The **Fisheries Improved for Sustainable Harvest** Project

Consolidated Report: Baseline Assessment of the Capture Fisheries and Marine Protected Areas (Reef Habitats) in the FISH Project's Focal Areas: Coron Bay, Danajon Bank, Lanuza Bay, and Tawi-Tawi Bay

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LIST OF ABBREVIATIONS AND ACRONYMS

FISH	Fisheries Improved for Sustainable Harvest
FPR	FISH Project Result
GPS	global positioning system
kg	kilogram
km	kilometer
LGU	local government unit
m	meter
MPA	marine protected area
PR	Project Result
t	ton
UPVFI	University of the Philippines in the Visayas Foundation, Inc.

1.0 INTRODUCTION

The main objective of the FISH Project is to conserve biological diversity in the four selected target areas through improved management of fish stocks and the fish habitats that support them in order to achieve an expected result of 10 percent increase in fish stocks by 2010. The objective is to increase marine fish stocks by at least 10% over this period as expressed in the FISH Project Result (FPR):

FPR - Marine fish stocks increased by 10% (over 2004 baseline levels) in focal areas by year 2010.

The main objective will be measured in terms of change in the marine fish stocks from 2004 to 2010.

The single measure of 10 percent increment is the FISH Project Result (FPR) and will be based mainly on Project Result (PR) 1, 2, and 3:

PR1 -	Abundance of selected fisheries resources in focal areas (% change in catch per unit effort compared to baseline based on fishery-independent methods)
PR2 -	Catch rate of selected fisheries in focal areas (% change in catch per unit effort compared to baseline based on fishery-dependent methods)
PR3 -	Reef fish density and biomass inside and adjacent to selected MPAs in focal areas (% change in biomass/500 m^2 compared to baseline)
PR4 -	Reef fish species richness within and adjacent to selected MPAs in four focal areas (average % change in number of species/500 m^2 compared to baseline)
PR5 -	Benthic condition inside and adjacent to selected MPAs in four focal areas (average % change in living coral cover compared to baseline)

This document summarizes the data collection activities, sampling procedures employed, and results to measure the various PRs. The methods used in the baseline data collection and analysis during the various surveys conducted in the four FISH Project areas from March to November 2004 will also serve as the standard method for the subsequent monitoring in 2006, 2008, and the final measurement in 2010. The procedures and methods were designed in such a way that subsequent monitoring events including the final measurement will be conducted in the same or at least a similar manner, replicating sampling stations, sampling procedures, and sampling periods. The sampling period will be replicated with the phase of the moon as reference. Baseline data collected will be used as reference point for determining the impact of FISH Project interventions on the fish stocks and will also serve as initial input to the fisheries profile of the project sites. The fisheries baseline was determined and established using the most practical methods applicable for the exploited multispecies fish stocks in the tropics. The choice of methods and parameters measured was based on the following:

- All potential practical means to measure changes in marine fish stocks were considered.

- Both fisheries dependent and fisheries independent methods were utilized.
- The choice of fisheries independent methods used in each area was based on skills available, practicality, and sustained use of gear in the area.
- Other fisheries related data and information were collected to supplement the evaluation of the primary project result.
- To the extent possible, practical methods were included such that these can be carried out by the stakeholders even after the project life.

2.0 METHODS

Fisheries baseline data were collected in selected sampling sites of the coastline and coastal waters of the focal areas in Danajon Bank, Calamianes Group of Islands, Surigao del Sur, and Tawi-Tawi (Figure 2-1). Considered as focal areas are the municipal waters of Coron Bay (Figure 2-2a) in Calamianes Group of Islands; Talibon, Bien Unido, Ubay and Pres. C.P. Garcia (Figure 2-2b) in Danajon Bank; Lanuza Bay (Figure 2-2c) in Surigao del Sur; and Tawi-Tawi Bay (Figure 2-2d) in Tawi-Tawi.

FIGURE 2-1
LOCATION OF FISH PROJECT TARGET AREAS

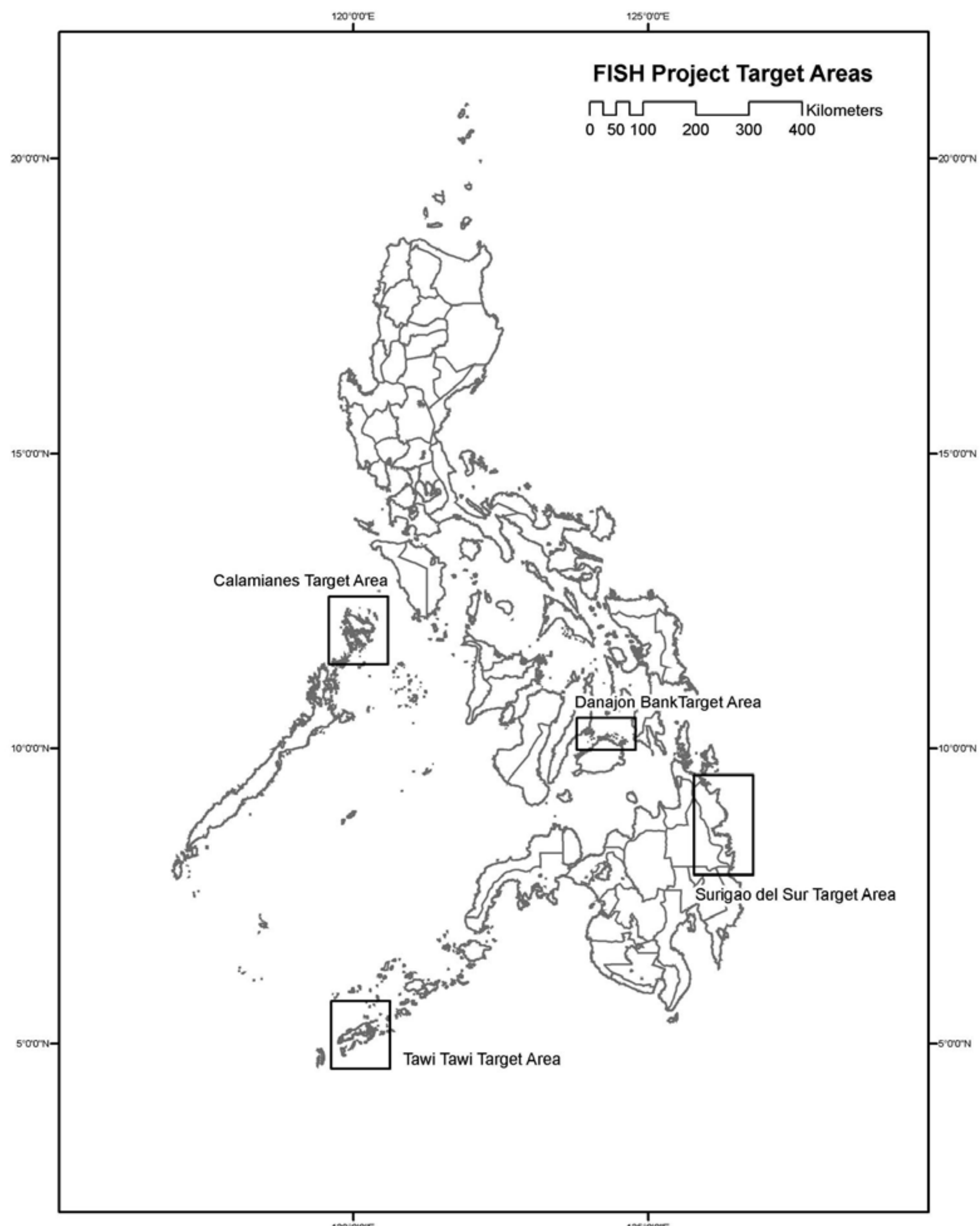


FIGURE 2-2a
CALAMIANES FOCAL AREA

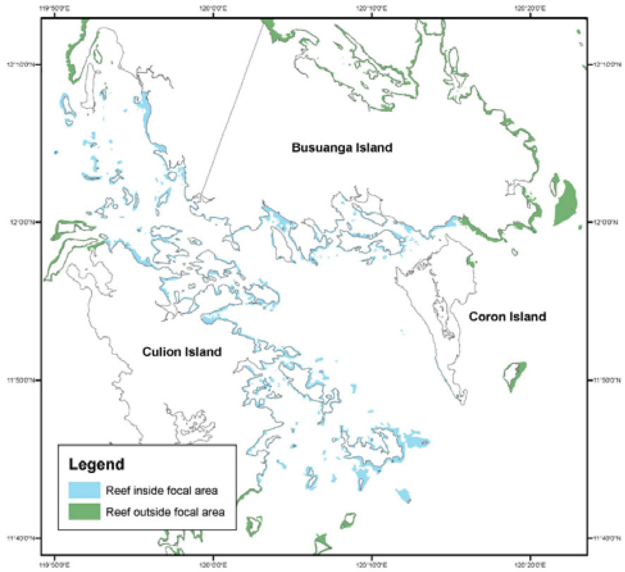


FIGURE 2-2b
DANAJON BANK FOCAL AREA

FIGURE 2-2c
LANUZA BAY FOCAL AREA

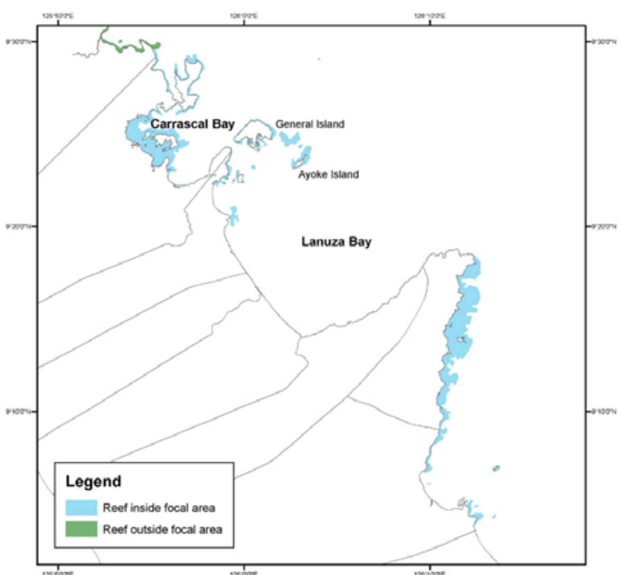


FIGURE 2-2d
TAWI-TAWI FOCAL AREA

2.1 ASSESSMENT OF CAPTURE FISHERIES

Two core teams were formed: one for Danajon Bank and Surigao del Sur and the other for Calamianes Group of Islands and Tawi-Tawi. A senior researcher leads each core team supported by a junior researcher, a catch and effort monitoring coordinator and 10 to 14 enumerators in each focal area. Two major tasks were performed in each focal area: a 3 to 4-week experimental fishing task and a 3-month catch and effort monitoring period. The former task was to serve as basis for estimating PR1 and latter was to serve as input for computing PR2. The junior researcher was primarily tasked to assist the senior researcher in the test fishing experiments while the catch and effort monitoring coordinator was assigned to supervise the enumerators and perform weekly data encoding. Encoded data passed through a quality control process before they were uploaded to a database prepared for the capture fisheries baseline assessment component.

The various activities under the capture fisheries baseline assessment and their actual schedule of implementation in the four focal areas are summarized in Table 2-1. Initial activities included the finalization of sampling design for test fishing, harmonization of catch and effort monitoring procedures, and standardization of forms and templates. Likewise, preliminary test fishing stations for candidate fishing gears were mapped out and possible deployment of enumerators were evaluated.

TABLE 2-1
SCHEDULE OF CAPTURE FISHERIES BASELINE ASSESSMENT ACTIVITIES DURING THE YEAR 2004

	Activities	**Month (Year 2004)**								
		Mar	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**
Cebu Office	Recruitment of core team members	■								
	Finalization of sampling design	■								
	Standardization of methods, forms, etc.	■	■							
	Development of encoding template		■	■	■					
	Database development			■	■	■				
	Data quality control & quality assurance				■	■	■	■	■	■
	Data input into the database					■	■	■	■	■
Danajon Bank	Coordination with LGU		■							
	Hiring of assistants and enumerators		■							
	Training of assistants and enumerators		■							
	Catch and effort monitoring			■	■	■				
	Experimental fishing			■	■					
	Data encoding and quality control			■	■	■	■			
	Report writing						■			
Coron Bay	Coordination with LGU		■	■						
	Hiring of assistants and enumerators		■							
	Training of assistants and enumerators		■	■						
	Catch and effort monitoring			■	■	■	■			
	Experimental fishing			■						
	Data encoding and quality control			■	■	■	■			
	Report writing						■	■		

TABLE 2-1 (continued)
SCHEDULE OF CAPTURE FISHERIES BASELINE ASSESSMENT ACTIVITIES DURING THE YEAR 2004

	Activities	Month (Year 2004)																																			
		Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov			
Tawi-Tawi Bay	Coordination with LGU																■	■	■	■																	
	Hiring of assistants and enumerators															■	■																				
	Training of assistants and enumerators																■	■																			
	Catch and effort monitoring																		■	■	■	■	■	■	■	■	■	■	■	■							
	Experimental fishing																		■				■	■	■												
	Data encoding and quality control																			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
	Report writing																																		■	■	■
Lanuza Bay	Coordination with LGU																	■	■																		
	Hiring of assistants and enumerators																	■	■																		
	Training of assistants and enumerators																		■	■																	
	Catch and effort monitoring																				■	■	■	■	■	■	■	■	■	■	■	■					
	Experimental fishing																					■	■	■													
	Data encoding and quality control																						■	■	■	■	■	■	■	■	■	■	■	■	■	■	
	Report writing																																		■	■	■

Pre-sampling activities in each focal area included a round of inspection of the entire area prior to actual field mobilization, focusing on rapid site appraisal and informal interview of randomly-selected local fishers and government authorities, mostly members of the local government units (LGU). The purpose of this activity is to obtain preliminary insights into the nature and extent of the fishing operations in the study area. The data obtained provided the basis for the subsequent work scoping and scaling of field manpower to execute the sampling plan. This was followed by the recruitment and organization of the test fishing and field monitoring teams to implement the pre-designed scope of work within the specified timeframe. The latter entailed a preparatory phase for hiring, training, tasking, deployment, and trial runs for data collection.

To provide a more or less complete and unbiased picture of the current state (base level in year 2004) of the harvestable fish stocks, both fishery-independent and fishery-dependent survey methods were utilized. In each focal area, a selection of fishing gear types were randomly deployed for the conduct of fishery-independent surveys. Catch and effort of all fishing gears were monitored for 3 months for the fishery-dependent survey. The fishery-independent survey provide unbiased estimates of stock sizes. The general plan was to deploy fishing gears in fishing areas randomly selected for the study. The fishery-dependent survey aims to provide estimates of the current level of catching rates by all fishing gears used in the area. Catch and effort information were collected in representative landing sites selected for the study.

Fishery-Independent Surveys to Measure PR1

Independent of the fishing activities in each focal area, the project team conducted exploratory or test fishing operations using fishing gears regularly used in the area and expected to be still in use during the entire life of the project. The selection of sampling stations (where test fishing runs were conducted) considered the locations of traditional or regular fishing grounds in the focal area. To ensure a random selection of the sampling stations, all possible fishing grounds for a gear were identified and plotted in consultations with local fishers. Each fishing ground or sampling station was assigned a number. The selection of fishing stations and sequence of test fishing runs were then determined through drawing of lots. This spatial distribution of stations and sequence of test fishing runs in each of the focal areas will be followed for future assessments throughout the entire life of the project.

Among the fishing gears considered for the survey across the four focal areas were the trawl, bottom-set longline, bottom-set gillnet, fish trap, crab pot, and beach seine. Although the trawl survey is considered as one of the more accurate methods in determining fish biomass, especially the demersal stocks, conducting this survey was possible only in Danajon Bank where the gear is still being tolerated. Trawl fishing is no longer allowed in Coron Bay, Lanuza Bay, and Tawi-Tawi Bay. Other fishing gears in the focal areas that were ultimately used in the fishery-independent surveys were the bottom-set longline, fish trap, and bottom-set gillnet (Table 2-2).

TABLE 2-2
FISHERIES INDEPENDENT SURVEYS CONDUCTED IN THE FOCAL AREAS

Fishing gears	Focal Areas			
	Danajon Bank	Coron Bay	Lanuza Bay	Tawi-Tawi Bay
Trawl	✓			
Bottom-set longline	✓	✓	✓	✓
Fish Trap	✓			✓
Bottom-set gillnet			✓	✓

Trawl Survey

Municipal permits from all concerned municipalities were obtained a month before conducting the survey. The trawl survey was scheduled for 4 days, and local government units and law enforcers were informed prior to the conduct of the activity. Twenty trawl stations were distributed throughout the focal area following the stratified sampling scheme. In addition, four control stations were assigned outside the focal area. Trawl stations were distributed to various water depth strata and relative to the area covered by each stratum. A trawl fishing gear commonly used in Danajon Bank was used. An external fine mesh net was added to cover the codend to collect smaller-sized fishes. The cover was made chiefly of fine mesh multifilament knotless net used to compensate for the selectivity inherent to the trawl fishing gear. Test fishing was conducted from May 19 to 22, 2004. Survey in additional fishing stations serving as control was conducted on July 5, 2004.

An outrigger fishing boat powered by a 65 horsepower Fuso 4DR5 engine was used for the trawling operation. The trawl net was 8.67 meters long with a footrope and headrope of 8.9 meters and 11.08 meters, respectively. A standard 30-minute dragging time was observed per trawl station. Catches were analysed and recorded per sampling station. Species caught were identified to species level with their corresponding common name in the area. Lengths of important and abundant species were measured and recorded and their frequency distributions established.

Bottom-set Longline Survey

Seven units of bottom-set longlines in Danajon Bank and six each in Coron Bay, Lanuza Bay, and Tawi-Tawi Bay were rented for this particular test fishing activity. A standard number of hooks and hook sizes were adhered to in each focal area following what is commonly used and peculiar to each area (Table 2-3). Whenever possible, only one type of bait was used. However, this became dependent upon what was actually available in the area during the survey period.

TABLE 2-3
SPECIFICATIONS AND MODE OF OPERATION OF BOTTOM-SET LONGLINE USED FOR TEST FISHING IN THE FOCAL AREAS

Gear specifications and mode of operation	Focal area			
	Danajon Bank	Coron Bay	Lanuza Bay	Tawi-Tawi Bay
Date of survey	Jun 15-23, 2004	May 23-28, 2004	Aug 8-17, 2004	Jul 10-15, 2004
Number of units	7	6	6	6
Number of hooks/unit	1,000	800	800	200
Hook size number	#566	#563 and #565	#562	#17 & #18
Bait	squid	anchovy/scad	anchovy	sardine/scad
Typical time of setting	3:00-5:00 a.m.	2:00–5:00 a.m.	3:00–6:00 a.m.	7:00-12:00 p.m.
Typical soak time	1 hour	1-2 hours	1-2 hours	1-2 hours
Number of settings/day	1	1	1	2-3
Number of fishing stations	30	33	30	69
Number of control stations	5	2	6	2

A focus group discussion with bottom-set longliners in each focal area was conducted primarily to identify their traditional fishing grounds and also to find out probable difficulties and problems that may be encountered in the course of the survey. Using the interview results, fishing stations were selected within the focal area and a few control sites outside the focal area. For each day of test fishing run, six sampling stations (seven in Danajon Bank) out of the entire identified fishing stations were selected at random. During the actual operation, the coordinates of the start and end of the mainline were determined and recorded. Soak times ranged from 1 to 2 hours and operations were carried out usually between 2:00 a.m. to 6:00 a.m. in Danajon Bank, Coron Bay, and Lanuza Bay, and from 7:00 p.m. to 12:00 p.m. in Tawi-Tawi Bay. Information gathered included total weight of the catch, species composition, weight and number per species, and length-frequency distribution of abundant species.

Fish Trap Survey

A focus group discussion with the local fish trap operators was conducted prior to the actual exploratory fishing survey to identify traditional fishing grounds for fish traps in the area and also to find out probable difficulties that may be encountered in the course of the fish trap surveys. A cluster of fish traps constitute a fish trap unit. Seven were used in Danajon Bank and five in Tawi-Tawi Bay (Table 2-4). In Danajon Bank, a cluster consisted of ten pots, while in Tawi-Tawi Bay it only consisted of six pots. Only fish traps commonly used the areas were used.

For each day of test fishing run, seven sampling stations in Danajon Bank and five in Tawi-Tawi Bay out of the entire identified fishing stations were selected at random. However, out of the ten sites identified in Tawi-Tawi only five were found accessible due to poor weather condition during the survey period. Coordinates of the fish pots during setting and hauling were recorded using the global positioning system (GPS). Soak time was 2 days in Danajon Bank and 3 days in Tawi-Tawi. The traps were hauled after the soaking period and then reset for the next operation after retrieval of the catch. Pot catches were segregated in labeled plastic bags for analysis back at the base port. Information gathered included total weight of the catch, species composition, weight and number per species, and length-frequency distribution of abundant species.

TABLE 2-4
SPECIFICATIONS AND MODE OF OPERATION OF FISH TRAPS USED FOR TEST FISHING IN THE FOCAL AREAS

Gear specifications and mode of operation	Focal area			
	Danajon Bank	Coron Bay	Lanuza Bay	Tawi-Tawi Bay
Date of survey	May 30 - Jun 12, 2004	n.a.	n.a.	Aug 13-25, 2004
Number of clusters	7	n.a.	n.a.	5
Number of pots/cluster	10	n.a.	n.a.	6
Soak period	2 days	n.a.	n.a.	3 days
Number of fishing stations	30	n.a.	n.a.	23
Number of control stations	5	n.a.	n.a.	0

Bottom-set Gillnet Survey

Four bottom-set gillnet units in Lanuza Bay and and three in Tawi-Tawi Bay were used for the survey. Each gillnet unit used in Lanuza Bay consisted of three pairs of panels made of mesh sizes 6, 7, and 8 knot mesh. Each panel had a standard length of 66 meters and a standard height of 50 meshes. Each gillnet unit used in Tawi-Tawi Bay consisted of 12 gillnet panels of different mesh sizes (7 and 8 knot mesh). The sequence of the various mesh size panels constituting each unit was determined randomly before each fishing run.

The fishing operations were designed following the common practice in the area. All possible bottom-set gillnet areas were identified through a focus group discussion with the bottom-set gillnet fishers. Sampling stations for each day of operation were selected randomly from the identified bottom-set gillnet areas.

Table 2-5 shows the specifications of the bottom-set gillnet survey in Lanuza Bay and Taw-Tawi Bay. Four sampling stations in Lanuza Bay and three in Tawi-Tawi bay were covered each day. Only one setting per day was done in Lanuza Bay while 2 setting operations per fishing station were made in Tawi-Tawi Bay, one in the late afternoon and another the following morning. Soak time per operation was 2 hours in Lanuza Bay and 1 hour in Tawi-Tawi Bay. The exact coordinates of the locations where the gears were set were recorded with a GPS. The catch from one gillnet unit was treated as one aggregate catch. However, upon hauling, the catch from panels with different mesh sizes were segregated and recorded separately. Information gathered included total weight of the catch, species composition, weight and number per species, and length-frequency distribution of abundant species.

TABLE 2-5
SPECIFICATIONS AND MODE OF OPERATION OF BOTTOM-SET GILLNETS USED FOR TEST FISHING IN THE FOCAL AREAS

Gear specifications and mode of operation	Focal area			
	Danajon Bank	Coron Bay	Lanuza Bay	Tawi-Tawi Bay
Date of survey	n.a.	n.a.	Oct 1-10, 2004	Aug 11-15, 2004
Number of units	n.a.	n.a.	4	3
Number of panels/unit	n.a.	n.a.	6	12
Length per panel	n.a.	n.a.	66 meters	200 meters
Height of panel	n.a.	n.a.	50 meshes	1 meter
Mesh sizes	n.a.	n.a.	#6, #7, and #8	#7 and #8
Typical time of setting	n.a.	n.a.	2:00–6:00 a.m.	a.m. and p.m.
Typical soak time/setting	n.a.	n.a.	2 hours	1 hour
Number of settings/day	n.a.	n.a.	1	2
Number of fishing stations	n.a.	n.a.	22	23
Number of control stations	n.a.	n.a.	6	0

Fishery-dependent Surveys to Measure PR2

Fishery-dependent surveys consisted mainly of catch and effort monitoring of all fishing activities during a specific period of time, in this case, 3 months. The assumption is that in subsequent project monitoring of this kind will also be conducted during the same 3-month period in years 2006, 2008, and 2010.

To get accurate results from the catch and effort monitoring activities, a field training was conducted before the actual monitoring. This consisted of discussion of the purpose of catch and effort monitoring, introduction to the basic principles of sampling, elaboration of the project sampling design, catch sampling strategies, and proper behavior during the catch sampling process. Actual catch monitoring practice runs were conducted for several days for the enumerators to practice and develop their skills following the proper sampling procedure.

To facilitate field activity, major and minor disembarkation areas for fishing boats were identified as strategic landing sites to improve visit schedule of enumerators. A preliminary record of the time and place of landings by landing site was acquired to organize the sampling plan in line with transportation schedules. Local residents were hired as enumerators through the assistance of local officials. The enumerator's assignment depended upon proximity, volume of catch landed, and frequency of landings. After some minor adjustments, catch and effort monitoring was regularly conducted in selected major and minor landing sites in each focal area (Figures 2-3 to 2-6).

The catch monitoring schedule followed a 3-day cluster scheme, designating the first 2 successive days for field work and the third day as rest day. The scheme always starts on the first day of each month. This provides a higher likelihood of sampling both lean and peak days of fishing, covering holidays, weekends, and "must" fishing days, such as market days.

The data collected include volume of catch landed per gear sampled, species composition of landed catch per gear with corresponding weight (kilograms), count (number) and length (centimeters, measured as fork length) measurements, and effort measurement (boat dimension, mode of propulsion, engine power, and gear specifications). Species landed were recorded using either the scientific names (as identified) or their local names. Identification of their scientific names was undertaken using the taxonomic guides provided in Rau and Rau (1980) and Masuda *et al.* (1984). The specific fishing areas for each of the monitored landed catch were also recorded with reference to a gridded map of the waters of the focal area (Figures 2-3 to 2-6). The location of the landing sites and the gridded map will be retained throughout the life of the project.

