

ABUNDANCE OF SHALLOW-WATER CORALS (ORDER SCLERACTINIA) IN THE SAFETY VALVE REGION OF BISCAYNE BAY, FLORIDA

Nancy A. Swope
Rosenstiel School of Marine and Atmospheric Science
Division of Marine Biology and Fisheries
4600 Rickenbacker Cswy., Miami, Florida 33149

ABSTRACT

The Safety Valve region of Biscayne Bay, Florida is an area of shallow seagrass and sand communities. Many organisms inhabit this area, among which are scleractinian corals. This region and the corals there have received little attention thus far. In this study, the abundance of corals in four areas within the Safety Valve region was examined. The number of corals ranged from 1 to 26 per square meter and averaged at 10.8 per square meter, up to 96% of which were Porites divaricata Lesueur.

INTRODUCTION

To some, the mention of scleractinian corals will bring to mind thoughts of grand reefs in the Pacific and Caribbean teeming with a diversity of life. Few though, would think of seagrass flats as important communities for corals, yet many species can be found there. The shallow seagrass beds of Biscayne Bay in Florida are a good example.

Biscayne Bay, located south of downtown Miami, is an oval body of water approximately 45 kilometers in length, 15 kilometers in width, and 4.5 meters in depth at its maximums. The bay is bordered to the west by the Florida mainland and to the east by a chain of islands,

lying upon the Key Largo limestone ridge (Hoffmeister 1974, Wanless 1976), most of which are the northernmost islands of the Florida Keys. The bay is mostly enclosed except for a few passages, the largest of which is an area between Key Biscayne and Soldier Key called the Safety Valve as seen in Figure 1.

The Safety Valve is located on the bay side of an area where the Key Largo limestone ridge is submerged a few meters (Wanless 1976). Sediments have accumulated to form a band of parallel east-west oriented shallow bars, each separated by deeper channels about 100 meters in width (Wanless 1976). The bars are composed of calcareous muds and sands, the majority of which are plates from the calcareous green alga Halimeda (Wanless 1976). A cross-section of the Safety Valve region and the relationship between the muds and sands can be seen in Figure 2. The thickness of the sediments throughout Biscayne Bay varies from none in parts (Voss et al. 1969) to its thickest, approximately seven meters, in the Safety Valve (Wanless 1976). The sediment thickness, among other factors, influences the type of community that inhabits the bottom (Voss et al. 1969). Seagrass communities favor thicker sediments and tend to dominate much of the Biscayne Bay bottom (Voss et al. 1969), including the bars of the Safety Valve (Wanless 1976).

Seagrass communities are complex webs of many infaunal and epifaunal populations. The typical seagrasses of Biscayne Bay are turtle grass (Thalassia testudinum Koenig), manatee grass (Syringodium filiforme Kutzing), and shoal grass (Halodule wrightii Ascherson). The extensive rhizome network of the grasses plays an important role in stabilizing the sediments of the bay (Wanless 1976). More details

on the grasses can be found in Thorhaug (1976). Other organisms that inhabit the seagrass communities are algae, especially calcareous green algae such as Penicillus spp. and Halimeda spp. (see Humm 1976), sponges, corals, polychaetes, bryozoans, gastropods, bivalves, cephalopods, crustaceans, and echinoderms (Voss et al. 1969).

A moderate amount of work has been done to study the abundance and distribution of organisms in Biscayne Bay. McNulty, Work, and Moore (1962) surveyed the infauna of the bay, but only in non-grass areas. O'Gower & Wacasy (1967) limited their work to the infauna of Virginia Key and Key Biscayne. Moore et al. (1968) worked only on the tidal flats of Virginia Key. Voss et al. (1969) produced species lists for taxa from alga to fish for the entire area of Biscayne National Monument which, at the time, was only proposed and did not include the Safety Valve region. Unfortunately, their work was only qualitative and not quantitative. Detailed studies have been done on southern Biscayne Bay and Card Sound by Bader (1969), Bader and Roessler (1971, 1972), and Iversen and Roessler (1973) due to the specific interest of Florida Power and Light Co. and their Turkey Point nuclear power plant. More recent studies, such as McLaughlin, Treat, and Thorhaug (1983), deal predominantly with the replanting of seagrasses and restoration of their communities due to damage from thermal discharges from the same power plant. Very little to no work has been done in the Safety Valve region or on the corals of Biscayne Bay. This study, conducted on September 29, 1990 by Dr. Peter Glynn and his Tropical Marine Ecology class, looked at the abundance of corals in the seagrass communities of the Safety Valve.

