Seagrass Survey: November 2001 Resurvey at the Florida Power Crystal River Generating Facility.

Revisit to Area last surveyed in 1995 by MML.

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Introduction

Mote Marine Laboratory (MML) surveyed seagrasses at the Florida Power Corporation (FPC) Crystal River facility in 1993, 1994 and 1995 (Estevez and Marshall, 1993; 1994; and 1995) in an attempt to determine the effect of newly installed helper cooling towers on the distribution of Submerged Aquatic Vegetation (SAV) in the discharge area and within the adjacent estuarine environment. Earlier Mattson et al. (1988) surveyed seagrasses in the thermally impacted area and found that standing crop, productivity, and growth rates were lower than at sites away from the Point of Discharge (POD). MML found several trends in their 3 years of study; 1) several new beds of SAV appeared along transects which were largely completely barren in 1993; 2) recruitment of seagrass into barren areas was not extensive; 3) 8 of the 15 surveyed beds showed some expansion beyond their original boundaries 4) percent coverage of SAV declined at 10 of 15 sites. FPC contracted the Coastal Seas Consortium, Inc., to resurvey the same area in November 2001 in order to determine if SAV beds have changed since the 1995 MML survey.

Our goal in the 2001 resurvey was not to revisit all of the sites but to select several in the areas considered to be most strongly impacted by the thermal effluent and to compare those to the MML (1993 through1995) results. Unfavorable weather conditions (rain and strong winds) limited us to surveys of basins 1, 2, and part of 3 (Figure 1). Basin 4 was not surveyed due to poor visibility. Observations were made in areas where visibility allowed and during low tides when we could walk the flats.

Methods

Station surveys

Our methods were much the same as those used by MML. A recent model Garmin GPS Map 76 was used to relocate the beds from location data given in the MML reports. After arriving at a station we attempted to find the original SAV boundary markers used by MML to delineate the seagrass bed edges in the first year of the MML studies (Estevez and Marshall, 1993). In 2001 we tried to find the markers by dragging a weighted rope through the previously marked beds. MML used the same method in its three years of monitoring. We found no markers at Stations 1 and 3 and two markers at Station 2. We therefore were not able to make the boundary measurements reported by MML. We relied upon MML's recorded GPS location data to find the approximate center of each bed. The Garmin GPS map 76 uses a Wide Area Augmentation System to improve accuracy of measurements and while we tried to find the SAV bed centers we were probably off by some unknown distance as a result of recent changes in the GPS navigational system. Finding two of the original markers at Station 2 at least confirmed that we had found the original study site. Michael Marshall's (a participant in and co-author of the MML studies) memory of the MML study sites coincided with the GPS-found locations.

We used the GPS unit to locate the shoreward and seaward edges of the study sites. We stopped the width measurements when we reached 100 meters beyond the inside edge of each seagrass bed. The beds at each of the basin 1 sites extended well beyond the 1995 boundaries.

We used a 1-m^2 quadrat divided into 100 subunits (10X10 cm squares) to determine % cover within each bed (Figure 2). Our % cover observations were taken at a series of haphazardly selected points by tossing the quadrat in front of us as we walked or swam through the study sites.

Transect Surveys

We used a similar quadrat technique to determine SAV bottom cover percentages along MML transects 1W, IN, 2W, 3W, 4W and 5W. We attempted to do more transects but poor water visibility limited this effort. . Instead of towing divers along the entire length of each transect we used a bounce diving method by which our observation points along each transect were spaced at 100m intervals (see Figure 3, transect 5W as an example of the dive point spacing). Upon arrival at a site a diver would determine SAV cover within 5 replicated 1m^2 quadrats and the boat operator would record those observations and depth, bottom type, and GPS determined location data. We used the MML location data again to find the transects. In most cases there were no markers left from the MML studies but we did find, through GPS navigation, two wooden stakes at the exact MML reported starting location at the northern most point of transect 5.

Results and Discussion

The seagrass bed begins at a point 74.6 meters away from the point of discharge (POD) and continues across Basin 1 to the saltmarsh on Basin 1's northern boundary. Transect seagrass observations (Table 1) from Transects 1N, 1W,and 2W (Fig.3) which traverse Basin 1 show seagrass % coverages range, as an average of the series of points checked on each transect, from 32% on Transect 1N to 39% on Transect 2W. *Halodule* was found at 50% of the points checked on transect 1N, at 62.5% of the points on Transect 2W, 75% of the points on Transect 3W, and at 55.6% of the points on Transect 1W (not including the 2A points). The 2A points were an extension of transect 1W into Rocky Creek. *Halodule* was found at several points inside the creek on its banks until a point was reached where rocky substrate replaced the soft sediments found at the creek mouth.

