In cooperation with the Hawai'i Coral Reef Assessment and Monitoring Program (CRAMP),
Hawai'i Institute of Marine Biology, University of Hawai'i

Biological Survey in Support of the USGS Turbidity and Sediment Baseline Survey on South Moloka'i Reef Flat, April 2005

By Rodgers, K.S., Jokiel, P.L., Smith, W.R., Farrell, F., Uchino, K.

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U.S. Department of the Interior
U.S. Geological Survey

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Biological Survey in Support of the USGS Turbidity and Sediment Baseline Survey on South Moloka'i Reef Flat, April 2005

By Rodgers, K.S.¹, Jokiel, P.L.¹, Smith, W.R.¹, Farrell, F.¹, and Uchino, K.¹

Introduction

A biological survey of the South Moloka'i coral reef was undertaken by the University of Hawai'i Coral Reef Assessment and Monitoring Program (CRAMP) in support of the extensive effort by USGS to characterize sediment dynamics on the south Moloka'i reef flat. The experimental design and sampling sites for the USGS project were established primarily to document patterns of sediment input, distribution and sediment output on the south Moloka'i reef in the area between Kamalo and Kaunakakai. The overall project experimental design was not driven by biological questions, but rather was designed to establish baseline data for water quality data and sediment distribution. The focus of the biological support component was to describe the biological condition at each of the USGS sediment/water quality sampling sites. The biological data were taken in a manner that will enable a future quantitative evaluation of possible changes in the benthos at each site over time. These data can then be related to any changes in turbidity, suspended sediment concentrations, or sediment on the reef flat.

Methods

On May 6-9, 2005, biological surveys were conducted at each sampling point along the nine shore-normal survey transects that had been established on the reef flat between Kamalo and Kaunakakai by the USGS (Figure 1). The location of each site had been marked with a numbered buoy by the USGS team. A biological survey was undertaken in order to provide biological information on the benthos at each sampling point.

Along with time, cost and effort, selection criteria for benthic sampling should include the population of interest, statistical power, accuracy, precision, sources of variability, the focus of the study and the spatial scale involved. A photographic transecting method was selected for use in this research for the following reasons:

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Figure 1. Image map showing study area along the south coast of Moloka'i. Biological survey data were collected along nine transects, with six stations at each, from Kamalo to Kaunakakai.

Method selection criteria required data compatibility with sites incorporated into this study (Jokiel et al. 2001).

A quantitative method is critical to most advanced statistical procedures.

Although the data input and analysis can be more time intensive, the photographic method is not restrained by the limitations of many other benthic sampling methods such as high observer variability or vertical overlap.

Precision using this photographic technique was determined to be high (~95% similarity among observers) compared to *in situ* observations (Brown et al. 2003).

Use of a camera monopod does not negatively impact the benthos.

Photographic methods allow for archiving and data verification, which is critical in addressing further questions, and in quality control.

The standard procedure developed by NOAA for ground truthing of reef maps in Hawai'i involves estimation of benthic cover in a 7 m radius from an accurately established GPS point. The geomorphological structure is determined and the biological cover type is estimated in 10% increments. The procedure developed for this study involved taking a large number of randomly selected digital images from within the 7 m radius in order to describe the benthic populations at each site in a statistically valid manner. This procedure will allow future comparisons and detection of change. A total of 40 digital photos were taken within the 7 m radius at each of the 54 stations established by GPS and marked by buoys. The sampling circle had a center point located 3.5 m to the west (down-current) of each buoy in order to avoid interfering with instrumentation that was located up-current (east) of some of the buoys. Thus, the 7 m diameter sampling circle was tangent to the

transect line at the east edge. Within each sampling circle a total of 40 haphazardly selected images were taken following the pattern shown in Figure 2. These high resolution digital images encompassed a 20 m² subsample of the 38.7m² area. A subset of 20 randomly selected images was chosen from the 40 images taken at each site.

Figure 2. Schematic diagram showing photographic sampling method. A total of 40 digital images were taken haphazardly inside of the 7 m transect circle following a row order of 2, 3, 7, 8, 8, 7, 3, 2 pattern. Subsequently, a random subset of 20 images (green) was analyzed.

An Olympus 5050 zoom digital camera with an Olympus PT050 underwater housing mounted to an aluminum monopod frame, 1.7 m from the substrate provides a 50 x 50 cm image. A 6 cm bar attached to the monopod provides a measurement scale. A temporal series of photoquads previously taken in the general vicinity established statistically, that low variability exists within stations (Brown et al. 2003). Therefore 20 randomly selected images from each area is more than adequate for this study. This level of sampling should be adequate to detect changes in these areas in future years. All of the images taken during the survey and data in the Appendices are archived with the National Oceanographic and Atmospheric Administration's (NOAA) National Oceanographic Data Center (NODC) which archives and provides public access to oceanographic and coastal data. Additional data collected during field surveys include a complete species lists (Appendices II, III, IV) and other *in situ* data observed using a dive mask or viewing box.

Values generated using this method are compatible with the long term monitoring CRAMP protocol and the rapid assessment techniques (RATs) used by the Coral Reef Assessment and Monitoring Program (Jokiel et al. 2001; Brown et al. 2003). Long-term CRAMP monitoring stations are established on hardbottom substrate with ten randomly selected 10 m permanent transects with endpoints marked by short stainless steel pins. CRAMP RAT stations are selected by generating 100 random points onto habitat maps using GPS Pathfinder Office 2.8. Navigational GPS is used in the field to determine the exact position of each point, marking the beginning of each 10 m transect. Both the long-term CRAMP monitoring and CRAMP RAT methodology also use 20 digital images from each transect to estimate benthic coverage. Photos generated in this survey were processed using the same methodology as existing monitoring and assessment data. Images are downloaded and imported into PhotoGrid to tabulate coral and benthic substrate types at each of 50 randomly selected points per image. Total mean percent coral cover by station, mean percent coral cover by species within a station, and species richness (number of species per transect) are calculated in Excel. Coral diversity was calculated using the Shannon-Weaver diversity index.

