PROCEEDINGS
OF THE
FOURTH SYMPOSIUM
ON THE
NATURAL HISTORY OF THE BAHAMAS

Edited by
W. Hardy Eshbaugh

Conference Organizer
Donald T. Gerace

Bahamian Field Station, Ltd.
San Salvador, Bahamas
1992

Printed in USA by Don Heuer

ISBN 0-935909-41-9

SEASONAL VARIATIONS IN SEAGRASS BIOMASS FROM A TROPICAL CARBONATE ENVIRONMENT

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ABSTRACT

Seagrass meadows can be found throughout the Caribbean and form the basis of the coastal food web where they occur. These ecosystems are also dynamic, often exhibiting periodic fluctuations in associated flora and fauna. The seagrasses can also exhibit drastic changes in biomass and standing stock over time. The purpose of this study was to compare above and below sediment biomass of seagrasses from different sites from San Salvador Island in order to determine if a particular site may exhibit predictable seasonal fluctuations. If so, this site could be used as a control, from which other Caribbean seagrass meadows could be compared. Core samples were taken from a number of sites around the island, separated by species and tissue type, washed, dried and weighed. Comparisons among sites over time indicated that most sites were not predictable over the three year sampling period, either due to high energy locations or because they were in a successional stage. Grahams Harbor sites, however, were relatively stable and predictable. Below sediment biomass of *Thalassia* increases from 50 to 75% during winter months. Biomass monitoring is continuing at all sites to determine long-term trends.

INTRODUCTION

Seagrasses occur in coastal sediments in all of the world's oceans (den Hartog, 1970). Seagrass meadows play important ecological roles where they occur (Zieman, 1982; Thayer *et al.*, 1984). These roles include; sediment stabilization (Fonseca and Fisher, 1986; Fonseca, 1989), providing a habitat for a variety of marine organisms (Kenworthy *et al.*, 1988) and forming the basis of the overall food web (Kenworthy *et al*, 1989).

Despite the wide spread occurrence of seagrass meadows, a number of reports have described their decline in various geographical regions, including the pandemic "wasting disease" of *Zostera marina* in the 1920-30's (den Hartog, 1987; Short *et al.*, 1987). More recently, significant declines have been reported in a number of locations around Australia (Shepherd *et al.*, 1989) and in Florida Bay (Robblee *et al*, 1991). Although some of these declines can be attributed to point source pollution, others remain unexplained. Often it is difficult to determine if declines are local or widespread due to the lack of long term monitoring studies of seagrass meadows at key locations.

Caribbean seagrasses are represented by four species; *Thalassia testudinum, Syringodium filiforme, Halodule wrightii* and *Halophila decipiens*. Most, although not all, Caribbean seagrass meadows are dominated by *Thalassia* in shallow water. Here we report seasonal biomass measurements from seagrass meadows around San Salvador Island, Bahamas from 1988 through 1991. This is the first four years of a long term monitoring project designed to serve as a control site from which seagrass biomass data obtained from other Caribbean sites can be compared. The objectives of this study include; 1) to locate a relatively stable meadow, 2) determine normal seasonal fluctuations in above and below sediment biomass, 3) establish a data base from which localized biomass changes can be correlated with Caribbean wide biomass changes, thus indicating either point-source or oceanic causes, and 4) establish a data-set from which other ecological studies within the meadows can be made (nutrient cycling,population studies,etc.).

MATERIALS AND METHODS

Seagrass samples were taken with 0.02 m2 corers to a depth of 20 cm from eight sites (Fig. 1) for a four year period.The frequency of sampling for each site, species present and some basic relative physical characteristics are presented in Table 1. Cores were placed in plastic bags upon removal from the substratum and washed free of adhering sediment on shore. Plants were then taken to the laboratory at the Bahamian Field Station where they were washed in 0.1N HCl, sorted by species, separated into above and below sediment tissue, and leaf counts made for each species. Seagrass tissue was then placed in drying boats and dried at 100° C for 48h.

San Salvador Island was selected as a particularly good site for this type of study because of its' location (24° 00'N, 74° 30'W; among the more easterly of the Bahama Archipelago Chain) and lack of anthropogenic disturbance. A more detailed description of the sample sites can be found in Smith *et al.* (1991).

