Oyster habitat enhancement feasibility study using a multifaceted approach to site selection along Florida's Springs Coast

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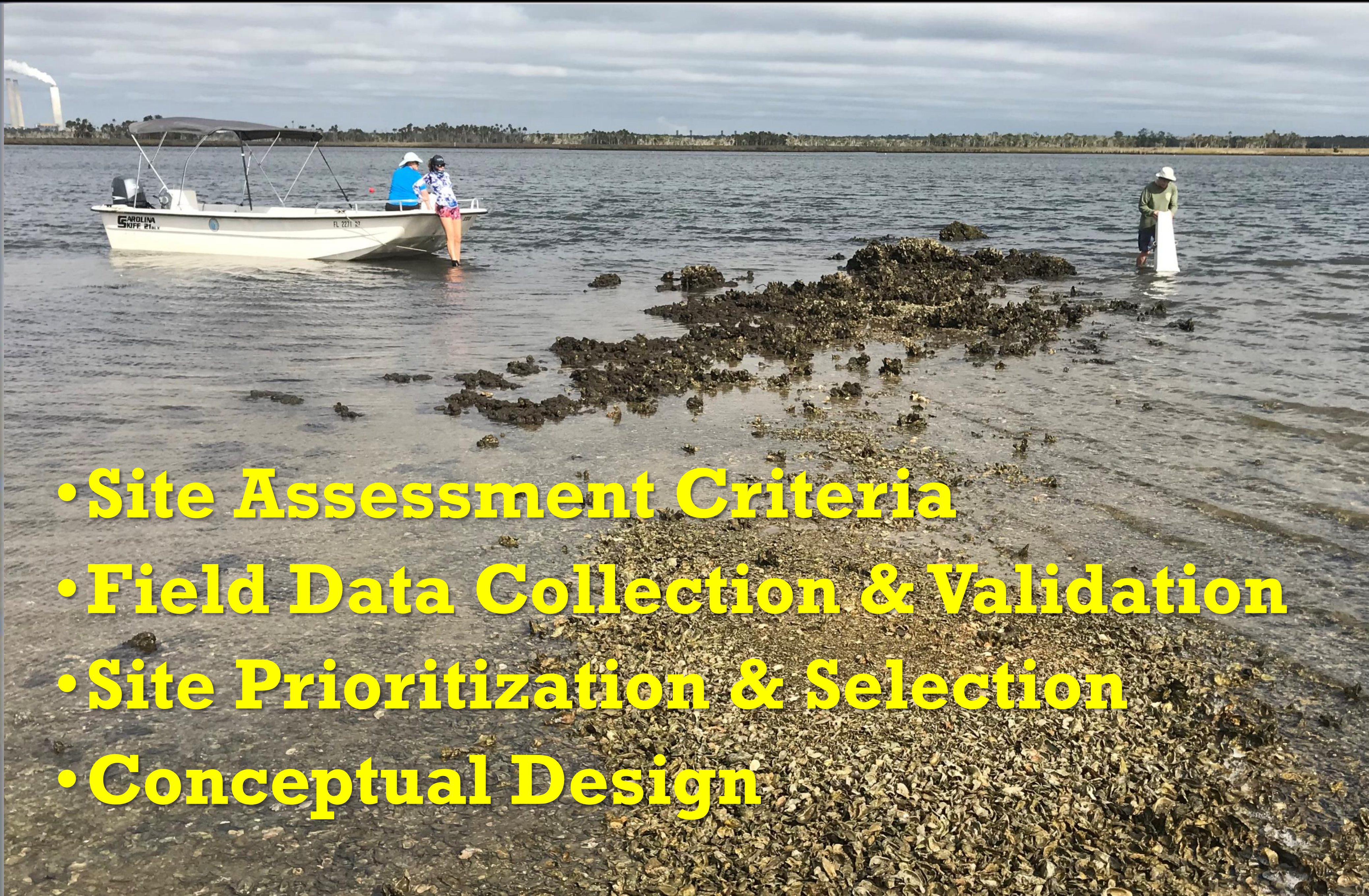
The Florida Springs Coast
"The Land of Mermaids & Manatees"
Rainbow
Kings Bay
Homosassa
Chassahowitzka
Weeki Wachee
CHASSAHOWITZKA SPRINGS
CRYSTAL RIVER/ KINGS BAY
WEEKI WACHEE SPRINGS
RAINBOW SPRINGS
HOMOSASSA SPRINGS



- Site Assessment Criteria
- Field Data Collection & Validation
- Site Prioritization & Selection
- Conceptual Design

Assessment Criteria Development

- Establish a site assessment matrix
- Literature review of prior habitat characterization efforts
- Data mining
  - GIS Layers
  - Salinity Distribution
  - Water Quality