Long-term CRAMP monitoring stations installed in 1999 off south Moloka'i include a pair of 3 m and 10 m stations located at Kamiloloa and Kamalo. RAT sites surveyed in 2002 are located off Kakahai'a and Kamiloloa. Kamalo and Kamiloloa sites vary from 959 m to 1775 m offshore, with depths ranging from 3 to 10 m. Kakahai'a sites vary from 725 m to 1700 m offshore, with depths ranging from 5 to 19 m. These sites, as well as the sites for the current survey are shown in Table 1 and Figure 3.

Table 1. Summary data for CRAMP long-term monitoring and rapid assessment technique (RAT) stations off South Moloka'i

Survey Type	Site	Station	Distance from shore	Depth (m)	Total Coral cover	Species Richness	Diversity (H')
RAT	Kakahai'a	1	1,657	19.1	85.8	2	0.69
RAT	Kakahai'a	2	1,420	9.7	69.8	2	0.40
RAT	Kakahai'a	3	1,684	19.1	61.4	3	0.83
RAT	Kakahai'a	4	1,392	10.3	53.2	4	0.96
RAT	Kakahai'a	5	1,059	5.2	53.4	6	0.81
RAT	Kakahai'a	6	877	5.2	57.6	5	1.24
RAT	Kakahai'a	7	1,362	18.5	69.2	4	0.81
RAT	Kakahai'a	8	1,284	8.2	61.2	4	0.95
RAT	Kakahai'a	9	739	3.3	42.6	4	0.83
RAT	Kamiloloa	1	1,208	9.1	3.8	4	1.11
RAT	Kamiloloa	2	1,055	4.2	10.0	3	0.69
RAT	Kamiloloa	3	1,211	3.6	6.2	3	0.28
Monitoring	Kamiloloa	3 m	959	3.0	3.3	2	0.22
Monitoring	Kamiloloa	10 m	1,138	10.0	1.3	1	1.14
Monitoring	Kamalo	3 m	1,320	3.0	55.9	5	0.76
Monitoring	Kamalo	10 m	1,762	10.0	51.2	5	1.14

Figure 3. Image map showing USGS, CRAMP, and RAT transect locations between Kamalo and Kaunakakai.

Results

No corals were recorded at any of the nine USGS transects at 50 m, 100 m, and 250 m from shore. Averages across transects showed total coral cover increased with distance from shore from

1.6% at 400 m, to 7.4% at 550 m, to 11.2% at 700 m (Figure 4). Coral cover ranged from 0% at most inshore sites to a high of 42% at the 700 m site of transect E, located at Kawela.

Figure 4. Graph showing percent coral cover at USGS survey sites.

Diversity and species richness are often used to describe coral reef community structure and environmental condition. Richness indicates the number of species, while diversity takes into account both the number of species and their abundance. However, diversity is low in Hawai'i and may not be an appropriate indicator of environmental conditions in this region. Hawaiian communities are often dominated by a few primary species where diversity does not decline with decreasing latitude as in other regions (Grigg 1983). Due to geographic isolation, corals in Hawai'i are depauperate relative to the Indo-West Pacific. Only 16 genera containing 42 species have been documented from the Main Hawaiian Islands. Difficult field identification and detection of cryptic or deep species and low digital resolution may also reduce the predictive ability of diversity. However, coral richness can be a useful measure in describing community structure and reef condition.

Overall, we recorded 13 coral species along the USGS transects (Appendix II). A total of 11 coral species were recorded from photographic images. The highest coral richness (10 species) was found at 700 m from shore on transect E, located at Kawela (Figure 5). Coral diversity was also highest at this station.

Figure 5. Graph showing species richness at USGS survey sites.

Inshore sites are comprised primarily of fine grain silt and sand (Appendix I). The native seagrass, *Halophila Hawaiiiana* was only recorded out to 100 m from shore on transect I, located at Kapa'akea. Average coral cover at CRAMP/RAT stations was high at Kamalo (53.5%) and Kakahai'a (61.6%) declining dramatically at Kamiloloa (6.7%).

Trends and patterns

When working with numerous parameters, multivariate techniques are commonly used to group similar sets of samples. This type of analysis is highly efficient in summarizing data for intrinsic analysis of ecological communities (Gauch 1982). Multivariate analysis can reveal the distribution of species along environmental gradients, highlight patterns in the data through spatial comparisons and habitat characterization, clarify habitat relationships and reveal trends and patterns with minimal expression of the noise typical in community data. With ordination techniques, similar entities are placed close to each other while dissimilar species or samples are located far apart in ordination space.

In community analysis involving large data sets that have several community gradients and high variability, detrended correspondence analysis (DCA) and non-metric multidimensional scaling (NMDS) have been shown to be highly effective (Gauch 1982; Clarke and Warwick 2001). These robust methods of multivariate analysis are relatively free from distortion and give equal emphasis to

all data. These quantitative techniques are useful in identifying differences in community types and environmental gradients.

Detrended Correspondence Analysis (DCA) provided a quantitative presentation of the relationship between benthic communities at each transect location (Figure 6). Seagrass occurs only at nearshore stations on transect I located at Kapa'akea. This group is unique and stands alone. All of the others fall along a continuum from fine mud (left of diagram) grading into a macroalgae dominated community along an axis moving upward and to the right. A second gradient from macroalgae dominated communities (top center of chart) grades into a coral dominated community as we move downward and onto the line labeled Axis 1. Stations farthest from shore (550 m and 700 m) are close together in ordination space due to high coral cover, while the majority of nearshore stations (50 m and 100 m) cluster to the lower left of Figure 6 due to high percentages of fine sediment. Figure 6 shows a quantitative relationship that all of the investigators on this project have observed in a qualitative fashion. Starting from shore we wade through thick silt and mud. Moving seaward we find firmer footing with increasing amounts of coral rubble and sand on a carbonate platform. These areas just outside of the mud zone are dominated by macroalgae. As we proceed seaward we generally encounter more and more coral until we reach a coral dominated community.

