

# SEAGRASS TRANSPLANTING AND RESTORATION IN TAMPA BAY

J. Nicholas Ehringer, James Anderson

## ABSTRACT

Reports of seagrass decline worldwide have been occurring for many years. The decline has been attributed to dredge and fill, pollution, and propeller scarring. Past techniques to restore seagrass beds have not always been successful with many transplanting projects having only a 20% survival rate. New techniques for seagrass recovery are presented that include: a seagrass formula for regrowth into prop scars, an injecting boat that can inject nutrients into prop scars, and a planting boat that can plant short shoots of *Halodule wrightii* in bare root or in peat pots. The planting boat can also plant seedlings of *Thalassia testudinum* grown from seeds. The injection system for regrowth of seagrasses into prop scars yielded results for *Thalassia testudinum* as high as 68% of complete recovery in 15 months and for *Halodule wrightii* at 76% of complete recovery in 15 months.

### Seagrass Loss in Florida

Seagrass loss in Florida has occurred for many years and has been extensive. The primary reasons for seagrass loss have been dredge and fill, changes in water quality and propeller damage. Examples of seagrass loss in Florida as reported by Sargent et al. (1994) were as follows:

- Florida has lost about 2 million acres of seagrasses.
- Indian River Lagoon has lost 30%.
- Charlotte Harbor has lost 29%.
- Tampa Bay has lost 80%.
- Ponce Deleon Inlet has lost 100%.
- St. Andrews Bay has lost 30%.
- Florida Bay has lost 60,000 acres since 1987.

The presence of prop scars in seagrass meadows has been a concern for a number of years. Sargent, et al (1994) reported that statewide there are about 63,989 acres of seagrass that have moderate to severe propeller damage. The most heavily scarred areas are in Monroe, Lee, Dade, Pinellas, and Charlotte counties. Monroe County leads the list with over 15,000 acres of moderate to severe damage.

The primary question about prop scar damage is: what can be done about it? The answers are varied and based upon

community approaches. Some of the techniques are:

- Some communities have decided just to wait and let the seagrasses regrow on their own.
- Pinellas and Hillsborough Counties have decided to shut down some seagrass beds to boaters. They have erected signs marking seagrass beds that are restricted. Both counties have also set up zones for “seagrass caution.” They have erected markers to warn boaters of the presence of seagrasses and to show caution. Ehringer (2000) compared restricted zones, caution zones and unrestricted zones in seagrass beds for propeller damage in Pinellas County for an eight-year period. Damage to seagrasses from boats was not significantly different from restricted zones to caution zones. The unrestricted zones were more heavily damaged. A conclusion of this report is that if signs are present, whether restricted or caution, less damage occurs in the seagrass beds from boaters.
- In the Florida Keys one approach to regrowth into prop scars was to erect

bird roosting posts. The posts were erected in the prop scars. Birds roosted on the posts and their excrement fertilized the seagrasses below.

- Experiments have also been conducted by Ehringer (2000) and others, to plant seagrasses into the prop scars and wait for recovery. This technique produced a recovery of only about 20% to 40% in a 2-year period.
- Another technique is to inject nutrients and plant growth regulators directly into the prop scars to stimulate the growth of seagrasses on the margins of the prop scar. Once stimulated, the seagrasses regrow back into the prop scar. This technique has been tested by Ehringer and Dawes (Dawes, 1997).

#### **Recovery of Seagrasses from Prop Scar Damage**

Recovery of seagrasses into prop scars can take many years. Zieman (1976) stated that *Thalassia testudinum* (turtle grass) might require at least two years to begin to recolonize a prop scar. Durako et al. (1992) stated that recovery to normal density would take from 3.6 to 6.4 years. Others have stated that complete seagrass recovery may take as long as ten years (Lewis and Estevez, 1988).

One of the reasons postulated for the slow regrowth of *Thalassia testudinum* into prop scars is the slow appearance of a new apical meristem on the rhizome (Dawes et al. 1997). Formation of a new apical meristem may take as long as 10 months (Kelly et al. 1971). However, this only partially explains the slow regrowth. Ehringer in 1993 speculated that the loss of the anaerobic bacteria in the sediment due to the stirring effect of the prop was part of the problem. Perhaps the bacteria were a

source of nutrients to the roots and rhizomes. It may take a period of time to regrow the bacteria colonies and, subsequently, the resulting nutrient load in the sediment.

