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Studies on Thalassia testudinum in Boat Propeller Cuts in Cockroach Bay, Florida.

Six Month Report: July 1995 to January 1996

6 February, 1996

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INTRODUCTION.

Detailed descriptions of Cockroach Bay and studies, that were begun in December, 1992, on the recovery of Thalassia testudinum (turtle grass) in propeller cuts are given in the Annual reports for 1993 and 1994, and in an extension report given in August of 1995. This report covers a six month period from July of 1995 to January of 1996. The goal of this project is to experiment with growth techniques for Thalassia testudinum and to map the seagrasses of Cockroach Bay, Little Cockroach Bay and Adjacent waters of Tampa Bay.

USF REPORT.

As described in the proposal, two of the original 6 Recovery Area (RA) sites were used: 2C, one of the entrances from Tampa Bay into RA 2, and an internal site in "Hole in the Wall in RA 4. As proposed, a third site was established in Tampa Bay exterior to site 2C (Ext).

The high level of rain and resulting high turbidity (due to phytoplankton, tannins, sediment) seriously hampered our ability to carry out field measurements. Water transparency was less than 10 cm during the summer months and lightning storms severely restricted field work. Thus, we were delayed in measuring blade growth and other subtidal studies. The first growth studies were not done at the three sites until September.

Abiotic data. The temperature and salinity graph (Fig. 1) demonstrates two important features of Cockroach Bay during the past three years. First, there is a strong seasonal cycle in both salinity and temperature. From September 1992 through 1995 the lowest and highest water temperature observed were 17 °C (Nov. 1992, Dec. 1993) and 33 °C (Aug 1994, June 1995). The lowest and highest salinities observed were 17 ppt (Sept. 1994, July 1995) and 34 ppt (Apr. 1995). Second, salinities in September and October 1994 and 1995 were lower than measured in the previous 2 years (1992: 27 to 30 ppt; 1993: 31 to 33 ppt) because of a return to average rain fall in the summers of 1994 and 1995 in the Tampa Bay area.

Low salinities occurred (inside: 11 ppt; outside: 15 ppt) again in CRB in August into October 1995 as reported for 1994. These depressions in salinity are of concern as a critical stress factor on the seagrass meadows in central CRB (sites 3 and 4). We expect to again see a drop in short shoot density in RA 4. Water temperatures continued to show a typical seasonal fluctuation with a sharp rise in May 1995 and continuing into December, as also found in 1993 and 1994.

Biotic data. Drift macro algal biomass in 1995 followed the same pattern as noted in 1993 and 1994. Biomass was high in the winter months, February and December and low in the summer months, May and October 1995 (Table 1) in all the three RAs (compare with Table 3; 1993, 1994 Annual Reports). The macro algal biomass was significantly higher ($P < 0.01$) at the Ext site in both October and December but not February, and this probably reflects higher salinities and clearer water in Tampa Bay. No macro algal biomass was found in May, 1995 and this may be due to the patchy nature of the drift plants or the high water temperatures. The winter rise in macro algal biomass coincides with a rise in salinity and drop in turbidity. It appears the macro algae replace the phytoplankton as nutrient "scrubbers" in the ecosystem.

The epiphyte load on blades of turtle grass showed the same seasonal influence as seen in 1993 and 1994; higher biomass occurring in February and a continued depression into December (Table 2). Although there were some significant differences ($P < 0.001$) between epiphyte biomass of scar and reference plants, there was no pattern in October and December.

There were no differences in short shoot density (Table 3) in October and all three sites were significantly different in December ($P < 0.001$) with the interior site RA 4 the highest. The large standard variation indicates the patchiness of these meadows. The above and below ground biomass (Table 4) did not differ significantly between sites in October although larger below ground biomasses were found at sites 2c and 4 than at the Ext site. Below ground biomass was significantly lower at site 4 in December and the below ground biomasses in 2C and 4 were lower in December when compared with October. It appears the stresses of turbid water and depressed salinities took a toll on the seagrass meadows within Cockroach Bay. Lower growth may result in the spring at these two sites.

Blade characteristics (blade number, width, and length) of Thalassia testudinum are compared for February, May, October and December 1995 in Table 5. There were no significant differences in blade characteristics for 2 scars (prop cut 1, 2) and the reference seagrass bed in sites 2C and 4 in February, May and October. Only blade length in site 2C was significantly different between the seagrass reference bed and 2 scars. In the Ext site, scar 2 showed a significantly higher number and wider blades in October and wider blades in December. Looking at sites 2C and 4, where there is data for February and May, blade number increased in May, the period of new growth and then showed a decline in December, a period of low growth. It will be interesting to see what happens in the spring growth based on a loss in below ground biomass at sites 2C and 4.

