

Final Report
Biscayne National Park Coral Reef Inventory and
Monitoring Project

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INTRODUCTION

Biscayne National Park's coral reefs are one of the rare and beautiful areas that the park was created to protect and preserve. The Resource Management division began collecting data about the park's coral reef resources in 1998 using underwater videography. Twenty-five meter long transects were video taped along the reef for archival and analysis. In 1998 and 1999 eight sites were surveyed (5 offshore bank reefs, 2 transitional reefs, and 1 patch reef). The number of coral colonies were counted from the videos, and density was estimated. Species richness and diversity were calculated from these colony counts.

In 2000, the survey was expanded in two ways, both spatially and in the types of data collected. Two methods were used: 25 meter long underwater video transects and in situ 2m by 25m belt transects where stony coral censuses were conducted. The underwater video transect is important for archive purposes and allows for further analysis including percent cover of the various biologic communities. However, underwater video of coral reef systems underestimates the amount of coral due to the cryptic nature of some species. The in situ under water coral census is important to use in conjunction with the video to make up for this shortcoming. It provides a more robust estimate of species richness for the area and allows for more exact species identification in the field, which becomes much harder in the lab from the video tape. The coral census also collects data on coral bleaching, black band disease, white diseases, other diseases, and the number of *Diadema antillarum* urchins. Ten replicate transects were surveyed at each site using these two methods. Surveys were conducted at 11 sites (4 patch reefs, 2 transitional reefs, and 5 offshore bank reefs). In 2001, videos from 1998, 1999, and 2000 were analyzed for percent cover data. No new data was collected.

METHODS

Field Data Collection

The survey used two types of data collection, underwater video transects and *in-situ* stony coral species census. This data collection was accomplished by a two person buddy team using SCUBA apparatus. The eleven sample sites are provided in Table 1. In 2000, sites that had been surveyed in 1998/99 were resurveyed at the same coordinates, while new sites were sampled based on random location.

Table 1. Sampling Sites

Site Name	Reef Type	Depth (ft)	Longitude	Latitude
Alina's Reef	Patch	22	80.16311645	25.38652992
Anniversary Reef	Patch	12	80.16413116	25.38884925
Bache Shoal	Patch	12	80.14855000	25.48633003
Ball Buoy	Transitional	20	80.18424987	25.31845092
Brewster Reef	Bank	22	80.10037994	25.56678009
Elkhorn Reef	Transitional	17	80.16400146	25.36300086
Long Reef	Bank	24	80.11927032	25.44479942
Marker 21	Patch	10	80.18620300	25.35504913
Pacific Reef	Bank	29	80.13817640	25.37166976
Star Reef	Bank	31	80.10047149	25.54500007
Triumph Reef	Bank	29	80.10817718	25.48756980

The survey used a 25m fiberglass transect tape, stretched taught from offshore to inshore, in an East-West direction. The transects were placed perpendicular to the depth contour most times. Sites ranged in depth from 3 to 9.5m (10 to 31 feet). Once at the sample site, one diver would stretch the tape, and the other would stay at the transect's origin. The tape would be stretched taught and tied off to the benthos. The videographer would swim slowly along the tape, using a Sony DCR-VX1000 digital video camera housed in a Gates underwater housing. During 1998 and 1999, a scale bar attached to the housing provided a reference for how far off the bottom the camera was held. In 2000, the bar was removed and replaced by two lasers, oriented so that the laser dots converged at 40 cm from the lens of the camera, provided the reference point for how far off the bottom the camera was held. The video was shot perpendicular to the reef surface as the diver swam slowly along the transect maintaining the 40 cm distance from the reef. This distance provided for a consistent frame width of roughly 60 cm, ensuring that analysis from the frame grabbed images was based on a consistent sample area.

Beginning in 2000, as the videographer video taped the transect, the dive buddy performed a census of stony coral species, noting any special conditions. The data was based on presence along the transect, 25 m long by 2 m wide, with 1 m on either side of the transect tape. As the observer swam along the transect, species were observed and logged onto an underwater data sheet. If the colony had bleaching, black band disease, a white disease, and/or other disease, it was noted. The number of *Diadema antillarum*, the long-spined urchin nearly wiped out by disease in the early 1980's, was also enumerated along the transect.

In 1998, transect numbers varied from 9 to 17. However, in 1999 and 2000, ten transects were placed parallel to one another along the reef generally greater than 5 meters apart. The exception in 2000 was Alina's Reef, a circular patch reef. At Alina's Reef, transects started on the eastern deep edge at the reef/sand interface and ran towards the center of the patch. Transects were established in this manner, in a counterclockwise direction covering the majority of the patch reef like spokes of a wagon wheel. Tapes were placed to ensure the shallow ends did not overlap.

Video Data

Digital video data was reviewed in the lab using the Sony digital video camera plugged into a Pentium computer using 'firewire' technology (IEEE-1394). A miroVideo DV300 image capture card (Pinnacle Systems, Inc.) along with miroVideo DVTools image capture software was used to review and capture the images into the computer's local hard drive. In this way, individual non-overlapping frames could be extracted from the video and used for data analysis. Adobe Photoshop (ver. 5.5) was used to convert the images to high-resolution JPEG format and resize the images to 640 x 480 pixels. The images from each site were then archived to CD-ROM for storage and analysis. About 40 to 60 images were captured per transect providing about 400-600 images per reef.

PointCount for Coral Reef '99, created by the Florida Keys National Marine Sanctuary's Coral Reef Hardbottom Monitoring Project, was used to analyze the digital image data. The software placed 10 random points on each image. The benthos below each point was identified, and the species or functional group was stored to a comma separated value file (*.csv) for further analysis. All analyzed files were entered into MS Access and linked to a point coverage in ArcView for visualization and summarization.

Species Inventory Data

The data from the species inventory was entered into a MS Access database using a Graphical User Interface (GUI) form, which mirrored the datasheet to minimize data entry errors. This data was then summarized and exported for further analysis. This summarized data was linked to the ArcView point coverage for data visualization.

RESULTS

Observations made in situ during the 2000 field sampling year provided valuable information regarding the species diversity and health of the coral reefs of Biscayne National Park. Ball Buoy Reef had the highest species richness with 24 species of stony coral observed (Table 2). The lowest number of species richness was observed at Anniversary Reef with 14 stony coral species. The greatest number of species seen on any one transect was 24 and occurred on Ball Buoy Reef (Table 3). The only occurrence of coral bleaching was seen at Bache Shoal on two finger coral (*Porites porites*) colonies. Black band disease was seen on great star coral (*Montastrea cavernosa*) at Alina's Reef and Long Reef. Elliptical star coral (*Dichocoenia stokesii*) was seen at Brewster Reef, Elkhorn Reef, and Long Reef with white disease or other disease. White disease was also noted at Marker 21 patch reef on symmetrical brain coral (*Diploria strigosa*) and at Star Reef on lesser starlet coral (*Siderastrea radians*).

Table 2. Stony Coral Species Richness by Site

Site Name	Stony Coral Species Observed 2000
Alina's Reef	23
Anniversary Reef	14
Bache Shoal	16
Ball Buoy	24
Brewster Reef	21
Elkhorn Reef	18
Long Reef	22
Marker 21	15
Pacific Reef	16
Star Reef	21
Triumph Reef	18

Table 3. Highest Number of Stony Coral Species by Transect

Sitename	Number of Stony Coral Species
Triumph Reef	10
Anniversary Reef	11
Marker 21	12
Pacific Reef	13
Elkhorn Reef	13
Long Reef	14
Bache Shoal	15
Alina's Reef	15
Star Reef	16
Brewster Reef	16
Ball Buoy	16

Species richness at the sites was determined using two different methods: in situ surveys and from point count data. The in situ surveys detected more species than the video data at all sites surveyed (Fig. 1). The reason is that the point count analysis from the video misses both cryptic species and rare species. Therefore, the in situ surveys are a necessary component for determining the number of species present at the study sites. Appendix A shows the presence or absence of stony coral species by site and transect determined from the in situ surveys conducted in 2000.

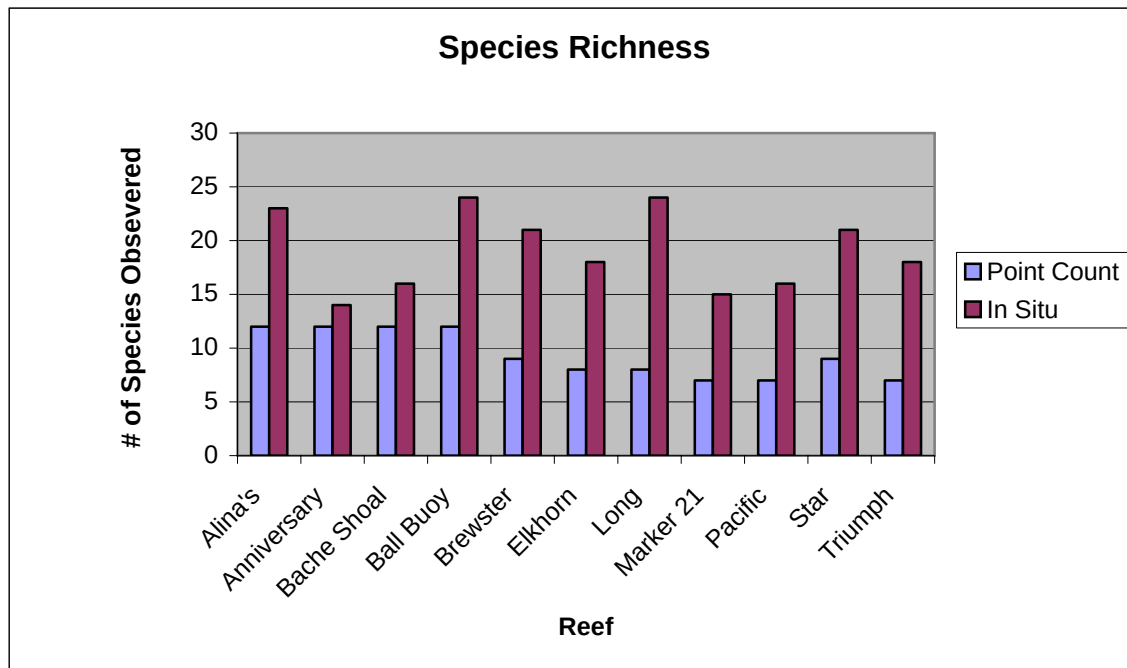


Figure 1. Species richness observed both *in situ* and from point count analysis of video data.

