Coral Reef Conservation Foundation Inc.

One Project, One Reef, One Tomorrow, Making the Difference Today ©

Rocky Mount Coral Propagation in the Light ©

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Grant Proposal

Table of Contents

Project Type

The scope of this project involves the establishment of a land based coral nursery and propagation facility. The primary purpose of this facility will be to facilitate the study and growth of live corals and to provide propagated corals to be reestablished along coastal reef systems. It will also further the advancement of educating the public on the latest conservation efforts and provide an open environment for further learning of our leaders of tomorrow.

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Project Name

Rocky Mount Coral Propagation in the Light

Executive Summary

Various reef systems, both naturally occurring and artificial, along the North Carolina Atlantic Coast and around the world have been in declining health since the past couple of decades due to coral bleaching, disease outbreaks, hurricanes, cold snaps and acute damage such as ship groundings. Reefs are vital habitat for rare species as well as commercially and recreationally important fish and invertebrates. They buffer the North Carolina coastal regions from the impacts of storms and attract divers and snorkelers from around the world. Prior to coral reef decline, many reefs were dominated by two hard corals: staghorn coral (Acropora cervicornis) and several massive boulder corals of the genus Montastrea.

This project focuses on studying and determining whether propagated corals can be introduced and thrive along the 42 artificial reef systems along the North Carolina coast and the restoration efforts for these important corals. Initially, staghorn coral will be grown in both undersea nurseries located along various reef systems and inside a Coral Reef Conservation Foundation Inc © (herein referred as CRCF INC ©) land-based facilities such as the propagation of boulder corals. These corals will then be planted on various reefs where they will create habitat for marine life, improve the aesthetics of degraded reefs and most importantly, kick start coral reproduction and reef recovery for the future.

At least 50,000 staghorn corals of varying sizes will be planted on reefs throughout the various 42 reef systems. A subset of these will be part of value-added scientific research performed inside this facility to help increase the pace and efficiency of future propagation and restoration activities. An additional 30,000 small boulder corals will repair 3,000 dead coral heads using an innovative 'reskinning' technology. Staghorn and boulder coral propagation and restoration efforts will be designed to encourage the restored corals to reproduce on their own and reseed other reefs.

Vision

CRCF INC © will strive to attain the following:

- Become a strong national organization with local partners
- Become a leading force for planning and implementation of environmental matters, marine reserves and marine related activities/programs.
- Be the voice of conservation beginning in North Carolina and thereby spreading to a national level.
- Sensitize the people of North Carolina and neighboring states to gain support for conservation issues.
- Educate the youth of North Carolina and the public about the importance of conserving and protecting the reef.
- Support the work of government institutions, agencies and other conservation groups working for conservation and the protection of the environment.

- Foster open dialogue with concerned persons, community officials and government representatives to bring about changes through behavioral adaptations, policy and legislation.
- Create a financially viable organization through the establishment of income-generating programs.
- Be a focal point for research and for facilitating all relevant scientific activities in North Carolina and the eastern coast.

Philosophy and Values

The decisions and actions of CRCF INC © are based on the belief that the coastal reefs are a source of food, beauty, security and marine resources on which the people and the State of North Carolina have come to depend on significantly for its economic and physical survival.

In carrying out its programs CRCF INC © will:

- Respect and enhance human, cultural, environmental and physical assets of the state and region.
- Promote the meaningful participation of all North Carolinians in the development process.
- Operate in a manner which reflects the highest ethical standards of both human activity and environmental ethics.

Aims of CRCF INC ©

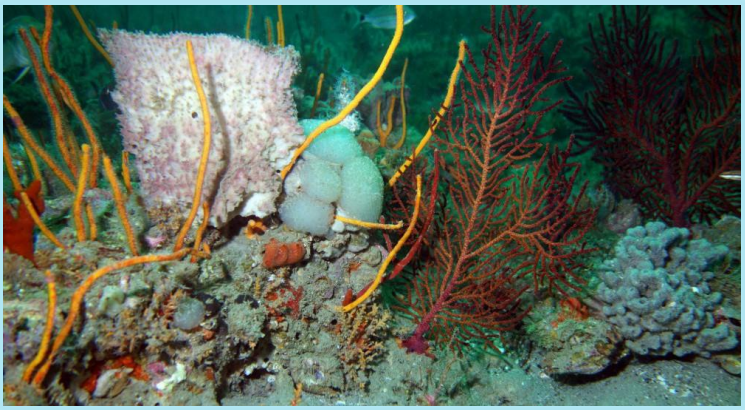
CRCF INC © during the next five years will strive to achieve the following ends:

- Promote sustainable development through community participation.
- Sensitize the people with conservation issues through public awareness and environmental education programs on marine and coastal conservation.
- Foster the sustainable development of the North Carolina and eastern coast reefs through its representation in community and government organizations/agencies and institutions.
- Protect and conserve the North Carolina and eastern coast reef and resources through the establishment of projects, research programs and the involvement in regional organizations and programs/activities.
- Advocate for conservation/environmentally friendly practices.

Range of Benefit

Rocky Mount Coral Propagation in the Light project will provide benefits to the local communities, the Atlantic Coast region, and the State of North Carolina. This project, will have a broader benefit, if proven successful, to the 42 artificial reefs of North Carolina, and along other states coastlines in subsequent years in addition to providing a much needed direct educational look into the causes of coral and reef decline, the changes in various marine ecosystems, and future ways to help the public become involved in conservation efforts. Restored corals will spawn on the various reefs and most of their larvae will be distributed by currents produced by the Gulf Stream.

Statement of Need



Problem - CRCF INC © was founded in response to a major problem and growing global concern - the degradation of coral reef ecosystems around the world. CRCF INC © is open to working with federal and local governments, other non-profits as well as for-profit organizations, and individuals to raise funds necessary to facilitate a multitude of projects all with one goal and that is to go beyond only studying and offering solutions to the declining coral reefs, but to also make an impact in the reef's survival and comeback. It is the goal of CRCF INC © to create a sustainable social, environmental, and economic benefit for every community in which it operates.

Coral habitats have been in decline since the 1970s, due to multiple stressors including coral bleaching, disease outbreaks, hurricanes, and cold snaps. Many reef areas have in the past displayed a zonation pattern dominated by three hard coral species: Elkhorn (Acropora palmata), staghorn (Acropora cervicornis), and massive star corals of the genus Montastrea (Jackson, 1992). These corals provided the framework that is important to other reef-dependent species, including many fish species. Populations of elkhorn and staghorn coral underwent a region-wide decline starting in the 1980s, with losses of up to 97% in some areas, due mainly to increased prevalence of bleaching and disease. These two species were listed as threatened under the Endangered Species Act in 2006. As a result, the boulder star coral (Montastrea annularis), mountainous star coral (Montastrea faveolata), and star coral (Montastrea franksi) are

currently being considered for listing as endangered, and the two Acroporid species have been proposed for up-listing to endangered. The loss of reproductively active coral colonies, increased distance between these colonies and low rates of juvenile coral colonies surviving to sexual maturity have combined to create a situation in which it is unlikely that corals will repopulate the reefs naturally. This contributes to decreased resilience of our reef system and depresses natural restorative processes. Habitat protection and threat abatement may not be enough to stop the decline of reefs and active restoration of coral populations is quickly becoming a feasible and cost-effective way to reestablish live corals to reefs.

