GULF COAST
MARINE LIFE CENTER

A Center of Excellence

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FLORIDA GULF OF MEXICO RESTORATION
PROJECT SUBMITTAL FORM

Form Purpose and Instructions:
• To assist the project proposal and review process, please complete this Submittal Form. Completion of the Form will contribute to the appropriate information being completely and accurately submitted for each project.
• Take as much space as needed for each question, but please keep responses as focused as possible. It may assist you to review all the questions before addressing any one question.
• Please submit one Form per project, if you have multiple projects - please submit one Form for each project.
• Please submit completed Forms to Restoration.Projects@dep.state.fl.us. Once your Form is successfully submitted, you will receive a confirmation email from the Florida Department of Environmental Protection.

Project Name:

Gulf Coast Marine Life Center – A Center of Excellence in Research, Technology, Education and Outreach for Ecological Restoration

Contact Information:

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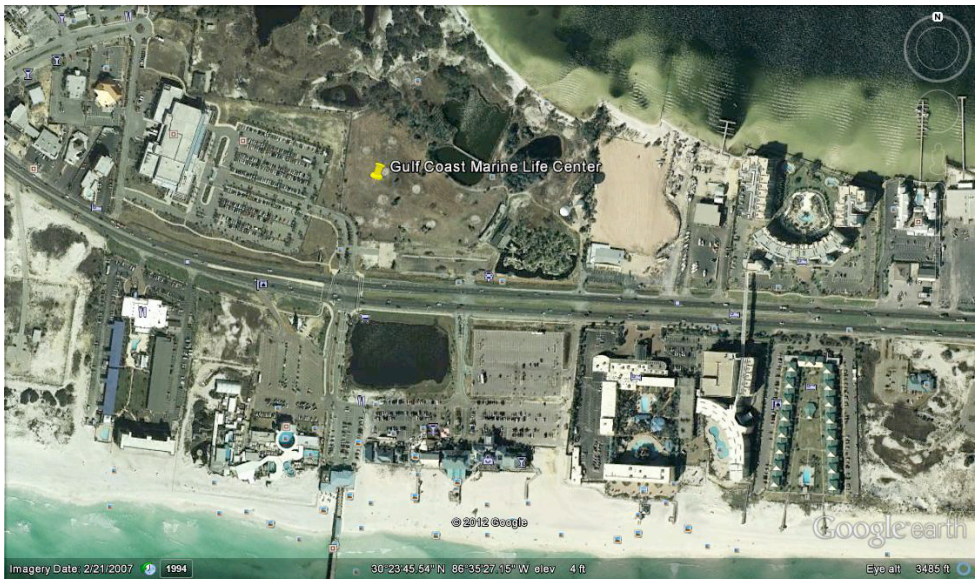
Project Location ***(Include a map, if possible, and the city, county, longitude/latitude, and watershed)*****:**
Okaloosa Island, Okaloosa County, FL.
30°23’35”N 86°34’20”W



Project Description *(Describe all aspects of the project)*:

The Gulf Coast Marine Life Center, a Florida 501(c)(3) company, in collaboration with experts from Louisiana State University, the University of Florida, the University of Miami, Texas A&M, the University of Maryland, the University of North Carolina Wilmington, and the University of New Hampshire, is dedicated to restoring the economic and environmental health of the Gulf Coast in the wake of the Deepwater Horizon Oil Spill. This project is bringing together some of the best minds the U.S. has to offer in the fields of hatchery technology, sustainable aquaculture, fisheries science, and habitat restoration to bolster the Gulf Coast ecosystem's ability to provide viable ecological services for decades to come. Both the economies of the region, and the nation as a whole, depend greatly on a healthy, productive Gulf of Mexico. The region's multi-billion dollar tourism industry is largely driven by access to beautiful Gulf beaches and world-class sport fishing. Much of our nation's shipping and oil production infrastructure is located in the Gulf. This infrastructure depends on healthy coastlines that have the resilience to withstand hurricanes and flooding. Approximately 40% of domestic seafood production comes from Gulf waters, thus ensuring its continued productivity is a matter of national food security as well.

The Center's efforts to address the priorities of the RESTORE Act will also support the US Department of Commerce and NOAA's National Aquaculture Policy, aimed at "Restoring Marine Habitats, Increasing Domestic Seafood Production, and Creating Sustainable Jobs."

The GCMLC's goals are threefold:

- Assist fisheries managers in rebuilding commercially important marine fish and shellfish stocks through ecologically and economically sustainable stock enhancement and habitat restoration efforts.

- Develop the physical and intellectual infrastructure to support the development of a sustainable aquaculture industry in the Gulf region.

- Promote responsible stewardship of the Gulf through education and outreach programs.

To this end, the Gulf Coast Marine Life Center (GCMLC) created a public-private partnership with our University Partners to develop a Center of Excellence on Okaloosa Island, Florida. The Center will be a multi-faceted facility consisting of the following major components:

- State-of-the-art marine finfish broodstock, hatchery, and nursery facilities for commercially important species native to the Gulf of Mexico (GOM)
- A tuna research and development facility
- A state-of-the-art shellfish hatchery and nursery
- A coastal plant production facility capable of supporting living shorelines restoration programs
- A habitat and fishery restoration initiative that will collaborate with third parties experienced in utilizing coastal plants, shellfish reefs, and artificial reef structures to protect shorelines, enhance water quality, and create complex habitats for juvenile fish, while strengthening valuable marine fish stocks through scientifically-sound stock enhancement efforts
- A modern, interactive Marine Life Center with aquatic exhibits and learning curricula to support and enhance education and ocean conservation

- An outreach program that works in partnership with Gulf Coast Sea Grant resources and expert personnel from Texas to New Hampshire to develop educational programs at all levels for both children and adults
- Classrooms and research labs designed to accommodate university level courses and advanced training workshops/seminars

The most advanced hatchery and aquaculture technologies, ecological restoration techniques, and scientific methods will be on display at the Center. In collaboration with some of the nation's leading scientists, the GCMLC will utilize proven culture technologies to raise oysters, bay scallops, blue crabs, and marine finfish on a scale sufficient to support extensive restoration/restocking activities as well as stimulate regional small business development. The GCMLC Phase I facility (*funding not being requested in this proposal*) will accommodate a state-of-the-art hatchery and early nursery for oyster and bay scallop production, followed by a second in-water nursery stage for single seed oysters utilizing floating upwellers. Phase I will also include a state-of-the-art hatchery and nursery for blue crab production, using a recirculating aquaculture system (RAS) for the environmentally sustainable grow-out of blue crab juveniles. This section of the facility will also include hatchery and nursery infrastructure for blue crab production, using a recirculating aquaculture system (RAS) for the environmentally sustainable grow-out of blue crab juveniles. Lastly, Phase I will houses a marine finfish nursery, using an advanced high density RAS for the grow-out of marine finfish fingerlings. Fingerlings will be provided by our University partner aquaculture programs and will be raised to a suitable release size in the GCMLC nursery. The Phase I infrastructure will provide a powerful resource to support Sea Grant research and outreach programs designed to transfer expertise and technology to the private sector.

The GCMLC University Partners will work hand in hand with Gulf Coast wildlife officials to support shellfish habitat restoration and multi-species finfish stock enhancement initiatives where deemed feasible by providing shellfish, juvenile finfish, and the scientific research necessary to support all State and Federal agencies responsible for wild populations of commercially important native GOM species.

Phase II of this project, which is the focal point of this proposal, will complete the vision for a truly unique center of excellence in the Gulf region. This phase of the project will add the following components:

- A state-of-the-art marine finfish broodstock and hatchery facility for commercially important species native to the Gulf of Mexico (GOM)
- A tuna research and development facility
- A coastal plant production facility to support living shorelines restoration programs
- A modern, interactive Marine Life Center with aquatic exhibits and learning curricula to support and enhance education and ocean conservation
- Classrooms and research labs designed to accommodate university level courses and advanced training workshops/seminars

* Conceptual drawings for both phases of the project can be found in the "Readiness for Implementation" Section.

Along with its primary restoration mission, the GCMLC will serve as an aquaculture technology center or technology hub, which will act as a catalyst for the growth of an aquaculture industry along the Gulf Coast of the United States. Consistent with the projected growth of the aquaculture industry in the US during the next decade, the GCMLC will provide mission essential infrastructure and expertise that will help grow and sustain this critically needed industry, creating thousands of well-paying jobs in the process.

Estimated Project Costs *(Describe the estimated costs of the project, including any assumptions for contingency and ongoing operations/maintenance. Identify other secured funding sources such as matching funds, in-kind contributions or state/federal dollars. In addition, if possible, complete and submit the Cost Appendix Sheet associated with this Form)***:**

The estimated cost of this project is $49,602,271, which includes operating costs for the first three years. The total capital cost of the project is estimated at $42,041,430, which includes building, equipment, and water supply costs. The average annual operating costs of the GCMLC project, including personnel, would be $2,520,280. Therefore for three years of operation, the total cost for this component of the project would be $7,560,841. Itemized budgets for capital and operating costs are included as an appendix at the end of the proposal narrative. Additionally, individualized operating cost budgets for each element of the GCMLC project are included in the budget appendix at the end of this proposal.

GCMLC PHASE II: 3-YEAR TOTAL COSTS		
Gulf Coast Marine Life Center - Phase II	**Total Cost (USD)**	
Total Capital Costs	**$**	**42,041,430**
Total Operating Costs (3-Year Total)	**$**	**7,560,841**
3-YEAR TOTAL COSTS	**$**	**49,602,271**

GCMLC PHASE II CAPITAL COSTS		
Gulf Coast Marine Life Center	**Total Cost (USD)**	
Total Building Costs (80,000sqft Finfish Broodstock, Hatchery and Tuna R&D facility)	$	20,881,800
Total Equipment Costs (Including Installation)	$	13,444,950
Total Additional Line Items	$	5,115,000
Total Contingency Costs (10%)	$	2,599,680
TOTAL CAPITAL COSTS	**$**	**42,041,430**

GCMLC PHASE II OPERATING COSTS				
Gulf Coast Marine Life Center	**Year 1**	**Year 2**	**Year 3**	**Cumulative Total (3 years)**
Multi-species Marine Finfish Broodstock Facility and Hatchery and Nursery	$ 942,590	$ 952,630	$ 962,871	$ 2,858,091
Tuna Research and Development Facility	$ 880,940	$ 887,860	$ 894,918	$ 2,663,718
Coastal Plant Production and Habitat Restoration Facility	$ 170,000	$ 172,060	$ 174,161	$ 516,221
Maintenance on all Systems	$ 141,400	$ 155,540	$ 178,871	$ 475,811
Insurance on Building and Equipment (Flood, Property, and Windstorm)	$ 181,000	$ 181,000	$ 181,000	$ 543,000
Utilities	$ 168,000	$ 168,000	$ 168,000	$ 504,000
TOTAL OPERATING COSTS	**$ 2,483,930**	**$ 2,517,090**	**$ 2,559,821**	**$ 7,560,841**

Figure 1 - GCMLC Phase II Total Capital and Equipment costs; and Total Operating costs for three years

Other Funding *(Indicate if the project is submitted for any potential funding or if it may be used to leverage additional funding, if so please describe the funding source [e.g. State/Federal Grants])***:**

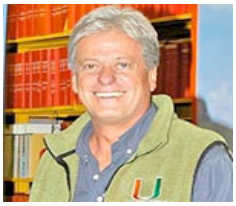
The GCMLC has received funding commitments of over $2,775,000, of which $400,000 has already been used for operational expenses that include all permitting, design, layout, engineering (civil, architectural, and aquaculture), and a $75,0000 lease payment to Okaloosa county for a total of $475,000. Okaloosa County Public Works has also commited $140,000 annually in lease payments to establish a property maintenance fund for the park surrounding the GCMLC. Three years after the start of operations, the GCMLC will be well positioned to secure state, federal, and private funding through grants, technology transfer agreements, training seminars, sponsored research, and more advanced academic programs. Additionally, the Center will be consistently producing hundreds of thousands of fish and shellfish juveniles for stock enhancement and habitat restoration initiatives, and surplus production will be available for sale to public and private entities. Therefore, it is expected that the GCMLC will maintain financial solvency and also help jumpstart the nascent aquaculture industry in the Gulf region by providing both juvenile and market-size fish and shellfish for the domestic seafood industry.

Technical Feasibility *(Describe the technologies involved and any relevant past experience or proven success with similar projects)***:**

The GCMLC amalgamates decades of research from multiple fields of marine science into one facility working towards one mission: the restoration of the Gulf of Mexico. Using a multi-faceted approach, the Center will build upon the long-standing, internationally-recognized track records of success of marine science programs at Louisiana State University, the University of Florida, the University of Miami, Texas A&M, the University of Maryland, the University of North Carolina Wilmington and the University of New Hampshire to utilize the most advanced science and technology available to carry out this project successfully.

Collectively, the GCMLC advisory board members have a proven record of successfully conducting and managing over $300,000,000 in grants for R&D and technology development for closing the cycle of a number of commercially important species of shellfish and marine fish. GCMLC University partners have already succeeded in mass-producing several species from hatchery to market-size using both advanced recirculating aquaculture systems (RAS) and modern open ocean grow-out methods. Combined with restocking programs, these technologies will assist in the development of an environmentally sustainable, technologically advanced, socially responsible and economically viable marine aquaculture industry to ensure that the U.S. has a secure domestic seafood supply for decades to come. The following list of international experts will be providing the GCMLC with the oversight for research, outreach, and educational activities for the center; additionally some of these experts will actively participate in research projects with the GCMLC.

The Gulf Coast Marine Life Center Advisory Board Members:



Dr. Daniel Benetti
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Professor and Director of Aquaculture University of Miami, Rosenstiel School of Marine and Atmospheric Science
Over 30 years of experience in hatchery and sustainable aquaculture technologies for challenging marine species.

Dr. Wade O. Watanabe
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Research Professor
Aquaculture Program Coordinator
University of North Carolina Wilmington, Center for Marine Science
Program Leader for Mariculture

Dr. Yonathan Zohar
zohar@umbc.edu
Chair and Professor, Interim Director, Institute of Marine and Environmental Technology
Dr. Zohar's research focuses on fish reproductive physiology and endocrinology as well as recirculating aquaculture and has applied his research to the cultivation of blue crabs.

Dr. Richard Langan
rlangan@cisunix.unh.edu
Professor at the University of New Hampshire and Director of Ocean and Coastal Technology Programs
Directs the Atlantic Marine Aquaculture Center developing advanced technology for raising native finfish and shellfish.

Dr. James P. McVey
jim.mcvey@noaa.gov
Vice President of Research and Operations for Indigo Seafood
Dr. McVey is a well-recognized consultant in marine aquaculture and ecology. He is a prominent figure in the areas of research, development, and policy of Aquaculture within the U.S.

Dr. Karl Havens
khavens@ufl.edu
Professor and Director, Florida Sea Grant College Program, University of Florida
Dr. Havens is leading the UF Oyster Recovery Team, identifying the causes of the 2012 oyster fishery collapse in Apalachicola Bay. Over 30 years of experience marine research, education and outreach, and Florida marine ecosystems.

