

Damon W. Moore

**A Proposed Path Forward for Large Scale Oyster
Habitat Restoration in the Manatee River**

December 7th, 2016

INTRODUCTION:

The purpose of this document is to explore the benefits, feasibility, justifications, and conceptual planning for implementing a large scale habitat restoration of eastern oyster (*Crassostrea virginica*) habitat in the Manatee River. There is a body of evidence that proves the Manatee River once supported a much greater abundance of living oyster habitat than it does now. Oysters are known to provide significant ecosystem services and restoration of those ecosystem services would provide numerous benefits. Information will be presented in the context of what will likely be necessary to facilitate moving a large-scale habitat restoration project forward based on past experience, discussions with local restoration practitioners, and research done exploring the potential for a large scale oyster restoration project in the Manatee River.

Impacts to oyster habitat occurred long ago and no one alive today has memories of “how it used to be”. Perhaps this was put best by H.A. Smeltz in an 1898 Bulletin of the United States Fish Commission:

“In 1876 I came to the west coast of Florida from one of the largest oyster-growing sections in the world, Chesapeake Bay. I landed at Cedar Keys and at once became interested in the oyster-beds of Florida...I continued southward to the Alafia River, Big and Little Manatee, Sarasota, Boca Grande oyster-bars and 100 miles farther south, and on every hand I found the same condition – oysters, oyster everywhere. How little did I think that in less than twenty-five years every one of these bars would be partially or totally depleted.” (Smeltz 1898)

As more time passes we run the risk as a society and restoration practitioners of setting restoration goals too low because of a lack of knowledge of an un-impacted historical condition, a problem of sliding baselines (Estevez 2010). I intend to, and have started the process, of

pushing forward with the early stages of implementing a large scale project to restore oyster habitat in the Manatee River.

In this early stage, the intent is to go big, and restore the maximum amount of oyster habitat feasible and restore the maximum benefit of ecosystem services provided. There is currently a unique funding opportunity for large scale projects of this nature through the RESTORE Act and this project will be submitted for consideration under numerous RESTORE Act funding streams. This will be the first phase of the Manatee River Oyster Habitat Restoration Project with this initial phase officially titled “Manatee River Oyster Habitat Restoration Project – Phase I: Master Restoration Plan Development and Pilot Oyster Reef Construction”.

Typical of large and complex restoration projects, extensive planning and baseline data gathering is necessary to accurately specify the scope of a restoration project. This instance is not an exception, and the first step of this project should be developing a well thought out and vetted plan. I will refer to this plan throughout this document as the Master Restoration Plan (MRP). Creation of the MRP serves to pave the way for the desired restoration..

For purposes of this exploration, a project area is defined as the estuarine portions of the Manatee River from Fort Hamer Road Bridge to Mouth of River at its confluence with Tampa and Sarasota Bays., The project area also includes the estuarine portions of the Braden River as

well as Wares Creek, Warner's Bayou (east and west), and McLewis Bayou. The project area is centered at approximately 27.509260, -82.528044. (Figure 1)

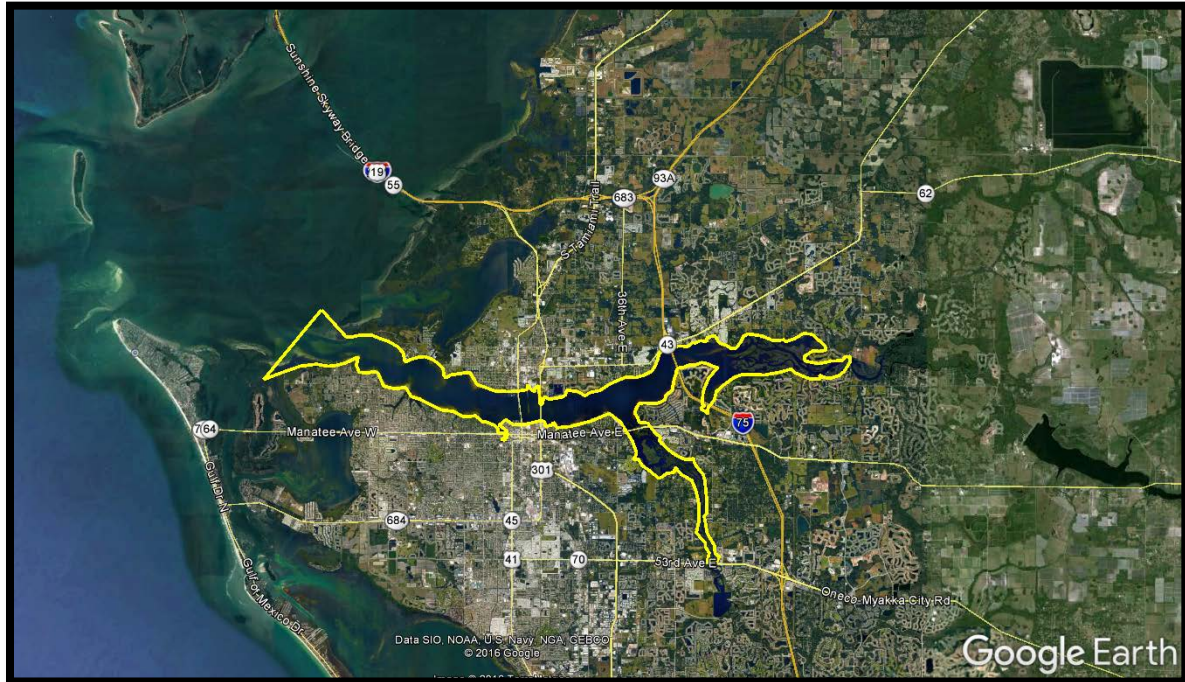


Figure 1 - Project Area within yellow polygon. (Google Earth, 2016)

