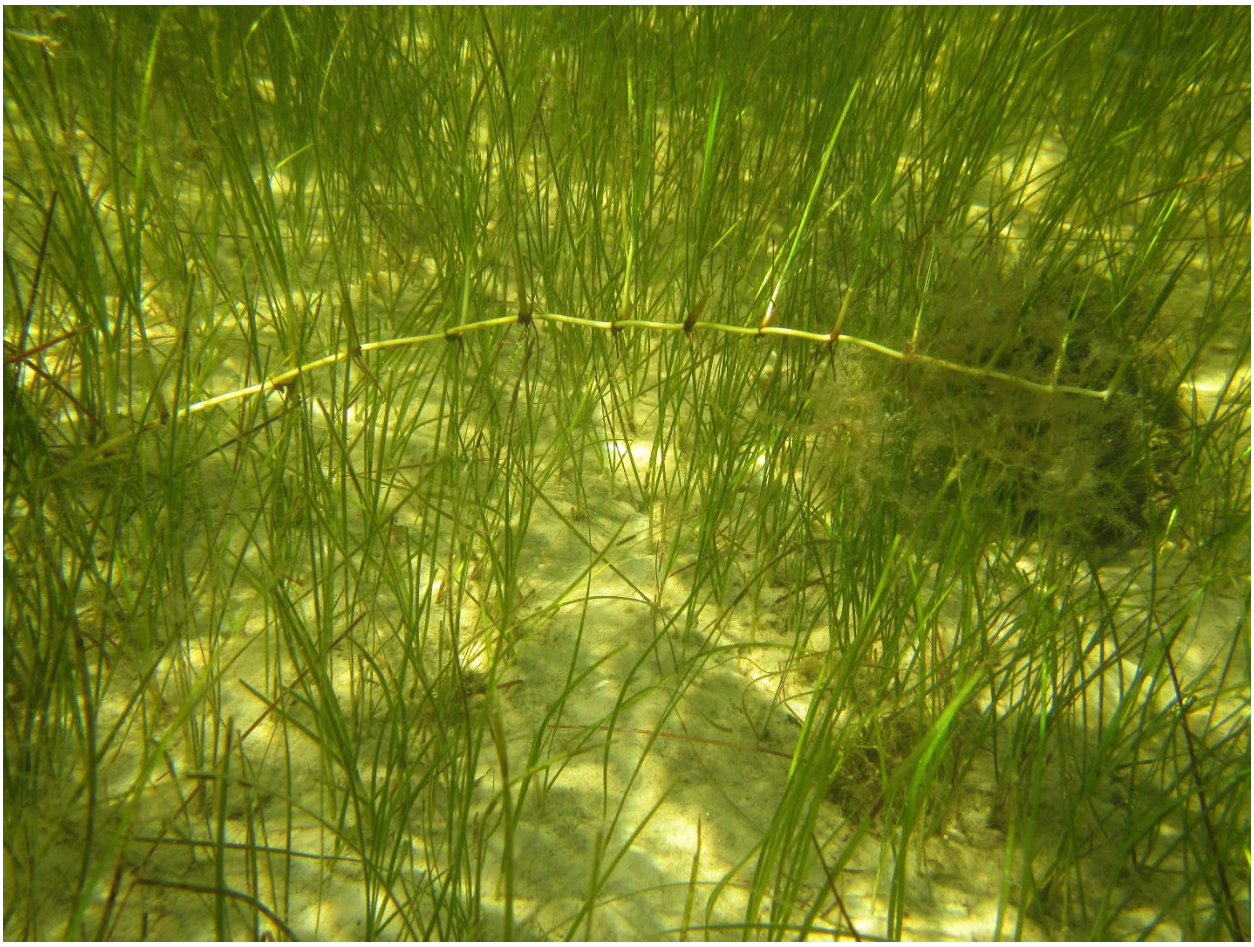
Indian River Lagoon Seagrass Monitoring

Standard Operating Procedures modified for Brevard County



St. Johns River Water Management District

September 2022

Brief overview of District seagrass monitoring

The Indian River Lagoon (IRL) is a diverse, shallow-water estuary spanning 40 percent of Florida's east coast. Stretching for 156 miles from Ponce de Leon Inlet in Volusia County to the southern boundary of Martin County, the lagoon is an important commercial and recreational fishery and economic resource. The East Central Florida Regional Planning Council (2016) estimated that the total annual economic value of the IRL at nearly $10 billion. Declining water quality is being addressed via numerous projects and programs. Seagrass is the lifeblood of the lagoon, serving as a nursery for juvenile fish, habitat for shrimp, and a food staple for manatees. The IRL is home to seven species of seagrass (see Appendix 1 for descriptions): *Halodule wrightii* (H.w.), *Syringodium filiforme* (S.f.), *Thalassia testudinum* (T.t.), *Ruppia maritima* (R.m.), *Halophila engelmannii* (H.e.), *Halophila decipiens* (H.d.), and *Halophila johnsonii* (H.j.).

For analytical purposes, the IRL is subdivided into regions labeled reaches (Figure 1) that were delineated by evaluating similarities in water quality parameters (C. Jacoby, unpublished data). Seagrass is monitored at 2 scales (Figure 2); large scale lagoon-wide mapping from aerial photography and finer-scale fixed transects. The lagoon-wide mapping has been completed every 2–3 years since 1986 in addition to a historical coverage produced for 1943. Fixed transect monitoring is used to detect detailed or small-scale changes within the lagoon's seagrass beds, such as changes in the offshore end of the canopy, abundance of different species, and species composition of beds. Because each transect extends to the edge of the bed, expansions or contractions of the bed can be detected, which are indicative of changing water quality.

