ASSESSMENT OF CORAL DAMAGE CAUSED BY A GROUNDED BARGE ON TANAPAG BARRIER REEF, SAIPAN, CNMI

by

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Final Report Submitted to

THE OFFICE OF COASTAL RESOURCES MANAGEMENT
Commonwealth of the Northern Marianas Islands

UNIVERSITY OF GUAM
MARINE LABORATORY

ENVIRONMENTAL SURVEY REPORT

No. 20

April, 1987

INTRODUCTION

This report includes the results of a limited marine survey of the coral damage caused by a self-powered barge that ran aground on the lagoonward edge of Tanapag Barrier Reef north of Managaha Island. Fieldwork for the survey was conducted on Feb. 20, 1987, and consisted of a general qualitative reconnaissance of the barge's drift course from where it first began to make bottom contact to where it finally became solidly grounded, and a quantitative survey of the barge grounding area (damaged area) and adjacent undamaged areas on the lagoon edge of the barrier reef (Fig. 1). Mr. Ben Aldan of the Coastal Resources Management Office, provided boat and logistic support for the survey.

METHODS

Coral communities were analyzed along transects using the plotless point-centered technique of Cottam et al. (1953). Two transects were established within the barge grounding area and two were established within adjacent undamaged areas (Fig. 1). Transects were established alongside an anchored boat, with about 15 m of anchor line out, at the seaward end of the grounding area (boat + anchor line = 20 m). A strong unidirectional lagoonward flow of water kept the anchored boat in a relatively stationery position. Within the damaged area six somewhat equidistant points were established on the substrate by throwing a geology hammer at about 10-meter intervals along the north

side of the anchored boat. Where the thrown hammer came to rest a sample point was established at the intersection of the hammer head and handle. Four quadrants were than formed around the point by establishing one axis along the hammer handle and another at right angles to it along the hammer head. The coral nearest the sample point in each quadrant was located and its specific name, size (diameter if round or maximum length and width if irregular), and distance from the center of the corallum to the sample point were recorded. Similar methodology was used to establish the remaining three transects, one alongside the south side of the boat within the damaged area and one each on the north and south sides of the boat within the adjacent undamaged areas. From these point-centered data the following calculations were used to estimate community structural parameters:

1. Total density of all species = $\frac{\text{unit area}}{(\text{mean point-to colony distance})^2}$

2. Density = $\frac{\text{relative density of a species}}{100}$ x total density of all species

3. Total percent coverage = total density of all species x average coverage value for all species

4. Percent coverage = density of a species x average coverage value for the species

5. Frequency = $\frac{\text{number of points at which a species occurs}}{\text{total number of points}}$

Colony size distribution data ($\bar{x}$ = arithmetic mean, s = standard deviation, and w = size range) were also calculated from the point-quarter data.

RESULTS AND DISCUSSION

Based upon reconnaissance snorkel observations it appears that as the barge drifted out of deeper regions of Tanapag Lagoon into shoaler water it began to make contact with some of the more prominent topographic relief features, such as coral mounds, pinnacles, and knobs. As the barge drifted into even shoaler lagoon areas more bottom contacts were made, which included overturning and disintegration of coral knobs and pinnacles. Continued drift carried the barge to the shallow lagoonward edge of the barrier reef where the bottom shoals rapidly to the shallow barrier reef-flat platform. At this location the barge became somewhat solidly grounded, but with some vertical and lateral motion in response to storm surge. Within this grounded area most topographic relief features were disintegrated with a resultant maximum relief of mostly less than 30 cm. Within adjacent undamaged reef areas topographic relief features with up to 2 meters of relief were common to abundant. Other evidence for recent disintegration of insitu framework reef deposits included an abundance of angular sand-to boulder-size fragments veneering the surface. Within the undamaged area such fragment were much less abundant and instead of being angular were worn and subrounded.

