Summary Report of Baseline Surveys for Benthic and Fish Communities in the Fagamalo No-Take Marine Protected Area, American Samoa

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INTRODUCTION

The village of Fagamalo in American Samoa became the first village in the Territory of American Samoa to set aside a portion of their coastline and marine environment as a Fishery Management Area (No-Take Marine Protected area). In May 2010 villagers of Fagamalo held an agreement signing ceremony with the American Samoa Department of Marine and Wildlife Resources that will see the protection of marine resources in 2.25 square kilometers of ocean. Fishing is prohibited in that protected area. This report describes baseline assessment surveys conducted as a partnership between NOAA's Coral Reef Ecosystem Program (CREP) and the American Samoa Department of Marine and Wildlife Resources (DMWR) in October–November of 2015 and March–April of 2016. CREP implements the Pacific Reef Assessment and Monitoring Program (RAMP), an ecosystem-scale interdisciplinary coral reef monitoring program.

METHODS

Sampling design

A two-stage stratified random sampling design was employed to survey the domain which encompassed hard bottom reef habitat from 0 to 30 meters within the Marine Protected Area (Fig 1). The stratification scheme incorporated fore reef habitat and three depth categories (shallow 0–6 m), mid-depth (>6–18 m) and deep (>18–30 m) (Table 1). A geographic information system and digital spatial databases of benthic habitats, reef zones, bathymetry, and marine reserve boundaries were used to facilitate spatial delineation of the sampling survey domain, strata, and sample units. Allocation of sampling effort was proportional to total strata area. Site locations (geographic coordinates) were randomly selected within each stratum. Estimates for strata are generated from site means and are weighted by strata area (Table 1). Island-scale and population estimates (means and totals) are calculated using weighted strata mean.

Table 1 – Summary of benthic and fish community surveys conducted in the Fagamalo No-Take Marine Protected Area, American Samoa.

Sampling Unit		Area (m^2)	Proportion	# Fish surveys	# Benthic surveys
FAGAMALO No take MPA		764231	1	20	18
	Forereef shallow	76769	0.10	4	5
	Forereef mid-depth	95072	0.12	8	6
	Forereef deep	73049	0.10	3	4
	Deep Bank	519340	0.68	5	3

Figure 1 – Map displaying the location and extent of the Fagamalo No-Take MPA, Tutuila, American Samoa.

Benthic survey method: Benthic surveys at each site were conducted within two, 18-m belt transects. Adult coral colonies (≥ 5 cm) were surveyed within 4, 2.5 m^2 segments on each transect, whereby coral colonies were identified to genus with the exception of a selected list of species that were consistently identifiable in situ (Appendix 1). Adult coral colonies were measured (maximum diameter to the nearest cm) and morphology was noted. In addition, partial mortality and condition of each colony was assessed. Partial colony mortality was quantified as the percent of dead tissue (classified as 'old dead' or 'recent dead'), and the cause of recent mortality was identified if possible. Old dead partial mortality was defined as the non-living portion of a colony where the corallite structures were either gone or covered over by organisms that were not easily removed. Recent dead partial mortality was defined as the non-living portion of a colony in which the corallite structures were still intact (unless freshly bitten by a fish or abraded) and the exposed skeleton was either stark white or had only a very thin layer of sediment, biofilm (i.e. bacteria),

diatoms, microalgae, or tiny turf algae. Conditions affecting each colony that were not affiliated with recent mortality (i.e., some diseases and bleaching) were noted, along with the extent (percent of colony affected) and severity (ranging from moderate to acute).

Juvenile coral colonies (< 5 cm) were surveyed within 3, $1m^2$ segments on each transect. Juvenile colonies were identified in the field by a distinct tissue and skeletal boundary that distinguished them from asexual fragments of larger adult colonies. Each juvenile colony was identified to the lowest taxonomic level possible (genus or species) and measured (both the maximum and perpendicular diameter to the nearest 2 mm).

Fish survey method: A pair of divers surveyed the fish assemblage at each site using a stationary-point-count method. Each diver identifies, enumerates, and estimates the total length of fishes within a visually estimated 15-m diameter cylinder with the diver stationed in the center. These data are used to calculate fish biomass per unit area ($g\ m^{-2}$) for each species. Mean summary metrics are calculated by weighting averages by the area per strata. Please visit this site for more information on our survey method and sampling design. All data are provisional.

RESULTS

Benthic surveys

A total of 18 sites were surveyed within the boundaries of the MPA. Herein we present site-level bubble maps which reports on estimates of benthic cover and relative abundance for: hard corals, crustose coralline algae, macroalgae, and the benthic substrate ratio (ratio of the sum of hard corals and coralline algae cover divided by the sum of macroalgae and turf algal cover). In addition, we also report on coral population demographic parameters, including estimates of colony densities for adults and juveniles, partial mortality (old and recent), as well as the prevalence of diseases, lesions, and bleaching. Island- and stratum-level estimates are also presented in table format.