Michael D. Chambers
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Ph.D. candidate in Biological Sciences at the University of New Hampshire
Michael has been a consultant for over twenty-three years, managing and developing open ocean aquaculture and marine biological research.

Dr. Phillip Elzer
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Professor, Pathobiological Sciences in the LSU School of Veterinary Medicine and Department of Veterinary Science in the LSU AgCenter.
Dr. Elzer's research involves multivalent vaccines for numerous infectious diseases, including Mad Cow Disease.

The U.S. is ahead of the world in developing advanced marine hatchery technologies, yet this nation is at risk of losing these technologies to other countries which have embraced the incorporation of sustainable marine aquaculture into the fabric of their economies, realizing numerous benefits including sustainable seafood production, job creation, and other socio-economic benefits to multiple stakeholders. It has been widely recognized both nationally and internationally that hatchery technologies developed in the US during the last decade are being "exported" to foreign countries, where a new industry producing tropical and subtropical species of marine fish has been created. These seafood products have been ultimately imported and sold to U.S. consumers. Although U.S. companies and consumers are benefiting from these efforts, most operations are being developed in foreign countries such as Panama, Costa Rica and Mexico. The GCMLC proposes to build upon the logistics and infrastructure of the U.S. academic and research communities to change this scenario. Now is the time to create a first-class facility to continue and expand the R&D, training, and outreach necessary to implement the latest aquaculture production technologies in the U.S. This will allow for the mass production of high-quality juvenile fish for restocking valuable GOM fishery stocks. In addition to restocking goals, the GCMLC will support sustainable aquaculture development in the GOM in the years to come.

The goals set forth in this project will be implemented through the eight primary components of the Gulf Coast Marine Life Center (GCMLC): 1) a shellfish hatchery and nursery for commercially important GOM native species; 2) a marine finfish broodstock facility, hatchery, and nursery for commercially important GOM native species; 3) a coastal plants production facility supporting third party living shorelines restoration programs; 4) a stock enhancement restoration program for native GOM shellfish and finfish; 5) a tuna research and development facility; 6) a public interactive Marine Life Center; 7) and a regional, state and nation wide outreach program; and 8) Classrooms and research labs designed to accommodate university level courses and advanced training workshops/seminars. The following sub-sections highlight the technologies involved in each component of the project, as well as the expertise and proven record of success in each project area. (*See appendices for more information on GCMLC programs*.)

Advanced Marine Finfish Broodstock, Hatchery, and Nursery Facilities (GCMLC Phases 1 and 2)

This GCMLC will utilize the advanced aquaculture technologies developed by our University collaborators for production of Gulf of Mexico species, notably: cobia, flounder, Florida pompano, red snapper, gag grouper, black sea bass, tuna, and mahi-mahi. Further research and development will be conducted to achieve mass production of juveniles for some of the more challenging species. The aquaculture operation will include facilities for broodstock spawning and egg collection, larval rearing, nursery, and full grow-out of commercially and ecologically important finfish that are native to the Gulf of Mexico. The broodstock facility will incorporate RAS technology to allow the GCMLC to mature and spawn the different marine finfish species throughout the year, thereby providing viable seedstock for the hatchery operation. The hatchery will apply proven methods, including all technological components, to support the mass-culture of marine finfish larvae. Live feeds and microalgae production will be essential to this aspect of the project; therefore, the GCMLC hatchery facility will have live plankton and microalgae production systems to provide suitable food items, such as rotifers, copepods and Artemia nauplii, to the newly hatched larvae. Once fish have been weaned onto inert diets for continued grow-out, they will either immediately enter an acclimation stage that precedes stock enhancement release, or the fish will be grown to larger sizes in the nursery for release at a later time.

Constructed in Phase 1, the nursery facility (funding not requested in this proposal) will incorporate the latest advancements in RAS technology in a nine-tank configuration capable of supporting the extensive stock enhancement activities of the GCMLC. Designed to reduce water discharge and adhere to the most stringent environmental regulations, the facility will function incredibly efficiently and serve as a model of U.S. land-based marine aquaculture. The system will give GCMLC the ability to grow tens of thousands of larger (greater than .5 lbs.) juvenile fish annually. Research has shown the benefits of growing fish to larger sizes prior to release in stock enhancement programs, and the GCMLC nursery facility will capitalize on this knowledge to provide hatchery-produced fish with the greatest chance of survival in the wild. The proposed nursery facility will also have the flexibility to accommodate a wide variety of marine fish species, allowing GCMLC to capitalize on existing hatchery infrastructure and technologies in the region (i.e. at Texas A&M and University of Miami) to obtain seedstock of other valuable Gulf species.

The juvenile fish produced in the hatchery and nursery will be directly available for stock enhancement in the Gulf of Mexico and the surrounding bays. By providing native GOM fish a clean and controlled environment for spawning and rearing, the GCMLC's team of experts will supply hundreds of thousands native finfish to the State of Florida for scientifically-sound release at various life stages into appropriate habitats under the guidance of Florida's Fish and Wildlife Conservation Commission. To enhance survivorship, the GCMLC proposes to raise and condition (adapt and train) juvenile finfish of targeted species in land-based RAS grow-out tanks prior to release at preselected sites, taking into consideration predator avoidance and availability of food and shelter. The technologies required for the marine finfish broodstock, hatchery and nursery components of this project have been implemented successfully by GCMLC researchers throughout the world, including previous work within the GOM ecosystem.

Tuna Research and Development Facility (GCMLC Phase 2)

Tuna are some of the highest value fish species on the market and thus undergoing extreme fishing pressure. Bluefin tuna for example, the most valued of all the tuna species, are being harvested to the verge of commercial extinction. To date, the international community has been unable to effectively manage these fisheries. Additionally, the Deepwater Horizon Spill occurred in known spawning grounds for Atlantic Bluefin tuna with yet to be determined consequences. Now more than ever it has become critical to develop the ability to produce mass quantities of the various tuna species for both commercial production and possible stock enhancement. To this end, the GCMLC is proposing a world-class tuna research and development facility.

Tuna aquaculture has faced a challenging past, yet this project offers a promising future. Problems with reproduction and spawning, systems management, microbial control, disease and parasites, feeds and feeding continue to plague tuna aquaculture, which has primarily been focused on bluefin tuna (*T.thynnus, T.orientalis,* and *T.maccoyii*). Because of these problems associated with bluefin tuna, we believe that it is important to work with different GOM tuna species to determine the idiosyncrasies that exist between species, which will help overcome the challenges faced by previous tuna aquaculture efforts. Currently, yellowfin tuna represent one of the best candidates for immediate success at GCMLC, due in large part to the extensive experience members of the GCMLC team have with this species. Thus, the inception phase of this facility will focus its efforts on the culture and grow-out of yellowfin tuna.

Due to the significant challenges of maintaining tuna in captivity, significant life support systems are required, especially when attempting to maintain naturally spawning broodstock specimens. By using a proven maturation and quarantine facility design, it will be possible to obtain consistent high-quality tuna spawns, allowing for unprecedented tuna aquaculture research and development opportunities. The proponents have had access to and are capitalizing on decades of research and tens of millions of dollars invested in tuna hatchery technologies the world over to establish a world-class facility in Destin, Okaloosa County, Florida. The time is right for the U.S. to become a world leader in tuna aquaculture development, and the GCMLC will facilitate this objective.

Tuna are the ultimate open ocean fish species. They grow to hundreds of pounds in size and migrate thousands of miles, thus requiring ample space in captivity. The tank and filtration systems to be implemented at the GCMLC will be truly impressive and second to none. The tuna facility will consist of two 1,535 m^3 Tuna tanks (56' diameter x 20' deep), two 600 m^3 Holding Tuna tanks (42' diameter x 15' deep), and four 170 m^3 Tuna Nursery / Holding tanks (28' diameter x 10' deep). This unique facility will have the ability to maintain captive broodstock populations of any of the four “true” tuna species found in the Gulf of Mexico: Atlantic bluefin tuna (*Thunnus thynnus*), yellowfin tuna (*T. albacares*), bigeye tuna (*T. obesus*), and blackfin tuna (*T. atlanticus*). The facility will have the capability to conduct spawning, larval rearing, and juvenile grow-out trials of each species on site, initially focusing on yellowfin tuna, and later expanding on this research to the severely overfished Atlantic bluefin tuna.

Staff members of the GCMLC, in collaboration with the world’s leading tuna aquaculture scientists, have been successful in developing aquaculture protocols for egg to market production of other fast growing, high value marine finfish such as cobia (*Rachycentron canadum*), mahi-mahi (*Coryphaena hippurus*), snapper (*Lutjanus spp.*), and yellowtail jacks (*Seriola spp.*). Also, in collaboration with the Inter-American Tuna Commission (IATTC) based in la Jolla, California, the proponents have benefitted

from conducting research at the world renown Achotines Laboratory in Panama over the last 11 years, where a fruitful collaboration has been developed with IATTC scientists and managers. This laboratory has a tuna maturation system where yellowfin tuna have been consistently spawning for the last 15 years. Building upon these achievements, the proponents intend to address the need for development of successful tuna aquaculture by developing hatchery technology for spawning and mass production of tuna fingerlings. Utilization of the state-of-the-art tuna research and development facilities at the GCMLC, in combination with well-trained staff and scientists, ensures this project the best chance of success in developing economically viable closed-cycle tuna production in the U.S.

Shellfish Hatchery (GCMLC Phase 1)

Oyster reefs are considered an extremely valuable habitat in estuarine and near-shore ecosystems. Throughout their natural range, oysters are generally the only hard substrate in an otherwise soft sediment environment. The three dimensional structure of oyster aggregations provides ideal habitat for colonization by dense communities of invertebrates, including other molluscs, crustaceans, and polychaetes which then attract foraging fish and larger invertebrates such as crabs and shrimp. It is estimated that 80 – 90% of fish captured in recreational saltwater fisheries depend on estuaries during some portion of their life-cycle, along with 75% of the nation's commercial fish and shellfish. The habitat importance of oyster aggregations in temperate regions has been compared to that of coral reefs in shallow tropical and subtropical environments. However, these vital habitats are being lost at a staggering rate throughout the world and particularly in the GOM. Therefore, GCMLC's restoration efforts are needed to help reverse this negative trend. (*See "Environmental Benefits" for more information*)

Scientific reviews of the environmental data for Choctawhatchee Bay in Florida and other embayments indicate that conditions are very favorable for shellfish restoration and private aquaculture. Initially, oysters will be the primary focus of shellfish culture and restoration activities at the GCMLC in Phase I (funding not requested in this proposal). In collaboration with some of the nation's leading shellfish scientists, the GCMLC will utilize proven culture technologies to raise oysters on a scale sufficient to support extensive restoration activities as well as regional small businesses. The land-based facility will be used for the hatchery and early nursery stages of production, followed by a second in-water nursery stage for single seed oysters utilizing floating upwellers. Based on projected production capacity of the facility, we are planning on twelve production runs of 18.8 million eyed larvae per year for an annual total of approximately 225 million eyed larvae. Production methods can be modified to support production of spat on shell or other hard substrates suitable for reef building, living shorelines and enhancement of existing reefs in addition to production of single seed oysters for use in private or community cultivation. Eyed larvae can also be shipped to other locations and set on shell or other substrates to save on shipping costs and reduce mortality of post-set oysters. A conservative estimate of potential annual production from our proposed facility is 90,000,000 adult oysters per year. As will be discussed in following sections, the environmental, economic, and social benefits of this aspect of the project are numerous.

Coastal Plants Production Facility (GCMLC Phase 2)

A Coastal Plant Production Facility will be established in order to significantly assist shoreline restoration projects by providing native plant stock and seed caches to recolonize and restore damaged coastal wetland areas. As a key component to this approach, the Marine Life Center's facilities will utilize state-of-the-art recirculating aquaculture systems (RAS) that recycle water by circulating it through filters. This approach is unique because it does not release nutrient-rich waste into the coastal environment. Rather, the dissolved nutrients from fish waste are used to drive plant growth in the Coastal Plant Production Facility. Where possible, water from the hatchery will be circulated directly into the Coastal Plant Facility. The Center itself will highlight multiple-use aquaculture, also known as integrated multi-trophic aquaculture (IMTA) to showcase the use of natural solutions to challenges presented by aquaculture. By converting fish waste into a valuable resource, this project will emphasize environmental sustainability.

The Gulf Coast Marine Life Center will build upon work conducted at Louisiana State University and University of New Hampshire, to incorporate their current technology on coastal plant genetic diversity, resilience, growth, biotic and abiotic tolerances, to the center's coastal plant nursery methodology. Researchers from University of New Hampshire have extensive experience propagating native herbaceous and woody plants for use in coastal wetland restoration, providing marsh grass species to many New England salt marsh restoration projects, and developing mangrove nurseries to aid habitat restoration initiatives in the Caribbean. Production of dominant coastal wetland species such as red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), smooth cordgrass (*Spartina alterniflora*), black needlerush (*Juncus roemerianus*), and various other native plants, are being used to restore damaged areas along the Gulf of Mexico coastline. Efforts will also be initiated to propagate less common species of special concern, or state-listed threatened and endangered species that also suffered impacts from the Deep Water Horizon spill, protecting natural heritage and plant species diversity. In addition to benefitting biodiversity, inclusion of rare species often boosts public interest and leads to unique opportunities for outreach and education, one of several central foci of this effort.

Habitat and Fishery Restoration Program

A) Stock Enhancement (GCMLC Phase 1)

Capitalizing on the success of the marine finfish hatchery and broodstock facility discussed previously, the GCMLC will work closely with State and Federal fisheries managers to conduct large-scale stock enhancement of economically and ecologically valuable marine finfish species in the Gulf of Mexico. Research has shown that dedicated, large-scale stock enhancement programs for finfish and shellfish have resulted in sustained commercial catches for multiple species in countries like Japan, Norway and Iran. Domestically, some of our collaborators have performed successful studies on smaller scales with fish like Striped Mullet and Pacific Threadfin in Hawaii, Winter Flounder in New Hampshire, and common Snook and Red Drum here in Florida. These successes have been achieved even with limited funding, infrequent collaboration, and through a narrow scope. Our proposed project will benefit from making stock enhancement a comprehensive and cohesive effort, and from having sufficient expertise and funds to raise, release, and study large numbers of healthy fish.

A responsible approach to the specific challenges that marine stock enhancement faces were outlined in a paper by Blankenship & Leber in 1995, and updated in Lorenzen et al. in 2010. The technical challenges include: developing appropriate hatchery systems and rearing practices, an empirical plan for optimal release strategies, performing disease and health management, as well as genetic resource management for maintaining wild diversity, and ensuring that hatchery-reared fish can be identified and monitored. Widely accepted as the best management practices for responsible stock enhancement, the authors' response to these issues echoes the mindset of GCMLC's proposed objectives, and serves as a guideline for approaching this challenging endeavor. Working with experts in various fields, we aim to employ a comprehensive plan to meet these challenges head on and bring about tangible results on a large scale.

