U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service
Center for Coastal Fisheries and Habitat Research
101 Pivers Island Road
Beaufort, North Carolina 28516

Ecological Characterization of Red Bay Bank, Florida Keys National Marine Sanctuary

and

Experimental Evaluation of the Effects of Excavation Depth on Recovery of Seagrasses and Associated Bank-top Communities Injured by Motor Vessels

Progress Report #2

February 6, 2001

by
W. Judson Kenworthy
Paula E. Whitfield
Kamille Hammerstrom
Manuel Merello

Submitted By:

W. Judson Kenworthy
Project Coordinator, CCFHR
February 6, 2001

Approved By:

Donald E. Hoss
Director, CCFHR
February 6, 2001

Don Scavia
Director, NCCOS
February 6, 2001

I. Introduction

This report covers the period from September 1, 2000 to February 1, 2001. Included are tasks accomplished during the report period and some preliminary results from the June 2000, September 2000, and January 2001 field trips.

II. General Study Objectives and Work Accomplishments

Task 1. Our first objective was to develop a baseline physical and biological characterization of Red Bay Bank in order to determine the contribution of the bank system to the overall biological productivity and diversity of the ecosystems in the Florida Keys National Marine Sanctuary (FKNMS) and throughout south Florida. In our first trip to the Red Bay Banks area we utilized 1/2400 and 1/3600 scale vertical aerial photography integrated with differential global positioning system (DGPS) based ground surveys to map, physically describe, and biologically characterize the habitat. We continued this characterization during our second (Sept. 2000) and third (Jan. 2001) trips, focusing on mapping physical and biological habitat characteristics and describing vessel injuries and blowhole disturbances.

We discovered while processing data from the June 2000 trip that our bathymetric data were not sufficient to create accurate surfaces of the injuries we mapped. Therefore we improved on our bathymetric data collection method using more sophisticated technology. A Garmin GPS Map 185 Ecosounder was coupled with a Trimble Pro-XR DGPS datalogger to collect and store bathymetry data with submeter horizontal resolution. The product of this integrated system yields a depth associated with each x, y coordinate collected using DGPS to generate detailed three-dimensional bathymetric profiles of the banks and associated features. In September 2000, we concentrated our efforts on three banks and three release channels in the Red Bay Bank area: Red Bay North banks 6, 8, and 11 (RBN6, RBN8, and RBN11), and release channels from the Red Bay North (RBN), Red Bay South (RBS), and Captain Joe (CJ) bank systems (Figure 1). On RBN 6, 8, and 11 we collected bathymetry data for four disturbance features, including two in which we had previously conducted detailed surveys. We also collected bathymetry data for the entire banks RBN 6 and 8 and the three release channels indicated in Figure 1. (see Figures 2 and 3 for examples of preliminary images generated using depth data collected during our September trip). In future trips we will collect additional bathymetric data on both banks and injuries.

In addition to the physical characterization, in September 2000 we also collected biological data from Red Bay North bank 6 and the three release channels shown in Figure 1 utilizing two different sampling methods. We recorded the abundance of seagrasses, macroalgae, and *Porites* using a modified Braun-Blanquet cover-abundance scale. On RBN6 and in the RBS release channel we laid out transects and collected cover-abundance data on 10 m (bank) and 4 m (release channels) intervals. In the RBN and RBS release channels, we collected cover-abundance data at randomly selected distances (between 1 and 10 m) from the boat's anchor in five compass directions (approximately 70, 140, 215, 290, and 360 degrees). Once we returned to the laboratory in North Carolina, we analyzed this data to determine which method most accurately captures the variability in habitat cover and abundance. From this analysis we concluded that in order to capture variability in all the biological cover categories (*Thalassia testudinum*, *Syringodium filiforme*, total seagrass, total macroalgae, and coral) a minimum of 15 Braun-Blanquet quadrats must be assessed in both the injury and the undisturbed adjacent seagrass community. This information enabled us to choose the best methods of biological data collection for the different types of characterizations (baseline versus injury) for this study and make recommendations for developing quantitative injury assessment protocols. During our biological characterizations for this task and the following task, we documented the presence of additional seagrass and algal species (see Table 1). The coupling of biological and physical data from the banks will enable us to characterize patterns of vegetation and coral cover, thereby focusing damage assessment protocols and restoration efforts in a manner appropriate to the area immediately surrounding seagrass injuries.