Restoration of injured or degraded coral reefs was identified as an important strategy in the National Coral Reef Action Strategy, written as a report to Congress about the implementation of the Coral Reef Conservation Act. Objectives under this strategy include developing and testing innovative methods to expedite reef restoration, promoting cost-effective restoration projects, and transferring proven restoration tools, techniques, and lessons learned to domestic and international partners. This project is a strong contributor to the overall habitat restoration component of the National Coral Reef Action Strategy.

Economic Sustainability - CRCF INC © is committed to offering its services globally. Given the global declining of the coral reef health, the need and desire to recreate these habitats will not go away. This will ensure a steady market for many generations to come. Additionally, since CRCF INC © is committed to being involved in every aspect of each projects life cycle, they will work with local community members providing jobs for marketing, sales, construction, delivery, installation in some areas, and maintenance tasks.

Social Sustainability - Communities and the world for that matter, depend on the food that comes from coral reefs. Many people will lose jobs and see their food resources constrained due to the decline in coral populations. Providing a solution to the problem is going to benefit everyone economically and socially. By repopulating and rejuvenating the coral reefs, this will ensure food supply, economic stability for communities which depend on the reefs for food, and protection against future storm surges for communities located closest to shore.

Environmental Sustainability - CRCF INC © will be ensuring that our planet's natural habitats for many ocean species as well as protecting the shore front from storm wreckage, through study, education, and action will thrive for future generations to come.

Problem/Opportunity:
Coral Reef Decline: coral reef decline is rapid and concerning. Estimates vary on the exact number (as do definitions of what to consider threatened), but the scientific and environmental management community agrees that most reefs can be classified as

"threatened". As of this writing, 25% of coral reefs are damaged beyond repair and 2/3 are under serious threat. The most recent global report suggests 75% of global reefs are threatened either locally or globally.

Threats to reef health include (but not limited to) –

1) Climate Change - coral require specific conditions to survive and grow at optimal levels. Water temperature should remain near 21°; changes of a few degrees can have catastrophic affects. Indeed, what research shows is that as water temperatures increase (due in large part to increases in anthropogenic carbon emissions) coral is forced to "spit-out" much needed algae, resulting in a lack of nutrient production, energy availability, and a lowered fitness. Climate change has led to many documented coral bleaching events, which can lead to the death of entire reef systems.

2) Harmful Practices - coral reefs are routinely exploited through illegal activity. Practices, such as cyanide fishing for aquarium fish, are poisoning coral by dynamite fishing. This literally blows the reef apart. Un-educated tourists, unknowingly, stand on or kick fragile coral as they swim (breaking off large chunks of reef).

Loss of Coral Reefs: declining coral reefs have many negative consequences both socially and environmentally.

Environmental Issues Include (but not limited to) - loss of entire ecosystems and loss of global biodiversity. Although reefs cover less than 1% of the ocean floor, they are home to 25% of all marine organisms. Therefore, coral reef degradation will result in extreme habitat destruction.

Social Issues Include (but not limited to) - loss of "storm buffers". Coastal reefs can absorb up to 90% of wave energy. An increase in coastal erosion and destruction to other coastal ecosystems, such as grass beds and mangroves, are massive risks. Coral reefs attract visitors to developing nations who want to snorkel, fish, and scuba dive. Some estimates say the total value of coral related tourism and recreation is over $9 billion dollars. Fishing that takes place on coral reefs will come to a halt if the reefs no longer exist. Overfishing can result in a loss of over US$1 billion and decreased food supplies for coastal people. This would be catastrophic since over 30 million people depend on coral for income and food.

3) Ocean Acidification - related to climate change, acidification also results due to an increase in atmospheric carbon dioxide, concentrations which continue to increase. The carbon dioxide is naturally exchanged with the ocean, leading to a) lower pH levels and increased acidification and b) a shallower calcium carbonate composition depth. Both affects lead to the inability of coral to grow and produce durable skeletons, ultimately resulting in decreased fitness, less dense Reefs, a lower competitive advantage, and a decline in available habitat for many reef associated species.

Project Description

The proposed project focuses on active restoration and introduction of coral populations along the North Carolina coastal artificial reef systems using two field-tested methods. The first is the creation of boulder coral colonies in land-based nursery facilities to be used to restore dead coral heads. The second is the propagation of staghorn corals in offshore nurseries to be out-planted into breeding populations on degraded reefs. Both methods increase live coral cover and three-dimensional structure at the restoration site and support recovery of reefs region-wide by encouraging successful reproduction. At least 50,000 staghorn corals of varying sizes will be planted on various reefs over the course of three years. A subset of these will be part of value-added scientific research to help improve future restoration and introduction activities in North Carolina as well as along the eastern Atlantic coast. An additional 30,000 boulder coral fragments will repair 3,000 dead coral heads using an innovative 'reskinning' technology. These efforts will be designed to encourage the restored corals

to reproduce on their own and reseed other reefs. CRCF INC © will administer the grant with a bulk of the funding going towards on the-ground restoration by CRCF INC © in partnership with Reef at Home and potentially other organizations as the project builds momentum. Additional assistance and guidance may be requested from the North Carolina Wildlife Conservation Commission if necessary.

Expected Benefits

Healthy coral reefs provide benefits to marine life and people alike. Reefs provide essential habitat to commercially and recreationally important fish species as well as thousands of species of invertebrates. They also are frequented by larger marine predators such as sharks, sea turtles and dolphins. Because of their high diversity and abundance of marine life, as well as their beauty, reefs attract people for fishing, snorkeling and diving. More than 43,000 jobs along the coastal North Carolina communities are supported by ocean recreation and tourism, accounting for more than half of the local economy. Intact reefs also provide a barrier for ocean waves, causing them to break offshore rather than on our shoreline. Without active restoration efforts these reefs are likely to continue to lose live coral cover, and reefs without live coral eventually erode. The benefits that our reefs are currently providing will be degraded if actions are not taken now to reverse this downward trend.