All transects with the exception of B and F show an increase in coral cover with distance from shore after 250 m. These two transects located at Pahoa and between One Ali'i and Kawela respectively, have little or no coral cover. Figure 7 showing transect H at Kamiloloa is typical of this trend. The trend of increasing coral cover with distance from shore remains unchanged at Kakahai'a (transect D) where RATs are included in the data set (Figure 8).

Figure 6. Graph showing Detrended Correspondence Analysis (DCA) of select benthic cover showing quantitative relationships between the sites as defined by biotic composition. The presence of seagrass separates I50 and I100 from the rest of the sites. All of the other sites fall along a gradient from higher coral cover (Points at the bottom of the graph on the line labeled Axis 1) to low coral cover with macroalgae (upper part of diagram) grading into macroalgae dominated sites and finally into sites that are entirely mud bottom (points on the left of the diagram falling on line labeled Axis 2). A250 and B700 were omitted by MVSP due to all 0 values.

Figure 7. Aerial image showing coral cover at USGS survey sites off Kamiloloa (transect H). Cover is proportional to the size of the bubble. Typical of the majority of transects, coral cover increases with distance from shore.

Figure 8. Aerial image showing coral cover at USGS survey sites on reef flat and eight RAT sites on reef face off Kakahai'a (transect D). Coverage is proportional to the size of the bubble. Note that coral increases with distance off shore.

Discussion

The biological section of this project provides a quantitative description of the USGS sediment-turbidity sampling sites conducted on the reef flat. In general, coral cover on the reef flat was observed to increase with distance from shore as described previously by Jokiel et al. (in press). Figure 9 shows the general distribution of corals on the south Moloka'i reef from the reef flat to the shelf. However, the sampling sites established for the turbidity-sediment studies were confined to the reef flat and did not address conditions on the reef crest and forereef. The relationship between conditions on the reef flat and conditions farther offshore has been summarized by Jokiel et al. (in press).

Figure 9. Generalized cross-section of the south Moloka'i reef showing coral cover increasing with distance from shore (from Jokiel et al. in press).

Summary

1. Benthic data were taken at each USGS sampling site in a manner that will allow future detection of change at each location.
2. The biological communities reflect geophysical conditions at each site. Corals are found on the outer reef flat in areas not impacted by the sediment.
3. Reduction of land-derived sediment delivery onto the reef flat will gradually improve water quality and environmental conditions for coral development. The present zone of live coral will gradually extend shoreward if conditions improve.
4. Reduction in terrigenous sediment delivery will benefit the coral reef communities on the forereef between One Ali'i and Kaunakakai as well as on the reef flat along the entire stretch of shoreline.

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Appendix I: Benthic cover and coral community parameters

Transect/m offshore	algae	coralline	substrate	turf	coral	seagrass	sand	silt	rubble	richness	diversity
A50	0.00	0.00	0.00	0.00	0.00	0.00	5.30	94.70	0.00	0.00	0.00
A100	0.32	0.00	0.00	1.47	0.00	0.00	87.70	10.50	0.00	0.00	0.00
A250	0.00	0.00	0.00	1.47	0.00	0.00	98.53	0.00	0.00	0.00	0.00
A400	1.26	0.42	0.00	5.05	0.00	0.00	34.60	0.00	58.68	0.00	0.00
A550	0.42	7.26	0.00	6.00	0.00	0.00	1.16	0.00	85.16	0.00	0.00
A700	0.00	4.56	0.00	0.67	5.56	0.00	9.67	0.00	79.22	3.00	0.97
B50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
B100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
B250	0.11	0.00	0.00	0.00	0.00	0.00	0.00	99.78	0.11	0.00	0.00
B400	2.25	0.00	0.00	1.53	0.00	0.00	39.78	54.81	1.64	0.00	0.00
B550	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00
B700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00
C50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
C100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
C250	1.41	0.00	1.65	5.65	0.00	0.00	52.59	38.71	0.00	0.00	0.00
C400	0.78	0.00	8.56	0.11	10.78	0.00	24.00	43.56	12.22	3.00	0.91
C550	4.74	0.00	23.29	0.00	7.69	0.00	33.83	2.95	27.50	3.00	0.97
C700	2.24	0.20	19.12	0.00	12.00	0.00	53.95	2.44	10.05	5.00	0.60
D50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
D100	31.60	0.00	0.00	1.60	0.00	0.00	13.00	47.20	6.60	0.00	0.00
D250	17.83	1.33	12.83	2.17	0.00	0.00	55.33	0.00	10.50	0.00	0.00
D400	10.55	1.64	19.27	1.45	3.09	0.00	19.09	0.18	44.73	2.00	0.47
D550	4.25	0.88	48.00	0.00	2.63	0.00	0.00	0.00	36.88	7.00	1.62
D700	1.06	0.47	43.41	0.00	3.18	0.00	0.00	0.00	51.88	3.00	0.82
E50	0.00	0.00	0.00	0.00	0.00	0.00	80.00	20.00	0.00	0.00	0.00
E100	0.00	0.00	0.00	0.01	0.00	0.00	85.00	14.99	0.00	0.00	0.00
E250	0.00	0.00	0.00	0.00	0.00	0.00	85.00	15.00	0.00	0.00	0.00
E400	4.63	0.01	0.00	7.25	0.25	0.00	40.88	8.50	7.50	1.00	0.00
E550	0.78	5.57	38.13	4.68	41.14	0.00	0.00	9.70	0.00	6.00	1.26
E700	0.44	30.81	21.93	1.43	44.85	0.00	0.55	0.00	0.00	5.00	0.98
F50	0.00	0.00	0.00	0.00	0.00	0.00	20.00	80.00	0.00	0.00	0.00
F100	0.00	0.00	0.00	1.33	0.00	0.00	79.78	17.78	1.11	0.00	0.00
Transect/m	algae	coralline	substrate	turf	coral	seagrass	sand	silt	rubble	richness	diversity

