US EPA Region 4 - Catastrophic Coral Disease Proposal

A. COVER PAGE & AWARD PROPOSAL SUMMARY

Title: Development of a Coral Disease Prevention and Response Program for the Florida Reef Tract

Geographic Location: Southeast Florida – Monroe, Miami-Dade, Broward, Palm Beach, & Martin counties

Funding Opportunity Number: EPA-R4-WPD-17-01

Total Project Cost: $600,000

Amount of Federal Funds Requested:	Year 1 - $100,000	Amount of Matching Funds Provided:	Year 1 - $200,000
	Year 2 - $200,000		Year 2 - $0
$400,000	Year 3 - $100,000	**$200,000**	Year 3 - $0

Requested Award Start Date & Award Period: October 1, 2017 - 36 months (Oct. 1, 2017 – Sept. 30, 2020)

APPLICANT CONTACT INFORMATION

Applicant: Florida Department of Environmental Protection DUNS: 8093966900000

Primary Point of Contact: Joanna C. Walczak

Title: Southeast Regional Administrator, Florida Coastal Office

Organization: Florida Department of Environmental Protection, Southeast Region

Street Address: 1277 N.E. 79th Street

City: Miami State: FL Zip: 33138

Phone: 305-795-2111 E-mail: joanna.walczak@dep.state.fl.us

Alternate Contact: Patricia Rose

Title: Office Manager, Coral Reef Conservation Program

Organization: Florida Department of Environmental Protection, Coral Reef Conservation Program

Street Address: 1277 N.E. 79th Street

City: Miami State: FL Zip: 33138

Phone: 305-795-1233 E-mail: patricia.rose@dep.state.fl.us

PROPOSAL SUMMARY

The Florida Department of Environmental Protection (FDEP) requests funding to develop a Coral Disease Prevention and Response Program for the Florida Reef Tract including a dedicated Coral Disease Response Specialist and priority research and management projects through federal Fiscal Years (FY) 2017 – 2020 with this US Environmental Protection Agency Region 4 Catastrophic Coral Disease proposal. With guidance from FDEP, the Disease Specialist will lead the development of priority research plans, protocols, and projects resulting in further understanding of current and prevention of future disease outbreaks across the Florida Reef Tract in Monroe, Miami-Dade, Broward, Palm Beach, and Martin counties. Key elements of the projects include: creation of capacity to acquire and evaluate critical data that lead to the development of tangible management actions, development of strategies and enhancement of partner capacity to respond to coral reef-related disease events through development of a Disease Prevention and Response Plan for the Florida Reef Tract, development and implementation of research on priority correlative and causative environmental conditions, and a general increase of awareness and appreciation of Florida's reef resources through continued public education and outreach.

PROPOSAL NARRATIVE

B. PROJECT DESCRIPTION

1. INTRODUCTION AND PROJECT DESCRIPTION

The Florida Department of Environmental Protection (FDEP) is Florida's lead agency for environmental management and stewardship - protecting our air, water and land. The vision of the FDEP is to create strong community partnerships, safeguard Florida's natural resources, and enhance its ecosystems. The FDEP Florida Coastal Office (FCO) Southeast (SE) Region is responsible for managing the State's coral reef related resources, including the including the Coral

Reef Conservation Program (CRCP) and co-management of the Florida Keys National Marine Sanctuary (FKNMS). These programs coordinate research, develop management strategies, and promote partnerships to protect the coral reefs, hardbottom communities, and associated reef resources across 330 nautical miles of the Florida Reef Tract in Monroe, Miami-Dade, Broward, Palm Beach, and Martin counties. As Florida's representative on the US Coral Reef Task Force and US All Islands Coral Reef Committee, the FCO SE Region also works to build partnerships, strategies, and support for on-the-ground action to conserve coral reefs in all of the US coral reef jurisdictions. The FDEP requests funding to develop a Coral Disease Prevention and Response Program for the Florida Reef Tract including a dedicated Coral Disease Response Specialist and priority research and management projects.

