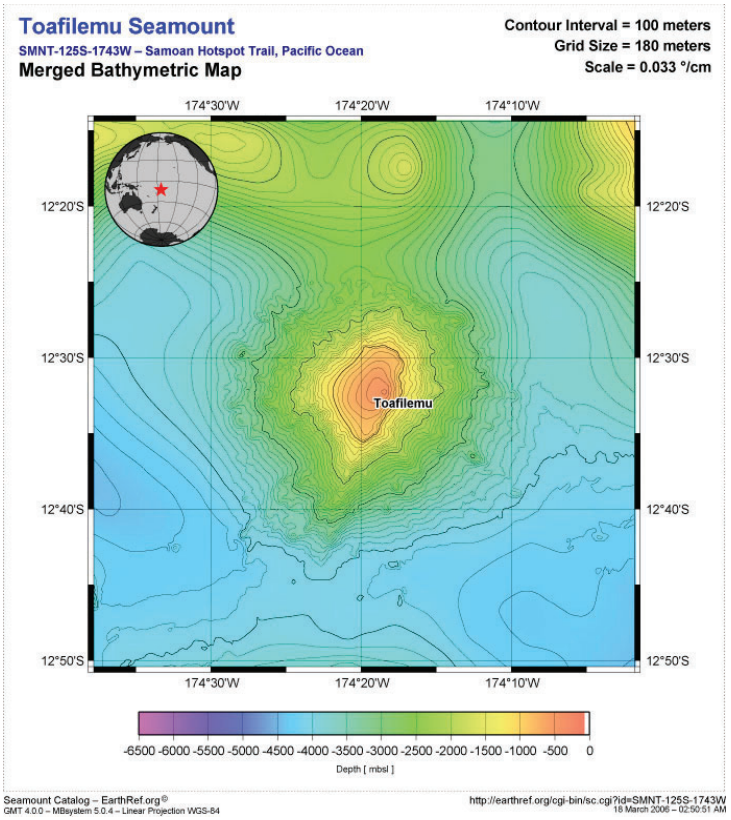

Figure A.8. Toafilemu Seamount.

Table A.1. Locations and morphological characteristics of seamounts within the EEZ of American Samoa and Samoa. 1= Koppers et al. 2010a; 2= Wessel et al. 2010; 3= estimates based on bathymetry from Koppers et al. (2010a); 4= estimates based on bathymetry from Smith and Sandwell (1997), 5=estimates based on bathymetry from NOAA PIBMC, 6= seamounts identified from visual inspection of the bathymetry. Names are based on seamount databases with local names provided in parenthesis where known.

Name	EEZ	Source	Longitude	Latitude	Depth of top (m)[1,3,4]	Height (m)[1,3,4]
Malu Malu Seamount	American Samoa	1,2	-169.7856	-14.6006	286 (3)	1,884 (3)
Malulu Seamount	American Samoa	1,2	-168.6422	-14.4728	2380 (3)	1,396 (3)
Muli Guyot (NE Bank)	American Samoa	1,2	-170.0822	-14.0479	49 (5)	2,926 (3)
Papatua Guyot (South Bank)	American Samoa	1,2	-170.6433	-14.8880	23 (3)	3,629 (3)
Soso Seamount	American Samoa	1,2	-170.2254	-13.7608	1,820 (3)	1,714 (3)
Tama'l Seamount	American Samoa	1	-170.5393	-13.7544	2,666 (3)	1,146 (3)
Tulaga Seamount (East Bank)	American Samoa	1,2	-170.0267	-14.5125	78 (5)	1,313 (3)
Vailulu'u Seamount	American Samoa	1,2	-169.0577	-14.2160	583 (5)	2,700 (3)
Unnamed Seamount 1	American Samoa	1	-167.5555	-14.7115	3,722 (3)	1,304 (3)
Unnamed Seamount 2	American Samoa	2	-171.8754	-10.6409	3,342 (3)	566 (3)
Unnamed Seamount 3	American Samoa	2	-171.5049	-10.5500	4,028 (3)	749 (3)
Unnamed Seamount 4	American Samoa	2	-171.2254	-10.4921	3,861 (3)	798 (3)
Unnamed Seamount 5	American Samoa	2	-170.4845	-11.1755	3,674 (3)	1,180 (3)
Unnamed Seamount 6	American Samoa	2	-170.3508	-11.9043	2,957 (3)	2,012 (3)
Unnamed Seamount 7	American Samoa	2	-170.3072	-11.5180	4,068 (3)	940 (3)
Unnamed Seamount 8	American Samoa	2	-169.8827	-11.1421	3,037 (3)	1,990 (3)
Unnamed Seamount 9	American Samoa	2	-169.8170	-11.5138	3,552 (3)	1,384 (3)
Unnamed Seamount 10	American Samoa	2	-169.5490	-10.3254	3,237 (3)	1,679 (3)
Unnamed Seamount 11	American Samoa	2	-168.8920	-11.2256	3,968 (3)	943 (3)
Unnamed Seamount 12	American Samoa	2	-168.4578	-16.6080	2,985 (4)	2,086 (4)
Unnamed Seamount 13	American Samoa	2	-168.4156	-16.3762	4,420 (4)	582 (4)
Unnamed Seamount 14	American Samoa	2	-168.3594	-11.9369	4,997 (3)	238 (3)
Unnamed Seamount 15	American Samoa	2	-168.3415	-12.2581	5,091 (3)	167 (3)
Unnamed Seamount 16	American Samoa	2	-168.3411	-16.9409	2,690 (4)	2,192 (4)
Unnamed Seamount 17	American Samoa	2	-168.1575	-16.8079	3,146 (4)	1,523 (4)
Unnamed Seamount 18	American Samoa	2	-168.1088	-14.1747	4,494 (3)	499 (3)
Unnamed Seamount 19	American Samoa	2	-168.0070	-16.2408	2,438 (4)	2,125 (4)
Unnamed Seamount 20	American Samoa	2	-167.8859	-15.9792	3,480 (3)	1,254 (3)
Unnamed Seamount 21	American Samoa	2	-167.2823	-12.6179	3,162 (3)	1,756 (3)
Unnamed Seamount 23	American Samoa	2	-167.2741	-15.7566	3,916 (3)	1,587 (3)
Unnamed Seamount 24	American Samoa	2	-166.8266	-15.6801	4,444 (4)	768 (4)
Unnamed Seamount 25	American Samoa	2	-166.1574	-16.2741	2,064 (4)	3,025 (4)
Unnamed Seamount 26	American Samoa	2	-165.4911	-15.1572	4,666 (4)	705 (4)
Unnamed Seamount 29	American Samoa	6	-167.7583	-15.8242	4,243 (3)	758 (3)
Unnamed Seamount 33	American Samoa	6	-172.2244	-11.8078	4,092 (3)	619 (3)
Unnamed Seamount 34	American Samoa	6	-169.7597	-10.3760	3,572 (3)	1,308 (3)
Unnamed Seamount 35	American Samoa	6	-167.2844	-13.0375	4,198 (3)	647 (3)
Unnamed Seamount 36	American Samoa	6	-167.2790	-13.3913	4,363 (3)	660 (3)
Unnamed Seamount 37	American Samoa	6	-170.1634	-14.3718	353 (3)	1,206 (3)
Unnamed Seamount 44	American Samoa	6	-170.0859	-11.7090	4,250 (3)	650 (3)
Unnamed Seamount 45	American Samoa	6	-166.9862	-14.9812	3,711 (3)	1,223 (3)
Unnamed Seamount 46	American Samoa	6	-167.0048	-14.8347	4,704 (3)	282 (3)
Unnamed Seamount 47	American Samoa	6	-167.3141	-15.1643	4,799 (3)	234 (3)
Unnamed Seamount 48	American Samoa	6	-167.7249	-15.1334	4,858 (3)	290 (3)
Unnamed Seamount 49	American Samoa	6	-167.8125	-15.4669	4,915 (3)	353 (3)

Table A.1 cont. Locations and morphological characteristics of seamounts within the EEZ of American Samoa and Samoa. 1= Koppers et al. 2010a; 2= Wessel et al. 2010; 3= estimates based on bathymetry from Koppers et al. (2010a); 4= estimates based on bathymetry from Smith and Sandwell (1997); 5=estimates based on bathymetry from NOAA PIBMC; 6= seamounts identified from visual inspection of the bathymetry. Names are based on seamount databases with local names provided in parenthesis where known.

Name	EEZ	Source	Longitude	Latitude	Depth of top (m)[1,3,4]	Height (m)[1,3,4]
Unnamed Seamount 50	American Samoa	6	-168.1543	-15.6757	4,887 (3)	269 (3)
Unnamed Seamount 51	American Samoa	6	-168.4162	-14.5275	4,104 (3)	730 (3)
Unnamed Seamount 53	American Samoa	6	-168.9760	-11.1330	4,608 (3)	378 (3)
Tisa Seamount	American Samoa /Samoa	1,2	-171.2235	-14.4073	861 (3)	2,140 (3)
Agavale Seamount	Samoa	1,2	-172.4833	-13.2333	995 (3)	1,986 (3)
Pasco Seamount	Samoa	1,2	-174.4157	-13.0865	94 (4)	3,051 (3)
Si'usi'u Seamount	Samoa	1,2	-173.6039	-13.2414	1,269 (3)	2,359 (3)
Taumatau Seamount	Samoa	1,2	-172.2503	-13.2894	842 (3)	1,890 (3)
Toafe'ai Seamount	Samoa	1,2	-173.9573	-12.2925	488 (3)	2,976 (3)
Toafilemu Seamount	Samoa	1,2	-174.3238	-12.5384	30 (4)	2,737 (3)
Tuapi'o Seamount	Samoa	1,2	-173.1259	-13.2477	425 (3)	2,966 (3)
Uo Mamae Seamount	Samoa	1	-172.2427	-14.9441	645 (3)	3,169 (3)
Unnamed Seamount 27	Samoa	1	-170.7861	-13.0671	3,796 (3)	1,004 (3)
Unnamed Seamount 30	Samoa	6	-173.7718	-12.8724	3,032 (3)	601 (3)
Unnamed Seamount 38	Samoa	6	-173.8263	-12.9707	2,349 (3)	1,379 (3)
Unnamed Seamount 39	Samoa	6	-174.2913	-12.2940	1,711 (3)	1,250 (3)
Unnamed Seamount 40	Samoa	6	-172.4459	-13.0042	3,098 (3)	698 (3)
Unnamed Seamount 41	Samoa	6	-171.4520	-13.2108	3,451 (3)	1,326 (3)
Unnamed Seamount 42	Samoa	6	-170.8492	-13.4912	3,711 (3)	941 (3)
Unnamed Seamount 43	Samoa	6	-171.1356	-13.9646	2,430 (3)	1,297 (3)

Peak depth ranged from 23 m to deeper than 5,000 m. The frequency of peak height by depth exhibited a bi-modal pattern, with the majority of seamount peaks located in water over >2000 m in depth (Figure A.2a). The majority of seamounts (60%) were less than 1,500 m in height (Figure A.2b).

Only Vailulu'u seamount (Figure A.3) is characterized as hydrothermally active, whereas the remaining seamounts are extinct volcanoes (Koppers et al. 2010b). The biological community varies among different locations on Vailulu'u and includes polychaetes, crinoids, octocorals, sponges, and a population of cutthroat eels (Staudigel et al. 2006).

In general, there is a lack of information on biological communities for other seamounts within the EEZ of Samoa and American Samoa. Seamounts Online (Stocks 2009) is a global database of user-contributed data on species distributions on seamounts. However, there was no data available for seamounts on the Samoan Archipelago at this time. The estimated depths of the top of the seamount features were used to determine whether shallow or mesophotic reefs were potentially present. Generally, mesophotic reefs range from ~30 to 150 m depth, although deeper records of zoxanthellate corals and coralline algae have been documented (Hinderstein et al. 2010). The estimated peaks of the seamount features were only shallower than 150 m depth for 5 out of 65 features, suggesting that mesophotic reefs are potentially present. Three of these seamounts are located within the American Samoa EEZ (Figures A.4-A.6) while the latter two features are located on the western edge of the Samoa EEZ (Figures A.7-A.8). Paputua Guyot, locally known as South Bank, has been identified as a drowned atoll in recent bathymetric surveys although development of mesophotic reef communities is lacking (R. Brainard, personal communication, NOAA Coral Reef Ecosystem Division, Honolulu, HI). All the remaining seamount features are estimated to be greater than 300 m deep, although actual depths should be interpreted with caution due to the scale and estimation methods of the bathymetry data. For example, there was a large difference in the depth of Tulaga Seamount, locally known as East Bank, when measured by multibeam sonar (78 m, PIBHMC) versus satellite altimetry (> 700 m).

CONCLUSIONS

A wide range of seamount morphologies exist within the Samoan EEZs. Approximately one third of the seamounts in the study area are derived from the Samoan hotspot which is presently located at Vailulu'u with the rest scattered in two main groups in the American Samoa EEZ. The five seamount features with potential mesophotic reef communities were evaluated further and used as inputs for understanding reef connectivity in Chapter 3 of this assessment.

ACKNOWLEDGEMENTS

The seamount databases available online and cited in this document are an excellent resource. We gratefully acknowledge Dr. Anthony Koppers for allowing us permission to use the original seamount maps available at EarthRef.org in our report.

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Appendix B: Shoreline to Shelf Edge Benthic Maps of Tutuila, American Samoa

Matthew S. Kendall[1]

INTRODUCTION

Accurate maps of coral reef ecosystems are a critical component of reef science and management. Mesophotic reefs around Tutuila, American Samoa makeup the majority of the area of coral reef ecosystems around the island but have not been comprehensively mapped and classified like their shallow water counterparts (see NOAA NCCOS 2005). To meet this need we created benthic maps of the mesophotic reef ecosystems and edge matched them to the existing shallow water maps to produce a comprehensive shoreline to shelf edge map of benthic features.

METHODS

Benthic features were visually interpreted from sonar imagery collected by the Pacific Islands Benthic Habitat Mapping Center (PIBHMC) (downloaded from http://www.soest.hawaii.edu/pibhmc/). Primary datasets used during map production were bathymetry and backscatter. Additional image datasets derived from these primary sources were also used during interpretation and included slope, rugosity, contours, and hillshade.

Areas of consistent tone and texture in the sonar imagery were identified visually by toggling among the various sonar datalayers. Boundaries were drawn around these contiguous sonar signatures using the Habitat Digitizer Extension to ArcGIS 9.0 (http://ccma.nos.noaa.gov/products/biogeography/digitizer/welcome.html). All features were delineated at a scale of 1:10,000. The minimum mapping unit (MMU- size of the smallest feature to be delineated) was restricted to 4,000 m^2 to be consistent with benthic maps recently produced for shallow water areas (NOAA NCCOS 2005).

Benthic features with consistent sonar signatures were attributed based on a classification scheme modified from the recently completed “Benthic Habitats of American Samoa, Guam, and CNMI” (NOAA NCCOS 2005). The scheme was originally designed for use with color satellite imagery. The spatial properties of the satellite and sonar imagery (i.e. 5 m bathymetry and 1 m back scatter grid resolution for sonar imagery versus 4 m color and 1 m black and white grid resolution for IKONOS satellite imagery) and scales of mapping were similar (i.e. on-screen digitizing scale was 1:10K for sonar imagery and 1:6K for satellite imagery, MMU was 4,000 m^2 for both data sources). Sonar signatures were primarily ground truthed using video transect data from a towed camera system which was supplemented with drop camera video on specific features. Video transect data was collected between 2002 and 2006 and obtained from PIBHMC (Bare et al. 2010). Supplemental drop camera data was collected in May 2010 and consisted of 119 sites on features in between the video transects. Each site was characterized by ~2 minutes of video for a total of ~4 hours of seafloor imagery.

A key goal was to create comprehensive maps of the coral reef ecosystem of Tutuila from the shoreline to the shelf edge. The extent of the sonar data was approximately from the insular shelf edge to the base of the fringing reefs around Tutuila, however, in places it did not cover all the way to the shelf edge, include the base of fringing reefs (lower fore reef), or necessarily include 100% coverage throughout the shelf. Gaps between sonar swaths on the shelf were simply ignored during digitizing since they were typically narrow and occurred in regions of relatively homogenous seafloor. To fill in gaps in coverage at the shelf edge, the 100 fathom isobath from NOAA Navigational Chart #83484 was overlayed in the GIS and used to assist in digitizing placement of the shelf edge polygon. The gap in coverage between the sonar data and the shoreline was filled using maps from the 2005 Benthic Habitats of American Samoa, Guam and CNMI data CD (NOAA NCCOS 2005). The satellite base maps (NOAA NCCOS 2005) were edge matched to sonar based maps principally along the seaward edge of the fore reef, a feature often visible in both sonar and satellite imagery. The shallow water map was generally clipped out in regions of overlap due to the higher interpretability of the sonar imagery of this zone relative to the satellite imagery.

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Classification Scheme

The classification scheme defined benthic habitats based on four attributes: 1) shelf zone, 2) general geomorphological structure, 3) detailed structure, and 4) percent hardbottom. Every feature in the benthic habitat map was assigned a designation from each level of the scheme. We customized the classification scheme to be compatible with, 1) the available sonar data for American Samoa, and 2) the existing benthic maps of shallow reefs for American Samoa (NOAA NCCOS 2005). The primary differences between this scheme and the one used to map shallow reefs of Tutuila were that biological cover was not mapped whereas percent hardbottom was. These changes were necessary to the scheme due to the differences in sonar and satellite imagery.

Zones

Thirteen mutually exclusive zones were identified from land to deep ocean corresponding to typical insular shelf and coral reef geomorphology. These zones included: Land, Shoreline Intertidal, Reef Flat, Lagoon, Back Reef, Reef Crest, Fore Reef, Bank/Shelf, Bank/Shelf Basin, Bank/Shelf Escarpment, Channel, Dredged, and Unknown. Figure B.1 illustrates zone types across a typical cross-section of the island shelf. Zone refers only to each benthic community's location and does not address substrate or structure types that are found within. For example, the Lagoon zone may include patch reefs, sand, and reef rubble; however, these are considered structural elements that may or may not occur within the lagoon zone and therefore, are not used to define it. Note that some zone categories exist only in the nearshore map (NOAA NCCOS 2005; e.g. shoreline/intertidal and reef crest) and others only exist in the sonar based portion of the map (e.g. bank/shelf escarpment and bank/shelf basin). See NOAA NCCOS (2005) and Bare et al. (2010) for additional cross sectional figures and example photographs of each zone type.

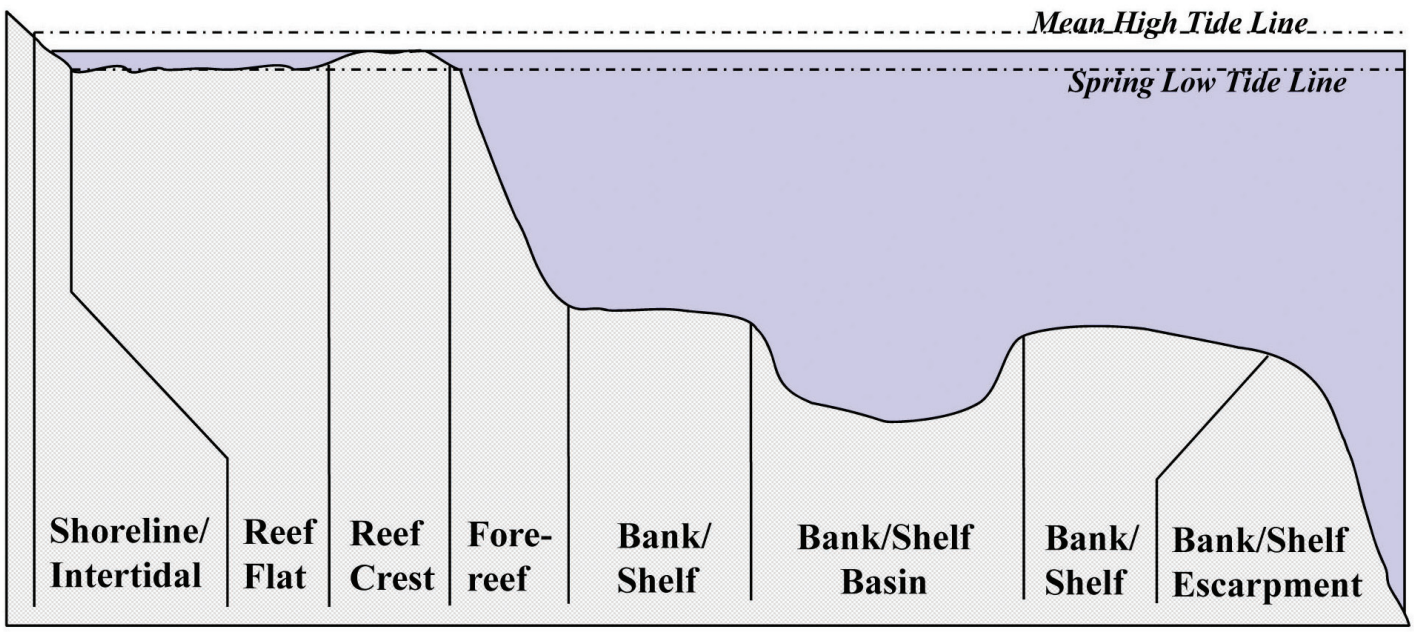

Figure B.1. Cross section of Zones.

Land

Terrestrial features at or near the spring high tide line. The shoreline is based on the official digital shoreline available at the time nearshore mapping was conducted (NOAA NCCOS 2005). As a result many of the land polygons may be smaller than the MMU used to delineate marine features.

Shoreline Intertidal

Area between the spring high tide line (or landward edge of emergent vegetation when present) and lowest spring tide level. Emergent segments of reefs are excluded from this zone and instead are defined below as Reef Crest. Typically, this zone is narrow due to the small tidal range in Tutuila. While present island-wide, the feature is often too narrow to be mapped on steep shorelines due to the scale of the imagery and the MMU.

Lagoon
Shallow area (relative to the deeper water of the bank/shelf) between the Shoreline Intertidal zone and the Back Reef of a reef. This zone is typically protected from the high-energy waves commonly experienced on the Bank/Shelf and Reef Crest zones.

Reef Flat
Shallow, semi-exposed area of little relief between the Shoreline Intertidal zone and the Reef Crest of a fringing reef. This broad, flat area often exists just landward of a Reef Crest and may extend to the shoreline or drop into a Lagoon. This zone is often somewhat protected from the high-energy waves commonly experienced on the Bank/Shelf and Reef Crest zones.

Back Reef
Area just landward of a Reef Crest that slopes downward towards the seaward edge of a Lagoon floor or Bank/Shelf. This zone is present only when a Reef Crest exists.

Reef Crest
The uppermost, and often flattened, emergent (especially during low tides) or nearly emergent segment of a reef. This high wave energy zone lies between the Fore Reef and Back Reef or Reef Flat zones. Breaking waves are often visible in aerial or satellite imagery at the seaward edge of this zone.