The GCMLC team recognizes the challenges of restocking programs when it comes to determining implementation and success. For this reason, restocking efforts will be conducted in collaboration and strict coordination with State and Federal agencies and fisheries experts to ensure compliance with regulations and monitoring. Furthermore, the GCMLC will be designed to utilize commercially proven systems and methods for producing substantial numbers of larger size fish in a cost effective manner. The GCMLC is aware of the complexities and opposing stances to ecosystem restoration and stock enhancement, and using a combination of advances made through previous efforts and continued research, are prepared to overcome the age-old challenges presented by stock enhancement. The vision being upheld is that of a symbiotic relationship with government regulators whereby Florida's resources are maximized to achieve healthier, more resilient GOM fisheries. *(For further information see Appendix)*

B) Shellfish Reefs (Phase 1)

The GCMLC's Shellfish hatchery and nursery will be capable of producing spat on shell or other hard substrates suitable for reef building, living shorelines and enhancement of existing reefs in addition to production of single seed oysters for use in private or community aquaculture. Eyed larvae can also be shipped to other locations and set on shell or other substrates to save on shipping costs and reduce mortality of post-set oysters. This practice, known as remote setting, has been used extensively for oyster recovery efforts in the Chesapeake Bay.

According to the recent report issued by the University of Florida Oyster Recovery Team, severe declines in the oyster population within the Gulf of Mexico region are primarily attributed to the lack of fresh water, and increased salinity, which has affected recruitment of juvenile oysters, as well as to overharvesting. GCMLC will seek opportunities to contribute to recovery efforts in neighboring embaysments and estuaries by providing oyster larvae for remote setting. The report also recommended that the oyster fishing community should consider leasing instead of an open fishery, opening up the opportunity for private aquaculture. GCMLC is well positioned to provide single seed to interested entrepreneurs as well as training in efficient and environmentally sustainable aquaculture methods. As will be discussed in following sections, the environmental, economic, and social benefits of this aspect of the project are numerous.

C) Artificial Reefs (GCMLC Phase 1)

One of the important factors affecting the survival of fish when released into the wild is availability of suitable habitat – a place to hide from predators and to support food resources that young fish need to grow. One way to provide this habitat is to deploy artificial reefs. Peer-reviewed research experiments conducted in the Gulf of Mexico indicate that hatchery-reared Red Snapper swiftly colonize newly constructed artificial reefs when these fish are released into the wild. I.e., releasing the fish onto unoccupied artificial reefs is beneficial to their survival. As a testament to their relatively rapid enhancement of benthic substrates, artificial reefs attract baitfish within hours of deployment. Within a couple of months corals, plants, barnacles, invertebrates and fish higher in the food web, such as snapper and grouper, colonize artificial reefs. Research shows that a maximum level of capacity is reached within 3-5 years. Artificial reefs help to disperse fishing pressure by creating new habitats providing shelter and food, thereby stimulating healthy fish populations. Healthy local fish stocks in turn benefit people and the economy, in that artificial reefs support fishing charters, dive shops, and other forms of tourism in the area. A recent University of Florida / Florida Sea Grant economic study showed that the benefit of artificial reefs, just in a six county area of SW Florida, is $253 million per year, and that the reefs support over 2,600 jobs. Many of Florida's coastal counties have artificial reef programs and they regularly deploy reefs for various purposes ranging from diving to fishing. Florida Sea Grant has been a driving force behind the state-wide artificial reef program, providing recurring workshops for artificial reef professionals and guidelines for deploying and managing reefs. In this project, the GCMLC will work with its partners, including Florida Sea Grant, to provide guidance to counties in the panhandle region of Florida in regard to where and when to deploy reefs in a manner that will support the survival and growth of fish released from the hatchery operation. In keeping with the goal of using science to direct effective restoration efforts, the GCMLC when called upon, also will be ready to provide finfish for stock enhancement to aid in the success of other artificial reef efforts throughout the State of Florida.

D) Education and Outreach Interactive Marine Life Center (GCMLC Phase 2)

In order to help the community connect with the research, development, and restoration activities being conducted at the GCMLC, an interactive marine life center will be constructed to allow visitors to see, learn, and gain hands-on experience with the different aspects of marine science and Gulf of Mexico restoration. Through close collaboration with the scientists, educators, and aquarium design experts at GCMLC, the interactive marine life center will provide opportunities for people of all ages to learn about the Gulf of Mexico ecosystem, the challenges it faces, and the techniques and technologies employed in the restoration and enhancement of this valuable ecosystem. Exhibits will elucidate the environmental, economic, and social benefits of the different habitats and marine life in the GOM, while providing an interactive experience for guests of all ages. Traditionally, marine science is either experienced by individuals visiting an aquarium or by individuals working in the field. The interactive marine life center will bridge this gap by bringing together the scientists, educators, and visitors to allow for a distinctive experience, which will be centered on GOM restoration. The unique position of the GCMLC allows for the technical feasibility of this concept, in that experts from these various disciplines will coalesce in one place, the Gulf Coast Marine Life Center.

Regional Outreach Program (GCMLC Phase 1 and 2)

Restoration of the Gulf of Mexico cannot be complete without ensuring that the Gulf region remains a vibrant component of the nation's economy, as well as an ecological treasure. In order to accomplish this, the GCMLC will work with Florida Sea Grant Outreach experts to include a unique interactive learning facility to support marine science education and outreach. Florida Sea Grant and UF/IFAS Extension support education and outreach that includes programs to provide coastal citizens with a greater understanding of the values of our coastal and marine resources, and to affect behaviors consistent with coastal and marine stewardship.

Florida Sea Grant and UF/IFAS Extension Agents, in Okaloosa and Walton Counties, are working in partnership with the Marine Life Center to develop informal education programs for youth and adults in areas focused on marine stewardship. They will also work with the Marine Life Center to develop community-based programs, educational materials and displays for use in the Center focused on issues related to marine stewardship.

Through this collaborative effort, the GCMLC facility have the capability to support regional outreach programs aimed at educating the next generation of GOM marine scientists, conservationists, resource managers, and policy makers. In collaboration with Universities throughout the U.S., as well as Florida Sea Grant outreach experts, the GCMLC outreach program will incorporate the following components:

A) Student Internships

The GCMLC will attract the best and brightest individuals to come and train under the guidance of experts in a variety of research areas, including: marine biology, aquaculture, fisheries management, genetics, nutrition, environmental science and policy, conservation, and ecosystem restoration. Former students of members of the GCMLC staff are working throughout the world at major research labs, NGOs, commercial operations, state and federal institutions, as well as in small business. The work conducted at the GCMLC will provide current students with invaluable experience that will, as they move on to careers in the private sector, academia, or government, benefit the Gulf of Mexico region, as well as the entire United States.

B) Publication and presentations

The results of the research conducted at the GCMLC will be published extensively in peer reviewed papers and trade journals, as well as in common media outlets. The proponents have extensive experience publishing in popular news media, academic journals, and online media formats, and they regularly present the results of their research to their peers at scientific and industry conferences. Such activities will continue as part of this project, and in this way, knowledge about the progress, challenges, and opportunities in Gulf of Mexico ecology and restoration science will be shared with as wide an audience as possible.

C) Technology transfers and employee training

Members of the GCMLC team have been engaged in aquaculture technology transfer projects for a number of different species of marine fish in the United States and abroad. As part of these technology transfer projects, the experts on the GCMLC staff assist companies with all aspects of setting up and running aquaculture operations. Additionally, companies participating in technology transfer projects with the GCMLC are able to send their employees to the GCMLC

facility for extensive training in advanced aquaculture techniques. Given the numerous components of the GCMLC, the opportunities for technology transfer and employee training are extensive and will undoubtedly help the GOM region in its economic diversification and job creation efforts.

D) ***Future collaboration with other fisheries and aquaculture research institutions***
The proponents have a long history of collaborating with other research and private sector institutions. Members of the GCMLC team have provided eggs, yolk-sac larvae, post-larvae, fingerlings, and broodstock of a variety of marine finfish species to universities and companies throughout the world. The proponents have also participated in multi-institution research projects designed to improve stock enhancement methods and aquaculture technologies for a number of different species. As the research and development activities at GCMLC proceed, the proponents will continue to collaborate with other researchers and institutions interested in advancing the science of ecosystem restoration, sustainable aquaculture, and effective natural resource management.

Environmental Benefits *(Describe the nature, magnitude, and timing of any environmental benefits attributable to the project. If possible, describe potential environmental performance measures [e.g. pollutant reduction]. Please address any potential environmental impacts associated with implementing or maintaining the project [e.g. loss of a habitat or conversion of habitat from one type to another during implementation]):*

The environmental benefits of the GCMLC project will be numerous, given that the restoration and enhancement of the Gulf of Mexico ecosystem comprise the core mission of the Center. Furthermore, the Gulf Coast region has yet to fully recover from the adverse environmental and economical effects of the Deepwater Horizon Oil spill, thus this project is relevant to the current state and future prosperity of the GOM. While environmental benefits can be difficult to quantify, particularly on a large spatial and temporal scale, the proponents will utilize the latest scientifically based environmental performance measures to track the success of the different restoration programs in this project. In doing so, the Center will be able to use adaptive management strategies to ensure restoration programs obtain the desired outcomes. Resource managers throughout the world employ similar tactics for tracking the success of all types of restoration projects, with the key being the ability to alter restoration strategies should the data indicate a deviation from the initial plan is necessary. This type of adaptive management has led to numerous successes in environmental restoration projects throughout the world, and many of the staff and collaborators of the GCMLC have been directly involved in managing these projects. Of particular importance in the case of the Gulf of Mexico will be the ability to accurately track and detect change as the restoration projects progress. The GCMLC program-specific environmental performance measures will be discussed below and the staff at the Center will continue to work with state and federal scientists to make sure that the chosen performance measures and bioindicators accurately reflect the effectiveness of each of the proposed restoration programs.

As previously discussed, the GCMLC's interdisciplinary research facility will provide a platform for executing stock enhancement and coastal restoration projects using a holistic approach to Gulf of Mexico restoration. Copious scientific studies have reported that enhancement of fish stocks is only

possible if sufficient habitat is available for stock recruitment. Therefore, the GCMLC will couple its stock enhancement activities with ongoing and future habitat restoration projects. The shellfish hatchery, for example, will have the capability to provide the natural materials to build and rehabilitate estuarine habitats throughout the region, with their effective use guided by the restoration programs associated with the Center.

Marine Finfish Broodstock and Hatchery Facility/Stock Enhancement Program

Utilization of the "responsible approach" will guide the habitat restoration program, especially the stock enhancement efforts. By applying the best available science, the GCMLC will strive to quantify the cumulative environmental benefits of its stock enhancement activities, which will aid in determination of the overall success of the program. It will be important to work closely with Florida Fish and Wildlife Conservation Commission to determine the effectiveness of the stock enhancement activities through fishery independent monitoring studies. Building upon years of successful stock enhancement programs implemented throughout the world, the GCMLC will take a proactive approach to tackling the contentious issues related to genetics, diseases, displacement, and ecosystem effects of such activities. Significant research will be conducted prior to any enhancement activities to gather baseline data on wild stock abundance, composition, health, and release locations. Small-scale trials such as predator-prey interactions and forced exercise will be conducted to determine the optimal conditioning for hatchery-produced fish to assure high survivability and recruitment success of released individuals. In cooperation with independent fisheries scientists and managers, we propose to conduct regular assessments of the release sites and associated habitats to determine the effectiveness of this stock enhancement approach. Additionally, fisheries surveys will be conducted to gauge the performance of the fishery restoration efforts and to note the extent of wild fishery relief the GCMLC's stock enhancement efforts have on the overall fish stocks of the GOM. Using multivariate analysis of the many components involved in stock enhancement, including the environmental, biological, sampling, and stocking components, the GCMLC will be able to spatially and temporally track and quantify the success of its stock enhancement efforts. Such information will also allow for assessment of the cumulative environmental benefits of these restoration activities.

Shellfish Hatchery and Nursery Facility

The ecosystem services provided by oysters, whether in reefs or cultivation arrays, are well documented in the scientific literature. An adult oyster can filter up to 50 gallons of water a day, removing suspended solids from surrounding waters, thereby increasing water clarity allowing sunlight to penetrate enabling sea grass growth and the foundations of the marine food chain to flourish. Oysters can remove significant amounts of nitrogen from the water column by ingesting phytoplankton and converting it into oyster flesh and shell, a process known as bioextraction. In addition, scientific studies have established that bacteria in sediment around shellfish beds biologically remove at least 20 percent of the nitrogen in wastes through a process similar to what is used in modern wastewater treatment plants. While some of the nutrients filtered from the water by shellfish are recycled back into the water column, the flux of undigested plant matter into the sediments stimulates bacterial processes known as denitrification. This process of transforming nitrogen into nitrate and then into harmless nitrogen gas allows its escape into the atmosphere instead of stimulating phytoplankton blooms that shade sea grasses and limit their growth. These findings suggest that if large shellfish populations could be restored, either through

commercial farming, stock enhancement or habitat restoration, these beds could play an important role in mitigating the effects excess nitrogen in our bays and estuaries.

Oyster reefs are considered extremely valuable habitat in estuarine and near-shore ecosystems. Throughout their natural range, oysters are generally the only hard substrate in an otherwise soft sediment environment. The three dimensional structure of oyster aggregations provides ideal habitat for colonization by dense communities of invertebrates, including other molluscs, crustaceans, and polychaetes which then attract foraging fish and larger invertebrates such as crabs and shrimp. It is estimated that 80 – 90% of fish captured in recreational saltwater fisheries depend on estuaries during some portion of their life cycle, along with 75% of the nation's commercial fish and shellfish. The habitat importance of oyster aggregations in temperate regions has been compared to that of coral reefs in shallow tropical and subtropical environments. However, these vital habitats are being lost at a staggering rate throughout the world and particularly in the GOM. Therefore, GCMLC's restoration efforts are needed to help reverse this negative trend.

The progress of the GCMLC's oyster reef restoration activities will be tracked and quantified using environmental monitoring of key parameters at the restoration sites, such as water quality, oyster population abundance, oyster recruitment abundance, early survival of transplanted oysters, the fecundity and genetic composition of the oysters, the volume of the oyster shells, and general demographics of the oyster populations. Using the previously described adaptive management strategy, the GCMLC will make regular assessments of the success of its oyster reef restoration sites, making changes along the way as necessary to accomplish the goal of oyster reef restoration in the Gulf of Mexico.

The Center will also benefit the environment as a whole through increasing research conducted on wild shellfish. Through the resources of the facility, wild shellfish can be analyzed and relied upon as early indicators of environmental problems. As filter feeders and biomass accumulators, shellfish are excellent bioindicators and present unique opportunities to get a better understanding of the coastal environment. In this way, the GCMLC programs will aid in not only the restoration of oyster reefs, but also in the conservation and enhancement of existing wild shellfish beds.

