Coral Reef Fish Biomass and Benthic Cover Along the North Coast of Timor-Leste Based on Underwater Visual Surveys in June 2013

Kaylyn McCoy, Paula Ayotte, Andrew Gray, Kevin Lino,
Brett Schumacher, and Max Sudnovsky

Joint Institute for Marine and Atmospheric Research
University of Hawaii
1000 Pope Road
Honolulu, Hawaii 96822

and

Pacific Islands Fisheries Science Center
NOAA Inouye Regional Center
1845 Wasp Boulevard
Building 176
Honolulu, Hawaii 96818

PIFSC Data Report DR-15-004
Issued 20 March 2015

TABLE OF CONTENTS

Summary 1
Background 1
Methods 2
Results and Discussion 6
Acknowledgements 17
References 18
Appendix A A-1
Appendix B B-1

SUMMARY

Coral reef fish and benthos were surveyed at 150 shallow-water coral reef sites across the north coast of Timor-Leste in June 2013 during a 21-day survey mission. This project was conducted by the National Oceanic and Atmospheric Administration (NOAA), Pacific Islands Fisheries Science Center's Coral Reef Ecosystem Division (CRED) using consistent methods, survey design, and personnel.

The goal of the survey work was to generate baseline data on the nearshore coral reef fish assemblages and associated benthic communities around Timor-Leste's north coast. Surveys were concentrated around the north coast due to (1) limited time and resources, but also (2) low water visibility and safety concerns for potential dive survey operations along the south shore.

Fish biomass and benthic cover were estimated at all survey sites. All site-level data are shown in Appendix A.

Key findings:

- Average hard coral cover was highest around Atauro Island (~ 20%), Oecuesse (17%), and Lautem (16%); lowest at Baucau (9%) and Liquisa (10%).
- Average total reef fish biomass for Timor-Leste was 41.1 g/m^2 (SE 3.1), which is slightly higher than other populated areas in the Pacific (30.6 g/m^2 (SE 2.1)) but more comparable to populated areas than remote (119.2 g/m^2 (SE 11.0)).
- The west side of Atauro Island had the highest average biomass (75.9 g/m^2 (SE 12.9)); Dili/Manatuto (23.4 g/m^2 (SE 2.0)) and Bobonaro (23.0 g/m^2 (SE 3.1)) had the lowest.
- Planktivores made up the majority of the overall fish biomass (50.3%), followed by primary consumers (22.3%), secondary consumers (18.8%), and lastly piscivores (8.6%).
- The surgeonfish family had the highest overall fish biomass (8.2 g/m^2 (SE 1.1)) and made up 19.8% of the total fish biomass. Overall, the average biomass of snappers, breams, groupers, parrotfishes, and emperors was comparable to other populated areas in the Pacific, although average fish biomass in West Atauro was comparable to other remote areas in the Pacific for these families.
- Species richness was high, with an average of 57 species per survey site.

BACKGROUND

The Coral Reef Ecosystem Division (CRED)–with funding from NOAA's Coral Reef Conservation Program (CRCP), the U.S. Agency for International Development (USAID), Regional Development Mission Asia (RDMA) and Timor-Leste in their effort to support the Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (CTI-CFF) in partnership with the Coral Triangle Support Partnership (CTSP)–has been providing technical assistance to Timor-Leste's Ministry of Agriculture and Fisheries and other marine practitioners. Through this multi-year partnership, CRED has introduced several scientific research tools and provided the

technical assistance to understand how these tools can be used to support coastal sustainability through an ecosystem approach to fisheries management (EAFM).

The main activities included:

- satellite-based mapping of coral reefs and near-shore ecosystems,
- assessing and providing tools to adapt to the cascading impacts of climate change and ocean acidification on near-shore ecosystems,
- building management capacity to develop and implement an EAFM plan,
- providing guidance and assistance in developing a spatial geographic information system (GIS) data framework to house and incorporate existing marine and terrestrial spatial data information layers to support coastal and fisheries management decision making, and
- assessing coral reef ecosystem and building local capacity to monitor ecosystem health.

The surveys described in this report fall under the last goal of assessing the coral reef ecosystem by providing baseline data to monitor ecosystem health.

METHODS

Survey Design

In total, 150 sites were surveyed around Timor-Leste's north shore, between June 4 and 27, 2013. The surveys were based on a common stratified random survey design, with site locations selected randomly using ArcGIS software. As a result of the large area of coastline and time and personnel constraints, survey efforts were focused on 8 sections of coastline within 7 districts, hereafter referred to as sectors. The 8 sectors were: Oecuesse, Bobonaro, Liquisa, West Atauro, East Atauro, Dili/Manatuto, Baucau, and Lautem. Each sector was treated as an independent survey area, and was separated by at least 18 km of coastline from adjacent sectors (with the exception of East and West Atauro, which are separated by 2 km). The target survey area was hard-bottom reef habitat in either a shallow (0–6 m) or mid-depth (6–18 m) range. For most CRED reef fish assessments, survey allocation is determined by area of hard-bottom reef habitat within 3 depth ranges; shallow, mid, and deep (18–30 m). The deep area of reef habitat was not surveyed as a result of safety restrictions set by the NOAA dive program. Hard-bottom reef habitat maps were not available at the time of the mission planning, so sites were randomly selected within a rough 30-m depth contour. Once the divers arrived at the randomly located survey site, they assessed the benthos to determine whether habitat and visibility were suitable and moved to the target depth range. If visibility was poor (< 7.5 m) or the substrate was soft, divers would search for a suitable site for ~ 5 minutes, and if one was not found, the divers ended the dive and moved on to the next site.

Survey Methodology

Fish Surveys

All sites were surveyed using CRED's standard coral reef fish assemblage survey method, stationary point counts (SPC). The SPC protocol closely follows that used by Ault and colleagues (Ault et al., 2006) and involves a pair of divers conducting simultaneous counts in adjacent, visually estimated 15-m-diameter cylindrical plots extending from the substrate to the limits of vertical visibility (Fig. 1). Prior to beginning each SPC pair, a 30-m line was laid across the substratum. Markings at 7.5 m, 15 m, and 22.5 m enabled survey divers to locate the midpoint (7.5 m or 22.5 m) and two edges (0 m and 15 m; or 15 m and 30 m) of their survey plots. Each count consisted of two components. The first of these was a 5-min species enumeration period in which the diver recorded the taxa of all species observed within their cylinder. At the end of the 5-min period, divers began the tallying portion of the count, in which they systematically worked through their species listing for each species and recorded the number of fish and size (total length, TL, to nearest cm) of each individual fish. The tallying portion was conducted as a series of rapid visual sweeps of the plot, with one species-grouping counted per sweep. To the extent possible, divers remained at the center of their cylinders throughout the count. However, small and cryptic species, which will tend to be underrepresented in counts made by an observer remaining in the center of a 7.5-m radius cylinder, were left to the end of the tally period, at which time the observer swam through their plot area carefully searching for those species. In cases where a species was observed during the enumeration period but was not present in the cylinder during the tallying period, divers recorded their best estimates of size and number observed in the first encounter during the enumeration period and marked the data record as 'non-instantaneous.' Surveys were not conducted if horizontal visibility was < 7.5 m, i.e., when observers could not distinguish the edges of their cylinder. For more detailed information, see Ayotte et al. (2011).

Benthic Photography

Upon completion of the fish survey, one diver photographed benthos at 1-m intervals along the transect line (30 photographs per site). A 1-m PVC stick was used to position a digital camera (Canon PowerShot SD1200 IS, 10.0 megapixel) directly above the substrate to frame an ~ 0.7-m^2 area photograph.

Analysis

Analysis of Benthic Cover

Coral Point Count with Extensions (CPCe, version 4.1; Kohler & Gill, 2006) was used to analyze benthic cover in each image by identifying the substrate type underneath a set of randomly assigned points.

Prior to this study, a pilot analysis was used to establish the optimum density of points identified per photograph, to meet the monitoring program objective of generating island-wide estimates of benthic cover. It was determined that 10 points per photograph was sufficient for image analysis effort (there was little difference in the coefficient of variation between 10, 15, 20, and 30 points per photograph).

Percent cover estimates were calculated for each site from the photo-quadrats by averaging the number of points that were identified for each functional group as follows: blue-green algae, hard coral, crustose coralline algae, encrusting algae, macroalgae, mobile fauna, sediment (sand), sessile invertebrate, soft coral, turf algae, and unclassified (the benthos is not clear and/or cannot be identified with a high level of confidence). Percent cover of each functional group was determined based on the number of identifiable points for each site (points that were on shadows were removed from the total number of points, but unclassified points were used). Site estimates were averaged for each sector.

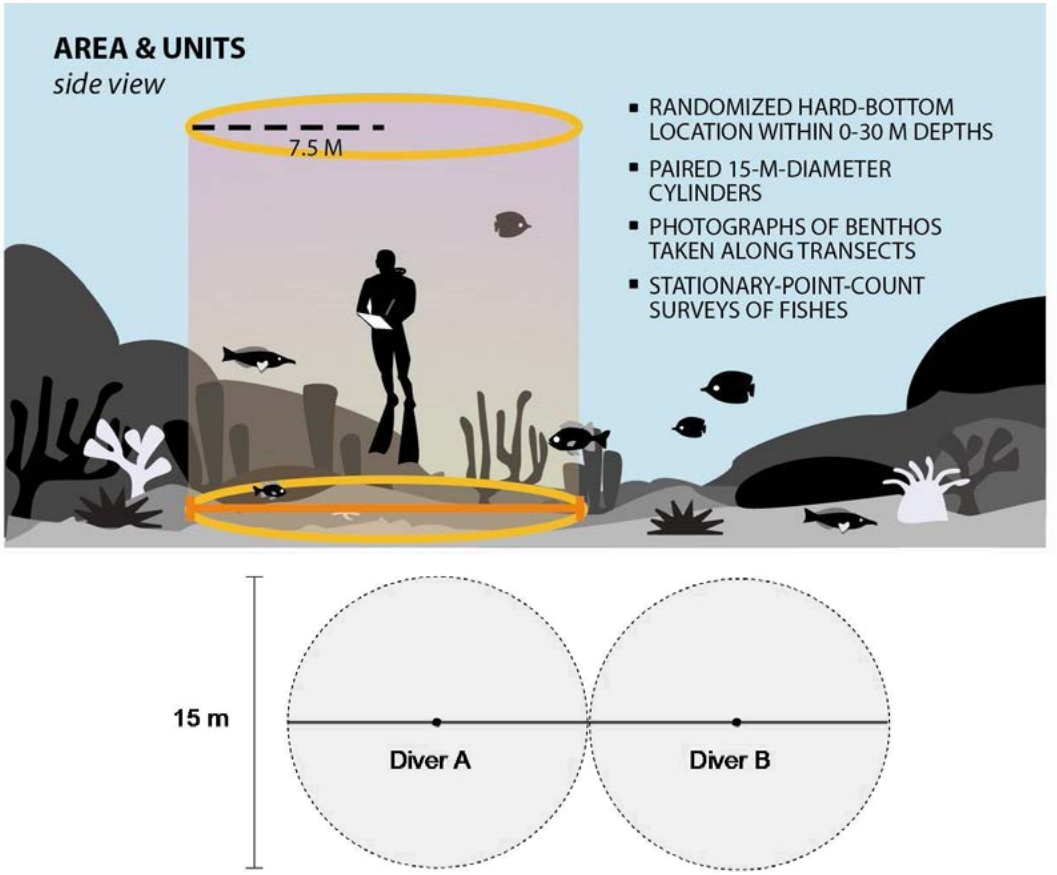

Figure 1.--Schematic of survey method.

Estimation of Biomass by Fish Groupings

Fish biomass was calculated using the following allometric equation to estimate weight from length measurements:

$$w = a \times L^b$$

The parameter a is a scaling coefficient for the weight at length of the fish species, and the parameter b is a shape parameter for the body form of the fish species. Biomass was calculated for each species at each site by averaging the two divers' estimates. Data were summarized using the R statistical program version 2.13.1.1

In estimating fish biomass, species data were pooled into "all fishes," and into a number of trophic, taxonomic, and size groupings. The four trophic groupings used were: "primary consumers" (herbivores and detritivores); "secondary consumers" (omnivores and benthic invertivores); "planktivores"; and "piscivores," (see Appendix B for species classifications) based on diet information taken largely from FishBase (Froese and Pauly, 2010). We also presented family-level data on emperors, snappers, breams, parrotfish, and groupers because of their general importance as fishery targets. Biomass was also pooled into size classes: small (0–20 cm), medium (21–50 cm), and large- bodied reef fish (> 50 cm).

Results were compared to averages of reef fish biomass at populated and remote areas across the Pacific where CRED has conducted reef fish surveys at ~ 40 islands and atolls since 2009 using the same survey methods and largely the same personnel. Total biomass and each of the fish groupings from Timor-Leste were compared to Pacific-wide averages of remote and populated islands and atolls (populated sites n = 923, remote sites n= 858) (Heenan et al. 2014). In the Pacific-wide data, remote islands were defined as having less than 50 humans within 100 km, as well as Wake Atoll and Midway Island, which have slightly higher populations but which have stringent limitations on fishing. We make extensive use of mean reference values from CRED's other surveys of those 'remote' and 'populated' islands to provide context to fish biomass values from Timor-Leste. While there are important other sources of natural variability among reefs, including biogeographic differences, we believe the reference values are useful as baselines for Pacific coral reefs – for example, we expect reefs with significant human impacts including fishing to be more similar to the Pacific 'populated' average than to the 'remote' average. In 2010, the population of Timor-Leste was reported at 1,066,409, with the district breakdown as follows: Oecusse: 64,025; Bobonaro: 92,049; Liquica: 63,403; Dili: 234,026; Manatuto: 42,742; Baucau: 111,694; Lautem: 59,787 (Government of Timor-Leste, Highlights 2010). A survey conducted in 2011 recorded fishing activity in 5 of Timor-Leste's districts (Oecusse, Bobonaro, Dili, Baucau, and Cova Lima). This survey reported that of those interviewed, 92.8% defined fishing as their occupation, and generally fished every day for 6-12 hours, which indicates a fair amount of fishing pressure (Timor-Leste 2013). In 2012, 3,034 registered fishing vessels were estimated to make up 1/3 of the total fishing fleet (Tsujimura el al. 2012).