MML found a "new" seagrass bed on Transect 1N in 1995 with an average percent over of <5% mean cover. The bed was irregularly shaped. By November 2001, percent cover at the 14 spots surveyed on this transect reached 100% based on the mean of bottom coverage from 5, 1 M^2 quadrats. Thus on this transect seagrasses are much more widely distributed and bottom coverage is much higher than when last observed in 1995.

The same is true of the other Basin 1 transects, 1W, 2W, and 3W. No large beds of seagrass were found on these transects in 1993, 1994, or 1995(MML 1993, 1994,1995- see Figure 3). The only seagrass found on these transects in the MML study were centered around the black dot points shown in Figure 3. In our survey, November (2001) we found an extensive bed of seagrass with an overall average for all observed points of 39.19 % for Transect 2W, 38% for Transect 1W and 34.5% for Transect 3W. Seagrass cover reached 100% (as shown in Figure 1) for several points on these three transects.

Intensive monitoring stations.

Basin 1 Stations.

We visited all three of the Basin 1 stations (Stations 1, 2, and 3) which were originally located and monitored by MML in 1993. We were not able to find the iron and concrete parking stone markers that were set out in 1993. We relied upon the MML GPS derived latitude and longitude data to find the beds. We searched for but could not find the center point markers at any of the sites we visited. We did find two re-bar edge markers at Station 2. Our bed width measurements were therefore made from the GPS located center of each bed to the outside edge or to a point not exceeding 100 meters past the shoreward point. The 1995 Station 1 measurements (MML, 1995) showed that the bed width was not much greater than when it had been first measured in 1993: it averaged 2.88 feet wider than the original 1993 measurement of 13.17 feet from the approximate center to the seaward edge. In 2001 we stopped our survey on Station 1 at 217 feet from the approximate position of the center marker. The *Halodule* in this area continued much further toward the discharge channel.

Halodule coverage in the shoreward side of Station 1 averaged 88.9% (Table2). In 2001 seagrass in the outer area beyond the position of the edge in 1995 averaged 97.9%. These % cover data are similar to those reported by MML (1995;). MML reported an interior cover by *Halodule* of 76.5%. The perimeter seagrass in the MML 1995 report was 78.4%. *Halodule wrightii* was the only seagrass present in the Station 1 area in all of the MML reports and in our 2001 survey.

The interior area of Station 2 had a mean of 30% *Halodule* cover in 2001. After swimming beyond the southern edge of the vegetated area we found a sandy patch with 0% seagrass cover. Beyond that patch to the south seagrasses started up again and continued toward the discharge channel. *Halodule* in that area averaged

74% cover. MML reported an interior %cover of 47.1% and a perimeter % cover of 44.0% in 1995. Their 1994 report showed higher percent cover in the interior, 96.4% and perimeter, 89.3% bed areas. The sandy patch seen in 2001 was approximately 114' wide so the seagrass beyond that area should be considered a new bed. The bed was determined to be 136' wide from the north edge to the beginning of the sand patch. This is considerably wider than reported in MML (1995). *Halodule wrightii* was the only seagrass observed at Station 3 and within the surrounding area. The decline in cover at Station 2 suggests a gradual loss of seagrass over time.

Station 3 SAV followed a similar pattern. *Halodule* covered an average 89.75% of the bottom near the original center. It covered 89.2% of the bottom in the newly colonized area beyond the edge of the bed where no seagrasses were found in 1995. MML reported a total cover of 51.6% in 1995. Station 3 seagrasses now extend well beyond 100 meters past the center marker. This is much expanded from the dimensions reported by MML (1995). *Halodule* was the only seagrass species in this area.

We attempted to survey Stations 5,6, and 7 but low visibility in the area at the time of our study, November 13-16, 2001, prevented us from being able to see the bottom and seagrass if it existed.

We did resurvey stations 11 and 12 in Rocky Cove. Station 12 had a mix of Syringodium (11.5% cover) and *Halodule* (55.5% cover). Estevez and Marshall (see Table 6 in MML 1995;) reported a bottom cover of 94%. Visibility at Station 12 was also very poor. These results are similar to that reported in MML (1995). The seagrasses at Station 12 are bounded by oyster bars and a deep channel making further expansion of this bed impossible.

Station 11, located deep in Rocky Cove, had 100% in 2001 and 98.8% in 19995,cover by *Syringodium filiforme*. The only other SAV species, the green alga, *Halophila engelmanni* was found there in 1993 but was not seen in 1995. Poor visibility during our 2001 survey prevented us from seeing if the alga was present.

Summary and Conclusions

Since the last MML survey (Estevez and Marshall, 1995) The seagrass *Halodule wrightii* has spread throughout Basin 1 and 2. Our results (Table 1) demonstrate that this species covers most of the area. It is only limited from covering the entirety of these two basins by rocky bars, shelly bottom inappropriate for seagrass growth and water depths considered to be either too shallow or too deep for *Halodule*. There is such extensive growth that prop scars (Fig.4) are now a problem in some areas. During our survey manatees were seen over the seagrass beds presumably feeding on the seagrass.