Fore Reef
Area along the seaward edge of the Reef Crest that slopes into deeper water to the landward edge of the Bank/Shelf platform. This feature is often referred to locally as the reef slope. Features not associated with an emergent Reef Crest but still having a seaward-facing slope that is significantly greater than the slope of the Bank/Shelf are also designated as Fore Reef.

Bank/Shelf
Deeper water area (relative to the shallow water in a lagoon or reef flat) extending offshore from the seaward edge of the Fore Reef or shoreline to the beginning of the escarpment where the insular shelf drops off into deep, oceanic water. If no Reef Crest is present, the Bank/Shelf is the flattened platform between the Fore Reef and deep open ocean waters or between the Shoreline Intertidal zone and open ocean.

Bank/Shelf Basin
Broad depressions of deeper water occurring in the Bank/Shelf. These features are surrounded by well defined inflections in bathymetry up to the relatively less deep waters of the Bank/Shelf.

Bank/Shelf Escarpment
This zone begins on the oceanic edge of the Bank/Shelf, where depth increases rapidly into deep, oceanic water and exceeds the depth limit of sonar imagery around Tutuila. This zone is intended to capture the inflection point of the shelf to deep waters of the open ocean.

Channel
Naturally occurring channels that often cut across several other zones.

Dredged
Area in which natural geomorphology is disrupted or altered by excavation or dredging.

Pinnacle
High relief features occurring in or adjacent to Bank/Shelf Basin that are capped by coral reef or hard bottom.

Unknown
Zone indistinguishable due to gaps between swaths in sonar imagery or due to turbidity, cloud cover, water depth, or other interference in satellite imagery.

Geomorphological Structures

Fifteen distinct and non-overlapping geomorphologic structure could be mapped by visual interpretation of sonar imagery. Structure refers only to predominate physical composition of the feature and does not address location (see Zone for shore to shelf edge location). The structure types are defined in a collapsible hierarchy ranging from four major classes (Coral Reef and Hardbottom, Unconsolidated Substrate, Other Delineations, and Unknown), to fifteen detailed classes listed and defined below. See NOAA NCCOS (2005) for example photographs and satellite images of each classification.

Coral Reef and Hardbottom

Solid substrates including bedrock, boulders, and reef building organisms. A thin veneer of sediment may be present. Detailed classes within this category include Aggregate Reef, Individual Patch Reef, Aggregated Patch Reefs, Spur and Groove, Pavement, Pavement with Sand Channels, Pavement with Patch Reefs, Reef Rubble, and Rock/Boulder.

Aggregate Reef

Continuous, high-relief coral formation of variable shapes lacking sand channels of Spur and Groove. Includes linear coral formations that are oriented parallel to shore or the shelf edge. This class is used for such commonly referred to terms as linear reef, fore reef or fringing reef.

Individual Patch Reef

Patch reefs are coral formations that are isolated from other coral reef formations by bare sand, seagrass, or other habitats and that have no organized structural axis relative to the contours of the shore or shelf edge. They are characterized by an often circular or oblong shape with a vertical relief of one meter or more in relation to the surrounding seafloor. Individual Patch Reefs are larger than or equal to the MMU.

Aggregated Patch Reefs

These features have the same defining characteristics as an Individual Patch Reef. However, this class refers to clustered patch reefs that individually are too small (less than the MMU) or are too close together to map separately. Where aggregated patch reefs share sand halos, the halo is included in the polygon.

Spur and Groove

This structure has alternating sand and coral formations that are oriented perpendicular to the shore or reef crest. The coral formations (spurs) of this feature typically have a high vertical relief relative to pavement with sand channels and are separated from each other by 1-5 meters of sand or hardbottom (grooves), although the height and width of these elements may vary considerably. This habitat type typically occurs in the Fore Reef or Bank/Shelf Escarpment zone.

Pavement

Flat, low-relief, solid rock in broad areas often with partial coverage of sand, algae, hard coral, gorgonians, zooanthids or other sessile invertebrates.

Pavement with Sand Channels

Areas of pavement with alternating sand/surge channel formations that are oriented perpendicular to the shore or Bank/Shelf Escarpment. The sand/surge channels of this feature have low vertical relief relative to Spur and Groove formations. This habitat type occurs in areas exposed to moderate wave surge such as the Bank/Shelf zone.

Pavement with Patch Reefs

Habitats of pavement with occasional patch reef formations that make up less than 10% of the area of the polygon. This habitat type occurs nested in pavement areas on the Bank/Shelf zone.

Reef Rubble
Dead, unstable coral rubble often colonized with turf, filamentous, calcareous, or encrusting macroalgae. This habitat often occurs landward of well developed reef formations in the Reef Crest, Back Reef or Reef Flat zones due to storm waves piling up dead coral. Reef Rubble can also occur in offshore areas due to diseased or physically impacted reef communities.

Rock/Boulder
Large, irregularly shaped carbonate blocks or volcanic rock often extending offshore from the island bedrock or headlands. Can also occur as aggregations of loose rock fragments that have been detached and transported from their native beds. Individual boulders often range in diameter from 0.25 – 3 m.

Unconsolidated Substrate
Areas of the seafloor consisting of small, unattached or uncemented particles with less than 10% cover of large stable substrate. Detailed structure classes of softbottom include Sand, Mud, Sand with Scattered Coral and Rock, and Algal Plain.

Sand
Coarse sediment typically found in areas exposed to currents or wave energy.

Mud
Fine sediment often associated with stream discharge and build-up of organic material in areas sheltered from high-energy waves and currents.

Sand with Scattered Coral and Rock
Primarily sand bottom with scattered rocks or small, isolated coral heads that are too small to be delineated individually (i.e. smaller than individual patch reefs). If the density of small coral heads is greater than 10% of the entire polygon, this structure type is described as Aggregated Patch Reefs.

Algal Pain
Low relief (<~0.25 m) substrate composed of a mixture of sand, live halimeda, halimeda sand, fleshy macroalgae, and rhodoliths. Relative abundance of these compositional elements is highly variable over scales of a few meters.

Other Delineations
Any other type of structure not classified as Coral Reef and Hardbottom or Unconsolidated Sediment. Usually related to the terrestrial environment and/or anthropogenic activity. Detailed structure classes include Land, Artificial, and Emergent Vegetation.

Land
Terrestrial features at or near the spring high tide line.

Artificial
Man-made habitats such as submerged wrecks, large piers, submerged portions of rip-rap jetties, and the shoreline of islands created from dredge spoil.

Emergent Vegetation
This category includes all species of mangroves regardless of canopy density. This class was not used the sonar derived map for obvious reasons but was retained in the classification scheme due to its occurrence in nearshore maps.

Unknown
Major structure indistinguishable due to data gaps from turbidity, cloud cover, water depth, ship orientation, line spacing, or other interference with an interpretable signature of the seafloor.

Unknown
Detailed structure indistinguishable as above.

Percent Hardbottom
Seven classes were used to denote the approximate proportion of each polygon occupied by hard bottom substrate. A polygon encompassing several patch reefs that were too small to be delineated individually is actually comprised of some area of patch reefs and some background structure such as sand. This category includes both "living" hard bottom such as patch reefs as well as "abiotic" features such as pavement and rock/boulder. This attribute can be used to estimate the combined amount of coral reef and hard bottom around the island based on the area of each polygon.

<10%
Used for all sand, mud, and sand with scattered coral and rock polygons.

10-30%
Used for some aggregated patch reef polygons and other discontinuous features.

30-50%
Used for some aggregated patch reef polygons and other discontinuous features.

50-70%
Used for some aggregated patch reef polygons and other discontinuous features.

70-90%
Used for some aggregated patch reef polygons, pavement, and other discontinuous features.

90-100%
Used for most individual patch reef, pavement, aggregate reef polygons, and other continuous features.

10-90%
This broad category was used for algal plain polygons due to the high variability in Rhodolith coverage of this bottom type which was not interpretable in the sonar imagery. Rhodoliths are hard algal nodules with ~5-10 cm diameter that are not cemented to the seafloor. They can form highly variable coverage from sparse (a few per square meter) to a nearly continuous cover over sand substrates.

RESULTS
The map product from this work is available for download from the NOAA/NOS/NCCOS/CCMA/ Biogeography Branch website at http://ccma.nos.noaa.gov/about/biogeography/.

ACKNOWLEDGEMENTS

Sonar data and towed camera imagery are essential tools for mapping coral reef ecosystems at this depth and are the basis of this mapping project in deeper waters. These data were collected and made available for this project by staff at the Pacific Islands Benthic Habitat Mapping Center and NOAA's NMFS/PIFSC/Coral Reef Ecosystem Division. We are particularly grateful to John Rooney, Alica Bare, and Kerry Grimshaw for obtaining and navigating those datasets. Laurie Bauer, Kim Roberson, Kevin Grant, Chris Caldow, and Ken Buja were intrumental in collecting additional ground validation data. Ken Buja provided help with the habitat digitizer and with sewing the shallow and deep water maps together.

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Bare AY, Grimshaw KL, Rooney J, Sabater MG, Fenner D, Carroll B. 2010. Mesophotic communities of the insular shelf at Tutuila, American Samoa. Coral Reefs 29:369-377.

NOAA NCCOS (National Centers for Coastal Ocean Science). 2005. Shallow-water benthic habitats of American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands (CD-ROM). NOAA Technical Memorandum NOS-NCCOS 8, Biogeography Team. Silver Spring, MD.

Appendix C: Fish and Coral Data Plots

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. Dashed red lines indicate the identified natural breaks in the data that were used to classify survey site values as high, medium, and low for each variable.

Figure C.1 - ASEPA

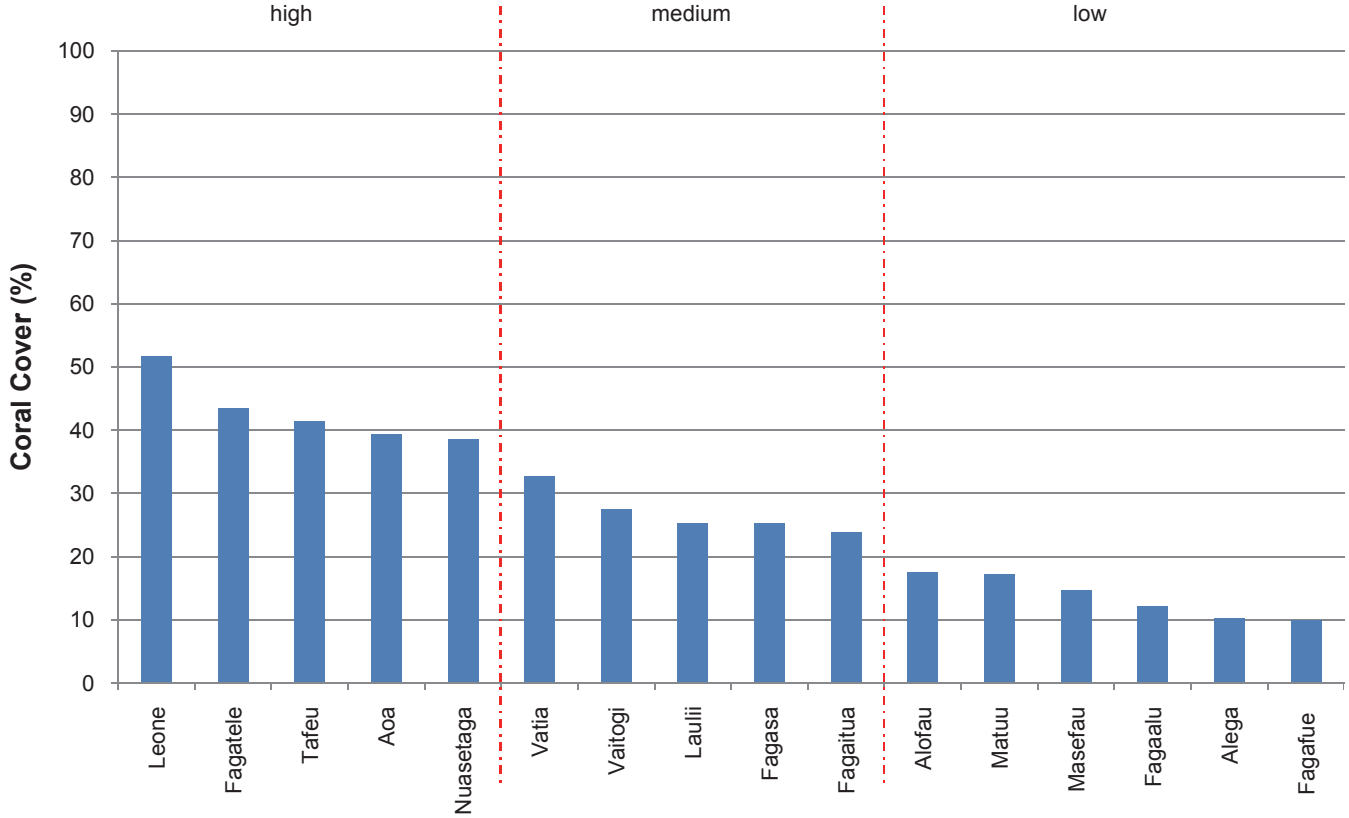
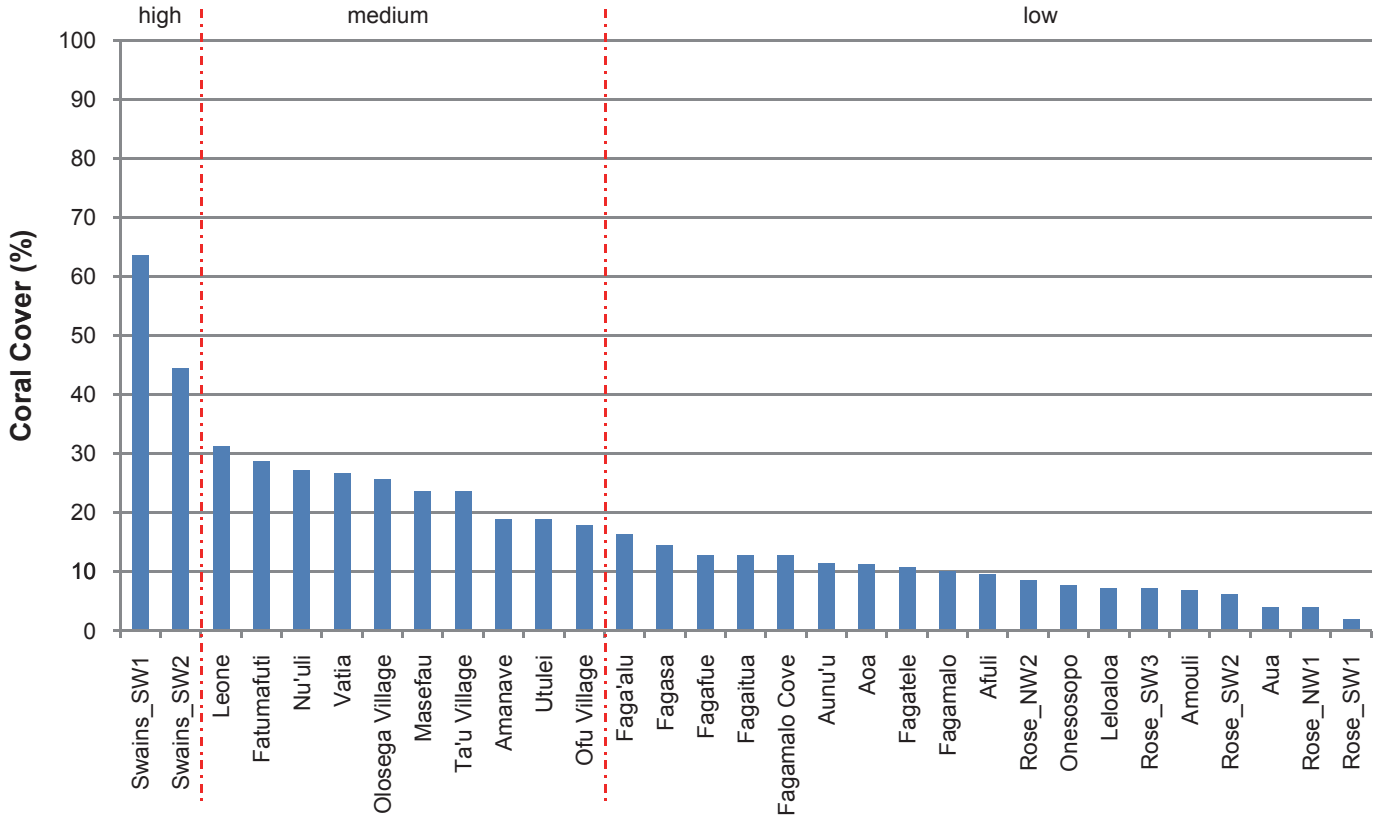


Figure C.2 - CRSR



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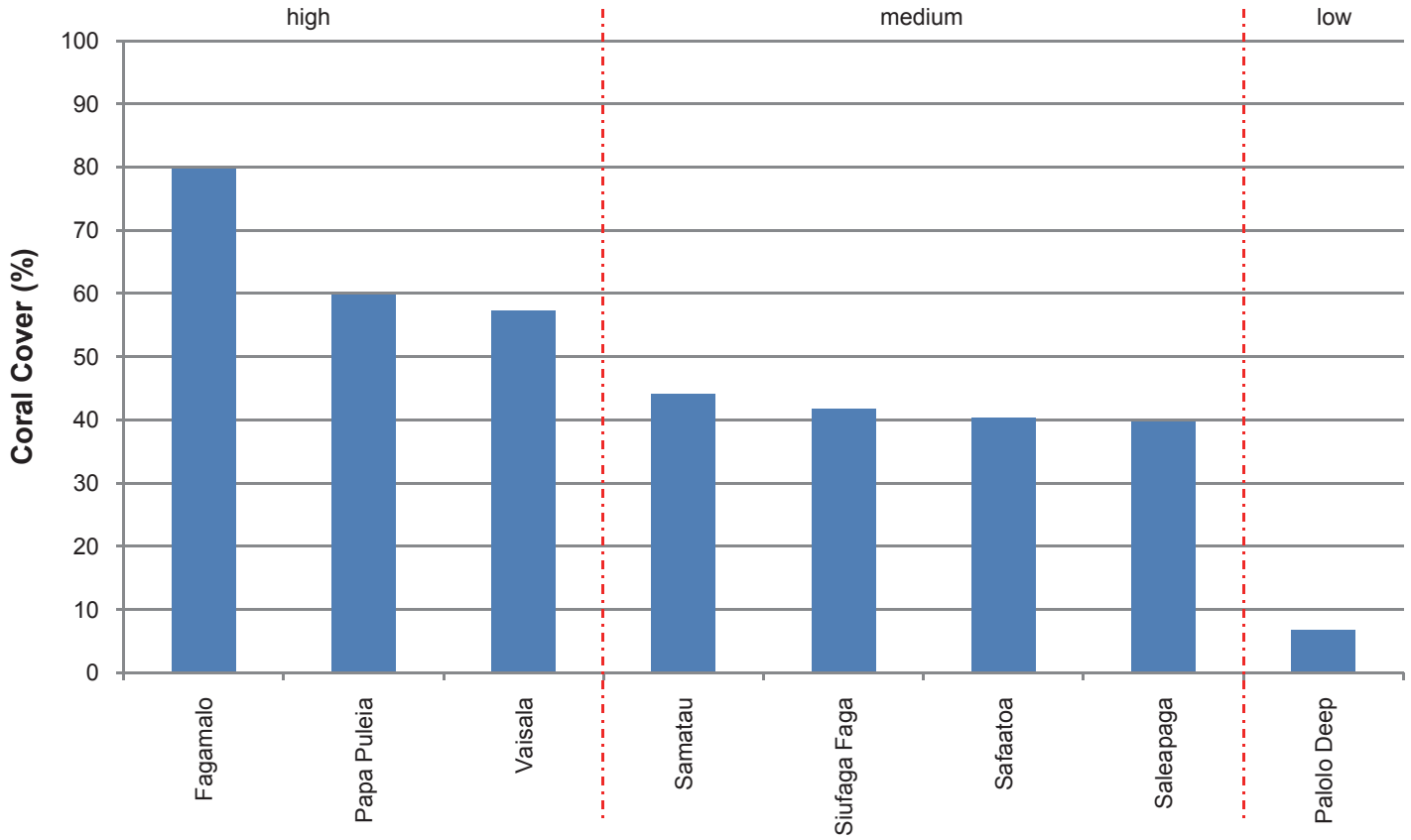

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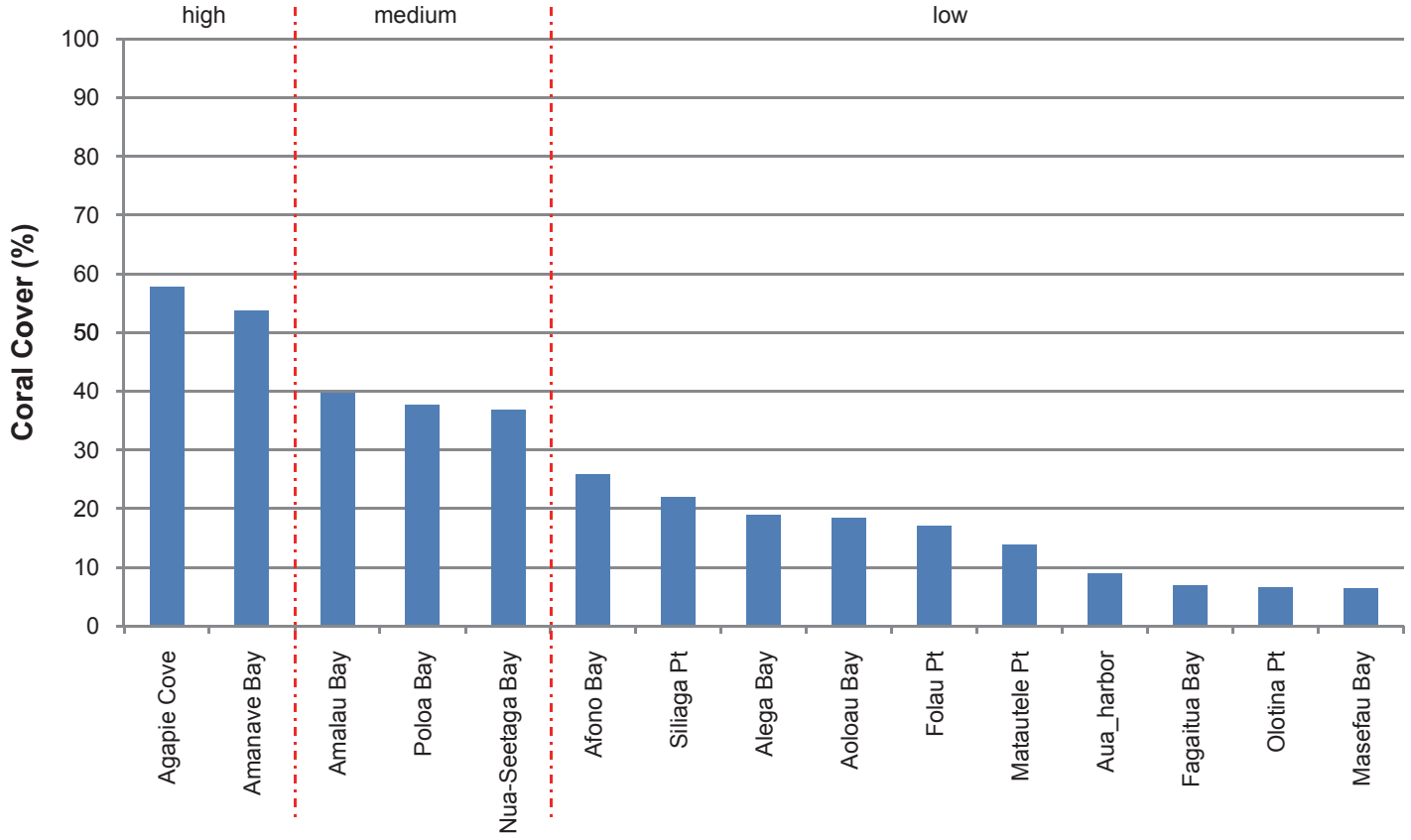