2. DESCRIPTION OF NEED

While disease outbreaks are not unprecedented along the Florida Reef Tract, this disease event is unique in that it has persisted and continued to spread since 2014, includes multiple diseases, and has impacted over 21 species of scleractinian coral, including primary reef builders and species that have been listed as Threatened under the Endangered Species Act (Table 1). Initially reported in Miami-Dade County in mid-2014, the disease has spread primarily north but also south across multiple reef management jurisdictions. Beyond Miami-Dade County, high disease prevalence (up to 80% of colonies at some sites) has now been confirmed in Martin, Palm Beach, and Broward counties, and more recently in the upper Florida Keys in Monroe County.

The majority of disease observations are of white plague-like with "white blotch" symptoms, although black band, white band, and dark spots have also been observed. The patterns of lesions, tissue mortality, susceptibility, and speed of progression has varied between the type of disease, species affected, and location. Some of the oldest (330+ years) and largest coral colonies have

suffered mortality within a matter of weeks. Additionally, a few especially susceptible species have effectively been eliminated from the known wild population. For example, over 95% of all known Pillar coral (*Dendrogyra cylindrus*) colonies are infected or have already died. Based on the area of reef habitat known to be impacted, estimates indicate that millions (if not hundreds of millions) of corals have likely been infected or have died from this disease event - even more are still at risk. Despite efforts by FDEP and our local management, scientific, and NGO community partners (Table 2) we have been unable to determine the full extent and cause of this persistent coral disease event due to limited technical and financial capacity.

While the Florida Reef Tract is significantly ecologically important, it is also incredibly important to south Florida's economy – annually contributing over 6 billion dollars in sales and income and supporting over 70,000 jobs (Johns et al. 2001 and 2004). As the current disease event shows no signs of stopping and continues to expand into the Florida Keys, the need for, and importance of, examining correlative or causative environmental factors (e.g., water quality, sediment transport, microbial communities, etc.) is critical. Identification of potential causes or drivers of mortality will allow for the development of management recommendations that can be implemented to reduce the current or prevent future risk to Florida's coral reef related populations.

Table 1 – List of coral species confirmed to be impacted by disease event in 2015 and 2016.

Species	Disease Observed 2015	Disease Observed 2016
*Acropora cervicornis**		X
Agaricia agaricites (Lettuce Coral)		X
Colpophyllia natans (Boulder Brain Coral)	X	X
Dendrogyra cylindrus (Pillar Coral)*	X	X
Dichocoenia stokesi (Elliptical Star Coral)	X	X
Diploria labyrinthiformis (Grooved Brain Coral)	X	X
Eusmilia fastigiata (Smooth Flower Coral)	X	X
Meandrina meandrites (Maze Coral)	X	X

Montastraea cavernosa (Great Star Coral)	X	X
Mycetophyllia spp.*		X
Orbicella annularis (Lobed Star Coral)*	X	X
Orbicella faveolata (Mountainous Star Coral)*	X	X
Orbicella fransksi (Boulder Star Coral)*		X
Porites astreoides (Mustard Hill Coral)		X
Pseudodiploria strigosa (Symmetrical Brain Coral)	X	X
Pseudodiploria clivosa (Knobby Brain Coral)	X	X
Siderastrea radians (Lesser Starlet Coral)		X
Siderastrea siderea (Massive Starlet Coral)		X
Solenastrea bournoni (Smooth Star Coral)	X	X
Stephanocoenia intersepta (Blushing Star Coral)		X

*Indicates Endangered Species Act (ESA) Threatened Species

3. PRIORITY AREA

This project will support research, management, and the development of partnerships to protect the coral reefs, hardbottom communities, and associated reef resources across 330 nautical miles of the Florida Reef Tract in Monroe, Miami-Dade, Broward, Palm Beach, and Martin counties, Florida.

PROJECT TASKS

The goal of this proposal is to develop a new program that will improve the conservation and management of southeast Florida's coral reefs by creating a plan and capacity for reporting, responding to, and ultimately preventing coral reef-related disease outbreaks.