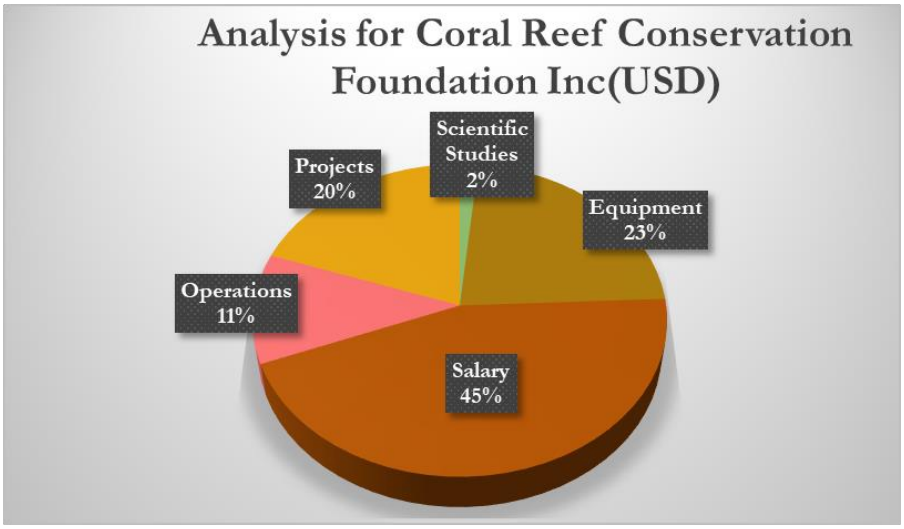
Plan of Evaluation

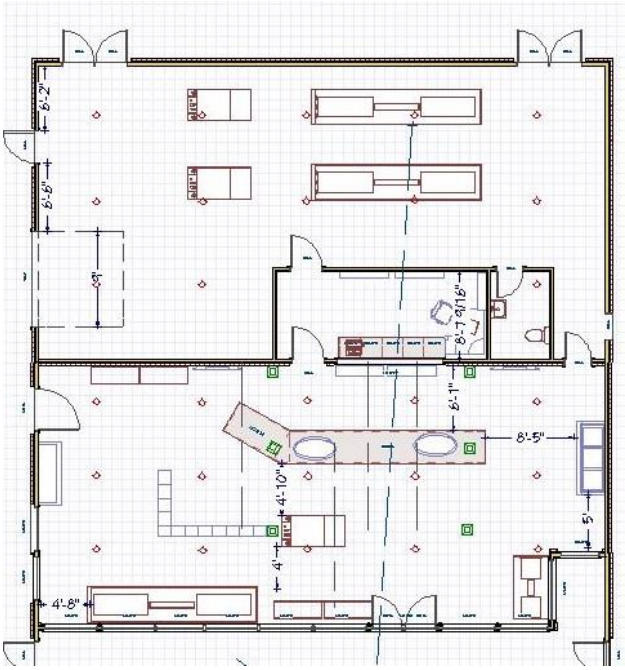
CRCF INC © land based nursery will be utilized in uncovering the specific cause of a reef's degradation and decline, collection and categorizing varying samples of which to be studied and harvested to recreate the exact or close to reef ecosystem inside of a controlled setting. Determining the best collective way to reverse the conditions which lead to the initial degradation and decline of the specific reef system and developing a safe and responsible way in which to repopulate the controlled samples by means of Coral Aquaculture, followed by the reintroduction of the repopulated samples back to the reef systems in which it originated. Once completed, the data and results are to be shared to educate local communities and governments on the maintenance, protection, and importance of sustaining a healthy reef system.

Budget

Success in achieving the goals of this business plan depends upon the Foundation raising the necessary capital resources in order sustain the efforts to restore and maintain our delicate reef systems. CRCF INC © plans to invest in the community the necessary land-based controlled nursery and center of operations along with the life-support systems to sustain the propagated corals and livestock, an avenue to educating the public on the fragile nature of our reef systems and what each of us can do to help protect them, and for the start and continuation of CRCF INC ©'s conservation, collection, and ultimate propagation of our reef's corals.

CRCF INC LAND BASED PROJECT BUDGET 2018			
Insert Grantmaker Name Here	Insert Agency Name Here		
Expenses	Total Project Expenses	Amount Requested from Funder	Explanation of Expenses
Salary and Benefits	$ 146,880	$ -	Excludes proportionate share off-site work
Contract Services (consulting, professional, fundraising)			Included in Cape Lookout Project Budget
Overhead	$ 35,631	$ -	Includes proportionate share of overhead
Training & Professional Development	$ -	$ -	Constrained for 1st year - unbudgeted
Insurance			Included in overhead
Travel & Accomodations			Included in Cape Lookout Project Budget
Land Based Equipment	$ 72,366	$ -	Includes all land based equipment for studies & also includes projected equipment needed for years 2 & 3
Supplies			Included in overhead
Printing, Copying & Postage			Included in overhead
Evaluation	$ -	$ -	
Marketing	$ -	$ -	Marketing Plan for 1st year constrained to social media & internal programs
Meals	$ -	$ -	
Administration			Included in Salary & Benefits
Off-site Equipment			Included in Cape Lookout Project Budget
Livestock Specimens	$ 5,000	$ -	Necessary "live" specimens for study
TOTAL EXPENSES	$ 259,876	$ -	



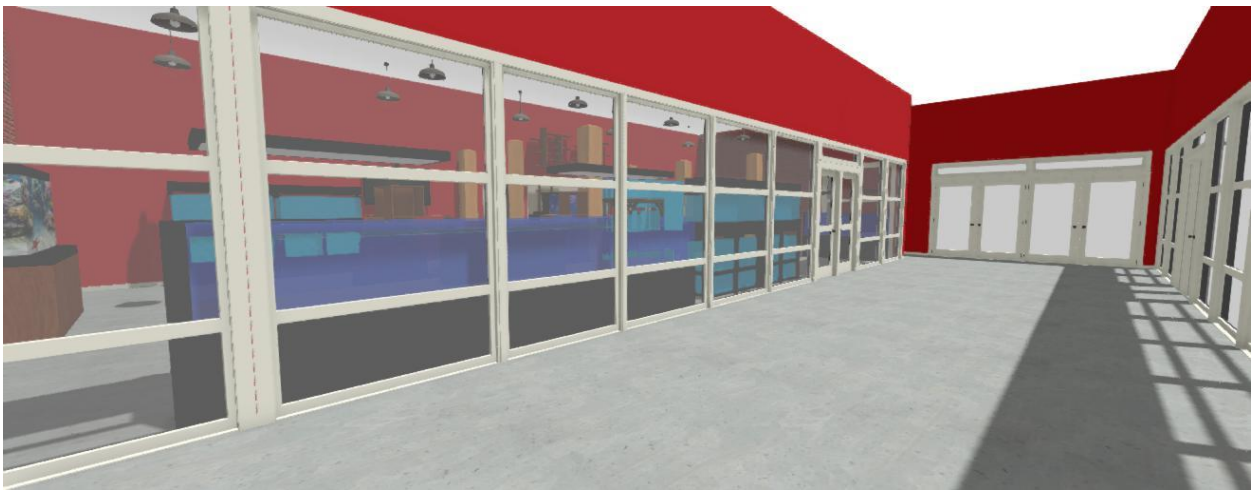


This cost includes indirect costs such as building and overhead, personnel, essential life support systems and tanks needed to grow corals in the nurseries in order to later outplant them to reefs and then monitor and perform maintenance on the out-planted corals at least twice to improve their survival and growth rates. With improving economies of scale costs per coral may decrease and if this occurs during the timeframe of the project the number of coral out-planted would increase accordingly. The budget is based on the projected cost of the project at the scale proposed.