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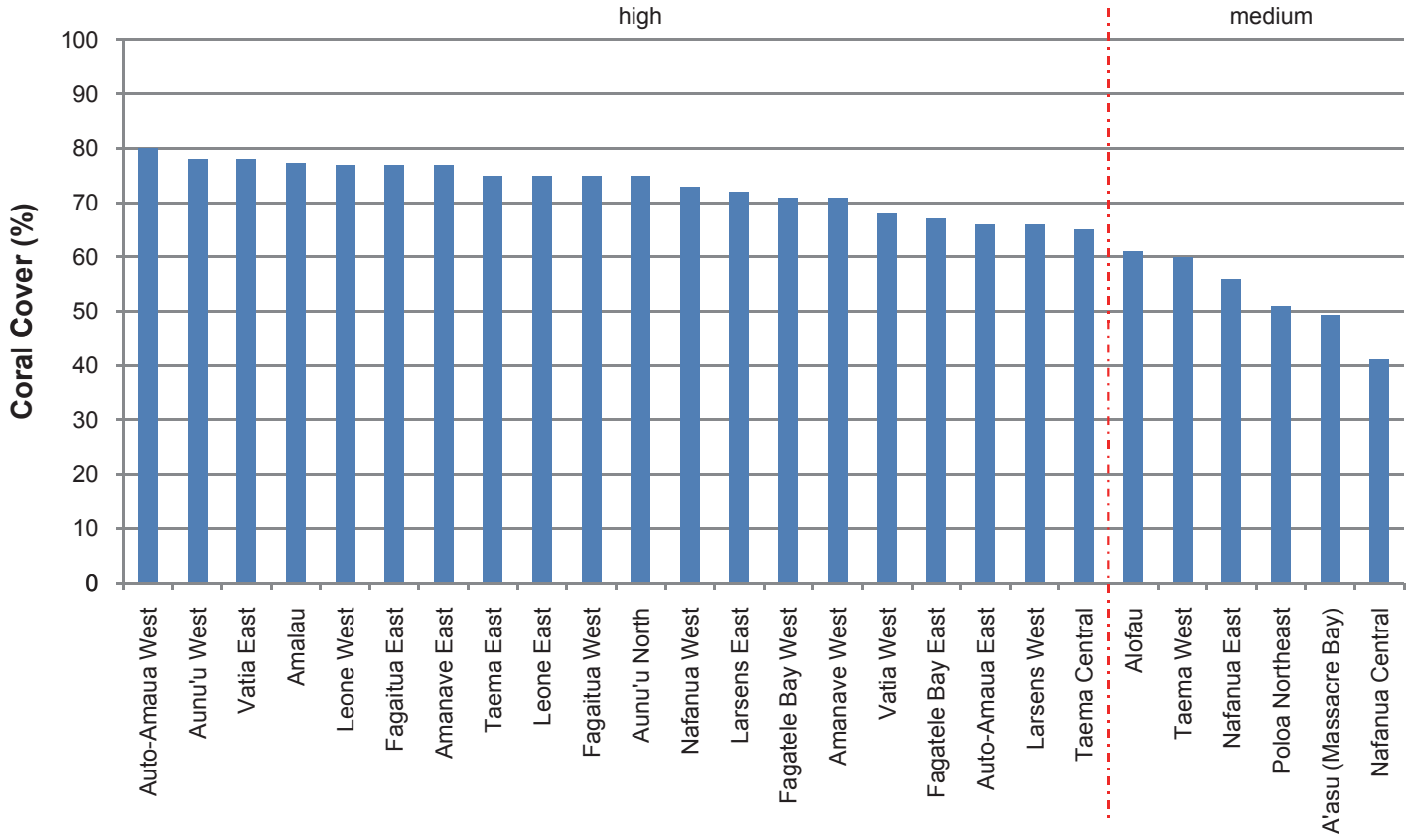

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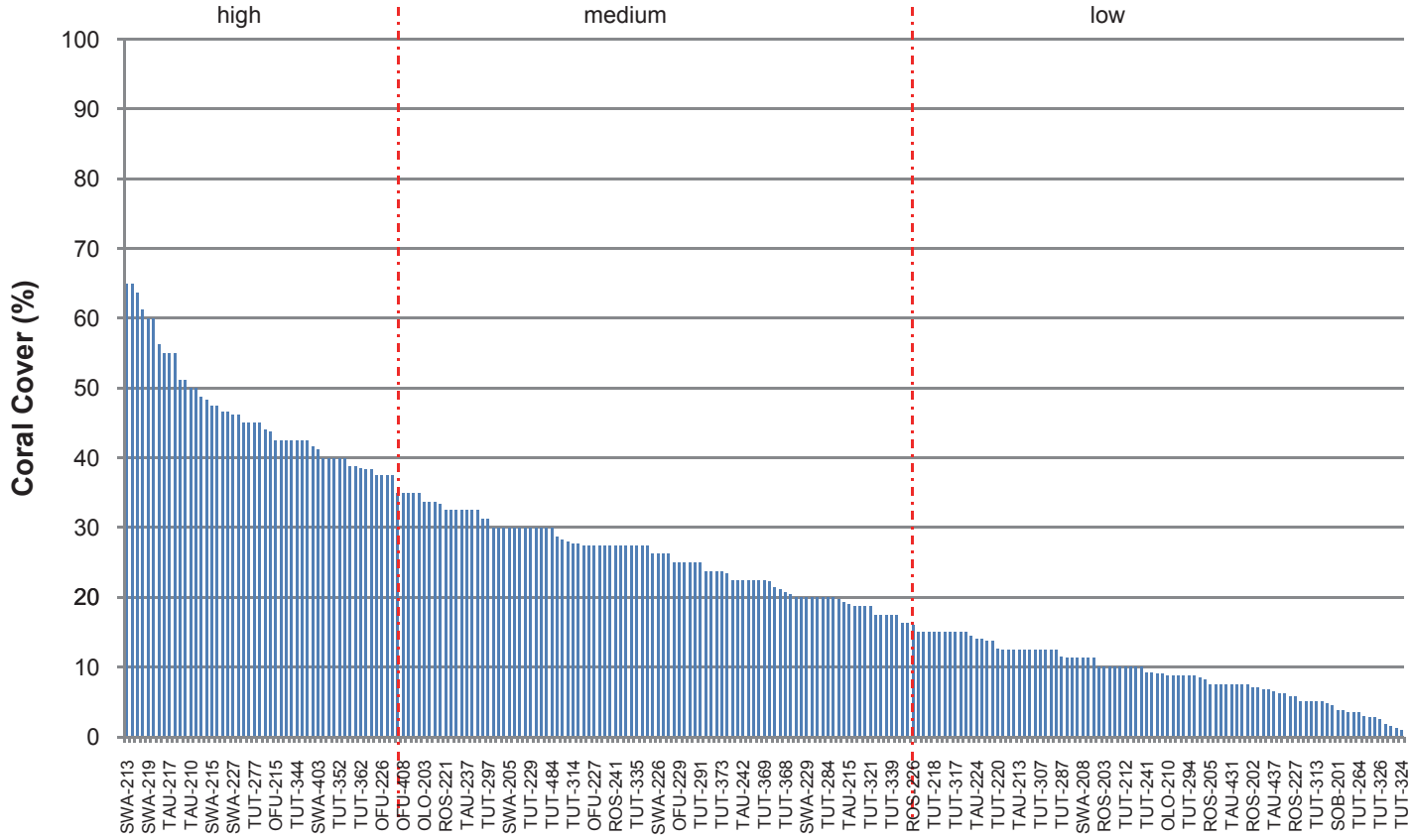

* due to the large number of sites, not all site labels are visible on this axis

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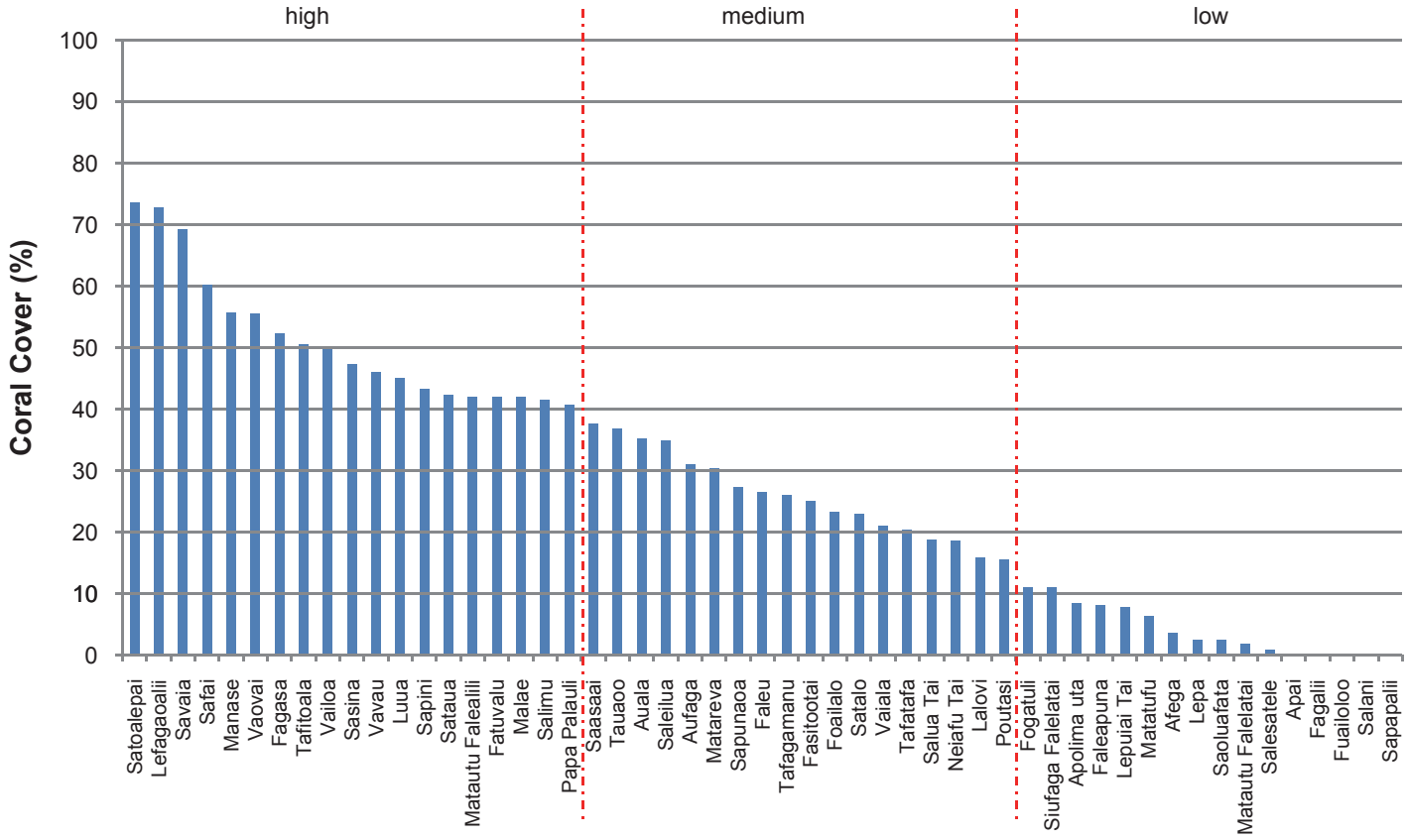

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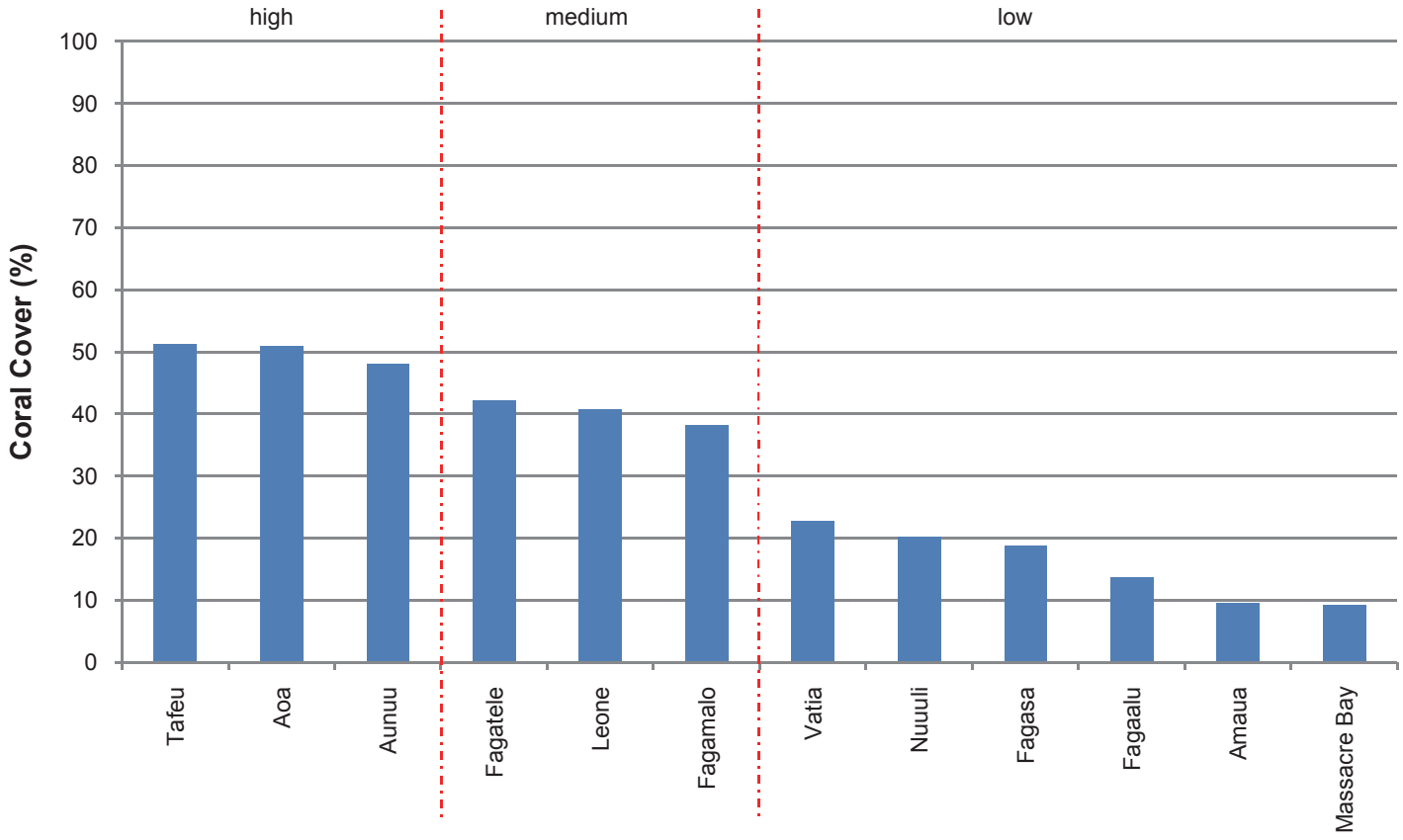

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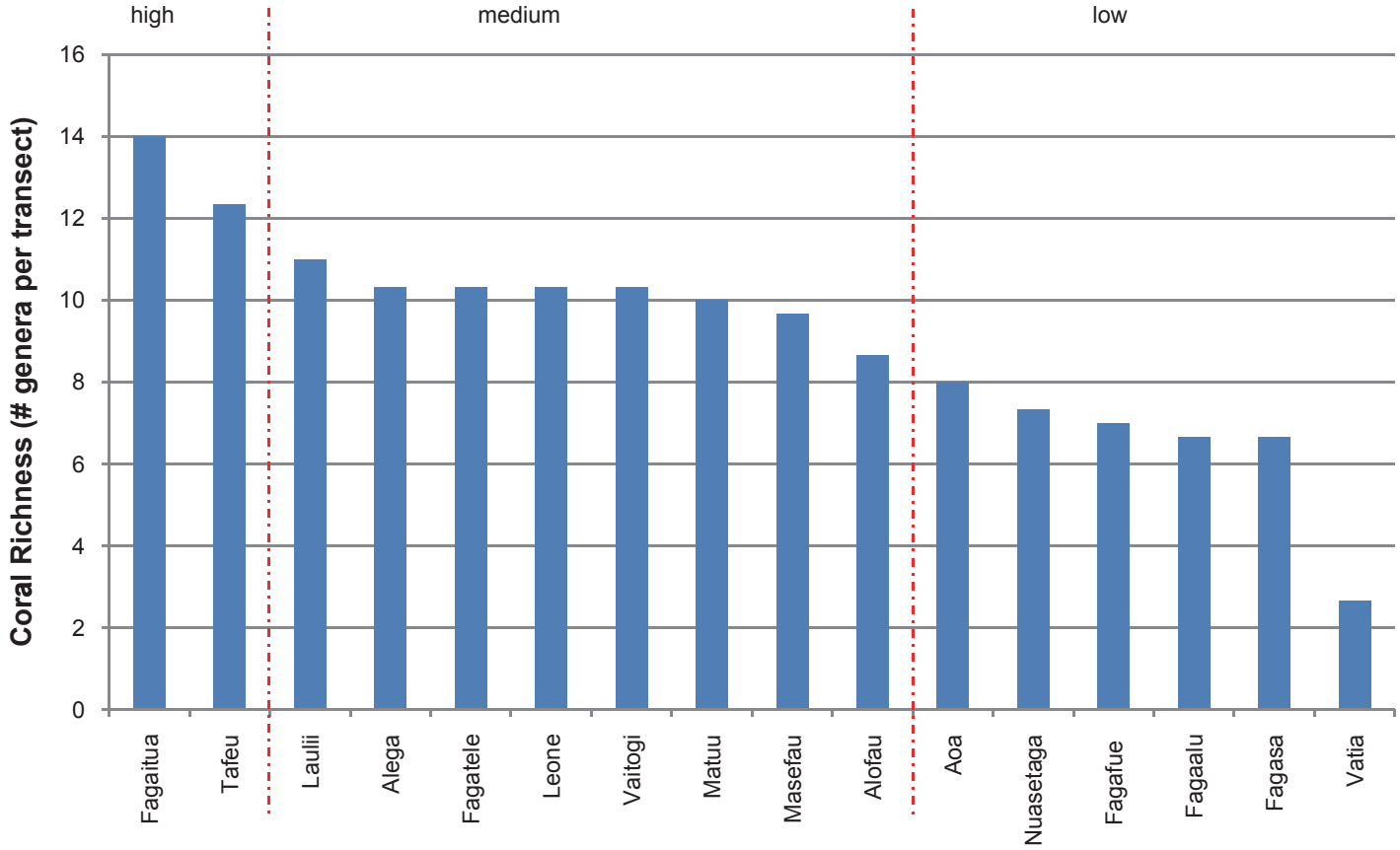

