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## FIELD OBSERVATION REPORT

**COMM:** 348704

**DATE:** October 27, 2017

**INSPECTOR:** Ms. Megan Reising, Coastal Systems International, Inc. (Coastal Systems)  
Mr. Mark Hartman, Coastal Systems  
Mr. Aaron Boehning, Coastal Systems

**RE:** **FIELD OBSERVATION REPORT FOR THE MARINE RESOURCE AND STRUCTURAL SURVEY OF THE TETRAHEDRON PATCH (BLACK) ARTIFICIAL REEF IN MARTIN COUNTY, FLORIDA**

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### 1. INTRODUCTION

Coastal Systems International, Inc. (Coastal Systems) divers conducted a marine resource survey on October 1, 2017 at the Tetrahedron Patch (Black) artificial reef in Martin County, Florida (Reef) between the hours of 9:36 and 10:06 am to provide general information on the ecological resources present and document the physical conditions at the Reef site. The Reef is located at approximately 7.3 miles east northeast (on a bearing of 68°) from Port Sewall at the mouth of the St. Lucie Inlet. See Figure 1 for a map of the Reef location and survey area. The survey was conducted pursuant to the U.S. Army Corps Permit #SAJ-1995-04128(SP-JKA) Condition 16, which requires that the artificial reefs installed are to be surveyed annually for 2 years. This monitoring represents the first annual survey of the Sirotkin artificial Reef Tetrahedron Patch (Black). The concrete tetrahedron modules are 4 feet and 5 feet solid concrete tetrahedrons with a steel rebar lifting eye.

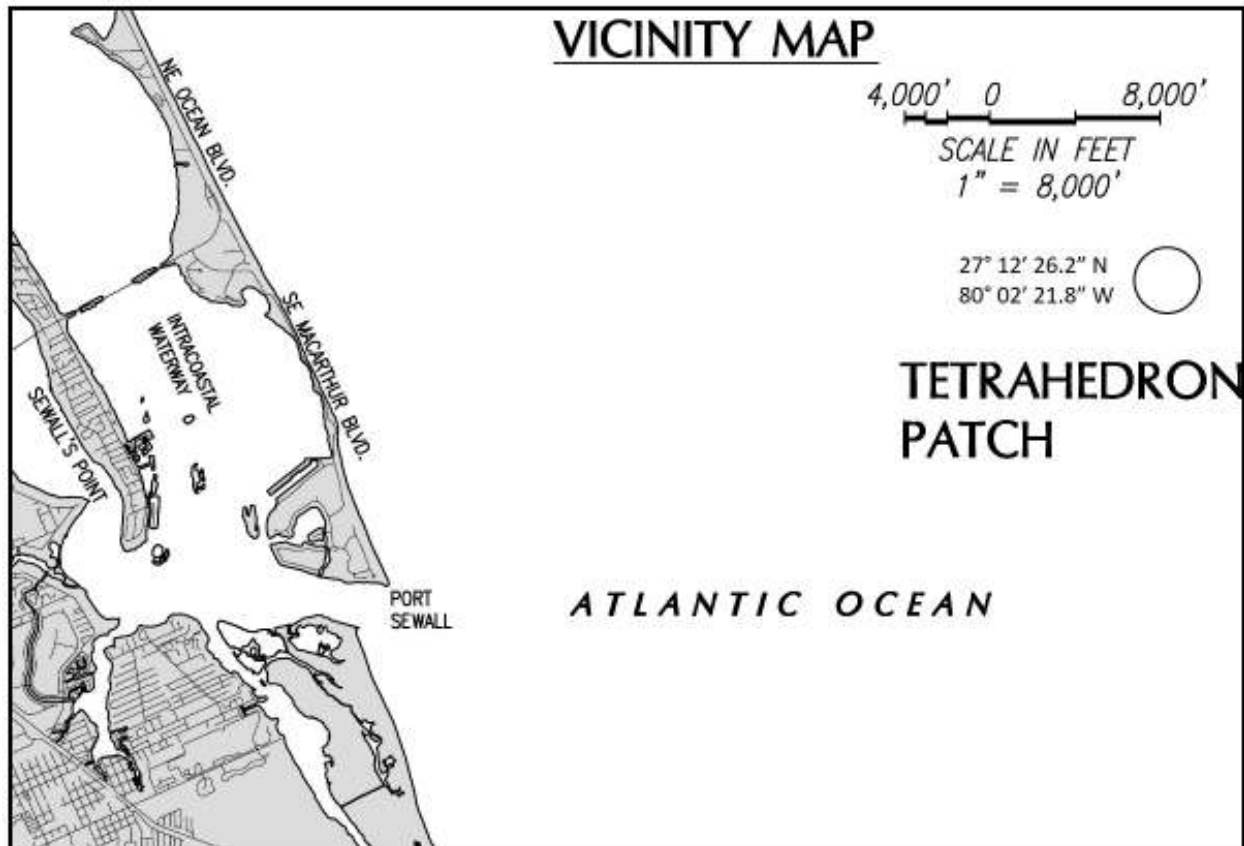
#### **Tetrahedron Patch (Black)**

- Location: 27° 12' 26.2" N and 80° 02' 21.8" W
- Materials: Modular concrete Florida specials (Martin County, n.d.)
- Maximum Depth: 92'
- Highest Reef Elevation: 95'
- Deployment Date: March 28 or June 28, 2002

### 2. METHODOLOGY

#### **Multi-beam Survey**

Coastal Systems performed a multi-beam survey of Tetrahedron Patch (Black), on June 28<sup>th</sup>, 2017, with sufficient overlap to ensure full coverage of the entire artificial reef. The survey was conducted using a Reson SeaBat 7125 multi-beam survey system using an Applanix Oceanmaster POS-MV inferential motion unit. Data was logged and verified using survey-grade transducers and HYPACK navigation software.



**Figure 1.** An overview of the location of the Tetrahedron Patch (Black) artificial reef.

### **Marine Resource Survey**

Two Coastal Systems biologists performed the marine resource survey at Tetrahedron Patch (Black). Underwater photographs were taken to document the reef from the four cardinal directions (north, south, east, and west) and the biologists visually assessed the overall durability and condition of the reef.

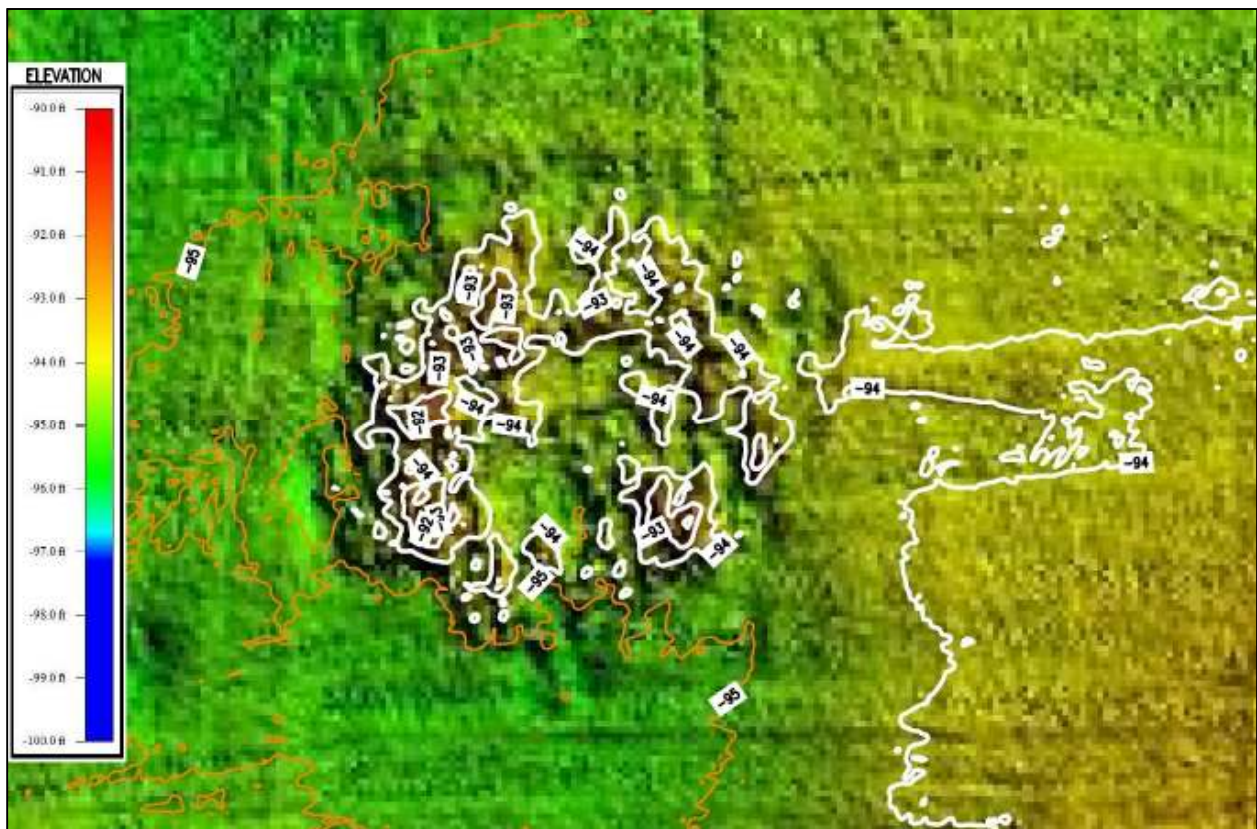
Fish identification and abundance was determined using the guidelines established by the Reef Environmental Education Foundation (REEF). The Roving Diver Technique (RDT) was used for a set time period of 20 minutes per site. The first biologist swam in a completely random pattern around the reef structure focusing on locating fish species on the Reef structure and in the water column above the Reef. The biologist identified fish species, noted the abundance of species on the Reef, and recorded physical condition data for the Reef structure on underwater slates. Four abundance categories were used based on approximately how many fish were seen throughout the dive [Single (1); Few (2-10), Many (11-100), and Abundant (>100)]. Following the dive, each diver recorded the species abundance data, survey time, depth, temperature, and other environmental information on previously prepared data sheets. The second biologist focused on benthic invertebrate species identification and locating cryptic fish species found in the interstitial spaces between reef components with careful attention paid to looking under various

structures and noting the information needed to identify the organisms to the lowest practical taxonomic level.

### 3. RESULTS

#### 3.1 Multi-beam Survey Results

The multi-beam survey of the Reef was completed on June 28<sup>th</sup>, 2017. The Tetrahedron Patch (Black) artificial reef is approximately 70 feet in diameter. Water depths within the artificial reef area ranged from 92 to 95 feet deep at the time of the survey, with the shallowest water occurring on the west and southwest edges of the artificial reef (Figure 2).