Leaf areas were significantly different ($P < 0.001$) within the Ext site in October and at 2C in December (Table 6). The differences did not show a pattern, scar 2 of the Ext site showed higher while both scars of 2c in December showed lower leaf areas.

Blade production (expressed as percent new blade per day; Table 7) was high in the October and December experiments when sites 2C and 4 are compared with previous data for February and May. In October, there was the problem of recovering the marked short shoots due to storms that delayed collections and severe water turbidity. It appears some of the old blade material was lost, before the marked plants could be collected, that is calculated in blade production. Based on daily blade production (% d^{-1}), the Tampa Bay Ext site had lower growth rates than the two CRB sites in October and this probably is due to loss of old blade material in RA 2C and 4. The December experiment indicated an continuation of high growth rates that reflected the warmer water temperatures during that period. The only significant ($P < 0.05$) difference in growth rates occurred between scars and reference beds at site 2c in October (both scars show higher growth) and 4 in December (prop cut 2 shows highest growth). Thus there is no pattern in blade growth between a reference seagrass bed and in scars.

Another way to view plant production is shown in Table 8 where the amount of blade produced per day per plant or per m^2 is given for October and December. This data takes into account only the amount of new blade growth and does not rely on old blade material. It is evident that the Ext plants showed significantly higher (($P < 0.01$) production whether expressed in terms of single plants or m^2. The data suggests a suppression of growth of Thalassia testudinum within Cockroach Bay, perhaps due to lower salinities, higher turbidity, and exposure at low tides.

Field Nursery. A field nursery for Thalassia testudinum was established in eastern (greater) CRB on November 4 (Figure 2). The nursery-transplant studies required a bare area within a Thalassia testudinum meadow. Four 2.6 m long permanent line transects were setup 1m apart in this bare area. The transect lines were marked every 20 cm and tags were placed on the line. Twelve tags were placed on each line indicating the placement of individual plants and the treatments they would receive (Fig. 1). A total of 4 treatments were chosen, and were replicated 3 times.

Treatments consisted of additions of nutrients and hormones in an agar matrix. The nutrient selected was ammonia as phosphate is not limiting and in high concentration in the plant (Rose, personal communication). The two hormones selected were NAA (growth regulator) and kinetin (cell division regulator) based on use in other seagrass studies (see reference report of CJD attached to proposal).

The 4 treatments were; agar only (control), agar + 2 mM NH_4^+, agar + 2 mM NH_4^+ + NAA, agar + 2 mM NH_4^+ + NAA, + Kinetin. Cubes of 2% agar (2 x 1 x 1 cm) containing the above chemicals were inserted about 10 cm into the sediment in contact with the short shoot on the day of transplantation; one cube on each side of the short shoot. Two agar blocks are placed, one on each side of each short shoot every two weeks since 4 November.

The agar blocks were made as follows. The control treatment © consisted of 20 g Bacto-agar (Difco Labs.) in 1 L distilled water. This concentration of agar was used to formulate all other treatments as well. The blocks containing 2 mM NH_4^+ (A) were made by adding 0.132g $(NH_4)_2SO_4$ to 1 L distilled H_2O before the addition of the 20g agar. The NAA solution (N) was made by adding 0.1862 g Napthaleneacetic acid (Sigma) to solution A before adding the agar. This solution is 10^{-3} M NAA. The Kinetin solution (K) was made by adding 0.215 g 6-Furfurlyaminopurine (Sigma) to solution N. The Kinetin was first added to 100 ml of 0.02N NaOH to allow it to dissolve. This solution is 10^{-3} M Kinetin.

All 4 solutions were poured into sterile enamel pans 1 cm deep to cool in a laminar flow hood. Once hardened the agar was cut with a scalpel, placed into ziplock bags under sterile conditions and refrigerated until the day of transplantation.

Summary. Growth of _Thalassia testudinum_ in CRB during the spring of 1995 followed the same pattern as reported in the 1993 and 1994 Annual Reports in the interior RA (4) and exterior RA (2C). In October, the depressed salinities (11 ppt being common) again occurred as in 1994. Establishment of the Ext site has demonstrated that the CRB plants do not do as well and support the idea of depressed growth due to lower salinities and perhaps exposure at low tides.

The nursery site is established; as of 11 January all but one of the 48 transplants is surviving. Transplantation of single short shoots into two prop cuts with fresh plants will be carried out in January. Presently a paper is being prepared for submission to Aquatic Botany presenting scar recovery information and Hillsborough E.P.C. is cited as the supporting institution.