Basin 1 is now up to 50% covered by a large bed of relatively dense *Halodule* bordered by oyster bars, within a mosaic of exposed rock, shallow sandy bars, and a few deep channels. Basin 1 is probably the area most impacted by the thermal effluent from the discharge canal. Thus it appears that the helper cooling towers have apparently altered the thermal regime to achieve suitable conditions for seagrass survival, bed expansion, and reproduction.

Seagrass beds, in Basin 1, at the last MML survey in 1995 had not expanded more than 2.75 meters from the original boundaries established in 1993. On our survey we found that the boundaries of beds 1, 2, and 3 were now located more than 35 meters from the original approximate center of each site. In fact, the beds have now grown into a more or less continuous bed of seagrass throughout Basin 1. Only inappropriate substrate types and depths presumably limiting to *Halodule* growth under the water clarity regime typical of this area break the bed in this area into large patches. There is a barren muddy/sandy band parallel to the discharge channel but it contained small, sparse patches of *Halodule* on our survey dates. These patches may indicate that this channel-side area is now being colonized by seagrass.

The large sand patch adjacent to Station 2 is an area that may not yet been colonized by seagrass. Seagrass adjacent to the seaward and shoreward borders of the sand patch is flourishing and the bed has expanded well beyond the limits of the Station 2 seagrass observed by MML.

Our observations in Basin 1 suggest that it might be possible for other seagrass species to grow in this area. *Halodule wrightii* is generally considered to be a fast growing early colonizer of shallow, barren areas within seagrass beds. Colonization by *Thalassia* and *Syringodium* would be expected to occur at a slower rate. The current mosaic-like arrangement of marsh, seagrass, rocky bars, oyster bars and shallow flats is ideal juvenile habitat for a large number of fish and invertebrate species. Fish can find shelter in the marshes and seagrasses at high tides and feed on the mud flats, oyster bars and rocky outcrops when tides are appropriate. We observed several large schools of small fishes while wading across our transects and at each station. Dolphins were also observed feeding on larger fish at numerous locations around the study site during our fieldwork.

Literature Cited

Estevez, E.D. and M. J. Marshall 1993. 1993 Summary Report for Crystal River 3 year NPDES monitoring project. FPC contract S01100. Environmental Service Department Florida Power Corporation.

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Estevez, E.D. and M. J. Marshall 1995. 1995 Summary Report for Crystal River 3 year NPDES monitoring project. FPC contract S01100 (addendum 1). Environmental Service Department Florida Power Corporation.

Mattson, R.A., J.R. Derrenbacker, Jr., R. R. Lewis, III. 1986. Effects of thermal addition from the Crystal River generating complex on the submergent macrophyte communities in Crystal Bay, Florida. In Mahadevan, K, Rhoda Evans, Paul Behrens, Thomas Biffar, and Lawrence Olsen (editors) Proceedings of the southeastern workshop on aquatic ecological effects of power generation. MML report 124, Sarasota, Florida.