We deployed temperature loggers on two banks and two release channels in June 2000. In September 2000 and January 2001 we collected and downloaded the temperature loggers. We discovered that two of the temperature loggers had failed sometime after the 09/00 deployment, but we had complete temperature data for two banktops and two release channels from 6/00 - 9/00 and data from one bank top and one release channel from 9/00 to 01/01. We switched out the failed loggers and redeployed four loggers in the same geographic locations as our earlier deployments. Temperature data revealed that it has been an extremely cold winter this year, with temperatures on the bank top as low as 16.1 °C and temperatures in the release channels as low as 15.5 °C.

Task 2. We continued our monitoring of seagrass and *Porites* coral injuries to assess the recovery of the biological communities of the five previously documented injury sites as well as additional injuries identified and sampled in June, 2000. Additional cover and abundance and short-shoot count data were collected in undisturbed control areas immediately adjacent to injuries on RBN6, RBN11, and RBS4, bringing our number of detailed injury surveys to 17.

Eighteen injuries were surveyed for *Thalassia* seedlings in September 2000. Seedling counts totaled 218 in nine injuries chosen for counts only. To examine the relationship between seedling recruitment and injury size, the remaining 9 injuries were divided into three size categories: < 100 m^2, 100-200 m^2, and > 200m^2. In three injuries in each of the size categories, seedlings were counted and the position of each seedling was marked by pounding rebar into the sediment 50-100 cm away from the seedling so that survival and mortality can be documented next spring. Braun-Blanquet estimates of cover and abundance of seagrass, macroalgae, and coral were recorded for the area surrounding each seedling (217 total). In injuries where no seedlings occurred, haphazardly selected positions were assessed for vegetative and coral cover and abundance. One of the objectives in this task is to develop a spatial model of seagrass recovery into disturbed areas, incorporating seedling data in order to determine the contribution of seedling recruitment to injury recovery. Injury recovery model output will be used in Habitat Equivalency Analysis (HEA) to determine interim resource services lost following an injury to a seagrass bed, a part of the injury assessment protocols.

In January 2001, we resampled the nine injuries in which we had previously marked seedlings with rebar. We censussed these injuries for *Thalassia* seedling survival and macroalgal coverage.

Task 3. We deployed two experiments on RBN8 to address regrowth into propellor scars. The objective of the first experiment was to determine the effect of excavation depth on recovery of seagrasses, macroalgae and coral. The objective of the second experiment was to determine the effect of regrading an excavation on the recovery of seagrasses, macroalgae, and coral. While we are taking a community-based approach to looking at recovery, we will focus on seagrass results for this report.

Excavation Experiment. We hypothesized that the severity of injuries to a *Thalassia* meadow are a function of the depth of sediment excavated by a disturbance. To test this hypothesis and to determine if there is a threshold excavation depth beyond which it is necessary to reestablish the sediment grade in order to facilitate recovery, we deployed a replicated experiment to determine the effect of excavation depth on the recovery rate of injured *T. testudinum* meadows. During our June trip we manually simulated 5 replicates each of excavation: control (no sediment disturbance or 0 cm depth), 10, 20 and 40 cm depth. Ten centimeter excavations were created by "mowing down" the above-ground organisms (seagrass, macroalgae, sponges) using hedge clippers. We then raked the excavation disturbance using hand tools until the depression was 10 cm deep. For the 20 cm and 40 cm treatments, we excavated using shovels and transported the excavated material (seagrass, macroalgae, sponges, coral, coral rubble and sediment) away from the experimental site with buckets.