Acknowledgments. The U.S.F. study was carried out with the help of a number of undergraduate (Manuel Merello, Dorothy Stevens, Katherine Siar) and graduate (John Andorfer, Brian Teasdale) students. Mr. Andorfer is the Research Assistant on this project and his help has been invaluable.

HCC Report

The HCC report consists of two parts: experiments on growth techniques for Thalassia testudinum and the mapping of the seagrasses in Cockroach Bay, Little Cockroach Bay, and adjacent waters of Tampa Bay.

Laboratory experiments: the first problem to overcome in the laboratory experiments was to establish stable marine aquaria. In the past we had difficulty keeping environmental conditions constant, therefore, the experiments were not successful. We set up two 90 gallon aquariums with salt water with a 250 watt halogen light sources. Heaters were placed in the water to stabilize the temperature and timers were placed on the lights for 14 hour days. The filtration system was a simple "bio-ball" filter with filter media superimposed in a 20 gallon aquarium. This system proved inadequate. We designed an "algae" filtration system in line with the other filter so that water trickled through the algae prior to going into the bio-ball filter. This worked very well. Next we added more light to each aquarium. The new lights were 40 watt fluorescent lights designed for marine aquaria plant growth. A water pump was added to each aquarium to create water movement in the tanks. Salinity has been kept fairly constant at 27 to 28 ppt. Temperature has been kept at 24 degrees C.

Experiment #1: The procedure involved procuring seagrasses from the bay and treating them with hormones and nutrients to attempt to stimulate growth. In Dixie paper cups we placed the following:

1. Nutrient agar.
2. Six drops of each hormone (Cytochine, Auxin, and a gibberellin)
3. Three drops of DMSO
4. Five granules of ammonia

Plants were prepared by having their rhizomes cut so that each plant maintained its rhizome. The plants were placed in the solution and the agar was allowed to solidify around the rhizomes. After solidification, the cups were cut away from the plants and the plants were gently placed in the aquaria. The plants were left in the aquaria for 6 weeks. No new growth was noted. Speculation is that the agar solution held up the molecules from getting to the rhizomes. The plants, therefore, starved to death.

Experiment #2: In this experiment the seagrasses were soaked in solutions instead of using the agar. After soaking for two hours the plants were placed in the aquaria. In aquarium #2 the plants were left alone to grow. In aquarium #1 the plants have been injected with nutrients and hormones each week. Injections were as follows:

1. A dilute solution of Miracle Grow (15-30-15) in seawater.
2. Three granules of ammonia.
3. Three drops of hormone.

This experiment was begun in mid December. Results are not yet in, however, most of the plants in both aquaria are alive and most are showing growth. By the end of February some plants will be pulled to see if apical meristem growth has been initiated in the rhizomes.

Outdoor Experiments: We obtained permission from the DEP marine fisheries lab located in the northern most portion of Manatee County near Cockroach Bay to set up outdoor experiments. The following were purchased:

1. Four crypts to grow plants in.
2. Water heaters
3. PVC pipes to connect the DEP. water system to our tanks.
4. Thermometers.
5. Heater regulators.

The tanks have been set up. Everything is in place. Sediment will be placed in the tanks before mid February and experiments will begin before the end of the month. Two of the tanks will be used for HCC experiments while the other two will be used by USF.

Weather considerations: the weather in 1995 played a considerable role in the mapping of the seagrasses at Cockroach Bay. During the months of August and September greater than average amounts of rainfall fell on Hillsborough County resulting in significant runoff through the bay. Runoff through the bay was heavy in silt and in tannic acid. This combination made it impossible to photograph the seagrasses from the air. Several visits to the bay confirmed this problem. The turbidity limited visibility to three inches in early September. By mid October the turbidity was reduced somewhat. Aerial photographs were taken in October even though some turbidity persisted. We photographed the area again in December with much better results.

Mapping: Aerial photographs were taken in October of Cockroach Bay, Little Cockroach Bay and adjacent waters of Tampa Bay at a 1 to 2,400 scale. Enlargements were made of these images. The images were scanned into the computer and digitized. Scaling was accomplished by using known ground distances. Mangroves and seagrasses were outlined on the computer images in order to give us a computer map but also square footage of the grasses and mangroves. The following data were computed for the entire area:

Area	Square feet	Acreage
Seagrasses	35,700,000	819.56
Mangroves	57,800,000	1,326.91

Detailed photographs: Aerial images of the site were taken in December at a scale of approximately 1 to 600. Of particular interest in the aerial photographs were the passes where boat traffic was most heavy. Our charge here was to determine if new prop scarring had occurred in any of the sites studied prior to July of 1995 and to make maps of prop scars in Little Cockroach Bay and in adjacent waters of Tampa Bay. The photographs are displayed on a poster board for viewing by the EPC staff.