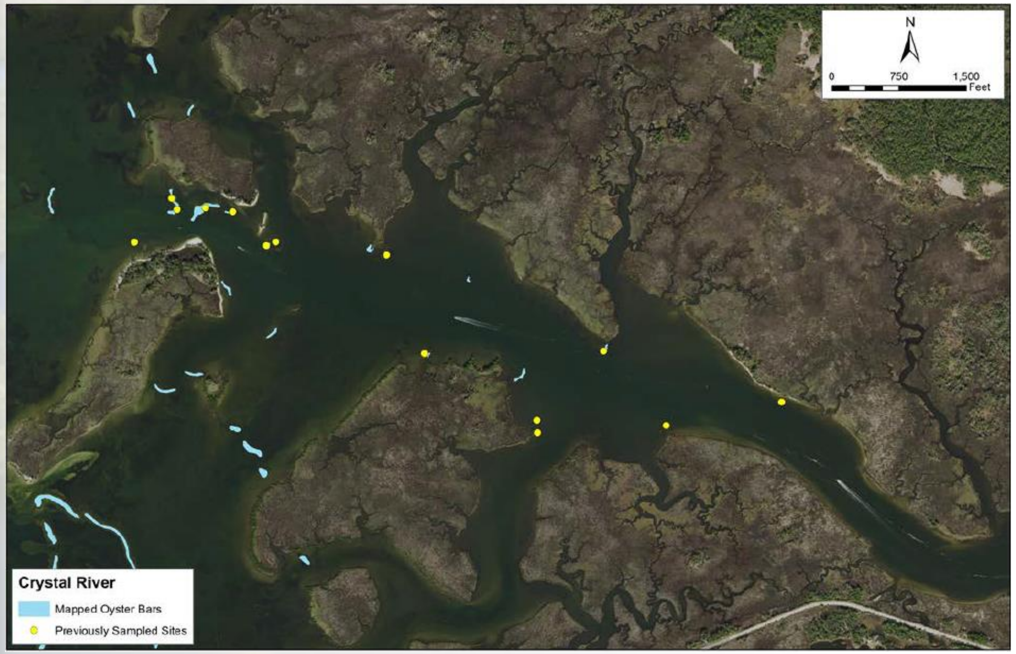
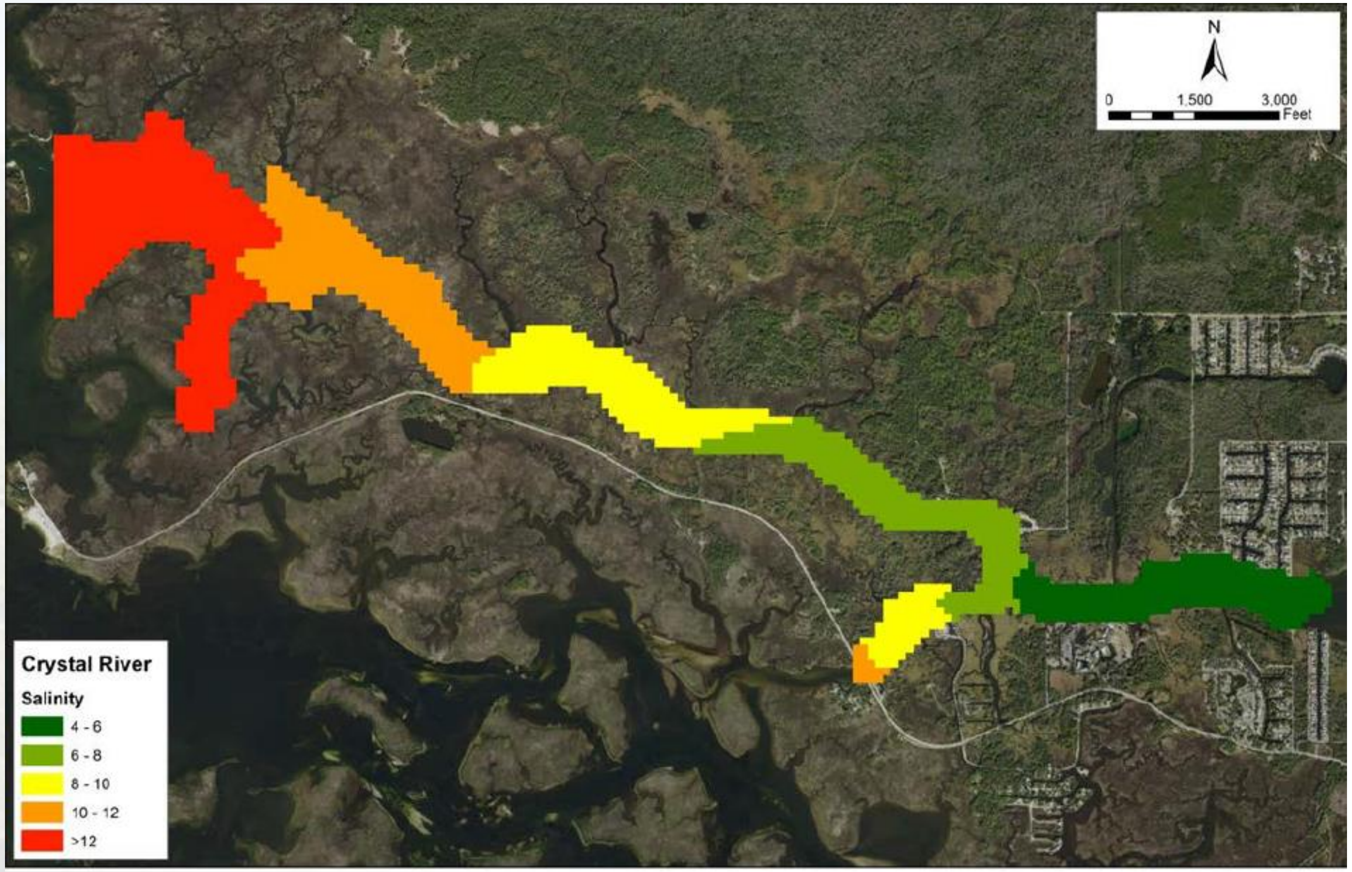


TABLE 1-1
SUMMARY OF AVAILABLE DATA USED TO GUIDE SAMPLING EFFORT FOR CRYSTAL AND HOMOSASSA RIVERS.