ANALYSIS:

The analysis section of this document will provide a background of oyster habitat in the Manatee River, and explore aspects to consider in implementing a project from this early stage as an idea and those necessary for creation of the Master Restoration Plan. Aspects covered will include:

- **Background**
- **Project Description**
- **Environmental Benefits**
- **Economic and Social Benefits**
- **Partnerships**

- **Estimated Project Costs**
- **Compliance with Federal, State, Local, and Tribal Laws/Regulations**
- **Technical Feasibility**
- **Conflicts or Complements to Existing Efforts**
- **Readiness for Implementation**
- **Public Acceptance**

Background:

The Manatee River is approximately 36 miles long with a watershed of just over 350 square miles which discharges at the confluence of two estuaries of national significance, Tampa Bay and Sarasota Bay. (Figure 2)

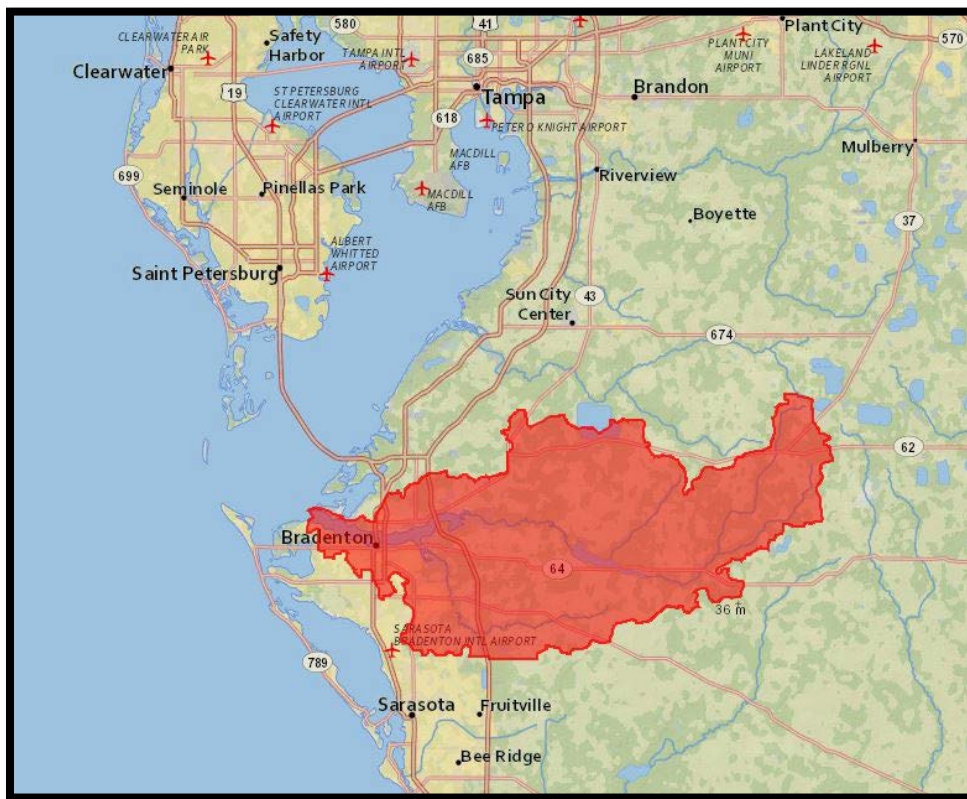


Figure 2 – The Manatee River Watershed. Approximately 350 Square miles shown within the red polygon. (Manatee County Water Atlas, 2016)

Once called the Oyster River (Williams 1837) (Figure 3), oysters provided a staple food for Native Americans and early settlers and were thought to be so numerous that they prevented ships from entering the river (Burger, 2007). The Manatee River historically supported a much greater abundance of living oyster habitat than it does now. There has been an estimated 90-99% loss of historical oyster reefs along the Gulf Coast of Florida (Beck et al. 2009).