FIGURE 2-3
GRID MAP AND CATCH AND EFFORT MONITORING POINTS IN DANAJON BANK

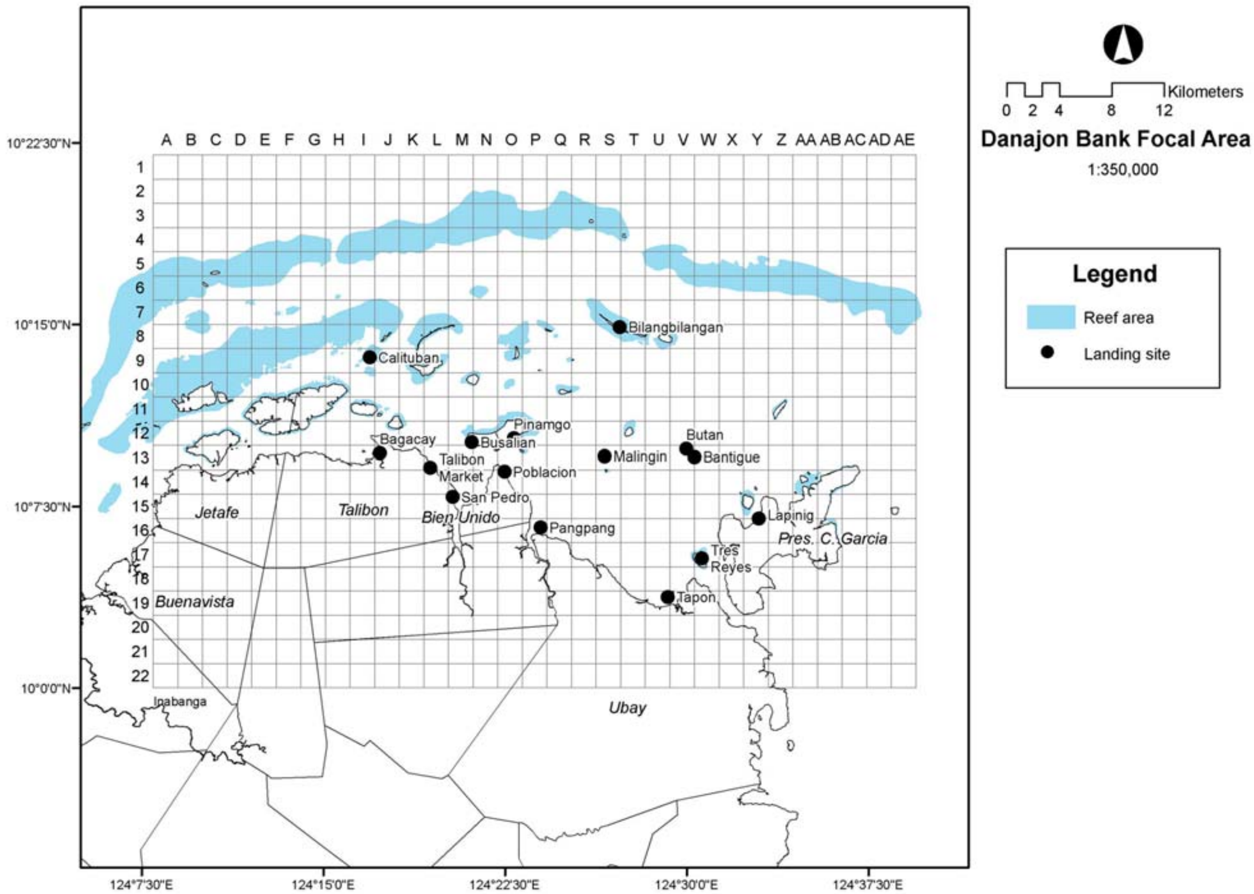


FIGURE 2-4
GRID MAP AND CATCH AND EFFORT MONITORING POINTS IN CORON BAY

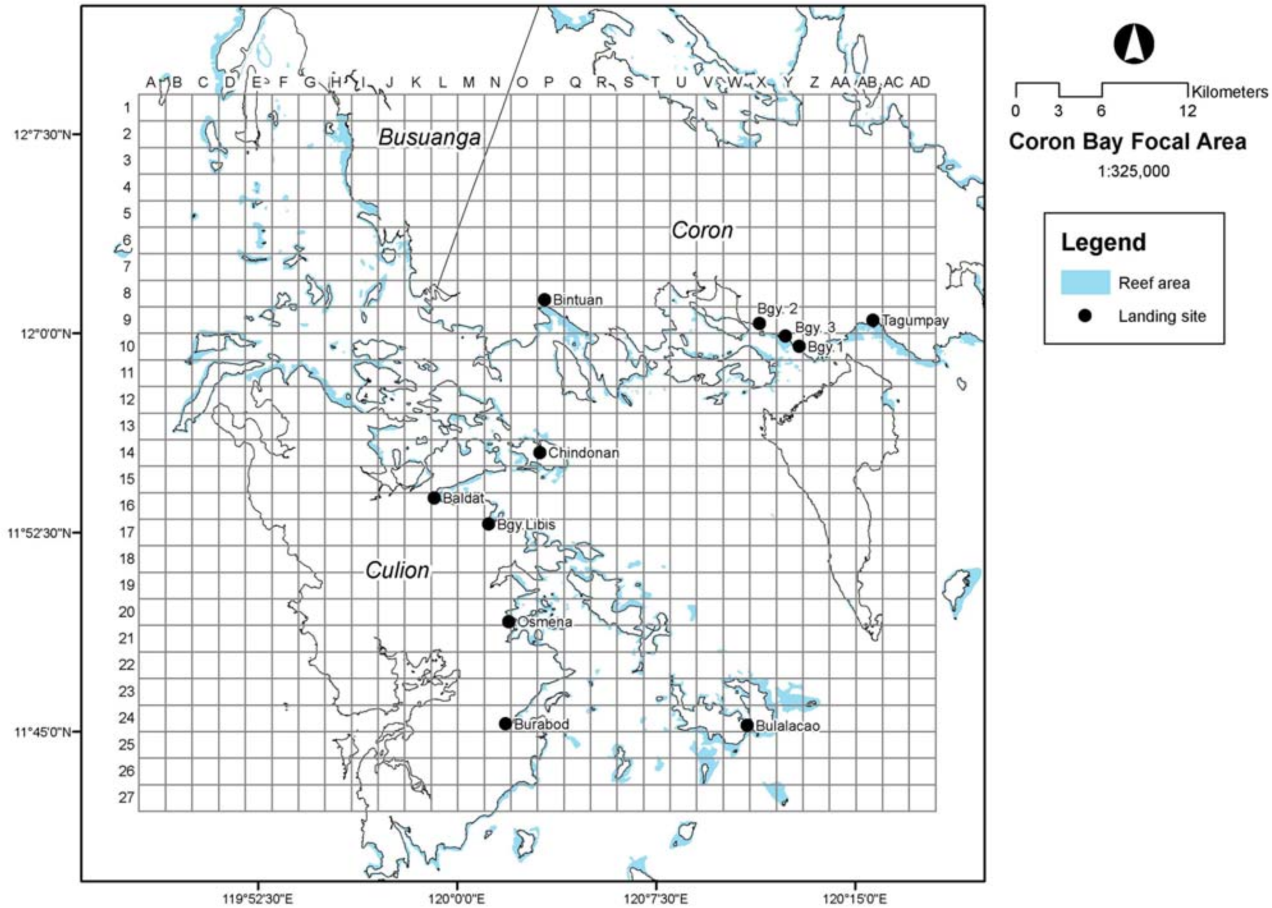


FIGURE 2-5
GRID MAP AND CATCH AND EFFORT MONITORING POINTS IN LANUZA BAY

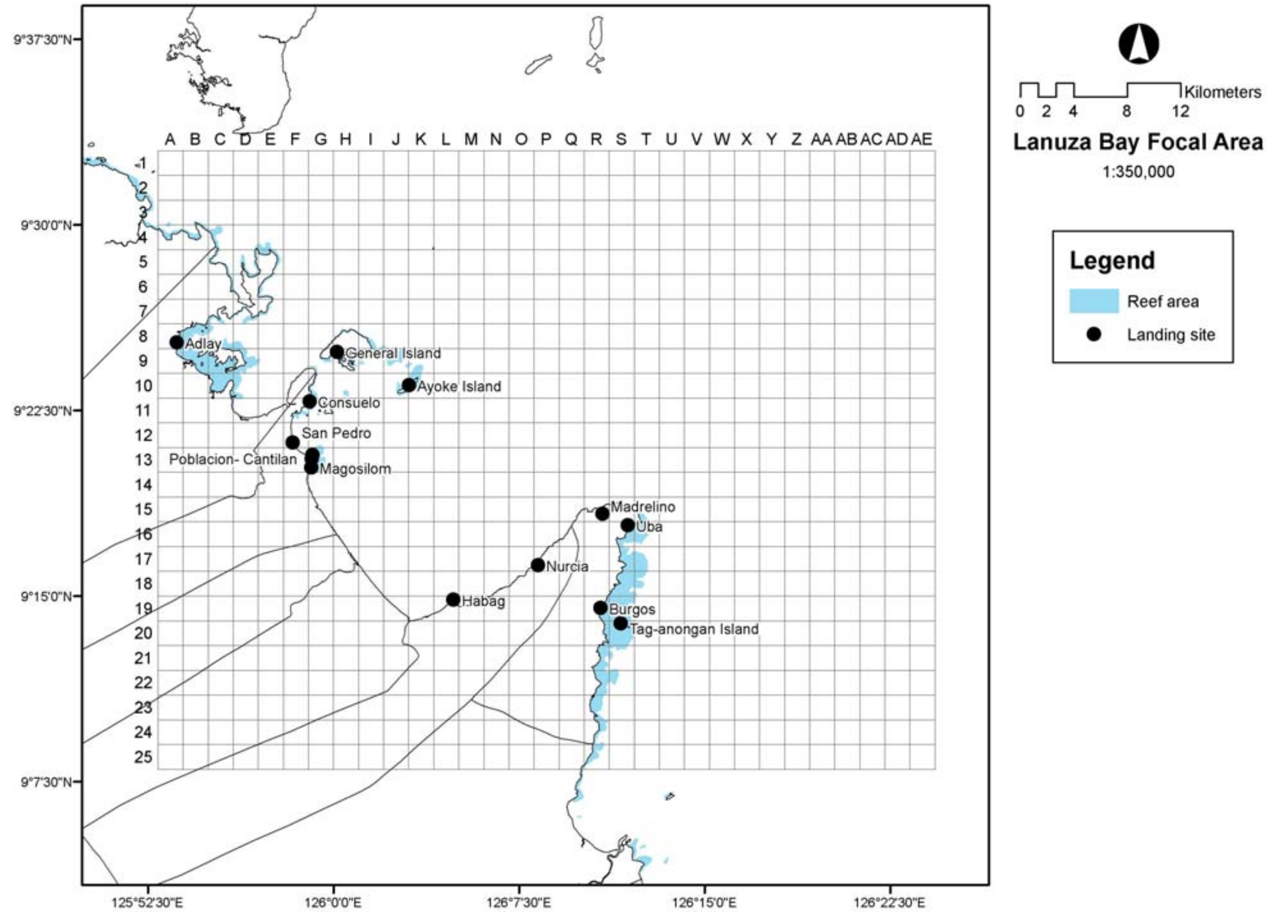
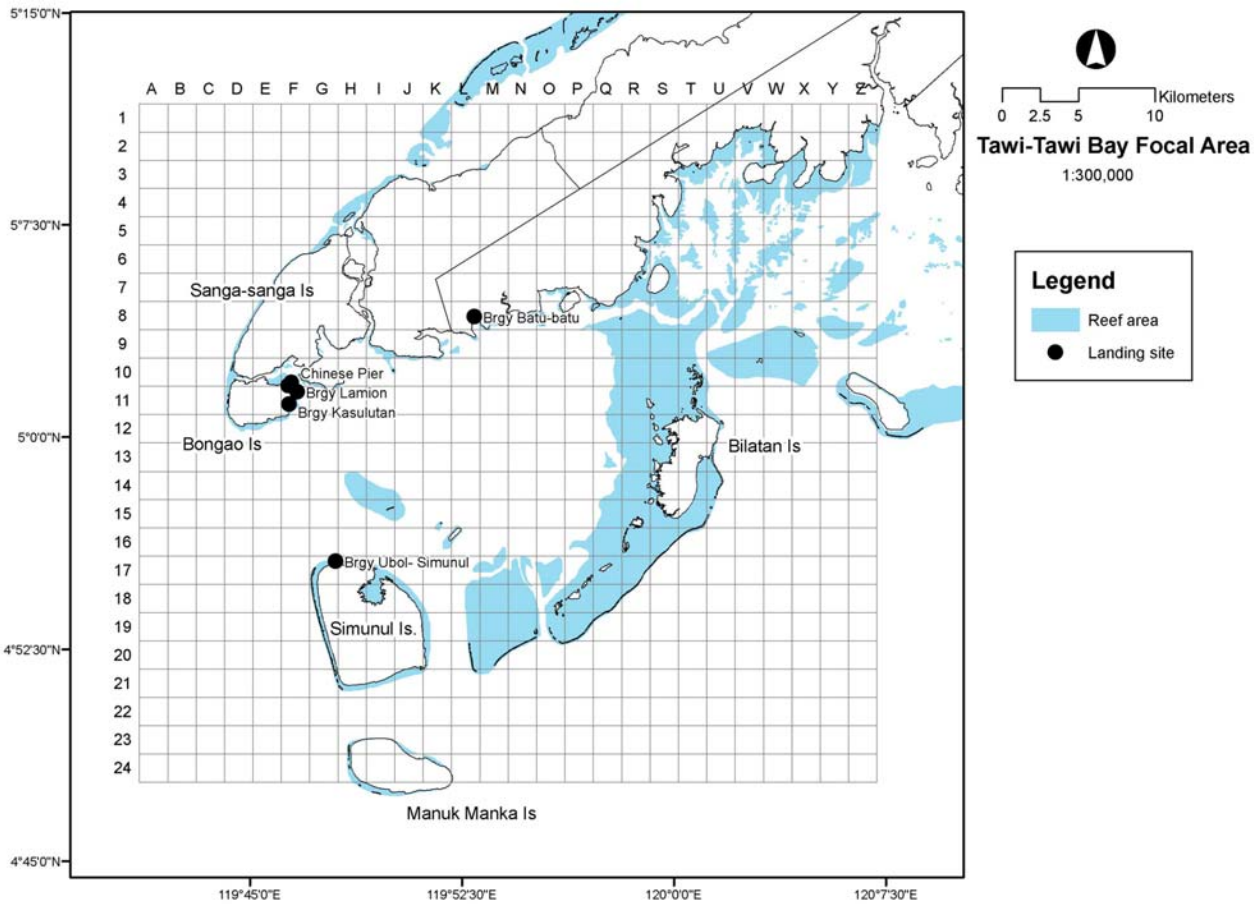


FIGURE 2-6
GRID MAP AND CATCH AND EFFORT MONITORING POINTS IN TAWI-TAWI BAY



2.2 ASSESSMENT OF MARINE PROTECTED AREAS

The FISH Project contracted the University of the Philippines in the Visayas Foundation Inc. (UPVFI) to conduct marine protected area (MPA) baseline assessment in the Calamianes, Surigao del Sur, and Tawi-Tawi focal areas, and Silliman University to do the same assessment in Danajon Bank. The following describes the methods used by these research groups.

Selection of Study Sites and Transects Within a Site

In each focal area, assessment teams conducted reconnaissance surveys to select MPAs to be included in the baseline assessment. The set of criteria listed in the Baseline Assessment Plan guided the selection process (Table 2-6).

TABLE 2-6
CRITERIA FOR SELECTING MPAS TO INCLUDE IN THE BASELINE ASSESSMENT

Criterion	Rationale
1. Recently established or not functioning well	Benefits (or lack thereof) from the MPA should be traceable to the supportive initiatives of the FISH Project
2. Minimum size of 10 ha; preferred size greater than 20 ha	More likely to be effective and thus more likely to exhibit detectable signs of improvement
3. No-take zone is present and likely to be enforced	Strong community support or interest in establishing or managing an MPA
4. Habitat has ecological value and potential for improvement	Live coral cover present, possible source or sink for coral reef, and fisheries recruitment

Except in Danajon Bank where several previously established MPAs were found, there were less than three MPAs in each focal area at the time of baseline assessment. This presented the opportunity to select sites where the FISH Project would facilitate the establishment of MPAs and to obtain "before MPA establishment" measurements of the performance indicators in these sites.

In selecting potential MPA sites, the following were considered: (i) exposure to waves, (ii) coastline shape/indentation, (iii) proximity to mangroves and linked shallow water habitats, and (iv) coarse estimates of living coral cover and general reef condition as determined by manta tow surveys.

Manta tow surveys covered as many of the reef areas as possible to construct a broad picture of the distribution of live coral cover within the chosen portion of the focal area. In a manta tow, an observer towed by a pumpboat makes a series of 2-minute observations along a path that follows the reef slope as close as possible. The observer uses a mask and snorkel and handles a manta board tied by rope to the pumpboat. In this survey, the observer estimated the cover of live hard coral, live soft coral, dead coral, dead coral with algae, abiotics (sand, rocks, or water), and others (algal beds, and other flora and fauna). He then listed these on an underwater slate mounted on the manta board after each 2-minute observation. Geographical coordinates of each observation were obtained using a handheld GPS unit. After transcriptions of the observations, the results were plotted on a map of the focal area to assist in selection of sites where base levels of performance indicators would be measured.

In addition to the above considerations, a site assessed by the independent baseline contractor in each focal area was included among the sites assessed during the baseline assessment in accordance with the instruction of USAID. This was intended to facilitate comparison of results.

The significance of site selection should be noted. Not only did it establish sites to be surveyed in detail using transects, it identified areas where the FISH Project would encourage MPA establishment and management by local communities.

As a rule, 5 transects inside and 5 transects adjacent to an MPA were established for data collection, for a total of 10 transects per MPA. Likewise, the assessment of a potential MPA site generally involved the use of 10 transects evenly distributed through the site. In some instances, however, unforeseen circumstances necessitated deviations from these rules.

Fish Visual Census to Estimate PR3 and PR4

Reef fish assemblages were surveyed using a modification of the standard visual census technique described by English *et al.* (1994). A 50 meter transect line was set parallel to depth contours along the reef slope. All fish encountered within 5 meters of the slope-side (Calamianes, Surigao del Sur, and Tawi-Tawi) or within 5 meters of both sides of the line (Danajon) were identified, counted, and their sizes (fork lengths) estimated to the nearest centimeter.

Fish biomass (kg/500m^2) was derived using size estimates from the surveys and length-weight conversions (of the form $W = aL^b$). The species-specific parameters a and b of such conversions are available from various references.

In addition to total fish biomass, this report presents information on fish biomass of indicator and target species, in accordance with the Baseline Assessment Plan. Species belonging to the family Chaetodontidae are indicators of good reef health because they feed on polyps of corals. Target species are targeted by fishers because they generally command the highest prices. In this report, those considered as target species belong to the following families: Acanthuridae, Haemulidae, Lethrinidae, Serranidae/Epinephelinae, Lutjanidae and Siganidae. Finally, although not mentioned in the Baseline Assessment Plan, this report includes a third category of reef fish, the commercially valuable fish species, which are comprised of target species plus locally valuable species (such as caesionids and scarids). This third category would give us an idea of the amount of foodfish.

Species richness was derived from the number of species encountered in the transect, which is automatically recorded in fish visual census. The unit for species richness in the sites surveyed in the Calamianes Islands, Surigao del Sur, and Tawi-Tawi is "No. of species/250m^2" because 5 meters of the slope side of the 50 meters transect was surveyed (5m x 50m = 250 m^2). On the other hand, the unit for species richness in Danajon Bank is "No. of species/500m^2" because both sides of the 50m transect were surveyed. Unlike abundance and biomass estimates, the number of species cannot be raised to obtain a unit with a convenient "per area" component because species richness is a non-proportional function of the area surveyed.

Point Intercept Technique to Estimate PR5

The percentage cover of living corals as well as other benthic life forms (such as soft corals, sponges, and others) was determined using the point intercept technique (Uychiaoco *et al.* 2000). Life forms intercepted every 0.25 meter by the 50 meter transect line were recorded, thus yielding 200 data points from each transect. The fraction of the 200 points in which a particular life form occurred was used to estimate the percentage cover of the lifeform. The same transect used in fish visual census was utilized in this type of survey.

In addition to percentage of living coral cover, supportive indices were calculated from the life form data, in accordance with the Baseline Assessment Plan. These indices are the Mortality Index (Gomez *et al*. 1994), the Development Index, the Condition Index and the Succession Indices (Manthachitra 1994). These indices with brief explanations are presented in Table 2-7.

Other Data Collected

The research teams also collected data on physical characteristics of the reef such as depth of transect and reef bottom, visibility, slope and substrate rugosity, which are routinely collected in such surveys. In addition, the research teams were asked to take advantage of opportunities to collect other data on reef resources apart from those that would be used for calculating the performance indicators. These include data on the abundance of juvenile fish and macro-invertebrates. In this report, these other data are not presented but references to them are made when they illuminate the main findings of the baseline assessment. These data will be included in the coastal profiles of the focal areas.

TABLE 2-7
ADDITIONAL INDICES OF REEF HEALTH

Index	Remarks
Mortality Index (MI) $= \frac{DC}{DC + HC}$	The fraction of hard corals that is dead. Note that the denominator represents the total living space available to hard corals.
Development Index (DI) = log (CRC / ARC) or DI = log [(LC + DC + Algae + OT) /Abiotics]	The ratio of coral reef-related components (CRC) to abiotic-related components (ARC). Provides a picture of 'the natural background of the reef".
Condition Index (CI) = log (LC / DRC) or CI = log [LC / (DC + Algae + OT)]	The ratio of live coral to dead coral-related components (DRC). Suggests the degree of stress on a reef.
Succession Index I (SI-I) SI-I = log (Algae/ (DC + OT))	The first of two indices that attempt to detect succession occurring on dead coral. Useful for monitoring reef recovery. SI-I refers to succession by algae.
Succession Index II (SI-II) SI-II = log (OT/ (DC + Algae))	SI-II refers to succession by other fauna.
Legend: DC = percentage cover of dead coral HC = percentage cover of hard coral LC = percentage cover of live coral	 Algae = percentage cover of algae OT = percentage cover of other fauna Abiotics = percentage cover of abiotics

Comparisons with the Results of the Independent Baseline Contractor

To the extent possible, this report attempts to compare the results of the FISH Project research teams with those obtained by the independent baseline contractor. However, the comparisons were not straightforward, that is, it was not possible to incorporate the results of the independent baseline contractor into the tables and figures of this report. For example, in the case of reef fish and benthos, the report of the independent baseline contractor did not present findings in summary tables but in graphs. While it might have been possible to obtain the actual values from graphs by eye, the values obtained would have been unreliable. In the particular case of reef fish, the independent baseline contractor did not include raw data from fish visual census in the appendix that is supposed to contain all their raw data.

Comparisons were possible when actual values were mentioned in the text. However, caution should be taken when interpreting such comparisons because in each site the independent baseline contractor conducted only 2 transects—one inside and one outside an MPA—compared with the 5 to 12 (mostly 10) transects per site conducted by the teams contracted by the FISH Project.

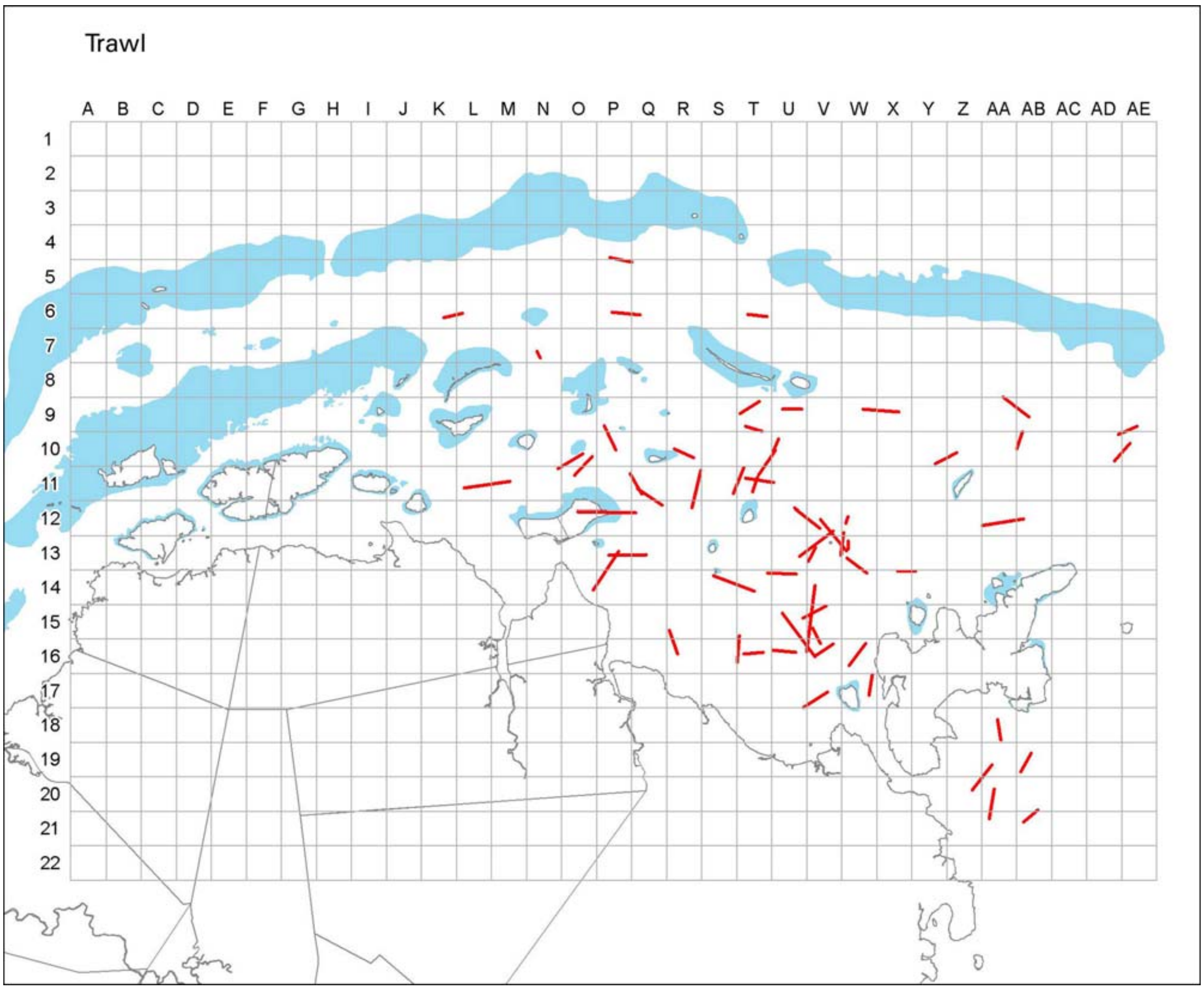
3.0 RESULTS AND DISCUSSION

3.1 PROJECT RESULT 1: ABUNDANCE OF SELECTED FISHERIES RESOURCES IN FOCAL AREAS

Trawl Survey

The trawl survey was conducted from May 19 to 22, 2004 and 05 July 2004 covering between 4 to 6 stations per day. Figure 3-1 shows the actual tracts trawled during that period. Two dragging operations had to be repeated due to gear break down and rough sea condition. Surveys in the 4 additional control stations outside the focal area were conducted in 05 July 2004.

FIGURE 3-1
FISHING TRACTS TRAWLED IN DANAJON BANK FROM MAY 19 TO 22, 2004 AND JULY 5, 2004



A total of 124 kg was caught from 24 successful drags in the trawl survey operations. An average of 4.54 kg (from catch of both codend and cover) was computed per 30-minute trawl operation from the 19 sampling stations surveyed and 7.6 kg for the 5 control stations (Table 3-1). The computed average catch retained at the cover represents the escapement from the codend. This is equivalent to 8.8 percent of the overall mean.

TABLE 3-1
SUMMARY OF CATCH (KG) PER OPERATION OF TRAWL TEST FISHING IN DANAJON BANK FROM MAY 19 TO 22, 2004 AND JULY 5, 2004

A. All catch included			
	Codend	**Cover**	**Total**
Survey station results:			
Average catch per operation	4.14	0.39	4.54
Standard deviation	5.54	0.88	5.89
n	19	19	19
Control station results:			
Average catch per operation	6.49	1.11	7.60
Standard deviation	3.55	1.61	5.12
n	5	5	5
B. Excluding jellyfish, sea urchins, and starfish			
	Codend	**Cover**	**Total**
Survey station results:			
Average catch per operation	1.16	0.17	1.33
Standard deviation	1.53	0.20	1.62
n	19	19	19
Control station results:			
Average catch per operation	5.98	1.11	7.09
Standard deviation	2.93	1.61	4.46
n	5	5	5

Jellyfishes, sea urchins, and starfishes constituted about 71 percent of the trawl catch. Excluding them from the computation would mean an average catch of only 1.33 kg per 30-minute trawl operation. This is equivalent to an average trawlable biomass density of 0.45 t/km^2, estimated using the average trawling speed of 2.65 km/hr and head rope of 8.9 meters. Compared in Table 3-2 are the average demersal biomass densities estimated from the trawl survey conducted in Danajon Bank and other estimates derived from selected fishing grounds in the Philippines. It indicates a very low demersal standing biomass for Danajon Bank, even much lower compared to highly overfished traditional fishing grounds like Manila Bay, Lingayen Gulf, and San Miguel Bay.

The dominant species in the catch was the pony fish, *Leiognathus splendens*, which comprised 42.9 percent of the total catch volume (Table 3-3). This was followed by lizard fish (*Saurida tumbil*), puffer fish (*Arothron* sp.), flathead (*Platycephalus indicus*), and goatfish (*Upeneus tragula*). A majority of the catch do not belong to the valuable species category. Valuable species appear only in small numbers and often very small individual sizes. All of these are indicative of heavy exploitation of the demersal stock that has resulted into biological overfishing.

TABLE 3-2
ESTIMATES OF THE AVERAGE DEMERSAL STOCK BIOMASS FROM TRAWL SURVEY IN DANAJON BANK COMPARED TO OTHER SELECTED FISHING GROUNDS IN THE PHILIPPINES

Fishing ground	Year	Biomass (t/km^2)	Source
Carigara Bay	1979-80	2.00	Armada & Silvestre, 1981
	1995-96	1.04	Pura, *et al.*, 1997
Lingayen Gulf	1978-79	1.33	Villoso & Aprieto, 1983
	1987-88	0.57	Ochavillo *et al.*, 1989
Manila Bay	1949-50	4.61	Warfel & Manacop, 1950
	1968-72	1.71	Silvestre *et al.*, 1987
	1992-93	0.47	Armada, 1994
San Miguel Bay	1947	10.60	Warfel & Manacop, 1950
	1980-81	2.13	Vakily, 1982
	1992-93	1.96	Cinco *et al.*, 1995
	1995-96	1.31	Soliman & Dioneda, 1997
Danajon Bank	2004	0.45	FISH, 2004

TABLE 3-3
RELATIVE ABUNDANCE, BY WEIGHT AND NUMBER, OF THE TOP 10 SPECIES CAUGHT DURING TRAWL SURVEY IN DANAJON BANK FROM MAY 19 TO 22, 2004

	Species/group	Local name	% Weight	% Number
1	*Leiognathus splendens*	dangay, potpot	42.9	72.0
2	*Saurida tumbil*	banghutin	7.4	0.3
3	*Arothron* sp.	butete	7.3	0.5
4	*Platycephalus indicus*	sunugan	6.4	0.3
5	*Upeneus tragula*	timbungan	4.2	3.4
6	Loliginidae	taroroton	3.8	1.5
7	*Apogon* sp. 1	moong	3.6	3.0
8	*Scolopsis taeniopterus*	silay	2.9	0.9
9	*Loligo* sp.	taroroton, nokos	2.5	0.6
10	*Leiognathus rivulatus*	potpot	2.3	3.5
	Others		16.7	14.0

Bottom-set Longline

The GPS readings of actual areas of operations of the bottom-set longline in the four focal areas are plotted in maps presented in Figures 3-2 to 3-5. These plots show more or less the fishing areas frequented by the bottom-set longline fishers in the different focal areas. Their choice of fishing ground is dictated by the depth and topography of the bottom. While they were deployed more or less throughout Danajon Bank, Lanuza Bay, and Tawi-Tawi Bay, bottom-set longline operation in Coron Bay were confined to areas near the coastline.