offshore											
F250	0.34	0.00	7.90	0.84	0.00	0.00	45.71	1.68	43.53	0.00	0.00
F400	1.54	0.31	8.15	2.00	0.31	0.00	31.54	0.00	56.15	1.00	0.00
F550	8.00	0.00	35.00	3.33	0.00	0.00	3.33	0.00	50.33	0.00	0.00
F700	1.54	1.85	51.08	1.38	0.00	0.00	14.62	0.00	29.54	0.00	0.00
G50	0.00	0.00	1.00	0.00	0.00	0.00	48.76	49.75	0.50	0.00	0.00
G100	12.12	0.00	0.00	0.00	0.00	0.00	78.79	9.09	0.00	0.00	0.00
G250	68.30	0.00	0.00	0.00	0.00	0.00	20.38	5.66	5.66	0.00	0.00
G400	76.00	0.00	0.00	0.00	0.00	0.00	14.00	0.00	10.00	0.00	0.00
G550	5.56	1.78	0.00	1.56	0.00	0.00	10.89	0.00	80.22	0.00	0.00
G700	21.33	7.33	42.83	0.50	4.17	0.00	1.17	0.00	22.67	2.00	0.28
H50	25.54	0.00	0.00	0.00	0.00	0.00	41.23	33.23	0.00	0.00	0.00
H100	47.45	0.00	0.00	0.00	0.00	0.00	44.00	8.55	0.00	0.00	0.00
H250	79.08	0.00	0.00	0.00	0.00	0.00	20.31	0.62	0.00	0.00	0.00
H400	5.64	0.00	0.00	3.45	0.00	0.00	88.18	2.73	0.00	0.00	0.00
H550	17.00	1.67	42.33	1.22	13.22	0.00	11.33	0.00	13.22	0.00	0.00
H700	2.90	7.69	48.72	3.57	31.22	0.00	5.69	0.00	0.22	0.00	0.00
I50	20.67	0.00	0.00	0.00	0.00	18.00	61.33	0.00	0.00	0.00	0.00
I100	8.00	0.00	0.00	4.00	0.00	18.00	70.00	0.00	0.00	0.00	0.00
I250	13.50	0.00	0.00	8.25	0.00	0.00	78.25	0.00	0.00	0.00	0.00
I400	3.10	0.00	4.00	0.60	0.00	0.00	92.00	0.00	0.30	0.00	0.00
I550	0.93	0.00	0.00	87.87	2.27	0.00	0.00	0.00	8.93	2.00	0.61
I700	0.00	0.00	68.38	0.00	0.00	0.00	31.50	0.00	0.00	0.13	0.00

Appendix II: Qualitative list of coral species (0=absent, 1=present)

CORALS

Date	Transect	Distance from vegetation line	<i>Cyphastrea ocellina</i>	<i>Montipora capitata</i>	<i>Montipora flabellata</i>	<i>Montipora patula</i>	<i>Pocillopora damicornis</i>	<i>Pocillopora edouxi</i>	<i>Pocillopora ligulata</i>	<i>Pocillopora meandrina</i>	<i>Porites compressa</i>	<i>Porites lichen</i>	<i>Poites lobata</i>	<i>Pavona varians</i>	<i>Psammocora stellata</i>	<i>Acanthophora specifera</i>	TOTAL CORAL SPECIES
4/8/2005	A	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/8/2005	A	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/8/2005	A	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/8/2005	A	400	0	0	0	0	1	0	0	1	1	0	0	0	0	0	3
4/8/2005	A	550	0	0	0	0	0	0	0	1	1	0	1	0	0	0	3
4/8/2005	A	700	1	1	1	0	1	0	0	1	1	0	0	0	0	0	6
4/6/2005	B	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/6/2005	B	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/6/2005	B	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/6/2005	B	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/6/2005	B	550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/6/2005	B	700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/8/2005	C	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/8/2005	C	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/8/2005	C	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/8/2005	C	400	0	1	0	0	0	1	0	1	1	0	1	0	0	0	5
4/8/2005	C	550	0	1	0	1	1	0	0	0	1	0	1	0	0	0	5
4/8/2005	C	700	1	1	1	1	1	0	0	1	1	0	1	0	0	0	8
4/9/2005	D	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/9/2005	D	100	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4/9/2005	D	250	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4/9/2005	D	400	0	0	0	1	1	0	0	0	1	0	0	0	0	1	4
4/9/2005	D	550	0	1	0	0	1	0	0	1	1	0	1	0	0	0	5
4/9/2005	D	700	0	1	1	0	1	0	0	1	0	0	0	0	1	0	5
4/9/2005	E	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/9/2005	E	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/9/2005	E	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/9/2005	E	400	0	0	0	0	0	0	0	1	0	0	0	0	0	1	2
4/9/2005	E	550	1	1	0	1	1	0	0	1	1	0	1	1	0	0	8
4/9/2005	E	700	1	1	1	1	1	0	0	1	1	1	1	1	0	0	10
4/6/2005	F	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/6/2005	F	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/6/2005	F	250	0	0	0	0	0	0	0	0	1	0	0	0	0	1	2
4/6/2005	F	400	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4/6/2005	F	550	0	0	0	0	1	0	0	0	0	0	0	0	0	1	2

CORALS

Date	Transect	Distance from vegetation line	<i>Cyphastrea ocellina</i>	<i>Montipora capitata</i>	<i>Montipora flabellata</i>	<i>Montipora patula</i>	<i>Pocillopora damicornis</i>	<i>Pocillopora edouxi</i>	<i>Pocillopora ligulata</i>	<i>Pocillopora meandrina</i>	<i>Porites compressa</i>	<i>Porites lichen</i>	<i>Porites lobata</i>	<i>Pavona varians</i>	<i>Psammocora stellata</i>	<i>Acanthophora specifera</i>	TOTAL CORAL SPECIES
4/6/2005	F	700	0	1	0	0	1	0	0	1	0	0	1	0	0	1	5
4/6/2005	G	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/7/2005	G	100	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4/7/2005	G	250	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4/7/2005	G	400	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4/7/2005	G	550	0	0	0	0	1	0	0	1	1	0	0	0	1	1	5
4/7/2005	G	700	0	1	0	1	0	0	1	1	1	0	1	0	1	1	8
4/7/2005	H	50	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4/7/2005	H	100	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4/7/2005	H	250	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4/7/2005	H	400	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4/7/2005	H	550	0	0	0	1	0	0	0	1	1	0	0	1	0	0	4
4/7/2005	H	700	0	1	0	1	1	0	0	1	0	0	1	1	0	0	6
4/7/2005	I	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/7/2005	I	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/7/2005	I	250	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4/7/2005	I	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/7/2005	I	550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/7/2005	I	700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix III: Qualitative list of algal species (0=absent, 1=present)