Task 1: Contract a Full-Time Disease Response Specialist (Post Doc)

A postdoctoral specialist will be contracted to assist FDEP organization of and/or participation in response teams, delegation of tasks, make informed decisions, and generally manage all the tasks

related to the creation of a disease outbreak prevention and response program (as will be defined in a Disease Outbreak Prevention and Response Plan). Specific tasks may include: collaborating with the FDEP, Florida Fish and Wildlife Conservation Commission (FWC), NOAA Coral Disease Health Consortium, US Geological Survey (USGS) National Wildlife Health Center, and other agencies and organizations leading response efforts; identifying and ensuring response team members are adequately trained; conducting an extensive historical review of disease incidents in Florida, serving as the initial point of contact for reports of potentially new disease outbreaks; organizing assessments, including a determination about the amount, type and quality of data to collect; assessing the feasibility of disease containment or other interventions; providing management recommendations for response activities and control methods; data management; and reporting and communications. Supplies and services will be purchased on a regular basis throughout each fiscal year to maintain office administration capabilities. Funds will also be used to support non-federal attendee travel as needed while conducting local partner meetings throughout the 5 counties, especially in years 1 & 2. Non-federal meeting attendees selected for travel will be determined by need and by their area of expertise. Hotel, meals, transportation, and per diem are included in travel costs. Bi-annual reports of progress made will be submitted on all progress made by the Disease Specialist.

Task 2: Development of a Disease Outbreak Prevention & Response Plan for the Florida Reef Tract

Under direction of FDEP, the Disease Response Specialist will coordinate the development of a detailed disease outbreak/rapid response plan for the Florida Reef Tract. The development of this plan will require a literature review of existing disease and rapid response plans, hosting regional workshops to solicit expert input, and drafting the plan itself. The disease outbreak/rapid response

plan will capture “lessons learned” from response efforts thus far, while also providing a roadmap to ensure managers are more adequately equipped to launch a response for future outbreaks. The plan will include an organized, systematic approach for determining the extent and impact of disease events, causative agent(s), potential sources of causative agents, and modes of transmission, as well as recommendations for identifying control or management strategies. Because of the scale and severity of this outbreak, such a plan might also eventually serve as a resource for others in the Caribbean and Pacific should they face similar issues in the future. This plan may also include rapid response recommendations for other reef-related impacts (algal blooms, sponge disease, etc.).

Task 3: Examine Correlative and/or Causative Environmental Factors

Under direction of FDEP, the Disease Response Specialist will compile and analyze all potentially relevant data sets that examine environmental conditions at the time of the original outbreak and what has allowed it to persist.

- *Task 3A - Develop a disease-relevant decision support tool (DST) with near real-time data updates for Florida Reef Tract managers*

  Investigate the condition of the coral reefs and factors that may be contributing to disease outbreaks. Work with partners to develop a database of existing disease information, including all relevant epidemiological, environmental, physical and sample data for retrospective and prospective investigations. This will include the design of an “informational dashboard” that displays reef monitoring data in spatially relevant maps. Building on previous local efforts, the dashboard forms a decision-support tool (DST) that can help identify appropriate management actions as well as aid in communicating the need for such actions.

While developing the database and dashboard, the project team can develop and fine-tune a multi-institutional, highly collaborative process by which disease and other reef benthic and fish monitoring data are assimilated annually and available for dashboard display. The dashboard will be web-enabled, publicly accessible, interactive, and user-friendly.

- *Task 3B – Design (and where possible implement) research studies to explore treated wastewater and sediment contamination potential correlations including microbial communities, heavy metals, coupled with thermal stress, etc.*

  A Comprehensive Conditions Report was developed to obtain data from disease field surveys and tissue samples, as well as environmental factors such as currents, temperature, rain fall, water quality, and sedimentation that may have contributed to the disease outbreak. Additional analysis of these data is necessary to determine if correlations exist. Specific methodologies will be based on the data available and the priority selected from the final Disease Outbreak Prevention and Response Plan.

Task 4: Communications Development

Communications are a critical part of any disease investigation and response effort. Under direction of FDEP, the Disease Response Specialist will work with local agencies and partners (e.g., tourism development councils) to craft effective messaging and media to disseminate content. Includes design and production of audience (public, elected officials, agency leadership, etc.) tailored communications pieces (format TBD – print, presentations, video, radio, web).

<u>Matching Fund Tasks –</u>

As match to the federal funds, state funds will be used in Year 1 of the project to complete the following:

Priority Sampling Workshop(s) -

Funds will be used to host a workshop(s) to establish analysis goals; determine priority sampling locations based on results of Disease Boundary and Surveillance surveys; determine collection protocols and analysis options for tissue, mucus, microbial, sediment, and water samples; and determine best approach for analyzing limited samples across histopathology, microbiology, analytical chemistry, etc. to determine the disease pathogens.