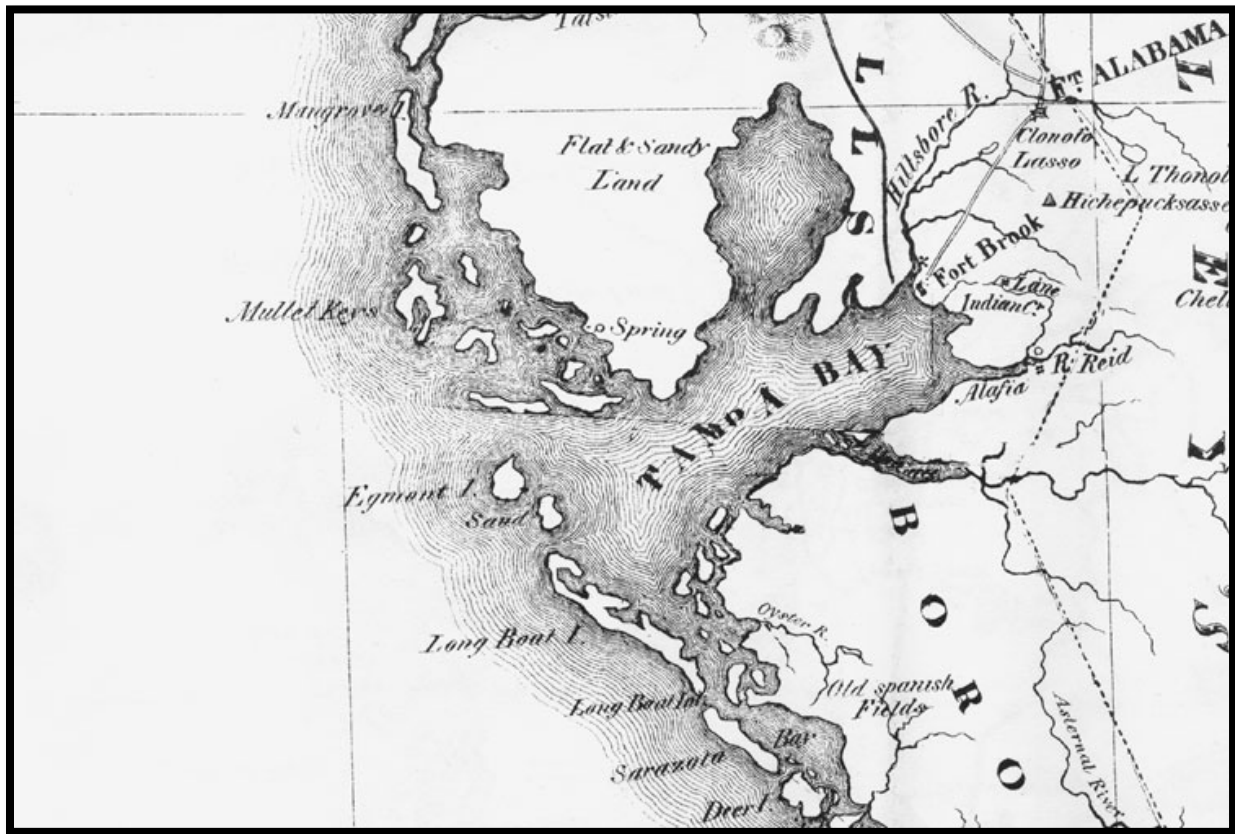


Figure 3 – Cut from J.L. William 1837 Map. Note Manatee River is referred to as "Oyster R."

Over time the extent of live oysters has decreased significantly. Historical reports note rampant over harvesting of oysters throughout the gulf coast of Florida by early settlers (Smeltz 1898, Townsend 1875). As the local human population dramatically increased through the 1900's, and the Manatee River was subject to dramatic changes such as altered land uses and

cover within the watershed, river bottom dredging and filling, shell mining, changes to freshwater inputs, and decreased water quality. These factors culminated in a dramatic decrease in the abundance of oysters.

Direct evidence of large scale mining of submerged shell deposits can be found in severance fee payment records. This is a process in which live and dead shell is dredged from the bottom and placed on barges. (Figure 4)



Figure 4 – Shell Dredge in Tampa Bay (The Florida Anthropologist Volume 25 June 1972 No. 2 Part 1 Commercial oyster Shell of Tampa Bay L.O. Warren)

The dredged oyster shells material was then used for numerous purposes on land. Just one company, the Bradenton Dredging and Shell Company, removed shell from the river totaling

over 650,000 cubic yards of material that was removed between 1931 and 1962 (Whitfield, 1975 p 15). It is likely that much of the material harvested was not reported. Shell mining and numerous other dredge and fill projects over the past 100 years have changed the physical character of shoreline and bottom of the river. These physical alterations resulting in a loss of hard substrate for oyster colonization appear to be the major limiting factor

There are currently pockets of living oyster bars along natural shorelines of the river as well as artificial hard substrates like pilings, revetments, and seawalls throughout most of the estuarine portions (personal observation). By qualitative analysis one sees that a significant area within estuarine portions of the river has a high potential for restoration of oyster habitat and associated ecosystem services. Observations of the current existing scattering of live oysters on the existing but limited hard substrates up and down the river paired with expansive shallow shorelines of sand bottom suggests there is potential for successful oyster habitat restoration within the Manatee River.