We have now completed two censuses of this experiment (September 2000 and January 2001), documenting changes in vegetative and coral cover and abundance, short-shoot counts of seagrass, and depth and area of excavation. Preliminary results to date indicate that in 10 cm excavations short-shoot counts for *Thalassia testudinum* and *Syringodium filiforme* recovered to undisturbed levels by the first census period, three months after the excavations were deployed. Figure 4 depicts the short-shoot count results for the first and second censuses of the excavation depth experiment. For both species, 20 and 40 cm treatments had significantly lower short-shoot counts than 10 cm and control treatments (p=0.0001, df=3 for both ANOVAs). While results for *Thalassia* remained the same for the next census in Jan 2001, *Syringodium* short-shoot counts in 20 cm excavations recovered such that they were no different than short-shoot counts in control and 10 cm treatments (p=0.03, df=3).

During the September 2000 trip we collected sediment cores from each excavation to document sediment grain-size distribution as the excavations age and are either filled by natural sedimentation processes or scoured by storms or other disturbance events. Preliminary depth data suggest that these experimental injuries have filled in somewhat.

Fill Experiment. During the September 2000 trip we deployed a second excavation experiment to examine the effect of regrading injuries on recovery rates of *Thalassia*, other macrophytes, and coral. We manually simulated excavation depths of 0 (no sediment disturbance or control) and 30 cm (using the same methods as previously described) in a Latin square design. Six replicates of the 30 cm excavations were filled to grade using pea-sized limestone quarry gravel ("fill" treatment), six replicates of the 30 cm excavations were left unfilled ("no fill" treatment), and 6 replicates were undisturbed.

The Fill Experiment was censussed for the first time during the January 2001 trip. The fill and no fill treatments did not recover significantly during the first four months of the experiment and both had fewer short-shoot counts of *Thalassia* and *Syringodium* than the control treatment (Figure 5) ($p<0.006$, df=2 for both ANOVAs).

Preliminary results from the Excavation and Fill Experiment suggest two things. First, shallow propeller scar injuries may not require any restoration to recover. Second, for injuries deeper than 10 cm, we may need to consider the composition of the community surrounding the injury when deciding what restoration options to recommend. Although the depth and area data have not been analyzed, our observations during our field work indicate that the treatments which have not been regraded have filled in slightly but the margins have expanded. Filling of the 30 cm excavations in the Fill Experiment has so far prevented them from growing larger and the limestone gravel has not been scoured out.

III. Workshops and Journal Publications

In November 2000 two members of our research team, Jud Kenworthy and Paula Whitfield, attended a national workshop at Rutgers University designed to provide scientific information regarding water craft impacts on coastal systems. The workshop, entitled "Impacts of Motorized Boats on Shallow Water Systems," provided our research team with an outlet and discussion venue for the results of the Red Bay Bank study. As part of the proceedings we prepared a manuscript for submission to the Journal of Coastal Research, which will be publishing the workshop in a special issue. A draft of this manuscript is attached to this report.

IV. Oral Presentations

Comparative Analysis of Regrowth into Prop-scars among Seagrass Beds in the Florida Keys: Providing the Scientific Support for Modeling Injury Recovery and Choosing Restoration Strategies. Presented by Jud Kenworthy at the Rutgers University water craft impacts workshop, November 2000.

Role of Storms in the Expansion and Propagation of Disturbances Initiated by Motor Vessels on Seagrass-*Porites* Coral Banks and the Consequences of Management Inaction. Presented by Paula Whitfield at the Rutgers University water craft impacts workshop, November 2000.

Ecological Characterization and Analysis of Disturbance and Recovery Dynamics on Seagrass-*Porites* Coral Banks in the Florida Keys National Marine Sanctuary: Linking Science to Conservation and Restoration of Natural Resources. Presented by Jud Kenworthy, Paula Whitfield, and Kamille Hammerstrom as part of the NOS Science Seminar Series at NCCOS, January 2001.