FIGURE 3-2
BOTTOM-SET LONGLINE STATIONS IN DANAJON BANK SAMPLED FROM JUNE 15 TO 23, 2004

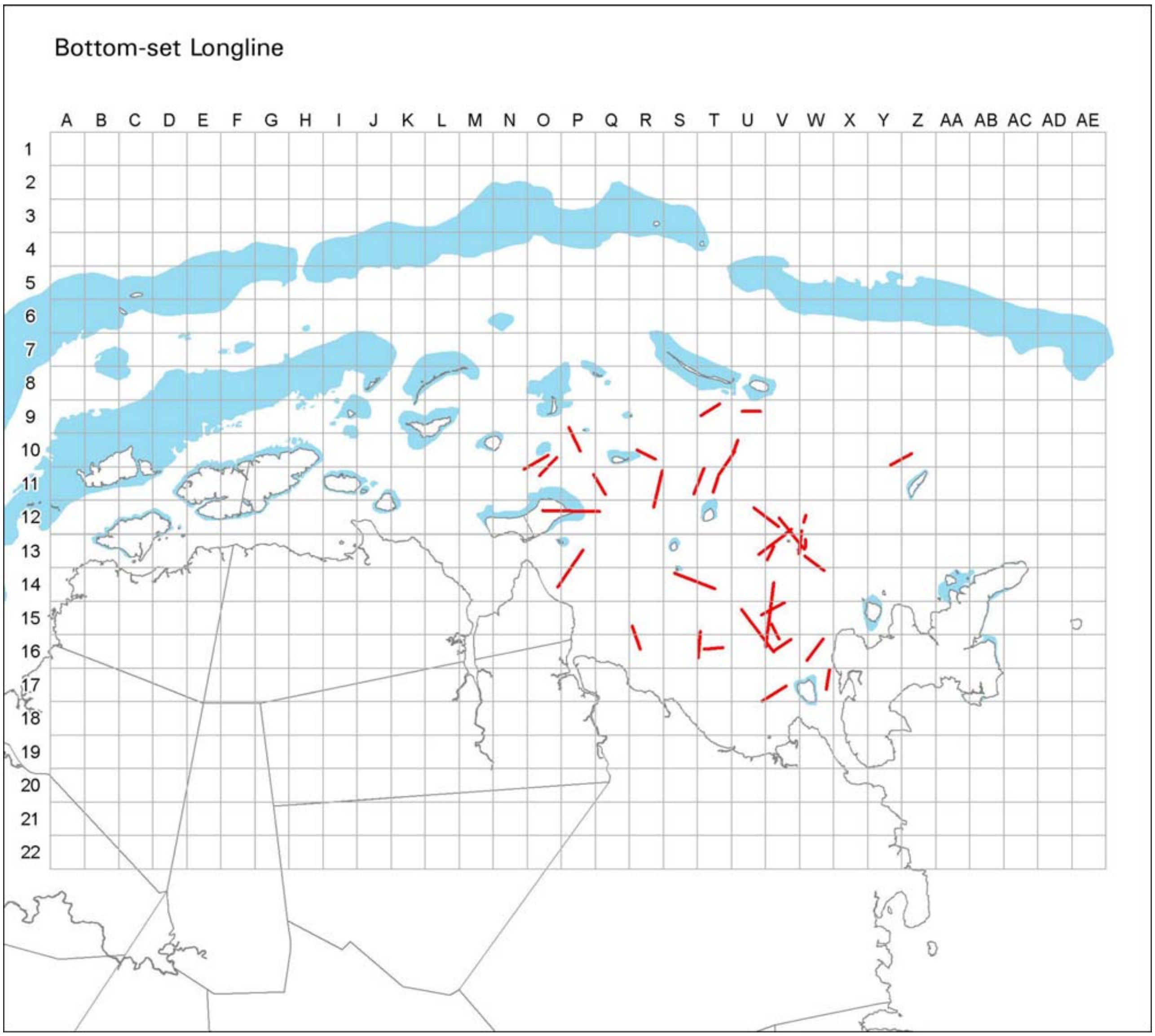


FIGURE 3-3
BOTTOM-SET LONGLINE STATIONS IN CORON BAY SAMPLED FROM MAY 23 TO 28, 2004

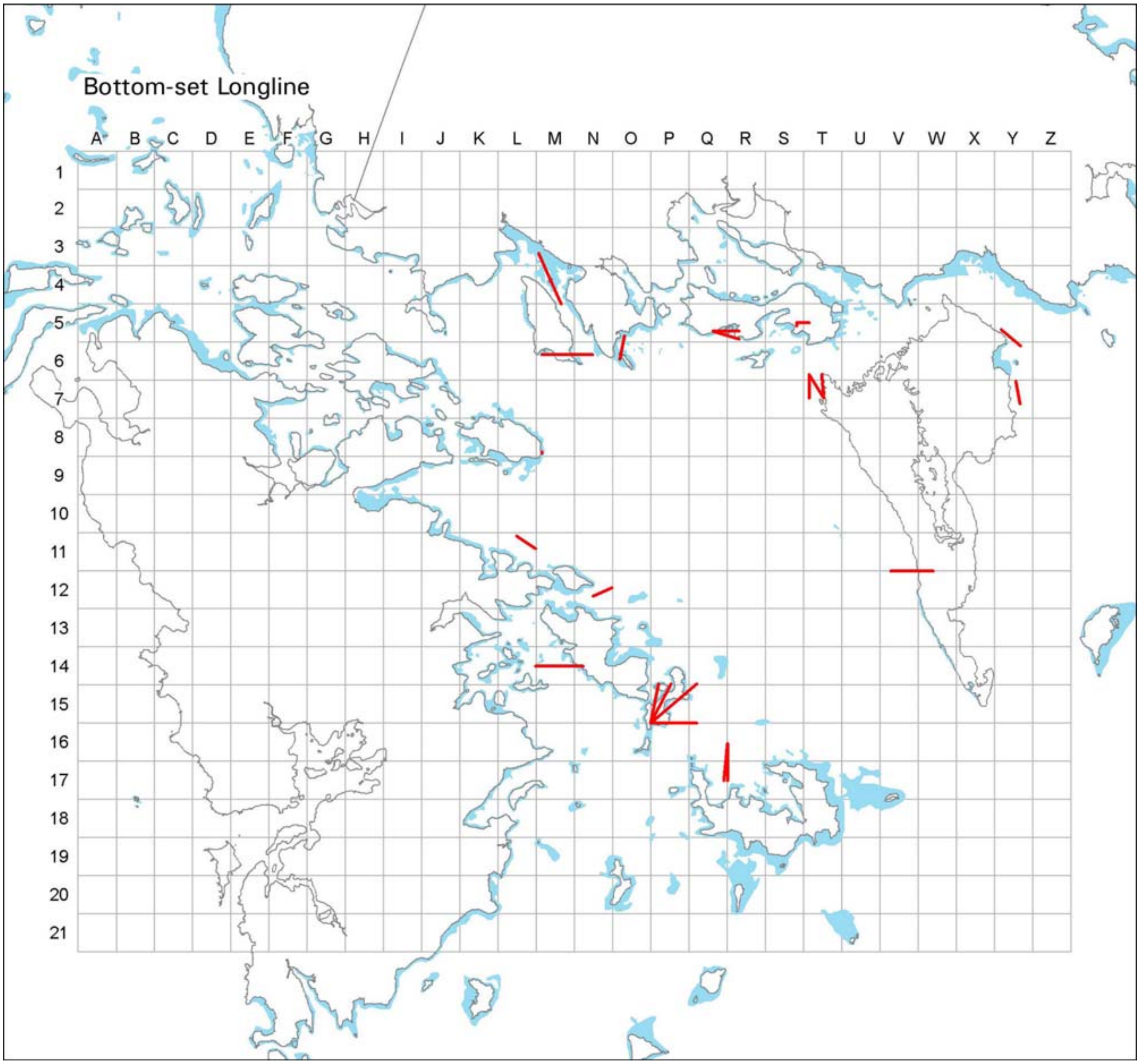


FIGURE 3-4
BOTTOM-SET LONGLINE STATIONS IN LANUZA BAY SAMPLED FROM AUGUST 8 TO 17, 2004

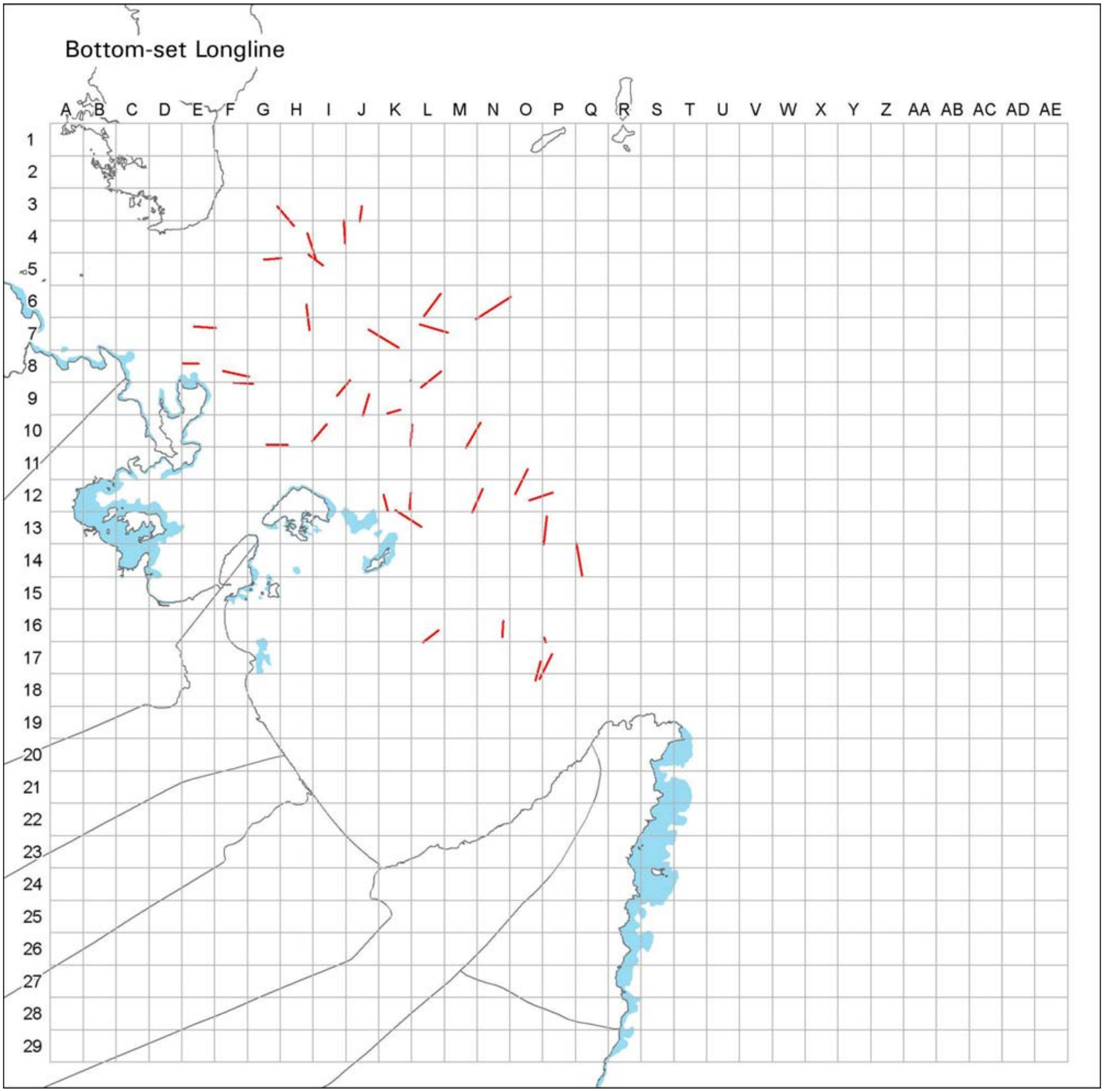


FIGURE 3-5
BOTTOM-SET LONGLINE STATIONS IN TAWI-TAWI BAY SAMPLED FROM JULY 10 TO 15, 2004

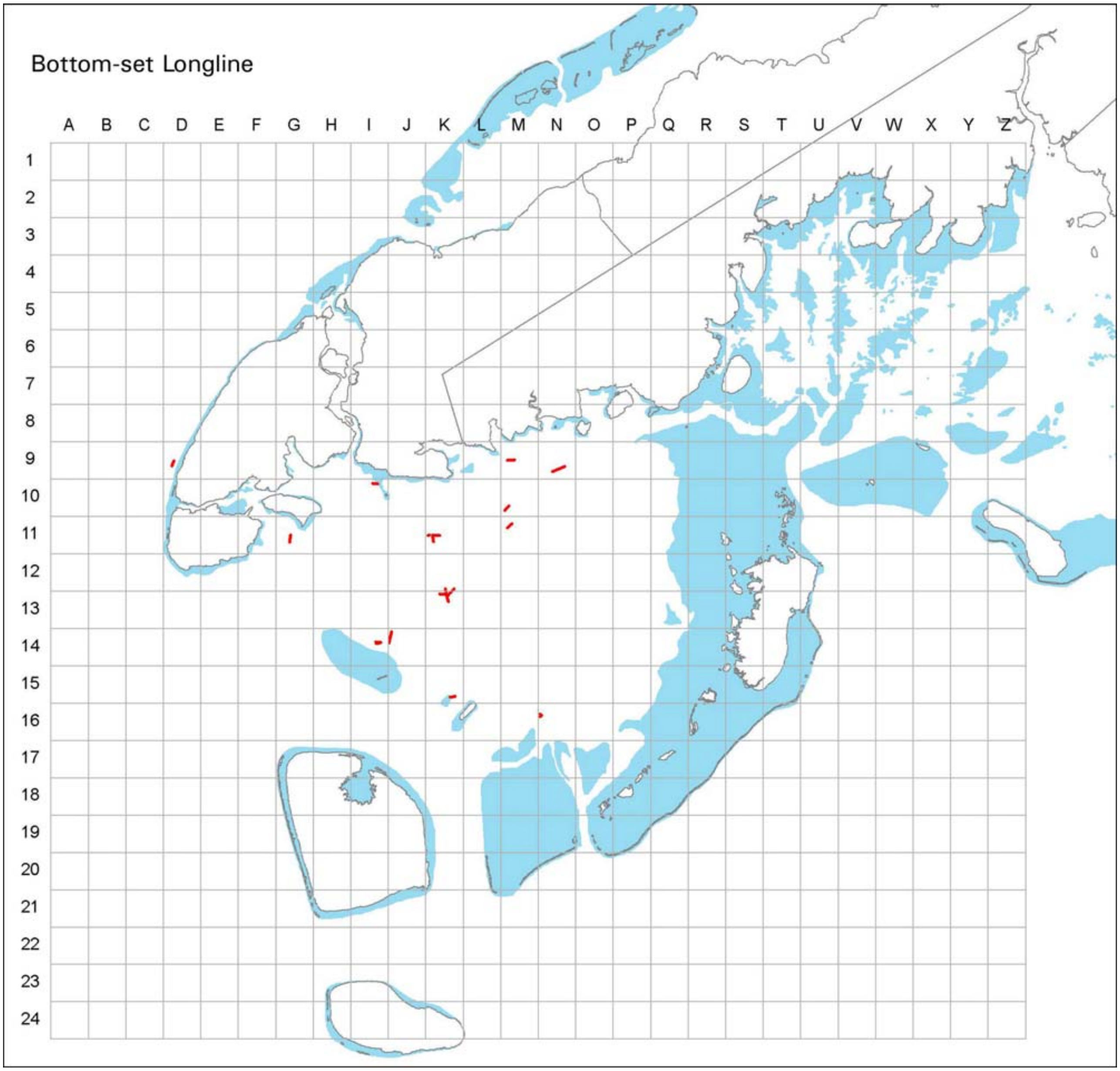


Table 3-4 summarizes the catch per operation in the four focal areas showing Coron Bay having the highest and Tawi-Tawi Bay the lowest. However, taking into consideration the typical number of hooks used in each area, Tawi-Tawi Bay becomes the highest and Danajon Bank the lowest.

TABLE 3-4
SUMMARY OF CATCH PER OPERATION OF BOTTOM-SET LONGLINE USED FOR TEST FISHING IN THE FOCAL AREAS IN 2004

	Focal area			
	Danajon Bank	**Coron Bay**	**Lanuza Bay**	**Tawi-Tawi Bay**
Number of hooks	**1,000**	**800**	**800**	**200**
Survey stations result:				
Average catch per operation	4.77	7.06	4.87	3.71
Standard deviation	3.03	3.20	3.63	2.89
n	30	33	30	69
Control stations result:				
Average catch per operation	5.66	3.48	4.11	0.95
Standard deviation	2.39	2.30	0.71	0.64
n	5	2	6	2

The catch in Danajon Bank (Table 3-5) was dominated by *Therapon jarbua*, locally known as "*bugaong*" followed by *Lethrinus lentjan* or "*katambak.*" Species with higher economic value, such as the groupers and the snappers, are not well represented in the catch. With the exception of the squirrel fishes or *Apogon* sp*.* all the other species comprising the top 10 in the catch of the bottom-set longline in Coron Bay (Table 3-6) have high economic value. The catch was dominated by very high valued species like the groupers and snappers. Various threadfins (*Nemepterus* spp.) and *Lethrinus lentjan* were the dominant species in Lanuza Bay (Table 3-7) and Tawi-Tawi Bay (Table 3-8), respectively.

TABLE 3-5
TOP 10 SPECIES CAUGHT DURING THE BOTTOM-SET LONGLINE OPERATION IN DANAJON BANK

#	**Species**	**Local name**	**% Weight**	**% Number**
1	*Therapon jarbua*	*bugaong*	50.6	35.7
2	*Lethrinus lentjan*	*katambak*	15.5	13.3
3	*Nemipterus hexodon*	*lagaw*	5.8	4.7
4	Congridae	*obod*	3.6	6.8
5	*Lutjanus chrysotaenia*	*manilan-on*	3.4	1.9
6	*Pentapodus setosus*	*siwsiw*	2.9	9.2
7	*Epinephelus sexfasciatus*	*pugawo*	1.3	0.2
8	*Gymnothorax* sp.	*bakasi, panangitan*	1.2	5.1
9	Muraenidae	*obod*	1.2	2.1
10	*Alutera monoceros*	*saguksuk*	1.1	0.1
	Others		13.4	20.7
	Total		100.0	100.0

TABLE 3-6
TOP 10 SPECIES CAUGHT DURING THE BOTTOM-SET LONGLINE OPERATION IN CORON BAY

#	Species	Local name	% Weight	% Number
1	*Lethrinus mahsena*	*mangagat*	35.2	7.9
2	*Apogon* spp.	*buslit*	11.6	9.3
3	*Lutjanus carponotatus*	*manilan-on*	5.8	6.8
4	*Lutjanus lutjanus*	*okag*	4.7	2.7
5	*Epinephelus macrospilus*	*suno*	4.3	6.0
6	*Pentapodus caninus*	*silay, silay puti*	4.2	6.3
7	*Lethrinus lentjan*	*kanuping*	3.5	1.9
8	*Lates calcalifer*	*apahap*	2.5	3.0
9	*Dasyatis kuhlii*	*pagi*	2.4	1.1
10	*Lethrinus ornatus*	*kanuping*	2.2	3.6
	Others		23.6	51.4

TABLE 3-7
TOP 10 SPECIES CAUGHT DURING THE BOTTOM-SET LONGLINE OPERATION IN LANUZA BAY

#	Species	Local name	% Weight	% Number
1	*Nemipterus* spp.	*Sagisi*	11.4	22.6
2	*Lutjanus lineolatus*	*saging saging*	7.5	14.2
3	*Lethrinus lentjan*	*katambak, kilawan*	7.3	2.3
4	*Plectorynchus pictus*	*Lipti*	6.9	1.1
5	*Nemipterus peronii*	*Sagisi*	6.7	8.1
6	*Lutjanus vitta*	*Puga*	4.7	5.8
7	*Lutjanus malabaricus*	*maya maya*	4.4	0.6
8	*Priacanthus tayenus*	*wakwak, wakwak lawihan*	3.9	5.8
9	*Etelis coruscan*	*Sagisi*	3.5	1.5
10	*Priacanthus* sp.	*Wakwak*	3.3	1.3
	Others		40.4	36.7

TABLE 3-8
TOP 10 SPECIES CAUGHT DURING THE BOTTOM-SET LONGLINE OPERATION IN TAWI-TAWI BAY

#	Species	Local name	% Weight	% Number
1	*Lethrinus lentjan*	*Laypapa*	16.6	11.7
2	*Lutjanus lutjanus*	*bahu-bahu*	11.3	10.4
3	*Procyllum venustum*	*kaytan tukkih*	10.9	8.3
4	*Nemipterus tolu*	*Kulisih*	9.7	19.9
5	*Gymnothorax flavimarginatus*	*indung manangitan*	4.5	3.9
6	*Dasyatis kuhlii*	*Kyampaw*	4.3	1.9
7	*Aetobatus narinari*	*pagi manuk*	4.1	0.2
8	*Himantura uarnak*	*pagi lan*	4.0	0.2
9	*Gymnothorax fimbriatus*	*Indung*	3.8	3.9
10	*Ginglymostoma cirratum*	*kaytan bissuh*	2.5	1.1
	Others		28.3	38.5

Fish Traps

Three clusters were lost during the fish trap fishing operation in Danajon Bank perhaps due to displacement of the gear because of underwater current or theft. They were immediately replaced with spare clusters and fishing operations were moved to other sites to avoid similar occurrence. Figure 3-6 and 3-7 show the GPS plots of successful sampling points in Danajon Bank and Tawi-Tawi Bay. Fish traps in these areas were mostly deployed in rocky bottom and near coral reefs. There was, however a big difference in the catch rates between the two areas (Table 3-9). The 10 traps per cluster in Danajon Bank had a catch rate of only 1.06 kg per fishing run (2 days soaking time) while the 6 traps per cluster in Tawi-Tawi Bay had a catch rate of 5.48 kg per fishing run (3 days soaking time)

TABLE 3-9
SUMMARY OF CATCH PER OPERATION OF FISH TRAP DURING TEST FISHING IN THE FOCAL AREAS

	Focal area			
	Danajon Bank	Coron Bay	Lanuza Bay	Tawi-Tawi Bay
Survey stations result:				
Average catch per operation	1.06			5.48
Standard deviation	0.68			3.58
n	30			23
Control stations result:				
Average catch per operation	1.93			
Standard deviation	0.52			
n	5			

FIGURE 3-6
FISH TRAP STATIONS IN DANAJON BANK SAMPLED FROM MAY 30 TO JUNE 12, 2004

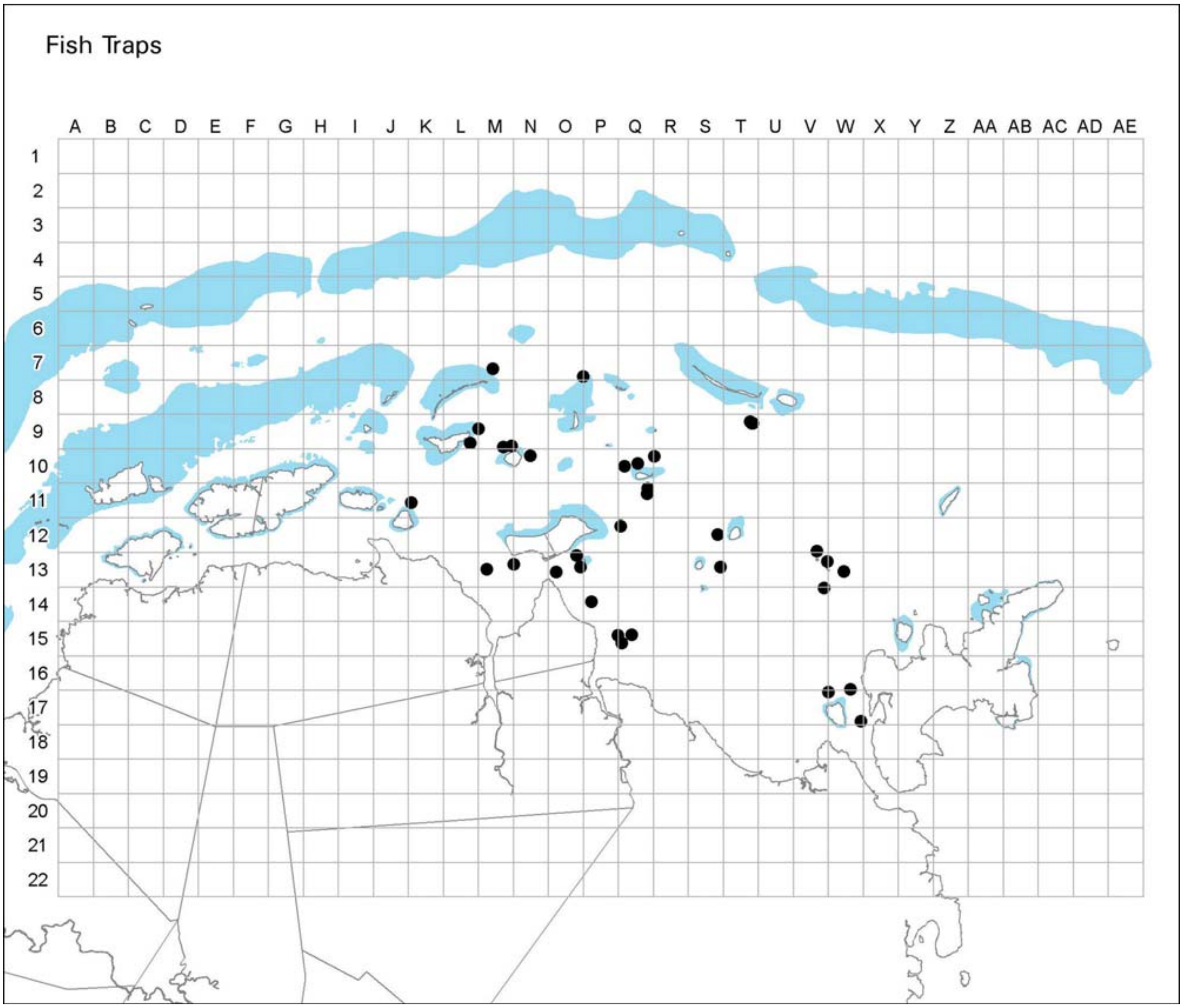
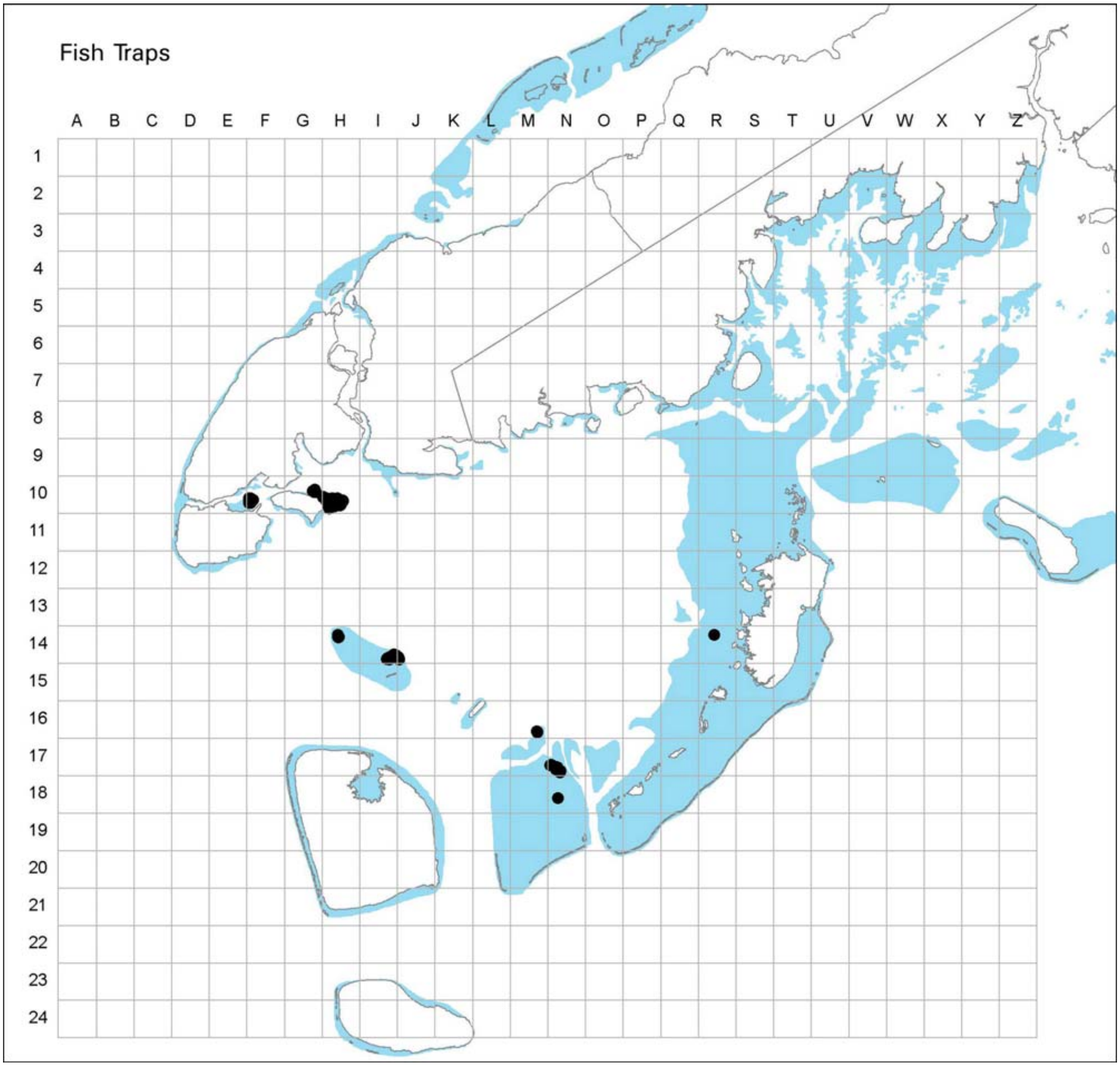


FIGURE 3-7
FISH TRAP STATIONS IN TAWI-TAWI BAY SAMPLED FROM AUGUST 13 TO 25 2004



Dominant species in the catch of the fish trap in Danajon Bank and Tawi-Tawi Bay are given in Table 3-10 and 3-11. Catch in Danajon Bank was dominated by *Monocanthus chinensis*, *Thalamita* sp. and *Pentapodus setosus*, together representing almost 50 percent of the catch. *Thalamita* sp., a species of crab, is obviously not a target species of the fish trap. The catches of fish traps in Tawi-Tawi Bay were better and dominated by higher valued species. They included various scolopsis species (*Scolopsis dubiosus, S. personatus, S. taeniopterus)* and goat fishes (*Parupeneus barberinus, P. heptacanthus, Upeneus tragula)*.