Project Description:

Oyster habitat restoration would consist largely re-introducing hard material or cultch (i.e. oyster shells, fossilized shell, lime stone riprap, and engineered structures) from barges into intertidal and sub tidal areas of the river that are determined likely to support oysters. An example of such an area are the Dot Dash islands at the interface of the Braden and Manatee Rivers. Live oyster reefs exists south of State Road 64, but north of the bridge, appear to have been removed sometime after 1940 as determined by aerial interpretation (Figures 5 and 6). The Manatee River appears to provide large areas that meet these criteria. (Figures 7 and 8)



Figure 5 - Dot Dash Islands 1940. Note dark signature surrounded by lighter color north of the islands and along the shoreline adjacent to the development with dock into river. Dark signature is likely oyster bars. (UF George A Smathers Libraries Digital Collections)

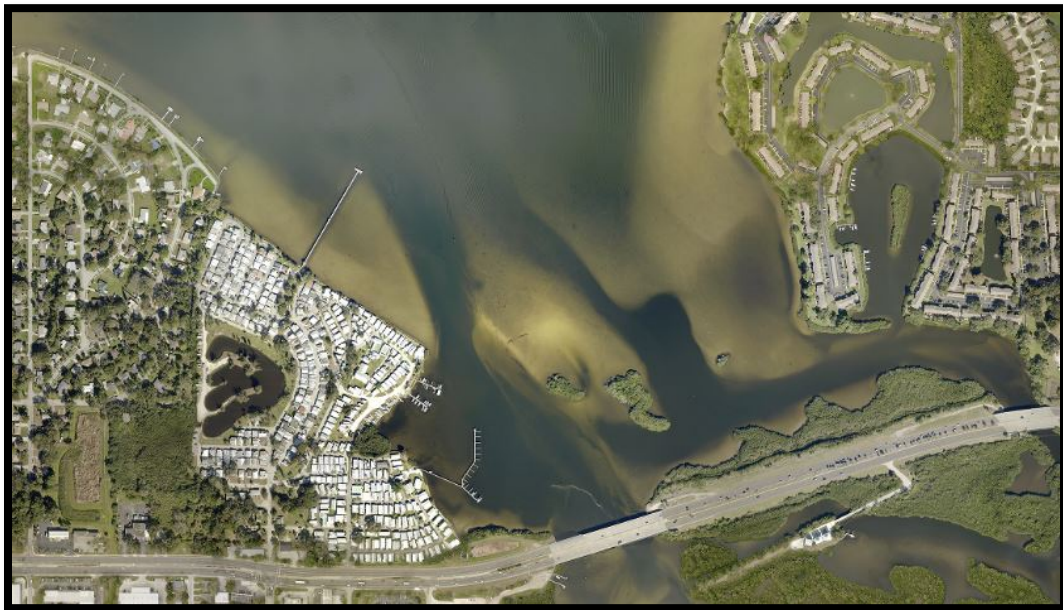


Figure 6 – Dot Dash Islands 2015. Note the Dark Signature is removed and sand bottom remains in areas believed to once harbor oysters. (Manatee County GIS 2016)

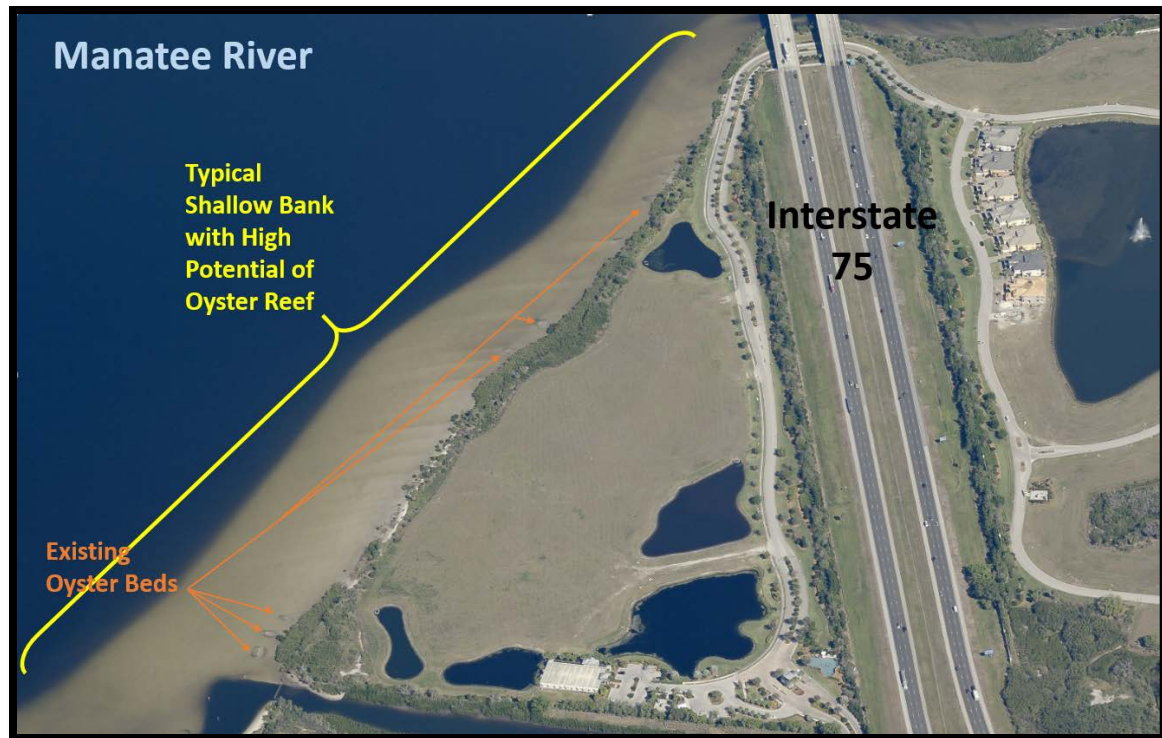


Figure 7 – 2015 Pictometry of area along south shore of Manatee River west of I-75. This is a typical large area with high potential for oyster restoration. (Manatee County GIS 2016)