In addition to the reef restoration and conservation efforts, the land-based nursery will also provide the public with a transparent look and education into the benefits of natures reef systems, corals, and the multitude of marine species which inhabit them as well as provide an avenue for those willing to join in on various restoration and conservation activities. It is the intention to also host various aquarium hobbyist gatherings and special event functions as well as provide a localized retail option for those wishing to take a small part of a living marine ecosystem home through the sale of aqua-cultured corals. By offering aqua-cultured corals for sale, this will further our conservation efforts as it would deter aquarium hobbyist from purchasing corals taken directly from our oceans as well as providing a source of income for future conservation and restoration efforts.

Equipment

In order for CRCF INC ©'s land-based nursery to be successful, it is necessary to provide adequate life support systems to monitor and grow successful corals to be out planted.

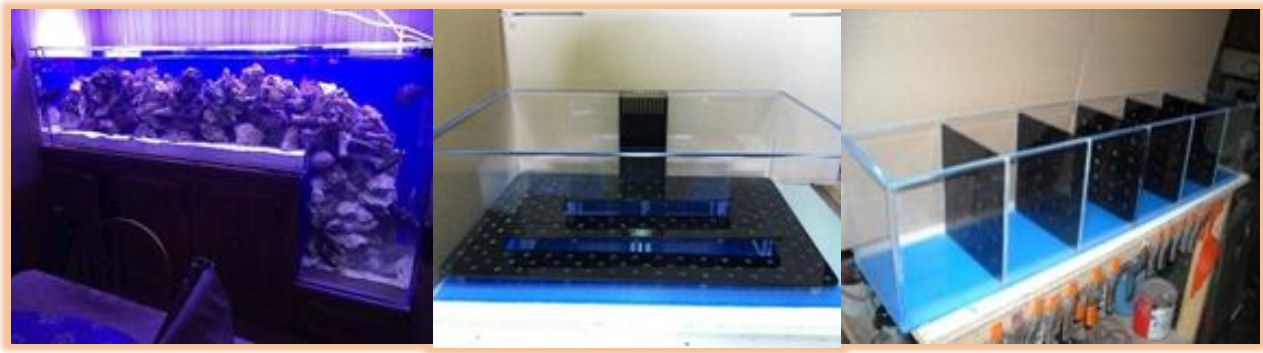


As a way of showcasing and drawing interest, it is the opinion of CRCF INC © that the frontal location should be both welcoming and transparent. Many in the public are fascinated to the underwater world with both its natural beauty and peacefulness. The various colors of marine life, such as corals and various fish species, typically draws and attracts eager eyes both young and old.

Capitalizing on this attraction, various tanks to be used to represent different marine ecosystems found around the world housing a multitude of species will make up much of the showroom floor. Here, some species of both corals and fish along with life supporting systems and equipment, various supplements and aquatic food will be offered for sale to help with both current and future project funding costs. This will also be our front lines of engagement with the community in providing educational materials and information on marine and reef restoration and conservation.

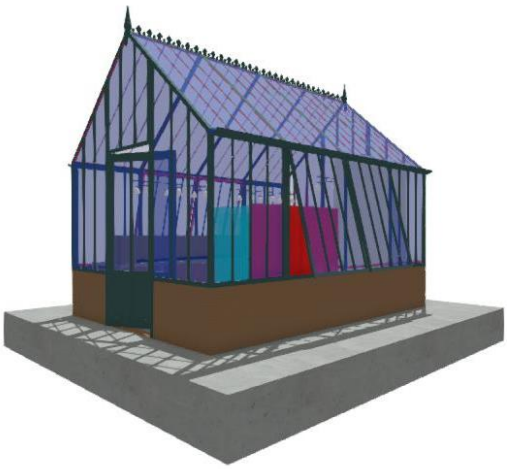
As seen in this 360-degree panoramic, the open space floor design and contributing tanks, along with open placements of various life support systems will be on view to assist with providing a transparent look into how marine life can survive and thrive along with providing education in the reproduction nature of various species. Flat screen televisions will also provide live information and news from around the world all matters relating to conservation and restoration of reef systems and marine life.

The showcase floor will include eight 67-gallon standalone tanks which will be utilized for live marine fish breeding totaling 268 gallons maintained by its own self-supporting life support system to include sump, filtration pumps, protein skimmers, monitoring system, and led lighting. For showcasing coral growth and propagation techniques, two 45-gallon tanks totaling 90 gallons will house various species of aqua-cultured coral fragments along with its own life supporting system consisting of a sump, filtration pumps and powerheads, protein skimmer, monitoring system, and full spectrum led lighting. In order to demonstrate various depths of coral growth along with providing a marine fish habitat, a 300-gallon drop-off tank with open life support system of a sump, protein skimmer, monitoring system, and full spectrum led lighting can provide valuable educational information on deep sea ecosystems.