Percent cover of major taxonomic groups were determined from the point count data. The categories include stony coral, octocoral (soft coral), macroalgae, porifera (sponges), substrate, zooanthids, and seagrass. The total percent cover of each of these categories per transect is shown for the sites in 1998 including Ball Buoy Reef (Fig.2), Elkhorn Reef (Fig. 3), Long Reef (Fig. 4), Star Reef (Fig. 5), Triumph Reef (Fig. 6), and Brewster Reef (Fig. 7). Total percent cover per transect for sites surveyed in 1999 include Alina's Reef (Fig. 8) and Pacific Reef (Fig. 9). Percent cover data from sites surveyed in 2000 are shown for Alina's Reef (Fig. 10), Anniversary Reef (Fig. 11), Bache Shoal (Fig. 12), Ball Buoy Reef (Fig. 13), Brewster Reef (Fig. 14), Elkhorn Reef (Fig. 15), Long Reef (Fig. 16), Marker 21 Reef (Fig. 17), Pacific Reef (Fig. 18), Star Reef (Fig. 19), and Triumph Reef (Fig. 20).

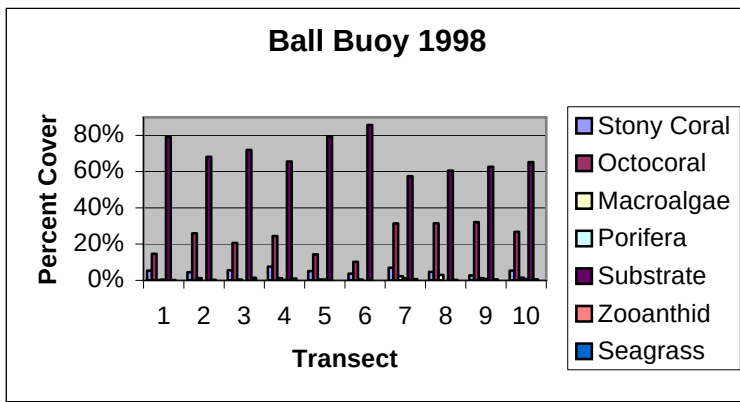


Figure 2. Percent cover of major benthic categories by transect for Ball Buoy Reef in 1998.

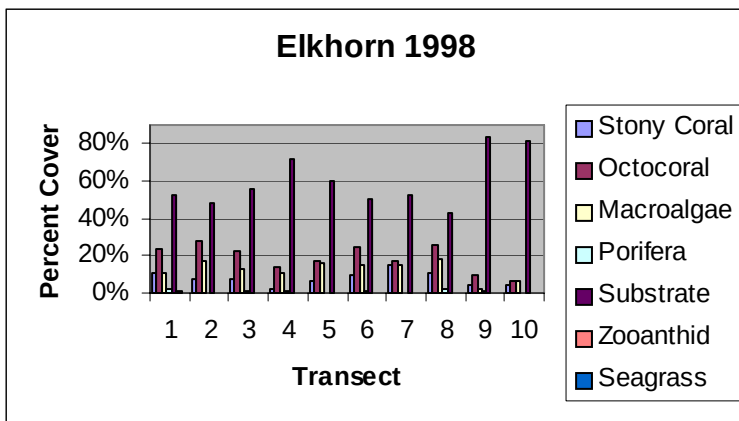


Figure 3. Percent cover of major benthic categories by transect for Elkhorn Reef in 1998.

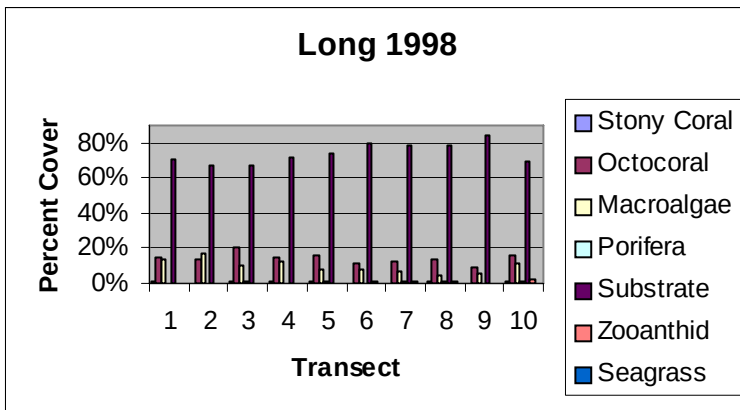


Figure 4. Percent cover of major benthic categories by transect for Long Reef in 1998.

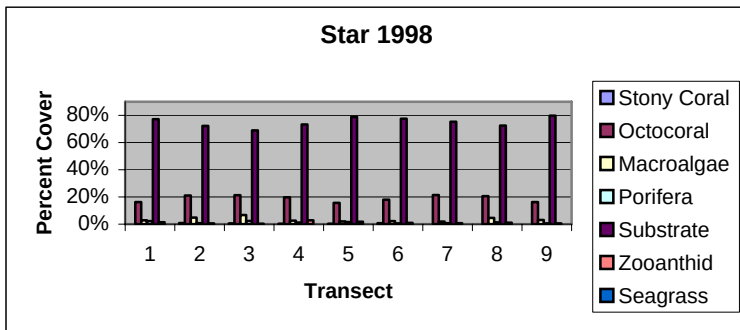


Figure 5. Percent cover of major benthic categories by transect for Star Reef in 1998.

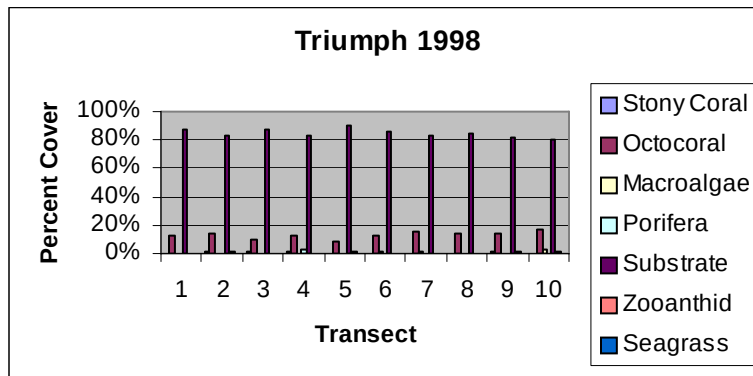


Figure 6. Percent cover of major benthic categories by transect for Triumph Reef in 1998.

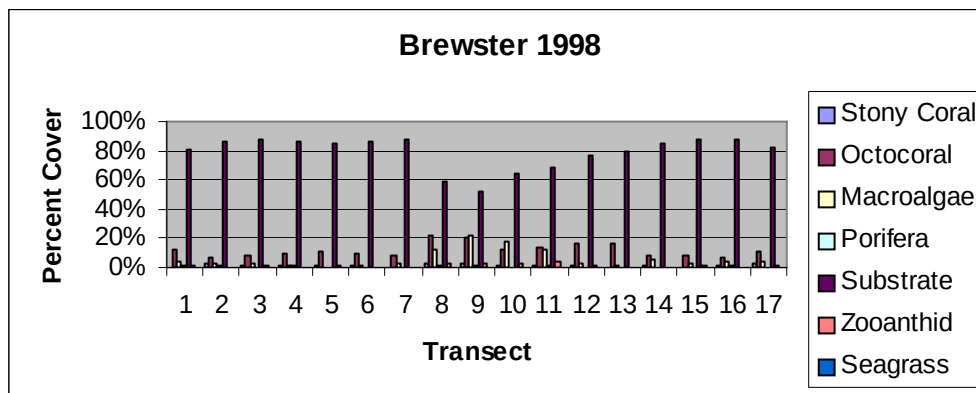


Figure 7. Percent cover of major benthic categories by transect for Brewster Reef in 1998.

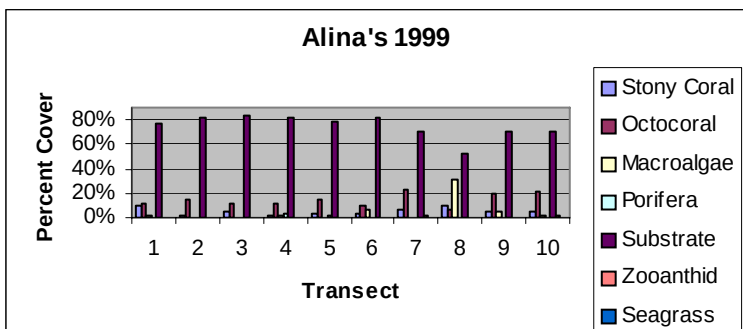


Figure 8. Percent cover of major benthic categories by transect for Alina's Reef in 1999.

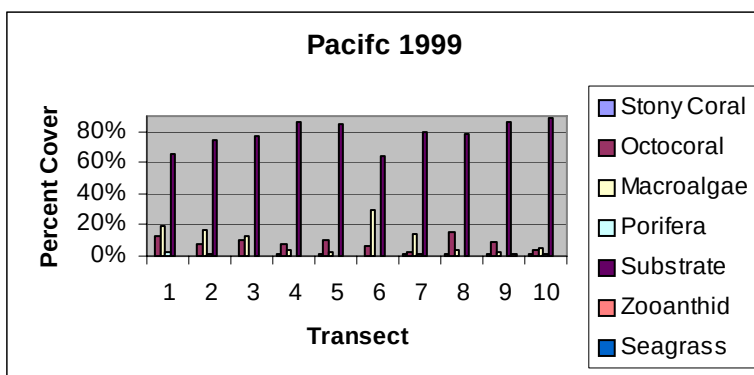


Figure 9. Percent cover of major benthic categories by transect for Pacific Reef in 1999.