METHODS AND MATERIALS

The primary study site was located in the northern portion of the Safety Valve, near the center of one of the bars just south of the "Stiltsville" area south of Key Biscayne and just east of Marker 1. The depth of the area was approximately one meter near low tide. Two 70 meter transect lines were aligned, one north-south and the other east-west, in a cross such that each of the four arms was 35 meters in length. On each transect arm, a team of two students was equipped with a 1 m X 1 m square hollow PVC quadrat with holes or openings so that water could fill and keep the quadrat flat on the bottom. Thirteen stations were chosen by computer-generated random numbers. Stations were the same distances from the center for each of the four arms. The quadrats were placed at each station and the number of colonies of each species found were counted. The definition of a colony, for counting purposes, was any individual unattached to others. When all 52 stations had been counted, the four teams of students each surveyed station #13 on each arm to determine the consistency of their surveys.

At three other sites, each progressively farther north such that the last site was in the "Stiltsville" area, surveys were done for a comparison with our primary site. At each, the quadrat was arbitrarily thrown, submerged, and the corals within counted. At the first of the three sites, seven quadrats were sampled. At each of the other two sites, four quadrats were surveyed.

RESULTS

The results of the quadrats for each of the transect arms can be seen in Tables 1 and 2. The cumulative results of species frequencies are in Table 3. The coral species found in the primary survey, in order of their abundance (mean number of individuals, range (min.-max.) per square meter), were Porites divericata Lesueur (10.38, 1-25, N=540), Cladocora arbuscula Lesueur (0.25, 0-3, N=13), Porites furcata Lammarck (0.06, 0-1, N=3), Siderastrea radians Pallas (0.06, 0-1, N=3), Manicina areolata Linnaeus (0.04, 0-1, N=2), Favia fragum Esper (0.02, 0-1, N=1), and Isophyllia spp. (0.02, 0-1, N=1). Oculina spp. was also seen in the area, but was not found in any of the quadrats. In the consistency test, shown in Table 4, a Chi-square goodness-of-fit test was performed. The only significant differences in group counting were found in the north arm for Porites divericata and Porites furcata ($0.025 < P < 0.01$ and $0.05 < P < 0.025$, respectively).

The results of the arbitrary sampling at the other three sites is shown in Table 5. A few species; Porites furcata, Favia fragum, and Isophyllia spp.; were not seen at these other sites and one species, Solenastrea spp., was only seen at the third ("Yellow house") site. When the data from the three sites is combined, the species abundance is smaller than that from the primary site for Porites divaricata (5.53, 0-13, N=83), but greater for the other corals.

Porites divaricata was the dominant species as it constituted 96% of the primary site species and 84% of the species at other sites. The dominance of this species can also be seen in the primary site's lack of diversity ($D = 0.08$, Simpson's Diversity, $N = 563$). Cladocora

arbuscula, the second in abundance, constituted 2% and 11%, respectively.

The results of this study show that corals on the Safety Valve can vary in abundance, from 1 to 26 per square meter in any one quadrat and averaged at 10.8 corals per square meter, 10.4 of which would be of the species Porites divaricata. If one were to extrapolate these results to an area in the grassbeds in the shape of a circle with a 70 meter diameter, as in the primary study site, there would be approximately 41500 coral colonies, almost 40000 of which would be Porites divaricata.