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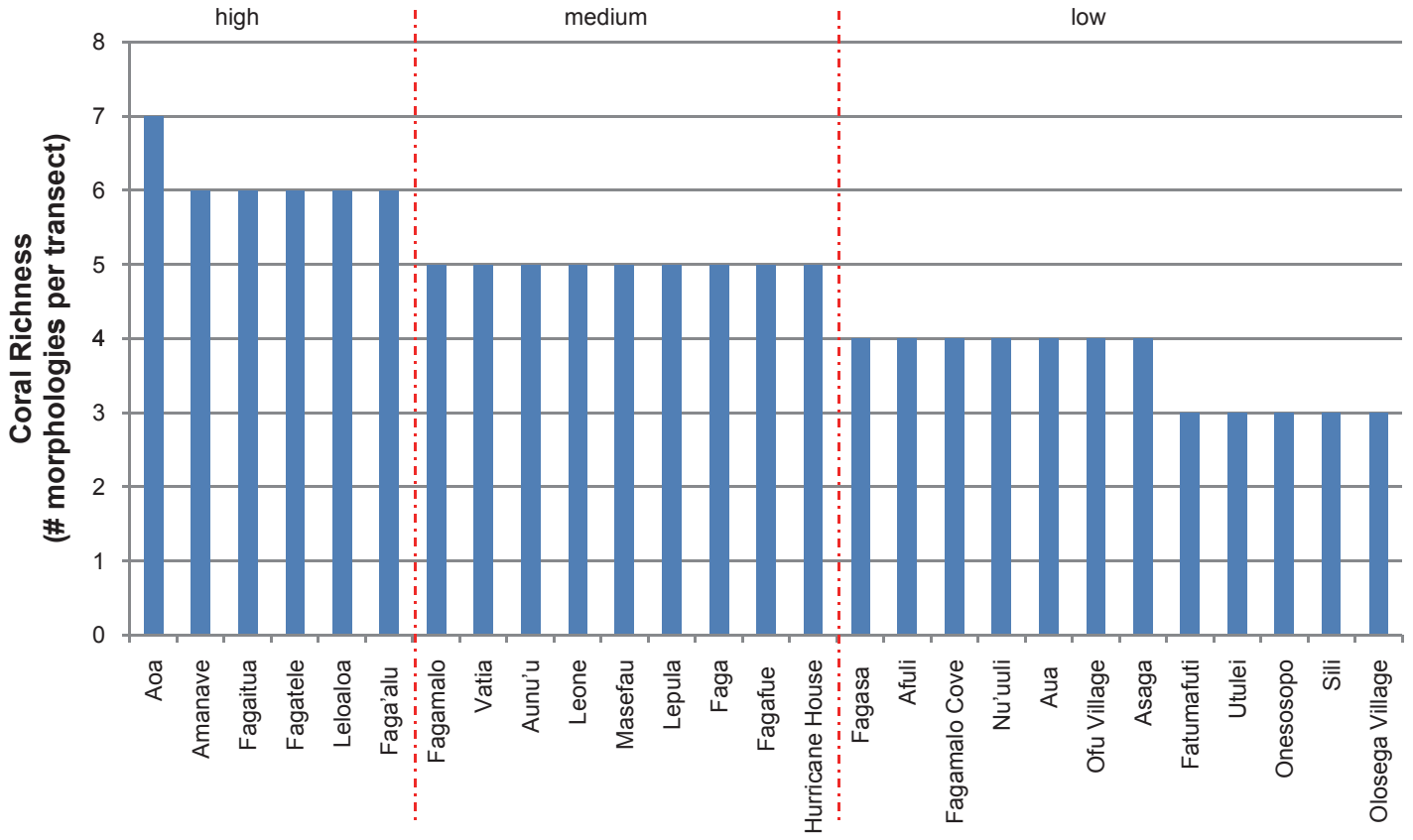
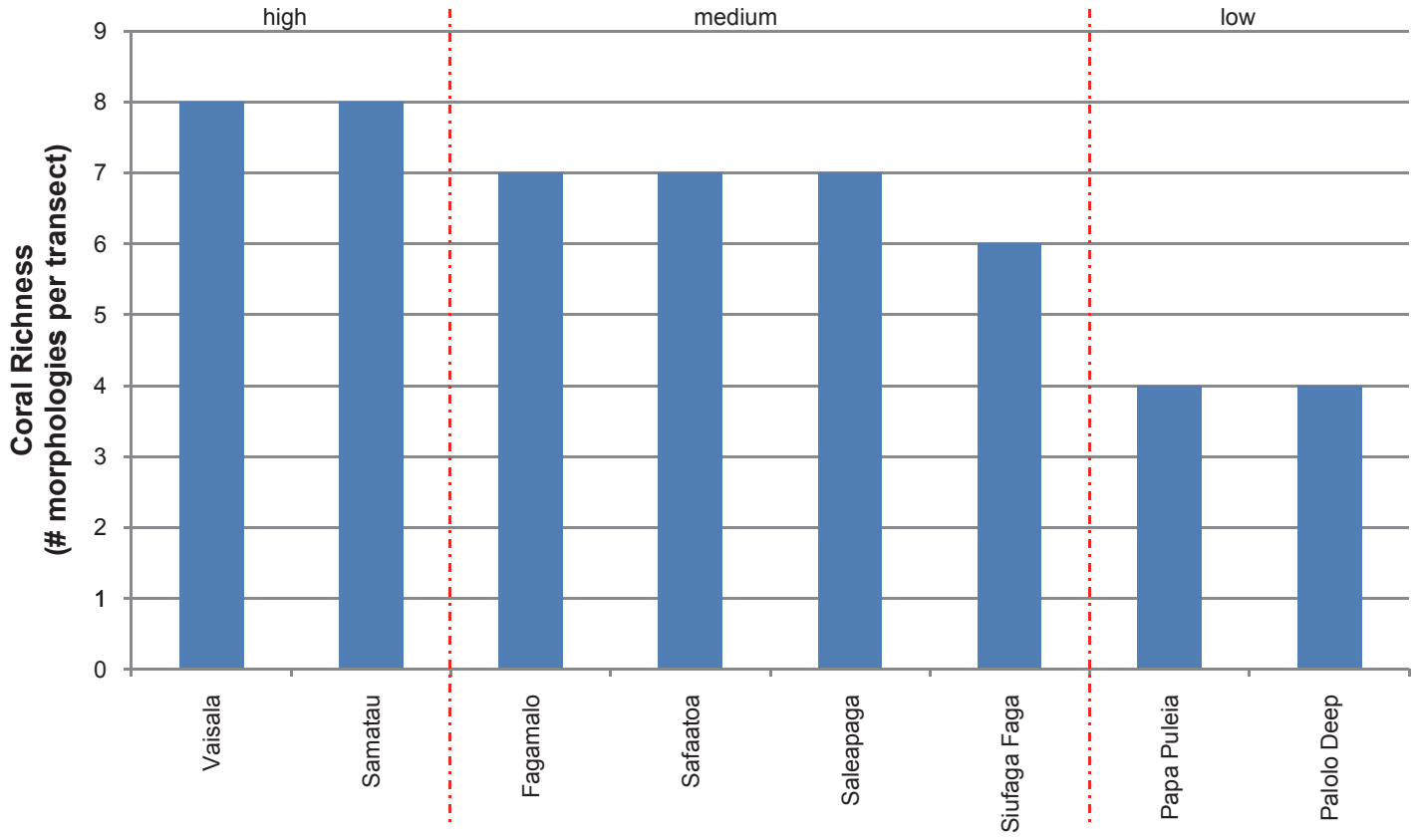


Figure C.11 - GCRMN



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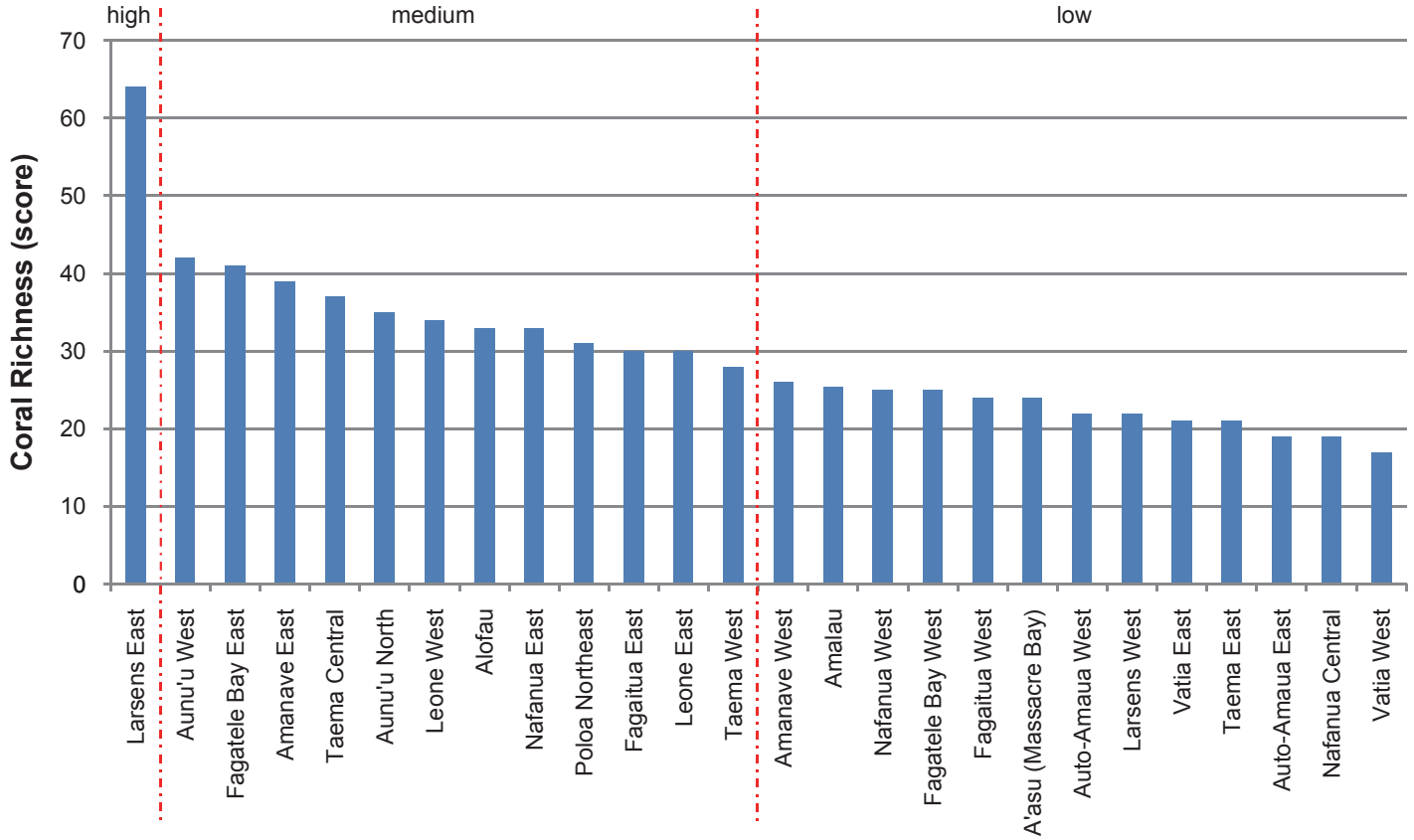

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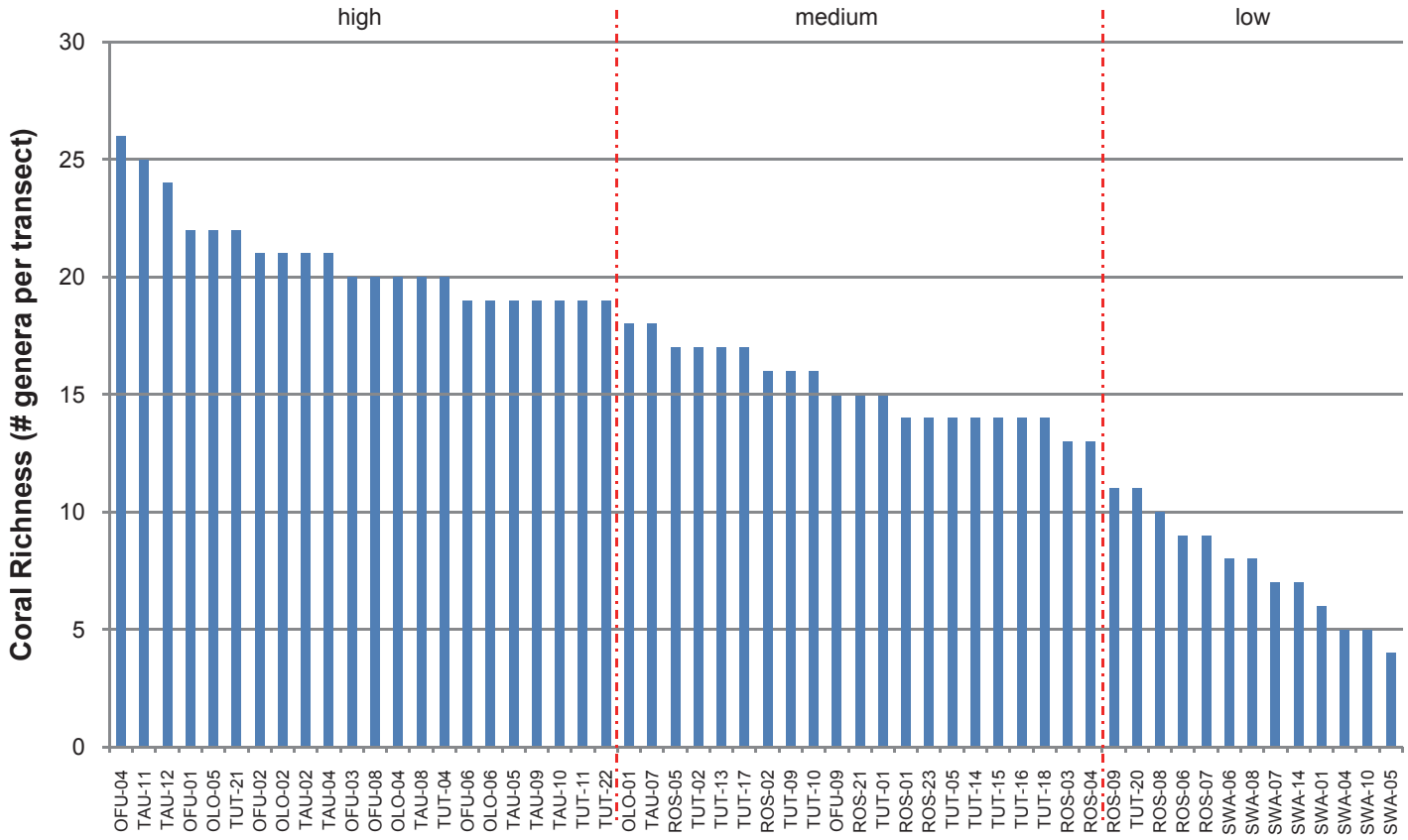

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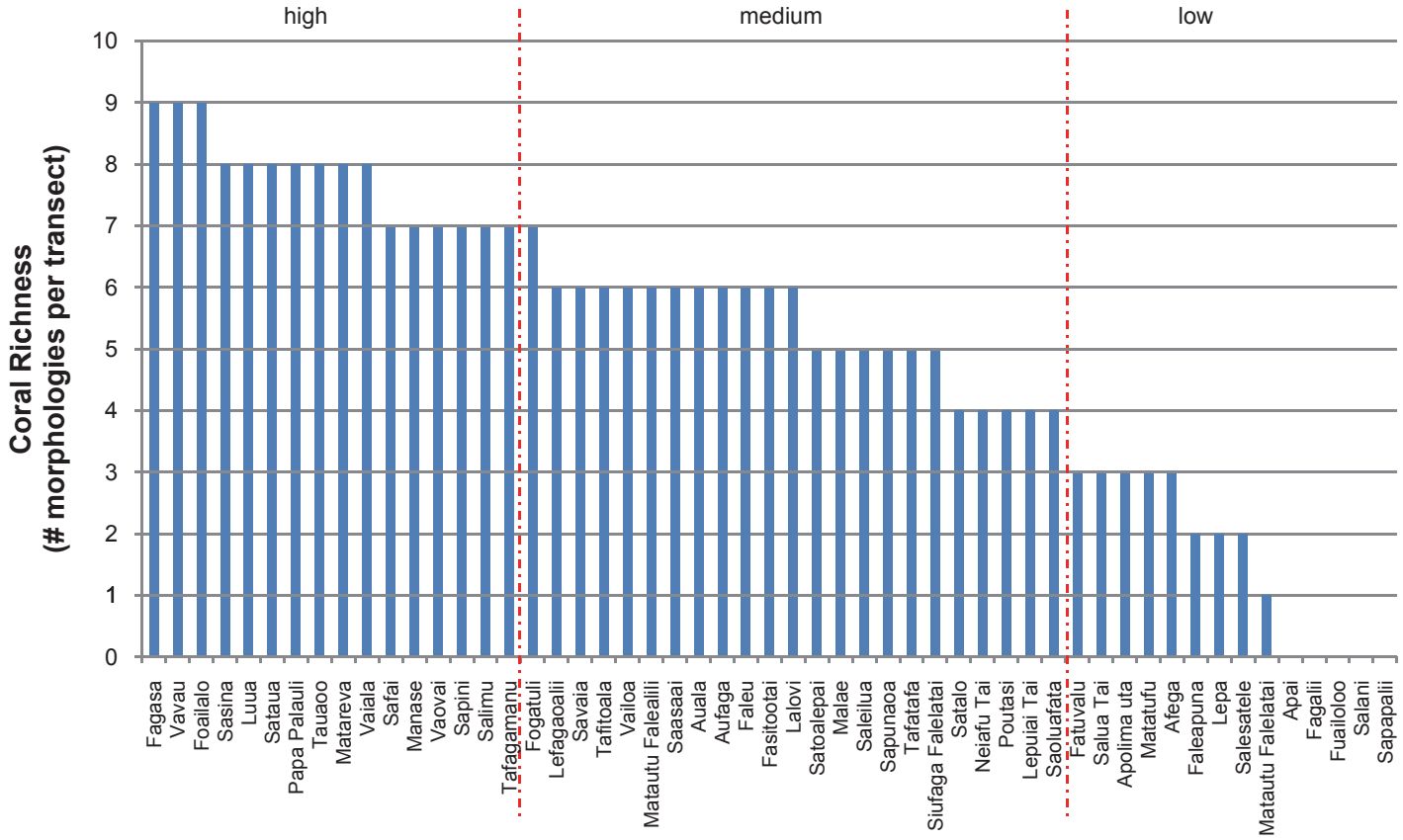

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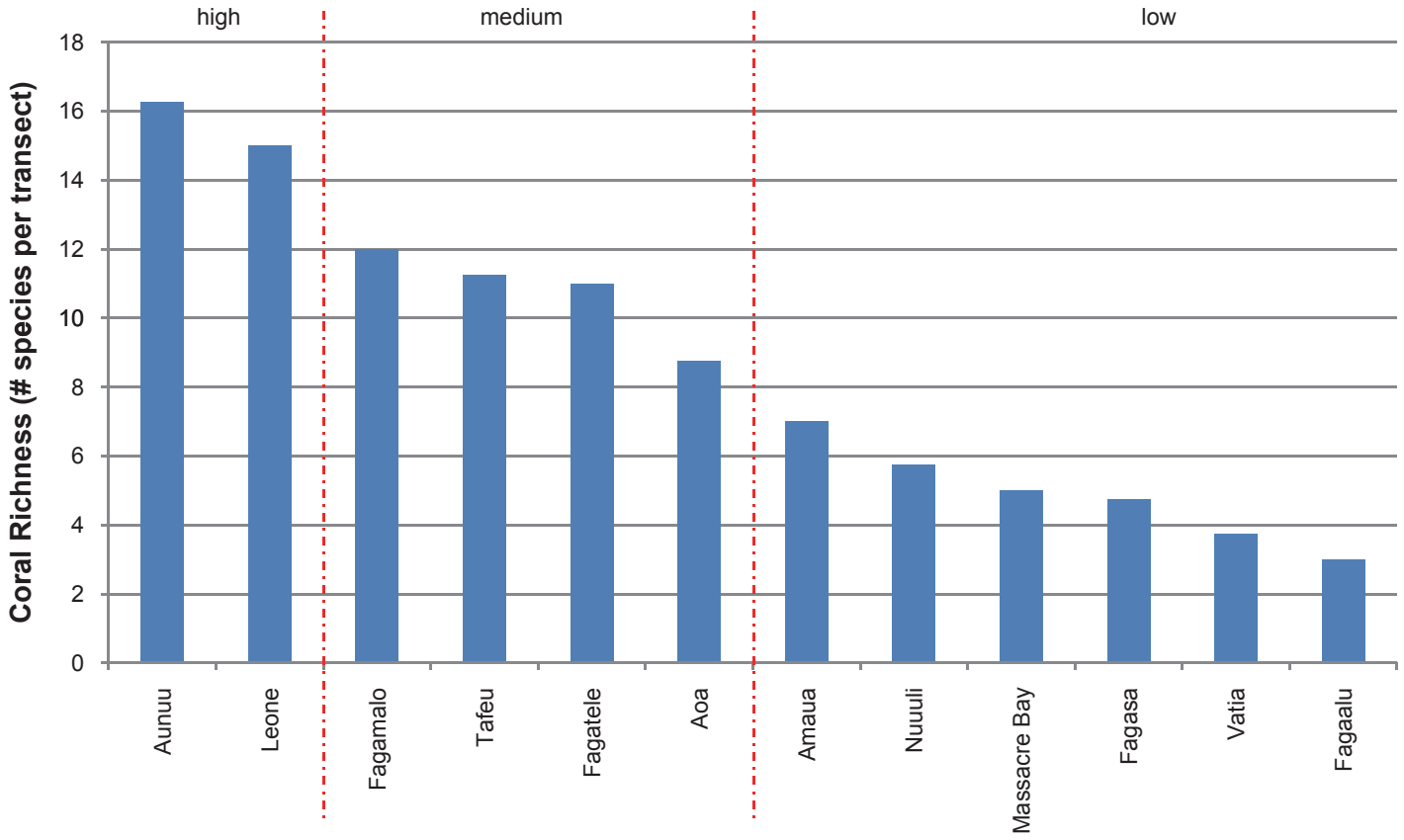

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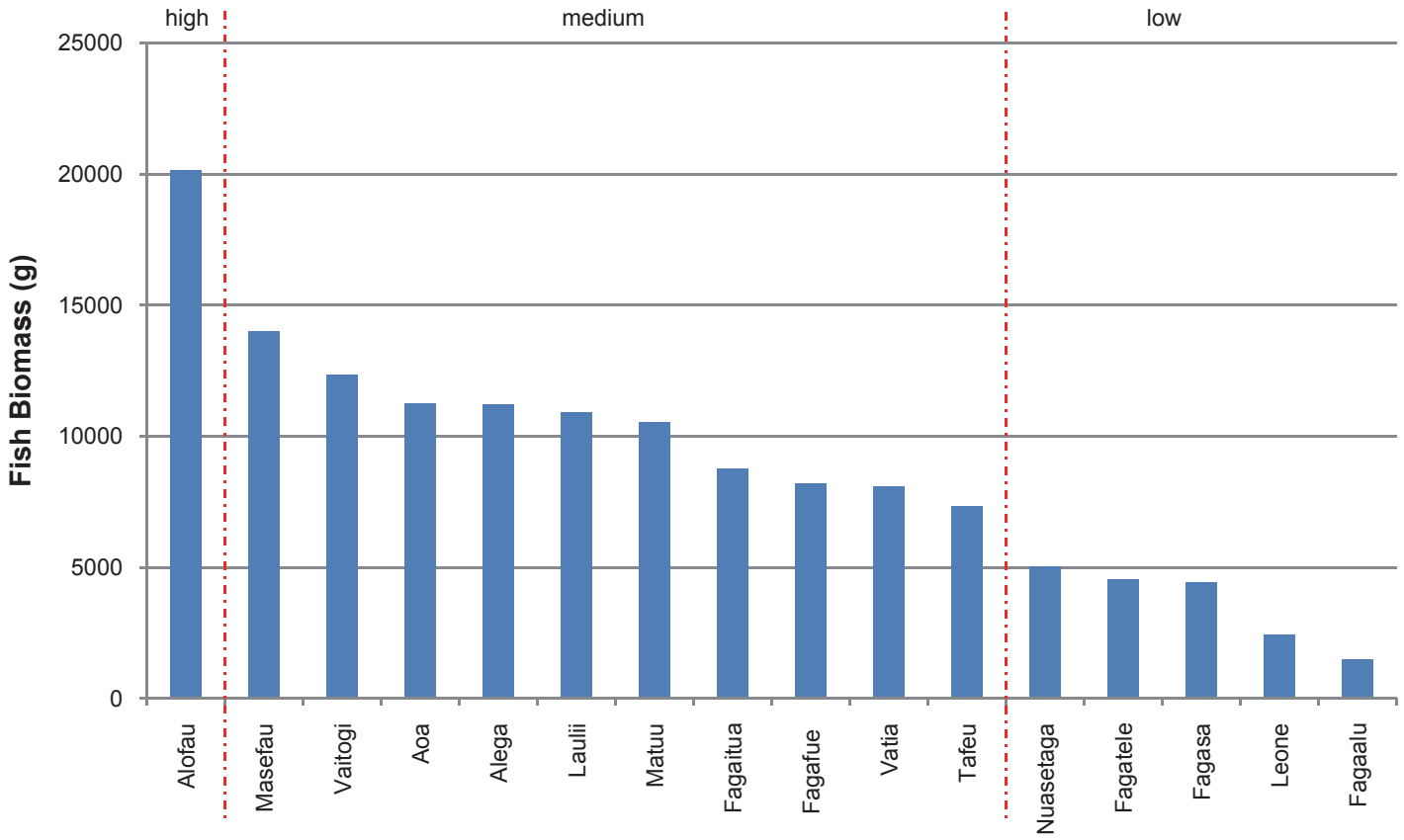

