Oyster Reef Habitat Restoration and Monitoring in Tarpon Bay FL

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Project Description

This project will re-establish stable, living intertidal oyster reefs in an area where oyster reefs were once prevalent but were detrimentally impacted by over-fishing, land use changes, dredging, disease and water quality issues. Tarpon Bay has received a variety of preservation efforts over the last few decades and its habitats are now protected from many of the activities (harvesting, land use changes, dredging, and direct development) which previously degraded oyster reefs in the bay. There is strong evidence that oyster sanctuaries for the native eastern oyster are successful by having significantly higher densities and lower disease prevalence (Powers et al. 2009). The protected status of Tarpon Bay at state and federal levels ensure a positive long-term conservation outcome.

Pre-project monitoring using trays filled with fossil oyster substrate shows the oyster recruitment potential in Tarpon Bay is between 400 and 6000 oysters/m2-yr. (Milbrandt et al. 2012). This is a relatively high rate of oyster recruitment compared to other areas (Milbrandt et al. 2012, Volety et al. 2009, Hadley et al. 2010). Due to the current lack of substantial hard reef structure to settle upon and prevalence of diseases (UNO Research Foundation 2012), the current recruitment potential has not resulted in a vigorous natural re-establishment of oyster reefs in Tarpon Bay. Providing a significant amount of appropriate hard substrate at the correct depth, of proper design and at a suitable location will result in the establishment of a functional living oyster reef. The functional oyster reefs to be established by this project will provide important ecological services to Tarpon Bay including: seston filtration and improved water clarity; control of phytoplankton blooms; improved pelagic-benthic coupling; creation of refugia from predation; creation of feeding habitat for mobile species; and provision of nesting habitat (Coen et al. 2007a).

The SCCF Marine Lab habitat restoration team has significant experience in planning, design, construction and monitoring of oyster reefs. Our work in Clam Bayou, on Sanibel Island resulted in over 800 m2 of functional, oyster habitat in an area where oyster habitat had been decimated after being disconnected from tidal exchange by land use changes (Milbrandt et al. 2012). Partnering with the City of Sanibel, SCCF Marine Lab obtained two grants in 2009, and began restoration work on mangrove and oyster habitats within Clam Bayou. Our work followed oyster reef restoration guidelines developed from previous oyster restoration efforts (Coen et al. 2007b; Brumbaugh et al. 2006; Gregalis et al. 2008) and the Oyster Restoration Workgroup (http://www.oyster-restoration.org/). Previous experience for the constructed reefs in Clam Bayou have allowed us to refine design criteria (proper elevation, position relative to existing oyster habitat, reef relief, flow conditions, etc. to increase the chances for success (Milbrandt et al. 2012).

The improvement of existing oyster reef habitat in Tarpon Bay offered by this project will strengthen the seagrass and mangrove habitats adjacent to the reefs through improved nutrient cycling and water clarity, as well as providing a needed refuge and nursery for many prey organisms (Coen et al. 2007, Tolley and Volety 2005). Oyster reefs are part of a near-shore ecosystem which includes mangrove wetland, oyster reef and seagrass communities. These communities are closely coupled and many species of fish and invertebrates utilize each of these communities during some point in their life history. Oyster reefs actively remove phytoplankton and sediment from the water exchanged with adjacent mangrove and seagrass communities. Seagrass also has the ability to improve water clarity.

Seagrass habitats, which cover over 50% of Tarpon Bay (SCCF, unpublished), will be positively affected by establishment of adjacent viable oyster reefs. The resulting improved water clarity increases the expanse and quality of the photic zone, while oyster filtration activity removes nutrients and organics from the water column and deposits them in substrates, becoming more useable to seagrass root systems. The improved water clarity and nutrient cycling associated with oyster reefs will allow seagrasses to expand in the local area around the constructed reefs. Seagrasses themselves also improve water clarity through removal of suspended matter (Peterson and Heck 2001). Improved seagrass habitat has the potential to benefit upper trophic level organisms through greater availability of habitat and food and better water quality. The federally-listed West Indian manatee consumes massive amounts of seagrass daily and depends upon healthy seagrass habitat for its survival. Similarly the federally protected loggerhead and green sea turtles and endangered smalltooth sawfish depend upon seagrass and oyster reef habitats for food items (Florida FWC 2012). All life stages of the locally endangered bay scallop also rely upon healthy seagrass habitats for refuge and food. All of these protected species are documented to reside within or frequently use Tarpon Bay (SCCF, unpublished). In addition, federally-protected bottlenose dolphins frequent Tarpon Bay in search of prey. Numerous commercially and recreationally valuable fish and invertebrate species including red drum, snook, tarpon, spotted seatrout, snappers, groupers, blue crab, and penaeid shrimp utilize the habitats of Tarpon Bay (Bortone et al. 2003).