RESULTS

Overall leaf counts and biomass measurements averaged over all sampling times are given in Table 2. All relatively low energy sites had a similar profile with respect to leaf counts and biomass. These sites contained all three seagrass species and were dominated by *Thalassia* followed by *Syringodium* then *Halodule*. The Cut Cay and Rice Bay sites were dominated by *Syringodium* (the meadow in Rice Bay was completely undercut by currents following the storm season of 1989). All other sites were dominated by *Thalassia* except East Beach which went through a gradual temporal change from *Syringodium* to *Thalassia* domination (discussed later).

Figure 1 shows root-rhizome biomass measurements at the Grahams Harbor site for three years. *Halodule* samples did not show a predictable pattern and *Syringodium* samples remained relatively constant throughout the sampling period. *Thalassia*, on the other hand, showed an increase in biomass by 60 to 70% during the winter months. The same basic pattern was observed with *Thalassia* stem-leaf biomass samples except for Dec. '90 (Figure 2). Leaf counts (Figure 3) did not exhibit the seasonal fluctuations indicated by the biomass measurements. In addition, the biomass dominance by *Thalassia* was not reflected by leaf counts in Graham's Harbor. This was true for Cut Cay samples as well, although root-rhizome and leaf biomass did correlate well (Figures 4-6). Seasonal fluctuations at Cut Cay, however, were not predicable.

The East Beach site appeared to be going through a change from a *Syringodium* dominated to a *Thalassia* dominated meadow which was indicated by biomass measurements (Figures 7-8), and leaf counts (Figure 9). This change was most apparent with leaf biomass (Figure 8), since *Syringodium* decreased throughout the sampling period. The French Bay site was among the most variable in San Salvador as indicated by a lack of correlation both seasonally, and between root-rhizome and leaf biomass data (Figures 10-11).

DISCUSSION

Among our sampling sites in San Salvador, the Graham's Harbor site appears to be the most stable and therefore, the most predictable. Hence,this site should be the most appropriate for use as a control site for the Caribbean. The cause for the winter increase in *Thalassia* biomass, at this site, is not known. Research is continuing to determine if this is due to increased summer herbivory, increased winter growth rates or some other factor(s).

It is interesting to note that species biomass distributions reflected relative current energy patterns (Tables 1-2), with the pioneering seagrass *Syringodium* being more prominent in high energy sites.This observation coupled with a lack of correlation between root-rhizome and leaf biomass indicates that these high energy areas remain in a state of flux throughout the year. An exception to this was the East Beach (T) site which appeared to be going through a successional stage. This probably occurs in high energy areas after a meadow has been undercut by a series of storm surges and then becomes revegetated.

In summary, monitoring seagrass beds in San Salvador over a long period of time has the advantage of not only providing a Caribbean control site, but also yielding basic data on the

TABLE 1. THREE YEAR SEAGRASS SAMPLING PROTOCOL FOR 1988-90.

SAMPLE DATE CODE

1 = 7/88
2 = 12/88
3 = 7/89
4 = 12/89
5 = 7/90
6 = 12/90

SEAGRASS CODE

T = THALASSIA
S = SYRINGODIUM
H = HALODULE

SITE		DATES SAMPLED	TOTAL # CORES	SPECES PRESENT
		RELATIVELY LOW ENERGY SITES		
GRAHAMS HARBOR	(GH)	1-6	210	T,S,H
BARKERS POINT	(BP)	2	30	T,S,H
WEST SNOW BAY	(WSB)	1	30	T,S,H
		INTERMEDIATE ENERGY SITES		
CUT CAY	(CC)	2-6	150	T,S,H
RICE BAY	(RB)	1-2	30	T,S,H
		SITES IMPACTED BY DELTA		
PIGEON CREEK 1	(PC1)	2-6	150	T,S
PIGEON CREEK 2	(PC2)	2-5	120	T
		HIGH ENERGY SITES		
FRENCH BAY DEEP	(FBD)	1	15	T,S
FRENCH BAY	(FB)	1,4-6	105	T,S
EAST BEACH T	(EBT)	1-2	30	T,S
EAST BEACH	(EB)	1-3,5-6	90	T,S(H in 3)

TABLE 2. SEAGRASS STANDING STOCK MEASUREMENTS AMONG SITES AROUND SAN SALVADOR ISLAND,BAHAMAS.