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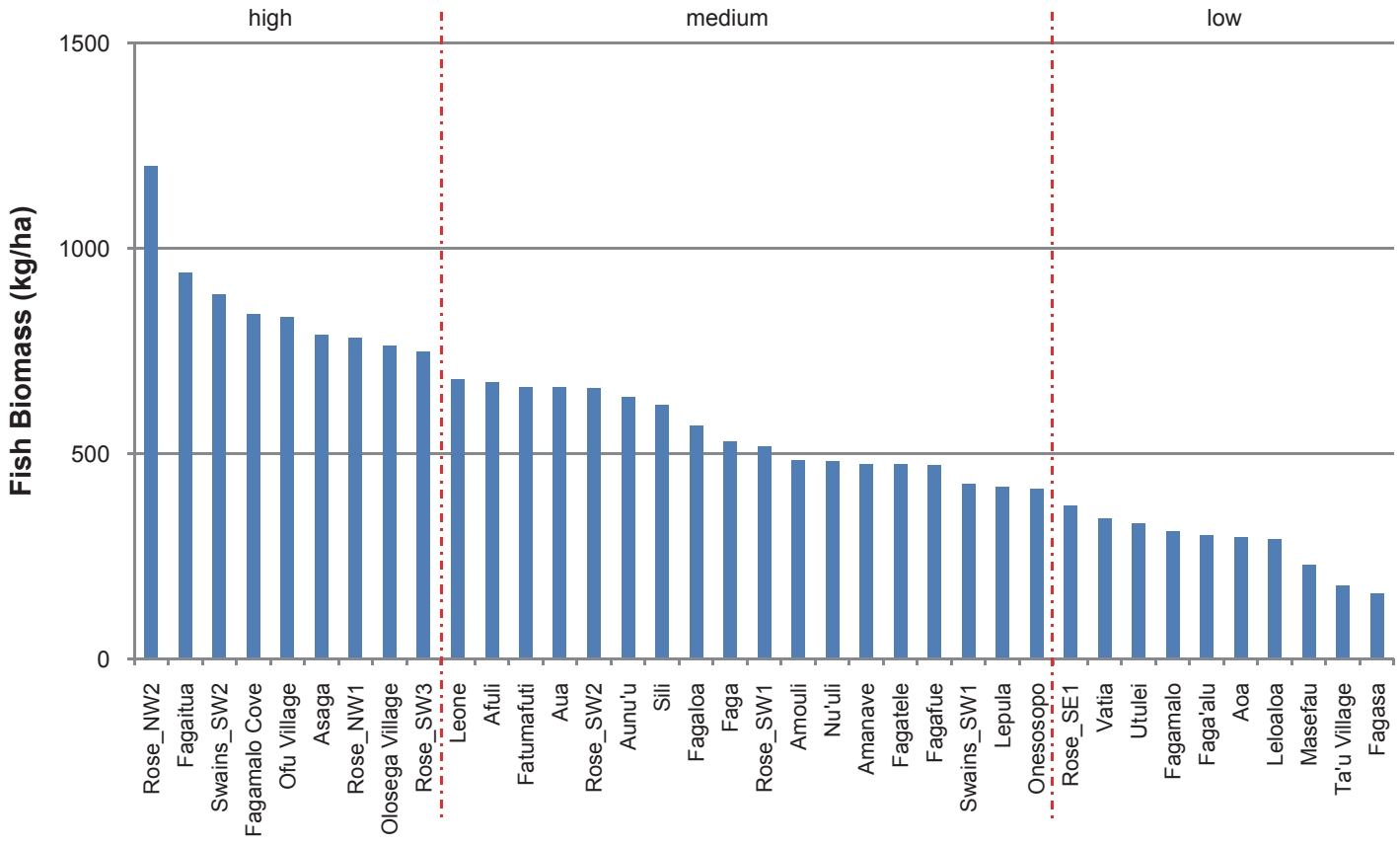

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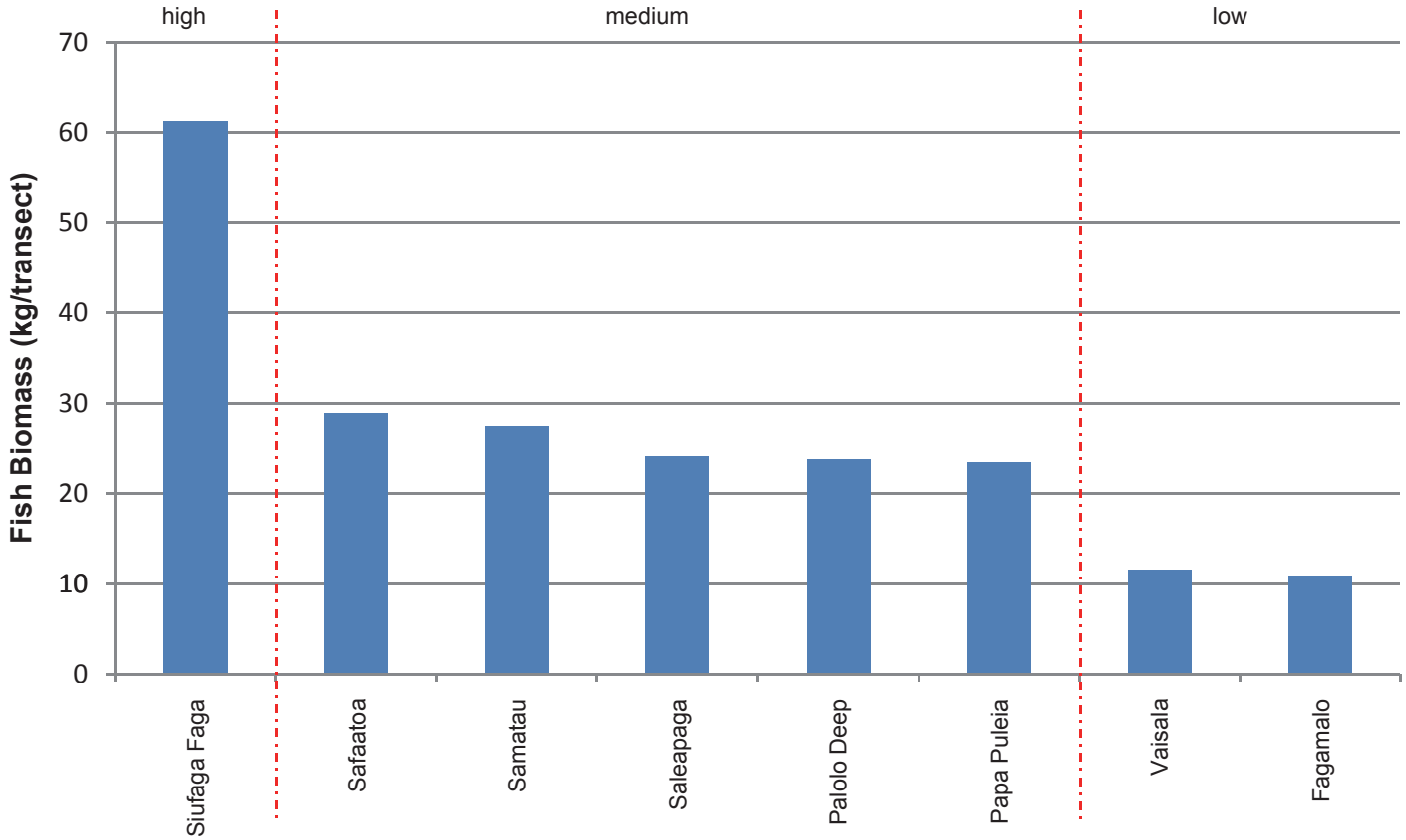

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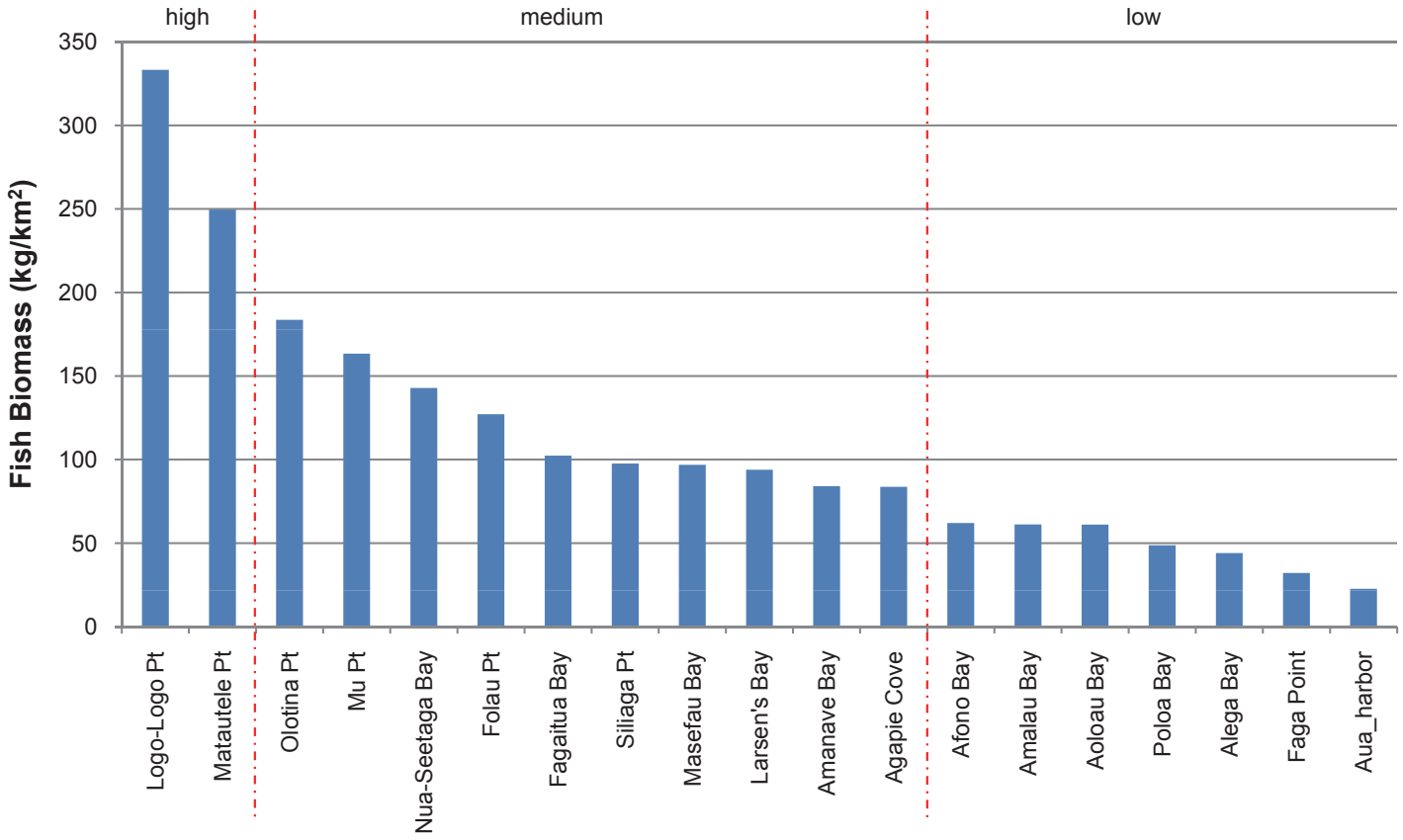

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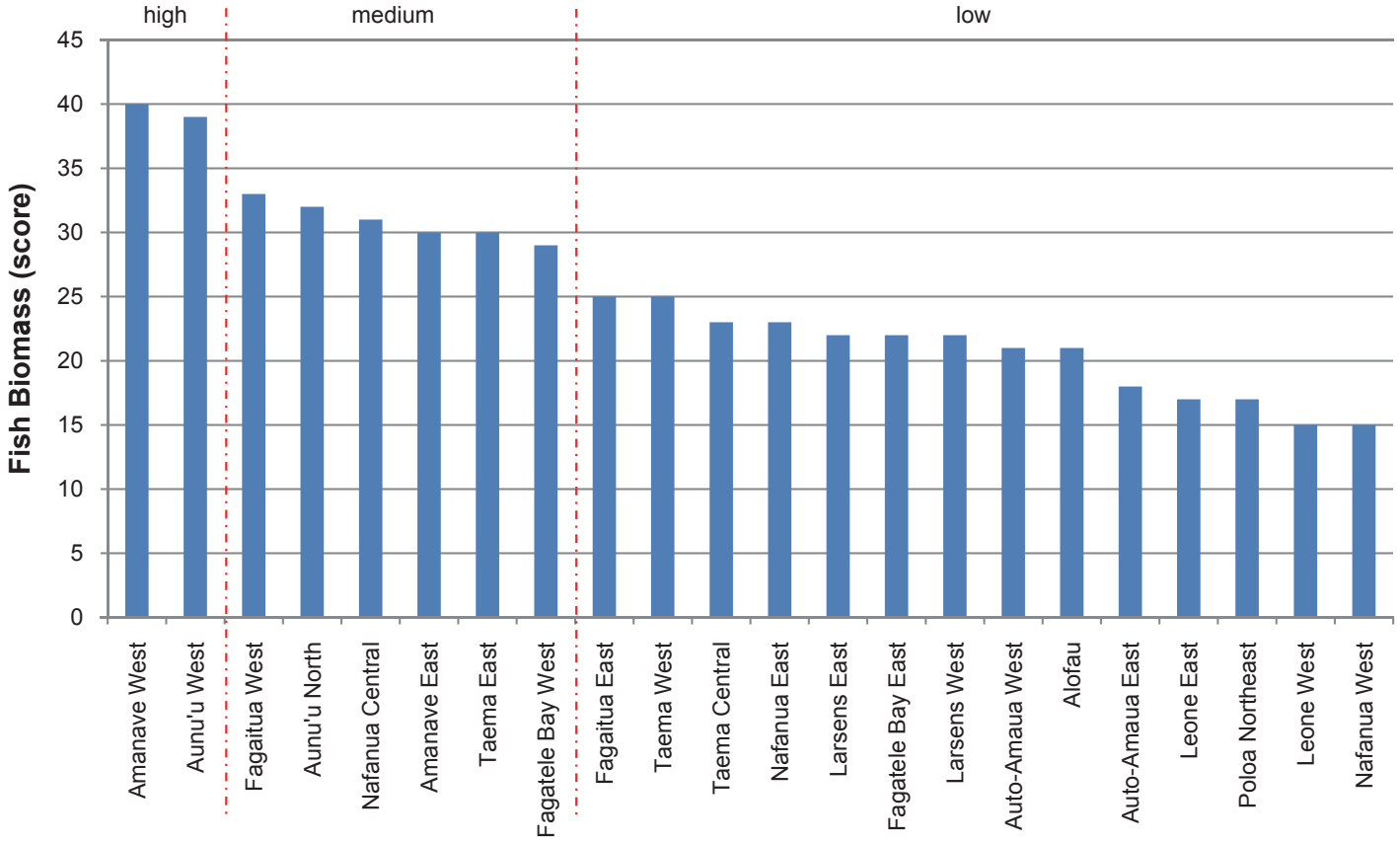

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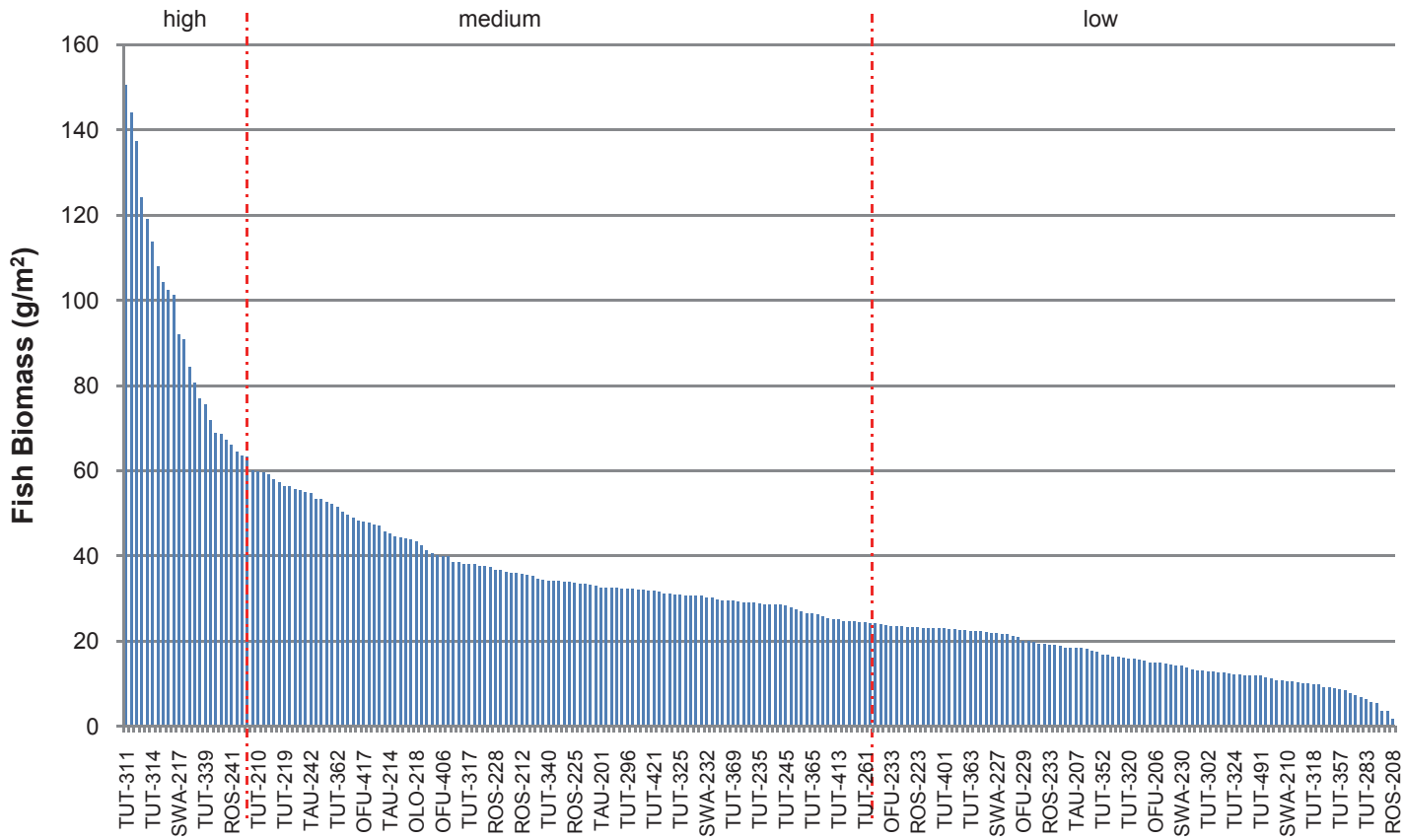

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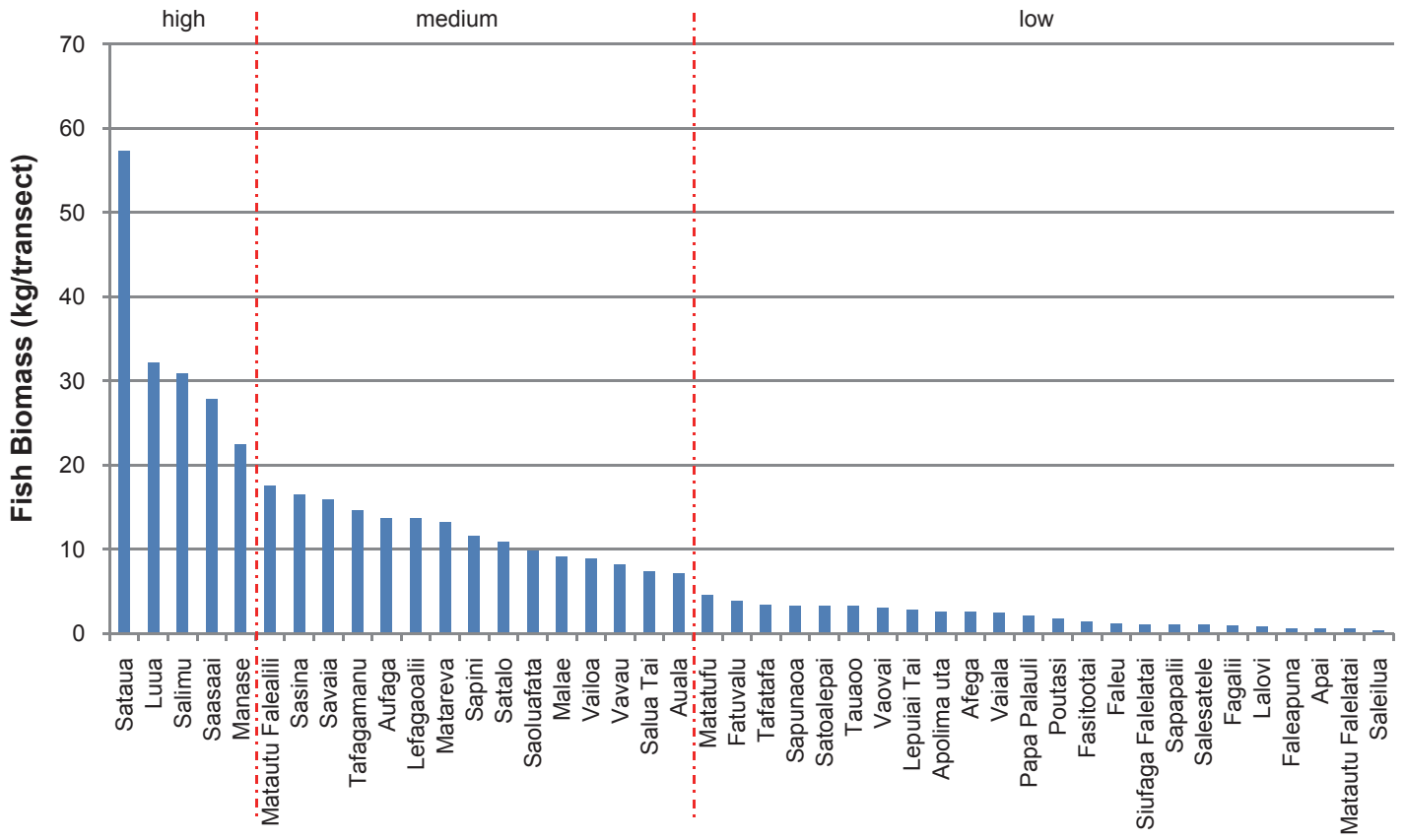

