REPAIR AND MAINTENANCE OF SEAGRASS MEADOWS
IN CHARLOTTE HARBOR

Final Report

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ABSTRACT

Effective habitat restoration is difficult to achieve in aquatic ecosystems. Species targeted for rehabilitation are often affected by multiple, low level stressors which are not very well understood. Seagrasses are a prime example because factors attributable to habitat losses are often regional in scale (e.g. nutrient loading) and are affected by unpredictable events (e.g. rainfall). Seagrasses are often targeted for restoration because of the services that they provide to a healthy ecosystem, such as forage, energy and protection from predators. The best opportunity for seagrass restoration is in the wake of a propeller scar, where natural processes will eventually lead to re-growth and recovery. Several creative, low impact techniques, were developed by Seagrass Recovery, Inc. (Jim Anderson) to stimulate and accelerate regrowth and recovery of propeller scars in Charlotte Harbor. The Sanibel-Captiva Conservation Foundation (SCCF) Marine Laboratory evaluated the effectiveness of these techniques during a one year study period. Underground injections (SAGE) and sediment tubes were placed in the study area and monitored relative to non injected scars and adjacent unscarred habitat. The injected and non-injected scars had higher shoot densities and longer blade lengths than sediment tube treated scars. There were no significant differences in shoot density and blade length between injected and non-injected, however, the injected sections of the scar had higher blade lengths. There was a massive macroalgal bloom in the study area for half of the study period. The thickness of the macroalgae was estimated to be over 1 m during at least three of the sampling events. This unfortunate coincidence left us with a few inconclusive findings. It also served to reinforce the difficulty of restoration in a system affected by multiple, low level stressors. Despite this, we report several key findings. Sediment tubes, designed for sediment stabilization or new habitat creation, were not very effective in a propeller scar in Charlotte Harbor. This conclusion was drawn after 1 year of observation, where the sediment and tube covered any new growth in the propeller scar. It is possible that longer monitoring or better water quality conditions during the study period would have encouraged the shoots to grow through the substrate in the sock. The SAGE injections were much more effective than sediment tubes in stimulating higher shoot densities and longer blade lengths in propeller scars. The process of succession in propeller scars is not well understood and reports of observations following a scar are rare in the scientific literature. This report contains data on this processes and our understanding of how a multi-species seagrass meadow regrows after a propeller scar disturbance.

INTRODUCTION

Charlotte Harbor has experienced a 29% loss in seagrass habitats, while area around the Sanibel Causeway has experienced 87% loss. Much of these losses were attributed to dredging activities or degradation of water quality (Tomasko et al. 2005). However, recent surveys of shallow water seagrass meadows have yielded a startling numbers of propeller scars. A systematic aerial survey of the extent of damage was conducted and a relative scale of scarring was mapped and further evaluated (Bell et al. 2002). Negative impacts on fish and crustaceans were not detected, however, it is widely believed that chronic low level disturbances degrade habitat and productivity (Adams et al. 2001).

Observations of propeller scars over time are rare in the scientific literature. Although commonly observed in marine intertidal algae (Sousa 1979), disturbance and succession in a multi-species seagrass meadow is not well understood. Substratum, microbial diversity, water quality, self-shading, macroalgal shading, and grazing frequency are drivers that can influence the rate of re-growth. Proactive measures that accelerate the re-growth process are the subject of this report. Recovery can be accelerated through measures such as installation of sediment tubes to prevent erosion or below-ground injections to stimulate microbial activity. Further, these techniques offer a high probability of rehabilitating seagrass habitats despite the low probability of success in those seagrass restoration projects attempted thus far. This project served as a demonstration project for future propeller scar restoration in Charlotte Harbor. Seagrass Recovery, Inc. treated several marked propeller scars in the J.N. “Ding” Darling National Wildlife Refuge. A sub-set of these were monitored to determine the effectiveness of these creative techniques.

MATERIALS AND METHODS

To evaluate the effectiveness of propeller scar remediation and restoration, monitoring was initiated immediately following the installation of sediment tubes and injection of SAGE. Upon our request, Seagrass Recovery injected in 12 m sections, alternating with 30 m sections with no injections. The sections were replicated twice on the same scar to provide a greater area to evaluate. The age of a propeller scar determined the rate of recovery and shoot density, therefore a single scar was evaluated for either sediment tube or SAGE injected treatments. At the ends of the two scars targeted for monitoring, a PVC pole, visible above the water, was pounded into the substratum. Below the water’s surface, two short PVC stakes delineated the start of the injected section, while a single PVC delineated non-injected sections. The total number of shoots and the length of five blades from shoots in a 0.0625 m^2 quadrat (25 cm square) were measured for 3 commonly occurring species of seagrasses (*T. testudinum, H. wrightii, S. filifomes*). The five blades measured were the longest blades on five separate, haphazardly chosen shoots. If there were less than five shoots in a quadrat, then the longest blades for available shoots were measured. Divers deployed quadrats along an underwater transect. A total of fifteen quadrats were sampled for the sediment tube and injection treatments, fifteen in non-injected propeller scars, and 15 quadrats immediately adjacent to the scar (target). In order to ensure non-biased selection of quadrat position, a random number generator was used to determine the distance from the beginning of each section to the first quadrat. A transect tape was extended on the monitored scars and quadrats were collected at 1.5 m intervals. Surveys were conducted a total of nine times during the one year study, every 30 to 60 days.