Coastal Plants Production Facility

The Gulf of Mexico contains over half of the United States' mainland coastal areas, and every year approximately 24-39 square miles of these coastal wetlands are lost. At the current rate of erosion, depreciation of coastal wetlands has the potential of moving the Gulf Coast shoreline inland over 30 miles in some areas, threatening innumerable natural communities and the many species they contain. Coastal plant communities provide significant habitat and physical structure critical to healthy coastal ecosystems including storm protection, sediment stabilization, and filtration of pollutants from commercial, residential, and agricultural land runoff, protecting vulnerable marine-life. Over 90% of Gulf of Mexico's fishery landings consist of marine species that depend on these estuaries at some point in their life cycle, yet negative effects on the carrying capacity of these habitats are already being observed. Many other marine species, such as invertebrates and marine mammals, also rely on coastal wetlands for habitat, protection, and food. Furthermore, millions of waterfowl and migratory birds,

including endangered and threatened species, seek shelter in this wetland habitat during winter months and risk being displaced as space becomes a limiting factor. This pattern, if not rectified, will continue to adversely affect soil and water quality, wildlife resilience, coastal infrastructure, and the economy.

The majority of coastal wetlands within the Gulf Coast are characterized as salt marsh, brackish marsh, and mangrove. Regardless of the dominant plant community, coastal wetlands are particularly susceptible to damage and impact from oil spills, which impose acute and chronic effects depending on the plant form (herbaceous versus woody), and the degree of oil fouling. While some principles of oil effects on vegetation are consistent between herbaceous and woody species, important distinctions must be made as the expression and magnitude of impact can vary based on the habit (i.e., growth form) of the dominant plant community. In general, herbaceous communities such as salt marsh and brackish marsh habitats, experience distinct and often-dramatic acute effects leading to loss of aboveground biomass, followed by re-growth of new shoots from underground roots or rhizomes within a growing season. In contrast shrub and forest communities, such as mangroves, may experience leaf damage and loss, but appear more resilient as woody structures (trunk, branches, and aerial roots structures) persist and may take several months to years to exhibit mortality. As we look forward into the coming years of habitat restoration in the Gulf, there is a clear need to provide a diversity of native coastal plants for widely varying impacts, natural communities, and restoration goals.

Tuna Research and Development Facility

Environmental restoration efforts will not be solely focused on nearshore and benthic species and habitats. One of the most heavily impacted, yet least studied, habitats during the Deepwater Horizon oil spill was the pelagic zone of the open ocean. Traditionally regarded as an oligotrophic desert of the sea, this area is home to a variety of high-value marine finfish species, including the heavily pressured Atlantic bluefin tuna (*Thunnus thynnus*). The Gulf of Mexico represents one of the only known spawning sites of this species, with spawning activity occurring during the warm summer months. It was during this time that the Deepwater Horizon incident occurred, leading many to believe that the fragile bluefin tuna population may have been negatively impacted. In order to gain a greater understanding of the reproductive biology and early life history of these rare, high-value fish, along with their closely related *Thunnus* congeners, the GCMLC will feature a state-of-the-art tuna research and development facility. The facility will have the capability to house broodstock populations of the four primary tuna species found in the Gulf of Mexico (bluefin, yellowfin, bigeye, and blackfin). As described in the previous “Technical Feasibility” section, efforts will be undertaken to spawn these fish in captivity and develop successful aquaculture methods for the mass-production of juvenile tuna. Upon completion of this stage of research and development, the Center will have the ability to incorporate tuna into its stock enhancement program. Due to the cannibalistic nature of larval and juvenile tuna, the Center will have the capability to grow fish out in land-based systems to sizes large enough to provide enhanced recruitment capability upon release in the wild. As has been shown with other species utilized in stock enhancement, the responsible release of hatchery-produced finfish can result in reductions of fishing pressure on wild stocks. When it comes to the bluefin tuna, whose populations have plummeted by more than 90% following intense overfishing over the past decades, the development of GCMLC’s tuna facility could not come at a more opportune time. Many scientists believe that sustainable aquaculture holds the key to relieving the fishing pressure on tuna stocks throughout the world, while providing much needed insight into the reproductive and early life history aspects of these iconic pelagic predators. In order to ensure success with this aspect of the GCMLC, the team of tuna experts at the Center will

have the capability to work with all four GOM *Thunnus* species, allowing for the rapid advancement of the science needed to develop the technology to mass-produce bluefin tuna by applying methods found successful with the smaller, and more easily cultured, tuna species such as yellowfin tuna. Success will be quantified in terms of aquaculture research and development goals: captive spawning, larval rearing success, complete closure of the lifecycle, and mass production of juvenile fish. Given the track record of success the GCMLC team brings to this project, the GOM will benefit from the first dedicated effort to incorporate tuna into a scientifically robust stock enhancement effort.

Marine Life Center

In order to involve the GOM communities in ecological restoration of their native areas, the GCMLC will house an interactive Marine Life Center, complete with a regional outreach program that will extend the impact of the Center's research and education programs. By working closely with Florida Sea Grant agents, the GCMLC will work to involve regional GOM communities in all aspects of its activities as discussed in the "Technical Feasibility" section. Performance measures used in the Marine Life Center and outreach program components of this project will focus on the number of individuals exposed to GOM educational activities. Additionally, all presentations, research, and restoration project results will be widely distributed through a wide variety of media outlets ranging from common news feeds to peer-reviewed academic journals. In this way, the public will be able to gauge the success of the GCMLC, and in keeping with the adaptive management strategy, the Center will be receptive to community needs in terms of determining research priorities and addressing well-founded requests of the working waterfront communities.

In the end, all aspects of the GCMLC program will work together towards the central goal of ecological and economic restoration of the GOM. As previously mentioned, stock enhancement activities will be performed in conjunction with other restoration projects along the GOM, such as living shoreline restoration, shellfish beds, and artificial reef deployment to provide essential fish habitat for not only the existing wild fish stocks, but also the strategic releases of hatchery-produced marine fish. In so doing, the ecosystem as a whole will benefit from the various GCMLC restoration programs, with each program working in close coordination with one another to assure a properly functioning ecosystem. While acknowledging that the proposed goals are ambitious and that there are and there will be many challenges to overcome, the proponents are determined and certain that the hurdles can and will be overcome and the proposed goals fully achieved within the budget and the time schedule proposed. The time has come to bring the US back to where it belongs: at the forefront of the most advanced hatchery, restoration and sustainable aquaculture technologies anywhere in the world.

Economic and Social Benefits *(Describe the economic and social benefits including those related to the project's improved ecosystem services and any estimates on jobs created or preserved)*:

The GCMLC facility will begin to have measurable benefits, both environmental and economic shortly after the initial production run of oysters and juvenile finfish, which we anticipate will occur approximately one year after the start of construction. GCMLC will use that time prior to production to conduct outreach and initial training for local entrepreneurs interested in commercial aquaculture and to

work with government agencies and NGOs involved in restoration activities in the Gulf region. The GCMLC's activities will address the need to protect and strengthen GOM ecosystem services through both physical and intellectual means. The specific benefits for the various GCMLC activities are addressed below.

Marine Finfish Broodstock and Hatchery Facility/Stock Enhancement

Commercial and recreational fishing are part of the heritage and lifeblood of the coastal communities along the GOM. The most recent NOAA report on "Fisheries Economics of the United States 2011" documents how vital these activities are to the economic wellbeing of both local communities and our nation. In the GOM region, 2011's commercial landings yielded $818 million in revenue, supporting more than 79,000 jobs and generated a sales impact (or total economic output) of $4.4 billion. For the same year, recreational fishing activities supported over 89,000 jobs, generated a sale impact of almost $9.3 billion, and contributed nearly $4.9 billion to GDP. Currently, underperforming fisheries, shrinking catch limits, and increasing season closures are threatening the long-term sustainability of the commercial and recreational fishing industries. Thus, a focal point of GCMLC activities is to help restore shellfish and finfish stocks back to a healthy state in order to maintain an economically viable and environmentally sound Gulf of Mexico for decades to come.

The GCMLC's hatchery will have the infrastructure, technology, and expertise to support large-scale fingerling and juvenile finfish production. Based on proposed facility design, the GCMLC Phase II marine finfish broodstock and hatchery will be capable of producing over 1.8 million cobia, Florida pompano, and flounder fingerlings a year for direct release or further growout for stock enhancement efforts (see *Figure 2*). Any portion of the fingerlings not used for stock enhancement will be made available to commercial farming operations, relieving a common hindrance to aquaculture development. Other Gulf native species such as red snapper, gag grouper, and amberjack may also be produced based on the needs of the regional fisheries management agencies.

Species	Larval Rearing System Volume (m3)	Fingerlings/m3	Total Fingerlings/rearing	Larval rearing/year	Total annual production
Cobia	120	1,200	144,000	6	864,000
Pompano	48	1,500	72,000	6	432,000
Flounder	48	2,000	96,000	6	576,000
Total					**1,872,000**

Figure 2 - GCMLC Hatchery Production Capabilities for Cobia, Florida Pompano and Flounder
**Prior to release, fingerlings will be grown out to a larger size at the GCMLC nursery and other off-site locations to increase survival.*

The proponents acknowledge that quantifying the economic benefits of stock enhancement is extremely difficult. Even though fishermen heavily target the species listed in Figure 2, very little information exists on stock enhancement activities for the species listed above. The Virginia Institute of Marine Science has conducted several pilot studies on the recapture rates of hatchery reared juvenile cobia (www.vims.edu). The studies documented recapture rates ranging from 10-20%. Based on current fishing regulations, a harvest size cobia and Florida pompano would be a minimum of 15 pounds and 1 pound, respectively. Assuming only 5% of the hatchery reared cobia and 10% of the hatchery reared pompano enter the fishery, the economic impact of such stock enhancement efforts would be substantial. The annual revenue that could be generated from retail restaurant sales of these high value finfish would

be more than $18 million (see *Figure 3*). This does not take into account the multiplier effect these sales would have, thus the full economic impact would be significantly higher.

Species	Number of Fish Released	% Survival to Harvest	Number of Fish Entering Fishery	Minimum Weight for Harvest (lbs)	Total Market Weight (lbs)	Retail Restaurant Value
Cobia	864,000	2.5%	21,600	15	129,600	$8,553,600
Fl. pompano	432,000	10%	43,200	1	43,200	$1,663,200
Total	**1,296,000**		**64,800**		**172,800**	**$10,216,800**

Figure 3 – Estimated Retail Restaurant Value of Two GCMLC Released Species
**It is assumed that cobia survival is significantly lower due to the time it takes for them to reach harvest size*

The economic benefits accrued to the recreational fishing industry and other secondary businesses, such as hotels and restaurants, stands to be the highest. The American Sportfishing Association (ASA) conducted an analysis of the NOAA report on "Fisheries Economics of the United States 2011" in an attempt to quantify the economic impact of recreational fishing in the U.S. on a per pound of harvested fish basis (www.asafishing.org). The ASA report derived a value of $331.32 per pound. Assuming a minimum average weight 15 pounds for cobia and 1 pound for both Florida pompano and flounder harvested by recreational anglers, the total annual economic impact would be $248,092,416. The proponents acknowledge that the ASA analysis is not peer-reviewed, but we believe that it sheds some light on the potential positive economic impact that the GCMLC's stock enhancement activities will have.

Species	Number of Fish Released	% Survival to Harvest	Number of Fish Entering Fishery	Minimum Weight for Harvest (lbs)	Total Harvest Weight (lbs)	Total Economic Impact of Recreational Harvest
Cobia	864,000	5%	43,200	15	648,000	$214,695,360
Fl. pompano	432,000	10%	43,200	1	43,200	$14,313,024
Flounder	576,000	10%	57,600	1	57,600	$19,084,032
Total	**1,296,000**		**86,400**		**691,200**	**$248,092,416**

Figure 4 – Total Economic Impact of Recreationally Harvested GCMLC Released Species

In an effort to illustrate a more conservative analysis, the proponents used assumptions derived from the available scientific literature to provide another example of the economic impact stock enhancement may have in the Gulf of Mexico region (*Figure 5*). In this scenario, the species is the red snapper (*Lutjanus campechanus*), one of the most commercially important and well-studied species of the GOM. The numbers are based on an estimated hatchery production of 275,000 juveniles released into the wild at two different sizes (2.5cm after hatchery stage and 15cm after nursery stage) using a science-based release strategy. This analysis uses willingness to pay ($25.04/lb.) to calculate the recreational value and ex-vessel price ($3.23) to calculate the commercial value of a pound of red snapper. The $1,047,210 annual value for proposed red snapper stock enhancement does not capture the secondary economic impacts that the harvest of these fish would have, thus the total economic impact of this scenario would be several times greater.

Size at Release (cm)	Number of Fish Released	% Survival to Harvest *	Number of Fish Entering Fishery**	Value of Fish Split between Commercial & Recreational
2.5	200,000	1%	2,000	**$220,465.44**
15	75,000	10%	7,500	**$826,745.40**

Figure 5 – The Potential Value of GCMLC Released Red Snapper
* "Wild Survival" is estimated from peer-reviewed scientific publications, and presented values are conservative estimates.
** Average weight of 3.6 kg per individual fish entering the fishery. Data obtained from NOAA dockside landings and Carter & Liese (2012) consumer evaluation data.

The GCMLC facility will directly create dozens of well-paying jobs and indirectly support dozens more with local service providers. One of the Center's long-term goals is to play an integral role in the creation of a robust marine aquaculture industry in the Gulf region. With the nation's annual seafood trade deficit exceeding $9 billion dollars, the increase in domestic production is of paramount importance. The training and technology transfer programs at the GCMLC will promote environmentally sustainable commercial farming operations that will create hundreds of skilled jobs. Each farm level job will create additional jobs across the supply chain in areas such as processing, distribution, and sales. Moreover, the GCMLC's hatchery production capabilities will be able to provide start-up commercial farms with healthy and reasonably priced oyster and marine finfish seed stock.

The GCMLC's long-term goals are to play an integral role in the creation of a robust marine aquaculture industry in the Gulf region. With the nation's annual seafood trade deficit exceeding $9 billion dollars, the increase in domestic production is of paramount importance. The training and technology transfer programs at the GCMLC will promote environmentally sustainable commercial farming operations that will create hundreds of skilled jobs. Each farm level job will create additional jobs up the supply chain in areas such as processing, distribution, and sales. Moreover, the GCMLC's hatchery production capabilities will be able to provide start-up commercial farms with healthy and reasonably priced oyster and marine finfish seed stock.

The technologies for the development and implementation of successful oyster and finfish aquaculture programs are well established. With a state of the art facility and the expertise of the GCMLC team using the methodology described above, success is highly likely. The best way to ensure a positive impact on the environment is through an orchestrated scientific effort, relying on expertise and proven methods, which will deliver long term environmental and economic benefits.

Shellfish Hatchery and Nursery Facility/Habitat Restoration

Restoration of coastal zones is a cost-effective and environmentally pro-active approach to protecting coastal communities and surrounding wildlife. Large-scale coastal restoration projects create jobs, motivate local communities to act, and fosters a sense of responsibility for the preservation of these ecosystems. Over 400 jobs have been created and sustained by merely eight of fifty restoration projects sponsored by NOAA. The Nature Conservancy estimated that a 10 year, 100 mile oyster reef project would generate 240 jobs, increased regional household incomes by $7.6 million, and provide $23 million in revenue and sale to local communities annually. Additionally, improving aesthetics and functionality of coastal wetlands will allow local communities to capitalize on the increasing popularity of eco-tourism. The U.S. Fish and Wildlife Service estimated $36 billion USD in 2009 were attributed to bird watching alone.