Table 1. Species list for seagrasses and macroalgae present, including major macroalgal categories. Included are phylum, order, and family levels of taxonomic classification. Also included are our morphological categories for algal thalli [turf (may be fleshy or calcareous), upright fleshy, upright calcareous].

Seagrass	
Family, Order	
Cymodoceaceae, Najadales	
Halodule wrightii	
Hydrocheritaceae, Butomales	
Thalassia testudinum	
Potamogetonaceae, Najadales	
Syringdodium filiforme	
Macroalgae	**Thallus Morphology**
Category	
Calcareous Chlorophyta	
Family, Order	
Anadyomenaceae, Cladophorales	
Anadyomene stellata	upright fleshy
Dasycladaceae, Dasycladales	
Dasycladus vermicularis	turf
Neomeris annulata	turf
Halimedaceae, Caulerpales	
Avrainvillea nigricans	upright calcareous
Halimeda incrassata	upright calcareous
Halimeda monile	upright calcareous
Halimeda opuntia	turf
Halimeda tuna	upright calcareous
Penicillus capitatus	upright calcareous
Penicillus dumetosis	upright calcareous
Penicillus pyriformis	upright calcareous
Rhizocephalus phoenix	upright calcareous
Udotea flabellum	upright calcareous
Polyphysaceae, Dasycladales	
Acetabularia crenulata	upright calcareous
Other Chlorophyta	
Caulerpaceae, Caulerpales	
Caulerpa lanuginosa	upright fleshy
Caulerpa prolifera	upright fleshy
Caulerpa racemosa	upright fleshy
Caulerpa sertularioides	upright fleshy

Table 1, Continued.

Macroalgae			Thallus Morphology
Other Chlorophyta, continued			
	Cladophoraceae, Cladophorales		
		Batophera oerstedii	turf
		Chaetomorpha aerea	turf
	Valoniaceae, Siphonocladales		
		Dictyosphaeria cavernosa	upright fleshy
		Ventricaria ventricosa	upright fleshy
Phaeophyta			
	Dictyotaceae, Dictyotales		
		Dictyota cervicornis	upright fleshy
		Dictyota divaricata	upright fleshy
Rhodophyta			
	Ceramiaceae, Ceramiales		
		Centroceras clavulatum	turf
	Champiaceae, Rhodymeniales		
		Champia parvula	upright fleshy
	Gracilariaceae, Gigartinales		
		Gracilaria sp.	upright fleshy
	Grateloupiaceae, Cryptonemiales		
		Halymenia sp.	upright fleshy
	Hypneaceae, Gigartinales		
		Hypnea cervicornis	upright fleshy
	Rhodomelaceae, Ceramiales		
		Acanthophora spicifera	upright fleshy
		Digenia simplex	upright fleshy
		Laurencia obtusa	upright fleshy
		Laurencia poitei	upright fleshy
		Laurencia papillosa	upright fleshy

Figure 1. Map of the bank system, arrows show the locations of the release channels where bathymetry data was collected.