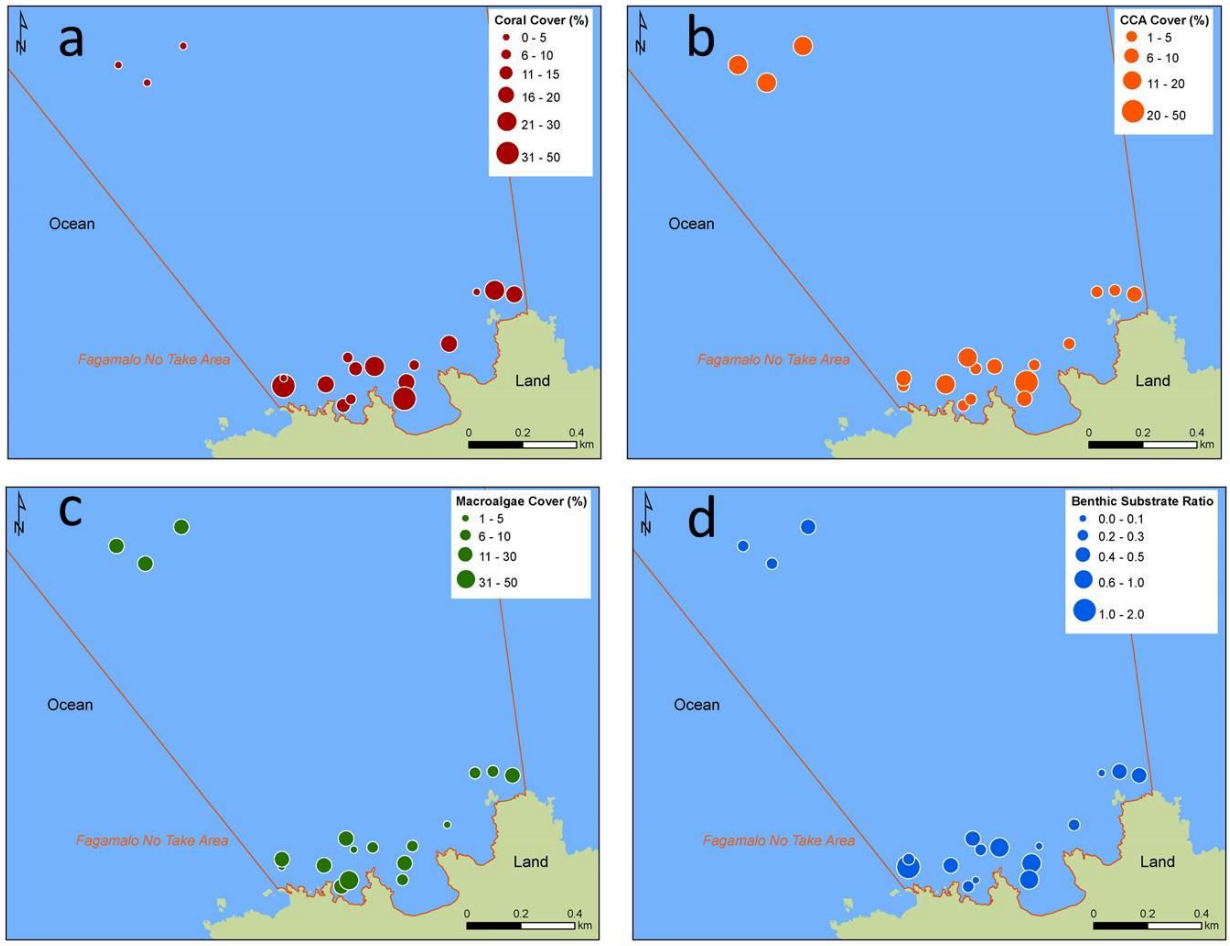


Figure 2 –Spatial comparison of benthic cover (%) values for at each survey site for: (a) live hard corals, (b) crustose coralline algae (CCA), (c) macroalgae, and (d) the benthic substrate ratio (ratio of mean cover for corals and crustose coralline algae combined to cover for non-accreting organisms) at the Fagamalo village No-Take MPA, derived from the analysis of benthic images acquired during surveys conducted in October–November 2015.

Table 2 –MPA-wide and stratum-specific estimates of mean (±SE) benthic cover for five functional groups, five scleractinian genera, and two macroalgal taxa at Fagamalo Village no-take MPA, derived from the analysis of benthic images acquired during surveys conducted in October–November 2015. Mean benthic cover estimates for north-west Tutuila derived from the 2015 Pacific Reef Assessment and Monitoring Program cruise in American Samoa are provided for reference.

	Fagamalo NT-MPA			Deep Bank		Forereef deep		Forereef mid-depth		Forereef shallow		NW Tutuila	
	MEAN %	SE	%CV	MEAN %	SE	MEAN %	SE	MEAN %	SE	MEAN %	SE	MEAN %	SE
Benthic cover													
Hard coral	6.60	2.00	0.30	2.00	1.07	5.00	1.50	23.61	5.02	18.20	5.03	23.64	3.8
Coralline algae	14.20	2.19	0.15	17.78	1.90	6.58	3.24	6.67	3.15	6.53	1.92	7.51	1.09
Macroalgae	16.81	4.43	0.26	18.78	4.95	12.25	4.26	5.89	1.80	21.40	4.38	10.41	1.43
Turfalgae	56.83	6.31	0.11	55.33	6.74	71.08	6.19	59.56	6.09	50.07	3.74	53.39	3.46
Sediment	1.81	1.02	0.57	2.11	1.16	2.25	1.70	0.83	0.32	0.53	0.34	3.15	0.99
Coral Genera													
Acropora spp.	1.00	0.78	0.78	0.89	0.89	0.50	0.40	2.39	0.83	0.53	0.39		
Astreopora spp.	0.51	0.30	0.58	0.00	0.00	0.17	0.17	3.50	2.03	0.60	0.27		
Monitpora spp.	2.29	0.98	0.43	0.11	0.11	0.25	0.25	9.33	3.28	10.20	4.70		
Pocillopora spp.	0.51	0.40	0.78	0.33	0.33	0.00	0.00	0.50	0.14	2.20	1.53		
Porites spp	0.99	0.31	0.32	0.00	0.00	3.00	1.50	4.39	0.89	1.60	0.59		
Macroalgae													
Halimeda spp.	0.30	0.22	0.74	0.22	0.22	1.42	0.64	0.11	0.07	0.00	0.00		
Encrusting algae	15.84	4.06	0.26	18.56	4.72	4.67	2.09	5.44	1.71	21.00	4.32		