Transects were established throughout the lagoon in the summer of 1994. All transects are monitored at least twice a year, summer and winter, corresponding roughly to times of maximum and minimum seagrass abundance, respectively. Between 2005 and 2017 a subset of transects were selected to represent each segment of the Lagoon, and they were monitored monthly. For routine monitoring of transects, a standardized, non-destructive, quantitative technique has been adopted. The intent of this methodology is to sample (1) repeatedly along a line at the same location, (2) quantitatively, (3) nondestructively, and (4) rapidly. Surveying each transect consists of laying out a marked line roughly perpendicular to shore out to the deep edge of the seagrass bed. The path for the line is marked with a series of PVC poles driven into the sediment at a maximum of 100-m intervals.

To document progress toward attaining and maintaining a macrophyte-based system (Steward et al. 2003), data from this long-term monitoring are evaluated annually (Figure 2). Increases in areal extent and mean transect length were observed throughout the 1990's, reaching a peak in 2007–2009. An abrupt decline in seagrass extent was observed in 2011 following an unprecedented phytoplankton bloom. Further declines were observed during the brown tide events in 2012 and 2016. Additional declines in extent and distances to the edge of the canopy were observed between 2016 and 2020. The most recent mapping was completed between May and June 2021. Unfortunately, the map documents the results of poor water quality caused by a bloom that began in summer of 2020 and continued into early 2021. This 40% decrease since the previous map means that areal extent is down approximately 75% from the largest extent recorded in 2007 and 2009. For details on mapping methodology, see Morris et al. (2018).

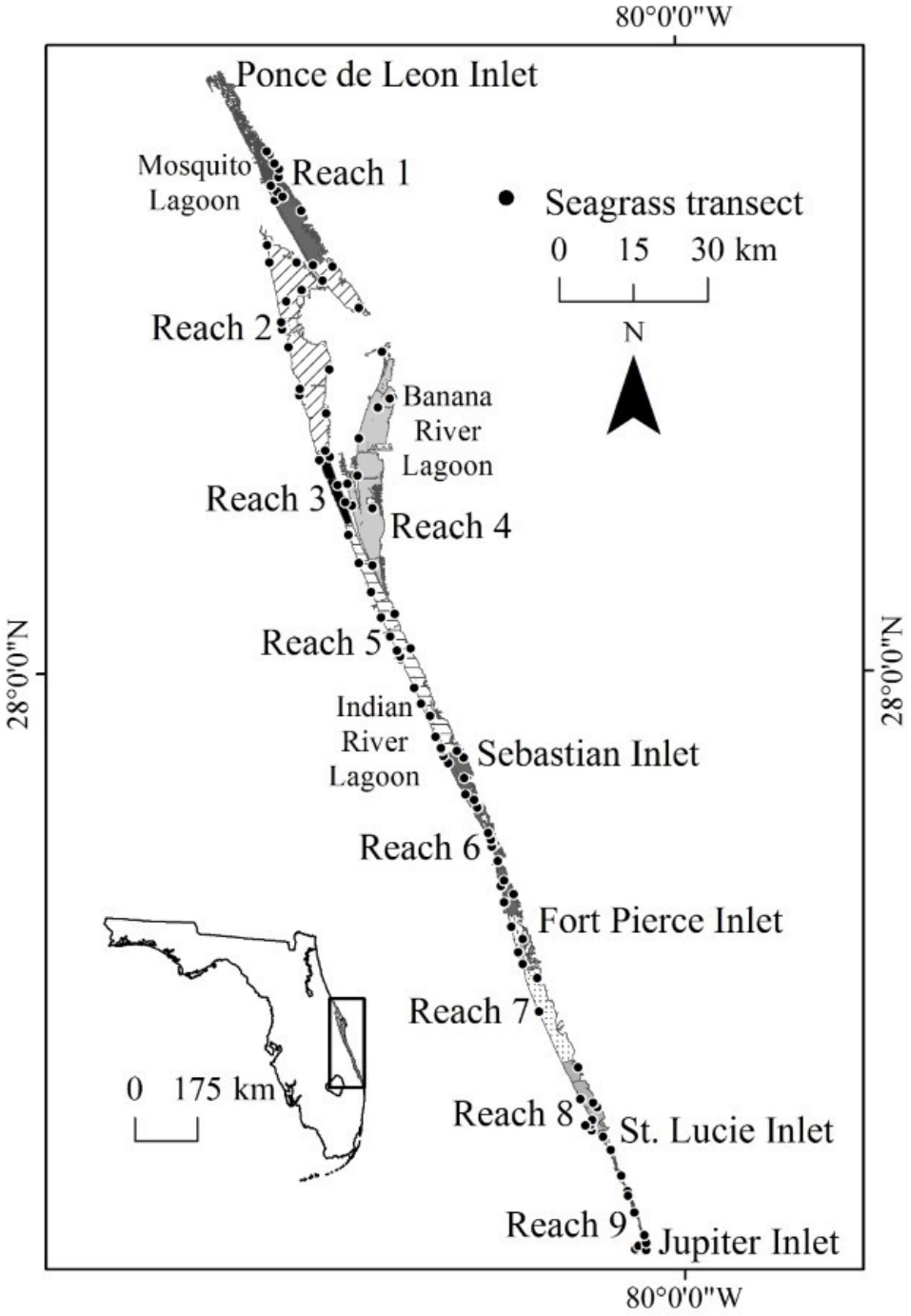


Figure 1. Map showing the location of the Indian River Lagoon and five inlets, nine reaches, and transects where seagrass is surveyed (Morris et al. 2021).