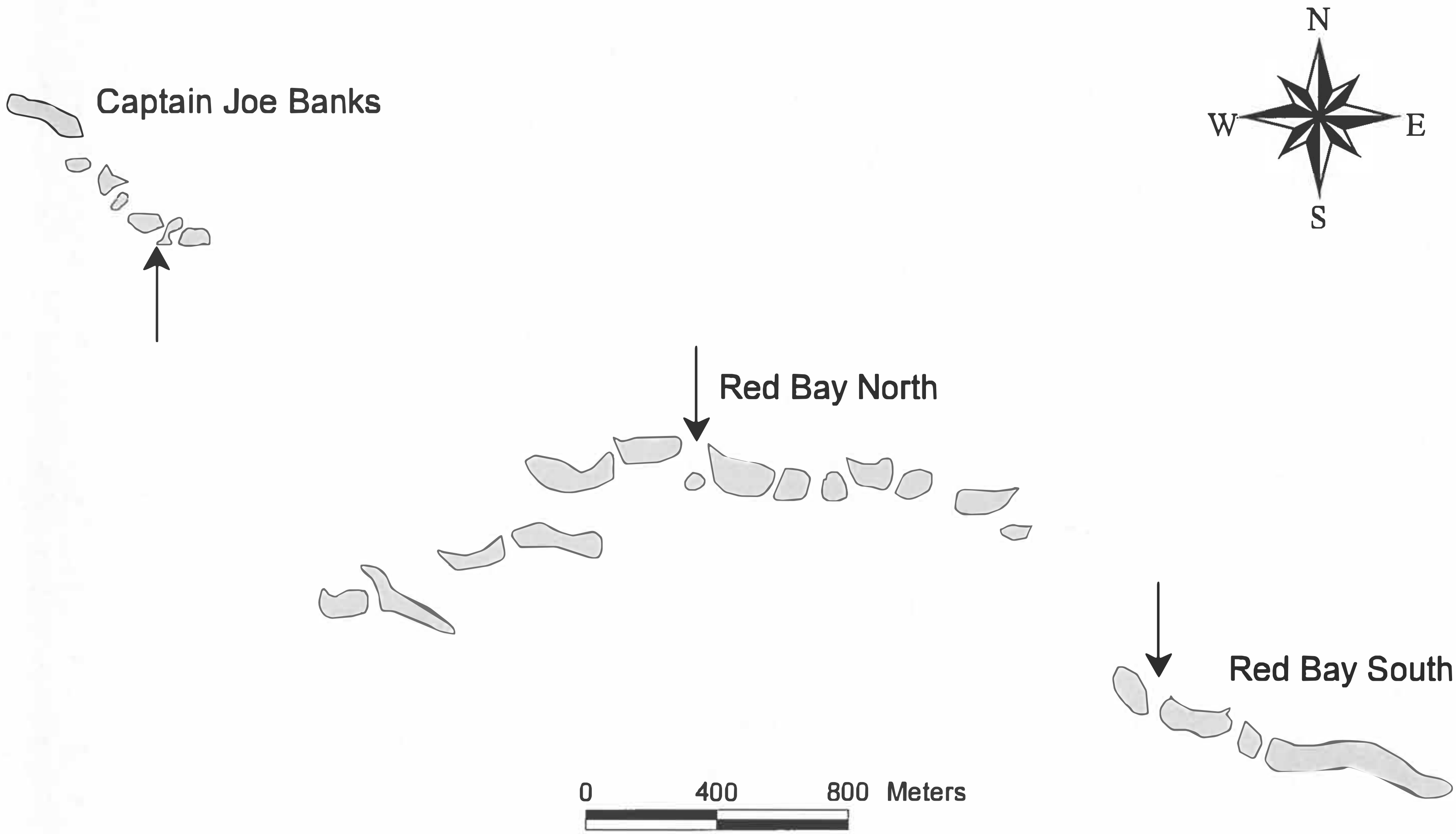


Figure 2. Three-dimensional graphic of bathymetry data collected from an injury.