Figure 8 - 2015 aerial shows the location of the area highlighted (Figure 7) in context of large shallow sand areas with the same aerial signature. (Manatee County GIS 2016)

Though a project as described above may sound like a simple task, it is not. There are numerous and significant challenges to moving a project like this forward. To proceed, a detailed and thoroughly vetted Master Restoration Plan (MRP) must be created and pilot oyster reefs must be designed, permitted, and constructed. Development of the MRP should consist of the following:

- Initial focus group meetings.
- Partnership building.
- Gathering and analysis of existing baseline and historical data.
- Filling in data gaps (i.e. mapping existing submerged aquatic resources, bathymetry, freshwater flows analysis, sedimentation analysis, spatial suitability model, biological limiting factors analysis, sea level rise implications analysis).
- Unintended Consequences Analysis
- Formulation of an overall project-wide conceptual restoration plan.
- Hosting and documenting public input and focus group meetings.
- Set quantifiable goals for restoration success.
- Engineer's cost estimates for full scale and unit based large scale project implementation.
- Determination of funding strategies.
- Legal Liabilities Assessment
- Design and permitting of a series strategically placed of pilot oyster reefs. (These reefs will be strategically located to assess oyster spat settlement and early establishment potential).
- Construction and monitoring of the pilot oyster reefs (**a major cost component**).
- Creating the MRP document including scalable and prioritized future projects.

Implementation of this plan should follow guidance provided in the Society of Ecological Restoration's "*Guidelines for Developing and Managing Ecological Restoration Projects*" (Clewett 2005). Creating the MRP and constructing Pilot Reefs paves the way for large scale oyster habitat and associated ecosystem services restoration in the Manatee River and will provide environmental, economic, and social benefits.

Environmental Benefits:

The environmental benefits from oyster habitat restoration in the Manatee River stem from the ecosystem services provided by intact oyster habitat. Ecosystem services provided are numerous and well-documented (ASMFC 2007). Oyster are often considered "ecosystem engineers" in that they directly or indirectly modulate the availability of resources to other species, by causing physical state

changes in biotic or abiotic materials. In doing so, they modify, maintain, and create habitats. As ecosystem engineers, oyster reefs are biogenic, in that they provide habitat for more oysters in the future (CHNEP 2012, Brumbaugh et al. 2006).

Numerous other species benefit from oyster habitat as they form the foundation for a complex biological community (Drexler et al. 2010). Oyster reefs provide the substrate for many lower tropic level organisms to grow on. Organism such as algae and non-mobile invertebrates thrive on oyster bars and are largely lacking on vast sand bottom areas where oyster reefs would be restored. The structure of oyster habitat also provides structural habitat support for many larger more charismatic species such as numerous gamefish, shrimp, crabs, which in turn support species at the top of the food chain including economically important game fish. A study by Drexler et al. in 2010 identified over 150 taxa in association with oyster habitat in Tampa Bay.

Oysters also provide environmental benefits by virtue of being a full time water filter (zu Ermgassen et al. 2016). Through their natural biological processes of filter feeding and bioaccumulation, oysters increase water quality in the Manatee River and associated downstream waters. Living oyster habitat has been documented to reduce nitrogen pollution (a primary concern for the health of local estuaries) and reduce turbidity (zu Ermgassen et al. 2016). Both of these actions lead to cleaner, clearer water which allows for greater light transmissivity in local waters. Greater light penetration through the water column supports continued restoration of another vitally important natural resource, seagrass beds. The filtration and nitrogen reducing benefits provided by oyster habitat also serves to reduce the impact of harmful algal blooms and resulting formation of anoxic zones which result in fish kills.

Oyster reefs, through their physical presence, provide important shoreline stabilization functions (CHNEP 2012). Having oyster reefs on a large scale provides environmental benefits by stabilizing the substrate underneath them, especially during storm events. Furthermore their presence along shorelines serves to protect and promote increases in adjacent natural and habitats such as mangroves, saltmarsh, coastal uplands, and seagrass beds, which synergistically increases resilience to coastal erosion and the

resultant increased turbidity. This is a very important factor as sea level rise continues and protection from coastal erosion becomes increasingly important.

Oysters also sequester atmospheric carbon as they grow, with shells composed of calcium carbonate (zu Ermgassen et al. 2016). The role oyster reefs play in support of increasing mangrove seagrass habitats is of particular importance because of the role those habitats also play in carbon sequestration. Oyster habitat restoration, as part of this project, will be conducted in a way to avoid impacting to other high value natural resources such as existing oyster reefs, seagrass beds, and hard bottom habitat. Permitting processes will require this project be conducted in a manner to identify and protect these resources.