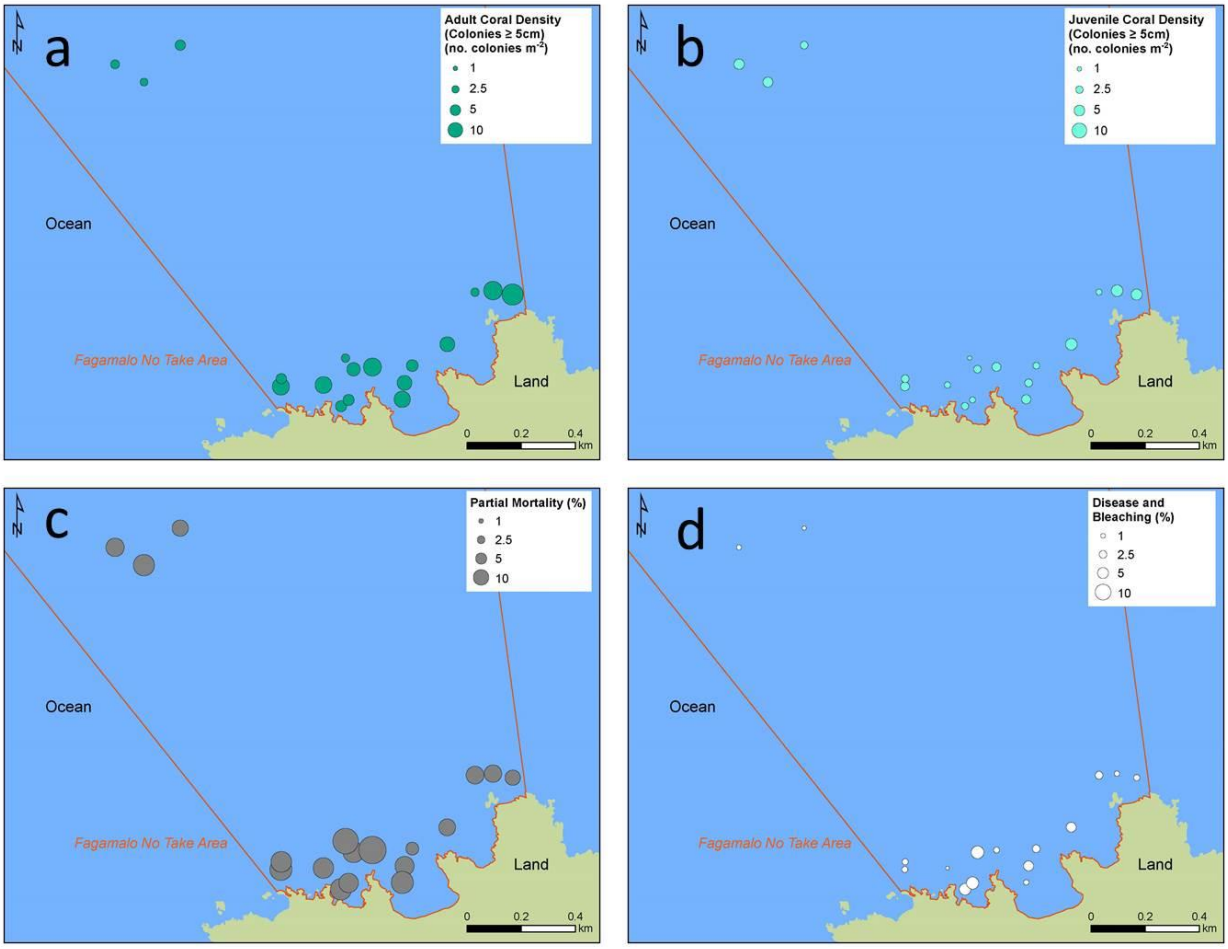


Figure 3 –Spatial comparison of coral population demographic parameters: (a) adult colony densities (col/m^2), (b) juvenile colony densities (col/m^2), (c) partial mortality (%; old only), and (d) prevalence of disease and bleaching at the Fagamalo village No-Take MPA, derived from the analysis of benthic images acquired during surveys conducted in October–November 2015.

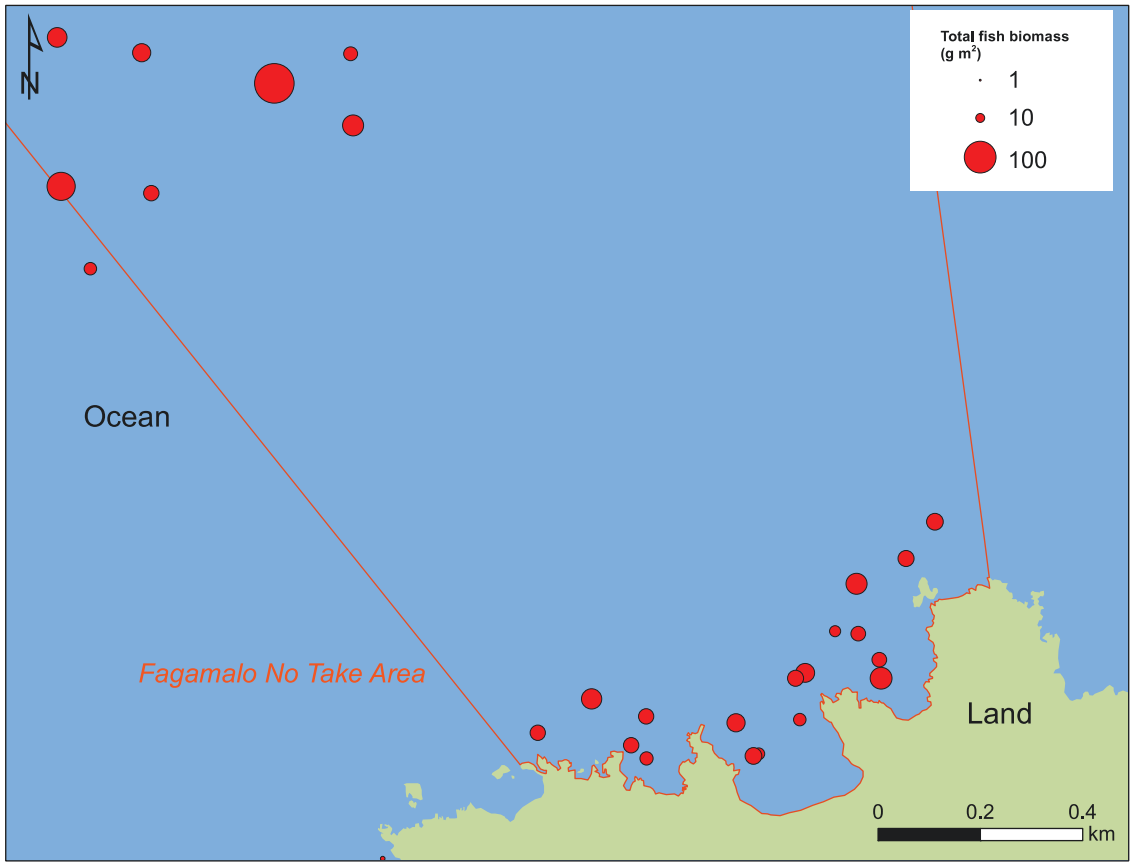
Table 3.–MPA-wide and stratum-specific estimates of mean (±SE) adult and juvenile coral colony densities (col/m^2), colony partial mortality (%) (old and recent), and prevalence of disease (%) and bleaching (%) for total scleractinians in the Fagamalo no-take Marine Protected Area, derived from baseline assessments conducted in October–November 2015. Mean demographic estimates for north-west Tutuila derived from the 2015 Pacific Reef Assessment and Monitoring Program cruise in American Samoa are provided for reference.