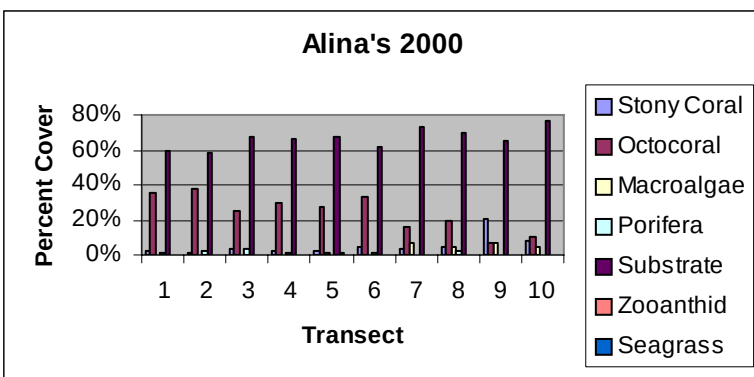


Figure 10. Percent cover of major benthic categories by transect for Alina's Reef in 2000.

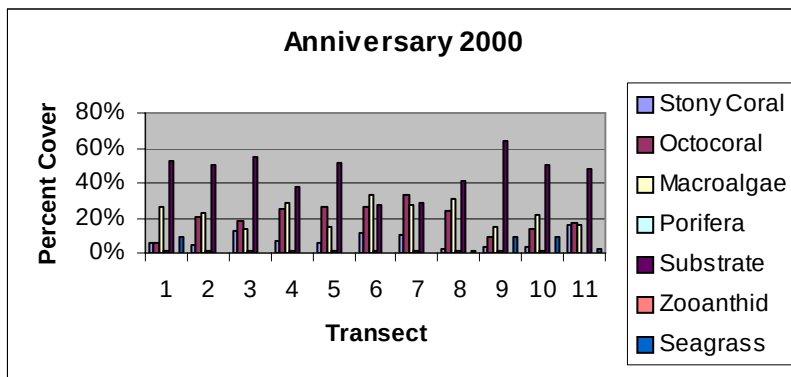


Figure 11. Percent cover of major benthic categories by transect for Anniversary Reef in 2000.

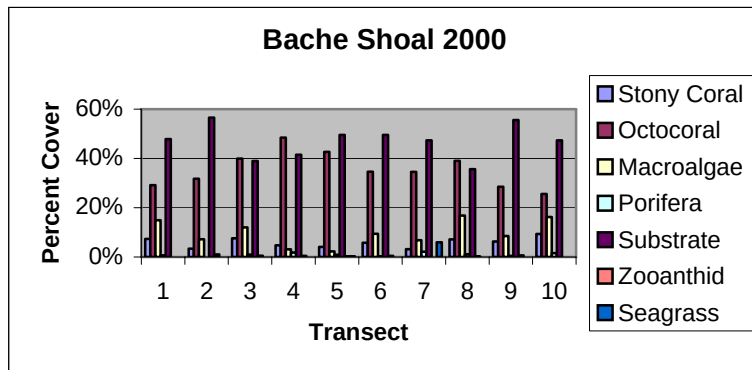


Figure 12. Percent cover of major benthic categories by transect for Bache Shoal in 2000.

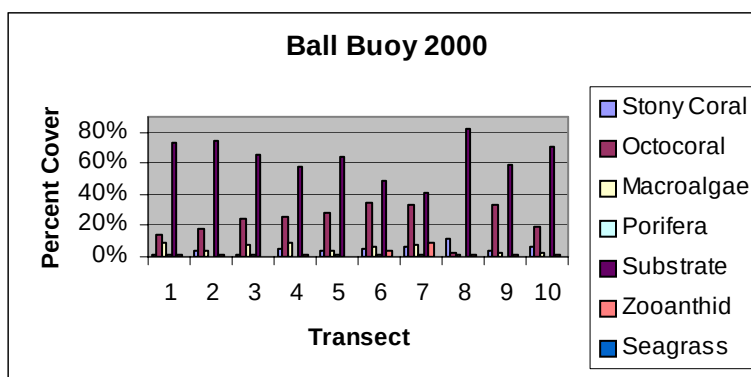


Figure 13. Percent cover of major benthic categories by transect for Ball Buoy Reef in 2000.

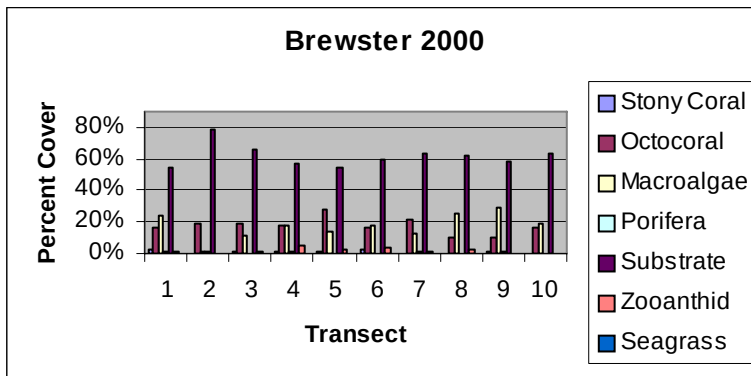


Figure 14. Percent cover of major benthic categories by transect for Brewster Reef in 2000.

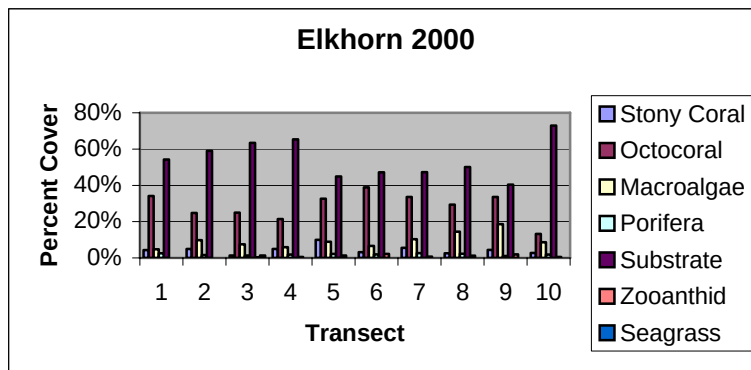


Figure 15. Percent cover of major benthic categories by transect for Elkhorn Reef in 2000.

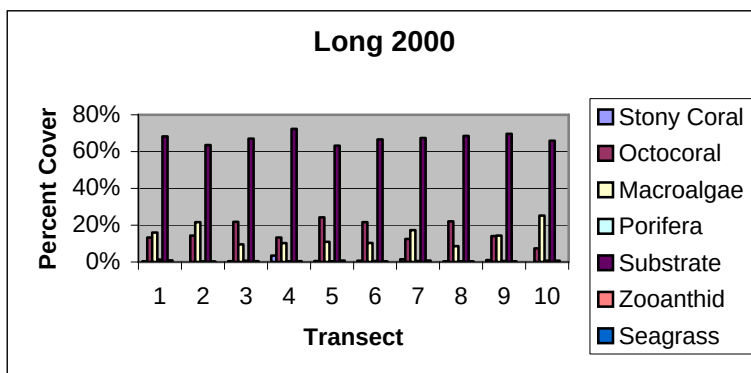


Figure 16. Percent cover of major benthic categories by transect for Long Reef in 2000.

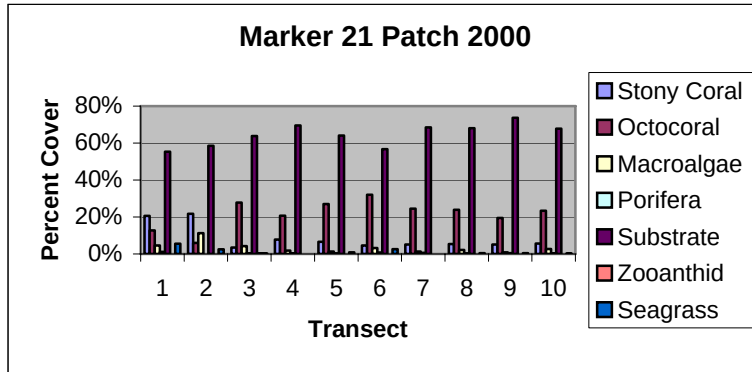


Figure 17. Percent cover of major benthic categories by transect for Marker 21 Reef in 2000.

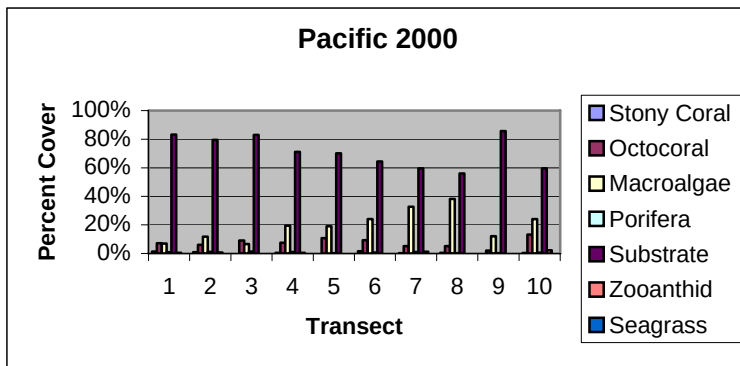


Figure 18. Percent cover of major benthic categories by transect for Pacific Reef in 2000.

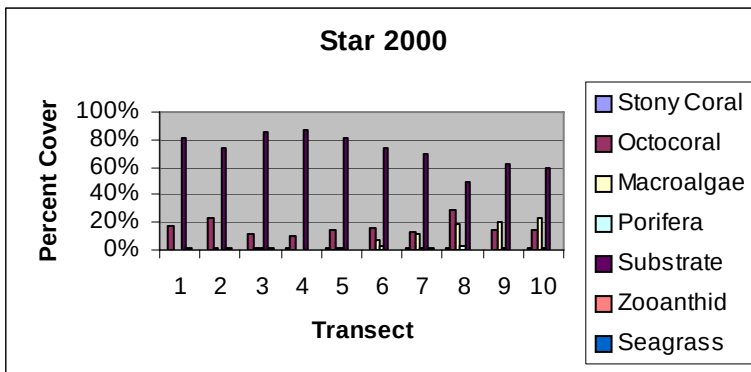


Figure 19. Percent cover of major benthic categories by transect for Star Reef in 2000.