Quantitative data of the coral species encountered from the point-centered analysis for the damaged and undamaged areas are presented in Tables 2 and 3 respectively. The

coral species encountered during the point-centered analysis indicate the predominant and common species along the transects. The presence of uncommon and rare species, not encountered during the point-centered analysis, were determined for the two areas by making 20 minute snorkel observations in each. An overall list of species is compiled for each area (damaged and undamaged) by combining those encountered during the point-centered analysis with those from the 20-minute snorkel observations in Table 1. Transect locations, water depth, and physiographic characteristics of the survey site are shown in Fig. 1.

Species Abundance

Overall species abundance was considerably ~~higher~~ lower in the damaged area where 25 species representing 8 families and 14 genera were recorded, compared to 42 species representing 12 families and 22 genera recorded from the undamaged area (Table 1). There were no species found in the damaged area that were not present in undamaged area. Surviving species in the damaged area consisted for the most part of small encrusting Montipora and Cyphastrea patches or small Goniastrea and Porites colonies located in small depressions, holes, or other cryptic refugia, and scattered living fragments of disintegrated massive colonies. At the time of the survey much of the physically disturbed substrate was covered with a dense turf (< 2.0 cm ht.) of filamentous

cyanophytic algae.

Substrate Coverage, Density, and Colony Size

In addition to low species abundance within the damaged area, substrate coverage by living corals, coral density, and colony size were also considerably lower than within adjacent undamaged areas (Tables 2 and 3). Within the undamaged area mean substrate coverage by living corals was 40 times greater ($x = 20.60\%$, $s = 3.53$, $w = 18.10 - 23.09$) than that in the damaged area ($x = 0.50\%$, $s = 0.57$, $w = 0.10 - 0.90$). Because of the presence of scattered disintegrated coral fragments within the damaged area differences in coral density were less dramatic, but even so, was over nine times greater in the undamaged area ($x = 4.32$ corals/m^2, $s = 0.34$, $w = 4.08-4.56$) than in the damaged area ($x = 0.46$ corals/m^2, $s = 0.24$, $w = 0.29 - 0.63$). Mean colony size of living corals within the undamaged area ($x = 18.3$ cm, $s = 2.97$, $w = 16.20 - 20.4$) were roughly twice as large as those within the damaged area ($x = 8.31$ cm, $s = 3.39$, $w = 5.9 - 10.7$).

LITERATURE CITED

Cottam, G., J. T. Curtis, and B. W. Hale. 1953. Some sampling characteristics of a population of randomly dispersed individuals. Ecology 34:731-757.