Data that were recorded on dive slates by divers were entered into a Microsoft Access database upon returning to SCCF marine laboratory. A second individual checked the entered data to ensure that there were no mistakes in transferring data from datasheets to the database. Mean shoot densities and standard deviations over the study period were plotted in SigmaPlot (version 10.0). Blade lengths were first averaged per quadrat, and then the mean blade length was plotted over the study period. Statistical evaluations were necessary to determine whether there were differences between injected and non-injected treatments and whether there were any monthly increases in density and blade length. Data were determined to have unequal variances, therefore non-parametric techniques were used. A Wilcoxan signed rank test was used to determine if differences were significant, the null hypothesis was rejected if $p < 0.05$. Comparisons were made among treatments for each month, for the entire study period, and among months for the study period.

RESULTS

There were two propeller scars that were monitored during the study period. Unscarred seagrasses adjacent to the two scars were monitored to provide a meaningful (albeit ambitious) target for propeller scar mediation. The mean shoot densities in the two target areas differed in density ($p<0.05$) with the area adjacent to the injected scar having shoot densities ranging from 15.5 to 18.3 per quarter meter square (0.0625 m2) while the area adjacent to the sediment tubes ranged from 11.9 to 15.9 per quadrat. Monthly comparisons of shoot density for treatments and the target are reported in Figure 1. A comparison of treatments over the entire study period (all months) revealed that sediment tube treated scars had the lowest shoot densities, less than 1 shoot per quadrat. There were no significant differences between injected and non-injected which had shoot densities between 3 to 4 shoots per quadrat. Over the course of the study period, there were some notable patterns in shoot density in the injected treatment. In October 2006, shoot densities in injected sediments were less than 1 shoot per quadrat. Shoot density increased to 4 shoots per quadrat in November in the injected and up to 3 shoots per quadrat in non-injected scars.

Blade lengths in target areas were between 111 mm and 234 mm (Figure 2). The monthly comparisons in the target and treated prop scars indicate a seasonal pattern of growth with blades growing from February to September. Over the entire study period, blade lengths were significantly lower in propeller scars than in the target area (Table 2), similar to the results obtained for shoot density. Sediment tube treated scars had the lowest blade lengths between 2 and 31 mm, while injected and non-injected had longer blade lengths (71-160 mm) but were not significantly different. However, recovery of prop scars was evident in monthly comparisons and towards the end of the study, blade lengths were no different from the target.

DISCUSSION

The one-year sampling period provided an opportunity to track the prop scar remediation relative to unscarred, high quality habitat. Unfortunately, the study period was at the end of a 3 year wet cycle, which is thought to be responsible for massive drift algae blooms. Drift algae is a normal component of a euryhaline sub-tropical estuary, however, the volume and biomass that accumulated in the study area obscured the effectiveness of the remediation. From January through April, the drift algae accumulation was so thick that it had to be pushed away from the prop scars in order to lay down the quadrat. The macroalgal species were documented by Dawes (2004) covered and appeared to smother the seagrasses during the study period. Despite this, several conclusions can be drawn about propeller scar remediation and restoration because of this work.

First, the sediment tubes were designed to stabilize sediments where there are high current velocities and wave action such as along navigation channels. Alternatively, they can be used to "buld up" new habitat to the correct depth (Jim Anderson, personal communication). They were used effectively in the Florida Keys where wave action and boat wakes can cause extensive erosion. In Charlotte Harbor, the benefits were not realized at the conclusion of the study period. Sediment tubes were laid on existing prop scars where some new growth had started. The tubes took about 2 months to decompose, and their thickness and application caused the lowest shoot densities. Perhaps longer monitoring or improved water quality conditions (e.g. light) during the study period would have encouraged growth through the sediment in the tube. However after the one year period, shoot density remained the lowest. Clearly, sediment tubes are effective for large vessel groundings to stabilize seagrass meadows. In Charlotte Harbor, stabilization was not required and the sediment tubes were less effective than SAGE injection or no injections.

Injected propeller scars rapidly increased in shoot density and blade length early in the study period. Since the scars were injected in September, October and November, it follows that the treatment would have an effect early in the study period. While we thought the injections would significantly increase prop scar shoot densities they did not out perform naturally recovering sections (non injected). This is partly due to the macroalgae covering the study area for half of the study period beginning precisely when the injections were stopped.