Data Source	River System	Mapped Oysters	Oyster Biology	Salinity Data	Relevant Findings
Water and Air Research, Inc. (2019)	Homosassa	Homosassa only			Areas with best developed oyster reefs typically off the main river channel
Evans et al. (2010)	Crystal	Crystal only		Limited	Oysters found from Gulf of Mexico up to areas with salinities < 5 ppt
SWFWMD 2016	Crystal and Homosassa	Crystal and Homosassa			Oyster "reefs" captured as side-benefit to seagrass mapping project. Not ground-truthed as were polygons mapped as seagrass
SWFWMD 2012	Crystal			Predicted annual average values	Lowest salinity range mapped was 4 to 6 ppt. Highest salinities mapped were > 12 ppt at Gulf of Mexico
SWFWMD 2018	Homosassa			Predicted annual average values	Lowest salinity range mapped was 10 to 12 ppt. Highest salinities mapped were > 17 ppt at Gulf of Mexico
Wilson et al. (2005)			Salinity tolerances for oysters		Citation of optimal salinity range for oysters of 10 to 28 ppt
Grizzle et al. (2002)			Impacts to oyster reefs from wave energy		Oyster reef health in estuaries along Florida's east coast can be impacted due to boat wakes
Garvis et al. (2015)			Impacts to oyster reefs from wave energy		Oyster reef health in estuaries along Florida's east coast can be impacted due to boat wakes
McGowan (2018)			Impacts to oyster reefs from wave energy		Healthy oyster reefs in Delaware estuaries are typically > 200 feet from nearest boating channel

Assessment Criteria Development

- Salinity distribution based on SWFWMD Hydrodynamic model
- Distance between the location of the 10ppt salinity isopleth and the mouth of both rivers were similar, approximately 8,000 feet



Distribution of expected average salinity values for Crystal River (SWFWMD, 2019)

Assessment Criteria Development

- Factors Influencing Oyster Distribution
  - Salinity
    - Can tolerate ~5 ppt (Parker et al. 2013)
    - Optimal Range: 10-28 ppt (Wilson et al. 2005)

In the Crystal River, oysters were documented from the Gulf of Mexico upstream to areas where salinities averaged just under 5 ppt (Evans 2010).

  - Substrate Type
    - Limestone Outcrops
    - Mudflats
  - Boat wakes (Grizzle et al. 2002, Garvis et al. 2015)

In Delaware, oyster reefs were not common in areas closer than 200 feet from boating channels, even after correcting for factors such as substrate and salinity (McGowan 2018).

Data Collection Design

Proposed Sampling Design

- 60 sites in the Homosassa River
  - 30 sites with no oysters expected
  - 15 sites with the expectation of mostly live oysters
  - 15 sites with the expectation of mostly dead oysters
- 60 sites in the Crystal River
  - 30 sites with no oysters expected
  - 15 sites with the expectation of mostly live oysters
  - 15 sites with the expectation of mostly dead oysters

TABLE 2-1
DISTRIBUTION OF SAMPLING EFFORT BETWEEN SITES ASSIGNED *A PRIORI* TO THE FOLLOWING STRATA

Location	Sites with no oysters expected	Sites with oysters expected		Total sites
		Mostly alive	Mostly dead	
Homosassa River	30	15	15	60
Crystal River	30	15	15	60