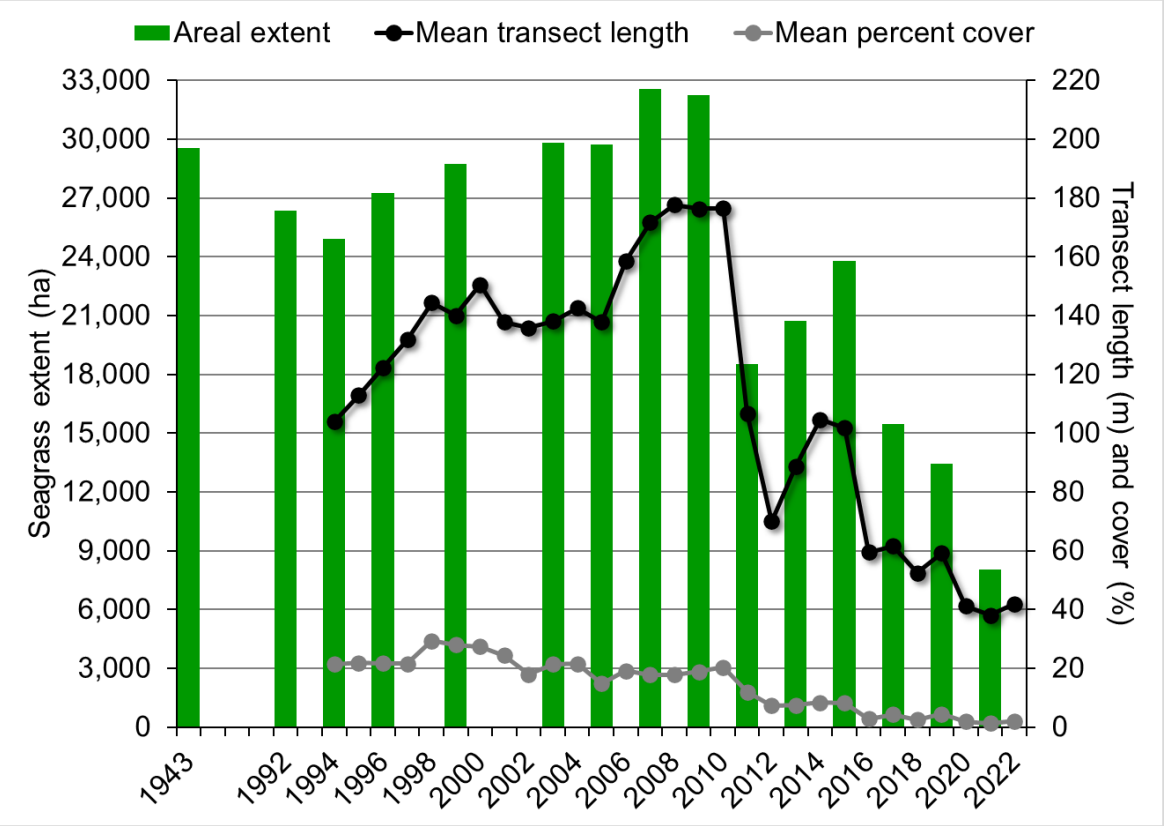


Figure 2. Areal extent of seagrass in maps derived from aerial photography, mean distances to the deep ends of the seagrass canopy (mean length of transects), and mean percent cover versus years (updated from Morris et al. 2021).

Special instructions for sampling a restored site:

Count surviving planting units for as many consecutive surveys as possible so that survivability can be calculated.

When planting units can no longer be identified reliably, switch to surveys using quadrats.

Procedure for sampling a quadrat:

A quadrat is a 1-m × 1-m square frame divided by cords into 100 squares that are each 10 cm × 10 cm (see Appendix 2).

Center the quadrat on the chosen location.

Record the following parameters in the order they are listed:

- Plot number – can be prerecorded on datasheets but should always be checked.
- Sampler initials – recorded for each quadrat.
- Water depth – recorded in centimeters to establish a profile of seagrass versus depth.
- Drift algae: Percent occurrence, biomass estimate, and canopy height.

- Percent occurrence – the number of the 10-cm by 10-cm cells that contain drift algae (maximum = 100); count each cell that contains drift algae.
- Biomass – based on the following scale from 0 to 5 (Appendix 4).
    - 0 – no algae
    - 1 – < 10 cells containing only single strands
    - 2 – ≥ 10 cells containing only single strands
    - 3 – < 50 cells containing "tumble weed" clumps
    - 4 – ≥ 50 cells containing "tumble weed" clumps, but the bottom is still visible
    - 5 – 100 cells containing "tumble weed" clumps, and the bottom is not visible
- Height of the drift algal canopy – measure the distance from the sediment to the top of the drift algae (sometimes canopy height needs to be measured outside the quadrat or prior to placing the quadrat).
- Species of algae – note the names of any drifting algae as comments in the field book and add the names of any attached algae besides *Caulerpa* species (see below). Collect specimens of any unknown algae for later identification. Note: *Lyngbya*/*Dapis* spp. may look like drift macroalgae but are included in epiphyte loads. Note the presence of such cyanobacteria but do not include them as drift algae.
- If necessary, clear drift algae from quadrat to prepare for other surveys.