We learned how *Thalassia testudinum* recovers from propeller scar damage in injected and non-injected sections. Early in the study period blade lengths were between 25 and 75 mm. Small leaves and shoots were appearing in the scar when adjacent lateral rhizomes and meristems grew. Later in the study period, blade lengths were between 100 and 150 mm, indicating growth over the growing season. This is a favorable sign that this scar is repairing, as the slope of the increase was similar to blades in the unscarred seagrass. Also, blade lengths in the injected sections were consistently longer than in non-injected sections demonstrating that the injections provided some stimulus of blade growth.

The creative, low impact methods offered by Seagrass Recovery offer some restorative tools to damaged seagrass meadows. In Charlotte Harbor, SAGE injections promoted blade growth and initially promoted an increase in shoot density. The sediment tube treated scar, however, did not demonstrate any promotion of blade elongation or shoot density. Given that sediment tubes are primarily for stabilizing sediments while promoting seagrass growth, their effectiveness in the study area was limited. The entire study area was smothered in drift algae for at least half of the study period, so the full potential of these treatments needs to be evaluated at additional locations in Charlotte Harbor.

LITERATURE CITED

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Table 1. Statistical comparison of shoot density for *Thalassia testudinum* in propeller scar mediated treatments and adjacent unscarred seagrass (target). A non-parametric ANOVA (Wilcoxan signed ranks test) was used to compare mean values among the groups.

	Injected	Non-Injected	Sediment Tube	Target
Injected	ns			
Non-Injected	ns	ns		
Sediment Tube	**	**	ns	
Target	**	**	**	ns

Table 2. Statistical comparison of blade length for *Thalassia testudinum* in propeller scar mediated treatments and adjacent unscarred seagrass (target). A non-parametric ANOVA (Wilcoxan signed ranks test) was used to compare mean values for each group.

	Injected	Non-Injected	Sediment Tube	Target
Injected	ns			
Non-Injected	ns	ns		
Sediment Tube	**	**	ns	
Target	**	**	**	ns

Figure 2. Shoot density in the study area. Symbols are mean shoot densities are reported in the number of shoots per 25 cm by 25 cm quadrats for each sampling event, error bars represent standard deviation.

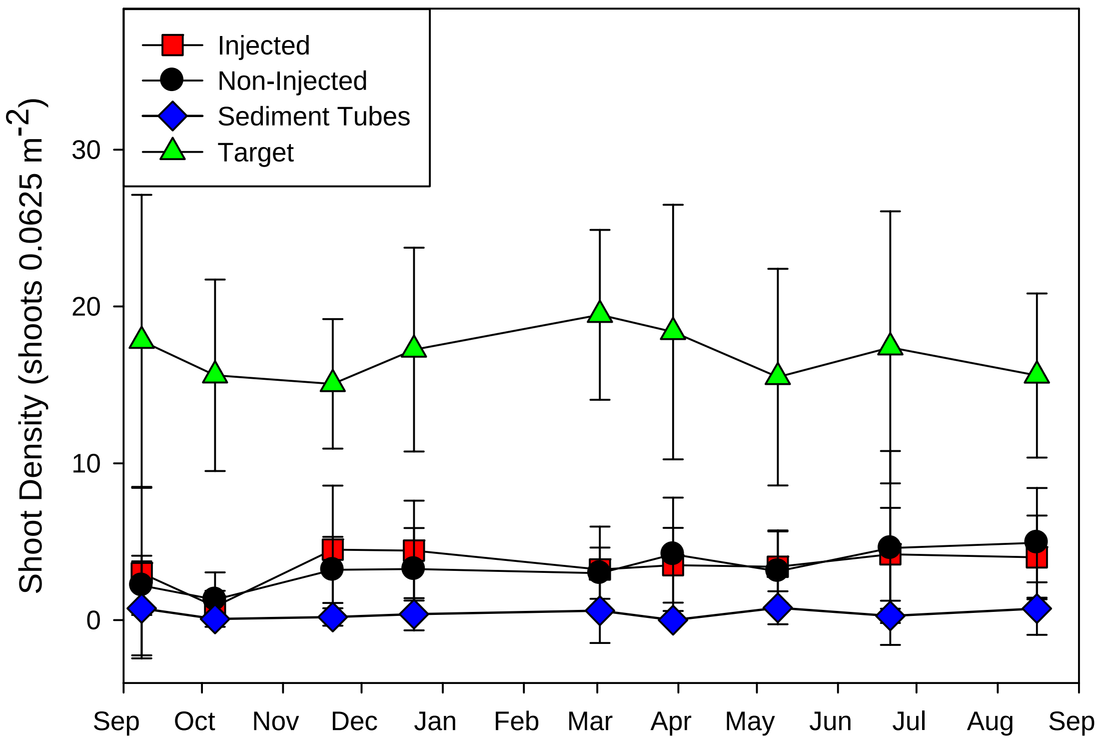

Figure 3. Blade length in the study area. Symbols are the mean blade length for blades in the quadrats