Living oyster reefs are critical habitat for lower trophic level organisms such as mud crabs, mussels, polychaetes, blue crabs, false mussels, grass shrimp, gastropods, blennies, gobies and toadfish. These organisms provide food to higher level fishes, birds and mammals, including protected species listed above. Restoring oyster reef habitat within Tarpon Bay will increase populations of reef-dependent organisms and thus benefit organisms higher in the food web.

Background

Tarpon Bay on Sanibel Island, Florida (Figure 1) is a semi-enclosed embayment connected to Pine Island Sound Aquatic Preserve which is adjacent to the Gulf of Mexico. With its abundant seagrass habitat, Tarpon Bay was once known for its abundant fishery and has a rich fishing heritage (first Tarpon caught on hook and line occurred here). Local commercial fishermen and state landings statistics reveal a decline in the area’s shellfish and finfish over the last 50+ years (Personal communication R. Woodring 2012, Florida FWC 2012). The wetland habitat adjacent to the bay was modified for mosquito control with canals and impoundments. Residential and commercial development of Sanibel Island threatened mangrove and seagrass habitats and diminished water quality. Over-fishing nearly eliminated oysters and scallops from the bay. Previous oyster reefs were removed from the bay or broken up into scattered shell hash. The severely reduced population of oysters was then subject to increased influence by poor water quality and diseases such as Perkinsus marinus (UNO Research Foundation 2012) which inhibit redevelopment of degraded reefs.

The Ding Darling National Wildlife Refuge began protecting some land adjacent to Tarpon Bay in 1945 (USFWS 2011). Expansion of the refuge in 1967, 1970, 1991, 1995, 2000 and 2009 eventually protected all of Tarpon Bay and adjacent mangrove habitat. Tarpon Bay itself was added to Refuge management in 1995 protecting all oyster, seagrass and mangrove habitat within the bay. Oyster harvest is prohibited within Tarpon Bay and human activities are restricted and monitored by NWR Law Enforcement. The habitats adjacent to Tarpon Bay are now classified as wilderness area under the National Wilderness Act. Additionally, Tarpon Bay is designated as a National Marine Protected Area (federal level) and as Outstanding Florida Waters (state level) giving the bay added levels of protection from development, land use alteration, dock construction, dredging, boat operation, and water quality deterioration. There is strong evidence that oyster sanctuaries for the native eastern oyster are successful by having significantly higher densities and lower disease prevalence (Powers et al. 2009). The City of Sanibel adopted the Sanibel Plan in 1976 which guides all development on Sanibel Island to minimize environmental impacts and drastically limits the expanse of development on the island. This plan is still in use today and has become a national reference on good development planning (The City of Sanibel 2012). Focusing on water quality improvement, in 2007 the City also implemented a low nitrogen and phosphorus fertilizer ordinance.

These measures give state, federal and local governments' greater responsibility and justification for environmentally sound planning in considering the future of Tarpon Bay. They also provide increased potential for successful restoration of habitats degraded by past events. The threats of over-fishing, unsustainable use, development and water quality degradation within Tarpon Bay have now been reduced, providing a unique opportunity to re-establish quality oyster reef habitat. Our research has shown oyster recruitment potential in Tarpon Bay is excellent (Milbrandt et al. 2012, Tolley et al. 2006) due to existing oyster populations on adjacent mangrove prop roots and in nearby Pine Island Sound. By providing a concentrated mass of suitable hard substrate to the area in which previous oyster reefs have been destroyed and removed by over fishing, we will re-establish living reef habitat in Tarpon Bay.