[1] R Development Core Team, http://www.r-project.org.

RESULTS AND DISCUSSION

Overview of Reef Benthos

Hard (scleractinian) coral cover ranged from 0.0 to 43.4% across sites, with an overall average of 15.7% (SE 0.9). East Atauro had the highest coral cover at 21.6% (SE 2.6), and Baucau had the lowest at 9.1% (SE 1.9) (Table 1, Fig. 2). Soft coral cover was similar and ranged from 0.0 to 57.0%, with an overall average of 15.1% (SE 1.2). The highest soft coral cover was found at Liquisa (21.9%, (SE 3.7)), and the lowest cover was at West Atauro (2.7% (SE 1.1)). Macroalgae cover was much lower than coral cover with a range of 0.0 – 28.4%, with an average of 1.4% (SE 0.3). Macroalgae cover and turf cover were similar throughout the sectors surveyed along the north coast of Timor-Leste. Encrusting algae, macroalgae, and crustose coralline algae cover were relatively low across all sectors, while turf and coral made up the majority of the benthos.

Table 1.--Mean percent cover (standard error) of reef benthos and benthic substrate ratio by sector.

Sector	# Sites	Hard coral %	Soft coral %	Macroalgae%	Sand%	Turf algae%	Encrusting algae %	CCA%	Benthic substrate ratio
Baucau	15	9.1 (1.9)	12.0 (2.9)	0.5 (0.4)	9.0 (3.5)	45.0 (6.7)	1.2 (0.4)	2.5 (0.7)	0.6
Bobonaro	16	14.1 (2.8)	17.8 (3.9)	0.9 (0.6)	5.2 (1.9)	54.8 (4.8)	0.7 (0.3)	2.4 (0.7)	0.8
Dili/Manatuto	29	14.2 (1.8)	16.0 (1.7)	0.4 (0.1)	10.5 (2.1)	40.5 (3.9)	1.5 (0.5)	3.5 (0.6)	1.0
East Atauro	12	21.6 (2.6)	13.8 (2.6)	1.6 (0.7)	7.6 (3.0)	36.2 (5.2)	2.6 (0.8)	8.7 (2.7)	1.5
Lautem	25	15.5 (2.6)	4.8 (2.1)	1.8 (1.0)	5.0 (1.5)	33.7 (5.5)	4.4 (1.4)	5.4 (1.3)	0.6
Liquisa	27	10.6 (1.7)	21.9 (3.4)	1.8 (0.6)	8.6 (1.6)	45.8 (5.0)	0.7 (0.2)	1.8 (0.7)	1.3
Oecuesse	16	17.2 (3.1)	13.8 (2.8)	1.5 (0.5)	12.2 (2.5)	48.1 (4.8)	0.3 (0.1)	0.7 (0.3)	0.9
West Atauro	10	20.3 (2.8)	7.6 (2.4)	2.7 (1.1)	0.5 (0.4)	46.2 (5.5)	3.6 (0.8)	7.0 (1.3)	0.8

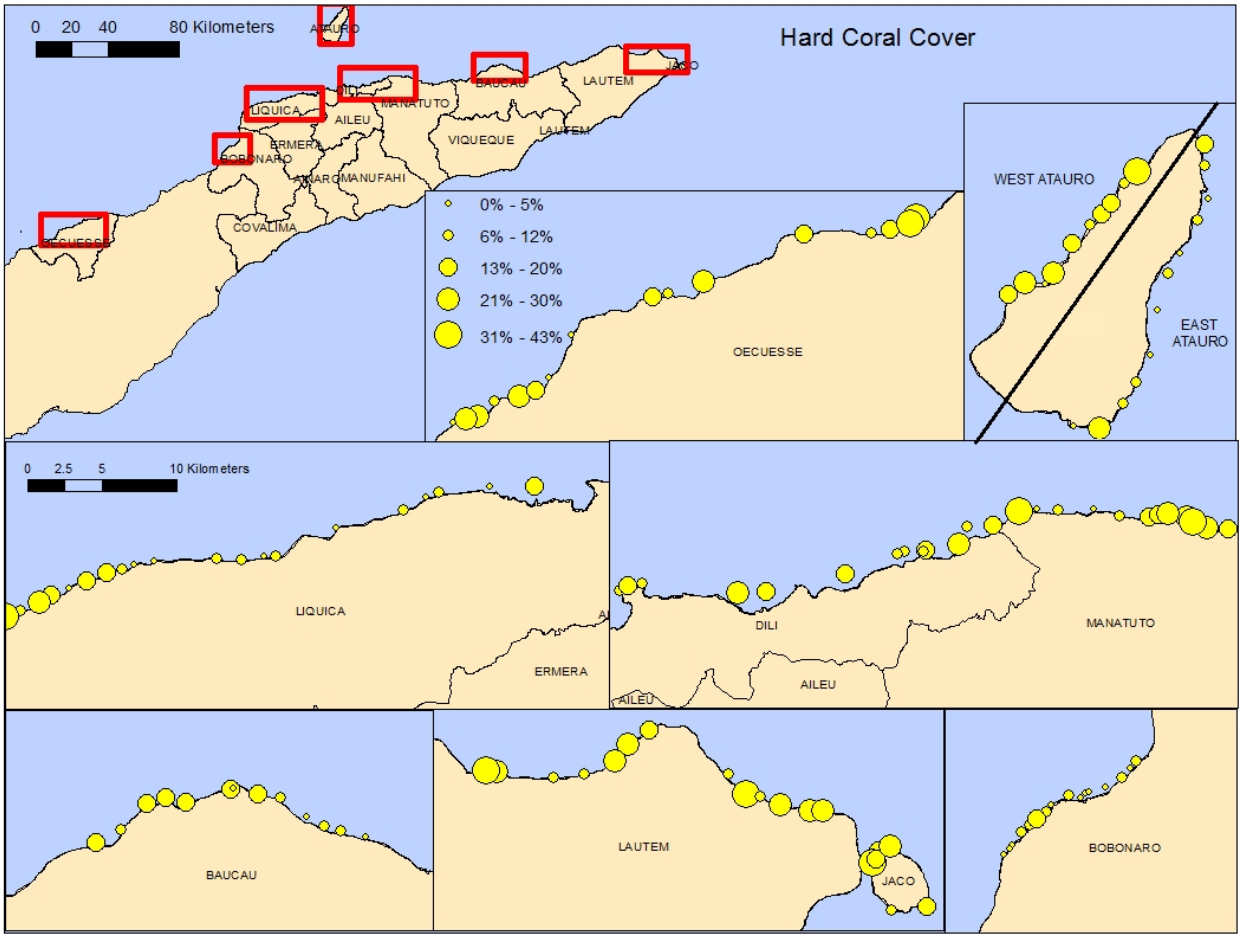

Figure 2.--Hard coral cover (%) per site, from photo-quadrat image analysis. Red boxes indicate the extent of the inset sectors.

Benthic substrate ratio is used as a metric of reef condition (Houk et al., 2010). The ratio is the sum of coral (hard and soft) and crustose coralline algae divided by the sum of turf and macroalgae; higher ratios indicate reefs with substrate dominated by coral and accreting, or reef building organisms, whereas low ratios indicate sites where benthos is dominated by organisms that do not contribute to reef structural growth. East Atauro and Oecuesse had substrate ratios higher than one, Dili/Manatuto had a ratio equal to one, and the remaining sectors had ratios less than one (Fig. 3).

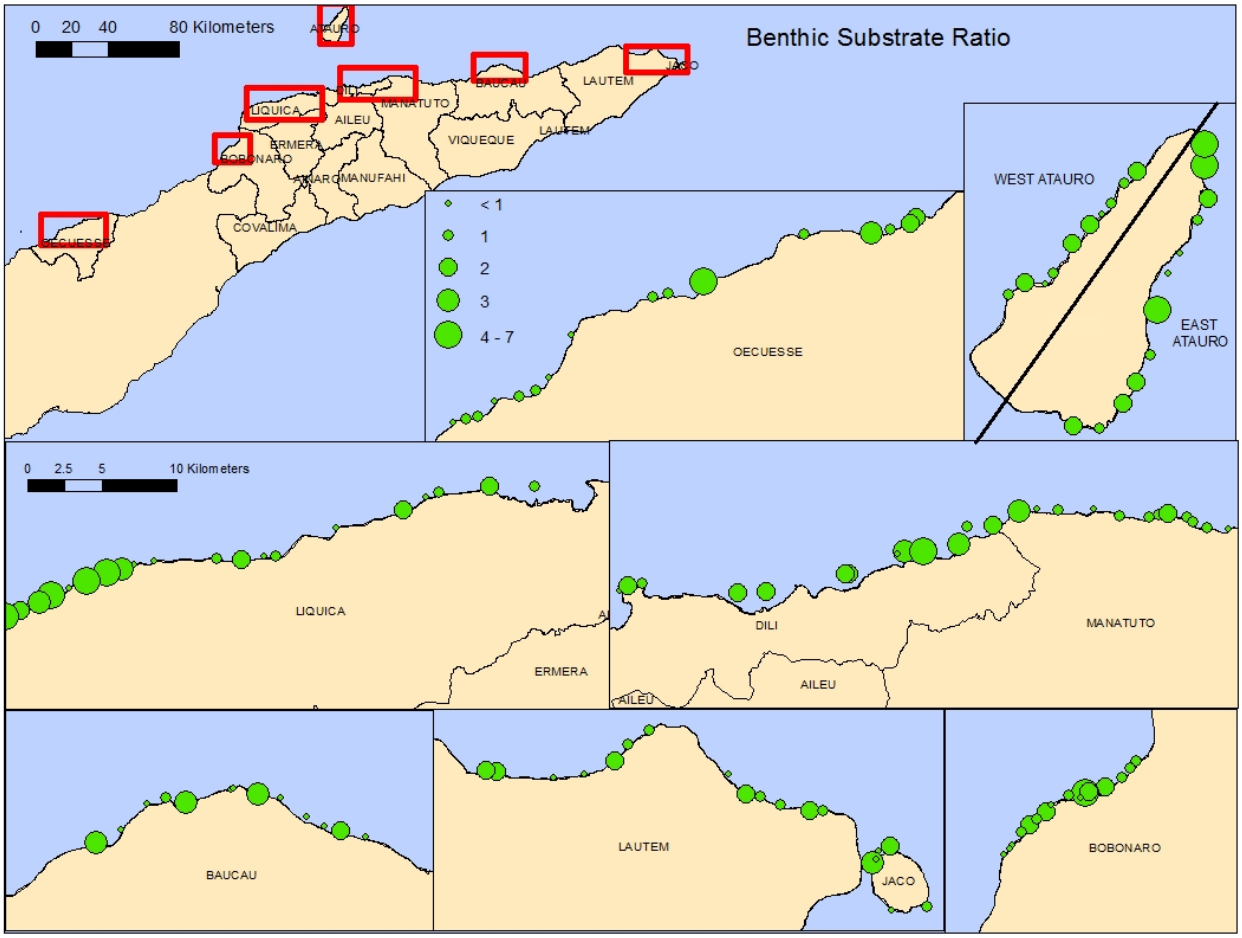

Figure 3.--Benthic substrate ratio per site.

Reef Fish Assemblages

Total Reef Fish Biomass

Total reef fish biomass at the 150 sites varied between 1.1 g/m^2 and 283.9 g/m^2. Total fish biomass was right-skewed—there were many sites with relatively low-to-moderate biomass and few at the high biomass end of the scale. The median value (the level at which half of sites had lower biomass and half of sites had higher biomass) was 31.5 g/m^2 (Fig. 4).

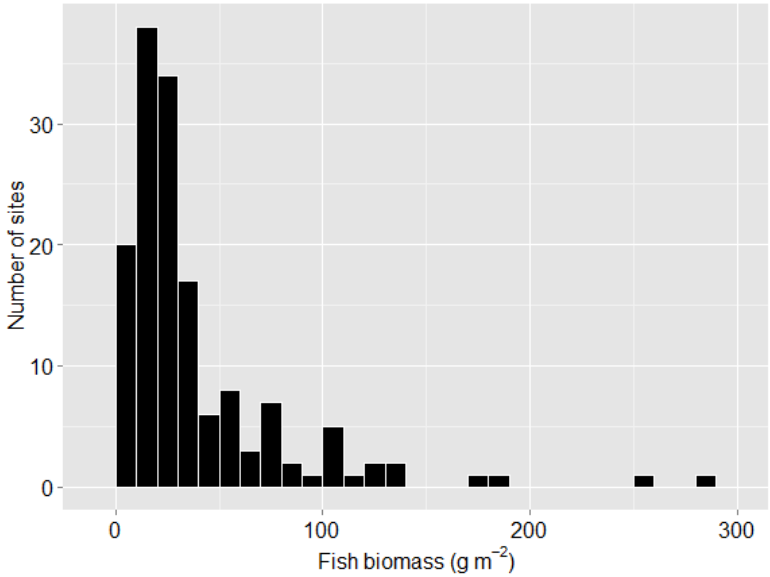

Figure 4.--Distribution of total reef fish biomass per site. Median site biomass was 31.5 g/m^2.