ALGAE

Date	Transect	Distance from vegetation line	<i>Asparagopsis taxiformis</i>	<i>Bornetella sphaerica</i>	<i>Caulerpa serrulata</i>	<i>Codium edule</i>	<i>Codium reediae</i>	<i>Coraline algae</i>	<i>Dasya sp.</i>	<i>Dictyosphaeria cavern.</i>	<i>Dictyosphaeria versluisii</i>	<i>Dictyota acutiloba</i>	<i>Dictyota sandvicensis</i>	<i>Galaxaura sp.</i>	<i>Gibsmithii glomerata</i>	<i>Gracilaria bursipastoris</i>	<i>Halimeda discoidea</i>	<i>Halimnion formosa</i>	<i>Halophila hawaiiensis</i>	<i>Hypnea cervicornis</i>	<i>Hypnea musciformis*</i>	<i>Laurencia sp.</i>	<i>Lyngbya majuscula</i>	<i>Martensia fragilis</i>	<i>Neomeris annulata</i>	<i>Padina australis</i>	<i>Sargassum echino.</i>	<i>Turbinaria ornata</i>	<i>Spyridia filamentosa</i>	<i>Wrangelia sp.</i>	TOTAL ALGAE SPECIES
4/8/2005	A	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/8/2005	A	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/8/2005	A	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/8/2005	A	400	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	4
4/8/2005	A	550	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
4/8/2005	A	700	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	4
4/6/2005	B	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/6/2005	B	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/6/2005	B	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/6/2005	B	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/6/2005	B	550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/6/2005	B	700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/8/2005	C	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/8/2005	C	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/8/2005	C	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
4/8/2005	C	400	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
4/8/2005	C	550	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	4
4/8/2005	C	700	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	4
4/9/2005	D	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/9/2005	D	100	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	4
4/9/2005	D	250	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	5
4/9/2005	D	400	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3
4/9/2005	D	550	1	0	0	0	0	1	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	8
4/9/2005	D	700	0	0	0	1	0	1	1	0	0	0	1	1	0	0	1	1	1	0	0	0	1	1	0	0	0	1	1	0	12

ALGAE

Date	Transect	Distance from vegetation line	<i>Asparagopsis taxiformis</i>	<i>Bornetella sphaerica</i>	<i>Caulerpa serrulata</i>	<i>Codium edule</i>	<i>Codium reediae</i>	<i>Coralline algae</i>	<i>Dasya sp.</i>	<i>Dictyosphaeria cavem.</i>	<i>Dictyosphaeria versluisii</i>	<i>Dictyota acutiloba</i>	<i>Dictyota sandvicensis</i>	<i>Galaxaura sp.</i>	<i>Gibsmithii glomerata</i>	<i>Gracilaria bursipastoris</i>	<i>Halimeda discoidea</i>	<i>Haliminia formosa</i>	<i>Halophila Hawaiiiana</i>	<i>Hypnea cervicornis</i>	<i>Hypnea musciformis</i> *	<i>Laurencia sp.</i>	<i>Lyngbya majuscula</i>	<i>Martensia fragilis</i>	<i>Neomeris annulata</i>	<i>Padina australis</i>	<i>Sargassum echino.</i>	<i>Turbinaria ornata</i>	<i>Spyridia filamentosa</i>	<i>Wrangelia sp.</i>	TOTAL ALGAE SPECIES	
4/9/2005	E	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4/9/2005	E	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4/9/2005	E	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4/9/2005	E	400	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	
4/9/2005	E	550	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	
4/9/2005	E	700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
4/6/2005	F	50	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
4/6/2005	F	100	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
4/6/2005	F	250	0	0	0	0	0	1	0	0	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	1	0	7	
4/6/2005	F	400	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	1	0	6	
4/6/2005	F	550	0	0	1	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	1	0	7	
4/6/2005	F	700	0	0	1	0	0	0	0	1	0	0	1	1	0	0	1	0	0	1	1	0	0	0	0	1	1	0	1	1	11	
4/6/2005	G	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4/7/2005	G	100	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	
4/7/2005	G	250	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	0	1	0	0	1	0	6	
4/7/2005	G	400	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	6
4/7/2005	G	550	0	0	0	0	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	5	
4/7/2005	G	700	0	0	1	1	1	0	0	1	0	1	1	1	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	11	
4/7/2005	H	50	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	3	
4/7/2005	H	100	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	1	0	5	
4/7/2005	H	250	0	0	0	0	0	1	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	1	0	7	
4/7/2005	H	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	2	
4/7/2005	H	550	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	5	
4/7/2005	H	700	0	0	0	1	1	1	0	1	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	8	
4/7/2005	I	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	
4/7/2005	I	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	3	
4/7/2005	I	250	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	

ALGAE

Date	Transect	Distance from vegetation line	<i>Asparagopsis taxiformis</i>	<i>Bornetella sphaerica</i>	<i>Caulerpa serrulata</i>	<i>Codium edule</i>	<i>Codium reediae</i>	<i>Coralline algae</i>	<i>Dasya sp.</i>	<i>Dictyosphaeria cavern.</i>	<i>Dictyosphaeria versluisii</i>	<i>Dictyota acutiloba</i>	<i>Dictyota sandvicensis</i>	<i>Galaxaura sp.</i>	<i>Gibsmithii glomerata</i>	<i>Gracilaria bursipastoris</i>	<i>Halimeda discoidea</i>	<i>Halimnia formosa</i>	<i>Halophila Hawaiiiana</i>	<i>Hypnea cervicornis</i>	<i>Hypnea musciformis*</i>	<i>Laurencia sp.</i>	<i>Lyngbya majuscula</i>	<i>Martensia fragilis</i>	<i>Neomeris annulata</i>	<i>Padina australis</i>	<i>Sargassum echino.</i>	<i>Turbinaria ornata</i>	<i>Spyridia filamentosa</i>	<i>Wrangelia sp.</i>	TOTAL ALGAE SPECIES
4/7/2005	I	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	2
4/7/2005	I	550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
4/7/2005	I	700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* invasive introduced species