Economic and Social Benefits:

The economic benefits of this project stem from the restoration of ecosystem services it would bring. While quantification of economic benefits from oyster reef restoration is inherently difficult due to the complex and sometimes indirect nature of economic gains achieved in habitat restoration, it is was determined in an Economic Valuation Study of Sarasota Bay that the economic value of Sarasota Bay resources have an economic value of 57.9 billion dollars. (Hindsley, 2011) It is safe to assume that by association to Sarasota and Tampa Bays, the Manatee River and resources that large-scale oyster habitat restoration would restore and support, would be valued highly.

Performing large-scale oyster habitat restoration in the Manatee River would likely result in direct economic benefits to the following:

- Local Contractors – through construction of oyster habitat.
- Local Commercial Fisheries – by increasing yields of local commercially important species such as mullet, and crabs.
- Local Recreational Fisheries – by increasing fishing locations and catches for recreational important species such as baitfish, redfish, seatrout, snook, sheepshead, etc.
- Coastal Property – by reducing coastal erosion, increasing water quality, and increasing property values.
- Local Tourism Industry – by protecting and enhancing local ecosystems that support the local tourism economy.

There are also significant social benefits that would result from large-scale oyster habitat restoration in the Manatee River for local residents and the many visitors to this area. Primary areas of social benefit are:

- Heritage – The presence of oysters in estuarine waters, and in large abundance, is part of the history of Manatee County and southwest Florida. Oysters once supported Americans and early settlers of Manatee County. Restoring this component of the local history will add value and sense of place.
- Aesthetics – Oysters on a low tide with sunset lit backdrop of shimmering waters framed by mangrove shorelines and people interacting with a clean and healthy waterway is the subject of many photographs.
- Scientific Understanding – This project will serve as a valuable case study for other local and regional oyster restoration projects.
- Intrinsic Value – Because there used to be oysters there, and there should be again.

Partnerships:

Manatee County would play the lead role in Phase I. There are not yet formal partnerships made for this project. Manatee County staff has had communications with scientists and restoration practitioners from the Tampa Bay Estuary Program, Sarasota Bay Estuary Program, National Wildlife Federation, Coastal Conservation Association, and The Nature Conservancy, about this project in its very preliminary stage. As this project develops and gains momentum we anticipate potential partnerships with, but not limited to, the following:

- City of Bradenton
- City of Palmetto
- Florida Fish and Wildlife Conservation Commission
- Florida Department of Environmental Protection
- Southwest Florida Water Management District
- Local Educational Institutions
- Local Commercial Fishing Industry Representatives
- Local Recreational Fishing Industry Representatives
- Local Environmental Non Profit Groups
- Mote Marine Laboratory
- US Fish and Wildlife Service Coastal Program
- US Army Corps of Engineers

- National Oceanic and Atmospheric Administration
- Tampa Bay Estuary Program
- Sarasota Bay Estuary Program
- Coastal Conservation Association
- National Wildlife Federation
- Audubon Society Coastal Sanctuaries
- West Coast Inland Navigation District

Estimated Project Costs:

Phase I of this project will consist of the tasks noted in the project description above for development of the MRP (including pilot oysterbars). The initial estimate of cost for Phase I is \$950,000 (Moore, 2016). It is assumed that the bulk of expenses associated with Phase I will come from two tasks; data collection/analysis for filling in data gaps and implementing the pilot oyster reefs. In areas of the river where existing data and qualitative analysis shows the highest probability for success, larger pilot reefs would be constructed relative to areas where success is less likely. Funds not spent on development of the data collection and analysis for MRP will go towards construction of pilot reefs. Conversely adequate study must be done for pilot reefs to be successful in providing the very important in situ data that will serve as a major contingent in determination of a maximized practicable restoration target for future funding. This strategy will serve as check and balance between development of the MRP and construction of the pilot oyster reefs. A high quality MRP is of primary importance.

Manatee County staff will dedicate a significant time working on this project. Other funding sources and strategies to attain that funding will be identified with implementation of this project through development of the MRP. This is the first step in what will amount to a multi-million dollar effort to maximize the restoration of oyster habitat and associated ecosystem services that will result from implementation of projects/future phases to be identified in the MRP, the ultimate deliverable document associated with Phase I of this project.

Compliance with Federal, State, Local, and Tribal Laws/Regulations:

This project will be in compliance with all Federal, State, Local, and Tribal laws and regulations. Development of the MRP will not require any special permitting but coordination with permitting agencies will need to occur in development of the plan. Construction of the pilot oyster reefs will require state and federal permit authorizations.

Federal authorization will be accomplished through a Nationwide or Individual Permit issued by the United States Army Corps of Engineers likely with Section 7 consultation through the National Marine Fisheries Service and United States Fish and Wildlife Service and any navigational issues approved by the United States Coast Guard. State Authorization will be accomplished with issuance of an Environmental Resource Permit and Sovereign Submerged Land approval by the Florida Department of Environmental Protection.