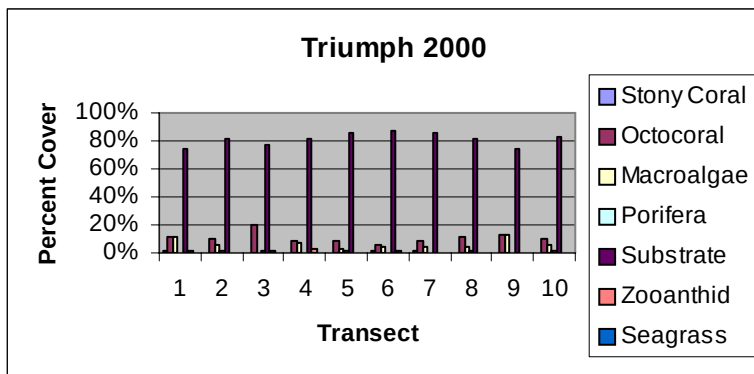


Figure 20. Percent cover of major benthic categories by transect for Triumph Reef in 2000.

Eight of the 11 sites were surveyed during two different years. Ball Buoy, Brewster, Elkhorn, Long, Star, and Triumph Reef were all surveyed in both 1998 and 2000. Alina's and Pacific Reef were surveyed in both 1999 and 2000. Mean percent cover of stony coral, soft coral, and macroalgae are shown for these reefs during multiple years in Figures 21-28. The mean cover and standard deviation of stony coral, octocoral, sponges, seagrass, and macroalgae for each site and year are shown in Appendix C. Appendix B shows the mean cover of species of stony coral and fire coral, as well as the mean cover of the other benthic groups including, macroalgae, seagrass, zooanthids, octocorals, sponges, and substrate, by site and year.

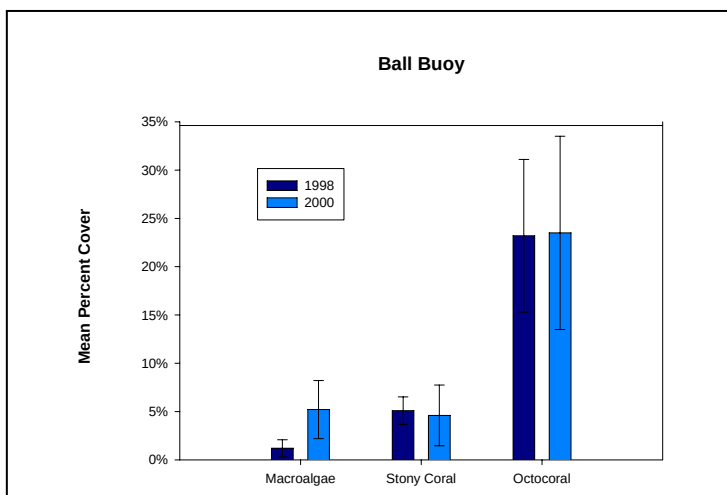


Figure 21. Mean percent cover for macroalgae, stony coral, and octocoral in 1998 and 2000 for Ball Buoy Reef.

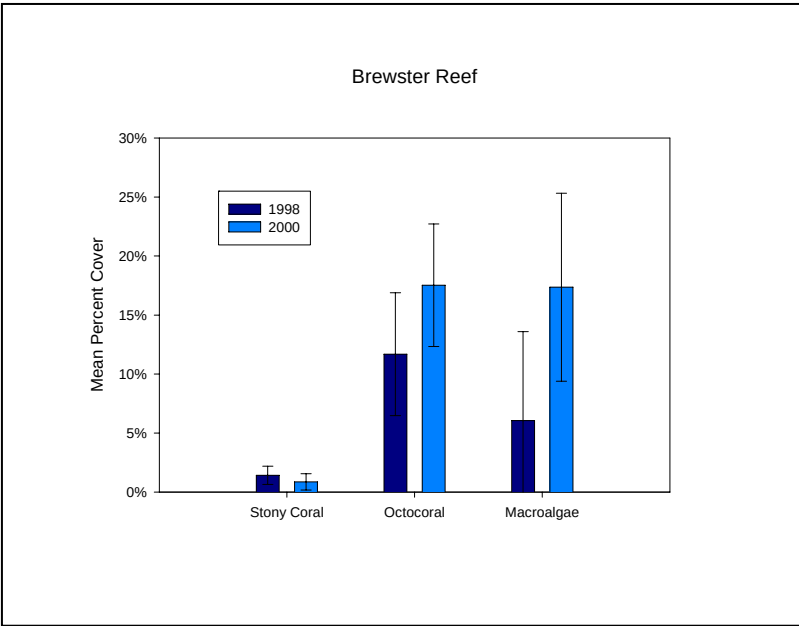


Figure 22. Mean percent cover for macroalgae, stony coral, and octocoral in 1998 and 2000 for Brewster Reef.

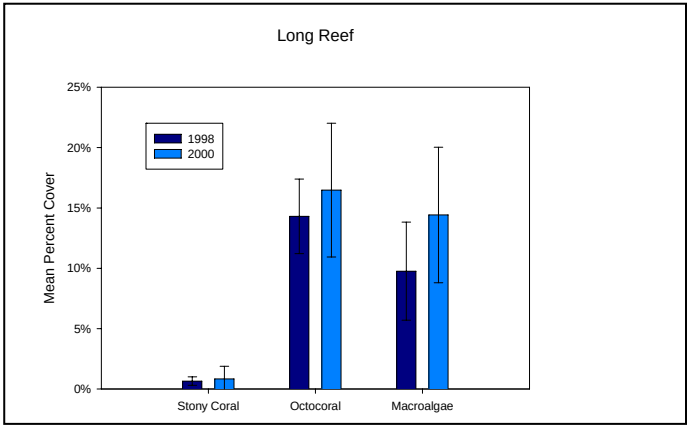


Figure 23. Mean percent cover for macroalgae, stony coral, and octocoral in 1998 and 2000 for Long Reef.

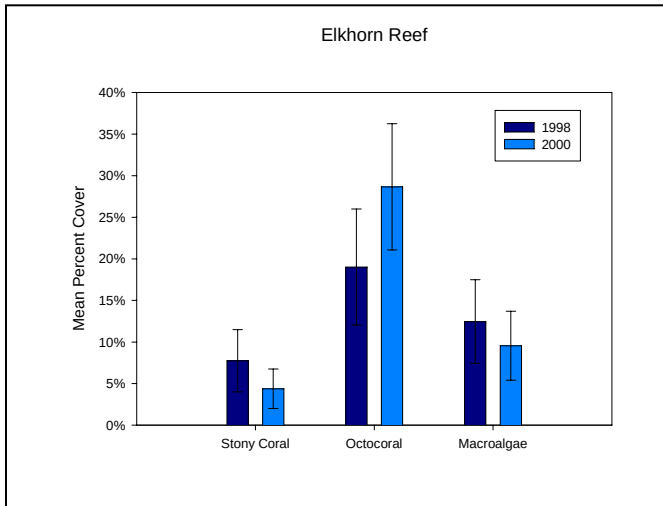


Figure 24. Mean percent cover for macroalgae, stony coral, and octocoral in 1998 and 2000 for Elkhorn Reef.

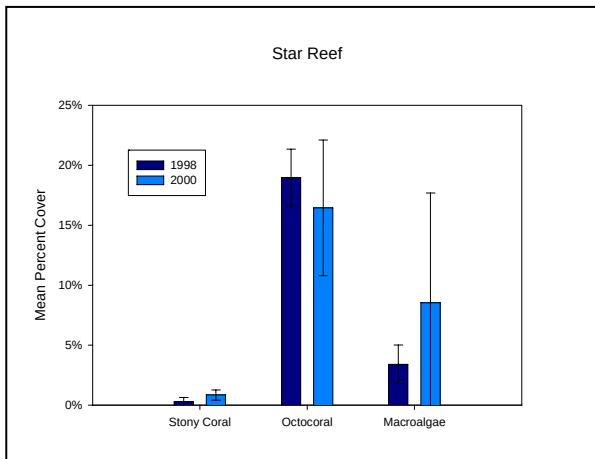


Figure 25. Mean percent cover for macroalgae, stony coral, and octocoral in 1998 and 2000 for Star Reef.

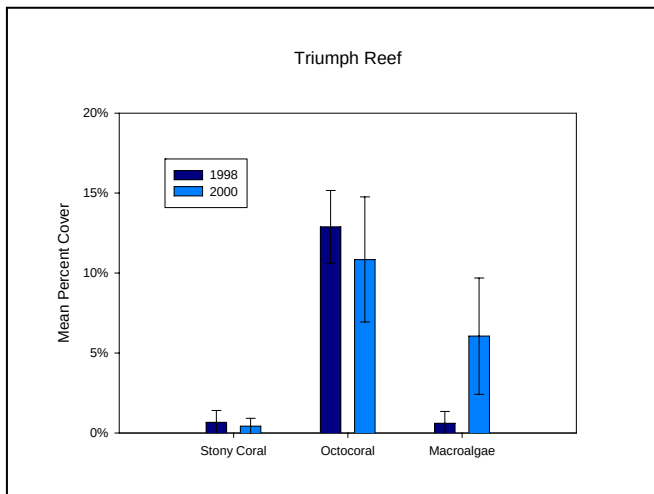


Figure 26. Mean percent cover for macroalgae, stony coral, and octocoral in 1998 and 2000 for Triumph Reef.