Figures

1-4

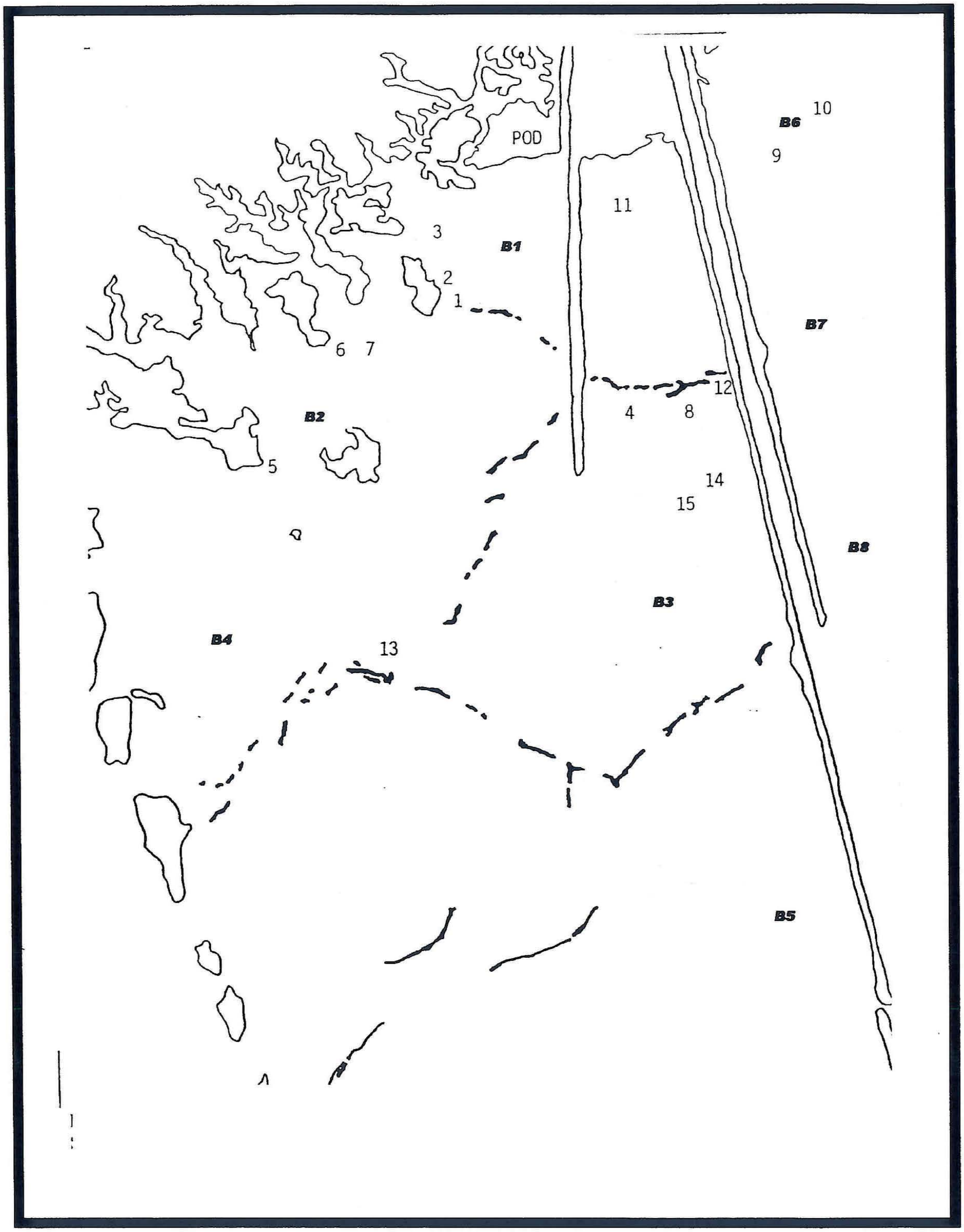

Figure 1. Map of basins as defined in Estevez and Marshall (1993) for MML's seagrass studies. Seagrass beds are numbered 1-15. Basins are identified by codes **B1-B5.**

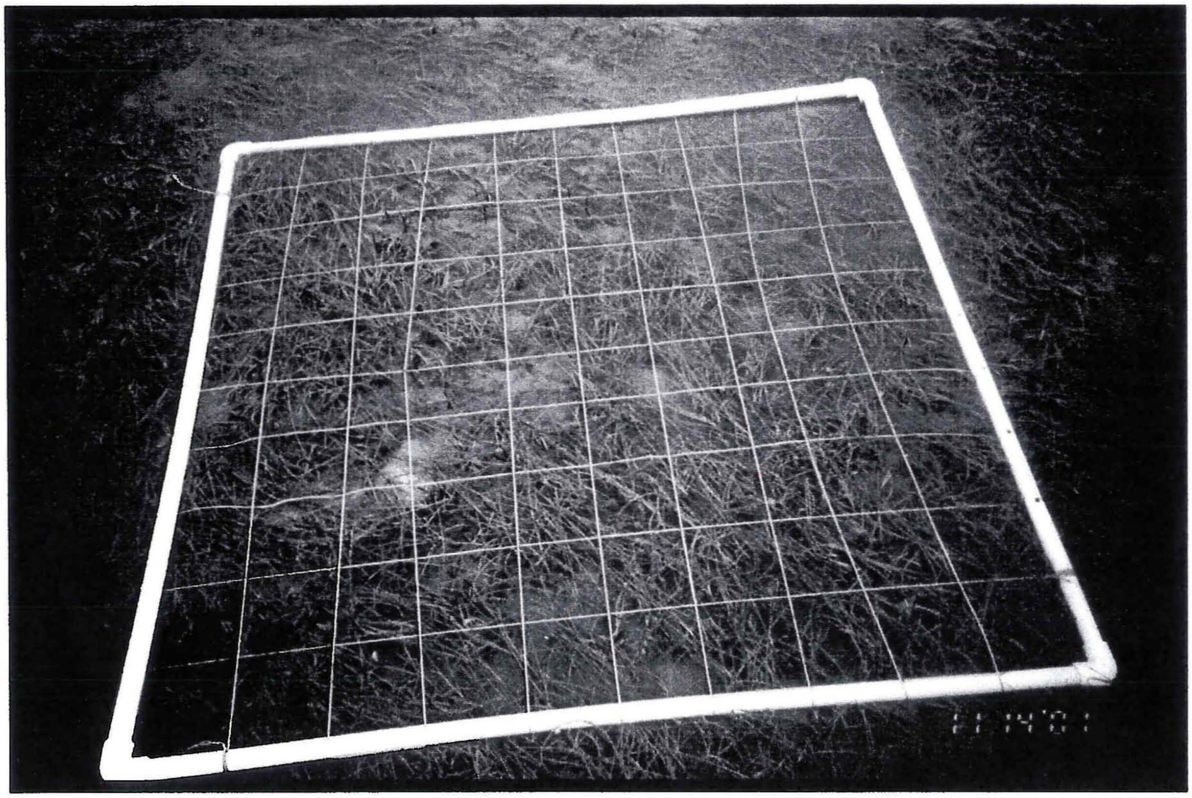

Figure 2. 1m x 1m quadrat used for this study. Photo shows the typical density of the seagrass, *Halodule*, at a location within 100m of the POD.