DISCUSSION

Corals are moderately abundant in the seagrass beds of the Safety Valve. Their density can vary from place to place over the seagrass flat, as was seen in Tables 1 and 2. In the north transect arm (Table 1), for example, the numbers of corals found seemed to vary according to seagrass type and density. In quadrats N1 through N4 and N13, dense seagrass, primarily Thalassia testudinum with some Halodule wrightii, was found. In quadrats N5 through N9, the seagrass was less dense in varying degrees. The seagrass in N10 through N12 had thinned out and only Halodule wrightii in low densities remained. The abundance of corals seems to be greatest in high density seagrass and lowest in less dense areas. This was also seen in the study done at the "yellow house" site where we must have been on the edge of one of the channels between bars because most of the substrate was coarse sand and bivalve shells. Few corals were found there except in one

quadrat which I would speculate (since I did not personally sample it) to have fallen in a grass area. Seagrass density might also explain the differences in abundance between the primary study site and the other three. More studies should be done to test this correlation between coral and seagrass density.

In the consistency test, our counts varied from team to team, although only significantly at the north station. The variation could be due to deviations from the colony definition in counting or possibly due to the accidental fragmentation of colonies during the surveys, thereby making one "colony" into two. Both of these are reasonable since the most abundant species are branching types. This inconsistency should be considered when reviewing the data.

LITERATURE CITED

- Bader, R.G. 1969. An Ecological Study of South Biscayne Bay in the Vicinity of Turkey Point. (Progress Report to the US Atomic Energy Commission.) University of Miami Report UML 6322.
- Bader, R.G. and M.A. Roessler. 1971. An Ecological Study of South Biscayne Bay and Card Sound, Florida. (Progress Report to US Atomic Energy Commission and Florida Power & Light Co.) University of Miami Report ML 71066.
- Bader, R.G. and M.A. Roessler. 1972. An Ecological Study of South Biscayne Bay and Card Sound, Florida. (Progress Report to US Atomic Energy Commission and Florida Power & Light Co.) University of Miami Report UM-RSMAS 72060.
- Harlem, P.W. 1979. Aerial Photographic Interpretation of the Historical Changes in Northern Biscayne Bay, Florida: 1925 to 1976. Sea Grant Tech. Bulletin #40.
- Hoffmeister, J.E. 1974. Land from the Sea. University of Miami Press, Coral Gables, Florida.
- Humm, H.J. 1976. The benthic algae of Biscayne Bay. Pp. 71-93 in Biscayne Bay: Past/Present/Future. A. Thorhaug, ed. University of Miami Press, Coral Gables, Florida.

- Iversen, E.S. and M.A. Roessler. 1973. Survey of the Biota of Card Sound. (Report to Florida Power & Light Co.) University of Miami Report ML 69126.
- McLaughlin, P.A., S.A.F. Treat, and A. Thorhaug. 1983. A restored seagrass (Thalassia) bed and its animal community. Environmental Conservation 10(3): 247-254.
- McNulty, J.K., R.C. Work, and H.B. Moore. 1962. Level sea bottom communities in Biscayne Bay and neighboring areas. Bulletin of Marine Science 12(2): 204-233.
- Moore, H.B. et al. 1968. Some biomass figures from a tidal flat in Biscayne Bay, Florida. Bulletin of Marine Science 18(2): 261-279.
- O'Gower, A.K. and J.J. Wacasy. 1967. Animal communities associated with Thalassia, Diplanthera, and sand beds in Biscayne Bay. I. Analysis in relation to water movements. Bulletin of Marine Science 17(1): 175-210.
- Rooth, C.G.H. 1976. Circulation and exchange processes in Southeastern Florida's coastal lagoons. Pp. 51-63 in Biscayne Bay: Past/Present/Future. A. Thorhaug, ed. University of Miami Press, Coral Gables, Florida.
- Thorhaug, A. 1976. The vascular plants of Biscayne Bay. Pp. 95-103 in Biscayne Bay: Past/Present/Future. A. Thorhaug, ed. University of Miami Press, Coral Gables, Florida.
- Voss, G.L., F.M. Bayer, C.R. Robins, M. Gomon, and E.T. LaRoe. 1969. The Marine Ecology of the Biscayne National Monument. (Report to the National Park Service, Dept. of the Interior.)
- Wanless, H.R. 1976. Geologic setting and recent sediments of the Biscayne Bay region, Florida. Pp. 1-31 in Biscayne Bay: Past/Present/Future. A. Thorhaug, ed. University of Miami Press, Coral Gables, Florida.