			GRAMS DRY WT. M-2	
SITE	SPECIES	LEAF COUNT M-2	LEAF-STEM	ROOT-RHIZOME
GH	T	405.1 (61.5)	24.60 (2.64)	136.40 (22.65)
	S	338.6 (35.4)	3.06 (0.47)	17.23 (1.69)
	H	307.6 (48.0)	1.68 (0.46)	9.68 (2.60)
BP	T	558.5 (62.5)	31.95 (5.35)	157.15 (18.20)
	S	316.5 (54.5)	3.15 (0.70)	8.75 (1.80)
	H	47.0 (28.5)	0.25 (0.15)	0.65 (0.30)
WSB	T	---	46.10 (6.80)	336.15 (42.70)
	S	---	3.10 (0.45)	11.60 (3.50)
	H	---	0.35 (0.20)	0.35 (0.20)
CC	T	932.9 (194.9)	63.50 (13.34)	434.67(141.35)
	S	1624.0 (463.7)	20.72 (6.28)	91.86 (39.84)
	H	755.7 (408.6)	10.60 (5.38)	110.56 (62.96)
RB	T	158.5 (31.0)	11.45 (9.45)	25.72 (22.72)
	S	1969.5 (214.5)	45.68 (14.82)	87.72 (7.22)
	H	219.5 (58.0)	2.20 (0.90)	5.22 (3.22)
PC1	T	1340.1 (211.9)	84.28 (22.36)	532.37(128.15)
	S	297.8 (76.4)	3.44 (0.69)	10.36 (1.70)
PC2	T	970.8 (78.2)	135.63 (30.59)	659.02(203.19)
FBD	T	---	181.50 (28.50)	141.00 (37.50)
	S	---	17.25 (3.25)	29.50 (6.60)
FB	T	1515.6 (178.7)	54.14 (16.82)	594.24(369.22)
	S	1285.6 (220.4)	7.97 (3.05)	32.58 (14.06)
EBT	T	---	150.98 (78.02)	191.22(166.18)
	S	---	19.35 (18.20)	22.12 (15.68)
EB	T	658.2 (256.2)	57.55 (13.84)	133.88 (90.79)
	S	3798.4(1161.2)	120.12 (31.51)	127.81 (32.26)

(STANDARD ERROR)