Appendix IV: Qualitative list of fish and invertebrate species (0=absent, 1=present)

Date	Transect	Distance from vegetation line	Fish																			Invertebrates							TOTAL INVERTEBRATE SPECIES
			<i>Abudefduf abdominalis</i>	<i>Acanthurus triostegus</i>	<i>Acanthurus nigrofuscus</i>	<i>Arothron hispidus</i>	<i>Canthigaster jactator</i>	<i>Chromis agilis</i>	<i>Chromis ovalis</i>	<i>Chromis verator</i>	<i>Dascyllus albisella</i>	<i>Psilogobius mainlandi.</i>	<i>Gomphosus varius</i>	<i>Microcanthus stigosus</i>	<i>Paracirrhites arcatus</i>	<i>P. imparipennis</i>	<i>Scarus sp.</i>	<i>Stegastes fasciolatus</i>	<i>Stethojulis balteata</i>	<i>Synodus dermatogenys</i>	<i>Thalassoma duperrey</i>	<i>Zebrasoma veliferum</i>	TOTAL FISH SPECIES	<i>Feather duster</i>	<i>Solar slug</i>	<i>Echinometra mathaei</i>	<i>Echinothrix diadema</i>	<i>Holothuria atra</i>	
4/8/2005	A	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4/8/2005	A	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4/8/2005	A	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4/8/2005	A	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4/8/2005	A	550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4/8/2005	A	700	0	1	0	0	1	0	0	0	1	0	0	0	0	0	1	1	0	1	0	6	0	0	0	0	0	0	
4/6/2005	B	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
4/6/2005	B	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
4/6/2005	B	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
4/6/2005	B	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
4/6/2005	B	550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
4/6/2005	B	700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
4/8/2005	C	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
4/8/2005	C	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
4/8/2005	C	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
4/8/2005	C	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
4/8/2005	C	550	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0		
4/8/2005	C	700	0	1	0	0	1	0	0	0	1	1	1	0	0	1	0	0	0	0	0	7	0	0	1	0	0	1	
4/9/2005	D	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
4/9/2005	D	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
4/9/2005	D	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
4/9/2005	D	400	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0		

Date	Transect	Distance from vegetation line	Fish																			Invertebrates						
			<i>Abudefduf abdominalis</i>	<i>Acanthurus triostegus</i>	<i>Acanthurus nigrofuscus</i>	<i>Arothron hispidus</i>	<i>Canthigaster jactator</i>	<i>Chromis agilis</i>	<i>Chromis ovalis</i>	<i>Chromis verator</i>	<i>Dascyllus albisella</i>	<i>Psilogobius mainlandi.</i>	<i>Gomphosus varius</i>	<i>Microcanthus stigosus</i>	<i>Paracirrhites arcatus</i>	<i>P. imparipennis</i>	<i>Scarus sp.</i>	<i>Stegastes fasciolatus</i>	<i>Stethojulis balteata</i>	<i>Synodus dermatogenys</i>	<i>Thalassoma duperrey</i>	<i>Zebbrasoma veliferum</i>	TOTAL FISH SPECIES	<i>Feather duster</i>	<i>Solar slug</i>	<i>Echinometra mathaei</i>	<i>Echinothrix diadema</i>	<i>Holothuria atra</i>
4/9/2005	D	550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1
4/9/2005	D	700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
4/9/2005	E	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/9/2005	E	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/9/2005	E	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/9/2005	E	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/9/2005	E	550	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	0	0	0	0	0
4/9/2005	E	700	0	0	0	1	0	0	0	0	0	1	0	0	0	1	1	0	0	1	0	6	0	0	0	0	0	0
4/6/2005	F	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/6/2005	F	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/6/2005	F	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/6/2005	F	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/6/2005	F	550	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	5	0	0	1	0	0	1	
4/6/2005	F	700	1	1	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	0	6	0	0	0	0	0	0
4/6/2005	G	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/7/2005	G	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/7/2005	G	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/7/2005	G	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/7/2005	G	550	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	1	0	6	0	0	0	0	0	0
4/7/2005	G	700	1	1	0	0	0	1	0	0	1	0	1	0	0	0	0	0	1	1	0	7	0	0	0	0	0	0
4/7/2005	H	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/7/2005	H	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/7/2005	H	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/7/2005	H	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/7/2005	H	550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1

Date	Transect	Distance from vegetation line	Fish																			Invertebrates								TOTAL INVERTEBRATE SPECIES
			<i>Abudefduf abdominalis</i>	<i>Acanthurus triostegus</i>	<i>Acanthurus nigrofuscus</i>	<i>Arothron hispidus</i>	<i>Canthigaster jactator</i>	<i>Chromis agilis</i>	<i>Chromis ovalis</i>	<i>Chromis verator</i>	<i>Dascyllus albisella</i>	<i>Psilogobius mainlandi.</i>	<i>Gomphosus varius</i>	<i>Microcanthus stigosus</i>	<i>Paracirrhites arcatus</i>	<i>P. imparipennis</i>	<i>Scarus sp.</i>	<i>Stegastes fasciolatus</i>	<i>Stethojulis balteata</i>	<i>Synodus dermatogenys</i>	<i>Thalassoma duperrey</i>	<i>Zebrasoma veliferum</i>	TOTAL FISH SPECIES	<i>Feather duster</i>	<i>Solar slug</i>	<i>Echinometra mathaei</i>	<i>Echinothrix diadema</i>	<i>Holothuria atra</i>	<i>Tripneustes gratilla</i>	
4/7/2005	H	700	1	1	0	1	0	1	1	1	1	1	0	0	0	1	0	1	0	1	1	0	13	1	0	0	0	0	0	1
4/7/2005	I	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4/7/2005	I	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4/7/2005	I	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4/7/2005	I	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4/7/2005	I	550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4/7/2005	I	700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Appendix V: Summary of coral survey parameters with example images