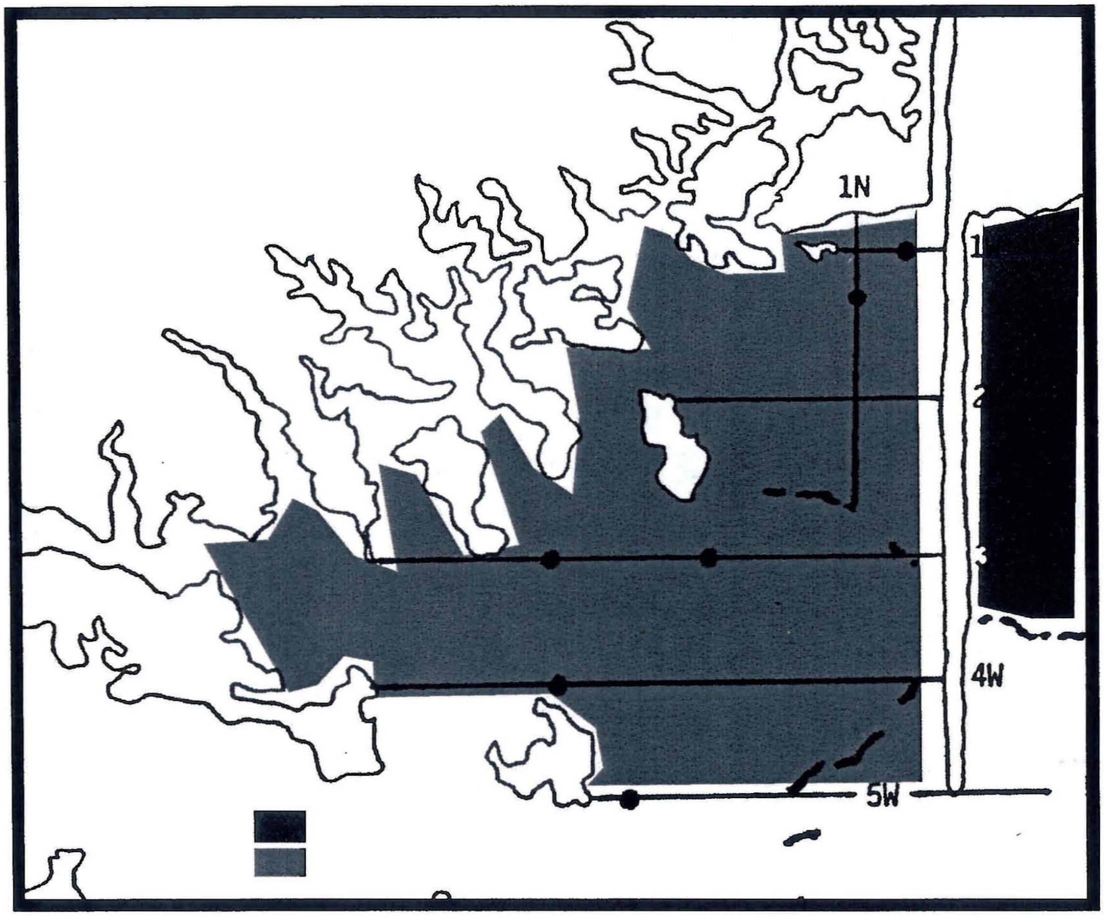

Figure 3. Transects monitored by MML. Black dots are locations where seagrass patches were located during the MML studies. The green area represents the current (November 2001) area which is largely covered by *Halodul*e. Dark green on the south side of the discharge canal represents the distribution of *Syringodium*.