Technical Feasibility:

Over the past ten years Manatee County Parks and Natural Resources staff have successfully implemented wide ranging and complex habitat restoration projects throughout Manatee County. With expenditure values over 30 million dollars, these projects have included garnering public support, technical aspects of habitat restoration, complex permitting challenges, community outreach & education, leveraging partnerships, and managing contracts. Manatee County staff are well supported by the public, capable, prepared, and determined to take on a project of this scope, scale, and of such importance, from start to finish. Working directly with oyster habitat restoration, Manatee County staff have successfully implemented smaller scale, community outreach driven oyster restoration projects within the internal waterways of Robinson Preserve.

This project will be modeled after the Charlotte Harbor National Estuary Program Oyster Habitat Restoration Plan for development of the MRP. The construction of the pilot reefs will be completed in a similar manner to other successful large scale oyster restoration projects such as those along the Texas coast conducted by the Texas Parks and Wildlife Department in and around Galveston Bay as well as other notable large projects in Louisiana, Alabama and the Florida panhandle.

Conflicts or Complements to Existing Efforts:

There are no known conflicts that this project would cause as it is specifically intended to seek out and work within any identified constraints. This project complements numerous existing efforts. The Manatee River is a Class III water and ecosystem benefits of filtration and denitrification provided by oyster habitat restoration will protect and increase quality for that designated use. The Manatee River also discharges into upper Sarasota Bay which is designated as an Outstanding Florida Water. Just north of the River is the Terra Ceia Aquatic Preserve within Tampa Bay. These special designations of the Manatee River and directly associated water bodies all have associated plans, goals, and objectives to protect and improve water quality, improve fisheries, sequester carbon, shoreline stabilization, bolster seagrass beds, increase forage habitat for birds, restore cultural values, increase environmental education/outreach, and other initiatives that implementation of this project would directly complement and support numerous other plans.

The proposed project is also included in the Tampa Bay Region High Priority Projects List developed by the Tampa Bay Estuary Program partners. The list includes fully-vetted projects from local governments, agencies and NGOs that have been ranked and evaluated using the criteria developed for the 2013 Southwest Florida Regional Ecosystem Restoration Plan; clearly address the Goals and Florida Priorities identified by the Trustees and the State of Florida; and respond to the relevant restoration types prioritized in the Programmatic Damage Assessment and Restoration Plan (PDARP). Projects have been peer-reviewed by local resource managers with expertise in water quality improvement, habitat restoration, and resource monitoring and approved for inclusion in the Tampa Bay Region High Priority Project List by the Tampa Bay Estuary Program Policy Board in November 2016. (Greening 2016)

There are certainly more statewide, regional, gulf wide, national, and international efforts that this project would complement and directly support.

Some specific additional examples are:

- Tampa Bay Estuary Program: CCMP - Implement the Tampa Bay Master Plan for Habitat Restoration and Protection- This project would complement this management plan through the restoration and protection of key bay habitats.
- Sarasota Bay Estuary Program: CCMP - This project compliments the SBEP's plan through the improved water quality, increased habitat, and enhancement natural resources of the area.
- Manatee County: Comprehensive Plan - This project compliments the County's Comprehensive Plan because shoreline uses under the Comprehensive Plan are prioritized with the most preferable being "Water dependent conservation uses such as fish, shellfish, and marine resource production, natural coastal habitat protection, shoreline stabilization,..."

Readiness for Implementation:

Phase I of this project, (Development of the Master Restoration Plan including constructing pilot reefs) for which we are requesting funding, is ready for implementation. Manatee County staff has reviewed current and historical aerial photographs, probed historical accounts of past oyster habitat occurrence in the Manatee River, and made qualitative in situ observations of existing oyster occurrence. These data and observations point to a high potential for a successful large scale habitat restoration project. Phase I is a necessary step for implementation of the overall Manatee River Oyster Habitat Restoration Project.

Public Acceptance:

There is no known opposition to the project. To date all who have been introduced to the concept have been very supportive. However, as the overall large scale oyster restoration project as in its early stages of development, conceptual plans have not been made available at public meetings for review and comment. Development of the MRP will include holding public and stakeholder meetings. These meetings will, among other things, aim to identify any potential opposition, concerns, or unintended consequences of implementing a large scale oyster restoration project in the Manatee River.

Through small scale oyster restoration projects Manatee County has completed within County preserves funded through the Tampa Bay Environmental Restoration Fund, Manatee County has observed that the public is highly supportive of the creation and restoration of oyster habitat. It's something that

has proven popular and satisfying among volunteers and the request for more oyster habitat restoration events has increased. People appreciate the idea of something with so many proven benefits.

By implementing Phase I of this project (for which we are requesting funding) development of the MRP will study, identify, and document any negative consequences. Some areas likely to be of concern and may require design considerations are:

- Submerged Land Titles and Encumbrances
- Avoidance of damage to existing submerged and intertidal natural resources
- Avoidance of identified current and historical recreation areas
- Avoidance and proper marking of potential navigational hazards.
- Avoidance of impact to listed species during and after construction.

Any large scale restoration project will bring up concerns and potential opposition to aspects of the project. A major reason we are requesting funding in phases is to identify and work through those issues in an open and well vetted manner to garner public support that will lead to a highly beneficial outcome of large scale habitat restoration in the Manatee River.