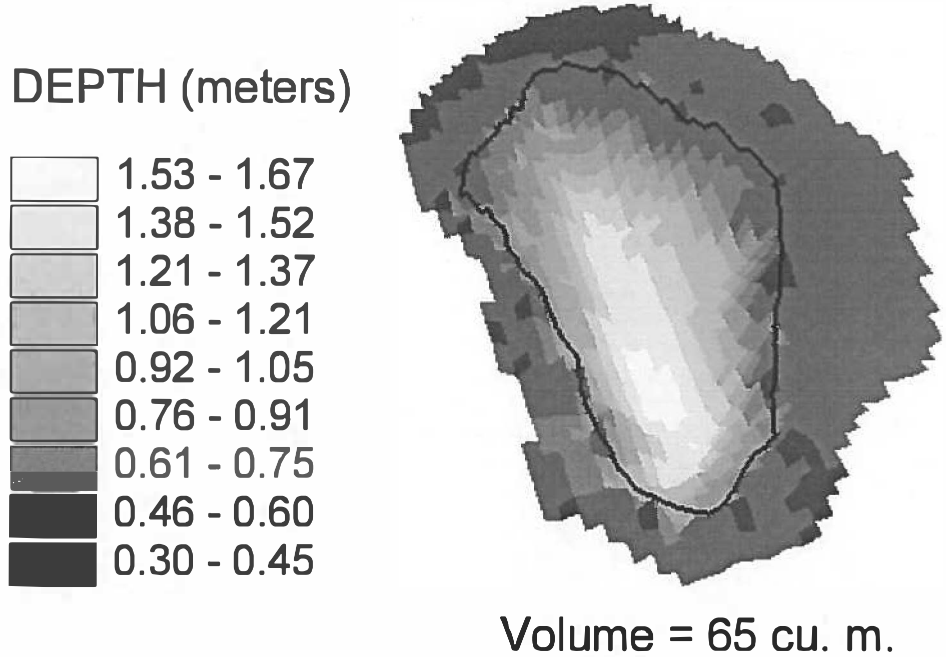


Figure 3. Three dimensional graphic of bathymetry data collected for a release channel.