The photographs are very difficult to interpret. The images were taken at a low tide and at a low sun angle. The images are excellent, however, interpretation problems occur because the seagrasses have been "burned" back to mere stubs of their usual size. This creates areas on the films that appear to be sand but are actually sparse and burned grasses (more will be said below). Some prop scars are clearly in sand but others may be through sparse seagrasses. Ground truthing has not helped much in this regard. We are due to take more photographs in February and March that perhaps can resolve this problem. Therefore, we will not report any data on this aspect until further analysis can take place.

One observation on the photographs is worth noting. In the "Hole-in-the-wall" area the sand has shifted to cover more seagrasses than previously noted. There appear to be new (or more powerful) currents moving through the area pushing sand and sediment up onto the grass beds. This observation is consistent with the increases in rainfall noted for 1995.

Conclusion and status of seagrasses: the status of seagrasses in Cockroach Bay is, at this time, in a "wait-and-see" situation. Both HCC and USF reports have noted the following:

- 1. Salinities were very low in the fall months.
- 2. Air temperatures were very low in the month of December coincident with low
- tides and easterly winds. The seagrasses were exposed.
- 3. Rainfall was above fifty inches in the area increasing runoff and increasing turbidity.

Because of environmental influences the grasses have been stressed, the blades have been shortened to mere stubs. In the spring, as the water warms up, seagrasses traditionally regrow. However, we pulled some shoots from the sediment in area 4 in January to see if the short shoots were still alive. Those in the middle of area 4 retained their green blades while those closer to "Hole-in-the-wall" tended to be brown. This would indicate that some are dead. We will wait until the spring months for further evaluation of the grasses.

<u>Addendum:</u> On Monday, February 5, 1996, some unusual events occurred that may have killed more seagrasses. The temperature at Cockroach Bay dropped to 26 Degrees F, the wind was out of the east, and the tide was exceptionally low. This combination of events made Cockroach Bay look empty. Most of the shallow sites between mangroves was exposed to the air with the wind blowing and the temperature dropping below freezing. The only water in Cockroach Bay was in the channels. The seagrasses were completely exposed. This event may have killed more seagrasses. Again, we will have to wait until the spring months to see how many have survived. Certainly, many of the mangroves have not.

Table 1. Biomass of macroalgae (gdwt m^{-2}) and species diversity at 3 sites in Cockroach Bay. Values are means ± S.D., n = 15.

Date	Site	Biomass (gdwt m^2)	Species Present
Feb. 95	2c	39.02 ± 32.29	8,10,11,17,19
	4	29.74 ± 38.40	8,11,17,19,21
May 95		NO MACRO ALGAE BIOMASS FOUND	
Oct. 95	Ext	13.16 ± 12.64^a	1,10,18,19
	2c	2.99 ± 3.66^b	1,10,19
	4	0	
Dec. 95	Ext	46.96 ± 27.38^a	1,5,6,7,11,20
	2c	13.48 ± 11.99^b	1,5,6,7,11,20
	4	1.75 ± 3.34^c	1,5,6,7,11,20

Legend:

1. *Acanthophora spicifera*
2. *Centroceras clavulatum*
3. *Chondria cnicophylla*
4. *Gracilaria sjoestedtii*
5. *G. tikvahiae*
6. *G. verrucosa*
7. *Hypnea musciformis*
8. *Laurencia poitei*
9. *Lyngbya majescula*
10. *Spyridia filamentosa*
11. *Ulva lactuca*
12. *Solaria filiformis*
13. *Lomentaria baileyiena*
14. *Chondria sedifolia*
15. *Caulerpa sertularioides*
16. *C. prolifera*
17. *Enteromorpha intestinalis*
18. *Agardhiella tenera*
19. *Gracilaria foliifera var angustissima*
20. *Champia parvula*
21. *Chondria tenuissima*

Table 2. Epiphyte load on short shoots of *Thalassia testudinum* sampled from within and along the edges of boat propeller cuts (Prop cut), and within adjacent *T. testudinum* grassbeds (Seagrass) from 3 sites in Cockroach Bay, 1995. Values are means ± S.D.; sample sizes vary between 14 and 15. Superscripts denote significant differences between study areas within each site ($P < 0.05$; Student's t-test and the Mann Whitney Rank Sum Test).