SUMMARY:

Large scale oyster habitat restoration in the Manatee River appears to be a worthwhile and feasible goal. Implementation of a project of the maximum scale to achieve the highest degree of restored ecological services possible will require an organized and well vetted approach. Through implementation of the proposed Manatee River Oyster Habitat Restoration Project – Phase I: Master Restoration Plan Development and Pilot Oyster Reef Construction will make achieving the goal of large scale oyster habitat restoration possible. Time is of the essence to take advantage of the unique opportunities for funding through the RESTORE Act. The Manatee River Oyster Habitat Restoration Project – Phase I: Master Restoration Plan Development and Pilot Oyster Reef Construction was submitted onto the FDEP project portal on December 5, 2016 to be considered for funding under the RESTORE Act.

CITATIONS:

ASMFC. 2007. *The importance of habitat created by molluscan shellfish to managed species along the Atlantic coast*. Habitat Management Series #8. Prepared by Coen, L.D. and R. Grizzle, with contributions by J. Lowery and K.T. Paynter, Jr. 106 pp.

Baggett, L.P., S.P. Powers, R. Brumbaugh, L.D. Coen, B. DeAngelis, J. Greene, B. Hancock, and S. Morelock, 2014. *Oyster habitat restoration monitoring and assessment handbook*. The Nature Conservancy. Arlington, VA, 96pp

Beck, M.W., R.D. Brumbaugh, L. Airoidi, A. Carranza, L.D. Coen, C. Crawford, O. Defeo, G.J. Edgar, B. Hancock, M. Kay, H. Lenihan, M.W. Luckenbach, C.L. Toropova and G. Zhang. 2009. *Shellfish reefs at risk: a global analysis of problems and solutions*. The Nature Conservancy, Arlington, VA. 52 pp.

Brumbaugh, R.D., M.W. Beck, L.D. Coen, L. Craig and P. Hicks. 2006. *A practitioners guide to the design and monitoring of shellfish restoration projects: an ecosystem services approach*. The Nature Conservancy, Arlington, VA. 32 pp.

Burger, Bill. 2007. *Oyster Beds Kept Big Vessels Out*. Herald-Tribune. Published May 12, 2007 p. A18.

CHNEP. Charlotte Harbor National Estuary Program 2012. *Charlotte Harbor National Estuary Program Oyster Habitat Restoration Plan*.
http://www.chnep.wateratlas.usf.edu/upload/documents/134_CHNEP-Oyster-Restoration-Plan-12Dec2012-lowres.pdf

Clewell A., Reiger J., Munro J. 2005. *Guidelines for Developing and Managing Ecological Restoration Projects*, 2nd Edition. www.ser.org & Tuscon: Society for Ecological Restoration International.

Drexler, M., M.L. Parker and S.P. Geiger. 2010. *Assessing the relative value of oyster (Crassostrea virginica) populations sampled from oyster reef, artificial seawall, mangrove, and restored habitats*. Florida Fish and Wildlife Conservation Commission Final report for contract # CZ907. 95 pp.

Estevez, E.D. 2010. *Mining Tampa Bay for a Glimpse of What Used to Be*. Bay Soundings. Spring 2010.
<http://baysoundings.com/legacyarchives/spring2010/Stories/MiningTampaBayforaGlimpseofWhatUsedtoBe.php>

Greening Holly. 2016. Personal Communication with Holly Greening, Director Tampa Bay Estuary Program by email 11.18.2016

Hindsley P. R., Ashton Morgan, O. 2014. The Sarasota Bay Economic Valuation Project: Phase II. <http://sarasotabay.org/wp-content/uploads/EVS-Phase-II-Full-report.pdf>

Moore, Damon W. 2016 FDEP Portal Project Proposal number: 1655 *Manatee River Oyster Habitat Restoration Project - Phase 1: Master Restoration Plan Development and Pilot Oyster Reef Construction*. Submitted by email 12.5.2016.

Smeltz, H.A. 1898. The oyster-bars of the west coast of Florida: their depletion and restoration. *Bulletin of the U.S. Fish Commission* 17:305-308.

Tampa Bay Estuary Program. 2006. *Charting the Course: The Comprehensive Conservation and Management Plan for Tampa Bay*. Tampa Bay Estuary Program.
http://www.tbep.org/tbep/download_charting_the_course.html

Tampa Bay Estuary Program/Joint Florida Gulf National Estuary Programs. 2013. *Southwest Florida Regional Ecosystem Restoration Plan*.
<http://www.tbep.tech.org/attachments/article/131/Southwest%20Florida%20Regional%20Ecosystem%20Restoration%20Plan,%20adopted%203-8-2013.pdf>

Townsend, Trench. *Wildlife in Florida with a visit to Cuba*. Hurst and Blackett Publishers. London 1875. P. 41-49

Whitfield W.K. Florida Department of Natural Resources Marine Research Laboratory. 1975. *Mining of Submerged Shell Deposits: History and Status of Regulation and Production of the Florida Industry*. Florida Marine Research Publications Number 11, October 1975

zu Ermgassen, P., Hancock, B., DeAngelis, B., Greene, J., Schuster, E., Spalding, M., Brumbaugh, R. 2016. *Setting objectives for oyster habitat restoration using ecosystem services: A manager's guide*. The Nature Conservancy, Arlington VA. 76pp.