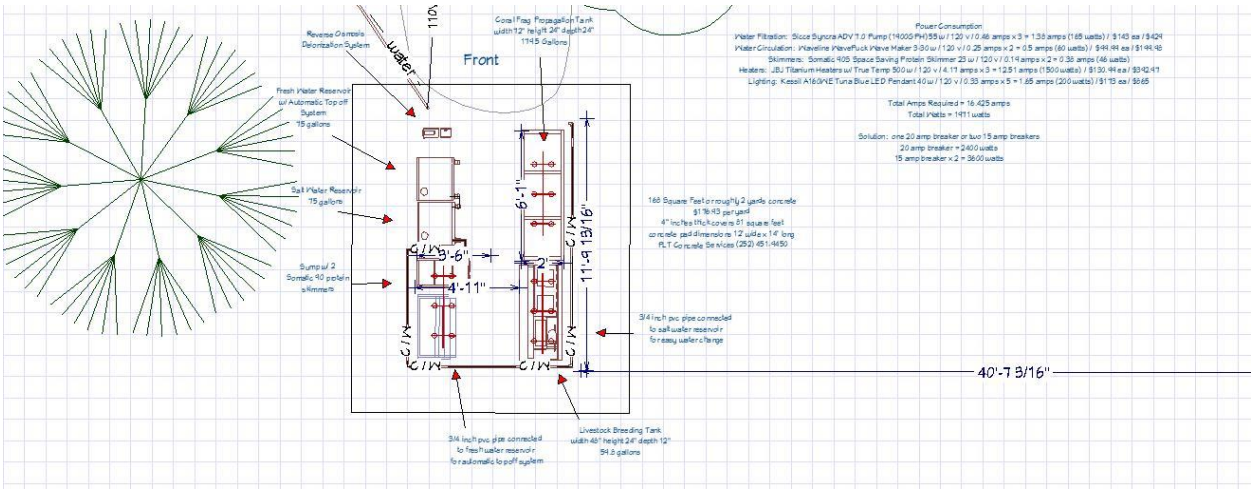


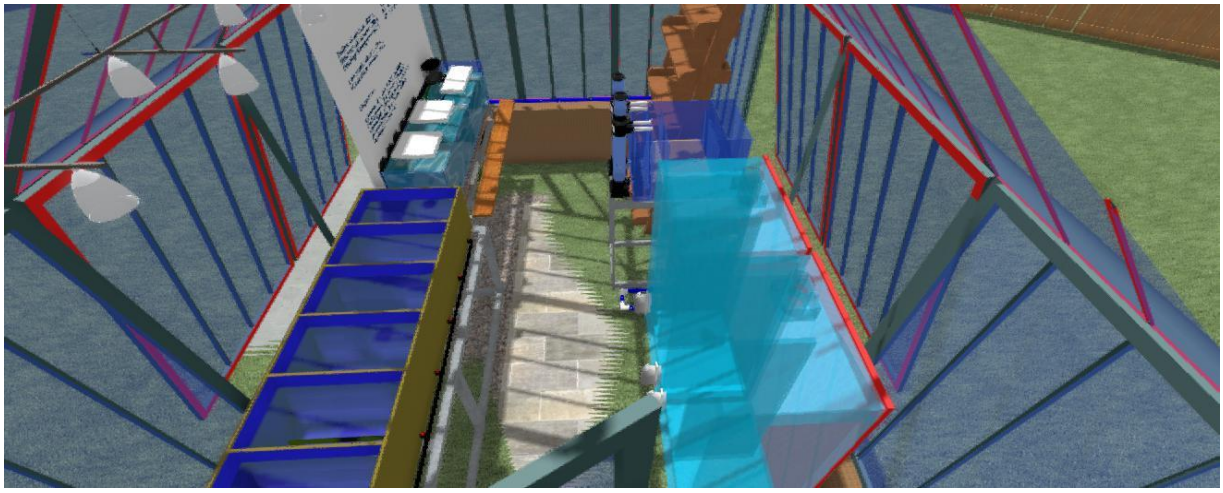
Pictures above are only a representative of possible tank configurations.

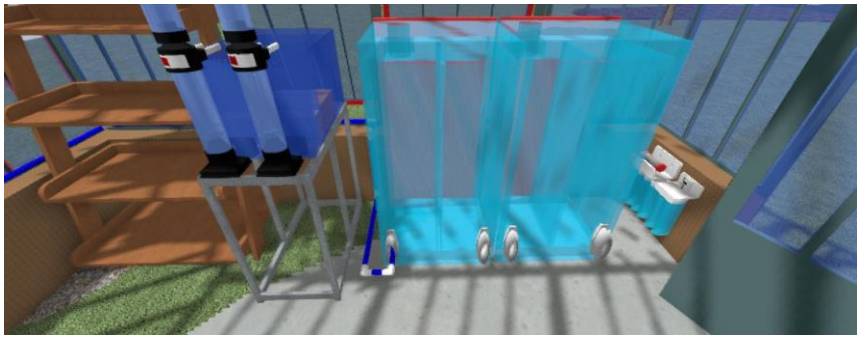
Located in the rear of the proposed facility will allow for housing of four 45-gallon coral propagation tanks along with two 300-gallon drop off tanks complete with their individual life-supporting systems to be used in connection with actual corals for re-skinning restoration projects. The total cost for the above listed equipment and systems are estimated to be between $72,365 and $100,000, not including marine species, live rock, and substrate.



In addition, a second facility currently in the process of construction at a separate location includes a 300 square foot greenhouse which will house two 20-gallon coral re-skinning tanks, a 60-gallon re-skinning tank, multiple marine fish breeding tanks, self-supporting life-support systems to include sumps, protein skimmers, full spectrum led lighting, monitoring systems, and RO/DI system with both fresh and saltwater reservoirs. CRCF INC © has obtained 40% of the necessary funds thus far to financially achieve the finalization of this facility.







Funding will be administered by CRCF INC © which will oversee the project subawards and lead coral restoration activities. *Indirect costs are real expenses an organization incurs while conducting a grant-funded project that cannot be specifically itemized in a proposal budget. Examples of typical indirect costs include operation and maintenance of facilities and equipment as well as administrative staffing (i.e. legal counsel, accountants, etc.). Indirect costs are usually included in grant budgets as a percentage of some or all the direct costs such as project staff, travel, supplies and so forth and this percentage is the indirect cost rate (ICR). The cost of this project is based on the number of corals of each size out-planted. Large corals cost more than small ones due to longer maintenance times in the nurseries and greater out-planting effort. The project is fully scalable, so a lesser amount of funding could be accepted and the number of corals out-planted would be scaled back accordingly or a greater amount of funding would lead to more corals out-planted.

The benefits of long-term foundation funding support would be securing the future of our delicate reefs which in return will not just preserve their existence, but also benefit the many communities along the coast such as through tourism and jobs, advancements in science and medicine as many of our medicines in wide use today stems from the many organisms and life which inhabit the reefs, and the list can go on. Exhibit A below illustrates the necessary funding which would be required for CRCF INC © to be successful.

It is important to note, that at no time will any wild harvested corals will be allowed for sale as goes against CRCF INC © policy.

Technical Feasibility

Acropora Nurseries

The project's primary restoration and recovery approach is to take small fragments of live tissue from healthy coral colonies of known genetic stock, grow them out in land-based facilities over time to create multiple colonies of each genetic type, and then outplant genetically distinct individuals in proximity to one another so they spawn and help reseed surrounding reefs. Each out-planting site directly enhances live coral cover, three-dimensional structure, fisheries habitat and tourism value.