	February	May	October	December
Exterior	-	-		
Seagrass			0.07 ± 0.03^{a}	0.07 ± 0.06^{a}
Prop cut 1			0.06 ± 0.02^{a}	0.04 ± 0.03^{a}
Prop cut 2			0.16 ± 0.10^{b}	0.01 ± 0.01^{b}
Site 2c				
Seagrass	0.67 ± 0.54	0.10 ± 0.06	0.06 ± 0.03	0.02 ± 0.02
Prop cut 1	0.30 ± 0.18	0.14 ± 0.09	0.02 ± 0.02	0.04 ± 0.03
Prop cut 2	-	-	0.06 ± 0.04	0.03 ± 0.03
Site 4				
Seagrass	0.09 ± 0.26	0.06 ± 0.04	0.04 ± 0.03^{a}	0.03 ± 0.03^{a}
Prop cut 1	0.08 ± 0.06	0.11 ± 0.06	0.04 ± 0.02^{a}	0.01 ± 0.01^{a}
Prop cut 2	-	-	0.10 ± 0.04^{b}	0.04 ± 0.03^{b}

Table 3. Ramet densities in 1m² of a *Thalassia testudinum* bed from 3 sites in Cockroach Bay, estimated from 15 haphazard chosen 25cm quadrats. Values are means ± S.D.'s.

Date	Ramet Density		
	Exterior site	Site 2c	Site 4
Oct. 95	139.73 ± 61.22	114.13 ± 40.96	152.53 ± 39.59
Dec. 95	176.00 ±50.98[a]	80.00 ±33.12[b]	231.47 ±57.65[c]

Table 4. Dry weight biomass allocation (g) and above and below ground biomasses in 1m² of a *Thalassia testudinum* bed from 3 sites in Cockroach Bay. Values are means ± S.D.'s; (n=3). The percent of the total biomass for each plant part is given in the ().

Date	Site	Dry Weight Biomass Allocations (g)				Biomass (g)	
		Blades	Short Shoots	Rhizomes	Roots	Above-ground	Below-ground
Oct. 95	Ext	103.27±27.18 (34.58)	105.95±38.32 (34.75)	66.24±4.77 (22.40)	24.89±5.32 (8.27)	103.27±27.18	197.08±46.93
	2c	75.88±24.39 (18.43)	128.50±17.81 (32.57)	171.79±75.23 (41.03)	33.01±15.17 (7.97)	75.88±24.39	333.31±97.28
	4	70.54±36.69 (16.72)	171.61±97.36 (39.61)	116.43±84.37 (24.13)	100.70±97.65 (19.55)	70.54±36.69	388.73±275.6
Dec. 95	Ext	81.39±14.31 (37.88)	51.51±6.49 (20.90)	66.88±25.11 (30.85)	15.79±6.43 (7.40)	81.39±14.31	260.05±31.27[a]
	2c	73.81±35.48 (31.92)	53.14±43.76 (23.86)	88.80±25.74 (40.37)	14.82±3.59 (6.80)	73.81±35.48	156.77±67.59[a]
	4	83.29±15.34 (24.23)	100.59±32.02 (28.85)	107.82±46.00 (30.82)	51.64±37.95 (16.10)	83.29±15.34	134.19±23.60[b]

Table 5. Blade characteristics of *Thalassia testudinum* sampled from within and along the edges of boat propeller cuts (Prop cut), and within adjacent *T. testudinum* grassbeds (Seagrass) from 3 sites in Cockroach Bay, 1995. Values are means (± S.D.); sample sizes vary between 14 and 15. Superscripts denote significant differences between sampling areas, within each site ($P < 0.05$; Student's t-test and Mann Whitney Rank Sum Test).