Reef fish biomass was relatively high (compared to overall Timor-Leste values) in 3 sectors: West Atauro (75.9 g/m^2 (SE 12.90)), Baucau (66.3 g/m^2 (SE 14.3)), and Lautem (51.4 g/m^2 (SE 8.9)). Average fish biomass in West Atauro was ~ 3 times higher than biomass in 4 sectors: Oecuesse (28.7 g/m^2 (SE 5.7)), Liquisa (26.1 g/m^2 (SE 4.1)), Dili/Manatuto (23.4 g/m^2 (SE 2.0)), and Bobonaro (23.0 g/m^2 (SE 3.1)), which were the sectors with lower biomass values (Fig. 5). The high biomass in West Atauro may be related to the relatively high structural complexity of the reef on the west side of Atauro, which was dominated by a steep wall. East Atauro had an intermediate average biomass (34.3 g/m^2 (SE 10.0)).

East Atauro, Oecuesse, Liquisa, Dili/Manatuto, and Bobonaro had average biomass values comparable to other populated areas in the Pacific islands (30.6 g/m^2 (SE 2.1)). While the other sectors had biomass values that were higher than the populated average, they were not as high as other remote areas in the Pacific islands (119.2 g/m^2 (SE 11.0)).

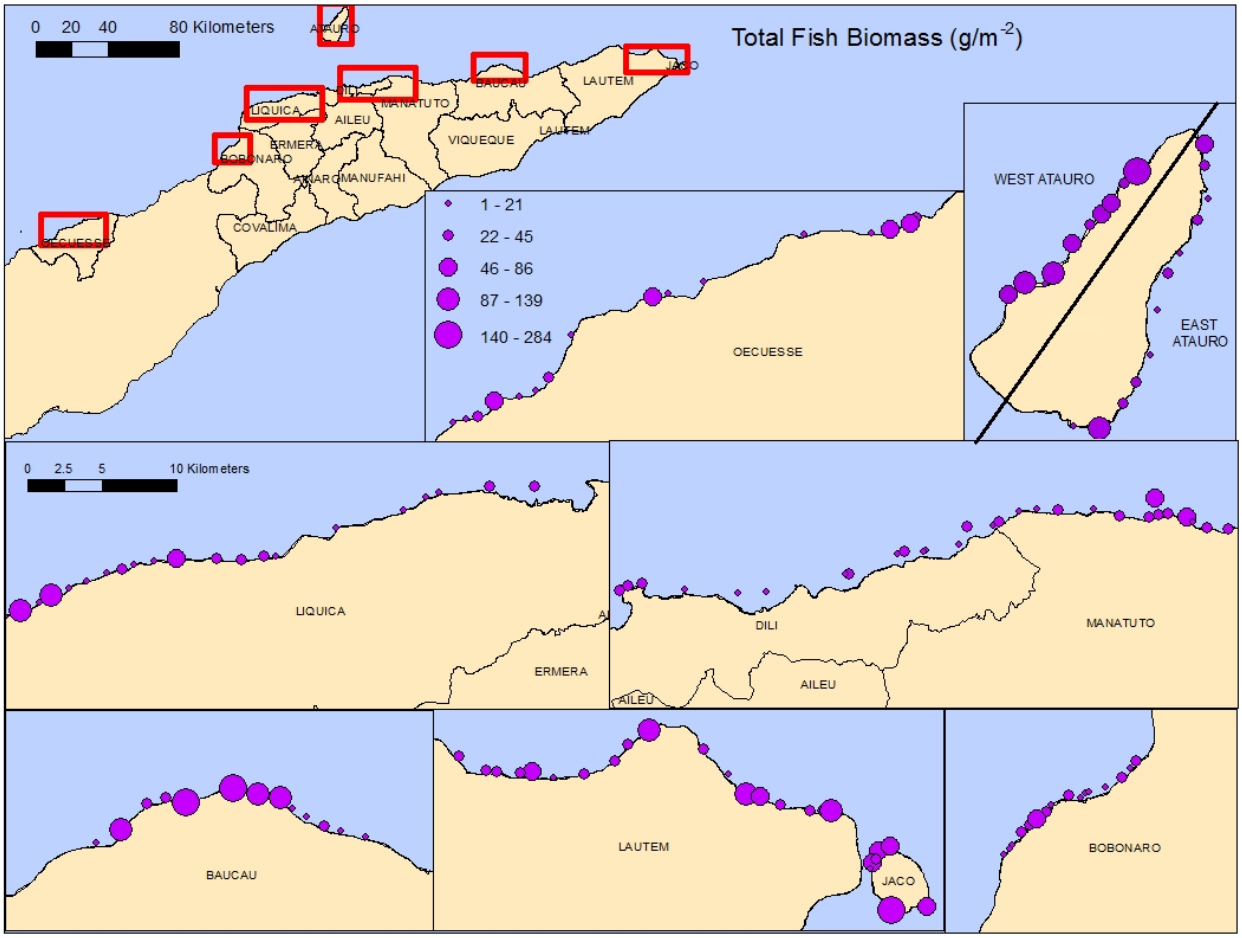

Figure 5.--Total reef fish biomass per survey site.

Fish Biomass by Consumer Group

Consumer group classifications are shown in Appendix B. In brief, 'primary consumers' are herbivores (e.g., feeds on plants) and detritivores (e.g., feeds on dead organic matter), largely comprised of surgeonfishes and parrotfishes; 'secondary consumers' are species that are largely omnivorous (e.g., feed on plants or animals) or feed on invertebrates, and includes most wrasses, butterflyfishes, triggerfishes and filefishes; 'planktivores' that feed on plankton and includes several unicorn fishes, damselfishes, fusiliers, and several soldierfishes; and 'piscivores' are fishes that feed primarily on other fish, and include most jacks, groupers, emperors, barracudas, sharks, moray eels, and lizardfishes.

Planktivores made up the majority of the overall biomass (50.3%), followed by primary consumers (22.3%), secondary consumers (18.8%), and lastly piscivores (8.6%) (Fig. 6). A large number of damselfish and fusiliers were observed during the surveys, accounting for much of the planktivore biomass. Even though planktivores were widely abundant, biomass varied substantially among sectors – from 5.6 g/m^2 (SE 1.5) in Bobonaro to 37.4 g/m^2 (SE 3.1) in Baucau. All sectors had planktivore biomass that was higher than the average of populated areas

in the Pacific islands surveyed by CRED, and 4 sectors (Baucau, East Atauro, Lautem, and West Atauro) had planktivore biomass comparable to remote areas of the Pacific islands.

Primary consumer biomass overall was comparable to populated areas in the Pacific islands, although there were notable differences among sectors. West Atauro had the highest biomass (24. 3 g/m^2 (SE 6.8)), which is closer to the biomass in other remote areas in the Pacific islands (29.2 g/m^2 (SE 1.6)). All other sectors had an average primary consumer biomass that was less than other populated areas in the Pacific islands (15.8 g/m^2 (SE 1.0)).

Secondary consumer biomass overall was comparable to populated areas of the Pacific islands, while biomass in individual sectors again ranged from less than populated areas to comparable to remote areas of the Pacific islands. Dili/Manatuto, East Atauro and Liquisa had biomass averages that were lower than populated areas, but Lautem's average biomass (12.3 g/m^2 (SE 5.4)) was comparable to remote areas in the Pacific islands (12.6 g/m^2 (SE 1.0)). Baucau, Bobonaro, Oecuesse and West Atauro's average biomass fell in between populated (6.7 g/m^2 (SE 0.4)) and remote areas in the Pacific islands.

Piscivore biomass was typically low (< 2 g/m^2) at 4 sectors, and with a maximum of 9.3 g/m^2 (SE 3.1) in Baucau. Most sectors, with the exception of Baucau and West Atauro, had piscivore biomass that was lower than the average from other populated areas surveyed by CRED (4.7 g/m^2 (SE 1.7)).

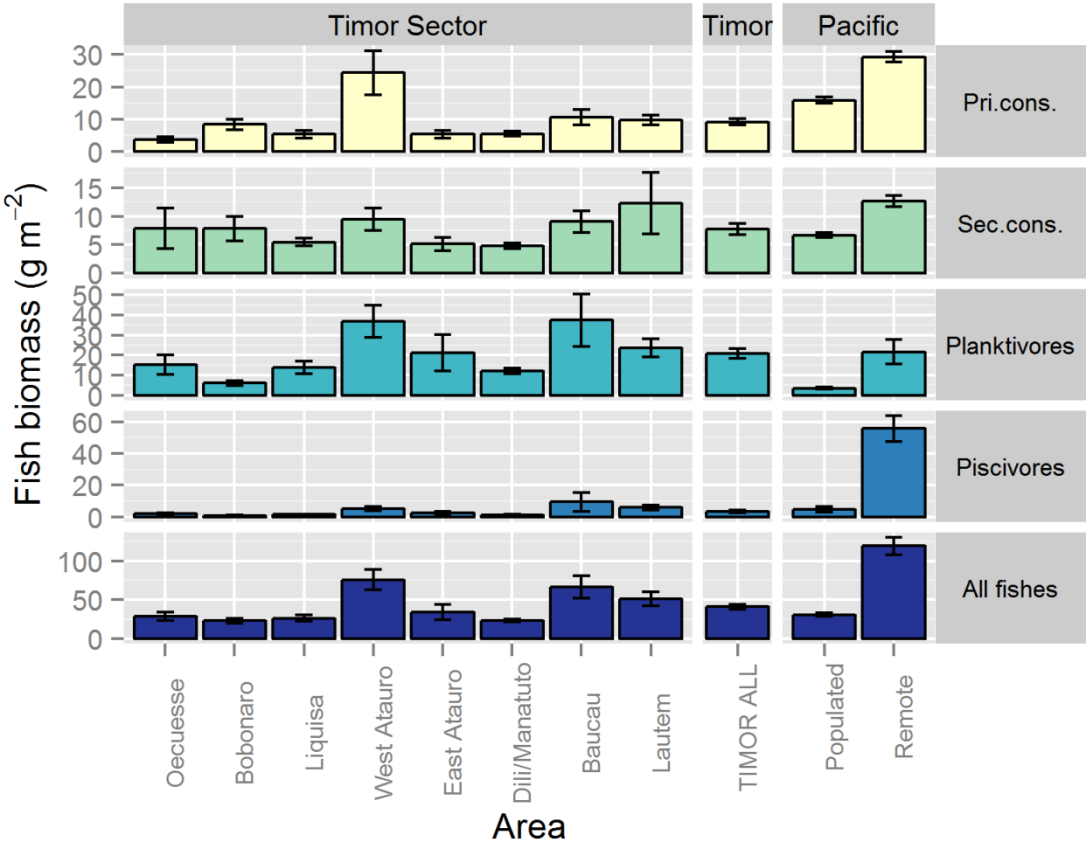

Figure 6.--Mean reef fish biomass (SE) by consumer group per sector. Sectors are ordered from west to east. Timor-wide average shown as TIMOR ALL. Populated average is pooled from 923 sites in the Pacific islands, and remote average is pooled from 858 sites in the Pacific islands. Note different scales on *y*-axes.

Fish Biomass by Family

Surgeonfish were the family with highest overall biomass (8.2 g/m^2 (SE 1.1)), and made up 19.8% of the overall biomass. Surgeonfish were followed by fusiliers (5.9 g/m^2 (SE 1.3)), and damselfish (5.6 g/m^2 (SE 0.5)), which made up 14.4% and 13.6% of the overall biomass, respectively.

Other fish families that are believed to be important mainly for fishing targets are: emperors, snappers, breams, parrotfish, and groupers (R. Pinto, Conservation International, personal communication). Emperor biomass overall was comparable to populated areas in the Pacific islands (0.4 g/m^2 (SE 0.2)), but at the sector level, the biomass at West Atauro (1.6 g/m^2 (SE 1.3)) was more comparable to remote areas of the Pacific islands (1.8 g/m^2 (SE 0.3)) (Fig. 7).

Overall, snapper biomass (3.1 g/m^2 (SE 0.5)) was comparable to populated areas in the Pacific islands (1.8 g/m^2 (SE 0.3)). Again, biomass in West Atauro (7.2 g/m^2 (SE 1.6)) was more

comparable to remote areas (9.5 g/m^2 (SE 1.6)) than populated of the Pacific islands. Baucau had higher snapper biomass than most other sectors (5.3 g/m^2 (SE 1.9)).

Breams are scarce in remote and populated areas in the Pacific islands (< 1 g/m^2). The overall biomass in Timor-Leste was also less than 1 g/m^2 but was highest in Bobonaro (0.6 g/m^2 (SE 0.2)).

Parrotfish overall biomass (2.8 g/m^2 (SE 0.7)) was lower than other populated areas in the Pacific islands (4.2 g/m^2 (SE 0.4)). However, West Atauro had an average biomass (10.2 g/m^2 (SE 5.2)) that was higher than remote areas in the Pacific islands (8.1 g/m^2 (SE 0.4)). All other sectors were lower than the average for populated areas of the Pacific islands.

As with emperors and breams, the difference between grouper biomass in remote and populated areas in the Pacific islands is small (2.6 g/m^2 vs 1.1 g/m^2). Overall, biomass fell below the populated average (0.9 g/m^2 (SE 0.1)).

As noted above, the biomass of most target families at West Atauro was comparable to the average for remote areas surveyed by CRED elsewhere in the Pacific islands, suggesting that West Atauro fish assemblages are relatively unimpacted by human activities. It is worth noting that reefs in that sector had atypical structure – specifically, much of the habitat was made up of relatively steep reef walls. Among the Timor sectors we surveyed, biomass was also relatively high at Baucau and Lautem, which had less complex/steep reef structure (Figs. 5 - 7). Other sectors had total biomass comparable to that observed at populated areas throughout the Pacific islands.

Very few sharks and jacks were seen on the surveys. Three whitetip reef sharks and one blacktip reef shark were seen off-transect in Baucau, and one grey reef shark was seen in Lautem. Jack biomass was less than 1 g/m^2 in every sector, and no jacks were seen in Bobonaro or East Atauro.