In addition to the indirect economic value of the ecosystem services that shellfish provide, private aquaculture can make a substantial contribution to the local and regional economy and provide alternative employment opportunities for the commercial fishing community. For example, if half of the oysters produced by GCMLC are used for commercial production, the farm gate value would be more that $13.5 million annually plus millions more generated through retail and restaurant sales. This represents a tremendous opportunity to stimulate direct economic benefit through sustainable and environmentally beneficial marine farming practices. Consumers, both local and seasonal visitors, will benefit from the availability of fresh and nutritious local seafood.

Furthermore, all stages of finfish and shellfish production offer exceptional educational opportunities for students from elementary through college age as well as for adult learning. Engaging students in finfish and shellfish production will enhance their skills and knowledge of math, biology, chemistry, and engineering, fostering an intrinsic appreciation for sustainable food production and healthy coastal ecosystems, as well as nurture the future of a scientifically adept U.S. workforce.

The following table uses assumptions derived from the available scientific literature to provide an example of the economic impact that a five-year oyster restoration program may have in the Gulf of Mexico coastal region. The numbers in *Figure 6* are based on an estimated hatchery production of 225,000,000 oyster larvae, released using two methods: spat on shell and single bottom planted at 20mm in size. Also included in the table below are estimates on the commercial production numbers and value of the commercial grow-out of oysters using cages.

GCMLC ESTIMATED OYSTER PRODUCTION REVENUE				
		Scenario A	Scenario B	Scenario C
Annual Production of Eyed-larvae	Spat Survival (60%)	A. Spat on Shell Survival Rate (15%)	B. Single Bottom Planted Survival Rate at 20mm size (30%)	C. Caged Oyster Survival Rate (40% of total larvae)
225,000,000	135,000,000	20,250,000	40,500,000	90,000,000
	Price per Oyster	$0.30	$0.30	$0.30
	Projected Annual Revenue	$6,075,000	$12,150,000	$27,000,000
	5-Year Total Annual Revenue	**$30,375,000**	**$60,750,000**	**$135,000,000**

Figure 6. - Potential economic impact of oyster stock enhancement

Marine Life Center

The education sector will experience significant benefits through the regional outreach and Marine Life Center portions of this project. Teachers and students from around the nation will be able to visit the GCMLC to gain firsthand experience in environmental restoration science, and will be left with techniques and technologies which can be employed in their own local ecosystems. Given the current emphasis on science, technology, engineering, and math (S.T.E.M.) in educational curriculums, the GCMLC will provide the perfect venue for educating tomorrow's leaders in these core subject areas, helping to maintain U.S. competitiveness in an ever-advancing global job market. The GCMLC proposes to capitalize on its partnership with several universities and expand its role with the school system to develop and run educational and outreach programs from elementary to high school, technical, undergraduate and graduate levels. (See more details in the "Technical Feasibility Section" of the proposal)

In order to achieve the sustainability of the Center's mission (restoration and stock enhancement efforts, educational and outreach programs, and continued research and development) beyond the three year grant proposal, the GCMLC will have several streams of incomes on which it can rely. The Center will

be able to utilize its infrastructure and expertise to generate revenue through research grants, training seminars, technology transfer activities, and through leasing all or any part of its facilities to the Gulf Coast Marine Life Center Foundation, LLC.

The GCMLC Phase I facility will begin to have measurable benefits, both environmental and economic shortly after the initial production run of oysters and juvenile finfish, which we anticipate will occur approximately one year after the start of construction. GCMLC will use that time prior to production to conduct outreach and initial training for local entrepreneurs interested in commercial aquaculture and to work with agencies and NGOs involved in restoration activities in the Gulf region. The specific benefits for the various GCMLC activities are addressed in the appendices.

Community Resilience *(Describe if the project assists in Florida's ability to anticipate, withstand, or recover from hazards or threats [e.g. hurricane preparedness, establishing living shorelines])***:**

Throughout the Gulf region, healthy GOM ecosystems translate into healthy coastal economies and communities. Florida's tourism industry, with its $67 billion dollar a year economic impact, is heavily dependent on 1,800 miles of coastlines that provide some of world's greatest beaches, diving, and sport fishing opportunities. Commercial and recreational fishing activities in the GOM sustain tens of thousands of jobs and have an annual economic impact in excess of $13 billion. The millions of people that work and live along the Gulf of Mexico coastline depend on wetlands and reefs to mitigate the impacts of hurricanes and storm surges through flood attenuation, shoreline stabilization, and the buffering of wave energy. This buffer reduces erosion thereby protecting people and property, including pipelines and ports servicing the oil and gas industry. Based on 2010 data, nearly 15 Floridians reside within ten miles of the coast. When combined with the fact that the infrastructure in Florida's 35 coastal counties has an estimated replacement value of $2 trillion, it becomes apparent that improved coastal resilience is critical. The effects of a weak buffer zone were felt in Louisiana with hurricanes Katrina and Rita. The storms severely damaged or destroyed 3,400 fishing fleets and accounted for an estimated $168 million in lost seafood revenues. It is estimated that the failure to address the continued loss of coastal wetlands will result in over $100 billion USD in infrastructure damages in the years to come.

With a significant portion of Florida's economy tied to the natural resources provided by the GOM, the conservation and restoration of these resources is vital to the state's coastal communities. Beautiful beaches, clean waters, and excellent sport fishing drive the tourism throughout Florida's Gulf Coast. This project will help rebuild and protect our shorelines in an ecologically sound manner with plants and shellfish rather than steel and cement. The shellfish and finfish hatcheries will allow for the augmentation of commercial valuable marine species. Couple with innovative research and proactive education outreach programs, GCMLC will help support the Gulf tourism industry and bolster seafood harvests for years to come. Commercial marine aquaculture is extremely limited in the GOM, despite being well suited for the activity. This project will bring aquaculture infrastructure and knowhow to the region to help develop an industry, create jobs, and bring economic diversification to Florida.

Conflicts or Complements to Existing Efforts *(Describe any ongoing activities in the project implementation area, if the project is part of another plan, and why the project does or does not interfere with that work. Please consider how the project may complement existing local, regional, and state efforts/plans/objectives)***:**

Rather than conflicting with any ongoing response/remediation work, the GCMLC is closely aligned with several ongoing efforts at all levels. The Center is positioned to participate in the Florida Fish and Wildlife Marine Fisheries Enhancement Initiative and the oyster recovery efforts in neighboring NW embayments and estuaries, as well as other embayments along the Gulf coast. We have begun discussions with the Nature Conservancy and county and state agencies to partner on oyster restoration projects throughout the Gulf region. Additionally, the Center has partnered with University of Florida Sea Grant representatives to discuss educational opportunities related to the GCMLC regional outreach program. Locally, the Marine Life Center has found support in the Okaloosa County Economic Development Council to produce jobs for individuals in areas that have been adversely affected by the Deepwater Horizon oil spill. Thus, the Marine Life Center mission will further existing response/remediation work at the regional level and at the local level.

Complies with Federal, State, Local, and Tribal Laws/Regulations *(Describe any concerns or potential conflicts)***:**

The GCMLC has studied the regulatory framework and is working with all relevant federal, state, local, and tribal groups for the proper permitting for the proposed Marine Life Center that will enable it to carry out its mission.

Readiness for Implementation *(Describe if the project has had any design or permitting work started or completed [attach permits or design work]. Please address any issues that may delay start or finish of the project)***:**

The GCMLC is currently working with architects, civil engineers, land planners, contractors, and aquatic exhibit designers to develop world class, state-of-the-art shellfish and marine finfish hatcheries, public exhibits, and coastal plant production facilities. The GCMLC engineers are estimating an additional 90 days of design work needed prior to construction of the project. Both Phase I and Phase II have received development orders approved by Okaloosa County Board of Commissioners and staff. In anticipation of the activities planned at the Marine Life Center facility, collaborations with marine science programs at a number of universities will allow for immediate commencement of restoration activities. Additionally, many of these same institutions are actively producing native GOM marine finfish species, which can be transferred to the GCMLC upon completion of the facility so the Center can be up and running once construction is completed. Most importantly, the technologies and qualified personnel at all levels have been identified and available immediately. The GCMLC is already working with several recognized professionals in the field who are committed to continuing and expanding their participation in this initiative.

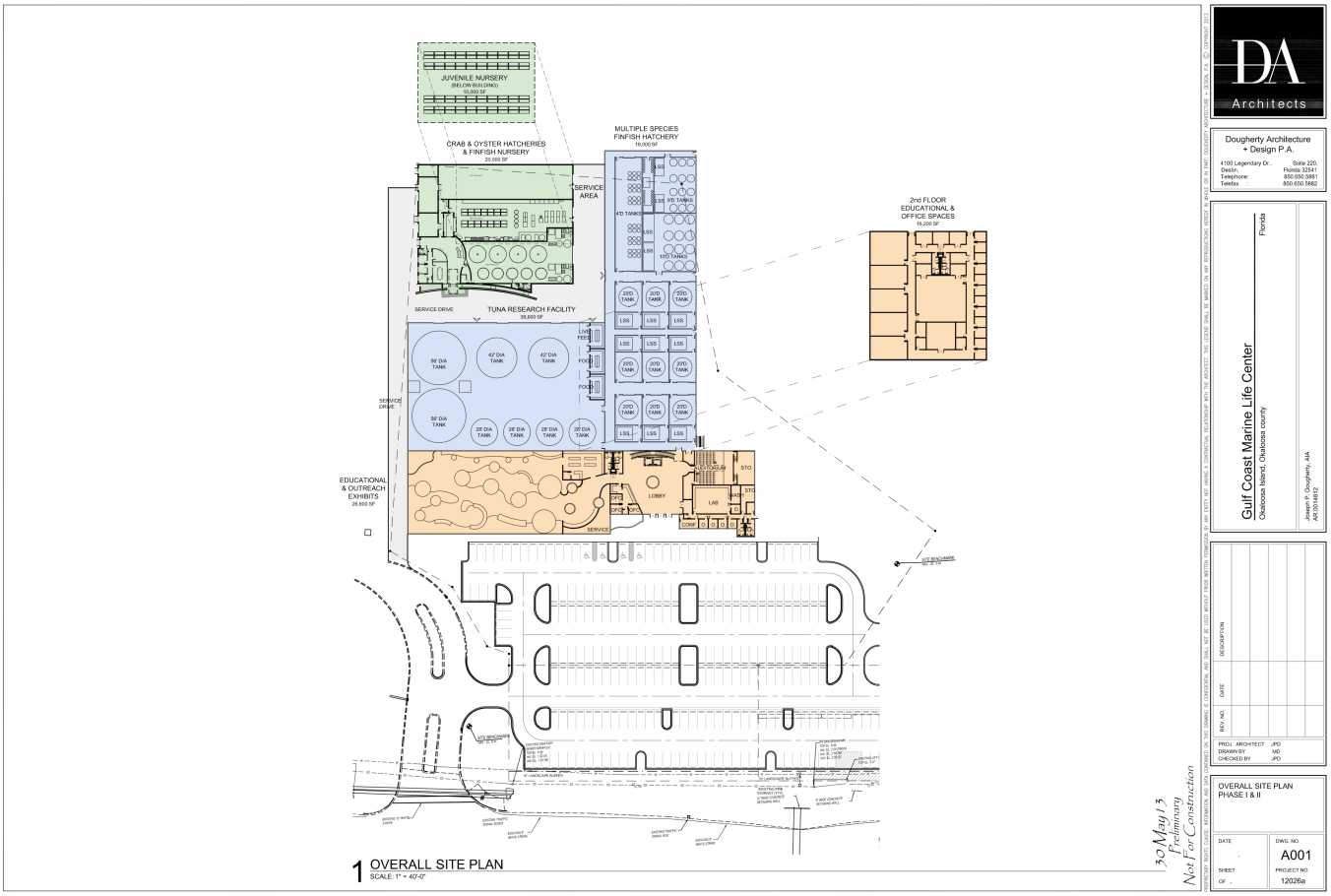

Figure 7 - Gulf Coast Marine Life Center Conceptual Drawing

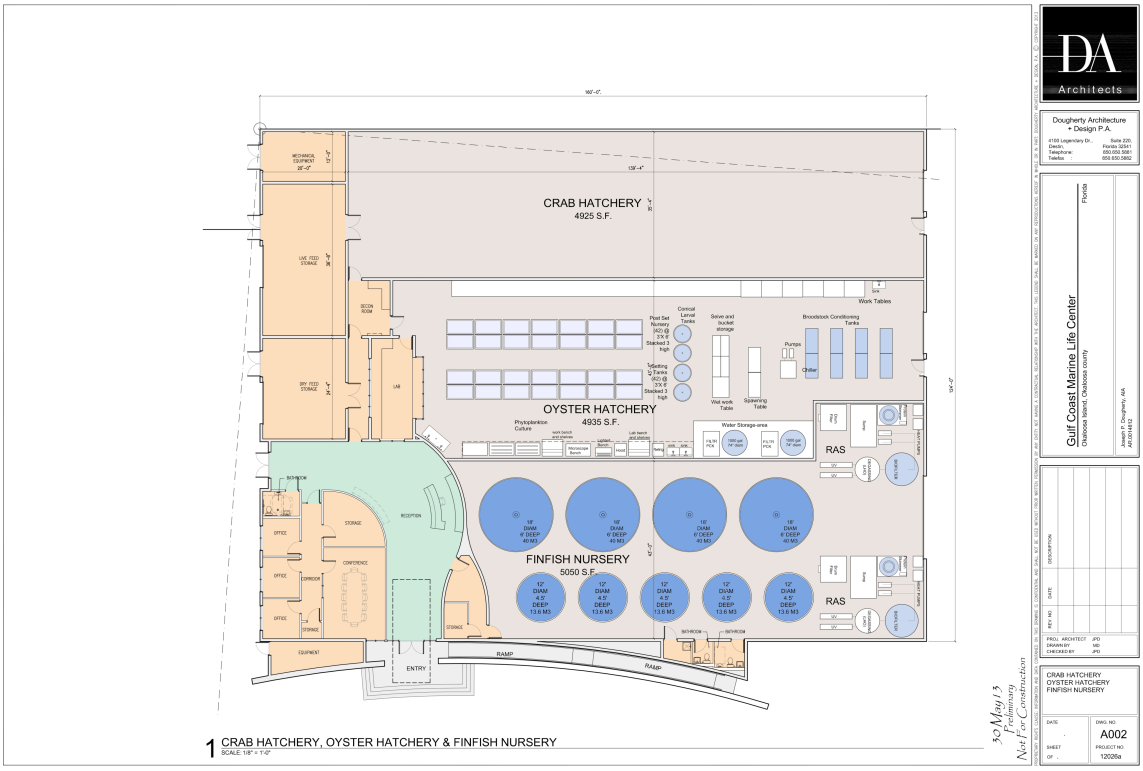

Figure 8 - Phase I - Shellfish Hatchery/ Nursery, Crab Hatchery and Nursery, and Marine Finfish Nursery