This type of project has been through an extensive “feasibility study” period beginning in 2004. In addition, the expertise and knowledge gained to date has been formalized into a “Practitioner's Guide to Acropora Restoration” (Johnson et al., 2011) that provides science-based guidelines for the activities to be undertaken as part of this expansion.

Over the past 10 years in the Upper Keys of Florida, and the past 4 years regionally (Florida and St. Croix and St. Thomas in the U.S. Virgin Islands), the program has scaled up from one nursery with a few hundred corals to 16 nurseries with over 40,000 corals. A significant investment was made in 2009 by the National Oceanic and Atmospheric Administration (NOAA) through the American Recovery and Reinvestment Act (ARRA) to scale the nurseries to production-level and get them ready for large-scale out-planting efforts. Funding would allow this program to be duplicated north along the Atlantic coast and will prove to be highly significant for the ecosystem and economy of the coastal North Carolina communities and then spreading vertically along the other Atlantic coastal states.

Proven Success. This project was born from a high school 4-H project in Key Largo, Florida. In 2000, twenty staghorn coral (Acropora cervicornis) larvae representing 3 genotypes settled and grew on an underwater live rock farm leased and operated by Ken Nedimyer. He and his daughter began to propagate the coral in a prototype coral nursery and later used for restoration purposes.

The first nursery was established in 2004 using corals that had settled on Ken Nedimyer's live rock farm in the Upper Keys of Florida and had been propagated on a small scale. Coral fragments from those original corals and others that were collected from Upper Keys reefs were established in a seafloor nursery, grown out for a year, and fragmented to create material for out-planting. The first out-planting included four sites ranging from inshore to offshore in the Upper Keys of Florida and it met with good success.

In August 2006, the same technique was replicated in the Lower Keys of Florida, and other parts of the Florida Gulf Coast. The same methods were used to collect material from wild colonies, grow them out in nurseries for a year, and then strategically outplant corals to reefs in each region.

In 2009 the nurseries expanded their inventory of genotypes and spent the first two years of the project growing out and propagating the corals to increase stock within the

nurseries. The nursery was installed and stocked in 2010 and the first out-planting event occurred in April 2012 and the outplants have shown close to 95% survivorship.

In 2012, just under 6,000 colonies were out-planted to 46 individual restoration sites. Immediately following out-planting, the nurseries housed over 30,000 corals, many of which are large enough to be split into multiple outplant-sized colonies.

Monitoring at the outplant sites at one and three months following out-planting showed high success rates. The out-planted corals began to grow over the nails and/or epoxy that initially secured them to the seafloor and attached themselves to the reef within a few months. Today they are growing and branching quickly. Over 70% survivorship has been achieved at all sites, with many sites showing much higher survival rates. This success is even though two storm systems - Tropical Storm Isaac and Hurricane Sandy - caused damage at specific sites, and short-lived coral disease outbreaks followed both systems.

Methods and Strategies

The How…Innovative Growth and Out-planting

Corals can grow and reproduce both sexually, through spawning, and asexually, through fragmentation: if a branch falls off on the reef and conditions are favorable, it can reattach and begin to grow a new colony.

By collecting small branches or fragments from a colony and raising them in controlled nurseries, we can take advantage of this naturally occurring process also known as propagation.

Tens of thousands of corals are produced through various pioneering propagation techniques.

Coral Tree Nursery® (Coral Restoration Foundation)

In 2010, Coral Restoration Foundation, located in Florida, developed the Coral Tree Nursery®. By utilizing a simple framework of PVC pipe is built which resembles the shape of a tree. The nursery tree is tethered to the ocean floor and buoyed with a subsurface float. Coral fragments are hung from the branches of the tree using monofilament line.

The tree floats in the water column and can move with storm-generated wave surges. This dissipates wave energy preventing damage to the tree structure or the corals themselves.

Visit a Coral Tree Nursery®

Through Catlin Seaview Survey, and Google Maps' Underwater Street-view, viewers can take a virtual tour around other successful coral propagation techniques in which CRCF INC © intends to build from.

Viewers are guided via a 360° image and can see coral fragments growing on the Coral Trees, as well as larger fragments attached to smaller, "hangman" structures, ready to collect gametes during the annual coral spawning.

Coral Out-planting and Maintenance

Corals are grown in nurseries for approximately six to nine months. After they have reached a substantial size, they are tagged and taken to a reef restoration site where they are attached directly to the reef using a non-toxic marine epoxy. Maintenance and monitoring of reef restoration sites continues years after the original coral out-planting.

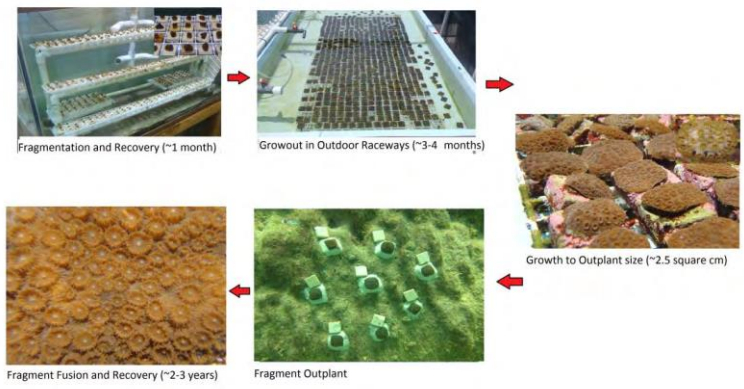
Coral colonies are routinely checked for disease, predation, tissue paling, and other deteriorating factors. Broken fragments can be reattached to the substrate, where they will grow into new coral colonies. Without reattachment, the broken fragments would most likely be unable to attach to the reef substrate on their own and would not survive.

Promoting Genetic Diversity

Each coral as it comes into the nursery is tagged and tracked, and it re-tagged before leaving. At the reef, a tag is placed next to the coral with information that identifies the genetic information and specific site data needed to track its progress.

Corals of varying genotypes are strategically placed onto the reef to promote genetic diversity and increase reproductive success during annual spawning events.

Land-Based Micro-fragmentation



The project's restoration and recovery approach is to create boulder coral micro-fragments from existing material in land-based nurseries and use them to perform coral "reskinning". These corals would be 1cm by 1cm fragments with the bases cut so that the coral tissue lies flush against a 2.5 cm^2 ceramic tile to maximize growth efficiency. Corals will then be maintained in a land-based facility for 6-8 months until they are ready for out-planting, which occurs when corals have completely grown over their ceramic mounts. Out-planting involves placing multiple micro-fragments onto a large dead coral head and allowing each fragment to grow independently. Within a relatively short-period of time the fragments grow together and fuse over the entire coral head. This process occurs much faster than the traditional approach of planting fewer large boulder coral fragments onto the reef. Given growth rates exhibited by fragments in culture, each group of 10 out-planted fragments should completely merge in as little as 2-3 years. When this occurs each group of fragments will cover roughly 650 cm, whereas a wild colony originating from a coral larva would take decades to achieve that size.