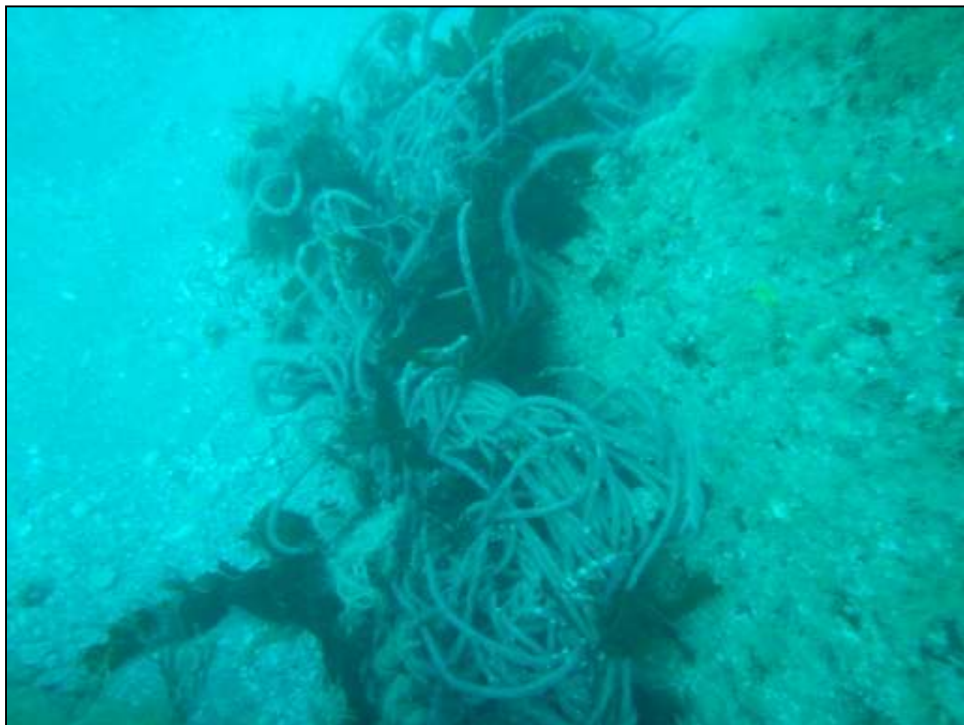
**Figure 2.** An overview of the Tetrahedron Patch (Black) artificial reef depths and the layout of the concrete modules.

#### 3.2 Structural Summary

The individual tetrahedron concrete modules are solid concrete units, weighing up to 3600 lbs. each at the surface. The concrete components of the tetrahedron modules were intact (Photograph 1); and there was no noticeable damage to the modules. However, numerous small patches of debris were observed at the base of modules as shown in Photograph 2. There was some noticeable sinking into the bottom of the structures observed during the survey as shown in Figure 3. Many tetrahedron concrete modules have been partially buried into the sand, due to either sinking of the module, or the accumulation of sand.

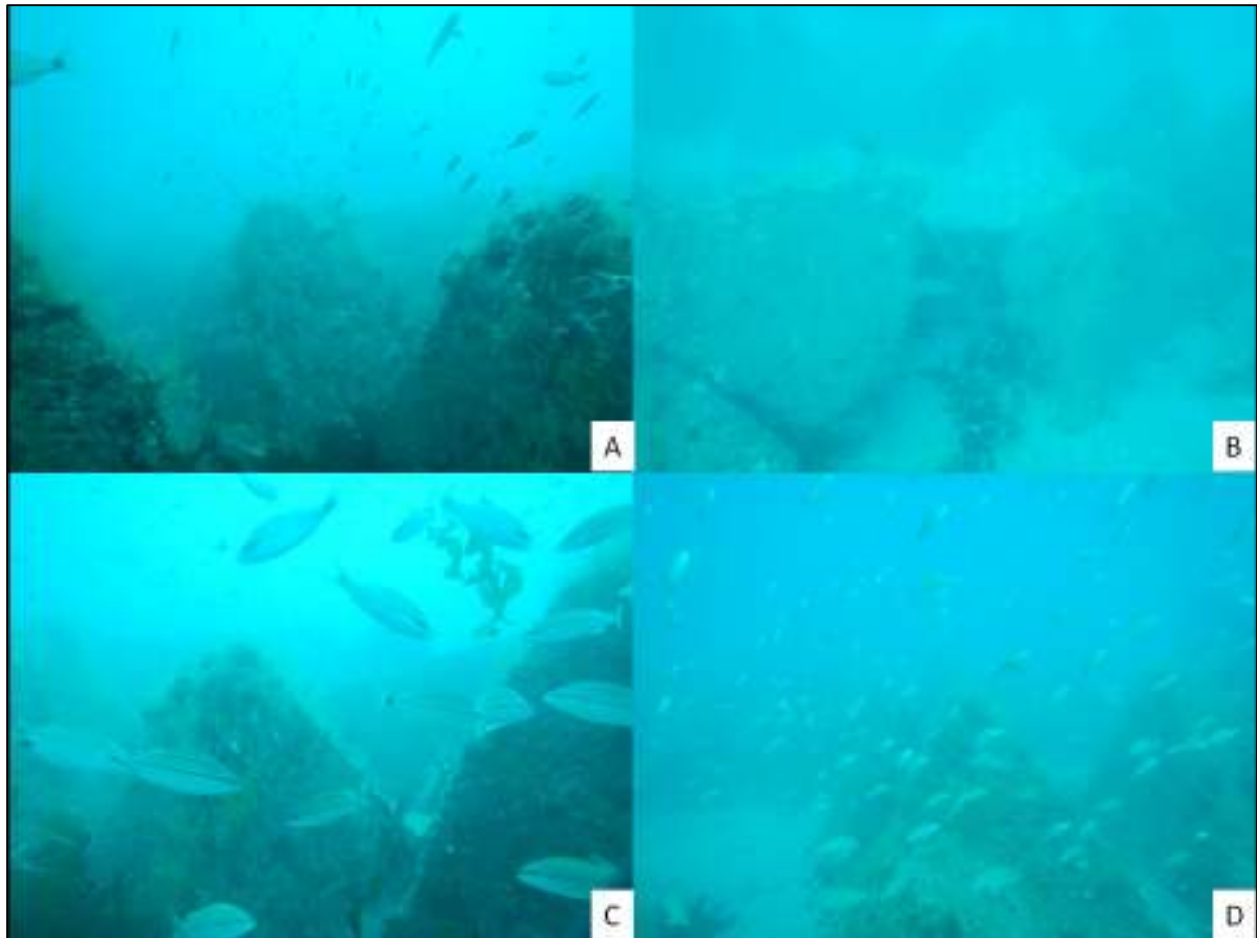


**Photograph 1.** A frontal view of the tetrahedron concrete module at the Site.



**Photograph 2.** Tangled line and rope at the base of modules was frequently observed during the survey.





**Figure 3.** An overview of the Tetrahedron Patch (Black) artificial reef looking north (A), south, (B), east (C), and west (D) from the tallest observed point on the reef.

### 3.3 Marine Resource Survey Results

The submerged lands at the Reef site consisted mostly of coarse sand with silt, shell hash, shells, sand dollar fragments, occasional concrete rubble, and various man-made debris. Visibility at the Reef was generally 25-30 feet.

#### Species Observed

The fish identification and abundance survey resulted in the observation of 22 fish species and 10 other species indicating a diverse population on the Reef. Most of the fish species observed occurred in a limited abundance, with the most abundant fish observed being Tomtate (*Haemulon aurolineatum*), Gray Snapper (*Lutjanus griseus*), and Cubbyu (*Pareques umbrosus*) which were present in high numbers as both juveniles and adults (Photograph 3). Approximately 3 Goliath Grouper (*Epinephelus itajara*) were seen on the Reef as they had been aggregating to spawn in the area (Robins, n.d.; Table 1; Photograph 4). Many large, invasive exotic Lionfish (*Pterois volitans*) were also observed among the concrete culverts (Photograph 5). In addition to the fish species, several other benthic invertebrate organisms were observed on the Reef including various Hermit Crabs (Photograph 6) and Yellowline Arrow Crabs (*Stenorhynchus*

*seticornis*). Sand Dollars (*Clypeaster subdepressus*) and Sea Biscuits (*Clypeaster rosaceus*) were observed in the interstitial spaces between the modules (Table 2). Growing directly on the substrate were several species of macroalgae such as *Dictyota* sp., *Sargassum* spp., *Botryocladia* sp., and turf algae (Table 3). The concrete modules were also heavily encrusted with algae, sponges, and other marine benthic organisms.

**Table 1.** Fish species and abundance observed on the Tetrahedron Patch (Black) Reef. Stage – Adult (A) or Juvenile (J). Abundance Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A).

Common Name	Scientific Name	Stage	Abundance
Bandtail Puffer	<i>Sphoeroides spengleri</i>	J	F
Belted Sandfish	<i>Serranus subligarius</i>	A	F
Black grouper	<i>Mycteroperca bonaci</i>	A	F
Blue Angelfish	<i>Holacanthus bermudensis</i>	A	F
Blue Tang	<i>Acanthurus coeruleus</i>	A	F
Cocoa Damselfish	<i>Stegastes variabilis</i>	A	F
Cubbyu	<i>Pareques umbrosus</i>	J, A	M
Doctorfish	<i>Acanthurus chirurgus</i>	A	F
Gray Snapper	<i>Lutjanus griseus</i>	J, A	A
Goliath Grouper	<i>Epinephelus itajara</i>	A	F*
Greater Soapfish	<i>Rypticus saponaceus</i>	A	S
Hogfish	<i>Lachnolaimus maximus</i>	A	F
Lane Snapper	<i>Lutjanus synagris</i>	A	F
Porkfish	<i>Anisotremus virginicus</i>	A	F
Red Lionfish	<i>Pterois volitans</i>	A	F
Sand Perch	<i>Diplectrum formosum</i>	A	F
Sheepshead	<i>Archosargus probatocephalus</i>	J, A	M
Sheepshead Porgy	<i>Calamus penna</i>	A	F
Spotted eel	<i>Gymnothorax moringa</i>	A	S
Tomtate	<i>Haemulon aurolineatum</i>	J, A	A
Two Spot Cardinalfish	<i>Apogon binotatus</i>	A	M
Whitespotted Soapfish	<i>Rypticus maculatus</i>	A	M

\*The Goliath Grouper currently have spawning aggregations in the area and their numbers are inflated as a result.

**Table 2.** Benthic invertebrate species and abundance observed on the Tetrahedron Patch (Black) Reef. Abundance Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A).

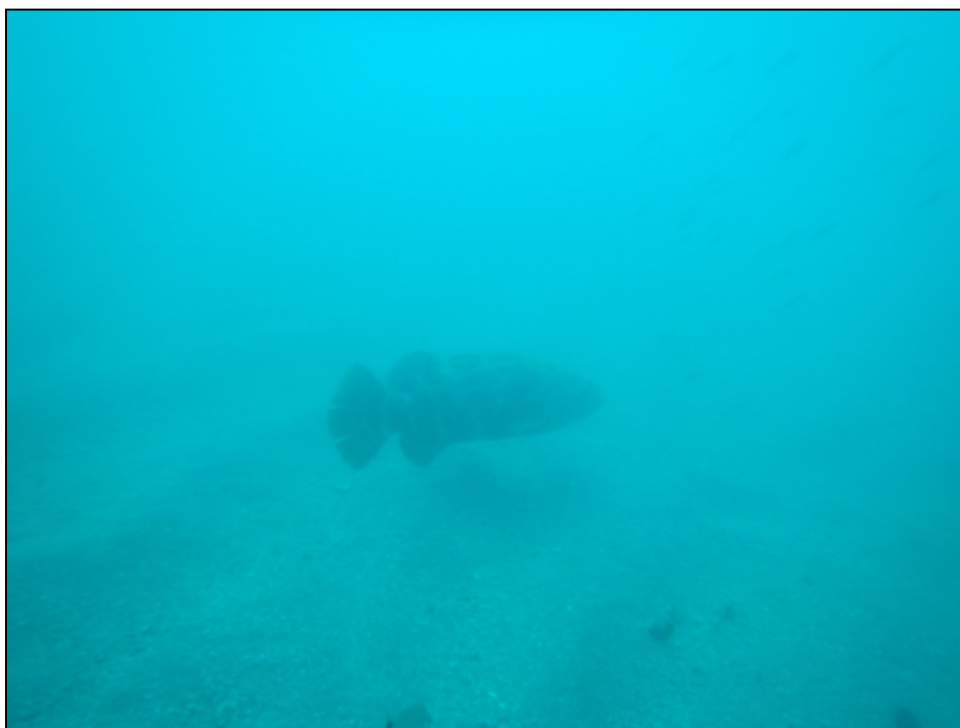
Common Name	Scientific Name	Abundance
Algae Hydroid	<i>Thyrosocyphus ramosus</i>	F
Barnacles	<i>Balanus</i> sp.	A
Encrusting Sponge	Unidentified species	F
Feather Duster Worm	<i>Sabellidae</i> sp.	F
Hermit Crabs	Unidentified species	F
Mollusca Rock Snails	Unidentified species	F
Red Netted Barnacles	<i>Megabalanus</i> sp.	A
Rock Boring Urchin	<i>Echinometra lucunter</i>	F
Snail	Unidentified species	S
Yellowline Arrow Crab	<i>Stenorhynchus seticornis</i>	M

**Table 3.** Algal species observed during the marine resource survey on the Tetrahedron Patch (Black) Reef. Abundance Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A).