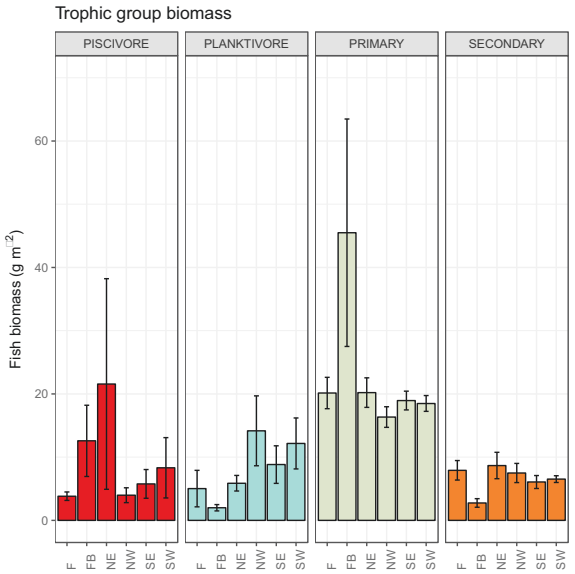
	Fagamalo NT-MPA			Deep bank		Forereef deep		Forereef mid-depth		Forereef shallow		NW Tutuila	
	MEAN	SE	%CV	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE
Demographics													
Density - Adults	5.47	0.87	0.16	3.67	0.56	4.33	0.69	11.65	1.21	11.13	2.66	9.84	3.18
Density - Juveniles	3.63	*0.60*	0.17	3.91	0.63	1.83	0.38	3.96	0.57	3.01	0.70	3.08	1.18
Old mortality	15.08	2.43	0.16	14.33	2.23	15.86	4.08	17.81	2.76	16.03	1.80	13.61	2.74
Recent mortality	0.24	0.09	0.36	0.05	0.03	0.98	0.27	0.67	0.24	0.26	0.11	0.87	0.25
Disease	1.11	0.64	0.58	0.46	0.46	1.33	0.80	2.88	0.91	3.14	1.44	0.85	0.72
Bleaching	0.55	0.42	0.77	0.36	0.36	0.81	0.81	1.22	0.43	0.78	0.49	4.72	3.16

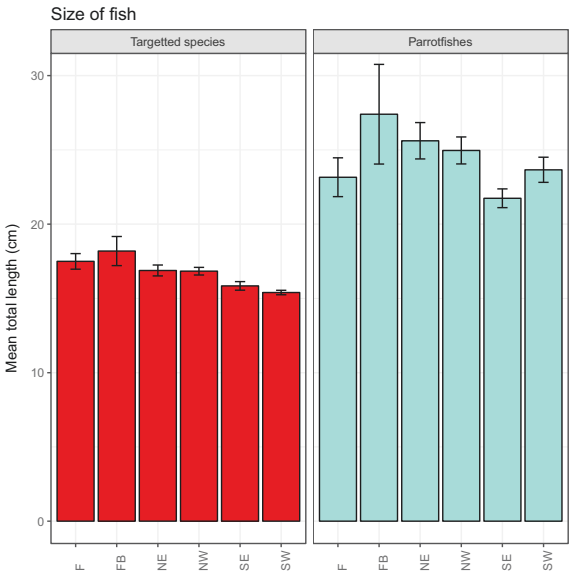
Summary fish surveys

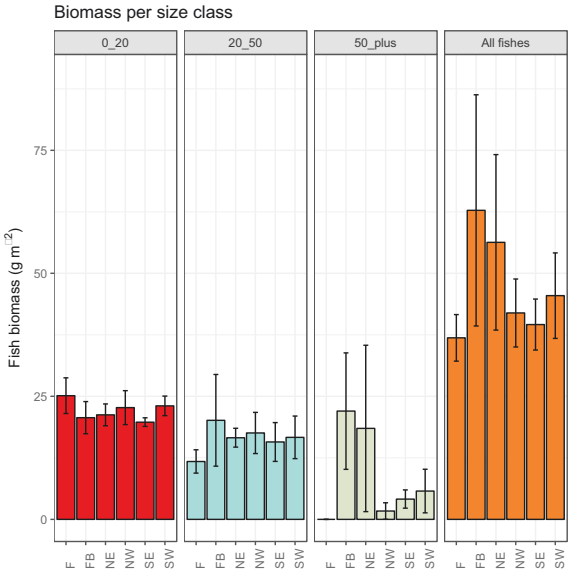
A total of 20 sites were surveyed within the boundaries of the Fagamalo MPA during the Reef Fish Survey Project in March-April 2016. The location of the survey sites, with total fish biomass is presented below (Figure 4). Summary metrics for biomass per trophic group, size class, large and small parrotfish and total fish biomass are presented in Figure 4 and Table 4, common family biomass in Table 5 and fish species biomass in Table 6. For individual site level estimates per species please use our pilot interactive data viewer accessible via this web link:

https://aheenan.shinyapps.io/Tutuila_Fagamalo_data_summary/









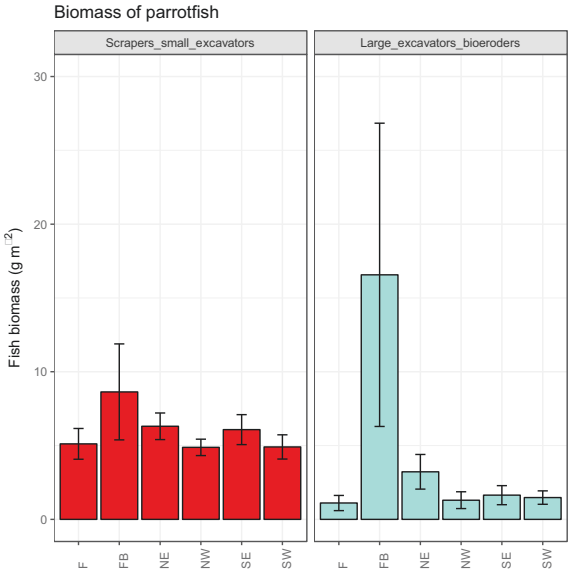


Figure 4. Map inset: the location of and total fish biomass (g m^{-2}) observed at the fish survey sites during the 2016 Fagamalo MPA baseline survey effort. Graphs display summary fish metrics per spatial unit: F = Fagamalo fore-reef, FB = Fagamalo Bank, and the cardinal quadrants of Tutuila island.

Table 4.–MPA-wide and depth stratum-specific estimates of mean (±SE) fish summary metrics for the Fagamalo no-take Marine Protected Area, derived from baseline assessments conducted in March-April 2016. Fish biomass (g m^{-2}) is reported per functional group, pri. Consumers = primary consumers which includes herbivores (which eat plants) and detritivores (which bottom feed on detritus), and sec. consumers (secondary) are largely omnivorous (eating a variety of fishes and invertebrates). Fish biomass is also reported for small (10 cm – 35 cm in total length (TL)) and larger (> 35 cm TL) parrotfishes, and for total fish biomass per size class. Mean size refers to the average size of the entire fish assemblage (for adults, juveniles < 30% of their maximum length) are removed. For reference, summary metrics are also reported for each for cardinal sectors of Tutuila, based on the most recent Pacific Reef Assessment and Monitoring Program cruise (2015) and the 2016 Reef Fish survey project. Cells are conditional formatted where the darker shades of red indicate higher values per summary metric.