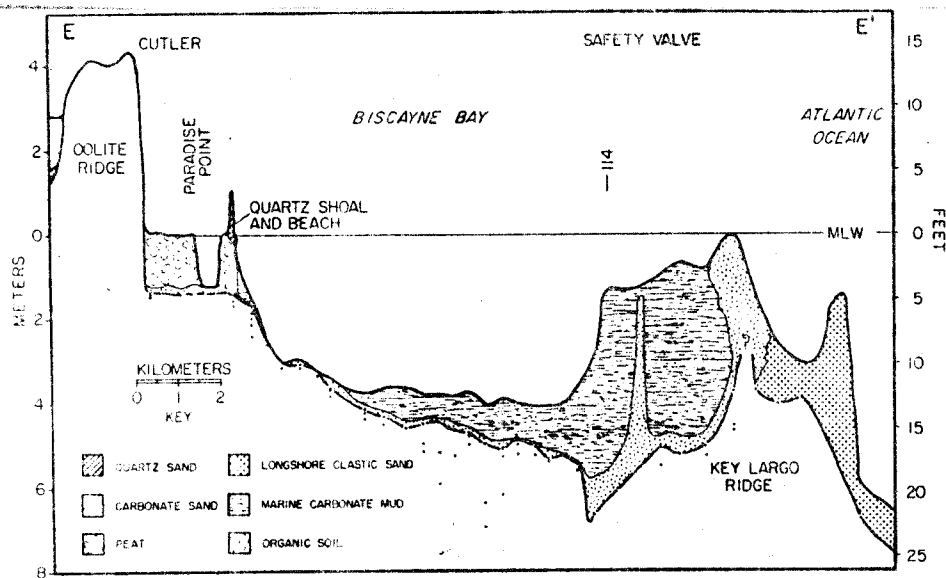
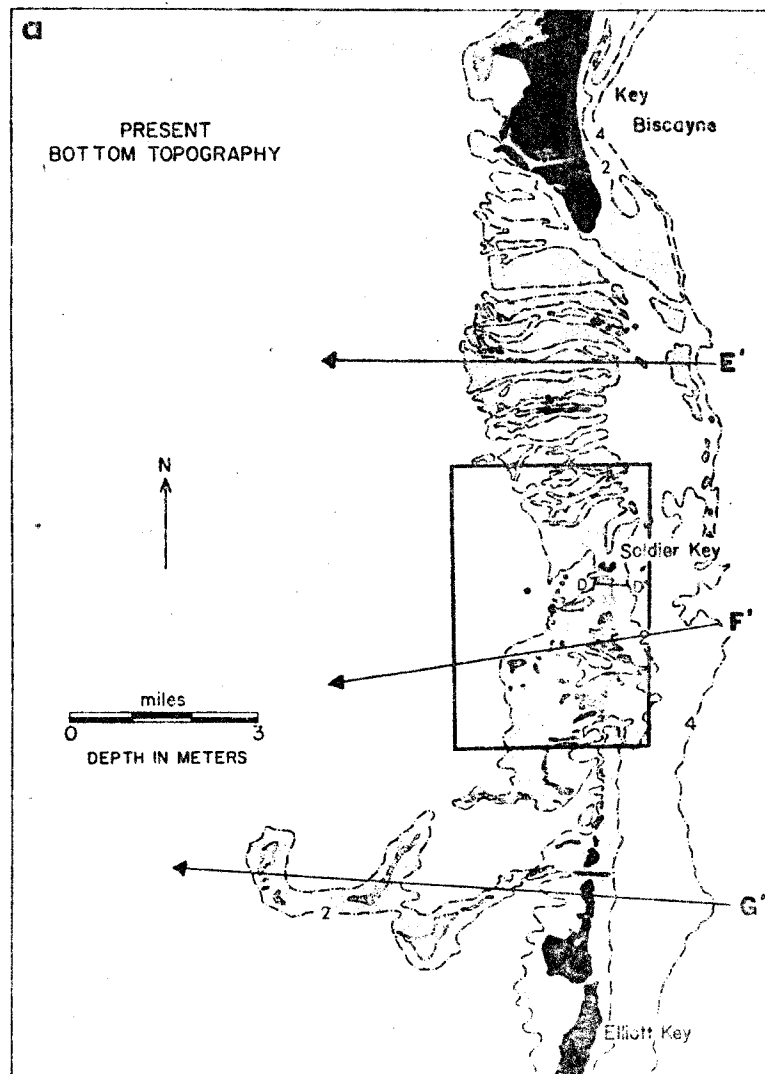