Common Name	Scientific Name	Abundance
Dictyopteris	<i>Dictyopteris justii</i>	M
Dictyota	<i>Dictyota</i> sp.	M
Green Sea Fingers	<i>Codium</i> sp.	F
Macroscopic Red Algae	<i>Halymenia</i> sp.	F
Red Grape Kelp	<i>Botryocladia</i> sp.	F
Sargassum	<i>Sargassum</i> spp.	M



**Photograph 3.** Numerous Tomtate (*Haemulon aurolineatum*) observed swimming within the modules at the site.



**Photograph 4.** A Goliath Grouper (*Epinephelus itajara*) observed along the periphery of the tetrahedron reef site.





**Photograph 5.** Several Lionfish (*Pterois volitans*) were observed among the modules at the site.



**Photograph 6.** Several Hermit Crabs were observed along the bottom at the reef site.

#### 4. CONCLUSION

The multi-beam survey of the Reef showed the Reef is approximately 70 feet in diameter, and the ranged from 92 to 95 feet deep, with the shallowest water occurring on the west and southwest edges of the reef. The tetrahedron modules making up the Reef were wholly intact; however, many tetrahedron concrete modules had been partially buried into the sand, due to either sinking of the module, or the accumulation of sand at the base.

The fish identification and abundance survey resulted in the observation of a total of 22 species, indicating a diverse population on the Reef. Most of the fish species observed occurred in a limited abundance, with the most abundant fish observed being Tomtate (*Haemulon aurolineatum*), Gray Snapper (*Lutjanus griseus*), and Cubbyu (*Pareques umbrosus*) which were present in high numbers as both juveniles and adults. Few Goliath Grouper (*Epinephelus itajara*) were seen on the Reef, as well as many large, invasive exotic Lionfish (*Pterois volitans*). In addition to the fish species, several other benthic invertebrate organisms were observed on including Hermit Crabs, Yellowline Arrow Crabs (*Stenorhynchus seticornis*), Sand Dollars (*Clypeaster subdepressus*), and Sea Biscuits (*Clypeaster rosaceus*). Growing directly on the substrate were several species of macroalgae such as *Dictyopteris justii*, *Dictyota* sp., *Codium* sp., *Botryocladia* sp., *Sargassum* spp., and turf algae.



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## FIELD OBSERVATION REPORT

**COMM:** 348704

**DATE:** November 3, 2017

**INSPECTOR:** Ms. Megan Reising, Coastal Systems International, Inc. (Coastal Systems)  
Mr. Mark Hartman, Coastal Systems  
Mr. Aaron Boehning, Coastal Systems

**RE:** **FIELD OBSERVATION REPORT FOR THE MARINE RESOURCE AND  
STRUCTURAL SURVEY OF THE DONALDSON TRIANGLE – REEFMAKER  
ARTIFICIAL REEF IN MARTIN COUNTY, FLORIDA**

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### 1. INTRODUCTION

Coastal Systems International, Inc. (Coastal Systems) divers conducted a marine resource survey on October 9, 2017 at the Donaldson Triangle – Reefmaker artificial reef in Martin County, Florida (Reef) between the hours of 10:01 and 10:28 am to provide general information on the ecological resources present and document the physical conditions at the Reef site. The Reefmaker module is located approximately 3.8 miles north by northeast (on a bearing of 60°) from Port Sewall. See Figure 1 for a map of the Reef location and survey area. The survey was conducted pursuant to the U.S. Army Corps Permit #SAJ-1995-04128(SP-JKA) Condition 16, which requires that the artificial reefs installed are to be surveyed annually for 2 years. This monitoring represents the first annual survey of the Donaldson Triangle – Reefmaker under this Permit Condition.

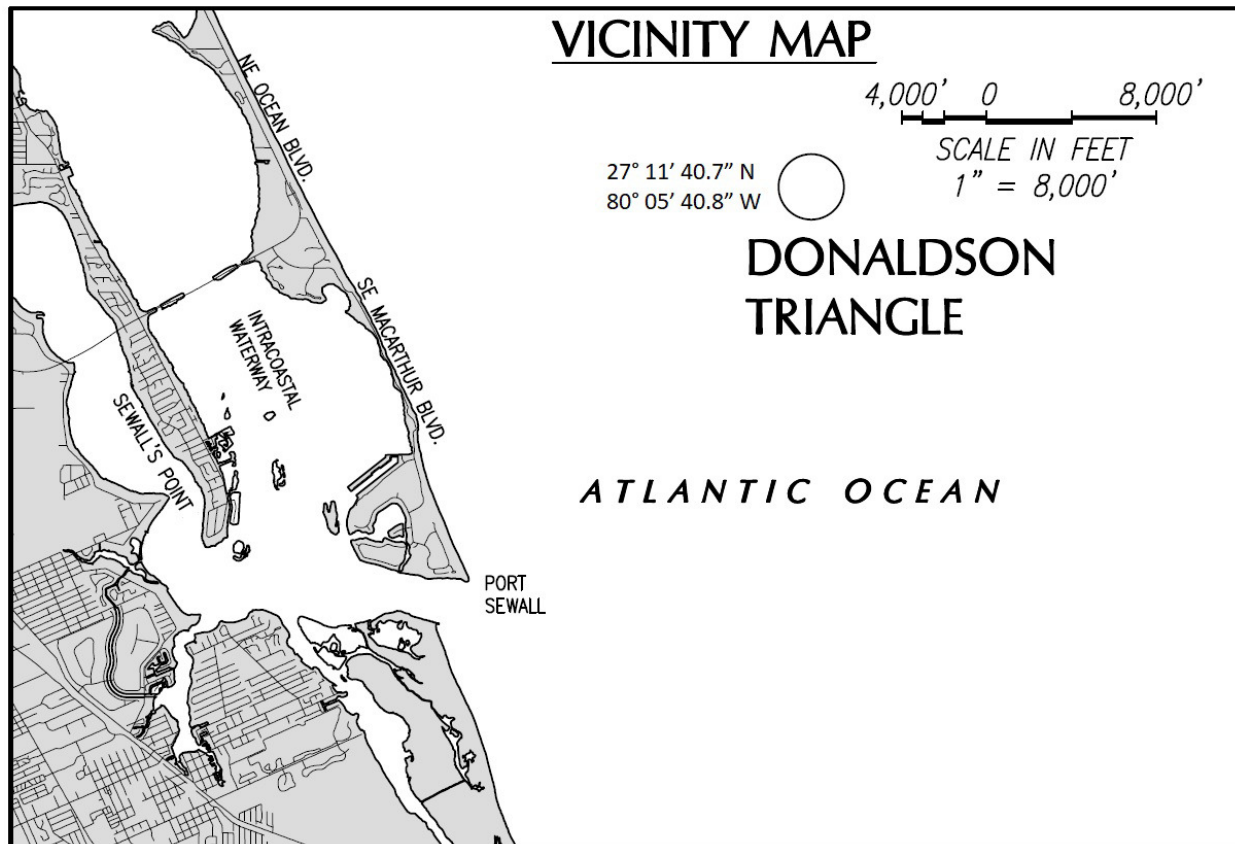
#### **Donaldson Triangle - Reefmaker**

- Location: 27° 11' 40.7" N and 80° 05' 40.8" W
- Materials: Reefmaker's "Florida Special module" (Made of concrete and steel; Martin County, n.d.)
- Maximum Depth: 53'
- Highest Reef Elevation: 48'
- Deployment Date: May 18, 2005

### 2. METHODOLOGY

#### **Multi-beam Survey**

Coastal Systems performed a multi-beam survey of Donaldson Triangle - Reefmaker, on June 28<sup>th</sup>, 2017, with sufficient overlap to ensure full coverage of the entire artificial reef. The survey was conducted using a Reson SeaBat 7125 multi-beam survey system using an Applanix Oceanmaster POS-MV inferential motion unit. Data was logged and verified using survey-grade transducers and HYPACK navigation software.



**Figure 1.** An overview of the location of the Donaldson Triangle - Reefmaker artificial reef.

### Marine Resource Survey

Two Coastal Systems biologists performed the marine resource survey at Donaldson Triangle – Reefmaker artificial reef. Underwater photographs were taken from the four cardinal directions (north, south, east, and west) and the biologists visually assessed the condition of the Reef.

Fish identification and abundance was determined using the guidelines established by the Reef Environmental Education Foundation. The Roving Diver Technique (RDT) was used for a set time period of 20 minutes per site. The first biologist swam in a completely random pattern around the reef structure focusing on locating fish species on the Reef structure and in the water column above the Reef. The biologist identified fish species, life stage, noted the abundance of species on the Reef, and recorded physical condition data for the Reef structure on underwater slates. Four abundance categories were used based on approximately how many fish were seen throughout the dive [Single (1); Few (2-10), Many (11-100), and Abundant (>100)]. Following the dive, each diver recorded the species abundance data, survey time, depth, temperature, and other environmental information on previously prepared data sheets. The second biologist focused on benthic invertebrate species identification and locating cryptic fish species found in the interstitial spaces between reef components with careful attention paid to looking under various structures and noting the information needed to identify the organisms to the lowest practical taxonomic level.



### 3. RESULTS

#### 3.1 Multi-beam Survey Results

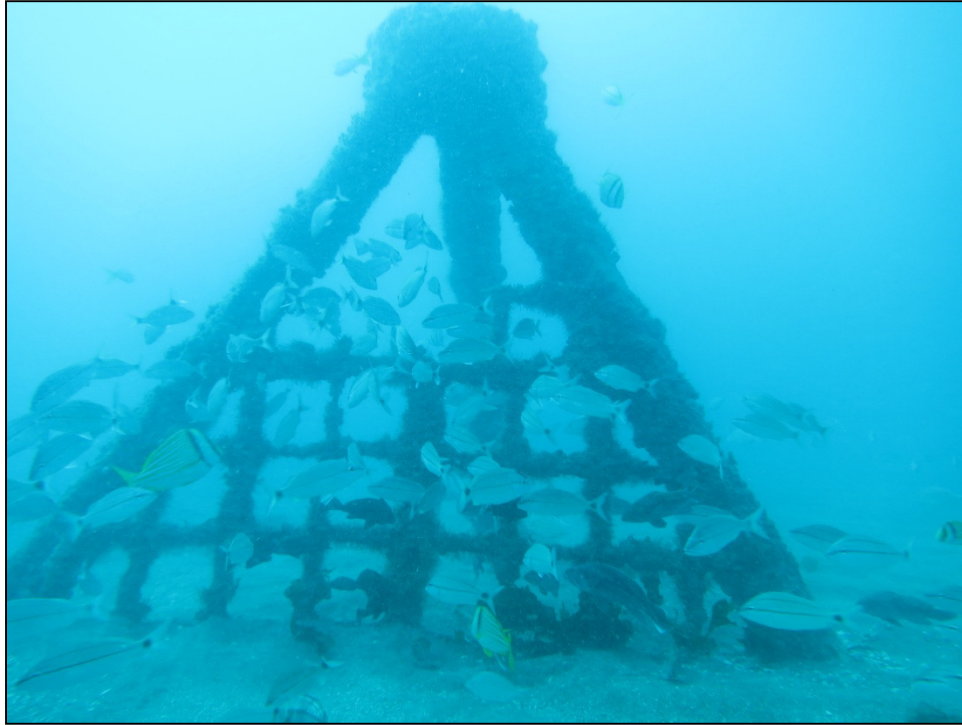
The multi-beam survey of the Donaldson Triangle - Reefmaker module was completed on June 28<sup>th</sup>, 2017, and showed the module is approximately 13.5 feet in diameter. Water depths around the artificial reef module were consistent and were 53 feet deep to the base of the Reefmaker module. The water depth was measured as 48 feet deep at the top of the artificial reef module (Figure 2).