Site Visits

Healthy oyster reef south of the main channel of the Homosassa River

Site Visits

Healthy oyster reef on the bank of the main channel of the Crystal River

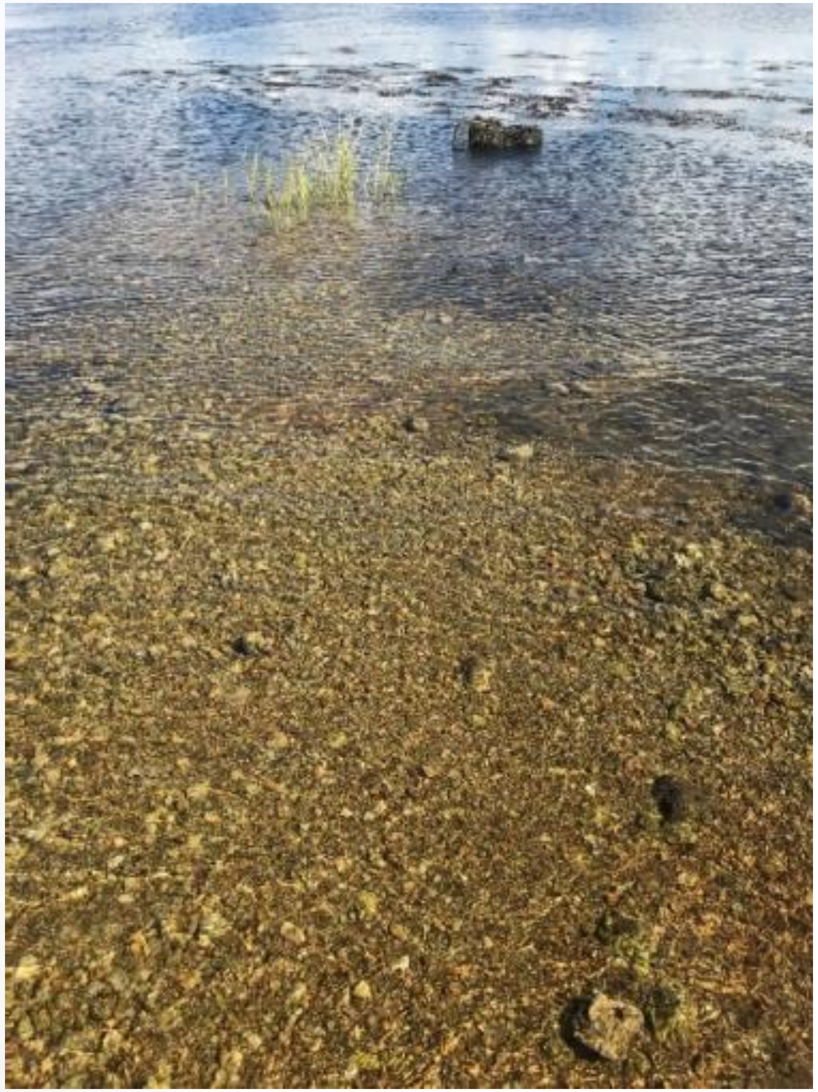
Site Visits

Oyster clumps growing on sand/shell in the Homosassa River

Site Visits

Oyster clumps growing on limestone in the Crystal River

Site Visits



Shell hash and sand with no oysters on the shoreline of the Homosassa River

Site Visits

Sand and mud substrate with no oysters on the shoreline of Crystal River

Site Visits - Results

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DISTRIBUTION OF SAMPLING EFFORT BETWEEN SITES ASSIGNED *A PRIORI* TO THE FOLLOWING STRATA

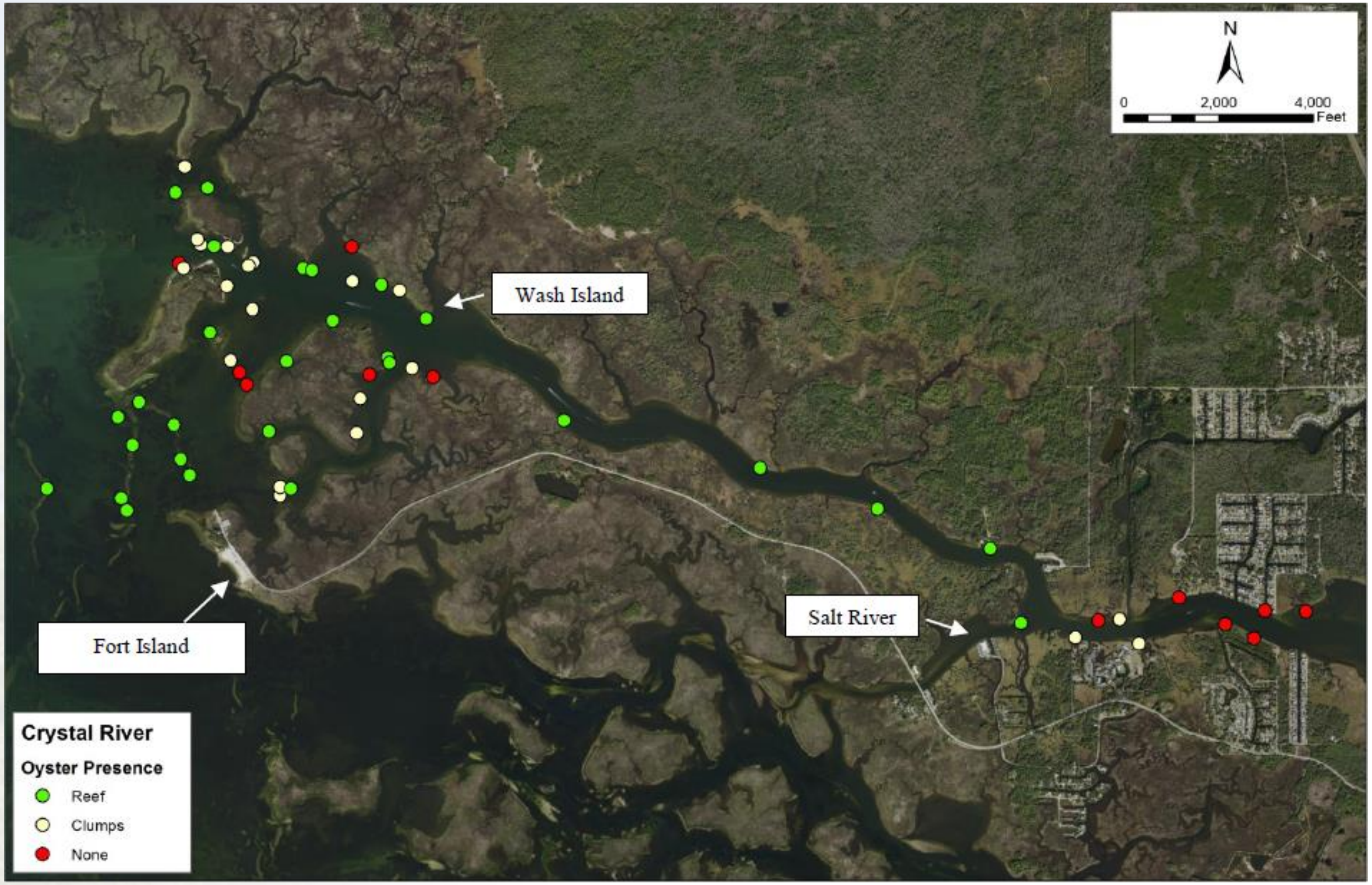
Location	Sites with no oysters expected	Sites with oysters expected		Total sites
		Mostly alive	Mostly dead	
Homosassa River	30	15	15	60
Crystal River	30	15	15	60