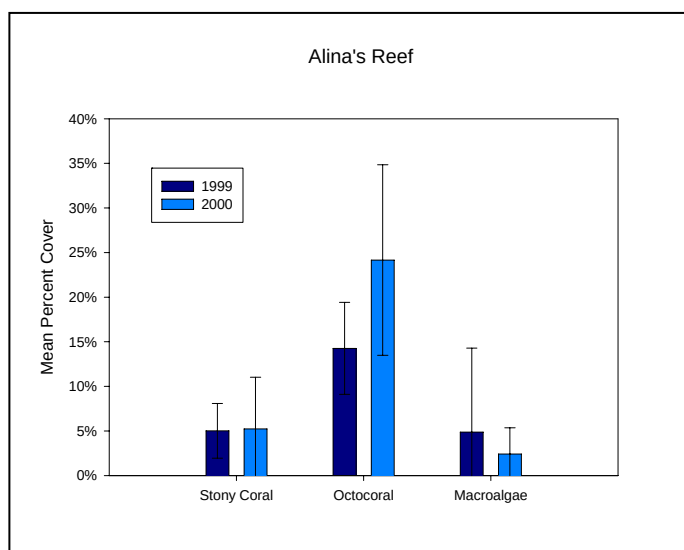


Figure 27. Mean percent cover for macroalgae, stony coral, and octocoral in 1998 and 2000 for Alina's Reef.

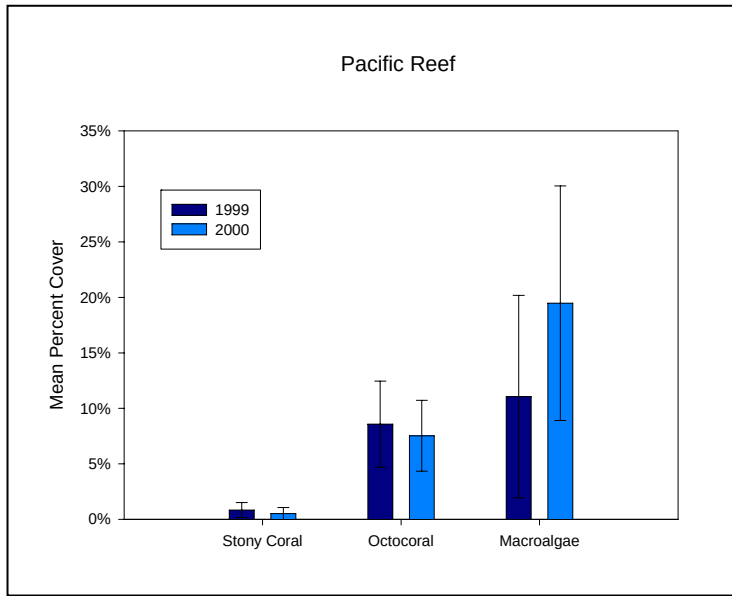


Figure 28. Mean percent cover for macroalgae, stony coral, and octocoral in 1998 and 2000 for Pacific Reef.

The data from 2000 were also broken down by reef type. Mean percent cover of stony coral by reef type is presented in Figure 29. It is interesting to note that the bank reefs all had lower stony coral cover than the patch reefs and transitional reefs. Mean percent cover of macroalgae (Fig. 30) and octocorals (Fig. 31) is also broken down by reef type. There doesn't appear to be any pattern of macroalgae cover by reef type. However, the octocoral cover shows a similar pattern by reef type as the stony coral cover. The bank reefs all had lower octocoral cover than the transitional and patch reefs.

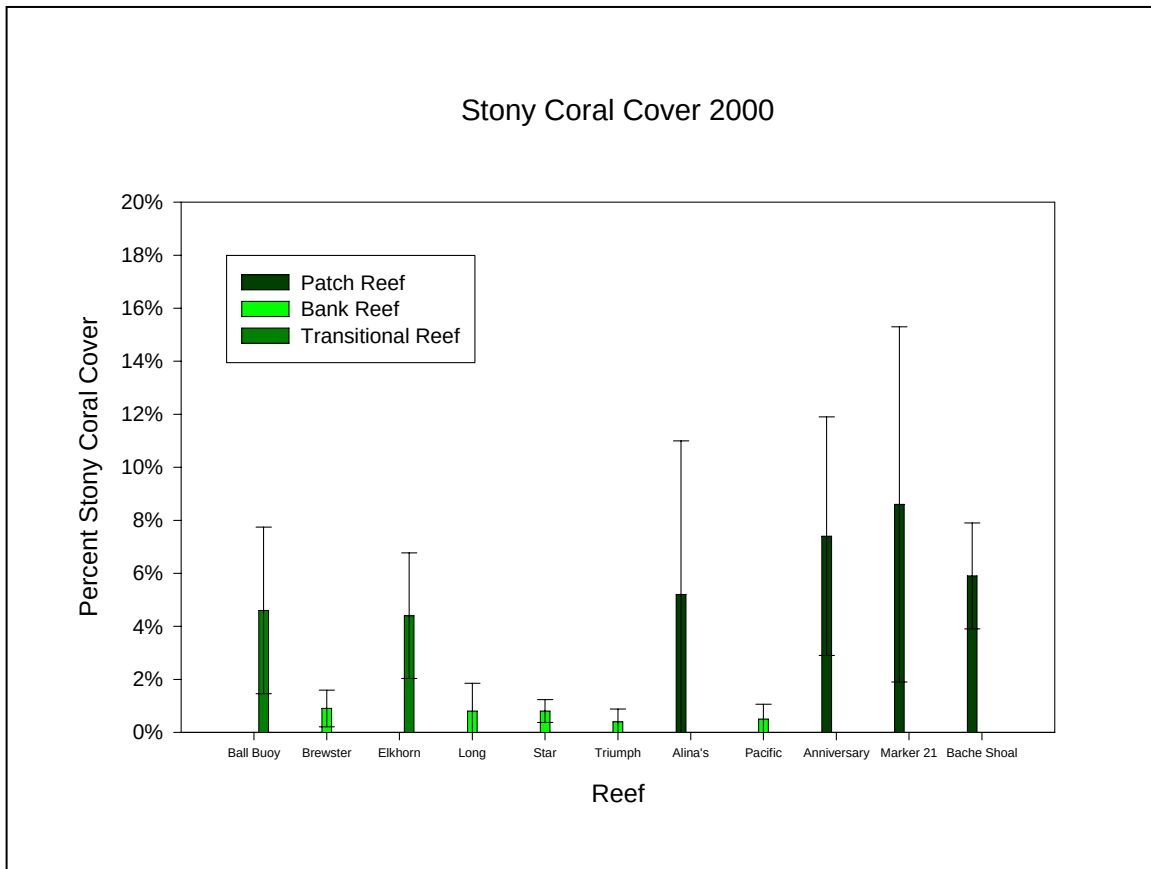


Figure 29. Mean percent cover of stony coral for different reef types.

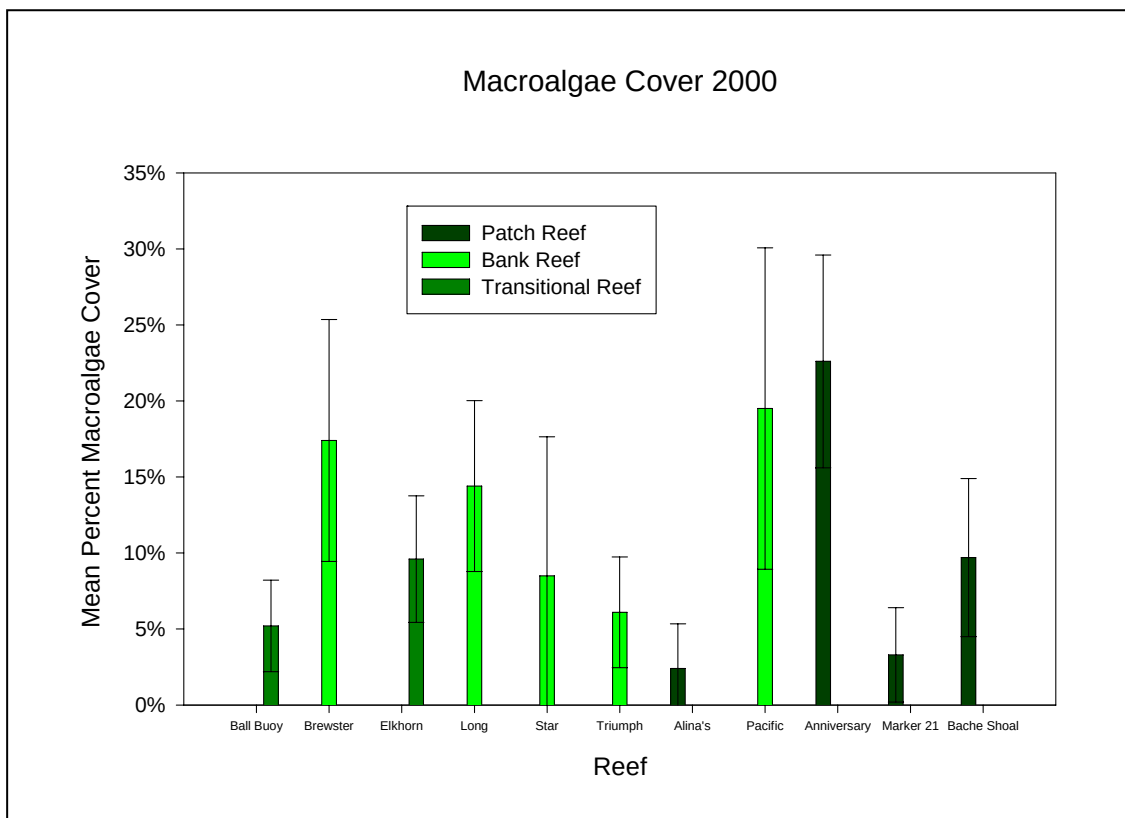


Figure 30. Mean percent cover of macroalgae for different reef types.