**Figure 2.** An overview of the Donaldson Triangle - Reefmaker artificial reef depths and the layout of the concrete modules.

#### 3.2 Structural Summary

The Donaldson Triangle – Reefmaker’s Florida Special module is over 10' tall with a 12' triangular base and originally had steel panels (designed much like lattice work) fitted to the sides. The module has approximately 800 square feet of surface area and a weight in air of over 5,000 lbs. The concrete structural component of the Reefmaker Florida Special module was still intact with no noticeable damage (Photograph 1). However, the steel components of the module were heavily corroded and the steel lattice work has become separated on two sides of the module and now lays partially buried in the sand beside the module (Photograph 2). There was also some noticeable settling of the structure into the sandy bottom observed during the survey, as shown in Figure 3.

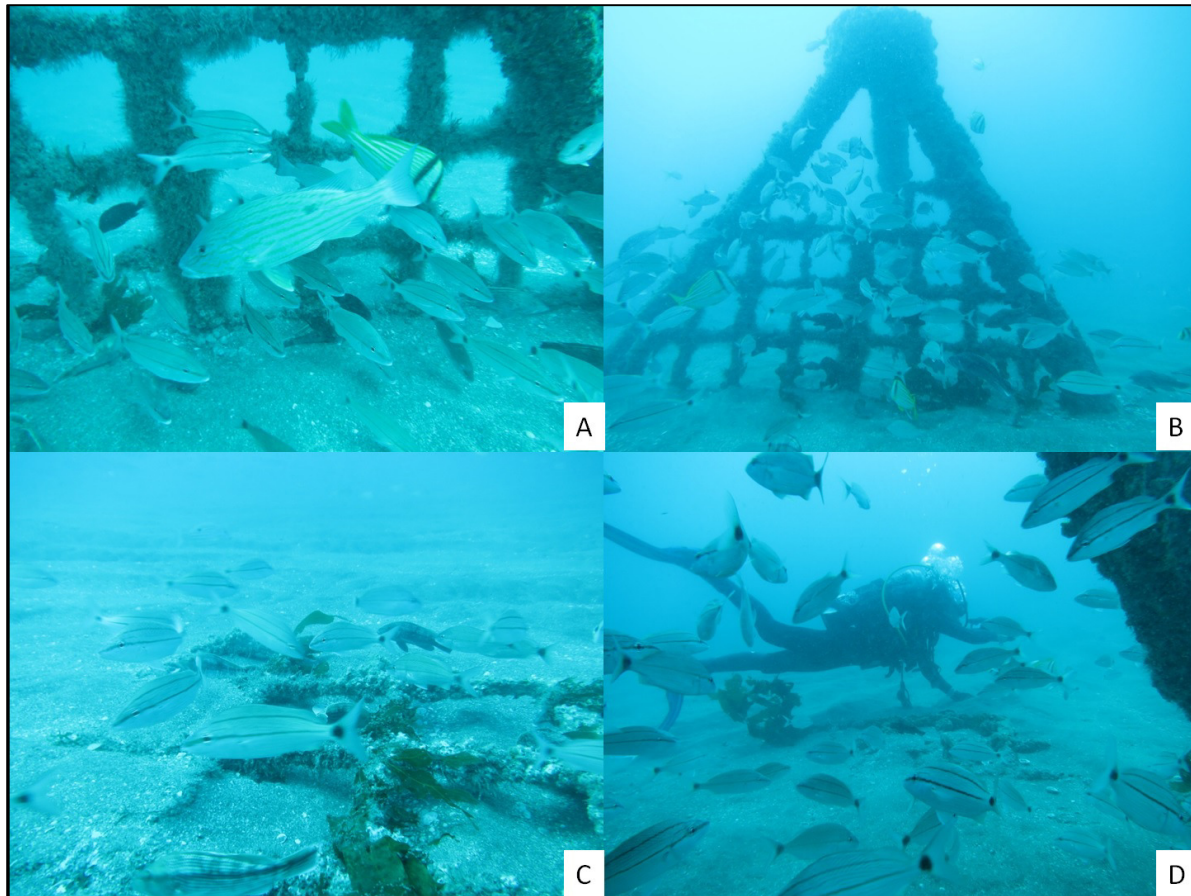


**Photograph 1.** A frontal view of the Donaldson Triangle - Reefmaker Florida Special.



**Photograph 2.** A view of one of the two sides of the Reefmaker Florida Special that have separated from the structure.





**Figure 3.** An overview of the Donaldson Triangle Reefmaker Florida Special artificial reef looking north (A), south at the Reefmaker Florida Special, (B), east (C), and west (D).

### 3.3 Marine Resource Survey Results

The submerged lands at the Reef site consisted mostly of coarse sand with silt, shell hash, shells, and sand dollar fragments. Visibility at the Reef was generally 25 to 30 feet and the current on the day of the survey was moderate.

#### Species Observed

The fish identification and abundance survey resulted in the observation of 17 fish species and 9 invertebrate species indicating a somewhat diverse assemblage on the single structure. What has limited further species diversity is likely the small Reef size, the lack of Reef complexity, relative Reef isolation, and fish species behavior towards traversing the large sandy areas in order to locate the Reef structure. Most of the fish species observed occurred in a limited abundance with the most abundant fish observed being Tomtate (*Haemulon aurolineatum*) present as both juveniles and adults (Photograph 3). One Great Barracuda (*Sphyrna barracuda*) was seen on the module apparently looking for a cleaning station, as it swam with its mouth was agape while it moved slowly around the module (Photograph 4). Many Saddled Blenny (*Malacoctenus triangulatus*) were observed inside of dead barnacles among the concrete portion of the Reefmaker structure (Photograph 5). In addition to the fish species, several other

benthic invertebrate organisms were observed on the Reef including various Hermit Crabs (Photograph 6) and Yellowline Arrow Crabs (*Stenorhynchus seticornis*; Table 2). Growing directly on the Reefmaker structure were several species of macroalgae such as *Dictyota* sp., *Laurencia* spp., and *Codium* sp. (Table 3).

**Table 1.** Fish species, life stage and abundance observed on the Donaldson Triangle - Reefmaker Reef. Stage – Adult (A) or Juvenile (J). Abundance Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A).

Common Name	Scientific Name	Stage	Abundance
Atlantic Spadefish	<i>Chaetodipterus</i>	A	F
Bigeye Scad	<i>Selar crumenophthalmus</i>	A	M
Black Seabass	<i>Centropristis striata</i>	A	F
Blue Runner	<i>Caranx crysos</i>	A	F
Cubby	<i>Pareques umbrosus</i>	J, A	F
Doctorfish	<i>Acanthurus chirurgus</i>	A	F
Gray Snapper	<i>Lutjanus griseus</i>	J, A	M
Great Barracuda	<i>Sphyraena barracuda</i>	A	S
Lane Snapper	<i>Lutjanus synagris</i>	A	F
Mackerel Scad	<i>Decapterus macarellus</i>	A	M
Porkfish	<i>Anisotremus virginicus</i>	A	F
Saddled Blenny	<i>Malacoctenus triangulatus</i>	A	F
Sand Perch	<i>Diplectrum formosum</i>	A	F
Sea Bream	<i>Archosargus rhomboidalis</i>	A	F
Sergeant Major	<i>Abudefduf saxatilis</i>	A	S
Tomtate	<i>Haemulon aurolineatum</i>	J, A	M
Yellowtail Snapper	<i>Ocyurus chrysurus</i>	A	F

**Table 2.** Benthic invertebrate species and abundance observed on the Donaldson Triangle - Reefmaker Reef. Abundance Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A).

Common Name	Scientific Name	Abundance
Algae Hydroid	<i>Thyroscyphus ramosus</i>	F
Barnacles	<i>Balanus</i> sp.	A
Encrusting Sponge	Unidentified species	F
Feather Duster Worm	<i>Sabellidae</i> sp.	F
Hermit Crabs	Unidentified species	F
Red Netted Barnacles	<i>Megabalanus</i> sp.	A
Rock Boring Urchin	<i>Echinometra lucunter</i>	F
Snail	Unidentified species	S
Yellowline Arrow Crab	<i>Stenorhynchus seticornis</i>	M

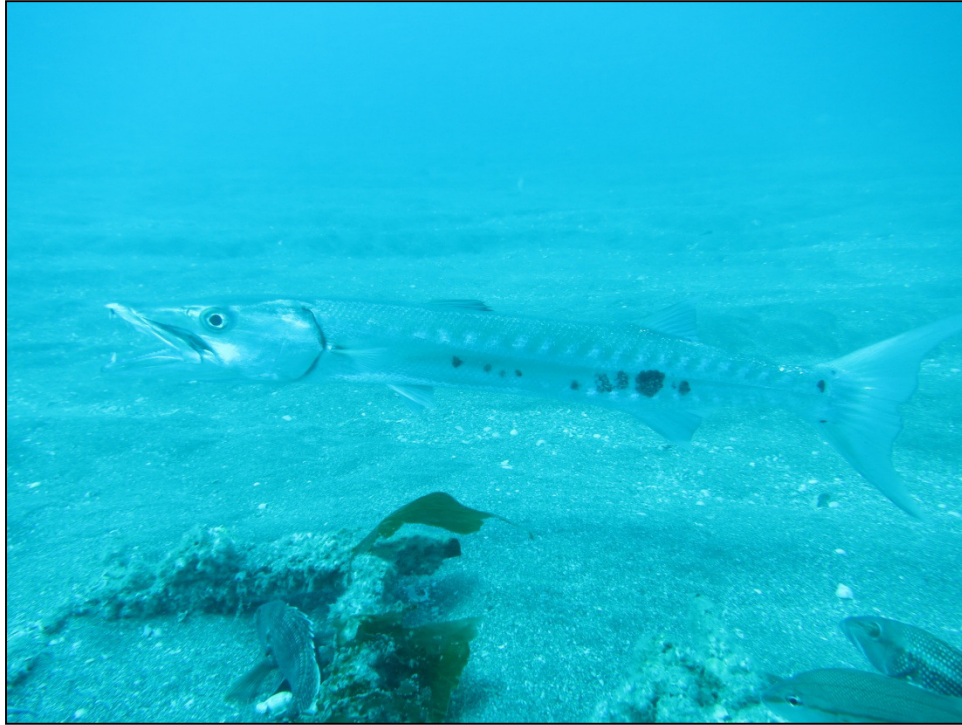


**Table 3.** Algal species observed during the marine resource survey on the Donaldson Triangle – Reefmaker artificial reef. Abundance Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A).

Common Name	Scientific Name	Abundance
Dictyota	<i>Dictyota</i> sp.	M
Green Sea Fingers	<i>Codium</i> sp.	M
Laurencia	<i>Laurencia</i> sp.	M



**Photograph 3.** Numerous Tomtate (*Haemulon aurolineatum*) observed swimming within the Donaldson Triangle - Reefmaker module.



**Photograph 4.** A Great Barracuda (*Sphyraena barracuda*) observed slowly circling the Donaldson Triangle - Reefmaker module.



**Photograph 5.** A Saddled Blenny (*Malacoctenus triangulatus*) observed living within barnacles on the Donaldson Triangle - Reefmaker module.