Coral Disease Event Boundary Surveys - Funds will be used to support partners conducting up to 90 in-water field surveys per event to determine the current boundary location of the disease event in the Florida Keys (near Islamorada). Subsequent repeat surveys through the year will determine if the boundary is progressing or not.

Coral Disease Surveillance Surveys - Funds will be used to support in-water field surveys to determine the full extent of the disease event across the entire Florida Reef Tract.

4. MILESTONE SCHEDULE

Progress during this project will be measured through the meeting of milestones we will set for all of the tasks described above as described in the project schedule below.

Project Schedule:

Year 1 Projects/ Tasks	Oct 17	Nov 17	Dec 17	Jan 18	Feb 18	Mar 18	Apr 18	May 18	Jun 18	Jul 18	Aug 18	Sept 18
Task 1 - Contract Initiation	x	x										
Task 1 - Position Hiring		x	x	x								
Task 2 - Literature Review				x	x	x	x	x	x			
Task 2 - Workshops						x	x	x	x	x		

Task 2 - Draft Plan									x	x	x	
Task 2 - Final Plan											x	x
Task 3A - DST Contract Initiation										x	x	x
Task 4 - Communication Products											x	x

Year 2 Projects/ Tasks	Oct 18	Nov 18	Dec 18	Jan 19	Feb 19	Mar 19	Apr 19	May 19	Jun 19	Jul 19	Aug 19	Sept 19
Task 3A - Compile Data	x	x	x	x	x							
Task 3A - Design DST Report	x	x	x	x	x	x						
Task 3A - Review DST	x	x	x	x	x	x	x	x	x	x		
Task 3A - Finalize DST										x	x	x
Task 3B - Design targeted studies	x	x	x	x	x	x	x	x	x			
Task 3B - Implement studies										x	x	x
Task 4 - Communication Products	x	x	x	x	x	x	x	x	x	x	x	x

Year 3 Projects/ Tasks	Oct 19	Nov 19	Dec 19	Jan 20	Feb 20	Mar 20	Apr 20	May 20	Jun 20	Jul 20	Aug 20	Sept 20
Task 3B - Design targeted studies	x	x	x	x								
Task 3B - Implement studies	x	x	x	x	x	x	x	x	x			
Task 3B - Draft Study Report(s)				x	x	x	x	x	x			
Task 3B - Final Study Report(s)								x	x	x	x	x

Task 4 - Communication Products	x	x	x	x	x	x	x	x	x	x	x	x

5. DETAILED BUDGET

The total amount of federal funding requested is $400,000. Matching funds in the amount of $200,000 for Year 1 of the award (total of $200,000) will be provided by the State of Florida DEP. Every effort has been, and will continue to be, made to identify all possible options for match to the requested federal funds under this proposal. The total proposal amount is $600,000.

Project Budget Summary--Year 1			
Category	**Federal funds**	**Matching funds**	**Total**
Contractual	$100,000	$200,000	**$300,000**
All tasks, including Disease Specialist salary, development of Response Plan, and communication pieces will be covered contractually. Matching funds will be contractually used for workshops to establish sampling and protocol priorities as well as for disease event boundary and surveillance surveys.			
TOTALS	**$100,000**	**$200,000**	**$300,000**
Project Budget Summary--Year 2			
Category	**Federal funds**	**Matching funds**	**Total**
Contractual	$200,000	$0	**$200,000**
All tasks, including Disease Specialist salary, development of the DST, targeted research projects, and communications pieces will be covered contractually.			
TOTALS	**$200,000**	**$0**	**$200,000**
Project Budget Summary--Year 3			
Category	**Federal funds**	**Matching funds**	**Total**
Contractual	$100,000	$0	**$200,000**
All tasks, including Disease Specialist salary, targeted research projects, and communications pieces will be covered contractually.			
TOTALS	**$100,000**	**$0**	**$200,000**
PROJECT TOTALS	**$400,000**	**$200,000**	**$600,000**

Budget based on historic costs for similar contractual services.