TABLE 3-10
TOP 10 SPECIES CAUGHT DURING FISH TRAP SURVEY IN DANAJON BANK

#	Species	Local name	%Weight	%Number
1	*Monocanthus chinensis*	*saguksuk*	20.2	20.2
2	*Thalamita* sp.	*kubaw*	14.9	14.9
3	*Pentapodus setosus*	*siwsiw*	11.3	11.3
4	*Upeneus tragula*	*timbungan*	7.3	7.3
5	*Helotes sexlineatus*	*gonggong*	5.7	5.7
6	*Scolopsis taeniopterus*	*silay*	4.7	4.7
7	*Upeneus* sp.	*timbungan*	4.5	4.5
8	*Octopus* sp.	*tabugok*	3.5	3.5
9	*Paracentropogon* sp.	*bantol*	3.4	3.4
10	*Pentapodus caninus*	*salinggukod*	3.1	3.1
	Others		21.5	21.5

TABLE 3-11
TOP 10 SPECIES CAUGHT DURING FISH TRAP SURVEY IN TAWI-TAWI BAY

#	Species	Local name	% Weight	% Number
1	*Scolopsis dubiosus*	*sahnungan*	12.5	8.2
2	*Scolopsis personatus*	*kulisih bullat*	11.7	18.0
3	*Scarus ghobban*	*ugus batahan*	7.5	2.7
4	*Scolopsis taeniopterus*	*kulisih bullat*	7.0	9.9
5	*Parupeneus barberinus*	*timbungan gadja*	4.4	2.3
6	*Diodon liturosus*	*dawtdutan*	3.6	1.5
7	*Arothron mappa*	*buntal*	3.4	2.0
8	*Upeneus tragula*	*tangbud*	2.7	4.8
9	*Parupeneus heptacanthus*	*timbungan*	2.5	3.7
10	*Lethrinus ornatus*	*kutambak*	2.5	1.0
	Others		42.2	45.9

Bottom-set Gillnet

From interviews with local fishers in Tawi-Tawi Bay, six sampling stations were identified and selected initially for the conduct of bottom-set gillnet test fishing. However, fishing operations were conducted in only three of the sites due to strong currents in the other selected sites. Some delays were also encountered in Lanuza Bay due to bad weather condition. Figure 3-8 and 3-9 show the GPS plots of successful bottom-set gillnet sampling points in Lanuza Bay and Tawi-Tawi Bay.

FIGURE 3-8
BOTTOM-SET GILLNET STATIONS IN LANUZA BAY SAMPLED FROM OCTOBER 1 TO 10, 2004

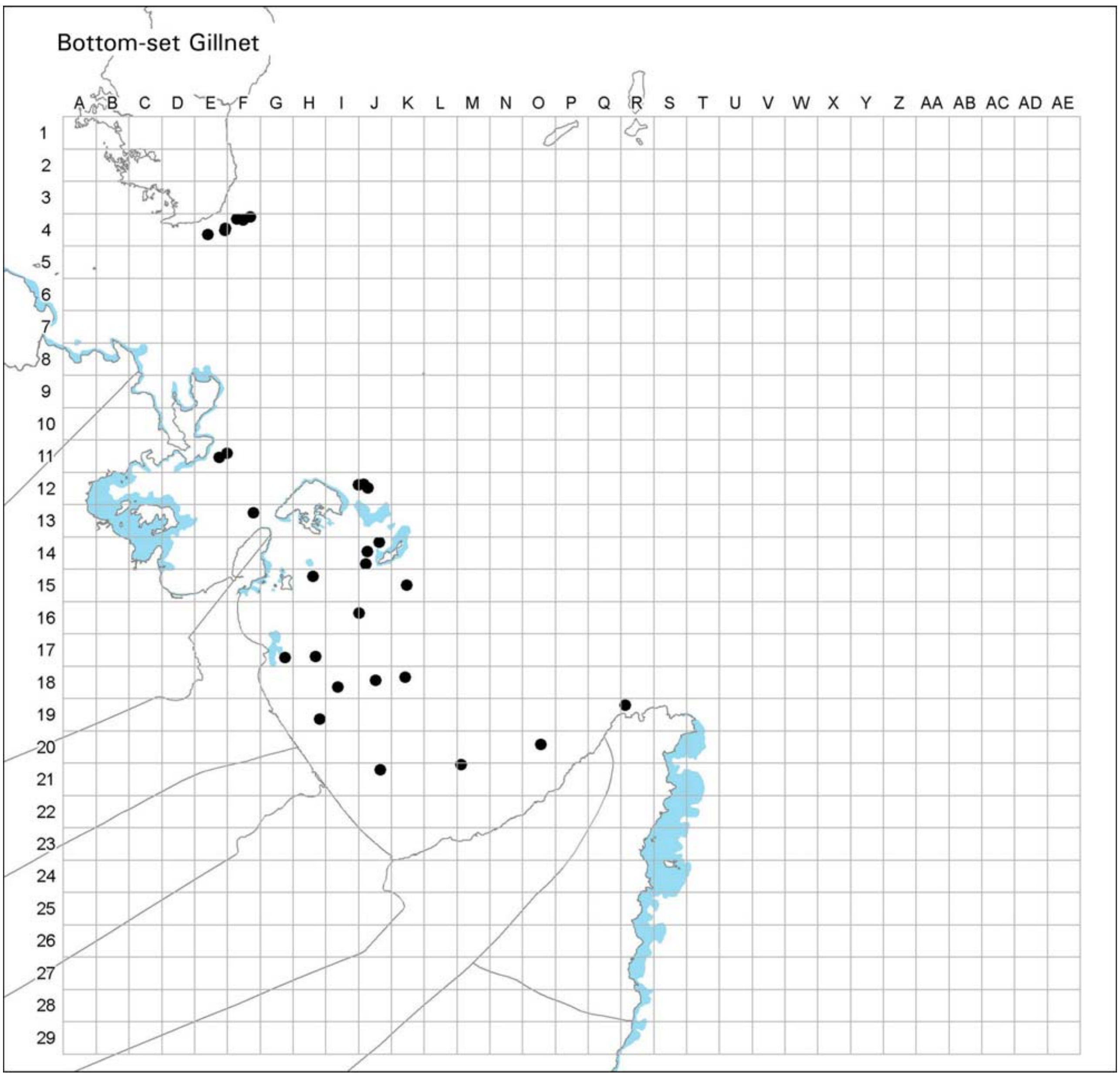


FIGURE 3-9
BOTTOM-SET GILLNET STATIONS IN TAWI-TAWI BAY SAMPLED FROM AUGUST 11 TO 15, 2004

The 66 meter long bottom-set gillnets in Lanuza Bay have catch rates of 2.12 kg per operation while the 200 meter bottom-set gillnets of Tawi-Tawi Bay landed an average of 5.86 kg per operation (Table 3-12). The catch in Lanuza Bay was dominated by *Euthynnus affinis* while slipmouth, *Leiognathus leuciscus*, was the major species caught in Tawi-Tawi Bay (Table 3-13 and 3-14).

TABLE 3-12
SUMMARY OF CATCH PER OPERATION OF BOTTOM-SET GILLNET USED FOR TEST FISHING IN THE FOCAL AREAS

	Focal area			
	Danajon Bank	Coron Bay	Lanuza Bay	Tawi-Tawi Bay
Survey stations result:				
Average catch per operation			2.12	5.86
Standard deviation			3.08	3.20
n			22	23
Control stations result:				
Average catch per operation			5.02	
Standard deviation			5.98	
n			6	

TABLE 3-13
TOP 10 SPECIES CAUGHT DURING BOTTOM-SET GILLNET DURING TEST FISHING OPERATIONS IN LANUZA BAY

#	Species	Local name	% Weight	%Number
1	*Euthynnus affinis*	*bulis*	18.3	2.4
2	*Dasyatis kuhlii*	*pagi*	9.1	1.2
3	(to be identified)	*hawig*	5.8	0.2
4	*Myripristis amaena*	*baga*	5.8	13.6
5	(to be identified)	*barong*	2.7	0.2
6	*Seriolina nigrofasciata*	*maru*	2.6	0.8
7	*Carcharhinus dussumieri*	*pating ilagan*	2.5	0.3
8	*Rastrelliger faughnii*	*anduhaw*	2.4	3.0
9	*Lutjanus vitta*	*puga*	2.2	2.3
10	*Portunus pelagicus*	*lambay*	1.7	1.4
	Others		46.9	74.6

TABLE 3-14
TOP 10 SPECIES CAUGHT DURING BOTTOM-SET GILLNET DURING TEST FISHING OPERATIONS IN TAWI-TAWI BAY

#	Species	Local name	% Weight	% Number
1	*Leiognathus leuciscus*	*sap-sap*	31.7	51.7
2	*Rastrelliger brachysoma*	*lumahan*	9.6	3.2
3	*Scolopsis taeniopterus*	*kulisih bullat*	8.3	4.7
4	*Sphyraena putnamiae*	*lambana*	7.8	2.3
5	*Pelates quadrilineatus*	*bigaung*	7.6	7.9
6	*Gerres oblongus*	*putih mata*	5.1	5.6
7	*Sphyraena barracuda*	*bangasan*	3.5	0.8
8	*Gerres oyena*	*putih mata*	3.0	3.2
9	*Gazza minuta*	*sap-sap*	2.6	4.8
10	*Sphyraena jello*	*lambana*	2.2	0.5
	Others		18.6	15.3

3.2 PROJECT RESULT 2: CATCH RATE OF SELECTED FISHERIES IN FOCAL AREAS

Catch and Effort Monitoring

Between 20 to 36 fishing gear types were encountered during the catch and effort monitoring in each focal area. Some gear types were encountered at least once while others at most 700 times during the 3-month monitoring. Table 3-15 to 3-18 summarize the average catch rates (kg per day), standard deviations, number of the gear type sampled, and standard errors of frequently used fishing gears. Only gears sampled at least 100 times during the 3-month catch and effort monitoring period were included. This was meant to reduce the variance (standard deviation and standard error). For future comparison, catch and effort of commercial fishing gears and illegal fishing methods operating in the focal areas that were likewise monitored will no longer be considered. The assumption is that these fishing gears will no longer be in operation in the focal areas once the FISH Project's fisheries resource management initiatives are in place. As a general observation, the mean catch rates of various fishing gears were relatively higher in Tawi-Tawi Bay and relatively lower in Danajon Bank.

TABLE 3-15
SUMMARY OF CATCH PER UNIT EFFORT OF FREQUENTLY USED FISHING GEARS IN DANAJON BANK

Gear	Variation	n	Mean	Stdev	St error
Crab liftnet	Crab liftnet	703	3.4	1.6	0.48
Danish seine	Danish seine	360	24.9	15.7	0.63
Fish corral	Fish corral	115	5.4	4.6	0.86
Gill net	Bottom set gillnet	136	15.7	21.4	1.36
Gill net	Crab gillnet	703	3.4	2.2	0.66
Gill net	Drift gillnet	425	7.4	6.7	0.91
Gill net	Drive-in gillnet	204	14.7	10.1	0.69
Gill net	Set gillnet with plunger	228	10.3	6.5	0.63
Hook and line	Bottom set longline	210	4.5	3.1	0.68
Hook and line	Simple hook and line	351	2.5	1.8	0.70
Pot	Crab pot	449	6.7	2.4	0.36
Trawl	Otter trawl	164	13.7	6.6	0.48

TABLE 3-16
SUMMARY OF CATCH PER UNIT EFFORT OF FREQUENTLY USED FISHING GEARS IN CORON BAY

Gear	Variation	n	Mean	Stdev	St error
Gill net	Bottom set gillnet	452	9.0	19.1	2.11
Gill net	Drift gillnet	146	21.5	17.4	0.81
Hook and line	Bottom set longline	142	11.0	18.1	1.65
Hook and line	Multiple handline	291	12.5	17.7	1.41
Hook and line	Simple hook and line	529	5.6	11.5	2.04

TABLE 3-17
SUMMARY OF CATCH PER UNIT EFFORT OF FREQUENTLY USED FISHING GEARS IN LANUZA BAY

Gear	Variation	n	Mean	Stdev	St error
Gill net	Bottom set gillnet	447	4.9	4.9	1.00
Gill net	Drift gillnet	264	11.7	9.2	0.79
Hook and line	Bottom set longline	472	9.0	8.8	0.99
Hook and line	Simple hook and line	191	4.3	4.5	1.06
Jig	Octopus jig	584	3.5	1.9	0.55
Jig	Squid jig	90	3.9	2.4	0.62
Spear	Handspear	245	6.3	4.4	0.70

TABLE 3-18
SUMMARY OF CATCH PER UNIT EFFORT OF FREQUENTLY USED FISHING GEARS IN TAWI-TAWI BAY

Gear	Variation	n	Mean	Stdev	St error
Dynamite	Dynamite	263	54.1	76.0	1.41
Gill net	Drift gillnet	156	55.9	38.7	0.69
Gill net	Surface set gillnet	425	29.3	18.7	0.64
Hook and line	Bottom set longline	209	15.6	11.1	0.71
Hook and line	Multiple handline	134	19.6	14.3	0.73
Hook and line	Troll line	113	29.6	30.2	1.02
Jig	Octopus jig	142	3.5	2.8	0.78
Ring net	Ring net	93	307.6	445.2	1.45
Spear	Spear gun	124	5.2	8.0	1.54
Spear	Spear with compressor	103	37.6	27.0	0.72

These catch rates estimated from catch and effort data, together with catch rates estimated through fishery-independent methods, will become part of the baseline information for estimating the success or failure of project. Methods and information gathering activities established during this baseline assessment work will serve as basis for future project monitoring activities. Established sampling months and sampling days will be adhered to, especially in reference to the moon phase to ensure similar conditions during monitoring.

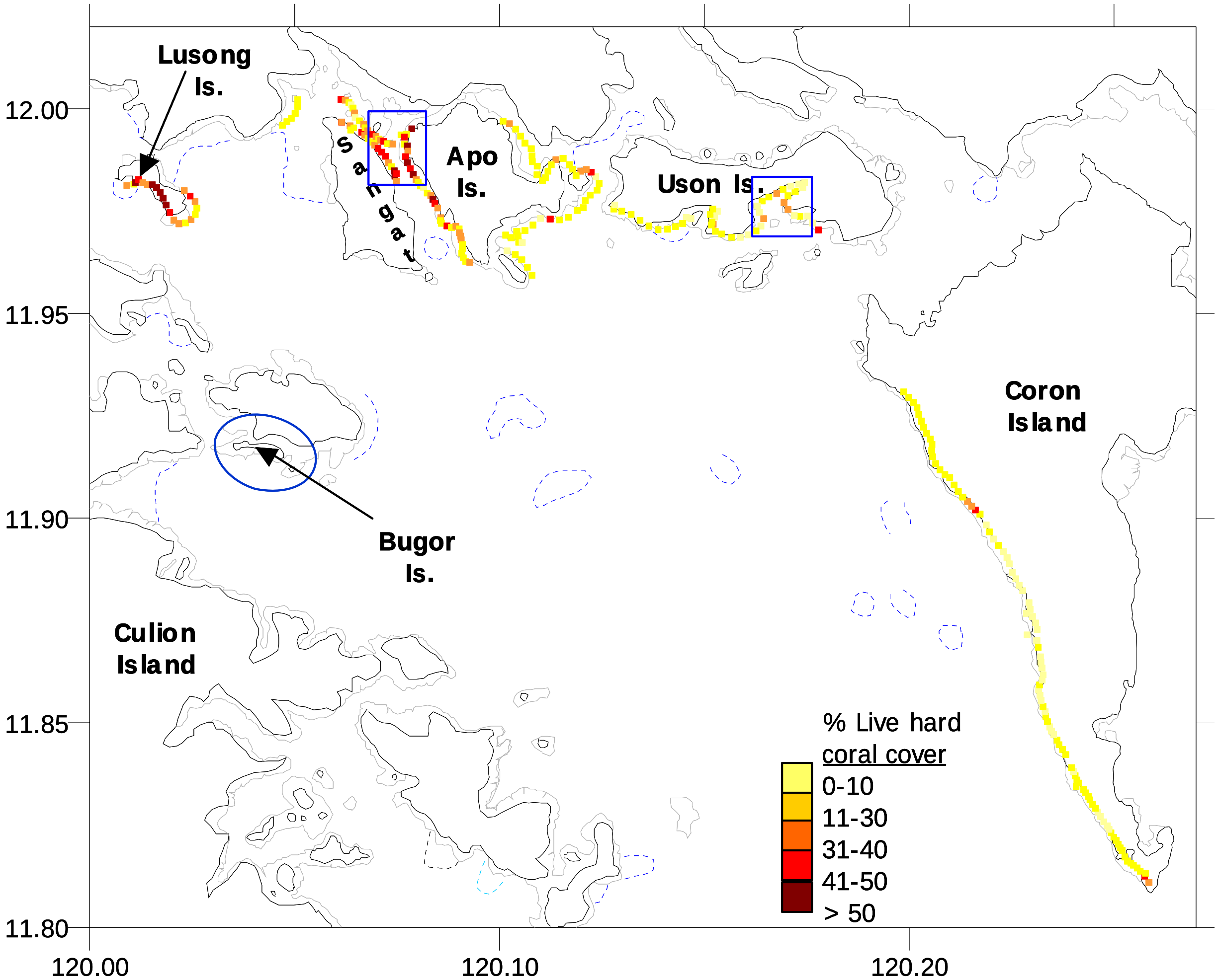
3.3 PROJECT RESULT 3: REEF FISH BIOMASS WITHIN AND ADJACENT TO SELECTED MPAS

Calamianes

The Calamianes focal area was surveyed in May 2004. There were reports of previous attempts to establish MPAs in the area, but at the time no MPAs existed with clearly defined boundaries, even on paper. Hence, the UPVFI survey team conducted reconnaissance and manta tow surveys. The UPVFI and FISH Project staff then jointly selected potential MPA sites to assess.

Two sites were selected, namely, the reef in the front of Brgy. Lajala in Uson Island and the reef fronting Sangat and Decalve Islands (Figure 3-10). A third site, Bugor Island, was selected as the common site with the independent baseline contractor. Preliminary findings of the independent baseline contractor suggested that reef conditions were the best in Bugor Island among the sites they had surveyed. Ten transect stations in each site were established (Figure 3-11 to 3-13).

FIGURE 3-10
MAP OF CALAMIANES FOCAL AREA SHOWING THE COVERAGE OF THE MANTA TOW SURVEY IN MAY 2004



Note: The rectangles indicate the two (2) sites chosen for detailed study using transects while the ellipse indicates the 3rd dive site common to this study and the independent assessment.

FIGURE 3-11
MAP SHOWING LOCATION OF DIVE STATIONS (ENCIRCLED CROSSES) AND THE DISTRIBUTION OF LIVE HARD CORAL (MANTA TOW SURVEY) IN THE USON ISLAND SITE IN CALAMIANES, PALAWAN IN MAY 2004

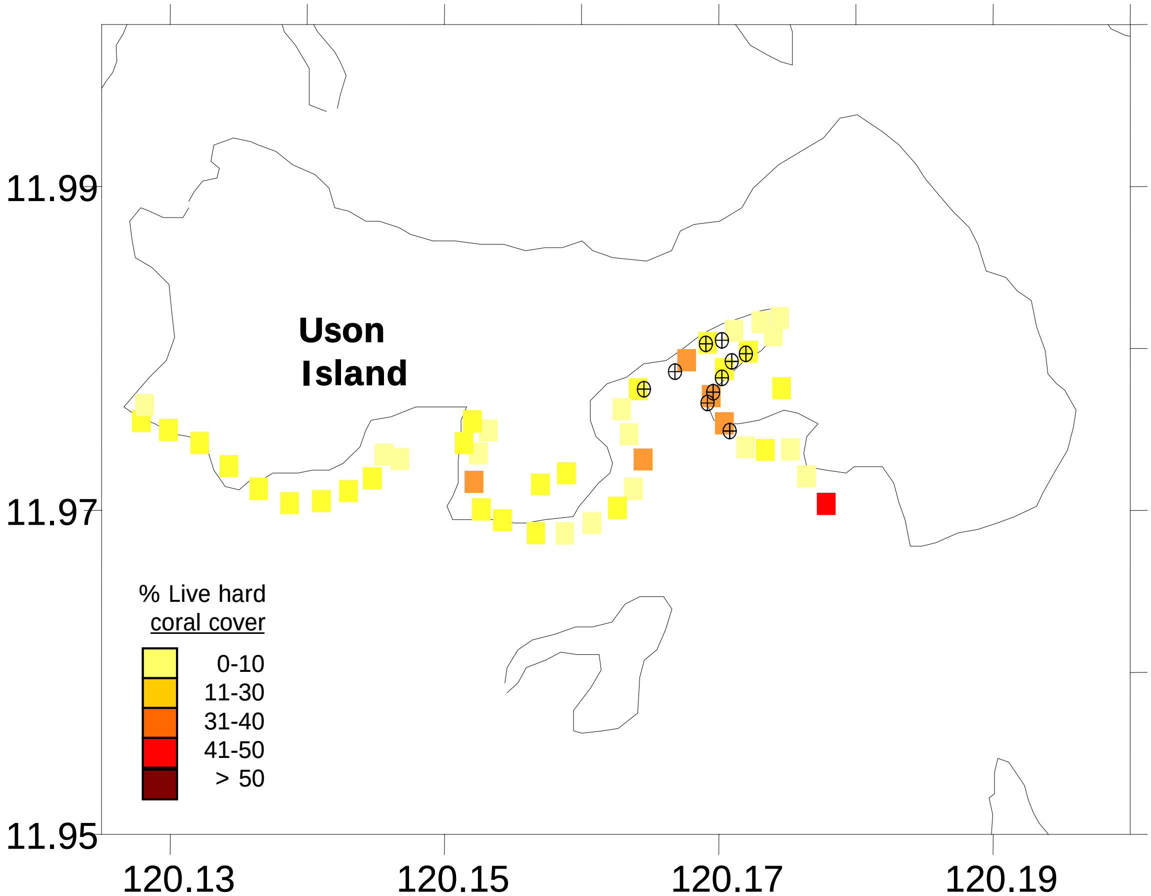


FIGURE 3-12
MAP SHOWING LOCATION OF DIVE STATIONS (ENCIRCLED CROSSES) AND THE DISTRIBUTION OF LIVE HARD CORAL (MANTA TOW SURVEY) IN THE APO-SANGAT ISLAND SITE IN CALAMIANES, PALAWAN IN MAY 2004

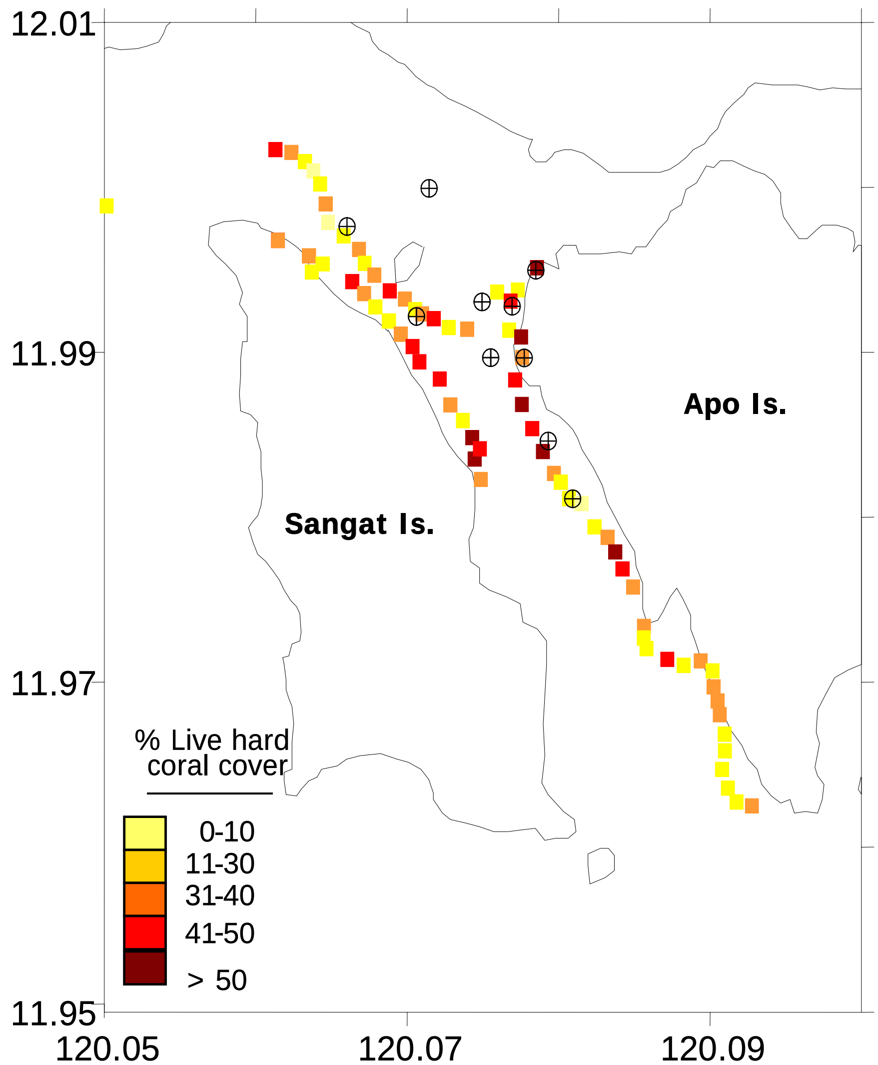


FIGURE 3-13
MAP SHOWING THE LOCATIONS OF DIVE STATIONS AROUND BUGOR ISLAND, CULION, IN CALAMIANES, PALAWAN IN MAY 2004

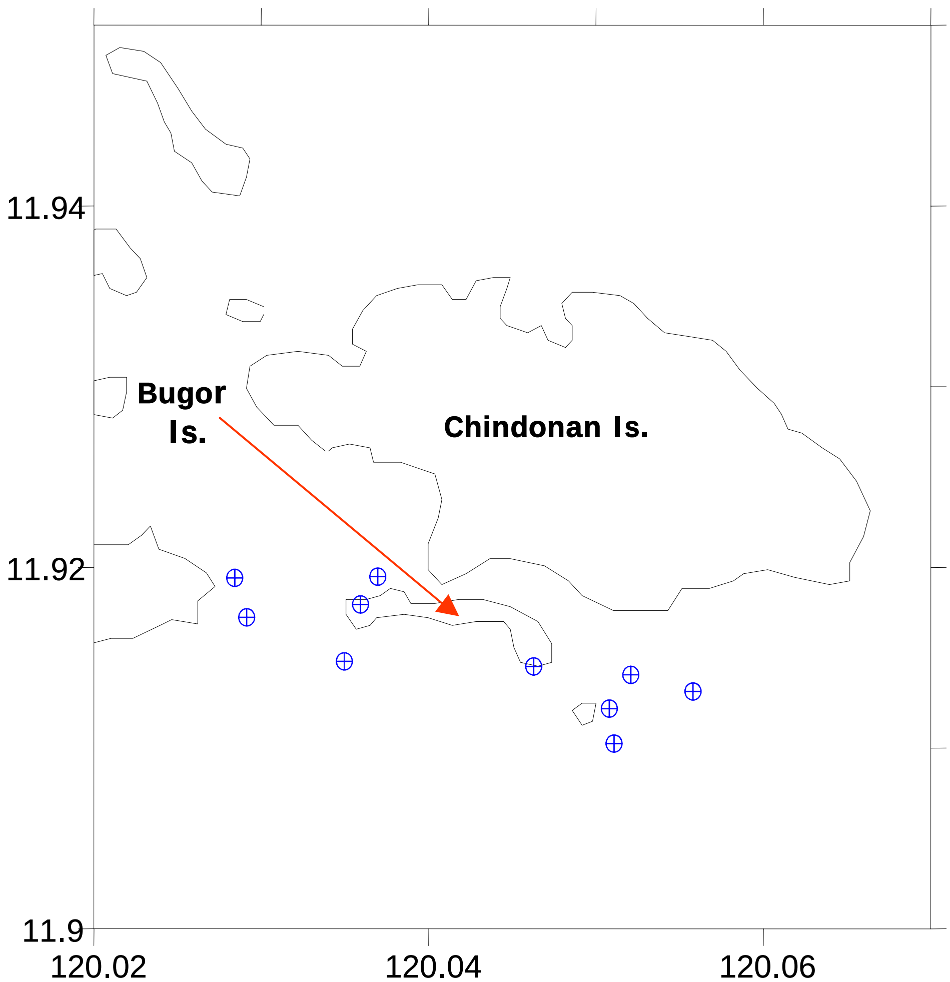


Table 3-19 lists biomass estimates for each site in terms of kg/500m^2, the unit for PR3, and t/km^2, for comparison with similarly reported estimates in other reefs of the country. Table 3-19 also lists abundance estimates (No. of individuals/500m^2), again to facilitate comparison with other areas. The biomass estimates of indicator, target species, and commercially valuable species are expressed as percentages of total biomass.