**Photograph 6.** Several Hermit Crabs were observed along the bottom and on the Reefmaker structure.

#### 4. CONCLUSION

The multi-beam survey of the Donaldson Triangle - Reefmaker artificial reef showed that the Reefmaker module is approximately 13.5 feet in diameter, with water depths at 53 feet deep at the base of the module. The concrete structural component of the Reefmaker Florida Special module was wholly intact with no noticeable damage. However, the steel components of the module were heavily corroded and the steel lattice work on two sides has become separated from the module and now lays partially buried in the sand beside the module. There was also some noticeable settling of the module into the sand observed during the survey.

The fish identification and abundance survey resulted in the observation of 17 fish species and 9 other invertebrate species indicating a reasonably diverse assemblage on the Reefmaker module. Most of the fish species observed were in a limited abundance, with the most abundant fish observed being Tomtate (*Haemulon aurolineatum*) present in high numbers as both juveniles and adults. Saddled Blennies (*Malacoctenus triangulatus*) were observed inside of dead barnacles encrusting the Reef structure. In addition to the fish species, several other benthic invertebrate organisms were observed on the Reef including various Hermit Crabs and Yellowline Arrow Crabs (*Stenorhynchus seticornis*). Growing directly on the Reefmaker structure were several species of macroalgae such as *Dictyota* sp., *Laurencia* spp., and *Codium* sp.



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## **FIELD OBSERVATION REPORT**

**COMM:** 348704

**DATE:** October 27, 2017

**INSPECTORS:** Ms. Megan Reising, Coastal Systems International, Inc. (Coastal Systems)  
Mr. Mark Hartman, Coastal Systems and Mr. Aaron Boehning, Coastal Systems

**RE:** **FIELD OBSERVATION REPORT FOR THE MARINE RESOURCE AND STRUCTURAL SURVEY OF THE MARTIN COUNTY SIROTKIN ARTIFICIAL REEF SITE 2 IN MARTIN COUNTY, FLORIDA**

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### **1. INTRODUCTION**

Coastal Systems International, Inc. (Coastal Systems) divers conducted a marine resource survey on October 1, 2017 at the Martin County Sirotkin artificial reef Site 2 (Reef) in Martin County, Florida between the hours of 11:50 am and 12:20 pm to provide general information on the ecological resources present and document the physical conditions at the Reef. The Reef is located approximately 7.3 miles east by northeast (on a bearing of 69°) from Port Sewall at the mouth of the St. Lucie Inlet. See Figure 1 for a map of the Reef location and survey area. The survey was conducted pursuant to the U.S. Army Corps Permit # SAJ-1995-04128(SP-JKA) Condition 16 which requires that the permittee submit a monitoring report annually for 2 years after each placement. This monitoring represents the first annual survey of Site 2.

#### **Sirotkin Site 2**

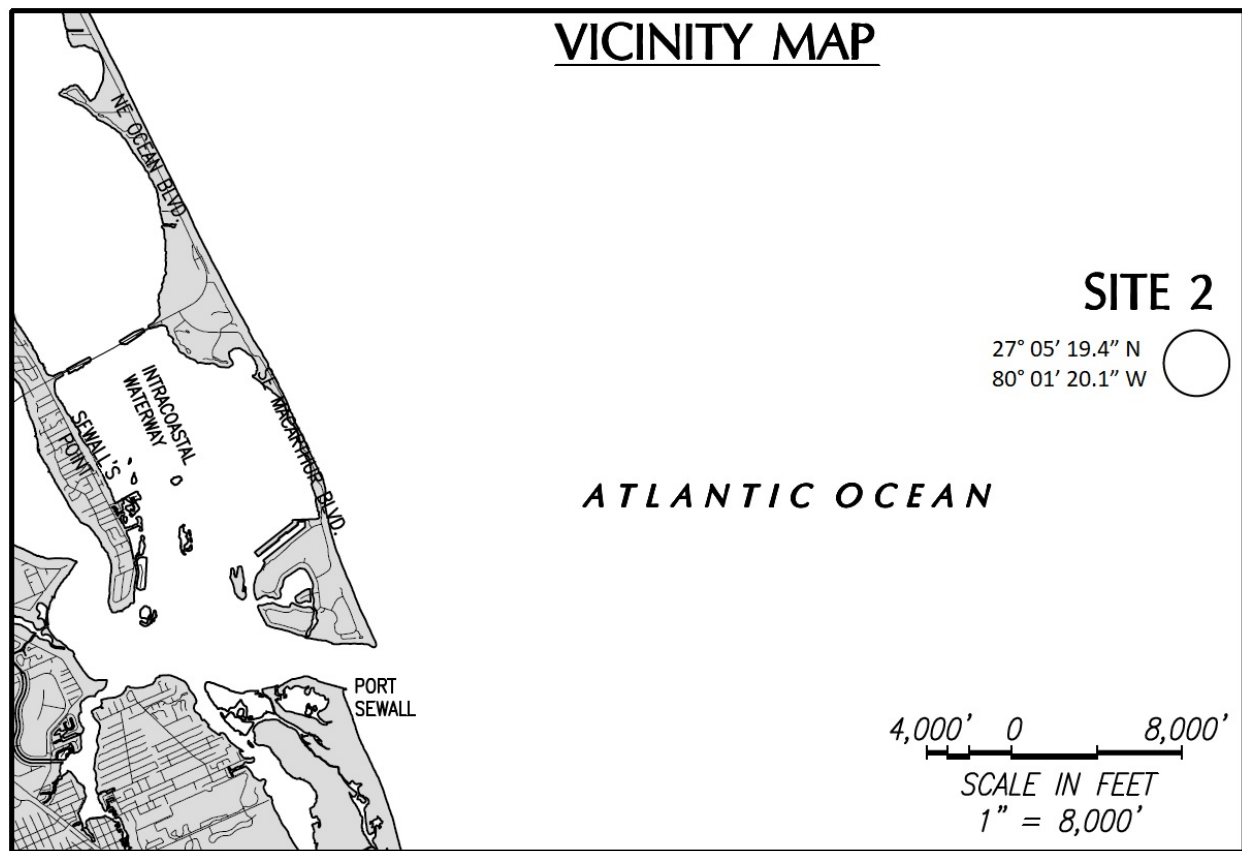
- Location: 27° 05' 19.4" N and 80° 01' 20.1" W
- Materials: 112 concrete poles and 28 concrete culverts (Martin County, n.d.)
- Maximum Depth: 90'
- Highest Reef Elevation: 85'
- Deployment Date: August 12, 2016

### **2. METHODOLOGY**

#### **Multi-beam Survey**

Coastal Systems performed a multi-beam survey of Site 2 on June 28<sup>th</sup>, 2017 with sufficient overlap to ensure full coverage of the entire Reef. The survey was conducted using a Reson SeaBat 7125 multi-beam survey system using an Applanix Oceanmaster POS-MV inferential motion unit. Data was logged and verified using survey-grade transducers and HYPACK navigation software.





**Figure 1.** An overview of the location of the Sirotkin Site 2.

### **Marine Resource Survey**

Two Coastal Systems biologists performed the marine resource survey at the Reef. Underwater photographs were taken to document the Reef from the four cardinal directions (north, south, east, and west) and the biologists visually assessed the overall durability and condition of the Reef.

Fish identification and abundance was determined using the guidelines established by the Reef Environmental Education Foundation (REEF). The Roving Diver Technique (RDT) was used for a set time period of 20 minutes at the Reef. The first biologist swam in a completely random pattern around the Reef focusing on locating fish species on the Reef structure and in the water column above the Reef. The biologist identified fish species, noted the abundance of species on the Reef, and recorded physical condition data for the Reef structure on underwater slates. Four abundance categories were used based on approximately how many fish were seen throughout the dive [Single (1); Few (2-10), Many (11-100), and Abundant (>100)]. Following the dive, each diver recorded the species abundance data, survey time, depth, temperature, and other environmental information on previously prepared data sheets. The second biologist focused on

benthic invertebrate species identification and locating cryptic fish species found in the interstitial spaces between the Reef components with careful attention paid to looking under various structures and noting the information needed to identify the organisms to the lowest practical taxonomic level.

### 3. RESULTS

#### 3.1 Multi-beam Survey Results

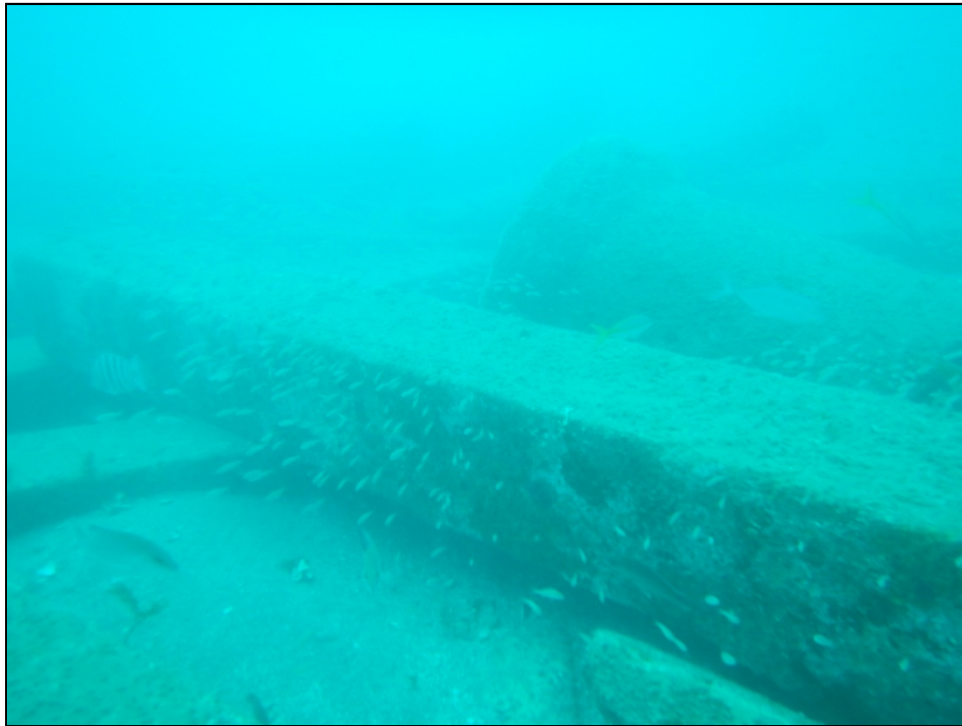
The multi-beam survey of the Reef was completed on June 28<sup>th</sup>, 2017. The Reef material is scattered throughout the bottom and is approximately 250 feet in diameter. Water depths within the Reef area ranged from 85 to 90 feet deep at the time of the survey, with the shallowest water occurring in approximately the center of the Reef, where a large (approximately 8 feet diameter) culvert is located (Figure 2).