Figure 1 GRAHAMS HARBOR

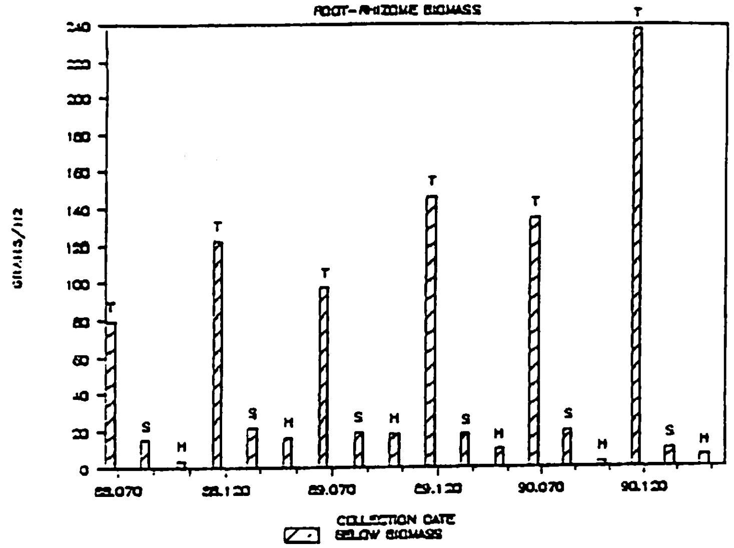


Figure 2 GRAHAMS HARBOR

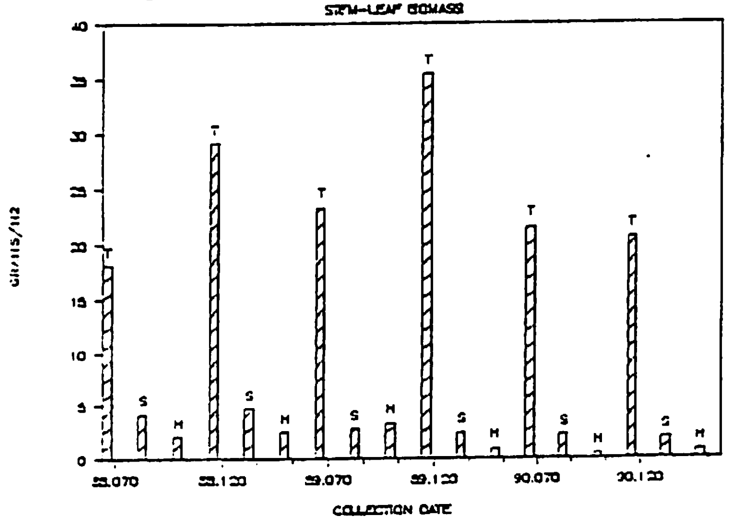


Figure 3 GRAHAMS HARBOR

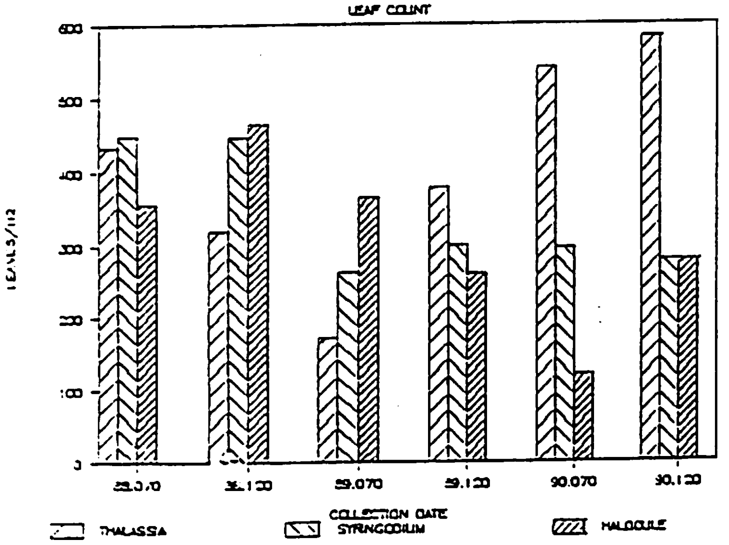


Figure 4 CUT CAY

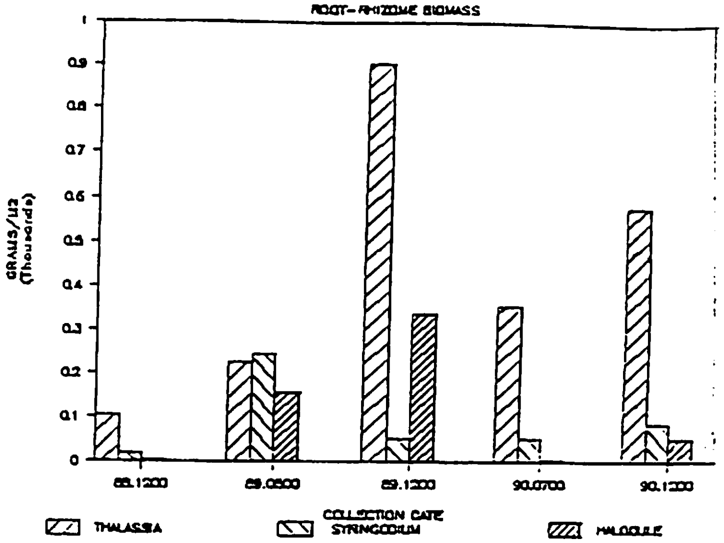


Figure 5 CUT CAY

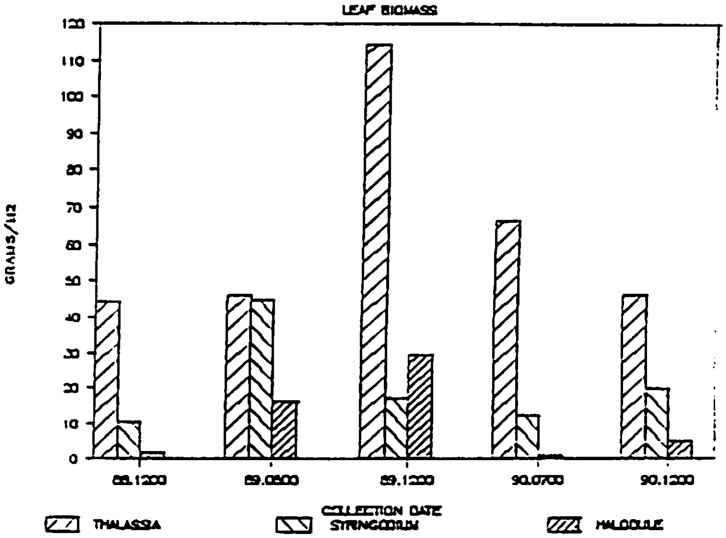


Figure 6 CUT CAY

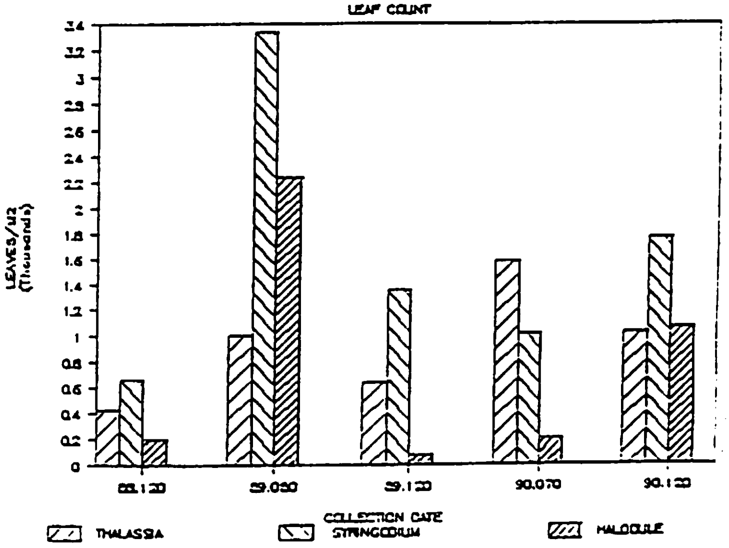


Figure 7 EAST BEACH

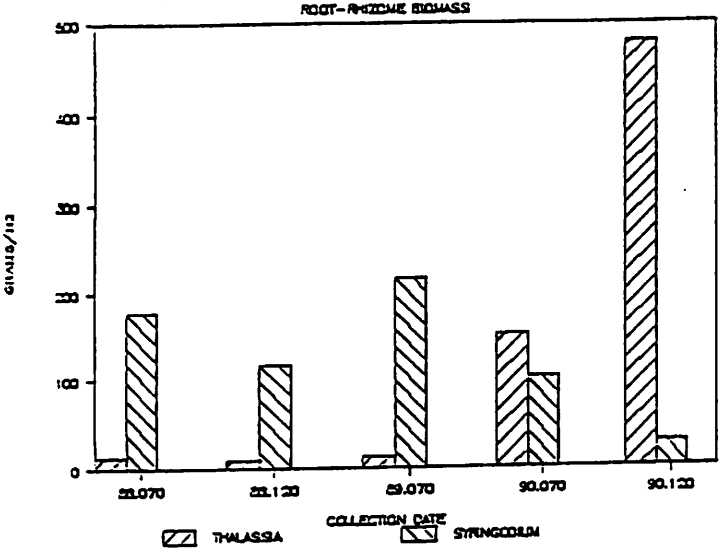


Figure 8 EAST BEACH