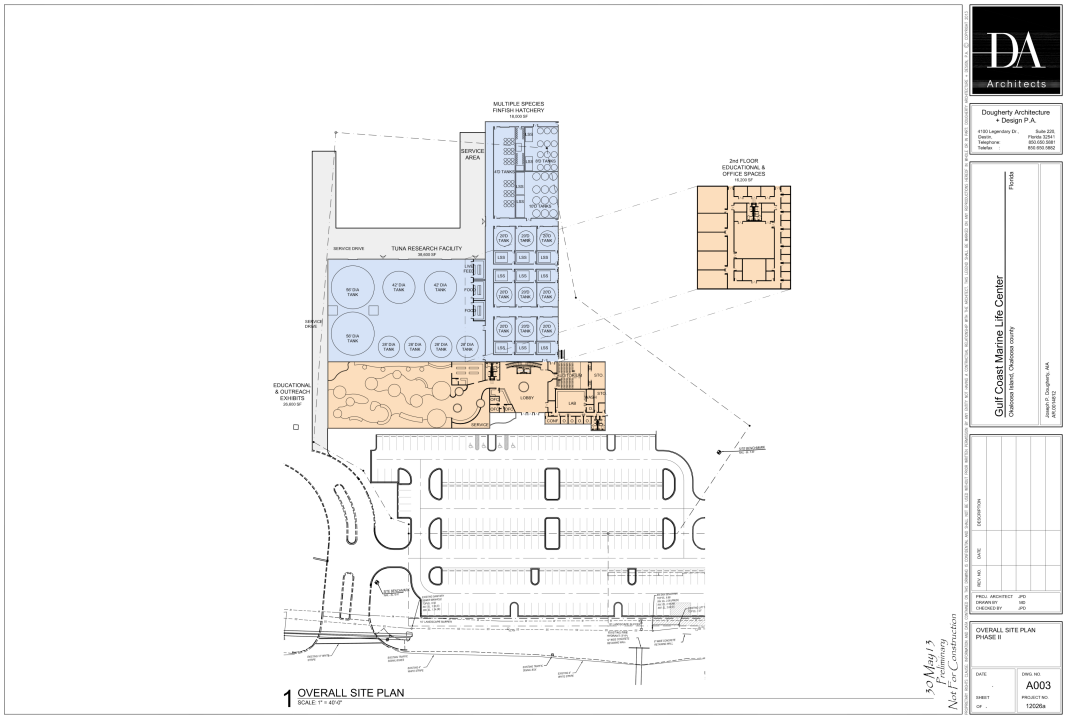

Figure 9 - Phase II - Multi-species Finfish Broodstock and Hatchery Facility and Tuna Research and Development Facility

Public Acceptance (*Describe any known or potential public approval or opposition to the project)***:**

Support for this initiative has been solid and compelling. The project has community support throughout Northwest Florida and the surrounding Gulf States. Some of the supporters are listed below:

- United States Senators and Representatives
- Louisiana State Senators and Representatives
- Florida State Senators and Representatives
- Governor of Louisiana
- President of Plaquemines Parish
- Bay County, Florida, County Commissioners
- Okaloosa County Board of County Commissioners
- Florida Restaurant & Lodging Association
- Santa Rosa County Commissioner
- Mayor of New Orleans, LA
- Bay County Board of County Commissioners
- Okaloosa County Board of Education Superintendent
- Deepwater Horizon Claims Center
- Florida Restaurant and Lodging Association
- Chairman the of Florida Restaurant and Lodging Association
- Mayor of Destin, Florida
- Mayor of Crestview, Florida
- Mayor of Niceville, Florida
- Okaloosa County Public Works
- Panama City, Florida, Chamber of Commerce
- Fort Walton Beach, Florida, Chamber of Commerce
- Mayor of Panama City Beach, Florida
- President of the Okaloosa County Economic Development Council
- Executive Director of the Okaloosa County Tourism Council
- Destin Fisherman's CO-OP
- Destin Charter Boat Association
- The Choctawhatchee Basin Alliance
- The Destin Fleet Marina
- Navarre Beach Marine Science Station
- Crestview, Florida, Chamber of Commerce
- Destin City Council Members, Florida
- Mayor of Fort Walton, Florida
- Destin City Manager, Florida
- Mayor of Fort Walton Beach, Florida
- Bay County Economic Development Alliance

Oyster restoration is currently of high priority for the state and local communities in the Gulf region and would likely be met with enthusiasm by all interested parties. Oyster aquaculture is considered environmentally beneficial by different organizations, government, and the community, including environmental groups that have voiced concerns about some forms of aquaculture; therefore, we do not anticipate any objection for environmental reasons. There is the possibility of some concerns by waterfront landowners over visual pollution from floating aquaculture gear or by recreational or commercial user groups over water space allocation. GCMLC will work with landowners, other user groups and potential oyster farmers to select sites and employ cultivation techniques to minimize any potential conflicts.

Any potential concerns regarding releasing hatchery-raised fish into the GOM are addressed and mitigated by noting that Florida already has strict regulations in place for any release program in order to prevent potential negative impact. Furthermore, all release-type efforts will be under the strict guidelines of Florida's Fish and Wildlife Conservation Commission.

The project may meet opposition from environmental groups regarding issues related to poorly established stock enhancement efforts that are rendered ineffective for restoring diminishing wild populations. This is true. However, all enhancement efforts conducted by the Marine Life Center will be done under direct supervision of the scientific community, working hand in hand with all relevant

Federal and State agencies, most notably the Florida Fish and Wildlife Conservation Commission. The scientists associated to this initiative are renown and internationally recognized in their fields of expertise. It is acknowledged that there is much more to stock enhancement than simply raising and releasing fish at random in the GOM. We take these concerns very seriously and are committed to rely on solid science to conduct these efforts. Significant scientific efforts will be made to determine the best possible way to benefit the ecology of the GOM, and to track the progress of wild populations through time.

The project might face challenges from environmental groups regarding pollution of the bay by finfish culture activities. These concerns will be eliminated because the nursery facilities will utilize state-of-the-art recirculating aquaculture systems (RAS) that recycle water by circulating it through filters rather than relying on dumping wastewater into the environment. In addition, modern hatchery technology utilizes probiotics and prophylaxis techniques (e.g. hydrogen peroxide) that are efficient in preventing and controlling any potential disease outbreaks without using antibiotics or other drugs. Lastly, where possible effluent water will be directed to the Coastal Plant Production Facility, effectively converting waste into nutrients for uptake by the plants, further emphasizing our environmental sustainability goals. To this effect, we are committed to establish proactive health management strategies with the collaboration of qualified and experienced veterinarians.

Additional Information you wish to provide *(Please include any maps, designs, drawings, photos, or background resources that may assist in completely and accurately understanding the project)***:**

Over the last two decades, the GCMLC's collaborating University scientists, partially funded by NOAA and Sea Grant, have been conducting interdisciplinary, multi-institutional research efforts to demonstrate that hatchery and advanced growout technologies can be environmentally and economically feasible in U.S. In particular, they have focused on developing technology that continues raising the bar on environmental sustainability while also being mindful of the need to make this practice economically viable. The proposed GCMLC project represents one of the most important and innovative R&D, technology development, educational, and outreach initiatives on restoration to ever be developed in the United States and the world.

Finally, a disclaimer that the proponents omitted citations that support the facts and claims presented in this proposal because the submittal form format does not call for or require references and literature cited. References to substantiate specific technical and scientific assertions made are available upon request. Additionally, lists of scientific publications by the primary collaborators on this project are included in the Appendix Section.

APPENDIX A:

FLORIDA GULF OF MEXICO RESTORATION: EDUCATION AND OUTREACH
(*Funding not being asked for in the proposal*)

OVERVIEW

The Gulf Coast Marine Life Center will promote responsible stewardship of the Gulf of Mexico through the implementation of education and outreach programs in Phase II of the project. These programs will be actualized by incorporating the multiple facets of the center's facilities, along with partnerships with educators, universities, and organizations such as Florida Sea Grant, incorporating their resources to develop educational programs for children and adults, as well as university students specializing in fisheries, marine aquaculture, and habitat restoration. The GCMLC will house an interactive Marine Life Center, complete with a regional outreach program that will extend the impact of the Center's activities.

EDUCATION

The education sector will experience significant benefits through the regional outreach programs established by the Marine Life Center. Teachers and students from the GOM region will be able to visit the GCMLC to gain firsthand experience in environmental restoration science, and will be taught techniques and technologies which can be employed in their own local ecosystems. Given the current emphasis on science, technology, engineering, and math (S.T.E.M.) in educational curriculums, the GCMLC will provide the perfect venue for exposing tomorrow's leaders in these core subject areas, helping to maintain U.S. competitiveness in an ever-advancing global job market. The GCMLC proposes to capitalize on its partnership with several universities and expand its role with the regional school systems to develop and execute academic and research programs for children and adults, ranging from elementary to high-school, technical institutes, and university undergraduate/graduate levels.

OUTREACH

The most advanced hatchery and aquaculture technologies, ecological restoration techniques, and fisheries scientific methods will be on display, thus providing a powerful resource to support organizations such as Sea Grant research and other outreach programs designed to transfer these experiences, knowledge and technology to the education, non-profit, and private sectors. The GCMLC will implement a regional outreach program aimed at educating the next generation of GOM marine scientists, conservationists, resource managers, and policy makers.

-Partnerships w/ universities for student training
The classrooms and research wet labs are designed to also accommodate student intern courses, university level courses, advanced training workshops, and seminars in a variety of research areas, including: marine biology, aquaculture, fisheries management, genetics, nutrition, environmental science and policy, conservation, and ecosystem restoration. The work conducted at the GCMLC will provide current students with internships and training that will prove to be an invaluable experience as they move on to careers in the private

sector, academia, or government, benefiting the Gulf of Mexico region, as well as the entire U.S.

-Nation-wide technology transfer

The GCMLC will serve as a hub for research and an incubator for private aquaculture ventures throughout the region, stimulating job creation and the growth of an aquaculture industry on the Gulf Coast of the United States. The methods and procedures develop for the Gulf will eventually be applied beyond the region to substantially benefit the U.S. as a whole.

Given the numerous components of the GCMLC, such as the hatchery facilities, classrooms and teaching labs, restoration programs, and the staff of scientific experts and professionals on-site, opportunities for technology transfer and employee training are extensive. This will undoubtedly help the GOM region in its economic diversification and job creation efforts. The establishment of a resource center, such as the GCMLC, will entice companies in the aquaculture industry to establish operations in the area, as they will be able to send their employees to the GCMLC facility for training on a number of different marine species while employing the most advanced and environmentally conscious techniques in aquaculture.

STUDENT FIELD TRIPS

As part of the GCMLC's drive to promote stewardship of Gulf of Mexico marine habitats and native species, the Center will host informative, hands-on field trips for students of all grade levels. Groups of thirty to forty students, along with teachers and chaperones, will be invited on a weekly basis during regular school hours, to witness firsthand an operating finfish and shellfish hatchery, learn about GOM coastal plants and habitat restoration, peruse the informational Marine Life Center Exhibit area, and take home lessons they can apply to their daily lives.

Upon arrival, the GCMLC Education and Outreach Coordinator will greet teachers and students, introducing them to their GCMLC education tour leaders. Their tour leader will escort the students to the Marine Life Center Cinema where they will be introduced to Gulf of Mexico native species, stock enhancement, and habitat restoration during a twenty minute informational video. Shortly after students will proceed to the GCMLC classrooms where they will spend approximately an hour of their time going through Gulf of Mexico habitat restoration workbooks, an aquaculture and stock enhancement info-session.

Smaller groups (i.e. honors classes) will conduct lab experiments, supervised by GCMLC staff members. Students will have been briefed in the classroom on the experiment procedures. Upon arrival to the lab, staff members will educate students on lab equipment and safety protocols prior to beginning the experiment. The experiments will run approximately one-hour.

Lab Exercises (examples):

- Count oyster seeds using volumetric samples to estimate production
- Count fish eggs using volumetric samples to estimate production
- Measure and weight of fish/oysters in tanks; calculate feeding efficiency
- Test water quality with lab test kits; determine if optimal for fish
- Identify and count live feeds (rotifers and *Artemia*); estimate feed for fish
- Observe specimens under microscopes; health assessment of gills, skin, etc.

The last segment of the day will be an informative tour of the Marine Life Center Exhibit and Touch Tanks, highlighting the challenges facing the GOM ecosystem, and the solutions towards a healthy prosperous future for the region. Once the tour is finalized, teachers, chaperones, and students will be free to walk around and further observe the facilities until the conclusion of the field trip.

Special field trips will be held for students geared towards natural sciences. Groups of ten to fifteen students will be given exclusive behind-the-scene tours, beyond the regular field trip protocol, including a walk-thru of all GCMLC's hatchery and nursery facilities. Lab experiments will be extensive and depending on group size may be conducted within the actual hatchery. Take home assignments will be given and students' work will be posted on GCMLC's website.

SEMINAR/WORKSHOPS

As part of Phase II of the GCMLC, in an effort to promote aquaculture and habitat restoration throughout the Gulf of Mexico region and nationally, the GCMLC will host quarterly workshops and seminars lasting three to ten days depending on the amount of material to be covered. These seminars will accommodate ten to thirty individuals at a time. Participation will be open to individuals of all experience levels, from the beginner to the working professional. The GCMLC facility is unique in that it will host a variety of activities all under one roof, such as a fully operational hatchery working with multiple finfish and shellfish species, a coastal plant facility with shoreline restoration initiatives, and a comprehensive Marine Life Center exhibit area complete with classrooms and labs. This conglomeration of specialties opens up many educational opportunities for individuals with an interest in different aquaculture species, habitat restoration, education and outreach, and aquarium enthusiasts. The center will work together with its university partners, as well as outreach organizations such as Sea Grant in order to develop and execute these seminars.

Seminar Topics include (but not limited to):
- Finfish Aquaculture Husbandry and Production Systems
- Tuna Aquaculture Husbandry and Production
- Shellfish Aquaculture Husbandry and Production Systems
- Recirculating Aquaculture Systems
- Educational workshops (Teachers only)

Morning Sessions:
Morning sessions will be held at the hatchery and laboratory facilities for hands-on demonstrations. Every morning a different department will be visited for observation and participation if applicable. Tours and demonstrations will be given in the areas of broodstock care, larval rearing, live feeds and algae, nursery, Tuna research and development, Shellfish hatchery, Aquarium, and when appropriate restoration activities in the field.

Afternoon Sessions:
After lunch break, classroom lectures and workbook materials will be covered on the above topics, specific to the ongoing workshop. Presentations by experts in the field and informational videos will also be shown in the cinema. The material covered in the afternoon session of the day will be the focus of hands-on activities for the next morning.

STUDENT INTERNSHIPS

The GCMLC will further support its relationship with university partners and private enterprises through internship programs. The center will offer various internship opportunities spanning the different departments and disciplines at the Marine Life Center. Undergraduate, graduate, and technical students whom are looking forward to a career in marine science will have the opportunity to intern onsite for three to six months under the direction of scientific experts, skilled professionals, and science professors encompassing several different fields of study.