**Figure 2.** An overview of the Sirotkin Site 2 depths and layout of concrete material.

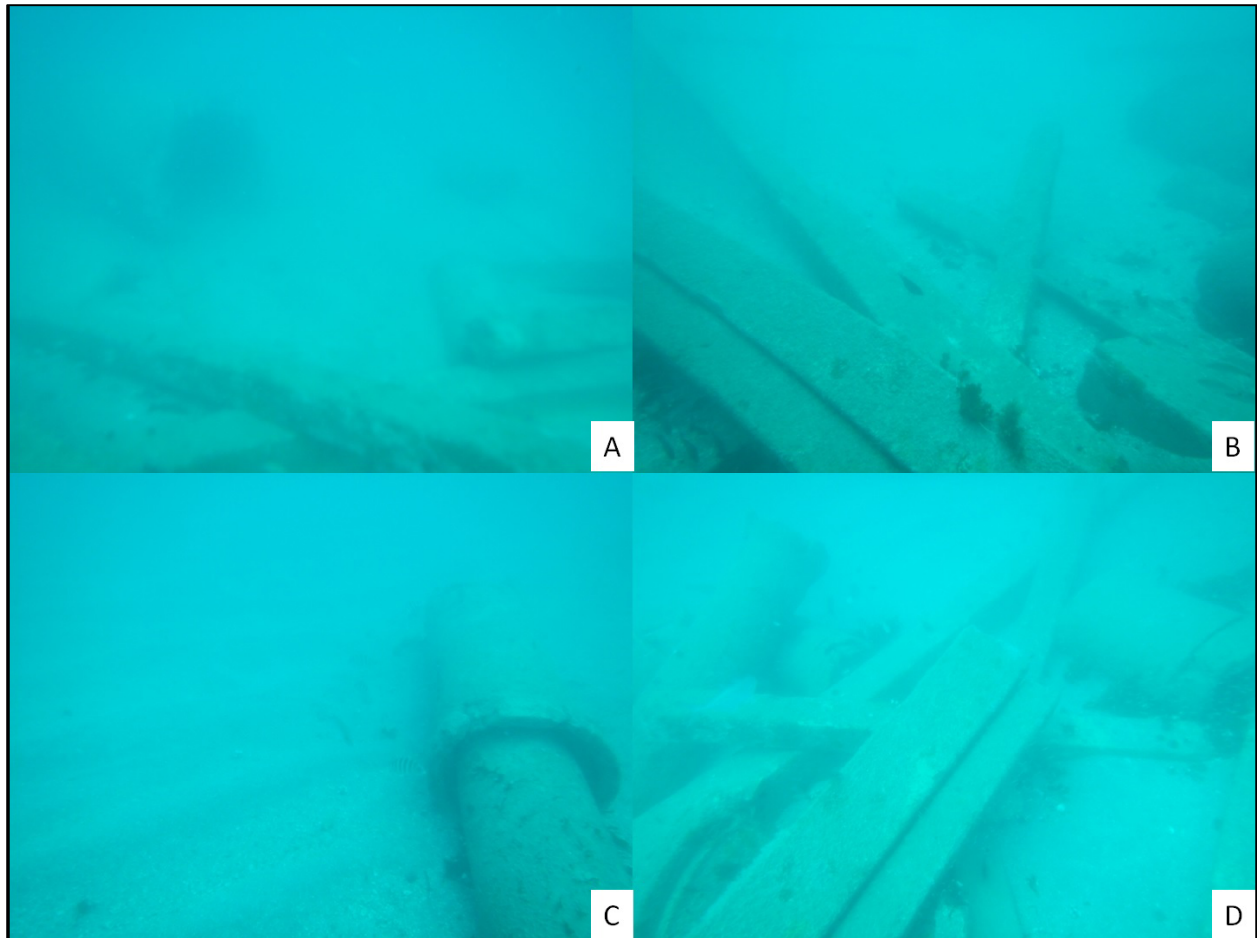
### 3.2 Structural Summary

The concrete components of the culverts and poles were intact, and very few of the steel rebar and reinforcing components were exposed or corroded (Photograph 1). It was not apparent if the reduced amount of damage to the concrete structures was due to the condition before placement, reduced to impacts to the structures due to the increased water depths, or reduced wave action after placement. Approximately 6 inches of primarily coarse sand was noted around the bases of the concrete poles, but no settlement/sinking of the Reef as a whole was apparent during the survey (Figure 3).



**Photograph 1.** No obvious damaged, exposed, or corroded rebar was observed on the concrete culverts and poles at South County Site 2.





**Figure 3.** An overview of Sirotkin artificial reef Site 2 looking north (A), south, (B), east (C), and west (D) from the tallest point on the reef.

### 3.3 Marine Resource Survey Results

The submerged lands at the Reef site consisted mostly of beach quality sand with silt, shell hash, sand dollar fragments, occasional concrete rubble, and various man-made debris. Visibility at the Reef was generally 15-20 feet.

#### Species Observed

The fish identification and abundance survey resulted in the observation of 32 species, indicating a diverse population on the Reef. The most abundant fish observed in high numbers were Tomtate (*Haemulon aurolineatum*) and Gray Snapper (*Lutjanus griseus*; Photograph 2). Approximately 10 Goliath Grouper (*Epinephelus itajara*) were also seen on the Reef as they had been aggregating to spawn in the area (Robins, n.d.; Table 1; Photograph 3). Many large, invasive exotic Lionfish (*Pterois volitans*) were also observed among the concrete culverts (Photograph 4). In addition to the fish species, several other benthic invertebrate organisms were observed on the Reef including lobster (*Panulirus argus*; Photograph 5), various Hermit Crabs



and Yellowline Arrow Crabs (*Stenorhynchus seticornis*; Photograph 6). Growing directly on the substrate were several species of macroalgae such as *Dictyopteris justii*, *Dictyota* sp., *Laurencia* sp., *Botryocladia* sp., *Sargassum* spp., and turf algae (Table 3).



**Photograph 2.** Numerous Tomtate (*Haemulon aurolineatum*) and Gray Snappers (*Lutjanus griseus*) among the concrete culverts at the Reef.

**Table 1.** Fish species and abundance observed on Sirotkin Site 2. Stage – Adult (A) or Juvenile (J). Abundance Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A).

Common Name	Scientific Name	Stage	Abundance
Belted Sandfish	<i>Serranus subligarius</i>	A	M
Black grouper	<i>Mycteroperca bonaci</i>	A	F
Blue Angelfish	<i>Holacanthus bermudensis</i>	A	F
Blue Runner	<i>Caranx crysos</i>	A	F
Blue Tang	<i>Acanthurus coeruleus</i>	A	F
Cobia	<i>Rachycentron canadum</i>	A	F
Cocoa Damselfish	<i>Stegastes variabilis</i>	A	F
Cottonwick	<i>Haemulon melanurum</i>	A	F
Cubby	<i>Pareques umbrosus</i>	J, A	M
Doctorfish	<i>Acanthurus chirurgus</i>	A	F
French Angelfish	<i>Pomacanthus paru</i>	A	F
Goliath Grouper	<i>Epinephelus itajara</i>	A	F*
Gray Snapper	<i>Lutjanus griseus</i>	J, A	A
Gray Triggerfish	<i>Balistes capricornus</i>	A	F
Lane Snapper	<i>Lutjanus synagris</i>	A	F
Porkfish	<i>Anisotremus virginicus</i>	A	M
Rainbow Wrasse	<i>Thalassoma lucasanum</i>	J	F
Red Lionfish	<i>Pterois volitans</i>	A	F
Saddled Blenny	<i>Malacoctenus triangulatus</i>	A	F
Sand Perch	<i>Diplectrum formosum</i>	A	F
Scamp	<i>Mycteroperca phenax</i>	A	S
Sharksucker	<i>Echeneis naucrates</i>	A	F
Sheepshead	<i>Archosargus probatocephalus</i>	J, A	M
Sheepshead Porgy	<i>Calamus penna</i>	A	F
Southern Stingray	<i>Dasyatis americana</i>	A	S
Spotted Eel	<i>Gymnothorax moringa</i>	A	S
Spotted Goatfish	<i>Pseudupeneus maculatus</i>	A	M
Spotted Scorpionfish	<i>Scorpaena plumieri</i>	A	F
Tomtate	<i>Haemulon aurolineatum</i>	J, A	A
Two Spot			
Cardinalfish	<i>Apogon binotatus</i>	A	M
Whitespotted Soapfish	<i>Rypticus maculatus</i>	A	M
Yellowtail Snapper	<i>Ocyurus chrysurus</i>	A	M

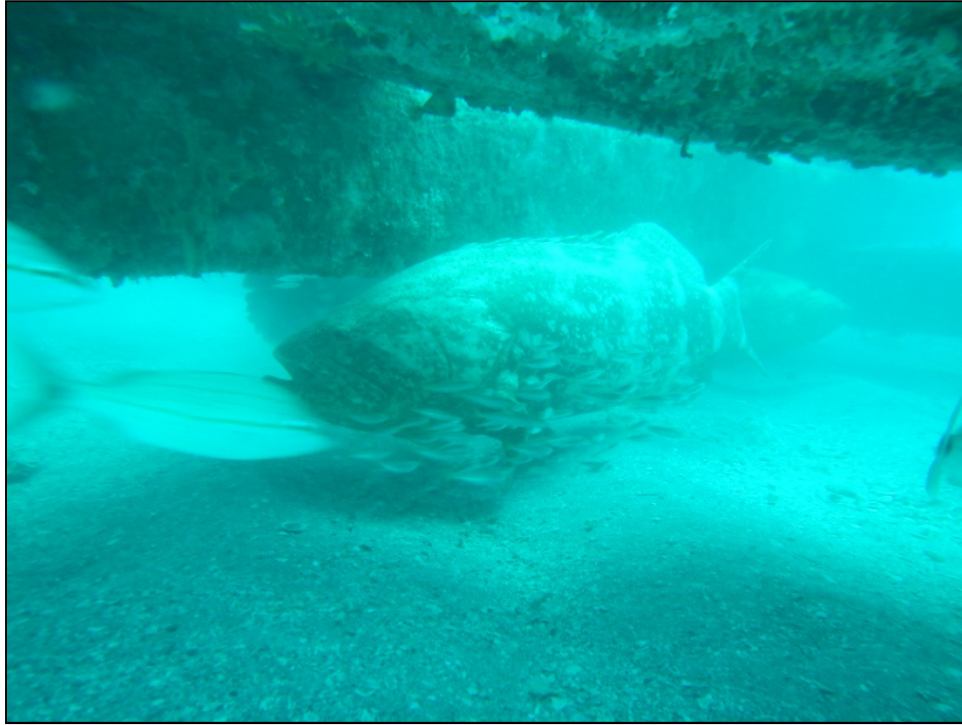
\*Goliath Grouper had spawning aggregations in the area and their numbers were inflated as a result.

**Table 2.** Benthic invertebrate species and abundance observed on Sirotkin Site 2. Abundance Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A).

Common Name	Scientific Name	Abundance
Algae Hydroid	<i>Thyrosocyphus ramosus</i>	F
Barnacles	<i>Balanus</i> sp.	A
Caribbean Spiny Lobster	<i>Panulirus argus</i>	F
Distaplia	<i>Distaplia bermudensis</i>	F
Encrusting Sponge	Unidentified species	F
Feather Duster Worm	<i>Sabellidae</i> sp.	F
Hermit Crabs	Unidentified species	F
Red Netted Barnacles	<i>Megabalanus</i> sp.	A
Rock Boring Urchin	<i>Echinometra lucunter</i>	F
Rock Snails	<i>Muricidae</i> sp.	F
Slate pencil urchin	<i>Eucidaris tribuloides</i>	F
Three rowed sea cucumber	<i>Isostichopus badionotus</i>	F
Variegated sea urchin	<i>Lytechinus variegates</i>	M
Yellowline Arrow Crab	<i>Stenorhynchus seticornis</i>	M

**Table 3.** Algal species observed during the marine resource survey. Abundance Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A).

Common Name	Scientific Name	Abundance
Dictyopteris	<i>Dictyopteris justii</i>	F
Dictyota	<i>Dictyota</i> sp.	M
Green Sea Fingers	<i>Codium</i> sp.	F
Laurencia	<i>Laurencia</i> sp.	F
Macroscopic Red Algae	<i>Halymenia</i> sp.	F
Red Grape Kelp	<i>Botryocladia</i> sp.	A
Sargassum	Sargassum spp.	F



**Photograph 3.** A Goliath Grouper (*Epinephelus itajara*) among the concrete poles at the site.



**Photograph 4.** Many large Lionfish (*Pterois volitans*) were among the concrete culverts at the Reef.





**Photograph 5.** A lobster (*Panulirus argus*) among several Cubbyu (*Pareques umbrosus*) at the base of a pole on the Reef site.



**Photograph 6.** Yellowline Arrow Crabs (*Stenorhynchus seticornis*) were observed between the concrete poles.

#### 4. CONCLUSION

The multi-beam survey of the Reef showed the Reef material is scattered throughout the bottom approximately 250 feet in diameter in water ranged from 85 to 90 feet deep. The shallowest water occurring in approximately the center of the Reef where a large diameter culvert is situated. The concrete components of the culverts and poles were intact, only approximately 6 inches of primarily coarse sand was noted around the bases of the concrete poles.