Area	Fagamalo	Fagamalo	Fagamalo	Fagamalo	Fagamalo	Fagamalo	Northeast	Northwest	Southeast	Southwest
Depth	Shallow	Mid	Deep	Deep bank	All	All	All	All	All	All
Reef zone	Forereef	Forereef	Forereef	Bank	Bank	Forereef	Forereef	Forereef	Forereef	Forereef
Samples	4	8	3	5	5	15	31	36	39	36
Piscivores	1.83 (0.67)	2.68 (0.63)	7.39 (2.16)	12.57 (5.71)	12.57 (5.64)	3.82 (0.67)	21.56 (16.66)	3.97 (1.18)	5.77 (2.28)	8.3 (4.77)
Planktivores	0.36 (0.18)	2.38 (0.74)	13.37 (10.39)	1.99 (0.5)	1.99 (0.5)	5.02 (2.89)	5.87 (1.24)	14.16 (5.52)	8.82 (2.97)	12.16 (4.03)
Primary consumers	25.42 (6.51)	15.21 (1.12)	21.01 (5.41)	45.49 (18.21)	45.49 (17.99)	20.14 (2.48)	20.2 (2.33)	16.33 (1.63)	18.95 (1.49)	18.49 (1.24)
Secondary consumers	7.21 (2.67)	10.61 (3.81)	5.13 (0.45)	2.75 (0.69)	2.75 (0.68)	7.91 (1.54)	8.67 (2.09)	7.48 (1.51)	6.06 (1.02)	6.52 (0.53)
Small parrotfish	4.81 (2.58)	4.62 (0.95)	6.07 (2.27)	8.63 (3.29)	8.63 (3.25)	5.11 (1.04)	6.3 (0.9)	4.88 (0.56)	6.08 (1.01)	4.91 (0.82)
Large parrotfish	0 (0)	0.55 (0.28)	2.99 (1.83)	16.57 (10.4)	16.57 (10.27)	1.11 (0.52)	3.22 (1.18)	1.3 (0.57)	1.64 (0.65)	1.47 (0.45)
Total fish biomass	34.81 (6.51)	30.88 (4.84)	46.9 (14.38)	62.8 (23.78)	62.8 (23.49)	36.89 (4.74)	56.3 (17.83)	41.94 (6.9)	39.59 (5.18)	45.46 (8.69)
0-20 cm TL	25.97 (0.54)	22.85 (3.84)	27.21 (12.14)	20.67 (3.3)	20.67 (3.26)	25.13 (3.62)	21.24 (2.22)	22.7 (3.45)	19.75 (0.88)	23.06 (1.98)
20-50 cm TL	8.84 (6.52)	8.03 (1.7)	19.7 (4.49)	20.13 (9.44)	20.13 (9.32)	11.76 (2.38)	16.59 (1.92)	17.56 (4.18)	15.72 (3.95)	16.66 (4.33)
50 + cm TL	0 (0)	0 (0)	0 (0)	22 (11.98)	22 (11.84)	0 (0)	18.48 (16.91)	1.69 (1.68)	4.12 (1.86)	5.74 (4.43)
Mean size targeted (cm)	18.09 (1.33)	17.13 (0.48)	17.34 (1.1)	18.19 (0.99)	18.19 (0.98)	17.49 (0.53)	16.88 (0.37)	16.84 (0.26)	15.84 (0.29)	15.4 (0.15)
Mean size parrots (cm)	21.42 (3.47)	23.3 (1.37)	24.8 (2.35)	27.4 (3.4)	27.4 (3.35)	23.16 (1.31)	25.61 (1.23)	24.96 (0.91)	21.74 (0.63)	23.66 (0.85)

Table 5.–MPA-wide and depth stratum-specific estimates of mean (±SE) common fish family biomass (g m^{-2}). See Table 4 legend for further detail.

Area	Fagamalo	Fagamalo	Fagamalo	Fagamalo	Fagamalo	Fagamalo	Northeast	Northwest	Southeast	Southwest
Depth	Shallow	Mid	Deep	Deep bank	All	All	All	All	All	All
Reef zone	Forereef	Forereef	Forereef	Bank	Bank	Forereef	Forereef	Forereef	Forereef	Forereef
Samples	4	8	3	5	5	15	31	36	39	36
Butterflyfish	0.67 (0.3)	1.37 (0.43)	0.68 (0.23)	0.4 (0.06)	0.4 (0.06)	0.95 (0.19)	1.03 (0.13)	0.74 (0.1)	1.05 (0.14)	1.16 (0.1)
Damselfish	1.13 (0.36)	2.18 (0.45)	2.94 (1.19)	1.76 (0.32)	1.76 (0.31)	2.08 (0.38)	2.16 (0.41)	1.99 (0.25)	2.65 (0.25)	2.78 (0.33)
Emperor	3.3 (2.67)	5.15 (3.34)	0.28 (0.2)	0 (0)	0 (0)	3.12 (1.4)	2.34 (0.99)	1.53 (0.69)	1.34 (0.69)	0.61 (0.21)
Fusilier	0 (0)	0.61 (0.61)	9.37 (8.74)	0 (0)	0 (0)	3.03 (2.43)	2.57 (0.98)	7.42 (3.77)	5.64 (2.75)	5.63 (2.02)
Grouper	0.92 (0.11)	1.21 (0.33)	1.64 (0.83)	8.66 (4.83)	8.66 (4.77)	1.25 (0.26)	2.46 (0.69)	1.16 (0.26)	0.64 (0.15)	1.38 (0.45)
Jack	0 (0)	0 (0)	2.63 (1.9)	1.61 (1.61)	1.61 (1.59)	0.78 (0.53)	0.56 (0.35)	1.17 (1.06)	0.31 (0.17)	1.05 (0.82)
Parrotfish	4.81 (2.58)	5.3 (1.01)	9.29 (3.31)	25.29 (12.53)	25.29 (12.38)	6.34 (1.25)	10.19 (1.64)	6.24 (0.94)	8.1 (1.32)	6.51 (0.79)
Snapper	0.61 (0.26)	0.73 (0.22)	3.54 (1.89)	0.2 (0.09)	0.2 (0.09)	1.53 (0.54)	2.02 (0.39)	5.44 (3.42)	2.67 (1.52)	3.39 (1.66)
Surgeonfish	18.18 (4.97)	8.18 (0.6)	9.9 (2.21)	18.98 (6.42)	18.98 (6.34)	11.83 (1.62)	9.12 (1.22)	8 (0.92)	8.8 (0.63)	12.79 (1.73)
Triggerfish	1.99 (1.05)	1.72 (0.35)	2.25 (0.28)	0.98 (0.36)	0.98 (0.35)	1.96 (0.34)	1.68 (0.29)	2.13 (0.31)	1.5 (0.18)	1.66 (0.19)
Wrasse	1.61 (0.3)	1.36 (0.21)	1.55 (0.52)	0.68 (0.2)	0.68 (0.19)	1.49 (0.18)	1.74 (0.17)	2.5 (1.24)	1.45 (0.15)	1.45 (0.14)