Overall mean biomass from all the stations in the three sites was 10.5 kg/500m^2 (20.9 t/km^2). This biomass level is considered moderate in comparison to the rest of the country (Hilomen *et al.* 2000). The overall mean fish abundance was 1032.4 ind/500m^2, which is relatively high in comparison with reefs along the South China Sea Coast of Luzon and those in western Visayas (Campos *et al.* 2004), but only moderate in level in comparison to reports from the entire country (Hilomen *et al.* 2001).

Mean abundance and biomass were highest in Bugor Island, followed by Sangat-Decalve Islands and by Lajala (Figure 3-14).

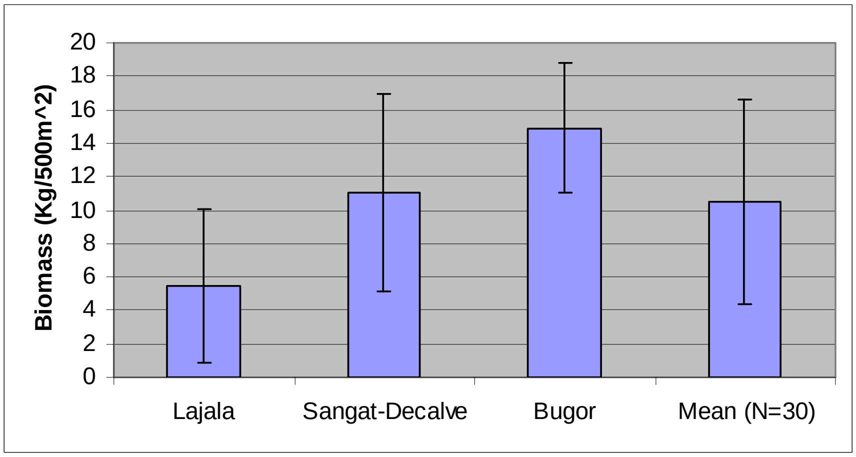
TABLE 3-19
BASELINE VALUES FOR PR3: REEF FISH ABUNDANCE AND BIOMASS AT POTENTIAL MPAS IN THE CALAMIANES FOCAL AREA, PALAWAN IN MAY 2004

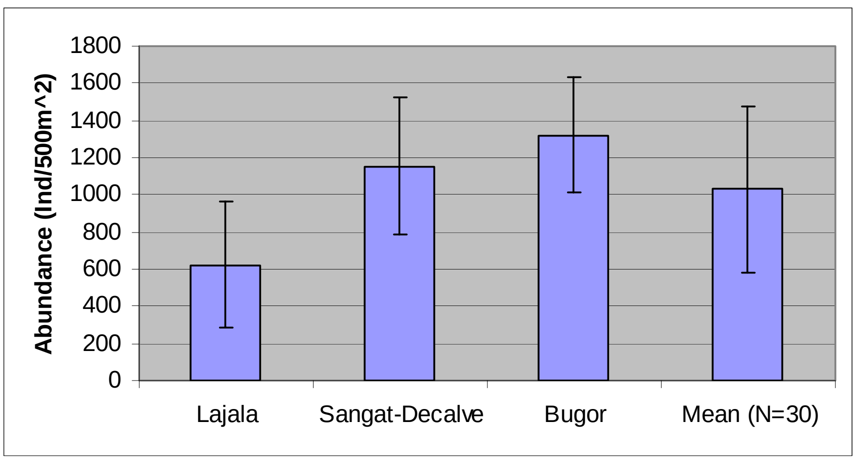
Site	Total Abundance	Total Biomass1	Total Biomass2	Indicator Species	Target Species	Commercially Valuable Species
	ind/500m^2	t/km^2	kg/500m^2	% of total biomass	% of total biomass	% of total biomass
Brgy. Lajala, Uson Is.						
n	10	10	10	10	10	10
Mean	621.6	11	5.5	3.7	13.5	51.8
SD	341.1	9.3	4.6	4.1	7.9	19.1
Min	164	2	1	0	0.0	22.6
Max	1456	36	18	10.7	30.0	78.9
Sangat-Decalve Islands						
n	10	10	10	10	10	10
Mean	1152.8	22	11	2	16.8	60.6
SD	369.3	11.9	5.9	2.1	9.6	14.4
Min	316	3.2	1.6	0	2.3	34.9
Max	1602	37.9	19	5.9	34.8	80.1
Bugor Is.						
n	10	10	10	10	10	10
Mean	1322.8	29.8	14.9	1.6	9.9	59.2
SD	307.7	7.7	3.9	1.2	6.7	11.7
Min	892	21.6	10.8	0.2	2.2	34.2
Max	1880	42.5	21.2	4.1	23.8	72.6
All Sites Combined						
n	30	30	30	30	30	30
Mean	1032.4	20.9	10.5	2.4	13.4	57.2
SD	447.3	12.3	6.1	2.8	8.4	15.3
Min	164	2	1	0	0.0	22.6
Max	1880	42.5	21.2	10.7	34.8	80.1

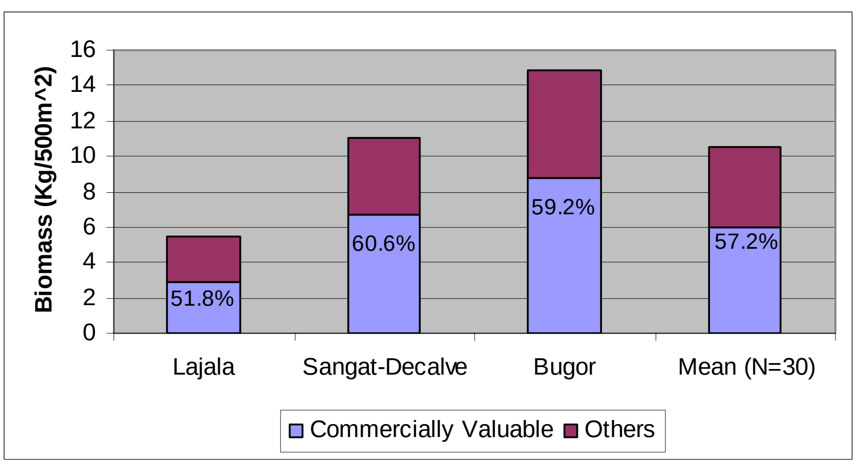
Legend:
SD = Standard Deviation

FIGURE 3-14

FROM TOP: BIOMASS (KG/500M²), ABUNDANCE (NO. OF INDIVIDUALS/500M²) AND PORTION OF BIOMASS COMPOSED OF COMMERCIALLY VALUABLE SPECIES (KG/500M²; PERCENTAGE ALSO INDICATED) OF REEF FISH AT POTENTIAL MPA SITES IN THE CALAMIANES FOCAL AREA IN MAY 2004







Note: The error bars represent 1 SD from the mean.

Chaetodontids are considered indicator species of good reef health since they are corallivores. Since live hard coral cover declines as stress on reefs increases, chaetodontid abundances should be low in impacted reefs. Mean chaetodontid abundance in the three sites surveyed ranged from 8-20 ind/500m^2, which is somewhat higher than the range of predicted values based on an overall live coral cover of about 50 percent, as shown by Nañola and Aliño (1999).

Target species, being highly priced, are considered to be the most vulnerable to fishing. Hence, their relative abundances in heavily fished and disturbed reefs would likely be low. In terms of biomass, target species amounted to 0.7-2.2 kg/500m^2 (mean = 1.5), comprising an average of 13.4 percent of overall fish biomass in the three sites (Table 3-19).

Target species abundance in the three sites surveyed ranged from 2.5-40.5 ind/500m^2, representing on average of only 1.6 percent of overall mean fish abundance. These values are not higher than reported values for reefs in Cabacongan, Bohol (Uychiaoco, *et al.* 2002a) and Port Barton, Palawan (Uychiaoco *et al.* 2002b); and lower than those reported in the vicinity of MPAs in Mabini, Batangas (White and Meneses 2002a), Gilutongan, Cebu (Arceo *et al.* 2002) and in Balicasag, Pamilacan and Sumilon (White and Meneses 2002b).

Commercially valuable species (target species plus scarids and caesionids) make up about 57.2 percent of the overall fish biomass in the sites surveyed. Thus, of the mean fish biomass of 10.5 kg/500m^2 valuable food fish make up about 6 kg. Commercially valuable species as a fraction of total biomass were comparable in Sangat-Decalve and Bugor, but noticeably lower in Lajala (Table 3-19 and Figure 3-14).

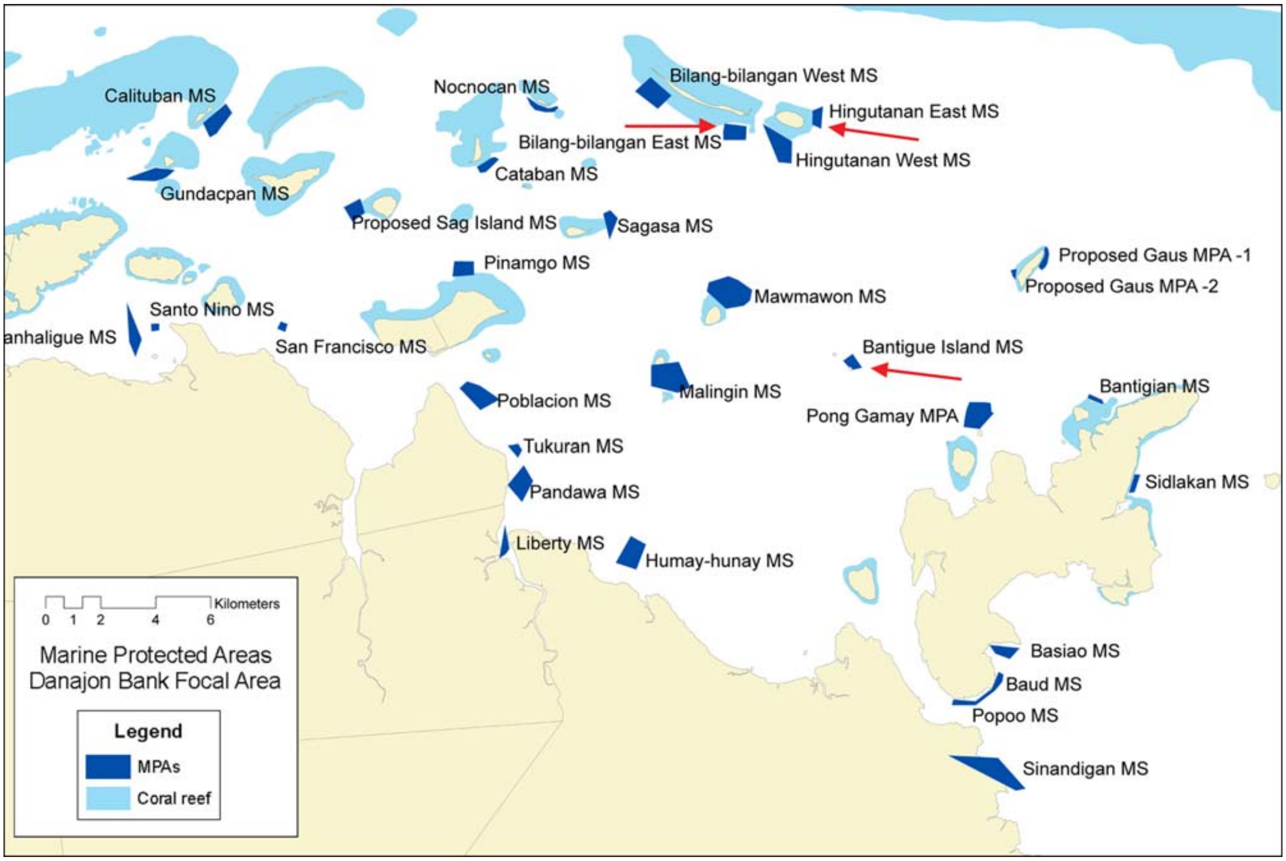
Danajon Bank

There were a number of MPAs in Danajon Bank when the Silliman University research team surveyed the area in July 2004. Following the criteria for selecting MPAs in Table 2-6, four MPAs were selected, namely, the MPAs off Bilangbilangan Island East, Hingutanan Island East, Bantigue Island and Guindakpan Island (Figure 3-15). Guindakpan was suggested as a common site by the independent baseline contractor since it was the best site they had surveyed in the area in terms of health of reef fish and reef benthos. Later, however, the FISH Project decided to exclude Guindakpan MPA because ecological conditions in the area suggest that it will not thrive well as an MPA. Thus, this report focuses on the findings at the MPAs off Bilangbilangan Island East, Hingutanan Island East and Bantigue Island.

Overall mean abundance from 36 transects was 374.1 ind/500m^2 (Table 3-20), which would be considered moderate compared with other reefs in the country (Hilomen *et al.* 2000). Overall mean biomass was 14.7 kg/500m^2, the highest among the focal areas, but was likewise moderate when compared with other reefs in the country (Hilomen *et al.* 2000). About half of this biomass was commercially valuable. The overall percentage of indicator species biomass (mean = 4.3 percent) was comparable with other focal areas.

With 19 transects surveyed in the Talibon area, the independent baseline contractor estimated mean biomass of 1.4 ± 1.1 kg/500m^2 and mean abundance of 208 ± 132 ind/500m^2 (DAI 2004). Note the large variability, which was also frequently observed in this baseline assessment.

FIGURE 3-15
MPAS IN DANAJON BANK, BOHOL



Note: Light grey areas around the islands indicate reef areas. The darker patches are the MPAs. Arrows point to the three MPAs that were surveyed.

TABLE 3-20
BASELINE VALUES FOR PR3: REEF FISH ABUNDANCE AND BIOMASS AT MPAS IN THE DANAJON BANK FOCAL AREA, BOHOL IN JULY 2004

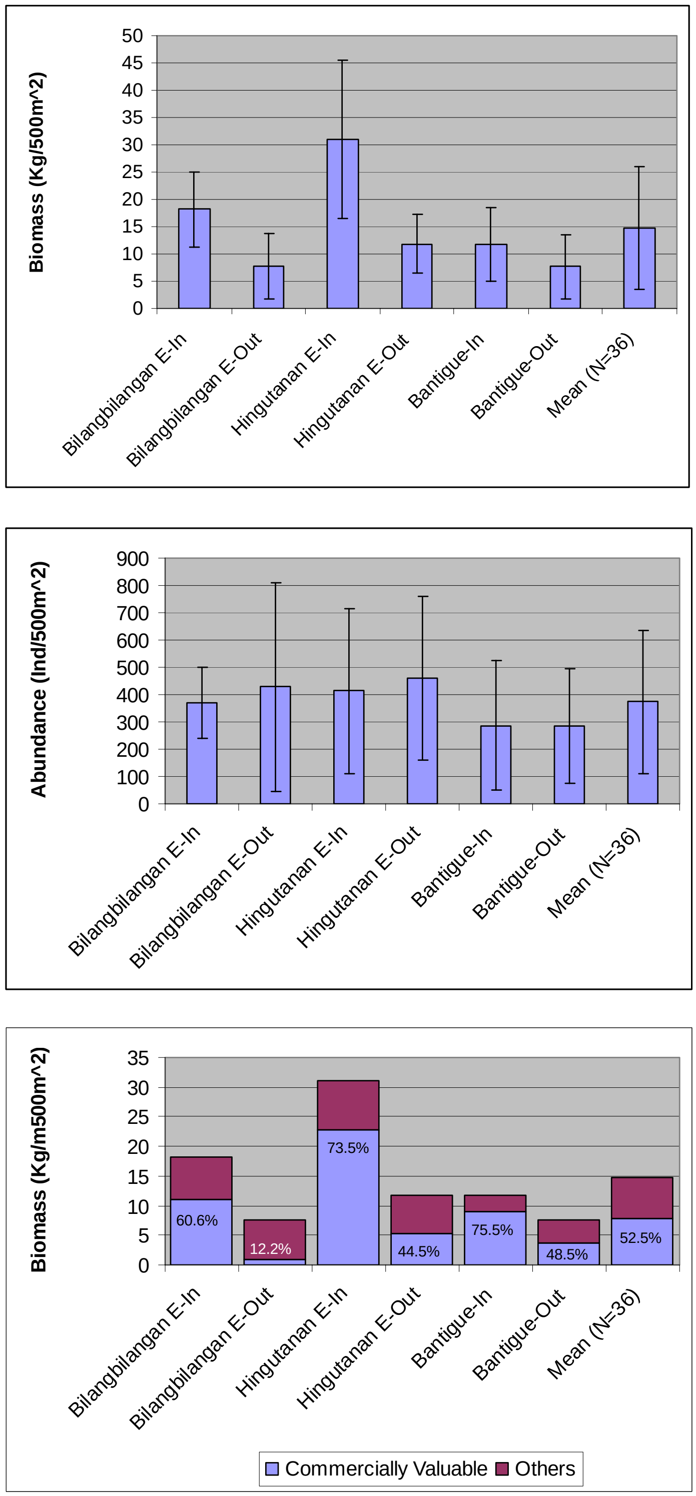
Site	Total Abundance	Total Biomass1	Total Biomass2	Indicator Species	Commercially Valuable Species
	ind/500m^2	t/km^2	kg/500m^2	% of total biomass	% of total biomass
Bilangbilangan East MPA-Inside					
n	6	6	6	6	6
Mean	370.7	36.4	18.2	3.7	60.6
SD	128.3	13.8	6.9	4.3	20.3
Min	209	16.1	8.1	0.0	36.8
Max	577	55.6	27.8	11.4	84.1
Bilangbilangan East MPA-Outside					
n	6	6	6	6	6
Mean	428.2	15.4	7.7	4.9	12.2
SD	383.8	12.1	6.0	4.7	6.3
Min	12	2.5	1.2	1.9	3.0
Max	834	33.7	16.8	13.7	19.3
Bilangbilangan East MPA-Inside and Outside Combined					
n	12	12	12	12	12
Mean	399.4	25.9	12.9	4.3	36.4
SD	274.5	16.6	8.3	4.3	29.1
Min	12	2.5	1.2	0.0	3.0
Max	834	55.6	27.8	13.7	84.1
Hingutanan East MPA-Inside					
n	6	6	6	6	6
Mean	415.0	62.2	31.1	1.0	73.5
SD	302.5	29.1	14.5	0.4	26.7
Min	76	37.4	18.7	0.3	40.5
Max	717	112.0	56.0	1.5	97.2
Hingutanan East MPA-Outside					
n	6	6	6	6	6
Mean	459.7	23.6	11.8	3.9	44.5
SD	301.4	10.8	5.4	3.9	24.7
Min	162	9.3	4.7	0.7	16.8
Max	836	34.4	17.2	10.4	79.4
Hingutanan East MPA-Inside and Outside Combined					
n	12	12	12	12	12
Mean	437.3	42.9	21.4	2.5	59.0
SD	288.8	29.1	14.5	3.0	28.8
Min	76	9.3	4.7	0.3	16.8
Max	836	112.0	56.0	10.4	97.2

TABLE 3-20 (continued)
BASELINE VALUES FOR PR3: REEF FISH ABUNDANCE AND BIOMASS AT MPAS IN THE DANAJON BANK FOCAL AREA, BOHOL IN JULY 2004

Site	Total Abundance	Total Biomass1	Total Biomass2	Indicator Species	Commercially Valuable Species
	ind/500m^2	t/km^2	kg/500m^2	% of total biomass	% of total biomass
Bantigue MPA-Inside					
n	6	6	6	6	6
Mean	286.0	23.6	11.8	1.5	75.5
SD	237.4	13.6	6.8	1.5	11.0
Min	55	7.3	3.6	0.0	65.6
Max	582	39.4	19.7	4.0	91.1
Bantigue MPA-Outside					
n	6	6	6	6	6
Mean	284.8	15.3	7.7	1.5	48.5
SD	208.8	11.7	5.9	1.6	34.9
Min	106	3.0	1.5	0.0	7.4
Max	659	37.5	18.7	3.6	92.7
Bantigue MPA-Inside and Outside Combined					
n	12	12	12	12	12
Mean	285.4	19.5	9.7	1.5	62.0
SD	213.2	12.8	6.4	1.5	28.4
Min	55	3.0	1.5	0.0	7.4
Max	659	39.4	19.7	4.0	92.7
All Sites Combined					
n	36	36	36	36	36
Mean	374.1	29.4	14.7	2.8	52.5
SD	261.6	22.4	11.2	3.3	30.2
Min	12	2.5	1.2	0.0	3.0
Max	836	112.0	56.0	13.7	97.2

FIGURE 3-16

FROM TOP: BIOMASS (KG/500M^2), ABUNDANCE (NO. OF INDIVIDUALS/500M^2) AND PORTION OF BIOMASS COMPOSED OF COMMERCIALLY VALUABLE SPECIES (KG/500M^2; PERCENTAGE ALSO INDICATED) OF REEF FISH ("IN") AND ADJACENT TO ("OUT") SELECTED MPA SITES IN THE DANAJON BANK FOCAL AREA IN JULY 2004



Note: The error bars represent 1 SD from the mean.

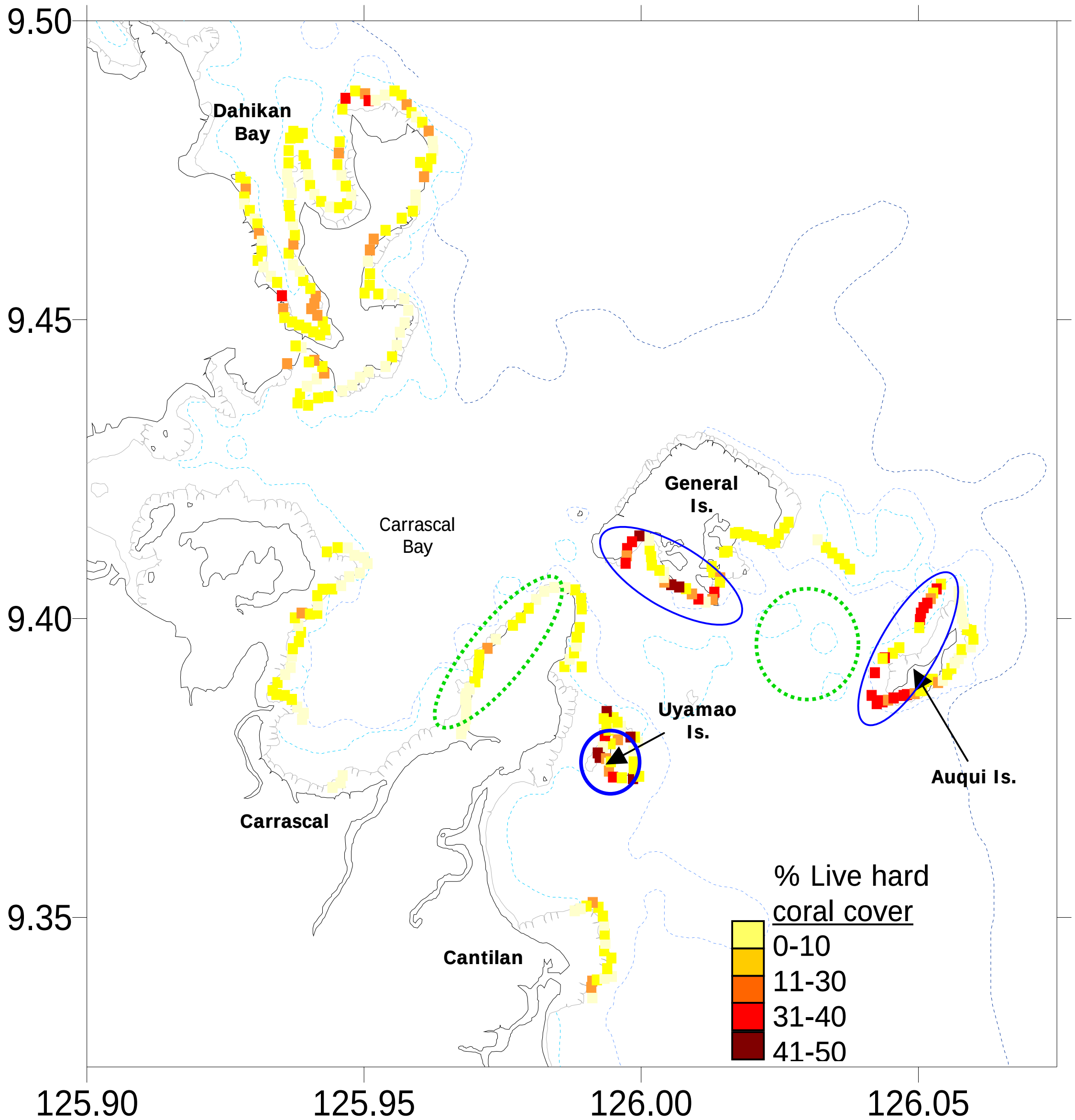
In these three MPAs, reef fish biomass was consistently higher inside than outside the MPAs (Figure 3-16). Reef fish biomass, however, was slightly lower inside the Bilang-Bilangan East and Hingutanan East MPAs, and equal inside and outside the Banituge MPA. This indicates that on the average, the fish surveyed at the time tended to have larger sizes inside the MPAs, suggesting perhaps that the MPAs are starting to have an effect on the biomass of resident fish. Likewise, the MPAs are apparently providing a sanctuary to commercially valuable species, which display higher values inside the MPAs in terms of both actual biomass and percentage of total reef fish biomass. It is too early to tell, however, if these are consistent tendencies (that is, may be expected in future surveys) or mere coincidences.

Surigao del Sur

When the Lanuza Bay focal area was surveyed in June 2004, there were two recently established MPAs in the area, namely, the Carrascal MPA and the Auqui MPA in the northern part of Lanuza Bay. Apart from the delineation of their boundaries in municipal ordinances, there were few other management activities at the time, making these two MPAs candidates for support from (and survey by) the FISH Project.

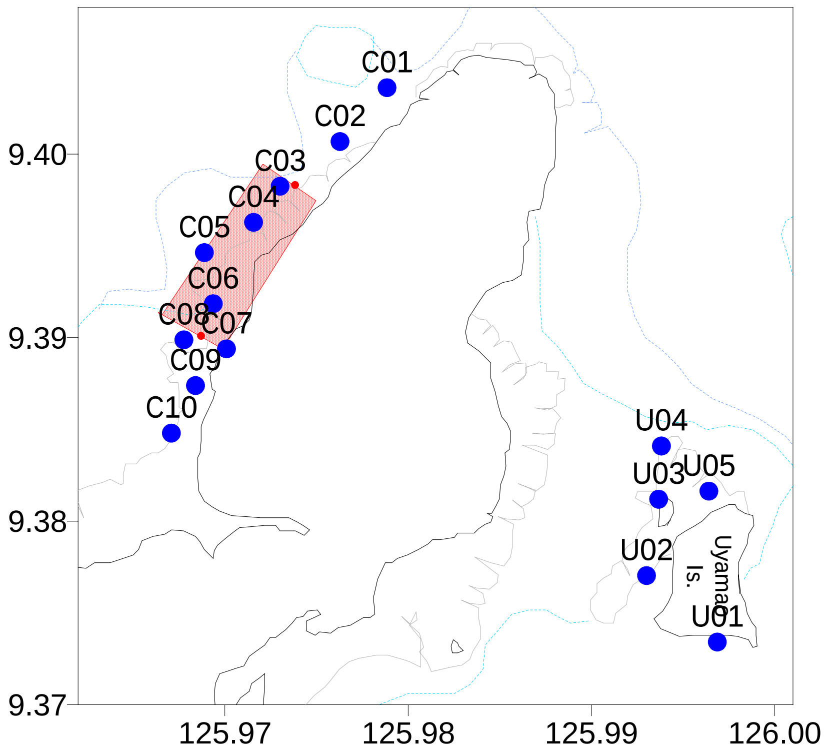
Manta tow surveys (Figure 3-17) were conducted to select transect sites (Figure 3-18). The UPVFI team was unable to survey a common site with the independent baseline contractor, which had concentrated its surveys in reefs off Cortes south of and outside Lanuza Bay but still within the focal area (Figure 3-19). Rough seas and logistical constraints prevented the team from traveling to the area.

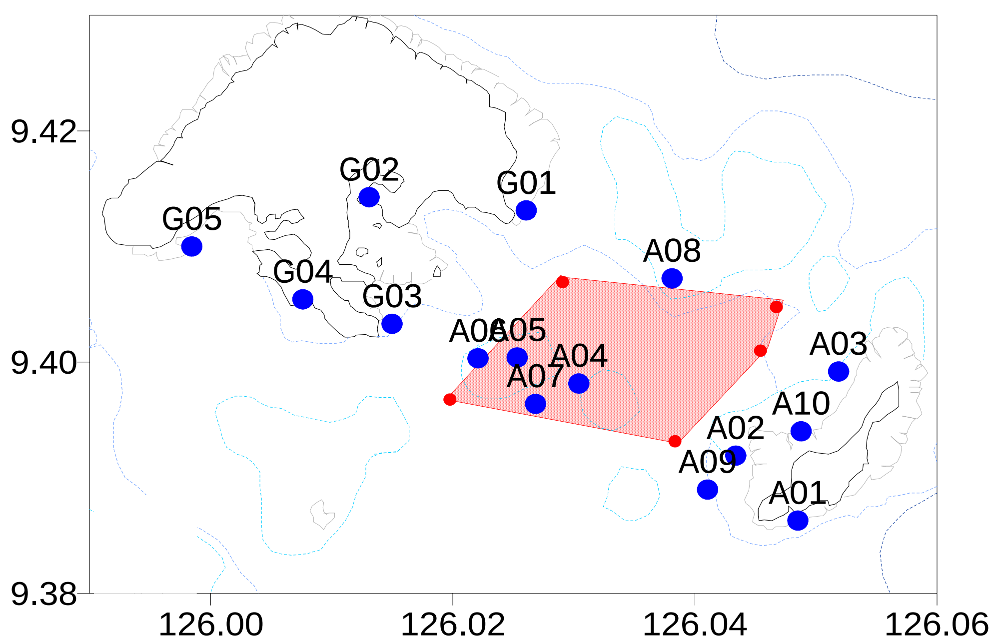
FIGURE 3-17
MAP OF THE SURIGAO DEL SUR FOCAL AREA SHOWING THE COVERAGE OF THE MANTA TOW SURVEY FROM DAHIKAN BAY, CARRASCAL TO AUQUI ISLAND, CANTILAN



Note: Areas encircled by broken ellipse designate existing MPA sites, those encircled by a solid ellipse designate the other three dive sites. The inner portions of Carrascal Bay include seagrass beds, mud banks and mangrove stands.