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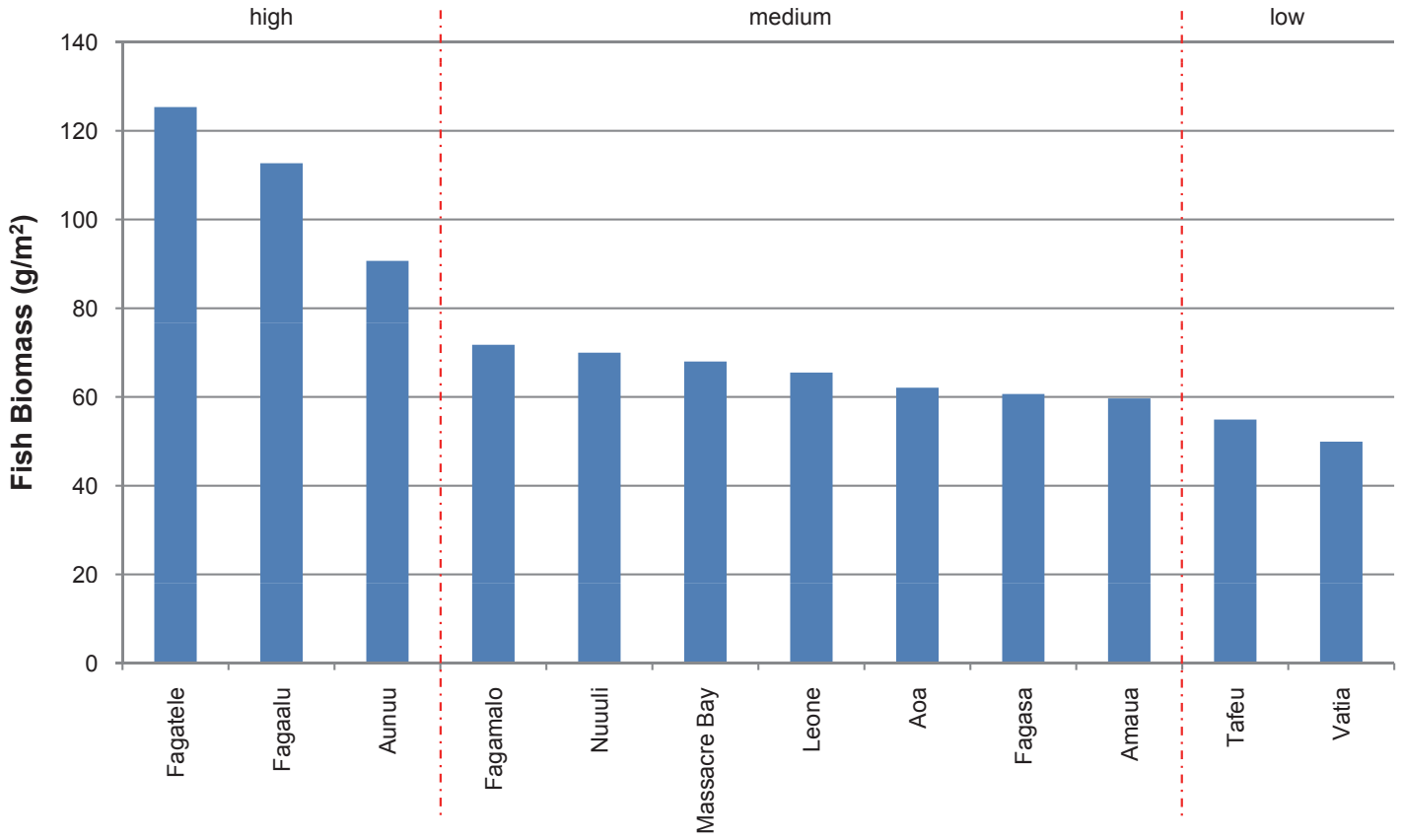

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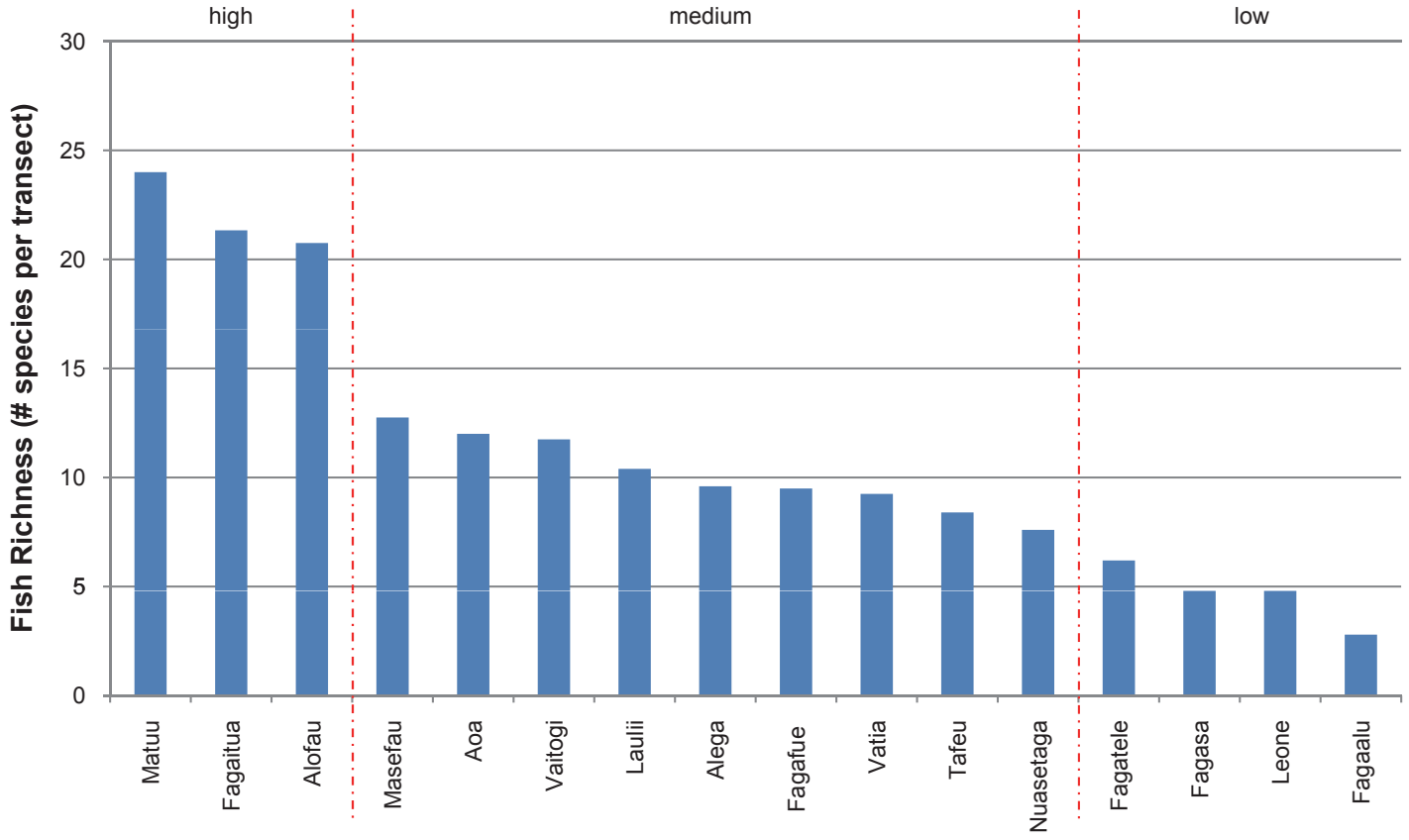

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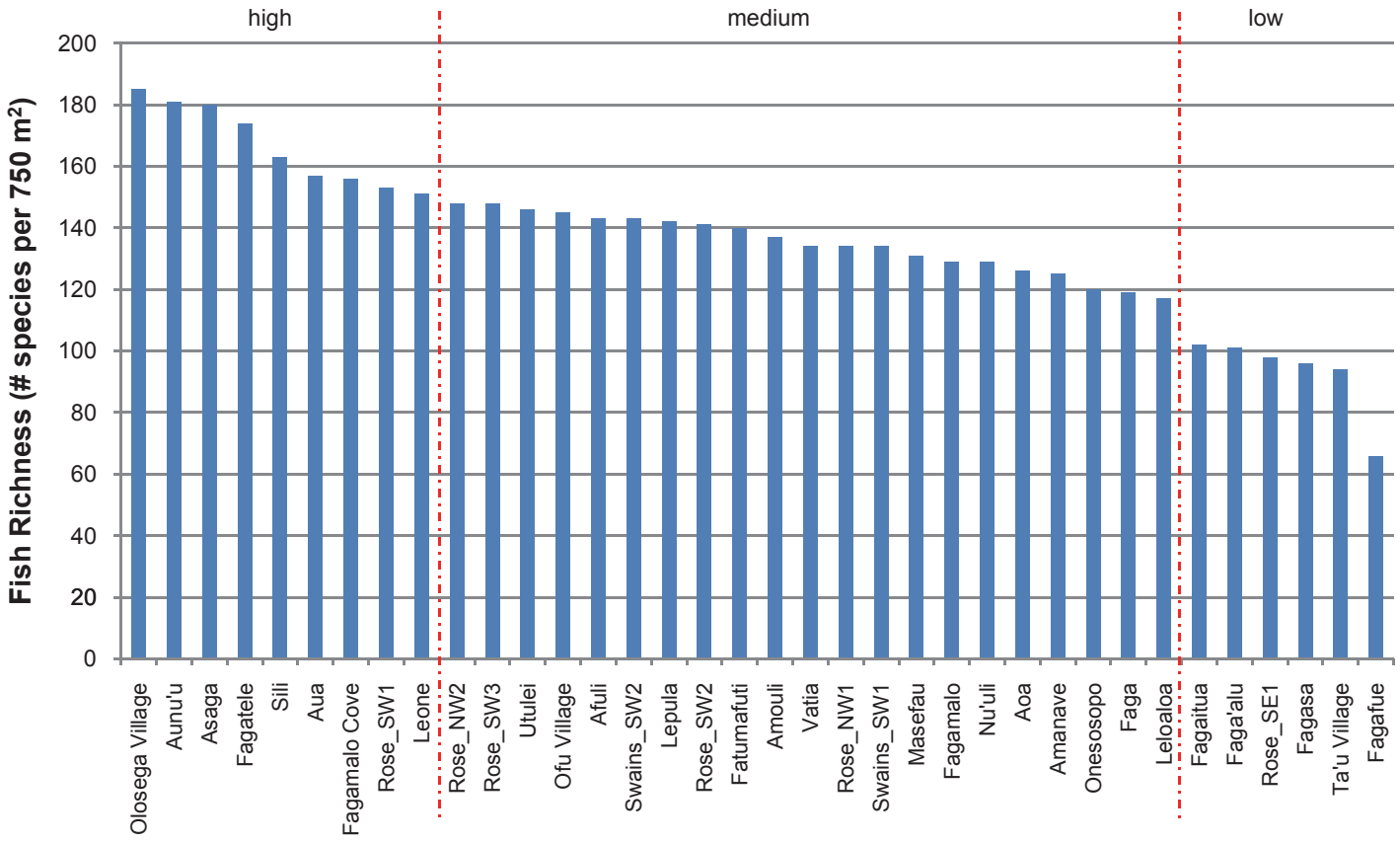

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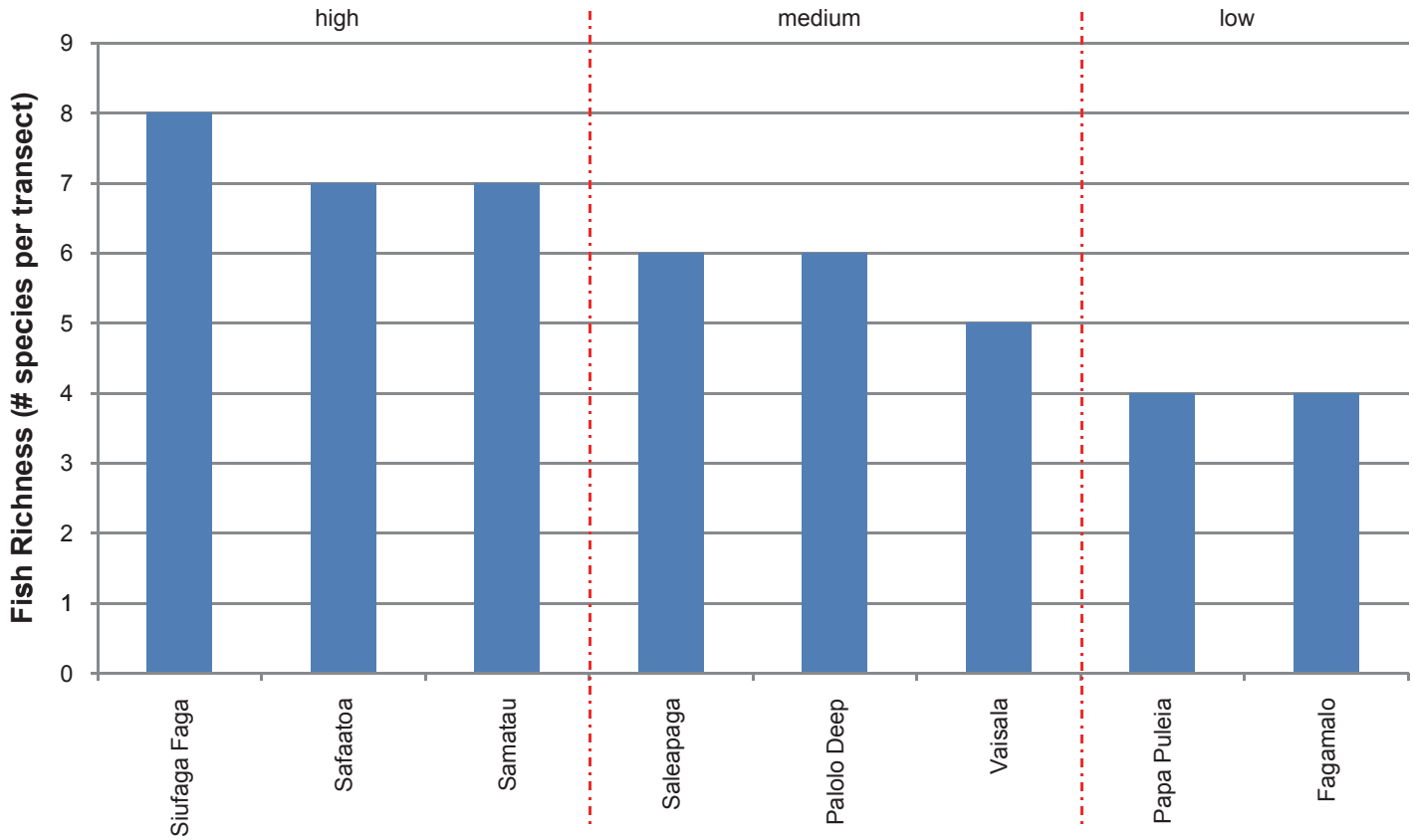

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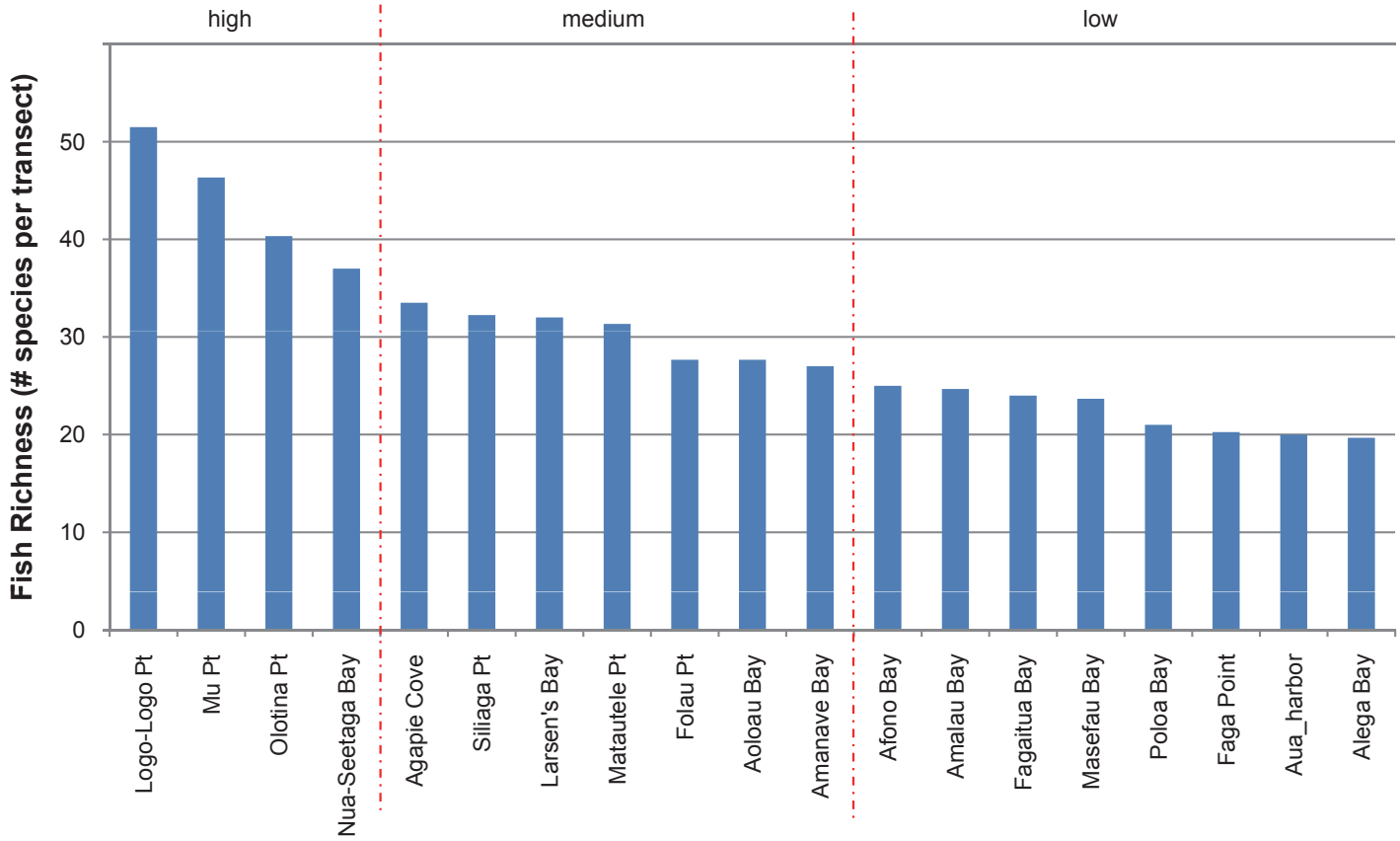

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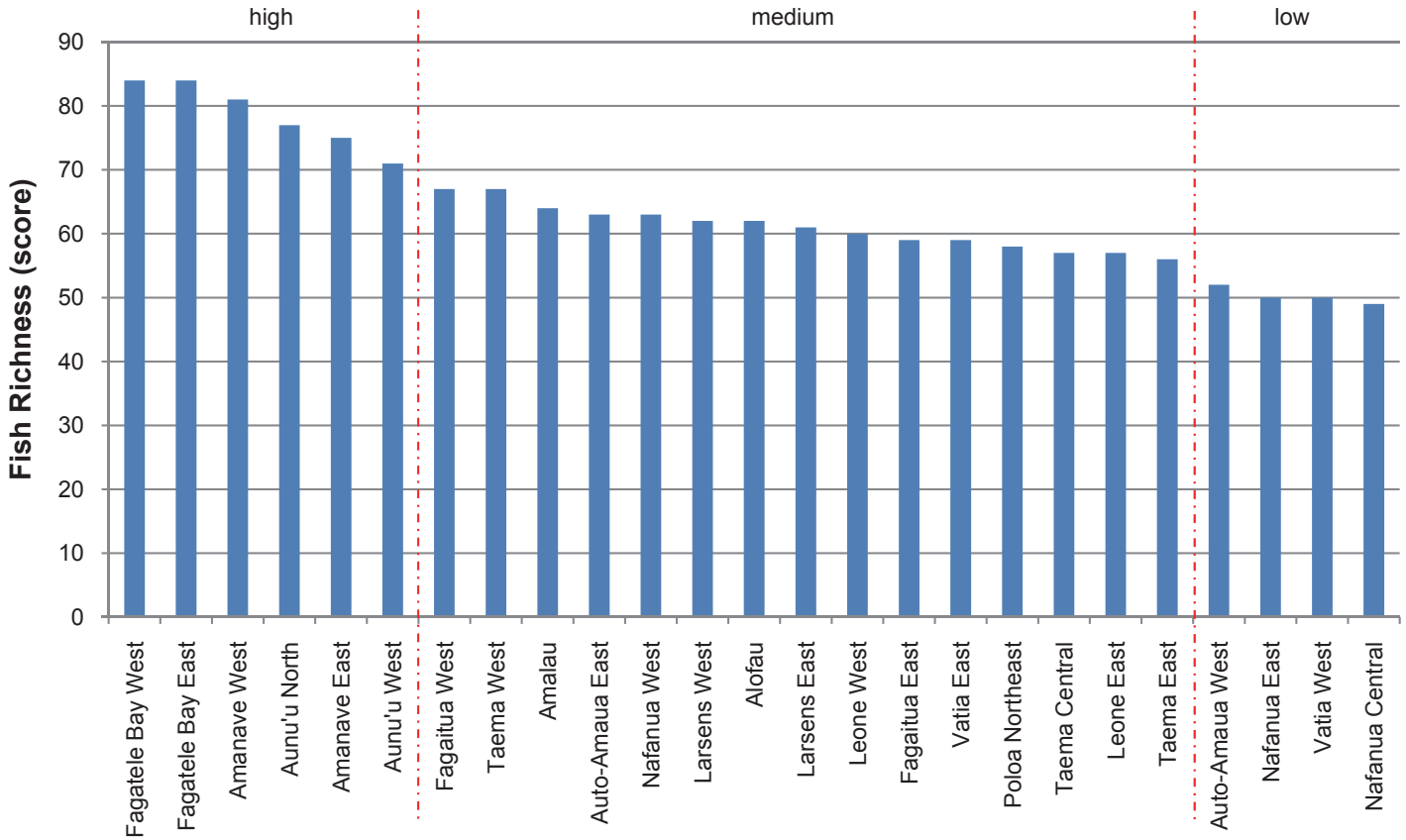