Figure 2. (top) Magnified view of the Safety Valve region and location of the cross-section. (bottom) Cross-section of Biscayne Bay through the Safety Valve. (From Wanless, H.R. 1976)

Table 1. Results of the surveys from the north and south transect arms, including the sum of the coral species frequencies, mean, and standard deviation. PD = *Porites divaricata* Lesueur, PF = *Porites furcata* Lammarck, CA = *Cladocora arbuscula* Lesueur, SR = *Siderastrea radians* Pallas, MA = *Manicina areolata* Linnaeus, FF = *Favia fragum* Esper, and I = *Isophyllia* spp.

NORTH							
QUADRAT	SPECIES FREQUENCY						
	PD	PF	CA	SR	MA	FF	I
1	12	0	0	0	0	0	0
2	11	0	0	0	0	0	0
3	13	0	0	0	0	0	0
4	9	0	0	0	0	0	0
5	7	0	1	0	0	1	0
6	4	0	0	0	0	0	0
7	6	0	3	0	0	0	0
8	9	0	0	0	1	0	0
9	8	0	0	0	0	0	0
10	1	0	0	0	0	0	0
11	3	0	0	0	0	0	0
12	2	0	0	1	0	0	0
13	13	0	3	0	0	0	0
TOTAL	98	0	7	1	1	1	0
MEAN (QUAD)	7.54	0.00	0.54	0.08	0.08	0.08	0.00
STD DEV	4.14	0.00	1.13	0.28	0.28	0.28	0.00

SOUTH							
QUADRAT	PD	PF	CA	SR	MA	FF	I
1	6	0	0	0	0	0	0
2	16	0	1	0	0	0	1
3	22	0	0	0	0	0	0
4	21	0	0	1	0	0	0
5	24	0	0	0	0	0	0
6	14	0	0	0	0	0	0
7	12	0	0	0	0	0	0
8	4	0	0	0	1	0	0
9	9	0	0	0	0	0	0
10	6	0	0	0	0	0	0
11	9	0	0	0	0	0	0
12	10	0	0	0	0	0	0
13	8	0	0	0	0	0	0
TOTAL	161	0	1	1	1	0	1
MEAN (QUAD)	12.38	0.00	0.08	0.08	0.08	0.00	0.08
STD DEV	6.56	0.00	0.28	0.28	0.28	0.00	0.28

Table 2. Results of the surveys from the east and west transect arms, including the sum of the coral species frequencies, mean, and standard deviation. PD = *Porites divaricata* Lesueur, PF = *Porites furcata* Lammarck, CA = *Cladocora arbuscula* Lesueur, SR = *Siderastrea radians* Pallas, MA = *Manicina areolata* Linnaeus, FF = *Favia fragum* Esper, and I = *Isophyllia* spp.

EAST							
QUADRAT	SPECIES FREQUENCY						
	PD	PF	CA	SR	MA	FF	I
1	16	0	2	0	0	0	0
2	16	0	0	0	0	0	0
3	18	0	0	0	0	0	0
4	5	0	0	0	0	0	0
5	12	1	0	0	0	0	0
6	13	0	1	0	0	0	0
7	3	0	0	0	0	0	0
8	5	0	0	0	0	0	0
9	9	0	0	0	0	0	0
10	6	0	0	0	0	0	0
11	5	0	0	0	0	0	0
12	2	0	0	0	0	0	0
13	3	1	1	0	0	0	0
TOTAL	113	2	4	0	0	0	0
MEAN (QUAD)	8.69	0.15	0.31	0.00	0.00	0.00	0.00
STD DEV	5.63	0.38	0.63	0.00	0.00	0.00	0.00