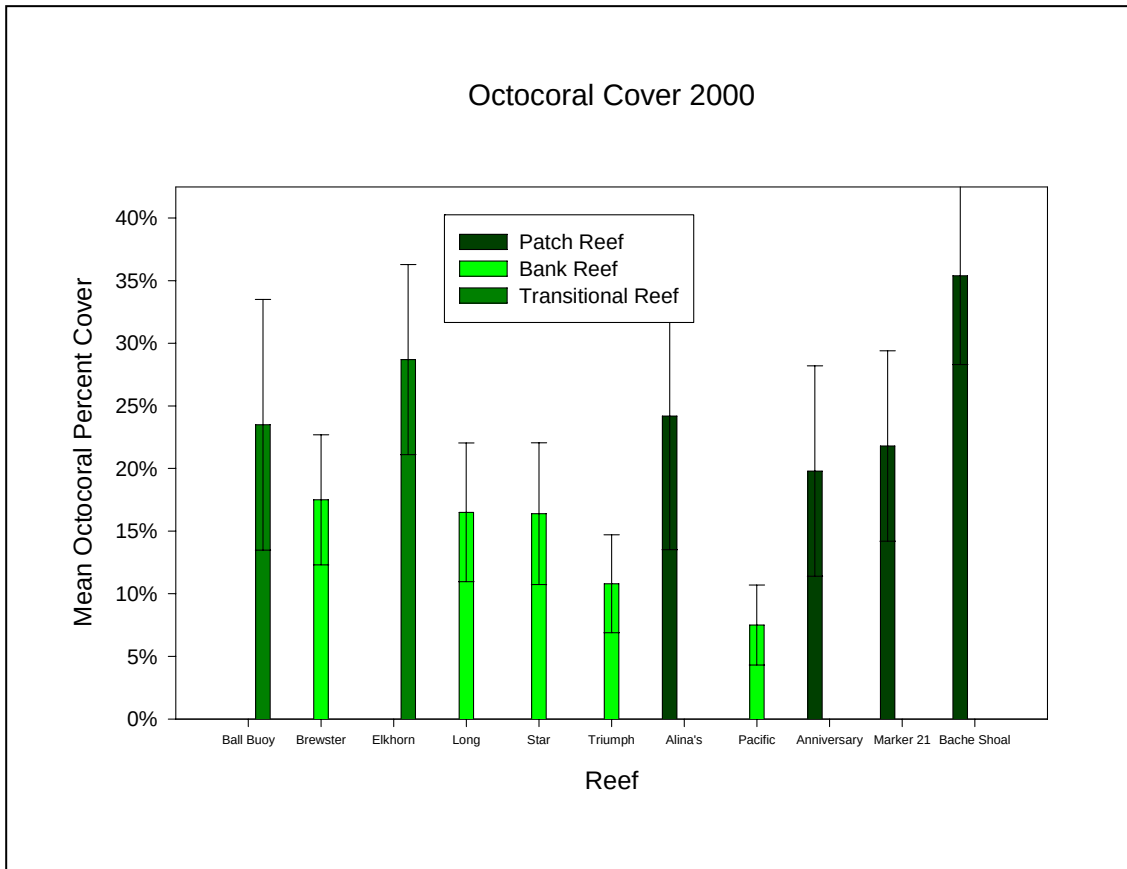


Figure 31. Mean percent cover of octocoral for different reef types.

DISCUSSION

Haphazard transects are a good method to use when trying to characterize a reef. However, haphazard surveys do not have the same power of detection as permanent monitoring stations. Therefore, no inference about changes in cover should be made from these data. If detecting changes in cover is the goal, survey methods powerful enough to detect these changes must be employed. A combination of random and permanent transects will allow both for accurate reef characterization by being able to generalize to the whole reef and also being able to detect change. It is recommended that future monitoring projects should utilize both these methods. It is also recommended that in situ surveys be used in combination with video monitoring since small, rare, and cryptic species are often undetectable from the video.

An interesting trend seen from this study is the greater cover of both stony coral and octocoral on patch reefs and transitional reefs than on bank reefs. This information can be useful for many management decisions. If the park ever decides to give special protection to certain reef sites by limiting activities, coral cover and diversity should be given attention. Areas with high cover and diversity may be good candidates for protection. In addition, reefs with low cover and diversity may also be good candidates for protection since these areas are more likely to be devastated by harmful activities.

Good baseline data are also essential for determining the impact of harmful events, both natural and human-induced. Damage to reefs can come in many forms including storms, anchor damage, ship groundings, disease, as well as many others. To accurately assess the effects that these occurrences have on reefs, good pre-disturbance data are crucial. Although this monitoring project is ending, at the very least, a good general survey of the reefs should be undertaken no less than once every few years so that decision makers have accurate, up-to-date information on one of the most important resources in Biscayne National Park.

Appendix A. Species by Site

Biscayne National Park Inventory and Monitoring Program Alina's Reef, Stony Coral and other taxa; Presence/Absence, 2000

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Acropora cervicornis</i>		1	1	1					1	1	1
<i>Agaricia agaricites</i> complex		1	1	1	1	1	1	1	1		
<i>Agaricia fragilis</i>								1			
<i>Colpophyllia natans</i>								1			1
<i>Dichocoenia stokesii</i>		1	1	1	1	1	1	1	1	1	1
<i>Diploria clivosa</i>				1					1	1	
<i>Diploria labyrinthiformis</i>			1	1			1				1
<i>Diploria strigosa</i>		1		1					1	1	1
<i>Eusmilia fastigiata</i>		1	1			1		1			
<i>Favia fragum</i>		1									
<i>Leptoseris cucullata</i>								1			
<i>Meandrina meandrites</i>				1	1	1					
<i>Millepora alcicornis</i>		1	1	1	1		1	1		1	1
<i>Montastraea annularis</i> complex		1	1		1	1	1	1	1		1
<i>Montastraea cavernosa</i>		1	1	1	1	1	1		1	1	1
<i>Mussa angulosa</i>								1			
<i>Mycetophyllia ferox</i>								1			
<i>Porites astreoides</i>		1	1	1	1	1	1	1	1	1	1
<i>Porites porites</i>		1	1	1	1	1	1	1	1	1	1
<i>Siderastrea radians</i>		1		1	1	1	1	1	1		1
<i>Siderastrea siderea</i>		1	1	1	1	1	1	1	1	1	1
<i>Solenastrea bournoni</i>			1			1					
<i>Stephanocoenia michelinii</i>		1				1		1			1

**Biscayne National Park Inventory and Monitoring Program
Anniversary Reef, Stony Coral and other taxa; Presence/Absence, 2000**

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Acropora cervicornis</i>							1				1
<i>Agaricia agaricites</i> complex					1	1	1	1	1		
<i>Dichocoenia stokesii</i>		1	1		1	1	1	1	1	1	1
<i>Diploria clivosa</i>		1	1	1				1		1	1
<i>Diploria labyrinthiformis</i>					1	1			1		
<i>Diploria strigosa</i>		1	1	1	1	1				1	1
<i>Millepora alcicornis</i>		1	1	1	1	1	1	1	1	1	1
<i>Montastraea annularis</i> complex		1	1							1	1
<i>Montastraea cavernosa</i>		1			1	1	1	1	1		
<i>Porites astreoides</i>		1	1	1	1	1	1	1	1	1	1
<i>Porites porites</i>		1	1	1	1	1	1	1	1	1	1
<i>Siderastrea radians</i>		1	1	1	1	1	1	1	1	1	1
<i>Siderastrea siderea</i>		1	1	1	1	1	1		1		
<i>Stephanocoenia michelinii</i>						1					

Biscayne National Park Inventory and Monitoring Program
Bache Shoal, Stony Coral and other taxa; Presence/Absence, 2000

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Agaricia agaricites</i> complex		1	1	1	1				1	1	
<i>Colpophyllia natans</i>			1				1	1	1	1	1
<i>Dichocoenia stokesii</i>		1	1	1	1	1	1				1
<i>Diploria clivosa</i>		1	1		1	1	1		1	1	1
<i>Diploria labyrinthiformis</i>		1	1	1	1	1		1	1	1	1
<i>Diploria strigosa</i>		1	1	1	1	1	1		1	1	1
<i>Eusmilia fastigiata</i>			1								
<i>Favia fragum</i>		1	1	1		1	1	1			
<i>Meandrina meandrites</i>		1				1			1	1	
<i>Millepora alcicornis</i>		1	1	1	1	1	1	1	1	1	1
<i>Montastraea annularis</i> complex		1	1	1	1	1	1	1	1	1	1
<i>Montastraea cavernosa</i>		1	1	1	1	1		1	1	1	
<i>Porites astreoides</i>		1	1	1	1	1	1			1	1
<i>Porites porites</i>		1	1	1	1	1	1	1	1	1	1
<i>Siderastrea radians</i>		1	1		1	1			1		
<i>Siderastrea siderea</i>		1	1	1	1	1	1	1	1	1	1

Biscayne National Park Inventory and Monitoring Program
Ball Buoy Reef, Stony Coral and other taxa; Presence/Absence, 2000

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Acropora palmata</i>		1							1	1	1
<i>Agaricia agaricites</i> complex		1		1	1	1	1	1	1	1	1
<i>Agaricia fragilis</i>		1	1	1		1		1			
<i>Colpophyllia natans</i>			1		1		1	1			
<i>Diadema antillarum</i>											1
<i>Dichocoenia stokesii</i>		1		1	1	1	1	1		1	1
<i>Diploria clivosa</i>									1		
<i>Diploria labyrinthiformis</i>			1		1	1		1		1	
<i>Diploria strigosa</i>			1	1			1		1		1
<i>Eusmilia fastigiata</i>					1						
<i>Leptoseris cucullata</i>			1								
<i>Meandrina meandrites</i>		1		1	1		1	1	1	1	
<i>Millepora alcicornis</i>		1	1	1	1	1	1	1	1	1	1
<i>Millepora complanata</i>			1		1	1	1	1	1	1	1
<i>Montastraea annularis</i> complex		1	1	1		1	1	1	1	1	1
<i>Montastraea cavernosa</i>		1	1	1	1	1	1	1	1	1	1
<i>Mycetophyllia aliciae</i>				1							
<i>Mycetophyllia danaana</i>			1			1		1			1
<i>Oculina diffusa</i>			1								
<i>Porites astreoides</i>		1	1	1	1				1	1	1
<i>Porites porites</i>		1	1	1	1	1	1	1	1	1	1
<i>Siderastrea radians</i>			1	1	1			1	1		
<i>Siderastrea siderea</i>		1	1	1	1	1	1	1	1	1	1
<i>Stephanocoenia michelinii</i>			1								