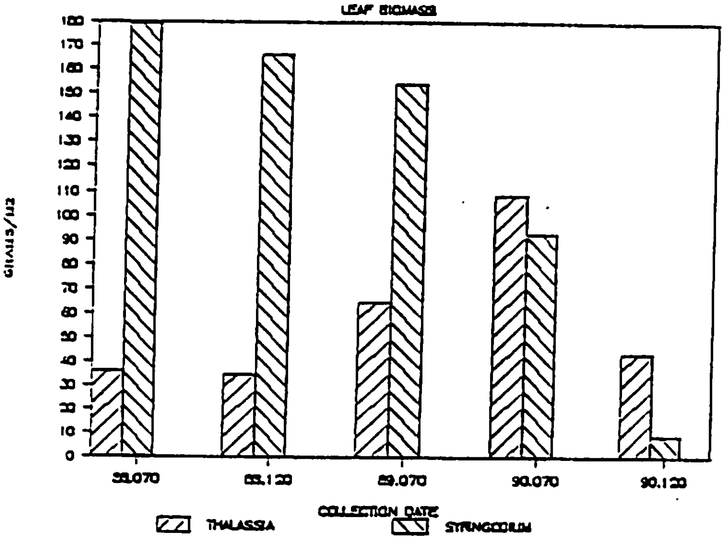


Figure 9 EAST BEACH

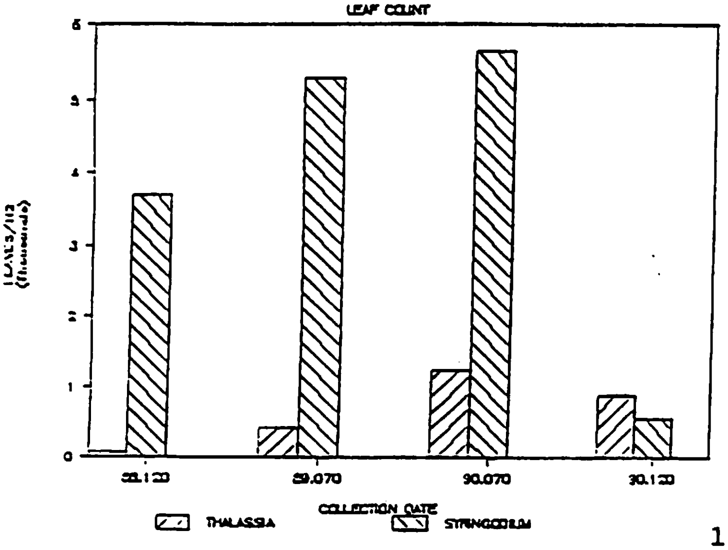


Figure 10 FRENCH BAY

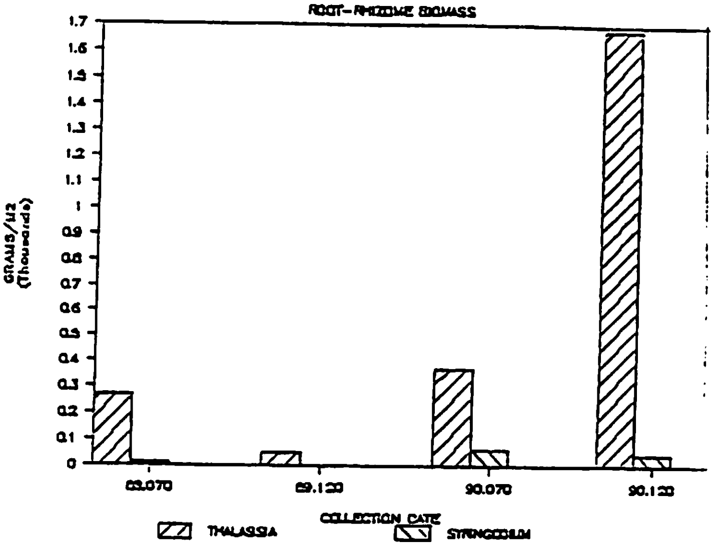
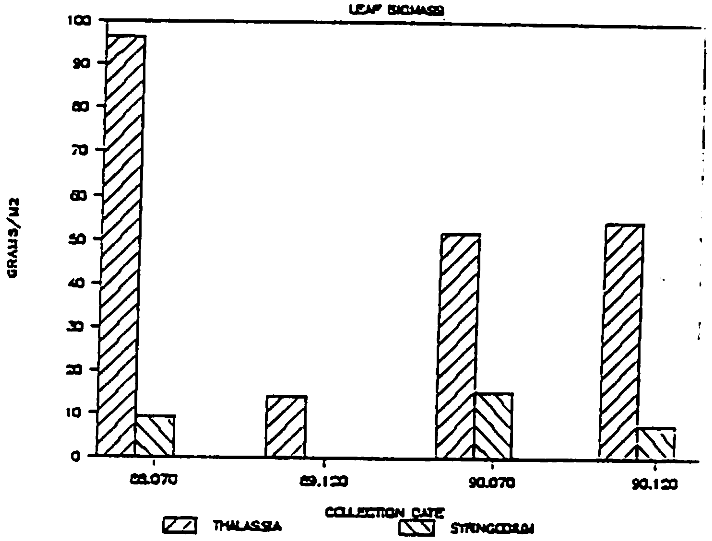


Figure 11 FRENCH BAY



growth of seagrasses in tropical carbonate environments. These studies are continuing.

ACKNOWLEDGMENTS

This work would not have been possible without the support of the following organizations: The Center for Field Research (EARTHWATCH), The Bahamian Field Station, Univ. of South Carolina Research and Productive Scholarship Grants and the many students and EarthCorps volunteers that participated in this project. We thank Don and Kathy Gerace (BFS), W.A. Pirkle and Blanche Premo-Hopkins (USCA), Andy Hudson and Janet Hamilton (CFR) for their help and encouragement. This is contribution No. 865 of the Belle W. Baruch Institute of Marine Biology and Coastal Research.

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