WEST							
QUADRAT	PD	PF	CA	SR	MA	FF	I
1	11	0	0	0	0	0	0
2	7	0	0	0	0	0	0
3	8	0	0	0	0	0	0
4	4	0	0	1	0	0	0
5	7	0	0	0	0	0	0
6	19	0	0	0	0	0	0
7	14	0	0	0	0	0	0
8	25	1	0	0	0	0	0
9	15	0	1	0	0	0	0
10	18	0	0	0	0	0	0
11	13	0	0	0	0	0	0
12	8	0	0	0	0	0	0
13	19	0	0	0	0	0	0
TOTAL	168	1	1	1	0	0	0
MEAN (QUAD)	12.92	0.08	0.08	0.08	0.00	0.00	0.00
STD DEV	6.14	0.28	0.28	0.28	0.00	0.00	0.00

Table 3. Cumulative results for the primary site transects. Cumulative species frequency, mean number of individuals per 13 quadrats, and mean number of individuals per quadrat are given.

	SPECIES FREQUENCY						
	PD	PF	CA	SR	MA	FF	I
TOTAL N	98	0	7	1	1	1	0
TOTAL E	113	2	4	0	0	0	0
TOTAL S	161	0	1	1	1	0	1
TOTAL W	168	1	1	1	0	0	0
SUM	540	3	13	3	2	1	1
MEAN (ARM)	135.0	0.75	3.25	0.75	0.50	0.25	0.25
STD DEV	34.73	0.96	2.87	0.50	0.58	0.50	0.50
MEAN (QUAD)	10.38	0.06	0.25	0.06	0.04	0.02	0.02
STD DEV	2.67	0.07	0.22	0.04	0.04	0.04	0.04
95% CONF.	0.23	0.17	0.13	0.10	0.36	----	----

Table 4. Results of the consistency test performed on the thirteenth station on each transect arm. A chi-square test was performed to test the significance of the differences (df = 3).

	N13				E15		
	PD	PF	CA		PD	PF	CA
NG	13	0	3		3	1	0
EG	31	0	1		3	1	1
SG	18	0	2		5	0	0
WG	30	3	0		4	0	0
MEAN	23.00	0.75	1.50		3.75	0.50	0.25
STD DEV	8.91	1.50	1.29		0.96	0.58	0.50
CHI-SQ.	10.35	9.00	3.34		0.74	2.00	3.00
SIGNIF.	P<.01	P<.025	NS		NS	NS	NS

	S13				W13		
	PD	PF	CA		PD	PF	CA
NG	11	0	0		15	0	0
EG	10	0	0		19	0	0
SG	8	0	0		16	0	0
WG	9	0	0		19	0	0
MEAN	9.50	0.00	0.00		17.25	0.00	0.00
STD DEV	1.29	0.00	0.00		2.06	0.00	0.00
CHI-SQ.	0.54	0.00	0.00		0.74	0.00	0.00
SIGNIF.	NS	NS	NS		NS	NS	NS

Table 5. Results for the "pole", "wreck", and "yellow house" sites, including totals for the three sites, mean individuals per quadrat, and standard deviation.

	PD	CA	SR	MA	SOL.
POLE/CAGES	7	3	0	0	0
	3	0	0	0	0
	3	1	0	0	0
	4	1	0	0	0
	11	0	1	0	0
	7	2	0	0	0
	5	0	0	0	0
WRECK	5	1	0	0	0
	12	2	0	1	0
	4	1	0	0	0
	9	0	0	0	0
YELLOW HOUSE	0	0	0	0	1
	13	0	0	0	1
	0	0	0	0	0
	0	0	1	0	0
TOTALS	83	11	2	1	2
MEAN (QUAD)	5.53	0.73	0.13	0.07	0.13
STD DEV	4.26	0.96	0.35	0.26	0.35