- *Caulerpa* species (C*. prolifera, C. sertularioides*, *C. mexicana*, etc.):
    - Percent occurrence – the number of 10-cm × 10-cm cells that contain attached *Caulerpa* of any species (maximum = 100). Note the names of all species on the datasheet and in the field book.
    - Percent cover – an estimate (from 0% to 100%) of the overall cover of *Caulerpa* (all species combined) within the 1-m^2 quadrat, not a count. Visualize "pushing" all the *Caulerpa* in the 1-m^2 quadrat to one corner until it fills a set of adjoining cells. Each completely full cell equals one percent cover. Thus, the number of filled cells is the percent cover.
- Seagrass:
    - Percent occurrence – the number of 10-cm × 10-cm cells that contain any species of seagrass (maximum = 100) represents the percent occurrence of all seagrass; the number of 10-cm × 10-cm cells that contain each species of seagrass (maximum = 100) represents the percent occurrence of the relevant species. Note: cells containing multiple species will be counted multiple times (one time for all seagrass and one time for each species).
    - Percent cover – estimates (from 0% to 100%) of the cover for each species of seagrass within the 1-m^2 quadrat and the cover of all species of seagrass. Please use one of two approaches.
        - Visualize "pushing" all the seagrass in the 1-m^2 quadrat to one corner until it fills a set of adjoining cells. Each completely full cell equals one percent cover percent. Thus, the number of filled cells is the percent cover. If there are two or more species, estimate the proportion of the total cover represented by each

species to determine percent cover for that species. If estimated cover is less than 1%, please provide an estimate from 0.05% to 0.99%. See Appendix 3 for examples. Please note that the *Caulerpa* percent cover and the total seagrass percent cover cannot add up to over 100%.

OR

- Visualize "pushing" each species in the 1-m^2 quadrat to one corner until it fills a set of adjoining cells. Estimate the percent cover for each species and sum them to yield the total percent cover. If estimated cover is less than 1%, please provide an estimate from 0.05% to 0.99%. See Appendix 3 for examples. Please note that the *Caulerpa* percent cover and the total seagrass percent cover cannot add up to over 100%.

- Epiphytic load – Enter Low (L), Moderate (M), or High (H) as determined by the epiphyte photo index (EPI) in Appendix 5 and these ranges:
  - Low = EPI 1a – 2e
  - Moderate = EPI 3a – 4e
  - High = EPI 5a – 5e

  Important considerations:
    - Length and width of seagrass blades (affects seagrass biomass).
    - Estimate should be determined by examining both sides of whole blades, not just fuzz on tip.
    - Type of epiphyte (a fine film over the entire blade may correspond to a heavy loading).
    - Make a note in the field book if calcareous epiphytes are present. These should not contribute to assigning the EPI category.
    - *Lyngbya/Dapis* spp. attached to H.w. blades should be included in the estimate of epiphytic load.
- Canopy height – recorded in centimeters for each species present.
  - Blades are "combed" with fingers vertically up along a measured pole (this could be the side of a quadrat or underwater slate marked in cm increments).
  - An average length for the blades is estimated to the nearest cm. Most blades tend to reach a similar maximum length, and any unusually long blades (<5%) should be excluded. If flowering R.m. is present, estimate separate canopy heights for blades with and without flowers.
- Shoot counts – from eight, predetermined, 10-cm × 10-cm cells in the quadrat. See Appendix 6 for the selection of cells.
  - Counts of individual shoots for each species are made at predetermined distances for monthly sites and at the samplers' discretion for summer and winter transects.
  - If the estimate of cover for one or more species of seagrass is ≤ 3%, all shoots in all cells need to be counted for every species in that category and the resulting

count is marked with “tot” and the abbreviation for the species in one of the rows for recording shoot counts (e.g., 57 tot H.w.). Such counts will be scaled differently from those based on eight cells.

Water quality:

- Field parameters are recorded using a multiparameter sonde at a depth of 0.5 m from the surface or half of the total depth if the water is shallower than 1 m.
- Allow the sonde to stabilize and record the relevant readings from the YSI datalogger, noting the time of recording on the datasheet.
- Refer to the manufacturer’s recommendations for calibration procedures.

Field notes:

- Additional notes about site conditions should be made. These notes only need to mention information that cannot be reflected on the datasheet.
- Examples include:
    - Condition of the seagrass and the overall bed – healthy, dying, exposed rhizomes; dense, patchy, sparse, etc.
    - Presence of epiphytes – density and type (calcareous?).
    - Presence of drift algae – indicate species whenever possible and if you cannot identify the species and it appears to be the dominant alga, collect a small sample for identification at the lab if possible or make descriptive notes regarding its color, which may help identify the appropriate division (e.g., green = chlorophyte, red = rhodophyte, brown = chromophyte, etc.).
    - Any other observations of note – critters, condition of the sediment/bottom, water clarity (wind driven turbidity? blooms present?).

References:

East Central Florida Regional Planning Council. 2016. Indian River Lagoon economic valuation update. Orlando, FL. 69 pp.

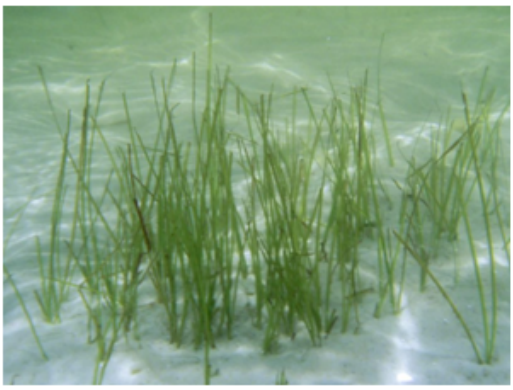
Miller-Myers R, Virnstein RW. 2000. Development and use of an epiphyte photo index (EPI) for assessing epiphyte loadings on the seagrass *Halodule wrightii*. In: Bortone, SA (ed) Seagrasses: monitoring, ecology, physiology, and management. CRC Press, Boca Raton, FL.