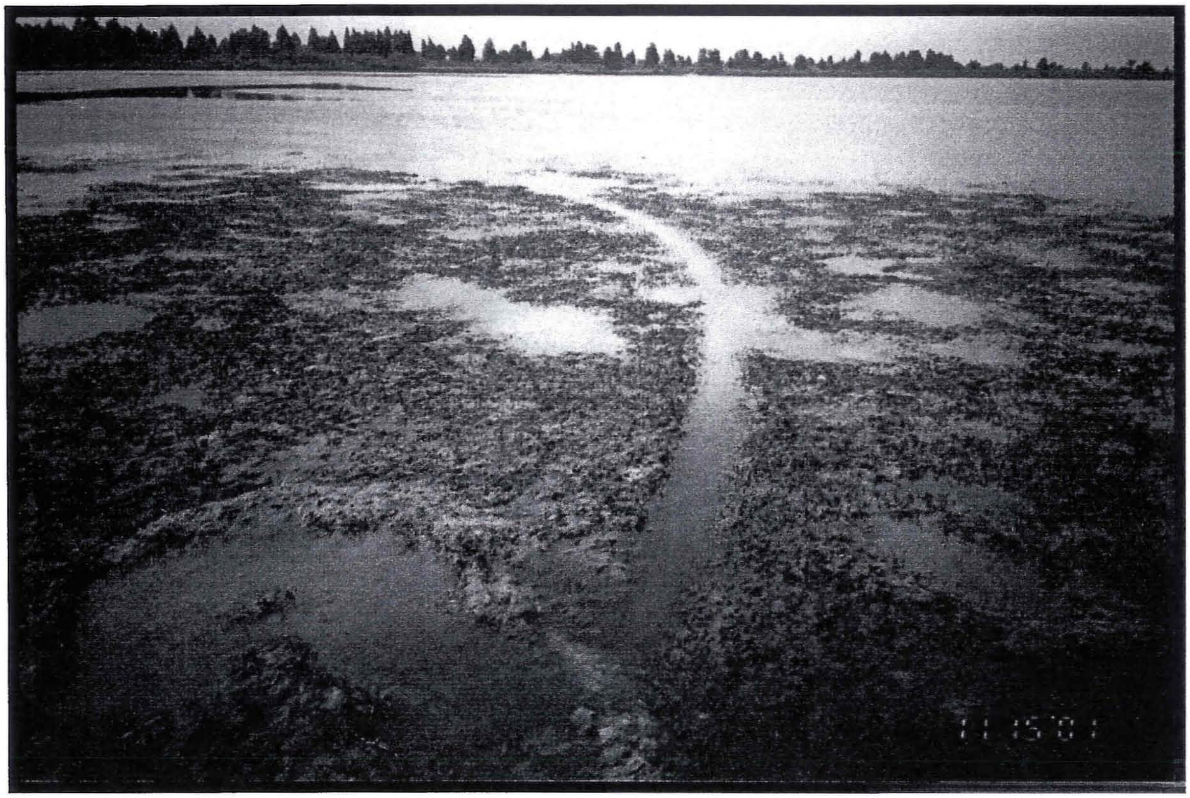

Figure 4. Prop scars in basin 1 during November 2001.

Appendix

Tables 1 and 2

Appendix Table 1. November 2001 Transect Data Florida Power Corporation Seagrass Survey

Transect Data Florida Power Corporation Seagrass Survey

Table 1A

Date	Transect	Station	Latitude	Longitude (Transect 1N)	Depth(Ft.)	SAV % Cover (Mean of 5 quads)	Seagrass or Bottom Type
11/15/01	1N	1	N28 57 41.0	W82 43 25.1	0	0	oyster bar
11/15/01	1N	2	N28 57 40.9	W82 43 25.6	0	0	edge of seagrass
11/15/01	1N	3	N28 57 40.9	W82 43 27.2	0.2	100	Halodule
11/15/01	1N	4	N28 57 41.6	W82 43 30.5	2	0	tidal channel
11/15/01	1N	5	N28 57 41.9	W82 43 32.1	0.5	99.4	Halodule
11/15/01	1N	6	N28 57 42.2	W82 43 32.6	0	0	oyster bar
11/15/01	1N	7	N28 57 42.4	W82 43 34.3	0	0	edge of bar
11/15/01	1N	8	N28 5742.7	W82 43 35.8	0.5	83.4	Halodule
11/15/01	1N	9	N28 57 43.3	W82 43 39.6	0.5	8.4	Halodule
11/15/01	1N	10	N28 57 44.0	W82 43 43.4	3.5	36	Halodule
11/15/01	1N	11	N28 57 44.9	W82 43 46.9	3	0	barren
11/15/01	1N	12	N28 57 45.5	W82 43 50.8	3.1	42	Halodule
11/15/01	1N	13	N28 57 46.3	W82 43 55.0	3.5	0	rock
11/15/01	1N	14	N28 57 46.1	W82 43 57.0	3.1	80	Halodule
				AVERAGE	1.42	32.09	