Internship Opportunities:
- Finfish Hatchery
- Shellfish Hatchery
- Coastal Plants Facility
- Tuna Research and Development Facility
- Fisheries/Stock Enhancement
- Marine Conservation
- Education and Outreach
- Habitat Restoration
- Aquarium Internships

These internships will prepare students for entry-level to mid-level positions within their field of study as they take on day-to-day tasks in a real world setting. Furthermore, they will also have access to a network of experts with substantial scientific working knowledge of the challenges facing the Gulf of Mexico and the possible solutions. Emerging marine scientists that can both work and think through problems to reach timely solutions will not only benefit the Gulf of Mexico, but the United States as a whole.

PERFORMANCE MEASURES

Performance measures used in the Marine Life Center's education and outreach program will focus on the number of individuals exposed to GOM educational activities as well as published data. A log of annual public visitors, educators and students, as well as visiting interns will be kept. Follow-up questionnaires will be sent to participating institutions and individuals to monitor the program's effectiveness and where improvements can be made. The Education and Outreach Coordinator will analyze this data and make changes accordingly.

The results of the research conducted at the GCMLC, such as presentations and restoration project progress, will be widely distributed through a wide variety of media outlets ranging from peer-reviewed academic journals, trade journals, as well as in common news feed outlets accessible to the public. Such activities will continue as part of this project, and in this way, knowledge about the progress, challenges, and opportunities in Gulf of Mexico ecology and restoration science will be shared with as wide an audience as possible. The public will be able to gauge the success of the GCMLC, and in keeping with the adaptive management strategy, the Center will be receptive to community needs in terms of prioritizing research activities and addressing well-founded requests of the working waterfront community.

***APPENDIX B*:**

COASTAL PLANT PRODUCTION FACILITY

OVERVIEW

The Gulf of Mexico shoreline has been receding for decades due to reduced sedimentation, hurricane damage, plant loss, and anthropogenic pressure. This loss of habitat has proven to be detrimental to the fish and wildlife that depend on this wetland habitat for shelter, food, and breeding grounds. Furthermore, it adversely affects the environment due to the significant reduction in the buffer zone between the coastal land and the marine environment. Plants and salt marsh grasses serve to filter land-runoff from residential and commercial areas, agricultural activities, and other industries that would otherwise reach and pollute the marine environment. This buffer zone also works in reverse as it protects the coastline, inhabitants, and infrastructure from wave energy, storm surges, and other sources of erosion. For these reasons third party coastal plant restoration efforts will be supported through GCMLC's Coastal Plant production facility. This facility will be a vital component to the center's goal in GOM habitat restoration. Researchers from our partner universities, Louisiana State University and University of New Hampshire, are national leaders in coastal plant restoration. Both universities have extensive experience propagating native herbaceous and woody plants for use in coastal wetland restoration, providing marsh grass species to many salt marsh restoration projects, and developing mangrove nurseries to aid habitat restoration initiatives. Additionally, working with organizations such as Nature Conservancy, which is currently running many successful coastal plant restoration projects, will enable the GCMLC to bring the best native plant specimens, techniques, and technologies to the GOM for an extensive restoration effort.

PLANT SPECIES

The Gulf of Mexico ecosystem is rich in diversity and home to many different plant species. Throughout the GCMLC's restoration efforts, the preservation of native species and genetic diversity is a vital element of the habitat restoration programs. Thus, all species harvested at the GCMLC for coastal restoration will be native to the GOM region.

The Marine Life Center will build upon work conducted at LSU and UNH. The Center will incorporate their current technology on coastal plant genetic diversity, resilience, growth, biotic and abiotic tolerances, to the GCMLC's Coastal Plant Production Facility. Production of dominant coastal wetland native species will be used to restore damaged areas along the Gulf of Mexico coastline. In addition, efforts will be initiated to propagate less common species of special concern (i.e. state-listed threatened and endangered species), which also suffered impacts from the oil spill, thus protecting natural heritage and plant species diversity. In addition to benefitting biodiversity, inclusion of rare species into restoration planning often boosts public interest and leads to unique opportunities for outreach and education, one of several central foci of this effort.

Plant Species:

- Red mangrove (*Rhizophora mangle*)
- Black mangrove (*Avicennia germinans*)

- Smooth cordgrass (*Spartina alterniflora*)
- Black needlerush (*Juncus roemerianus*)
- Various other native plants

SEED TECHNOLOGY

During coastal restoration efforts, once seeds are deployed into the environment, there is little that can be done to ensure optimal growing conditions. For this reason the resilience, fertility, germination rates, and ability of the plants to set, grow, and spread are all key to a successful restoration effort. For example, LSU's PolyC15, a version of seed-based smooth cordgrass being produced by their scientists and students, offers a very high yield rate, producing 631 pounds of seed per acre, compared to a control variety, Vermillon, which produces only 261 pounds per acre. LSU has developed this strain to have this ability by focusing on high yields fostered by improved seed set, a high fertility rate, high germination rates, and most importantly a high genetic diversity that effectively helps to ward off disease, parasites, and mass die-offs maintaining biodiversity within the habitat, thereby restoring ecosystem processes and functions.

Seeds being used for restoration efforts also benefit from technologies such as coating and the addition of enhancement materials. Coating the seeds adds weight, therefore improving the ability of the seed to set. Materials can also be added as a coating to enhance water attraction, improve the seed's ability to stick to the soil, add oxygen-generating materials improving survivability, and prevent digestibility of birds which feed on the seeds. There are other components that can be added directly into the seed to prevent fungus, insect infection, and other afflictions affecting the seed's chance to take root and grow within its new habitat.

OUTREACH

Coastal plant restoration projects are large-scale requiring investment and participation from both private and public partnerships, government and community members, and a substantial volunteer effort. It is clear that education and outreach will be an important component of GCMLC's Coastal Plant Production Facility.

The center will work with existing entities to promote GOM coastal wetland restoration through community education and outreach, as well as with existing and future partnerships with local grade schools. LSU for example, has partnered with educators and created a network of schools that have pledged financial support, dedicated a culture area within their school to grow coastal plants, and tend to the care of the plants with help of student volunteers. These plants and the seeds from these plants are then used for large coastal habitat restoration efforts.

APPENDIX C:

FINFISH STOCK ENHANCEMENT

OVERVIEW

Despite being a region that has gone through intense overfishing, catastrophic natural disasters, and monumental anthropogenic abuse, the Gulf of Mexico yields more finfish, shrimp, and shellfish annually than the south and mid-Atlantic, Chesapeake, and New England areas combined, generating 40% of the seafood caught commercially in the entire U.S. The Gulf is diverse and rich in terms of desirable species in global seafood market. Reef and coastal fish such as snapper, grouper, amberjack, pompano, triggerfish and cobia have tremendous commercial value today, and hold the potential to further expand. A unique strength of the GOM fishery relative to many others is its proportionally large recreational sector, which has a multi-billion dollar annual economic impact on the region.

Unfortunately, long-term fishing pressure placed on GOM native species has led to dwindling fish stocks. Furthermore, reactive management practices of the past have lead to a decrease in individuals reaching peak gonad development. This has reduced wild fish stock's ability to recover from overfishing. For example, it is estimated that over the past century the spawning stock biomass of red snapper in the GOM has been reduced by 93 percent. Red snapper are a long-lived species with a complex life history, and the majority of egg production is generated by the older individuals of 12-15+ years. In light of the current circumstances fisheries are facing, numerous restrictions, limited catch rates, and shorter fishing seasons have been implemented. Though these measures provide some aid to counter overfishing, it has not been enough and it is time to take a proactive stance in rebuilding GOM fish stocks.

While freshwater stock enhancement is accepted and funded throughout the United States for trout and other salmonids, marine stock enhancement has been mostly limited to research and development. The GCMLC will implement a comprehensive and holistic restocking protocol with the support of its university partners and regional fisheries management agencies. The center will utilize proven culture techniques for species like cobia, flounder, pompano, and snapper for the purposes of stock enhancement. The proposed stock enhancement effort of these species, as well as future native GOM species will be both responsible and effective, adhering and surpassing the guidelines of Florida Fish and Wildlife and other relevant regulatory agencies. The marine scientific community has invested in and learned about stock enhancement, hatchery science, tagging, wild fish life cycles and behavior, working with fishermen and communities, it would be a shame to remain at a research and development stage indefinitely. It is time to perform a large-scale stock enhancement effort so that a real impact can be achieved and our technological potential as both consumers and stewards can be realized.

Breeding Program

The GCMLC strongly supports a stock enhancement effort where the understanding of genetic variance amongst separate sub populations of a species. It is optimal to utilize broodstock from the specific sub population targeted by the stock enhancement effort. Additionally, a large number of broodstock should

be employed in order to preserve genetic diversity in the long run. The threshold of genetic diversity set by the FWC limits the stock enhancement's augmentation of wild stocks to five percent per year. As such, large quantities of broodstock will be utilized in the production of finfish for stock enhancement, with a rotation of brooding cohorts to eliminate the potential for genetic normalization in the wild stocks. In so doing, the guidelines set forth by the FWC's Genetic Policy for the Release of Finfishes in Florida will be strictly followed.

It is the center's goal to exceed the FWC's five percent threshold in the future, multiplexing, genetic variability assessments via the use of microsatellite multiplex panels, which will be employed to achieve the following breeding and subsequent genetic assessment protocols and requirements established by the FWC. In following these guidelines, we aim to provide a genetically responsible stock enhancement program to augment these ecologically and financially important resources for the state of Florida.

I. Incorporate broodfish that collectively encompass a suitable range of adaptive genetic variation available in the natural stock.
II. Avoid the production of inbred fish.
III. Use sufficiently high effective numbers of breeders.
IV. Avoid artificial and domestication selection.
V. Compare levels of genetic diversity in wild stocks.
VI. Estimate levels of genetic diversity between cultured and wild stocks.
VII. Directly or indirectly estimate the relative proportions of cultured and wild fish in the admixed population.

PERMITTING

The Florida Marine Stock Enhancement Advisory Board (MSEAB) meets twice a year with program biologists and fisheries experts to discuss the guidelines and procedures for stock enhancement efforts within Florida. The advisory board is comprised of representatives from the commercial and recreational fishing industry, scientists, conservationists, and government officials, and most importantly Fish and Wildlife commissioners. The Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWRI) manages Florida's marine stock enhancement program. The necessary permits are issued through the Fish and Wildlife Commission.

The GCMLC is very familiar with the current guidelines issued by the MSEAB and FWC. The center's goal is to not only adhere to these guidelines, but when possible exceed the given expectations.

SITE SELECTION AND RELEASE

The GCMLC acknowledges that in order to achieve success in restocking to rebuild the population of GOM marine finfish, the regional population structure and metapopulation dynamics must be well understood. A lack of understanding in this department has undermined the efficacy of previous efforts. The concept of population connectivity is defined by sources and sinks. Sources are defined as sub populations, which provide additional larvae that recruit to the juvenile habitat connected to a separate sub population of spawning adults. On the other hand, sinks take in recruits from other subpopulations, but do not reciprocate. This network of exchanges between sources and sinks is known as larval transport. Thus, nursery habitats that provide well-defined pathways to the habitats of source spawning

stock populations should be utilized as stocking sites. The identification of such populations and associated habitats will be paramount to the success of this stock enhancement effort.

The lack of suitable habitat for the stocked fish to recruit to can is another major concern for successful stock enhancement. However, the GCMLC will simultaneously address this obstacle through its collaboration with third-party habitat restoration efforts. When called upon the GCMLC will supply fish for stock enhancement onto artificial reefs as well as living reefs constructed from hatchery-reared shellfish, particularly oysters. The hatchery-reared juveniles can be released onto these empty artificial reefs and/or living reefs. Past experiments with the release of juvenile red snapper onto empty artificial reefs have proved to increase the post-release survival of hatchery reared fish.

Site quality for the release of hatchery reared juvenile finfish will be quantified and potential sites will be ranked by habitat type, connectivity, and existing biomass of competitive species. Geographic Information Systems (GIS) software is and will continue to be utilized by the GCMLC to isolate optimal release sites. The figure below uses GIS software to provide a visual analysis of import site selection data such as bathymetry, sediment type, artificial reef locations, Marine Protected Area, and any restricted fishing areas.

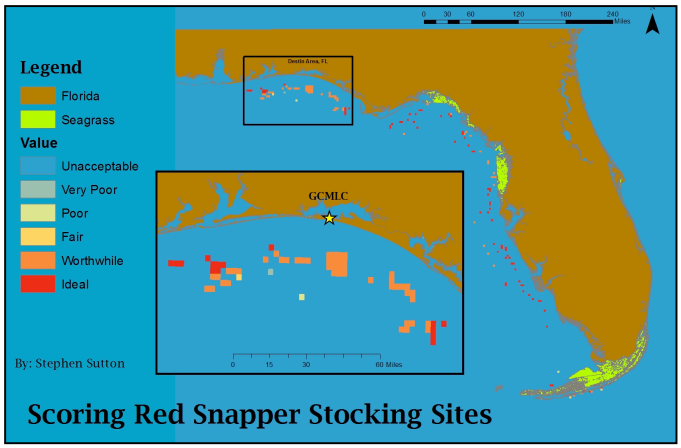

Fig. 1 - Includes sea grass beds and the state of Florida shoreline (from USGS). Scores of 'unacceptable' indicate that it would not be a wise investment to stock in this area, as survival and/or ability to measure efficacy would likely be low. The inset map highlights the area around the GCMLC, which could be potential release sites for hatchery reared red snapper juveniles

The survival of the stocked fish is correlated to release size, magnitude, season, habitat, stress, and a number of acute oceanographic factors such as tide, temperature, and food availability. Furthermore, the acclimatization of the released fish into the natural environment can play a crucial role in survival or mortality. By accounting for all of these factors in site selection and temporal planning, survivability can be maximized. Meanwhile, the release strategy must account for economic efficiency. In a way, the economic considerations of stock enhancement survivability are akin to the 'r' and 'k' reproductive strategies found in nature. Increased economic investment in each individual will yield greater survivability, but fewer individuals can be afforded. Under this regime, an inflection point of economic survival should be isolated and utilized, while simultaneously and comprehensively accounting for the remaining spatial, temporal, and ecological factors.

MONITORING

By economically producing fish on a commercial scale, employing a comprehensive release strategy, and involving both recreational and commercial fishers to monitor returns, the GCMLC and its partners can improve the performance of GOM fish stocks.

Isolating a metric of success is critical to determining the value of the stock enhancement effort. Whether the value is associated with added ecological services or a more productive fishery, the ability to enumerate the actual impact of stock enhancement enables intelligent expansion, early identification of failures, and efficient fisheries management. Today both scientists and managers are equipped with a variety of tools that increase the feasibility of large scale stock enhancement monitoring. From otolith staining and statistical models, to nanotechnology and genetic tagging, new technologies provide great potential in the battle to overcome the uncertain metrics of stock enhancement impact. However, this must be done in an economic and practical way, wherein a combination of tools will be utilized to maximize the quantity and quality of data.