Seagrass planting programs have not been very successful. Fonseca, Kenworthy and Thayer (1987) reported results of an extensive comparison of seagrass transplanting techniques. In one of their planting projects all manatee grass was gone and only 30% of the shoal grass had survived. In another planting project in Tampa Bay by Fonseca, Kenworthy and Courtney, 14 plots of seagrasses were planted with 6 plots losing 95% to 100% of their plants. Another 5 sites were lost later. Fonseca, Kenworthy, Courtney and Hall reported in 1994 on another transplanting project in which 40% of transplants of *Syringodium filiforme* survived. All of their transplants of *Halodule wrightii* failed to survive. Techniques have been tried using peat pots, bare root, staples, and a variety of other methods (Breedveld 1975; Fonseca 1987). Yet the survival of the transplants remains low (Fonseca 1996).

#### **Injection of Prop Scars**

Experiments have been conducted by Ehringer in Tampa Bay since 1993 working with fertilizers and plant growth regulators in an attempt to regrow seagrasses into prop scars. Experiments were conducted in Cockroach Bay, a small bay attached to Tampa Bay, and at the Fort DeSoto Aquatic Preserve (Pinellas County) from 1993 through 2000. From 1997 to 2000 the manner of injection was an injector boat built by James Anderson of Ruskin, Florida.

A seagrass formula was arrived at by a series of small experiments conducted at Cockroach Bay and at the Department of Environmental Protection's fish hatchery from 1994 to 1997. Small tanks were set up

at the hatchery with marine sediments and flow-through salt water. Short shoots of *Thalassia testudinum* were grown in the tanks. A series of experiments were conducted using a variety of plant growth regulators supplied by Abbott Laboratories, including auxins, cytokinins and gibberellins to determine if apical meristem growth could be initiated on a cut rhizome. Only one combination of chemicals induced apical meristem growth. A mixture of 2 ml gibberellic acid and 2 ml 6-benzyladenine injected near the cut rhizome caused apical meristems to grow on the rhizomes in 12 of 15 plants within 4 weeks. No apical meristems grew on the controls or any other combination of plant growth regulators. Further experiments were conducted to determine whether urea or nitrate was an optimal source of nitrogen for the rhizomes of *Thalassia testudinum*. Comparisons were made between the sediments of a prop scar and those of a healthy seagrass bed. The largest difference between the two was that of nitrogen. Ammoniac nitrogen was about 60% less in prop scar sediments than in healthy seagrass sediment. Experiments conducted with Clinton Dawes determined that the use of nitrates produced no effect on growth (Dawes 1997). Therefore, a series

of small experiments was conducted at Cockroach Bay to determine if urea could be an adequate source of nutrients for *Thalassia testudinum*. Urea was injected around prop-cut rhizomes in concentrations of 2 ml, 4 ml, 6 ml, and 10 ml dissolved in 10 ml of seawater. Injections were made by hand, one injection every two weeks for 4 injections. Seagrasses regrew into the prop scars in all of the concentrations above that of the controls. More growth was evident in the 10 ml concentration. This series of experiments led to the formulation of urea, gibberellic acid and 6-benzyladenine as a formula that could induce growth of *Thalassia testudinum* into damaged seagrass beds.

James Anderson built a special boat and injection system in the winter of 1997. The boat was designed to inject a nutrient formula as mentioned above into the seagrass sediments. The machine has a series of small injectors that introduce about 10 ml of formula into the sediment. The injectors are set in a circular pattern around a wheel (Fig. 1). As the wheel rolls along the bottom, the nutrients are injected into the sediment with a force of about 20 pounds per square inch. Injections only occur when the nozzles are pointed down.



Figure 1. Injectors on Anderson's injector boat.

There are two wheels that roll along the sediment parallel to each other injecting at the same time. The boat contains a 100-gallon tank for mixing of the formula. The formula is pumped from the tank through a series of tubes down to the injectors.

A mixture of 100 pounds of prilled urea 44% (purchased from Scott's) plus 2 ounces of synthetic cytokinin (6-benzyladenine) and 2 ounces of a gibberellic acid (donated by Abbott Laboratories) was mixed in 100 gallons of seawater. The seawater was obtained from the bay at the site of the injections. Injections were placed into the sediment about every 20 centimeters along designated prop scars. Injections were made at Fort DeSoto beginning in May of 1997 and extended for 5 injections approximately every 7 to 14 days. An additional injection was made in May of 1998. Injections were also made in Cockroach Bay in the same manner.