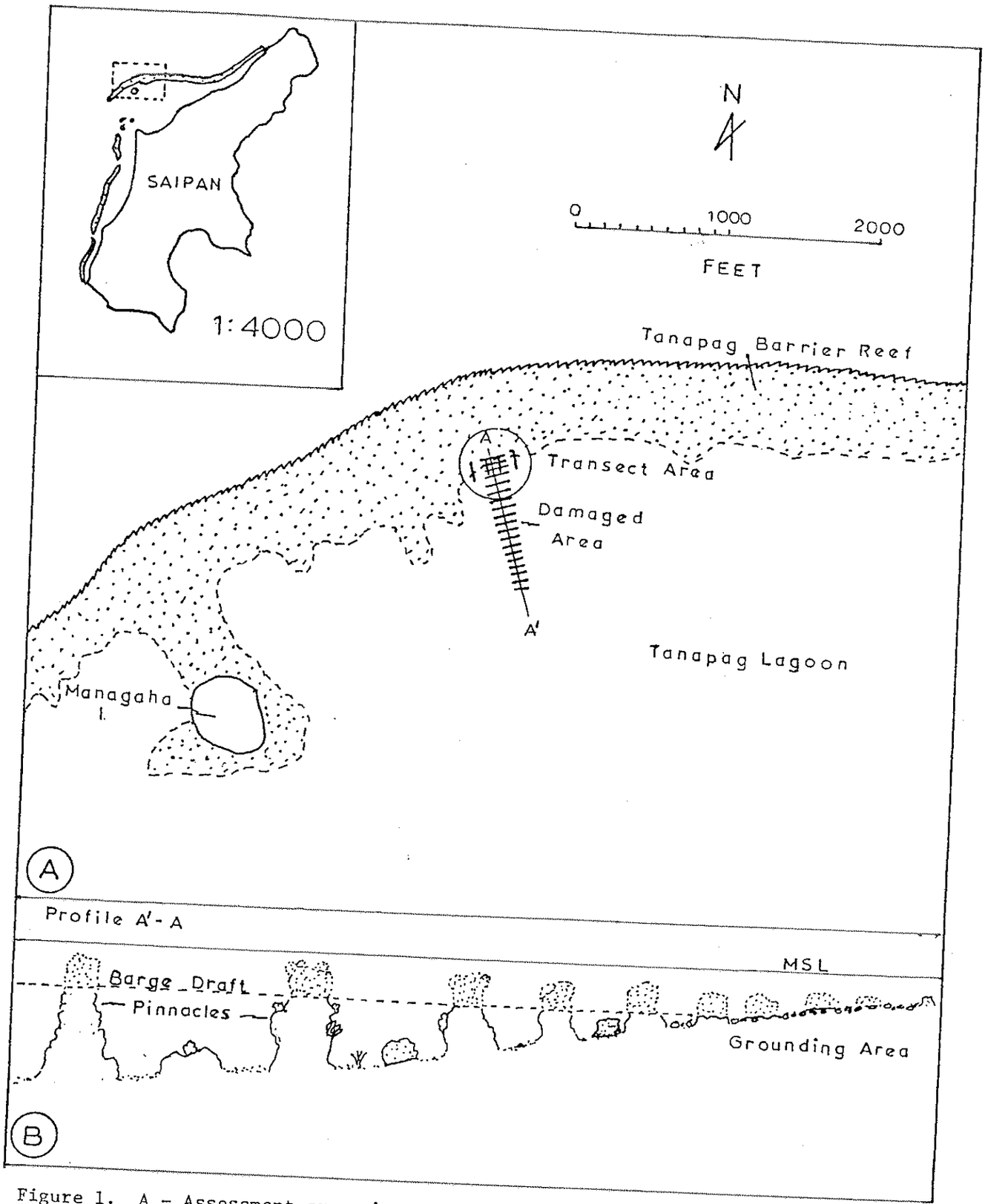

Figure 1. A - Assessment area showing the transect and damaged reef areas. Stippled area denotes the shallow barrier reef platform. B - Vertical profile through the damaged reef area. Stippling denotes damaged coral pinnacles caused by the drifting barge.

Table 1. List of coral species encountered on the transects, or observed within the vicinity of the transects.

	Undamaged Area	Damaged Area
Acropora humilis (Dana, 1846)	x	x
Acropora tenuis (Dana, 1846)	x	
Acropora palifera (Lamarck, 1816)	x	x
Astreopora myriophthalma (Lamarck, 1816)	x	
Coscinaraea sp. 1	x	
Cyphastrea chalcidicum (Forskal, 1775)	x	
Cyphastrea serailia (Forskal, 1775)	x	x
Distichopora violacea (Pallas, 1766)	x	x
Favia favus (Forskal, 1775)	x	
Favia pallida (Dana, 1846)	x	x
Favia stelligera (Dana, 1846)	x	
Favites russelli (Wells, 1954)	x	x
Galaxea fascicularis (Linnaeus, 1758)	x	
Gardineroseris planulata (Dana, 1846)	x	
Goniastrea edwardsi Chevalier, 1971	x	
Goniopora lobata Milne Edwards and Haime, 1860	x	x
Heliopora coerulea (Pallas, 1766)	x	
Herpolitha limax (Houttuyn, 1772)	x	x
Leptastrea purpurea (Dana, 1846)	x	
Millepora platyphylla Hemprich and Ehrenberg, 1834	x	x
Millepora tuberosa Boschma, 1966	x	x
Montipora ehrenbergii Verrill, 1875	x	x
Montipora hoffmeisteri Wells, 1954	x	x
Montipora lobulata Bernard, 1897		
Montipora verrilli Vaughan, 1907		
Pavona duerdeni Vaughan, 1907		
Pavona sp. 2	x	x
Pavona sp. 3	x	
Platygyra pini Chevalier, 1975	x	
Pocillopora elegans Dana, 1846	x	x
Pocillopora eydouxi Milne Edwards Haime, 1860	x	x
Pocillopora setchelli Hoffmeister, 1929	x	
Pocillopora verrucosa (Ellis and Solander, 1786)	x	
Porites (P.) australiensis Vaughan, 1918	x	x
Porites (P.) lichen Dana, 1846	x	x
Porites (P.) lobata Dana, 1846	x	
Porites (P.) lutea Milne Edwards and Haime, 1860	x	x
	x	x