According to extensive literature, stock enhancement efforts have returned mixed results as measured by our most commonly used metric: recapture percentage. Recapture rates, especially of small-scale and poorly funded projects are only reporting a fraction of the project's success. The size of this fraction of course changes with the magnitude and exact approach of the effort, but it is crucial to realize that tag return/recapture rates are always a conservative measure of success. There is a high level of stocking variability (how many fish, percentage marked or tagged, season, location, tag methods, etcetera), and uncertainty in sampling efficacy due to the sheer size of the ocean. Stock augmentation is not like a traditional science experiment in a laboratory, but that should not prevent it from receiving our utmost effort, expertise and attention. Literature and logic collectively suggest that the recapture rates we see in enhancement efforts will, and have, only increased as technology, understanding and the scale of enhancement efforts increase. In saying that, it is emphasized that the GCMLC will take all necessary measures and implement the most advanced technologies available to fisheries to monitor the stock enhancement efforts within the GOM.

Along with monitoring success in numbers, any signs of disease need to be closely monitored. There are two primary dangers of restocking with regard to diseases, viruses, and pathogens. The first is the potential for transmission of pathogens and diseases from the hatchery reared fish to wild stocks, resulting in the weakening of an already depleted fishery. The second is the risk of the hatchery-reared fish lacking the fitness to contend with diseases and pathogens found in nature upon their release. This would result in a futile stock enhancement effort, wherein released juveniles would die off before assimilating into the spawning population. As these risks range from minor to extreme and probable to unlikely, they must be addressed with parallel magnitudes of management. By identifying the likelihood, pathways, and consequences of these risks, comprehensive risk management strategies will be employed by the GCMLC to eliminate hazards to wild stocks and promote the overall success of the stock enhancement endeavor. These strategies are currently being implemented at the University of Miami Experimental Hatchery, and the GCMLC will build upon their methods to ensure the fish being released for stock enhancement are healthy and free of any pathogens or other afflictions that could potentially harm wild stocks.

APPENDIX D:

GCMLC PHASE II TOTAL BUDGET COSTS

TOTAL PROJECT COST (*including 3 year operation costs*) = **$ 49,602,271**

GCMLC PHASE II: 3-YEAR TOTAL COSTS	
Gulf Coast Marine Life Center - Phase II	**Total Cost (USD)**
Total Capital Costs	**$ 42,041,430**
Total Operating Costs (3-Year Total)	**$ 7,560,841**
3-YEAR TOTAL COSTS	**$ 49,602,271**

GCMLC PHASE II CAPITAL COSTS	
Gulf Coast Marine Life Center	**Total Cost (USD)**
Total Building Costs (80,000sqft Finfish Broodstock, Hatchery and Tuna R&D facility)	$ 20,881,800
Total Equipment Costs (Including Installation)	$ 13,444,950
Total Additional Line Items	$ 5,115,000
Total Contingency Costs (10%)	$ 2,599,680
TOTAL CAPITAL COSTS	**$ 42,041,430**

GCMLC PHASE II OPERATING COSTS				
Gulf Coast Marine Life Center	**Year 1**	**Year 2**	**Year 3**	**Cumulative Total (3 years)**
Multi-species Marine Finfish Broodstock Facility and Hatchery and Nursery	$ 942,590	$ 952,630	$ 962,871	$ 2,858,091
Tuna Research and Development Facility	$ 880,940	$ 887,860	$ 894,918	$ 2,663,718
Coastal Plant Production and Habitat Restoration Facility	$ 170,000	$ 172,060	$ 174,161	$ 516,221
Maintenance on all Systems	$ 141,400	$ 155,540	$ 178,871	$ 475,811
Insurance on Building and Equipment (Flood, Property, and Windstorm)	$ 181,000	$ 181,000	$ 181,000	$ 543,000
Utilities	$ 168,000	$ 168,000	$ 168,000	$ 504,000
TOTAL OPERATING COSTS	**$ 2,483,930**	**$ 2,517,090**	**$ 2,559,821**	**$ 7,560,841**

CAPITAL COSTS

Gulf Coast Marine Life Center	Footprint (SQFT)	Building Costs ($/SQFT)	Building Costs (USD)	Equipment Costs (Installation Included) (USD)	Total Cost (USD)
Multi-species Marine Finfish Broodstock Facility and Hatchery	18,304	200	$ 3,660,800	$ 2,265,000	$ 5,925,800
Tuna Research and Development Facility	38,600	200	$ 7,720,000	$ 5,106,200	$ 12,826,200
Coastal Plants Production and Habitat Restoration Facility	5,000	20	$ 100,000	$ 100,000	$ 200,000
Educational Exhibits and Labs	30,855	200	$ 6,171,000	$ 5,570,000	$ 11,741,000
Educational Areas and Offices	16,150	200	$ 3,230,000	$ 403,750	$ 3,633,750
TOTALS	**108,909**		**$ 20,881,800**	**$ 13,444,950**	**$ 34,326,750**

Additional Line Items			
Site Work/Parking			$ 1,200,000
Aeration pumps and distribution			$ 75,000
Injection well collection and storage			$ 100,000
Oxygen storage and distribution			$ 80,000
Backup generator			$ 500,000
Roof Hatch			$ 250,000
Freight Elevators			$ 150,000
Landscaping Exterior lighting and Signage			$ 75,000
Builder Risk insurance			$ 40,000
Soft Costs			$ 1,500,000
Impact fees			$ 50,000
MEP Commissioning			$ 120,000
Threshold/Mechanical Inspection			$ 10,000
Development Management			$ 965,000
Total Additional Line Items			**$ 5,115,000**
Total Building Costs			**$ 20,881,800**
Total Equipment Costs			**$ 13,444,950**
Total Contingency Costs (10%) on Building and Line Item Costs			**$ 2,599,680**
TOTAL CAPITAL INVESTMENT			**$ 42,041,430**

GCMLC PHASE II EQUIPMENT COSTS

Gulf Coast Marine Life Center	Finfish	Tuna	Restoration	Equipment Costs (Installation Incld) (USD)
Phase II Equipment Costs	$2,265,000	$5,106,200	$ 100,000	$ 7,471,200
TOTALS				**$ 7,471,200**

GCMLC Multi-Species Finfish Broodstock, Hatchery, & Nursery Equipment			
Marine Finfish Broodstock Tank (50 m^3: 20' x 6') w/ filtration	9	$ 75,000	$ 675,000
Large Larval Rearing System (Twelve 10 m^3 tanks with life support systems)	1	$ 400,000	$ 400,000
Medium Larval Rearing System (Twelve 7 m^3 tanks with life support systems)	1	$ 300,000	$ 300,000
Small Larval Rearing System (Twenty four 0.75 m^3 tanks with life support systems)	1	$ 140,000	$ 140,000
Live Feeds Production Lab	1	$ 50,000	$ 50,000
Wet Lab/Water Quality Lab	1	$ 50,000	$ 50,000
Nursery (Twelve 35 m^3 tanks high density RAS w/ all filtration components)	1	$ 650,000	$ 650,000
Total Equipment Costs			**$ 2,265,000**
FINFISH BROODSTOCK HATCHERY AND NURSERY TOTAL EQUIPMENT COST			**$ 2,265,000**

GCMLC Tuna Research and Development Facility Equipment			
Yellowfin Tuna Broodstock Tank Systems (1,535 m^3: 56' x 20')	2	$ 800,000	$ 1,600,000
Blackfin Tuna Broodstock / General Holding Tank Systems (600 m^3: 42' x 15')	2	$ 450,000	$ 900,000
Tuna Nursery / General Holding Tank Systems (170 m^3: 28' x 10')	3	$ 200,000	$ 600,000
Tuna Quarantine Tanks Tank (50 m^3: 20' x 6') w/ filtration	2	$ 75,000	$ 150,000
General Life Support Equipment	1	$ 1,000,000	$ 1,000,000
Bobcat	1	$ 30,000	$ 30,000
Hydraulic Crane (indoors for moving large fish)	1	$ 50,000	$ 50,000
Portable Fish Pump (for moving fingerlings)	1	$ 25,000	$ 25,000
Hydraulic rotating tank cleaner	1	$ 5,000	$ 5,000
SCUBA equipment	2	$ 600	$ 1,200
Forklift-accessible Freezer (for all frozen GCMLC feed, approx. 15 - 20 pallets per w	1	$ 40,000	$ 40,000
Customized Broodstock Vessel and Work Boat	1	$ 500,000	$ 500,000
Customized Live Broodstock Transport Truck Trailer	1	$ 175,000	$ 175,000
Misc. Equipment (analytical supplies, scales, transport equipment, etc.)	1	$ 30,000	$ 30,000
Total Equipment Costs			**$ 5,106,200**
TUNA RESEARCH AND DEVELOPMENT TOTAL EQUIPMENT			**$ 5,106,200**

GCMLC Coastal Plants and Habitat Restoration Production Facility			
Office Furniture	1	$ 15,000	$ 15,000
Office Equipment (PCs, Printers, Copier etc.)	1	$ 25,000	$ 25,000
Coastal Plant Nursery Equipment	1	$ 60,000	$ 60,000
Total Equipment Costs			**$ 100,000**
COASTAL PLANTS AND HABITAT RESTORATION TOTAL EQUIPMENT COST			**$ 100,000**

GCMLC Multi-Species Finfish Broodstock and Hatchery

OPERATING COSTS

Facility Supplies	Year 1	Year 2	Year 3	Cumulative Total (5 years)
Broodstock				
Feed (kg)	$ 40,590	$ 40,590	$ 40,590	$ 121,770
Seasonal Broodstock Capture Trips	$ 30,000	$ 30,000	$ 30,000	$ 90,000
Chemicals	$ 6,000	$ 6,000	$ 6,000	$ 18,000
Misc. Supplies	$ 10,000	$ 10,000	$ 10,000	$ 30,000
Larval Rearing and Live Feeds				
Technical supplies	$ 110,000	$ 110,000	$ 110,000	$ 330,000
Nursery				
Feed (kg of pelletized feed)	$ 108,000	$ 108,000	$ 108,000	$ 324,000
Chemicals	$ 3,000	$ 3,000	$ 3,000	$ 9,000
Misc. Supplies	$ 5,000	$ 5,000	$ 5,000	$ 15,000
Annual Broodstock, Hatchery, & Nursery Facility Supplies	**$ 312,590**	**$ 312,590**	**$ 312,590**	
3-Year Total Broodstock, Hatchery, & Nursery Facility Supplies			**$**	**937,770**
Facility Personnel (Salary + Fringe)				
Position				
Hatchery Manager (1)	$ 88,000	$ 89,760	$ 91,555	$ 269,315
Broodstock Supervisor (1)	$ 68,000	$ 69,360	$ 70,747	$ 208,107
Nursery Supervisor (1)	$ 68,000	$ 69,360	$ 70,747	$ 208,107
Live Feeds Supervisor (1)	$ 68,000	$ 69,360	$ 70,747	$ 208,107
Hatchery Technicians (2)	$ 80,000	$ 81,600	$ 83,232	$ 244,832
Nursery Technicians (3)	$ 75,000	$ 76,500	$ 78,030	$ 229,530
Interns (Including travel) (6)	$ 128,000	$ 128,000	$ 128,000	$ 384,000
Facility Support (Electrician / Plumber / HVAC) (1)	$ 55,000	$ 56,100	$ 57,222	$ 168,322
Annual Broodstock, Hatchery, & Nursery Facility Personnel	**$ 630,000**	**$ 640,040**	**$ 650,281**	
3-Year Total Broodstock, Hatchery, & Nursery Facility Personnel			**$**	**1,920,321**
Broodstock, Hatchery, & Nursery Facility Operating Costs Total			**$**	**2,858,091**

GCMLC Tuna Research and Development Facility

OPERATING COSTS

Facility Supplies	**Year 1**	**Year 2**	**Year 3**	**Cumulative Total (3 years)**
Feed (kg) (assume 10,500 kg of feed per month for fully stocked facility)	$ 464,940	$ 464,940	$ 464,940	$ 1,394,820
Seasonal Broodstock Capture Trips (assume 6 trips per year for replacement)	$ 60,000	$ 60,000	$ 60,000	$ 180,000
Treatment Chemicals / Drugs	$ 5,000	$ 5,000	$ 5,000	$ 15,000
Misc. Supplies	$ 5,000	$ 5,000	$ 5,000	$ 15,000
Annual Tuna Research and Development Facility Supplies	**$ 534,940**	**$ 534,940**	**$ 534,940**	
3-Year Total Tuna Research and Development Facility Supplies				**$ 1,604,820**
Facility Personnel (Salary + Fringe)				
Position				
Director of Tuna Research and Development (1)	$ 100,000	$ 102,000	$ 104,040	$ 306,040
Research Associates (2)	$ 136,000	$ 138,720	$ 141,494	$ 416,214
Tuna Facility Technicians (2)	$ 110,000	$ 112,200	$ 114,444	$ 336,644
Annual Tuna Research and Development Facility Personnel	**$ 346,000**	**$ 352,920**	**$ 359,978**	
3-Year Tuna Research and Development Facility Personnel				**$ 1,058,898**
Tuna Research and Development Facility Operating Costs Total				**$ 2,663,718**

GCMLC Coastal Plant Production and Habitat Restoration Facility

OPERATING COSTS

Facility Supplies	**Year 1**	**Year 2**	**Year 3**	**Cumulative Total (5 years)**
Public Informational Materials (Brochures, Portfolios, Videos, etc.)	$ 25,000	$ 25,000	$ 25,000	$ 75,000
Misc. Office Supplies	$ 12,000	$ 12,000	$ 12,000	$ 36,000
Plant Propagation Supplies	$ 15,000	$ 15,000	$ 15,000	$ 45,000
Monitoring Equipment Supplies	$ 10,000	$ 10,000	$ 10,000	$ 30,000
Analytical Supplies	$ 5,000	$ 5,000	$ 5,000	$ 15,000
Annual Habitat Restoration and Coastal Plant Production Facility Supplies	**$ 67,000**	**$ 67,000**	**$ 67,000**	
3-Year Total Habitat Restoration and Coastal Plant Production Facility Supplies				**$ 201,000**
Facility Personnel (Salary + Fringe)				
Position				
Coastal Plants Production Supervisor	$ 68,000	$ 69,360	$ 70,747	$ 208,107
Coastal Plants Production Technicians (1)	$ 35,000	$ 35,700	$ 36,414	$ 107,114
Annual Habitat Restoration and Coastal Plant Production Facility Personnel	**$ 103,000**	**$ 105,060**	**$ 107,161**	**$ 315,221**
Habitat Restoration Program and Coastal Plant Production Facility Operating Costs Total				**$ 516,221**

APPENDIX E:

REFERENCES

OVERVIEW

The reference list below has been provided as an example of the expertise behind the different major components of the Gulf Coast Marine Life Center. It includes selected publications written by three of the primary scientific collaborators on the GCMLC advisory board. This list is not comprehensive; further references can be made available upon request.

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University of Miami, Rosenstiel School of Marine and Atmospheric Science

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