Even with these protective measures in place other threats will influence the long-term outcome of reef restoration in Tarpon Bay. The reduced oyster population resulting from overfishing, and other human impacts, has allowed oyster disease to have a greater impact on oyster reef health. Prevalence of Perkinsus in Tarpon Bay and nearby Pine Island Sound is high during the summer months and causes mass oyster mortality (UNO Research Foundation 2012; Milbrandt et al. 2012). The influence of disease is thought to be (oyster) concentration dependent (Craig et al. 1989; Bobo 1997; Crosby and Roberts 1990; Luckenbach et al. 2005). Until reef oyster population can increase significantly, the annual mortality due to disease may limit expansion of reef habitat. This project will result in a positive spike in the oyster reef population in small areas of Tarpon Bay. Constructed reefs may develop into islands of high oyster abundance which will allow reefs to expand into nearby areas by overcoming the stifling impact of disease.

Regional development and water management decisions have the potential to detrimentally impact Tarpon Bay. The Caloosahatchee River can serve as a conduit for pollutant-laden agricultural runoff from the Everglades Agricultural Area to flow into San Carlos Bay and Pine Island Sound. The South Florida Water Management District (SFWMD) controls the release of waters down the Caloosahatchee through the S-79 structure. Tarpon Bay is located directly across San Carlos Bay from the mouth of the Caloosahatchee River and will be influenced by water management decisions and activities. During 2 years of the past 10 years multiple hurricanes made landfall in Florida. These caused large loadings of pollutants to be released through S-79 downstream into the Tarpon Bay vicinity. However, lower salinities improved Tarpon Bay oysters (Volety, pers. comm.) because it decreased the Perkinsus prevalence. Tarpon Bay oysters have high Perkinsus prevalence during dry periods, when water managers (SFWMD) shut off freshwater flow completely to the estuary. These scenarios are under consideration in the Comprehensive Everglades Restoration Project (CERP) which uses oyster monitoring as part of its performance measurement system. The long-term goal is to optimize freshwater flows to avoid extreme flows (high or low) and stabilize the region.

Methods

The primary goal of this project will be to construct and monitor 500 square meters of totally functional living oyster reef within Tarpon Bay. The goal will be met by completing these project objectives: 1.) Approximately 120 cubic yards (yd3) of oyster shell substrate will be collected from restaurants or purchased from fossil shell quarry. Since 2010, SCCF Marine lab has operated an oyster recycling program with local restaurants to collect oyster shell for future restoration efforts. The shell is quarantined on Ding Darling Wildlife Refuge property and is ready for use in this project. Any shell substrate needed beyond the amount available through this effort will be purchased from our fossil shell supplier in Sarasota, Florida and transported by semi-truck to our storage area. 2.) Store collected shell on Ding Darling National Wildlife Refuge (NWR) property adjacent to Tarpon Bay. SCCF Marine Lab has obtained permission from the NWR to store shell substrate to be used in this project on their property adjacent to Tarpon Bay near seawall which will be used to load shell onto the transport barge. 3.) Stake boundaries of three project oyster reefs (165 m2/reef average) at three Tarpon Bay locations (Figure 2). These sites have already been surveyed and chosen based upon successful reef development potential including proper elevation, flow, substrate, recruitment potential, accessibility for construction purposes, salinity regime and food availability. NWR biologists participated in site pre-selection and approve of these locations. The edge of nearest seagrass beds will also be determined and mapped using Trimble GPS and ARC GIS 10 software. 4.) Organize volunteer efforts through social networking, public media, and established ties with local schools. Previous community-based oyster restoration efforts by SCCF Marine Lab have allowed us to develop a volunteer network from which to activate volunteers from local schools and other organizations as well as walk-ons. 5.) With volunteer help (50-70 volunteer hours), fill approximately 500 mesh bags with oyster shell to serve as reef boundaries. The bag filling methods have already been developed in previous reef-building efforts using PVC tubes inserted into pre-cut plastic mesh bags and then filled with about 28 pounds (4.5 gallons) of shell substrate per bag. Bags will be staked at storage site adjacent to Tarpon Bay at SCCF Marine Lab until loaded onto barge. 6.) With volunteer help, prepare barge for transport of shell to Tarpon Bay sites (20-