	February			May			October			December		
	No.	Width (cm)	Length (cm)	No.	Width (cm)	Length (cm)	No.	Width (cm)	Length (cm)	No.	Width (cm)	Length (cm)
Exterior	-	-	-	-	-	-						
Seagrass							3.80^a (0.56)	0.77^a (0.09)	16.08 (2.51)	3.07 (0.80)	0.62^a (0.06)	10.30 (2.34)
Prop cut 1							3.93^a (0.70)	0.78^a (0.09)	16.39 (3.89)	3.50 (0.76)	0.78^b (0.10)	9.24 (2.02)
Prop cut 2							4.80^b (1.37)	0.89^b (0.08)	15.48 (3.29)	3.33 (0.72)	0.76^b (0.10)	9.74 (2.07)
Site 2c												
Seagrass	2.27 (0.47)	0.62 (0.11)	11.70 (2.45)	3.83 (0.72)	0.70 (0.07)	15.72 (3.41)	3.67 (0.72)	0.67 (0.08)	14.95 (4.68)	3.13 (0.64)	0.63 (0.07)	10.43^a (1.94)
Prop cut 1	2.69 (0.85)	0.66 (0.09)	10.52 (2.33)	4.67 (1.11)	0.71 (0.10)	15.12 (4.15)	3.14 (0.86)	0.59 (0.09)	14.45 (2.85)	3.00 (0.58)	0.56 (0.07)	7.17^b (1.21)
Prop cut 2	-	-	-	-	-	-	3.73 (0.70)	0.63 (0.11)	13.74 (3.47)	2.71 (0.61)	0.59 (0.08)	8.87^c (1.92)
Site 4												
Seagrass	2.67 (0.71)	0.63 (0.10)	7.81 (1.93)	4.50 (0.92)	0.68 (0.10)	15.08 (2.99)	3.4 (0.83)	0.56 (0.09)	8.22 (1.19)	2.93 (0.59)	0.49 (0.08)	7.32 (1.22)
Prop cut 1	2.93 (0.47)	0.61 (0.14)	7.63 (1.13)	4.73 (0.88)	0.68 (0.09)	15.33 (3.58)	3.79 (1.12)	0.56 (0.08)	6.96 (1.52)	2.80 (0.68)	0.52 (0.08)	6.27 (1.30)
Prop cut 2	-	-	-	-	-	-	3.20 (0.94)	0.59 (0.09)	7.67 (2.18)	3.00 (0.53)	0.51 (0.07)	5.20 (1.08)

Table 6. Leaf areas of individual *Thalassia testudinum* ramets sampled from within and along the edges of boat propeller cuts (Prop cut), and within adjacent *T. testudinum* grassbeds (Seagrass) from 3 sites in Cockroach Bay, 1995. Values are means ± S.D.; sample sizes vary between 14 and 15. Superscripts denote significant differences between sampling areas, within each site ($P < 0.05$; Student's t-test and Mann Whitney Rank Sum Test).

	February	May	October	December
Exterior	-	-		
Seagrass			47.51 ± 11.65[a]	18.90 ± 4.33
Prop cut 1			49.71 ± 15.74[a]	25.00 ± 7.87
Prop cut 2			64.39 ± 20.18[b]	24.75 ± 8.69
Site 2c				
Seagrass	16.49 ± 6.85	41.61 ± 15.90	30.32 ± 12.84	20.23 ± 4.63[a]
Prop cut 1	18.37 ± 7.24	50.58 ± 20.94	27.36 ± 10.54	12.39 ± 4.20[b]
Prop cut 2	-	-	32.36 ± 12.24	14.73 ± 6.13[b]
Site 4				
Seagrass	12.77 ± 5.40	48.58 ± 20.26	15.52 ± 4.61	10.39 ± 2.91
Prop cut 1	13.95 ± 5.22	50.46 ± 22.26	14.74 ± 5.42	9.27 ± 3.51
Prop cut 2	-	-	14.34 ± 5.90	7.93 ± 2.73

Table 7. Blade production (% d^{-1}) of *Thalassia testudinum* sampled from within and along the edges of boat propeller cuts (Prop cut), and within adjacent *T. testudinum* grassbeds (Seagrass) from 3 sites in Cockroach Bay, 1995. Values are means ± S.D.; sample sizes vary between 14 and 15. Superscripts denote significant differences between study areas within each site ($P < 0.05$; Student's t-test and the Mann Whitney Rank Sum Test).

	February	May	October	December
Exterioir	-	-		
Seagrass			3.18 ± 1.53	4.65 ± 2.51
Prop cut 1			2.72 ± 1.08	4.57 ± 2.68
Prop cut 2			3.12 ± 1.31	4.26 ± 1.44
Site 2c				
Seagrass	2.12 ± 1.60	4.44 ± 2.19	5.55 ± 1.59[a]	4.94 ± 1.49
Prop cut 1	1.58 ± 0.85	3.98 ± 2.20	7.95 ± 2.70[b]	6.01 ± 2.36
Prop cut 2	-	-	8.32 ± 3.89[b]	5.89 ± 2.38
Site 4				
Seagrass	2.41 ± 1.18	3.87 ± 1.33	7.84 ± 3.52	5.11 ± 0.99[a]
Prop cut 1	1.90 ± 0.76	3.54 ± 1.26	7.46 ± 3.60	4.36 ± 1.68[a]
Prop cut 2	-	-	7.79 ± 3.25	6.73 ± 2.73[b]

Table 8 . The amount of plant material produced per day (gdwt) for individual plants and for 1m² of a *Thalassia testudinum* bed from 3 sites in Cockroach Bay. Values are means ± S.D.'s; (n=15).