Table 1 B

Transect 2W

Date	Transect	Station	Latitude	Longitude	Depth(Ft.)	SAV % Cover	Seagrass or Bottom Type
11/15/01	2W	1	N28 58 02.5	W82 43 49.2	1.5	0	sand/mud
11/15/01	2W	2	N28 57 58.6	W82 43 49.1	2.5	86	Halodule
11/15/01	2W	3	N28 57 55.4	W82 43 49.0	2.7	24	Halodule
11/15/01	2W	4	N28 57 52.5	W82 43 49.1	2.7	65.5	Halodule
11/15/01	2W	5a	N28 57 49.2	W82 43 49.8	3	0	sand/mud
11/15/01	2W	6	N28 57 46.1	W82 43 49.9	3.3	90	Halodule
11/15/01	2W	7	N28 57 42.5	W82 43 50.8	2.8	48	Halodule
11/15/01	2W	8	N28 57 39.2	W82 43 49.5	2.7	0	sand/mud
			AVERAGE		2.65	39.19	

Table 1C

Transect 3W							
Date	Transect	Station	Latitude	Longitude	Depth(Ft.)	SAV % Cover	Seagrass or Bottom Type
11/15/01	3W	1	N28 57 40.6	W82 44 04.7	2	0	sand/mud
11/15/01	3W	2	N28 58 01.0	W82 44 01.2	2	47	Halodule
11/15/01	3W	3	N28 57 59.7	W82 44 01.3	2.5	2	Halodule
11/15/01	3W	4	N28 57 54.1	W82 44 01.9	2.6	95.4	Halodule
11/15/01	3W	5	N28 57 50.7	W82 44 02.3	3	58	Halodule
11/15/01	3W	6	N28 57 47.9	W82 44 02.3	3	0	rock
11/15/01	3W	7	N28 57 44.1	W82 44 02.7	2.9	37	Halodule
11/15/01	3W	8	N28 57 40.7	W82 44 02.3	2.7	0.8	Halodule
11/15/01	3W	9	N28 58 04.4	W82 44 01.1	2.5	100	Halodule
11/15/01	3W	10	N28 58 06.7	W82 43 59.8	2.6	38	Halodule
11/15/01	3W	11	N28 58 10.6	W82 44 03.2	2.5	36	Halodule
11/15/01	3W	12	N28 58 28.9	W82 44 07.3	2	0	sand/mud
			AVERAGE		2.53	34.52	

Table 1D

Transect 4w							
Date	Transect	Station	Latitude	Longitude	Depth(Ft.)	SAV % Cover	Seagrass or Bottom Type
11/16/01	4w	1	N28 58 32.5	W82 44 19.0	3	0	edge of marsh/soft black mud
11/16/01	4W	2	N 28 58 36.2	W82 44 19.1	4.8	0	muck
11/16/01	4W	3	N 28 58 14.0	W82 44 16.9	3.9	0	mud
11/16/01	4W	4	N28 58 03.6	W82 44 16.2	2.9	25	Halodule
11/16/01	4W	5	N28 58 00.4	W82 44 16.6	4.9	1.4	rocky
			AVERAGE		3.9	5.28	

Appendix Table 1 (continued):

Table 1E

Transect 5w

Date	Transect	Station	Latitude	Longitude	Depth(Ft.)	SAV % Cover	Seagrass or Bottom Type
11/16/01	5W	1	N28 58 08.5	W82 44 36.3	3.4	2	
11/16/01	5W	2	N28 58 04.6	W82 44 37.4	3.6	0	barren
11/16/01	5W	3	N28 58 02.0	W82 44 36.9	4.4	0	barren
11/16/01	5W	4	N28 57 57.9	W82 44 37.0	5.6	0	barren
11/16/01	5W	5	N28 57 55.0	W82 44 36.6	6.6	0	barren
11/16/01	5W	6	N28 57 51.6	W82 44 36.1	6.2	0	barren
11/16/01	5W	7	N28 57 48.8	W82 44 36.1	3	0	shell
11/16/01	5W	8	n28 57 45.8	W82 44 35.3	5.8	0	barren
			AVERAGE		4.825	0.25	

Table 1F

Transect 1W (2A stations not in MML surveys)

11/14/01	**1W**	**1**	N28 57 38.0	W82 43 29.5			POD
11/14/01	1W	2	N28 57 38.5	W82 43 29.5	0.1	88	Halodule start
11/14/01	1W	3	N28 57 38.9	W82 43 29.5	0.1	100	Halodule
11/14/01	1W	4	n28 57 40.2	W 82 43 29.5	0.1	100	Halodule
11/14/01	1W	5	N28 57 41.2	W 82 43 29.5	0.1	26	Halodule
11/14/01	1W	6	N28 57 41.0	W 82 43 29.5	0.1	0	rocky bar
11/14/01	1W	7	N28 57 42.0	W82 43 29.5	0	0	rocky bar
11/14/01	1W	8	N 28 57 43.6	W82 43 29.5	0	0	rocky bar
11/14/01	1W	9	N28 57 44.5	W82 43 29.5	0.5	100	shallow channel
11/14/01	1W	10	N 28 57 47.1	W82 43 29.5	0.5	0	marsh edge
11/14/01	2A	1	N28 57 45.9	W82 43 28.3	1	0	creek entrance
11/14/01	2A	2	N28 57 45.8	W 82 43 26.4	1	1	Halodule
11/14/01	2A	3	N28 57 45.5	W82 43 24.6	1	80	Halodule
11/14/01	**2A**	**4**	N28 57 45.5	W 82 43 22.7	0.375	0	rocky bar
			AVERAGE			38.08	

Appendix -Table 2. **Intensive monitoring FPC Station Data - 2001 Survey. All** location data is given in degrees/minutes/seconds. Center locations are approximations of center positions established by MML.