50 volunteer hours). A donated pontoon boat has been converted into a shell transport barge and was heavily used during previous reef building projects in Clam Bayou. The barge now needs maintenance including new rub rails, replacement of several plywood flooring sheets and bottom paint before use on this project. 7.) With volunteer help, transport bagged shell from storage site and place around perimeter of three reefs (75-100 volunteer hours). The first step of reef construction will be outlining the shape of reefs using bagged shell. The perimeter of each reef (3 reefs total) will be defined using bagged shell. About 500 bags will be needed to make reef boundaries. The area inside the reef will then be filled with loose shell.8.) With volunteer help, transport approximately 105 yd^3 of oyster shell substrate from storage area to three oyster reef construction sites and place within reef perimeter previously constructed using mesh bags filled with shell (250-350 volunteer hours). This will be the most labor-intensive portion of project requiring the movement, transport and placement of a majority of the shell volume to be used in constructing the reefs. Loose shell will be moved from shell piles in storage areas by shovel and wheel barrow and loading onto barge at seawall near SCCF Marine Lab. Two or three barge loads will be moved during a 4-6 hour volunteer event. 9.) Nine, 0.15 m^2 monitoring trays will be installed in each reef. The trays will be filled with oyster shell substrate to same height as surrounding reef. Three trays will be placed in each of three depth strata. During each annual sampling event three trays, one from each depth strata, will be removed for analysis of resident reef organisms and oyster recruitment. For comparison purposes, nine monitoring trays will also be placed at three sites with natural oyster assemblages within Tarpon Bay and nine trays will be placed at each of three sites within Pine Island Sound just outside Tarpon Bay. Three trays from each of these sites will be sampled at the same time the constructed reef trays are collected. 10.) Using GPS and GIS systems, accurately map locations and dimensions of completed reefs. Trimble GPS equipment will be used to accurately map the finished constructed reefs with elevation above MSL determined. 11.) Dr. Ray Grizzle will obtain initial (t=0) seston removal rates above newly constructed reefs using in-situ fluorometry. Using in-situ fluorometric methods developed in previous studies (Grizzle et al. 2008; Grizzle and Ward 2012), Dr. Grizzle will determine seston removal rates over each constructed reef immediately after construction, when removal should be near 0 %, and after 1 -2 years of reef development. The best time to obtain the second set of measurements will be in late spring before the summer disease mortality spike. The data will be analyzed by Dr. Grizzle and provided as a report to SCCF Marine Lab and attached to final project report. Seston filtration is one of the most valuable ecosystem services supplied by oyster reef habitats. 12.) Oyster recruitment and resident organisms on the project reefs will be sampled 1 year after initial construction by removing three of the nine 0.15 m^2 monitoring trays installed in each reef. The three to be sampled after one year will be chosen randomly from each depth strata. Samples will be washed through a 2mm stainless steel mesh sieve and resident organisms sorted and preserved for identification. Oyster recruits found on sample substrate will be measured and enumerated. Live oyster data will be analyzed using non-parametric and multivariate statistical methods, size class distributions will be developed and species diversity indices calculated for resident organisms (5-10 volunteer hours). 13.) Reef sampling will be repeated after 2 and 3 years using same methods. 14.) Annual reports detailing data collected after 1, 2 and 3 years will be generated and distributed to funding organizations. 16.) A peer–reviewed paper will be submitted for publication in a pertinent scientific journal within 3 years of funding and results of project presented at a major scientific conference.

Taken together these activities will produce three viable living oyster reefs in an area which oysters had been removed by years of over-harvesting and excessive human activity. The reefs will re-establish areas with sufficient mass of oyster substrate to allow natural development of a living oyster reef. Due to existing oyster populations on mangrove prop roots and in sparse reefs around Pine Island Sound, oyster recruitment potential has been measured to be good in Tarpon Bay. SCCF Marine Lab has previously undertaken two oyster habitat restoration projects in a back bay area of Sanibel Island and has the expertise, methodologies and equipment to make this proposed project a success.

The mission of J.N. “Ding” Darling National Wildlife Refuge is “to protect, enhance, and restore the natural diversity and integrity of the refuge, in cooperation with our partners, for present and future generations.” In addition, the Comprehensive Conservation Plan (USFWS 2011) states that enhancing fish and wildlife habitat along shorelines and restoring estuarine areas as well as supporting public involvement in addressing watershed issues are priority goals. This proposed project lies within the boundaries of the refuge and directly addresses these priority goals and supports their mission statement. The wildlife refuge is also developing a Wildlife and Habitat Management Plan (estimated completion 2013) which will include the rehabilitation of oyster habitat as a priority. Similarly, the project lies within The Charlotte Harbor National Estuary Program (CHNEP) which is facilitating a regional oyster restoration plan with The Nature Conservancy (TNC) with many stakeholders within the CHNEP area. This plan addresses methodologies, monitoring, success criteria, and permitting.

