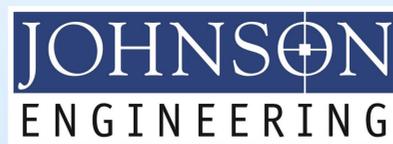


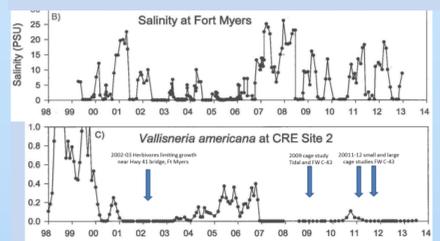
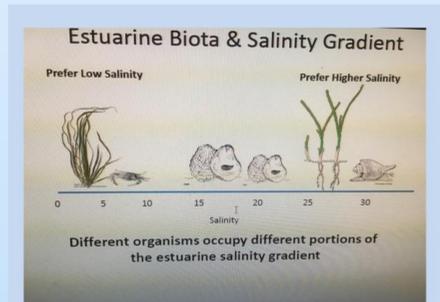
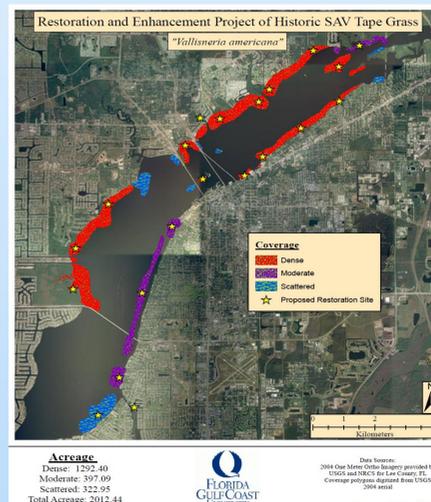
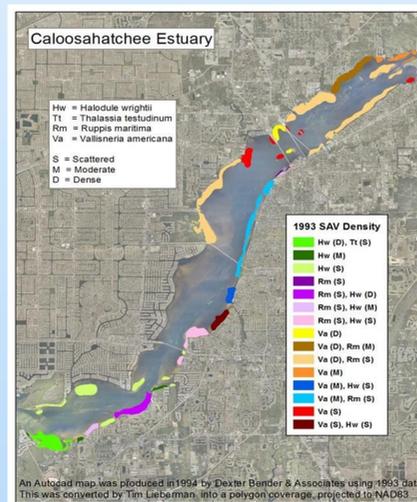
Vallisneria americana restoration in the Caloosahatchee river & estuary: building coastal resiliency through partnerships, applied research & adaptive management.

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Ecosystem Services of *Vallisneria americana*

- Habitat for fishes, crabs, shrimp, crayfish, bivalves, epiphytes, and numerous aquatic insects
- Forage for endangered manatees, freshwater turtles, waterfowl, fish, crayfish and snails
- Stabilizes sediments, attenuates wave action, improves water clarity, and removes nutrients
- Used by over 44 species of fishes including snook, seatrout, drum, bass, and sunfishes



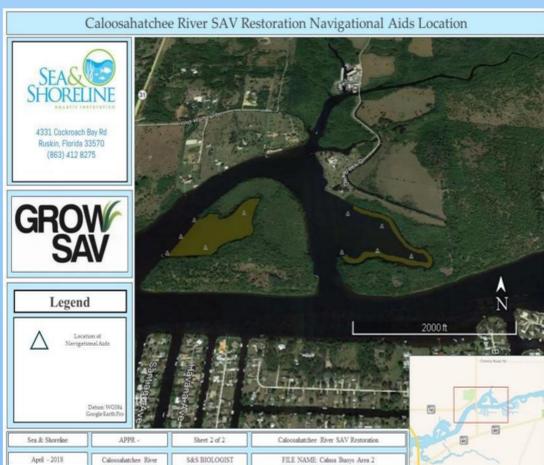
Vallisneria "Average Proportion Vegetated/m2" System Status Report 2014 (J. Douglas, Ph.D. FGCU). Vallisneria appears to be "down for the count"

Historic distribution and density of SAV species reported from the Caloosahatchee River estuary in Fort Myers - Cape Coral area of SW Florida (left) and *Vallisneria americana* density (right). Virtually all of the 1,200-acres of *Vallisneria americana* (and seed bank) has been lost since 2001. The project goal is to restore these grass beds in the upper estuary.