Proven Success. Mote Marine Laboratory in Sarasota, Florida, has worked with the species in question producing large fragments for close to 5 years prior to the development of the micro fragmenting technique. Fragment production has increased exponentially through the production of micro fragments. In 2011, the number of large fragments present at the facility was matched by the number of micro fragments in less than 6 months. In 2012, an additional 1,000 micro fragments were created for 1 month, and the lab is on track to produce upwards of 10,000 fragments in 2013. Mote is now able to provide renewable source material for large-scale restoration projects incorporating these increasingly rare stony coral species, something which has not been achieved prior to these efforts.

In 2010 and 2011, Mote scientists performed out planting using large land-cultured coral fragments to assess the feasibility of using these corals for restoration purposes. Four boulder coral species were planted including Montastrea faveolata, Montastrea cavernosa, Stephanocoenia intersepta, and Siderastrea siderea. In total, 312 fragments were mounted on cinder blocks directly adjacent to inshore and offshore reef environments near Big Pine Key, Florida. Three years after out planting, nearly 90% of colonies are healthy and growing with survivorship highest in the M. faveolata, M. cavernosa, and S. siderea. Colonies have displayed substantial growth and resilience to changing conditions during this time, which suggests that land-cultured corals can be used effectively for restoration.

In a proof of concept outplant performed in May 2013, a total of 192 fragments were out planted at an inshore and an offshore reef near Big Pine Key, Florida. At each site 48 Montastrea cavernosa and 48 Montastrea faveolata were divided into 12 small arrays of 8 fragments each. Arrays were planted haphazardly along the surface of a dead coral skeleton and spaced evenly over an area 30cm in diameter. This initial area was selected to be well above reproductive size, which occurs in colonies greater than 100cm² (Szmant, 1991). Fragments were secured to dead skeletons of the same species using underwater epoxy (all fix, Cir Cut Corporation). The sides of each tile were shored up with epoxy so that a gentle gradient was present between the fragment and the substrate (Figure 11), to allow ease of initial growth onto surrogate skeletons. Acclimation to each site was a success, with all fragments displaying vibrant colors and healthy polyp extension shortly after being planted. One month later, many corals had already begun sheeting out over available substrate adjacent to each fragment. Fragments were also shifting their pigmentation to resemble the variation associated with naturally occurring colonies at each site. These preliminary results suggest that planted fragments are adapting well to their new environment and are well on their way to restoring the heads they were planted on.

Figure 5. Depicted is the process of securing a coral array to a dead skeleton. Each site was cleaned and marked according to a 30cm template; fragments were then secured using epoxy and photographed to track growth and survival.

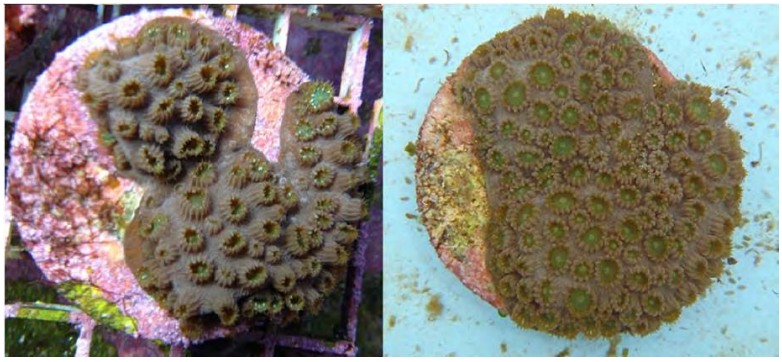


Figure 3. When two micro fragments from the same brood stock colony come into contact, they merge together to more quickly resheet the colony.

Environmental Benefits

Live coral provides the three-dimensional structure associated with reefs; without live tissue producing new limestone, the reef framework erodes away over time. The diversity and structural complexity of shallow water reefs have been greatly reduced and fleshy macroalgae now occupies much of the space formerly occupied by live coral. Increased cover of algae and sediment inhibits successful coral larvae settlement. Combined, the ability of North Carolina's reefs to cope with and recover from ongoing disturbances (e.g. diseases, bleaching events, ship groundings, hurricanes, water pollution events) is significantly reduced. By out planting live corals to the reefs, we can increase coral cover and diversity, and restore structure that is important for other species that make their home on the reef.

Living reefs provide essential habitat for fishes including many commercially and recreationally important species (Bruckner, 2002; Shinn, 1966). Juvenile reef fish, schooling bait fish, large herbivores and predatory reef fish, and invertebrates are associated with staghorn and elkhorn thickets on reefs (Lirman, 1999). Based on a review by Bruckner (2002) in the Proceedings of the Caribbean Acropora Workshop: Potential Application of the U.S. Endangered Species Act as a Conservation Strategy (Proceedings): "The structural and ecological roles of Acroporid corals in the Caribbean are unique and cannot be filled by other coral species. Their rapid accretion rates and structural complexity are unmatched. The loss of these characteristics will likely result in a significant loss of reef function and structure. At present, there is no indication that any other Caribbean coral species can replace the significant role that Acroporid corals play within reef communities of the region."

The benefits of increased coral cover and diversity, and structural complexity will be realized as soon as corals are restored to the reef. Past out planting of both Acroporid corals and boulder coral species have had high success rates (>75%). The outplant sites will be monitored at least twice after out planting to determine coral survivorship

and condition. Some outplants will be monitored more frequently or for a longer period to answer specific research questions that may help increase success at future outplant sites.

Over time, the corals will continue to grow and contribute to the spawning population which should help reseed reefs throughout the North Carolina coast. Each outplant site has a direct restoration area of at least 100 square meters. The dispersal range of coral larvae resulting from sexual reproduction of the restored corals is conservatively 1 kilometer, creating a potential long-term restoration area of 74 hectares per site. The benefits of increased coral cover and habitat structure will continue well past the life of this project funding, both at the direct outplant sites and regionally.

Economic Benefits

Coral reefs and associated habitats provide fishery and nature tourism resources that represent a critical source of food and livelihoods for people. The North Carolina Sea Grant in collaboration with Duke Nicholas Institute reports that:

1) Dive operations, sport fishing and recreational boating generate significant revenue for local dive shops, charter boat operators and local businesses. The economic impact from tourism and recreation contributed upwards to $276.7 million dollars and providing over 38 thousand jobs in 2016.

2) In 2016, it was estimated that fishermen received $633.8 million in harvest revenue which generated $1.6 billion in sales/output in North Carolina.