Date	Site	g/day/plant	g/day/1m²
Oct. 95	Ext	0.006 ± 0.003^{a}	0.787 ± 0.493^{a}
	2c	0.003 ± 0.001^{b}	0.378 ± 0.108^{b}
	4	0.002 ± 0.001^{c}	0.312 ± 0.171^{c}
Dec. 95	Ext	0.006 ± 0.016^{a}	1.112 ± 2.810^{a}
	2c	0.002 ± 0.001^{a}	0.188 ± 0.084^{b}
	4	0.001 ± 0.000^{b}	0.339 ± 0.101^{c}

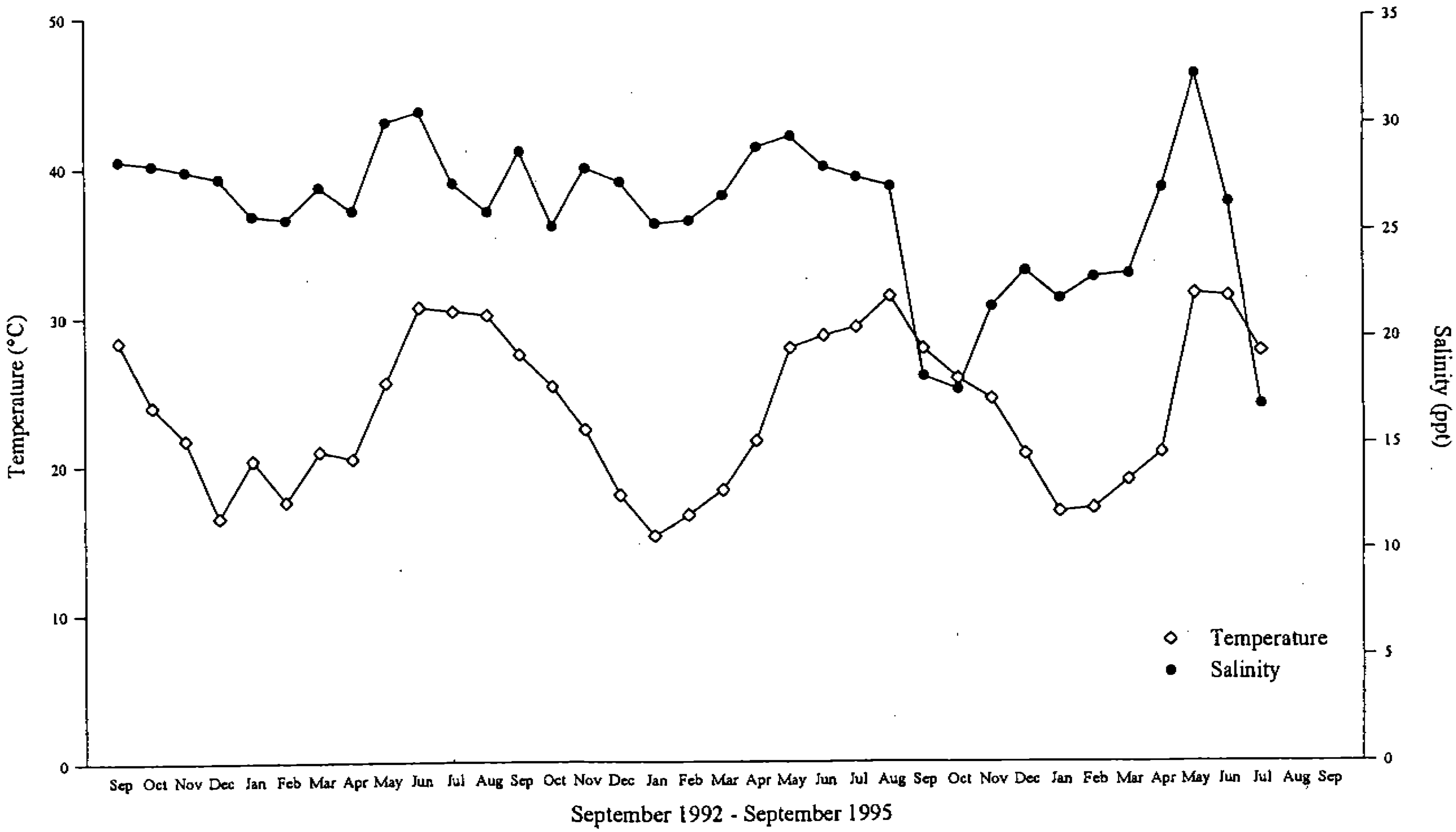