TABLE 2-2

DISTRIBUTION OF SAMPLING EFFORT, AS MODIFIED BASED ON INITIAL FIELD WORK

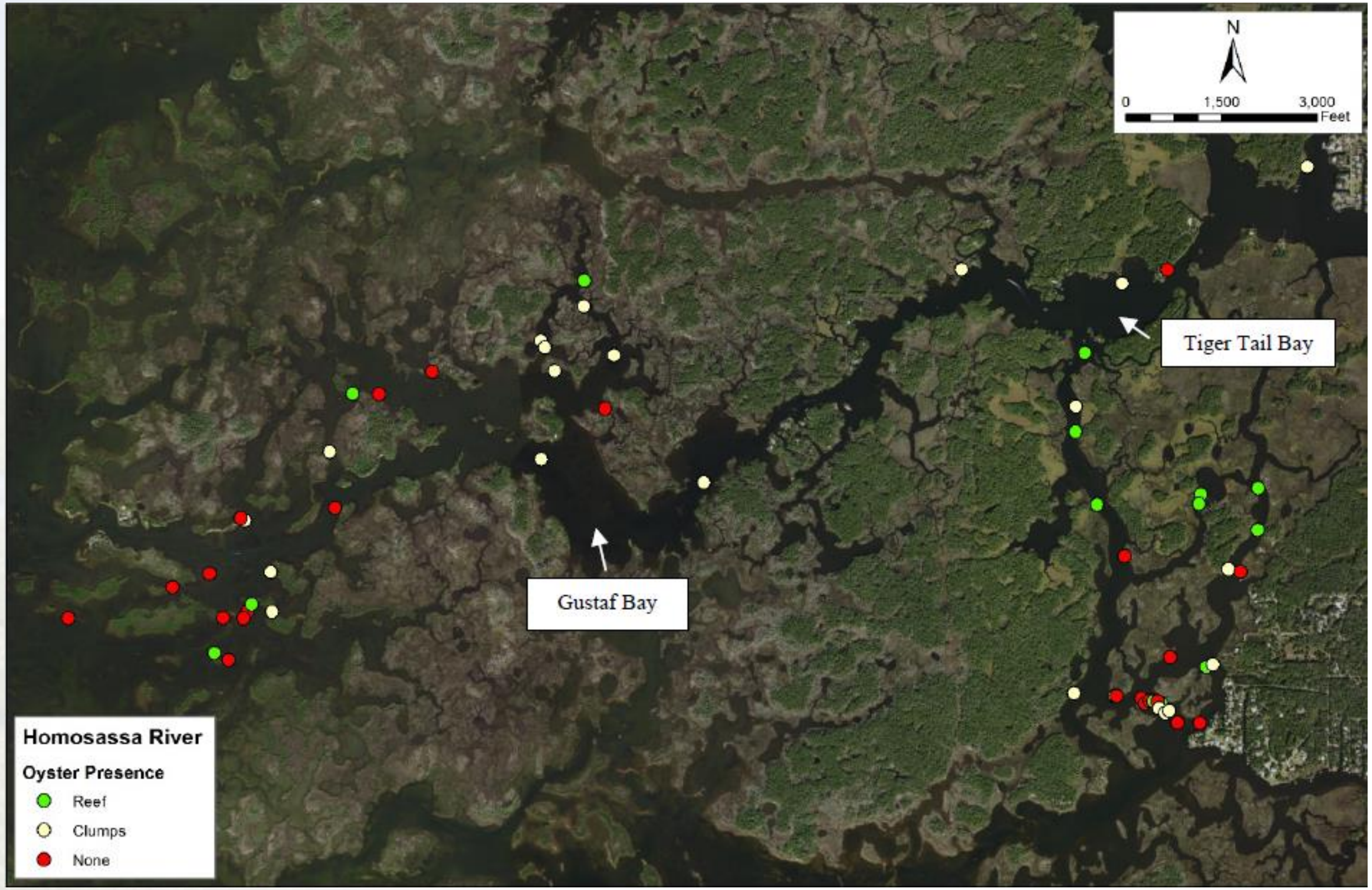
Location	Sites with no oysters found	Oyster clumps	Oyster reefs	Total sites
Homosassa River	23	22	15	60
Crystal River	13	40	28	60