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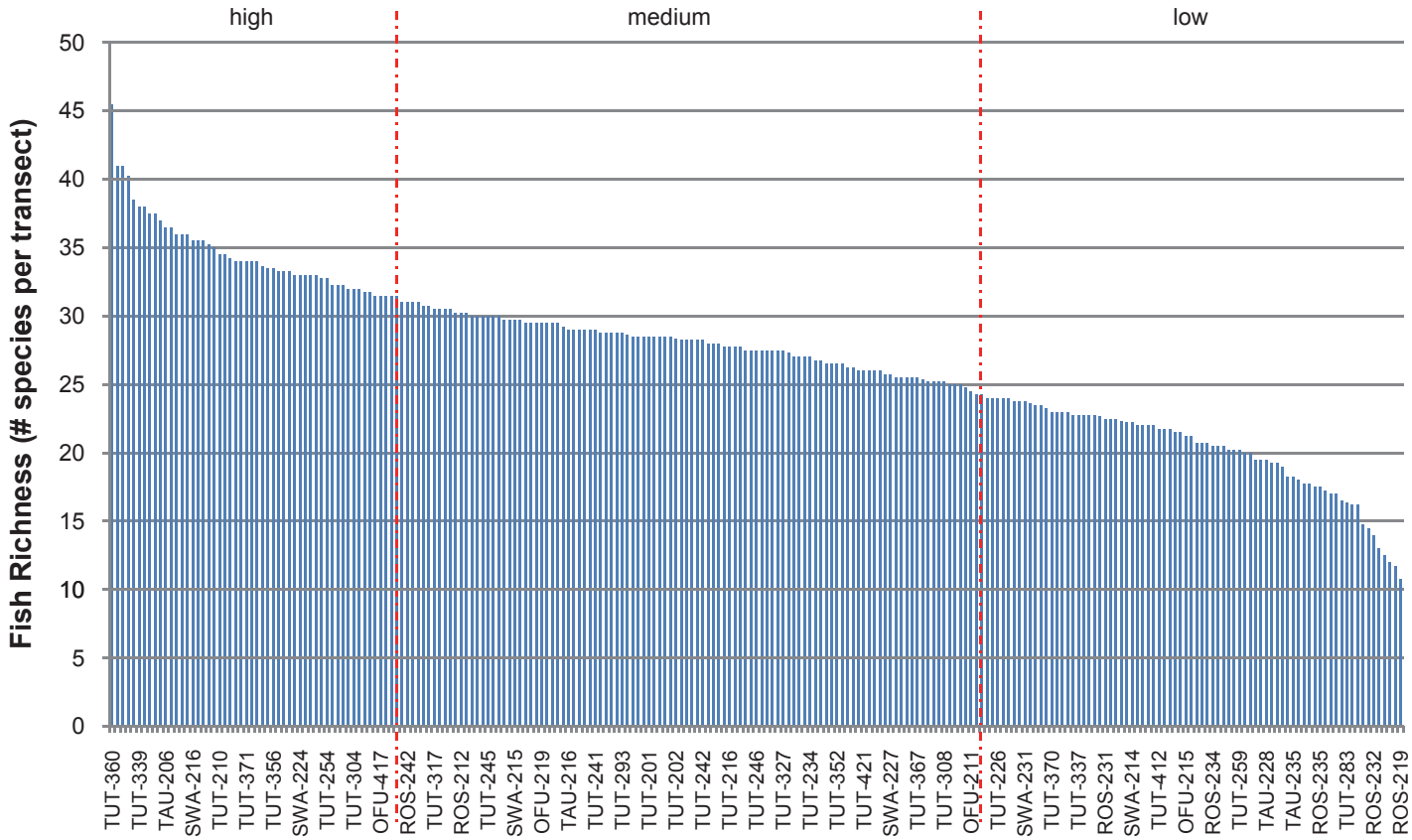

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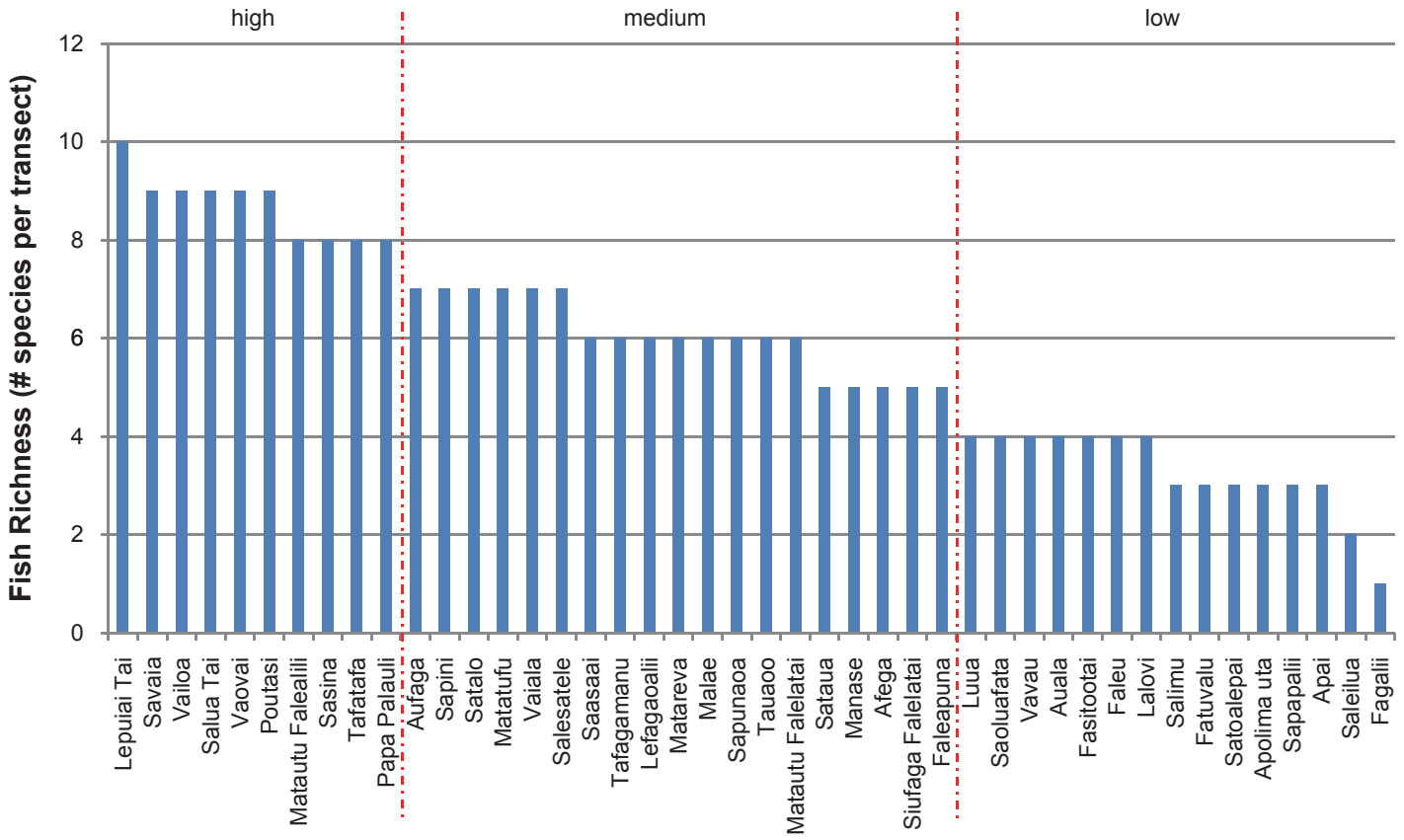
Figure C.30 - SFR



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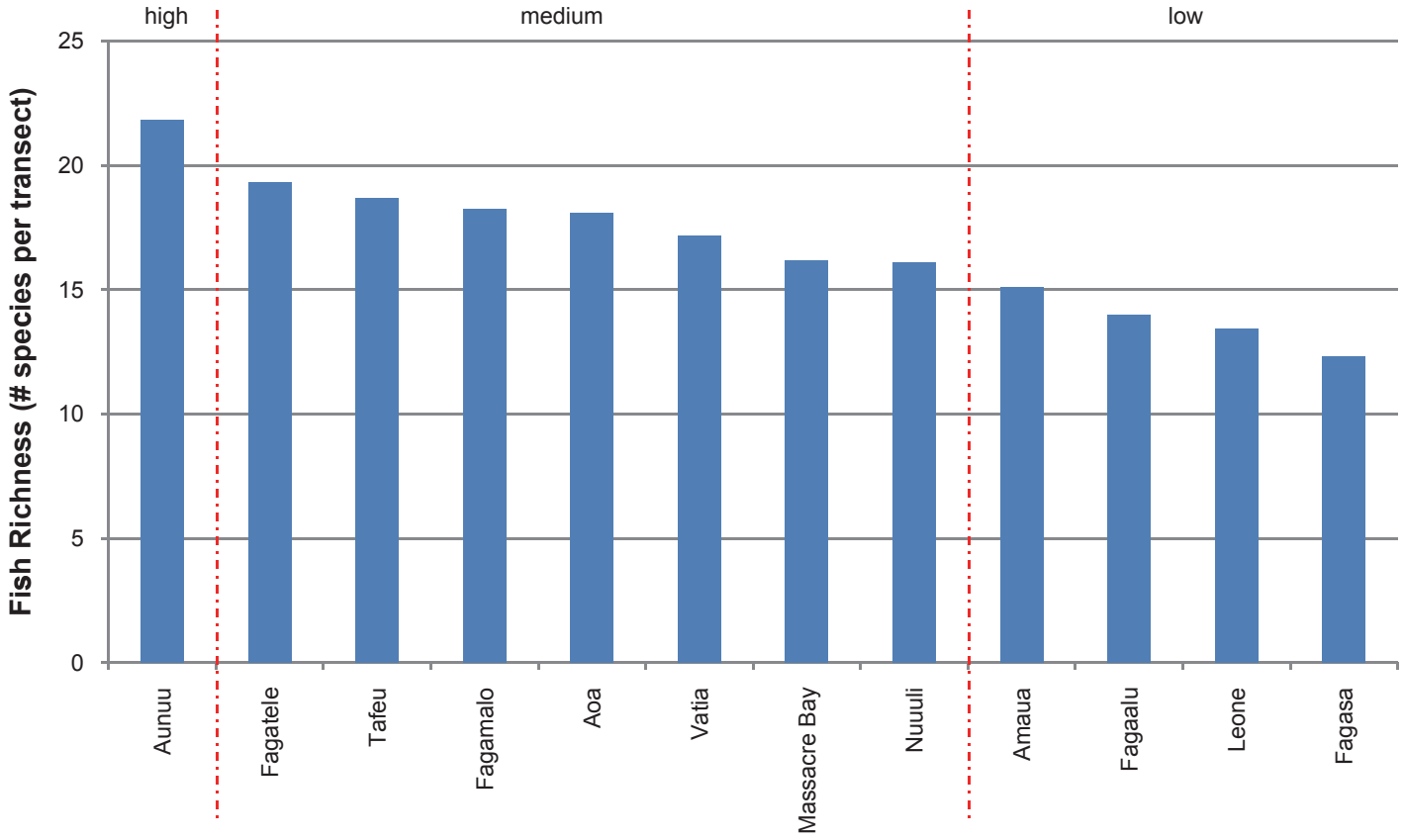


Figure C.32. MDS plots based on coral community data for sites in each of the American Samoa studies. Sites are coded by Bioregion. The R value of the Global ANOSIM test among all Bioregions is provided where results were significant. For the MPABR data, the Nafanua Central site was excluded as an extreme outlier.

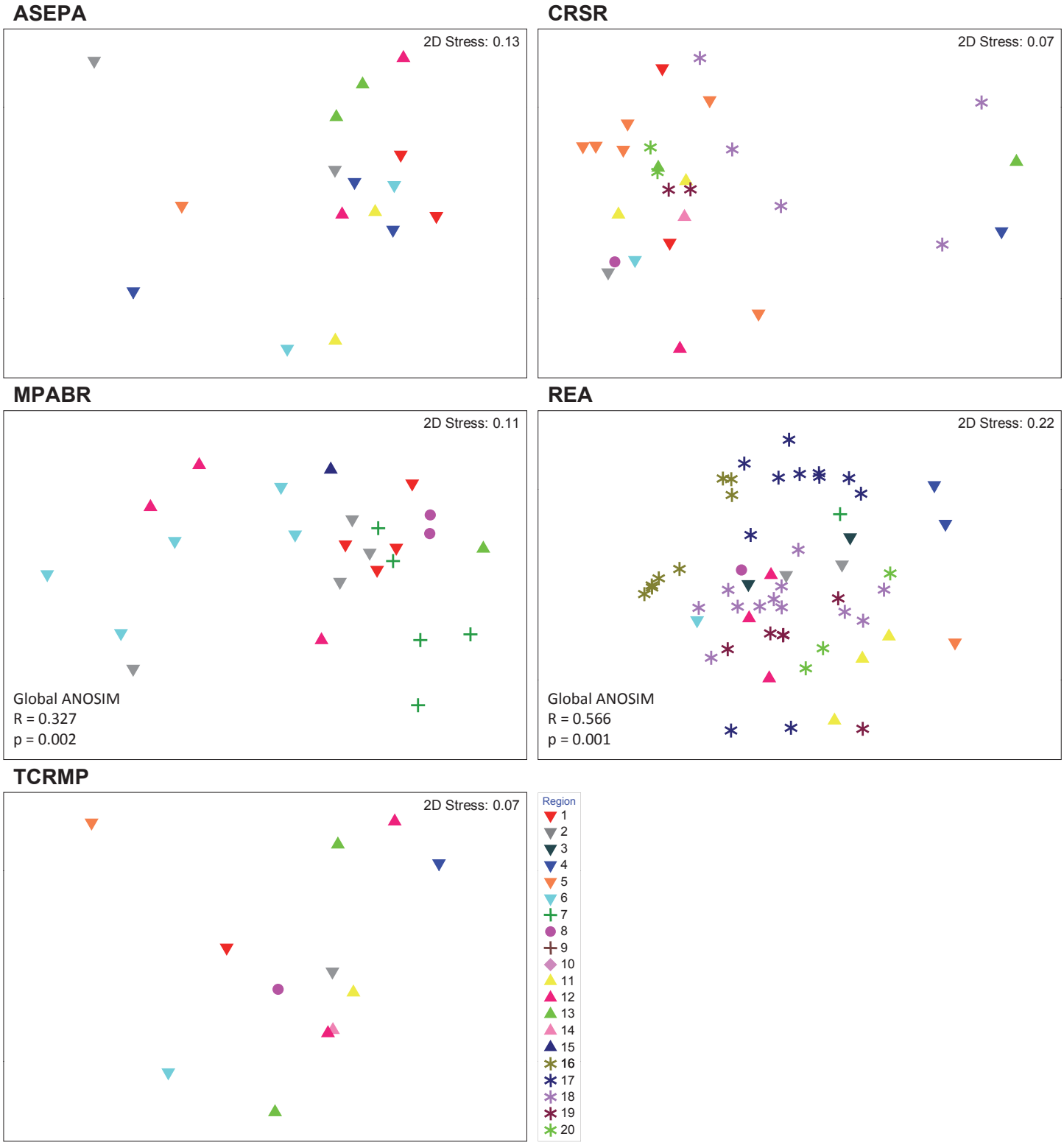


Figure C.33. MDS plots based on fish community data for sites in each of the American Samoa studies. Sites are coded by Bioregion. The R value of the Global ANOSIM test among all Bioregions is provided where results were significant.

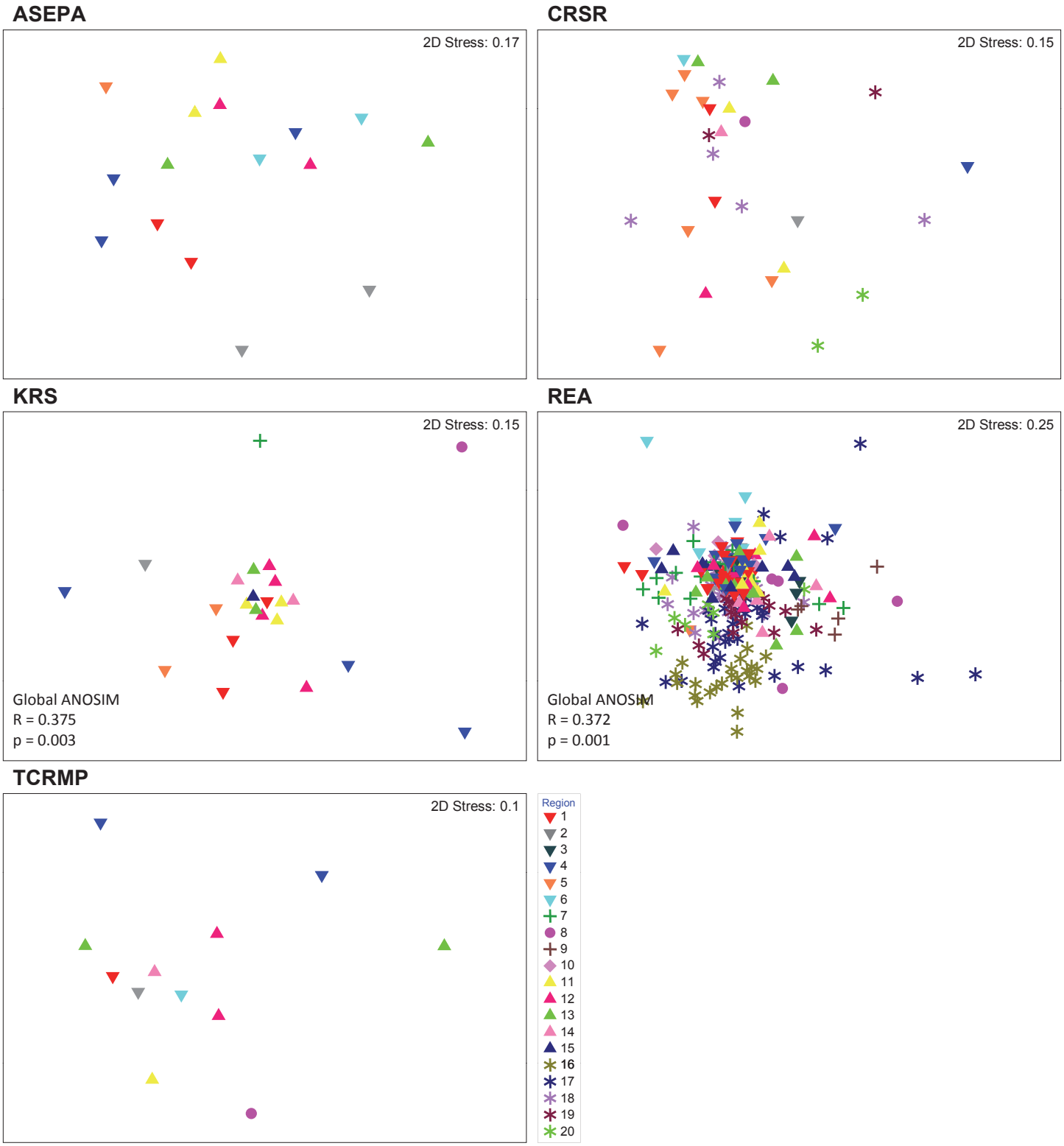
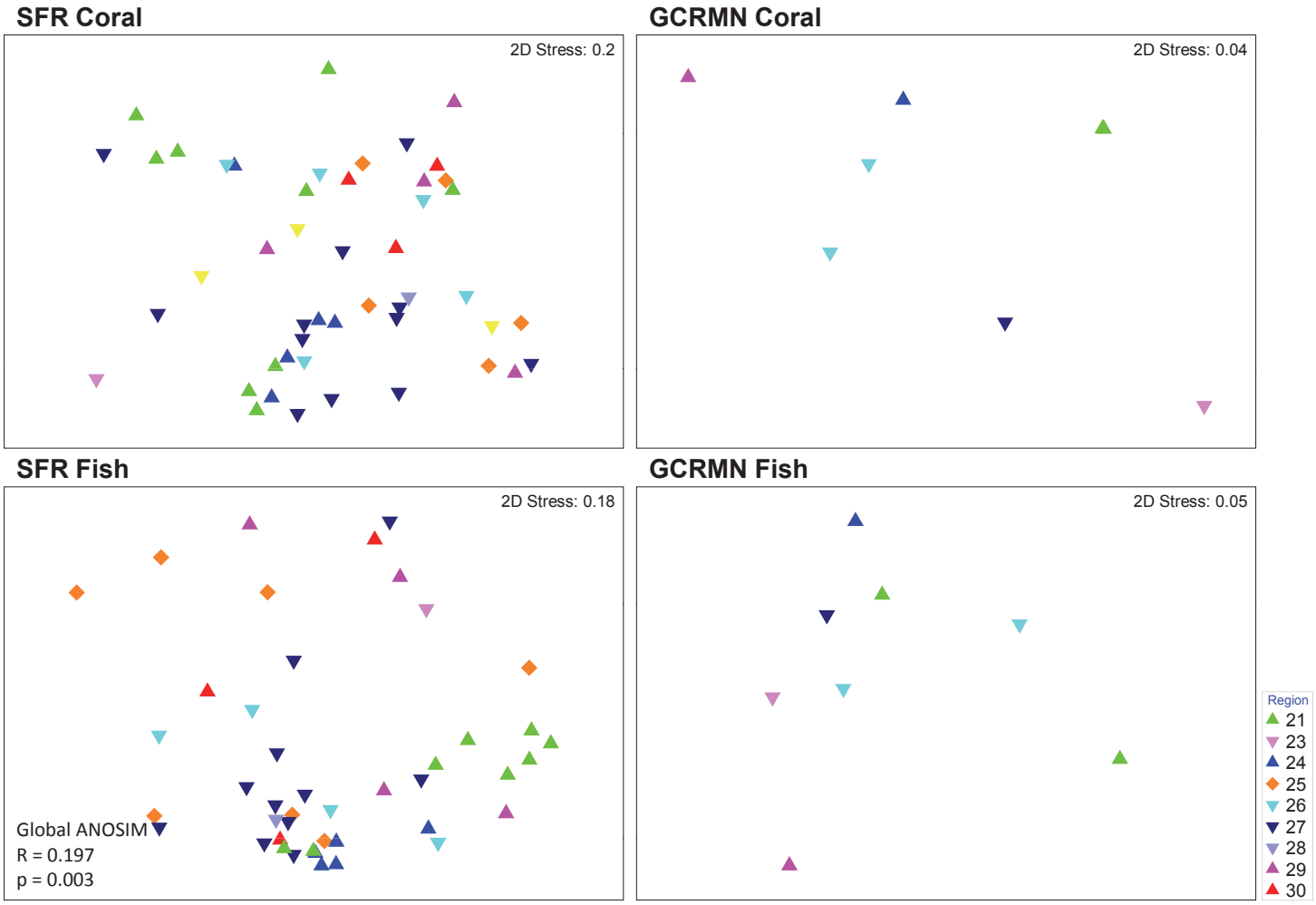


Figure C.34. MDS plots based on coral and fish community data for sites in each of the Samoa studies. Sites are coded by Bioregion. The R value of the Global ANOSIM test among all Bioregions is provided where results were significant. For the SFR fish community data, the Fagali'i site was excluded as an extreme outlier.