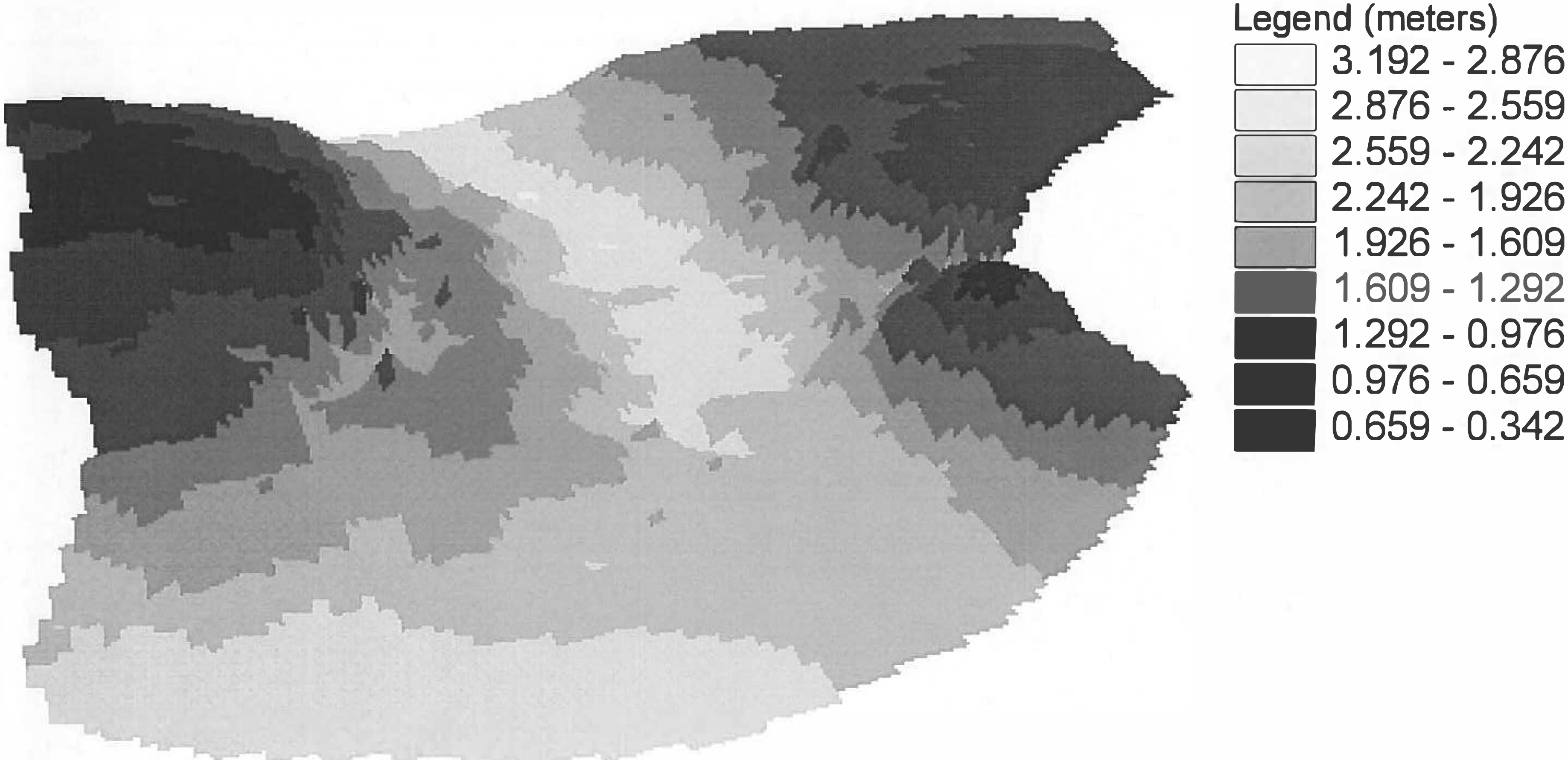
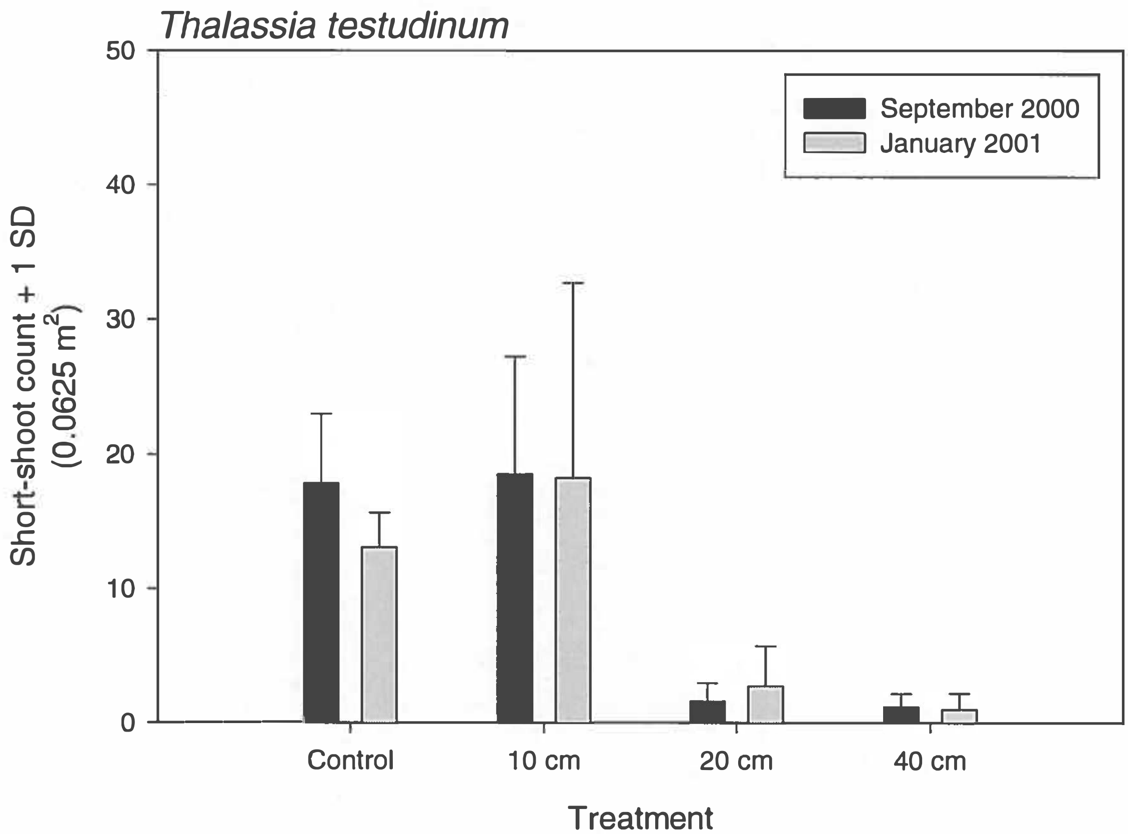