Morris LJ, Hall LM, Jacoby CA, Chamberlain RH, Hanisak MD, Miller JD, Virnstein RW. 2021. Seagrass in a changing estuary, the Indian River Lagoon, Florida, United States. Front. Mar. Sci. 8:789818. doi: 10.3389/fmars.2021.789818

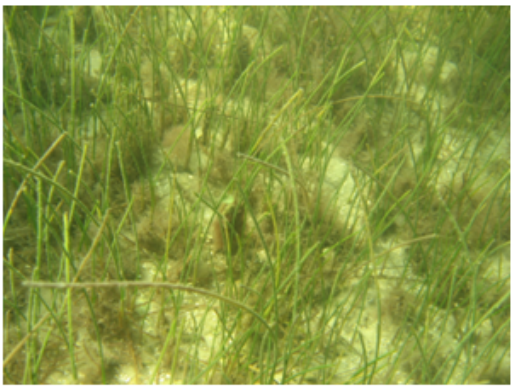
Steward J, Brockmeyer R, Virnstein R, Gostel P, Sime P, Vanarman J. 2003. Indian River Lagoon Surface Water Improvement and Management (SWIM) Plan, 2002 Update. St. Johns River Water Management District, Palatka, Florida and South Florida Water Management District, West Palm Beach, Florida.

Appendices:

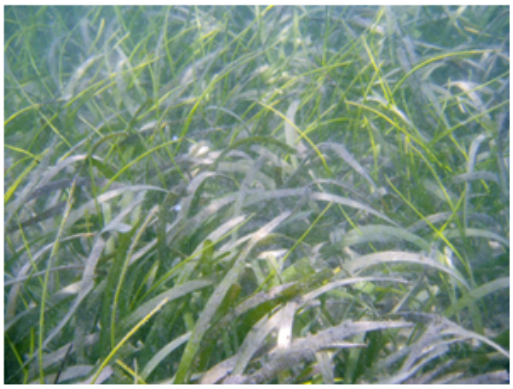
Appendix 1: Descriptions of seagrass species



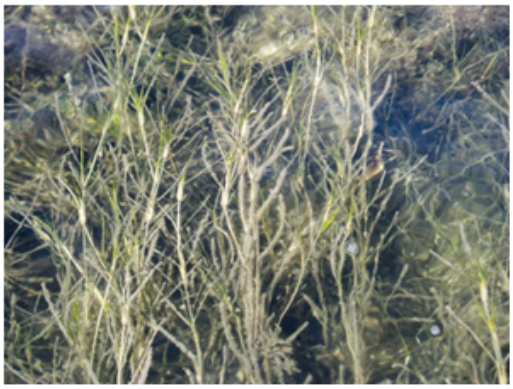
Shoal grass (*Halodule wrightii*) - Shoal grass is the most common of the seagrasses, and it can be found throughout the lagoon. It is most abundant in shallow water (less than 6.5 feet), and it tolerates a range of salinities. Clusters of multiple leaves, with notches at their tips, originate from a single node along a creeping, branched rhizome (a stem that grows horizontally and gives rise to both leaves and roots) and can grow to lengths of four to 10 inches. Shoal grass is considered a pioneer species because it can grow and spread quickly to stabilize the sediment.



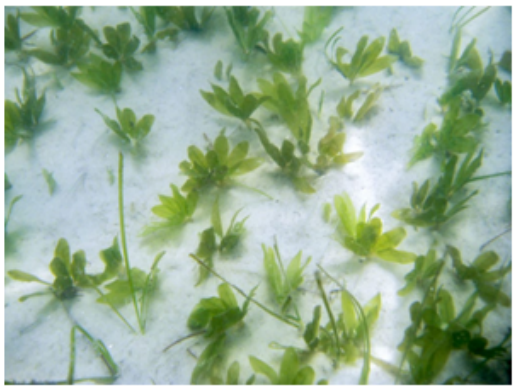
Manatee grass (*Syringodium filiforme*) - Manatee grass is found at mid-depths (5 feet) throughout the lagoon and can grow to lengths of 14 inches. It is rarely found in shallow water and is often found in mixed beds with other species. The blades of this seagrass are cylindrical, with two to four blades arising from each node in the rhizome.



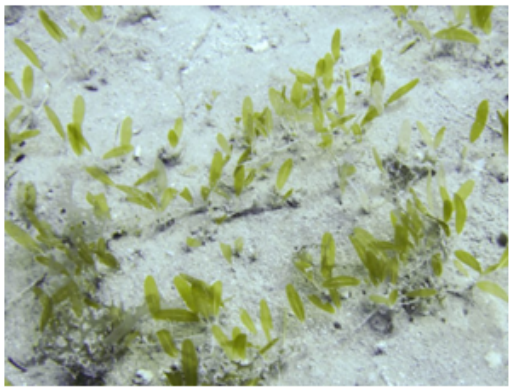
Turtle grass (*Thalassia testudinum*) - Turtle grass can be found in the southern half of the lagoon (south of Sebastian Inlet) at mid-depths. Blades of turtle grass are flat and ribbon-like, growing to 14 inches long and a half inch wide. Blades can lengthen up to one inch per week under ideal conditions. *Thalassia* has the highest requirement for light of all the seagrasses in the lagoon, and it is an excellent indicator of healthy, stable water quality.



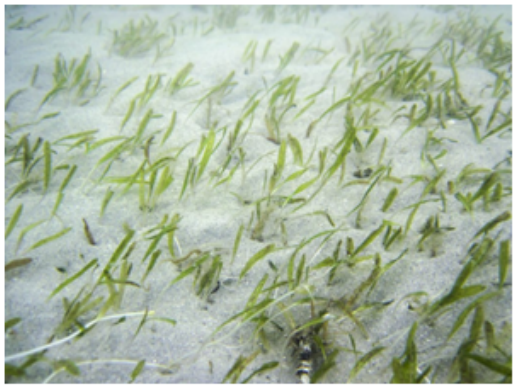
Widgeon grass (*Ruppia maritima*) - Widgeon grass grows in patches throughout the lagoon in very shallow water (often less than 1 foot), and it can be found in areas with low salinity. The blades arise alternately from a sheath, and they are wider at their bases and taper to long pointed tips. This grass closely resembles shoal grass, but its blades lack notches at their tips.