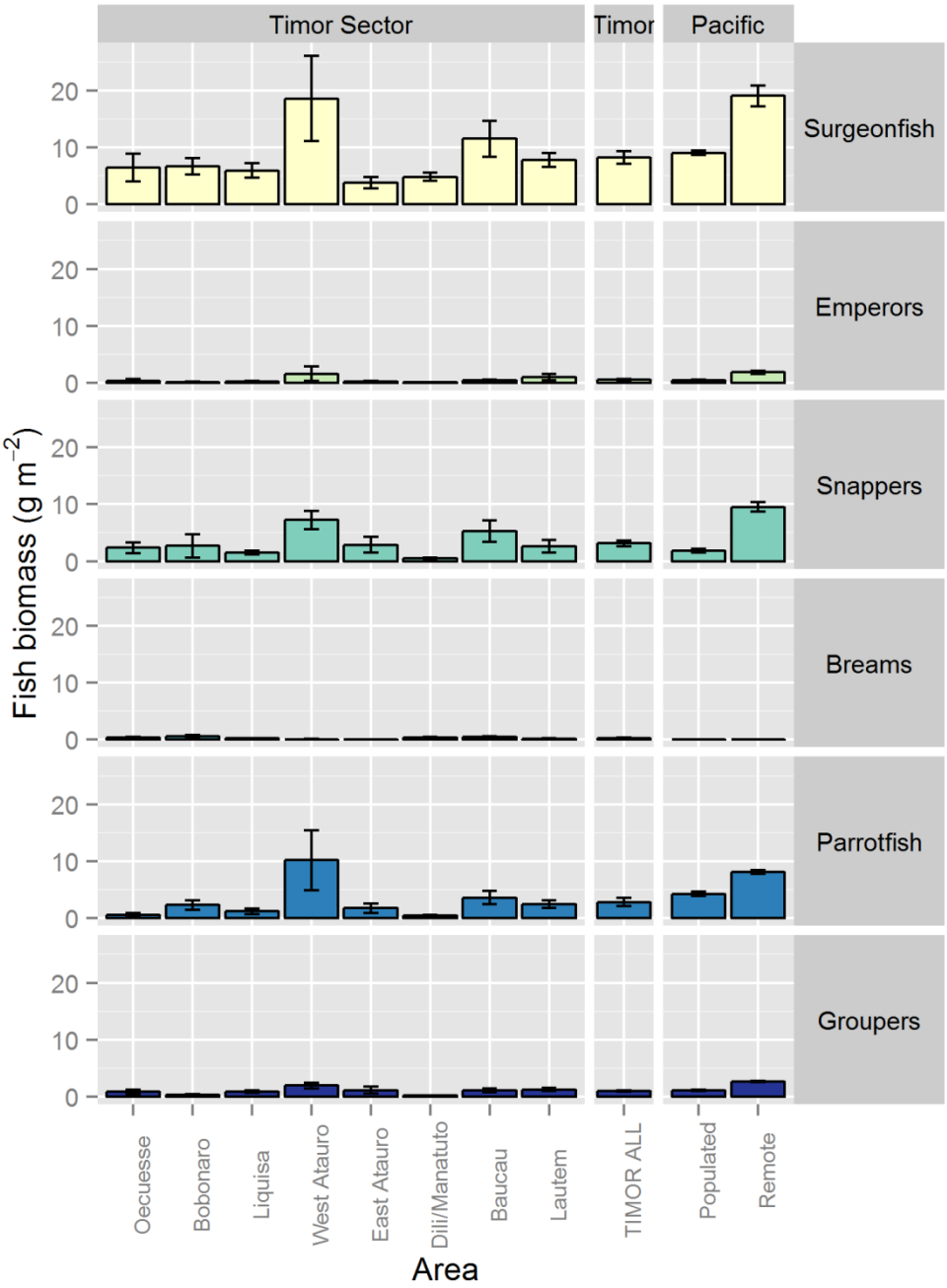

Figure 7.--Mean reef fish biomass (standard error) by family per sector. Sectors are ordered from west to east. Timor-wide average shown as TIMOR ALL. Populated average is pooled from 923 sites in the Pacific, and remote average is pooled from 858 sites.

Fish Biomass by Size Class

Fish biomass was pooled into 3 classes: small (0–20 cm), medium (21–50 cm), and large-bodied reef fish (> 50 cm). Small-bodied reef fish made up the majority of the biomass overall, and in each sector (Fig. 8). Overall, small-bodied reef fish biomass in Timor-Leste was comparable to what CRED surveys have observed at remote, unpopulated areas in the Pacific islands. This is likely a reflection of the high abundance of damselfishes, small surgeonfishes, triggerfishes, wrasses, and butterflyfishes at Timor-Leste sites. Biomass of medium and large-bodied reef fishes was generally comparable to values from other human-populated areas in the Pacific islands surveyed by CRED.

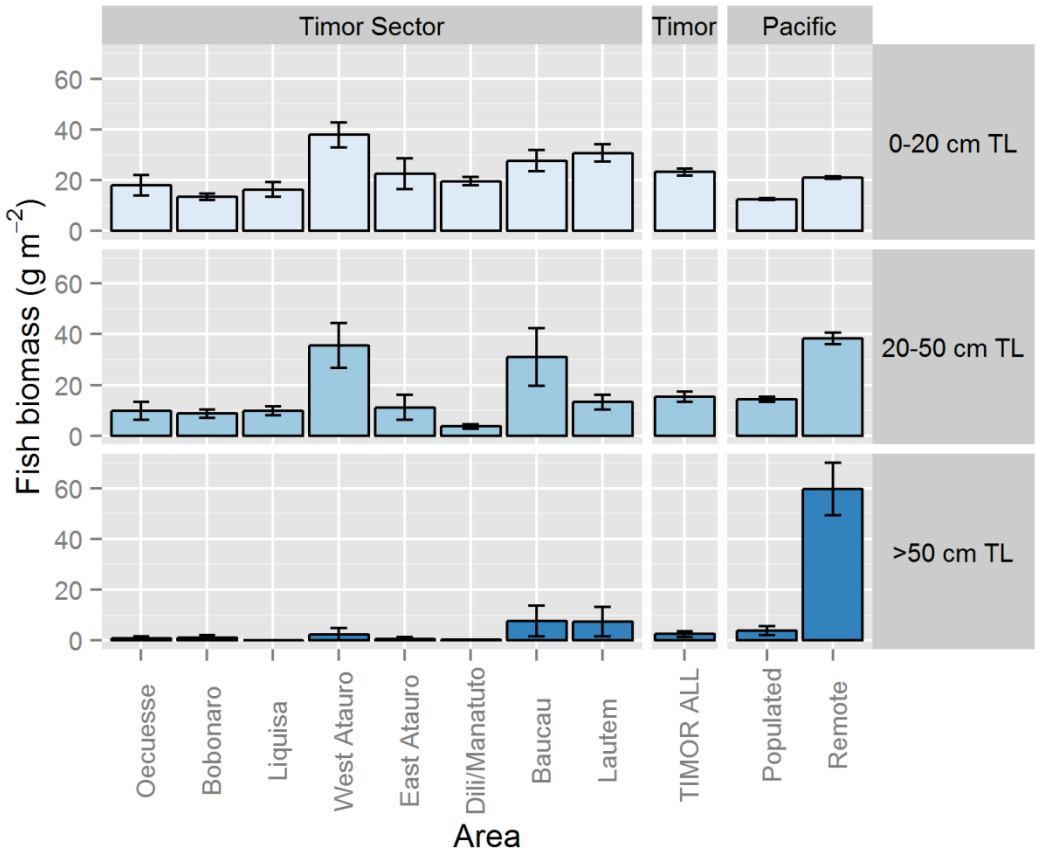

Figure 8.--Mean reef fish biomass (standard error) by size per sector. Sectors are ordered from west to east. Timor-wide average shown as TIMOR ALL. Populated average is pooled from 923 sites in the Pacific islands, and remote average is pooled from 858 sites in the Pacific islands.

Species Richness

Timor-Leste sites had extremely high species richness in comparison to other Pacific islands locations surveyed by CRED. The average species richness for all sectors, 57 species per site, was higher than any other region that CRED surveys (typically around 25 to 40, Fig. 9).

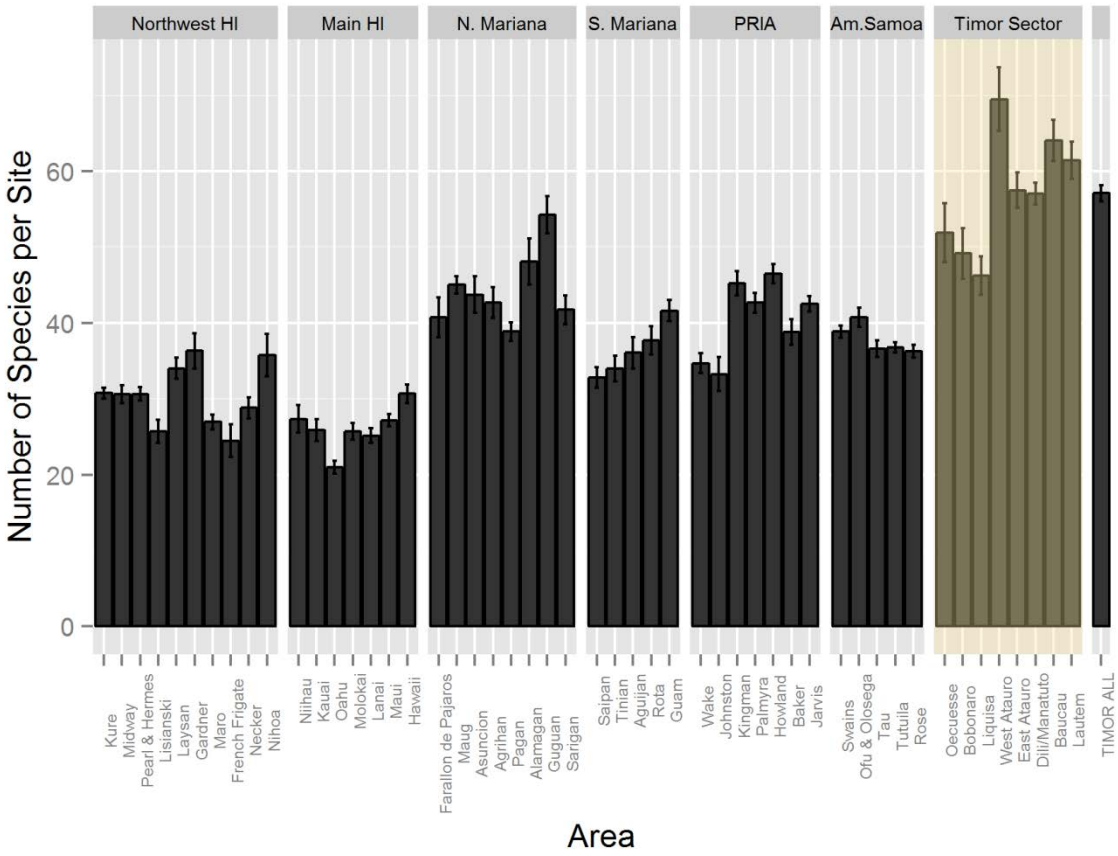

Figure 9.--Average species richness by sector/island for all Pacific islands areas surveyed by CRED.

ACKNOWLEDGEMENTS

We would like thank NOAA's Coral Reef Conservation Program (CRCP), the U.S. Agency for International Development (USAID) Timor-Leste Mission, the USAID Regional Development Mission for Asia (RDMA), the United States Embassy for Timor Leste, the Coral Triangle Support Partnership (CTSP), and the Timor-Leste Ministry of Agriculture and Fisheries (MAF) for technical assistance, support, and funding.

There are many individuals that we would also like to thank for their various contributions to the success of this project including: Candice Mohan, Imaculada Gusmao, Jose Monteiro, Anselmo Lopes Amaral, Rudi de Jesus, and Geraldo Mendes of Conservation International (CI), Maurice Knight of CTSP, the honorable Rafael Pereira Goncalves, Lourenco Borges Fontes, Augusto Fernandes, Domingos Gonsalves, Nelio Viegas, Custodio Bobo, and Jose Soares of MAF, Rick Scott, Paul Randolf, Peter Cloutier, Melissa Francis, Flavia Da Silva, Ryder Rodgers, Jessie Snaza of USAID Timor Leste, and Sara Locke of the U.S. Embassy.

We would like to thank the Compass Charters staff, the crew of the Sundancer NT, Harbor Master of the Timor-Leste Maritime College for dive operation support, as well as the staff at Robella's Place, Palm Beach Apartments Barry's Eco-Resort, and Caimeo Beach Resort for accommodations. We would also like to thank Amanda Toperoff (CRED), and Deborah Yamaguchi (PIFSC) for development of outreach and education materials, Peter Cloutier (USAID), Rusty Brainard (CRED), and Janna Shackeroff (CRCP) for conceiving and developing the original proposals with MAF to conduct these surveys.

A special thank you to Rui Miguel Pinto (CI), who was essential in every aspect of the mission, for his support, facilitation, and invaluable local knowledge.

REFERENCES

Ault, J. S., S. G. Smith, J. A. Bohnsack, J. Luo, D. E. Harper, and D. B. McClellan.
2006. Building sustainable fisheries in Florida's coral reef ecosystem: positive signs in the dry Tortugas. Bull. Mar. Sci. 78(3):633-654.

Ayotte, P., K. McCoy, I. Williams, and J. Zamzow.
2011. Coral Reef Ecosystem Division standard operating procedures: data collection for Rapid Ecological Assessment fish surveys. Pacific Islands Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396. Pacific Islands Fish. Sci. Cent. Admin. Rep. H-11-08, 24 p.