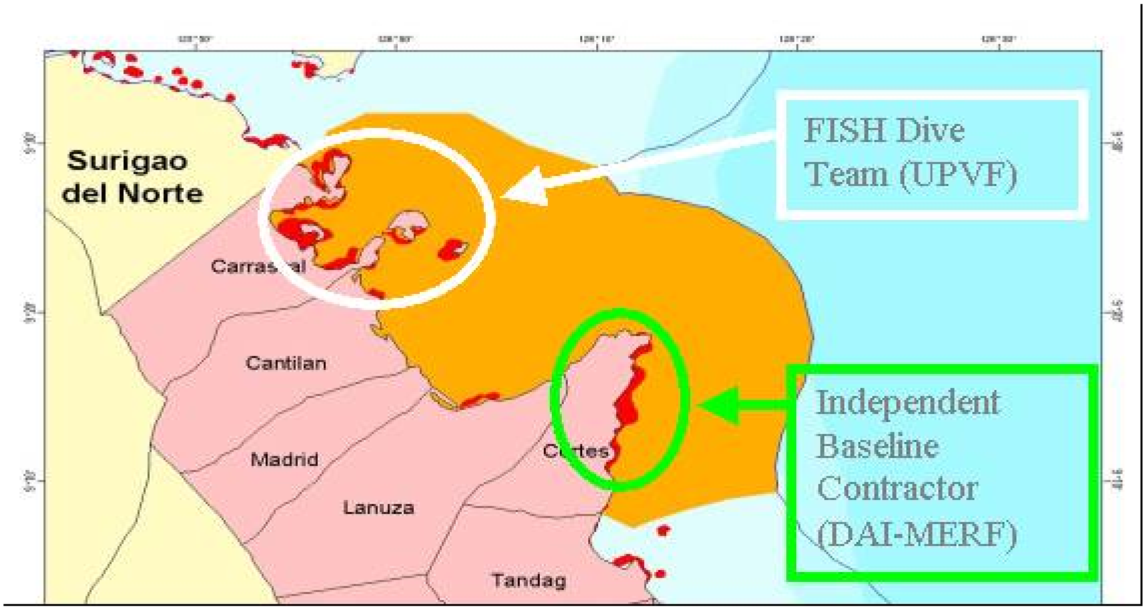
FIGURE 3-18
MAPS SHOWING DIVE STATION LOCATIONS IN THE CARRASCAL MPA AND UYAMAO (TOP), AND GENERAL ISLAND AND AUQUI MPA (BOTTOM) IN CARRASCAL-CANTILAN, SURIGAO DEL SUR IN JUNE 2004





Note: Approximate boundaries of MPAs are indicated by shaded area.

FIGURE 3-19
THE UPVFI SURVEYED THE REEFS OF THE CARRASCAL-CANTILLAN AREA (30 TRANSECTS) WHILE THE INDEPENDENT BASELINE CONTRACTOR SURVEYED THE CORTES AREA OUTSIDE OF LANUZA BAY



Overall fish biomass for the area was 6.8 kg/500m^2 (~ 13.7 t/km^2) with a range of 0.3 – 30.5 (Table 3-21). This is low compared to the rest of the country (Hilomen *et al.* 2001). Spatially, there were a few stations in Carrascal that showed relatively higher biomass than the rest of the stations, although overall mean levels were comparable in most sites, except in Uyamao where mean biomass levels were only half those in the other sites (mean = 3.5 kg/500m^2, vs. means = 7.1-8.0 kg/500m^2).

The overall mean fish abundance was 636.9 ind/500m^2 (Table 3-21), which is relatively high in comparison with reefs along the South China Sea Coast of Luzon, comparable to those in western Visayas (Campos *et al.* 2004), but only moderate in level in comparison to reports from the entire country (Hilomen *et al.* 2000). On the whole, fish abundance was highest in the Carrascal area (mean = 978 ind/500m^2, range: 585-1866) (Figure 3-20), while the rest of the study area showed similarly rather low values. In both MPA Sites, Carrascal and Auqui, there was little difference between "outside" and "inside" abundance estimates, although overall abundance for the Auqui area was only about half those in Carrascal (mean = 409.4 ind/500m^2, range: 218-744). Similarly, abundance estimates in Uyamao were also low (mean = 412.4 ind/500m^2, range: 234-618), while those around General Island were a little higher (mean= 634.4 ind/500m^2, range: 248-1146).

In the four sites surveyed, target species abundance ranged from 24.4 to 57.2 ind/500m^2, representing on average only 6.4 percent of overall mean fish abundance, which amounts to about 41.1 ind/500m^2. These values are lower than reported values of target species abundance (ind/500m^2) for reefs in Bohol Strait (Balicasag, Pamilacan and Sumilon Is.; range = 51.5-203.6; White and Meneses 2002a) and Mabini and Tingloy in Batangas (range=

47.6-86.3; White and Meneses 2002b), comparable to those in Gilutongan, Cebu (range = 0-179.6; Arceo *et al.* 2002), but somewhat higher than reported values for Cabacongan, Bohol (range = 0-29.3; Uychiaoco, *et al.* 2002a) and Port Barton, Palawan (range = 4.9-50.9; Uychiaoco *et al.* 2002b).

Commercially valuable species make up about 49.7 percent of the overall fish biomass in the sites surveyed. Thus, of the mean fish biomass of 6.85 kg/500m^2 (Table 3-21), valuable food fish make up about 2.4 kg, which is about half of what was observed in the Calamianes Island, Palawan in May 2004. The amount of commercially valuable species as a fraction of total biomass is comparable in all sites except inside the Auqui MPA where the fractions were relatively high at 71.1 percent (Figure 3-20).

TABLE 3-21
BASELINE VALUES FOR PR3: REEF FISH ABUNDANCE AND BIOMASS AT POTENTIAL AND EXISTING MPAS IN THE LANUZA BAY FOCAL AREA, SURIGAO DEL SUR IN JUNE 2004

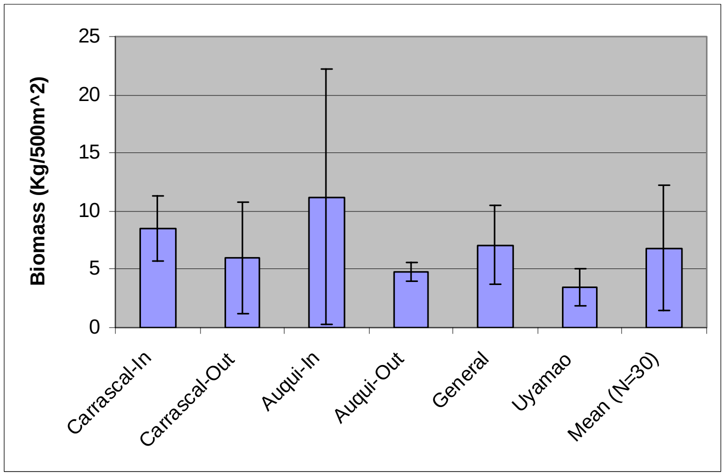
Site	Total Abundance	Total Biomass1	Total Biomass2	Indicator Species	Target Species	Commercially Valuable Species
	ind/500m^2	t/km^2	kg/500m^2	% of total biomass	% of total biomass	% of total biomass
Carrascal MPA-Inside						
n	5	5	5	5	5	5
Mean	1078.4	17	8.5	4.4	13.1	46.4
SD	456.14	5.6	2.8	0.9	8.2	8.1
Min	768	8.4	4.2	3.3	3.9	35.7
Max	1866	23.7	11.9	5.7	23.1	54.0
Carrascal MPA-Outside						
n	5	5	5	5	5	5
Mean	877.6	12	6	5.3	12.0	41.2
SD	342.7	9.6	4.8	3	9.4	34.9
Min	584	0.6	0.3	2.6	0.0	0.0
Max	1448	23.2	11.6	9.4	21.7	71.5
Carrascal MPA-Inside and outside combined						
n	10	10	10	10	10	10
Mean	978.0	14.5	7.3	4.8	12.5	43.8
SD	394.8	7.9	3.9	2.1	8.3	24.1
Min	838	16.5	8.3	2.6	0.0	0.0
Max	584	0.6	0.3	9.4	21.7	71.5
Auqui MPA-Inside						
n	5	5	5	5	5	5
Mean	364.4	22.3	11.2	6.7	45.6	71.1
SD	219.3	22	11	6.0	16.4	21.9
Min	218	8.5	4.3	2.6	22.4	38.1
Max	744	61.1	30.5	16.7	62.3	89.4

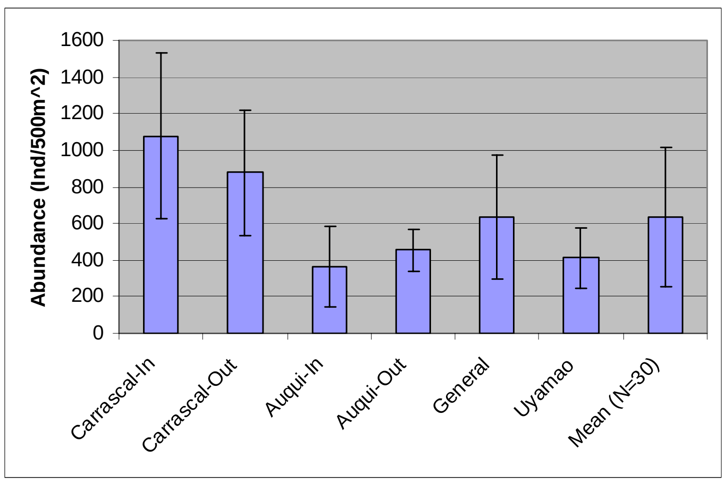
TABLE 3-21 (continued)
BASELINE VALUES FOR PR3: REEF FISH ABUNDANCE AND BIOMASS AT POTENTIAL AND EXISTING MPAS IN THE LANUZA BAY FOCAL AREA, SURIGAO DEL SUR IN JUNE 2004

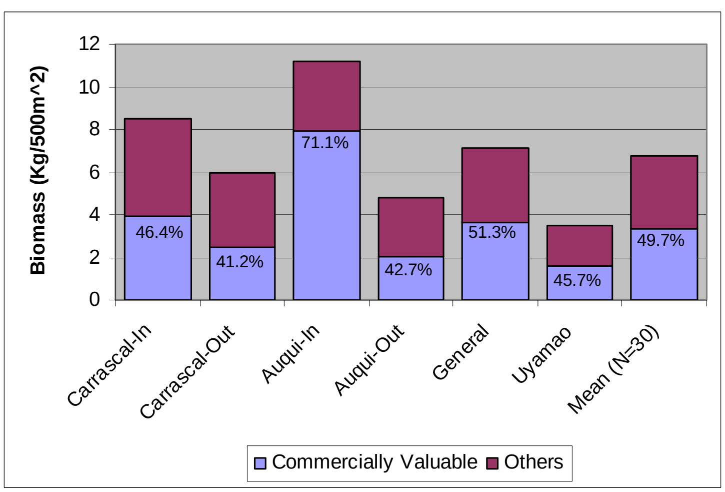
Site	Total Abundance	Total Biomass1	Total Biomass2	Indicator Species	Target Species	Commercially Valuable Species
	ind/500m^2	t/km^2	kg/500m^2	% of total biomass	% of total biomass	% of total biomass
Auqui MPA- Outside						
n	5	5	5	5	5	5
Mean	454.4	9.5	4.8	5.1	20.8	42.7
SD	115.2	1.7	0.8	4.2	9.1	15.3
Min	310	7.3	3.6	1.6	11.3	21.4
Max	586	11.9	6	12.1	35.5	62.2
Auqui MPA-Inside and outside combined						
n	10	10	10	10	10	10
Mean	409.4	15.9	8	5.9	33.2	56.9
SD	171.8	16.2	8.1	5	18.0	23.2
Min	218	7.3	3.6	1.6	11.3	21.4
Max	744	61.1	30.5	16.7	62.3	89.4
General Island						
n	5	5	5	5	5	5
Mean	634.4	14.3	7.1	9.6	19.7	51.3
SD	335.6	6.9	3.4	6.1	10.3	11.7
Min	248	8.7	4.4	3.1	7.2	38.5
Max	1136	25.5	12.8	16	31.5	65.3
Uyamao Island						
n	5	5	5	5	5	5
Mean	412.4	6.9	3.5	8	28.7	45.7
SD	165.8	3.1	1.6	5.9	13.0	15
Min	234	3.9	2	0.9	6.1	23.4
Max	618	11.8	5.9	14.2	37.7	62.3
All Sites Combined						
n	30	30	30	30	30	30
Mean	636.9	13.7	6.8	6.5	23.3	49.7
SD	378.8	10.8	5.4	4.7	15.5	20.7
Min	218	0.6	0.3	0.9	0.0	0
Max	1866	61.1	30.5	16.7	62.3	89.4

FIGURE 3-20

FROM TOP: BIOMASS (KG/500M²), ABUNDANCE (NO. OF INDIVIDUALS/500M²) AND PORTION OF BIOMASS COMPOSED OF COMMERCIALLY VALUABLE SPECIES (KG/500M²; PERCENTAGE ALSO INDICATED) OF REEF FISH INSIDE ("IN") AND ADJACENT TO ("OUT") SELECTED MPAS AND POTENTIAL MPA SITES IN THE LANUZA BAY FOCAL AREA IN JUNE 2004







Note: The error bars represent 1 SD from the mean.

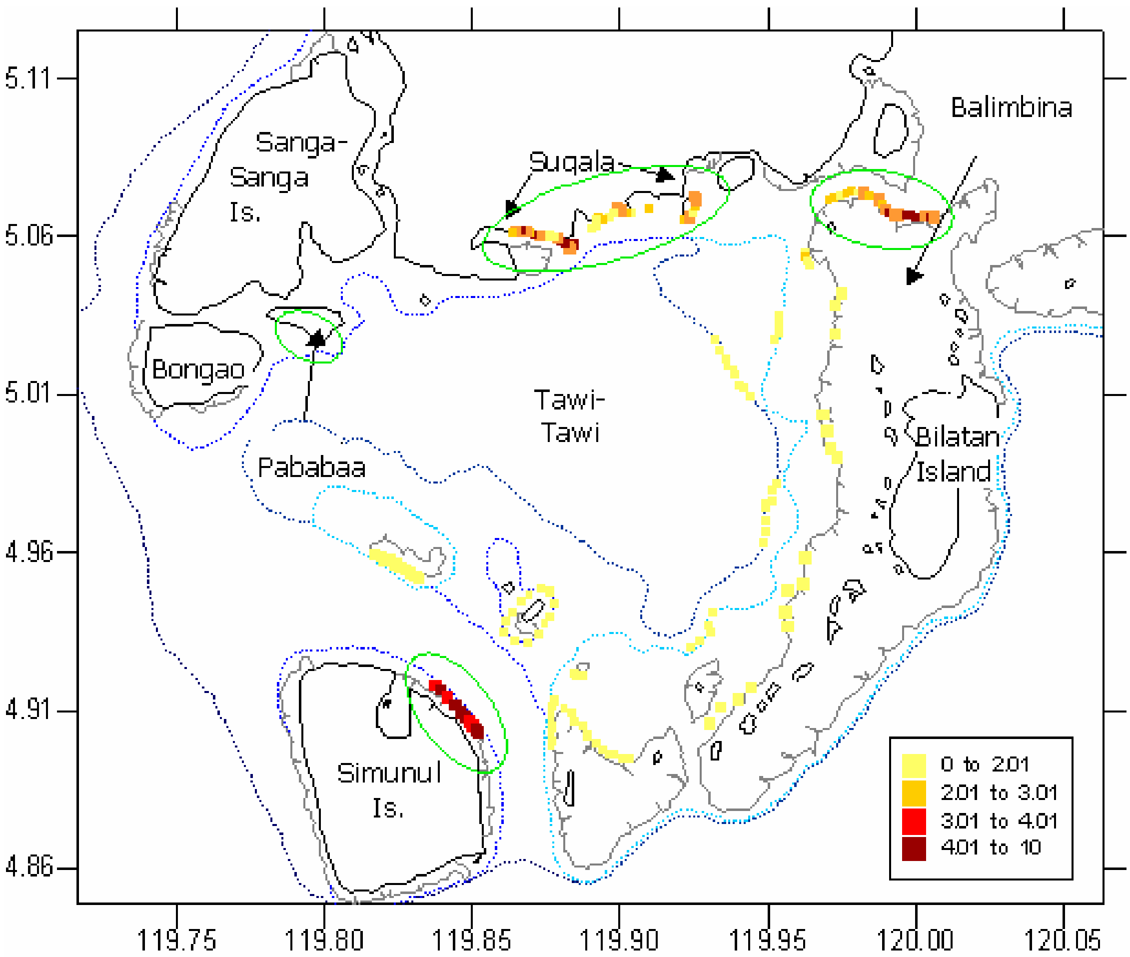
Tawi-Tawi

When the Tawi-Tawi Focal Area was surveyed in July and August 2004, there were reports of an MPA in Pababag Island. However, officials interviewed could not produce a document with the boundaries of the supposed MPA, although they would point to the general direction of the site and refer to it as an MPA. Apparently, the initiative was still at the conceptual stage and was something that could be encouraged into fruition by the FISH Project. Thus, the UPVFI research team conducted manta tows, particularly in areas not covered by the independent baseline contractor, to select potential MPA sites, in addition to the Pababag Island "MPA".

The area covered by the manta tow survey (Figure 3-21) extended from Pababag Island, just east of Bongao, southwards to northeast Simunul Island, then further east and north covering the reef flat area surrounding the Bilatan group of islands and islets, up to the Balimbing reef flat, then westwards along the coast of Sugala. In the eastern portion of the study area, the extensive reef flat showed uniformly and consistently poor coral cover interspersed with extensive areas of sand and bare rock. For this reason, manta tow surveys were done for stretches of 10 to 5 minutes (in some cases even less), with 10 to 15 minute runs in between. As a result, the estimated live coral cover markers are discontinuous, although the spaces in between are most likely of poor coral cover as well.

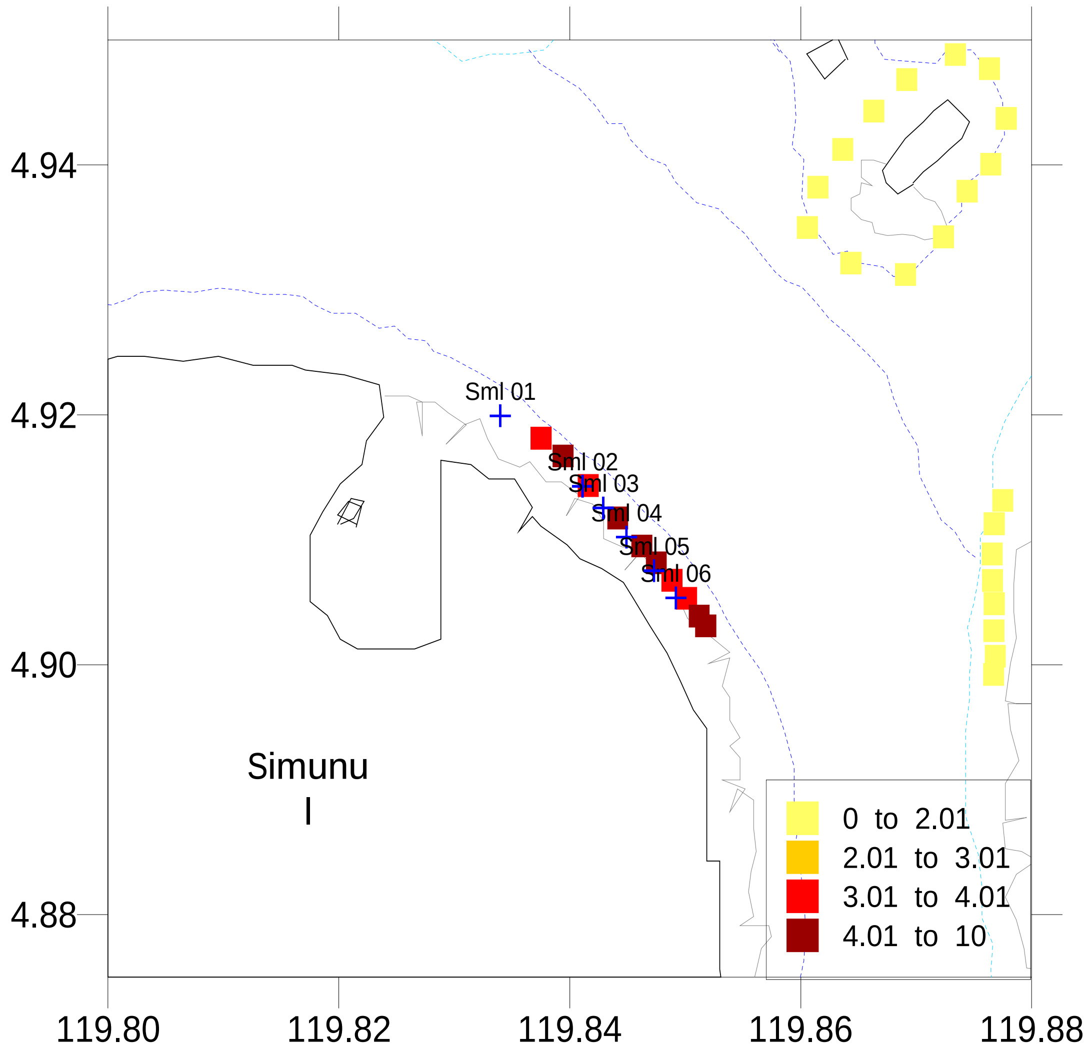
Based on manta tows, there were only three sites where live hard coral cover exceeded 30 percent. These include the northeast portion of Simunul Island, the northern portion of the Balimbing reef flat and the coastline of Sugala. The 30 dive stations were thus distributed among four sites, including the MPA in Pababag Island. Originally, the plan was to establish 10 dive stations in each of the three sites. However, potentially dangerous conditions brought about by very strong currents in the Simunul site limited the work there to six stations (Figure 3-22). In addition, given the absence of MPAs in the rest of the focal area, a decision was made to spread out the coverage of the remaining 14 stations along the Balimbing Reef Flat and the Sugala coastline. The 30 stations were thus distributed as follows: Pababag MPA (10 stations), Simunul Island (6 stations), Balimbing reef flat (5 stations), and the Sugala coastline (9 stations) (Figure 3-22 and 3-23).

FIGURE 3-21
MAP SHOWING THE RESULTS OF THE MANTA TOW SURVEY AND THE DIVE SITE LOCATIONS (ELLIPSES) IN TAWI-TAWI IN JULY-AUGUST 2004



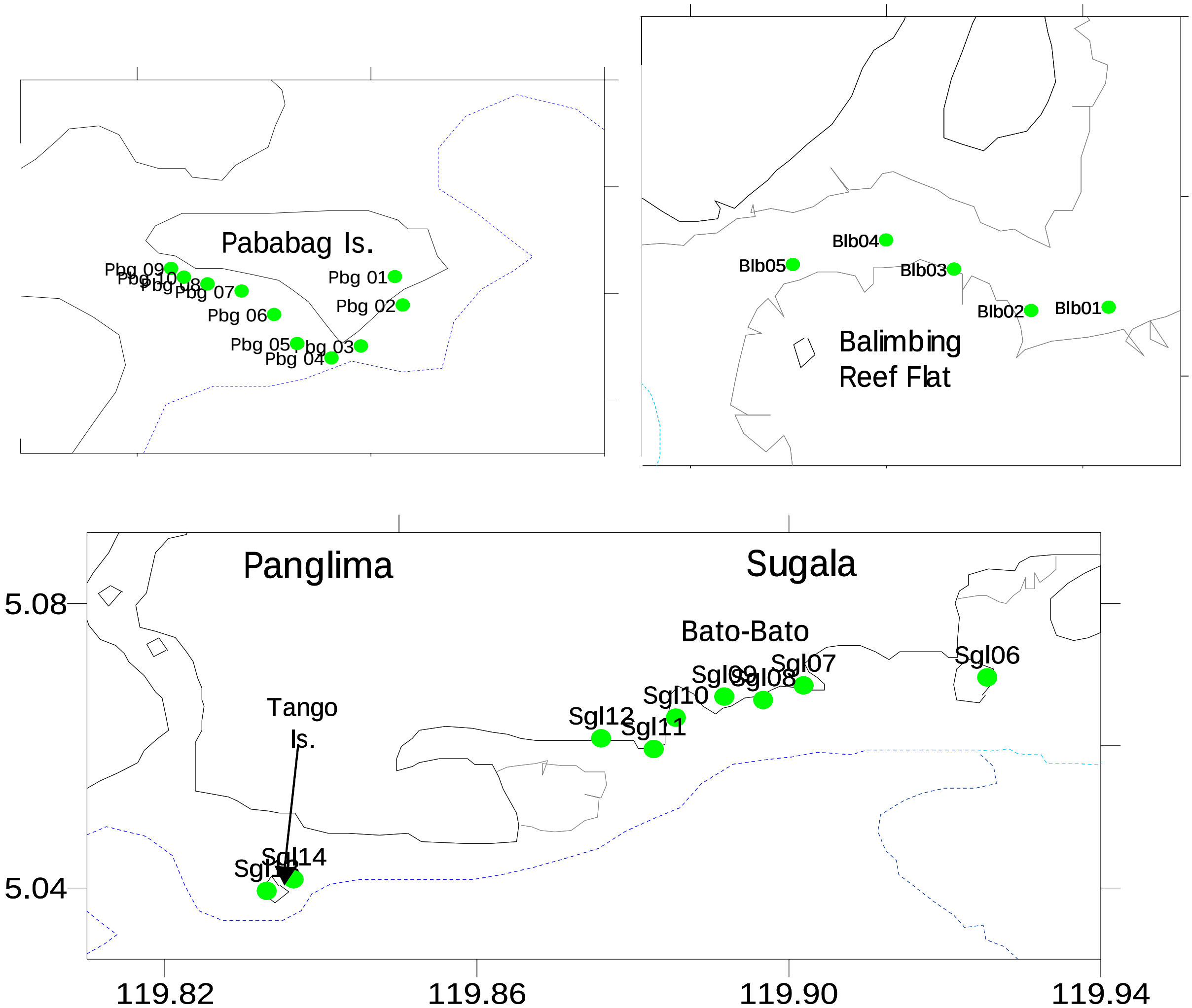
Note: Pababag Island (encircled by a solid ellipse) was also surveyed by the independent baseline contractor.

FIGURE 3-22
SPECIFIC DIVE STATION LOCATIONS IN THE SOUTHERN PORTION OF TAWI-TAWI OFF SIMUNUL ISLAND IN JULY-AUGUST 2004



Note: Initial manta tow results are superimposed. Crosses indicate stations.

FIGURE 3-23
SPECIFIC DIVE STATION LOCATIONS IN THE NORTHERN PORTION OF TAWI-TAWI IN JULY-AUGUST 2004



Fish biomass (Table 3-22a and Figure 3-24) was high in both Sugala and Simunul (means: 9.9 - 13 kg/500m^2; range: 4.6 - 21.5) but low in Pababag and Balimbing (means: 4.9 - 5.6 kg/500m^2; range: 2.8 – 8.6). Overall fish biomass for the area was 8.1 kg/500m^2, with a range of 2.8 – 21.5. While this is still low compared to the rest of the country (Hilomen *et. al.* 2001), estimates for Sugala and Simunul are moderate in level, with a couple of stations in these sites showing high biomass.