Table 6.–MPA-wide and depth stratum-specific estimates of mean (±SE) fish species biomass (g m^{-2}). See Table 4 legend for further detail. Species codes: ACLI - Acanthurus lineatus, ACNC - Acanthurus nigricans, CAAB - Carcharhinus amblyrhynchos, CAME - Caranx melampygus, CEAR - Cephalopholis argus, CHFN - Chlorurus frontalis, CHJA - Chlorurus japanensis, CHMC - Chlorurus microrhinos, CHSO - Chlorurus sordidus, CHUD - Cheilinus undulatus, CTSR - Ctenochaetus strigosus, LUKA - Lutjanus kasmira, NAHE - Naso hexacanthus, NALI - Naso lituratus, NAVL - Naso vlamingii, SCFO - Scarus forsteni, SCFR - Scarus frenatus, SCRU - Scarus rubroviolaceus, TROB - Triaenodon obesus.

Area	Fagamalo	Fagamalo	Fagamalo	Fagamalo	Fagamalo	Fagamalo	Northeast	Northwest	Southeast	Southwest
Depth	Shallow	Mid	Deep	Deep bank	All	All	All	All	All	All
Reef zone	Forereef	Forereef	Forereef	Bank	Bank	Forereef	Forereef	Forereef	Forereef	Forereef
Samples	4	8	3	5	5	15	31	36	39	36
ACLI	0.55 (0.38)	0.43 (0.29)	0 (0)	0 (0)	0 (0)	0.34 (0.15)	0.76 (0.36)	0.27 (0.09)	1.38 (0.31)	0.84 (0.27)
ACNC	3.05 (1.39)	2.02 (0.41)	1.14 (0.61)	3.73 (0.7)	3.73 (0.7)	2.08 (0.47)	1.83 (0.31)	1.39 (0.35)	1.48 (0.24)	3.22 (0.47)
CAAB	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3.09 (3.08)
CAME	0 (0)	0 (0)	2.63 (1.9)	1.61 (1.61)	1.61 (1.59)	0.78 (0.53)	0.44 (0.3)	0.69 (0.59)	0.27 (0.17)	0.27 (0.24)
CEAR	0.12 (0.12)	0.43 (0.26)	0.19 (0.19)	0.73 (0.26)	0.73 (0.26)	0.26 (0.11)	0.82 (0.25)	0.46 (0.13)	0.25 (0.08)	0.49 (0.13)
CHFN	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.59 (0.45)	0.07 (0.07)	0.31 (0.19)	0.02 (0.02)
CHJA	0.9 (0.5)	0.77 (0.31)	0.95 (0.61)	0.48 (0.3)	0.48 (0.3)	0.86 (0.25)	2.22 (0.64)	1.5 (0.28)	1.69 (0.43)	0.56 (0.14)
CHMC	0 (0)	0.14 (0.14)	0 (0)	4.11 (2.63)	4.11 (2.6)	0.05 (0.05)	0.28 (0.22)	0.9 (0.42)	0.63 (0.38)	0.69 (0.35)
CHSO	1.37 (0.44)	1.17 (0.35)	1.71 (0.57)	2.37 (0.95)	2.37 (0.94)	1.39 (0.24)	0.99 (0.29)	0.74 (0.19)	1.49 (0.27)	1.65 (0.32)
CHUD	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1.3 (1.3)	0 (0)	0 (0)
CTSR	10.15 (3.7)	3.45 (0.45)	3.98 (1.25)	10.73 (3.77)	10.73 (3.72)	5.71 (1.16)	3.16 (0.37)	2.96 (0.35)	3.75 (0.39)	4.57 (0.59)
LUKA	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.04 (0.03)	0 (0)	0 (0)	0 (0)
NAHE	0 (0)	0 (0)	0.69 (0.69)	0 (0)	0 (0)	0.2 (0.19)	0.3 (0.28)	0 (0)	0.12 (0.09)	2.07 (1.33)
NALI	0.32 (0.32)	0.8 (0.24)	1.13 (0.46)	2.57 (1.78)	2.57 (1.76)	0.75 (0.18)	0.46 (0.09)	0.73 (0.15)	0.29 (0.12)	0.36 (0.09)
NAVL	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.29 (0.23)	0 (0)	0 (0)	0.42 (0.42)
SCFO	2.22 (2.22)	1.09 (0.41)	0.71 (0.41)	2.49 (1.28)	2.49 (1.26)	1.33 (0.68)	0.49 (0.15)	1.07 (0.3)	0.98 (0.58)	0.35 (0.17)
SCFR	0 (0)	0.13 (0.13)	0 (0)	1.24 (0.83)	1.24 (0.82)	0.05 (0.04)	0.01 (0.01)	0.02 (0.02)	0.09 (0.09)	0.15 (0.06)
SCRU	0.12 (0.12)	0.45 (0.22)	0.78 (0.78)	9 (6.28)	9 (6.2)	0.45 (0.23)	2 (0.93)	0.36 (0.11)	0.61 (0.35)	0.56 (0.24)
TROB	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2.14 (1.57)	0 (0)

Appendix 1. List of coral species consistently identified by divers during benthic surveys in the Fagamalo Village no-take MPA (October –November 2015).