Site Visits - Results



Site locations in Crystal River classified as oyster reefs, oyster clumps, and no live oysters

Site Visits - Results



Site locations in Homosassa River classified as oyster reefs, oyster clumps, and no live oysters

Site Visits – Substrate Type

- Substrate Type
  - Crystal River: 71% of oyster reef sites were limestone
  - Homosassa River: 27% of oyster reef sites were limestone

TABLE 2-4
SUBSTRATE CHARACTERISTICS FOR OYSTER REEF CLASSIFICATIONS IN THE CRYSTAL AND HOMOSASSA RIVERS. VALUES ARE EXPRESSED AS THE PERCENTAGE OF ALL SITES WITHIN EACH CATEGORY ASSOCIATED WITH EACH SUBSTRATE CATEGORY. DATA FROM NOVEMBER 2018.

System	Category	Limestone (% of sites)	Sand or Sand/Shell (% of sites)	Mud or Mud/Shell (% of sites)
Crystal River	No live oysters	23	15	62
Crystal River	Oyster clumps	25	40	35
Crystal River	Oyster reefs	71	18	11
Homosassa River	No live oysters	13	33	54
Homosassa River	Oyster clumps	48	14	38
Homosassa River	Oyster reefs	27	46	27

- Substrate requirements differ between the two systems

Site Visits – Boat Wakes

Location along Homosassa River at Channel Marker 46, showing proximity of boating channel to location with oysters (on lee side of limestone outcropping) and without oysters (on exposed side of limestone outcropping).

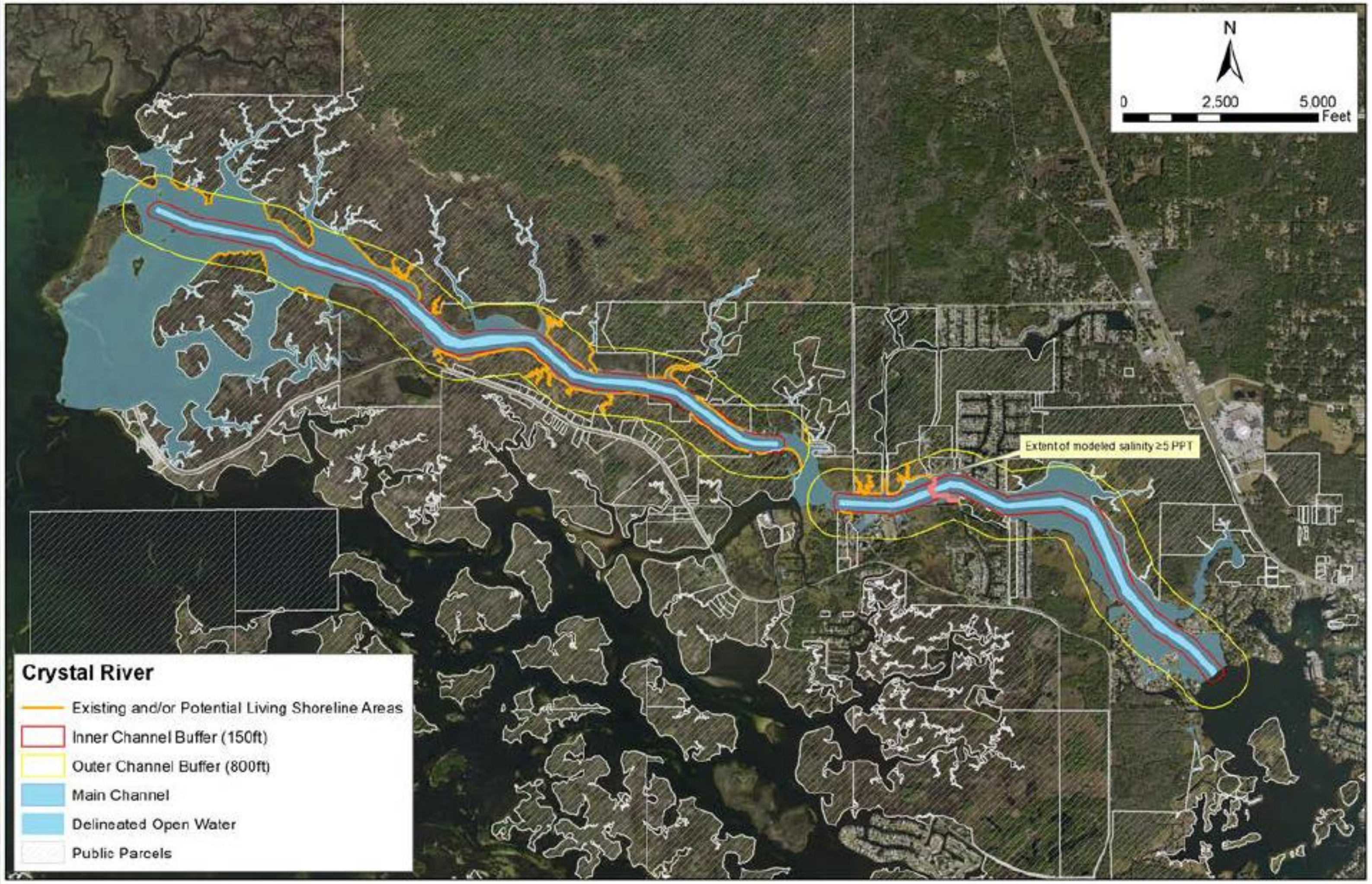
Site Visits – Boat Wakes

TABLE 2-5
AVERAGE DISTANCE (FEET) BETWEEN NEAREST BOUNDARY OF CLOSEST BOATING CHANNEL AND SITES VISITED FOR EACH OYSTER REEF CLASSIFICATION IN THE CRYSTAL AND HOMOSASSA RIVERS. DISTANCES ESTIMATED USING GIS. NA = NOT APPLICABLE.