TABLE 3-22A
BASELINE VALUES FOR PR3: REEF FISH ABUNDANCE AND BIOMASS AT POTENTIAL AND EXISTING MPAS IN THE TAWI-TAWI FOCAL AREA IN JULY-AUGUST 2004

Site	Total Abundance	Total Biomass1	Total Biomass2	Indicator Species	Target Species	Commercially Valuable Species
	ind/500m^2	t/km^2	kg/500m^2	% of total biomass	% of total biomass	% of total biomass
Pababag Island MPA, Bongao						
n	10	10	10	10	10	10
Mean	797.8	9.7	4.9	6	11.3	23.4
SD	426.4	2.9	1.4	8.1	4.1	12
Min	530	5.6	2.8	0.2	6.4	11.4
Max	1920	14.6	7.3	27.5	20.5	49.9
Balimbing Reef Flat						
n	5	5	5	5	5	5
Mean	787.6	11.3	5.6	1.2	9.9	23.7
SD	107.1	3.5	1.8	1.2	10.8	11.7
Min	684	8.8	4.4	0.0	0.0	15.1
Max	940	17.3	8.6	2.4	28.2	44.1
Batu-Batu, Sugala Coast						
n	9	9	9	9	9	9
Mean	1126.4	19.9	9.9	3.6	11.3	37.5
SD	343.3	7.1	3.5	2.6	8.2	18.2
Min	880	9.2	4.6	0.3	1.5	7.5
Max	1962	29.8	14.9	8	21.9	59.4
Simunul Island						
n	6	6	6	6	6	6
Mean	843.7	26	13	5.2	21.1	29.6
SD	336.9	12.8	6.4	2.0	7.6	11.8
Min	552	11.3	5.7	2.7	10.7	10.9
Max	1388	43	21.5	8.2	31.4	42

TABLE 3-22A (continued)
BASELINE VALUES FOR PR3: REEF FISH ABUNDANCE AND BIOMASS AT POTENTIAL AND EXISTING MPAS IN THE TAWI-TAWI FOCAL AREA IN JULY-AUGUST 2004

Site	Total Abundance	Total Biomass1	Total Biomass2	Indicator Species	Target Species	Commercially Valuable Species
	ind/500m^2	t/km^2	kg/500m^2	% of total biomass	% of total biomass	% of total biomass
All Sites Combined						
n	30	30	30	30	30	30
Mean	903.9	16.3	8.1	4.3	13.1	28.9
SD	363.9	9.4	4.7	5.1	8.2	14.7
Min	530	5.6	2.8	0	0.0	7.5
Max	1962	43	21.5	27.5	31.4	59.4

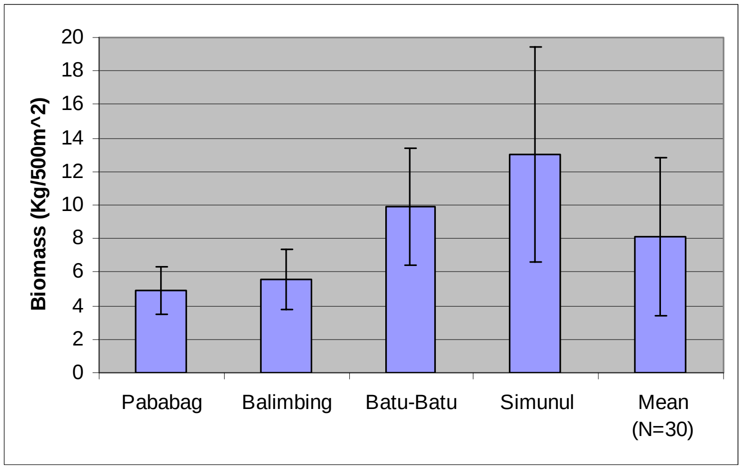
The overall mean fish abundance was 903.9 ind/500m^2 (Table 3-22a), which is in the higher range of estimates for reefs along the South China Sea Coast of Luzon and those in western Visayas (Campos *et al.* 2004), but are still considered moderate in level with respect to the entire country (Hilomen *et al.* 2000). Fish abundance was highest along the Sugala coast (Figure 3-24), with a mean of 1126.4 ind/500m^2, although there were one or two stations with high abundance estimates in the other sites as well.

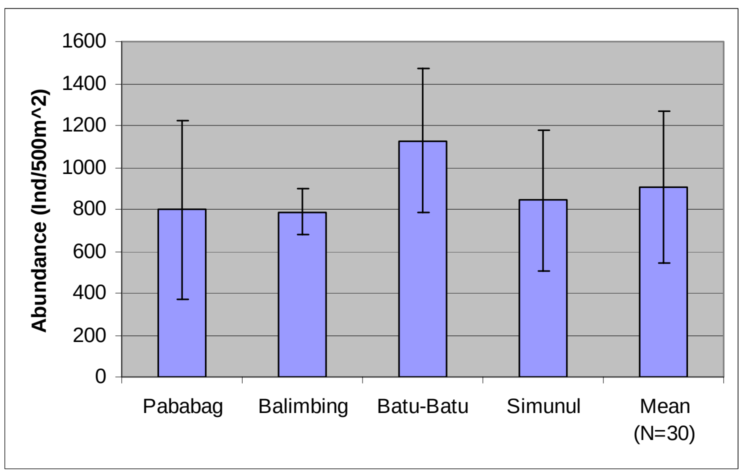
Chaetodontids, the indicators of reef health, were most abundant in Simunul, but showed rather scattered abundances in Pababag and Sugala. They were least abundant along the Balimbing reef flat, where the cover of live hard coral is also lowest (see below). Mean chaetodontid abundance in the four sites surveyed ranged from 0-82 ind/500m^2 (mean = 17.9), which is higher than the range of predicted values based on an empirical relationship between overall live coral cover (~50 percent, see below) and chaetodontid abundances presented by Nañola and Alino (1999).

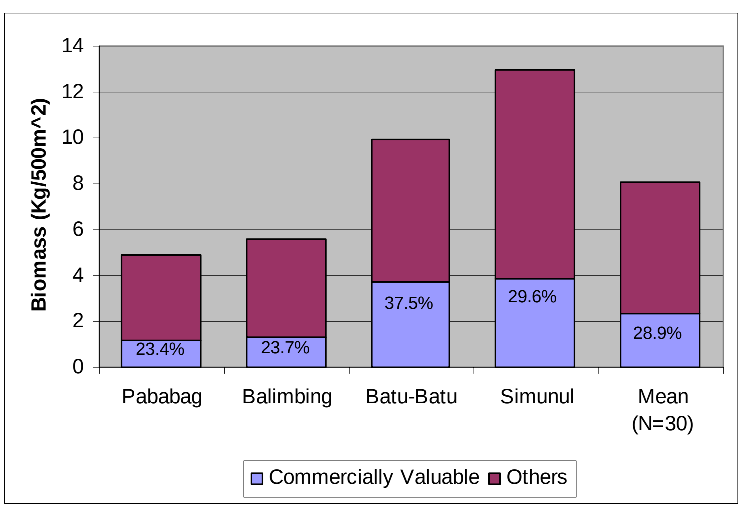
The target species showed highest abundances in Simunul, showing an average biomass of 2.6 kg/500m^2, representing about 21 percent of total fish biomass in the site. Overall, target species showed a mean biomass of 1.2 kg/500m^2, representing only about 13 percent of mean total fish biomass in the four sites (Table 3-22a).

Target fish abundances ranged from 0-42 ind/500m^2 in all sites except Simunul. These are comparable to values reported for Cabacongan, Bohol and Port Barton, Palawan (Uychiaoco *et al.* 2002a and b respectively). In Simunul however, target fish abundance was much higher, ranging from 64-716 ind/500m^2. These estimates are much higher than what has been reported in other reef areas in the country (Philreefs 2002). The highly productive reefs in Bohol Sea, including Pamilacan, Sumilon, and Balicasag (White and Meneses 2002) would fall into the same category as Simunul. Together with other locally valuable fish groups, that is, scaridae and caesionidae, target or valuable species represented at least 30 percent of mean total fish biomass in Sugala and Simunul.

FIGURE 3-24
FROM TOP: BIOMASS (KG/500M^2), ABUNDANCE (NO. OF INDIVIDUALS/500M^2) AND PORTION OF BIOMASS COMPOSED OF COMMERCIALLY VALUABLE SPECIES (KG/500M^2; PERCENTAGE ALSO INDICATED) OF REEF FISH AT POTENTIAL MPA SITES IN THE TAWI-TAWI FOCAL AREA IN JULY-AUGUST 2004







Note: The error bars represent 1 SD from the mean.

3.4 PROJECT RESULT 4: REEF FISH SPECIES RICHNESS WITHIN AND ADJACENT TO SELECTED MPAS

In the stations surveyed in the Calamianes, a total of 175 species of reef fish, comprising 34 families, were recorded in 30 dive stations. Of these, the Labridae, Pomacentridae, Scaridae and Apogonidae were the most species-rich families, together making up about 59 percent of all species recorded in the three sites. On the whole the reef fish assemblages are dominated by small cryptic species that live amongst the corals, or at least very close to them (such as Pomacentrids), and exhibit very limited movement within the reef.

The number of fish species recorded (within 250m^2) in all 30 stations in the Calamianes ranged from 21 to 56, with a mean of about 36 (Table 3-22b). The average species richness per station was lowest in Lajala Island, but much higher in Sangat-Decalve (37.8) and Bugor (40.6) (Figure 3-25). The relative ranking of these three sites in terms of reef fish species richness was consistent with their relative ranking in terms of reef fish biomass and abundance (Figure 3-14).

In Danajon Bank, the mean species richness from 36 transects is 23.3 species/500m^2 with a range of 2 to 48 (Table 3-22b). The Hingutunan MPA had the highest species richness, followed by Bilangbilangan and Bantigue (Figure 3-25). Species richness was greatest in the two outer islands of Hingutanan and Bilangbilangan possibly because these islands were less silted and in better health.

TABLE 3-22B
BASELINE VALUES FOR PR4: SPECIES RICHNESS (NO. OF SPECIES/UNIT AREA) OF REEF FISH COMMUNITIES AT POTENTIAL AND EXISTING MPAS IN THE FOCAL AREAS

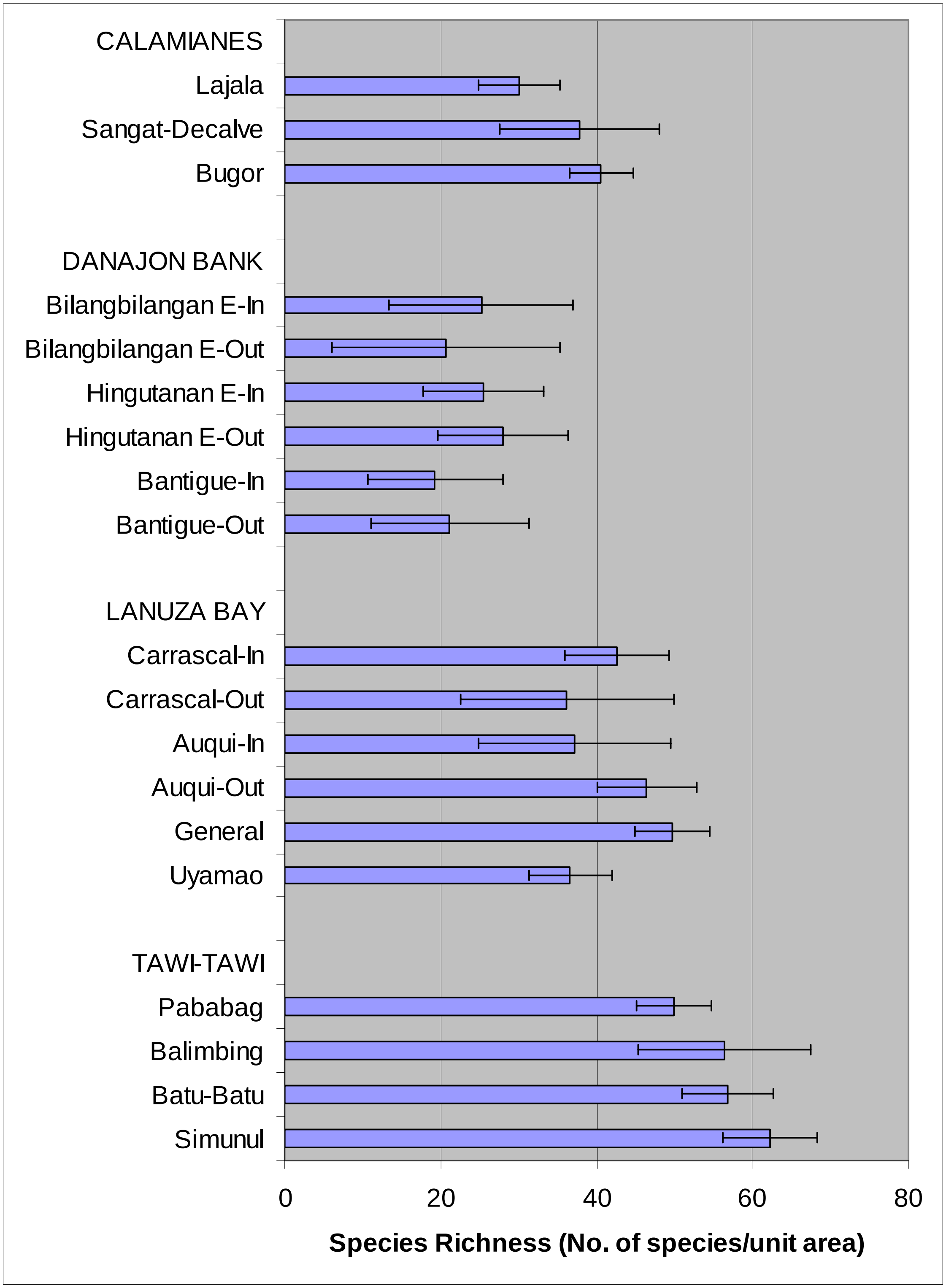
Site	n	Mean	SD	Min	Max
Calamianes Islands					
Brgy. Lajala, Uson Island	10	30.1	5.3	23	38
Sangat-Decalve Islands	10	37.8	10.2	21	56
Bugor Island	10	40.6	4.1	34	46
All sites in Calmianes combined	30	36.2	8.1	21	56
Danajon Bank					
Bilangbilangan East MPA-Inside	6	25.2	11.8	16	48
Bilangbilangan East MPA-Outside	6	20.7	14.7	2	37
Bilangbilangan East MPA-Inside and outside combined	12	22.9	12.9	2	48
Hingutanan East MPA-Inside	6	25.5	7.7	16	36
Hingutanan East MPA-Outside	6	28.0	8.4	20	41
Hingutanan East MPA-Inside and outside combined	12	26.8	7.8	16	41
Bantigue MPA-Inside	6	19.3	8.6	7	29
Bantigue MPA-Outside	6	21.2	10.1	12	36
Bantigue MPA-Inside and outside combined	12	20.3	9.0	7	36
All sites in Danajon Bank combined	36	23.3	10.2	2	48

TABLE 3-22B (continued)

BASELINE VALUES FOR PR4: SPECIES RICHNESS (NO. OF SPECIES/UNIT AREA) OF REEF FISH COMMUNITIES AT POTENTIAL AND EXISTING MPAS IN THE FOCAL AREAS

Site	n	Mean	SD	Min	Max
Lanuza Bay, Surigao del Sur					
Carrascal MPA-Inside	5	42.6	6.7	36	52
Carrascal MPA-Outside	5	36.2	13.7	12	46
Carrascal MPA-Inside and outside combined	10	39.4	10.7	12	52
Auqui MPA-Inside	5	37.2	12.3	25	51
Auqui MPA- Outside	5	46.4	6.4	40	57
Auqui MPA-Inside and outside combined	10	41.8	10.4	25	57
General Is.	5	49.8	4.8	45	57
Uyamao Is.	5	36.6	5.3	30	43
All sites in Lanuza Bay combined	30	41.5	9.7	12	57
Tawi-Tawi					
Pababag Is. MPA, Bongao	10	50	4.8	39	56
Balimbing Reef Flat	5	56.4	11.1	42	69
Batu-Batu, Sugala Coast	9	56.8	5.8	45	64
Simunul Is.	6	62.2	6.1	52	68
All sites in Tawi-Tawi combined	30	55.5	7.8	39	69

FIGURE 3-25
REEF FISH SPECIES RICHNESS (NO. OF SPECIES/UNIT AREA) INSIDE ("IN") AND ADJACENT TO ("OUT") SELECTED MPAS AND POTENTIAL MPA SITES IN THE FOCAL AREAS OF THE FISH PROJECT, MAY-AUGUST 2004



In the Lanuza Bay focal area at Surigao del Sur, a total of 259 species of reef fish, belonging to 36 families, were recorded in 30 dive stations. Of these, the Labridae (53 species), Pomacentridae (49 species) and Chaetodontidae (22 species) were the most species-rich families, together making up about 48 percent of all species recorded in the four sites. On average, small cryptic fish such as pomacentrids and apogonids comprised 39 percent of the reef fish assemblage, while school-forming fishes like caesionids and plotosids (juveniles) comprised about 33 percent.

Overall mean species richness in Lanuza Bay, Surigao del Sur was 41.5 species/250m^2 with a range of 12 to 57 (Table 3-22b). Species richness is best compared among areas that were surveyed with equal sample sizes. Thus, with regard to the species richness values for MPAs in Lanuza Bay in Table 3-22b, the values pertaining to “inside and outside combined” (n=10) should be temporarily disregarded so that we will be comparing samples of size n=5. Hence, in terms of number of species, there appears to be a large difference between the MPA (mean = 42.6, range: 36-52) and non-MPA (mean=36.2, range: 12-46) stations in Carrascal. A closer look at both sets of data, however, revealed that Station 10 is an outlier. Excluding this data point, the difference between the two portions becomes negligible, and both are similar to species richness estimates in General Island (mean=49.8, range: 45-57) and those in the “outside MPA” stations around Auqui Island (mean = 46.4, range: 40-57). In comparison, species richness estimates around Uyamao Island (mean=36.6, range: 30-43) are somewhat lower and similar to those “inside” the Auqui MPA (mean=37.2, range: 25-51). On the whole, General Island, Auqui Island and a couple of stations in the area between them (Auqui MPA) and in Carrascal show moderate to high species richness.

A total of 350 species of reef fish, belonging to 43 families, were recorded in the 30 dive stations surveyed in Tawi-Tawi. Of these, the Labridae (73 species) and Pomacentridae (63 species) were the most species-rich families, together making up about 39 percent of all species recorded in the four sites.

Species richness was highest in Simunul (mean = 62.2 spp/250m^2), followed by the Balimbing reef flat and Sugala coast (mean = 56.4 and 56.8 respectively), and lowest in Pababag Island (Table 3-22b and Figure 3-25). Species richness, however, cannot be directly compared between the four sites, because of differences in the number of stations surveyed. Theoretically, the number of taxa observed increases as the number of samples increases. Hence, when sites with many stations show less taxa than sites with less stations, species richness is likely to be higher in the latter. In the four sites surveyed, the total number of families recorded was highest (33) in those sites with the most stations (Pababag and Sugala), although Simunul, with only six stations surveyed, was not far behind with 30 families recorded (Table 3-22b). This suggests higher species richness in the latter.

The independent baseline contractor found Bongao, Tawi-Tawi as the most diverse site with 55 to 65 species per 500m^2, based on fish visual census (DAI 2004).

3.5 PROJECT RESULT 5: BENTHIC CONDITION INSIDE AND ADJACENT TO SELECTED MPAS

Table 3-23 and Figure 3-26 present the percentage of live coral cover in the sites surveyed, which is the primary parameter for measuring project performance with regard to PR5. In the Calamianes, live hard coral cover was comparable between the three surveyed sites. In Danajon Bank, higher coral cover was observed inside the MPAs of Bilangbilangan E and Hingutanan E, but the reverse situation was exhibited by the Bantigue MPA. As in the Calamianes, variability of live hard coral cover between sites surveyed was relatively small.

In contrast, the sites surveyed at Lanuza Bay and Tawi-Tawi exhibited large differences in mean live hard coral cover (Figure 3-26). In Lanuza Bay, the lowest values were observed in and outside of the Carrascal MPA and around Uyamao Island. General Island dive stations showed the highest live coral cover, averaging over 75 percent. On the whole, live coral cover was relatively high around General Island and in the southern, leeward side of Auqui.

In Tawi-Tawi, overall live hard coral cover in the various dive sites was moderate (mean= 47.6 percent), but ranged from 5.5 to 83 percent (Table 3-23). On average, the Balimbing reef flat site showed the lowest live hard coral cover, while there were at least three stations in each of the other three sites with > 50 percent live cover. Highest live coral cover was shown for the west side of Pababag Island and along the shallow central portion of Sugala.

While the percentage of live coral cover is the primary measure of project performance with regard to PR5, the Baseline Assessment Plan calls for the use of the Mortality Index (Gomez *et al.* 1994), the Development Index, the Condition Index and the Succession Indices (Manthachitra 1994) as a means to paint a more complete picture of benthic conditions in the sites surveyed. Live hard coral cover has the advantage of being simple and easily understood. It seems straightforward to measure coral cover during baseline assessment and to expect changes in this parameter to reflect the quality of MPA management. However, coral cover may not increase, or maybe slow to increase, if the area for coral colonization is absent or limited. Also, as an index, live coral cover will not show the difference between a pristine reef with only 50 percent coral cover because the rest of the reef is naturally occupied by sand and a stressed reef with only 50 percent of its coral cover remaining because of ongoing siltation. Hence, the Baseline Assessment Plan lists supportive indices.

Perhaps the most useful among these supportive indices is the Mortality Index of Gomez *et al.* (1994), which is the percentage of hard coral that have died (recently). The Mortality Index also indirectly indicates the amount of corals that survive, namely, Survival (%) = 100% - Mortality (%). For example, at Lajala the measured mortality of hard corals is 43.9 percent on the average (Table 3-24) and conversely, the survival of corals is 56.1 percent.

TABLE 3-23
BASELINE VALUES FOR PR5: LIVE CORAL COVER (%) AT POTENTIAL AND EXISTING MPAS IN THE FOCAL AREAS

Site	n	Mean	SD	Min	Max
Calamianes Islands					
Brgy. Lajala, Uson Is.	10	47.9	14.0	29.5	75.5
Sangat-Decalve Islands	10	45.5	18.7	22.5	82.0
Bugor Is.	10	48.9	22.5	14.5	82.0
All sites in Calamianes combined	30	47.4	18.1	14.5	82.0
Danajon Bank					
Bilangbilangan East MPA-Inside	6	21.3	10.6	7.0	30.5
Bilangbilangan East MPA-Outside	6	14.2	8.1	7.0	29.0
Bilangbilangan East MPA-Inside and outside combined	12	17.7	9.7	7.0	30.5
Hingutanan East MPA-Inside	6	24.3	9.9	10.0	36.5
Hingutanan East MPA-Outside	6	21.1	6.5	9.5	27.5
Hingutanan East MPA-Inside and outside combined	12	22.7	8.2	9.5	36.5
Bantigue MPA-Inside	6	30.6	3.7	25.5	34.5
Bantigue MPA-Outside	6	38.6	27.1	3.0	72.0
Bantigue MPA-Inside and outside combined	12	34.6	18.9	3.0	72.0
All sites in Danajon Bank combined	36	25.0	14.7	3.0	72.0
Lanuza Bay, Surigao del Sur					
Carrascal MPA-Inside	5	35.8	19.4	17.5	67.0
Carrascal MPA-Outside	5	12.0	8.8	2.5	22.5
Carrascal MPA-Inside and outside combined	10	23.9	18.9	2.5	67.0
Auqui MPA-Inside	5	41.0	22.8	6.5	67.5
Auqui MPA- Outside	5	69.7	18.0	47.0	90.5
Auqui MPA-Inside and outside combined	10	55.4	24.6	6.5	90.5
General Is.	5	75.7	8.9	65.0	86.0
Uyamao Is.	5	45.1	22.6	1.0	57.5
All sites in Lanuza Bay combined	30	45.1	27.3	1.0	90.5
Tawi-Tawi					
Pababag Is. MPA, Bongao	10	54.1	28.3	9.5	83.0
Balimbing Reef Flat	5	28.4	13.5	5.5	39.5
Batu-Batu, Sugala Coast	9	53.9	22.6	15.5	81.5
Simunul Is.	6	43.5	27.2	13.0	81.0
All sites in Tawi-Tawi combined	30	47.6	25.2	5.5	83.0

FIGURE 3-26
LIVE HARD CORAL COVER (%) INSIDE ("IN") AND ADJACENT TO ("OUT") SELECTED MPAS AND POTENTIAL MPA SITES IN THE FOCAL AREAS OF THE FISH PROJECT, MAY-AUGUST 2004

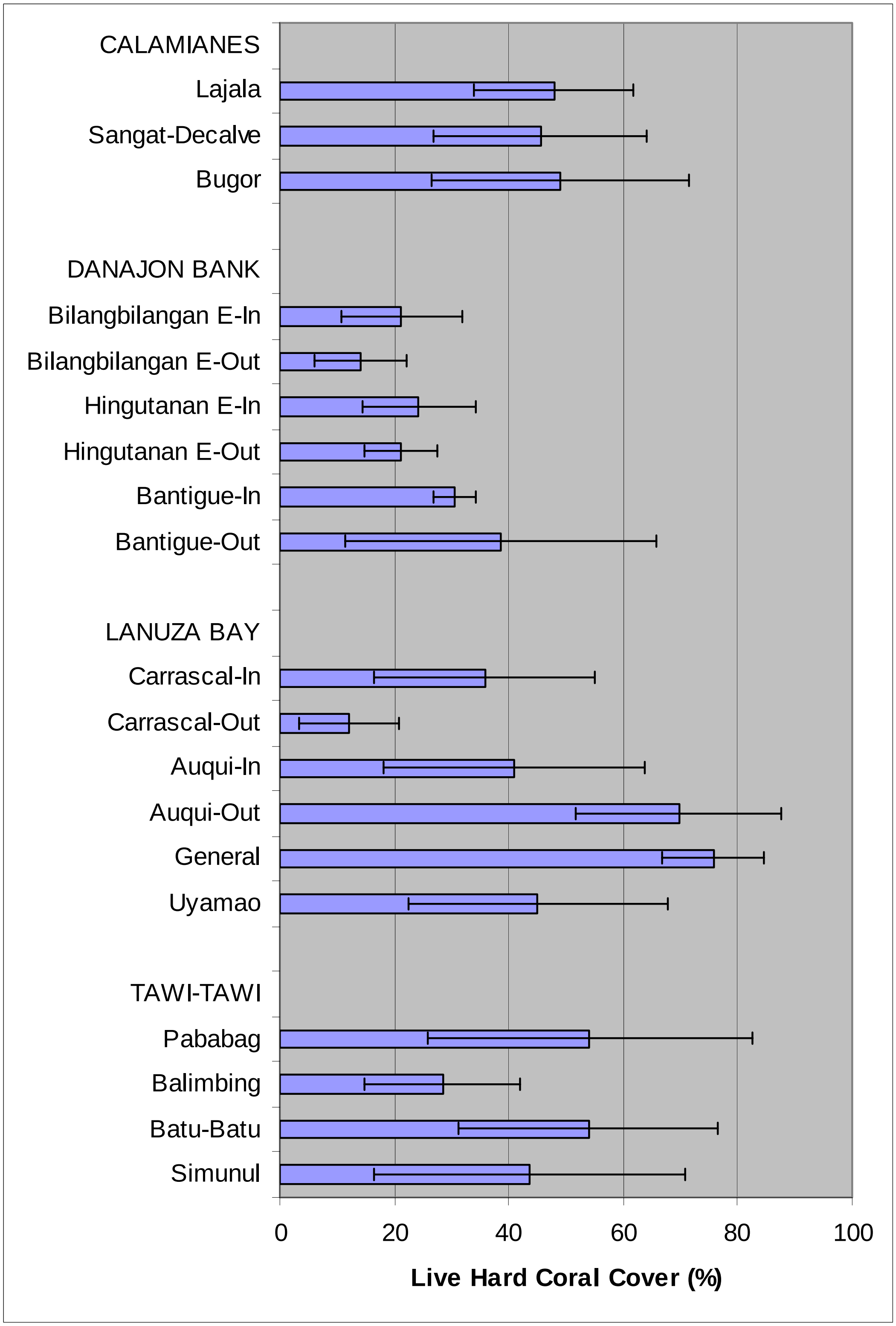


TABLE 3-24
MORTALITY (%) OF HARD CORALS AT POTENTIAL AND EXISTING MPAS IN THE FOCAL AREAS

Site	n	Mean	SD	Min	Max
Calamianes Islands					
Brgy. Lajala, Uson Is.	10	43.9	20.9	2.8	69.6
Sangat-Decalve Islands	10	43.7	24.4	3.8	76.9
Bugor Is.	10	40.9	27.4	13.2	85.1
All sites in Calamianes combined	30	42.8	23.5	2.8	85.1
Danajon Bank					
Bilangbilangan East MPA-Inside	6	15.5	16.5	0.0	34.1
Bilangbilangan East MPA-Outside	6	33.5	33.7	1.7	77.8
Bilangbilangan East MPA-Inside and outside combined	12	24.5	27.0	0.0	77.8
Hingutanan East MPA-Inside	6	23.3	19.3	4.8	50.0
Hingutanan East MPA-Outside	6	30.3	30.9	0.0	65.1
Hingutanan East MPA-Inside and outside combined	12	26.8	24.9	0.0	65.1
Bantigue MPA-Inside	6	21.0	21.6	0.0	45.5
Bantigue MPA-Outside	6	33.4	38.2	0.0	87.2
Bantigue MPA-Inside and outside combined	12	27.2	30.3	0.0	87.2
All sites in Danajon Bank combined	36	26.2	26.7	0.0	87.2
Lanuza Bay, Surigao del Sur					
Carrascal MPA-Inside	5	53.4	21.5	27.2	82.5
Carrascal MPA-Outside	5	62.0	36.3	0.0	95.7
Carrascal MPA-Inside and outside combined	10	57.7	28.5	0.0	95.7
Auqui MPA-Inside	5	52.9	24.9	31.8	93.3
Auqui MPA- Outside	5	22.1	14.1	6.7	41.3
Auqui MPA-Inside and outside combined	10	37.5	25.0	6.7	93.3
General Is.	5	15.3	3.2	12.7	20.8
Uyamao Is.	5	51.6	30.6	22.8	97.3
All sites in Lanuza Bay combined	30	42.9	28.4	0.0	97.3
Tawi-Tawi					
Pababag Is. MPA, Bongao	10	8.0	8.8	0.0	25.5
Balimbing Reef Flat	5	3.8	3.3	0.0	8.7
Batu-Batu, Sugala Coast	9	16.2	10.4	0.0	25.9
Simunul Is.	6	37.7	28.6	6.2	66.7
All sites in Tawi-Tawi combined	30	15.7	18.5	0.0	66.7

In a number of instances, the Mortality Index values calculated for a site were consistent with what we would expect given the percentage of live hard coral cover, thus lending support to our initial and tentative conclusions about the relative health of a site. In general, we would expect mortality to be relatively high when live hard coral cover is relatively low, and vice-versa. As mentioned earlier, in Danajon Bank coral cover was higher inside than outside the MPAs of Bilangbilangan E and Hingutanan E (Figure 3-26). In Figure 3-27, we see that indeed the corals outside these MPAs suffer higher mortality than the corals inside. When we compare Figure 3-26 and 3-27, we find other pairings that are consistent with what we would normally expect. These include: (i) inside and outside the Carrascal MPA, (ii) inside and outside the Auqui MPA, (iii) General and Uyamao, and (iv) Batu-Batu and Simunul. Thus, on the basis of these two indices, benthic conditions are probably better inside than outside the following MPAs: Bilangbilangan E, Hingutanan E and Carrascal. On the other hand, at Auqui MPA the reef condition is worse inside than outside the MPA.