7. TRANSFER OF RESULTS

Following the State of Florida's Sunshine Law, all environmental, socioeconomic, and correlative data (including photos and videos) and any information collected and/or created using funds from

FDEP and/or this EPA award will be made visible, accessible, and independently understandable to public users, free of charge, within 90 days of the end of the award via FDEP webpage at: http://www.dep.state.fl.us/coastal/programs/coral/reports/crcp.htm

Any datasets too large to be available via the FDEP webpage will be immediately made available upon request to: coral@dep.state.fl.us. All data/metadata and content will comply with International Organization for Standardization (ISO) Standards for documenting environmental data and information. All data and products will be archived in multiple locations and on multiple mediums (e.g., hard drives, website, and hard copy CD/DVDs in FDEP's library) and will be provided to EPA for long-term storage. Additionally, results will be actively shared with over 80 representatives of the Florida Reef Tract management community (see Partnerships - Table 2) through presentations at local meetings and webinars as appropriate. Results will also be presented to the US Coral Reef Task Force and US All Islands Coral Reef Committee at biannual meetings to ensure the information is shared with other US coral reef jurisdictions.

8. STRATEGIC LINKAGES - OUTPUTS AND OUTCOMES

i. **Link to EPA Strategic Plan:**

This project directly supports the EPA's 2014-2018 Strategic Plan, specifically Goal 2: Protecting America's Waters -- Protect and restore our waters to ensure drinking water is safe, and that aquatic ecosystems sustain fish, plants, and wildlife, and economic, recreational, and subsistence activities. It also directly supports Goal 2, Objective 2.2: Protect and Restore Watersheds and Aquatic Ecosystems -- Protect the quality of rivers, lakes, streams, and wetlands on a watershed basis, and protect urban, coastal, and ocean waters.

ii. Task Products (Outputs):

Task	Product Description	Type or Format	Expected date of availability
Task 1: Disease Response Specialist	Bi-annual Progress Report	Final Progress Reports (Word)	Every 6 months
Task 2: Disease Prevention and Response Plan	Disease Prevention and Response Plan including workshop summaries and research priorities	a) Literature Review summary b) Workshop summaries (Word) c) Draft and Final Plan (Word and PDF)	a) May 2018 b) July 2018 c) July/Aug 2018
Task 3A: Decision Support Tool	a) Compilation of reef monitoring data b) Report Design c) Interactive DST d) Streamlined DST dashboard	a) TBD based on data format b) Word and PDF Templates c) ArcGIS Layer package (*.lpk) d) ArcGIS and Shiny data-viewing platforms	a) January 2019 b) February 2019 c) August 2019 d) August 2019
Task 3B: Priority Research Projects	Research Scope of Work and (if applicable) Final Implementation Report(s)	a) Scopes of Work for priority research projects (Word) b) Draft and Final Implementation Report(s) (if applicable)	November 2019 - August 2020
Task 4: Communication Products	Format TBD – print, presentations, video, radio, web, etc.	a) PowerPoint presentation and folder with educational handouts (PPT and PDF) b) Other communication products, as needed	TBD - July 2018 – August 2020

iii. Task Outcomes:

The expected outcomes of this project directly support EPA's 2014-2018 Strategic Plan, Goal 2 by increasing capacity in Florida to respond to coral disease outbreaks and manage coral reefs in general – ultimately ensuring sustainable fish, plants, and wildlife, and economic, recreational, and subsistence activities. Any trends in the data collected and analyzed will assist in the development of action strategies to better conserve southeast Florida's coral reef resources. Managers will be able to make transparent decisions in response to condition and resiliency information, since that

information will be made both accessible and easy to interpret. Further, managers will be able to measure progress towards goals and assess the effectiveness of various actions. This program also promotes partnerships, information sharing, and collaboration across agencies, academia, non-governmental organizations, and the general public which is essential for implementing effective management and conservation strategies.

iv. Tracking Outputs and Outcomes

The progress of this project and each task will be closely monitored to ensure measurable steps toward completion of the tasks are achieved in a timely manner. This will be done through a combination of agency and programmatic oversight as well as periodic meetings with technical and administrative staff to reevaluation timelines and budgets, as needed.

9. PROGRAMMATIC CAPABILITY/TECHINCAL EXPERIENCE/QUALIFICATIONS

i. **Organizational Experience** - As previously stated, the FDEP is Florida's lead agency for environmental management and stewardship - protecting our air, water and land. The resources of the FDEP and the FCO SE Region contribute to the implementation and success of this project.

ii. **Project Management/Personnel:**

- Principal Investigator (PI) – *Southeast Regional Administrator* – Appointed State representative to the USCRTF and AIC. Oversees direction of CRCP and FDEP's co-management of the FKNMS. Oversees all management and maintenance of FCO SE Region facilities and staff and coral reef resource management, monitoring, research, enforcement, and public education programs and activities in southeast Florida.