Star grass (*Halophila engelmannii*) - Star grass generally is more common in the northern lagoon, but it can be found throughout the system. Star grass grows at a range of depths and sometimes with other species in mixed beds. Whorls of four to eight blades, one-half inch to an inch long, grow from a single stem forming a star-like pattern.

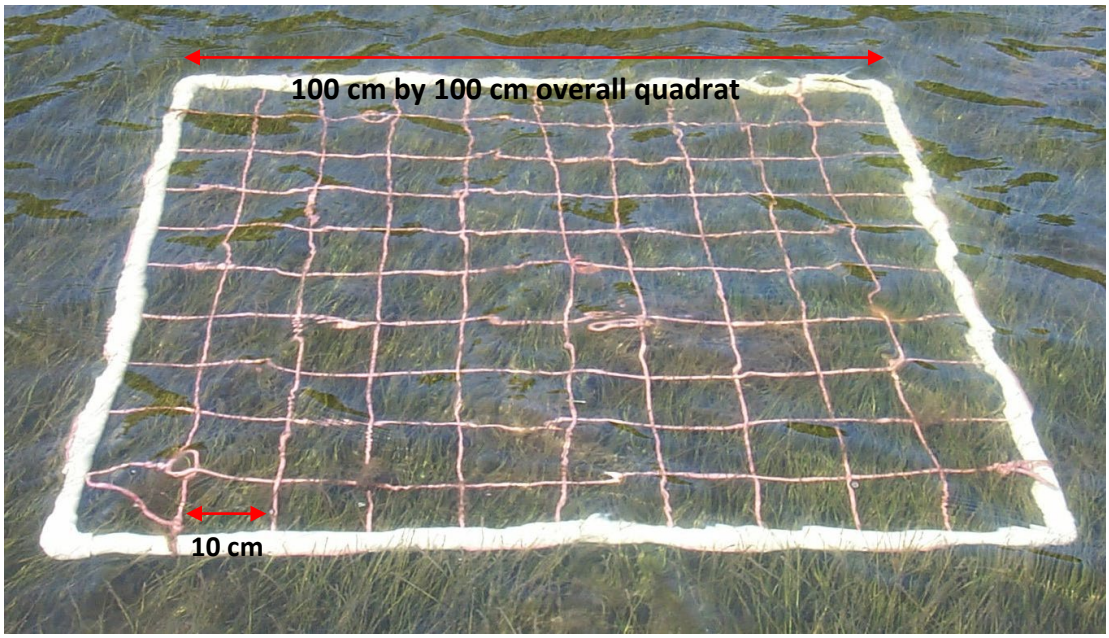


Paddle grass (*Halophila decipiens*) - Paddle grass is the only species in the lagoon that is an annual, which means its blades are lost in cold weather and reemerge in warm weather. It generally is found in deeper water, and it is most abundant at the southern end of the lagoon, south of Sebastian Inlet. The blades, between one-half inch to an inch in length, resemble those of Johnson's seagrass, but they have small notches on their margins, a broader paddle-shape and more rounded tips.