Froese, R., and D. Pauly.
2010. FishBase, World Wide Web electronic publication. www.fishbase.org

Heenan A, Ayotte P, Gray A, Lino K, McCoy K, Zamzow J, Williams I.
2014. Pacific Reef Assessment and Monitoring Program. Data Report: Ecological monitoring 2012-2013 -- reef fishes and benthic habitats of the main Hawaiian Islands, American Samoa, and Pacific Remote Island Areas. Pacific Islands Fisheries Science Center, PIFSC Data Report, DR-14-003, 112 p.

Highlights of the 2010 Census Main Results in Timor-Leste.
2010. General Directorate of Statistics. http://www.statistics.gov.tl/wp-content/uploads/2013/12/English_20Census_20Summary_202011.pdf

Houk, P., C. Musburger, and P. Wiles.
2010. Water quality and herbivory interactively drive coral-reef recovery patterns in American Samoa. PLoS ONE 5:11.

Kohler K. E., and S. M. Gill.
2006. Coral Point Count with Excel extensions (CPCe): A Visual Basic program for the determination of coral and substrate coverage using random point count methodology. Comput Geosci 32: 1259-1269.

Timor-Leste A visual guide of key baseline survey findings.
2013. Food and Agriculture Organization of the United Nations, Regional Fisheries Livelihoods Programme (RFLP) for Southeast Asia (GCP/RAS/237/SPA). http://www.fao.org/docrep/017/ap049e/ap049e00.pdf

Tsujimura, T.N., Alonso, E., Amaral, L. & Rodrigues, P.
2012. Safety at sea assessment in the Timor-Leste small-scale fisheries sector. Technical report. Bangkok: Regional Fisheries Livelihoods Programme for South and Southeast Asia (GCP/RAS/237/SPA) Field Project Document 2012/TIM/1.

APPENDIX A—SITE-LEVEL DATA

Sector	Site	Latitute	Longitude	Depth (m)	Species richness	Benthos		Fish Biomass (g/m^2)																
						Hard coral (%)	Substrate ratio	Piscivores	Planktivores	Pri. consumer	Sec. consumer	All fishes	0-20 cm TL	20-50 cm TL	>50 cm TL	Surgeonfish	Fusilier	Jacks	Emperors	Snappers	Breams	Damselfish	Parrotfish	Groupers
Baucau	BAU-0009	-8.419592	126.427089	13.8	65	13.5	2.3	15.9	49.7	30.0	9.8	105.4	50.8	40.9	13.7	21.4	23.6	0.0	2.4	26.9	1.4	9.5	7.3	1.7
Baucau	BAU-0048	-8.449557	126.329180	4.4	53	19.0	1.9	0.7	8.4	5.3	2.3	16.7	15.1	1.5	0.0	2.2	0.0	0.3	0.0	0.0	0.3	6.7	1.8	0.2
Baucau	BAU-0059	-8.425927	126.360058	9.4	75	17.2	0.3	0.8	13.7	12.3	10.5	37.3	23.5	13.8	0.0	10.0	0.0	0.0	0.0	2.6	1.2	7.3	3.2	0.1
Baucau	BAU-0039	-8.425056	126.383970	7.8	94	19.1	2.0	9.9	107.3	31.7	34.7	183.6	76.9	98.0	8.7	45.1	39.9	0.0	0.0	14.8	0.7	10.8	19.3	5.2
Baucau	BAU-0053	-8.416937	126.410928	2.5	46	13.9	0.4	0.5	10.1	1.4	3.4	15.3	14.5	0.9	0.0	1.0	0.0	0.0	0.9	0.0	0.0	9.4	0.1	0.5
Baucau	BAU-0034	-8.440992	126.344494	12.2	74	7.1	0.2	101.7	24.2	8.5	4.7	139.2	16.0	23.7	99.4	4.8	14.9	0.0	0.0	3.4	0.6	5.6	2.9	0.8
Baucau	BAU-0032	-8.422367	126.371749	4.4	65	18.2	0.4	1.2	11.3	18.1	13.2	43.8	26.0	17.8	0.0	13.8	0.0	0.0	0.0	8.4	0.7	7.9	3.8	1.1
Baucau	BAU-0010	-8.466956	125.931734	15.1	67	0.0	0.0	6.6	18.3	23.5	7.8	56.1	29.3	26.9	0.0	13.0	0.0	0.0	0.0	0.0	0.7	8.5	9.1	3.7
Baucau	BAU-0001	-8.416009	126.412106	15.4	76	0.3	0.1	7.2	226.9	4.9	17.1	256.1	57.9	198.3	0.0	44.2	140.5	2.9	0.3	20.8	0.2	10.1	2.3	1.7
Baucau	BAU-0019	-8.442408	126.477598	5.0	51	5.9	1.1	0.9	13.5	1.7	2.8	18.8	18.8	0.0	0.0	1.3	0.0	0.0	0.0	0.3	0.0	7.8	0.1	0.7
Baucau	BAU-0022	-8.422104	126.441223	13.6	75	8.1	0.2	1.1	78.1	4.5	15.0	98.6	41.0	57.6	0.0	10.3	58.2	0.0	1.3	1.5	0.0	6.5	0.7	0.5
Baucau	BAU-0003	-8.445504	126.492186	5.2	53	4.2	0.2	0.2	4.4	1.6	2.7	9.0	8.5	0.5	0.0	1.2	0.0	0.0	0.2	0.8	0.0	3.8	0.1	0.2
Baucau	BAU-0028	-8.438971	126.467505	4.6	72	8.6	0.2	0.6	11.1	13.6	7.5	32.7	26.8	5.9	0.0	8.1	1.8	0.0	0.9	0.0	1.1	6.1	4.2	0.3
Baucau	BAU-0006	-8.433603	126.456398	10.6	53	1.0	0.1	1.4	6.4	4.7	5.5	18.0	12.7	5.3	0.0	2.6	0.0	0.0	0.0	2.7	0.8	5.4	0.8	0.2
Baucau	BAU-0014	-8.428236	126.448185	5.2	50	0.0	0.0	0.3	5.2	1.6	2.8	9.9	8.6	1.3	0.0	0.8	0.0	0.0	0.0	1.3	0.1	3.9	0.1	0.3
Bobonaro	BOB-0020	-8.844149	125.022225	9.5	58	31.8	1.2	1.3	13.3	17.0	4.6	36.1	23.1	13.0	0.0	11.8	0.0	0.0	0.0	0.0	0.2	2.9	12.2	0.8
Bobonaro	BOB-0014	-8.856125	125.011812	4.3	37	1.0	0.1	0.8	3.1	10.7	4.8	19.3	14.6	4.7	0.0	12.4	0.0	0.0	0.2	0.0	0.7	0.7	0.0	0.0
Bobonaro	BOB-0017	-8.862270	125.006629	4.4	31	1.7	0.0	0.0	1.3	12.8	2.9	17.0	7.3	9.6	0.0	5.9	0.0	0.0	0.0	0.6	0.3	1.0	6.7	0.0
Bobonaro	BOB-0011	-8.836380	125.032051	8.6	72	22.8	1.0	1.5	9.3	7.7	7.7	26.2	12.0	14.2	0.0	4.0	0.0	0.0	0.0	7.1	0.2	1.9	2.2	0.0
Bobonaro	BOB-0005	-8.848694	125.017609	11.9	70	14.9	0.7	2.3	10.9	12.8	9.0	35.1	19.2	15.9	0.0	7.6	0.3	0.0	1.2	0.0	1.9	2.9	8.1	1.7
Bobonaro	BOB-0023	-8.831917	125.035331	5.3	41	18.1	0.4	0.4	1.7	9.5	3.6	15.2	13.3	1.9	0.0	6.0	0.0	0.0	0.0	0.0	0.0	1.2	2.8	0.4
Bobonaro	BOB-0019	-8.858547	125.010049	4.2	33	7.2	0.1	0.0	4.8	3.4	3.6	11.8	11.0	0.8	0.0	1.7	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0
Bobonaro	BOB-0003	-8.840236	125.026360	7.9	77	18.1	0.8	4.5	9.8	13.2	41.8	69.3	19.5	32.2	17.6	10.6	2.0	0.0	0.1	37.8	0.3	3.6	3.8	0.1
Bobonaro	BOB-0007	-8.805762	125.087062	9.2	41	17.5	0.6	0.2	1.4	3.8	20.0	25.4	8.0	17.4	0.0	3.2	0.3	0.0	0.7	1.7	0.6	0.6	0.0	0.0
Bobonaro	BOB-0080	-8.821381	125.068406	2.9	38	36.3	1.4	0.5	2.4	7.8	3.6	14.3	11.6	2.7	0.0	7.8	0.0	0.0	0.0	0.0	2.7	1.8	0.0	0.5
Bobonaro	BOB-0092	-8.824967	125.056050	5.2	56	15.3	3.7	0.0	4.5	3.3	7.9	15.7	12.3	3.4	0.0	3.2	0.0	0.0	0.0	0.0	0.3	4.2	0.5	0.0
Bobonaro	BOB-0087	-8.826243	125.045993	12.9	39	4.4	0.6	0.2	6.3	26.6	7.2	40.4	21.3	19.0	0.0	25.3	0.0	0.0	0.0	0.0	1.5	0.9	2.1	0.1
Bobonaro	BOB-0088	-8.823927	125.058103	5.5	62	9.9	1.1	0.2	4.7	3.4	5.2	13.4	11.7	1.7	0.0	3.0	0.0	0.0	0.0	0.0	0.2	4.0	0.0	0.0
Bobonaro	BOB-0099	-8.809983	125.082869	11.1	45	15.4	0.8	0.7	2.0	1.5	5.0	9.2	7.4	1.7	0.0	1.4	0.0	0.0	0.0	0.5	0.2	1.2	0.0	0.5
Bobonaro	BOB-0082	-8.815751	125.077934	7.1	59	12.5	0.5	1.2	22.8	3.7	2.5	30.2	20.3	9.9	0.0	4.7	11.3	0.0	0.0	0.0	0.2	6.5	0.0	1.0
Dili/Manatuto	DIL-0007	-8.522515	125.607734	5.4	68	7.1	0.2	0.4	16.8	4.1	8.2	29.5	22.5	7.0	0.0	9.4	0.0	0.0	0.0	0.0	0.2	5.6	0.2	0.3
Dili/Manatuto	DIL-0024	-8.518401	125.621216	12.0	49	7.1	0.7	0.0	32.1	2.2	3.0	37.2	31.0	6.3	0.0	3.1	7.6	0.0	0.0	0.0	0.4	3.1	0.0	0.0
Dili/Manatuto	DIL-0022	-8.523916	125.696660	2.3	45	16.1	1.1	0.0	5.3	1.5	2.8	9.6	9.6	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.6	5.1	0.1	0.0
Dili/Manatuto	DIL-0010	-8.524247	125.679423	9.3	50	23.3	1.4	0.7	7.0	5.0	4.2	16.9	14.2	2.7	0.0	1.6	0.0	0.0	0.0	0.0	0.0	3.6	2.1	0.7
Dili/Manatuto	DIL-0023	-8.522222	125.647268	3.9	45	0.0	0.0	0.3	4.8	6.1	3.4	14.5	14.5	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.3	4.0	1.6	0.3
Dili/Manatuto	DIL-0026	-8.484514	125.818187	15.0	43	6.5	0.5	0.4	8.2	9.4	8.3	26.2	21.4	4.9	0.0	7.4	0.0	0.0	0.3	0.4	0.1	4.8	0.0	0.2
Dili/Manatuto	DIL-0021	-8.483779	125.833509	5.8	54	17.9	1.3	0.1	4.8	2.8	4.4	12.2	12.2	0.0	0.0	2.7	0.0	0.0	0.0	0.4	0.3	4.0	0.0	0.1
Dili/Manatuto	DIL-0005	-8.498675	125.793209	5.5	57	14.4	2.5	0.3	4.4	7.9	3.9	16.5	15.1	1.4	0.0	5.3	0.0	0.0	0.0	1.0	0.6	2.6	0.0	0.0
Dili/Manatuto	DIL-0004	-8.498957	125.780292	10.8	52	9.7	2.2	0.3	22.5	4.5	9.0	36.4	18.3	18.1	0.0	10.1	5.4	0.0	0.3	0.0	0.5	6.6	1.5	0.0