Appendix D: Key attributes and activities of MPAs in the existing network of MPAs in American Samoa as of January 2011

Data provided by Alice Lawrence

Table D.1. General description of MPA implementation and management.

MPA	Level of Government	Management Authority	Designation	Management Plan or Informal Rules	Laws & Regulations
Alofau CFMP Reserve	Territorial	DMWR[a], village	2001	Cooperative Agreement	ASAC § 24.10
Amanave CFMP Reserve	Territorial	DMWR[a], village	2009	Cooperative Agreement	ASAC § 24.10
Amaua & Auto CFMP Reserve	Territorial	DMWR[a], village	2003	Cooperative Agreement	ASAC § 24.10
Aoa CFMP Reserve	Territorial	DMWR[a], village	2005	Cooperative Agreement	ASAC § 24.10
Aua CFMP Reserve	Territorial	DMWR[a], village	2002	Cooperative Agreement	ASAC § 24.10
Fagamalo CFMP Reserve	Territorial	DMWR[a], village	2003	Cooperative Agreement	ASAC § 24.10
Fagamalo No-Take MPA	Territorial	DMWR[b], village	2010	Cooperative Agreement; Management Plan being Finalized	ASAC § 24.1001, ASAC § 24.1008 (c)(1)
Leone Pala SMA	Territorial	ASCMP[c], village	1994	None	ASCA § 24.0503, ASAC § 26.0221
Masausi CFMP Reserve	Territorial	DMWR[a], village	2002	Cooperative Agreement	ASAC § 24.10
Matu'u & Faganeanea CFMP Reserve	Territorial	DMWR[a], village	2005	Cooperative Agreement	ASAC § 24.10
Nu'uuli Pala SMA	Territorial	ASCMP[c], village	1995	None	ASCA § 24.0503, ASAC § 26.0221
Ofu Vaoto Marine Park	Territorial	DPR, DMWR	1994	None	ASCA § 18.0214
Pago Pago Harbor SMA	Territorial	ASCMP[c], village	1997	None	ASCA § 24.0503, ASAC § 26.0221
Poloa CFMP Reserve	Territorial	DMWR[a], village	2001	Cooperative Agreement	ASAC § 24.10
Sailele CFMP Reserve	Territorial	DMWR[a], village	2005	Cooperative Agreement	ASAC § 24.10
Alega Private Marine Reserve	Private	Alega village[d]	1985	Unwritten Agreement	Unwritten Rules
Vatia CFMP Reserve	Territorial	DMWR[a], village	2001	Cooperative Agreement	ASAC § 24.10
Fagatele Bay NMS	Federal/ Territorial Co-Managed	NOAA[e], AS DOC	1986	Management Plan (1986), Management Plan Review Process underway (2009)	16 USC 1431 et seq., Public Law 106-513, 15 CFR 922.100-104
NPSA - Ofu unit	Federal	NPS[f]	1988 (lease finalized in 1993)	Management Plan (1997)	16 USC 410qq-410qq-1
NPSA - Ta'u unit	Federal	NPS[f]	1988 (lease finalized in 1993)	Management Plan (1997)	16 USC 410qq-410qq-1
NPSA - Tutuila unit	Federal	NPS[f]	1988 (lease finalized in 1993)	Management Plan (1997)	16 USC 410qq-410qq-1
Rose Atoll MNM/NWR	Federal	USFWS[g], NOAA	2009 (MNM), 1973 (NWR)	Management Plan Development Process underway	Presidential Proclamation 8337, 16 U.S.C. 668dd-ee, Public Law 105-57

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e – Gene Brighouse (Superintendent), Gene.Brighouse@noaa.gov; Kevin Grant (Deputy Superintendent), Kevin.Grant@noaa.gov
f – Mike Reynolds (Superintendent), Mike_Reynolds@nps.gov; Tim Clark (Marine Ecologist), Tim_Clark@nps.gov
g – Frank Pendleton (Rose Atoll Marine National Monument and National Wildlife Refuge Manager), Frank_Pendleton@fws.gov

Table D.2. Conservation focus and management practices.

MPA	Primary Conservation Focus	Protection Focus	Level of Protection	Permanence	Constancy	Fishing Restriction	Vessel Restrictions	Anchoring Restrictions
Alofau CFMP Reserve	Cultural Heritage	Ecosystem	Uniform Multi-Use	Conditional	Year Round	Commercial, Recreational Prohibited[a]	Unrestricted	Unrestricted
Amanave CFMP Reserve	Cultural Heritage	Ecosystem	Uniform Multi-Use	Conditional	Year Round	Commercial, Recreational Prohibited[a]	Unrestricted	Unrestricted
Amaua & Auto CFMP Reserve	Cultural Heritage	Ecosystem	Uniform Multi-Use	Conditional	Year Round	Commercial, Recreational Prohibited[a]	Unrestricted	Unrestricted
Aoa CFMP Reserve	Cultural Heritage	Ecosystem	Uniform Multi-Use	Conditional	Year Round	Commercial, Recreational Prohibited[a]	Unrestricted	Unrestricted
Aua CFMP Reserve	Cultural Heritage	Ecosystem	Uniform Multi-Use	Conditional	Year Round	Commercial, Recreational Prohibited[a]	Unrestricted	Unrestricted
Fagamalo CFMP Reserve	Cultural Heritage	Ecosystem	Uniform Multi-Use	Conditional	Year Round	Commercial, Recreational Prohibited[a]	Unrestricted	Unrestricted
Fagamalo No-Take MPA	Natural Heritage	Ecosystem	No Take	Conditional	Year Round	All Fishing Prohibited	Unrestricted	TBD
Leone Pala SMA	Natural Heritage	Ecosystem	Uniform Multi-Use	Permanent	Year Round	Commercial, Recreational Restricted	Unrestricted	Unrestricted
Masausi CFMP Reserve	Cultural Heritage	Ecosystem	Uniform Multi-Use	Conditional	Year Round	Commercial, Recreational Prohibited[a]	Unrestricted	Unrestricted
Matu'u & Faganeanea CFMP Reserve	Cultural Heritage	Ecosystem	Uniform Multi-Use	Conditional	Year Round	Commercial, Recreational Prohibited[a]	Unrestricted	Unrestricted
Nu'uuli Pala SMA	Natural Heritage	Ecosystem	Uniform Multi-Use	Permanent	Year Round	Commercial, Recreational Restricted	Unrestricted	Unrestricted
Ofu Vaoto Marine Park	Natural Heritage	Ecosystem	Uniform Multi-Use	Permanent	Year Round	Commercial, Recreational Restricted	Presently Unknown	Presently Unknown
Pago Pago Harbor SMA	Natural Heritage	Ecosystem	Uniform Multi-Use	Permanent	Year Round	Commercial, Recreational Restricted	Unrestricted	Unrestricted
Poloa CFMP Reserve	Cultural Heritage	Ecosystem	Uniform Multi-Use	Conditional	Year Round	Commercial, Recreational Prohibited[a]	Unrestricted	Unrestricted
Sailele CFMP Reserve	Cultural Heritage	Ecosystem	Uniform Multi-Use	Conditional	Year Round	Commercial, Recreational Prohibited[a]	Unrestricted	Unrestricted
Alega Private Marine Reserve	Sustainable Production	Ecosystem	Uniform Multi-Use	Permanent	Year Round	All Fishing Restricted[b]	Restricted	Restricted
Vatia CFMP Reserve	Cultural Heritage	Ecosystem	Uniform Multi-Use	Conditional	Year Round	Commercial, Recreational Prohibited[a]	Unrestricted	Unrestricted
Fagatele Bay NMS	Natural, Cultural Heritage	Ecosystem	Zoned Multi-Use	Permanent	Year Round	Commercial, Recreational Restricted	Unrestricted	Restricted
NPSA - Ofu unit	Natural, Cultural Heritage	Ecosystem	Uniform Multi-Use	Permanent*	Year Round	Commercial, Recreational Restricted[c]	Unrestricted	Unrestricted
NPSA - Ta'u unit	Natural, Cultural Heritage	Ecosystem	Uniform Multi-Use	Permanent*	Year Round	Commercial, Recreational Restricted[c]	Unrestricted	Unrestricted
NPSA - Tutuila unit	Natural, Cultural Heritage	Ecosystem	Uniform Multi-Use	Permanent*	Year Round	Commercial, Recreational Restricted[c]	Unrestricted	Unrestricted
Rose Atoll MNM/NWR	Natural Heritage	Ecosystem	Zoned w/ No Take Areas	Permanent	Year Round	Commercial, Recreational Restricted	Restricted	Restricted

a – The reserve is closed to all fishing apart from when it is opened for subsistence fishing at certain times of the year.
b – Only subsistence fishing with traditional methods by villagers/relatives is allowed.
c – Only subsistence fishing with traditional methods is allowed.
* 50 year renewable lease and permanent federal funding.

Table D.3. Biological and socio-economic monitoring/assessment and community involvement.

MPA	Biophysical Assessments/ Monitoring	Socio-economic Assessments/ Monitoring	Community/Stakeholder Engagement	Community Power to Take/Enforce Man agement Decisions?
Alofau CFMP Reserve	Baseline Assessment; Biannual Monitoring Program	Future Plans to Design and Implement Socio-economic Monitoring	Involved in Management Planning, Involved in Site Management, Existence of Collaborative Management Mechanisms	Yes
Amanave CFMP Reserve	Baseline Assessment; Biannual Monitoring Program	Future Plans to Design and Implement Socio-economic Monitoring	Involved in Management Planning, Involved in Site Management, Existence of Collaborative Management Mechanisms	Yes
Amaua & Auto CFMP Reserve	Baseline Assessment; Biannual Monitoring Program	Future Plans to Design and Implement Socio-economic Monitoring	Involved in Management Planning, Involved in Site Management, Existence of Collaborative Management Mechanisms	Yes
Aoa CFMP Reserve	Baseline Assessment; Biannual Monitoring Program	Future Plans to Design and Implement Socio-economic Monitoring	Involved in Management Planning, Involved in Site Management, Existence of Collaborative Management Mechanisms	Yes
Aua CFMP Reserve	Baseline Assessment; Biannual Monitoring Program	Future Plans to Design and Implement Socio-economic Monitoring	Involved in Management Planning, Involved in Site Management, Existence of Collaborative Management Mechanisms	Yes
Fagamalo CFMP Reserve	Baseline Assessment; Biannual Monitoring Program	Future Plans to Design and Implement Socio-economic Monitoring	Involved in Management Planning, Involved in Site Management, Existence of Collaborative Management Mechanisms	Yes
Fagamalo No-Take MPA	Baseline Assessment	Baseline Assessment; Monitoring Program in Development	Involved in Management Planning, Involved in Site Management	Yes
Leone Pala SMA	Presently Unknown	Presently Unknown	Involved in Management Planning	No
Masausi CFMP Reserve	Baseline Assessment; Biannual Monitoring Program	Future Plans to Design and Implement Socio-economic Monitoring	Involved in Management Planning, Involved in Site Management, Existence of Collaborative Management Mechanisms	Yes
Matu'u & Faga-neanea CFMP Reserve	Baseline Assessment; Biannual Monitoring Program	Future Plans to Design and Implement Socio-economic Monitoring	Involved in Management Planning, Involved in Site Management, Existence of Collaborative Management Mechanisms	Yes
Nu'uuli Pala SMA	Presently Unknown	Presently Unknown	Involved in Management Planning	No
Ofu Vaoto Marine Park	Presently Unknown	Presently Unknown	Presently Unknown	Presently Unknown
Pago Pago Harbor SMA	Presently Unknown	Presently Unknown	Involved in Management Planning	No
Poloa CFMP Reserve	Baseline Assessment; Biannual Monitoring Program	Future Plans to Design and Implement Socio-economic Monitoring	Involved in Management Planning, Involved in Site Management, Existence of Collaborative Management Mechanisms	Yes
Sailele CFMP Reserve	Baseline Assessment; Biannual Monitoring Program	Future Plans to Design and Implement Socio-economic Monitoring	Involved in Management Planning, Involved in Site Management, Existence of Collaborative Management Mechanisms	Yes
Alega Private Marine Reserve	Fish Catch Monitoring by Tisa; DMWR Key Reef Spe-cies Program Monitoring Site	None	Village Community Designated and Manages the Reserve	Yes
Vatia CFMP Reserve	Baseline Assessment; Biannual Monitoring Program	Future Plans to Design and Implement Socio-economic Monitoring	Involved in Management Planning, Involved in Site Management, Existence of Collaborative Management Mechanisms	Yes
Fagatele Bay NMS	NOAA Biogeographic Assess-ment in 2008, 2010; Long-term Monitoring Program in Place	Baseline Assessment; Monitoring Program in Development	Involved in Management Planning, Existence of Collaborative Management Mechanisms	Some
NPSA - Ofu unit	Baseline Assessment; Annual Monitoring Program	Occasional Assessments	Involved in Management Planning, Existence of Collaborative Management Mechanisms	Some
NPSA - Ta'u unit	Baseline Assessment; Annual Monitoring Program	Occasional Assessments	Involved in Management Planning, Existence of Collaborative Management Mechanisms	Some
NPSA - Tutuila unit	Baseline Assessment; Annual Monitoring Program	Occasional Assessments	Involved in Management Planning, Existence of Collaborative Management Mechanisms	Some
Rose Atoll MNM/ NWR	Baseline Assessment; Regular Monitoring Program	Occasional Assessments	Some - Involved in Management Planning Process; Meetings held in Manu'a and Tutuila, November 2009	No

Table D.4. Current and future projects.

MPA	Existing Projects/Activities	Collaborative Work	Future Projects/Activities
Alofau CFMP Reserve	Education & Outreach; Monitoring; Village Beach & Underwater Clean Ups; Community Reef Monitoring	w/ No-Take MPA Program on Education & Outreach Programs, Socio-economic Assessments, MPA Designation Work, VMPA Awareness, and Enforcement Partnerships	Regular Biological Monitoring; Socio-economic Surveys; Education & Outreach; Training and Capacity Building; Enforcement Activities (e.g. Boat Patrols)
Amanave CFMP Reserve	Education & Outreach; Monitoring; Village Beach & Underwater Clean Ups; Community Reef Monitoring	w/ No-Take MPA Program on Education & Outreach Programs, Socio-economic Assessments, MPA Designation Work, VMPA Awareness, and Enforcement Partnerships	Regular Biological Monitoring; Socio-economic Surveys; Education & Outreach; Training and Capacity Building; Enforcement Activities (e.g. Boat Patrols)
Amaua & Auto CFMP Reserve	Education & Outreach; Monitoring; Village Beach & Underwater Clean Ups; Community Reef Monitoring	w/ No-Take MPA Program on Education & Outreach Programs, Socio-economic Assessments, MPA Designation Work, VMPA Awareness, and Enforcement Partnerships	Regular Biological Monitoring; Socio-economic Surveys; Education & Outreach; Training and Capacity Building; Enforcement Activities (e.g. Boat Patrols)
Aoa CFMP Reserve	Education & Outreach; Monitoring; Village Beach & Underwater Clean Ups; Community Reef Monitoring	w/ No-Take MPA Program on Education & Outreach Programs, Socio-economic Assessments, MPA Designation Work, VMPA Awareness, and Enforcement Partnerships	Regular Biological Monitoring; Socio-economic Surveys; Education & Outreach; Training and Capacity Building; Enforcement Activities (e.g. Boat Patrols)
Aua CFMP Reserve	Education & Outreach; Monitoring; Village Beach & Underwater Clean Ups; Community Reef Monitoring	w/ No-Take MPA Program on Education & Outreach Programs, Socio-economic Assessments, MPA Designation Work, VMPA Awareness, and Enforcement Partnerships	Regular Biological Monitoring; Socio-economic Surveys; Education & Outreach; Training and Capacity Building; Enforcement Activities (e.g. Boat Patrols)
Fagamalo CFMP Reserve	Education & Outreach; Monitoring; Village Beach & Underwater Clean Ups; Community Reef Monitoring	w/ No-Take MPA Program on Education & Outreach Programs, Socio-economic Assessments, MPA Designation Work, VMPA Awareness, and Enforcement Partnerships	Regular Biological Monitoring; Socio-economic Surveys; Education & Outreach; Training and Capacity Building; Enforcement Activities (e.g. Boat Patrols)
Fagamalo No-Take MPA	Education & Outreach; Biological Assessments; Learning Exchange; Current Surveys; Drop Cam Surveys; Larval Dispersal Modeling	w/ CFMP on Education & Outreach Programs, Socio-economic Assessments and MPA Designation Work; w/ Fishery Staff for Drop Cam Work; w/ EPA on Current Surveys and Modeling	MPA Designation Process; Education & Outreach; Engagement Workshops; Monitoring Training; Socio-economic Surveys; Modeling; Mapping; Network Development; Improve Enforcement
Leone Pala SMA	Presently Unknown	Presently Unknown	Presently Unknown
Masausi CFMP Reserve	Education & Outreach; Monitoring; Village Beach & Underwater Clean Ups; Community Reef Monitoring	w/ No-Take MPA Program on Education & Outreach Programs, Socio-economic Assessments, MPA Designation Work, VMPA Awareness, and Enforcement Partnerships	Regular Biological Monitoring; Socio-economic Surveys; Education & Outreach; Training and Capacity Building; Enforcement Activities (e.g. Boat Patrols)
Matu'u & Faganeanea CFMP Reserve	Education & Outreach; Monitoring; Village Beach & Underwater Clean Ups; Community Reef Monitoring	w/ No-Take MPA Program on Education & Outreach Programs, Socio-economic Assessments, MPA Designation Work, VMPA Awareness, and Enforcement Partnerships	Regular Biological Monitoring; Socio-economic Surveys; Education & Outreach; Training and Capacity Building; Enforcement Activities (e.g. Boat Patrols)
Nu'uuli Pala SMA	Presently Unknown	Presently Unknown	Presently Unknown
Ofu Vaoto Marine Park	Presently Unknown	Presently Unknown	Presently Unknown
Pago Pago Harbor SMA	Presently Unknown	Presently Unknown	Presently Unknown
Poloa CFMP Reserve	Education & Outreach; Monitoring; Village Beach & Underwater Clean Ups; Community Reef Monitoring	w/ No-Take MPA Program on Education & Outreach Programs, Socio-economic Assessments, MPA Designation Work, VMPA Awareness, and Enforcement Partnerships	Regular Biological Monitoring; Socio-economic Surveys; Education & Outreach; Training and Capacity Building; Enforcement Activities (e.g. Boat Patrols)

Table D.4. cont. Current and future projects.

MPA	Existing Projects/Activities	Collaborative Work	Future Projects/Activities
Sailele CFMP Reserve	Education & Outreach; Monitoring; Village Beach & Underwater Clean Ups; Community Reef Monitoring	w/ No-Take MPA Program on Education & Outreach Programs, Socio-economic Assessments, MPA Designation Work, VMPA Awareness, and Enforcement Partnerships	Regular Biological Monitoring; Socio-economic Surveys; Education & Outreach; Training and Capacity Building; Enforcement Activities (e.g. Boat Patrols)
Alega Private Marine Reserve	Education & Outreach; Fish Catch Monitoring; Turtle Nest Monitoring; Annual Palolo Worm Festival & Fishing Events; Practicing of Traditional Fishing Methods	w/ DMWR's Marine Monitoring Program, Marine Mammal Monitoring Program	REEF Fish ID program to be Implemented using Observations by Visitors to the Reserve; Traditional Knowledge Documentation Project
Vatia CFMP Reserve	Education & Outreach; Monitoring; Village Beach & Underwater Clean Ups; Community Reef Monitoring	w/ No-Take MPA Program on Education & Outreach Programs, Socio-economic Assessments, MPA Designation Work, VMPA Awareness, and Enforcement Partnerships	Regular Biological Monitoring; Socio-economic Surveys; Education & Outreach; Training and Capacity Building; Enforcement Activities (e.g. Boat Patrols)
Fagatele Bay NMS	Management Plan Review and Possible Additional Sanctuary Unit Designation Process; Biogeographic Assessment; Community Engagement; Scientific Research; Maritime Heritage Study	w/ ASCC Internship Program; w/ LBJ Hospital to open a Hyperbaric Chamber on Island; w/ Sea Education Association (S.E.A.) on Oceanographic Research, Education, and Cultural Exchange; w/ Hawaiian Islands Humpback Whale NMS and DMWR on Humpback Whale and Cetacean Research; w/ NCCOS on Biogeographic Assessment of the Samoan Archipelago; w/ Le Tausagi: Enviro-Discoveries Camps; w/ ASG - Preserve America Initiatives; w/ University of Hawaii - Research and Monitoring	Renovate Sanctuary Offices and Visitor's Center; Proposed Plans to Expand to Include Additional Units at Tutuila: Larsen Bay and Aunu'u, Manu'a: Ta'u, Rose Atoll, and Swains island; International Exchange Program; Education Workshop; Climate Change Strategy
NPSA - Ofu unit	Siapo Educational DVD; Natural History of AS Publication; Research Papers; New NP Ranger on Ofu	w/ DMWR, NOAA, FWS, DOI-insular office, Office of Samoan Affairs, PICED, Coast Guard, Territorial EMS/LBJ Hospital, Territorial Historic Preservation Office, ASCC, Land Grant, Sea Grant, and the Villages of Vatia, Fagasa, Pago Pago, Sili, Ofu, Olosega, Ta'u, Fiti'uta, and Faleasou on Various Projects	Research; Annual Monitoring; Education & Outreach; Encourage Climate Change Research on Impacts to Coral Reefs at Ofu Field Station
NPSA - Ta'u unit	Siapo Educational DVD; Natural History of AS Publication; Research Papers	w/ DMWR, NOAA, FWS, DOI-insular office, Office of Samoan Affairs, PICED, Coast Guard, Territorial EMS/LBJ Hospital, Territorial Historic Preservation Office, ASCC, Land Grant, Sea Grant, and the Villages of Vatia, Fagasa, Pago Pago, Sili, Ofu, Olosega, Ta'u, Fiti'uta, and Faleasou on Various Projects	Research; Annual Monitoring; Education & Outreach
NPSA - Tutuila unit	Siapo Educational DVD; Natural History of AS Publication; Research Papers	w/ DMWR, NOAA, FWS, DOI-insular office, Office of Samoan Affairs, PICED, Coast Guard, Territorial EMS/LBJ Hospital, Territorial Historic Preservation Office, ASCC, Land Grant, Sea Grant, and the Villages of Vatia, Fagasa, Pago Pago, Sili, Ofu, Olosega, Ta'u, Fiti'uta, and Faleasou on Various Projects	Research; Annual Monitoring; Education & Outreach
Rose Atoll MNM/NWR	Planning Review Updates; Public Consultations	w/ DMWR on Research and Monitoring Work; Currently w/ FBNMS and NMFS to Develop Management Plans for the MNM	Collaborate w/ NMFS and DMWR on Monitoring Efforts

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A BIOGEOGRAPHIC ASSESSMENT OF THE SAMOAN ARCHIPELAGO

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