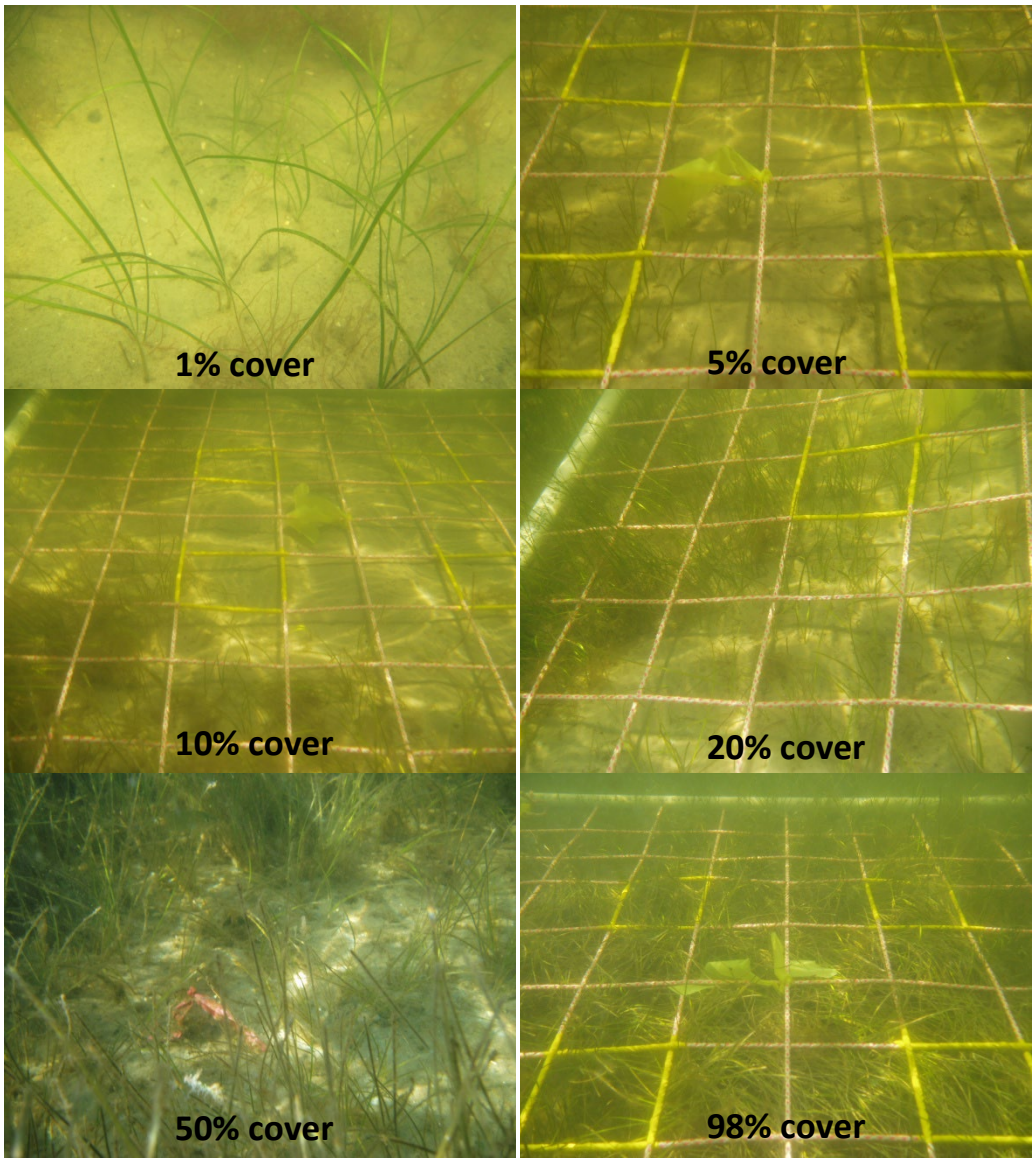


Johnson's grass (*Halophila johnsonii*) - Johnson's seagrass is found in southeast Florida, including the southern half of the lagoon. Johnson's seagrass is short, one to two inches long, with paired leaves that have central veins originating from a single node on a rhizome. It can form dense patches, with patches often split between deep water and shallow shoals, possibly due to competition for light with larger species. Johnson's seagrass was named in honor of J. Seward Johnson Sr., founder of Harbor Branch Oceanographic Institution in Fort Pierce. The status of this species is under review, and it may be renamed.

Appendix 2: Design of a quadrat



Appendix 3: Examples of percent cover for seagrass



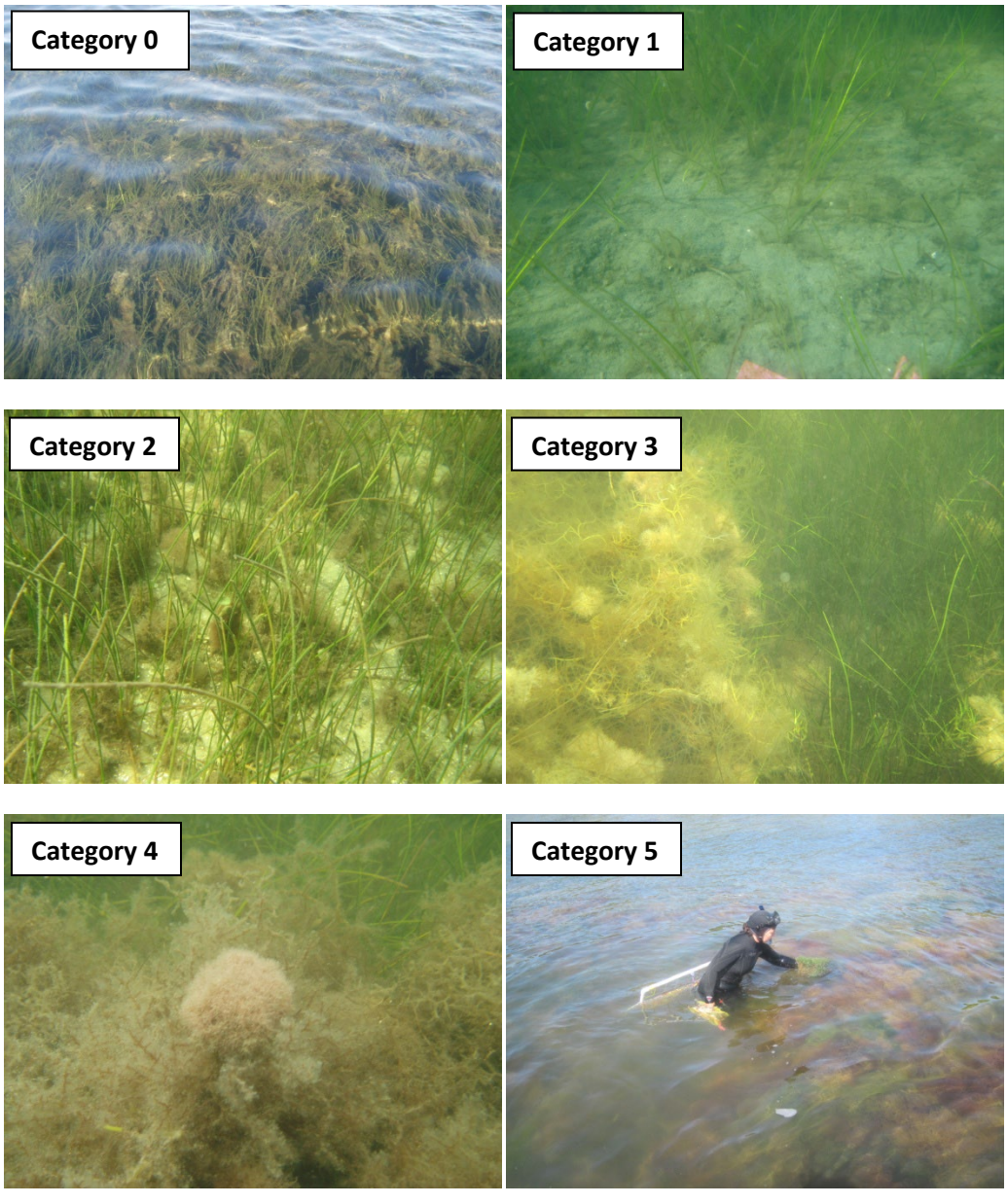
Shoot counts also provide guidance for estimating percent cover (Table 1).