Sector	Site	Latitute	Longitude	Depth (m)	Species richness	Benthos		Fish Biomass (g/m^2)																
						Hard coral (%)	Substrate ratio	Piscivores	Planktivores	Pri. consumer	Sec. consumer	All fishes	0-20 cm TL	20-50 cm TL	>50 cm TL	Surgeonfish	Fusilier	Jacks	Emperors	Snappers	Breams	Damselfish	Parrotfish	Groupers
Dili/Manatuto	DIL-0018	-8.520169	125.612549	5.8	59	15.2	1.4	0.1	14.7	9.8	12.2	36.9	30.9	6.0	0.0	6.2	0.0	0.0	0.0	0.5	1.2	12.9	0.0	0.0
Dili/Manatuto	MAN-0036	-8.478292	125.951075	9.3	62	29.2	0.9	1.3	36.8	6.6	6.1	50.8	49.4	1.5	0.0	4.1	12.9	0.0	0.0	0.4	0.4	9.0	0.2	1.0
Dili/Manatuto	MAN-0047	-8.478854	125.927663	3.8	56	15.3	0.6	0.0	10.5	9.0	2.5	22.1	21.5	0.5	0.0	7.1	0.0	0.0	0.0	0.0	0.0	9.1	0.8	0.0
Dili/Manatuto	MAN-0051	-8.478065	125.910296	3.2	72	6.1	0.4	0.1	14.5	1.4	7.7	23.7	20.8	2.8	0.0	1.0	0.0	0.0	0.0	2.3	0.2	14.2	0.0	0.0
Dili/Manatuto	MAN-0052	-8.473765	125.894529	16.7	56	2.6	0.1	0.9	9.0	3.6	6.2	19.6	15.4	4.2	0.0	6.5	0.0	0.6	0.0	1.1	0.0	2.3	0.0	0.3
Dili/Manatuto	MAN-0058	-8.484952	125.963014	4.8	66	28.6	0.6	16.3	15.8	8.2	5.1	45.4	22.4	22.9	0.0	6.3	0.0	0.0	0.6	0.5	1.2	10.7	1.3	0.1
Dili/Manatuto	MAN-0055	-8.477263	125.933351	11.7	62	13.2	0.4	0.3	13.3	4.9	3.4	21.9	21.1	0.8	0.0	2.9	0.0	0.0	0.0	0.1	0.3	7.1	0.0	0.3
Dili/Manatuto	MAN-0053	-8.474177	125.873090	13.6	55	6.8	0.7	0.7	15.7	3.1	3.4	22.9	21.3	1.6	0.0	4.7	1.7	0.0	0.0	1.6	0.2	6.2	0.2	0.3
Dili/Manatuto	MAN-0001	-8.511286	126.047874	7.0	54	4.7	0.1	0.3	11.7	4.4	4.1	20.4	17.8	2.6	0.0	2.7	0.5	0.0	0.0	0.5	1.0	4.6	0.1	0.3
Dili/Manatuto	MAN-0007	-8.485610	125.975921	12.0	55	13.0	0.2	0.2	16.6	4.2	2.6	23.5	21.2	2.3	0.0	3.5	0.0	0.0	0.0	0.0	0.1	10.7	0.0	0.1
Dili/Manatuto	MAN-0046	-8.481394	125.954323	4.5	55	34.4	0.9	0.2	6.8	5.3	2.8	15.2	15.2	0.0	0.0	4.7	0.0	0.0	0.0	0.0	0.0	5.7	0.2	0.0
Dili/Manatuto	MAN-0064	-8.476417	125.939402	4.1	62	20.8	1.0	0.1	9.9	20.9	4.2	35.0	31.9	3.1	0.0	19.5	0.0	0.0	0.0	0.0	0.3	9.4	1.1	0.0
Dili/Manatuto	DIL-0001	-8.495140	125.812595	5.3	60	21.6	2.9	0.8	7.8	4.3	4.1	17.0	16.1	0.8	0.0	3.7	0.0	0.0	0.0	0.0	0.3	7.0	0.1	0.3
Dili/Manatuto	MAN-0059	-8.481596	125.837457	10.2	56	0.0	0.0	0.0	21.0	6.9	2.9	30.8	29.4	1.4	0.0	5.1	0.0	0.0	0.0	0.0	0.4	11.2	0.2	0.0
Dili/Manatuto	DIL-0012	-8.512661	125.744008	12.7	58	12.9	1.2	0.6	4.8	3.7	3.5	12.6	10.7	1.9	0.0	2.3	0.0	0.0	0.0	0.3	0.4	3.1	1.6	0.2
Dili/Manatuto	MAN-0037	-8.474921	125.849096	2.6	47	43.4	2.7	0.0	4.0	1.6	1.3	6.9	6.9	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	3.3	0.2	0.0
Dili/Manatuto	DIL-0031	-8.499445	125.791457	3.2	56	12.1	3.6	0.3	4.2	3.7	3.9	12.0	12.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.8	4.3	0.0	0.0
Dili/Manatuto	DIL-0032	-8.500412	125.775412	10.7	72	12.2	0.4	0.9	6.3	5.5	7.3	19.9	17.6	2.3	0.0	3.0	0.0	0.0	0.0	2.5	0.3	3.5	0.0	0.8
Dili/Manatuto	MAN-0034	-8.473545	125.860253	13.7	64	2.3	0.1	0.3	11.5	3.6	3.6	19.0	13.1	5.9	0.0	4.4	0.0	0.0	0.0	2.1	0.0	4.2	1.7	0.1
East Atauro	VIL-0026	-8.149358	125.643143	13.9	56	34.4	3.8	9.0	15.5	9.3	7.0	40.8	25.2	15.6	0.0	6.6	0.0	0.0	0.0	8.6	0.0	10.0	2.0	0.3
East Atauro	VIL-0004	-8.182166	125.638896	5.3	61	17.4	0.6	1.6	13.0	5.9	2.7	23.1	21.6	1.5	0.0	5.0	0.0	0.0	0.1	1.0	0.1	10.0	0.0	0.5
East Atauro	VIL-0006	-8.214182	125.620525	11.2	56	16.5	0.3	1.5	15.1	3.6	2.4	22.6	20.3	2.3	0.0	0.8	0.0	0.0	0.0	0.0	0.0	10.5	1.8	1.1
East Atauro	VIL-0034	-8.292690	125.593208	9.1	62	16.8	1.0	9.1	14.0	3.7	9.1	35.9	18.4	9.6	7.9	3.0	1.4	0.0	0.1	5.5	0.0	8.8	0.2	8.2
East Atauro	VIL-0032	-8.263296	125.610253	11.0	43	7.1	0.8	0.8	7.6	4.0	2.6	15.1	13.0	2.1	0.0	2.0	0.0	0.0	0.0	0.0	0.1	2.7	2.2	0.7
East Atauro	VIL-0040	-8.306590	125.563607	5.4	63	28.3	1.3	0.2	6.5	4.7	3.2	14.6	14.6	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	6.5	1.1	0.1
East Atauro	VIL-0012	-8.307491	125.579443	14.1	48	16.7	0.7	1.7	116.7	5.5	4.6	128.5	88.4	40.1	0.0	11.2	33.5	0.0	0.4	3.4	0.0	32.4	0.0	0.0
East Atauro	VIL-0035	-8.279574	125.601449	4.1	55	26.6	1.3	1.6	11.2	2.5	9.0	24.4	15.7	8.7	0.0	2.0	0.0	0.0	1.0	0.4	0.0	5.8	0.0	0.7
East Atauro	VIL-0017	-8.236413	125.614013	3.7	62	35.1	3.3	0.2	4.9	4.1	3.8	12.9	10.3	2.6	0.0	2.1	0.0	0.0	0.0	0.7	0.0	2.8	2.0	0.0
East Atauro	VIL-0005	-8.135931	125.642619	5.4	78	27.0	3.5	2.4	38.0	15.7	14.3	70.5	20.7	49.8	0.0	7.7	19.8	0.0	1.0	14.8	0.1	3.5	10.0	0.0
East Atauro	VIL-0044	-8.168952	125.645254	15.8	40	22.3	1.2	1.8	7.6	2.8	1.1	13.2	12.3	1.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	5.3	0.0	1.8
East Atauro	VIL-0015	-8.201842	125.628124	3.5	66	10.6	0.3	0.4	4.4	2.8	2.2	9.9	9.2	0.7	0.0	1.2	0.0	0.0	0.1	0.0	0.0	1.8	1.6	0.3
Lautem	LAU-0002	-8.376614	127.232402	11.5	68	38.7	1.3	3.3	103.6	9.6	4.3	120.8	83.2	37.7	0.0	9.4	22.3	0.0	0.0	0.0	0.0	3.2	5.8	3.3
Lautem	LAU-0026	-8.346345	127.161002	15.2	65	24.0	0.6	0.2	8.9	8.4	12.5	30.0	23.9	6.2	0.0	4.5	0.0	0.0	0.0	0.0	0.0	6.8	3.3	0.0
Lautem	LAU-0008	-8.364733	127.221837	15.9	62	11.8	0.2	0.6	5.5	4.1	2.2	12.4	11.5	0.8	0.0	2.7	0.0	0.0	0.0	0.0	0.1	1.9	0.8	0.5
Lautem	LAU-0030	-8.378334	127.240776	8.6	44	6.8	0.5	2.4	41.9	23.1	2.9	70.3	68.7	1.6	0.0	21.2	27.0	9.3	0.5	0.0	0.0	4.5	0.7	1.4
Lautem	LAU-0004	-8.338334	127.173606	12.6	80	17.8	0.8	4.0	90.5	6.9	6.0	107.3	86.8	20.5	0.0	11.1	53.5	0.4	0.0	0.0	0.0	8.5	0.0	3.4
Lautem	LAU-0018	-8.356376	127.152711	4.7	70	24.5	0.9	0.9	9.4	7.8	3.5	21.6	19.5	2.2	0.0	7.5	4.8	0.0	0.0	0.0	0.2	2.8	0.0	0.8
Lautem	LAU-0013	-8.382826	127.253136	2.1	59	22.3	0.6	1.6	14.9	17.7	6.7	41.0	32.7	8.2	0.0	16.2	6.5	0.0	0.0	0.6	0.3	4.3	0.6	1.4
Lautem	LAU-0022	-8.386474	127.270848	13.2	65	23.0	1.1	0.7	19.9	4.3	4.9	29.8	22.5	7.3	0.0	1.1	0.0	0.0	0.0	4.0	0.0	11.6	2.0	0.3