Figure 4. Short-shoot counts collected for *Thalassia testudinum* and *Syringodium filiforme* during September 2000 and January 2001 census dates.



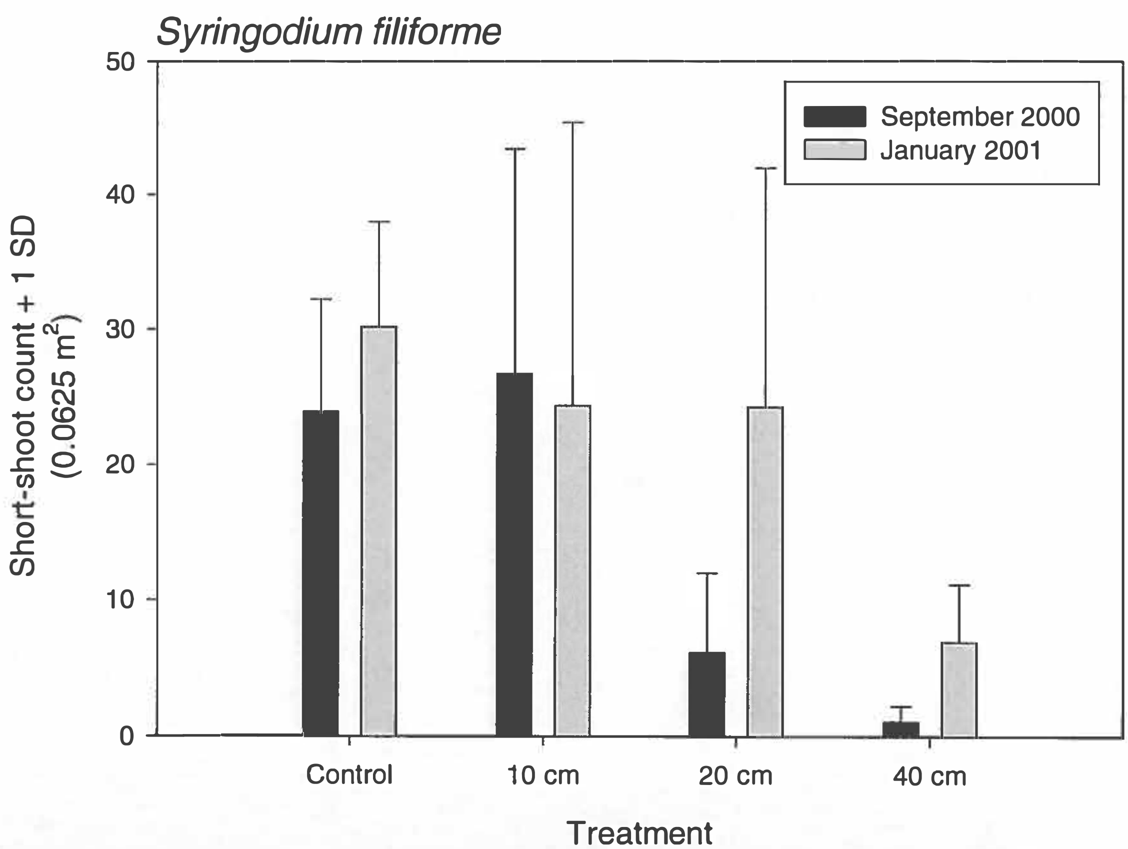


Figure 5. *Thalassia testudinum* and *Syringodium filiforme* short-shoot counts from the Fill Experiment deployed in September 2000.