Table 1. Shoot estimates for 1% cover

Species	Median shoots/square
Halodule wrightii	40
Syringodium filiforme	38
Thalassia testudinum	22
Ruppia maritima	30
Halophila engelmannii	29
Halophila decipiens	50
Halophila johnsonii	58

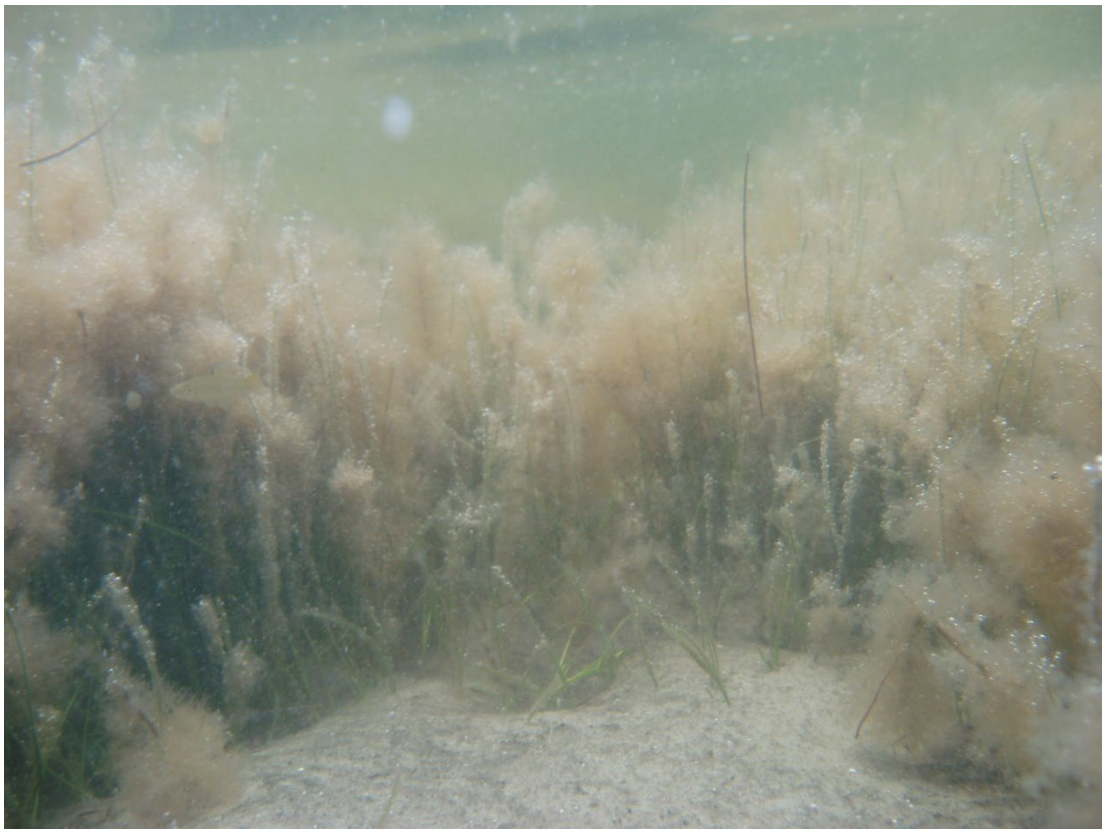
Appendix 4: Examples of drift algal biomass

Category	Algae abundance	Algae biomass (g dry wt m^{-2})
0	No algae	0
1	<10% occurrence of only single strands	0.35
2	≥10% occurrence of only single strands	1.98
3	<50% occurrence of "tumble weed" clumps	21.37
4	≥50% occurrence of "tumble weed" clumps	47.74
5	100% occurrence of "tumble weed" clumps; cannot see the bottom	141.94



Appendix 5: Epiphyte Photo Index

Category	Sub-category (gram epiphyte/gram seagrass)				
	a	b	c	d	e
0	0	0	0	0	0
1	0.121	0.177	0.190	0.228	0.232
2	0.264	0.282	0.342	0.390	0.416
3	0.465	0.517	0.544	0.593	0.672
4	0.761	0.799	0.800	0.805	0.870
5	0.910	0.980	1.087	1.120	1.525




1a
2a
3a
4a
5a
1b
2b
3b
4b
5b
1c
2c
3c
4c
5c
1d
2d
3d
4d
5d
1e
2e
3e
4e
5e

Appendix 6: Procedure for shoot counts

For quadrats where percent cover for a species of seagrass is greater than 3%, count shoots in the eight red cells (should have 8 individual shoot counts to record on the datasheet).

10	20	30	40	50	60	70	80	90	100
9	19	29	39	49	59	69	79	89	99
8	18	28	38	48	58	68	78	88	98
7	17	27	37	47	57	67	77	87	97
6	16	26	36	46	56	66	76	86	96
5	15	25	35	45	55	65	75	85	95
4	14	24	34	44	54	64	74	84	94
3	13	23	33	43	53	63	73	83	93
2	12	22	32	42	52	62	72	82	92
1	11	21	31	41	51	61	71	81	91

If the percent cover is less than or equal to 3% for all species of seagrass, count all shoots in all cells of the quadrat.

If more than one species is present and percent cover for one is less than or equal to 3%, count all shoots for that species and proceed to count the 8 squares for the species with greater than 3% cover.

Appendix 7. List of field equipment

- Multiparameter sonde
- Yellow field book
- Secchi disk
- Depth pole
- 1-m^2 PVC quadrat for each sampler (divided by strings into 100 cells, each 10-cm by 10-cm)
- Tote with clipboard, datasheets, pencils, erasers, slates, vinegar, and defog/baby shampoo
- Dive flag
- Personal dive gear
- Seagrass Site Descriptions
- Seagrass sampling plan spreadsheet
- Handheld GPS and/or onboard Garmin
- Deionized water
- Rinse water