Appendix V: Summary of coral survey parameters with example images

Transect		Total cover	Species richness	Diversity
A50		0.0	0.0	n/a
%cover	sand	5.3	silt	94.7

Transect		Total cover	Species richness	Diversity
A100		0.0	0.0	n/a
%cover	sand	87.7	algae	0.3
	silt	10.5	turf	1.5

Transect		Total cover	Species richness	Diversity
A250		0.00	0.00	n/a
%cover	sand	98.5	turf	1.5

Transect		Total cover	Species richness	Diversity
A400		0.0	0.0	n/a
%cover	coralline	0.4	rubble	58.7
	algae	1.3	turf	5.1
	sand	34.6		

Transect		Total cover	Species richness	Diversity
A550		0.0	0.0	n/a
%cover	coralline	7.3	rubble	85.2
	algae	0.4	turf	6.0
	sand	1.2		

Transect		Total cover	Species richness	Diversity
A700		5.6	3.0	0.97
%cover	sand	9.7	<i>M.capitata</i>	1.0
	rubble	79.2	<i>P.meandrina</i>	1.3
	turf	0.7	<i>P.compressa</i>	3.2
	coralline	4.6	Porifera	0.3

Transect		Total cover	Species richness	Diversity
B50		0.0	0.0	n/a
%cover	silt	100.0		

Transect		Total cover	Species richness	Diversity
B100		0.0	0.0	n/a
%cover	silt	100.0		

Transect		Total cover	Species richness	Diversity
B250		0.0	0.0	n/a
%cover	silt	99.8	algae	0.1
	rubble	0.1		

Transect		Total cover	Species richness	Diversity
B400		0.0	0.0	n/a
%cover	sand	39.8	algae	2.3
	silt	54.8	rubble	1.6
	turf	1.5		

Transect		Total cover	Species richness	Diversity
B550		0.0	0.0	n/a
%cover	sand	100.0		

Transect		Total cover	Species richness	Diversity
B700		0.0	0.0	n/a
%cover	rubble	100.0		

Transect		Total cover	Species richness	Diversity
C50		0.0	0.0	n/a
%cover	silt	100.0		

Transect		Total cover	Species richness	Diversity
C100		0.0	0.0	n/a
%cover	silt	100.0		

Transect		Total cover	Species richness	Diversity
C250		0.0	0.0	n/a
%cover	algae	1.4	silt	38.7
	sand	52.6	turf	5.7
	substrate	1.7		

Transect		Total cover	Species richness	Diversity
C400		10.8	3.0	0.91
%cover	sand	24.0	<i>P.compressa</i>	4.3
	silt	43.6	<i>M.capitata</i>	5.6
	algae	0.8	<i>P.meandrina</i>	0.9
	rubble	12.2	substrate	8.6
	turf	0.1		

Transect		Total cover	Species richness	Diversity
C550		7.7	3.0	0.97
%cover	algae	4.7	rubble	27.5
	sand	33.8	<i>P.compressa</i>	2.4
	substrate	23.3	<i>M.patula</i>	1.1
	silt	3.0	<i>M.capitata</i>	4.2

Transect		Total cover	Species richness	Diversity
C700		12.0	5.0	0.6
%cover	coralline	0.2	<i>M.capitata</i>	9.8
	rubble	10.1	<i>C.ocellina</i>	0.1
	sand	54.0	<i>P.compressa</i>	0.1
	silt	2.4	<i>M.patula</i>	1.9
	substrate	19.1	<i>P.damicornis</i>	0.2
			algae	2.2

Transect		Total cover	Species richness	Diversity
D50		0.0	0.0	n/a
% cover	silt	100.0		

Transect		Total cover	Species richness	Diversity
D100		0.0	0.0	n/a
% cover	algae	31.6	silt	47.2
	rubble	6.0	turf	1.6
	sand	13.0		

Transect		Total cover	Species richness	Diversity
D250		0.0	0.0	n/a
% cover	coralline	1.3	sand	55.3
	algae	17.8	substrate	12.8
	rubble	10.5	turf	2.2

Transect		Total cover	Species richness	Diversity
D400		3.1	2.0	0.47
% cover	coralline	1.6	sand	19.1
	algae	10.6	silt	0.2
	substrate	19.3	<i>P.damicornis</i>	0.6
	turf	1.5	<i>P.compressa</i>	2.6
	rubble	44.7		

Transect		Total cover	Species richness	Diversity
D550		2.6	7.0	1.62
% cover	coralline	0.9	<i>M.capitata</i>	0.3
	algae	4.3	<i>M.patula</i>	0.1
	Holothuria	0.1	<i>P.damicornis</i>	0.3
	rubble	36.9	<i>P.ligulata</i>	0.3
	sand	0.0	<i>P.meandrina</i>	1.3
	substrate	48.0	<i>Pcompressa</i>	0.3
			<i>P.lobata</i>	0.3

Transect		Total cover	Species richness	Diversity
D700		3.18	3.00	0.82
% cover	coralline	0.5	<i>M.capitata</i>	1.7
	rubble	51.9	<i>P.damicornis</i>	0.1
	substrate	43.4	<i>P.meandrina</i>	1.1
	algae	1.1		

Transect		Total cover	Species richness	Diversity
E50		0.0	0.0	n/a
% cover	sand	80.0	silt	20.0

Transect		Total cover	Species richness	Diversity
E100		0.0	0.0	n/a
% cover	sand	85.0	silt	15.0

Transect		Total cover	Species richness	Diversity
E250		0.0	0.0	n/a
% cover	sand	85.0	silt	15.0