FIGURE 3-27
CORAL MORTALITY (%) INSIDE ("IN") AND ADJACENT TO ("OUT") SELECTED MPAS AND POTENTIAL MPA SITES IN THE FOCAL AREAS OF THE FISH PROJECT, MAY-AUGUST 2004

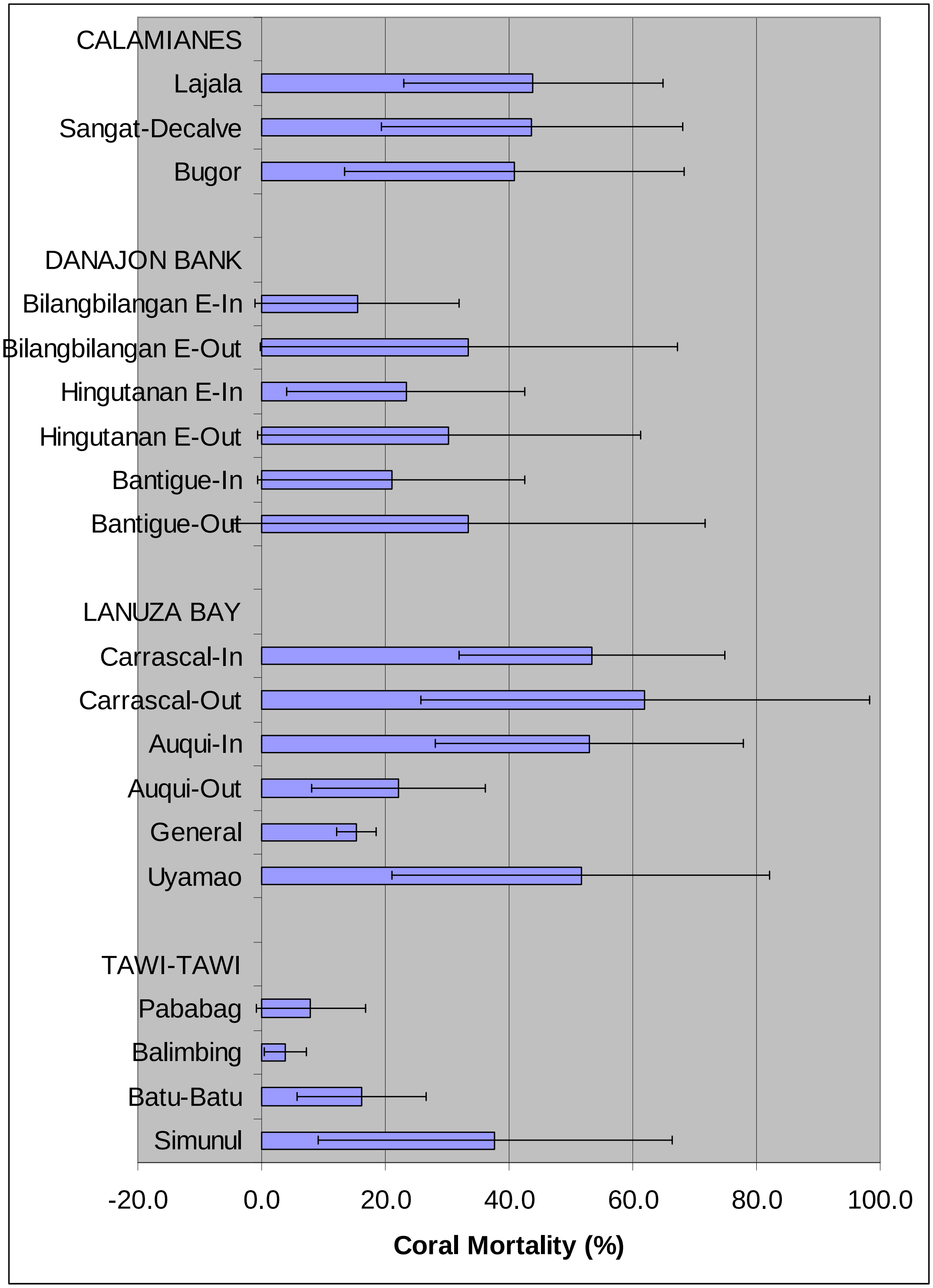
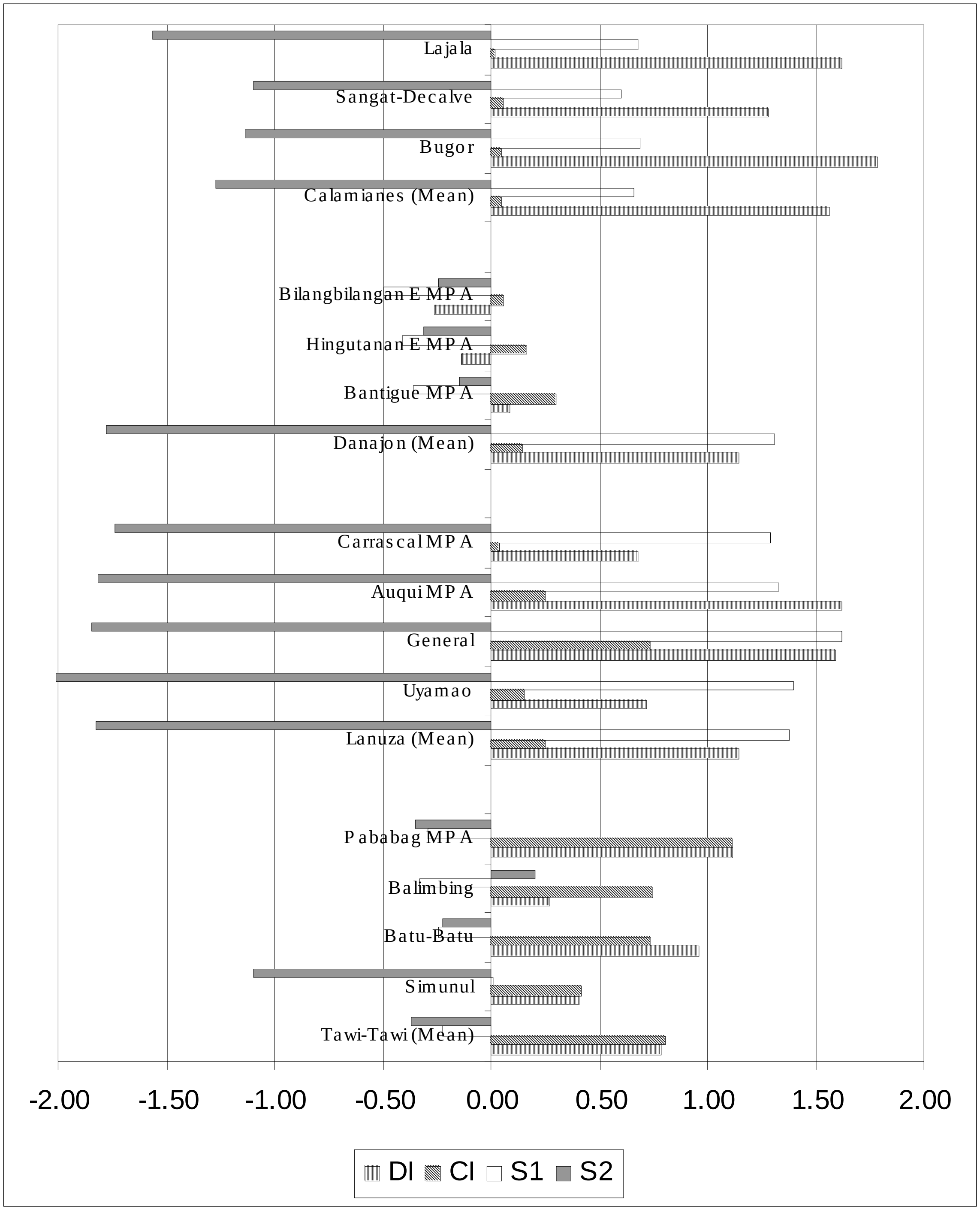


FIGURE 3-28
DEVELOPMENT (DI), CONDITION (CI), SUCCESSION 1 (SUCCESSION OF ALGAE ON DEAD CORALS, S1) AND SUCCESSION 2 (SUCCESSION OF OTHER FAUNA ON DEAD CORALS, S2) INDICES OF CORAL REEFS AT POTENTIAL AND EXISTING MPAS IN THE FOCAL AREAS



The calculated values for the Development, Condition and Succession indices (Manthachitra 1994) are presented in Table 3-25 and Figure 3-28. The Development Index is the ratio of living and once-living components of a reef (specifically, live coral, dead coral, and algae and other fauna growing on corals) to the abiotic components of a reef (see Table 2-7). Thus, it attempts to measure the degree to which living components have colonized the non-living component of the environment, thus indicating the extent of natural reef development. On the other hand, the Condition Index, like the Mortality Index, is based on the fact that in the short term, corals cannot grow on abiotic components like sand or silt. It is the ratio of live hard coral cover to the other sections of the reef that could be or could have been colonized by corals, represented by dead corals, and algae and other fauna growing on corals. This ratio decreases as hard corals die or are overgrown by algae and other fauna (such as soft corals), thus indicating degree of stress. The Succession indices attempt to measure the "sequential changes of benthic community occurring on dead coral." These two indices try to depict the early stages of coral recovery, in which algae (Succession Index 1) are typically the first to grow on dead coral, followed by other fauna (Succession Index 2). In these indices, log transformation is done to minimize the wide differences in values that one would otherwise obtain.

TABLE 3-25

INDICES OF DEVELOPMENT (DI), CONDITION (CI), SUCCESSION 1 (SUCCESSION OF ALGAE ON DEAD CORALS, S1) AND SUCCESSION 2 (SUCCESSION OF OTHER FAUNA ON DEAD CORALS, S2) OF CORAL REEFS AT POTENTIAL AND EXISTING MPAS IN THE FOCAL AREAS

Site	n	DI (Mean)	DI (SD)	CI (Mean)	CI (SD)	S1 (Mean)	S1 (SD)	S2 (Mean)	S2 (SD)
Calamianes Islands									
Brgy. Lajala, Uson Is.	10	1.62	1.10	0.02	0.26	0.68	0.60	-1.56	0.89
Sangat-Decalve Islands	10	1.28	0.76	0.06	0.38	0.60	0.87	-1.10	1.14
Bugor Is.	10	1.79	1.12	0.05	0.50	0.69	1.18	-1.14	1.00
All sites in Calamianes combined	30	1.56	1.00	0.05	0.40	0.66	0.90	-1.27	1.00
Danajon Bank									
Bilangbilangan East MPA	12	-0.26	0.22	0.06	0.33	-0.50	0.73	-0.24	1.37
Hingutanan East MPA	12	-0.14	0.32	0.16	0.29	-0.41	0.52	-0.31	1.17
Bantigue MPA	12	0.08	0.34	0.30	0.54	-0.36	0.47	-0.14	0.92
All sites in Danajon Bank	36	-0.10	0.07	0.17	0.14	-0.42	0.14	-0.23	0.23
Lanuza Bay, Surigao del Sur									
Carrascal MPA	10	0.68	1.35	0.04	0.76	1.29	0.85	-1.74	0.85
Auqui MPA	10	1.62	0.93	0.25	0.62	1.33	1.39	-1.82	0.98
General Is.	5	1.59	1.02	0.74	0.1	1.62	0.36	-1.84	0.48
Uyamao Is.	5	0.72	1	0.16	0.44	1.4	0.66	-2.01	0.54
All sites in Lanuza Bay combined	30	1.15	1.15	0.25	0.62	1.38	0.96	-1.83	0.78

TABLE 3-25 (continued)
INDICES OF DEVELOPMENT (DI), CONDITION (CI), SUCCESSION 1 (SUCCESSION OF ALGAE ON DEAD CORALS, S1) AND SUCCESSION 2 (SUCCESSION OF OTHER FAUNA ON DEAD CORALS, S2) OF REEFS CORALS AT POTENTIAL AND EXISTING MPAS IN THE FOCAL AREAS

Site	n	DI (Mean)	DI (SD)	CI (Mean)	CI (SD)	S1 (Mean)	S1 (SD)	S2 (Mean)	S2 (SD)
Tawi-Tawi									
Pababag Is. MPA, Bongao	10	1.12	0.45	1.12	0.43	-0.30	1.10	-0.35	1.22
Balimbing Reef Flat	5	0.28	0.31	0.75	0.74	-0.33	0.76	0.20	0.73
Batu-Batu, Sugala Coast	9	0.96	0.66	0.74	0.37	-0.25	0.99	-0.22	0.91
Simunul Is.	6	0.41	0.30	0.42	0.58	0.01	0.87	-1.10	0.53
All sites in Tawi-Tawi combined	30	0.79	0.58	0.80	0.55	-0.23	0.94	-0.37	0.99

The easiest way to interpret these indices is to use the qualitative translation provided by Manthachitra (1994), which is partially reproduced in Table 3-26. Note that the calculated index values can be expressed as percentages. The reason these percentages are reproduced here is to show the classification of a particular condition of the benthic community as either poor, fair, good, and so on, is almost purely arbitrary; it is based on the arbitrary division of the 0-100 percent range into five equal intervals (of 20 percent "width"). There is no ecological reason for selecting these specific intervals (although the assignment of the corresponding qualitative rating to each interval is not completely unreasonable). The fact that the intervals have one size only suggests that convenience was the paramount—if not the only—consideration in selecting these intervals. In short, only broad stroke interpretations of these indices should be attempted.

Table 3-27 presents the qualitative translation of the index values in Table 3-25, using the scheme in Table 3-26. In terms of the Development Index, the sites in Danajon Bank stand out in having mostly fair development, which is markedly lower than the mostly "very good" rating of the sites in the other focal areas. This is because the reefs sampled in Danajon Bank have distinctly large proportions of abiotics. In the Bilangbilangan E MPA, for instance, the mean percentage of abiotics is 59.2 percent, ranging from 38.0-82.0 percent.

In terms of the Condition Index, Tawi-Tawi is the stand out with "very good" rating for all sites except Simunul, which was rated "good." This is consistent with the sites in Tawi-Tawi showing among the lowest values for Coral Mortality (Figure 3-27), except for Simunul. In comparison with the other sites in Tawi-Tawi, Simunul is exposed to strong wave action.

In terms of the Succession Indices, the Calamianes and Lanuza Bay sites are similar in having mostly "very good" values for Succession Index 1 (succession by algae) along with "very poor" values for Succession Index 2. This suggests that on the dead coral in these sites, succession by algae is ongoing while succession by other fauna is yet to come. On the other hand, in Danajon Bank and Tawi-Tawi succession by either algae or other fauna on dead coral is apparently minimal. If succession by these biota truly signifies the early stages of the recovery of dead coral, then this is bad news for Danajon but less of a worry for Tawi-Tawi because there are fewer corals in the latter that are in need of recovery (that is, low coral mortality).

TABLE 3-26
SEMI-QUALITATIVE SCALE FOR AN ASSESSMENT OF INDEX QUALITY (MANTHACHITRA 1994)

Quality	Percentage (100 x)/(x + y)	Index scale Log (x/y)
Very Poor	< 20%	< - 0.602
Poor	20.01% to 40.00%	- 0.602 to – 0.176
Fair	40.01% to 60.00%	- 0.175 to 0.176
Good	60.01% to 80.00%	0.177 to 0.602
Very Good	> 80%	> 0.602

TABLE 3-27
QUALITY OF REEFS BASED ON THE INDICES OF DEVELOPMENT (DI), CONDITION (CI), SUCCESSION 1 (SUCCESSION OF ALGAE ON DEAD CORALS, S1) AND SUCCESSION 2 (SUCCESSION OF OTHER FAUNA ON DEAD CORALS, S2)

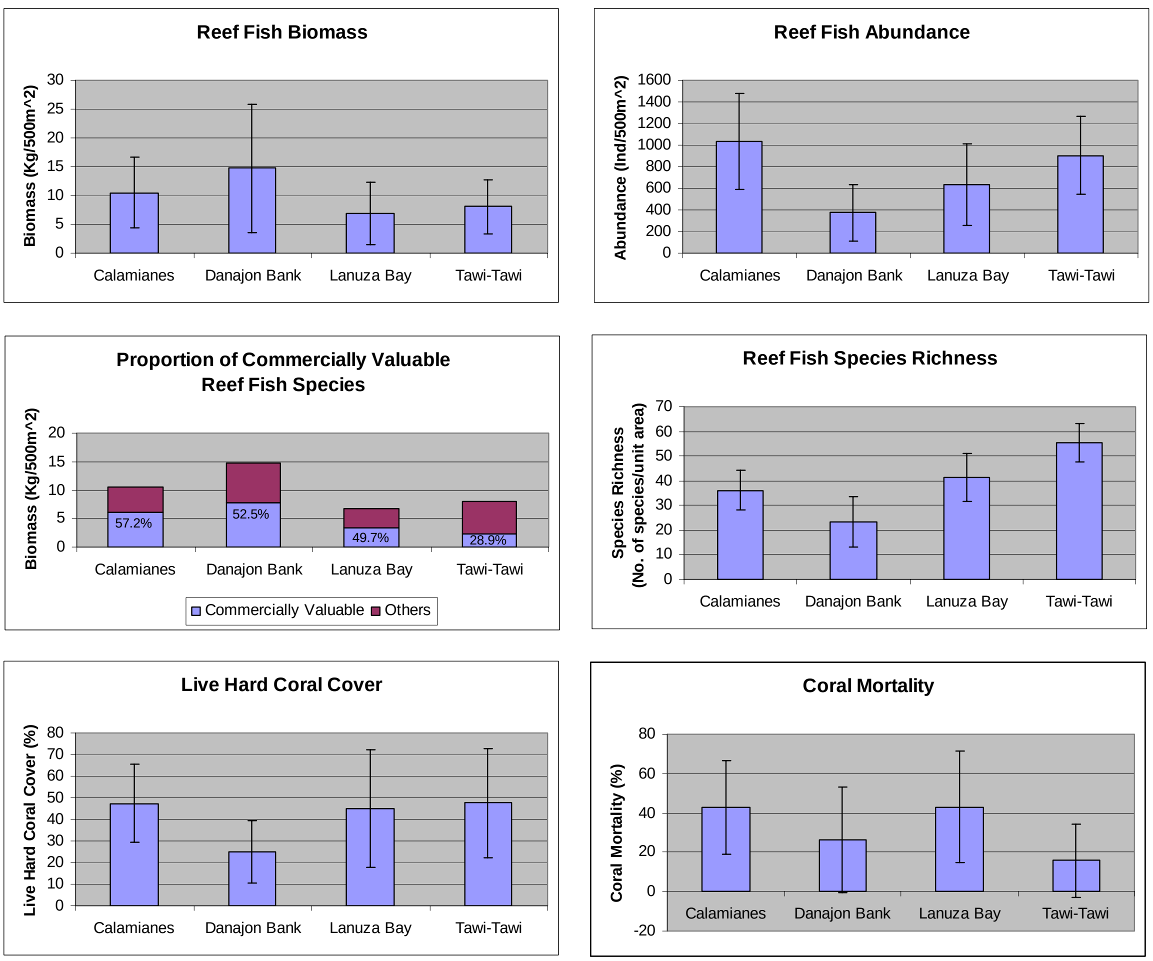
Site	DI	CI	S1	S2
Calamianes				
Lajala	Very Good	Fair	Very Good	Very Poor
Sangat-Decalve	Very Good	Fair	Good	Very Poor
Bugor	Very Good	Fair	Very Good	Very Poor
Mean (n = 30)	Very Good	Fair	Very Good	Very Poor
Danajon Bank				
Bilangbilangan E MPA	Poor	Fair	Poor	Poor
Hingutanan E MPA	Fair	Fair	Poor	Poor
Bantigue MPA	Fair	Good	Poor	Fair
Mean (n = 36)	Fair	Fair	Poor	Poor
Lanuza Bay				
Carrascal MPA	Very Good	Fair	Very Good	Very Poor
Auqui MPA	Very Good	Good	Very Good	Very Poor
General	Very Good	Very Good	Very Good	Very Poor
Uyamao	Very Good	Fair	Very Good	Very Poor
Mean (n = 30)	Very Good	Good	Very Good	Very Poor
Tawi-Tawi				
Pababag MPA	Very Good	Very Good	Poor	Poor
Balimbing	Good	Very Good	Poor	Good
Batu-Batu	Very Good	Very Good	Poor	Poor
Simunul	Good	Good	Fair	Very Poor
Mean (n = 30)	Very Good	Very Good	Poor	Poor

Comparison of the Four Focal Areas in Terms of PRs 3-5

Figure 3-29 compares the focal areas in terms of overall mean values of reef fish biomass, abundance and species richness, as well as proportion of commercially valuable reef fish species, live hard coral cover, and coral mortality.

In terms of mean reef fish biomass, which is the measure for PR3, Danajon registered the highest followed by Calamianes, Tawi-Tawi and lastly by Lanuza Bay. The mean reef fish biomass values at Danajon and Calamianes are moderate while those in Tawi-Tawi and Lanuza Bay are low compared to estimates from reefs in other parts of the country. There are, however, specific sites in Tawi-Tawi where reef fish biomass is moderate.

FIGURE 3-29
COMPARISON OF THE FOCAL AREAS IN TERMS OF MEAN REEF FISH BIOMASS ($KG/500M^2$), MEAN REEF FISH SPECIES RICHNESS (NO. OF SPECIES/TRANSECT AREA), MEAN PORTION OF BIOMASS COMPOSED OF COMMERCIALLY VALUABLE SPECIES ($KG/500M^2$; PERCENTAGE ALSO INDICATED), MEAN LIVE HARD CORAL COVER (%) AND CORAL MORTALITY (%) OF SELECTED MPAS AND POTENTIAL MPA SITES



Note: In all cases n=30 except in Danajon Bank where n=36. The error bars represent 1 SD from the mean.

The trend in mean reef fish abundance across the focal areas reflects the trend in mean reef fish biomass, except in the case of Danajon, which registered the lowest mean abundance despite having the largest mean biomass. This could be due to generally larger species in Danajon, generally larger-sized individual fish in Danajon, differences in observers or a combination of these.

The mean proportion of commercially valuable reef fish species was comparable among the focal areas except in Tawi-Tawi, where the proportion was about half of the highest (Calamianes). However, Tawi-Tawi registered highest species richness, suggesting that the low proportion of commercially valuable species in Tawi-Tawi was partly the result of high numbers of other species. Thus, the relatively low proportion of commercially valuable species in Tawi-Tawi should not be automatically considered as the result of targeting of these species by fishers.

In Figure 3-29, the mean species richness values for Calamianes, Surigao del Sur and Tawi-Tawi are readily comparable because in each case n = 30 and the area surveyed per transect was the same (250m^2). With regard to Danajon Bank, it would have been difficult to interpret its value for species richness relative to the other focal areas because in this case n = 36 and the area surveyed per transect was 500m^2. Fortunately, we can be certain that Danajon Bank has the lowest mean species richness among the four focal areas because its value is the lowest numerically, despite the fact that in any survey species richness increases in some non-proportional fashion as either the number of transects or the area covered by each transect increases. Thus, in the order of decreasing mean species richness, the focal areas are listed as follows: Tawi-Tawi, Lanuza Bay, Calamianes and Danajon Bank. Note that mean species richness in Danajon Bank is markedly lower than mean species richness in Calamianes, the second lowest. The independent baseline contractor also observed the highest and lowest reef fish species richness values at Tawi-Tawi and Danajon, respectively (DAI 2004).

In terms of PR5 or percentage living coral cover, the mean values in Calamianes, Lanuza Bay, and Tawi-Tawi are comparable, while in Danajon Bank the mean value is noticeably lower (barely half of the next lowest). The trend in mean live hard coral cover across the focal areas seems to be reflected by the trends in reef fish abundance and species richness.

Issues

In the course of the baseline assessment of MPAs, a number of problems and issues were encountered. The major ones were the following:

- Lack of existing MPAs at the time of assessment
- Changing boundaries of MPAs
- Different units of species richness
- Large variability between transects

Lack of existing MPAs at the time of assessment

At the Tawi-Tawi and Calamianes focal areas, there were no existing MPAs when the baseline assessment was conducted. At the Lanuza Bay focal area, there were only two suitable MPAs, one short of the required three in which the performance of the FISH Project would be assessed. It was only at Danajon Bank where there were at least three MPAs. In cases where there were no or not enough MPAs, the UPVFI team surveyed potential MPA sites. In these potential sites, the FISH Project subsequently initiated steps that would lead to MPA establishment. However, assessment of the sites before establishment, while very much desirable, is not the baseline assessment prescribed by the Baseline Assessment Plan and the Performance Monitoring Plan. These plans call for the measurement of the performance indicators inside and adjacent to each MPA using an equal number of transects, with a minimum of five transects inside and five transects adjacent to each MPA. In other words, for sites in which there were no MPA boundaries during the time of assessment, real baseline assessment can only be done after these boundaries are established so that the requisite number of transects inside and outside these boundaries can be surveyed.

At the time of this writing, an in-house monitoring team organized by the FISH Project is conducting the baseline assessment of such MPAs in Calamianes and Lanuza Bay. In many cases, the original transects established by UPVFI when boundaries of these MPAs did not exist are today not suitably located to represent the inside and outside reef areas of these MPAs. Thus, real baseline assessment of these newly initiated MPAs is only happening now, with the proper allocation of transects. (The MPAs in Danajon Bank are being revisited for the first time.) In Tawi-Tawi, establishment of MPAs at potential sites is still at the conceptual stage, with no assurances that boundaries recommended by the FISH Project will be acceptable to the community. Thus, baseline assessment at these sites has yet to begin, and will likely happen in 2006.

On the whole, baseline assessment of MPAs, which was originally conceptualized as an activity that would begin and end during the first year of the project, is actually an activity that could extend to the third year of the project.

Changing boundaries of MPAs

Because the MPAs supported and monitored by the FISH Project are mostly newly initiated, their boundaries are still subject to change. Local officials modify the boundaries of MPAs in their documents, sometimes on their own and at other times following suggestions from FISH Project staff. This has obvious implications on transects presently treated as inside and outside the MPA. In subsequent annual monitoring, sampling points will have to be adjusted in response to changes in MPA boundaries. Boundaries, however, are expected to become permanent after the MPA establishment process reaches advanced stages (such as enactment of municipal ordinance, demarcation with buoys, and others).

Essentially, what this issue and the preceding issue implies is that, as the FISH Project proceeds, some transects established during the early stages of the project will have diminished value for comparing with the final outcome. There will be an inevitable discarding of transect data as newer, more appropriately located transects replace old ones.

Different units of species richness

Despite instructions to use standardized assessment procedures, the UPVFI team and the Silliman University team surveyed different areas of the 50 meter transect, with Silliman University surveying 5 meters on both sides of the transect as prescribed while UPVFI surveyed 5 meters of the slope side (landward side) only. Thus, for Calamianes, Lanuza Bay and Tawi-Tawi, reef fish species richness is reported as the number of species per 250m^2 while for Danajon Bank the unit is the number of species per 500m^2. It is somewhat consoling to note that species richness is a supportive PR that will not be included in the calculation of the increase in fish stocks. Nevertheless, this error should be rectified in subsequent monitoring.

It should be noted that the reporting of species richness as the number of species in a locality is more widely accepted than reporting it as the number of species per unit area. There are legitimate questions about the practice of averaging observations of species per unit area and proclaiming the resulting figure as the area's species richness. The more common practice is to count all species encountered. However, the resulting figure would be a function of sample size and number, which were unfortunately not held constant during baseline assessment. In any case, the proper way to determine species richness is to use cumulative species curves. In subsequent monitoring, the in-house reef assessment team of the project will endeavor to determine such curves. Efforts to properly monitor changes in species richness are worthwhile because, although species richness does not go into the quantitative calculation of overall project success, biodiversity conservation is a major goal of the FISH Project.

Large variability between transects

As the error bars of graphs in this report suggest, there is substantial variability among the transects. Variability can be reduced to some extent by increasing sample size, but reduction of variability to the point of statistically defensible conclusions is not to be pursued because it will only come at prohibitive costs. Such is the nature of the coastal environment where the distribution of resources is uneven. Fish tend to gather around certain features like coral heads or to move in groups towards a point that is the food source of the moment. Even with non-mobile benthic resources, the distribution of biota and abiotics is anything but uniform and predictable. One can visualize that if a transect is moved transversely just one meter from its current position, a widely different estimate of coral cover will be obtained. Thus, there is no choice but to compare means while accepting the large deviations accompanying those means.

In future monitoring, the number of transects will be increased when possible and complemented by stratification as knowledge of the focal areas increases.

4.0 CONCLUSION

The baseline data upon which the FISH Project Results will be established and measured over the life of the project were summarized and presented so that succeeding monitoring events can follow in the same manner and procedure. Though not without problems and deviations from original plans, the baseline assessment of capture fisheries and reef habitats achieved the goal of establishing base levels of verifiable indicators against which the performance of fisheries resource management initiatives and MPAs supported by the FISH Project can be measured. Although the full raw data set is not presented herein, the methods and results that show the status of the fish stocks and reef habitats in 2004 was established and can, therefore, provide the platform for a comparative analysis in 2006 and beyond to measure changes over time in the FISH focal areas.

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