Table 1. Continued.

	Undamaged Area	Damaged Area
Porites (P.) murrayensis Vaughan, 1918	x	
Porites (P.) solida (Forskal, 1775)	x	
Porites (S.) convexa Verrill, 1864	x	x
Psammocora sp. 1	x	x
Stylophora mordax (Dana, 1846)	x	x
Total Species	42	25
Total Genera	22	14
Total Familes	12	8

Table 2. Coral size distribution, frequency, density, and percent substrate coverage by corals at Transects A and B within the damaged reef area. Species are listed alphabetically.

Coral Species	Size Distribution (colony diameters in cm) n	$\bar{y}$	s	w	Freq.	Density per m^2	% cover
Damaged Area, South Side A							
Acropora palifera (Lamarck, 1816)	2	14.2	1.1	13.4-15.0	0.33	0.06	0.09
Cyphastrea serailia (Forskal, 1775)	2	6.9	3.3	4.5- 9.2	0.33	0.06	0.02
Goniastrea edwardsi Chevalier, 1971	2	4.5	1.4	3.5- 5.5	0.33	0.06	0.01
Leptastrea purpurea (Dana, 1846)	1	4.9	-	-	0.17	0.03	0.01
Montipora hoffmeisteri Wells, 1954	1	8.5	-	-	0.17	0.03	0.02
Montipora lobulata Bernard, 1897	1	5.7	-	-	0.17	0.03	0.01
Montipora verrilli Vaughan, 1907	1	2.4	-	-	0.17	0.03	0.001
Porites (P.) lichen Dana, 1846	2	16.2	0.7	15.7-16.7	0.33	0.06	0.12
Porites (P.) lobata Dana, 1846	4	17.4	17.2	7.4-43.0	0.67	0.12	0.49
Porites (P.) lutea Milne Edwards and Haime, 1860	4	11.2	2.9	9.2-15.5	0.67	0.12	0.12
Porites (S.) convexa Verrill, 1864	1	4.5	-	-	0.17	0.03	0.01
Total Community	21	10.7	8.6	2.4-43.0		0.63	0.901
Damaged Area, Northside B							
Cyphastrea chalcidicum (Forskal, 1775)	1	4.2	-	-	0.17	0.014	0.002
Cyphastrea serailia (Forskal, 1775)	2	4.2	2.5	2.4- 5.9	0.33	0.027	0.004
Goniastrea edwardsi Chevalier, 1971	1	15.5	-	-	0.17	0.014	0.026
Millepora platyphylla Hemprich and Ehrenberg, 1834	2	4.4	0.2	4.2- 4.5	0.33	0.027	0.004
Millepora tuberosa Boschma, 1966	1	2.4	-	-	0.17	0.014	0.001
Montipora ehrenbergii Verrill, 1875	3	4.1	1.8	2.4- 5.9	0.33	0.041	0.006
Montipora verrilli Vaughan, 1907	5	5.6	1.5	3.5- 7.4	0.50	0.068	0.018
Pavona duerdeni Vaughan, 1907	1	8.1	-	-	0.17	0.014	0.007

Table 2. Continued.