Sector	Site	Latitute	Longitude	Depth (m)	Species richness	Benthos		Fish Biomass (g/m^2)																
						Hard coral (%)	Substrate ratio	Piscivores	Planktivores	Pri. consumer	Sec. consumer	All fishes	0-20 cm TL	20-50 cm TL	>50 cm TL	Surgeonfish	Fusilier	Jacks	Emperors	Snappers	Breams	Damselfish	Parrotfish	Groupers
Lautem	LAU-0009	-8.386968	127.278390	5.0	59	23.6	0.7	1.4	8.3	5.2	6.7	21.6	17.2	4.4	0.0	2.7	0.0	0.0	0.0	2.9	0.3	7.0	2.4	0.6
Lautem	LAU-0020	-8.386367	127.284009	12.2	78	0.0	0.0	20.5	77.7	5.0	9.6	112.8	54.1	58.7	0.0	27.1	21.7	0.1	0.6	13.9	1.2	11.9	0.6	0.5
Lautem	LAU-0061	-8.418000	127.309000	4.8	48	34.9	2.1	2.6	35.3	4.2	9.6	51.7	39.4	11.4	0.9	0.8	3.6	0.0	0.0	0.0	0.0	23.0	1.4	1.4
Lautem	LAU-0062	-8.415641	127.311108	3.1	57	15.6	0.4	0.5	10.4	8.7	3.3	23.0	18.1	4.9	0.0	5.1	0.0	0.0	0.0	0.5	0.2	5.0	2.7	0.3
Lautem	LAU-0064	-8.408228	127.319420	12.0	89	25.8	1.2	18.6	19.3	11.8	33.6	83.3	55.3	26.3	1.8	3.8	0.0	1.8	10.5	15.8	0.0	6.8	4.2	7.8
Lautem	LAU-0070	-8.422000	127.307000	14.8	45	0.0	0.0	3.8	8.9	3.9	4.3	20.8	16.0	4.9	0.0	1.8	0.0	2.7	0.0	0.0	0.0	5.0	1.1	1.1
Lautem	LAU-0006	-8.446508	127.320295	9.7	62	10.0	0.2	18.9	70.2	27.7	167.1	283.9	31.5	79.1	173.3	15.5	49.2	2.3	0.0	28.1	0.7	3.9	12.9	0.2
Lautem	LAU-0071	-8.444480	127.341418	9.3	79	14.0	0.6	4.7	17.5	36.3	15.8	74.4	42.9	23.6	7.8	14.8	0.0	1.4	0.0	0.6	0.0	6.5	17.9	2.9
Lautem	LAU-0023	-8.349750	127.206602	5.7	57	0.0	0.0	0.6	13.6	6.4	3.9	24.6	22.4	2.2	0.0	4.7	0.0	0.0	0.0	0.5	0.0	11.5	0.1	0.4
Lautem	LAU-0011	-8.364611	127.134615	8.7	72	7.8	0.4	1.5	9.1	3.5	10.6	24.8	17.7	7.1	0.0	3.0	0.0	0.0	0.6	4.3	0.2	2.0	0.1	0.8
Lautem	LAU-0010	-8.366614	127.115830	2.6	36	6.1	0.1	0.7	3.1	9.0	6.3	19.1	14.1	5.0	0.0	7.9	0.0	0.0	2.1	0.9	0.0	2.8	0.4	0.5
Lautem	LAU-0024	-8.362894	127.081429	5.5	59	26.5	1.5	9.6	9.2	6.8	4.8	30.3	18.4	3.0	8.9	3.3	0.0	0.0	8.9	1.0	0.3	6.1	2.8	0.5
Lautem	LAU-0028	-8.353539	127.058567	5.7	71	0.0	0.0	0.6	6.7	11.0	4.2	22.6	22.0	0.5	0.0	9.1	0.0	0.0	0.2	0.6	0.0	6.9	1.5	0.5
Lautem	LAU-0003	-8.362789	127.103334	10.2	58	0.0	0.0	36.4	8.0	3.2	4.8	52.4	17.2	35.2	0.0	2.9	0.0	0.0	0.0	0.5	0.5	3.6	0.1	1.3
Lautem	LAU-0014	-8.363659	127.095621	4.9	65	0.0	0.0	0.8	6.6	14.9	5.7	28.0	21.8	6.2	0.0	11.0	0.0	0.0	0.0	1.0	0.4	4.5	2.8	0.3
Lautem	LAU-0029	-8.362197	127.075169	11.9	66	33.8	0.9	2.0	20.5	5.9	2.3	30.7	22.5	8.3	0.0	11.5	0.0	0.0	0.0	0.1	0.0	9.5	1.0	1.9
Liquisa	LIQ-0007	-8.559743	125.422529	13.7	42	5.0	1.0	1.3	16.2	1.6	5.1	24.2	9.3	14.9	0.0	13.8	0.0	0.0	0.0	1.4	0.4	2.0	0.1	0.4
Liquisa	LIQ-0012	-8.559717	125.449542	5.5	53	20.2	0.7	0.0	18.6	12.7	1.9	33.3	24.3	9.0	0.0	11.3	0.0	0.0	0.0	0.0	0.0	3.4	0.7	0.0
Liquisa	LIQ-0030	-8.563152	125.391697	16.0	39	9.4	0.5	1.7	2.9	1.5	1.2	7.3	5.7	1.7	0.0	0.7	0.0	0.0	0.0	0.0	0.0	2.0	0.0	1.7
Liquisa	LIQ-0001	-8.566286	125.383981	5.3	16	0.0	0.0	0.2	0.0	0.8	2.7	3.8	1.9	1.8	0.0	0.0	0.0	0.0	0.9	1.0	0.5	0.2	0.0	0.2
Liquisa	LIQ-0008	-8.574045	125.370505	2.5	47	10.8	1.1	0.8	4.2	9.2	2.5	16.7	13.7	3.0	0.0	9.1	0.0	0.0	0.0	0.7	0.0	3.8	0.0	0.0
Liquisa	LIQ-0015	-8.584635	125.329447	12.8	35	2.1	0.0	2.7	2.4	0.8	2.2	8.0	6.5	1.5	0.0	0.7	0.0	0.0	0.0	0.7	0.1	0.7	0.0	1.5
Liquisa	LIQ-0028	-8.602119	125.293284	5.8	38	9.7	0.6	0.3	3.1	1.8	0.8	6.0	6.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.3	1.6	0.0	0.3
Liquisa	LIQ-0014	-8.602247	125.286132	14.6	50	2.3	0.1	4.0	31.5	2.7	4.9	43.1	28.6	14.5	0.0	20.5	3.2	2.6	0.0	1.3	0.5	3.4	1.5	1.3
Liquisa	LIQ-0035	-8.604415	125.272245	6.2	51	8.7	1.1	0.1	23.3	0.7	11.3	35.3	5.7	29.7	0.0	21.5	0.0	0.0	0.0	8.0	0.1	2.2	0.0	0.0
Liquisa	LIQ-0043	-8.603072	125.257353	16.2	49	10.4	0.8	0.3	17.3	2.4	3.7	23.6	16.5	7.1	0.0	8.8	4.6	0.0	0.7	1.1	0.2	1.4	0.0	0.0
Liquisa	LIQ-0058	-8.603544	125.232883	13.8	55	0.0	0.0	2.4	36.6	2.2	10.6	51.8	33.5	18.3	0.0	4.1	23.9	0.0	1.2	2.7	0.2	4.3	0.0	1.6
Liquisa	LIQ-0041	-8.604719	125.219306	3.2	36	0.0	0.0	0.2	2.3	1.1	10.0	13.6	5.6	8.1	0.0	0.2	0.0	0.0	0.0	1.0	0.0	1.3	0.8	0.0
Liquisa	LIQ-0045	-8.606795	125.207641	5.0	14	0.3	0.1	0.0	0.2	0.2	3.5	3.8	3.8	0.0	0.0	0.2	0.0	0.0	0.3	0.0	1.0	0.3	0.0	0.0
Liquisa	LIQ-0059	-8.609982	125.200553	13.0	55	5.8	2.0	4.0	12.5	5.4	6.2	28.1	17.2	10.9	0.0	1.7	0.0	0.0	0.0	6.7	0.1	1.9	0.0	0.0
Liquisa	LIQ-0036	-8.612112	125.190976	10.4	71	15.7	3.3	2.9	10.7	2.4	3.7	19.7	15.9	3.7	0.0	1.1	0.0	0.0	1.4	0.3	0.1	4.0	0.1	2.9
Liquisa	LIQ-0060	-8.621411	125.167989	4.8	23	0.0	0.0	0.5	0.6	0.2	6.6	7.9	4.6	3.3	0.0	0.2	0.0	0.0	0.2	4.2	0.4	1.2	0.0	0.5
Liquisa	LIQ-0057	-8.634857	125.139212	13.1	58	7.0	1.3	2.3	74.4	8.5	19.5	104.7	78.6	26.1	0.0	2.0	9.0	0.0	0.2	2.7	0.6	4.3	0.0	2.0
Liquisa	LIQ-0033	-8.638677	125.129358	3.4	51	32.8	4.6	0.2	3.9	3.2	2.7	10.0	10.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.4	2.7	0.1	0.0
Liquisa	LIQ-0044	-8.644693	125.121287	7.3	47	13.4	0.9	0.7	7.6	8.4	6.7	23.4	18.3	5.1	0.0	6.1	0.0	0.0	0.0	0.2	0.1	1.9	2.2	0.0
Liquisa	LIQ-0042	-8.662750	125.110477	5.2	52	14.8	1.8	0.2	3.7	22.8	2.2	28.9	9.3	19.6	0.0	13.9	0.0	0.1	0.0	0.0	0.0	1.2	8.3	0.2
Liquisa	LIQ-0046	-8.669484	125.106761	10.7	53	10.4	0.8	2.5	4.9	3.9	10.1	21.4	10.0	11.3	0.0	1.0	0.0	0.0	0.7	1.2	0.0	1.7	1.0	2.4
Liquisa	LIQ-0047	-8.680759	125.101837	17.6	52	10.9	0.3	2.7	1.8	6.8	6.2	17.5	7.8	9.7	0.0	4.6	0.0	0.0	0.0	0.3	0.2	0.4	0.0	2.0
Liquisa	LIQ-0040	-8.692893	125.098771	5.5	46	12.9	0.2	1.4	2.2	16.6	3.2	23.4	10.0	13.4	0.0	5.2	0.0	0.0	0.0	1.1	0.0	1.6	7.2	1.3

Sector	Site	Latitute	Longitude	Depth (m)	Species richness	Benthos		Fish Biomass (g/m^2)																
						Hard coral (%)	Substrate ratio	Piscivores	Planktivores	Pri. consumer	Sec. consumer	All fishes	0-20 cm TL	20-50 cm TL	>50 cm TL	Surgeonfish	Fusilier	Jacks	Emperors	Snappers	Breams	Damselfish	Parrotfish	Groupers
Liquisa	LIQ-0061	-8.650555	125.115250	12.2	61	21.8	1.3	2.2	38.1	9.6	10.1	60.1	46.7	13.3	0.0	5.1	36.2	0.0	0.0	1.9	0.4	0.9	1.5	1.5
Liquisa	LIQ-0062	-8.629896	125.150293	4.6	45	24.7	2.5	0.4	3.1	5.4	5.8	14.7	9.7	5.0	0.0	3.6	0.0	0.0	0.0	4.1	0.0	2.1	1.1	0.1
Liquisa	LIQ-0063	-8.617030	125.179025	4.4	52	16.1	3.6	1.2	5.0	1.1	1.6	9.0	8.0	1.0	0.0	0.5	1.9	0.8	0.0	0.2	0.0	2.0	0.0	0.0
Oecuesse	OEC-0024	-9.308418	124.123721	4.8	66	24.8	0.6	3.6	18.0	1.6	5.2	28.3	18.8	9.5	0.0	1.3	10.9	0.0	0.0	1.0	0.2	6.1	0.1	3.5
Oecuesse	OEC-0021	-9.295987	124.148957	4.6	47	22.0	0.4	4.1	3.0	2.6	3.8	13.5	8.9	4.6	0.0	2.4	0.2	0.0	0.0	0.0	0.0	1.5	0.0	3.9
Oecuesse	OEC-0019	-9.284448	124.166510	8.5	30	0.0	0.0	2.8	7.0	5.9	7.3	23.0	14.4	8.6	0.0	5.9	0.0	0.0	0.0	6.0	0.0	6.3	0.0	0.7
Oecuesse	OEC-0011	-9.259027	124.180194	5.7	37	3.9	0.3	0.1	1.2	3.1	2.5	6.9	4.3	2.5	0.0	2.9	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.1
Oecuesse	OEC-0016	-9.298824	124.133754	9.9	37	8.5	0.2	7.8	2.6	1.9	61.1	73.3	6.1	59.4	7.8	0.5	0.0	0.0	0.0	8.8	0.8	0.2	0.0	0.0
Oecuesse	OEC-0022	-9.309815	124.116193	9.5	64	26.9	0.6	0.2	11.0	1.9	1.8	14.9	14.3	0.6	0.0	1.3	5.3	0.0	0.0	0.0	0.3	2.6	0.0	0.2
Oecuesse	OEC-0007	-9.292349	124.158819	12.9	64	17.5	0.6	3.5	4.4	5.1	4.5	17.5	13.4	4.1	0.0	3.3	0.0	0.0	0.0	0.8	0.2	1.2	1.2	3.5
Oecuesse	OEC-0032	-9.188166	124.389026	4.4	51	36.1	1.4	0.2	3.0	14.3	4.7	22.2	15.7	6.5	0.0	10.1	0.0	0.0	0.0	0.0	0.6	2.4	3.9	0.1
Oecuesse	OEC-0002	-9.233661	124.238932	4.4	44	8.0	0.9	0.1	3.5	8.4	2.1	14.0	6.0	8.1	0.0	6.1	0.0	0.0	0.0	0.0	0.4	2.5	2.2	0.0
Oecuesse	OEC-0043	-9.195606	124.372634	13.7	65	18.3	0.6	0.5	68.1	3.9	6.2	78.8	49.8	29.0	0.0	25.6	33.7	0.0	0.0	1.3	1.9	5.8	0.0	0.1
Oecuesse	OEC-0052	-9.197917	124.320733	6.6	55	19.6	0.7	0.0	4.2	1.3	2.5	8.0	4.9	3.1	0.0	1.0	0.0	0.0	0.0	0.4	0.0	1.3	0.3	0.0
Oecuesse	OEC-0030	-9.236077	124.229550	8.5	62	16.5	0.6	0.0	46.9	2.1	4.9	53.9	49.9	4.0	0.0	36.4	2.6	0.0	0.0	1.2	0.3	3.0	0.1	0.0
Oecuesse	OEC-0045	-9.226611	124.260027	4.2	55	23.6	3.7	0.2	8.7	1.4	7.3	17.6	14.7	3.0	0.0	1.2	1.3	0.0	0.0	5.0	0.0	4.4	0.0	0.0
Oecuesse	OEC-0056	-9.197467	124.361369	1.5	44	6.3	2.7	0.1	4.0	0.8	1.2	6.1	6.1	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.1
Oecuesse	OEC-0058	-9.191774	124.385266	11.7	87	41.7	1.6	8.2	56.1	5.3	10.3	79.9	59.3	13.8	6.8	4.0	0.1	0.0	5.3	13.2	0.8	27.3	1.9	0.8
West Atauro	ATA-0074	-8.178220	125.580960	2.8	50	4.4	0.2	3.5	17.7	27.3	2.5	50.9	27.0	24.0	0.0	25.1	0.0	0.0	0.0	5.4	0.0	3.5	4.2	0.7
West Atauro	ATA-0063	-8.196460	125.562707	6.3	66	28.1	1.2	14.1	35.6	13.3	10.0	73.0	39.9	33.1	0.0	3.7	0.0	8.7	0.9	12.3	0.0	10.4	8.1	0.5
West Atauro	ATA-0077	-8.159662	125.594092	2.2	75	9.8	0.6	0.5	11.7	15.3	2.2	29.7	20.5	9.2	0.0	8.3	0.0	0.0	0.0	3.7	0.0	4.4	5.7	0.4
West Atauro	ATA-0058	-8.220772	125.546216	2.2	47	9.4	0.2	0.2	4.0	3.3	2.3	9.8	9.8	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.2	0.9	0.1	0.1
West Atauro	ATA-0066	-8.219725	125.534013	14.9	84	36.3	1.0	5.7	31.5	77.1	24.1	138.4	62.5	51.8	24.1	20.3	17.6	0.0	12.9	9.1	0.0	2.2	56.3	0.5
West Atauro	ATA-0076	-8.184868	125.573667	10.5	62	30.3	1.2	7.3	21.4	6.2	4.0	38.9	31.5	7.4	0.0	3.3	2.3	0.0	0.0	4.1	0.0	6.7	1.2	3.1
West Atauro	ATA-0075	-8.172055	125.586454	4.2	85	18.6	0.6	1.2	31.6	10.7	8.7	52.1	44.7	7.4	0.0	4.5	0.0	0.0	0.0	1.0	0.4	28.9	5.6	1.0
West Atauro	ATA-0070	-8.213892	125.551334	12.9	79	24.6	0.8	2.7	69.8	19.8	10.1	102.4	43.0	59.4	0.0	7.6	42.6	0.0	0.4	7.9	0.0	8.7	13.5	1.9
West Atauro	ATA-0062	-8.153013	125.602422	14.0	67	26.8	1.6	9.2	105.2	52.3	11.0	177.6	66.5	111.1	0.0	83.2	36.9	0.0	0.0	11.0	0.0	4.1	1.6	4.1
West Atauro	ATA-0053	-8.226789	125.524135	15.2	80	14.6	0.6	7.7	40.1	18.2	19.8	85.7	33.1	52.6	0.0	26.4	0.0	0.0	1.5	18.0	0.0	3.6	5.6	6.9

APPENDIX B—CONSUMER GROUP SPECIES

Fishes were categorized into four functional trophic groups: primary consumers (herbivores and detritivores); secondary consumers (omnivores and benthic invertivores); planktivores; and piscivores. Because diets of species change ontogenetically and with environmental conditions, and because there are few comprehensive diet studies of many coral reef fish species, it is difficult to develop more sophisticated trophic categorization. However, these broad and robust groupings are consistent with classifications used for other studies and by CRED for previous reports (Williams et al., 2011; DeMartini et al., 2008; Williams et al., 2008; Friedlander et al., 2010).