Table 2-1
Station 1

Center at: N 28 57 58.1
W 82 43 56.6

Quad #	% Cover	Bed Position	Species	Quad#	Bed Position	%Cover	Species
1	100	interior	*Halodule*	11	outer	100	*Halodule*
2	97	interior	*Halodule*	12	outer	98	*Halodule*
3	95	interior	*Halodule*	13	outer	99	*Halodule*
4	98	interior	*Halodule*	14	outer	100	*Halodule*
5	83	interior	*Halodule*	15	outer	96	*Halodule*
6	89	interior	*Halodule*	16	outer	100	*Halodule*
7	95	interior	*Halodule*	17	outer	99	*Halodule*
8	99	interior	*Halodule*	18	outer	98	*Halodule*
9	34	interior	*Halodule*	19	outer	100	*Halodule*
10	99	interior	*Halodule*	20	outer	89	*Halodule*
avg	**88.9**					**97.9**	
S.D.	**20.00**					**3.38**	

Seaward edge of bed N28 57 56.3
W82 43 57.7

note: Extends beyond 217+ feet from original center.

Table 2-2
Station 2

Center at: N28 58 00.8
W82 43 51.0

Quad #	%Cover	Bed Position	Species	Quad #	% Cover	Bed Position	Species
1	0	inner	sand				
2	0	inner	sand	18	0	Outer	sand patch
3	0	inner	sand	19	0	outer	sand patch
4	0	inner	sand	20	0	outer	sand patch
5	14	inner	Halodule	21	0	Outer	sand patch
6	75	inner	Halodule	22	0	outer	sand patch
7	7	inner	Halodule	23	0	outer	sand patch
8	0	inner	sand	24	0	Outer	sand patch
9	8	inner	Halodule	25	0	outer	sand patch
10	8	inner	Halodule	26	0	outer	sand patch
11	35	inner	Halodule	27	0	Outer	sand patch
12	23	inner	Halodule	28	0	outer	sand patch
13	95	inner	Halodule	29	0	outer	sand patch
14	87	inner	Halodule	30	0	Outer	sand patch
15	95	inner	Halodule	31	0	outer	sand patch
16	63	inner	Halodule	32	0	outer	sand patch
17	0	inner	Halodule	33	25	Outer	Halodule
				34	95	outer	Halodule
				35	90		Halodule
				36	86		Halodule
Avg.	30.00				15.58		
SD	37.11				33.78		

Table 2-3
Station 3

Center at: N28 58 03.7
W 82 43 43.0

Quad #	% Cover	Species	bed position	Quad #	% Cover	Species	bed position
1	100	Halodule	inner	10	74	Halodule	outer
2	100	Halodule	inner	11	85	Halodule	outer
3	100	Halodule	inner	12	73	Halodule	outer
4	100	Halodule	inner	13	69	Halodule	outer
5	100	Halodule	inner	14	88	Halodule	outer
6	100	Halodule	inner	15	100	Halodule	outer
7	100	Halodule	inner	16	100	Halodule	outer
8	80	Halodule	inner	17	92	Halodule	outer
9	27	Halodule	inner	18	100	Halodule	outer
		Halodule	inner	19	100	Halodule	outer
				20	100	Halodule	outer
Avg.	89.67				89.18	Halodule	outer
SD	24.41				12.29		

note: seagrass bed continues 100+ meters beyond center of Station 3.

Table 2-4
Station 11

center at: N 28 57 05.9
W 82 44 16.0

Quad #	Halodule	Syringodium	Total (H.+S.) %Cover
1	80	0	80
2	60	0	60
3	70	0	70
4	50	10	60
5	40	5	45
6	60	0	60
7	80	0	80
8	10	40	50
9	90	0	90
10	15	60	75
Avg.	55.5	11.5	67
S.D.	27.13	21.09	14.38

Table 2-5
Station 12
Center at: N28 57 23.7
W 82 43 38.3

Quad #	%Cover	Species
1	100	Syringodium
2	100	Syringodium
3	100	Syringodium
4	100	Syringodium
5	100	Syringodium
6	100	Syringodium
7	100	Syringodium
8	100	Syringodium
9	100	Syringodium
10	100	Syringodium
11	100	Syringodium
Avg.	100	Syringodium
S.D.	0	