Coral Species	Size Distribution (colony diameters in cm) n	$\bar{y}$	s	w	Freq.	Density per m^2	% cover
Porites (P.) australiensis Vaughan, 1918	1	5.7	-	-	0.17	0.014	0.004
Porites (P.) lobata Dana, 1846	1	11.2	-	-	0.17	0.014	0.014
Porites (P.) lutea Milne Edwards and Haime, 1860	2	5.3	4.0	2.4- 8.1	0.33	0.027	0.008
Psammocora sp. 1	1	8.8	-	-	0.17	0.014	0.008
Total Community	21	5.9	3.2	2.4-11.2		0.288	0.101

Table 3. Coral size distribution, frequency, density, and percent substrate coverage at Transects A and B within the undamaged reef area. Species are listed alphabetically.

Coral Species	Size Distribution (colony diameters in cm) n	$\bar{y}$	s	w	Freq.	Density per m^2	% cover
Undamaged Area, South Side A							
Cyphastrea chalcidicum (Forskal, 1775)	1	6.5	-	-	0.17	0.017	0.06
Goniastrea edwardsi Chavalier, 1971	2	12.3	9.9	5.3-19.3	0.33	0.34	0.54
Heliopora coerulea (Pallas, 1766)	1	25.9	-	-	0.17	0.17	0.90
Millepora platyphylla Hemprich and Ehrenberg, 1834	4	27.0	23.5	4.6-49.1	0.50	0.68	6.14
Montipora lobulata Bernard, 1897	1	21.4	-	-	0.17	0.17	0.61
Pavona duerdeni Vaughan, 1907	2	6.8	6.2	2.4-11.2	0.33	0.34	0.18
Platygra pini Chevalier, 1975	1	4.6	-	-	0.17	0.17	0.03
Porites (P.) lichen Dana, 1846	1	9.8	-	-	0.17	0.17	0.13
Porites (P.) murrayensis Vaughan, 1918	1	17.4	-	-	0.17	0.17	0.41
Porites (P.) lutea Milne Edwards and Haime, 1860	6	26.8	21.0	11.0-63.3	0.83	1.01	8.72
Porites (S.) convexa Verrill, 1864	3	28.9	26.5	5.9-57.9	0.33	0.51	5.25
Stylophora mordax (Dana, 1846)	1	9.4	-	-	0.17	0.17	0.12
Total Community	24	20.4	17.8	2.4-63.3		4.08	23.09
Undamaged Area, North Side B							
Acropora palifera (Lamarck, 1816)	3	45.3	19.2	31.4-67.2	0.50	0.57	10.27
Favia favus (Forskal, 1775)	1	6.0	-	-	0.17	0.19	0.05
Gardineroseris planulata (Dana, 1846)	1	5.3	-	-	0.17	0.19	0.04
Goniastrea edwardsi Chevalier, 1971	7	5.1	1.7	2.4- 6.0	0.67	1.33	0.21
Montipora ehrenbergii Verrill, 1875	1	4.9	-	-	0.17	0.19	0.04
Montipora lobulata Bernard, 1897	1	5.5	-	-	0.17	0.19	0.04

Table 3. Continued

Coral Species	Size Distribution (colony diameters in cm) n	$\bar{y}$	s	w	Freq.	Density per m^2	% cover
Pocillopora verrucosa (Ellis and Solander, 1786)	1	14.1	-	-	0.17	0.19	0.30
Porites (P.) lichen Dana, 1846	2	14.3	1.3	13.3-15.2	0.33	0.33	0.61
Porites (P.) lutea Milne Edwards and Haime, 1860	7	22.9	11.00	11.5-44.7	0.50	1.33	6.54
Total Community	24	16.2	15.9	2.4-67.2		4.56	18.10

Total No. Species 17