Species	Species code		Species	Species code
Acanthastrea hemprichii	AHEM		Merulina ampliata	MAMP
Acanthastrea ishigakiensis	AISH		Merulina scabricula	MSCA
Acropora abrotanoides	AABR		Montastraea curta	MCUR
Acropora aspera	AASP		Montastraea valenciennesi	MVAL
Acropora cytherea	ACYT		Montipora caliculata	MCAL
Acropora humilis	AHUM		Montipora incrassata	MINC
Acropora hyacinthus	AHYA		Pachyseris rugosa	PRUG
Acropora nobilis	ANOB		Pavona cf chiriquiensis	PCHI
Acropora paniculata	APAN		Pavona diffluens	PDIF
Acropora speciosa	ASPE		Pavona duerdeni	PDUE
Acropora verweyi	AVER		Pavona maldivensis	PMAL
Alveopora verrilliana	ALVE		Pavona varians	PVAR
Astreopora myriophthalma	AMYR		Pavona venosa	PVEN
Coeloseris mayeri	CMAY		Platygyra daedalea	PLDA
Coscinaraea columna	CCOL		Platygyra pini	PPIN
Coscinarea exesa	CEXE		Plesiastrea versipora	PLVE
Diploastrea heliopora	DHEL		Pocillopora damicornis	PDAM
Echinopora gemmacea	EGEM		Pocillopora danae	PDAN
Echinopora lamellosa	ELAM		Pocillopora eydouxi	PEYD
Favia matthaii	FMAT		Pocillopora meandrina	PMEA
Favia stelligera	FSTE		Pocillopora woodjonesi	PWOO
Galaxea astreata	GAAS		Porites cylindrica	PCYL
Galaxea fascicularis	GFAS		Porites horizontalata	PHOR
Gardinoseris planulata	GPLA		Porites lichen	PLIC
Goniastrea edwardsi	GEDW		Porites lobata	PLOB
Goniastrea pectinata	GPEC		Porites lutea	PLUT
Goniastrea retiformis	GRET		Porites monticulosa	PMON
Heliopora coerula	HCOE		Porites rus	PRUS
Hydnophora exesa	HEXE		Porites solida	PSOL
Hydnophora microconnos	HMIC		Psammocora haimeana	PHAI
Hydnophora rigida	HRIG		Psammocora nierstraszi	PNIE
Leptastrea bewickensis	LBEW		Psammocora stellata	PSTE
Leptastrea pruinosa	LPRU		Scapophyllia cylindrica	SCYL
Leptastrea purpurea	LPUR		Stylophora pistillata	SPIS
Leptastrea transversa	LTRA		Turbinaria mesenterina	TMES
Leptoria phyrgia	LPHY		Turbinaria peltata	TPEL
Leptoseris incrustans	LINC		Turbinaria reniformis	TREN
Leptoseris myceteroides	LMYC		Turbinaria stellulata	TSTE

Appendix 2 Fish species observed during the 2016 surveys ranked by abundance

SPECIES	COUNT	TAXONNAME	FAMILY	COMMONFAMILY	TROPHIC GROUP
CHIO	304	Chromis iomelas	Pomacentridae	Damselfish	PRIMARY
CTSR	173	Ctenochaetus striatus	Acanthuridae	Surgeonfish	PRIMARY
CHMA	102	Chromis margaritifer	Pomacentridae	Damselfish	PLANKTIVORE
POVA	80	Pomacentrus vaiuli	Pomacentridae	Damselfish	PLANKTIVORE
CHAC	78	Chromis acares	Pomacentridae	Damselfish	PLANKTIVORE
PLDI	75	Plectroglyphidodon dickii	Pomacentridae	Damselfish	SECONDARY
CHXA	72	Chromis xanthura	Pomacentridae	Damselfish	PLANKTIVORE
PONR	67	Pomacentrus nigriradiatus	Pomacentridae	Damselfish	PLANKTIVORE
DARE	66	Dascyllus reticulatus	Pomacentridae	Damselfish	PLANKTIVORE
ACNF	59	Acanthurus nigrofuscus	Acanthuridae	Surgeonfish	PRIMARY
ACNC	55	Acanthurus nigricans	Acanthuridae	Surgeonfish	PRIMARY
GNAU	49	Gnathodentex aureolineatus	Lethrinidae	Emperor	SECONDARY
MUVA	46	Mulloidichthys vanicolensis	Mullidae	Goatfish	SECONDARY
ACTR	45	Acanthurus triostegus	Acanthuridae	Surgeonfish	PRIMARY
CEBI	37	Centropyge bispinosa	Pomacanthidae	Angelfish	PRIMARY
THQU	28	Thalassoma quinquevittatum	Labridae	Wrasse	SECONDARY
STFA	27	Stegastes fasciolatus	Pomacentridae	Damselfish	PRIMARY
PLJO	26	Plectroglyphidodon johnstonianus	Pomacentridae	Damselfish	SECONDARY
CIVR	25	Cirripectes variolosus	Blenniidae	Blenny	PRIMARY
CHBR	24	Chrysiptera brownriggii	Pomacentridae	Damselfish	PRIMARY
CEFL	23	Centropyge flavissima	Pomacanthidae	Angelfish	PRIMARY
CHTA	22	Chrysiptera taupou	Pomacentridae	Damselfish	PRIMARY
MYKU	21	Myripristis kuntee	Holocentridae	Soldierfish	PLANKTIVORE
NALI	21	Naso lituratus	Acanthuridae	Surgeonfish	PRIMARY
CHTE	18	Chromis ternatensis	Pomacentridae	Damselfish	PLANKTIVORE
CHPW	17	Chaetodon pelewensis	Chaetodontidae	Butterflyfish	SECONDARY
SCPS	16	Scarus psittacus	Scaridae	Parrotfish	PRIMARY
BAUN	14	Balistapus undulatus	Balistidae	Triggerfish	SECONDARY
PLLA	14	Plectroglyphidodon lacrymatus	Pomacentridae	Damselfish	PLANKTIVORE
PAMU	13	Parupeneus multifasciatus	Mullidae	Goatfish	SECONDARY
BLEN	12	Blenniidae	Blenniidae	Blenny	PLANKTIVORE
CEUR	12	Cephalopholis urodeta	Serranidae	Grouper	PISCIVORE
CTCY	12	Ctenochaetus cyanocheilus	Acanthuridae	Surgeonfish	PRIMARY
HAHO	12	Halichoeres hortulanus	Labridae	Wrasse	SECONDARY
APFU	11	Aphareus furca	Lutjanidae	Snapper	PISCIVORE
CHRE	11	Chaetodon reticulatus	Chaetodontidae	Butterflyfish	SECONDARY
CHSO	11	Chlorurus sordidus	Scaridae	Parrotfish	PRIMARY
CATE	10	Caesio teres	Caesionidae	Fusilier	PLANKTIVORE
PAAR	10	Paracirrhites arcatus	Cirrhitidae	Hawkfish	SECONDARY
CACE	9	Caesio caerulaurea	Caesionidae	Fusilier	PLANKTIVORE