The fish identification and abundance survey resulted in the observation of 32 species, indicating a diverse population on the Reef. The most abundant fish observed in high numbers were Tomtate (*Haemulon aurolineatum*) and Gray Snapper (*Lutjanus griseus*). Approximately 10 Goliath Grouper (*Epinephelus itajara*) were also seen on the Reef as they had been aggregating to spawn in the area. Many large, invasive exotic Lionfish (*Pterois volitans*) were also observed among the concrete culverts. In addition to the fish species, several other benthic invertebrate organisms were observed on the Reef including lobster, various Hermit Crabs and Yellowline Arrow Crabs. Growing directly on the substrate were several species of macroalgae such as *Dictyota* sp., *Laurencia* sp., *Botryocladia* sp., *Sargassum* spp., and turf algae.

## 5. REFERENCES

Martin County. (n.d.). Retrieved October 16, 2017, from <https://www.martin.fl.us/martin-county-services/artificial-reef-locations>

Robins, R. H. (n.d.). Goliath Grouper. Retrieved October 16, 2017, from <https://www.floridamuseum.ufl.edu/fish/discover/species-profiles/epinephelus-itajara>



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## FIELD OBSERVATION REPORT

**COMM:** 348704

**DATE:** October 25, 2017

**INSPECTOR:** Ms. Megan Reising, Coastal Systems International, Inc. (Coastal Systems)  
Mr. Mark Hartman, Coastal Systems  
Mr. Aaron Boehning, Coastal Systems

**RE:** **FIELD OBSERVATION REPORT FOR THE MARINE RESOURCE AND  
STRUCTURAL SURVEY OF THE SITE 14 ARTIFICIAL REEF IN MARTIN  
COUNTY, FLORIDA**

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### 1. INTRODUCTION

Coastal Systems International, Inc. (Coastal Systems) divers conducted a marine resource survey on September 30, 2017 at the South County artificial reef Site 14 in Martin County, Florida (Reef) between the hours of 11:55 am and 12:25 pm to provide general information on the ecological resources present and document the physical conditions at the Reef. The Reef is located at 8.5 miles southeast by east (on a bearing of 125°) from Port Sewall at the mouth of the St. Lucie Inlet. See Figure 1 for a map of the Reef location and survey area. The survey was conducted pursuant to the U.S. Army Corps Permit # SAJ-2006-1955(IP-JWH) Condition 16, which requires that the permittee submit a monitoring report annually for 2 years after each placement. This monitoring represents the first annual survey of the South County artificial reef Site 14.

#### Site 14

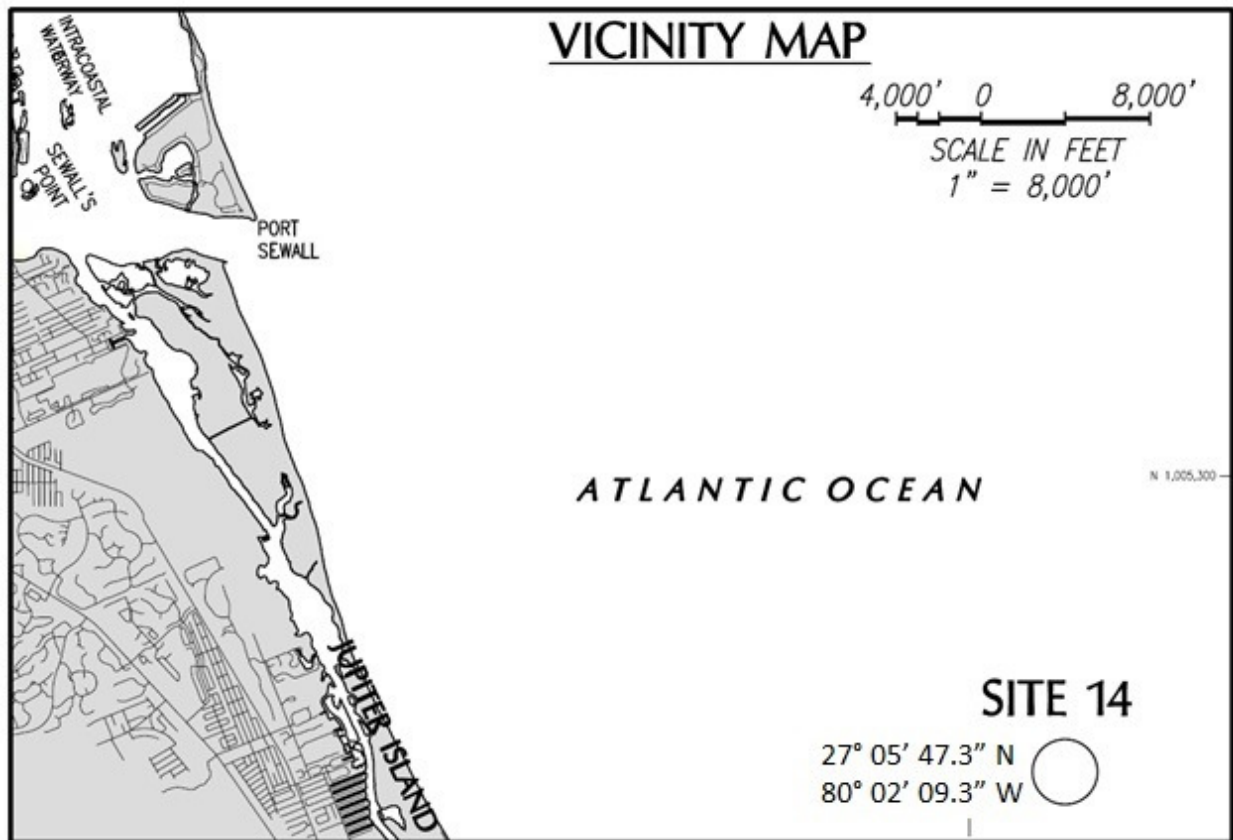
- Location: 27° 05' 47.3" N and 80° 02' 09.3" W
- Materials: 240 concrete culverts and 145 concrete poles and slabs (Martin County, n.d.)
- Maximum Depth: 77'
- Highest Reef Elevation: 65'
- Deployment Date: August 2, 2016

### 2. METHODOLOGY

#### Multi-beam Survey

Coastal Systems performed a multi-beam survey of Site 14, on June 27th, 2017, with sufficient overlap to ensure full coverage of the entire Reef. The survey was conducted using a Reson SeaBat 7125 multi-beam survey system using an Applanix Oceanmaster POS-MV inferential motion unit. Data was logged and verified using survey-grade transducers and HYPACK navigation software.





**Figure 1.** An overview of the location of the South County Site 14.

### Marine Resource Survey

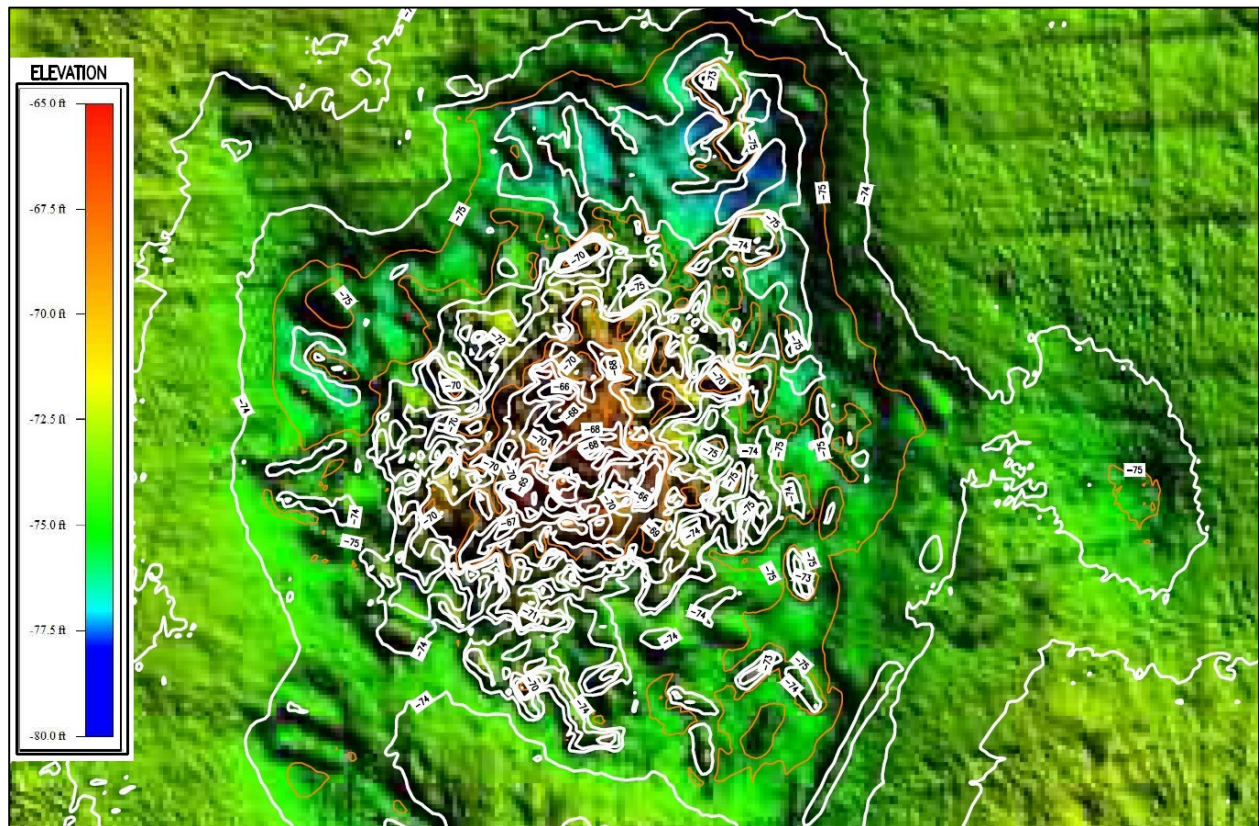
Two Coastal Systems biologists performed the marine resource survey at Site 14. Underwater photographs were taken to document the Reef from the four cardinal directions (north, south, east, and west) and the biologists visually assessed the durability and condition of the reef.

Fish identification and abundance was determined using the guidelines established by the Reef Environmental Education Foundation (REEF). The Roving Diver Technique (RDT) was used for a set time period of 20 minutes per site. The first biologist swam in a random pattern around the reef structure focusing on locating fish species on the Reef and in the water column above the Reef. This biologist identified the fish species, life stage (juvenile/ adult), noted the abundance of each species on the Reef, and recorded the physical condition data for the Reef structure on an underwater slate. Four abundance categories were used based on approximately how many fish were seen throughout the dive [Single (1); Few (2-10), Many (11-100), and Abundant (>100)]. Following the dive, each diver recorded the species abundance data, survey time, depth, temperature, and other environmental information on previously prepared data sheets. The second biologist focused on benthic invertebrate species identification and locating cryptic fish species found in the interstitial spaces between reef components with careful attention paid to looking under various structures and noting the information needed to identify the organisms to the lowest practical taxonomic level.

### 3. RESULTS

#### 3.1 Multi-beam Survey Results

The multi-beam survey of the Reef was completed on June 27<sup>th</sup>, 2017. The South County Reef Site 14 is approximately 90 feet in diameter. Water depths within the Reef area ranged from 65 to 77 feet deep at the time of the survey, with the shallowest water occurring just southwest of the approximate center of the Reef (Figure 2).