3) In relation to the above, aqua culture such as with finfish and shellfish farming, generated $0.91 million with coastal and habitat protection and restoration representing $9.3 billion (biodiversity, habitat and flood relief in coastal wetlands).

4) In 2016, the total economic impact of the coastal North Carolina communities represent $2.084 billion in GDP, creating over 43 thousand job opportunities with over $800 million in wages.

Along with these tangible commodities provided by coral reefs, the intrinsic beauty of healthy reef communities is a crucial factor in the quality of life and recreational satisfaction of North Carolina coastal residents and visitors. Restoration of these critical reef-building corals will provide added recreational and commercial benefits the State of North Carolina through enhanced fishing and diving opportunities.

The aesthetic changes on the reef will be realized immediately. Divers love to visit reefs that have been restored, both because they have more live coral and because they are

an example of how people can make a positive difference in the future of reefs. Even small corals can look impressive if they are out planted densely.

Over time, these corals will continue to grow on the reef – within 3-5 years even the smallest Acropora outplants will be basketball-sized and Montastrea outplants will be well on their way to reskinning dead coral heads. These corals are even more impressive to divers and are almost indistinguishable from natural colonies. They also will be providing important nursery habitat for small fish and helping to contribute to a healthy reef fish population.

Community Economic & Environmental Resilience Benefits

Healthy coral reefs have rough surfaces and structures that help dissipate the force of waves that would otherwise break on the shoreline (http://www.noaa.gov/features/protecting_1208/coastlines.html). Up to 90% of the energy from wind-generated waves is absorbed by reefs. Every meter of reef protects an estimated $47,000 of property value in the US (The H. John Heinz III Center for Science Economics and the Environment, 2000). In North Carolina, the absence of reefs would cause parts of the shoreline to be eroded. Therefore, the health of North Carolina's reefs is directly related to the shoreline's ability to withstand the wave energy of hurricanes and other wave-generating events.

A recent study entitled "Coastal habitats shield people and property from sea-level rise and storms" assesses and ranks coastal habitat types for their ability to reduce the relative vulnerability of people and property to erosion and flooding from storms and ranks reefs at the highest level of protection with a protective distance of 2,000m.

Complements to Existing Efforts

It is widely recognized that active restoration must be paired with large-scale management efforts aimed at protecting coral reefs region-wide. The need to link active restoration with other available management tools such as Marine Protected Areas has been recently highlighted in the review conducted by Young et al. (2012) where restoration practitioners gave the highest likelihood of success to reef restoration efforts conducted in areas that were under concurrent protection from human activities.

Organization Information & Project Management

The Board of Director(s) for CRCF INC © will be responsible for conducting the corporate affairs of the organization, including, but not limited to, the opening/closing of

bank accounts; effecting title on property holdings; and executing the legal affairs of the CRCF INC ©. The board of directors will also assist with policy formation & goals and will promote the image of CRCF INC © at the local, regional, and national level. The board will meet once quarterly to discuss the annual report, and make decisions where necessary, in the best interest of CRCF INC © and of the impact and benefit it can make.

Mrs. Trisha M. David President/Chief Executive Officer/Managing Director

Boice-Willis, Credentialing / Insurance

Education - Careers Technical College, Lafayette, Louisiana. Nursing Assistant

Careers Technical College, Lafayette, Louisiana. Medical Coding and Billing

Professional - Credentialing Specialist Boice-Willis, Rocky Mount, NC

Certifications - Microsoft Word, Excel, GE Centricity, ECW, Cerner, AMA, CMS, Palmetto, NC Tracks, ICD-9, ICD-10, NPDB, Medicare, Medicaid, Credentialing

Mr. Kemp J. David Secretary/Technical Advisory Committee/Board Member

Wheeler & Woodlief Funeral Home and Cremation Services, VP

Reef at Home, Owner

Education - B.A. Business Northwestern State University of Louisiana

Professional - VP Wheeler & Woodlief Funeral Home, Rocky Mount, NC

	Captain, Signal Officer, 2nd Squadron, 183 Calvary Regiment, 116th Infantry Battalion Combat Team, Virginia Army National Guard, United States Army
Certifications -	Certified Diver, NAUI Advanced Open Water Diver, PADI Enriched Air Nitrox (EANx) Diver, NAUI Night Diver, PADI Underwater Navigator, PADI
Civic -	Board Member, Harrison Family YMCA Board Member, Rocky Mount Kiwanis Club Former Committee Member, Twin Counties Chamber of Commerce Small Business Committee Secretary, Coral Reef Conservation Foundation
Experience -	Over 10 years-experience in marine environments, artificial ecosystems, and underwater photography

The project manager provides the technical/scientific expertise to carry out the awarded project. They are also responsible for all programmatic deliverables.

The grants specialist provides financial oversight and monitoring, prepares financial reports and works with the project manager in reviewing same for accuracy before submitting. The grants specialist, in coordination with the project manager, ensure that the project is carried out according the terms and conditions of the award documents, and any relevant rules and regulations/guidelines. The project manager ensures that the award document does not compromise any state laws or internal CRCF INC © policies and procedures.

At the start of funding, a monitoring plan and tracking spreadsheet will be developed. This spreadsheet will be due in conjunction with quarterly or biannual financial and programmatic reporting. Quarterly financial reports will be reviewed, and funding will not be paid until CRCF INC © has received the deliverables associated with payment and is assured that all work has been completed. Based on the reporting requirements, a quarterly or biannual report template will be developed. This will help CRCF INC © monitor that all work is being completed on time and to specification and will ensure that reports submitted are complete and reviewed for accuracy.

Future Goals and Objectives

The mission of CRCF INC © is to advance the understanding, use and conservation of coral reefs and coastal environments through an integrated effort in data

gathering/sharing, education, and outreach community and local governments and stakeholders.

Through propagation techniques, tens of thousands of corals can be grown and maintained in a controlled environment before being strategically out-planted on reefs allowing them to continue a path to natural recovery. The broad objectives are aimed at developing this effort and sustaining the same effort for long term. These objectives are used to set goals that are attainable based on the following criteria.

All activities must satisfy three major criteria:

1. Be based on a strong rationale

2. Demonstrate scientific merit as determined by national experts in the field

3. Produce application-oriented results that are clearly useful in industry, management and/or science.

CRCF INC © core values are of excellence, relevance, integrity, teamwork, and accountability. In developing and sustaining our priorities, we will seek the advice of experts in the field and stakeholders that represent the broad community of individuals and organizations with marine interest. Their regular and frequent input helps us sustain a dynamic and flexible view of issues through the eyes of our various coastal constituencies. Based upon this input, CRCF INC © will be the model for data and information sharing, research, education, and outreach for our conservation programs.

These priority areas cross-cut many concerns both environmentally and for conservation.

Photos