A counting method was established to determine the number of new shoots that would potentially grow into the prop scars after the injections. A one-meter square PVC frame was made to place over PVC stakes placed in a square pattern over a prop

scar (Fig. 2). The center portion of the frame had a 1 m × 22 cm frame inside the larger frame that fit over the prop scar lengthwise.

This frame was set over the stakes at each counting period so that the seagrass shoots could be counted each time in the same manner. Six sites were established for counting in each prop scar, with up to 10 scars per study. Sites were set up as controls in the same manner. The results from the injection sites were as follows:

- In Cockroach Bay experiments were conducted over a 2-year period. Using the injecting boat in this series of experiments with 75 replications *Halodule wrightii* regrew into prop scars at 76% of complete recovery in one season. Complete recovery was determined by setting the frame randomly over established seagrass beds and counting the shoots in the frame. Ten counts were made in *Thalassia testudinum* and 10 counts in *Halodule wrightii*. The numbers were averaged to determine the approximate value of a normal seagrass bed in Fort DeSoto and in Cockroach Bay. Complete recovery



Figure 2. PVC frame set over a prop scar.

of *Thalassia testudinum* would be 70 short shoots per 25 cm by 1 meter. Complete recovery of *Halodule wrightii* would be 200 short shoots. The results of the experiments are listed below. Statistics for all of the experiments show that regrow was significantly greater using the nutrient formula (Table 1).

- In Fort DeSoto at the start of this experiment 9.25 shoots of *Thalassia testudinum* were found in the prop scars (13.2% of complete recovery). The prop scars were injected with the injector boat. After 15 months the average number of shoots was 47.3, or 68% of complete recovery (Table 1). Therefore, prop scar recovery had grown to the point of 68% of a normal seagrass bed in 15 months at Fort DeSoto as a result of the injections.

Further experiments will be conducted in 2001 in Pinellas County on the injection system to verify the recorded growth of seagrasses into prop scars via the injection system.

**Mechanical Planting**

In early 1998 James Anderson of Ruskin, Florida designed, built and patented a seagrass planting boat (Fig. 3). The pontoon boat floats over the seagrass beds while two workers on the boat “feed” the

seagrasses into a planting wheel. The wheel pushes the seagrasses into the sediment at a precise depth so that the rhizomes are about 5 cm into the sediment. Depending upon the number of seagrasses to be planted per acre, the boat has the potential to plant an acre in a day or two using two to three workers. This depends upon the number planted per acre. For example, planting 15,000 shorts per acre would require 2 days, while 8,000 per acre would require one day.

This technique requires fewer workers, is faster than traditional methods, and is less expensive. In addition, since the planter floats over the seagrass beds, there is no damage to the planted seagrasses by workers walking through the beds to plant new seagrasses. The planter has been used on a limited basis in Cockroach Bay, in Fort DeSoto, in the Florida Keys and in Laguna Madre waterway at Corpus Christi, Texas. The system plants *Halodule wrightii* in peat pots or as bare root units. In 1998 and in 1999, 7,850 short shoots of *Halodule wrightii* were planted using the boat in Fort DeSoto. Approximately 48% of the units survived yielding 3,980 square feet of *Halodule wrightii* in a count conducted one year later.

**A Seagrass Nursery**

A seagrass nursery was established in the field using plants removed from Fred Howard Park. The seagrasses (*Thalassia*

**Table 1.** Injection results for Cockroach Bay and Fort DeSoto (average number of short shoots per 25 cm × 1 meter).

		MAY 1997		SEP 1997		JULY 1998	
		injected	control	injected	control	injected	control
Cockroach Bay	<i>Halodule wrightii</i> <sup>1</sup>	21.5	3.0	45.5	6.5	148	10
	<i>Thalassia testudinum</i> <sup>2</sup>	6.75	4.13	—	—	23.0	9.10
Fort DeSoto	<i>Thalassia testudinum</i> <sup>3</sup>	9.25	14.0	40.7	17.3	47.3	19.5

<sup>1</sup>t stat = 23.41, P(T<=) one tail and two-tailed yields less than .0001, t critical one tail = 1.761, SS = 1127.5, Mean<sub>A</sub> = 108.625, df=0  
<sup>2</sup>t stat = 7.00, P(T<=) one tail and two-tailed yields less than .0001, t critical one tail = 1.894, SS = 687.94, Mean<sub>A</sub> = 11.375, df=14  
<sup>3</sup>t stat = 21.14, P(T<=) one tail and two-tailed yields less than .0001, t critical one tail = 1.812, SS = 11023.27, Mean<sub>A</sub> = 43.63, df=0



Figure 3. Anderson's planting boat. Note the planting wheel in the center.