Primary Consumers (herbivores and detritivores; includes most surgeonfish and parrotfish, plus smaller primary herbivores such as pygmy angels, and sharpnose puffers, herbivorous damselfish, and others): *Abudefduf sordidus, Acanthuridae sp, Acanthurus bariene, Acanthurus blochii, Acanthurus leucocheilus, Acanthurus lineatus, Acanthurus maculiceps, Acanthurus nigricans, Acanthurus nigricauda, Acanthurus nigrofuscus, Acanthurus olivaceus, Acanthurus pyroferus, Acanthurus sp, Acanthurus triostegus, Amphiprion sandaracinos, Calotomus carolinus, Cantherhines pardalis, Canthigaster axilogus, Canthigaster bennetti, Canthigaster papua, Canthigaster valentini, Centropyge bicolor , Centropyge bispinosa, Centropyge fisheri, Centropyge nox, Centropyge tibicen, Centropyge vrolikii, Cetoscarus ocellatus, Chaetodon semeion, Chelonia mydas, Chlorurus bleekeri , Chlorurus japanensis, Chlorurus microrhinos, Chlorurus sordidus, Chromis amboinensis, Chromis atripes, Chrysiptera brownriggii, Chrysiptera rex, Chrysiptera rollandi, Chrysiptera talboti, Chrysiptera unimaculata, Cirripectes sp, Ctenochaetus binotatus, Ctenochaetus cyanocheilus, Ctenochaetus sp, Ctenochaetus striatus, Hipposcarus longiceps, Kyphosidae sp, Kyphosus cinerascens, Melichthys vidua, Monacanthidae sp, Naso brachycentron, Naso lituratus, Naso thynnoides, Naso tonganus, Naso unicornis, Ostracion, Plectroglyphidodon leucozonus, Scaridae sp., Scarus dimidiatus, Scarus festivus, Scarus flavipectoralis, Scarus forsteni, Scarus frenatus, Scarus fuscocaudalis, Scarus niger, Scarus oviceps, Scarus prasiognathos, Scarus psittacus, Scarus rivulatus, Scarus rubroviolaceus, Scarus schlegeli, Scarus sp., Scarus spinus, Scarus tricolor, Scarus xanthopleura, Siganidae sp, Siganus argenteus, Siganus corallinus, Siganus guttatus, Siganus puellus, Siganus punctatus, Siganus virgatus, Siganus vulpinus, Stegastes albifasciatus, Stegastes fasciolatus, Stegastes sp., Zebrasoma scopas, Zebrasoma veliferum.*

Secondary Consumers (omnivores and invertivores; includes most wrasse, butterflyfish, goatfish, triggerfish, filefish, pufferfish, hawkfish, snapper, several soldierfish, and squirrelfish) *Aeoliscus strigatus, Aetobatus narinari, Amanses scopas, Amblyglyphidodon curacao, Amphiprion ocellaris, Anampses caeruleopunctatus, Anampses melanurus, Anampses meleagrides, Anampses sp, Anampses twistii, Apolemichthys trimaculatus, Arothron hispidus, Arothron mappa, Arothron nigropunctatus, Balistapus undulatus, Balistoides conspicillum, Balistoides viridescens, Bodianus axillaris, Bodianus bilunulatus, Bodianus diana, Bodianus dyctynna, Bodianus mesothorax, Bolbometopon muricatum, Chaetodon adiergastos , Chaetodon auriga, Chaetodon baronessa, Chaetodon bennetti, "Chaetodon citrinellus , Chaetodon decussatus, Chaetodon ephippium, Chaetodon lineolatus, Chaetodon lunula , Chaetodon lunulatus, Chaetodon melannotus, Chaetodon meyeri, Chaetodon ocellicaudus, Chaetodon ornatissimus, Chaetodon punctatofasciatus, Chaetodon rafflesii, Chaetodon speculum, Chaetodon trifascialis, Chaetodon ulietensis, Chaetodon unimaculatus, Chaetodon vagabundus, Chaetodon xanthurus, Chaetodontidae sp, Chaetodontoplus melanosoma, Cheilinus chlorourus,*

Cheilinus fasciatus, Cheilinus oxycephalus, Cheilinus sp., Cheilinus trilobatus, Cheilinus undulatus, Cheilio inermis, Cheilodipterus artus, Cheilodipterus quinquelineatus, Choerodon anchorago, Cirrhitichthys aprinus, Cirrhitichthys oxycephalus, Cirrhitidae sp, Coradion chrysozonus, Coris batuensis, Coris dorsomacula, Coris gaimard, Diagramma melanacrum, Epibulus brevis, Epibulus insidiator, Exallias brevis, Forcipiger flavissimus, Forcipiger longirostris, Genicanthus lamarck, Genicanthus melanospilos, Gnathodentex aureolineatus, Gobiidae sp, Gomphosus varius, Haemulidae sp, Halichoeres biocellatus, Halichoeres chrysus, Halichoeres claudia, Halichoeres hortulanus, Halichoeres margaritaceus, Halichoeres marginatus, Halichoeres melanurus, Halichoeres melasmapomus, Halichoeres miniatus, Halichoeres nebulosus, Halichoeres ornatissimus, Halichoeres pallidus, Halichoeres podostigma, Halichoeres prosopeion, Halichoeres richmondi, Halichoeres scapularis, Halichoeres sp, Halichoeres timorensis, Halichoeres trimaculatus, Hemigymnus fasciatus, Hemigymnus melapterus, Heniochus chrysostomus, Heniochus singularius, Heniochus varius, Hologymnosus annulatus, Hologymnosus doliatus, Labrichthys unilineatus, Labridae sp, Labroides bicolor, Labroides dimidiatus, Labroides pectoralis, Labropsis alleni, Labropsis manabei, Labropsis xanthonota, Lethrinidae sp, Lethrinus erythracanthus, Lethrinus harak, Lethrinus microdon, Lethrinus obsoletus , Lethrinus ornatus, Lutjanidae sp, Lutjanus biguttatus, Lutjanus decussatus, Lutjanus fulviflamma, Lutjanus fulvus, Lutjanus gibbus, Lutjanus kasmira, Lutjanus lunulatus, Lutjanus lutjanus, Lutjanus madras, Lutjanus rivulatus, Macropharyngodon meleagris, Macropharyngodon negrosensis, Malacanthus brevirostris, Malacanthus latovittatus, Monotaxis grandoculis, Mulloidichthys flavolineatus, Mulloidichthys vanicolensis, Myripristis violacea, Neoniphon sammara, Neoniphon sp, Novaculichthys taeniourus, Ostracion meleagris, Ostracion solorensis, Oxycheilinus bimaculatus, Oxycheilinus celebicus, Oxycheilinus sp., Oxymonacanthus longirostris, Paracirrhites arcatus, Paraluteres prionurus, Parapercis clathrata, Parapercis millepunctata, Parapercis sp, Parapercis tetracantha, Parcheilinus flavianalis, Parupeneus barberinus, Parupeneus crassilabris, Parupeneus heptacanthus, Parupeneus indicus, Parupeneus macronemus, Parupeneus multifasciatus, Parupeneus pleurostigma, Pentapodus aureofasciatus, Pervagor janthinosoma, Pervegor melanocephalus, Pinguipedidae sp, Plagiotremus rhinorhynchos, Plagiotremus tapeinosoma, Platax boersii, Plectorhinchus chaetodontoides, Plectorhinchus chrysotaenia, Plectorhinchus gibbosus, Plectorhinchus lessonii, Plectorhinchus lineatus, Plectorhinchus picus, Plectorhinchus polytaenia, Plectorhinchus vittatus, Plectroglyphidodon dickii, Plectroglyphidodon johnstonianus, Pomacanthidae sp, Pomacanthus annularis, Pomacanthus imperator, Pomacanthus navarchus, Pomacanthus semicirculatus, Pomacanthus sexstriatus, Pomacentridae sp, Pseudobalistes flavimarginatus, Pseudocheilinus evanidus, Pseudocheilinus hexataenia, Pseudocheilinus octotaenia, Pseudochromis sp, Pseudocoris heteroptera, Pseudodax moluccanus, Pteragogus enneacanthus, Pterois antennata, Pygoplites diacanthus, Rhinecanthus rectangulus, Rhinecanthus verrucosus, Sargocentron caudimaculatum, Sargocentron diadema, Sargocentron microstoma, Sargocentron spiniferum, Scolopsis affinis, Scolopsis auratus, Scolopsis bilineatus, Scolopsis ciliatus, Scolopsis lineata, Scolopsis monogramma, Scolopsis spp, Scolopsis vosmeri, Scolopsis xenochrous, Stethojulis interrupta, Stethojulis strigiventer, Stethojulis trilineata, Sufflamen bursa, Sufflamen chrysopterum, Sufflamen fraenatum, Taeniura lymma, Taeniura meyeni, Tetraodontidae sp, Thalassoma jansenii, Thalassoma purpureum, Thalassoma quinquevittatum, Upeneus tragula, Valenciennea strigata, Zanclus cornutus

Planktivores

Abudefduf sexfasciatus, Abudefduf vaigiensis, Acanthochromis polyacanthus ,Acanthurus mata Acanthurus nubilus, Acanthurus thompsoni, Amblyglyphidodon aureus, Amblyglyphidodon leucogaster , Amphiprion clarkii, Amphiprion melanopus, Amphiprion perideraion ,Anthias sp, Apogonidae sp, Archamia biguttata, Archamia fucata, Blenniidae sp, Bodianus anthioides, Caesio caerulaurea , Caesio cuning, Caesio lunaris, Caesio teres, Caesionidae sp, Cephalopholis cyanostigma, Cephalopholis polleni, Chaetodon kleinii, Chromis alpha, Chromis analis, Chromis atripectoralis, Chromis delta, Chromis lepidolepis, Chromis lineata, Chromis margaritifer, Chromis retrofasciata, Chromis ternatensis, Chromis viridis, Chromis weberi, Chromis xanthochira,Chromis xanthura, Chrysiptera cyanea, Cirrhilabrus exquisitus, Cirrhilabrus lubbocki ,Cirrhilabrus solorensis,Cirrhilabrus sp, Dascyllus aruanus, Dascyllus reticulatus, Dascyllus trimaculatus, Decapterus macarellus, Ecsenius bicolor, Epinephelus caeruleopunctatus, Gunnellichthys curiosus, Hemitaurichthys polylepis, Heniochus acuminatus, Heniochus diphreutes, Lepidozygus tapeinosoma, Luzonichthys whitleyi, Macolor macularis, Macolor niger, Macolor sp, Meiacanthus atrodorsalis, Melichthys niger, Microdesmidae sp, Myripristinae sp, Myripristis adusta, Myripristis berndti,Myripristis kuntee, Myripristis murdjan, Myripristis vittata, Naso brevirostris, Naso caeruleacauda, Naso hexacanthus, Naso lopezi, Naso vlamingii, Nemateleotris magnifica, Neoglyphidodon crossi, Neoglyphidodon melas, Neoglyphidodon nigroris, Neoglyphidodon thoracotaeniatus, Neopomacentrus azysron, Odonus niger, Paracaesio xanthura ,Paracanthurus hepatus, Parapriacanthus ransonneti, Pempheridae sp, Pempheris oualensis, Pempheris vanicolensis, Plectroglyphidodon lacrymatus, Pomacentrus adelus, Pomacentrus amboinensis, Pomacentrus auriventris, Pomacentrus bankanensis, Pomacentrus brachialis, Pomacentrus coelestis, Pomacentrus lepidogenys, Pomacentrus melanochir, Pomacentrus moluccensis, Pomacentrus nagasakiensis, Pomacentrus nigromarginatus, Pomacentrus pavo, Pomacentrus philippinus, Pomacentrus reidi, Pomacentrus vaiuli, Priacanthus hamrur, Priacanthus sp, Pseudanthias dispar, Pseudanthias huchtii, Pseudanthias hypselosoma, Pseudanthias lori, Pseudanthias parvirostris, Pseudanthias pleurotaenia, Pseudanthias squamipinnis, Pseudanthias tuka, Pseudocoris yamashiroi, Ptereleotris evides, Ptereleotris heteroptera, Ptereleotris zebra, Pterocaesio marri, Pterocaesio pisang, Pterocaesio randalli, Pterocaesio tile, Spratelloides delicatulus, Stethojulis bandanensis, Thalassoma amblycephalum, Thalassoma hardwicke, Thalassoma lunare, Xanthichthys auromarginatus

Piscivores

(includes sharks, large jacks, mackerel, tuna, most groupers, some larger snappers and emperors, moray eels, assorted smaller piscivores such as lizardfishes, trumpetfish, and others)

Aethaloperca rogaa, Anyperodon leucogrammicus, Aphareus furca, Aprion virescens, Aulostomus chinensis, Carangidae sp, Carangoides ferdau,Caranx lugubris, Caranx melampygus, Caranx sexfasciatus, Carcharhinus amblyrhynchos, Carcharhinus melanopterus, Cephalopholis argus, Cephalopholis leopardus, Cephalopholis miniata, Cephalopholis sexmaculata, Cephalopholis sp, Cephalopholis spiloparaea, Cephalopholis urodeta, Cheilodipterus macrodon, Elagatis bipinnulata, Epinephelus bontoides, Epinephelus fasciatus, Epinephelus fuscoguttatus, Epinephelus maculatus, Epinephelus merra, Epinephelus sp, Epinephelus spilotoceps, Euthynnus affinis, Fistularia commersonii,Gracila albomarginata, Grammatorcynus bilineatus, Gymnosarda unicolor, Gymnothorax javanicus, Gymnothorax sp, Heteroconger hassi, Lethrinus olivaceus, Lethrinus xanthochilus, Lutjanus bohar,

Lutjanus carponotatus, Lutjanus ehrenbergii, Lutjanus monostigma, Oxycheilinus digramma, Oxycheilinus unifasciatus, Paracirrhites forsteri, Parupeneus cyclostomus, Plectropomus areolatus, Pterois volitans, Scomberoides lysan, Scomberomorus commerson, Scombridae sp, Scorpaenopsis diabolus, Serranidae sp, Sphyraena barracuda, Sphyraena qenie, Synodontidae sp, Synodus dermatogenys, Synodus jaculum, Triaenodon obesus, Tylosurus crocodilus, Variola albimarginata, Variola louti