Historically, the tidal Caloosahatchee River and upper (oligohaline) estuary was covered with vast submerged beds of tape grass, (*Vallisneria americana*) also known as eel grass and wild celery. Research has shown that these *Vallisneria* beds provided habitat for shrimp, crabs, bivalves and over 44 species of fish. They also provided forage for threatened manatees, migratory waterfowl, freshwater turtles, and many other aquatic herbivores. Since 2001, the Caloosahatchee estuary has lost over 1,200 acres of dense *Vallisneria* beds due to a combination of factors including anthropogenic discharges of freshwater from Lake Okechobee, reductions in base flow, and droughts in 2001 and 2007-08 resulting in abnormally high salinity levels (>20 ppt) for several weeks or months. There has been no documented *Vallisneria* pistillate (female) flowering since 1999 and the sediment seed bank appears completely exhausted, with little prospect for natural recovery. Several small pilot restoration projects were conducted between 2002-2009 with two slightly larger projects completed in 2013 and each found that excessive grazing pressure was controlling growth and recovery of *Vallisneria*, both in the estuary and freshwater sections of the Caloosahatchee. The most recent, and larger pilot restoration project (2015-2018) was conducted at four freshwater sites upstream of the S-79 control structure using ten (10) Grow SAV[™] enclosures at each site. Flowering and seed production was observed in four months, but only inside enclosures. *Vallisneria* shoot densities inside enclosures peaked at 1,700 shoots/square meter within 16 months of planting. After three years, there was no growth outside of enclosures due to grazing pressure. Primary grazers include freshwater turtles, manatees, crabs, fishes and the invasive non-native apple snail, *Pomacea maculata*. It became clear that a much larger scale up of the restoration was needed to ensure establishment of plants and allow for flowering and seed production. Such scaled-up *Vallisneria* restoration have been successful in King's Bay, Citrus County, Florida. A scaled-up 20-acre *Vallisneria* restoration project is currently underway at three sites in the Caloosahatchee River estuary funded by the State of Florida. The project represents a unique public/private/academic partnership with the not-for profit Angler Action Foundation administering the project for the State of Florida. Sea and Shoreline LLC constructed Grow SAV[™] enclosure cages and installed >12,500 *Vallisneria americana* plants in 500 enclosures (≥25/exclosure), as well as planting 75,000 individual plugs along with 25,000 *Ruppia maritima* plugs. Johnson Engineering ecologists are integrating research and restoration by quantifying ecosystem services provided by *Vallisneria* beds through monitoring fish and macroinvertebrate communities, C, TN and TP uptake, water clarity, and plant growth and reproduction. Florida Gulf Coast University faculty and graduate students have teamed with Johnson Engineering to quantify ecosystem services provided by the *Vallisneria* restoration. The restoration project was initiated in October 2018 with initial planting completed in January 2019. The study includes three years of maintenance and monitoring.



Grazers (above) must be excluded until grass beds become established.



Restoration Strategy for Scaled-up 20-acre Phase II: 2018 - 2021

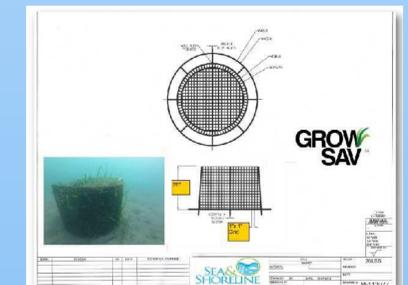
- Planted in Caloosahatchee River upper estuary: 500 planted enclosures at 3 locations
- Planted male and female *Vallisneria* plants at each location (75,000 *Vallisneria* & 25,000 *Ruppia*)
- Monitoring SAV plant growth, flowering & seed production for 3 years.
- Conducting fish and macroinvertebrate surveys semi-annually.
- Assessing nutrient (TN, TP, C) uptake, biomass, ecosystem services, and seed bank recovery.

Factors controlling growth and distribution of *Vallisneria americana*:

- Salinity levels and duration of exposure (Doering and Chamberlain 2000).
- Water clarity, light attenuation, color (Bortone and Turpin 2000)
- Sediment type, nutrient concentrations, and genetic strains (Gettys and Haller 2011)
- Herbivory (Ceilley and Bortone 2003, Hauxwell et al. 2004, SCCC 2008, Ceilley 2009, Moore et al. 2010)



Vallisneria americana collected immediately after enclosure cage removal on July 12 (left) and 24 hours later on July 13, 2018 (right).



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"The massive die-off of *Vallisneria americana* in the Caloosahatchee River estuary in 2000-01 will constitute 'serious harm' or a permanent, irreversible loss unless we take actions to restore it. Restoration of this critical estuarine habitat is our mission." D.W. Ceilley M.S. CSE, Restoration Ecologist