*testudinum* and *Halodule wrightii*) were removed as part of a mitigation plan to widen the beach at the park. Approximately 1,000 square feet of seagrasses were planted at Mangrove Point, near Simmons Park in Tampa Bay. The site was chosen for the following reasons:

1. The site was privately owned. It does not have boat traffic through it.
2. The site had some seagrasses growing in it along an opposite bank; therefore, the water quality was conducive to seagrass planting.
3. The salinity regime was within a normal range for seagrasses.
4. The site has an easy access for boats and the site is shallow.

Beginning on June 18, 1998 and several dates thereafter, seagrasses were planted at the site by hand. Plants were soaked in the seagrass formula of urea, gibberellic acid and 6-benzyladenine prior to planting. Twenty-two boxes were planted on June 18, 1998. About 400 short shoots of *Halodule wrightii* were planted with the planting boat. In August about 650 short shoots of *Thalassia testudinum* and 475 short shoots of *Halodule wrightii* were

planted at the site by hand. Two years after planting a visit to the site revealed that the seagrasses had coalesced into a bed of approximately 700 square meters.

#### **Planting Seeds of *Thalassia testudinum***

Seeds of *Thalassia testudinum* typically float inshore in very large amounts in the months of August and September in Monroe and Dade Counties, Florida. About 3,879 seeds were collected in September of 1998. An additional 650 seeds were collected a week later. The seeds were placed in small peat pots with metal disks attached to their base. The units were stored in saltwater upland tanks at a seagrass nursery in Ruskin, Florida and in tanks at Long Key. The seeds were kept at the nursery for about 6 weeks allowing them time to grow into small seedlings. The planting units were transported to the Florida Keys and planted at a site selected by personnel from the Florida Department of Environmental Protection (DEP). The seedlings were planted using the planting boat. The use of peat pots with disks attached proved to be a good choice because the units were set into the sediment in a manner that could not be dislodged by currents.

### SUMMARY

Since 1991 a series of experiments has been conducted to attempt to regrow seagrasses into propeller scarred beds. Analyses were made of the sediments of healthy seagrass beds and compared to that of a prop scar. From this series of experiments a formula was derived that replaced the lost nutrients in a prop scar. Following this, another series of experiments was conducted in order to find a formula for a plant growth regulator that would grow an apical meristem on a cut rhizome of *Thalassia testudinum*. The combination of nutrients and plant growth regulators was tested in prop scars in Cockroach Bay and Fort DeSoto. The result showed that about 68% of complete regrowth was possible in one season for *Thalassia testudinum* and 76% for *Halodule wrightii*. The formula was injected into the sediment using an injector boat built by James Anderson. Mr. Anderson also built a seagrass planting boat that was capable of planting up to an acre of seagrasses in one day. The boat has been tested in Tampa Bay, the Florida Keys and in Texas. The planting boat has been used to plant short shoots of *Halodule wrightii* in peat pots and bare root. It has also been used to plant seedlings of *Thalassia testudinum* grown from seeds in the Florida Keys. These new techniques, taken together, offer a wide range of mitigation possibilities for recovery of seagrasses. Seagrasses can be planted in bare areas, prop scars can be recovered, and planting of seagrasses can be accelerated by means of a planting boat.

Future research is needed to refine some of the techniques demonstrated in this study. For example, the technique of using seeds of *Thalassia testudinum*, growing them in peat pots, and planting them with the planting boat needs a rigorous evaluation since no follow-up data is available. The seagrass nursery concept worked very well, but needs to be expanded to other sites, especially an upland nursery. Finally,

the use of injections can be further quantified with injections into newly planted sites to determine whether or not growth of newly planted seagrasses will occur more readily with the nutrient additions.

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*Ehringer, Anderson*

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(JNE) Hillsborough Community College, 10414 E.  
Columbus Drive, Tampa, FL 33619; (JA) 3523 24<sup>th</sup>  
Street South, Ruskin, FL 33570