4. Outcomes and Indicators: Describe the general monitoring approach that will be used to assess progress on one or more of the indicators presented previously in the application. Please note any challenges or limitations you anticipate in conducting this monitoring or the interpretation of anticipated results.

Success of this project will be measured based upon pre-determined indicators and metrics described previously. Each indicator is listed and discussed below in the context of approach and challenges/limitations:

a. Construction of 500 square meters of oyster reef. After construction, the total area, elevation and relative position above substrate will be measured using Trimble RTK GPS instrumentation. The information gathered will allow accurate assessment of total reef area constructed and its true location within the near shore ecosystem of Tarpon Bay.

b. Successful recruitment of living oysters. Nine, 0.15 m2 monitoring trays will be installed in each reef. The trays will be filled with oyster shell substrate to same height as surrounding reef. Three trays will be placed in each of three depth strata. After one year, trays from each depth strata will be removed for analysis of resident reef organisms and oyster recruitment. For comparison purposes, nine monitoring trays will also be placed at three sites with natural oyster assemblages within Tarpon Bay and nine trays will be placed at each of three sites within Pine Island Sound just outside Tarpon Bay to examine regional trends. Three trays from each of these sites will be sampled at the same time the constructed reef trays are collected. Oysters recruited to the substrate in each of these trays will be measured and enumerated. Mean age class distributions and oyster density will be determined from data collected and comparisons will be made between reefs. A target minimum recruitment rate of 200 oysters/m2-yr. will be used as a measure of success, based upon previous monitoring in area. Results will also be compared to previous studies. The cyclic nature of oyster disease will have an effect on results each year. Disease prevalence and intensity is greatest in summer months and mortality rate of new recruits may be high. During cooler fall and winter months, disease prevalence and intensity decrease and survivorship of new recruits is high. Exceptionally dry or wet years may affect disease prevalence. To assess the long-term viability of constructed reefs in these disease prone areas, sampling will occur at consistent intervals and in same season annually. We plan to sample annually in April, before annual disease mortality rate increases. Three years of monitoring will provide an indication whether reefs are viable in the face of the possible influence of disease, yet longer term monitoring (10+ years) may be needed.

c. Establishment of viable oyster reef habitat with 10 or more species of resident reef organisms. The monitoring tray approach to evaluate resident reef organisms has been used in previous studies (Milbrandt et al. 2012, Coen et al. 2007, Oyster Restoration Workgroup 2012) and the results from this study will be comparable. However this approach may not accurately measure the diversity of reef residents due to methodology. Small resident organisms may be lost from trays during collection due to wash-out, and many other reef organisms may colonize the sediment areas between oysters and may not be found in trays. In addition more mobile residents will flee trays during collection. However, the consistent use of this methodology will provide a relative comparison between sites, areas and other studies using this method. Based upon previous studies (in this area and other locations), a target resident species richness value of 10 will be established as a criteria for success.

d. Removal of chlorophyll a from water column. Over the past 10 years, Dr. Ray Grizzle has developed in-situ fluorometric methods to estimate phytoplankton removal rates above oyster reefs and constructed reefs. One of the major ecosystem services of oyster reefs is the removal of seston from the water column, thus improving clarity and improving nutrient cycling. His approach measures ecosystem uptake of chlorophyll over reefs. The limitations of this methodology include short sampling duration, the effects of seasonality and diurnal cycles and the effects of other organisms besides oysters on seston removal. However, previous work has shown that multiple sampling events over several days are sufficient to show removal if it is occurring. Our target value for project success is at least 10% removal of measurable seston consistent with results from previous in-situ studies in Tarpon Bay by Dr. Grizzle.

f. Participation by community volunteers. The participation of community members in habitat restoration activities provides an educational opportunity and allows a sense of community ownership and stewardship. Previous community-based oyster and mangrove restoration efforts undertaken by SCCF Marine Lab have been extremely successful allowing opportunity to educate a diverse cross-section of the community on value of healthy estuarine habitats. Media coverage and recognition has strengthened the sense of successful project implementation. A target of 550 volunteer hours has been set as a metric for a successful project outcome. This metric may not accurately reflect the value of the community based approach as education lasts a lifetime and may positively influence community members for a lifetime.

g. Media coverage of project events. To solidify community awareness and stewardship, local media will be encouraged to cover several events and project development. Past habitat restoration projects undertaken by SCCF Marine Lab have successfully incorporated positive media coverage to inspire participation, educate the general community and further elevate the awareness of estuarine habitat value, condition, and environmental challenges. A project success target of 2 media events related to project efforts per year. One newspaper story and one television story per year will help get the word out and promote the positive aspects of this project.