System	Category	Average distance to nearest boating channel (feet)
Crystal River	No live oysters	409
Crystal River	Oyster clumps	368
Crystal River	Oyster reefs	321
Homosassa River	No live oysters	177
Homosassa River	Oyster clumps	249
Homosassa River	Oyster reefs	NA

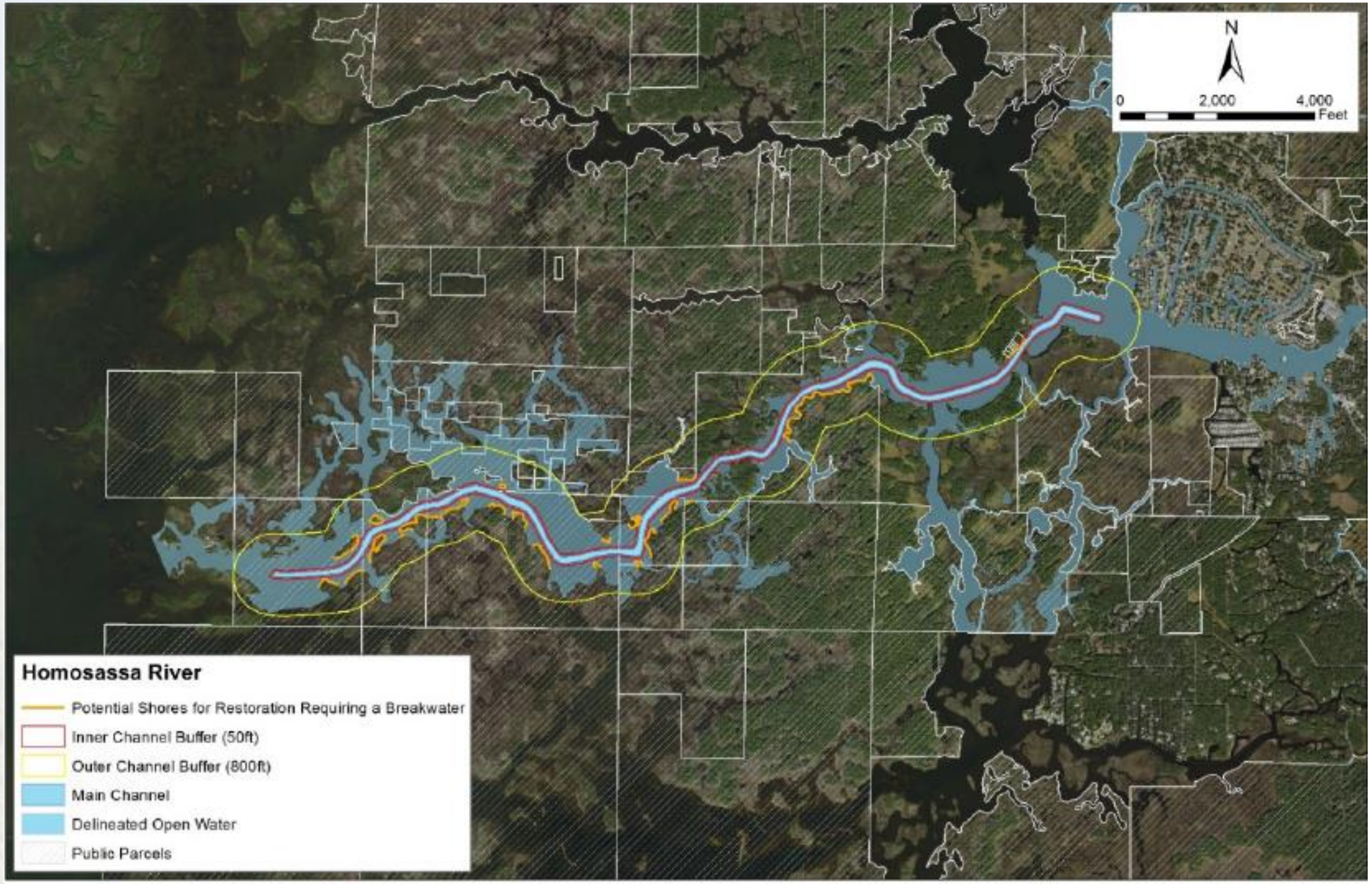
- Homosassa River minimum distance threshold ≈ 200 feet
- Similar findings in Delaware Bay (McGowan 2018)

Site Selection and Prioritization



Potential priority areas of the Crystal River where living shoreline projects with oyster reefs are likely to be successful

Site Selection and Prioritization



Potential priority areas of the Homosassa River where living shoreline projects with oyster reefs are likely to be successful