Support personnel working with the PI to complete the objectives of this award include:

- *FKNMS Management Liaison* – Assists SE Regional Administrator in all aspects of co-management of the FKNMS and is the Manager of the Coupon Bight and Lignumvitae Aquatic Preserves. Primary coral disease point of contact for FDEP.

- *Office Manager* - Oversees daily FCO SE Region business operations and provides administrative support. Key responsibilities include all personnel forms and procedures; preparing and processing purchase requisitions and reviewing procurement; obtaining competitive bids from authorized vendors for goods and services; budget preparation and tracking; preparing, reviewing, and tracking invoices; timesheets; reviewing and processing travel authorizations; contract and grant review and routing. Also provides staff health and safety training, and is the Miami Unit Diving Safety Officer for the FDEP Diving Program.

- *CRCP Manager* – Plans, directs, and coordinates all activities of the CRCP. Serves as Chair of the Southeast Florida Coral Reef Initiative. Oversees the CRCP's development and implementation of activities to identify and respond to marine biological incidents and debris, and better understand the resilience of reef resources in the SE Florida region.

10. PARTNERSHIP INFORMATION

This proposal reflects a significant effort in collaboration across numerous local, state, and federal agencies, universities, and non-governmental organizations, as well as the general public. Implementation of this proposal is needed to address some of the most pressing coral reef management needs in Florida. The following list of partners will assist in various aspects of all tasks, including but not limited to: scope of work development, data collection, deliverable reviewing, and assisting with communication to the broader public.

Table 2 – List of partner associations currently assisting in various disease event response activities.

- Broward County
- Coral Restoration Foundation
- Cry of the Water
- Florida Aquarium
- Florida Atlantic University
- Florida Department of Environmental Protection
    - Coral Reef Conservation Program
    - Division of Environmental Assessment and Restoration
    - Florida Coastal Office
    - Florida Coastal Management Program
    - Florida Keys National Marine Sanctuary
- Florida Fish and Wildlife Conservation Commission
    - Fish and Wildlife Research Institute
- Florida International University
- George Mason University
- Martin County
- Miami-Dade County
- Monroe County
- Mote Marine Laboratory
- National Oceanic and Atmospheric Administration
    - Coral Reef Conservation Program
    - Florida Keys National Marine Sanctuary
    - National Marine Fisheries Service – SE Region & SE Fisheries Science Center
    - Coastal Zone Management Program
- National Park Service
    - Biscayne National Park
    - Dry Tortugas National Park
    - South Florida/Caribbean Network
- Nova Southeastern University/National Coral Reef Institute
- Palm Beach County
- Palm Beach County Reef Rescue
- Smithsonian Institute
- The Nature Conservancy
- United States Geological Survey
    - National Wildlife Health Center
- University of Florida
- University of Miami Rosenstiel School of Marine and Atmospheric Science
- University of South Florida

11. PAST PERFORMANCE

A. **Successful Federal Cooperative Agreements within the last 3 years-** All timelines, reporting deadlines, budgets, and deliverables were met as agreed to in the following cooperative agreements:

   i. **NOAA CRCP State and Territorial Coral Reef Conservation Cooperative Agreements - FY15 and FY16 - NA15NOS4820036**

   ii. **NOAA CRCP State and Territorial Coral Reef Conservation Cooperative Agreements - FY17 and FY18 - NA17NOS4820032**

B. **Restoration Demonstration Project Information -** Not applicable. This project does not involve restoration.

C. **Quality Assurance/Quality Control Statement** – A Quality Assurance/Quality Control plan will be submitted as necessary to ensure proper and accurate measures are taken during all stages of the project including methods development, data collection, data maintenance, and data analysis.

D. **Invasive Species Control** – Not applicable. This project does not involve invasive species.

References Cited:

Johns GM, Leeworthy VR, Bell FW, Bonn MA (2001) Socioeconomic Study of Reefs in Southeast Florida. Final Report. Hazen and Sawyer Environmental Engineers & Scientists;

Johns GM, Milon JW, Sayers D (2004) Socioeconomic Study of Reefs in Martin County, FL. Final