5. Project Team: List key individuals and describe their qualifications relevant for project implementation.

Dr. Eric Milbrandt is the Director of the SCCF Marine Laboratory and is an affiliate member of the Coastal Watershed Institute at Florida Gulf Coast University. His research expertise includes the ecology and management of mangrove swamps, disturbances to coastal habitats, and restoration ecology. He has received grants from numerous local, state and federal sources was most recently the project manager for a grant-funded project to restore shellfish and mangroves on Sanibel Island where 5 reefs totaling nearly 500 sq. m. were constructed.

Mark Thompson, M.S., is a Research Associate at SCCF Marine Lab. He has participated in proposing, planning and implementing several habitat restoration projects (including oyster reef) while at SCCF. His experience includes managing and implementing and analyzing results from environmental and ecosystem monitoring projects with SCCF, Florida DEP, US Peace Corps, and South Carolina Marine Resources Research Institute among others.

Dr. Aswani Volety is a Professor of Marine Science in the Department of Marine and Ecological Sciences at the Florida Gulf Coast University. His research expertise includes shellfish diseases, physiology, immunopathology, toxicology, and management and restoration of shellfish habitat. His current research includes investigating the effects of watershed alteration, freshwater inflows and contaminants on the biochemical, physiological, and ecological responses of oysters. Dr. Volety has collected oyster reef metrics in Tarpon Bay on natural reefs since 2002. Continued collaboration with SCCF will be further developed through a graduate student fellowship and a topic related to the oyster reef construction and monitoring in Tarpon Bay.

Dr. Ray Grizzle is a Research Professor at Jackson Estuarine Laboratory and the University of New Hampshire. He received his Ph.D. from Rutgers in 1988. Recent and current projects include bottom habitat mapping in the Gulf of Maine, succession of benthic communities in restored eelgrass beds and intertidal mudflats, the impacts of open ocean aquaculture activities on benthic communities, and temporal dynamics of benthos in New England coastal waters. In addition to community-level research, our program includes the physiological ecology and population-level aspects of several species of bivalve molluscs. This work has dealt with how environmental factors like water currents and food quantity and quality affect feeding and growth. He had measured community uptake rates previously in Tarpon Bay (2009-2011) and with a recently completed oyster reef restoration project on Sanibel Island.

Tara Wertz, M.S., is the Refuge Biologist at J.N. “Ding” Darling National Wildlife Refuge. She obtained a M.S. from South Dakota State University in Wildlife and Fisheries Sciences and is a Certified Wildlife Biologist (The Wildlife Society). She is the program leader for biology staff of 5 people and is responsible for all biological surveys on 5 national wildlife refuges on the Gulf Coast of SW Florida. She currently serves as technical expert on Caloosahatchee Estuary stakeholders, serves as refuge representative on SW Florida Watershed Council; coordinates with local agencies and non-governmental organizations for upland and wetland restoration projects across Sanibel Island and surrounding waters.

Budget:

Planning	
Restoration Plan	$5000
Site Visits	$4000
Admin., overhead and indirect	$9002.4
Other	$1840
Construction:	
Contracts	$
Administration and mobilization	$12234.6
Other	$6975
Monitoring	
Contracts	$20,000
Data Collection	$4403
Administration	$3420
Other	$3108

The main costs incurred will be salaries. The project proposal will include 6 months of research associate at $29,040 (salary and benefits) and contractual services by Dr. Ray Grizzle at $15,000 and one FGCU graduate student sponsorship at $5,000. Total salaries and contractual is $49,040. Supplies and materials total $4275 for hardware to repair existing oyster transport barge, purchasing fossil oyster shell for reef substrate, wheel barrows, shovels, water quality monitoring equipment supplies, mesh bags and volunteer event supplies. Boat usage fees are estimated at $5200 for 26 days and vehicle mileage is estimated at 1500 @0.56/mile = $840. We also include

$1500 for travel and fees associated with presenting results at CERF or similar conference.
$9,128 is included as indirect charges (15%).

We are able to provide $28003.80 in matching funds which include $11,000 in community volunteer hours, $12,980 in PhD level scientist hours (at $6490/month) and $4023.80 in indirect costs (Indirect cost for match at 0.31 x match total).