Site Selection Matrix

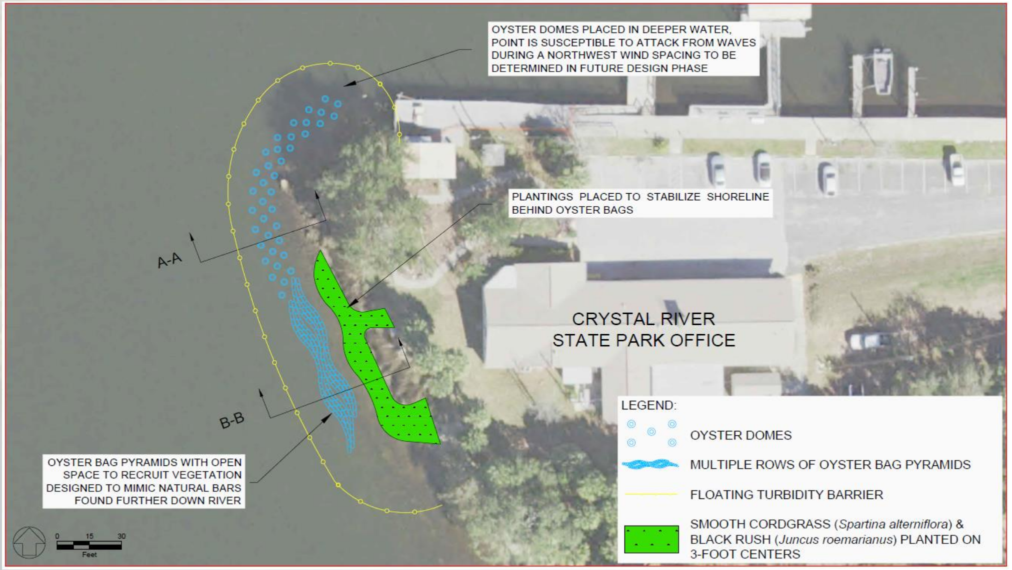
TABLE 3-1
CHARACTERIZATION OF SITE ATTRIBUTES TO BE CONSIDERED FOR OYSTER REEF DEVELOPMENT. VALUES FOR "SCORE" REPRESENT SUBJECTIVE ASSESSMENTS OF THE IMPORTANCE OF A GIVEN ATTRIBUTE TO INFLUENCE THE SUCCESS OF OYSTER REEF PROJECTS

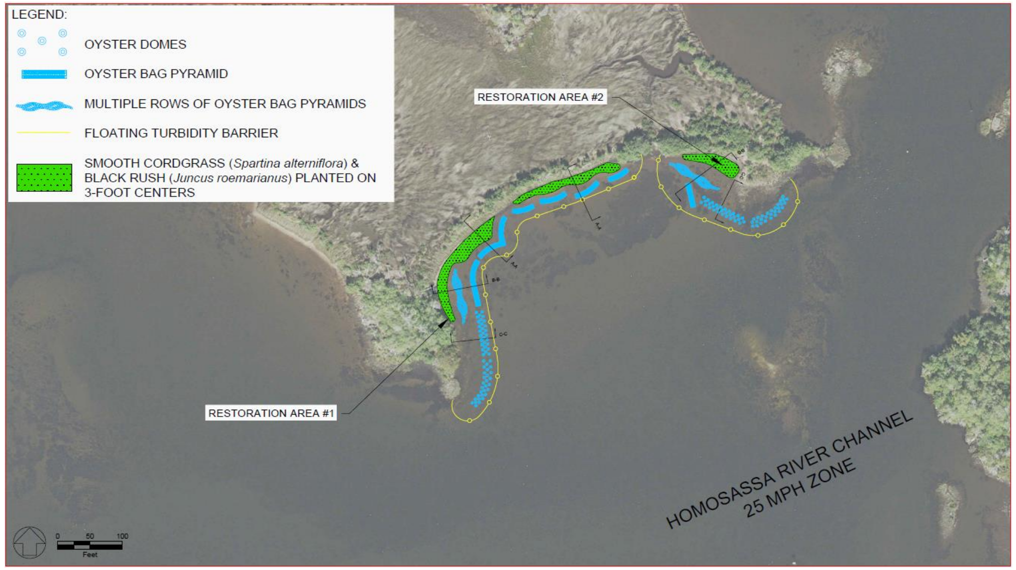
	Average salinity (ppt)			Substrate type			Distance from nearest boating channel (feet)		Land ownership	
Range or category	< 5	5 to 10	> 10	Mud or mud/shell	Sand or sand/shell	Limestone	< 150	> 150	Private	Public
Potential scores	0	3	5	0	3	5	0	5	0	5

- Results in reasonable predictions of how likely a location would be for allowing oyster reefs to develop
- Caveats:
  - Substrate type is not known *a priori* in any detail, requires site visits
  - Substrate may be could be modified through the use of fill
  - Wave attenuation devices could be used in areas less than 150 feet from boat channels
  - Private lands could do very well of oyster reef projects

Conclusions

- A site selection matrix helped target areas with the greatest potential for success
- Spatial distribution of oyster reefs is influenced by different factors in the Crystal and Homosassa River estuaries
  - Crystal River – Factor that most strongly restricts oyster development is salinity
  - Homosassa River – Factor most strongly restricts oyster development is proximity to boat channels



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