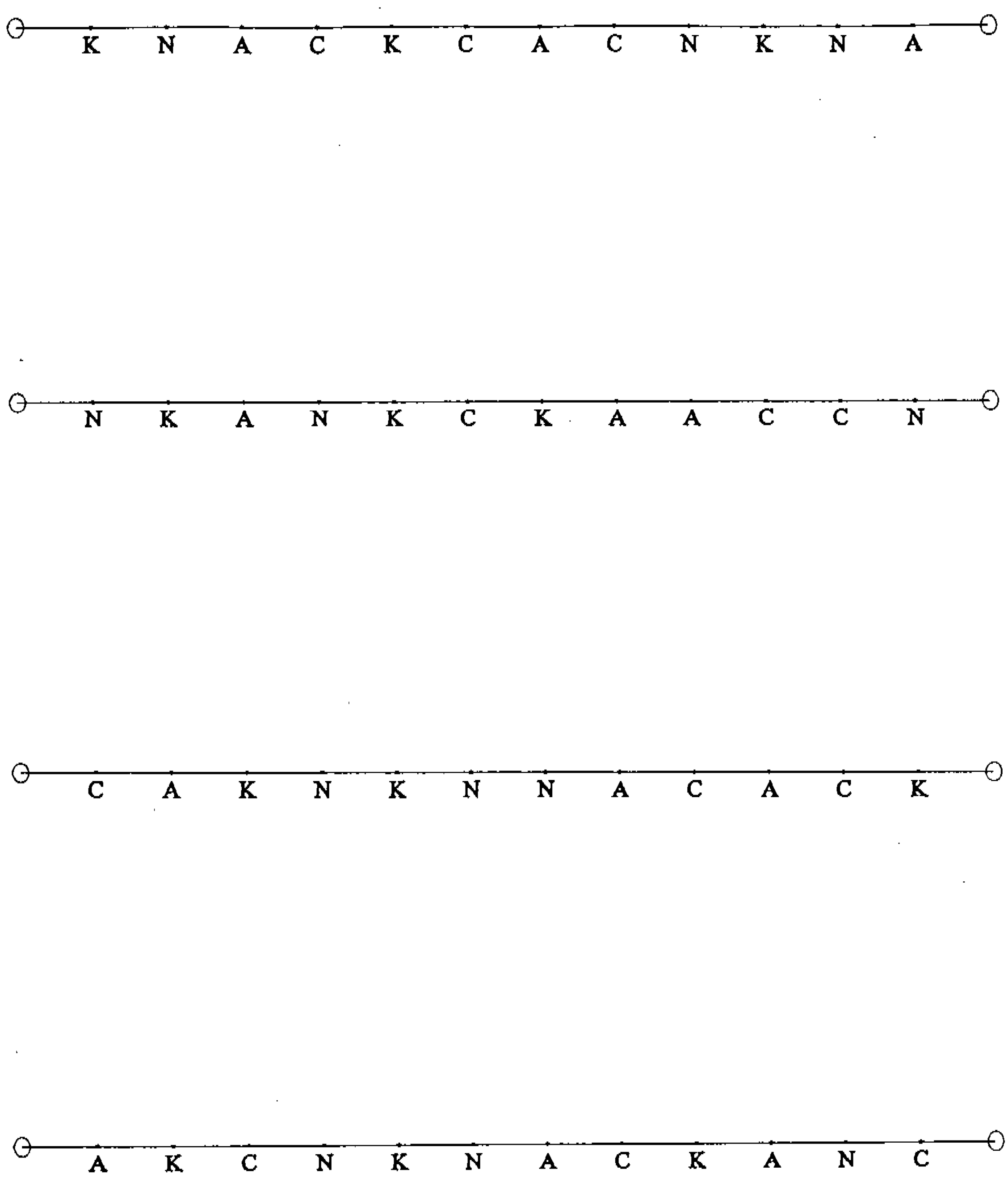

50
40
30
20
10
0
Temperature (°C)
35
30
25
20
15
10
5
0
Salinity (ppt)
Temperature
Salinity
Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep
September 1992 - September 1995

Fig. 1



KEY

C = CONTROL
A = $NH4^+$
N = $NH4^+$ & NAA
K = $NH4^+$, NAA, & KINETIN
BAR = 20 cm