CEAR	9	Cephalopholis argus	Serranidae	Grouper	PISCIVORE
MEVI	9	Melichthys vidua	Balistidae	Triggerfish	PRIMARY
CHTR	8	Chaetodon trifascialis	Chaetodontidae	Butterflyfish	SECONDARY
GOVA	8	Gomphosus varius	Labridae	Wrasse	SECONDARY
CHJA	7	Chlorurus japanensis	Scaridae	Parrotfish	PRIMARY
ZESC	7	Zebrasoma scopas	Acanthuridae	Surgeonfish	PRIMARY
HAOR	6	Halichoeres ornatissimus	Labridae	Wrasse	SECONDARY
NESA	6	Neoniphon sammara	Holocentridae	Soldierfish	SECONDARY
ACLI	5	Acanthurus lineatus	Acanthuridae	Surgeonfish	PRIMARY
PACY	5	Parupeneus cyclostomus	Mullidae	Goatfish	PISCIVORE
PYDI	5	Pygoplites diacanthus	Pomacanthidae	Angelfish	SECONDARY
APVI	4	Aprion virescens	Lutjanidae	Snapper	PISCIVORE
CHLU	4	Chaetodon lunula	Chaetodontidae	Butterflyfish	SECONDARY
LADI	4	Labroides dimidiatus	Labridae	Wrasse	SECONDARY
LIZA	4	Synodontidae	Synodontidae	Lizardfishes	PISCIVORE
OXDI	4	Oxycheilinus digramma	Labridae	Wrasse	PISCIVORE
PSEV	4	Pseudocheilinus evanidus	Labridae	Wrasse	SECONDARY
BOAX	3	Bodianus axillaris	Labridae	Wrasse	SECONDARY
CADU	3	Cantherhines dumerilii	Monacanthidae	Filefish	SECONDARY
CASO	3	Canthigaster solandri	Tetraodontidae	Pufferfish	PRIMARY
FOFL	3	Forcipiger flavissimus	Chaetodontidae	Butterflyfish	SECONDARY
LARU	3	Labroides rubrolabiatus	Labridae	Wrasse	SECONDARY
PAFO	3	Paracirrhites forsteri	Cirrhitidae	Hawkfish	PISCIVORE
PSOC	3	Pseudocheilinus octotaenia	Labridae	Wrasse	SECONDARY
PTEV	3	Ptereleotris evides	Ptereleotridae	Dartfish	PLANKTIVORE
SCOV	3	Scarus oviceps	Scaridae	Parrotfish	PRIMARY
SCRU	3	Scarus rubroviolaceus	Scaridae	Parrotfish	PRIMARY
SUBU	3	Sufflamen bursa	Balistidae	Triggerfish	SECONDARY
THHA	3	Thalassoma hardwicke	Labridae	Wrasse	PLANKTIVORE
ACAC	2	Acanthurus achilles	Acanthuridae	Surgeonfish	PRIMARY
CAME	2	Caranx melampygus	Carangidae	Jack	PISCIVORE
CHCI	2	Chaetodon citrinellus	Chaetodontidae	Butterflyfish	SECONDARY
CHLT	2	Chaetodon lunulatus	Chaetodontidae	Butterflyfish	SECONDARY
CHMC	2	Chlorurus microrhinos	Scaridae	Parrotfish	PRIMARY
CHTL	2	Cheilinus trilobatus	Labridae	Wrasse	SECONDARY
CHUL	2	Chaetodon ulietensis	Chaetodontidae	Butterflyfish	SECONDARY
HABI	2	Halichoeres biocellatus	Labridae	Wrasse	SECONDARY
HEFA	2	Hemigymnus fasciatus	Labridae	Wrasse	SECONDARY
LAXA	2	Labropsis xanthonota	Labridae	Wrasse	SECONDARY
LUFU	2	Lutjanus fulvus	Lutjanidae	Snapper	SECONDARY
MAME	2	Macropharyngodon meleagris	Labridae	Wrasse	SECONDARY
MANI	2	Macolor niger	Lutjanidae	Snapper	PLANKTIVORE
MOGR	2	Monotaxis grandoculis	Lethrinidae	Emperor	SECONDARY

PEOU	2	Pempheris oualensis	Pempheridae	Sweeper	PLANKTIVORE
PIPO	2	Pictichromis porphyreus	Pseudochromidae	Dottyback	SECONDARY
PSPA	2	Pseudanthias pascalus	Serranidae	Anthias	PLANKTIVORE
SCFR	2	Scarus frenatus	Scaridae	Parrotfish	PRIMARY
ZACO	2	Zanclus cornutus	Zanclidae	Moorish idol	SECONDARY
ACNI	1	Acanthurus nigricauda	Acanthuridae	Surgeonfish	PRIMARY
ACPY	1	Acanthurus pyroferus	Acanthuridae	Surgeonfish	PRIMARY
AMCH	1	Amphiprion chrysopterus	Pomacentridae	Damselfish	PLANKTIVORE
AMSC	1	Amanses scopas	Monacanthidae	Filefish	SECONDARY
ANLE	1	Anyperodon leucogrammicus	Serranidae	Grouper	PISCIVORE
ANTW	1	Anampses twistii	Labridae	Wrasse	SECONDARY
CAPA	1	Cantherhines pardalis	Monacanthidae	Filefish	PRIMARY
CELE	1	Cephalopholis leopardus	Serranidae	Grouper	PISCIVORE
CEOC	1	Cetoscarus ocellatus	Scaridae	Parrotfish	PRIMARY
CHEP	1	Chaetodon ephippium	Chaetodontidae	Butterflyfish	SECONDARY
CHMD	1	Cheilodipterus macrodon	Apogonidae	Cardinalfish	PISCIVORE
CHOX	1	Cheilinus oxycephalus	Labridae	Wrasse	SECONDARY
CHSE	1	Chaetodon semeion	Chaetodontidae	Butterflyfish	PRIMARY
HAMA	1	Halichoeres marginatus	Labridae	Wrasse	SECONDARY
HAPR	1	Halichoeres prosopeion	Labridae	Wrasse	SECONDARY
LABI	1	Labroides bicolor	Labridae	Wrasse	SECONDARY
LAUN	1	Labrichthys unilineatus	Labridae	Wrasse	SECONDARY
MEAT	1	Meiacanthus atrodorsalis	Blenniidae	Blenny	PLANKTIVORE
MYSP	1	Myripristinae	Holocentridae	Soldierfish	PLANKTIVORE
OXUN	1	Oxycheilinus unifasciatus	Labridae	Wrasse	PISCIVORE
PAHE	1	Paracirrhites hemistictus	Cirrhitidae	Hawkfish	PISCIVORE
PAPL	1	Parupeneus pleurostigma	Mullidae	Goatfish	SECONDARY
PLLV	1	Plectropomus laevis	Serranidae	Grouper	PISCIVORE
PSHE	1	Pseudocheilinus hexataenia	Labridae	Wrasse	SECONDARY
SASP	1	Sargocentron spiniferum	Holocentridae	Soldierfish	SECONDARY
SCFO	1	Scarus forsteni	Scaridae	Parrotfish	PRIMARY
SCGL	1	Scarus globiceps	Scaridae	Parrotfish	PRIMARY
SCSC	1	Scarus schlegeli	Scaridae	Parrotfish	PRIMARY
STBN	1	Stethojulis bandanensis	Labridae	Wrasse	PLANKTIVORE
VALO	1	Variola louti	Serranidae	Grouper	PISCIVORE