Biscayne National Park Inventory and Monitoring Program
Brewster Reef, Stony Coral and other taxa; Presence/Absence, 2000

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Agaricia agaricites</i> complex		1		1	1	1	1	1	1	1	1
<i>Agaricia fragilis</i>		1			1	1					1
<i>Colpophyllia natans</i>		1					1				
<i>Dichocoenia stokesii</i>		1	1	1	1	1	1	1	1	1	1
<i>Diploria labyrinthiformis</i>				1	1	1	1	1	1	1	1
<i>Diploria strigosa</i>			1				1	1	1		1
<i>Eusmilia fastigiata</i>		1								1	
<i>Leptoseris cucullata</i>				1							
<i>Madracis decactis</i>									1		1
<i>Meandrina meandrites</i>		1	1	1		1	1	1	1	1	1
<i>Millepora alcicornis</i>		1	1	1	1	1	1	1	1	1	1
<i>Millepora complanata</i>		1					1	1			
<i>Montastraea annularis</i> complex		1	1	1	1	1	1	1		1	1
<i>Montastraea cavernosa</i>			1	1	1		1			1	1
<i>Porites astreoides</i>			1	1	1	1	1			1	1
<i>Porites porites</i>		1	1	1		1		1	1	1	1
<i>Scolymia lacera</i>					1						
<i>Siderastrea radians</i>		1	1	1					1		1
<i>Siderastrea siderea</i>		1	1	1	1	1	1	1	1	1	1
<i>Solenastrea bournoni</i>				1	1		1		1	1	1
<i>Stephanocoenia michelinii</i>		1				1		1	1	1	1

Biscayne National Park Inventory and Monitoring Program
Elkhorn Reef, Stony Coral and other taxa; Presence/Absence, 2000

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Agaricia agaricites</i> complex		1	1	1	1	1	1	1	1	1	1
<i>Agaricia fragilis</i>				1							
<i>Colpophyllia natans</i>			1			1	1	1	1		
<i>Diadema antillarum</i>		1						1			
<i>Dichocoenia stokesii</i>		1	1	1		1	1	1	1	1	1
<i>Diploria clivosa</i>							1	1			
<i>Diploria labyrinthiformis</i>		1			1			1		1	
<i>Diploria strigosa</i>							1		1		1
<i>Eusmilia fastigiata</i>							1				
<i>Meandrina meandrites</i>						1		1			
<i>Millepora alcicornis</i>		1	1	1	1	1	1	1	1	1	1
<i>Millepora complanata</i>		1	1			1	1				
<i>Montastraea annularis</i> complex			1				1	1	1		
<i>Montastraea cavernosa</i>		1	1	1	1	1		1	1		
<i>Porites astreoides</i>			1	1	1	1	1	1	1	1	1
<i>Porites porites</i>		1	1	1	1	1	1	1	1	1	1
<i>Siderastrea radians</i>		1		1			1		1	1	1
<i>Siderastrea siderea</i>		1	1	1	1	1	1	1	1	1	1

Biscayne National Park Inventory and Monitoring Program
Long Reef, Stony Coral and other taxa; Presence/Absence, 2000

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Acropora cervicornis</i>					1						
<i>Agaricia agaricites complex</i>		1	1	1	1	1	1	1	1	1	1
<i>Agaricia fragilis</i>					1						1
<i>Colpophyllia natans</i>			1			1		1			
<i>Diadema antillarum</i>											1
<i>Dichocoenia stokesii</i>		1	1	1	1	1	1	1	1	1	
<i>Diploria clivosa</i>				1	1	1					
<i>Diploria strigosa</i>			1		1	1	1		1		
<i>Eusmilia fastigiata</i>		1								1	1
<i>Favia fragum</i>				1						1	
<i>Leptoseris cucullata</i>		1									
<i>Meandrina meandrites</i>			1		1		1	1	1	1	1
<i>Millepora alcicornis</i>		1	1	1	1	1	1	1	1	1	1
<i>Millepora complanata</i>		1	1		1	1	1	1			
<i>Montastraea annularis complex</i>			1		1					1	1
<i>Montastraea cavernosa</i>		1	1	1			1	1	1	1	1
<i>Porites astreoides</i>			1		1	1	1	1	1		1
<i>Porites porites</i>		1	1	1		1	1	1	1	1	1
<i>Siderastrea radians</i>			1	1	1	1		1	1	1	1
<i>Siderastrea siderea</i>		1	1	1	1	1	1	1	1	1	1
<i>Solenastrea bournoni</i>			1								1
<i>Stephanocoenia michelinii</i>		1				1					1

Biscayne National Park Inventory and Monitoring Program
Marker "21", Stony Coral and other taxa; Presence/Absence, 2000

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Acropora cervicornis</i>				1	1						
<i>Agaricia agaricites</i> complex			1	1	1	1	1		1		1
<i>Colpophyllia natans</i>									1		
<i>Dichocoenia stokesii</i>				1	1	1	1	1	1	1	
<i>Diploria clivosa</i>		1			1				1	1	1
<i>Diploria labyrinthiformis</i>				1						1	
<i>Diploria strigosa</i>				1	1			1	1	1	1
<i>Millepora alcicornis</i>		1	1	1	1	1	1	1	1	1	1
<i>Montastraea annularis</i> complex		1	1	1	1	1	1				
<i>Montastraea cavernosa</i>				1	1		1	1			1
<i>Porites astreoides</i>		1	1	1	1	1	1	1	1	1	1
<i>Porites porites</i>		1		1	1	1	1	1	1	1	1
<i>Siderastrea radians</i>				1	1	1	1	1	1	1	1
<i>Siderastrea siderea</i>		1	1	1	1	1	1	1	1	1	1
<i>Solenastrea bournoni</i>						1					

Biscayne National Park Inventory and Monitoring Program
Pacific Reef, Stony Coral and other taxa; Presence/Absence, 2000

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Agaricia agaricites</i> complex		1	1	1	1	1	1	1	1	1	1
<i>Dichocoenia stokesii</i>		1	1	1	1	1	1	1	1	1	1
<i>Diploria labyrinthiformis</i>		1	1			1	1	1			1
<i>Eusmilia fastigiata</i>					1	1			1	1	
<i>Favia fragum</i>					1	1					1
<i>Madracis decactis</i>		1	1			1	1			1	
<i>Meandrina meandrites</i>		1		1	1	1		1	1		1
<i>Millepora alcicornis</i>		1	1	1	1	1	1	1	1	1	1
<i>Montastraea annularis</i> complex			1				1				
<i>Montastraea cavernosa</i>			1		1		1				
<i>Porites astreoides</i>		1	1	1	1	1	1	1	1	1	
<i>Porites porites</i>		1	1	1	1	1	1	1	1	1	1
<i>Siderastrea radians</i>		1	1	1	1	1	1	1	1	1	1
<i>Siderastrea siderea</i>		1		1	1	1	1	1	1	1	1
<i>Solenastrea bournoni</i>		1	1			1					
<i>Stephanocoenia michelinii</i>			1	1	1		1	1		1	

**Biscayne National Park Inventory and Monitoring Program
Star Reef, Stony Coral and other taxa; Presence/Absence, 2000**

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Agaricia agaricites</i> complex		1	1	1	1	1	1	1	1	1	1
<i>Agaricia fragilis</i>									1		1
<i>Colpophyllia natans</i>					1						
<i>Dichocoenia stokesii</i>		1	1	1	1	1	1	1	1	1	1
<i>Diploria labyrinthiformis</i>			1		1	1	1			1	
<i>Eusmilia fastigiata</i>									1	1	1
<i>Favia fragum</i>							1		1		
<i>Leptoseris cucullata</i>									1		
<i>Madracis decactis</i>									1		1
<i>Meandrina meandrites</i>		1		1	1	1	1	1	1		1
<i>Millepora alcicornis</i>		1	1	1	1	1		1	1	1	1
<i>Montastraea annularis</i> complex			1				1	1	1	1	1
<i>Montastraea cavernosa</i>			1			1			1		1
<i>Mycetophyllia aliciae</i>									1		
<i>Porites astreoides</i>				1		1			1	1	1
<i>Porites porites</i>		1	1	1	1	1	1	1		1	1
<i>Scolymia lacera</i>									1		
<i>Siderastrea radians</i>		1		1	1		1	1			
<i>Siderastrea siderea</i>		1	1			1	1	1	1	1	1
<i>Solenastrea bournoni</i>				1	1			1			
<i>Stephanocoenia michelinii</i>							1		1	1	1

**Biscayne National Park Inventory and Monitoring Program
Triumph Reef, Stony Coral and other taxa; Presence/Absence, 2000**

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Acropora cervicornis</i>							1				
<i>Agaricia agaricites</i> complex		1	1	1	1	1	1	1	1	1	1
<i>Agaricia fragilis</i>		1	1				1				1
<i>Colpophyllia natans</i>			1		1				1		
<i>Dichocoenia stokesii</i>			1	1				1	1	1	1
<i>Diploria labyrinthiformis</i>						1					
<i>Diploria strigosa</i>			1				1				
<i>Favia fragum</i>		1									
<i>Meandrina meandrites</i>			1								
<i>Millepora alcicornis</i>		1	1	1	1	1	1	1	1	1	1
<i>Millepora complanata</i>					1					1	
<i>Montastraea annularis</i> complex				1		1				1	
<i>Montastraea cavernosa</i>		1				1		1			
<i>Porites astreoides</i>					1			1	1	1	
<i>Porites porites</i>		1	1	1				1	1	1	1
<i>Siderastrea radians</i>									1	1	1
<i>Siderastrea siderea</i>		1	1	1	1	1	1	1	1	1	1
<i>Stephanocoenia michelinii</i>			1					1			1

Appendix B. Mean Percent Cover of Stony Coral Species, Millepora Species, and Benthic Groups by Site and Year