Transect		Total cover	Species richness	Diversity
E400		0.3	1.0	n/a
% cover	rubble	7.5	sand	40.9
	coralline	0.1	silt	8.5
	algae	4.6	substrate	30.9
	turf	7.3	<i>P.damicornis</i>	0.3

Transect		Total cover	Species richness	Diversity
E550		41.1	6.0	1.26
% cover	algae	0.8	<i>P.lobata</i>	0.7
	coralline	5.6	<i>P.meandrina</i>	0.7
	silt	9.7	<i>M.capitata</i>	13.9
	substrate	38.13	<i>M.patula</i>	12.37
	turf	4.68	<i>P.varians</i>	0.22
			<i>P.compressa</i>	13.82

Transect		Total cover	Species richness	Diversity
E700		44.9	5.0	0.98
% cover	coralline	30.8	<i>M.capitata</i>	30.4
	algae	0.4	<i>M.patula</i>	6.7
	sand	0.6	<i>P.varians</i>	0.2
	substrate	21.9	<i>P.meandrina</i>	2.6
	turf	1.4	<i>P.lobata</i>	4.9

Transect		Total cover	Species richness	Diversity
F50		0.0	0.0	n/a
%cover	sand	80.0	silt	20.0

Transect		Total cover	Species richness	Diversity
F100		0.0	0.0	n/a
%cover	sand	79.8	rubble	1.1
	silt	17.8	turf	1.3

Transect		Total cover	Species richness	Diversity
F250		0.0	0.0	n/a
%cover	rubble	43.5	silt	1.7
	algae	0.3	substrate	7.9
	sand	45.7	turf	0.8

Transect		Total cover	Species richness	Diversity
F400		0.3	1.0	n/a
%cover	rubble	56.2	sand	31.5
	coralline	0.3	substrate	8.2
	algae	1.5	<i>P.damicornis</i>	0.3
	turf	2.0		

Transect		Total cover	Species richness	Diversity
F550		0.0	0.0	n/a
%cover	rubble	50.3	substrate	35.0
	algae	8.0	turf	3.3
	sand	3.3		

Transect		Total cover	Species richness	Diversity
F700		0.0	0.0	n/a
%cover	rubble	29.5	sand	14.6
	coralline	1.9	substrate	51.1
	algae	1.5	turf	1.4

Transect		Total cover	Species richness	Diversity
G50		0.0	0.0	n/a
% cover	rubble	0.5	silt	49.8
	sand	48.8	substrate	1.0

Transect		Total cover	Species richness	Diversity
G100		0.0	0.0	n/a
% cover	algae	12.1	silt	9.1
	sand	78.8		

Transect		Total cover	Species richness	Diversity
G250		0.0	0.0	n/a
% cover	rubble	5.7	silt	5.7
	algae	68.3	sand	20.4

Transect		Total cover	Species richness	Diversity
G400		0.0	0.0	n/a
% cover	rubble	10.0	sand	14.0
	algae	76.0		

Transect		Total cover	Species richness	Diversity
G550		0.0	0.0	n/a
% cover	rubble	80.2	turf	1.6
	algae	5.6	coralline	1.8
	sand	10.9		

Transect		Total cover	Species richness	Diversity
G700		4.2	2.0	0.28
% cover	rubble	22.7	substrate	42.8
	coralline	7.3	<i>P.meandrina</i>	3.8
	algae	21.3	<i>P.compressa</i>	0.3
	sand	1.2	turf	0.5

Transect		Total cover	Species richness	Diversity
H50		0.0	0.0	n/a
% cover	algae	25.5	silt	33.2
	sand	41.2		

Transect		Total cover	Species richness	Diversity
H100		0.0	0.0	n/a
% cover	algae	47.5	silt	8.6
	sand	44.0		

Transect		Total cover	Species richness	Diversity
H250		0.0	0.0	n/a
% cover	algae	79.1	silt	0.6
	sand	20.3		

Transect		Total cover	Species richness	Diversity
H400		0.0	0.0	n/a
% cover	algae	5.6	sand	88.2
	turf	3.5	silt	2.7

Transect		Total cover	Species richness	Diversity
H550		13.2	5.0	0.94
% cover	rubble	13.2	<i>M.capitata</i>	8.7
	coralline	1.7	<i>P.damicornis</i>	0.4
	algae	17.0	<i>P.meandrina</i>	3.3
	sand	11.3	<i>P.compressa</i>	0.6
	substrate	42.3	<i>P.stellata</i>	0.2
	turf	1.2		

Transect		Total cover	Species richness	Diversity
H700		31.2	7.0	1.26
% cover	rubble	0.2	<i>M.capitata</i>	5.2
	coralline	7.7	<i>M.patula</i>	2.5
	algae	2.9	<i>P.varians</i>	0.1
	sand	5.7	<i>P.meandrina</i>	7.4
	substrate	48.7	<i>P.damicornis</i>	0.2
	turf	3.6	<i>P.lobata</i>	15.7
			<i>P.stellata</i>	0.1

Transect		Total cover	Species richness	Diversity
I50		0.0	0.0	n/a
% cover	algae	20.7	sand	61.3
	<i>Halophila</i>	18.0		

Transect		Total cover	Species richness	Diversity
I100		0.0	0.0	n/a
% cover	algae	8.0	sand	70.0
	<i>Halophila</i>	18.0	turf	4.0

Transect		Total cover	Species richness	Diversity
I250		0.0	0.0	n/a
% cover	algae	13.5	turf	8.3
	sand	78.3		

Transect		Total cover	Species richness	Diversity
I400		0.0	0.0	n/a
% cover	rubble	0.3	sand	92.0
	algae	3.1	substrate	4.0
	turf	0.6		

Transect		Total cover	Species richness	Diversity
I550		2.3	2.0	0.61
% cover	rubble	8.9	<i>M.capitata</i>	1.6
	algae	0.9	<i>P.meandrina</i>	0.7
	turf	87.9		

Transect		Total cover	Species richness	Diversity
I700		0.0	0.0	n/a
% cover	rubble	0.1	substrate	68.4
	sand	31.5		