Year	1998	1998	1998	1998	1998	1998	1999
Site	Ball Bouy Reef	Brewster Reef	Elkhorn Reef	Long Reef	Star Reef	Triumph Reef	Alina's Reef
Transects	10	17	10	10	9	10	10
Acropora cervicornis	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Acropora palmata	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Agaricia agaricites complex	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Colpophyllia natans	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.1%
Dichocoenia stokesii	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Diploria clivosa	0.2%	0.1%	0.1%	0.1%	0.0%	0.1%	0.1%
Diploria labyrinthiformis	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%
Diploria strigosa	0.3%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%
Macroalgae	1.2%	6.1%	12.5%	9.8%	3.4%	0.6%	4.9%
Meandrina meandrites	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Millepora alcicornis	0.2%	0.4%	0.2%	0.1%	0.0%	0.0%	0.2%
Millepora complanata	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Montastraea annularis complex	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%
Montastraea cavernosa	0.0%	0.1%	0.1%	0.1%	0.0%	0.0%	0.2%
Octocorallia	23.2%	11.7%	19.0%	14.3%	19.0%	12.9%	14.3%
Porifera	0.4%	0.7%	0.9%	0.5%	1.2%	0.7%	0.8%
Porites astreoides	3.1%	0.1%	2.9%	0.0%	0.1%	0.1%	1.2%
Porites porites	0.6%	0.0%	2.7%	0.0%	0.0%	0.1%	0.3%
Scleractinia	0.1%	0.2%	0.2%	0.1%	0.1%	0.0%	0.1%
Seagrass	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Siderastrea radians	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Siderastrea siderea	0.4%	0.1%	1.0%	0.1%	0.0%	0.1%	1.8%
Solenastrea bournoni	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Substrate	69.6%	79.1%	59.7%	74.3%	75.0%	84.5%	74.7%
Zoanthidea	0.5%	1.0%	0.2%	0.5%	1.1%	0.6%	0.4%

Year	1999	2000	2000	2000	2000	2000	2000
Site	Pacific Reef	Alina's Reef	Anniversary Reef	Bache Shoal	Ball Bouy Reef	Brewster Reef	Elkhorn Reef
Transects	10	10	11	10	10	10	10
Acropora cervicornis	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Acropora palmata	0.0%	0.0%	0.0%	0.0%	0.9%	0.0%	0.0%
Agaricia agaricites complex	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Colpophyllia natans	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%
Dichocoenia stokesii	0.0%	0.1%	0.0%	0.1%	0.0%	0.1%	0.0%
Diploria clivosa	0.0%	0.0%	0.6%	0.2%	0.0%	0.0%	0.0%
Diploria labyrinthiformis	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Diploria strigosa	0.1%	0.0%	0.5%	0.1%	0.3%	0.1%	0.1%
Macroalgae	11.1%	2.4%	22.6%	9.7%	5.2%	17.4%	9.6%
Meandrina meandrites	0.0%	0.1%	0.0%	0.1%	0.1%	0.0%	0.0%
Millepora alcicornis	0.1%	0.3%	0.4%	0.1%	0.7%	0.3%	0.4%
Millepora complanata	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
Montastraea annularis complex	0.0%	2.7%	0.0%	0.8%	0.7%	0.1%	0.2%
Montastraea cavernosa	0.0%	0.0%	0.1%	0.0%	0.6%	0.0%	0.2%
Octocorallia	8.6%	24.2%	19.8%	35.4%	23.5%	17.5%	28.7%
Porifera	0.7%	1.2%	1.2%	1.0%	0.8%	0.7%	1.9%
Porites astreoides	0.2%	0.6%	2.4%	2.0%	0.4%	0.0%	1.1%
Porites porites	0.1%	0.3%	1.3%	0.6%	0.1%	0.0%	1.4%
Scleractinia	0.0%	0.1%	0.1%	0.3%	0.1%	0.1%	0.1%
Seagrass	0.0%	0.0%	2.8%	0.6%	0.0%	0.0%	0.1%
Siderastrea radians	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Siderastrea siderea	0.1%	1.0%	2.0%	1.6%	0.5%	0.1%	0.9%
Solenastrea bournoni	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Substrate	78.5%	66.6%	46.0%	47.0%	63.7%	61.8%	54.5%
Zoanthidea	0.3%	0.4%	0.1%	0.4%	2.2%	1.8%	0.9%

Year	2000	2000	2000	2000	2000
Site	Long Reef	Marker 21 Reef	Pacific Reef	Star Reef	Triumph Reef
Transects	10	10	10	10	10
Acropora cervicornis	0.0%	0.0%	0.0%	0.0%	0.1%
Acropora palmata	0.0%	0.0%	0.0%	0.0%	0.0%
Agaricia agaricites complex	0.0%	0.0%	0.0%	0.0%	0.0%
Colpophyllia natans	0.0%	0.0%	0.0%	0.0%	0.0%
Dichocoenia stokesii	0.0%	0.0%	0.0%	0.1%	0.0%
Diploria clivosa	0.4%	0.0%	0.0%	0.1%	0.0%
Diploria labyrinthiformis	0.0%	0.0%	0.2%	0.0%	0.0%
Diploria strigosa	0.1%	0.1%	0.0%	0.2%	0.0%
Macroalgae	14.4%	3.3%	19.5%	8.5%	6.1%
Meandrina meandrites	0.0%	0.0%	0.0%	0.0%	0.0%
Millepora alcicornis	0.2%	0.4%	0.1%	0.3%	0.1%
Millepora complanata	0.0%	0.0%	0.0%	0.0%	0.0%
Montastraea annularis complex	0.0%	4.1%	0.0%	0.0%	0.0%
Montastraea cavernosa	0.0%	0.0%	0.0%	0.0%	0.0%
Octocorallia	16.5%	21.8%	7.5%	16.4%	10.8%
Porifera	0.5%	0.4%	0.7%	1.2%	0.8%
Porites astreoides	0.1%	2.1%	0.0%	0.1%	0.1%
Porites porites	0.1%	0.7%	0.0%	0.0%	0.0%
Scleractinia	0.0%	0.1%	0.0%	0.0%	0.0%
Seagrass	0.0%	1.3%	0.0%	0.0%	0.0%
Siderastrea radians	0.0%	0.0%	0.0%	0.0%	0.0%
Siderastrea siderea	0.0%	1.1%	0.1%	0.0%	0.1%
Solenastrea bournoni	0.0%	0.0%	0.0%	0.0%	0.0%
Substrate	67.2%	64.6%	71.2%	72.3%	81.2%
Zoanthidea	0.5%	0.0%	0.5%	0.6%	0.7%

Appendix C. Mean Percent Cover and Standard Deviation of Major Benthic Groups by Site and Year

Year	1998	1998	1998	1998	1998	1998	1999
Site	Ball Bouy Reef	Brewster Reef	Elkhorn Reef	Long Reef	Star Reef	Triumph Reef	Alina's Reef
Transects	10	17	10	10	9	10	10
Total Stony Coral							
Mean Cover	5.1%	1.4%	7.7%	0.7%	0.3%	0.7%	5.0%
Standard Dev.	1.4%	0.7%	3.7%	0.4%	0.3%	0.7%	3.1%
Octocoral							
Mean Cover	23.2%	11.7%	19.0%	14.3%	19.0%	12.9%	14.3%
Standard Dev.	7.9%	4.6%	7.0%	3.1%	2.4%	2.3%	5.2%
Sponge							
Mean Cover	0.4%	0.7%	0.9%	0.5%	1.2%	0.7%	0.8%
Standard Dev.	0.4%	0.4%	0.7%	0.4%	0.7%	0.6%	0.9%
Seagrass							
Mean Cover	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Standard Dev.	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Macroalgae							
Mean Cover	1.2%	6.1%	12.5%	9.8%	3.4%	0.6%	4.9%
Standard Dev.	0.9%	7.5%	5.0%	4.1%	1.6%	0.6%	0.3%

Year	1999	2000	2000	2000	2000	2000	2000
Site	Pacific Reef	Alina's Reef	Anniversary Reef	Bache Shoal	Ball Bouy Reef	Brewster Reef	Elkhorn Reef
Transects	10	10	11	10	10	10	10
Total Stony Coral							
Mean Cover	0.8%	5.2%	7.4%	5.9%	4.6%	0.9%	4.4%
Standard Dev.	0.7%	5.8%	4.5%	2.0%	3.1%	0.7%	2.4%
Octocoral							
Mean Cover	8.6%	24.2%	19.8%	35.4%	23.5%	17.5%	28.7%
Standard Dev.	3.9%	10.7%	8.4%	7.1%	10.0%	5.2%	7.6%
Sponge							
Mean Cover	0.7%	1.2%	1.2%	1.0%	0.8%	0.7%	1.9%
Standard Dev.	0.8%	1.1%	0.3%	0.7%	0.6%	0.4%	0.5%
Seagrass							
Mean Cover	0.0%	0.0%	2.8%	0.6%	0.0%	0.0%	0.1%
Standard Dev.	0.0%	0.0%	4.2%	1.9%	0.0%	0.0%	0.4%
Macroalgae							
Mean Cover	11.1%	2.4%	22.6%	9.7%	5.2%	17.4%	9.6%
Standard Dev.	9.1%	2.9%	7.0%	5.2%	2.6%	8.0%	4.2%

Year	2000	2000	2000	2000	2000
Site	Long Reef	Marker 21 Reef	Pacific Reef	Star Reef	Triumph Reef
Transects	10	10	10	10	10
Total Stony Coral					
Mean Cover	0.8%	8.6%	0.5%	0.8%	0.4%
Standard Dev.	1.0%	6.7%	0.6%	0.4%	0.5%
Octocoral					
Mean Cover	16.5%	21.8%	7.5%	16.4%	10.8%
Standard Dev.	5.5%	7.6%	3.2%	5.7%	3.9%
Sponge					
Mean Cover	0.5%	0.4%	0.7%	1.2%	0.8%
Standard Dev.	0.3%	0.4%	0.4%	0.9%	0.7%
Seagrass					
Mean Cover	0.0%	1.3%	0.0%	0.0%	0.0%
Standard Dev.	0.0%	1.8%	0.0%	0.0%	0.0%
Macroalgae					
Mean Cover	14.4%	3.3%	19.5%	8.5%	6.1%
Standard Dev.	5.6%	3.1%	10.6%	9.1%	3.6%