**Figure 2.** An overview of the South County Reef Site 14 depths and layout of concrete material.

#### 3.2 Structural Summary

The concrete components of the culverts and poles were intact (Photograph 1); however, the steel rebar and reinforcing components were exposed and corroded on many of the structures, especially at the ends of the culverts (Photograph 2). It was not apparent if the damage was there before placement, due to impacts sustained during placement, or the result of the combination of wave action, erosion, and corrosion after placement. Additionally, approximately 2 feet of primarily coarse sand was seen built up around the bases of the concrete culverts and poles, and the Reef appears to lie in a shallow sandy depression, so some scouring seems to have occurred (Figure 3).

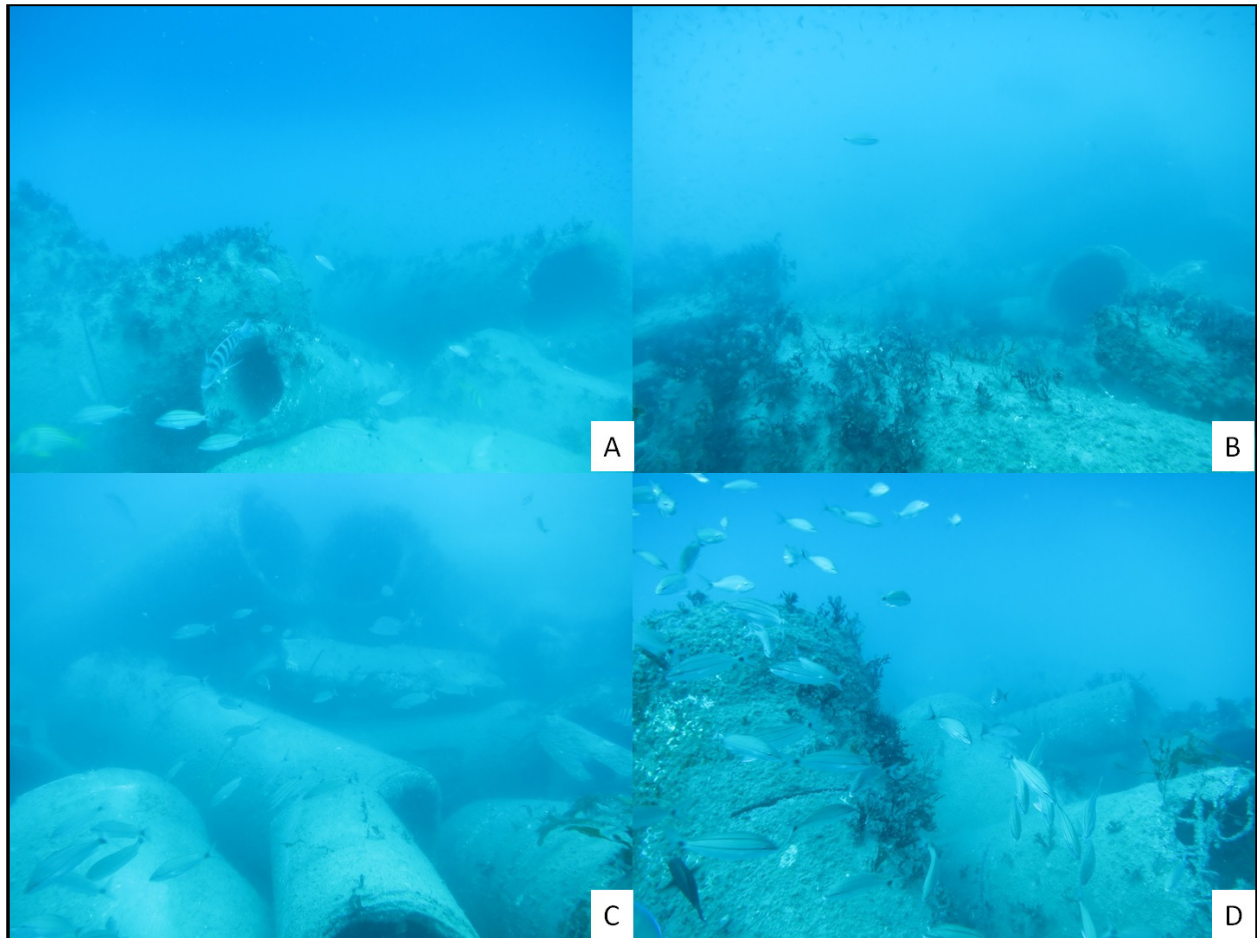




**Photograph 1.** An aerial view of the concrete culverts, poles, and slabs on the Reef.



**Photograph 2.** Damage and exposed, corroded, rebar typical of many of the ends of the concrete culverts on poles on the Reef.



**Figure 3.** An overview of the South County artificial reef Site 14 looking north (A), south, (B), east (C), and west (D) from the tallest point on the Reef.

### 3.3 Marine Resource Survey Results

The submerged lands at the artificial reef site consisted mostly of beach quality sand with occasional silt, shell hash, sand dollar fragments, concrete fragments, and various man-made debris. Visibility on the Reef was generally 30-40 feet at the time of the survey.

#### Species Observed

The fish identification and abundance survey resulted in the observation of 27 species, indicating a diverse population on the Reef. The most abundant fish observed were Tomtate (*Haemulon aurolineatum*) and Gray Snapper (*Lutjanus griseus*), and a large school of Mackerel Scad (*Decapterus macarellus*), a pelagic fish and likely affiliated with the site permanently. Due to the timing of the survey, 5 Goliath Grouper were seen on the Reef as they had been aggregating to spawn in the area (Robins, n.d.; Table 1; Photograph 4). Many large, invasive exotic Lionfish (*Pterois volitans*) were also observed among the concrete culverts (Photograph 5). In addition to the fish species, several benthic invertebrate organisms were observed on the Reef including Barnacles, Sponges, Tunicates, Hydroids, Hermit Crabs and Yellowline Arrow Crabs (*Stenorhynchus seticornis*; Table 2; Photograph 6). Sand Dollars (*Clypeaster subdepressus*) and



Sea Biscuits (*Clypeaster rosaceus*) were observed in the interstitial spaces between the culverts and poles. Growing directly on the substrate were several species of macroalgae such as *Dictyota* sp., *Laurencia* sp., *Botryocladia* sp., *Sargassum* spp., and turf algae (Table 3).

**Table 1.** Fish species recorded on Site 14. Stage – Adult (A) or Juvenile (J). Abundance Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A).

Common Name	Scientific Name	Stage	Abundance
Belted Sandfish	<i>Serranus subligarius</i>	A	F
Black Margate	<i>Anisotremus surinamensis</i>	A	M
Blue Angelfish	<i>Holacanthus bermudensis</i>	A	F
Blue Runner	<i>Caranx crysos</i>	A	F
Blue Tang	<i>Acanthurus coeruleus</i>	A	F
Bluehead Wrasse	<i>Thalassoma bifasciatum</i>	A	F
Cocoa Damselfish	<i>Stegastes variabilis</i>	A	F
Common Snook	<i>Centropomus undecimalis</i>	A	F
Cottonwick	<i>Haemulon melanurum</i>	A	F
Cubby	<i>Pareques umbrosus</i>	J, A	M
Doctorfish	<i>Acanthurus chirurgus</i>	A	F
French Angelfish	<i>Pomacanthus paru</i>	A	F
Goliath Grouper	<i>Epinephelus itajara</i>	A	F*
Gray Angelfish	<i>Pomacanthus arcuatus</i>	A	F
Gray Snapper	<i>Lutjanus griseus</i>	J, A	A
Gray Triggerfish	<i>Balistes capriscus</i>	A	S
Highhat	<i>Equetus acuminatus</i>	A	F
Mackerel Scad	<i>Decapterus macarellus</i>	A	A
Palehead Blenny	<i>Labrisomus gobio</i>	A	F
Porkfish	<i>Anisotremus virginicus</i>	A	F
Queen Angelfish	<i>Holacanthus ciliaris</i>	A	F
Red Lionfish	<i>Pterois volitans</i>	A	F
Sergeant Major	<i>Abudefduf saxatilis</i>	A	F
Sheepshead	<i>Archosargus probatocephalus</i>	J, A	M
Sheepshead Porgy	<i>Calamus penna</i>	A	F
Spotted Scorpionfish	<i>Scorpaena plumieri</i>	A	F
Tomtate	<i>Haemulon aurolineatum</i>	J, A	A

\*The Goliath Grouper currently have spawning aggregations in the area and their numbers are inflated as a result.

**Table 2.** Invertebrate species observed during the marine resource survey. Abundance Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A).

Common Name	Scientific Name	Abundance
Algae Hydroid	<i>Thyrosocyphus ramosus</i>	F
Ascidian Tunicates	<i>Polyandrocarpa</i> sp.	S
Barnacles	<i>Balanus</i> sp.	A
Button Tunicates	<i>Distaplia corolla</i>	F
Clavelina Tunicates	<i>Clavelina</i> sp.	F
Distaplia	<i>Distaplia bermudensis</i>	F
Encrusting Sponge	Unidentified species	F
Feather Duster Worm	<i>Sabellidae</i> sp.	F
Half-naked Pen Shell	<i>Atrina seminude</i>	S
Hermit Crabs	Unidentified species	F
Red Netted Barnacles	<i>Megabalanus</i> sp.	A
Sand Dollar	<i>Clypeaster subdepressus</i>	M
Sea Biscuit	<i>Clypeaster rosaceus</i>	M
Yellowline Arrow Crab	<i>Stenorhynchus seticornis</i>	M

**Table 3.** Algal species observed during the marine resource survey. Abundance Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A).

Common Name	Scientific Name	Abundance
Dictyota	<i>Dictyota</i> sp.	M
Green Sea Fingers	<i>Codium</i> sp.	A
Laurencia	<i>Laurencia</i> sp.	M
Macroscopic Red Algae	<i>Halymenia</i> sp.	F
Red Grape Kelp	<i>Botryocladia</i> sp.	A
Sargassum	Sargassum spp.	M



**Photograph 3.** Numerous Tomtate (*Haemulon aurolineatum*) above the concrete culverts at the Reef.



**Photograph 4.** A Goliath Grouper (*Epinephelus itajara*) among the concrete culverts at the Reef.





**Photograph 5.** Several Lionfish (*Pterois volitans*) were among the concrete culverts at the Reef.



**Photograph 6.** Several Yellowline Arrow Crabs (*Stenorhynchus seticornis*) were observed between the culverts and pipes on the Reef.



#### 4. CONCLUSION

The multi-beam survey showed the Reef is approximately 90 feet in diameter and ranged from 65 to 77 feet deep, with the shallowest water occurring just southwest of the approximate center of the Reef.

The concrete components of the culverts and poles were intact; however, the steel rebar and reinforcing components were exposed and corroded on many of the structures, especially at the ends of the culverts. Approximately 2 feet of coarse sand was seen built up around the bases of the concrete culverts and poles, and the Reef now appears to lie in a shallow sandy depression, indicating some scouring seems to have occurred.

The fish identification and abundance survey resulted in the observation of 27 species, indicating a diverse population on the Reef. The most abundant fish observed were Tomtate (*Haemulon aurolineatum*) and Gray Snapper (*Lutjanus griseus*), and a large pelagic school of Mackerel Scad (*Decapterus macarellus*). Due to the timing of the survey, 5 Goliath Grouper were seen on the Reef among the concrete culverts as they had been aggregating to spawn in the area. In addition to the fish species, several benthic invertebrate organisms were observed on the Reef including Barnacles, Sponges, Tunicates, Hydroids, Hermit Crabs and Yellowline Arrow Crabs (*Stenorhynchus seticornis*), Sand Dollars (*Clypeaster subdepressus*), and Sea Biscuits (*Clypeaster rosaceus*). Growing directly on the substrate were several species of macroalgae such as *Dictyota* sp., *Laurencia* sp., *Botryocladia* sp., *Sargassum* spp., and turf algae.

## 5. REFERENCES

Martin County. (n.d.). Retrieved October 16, 2017, from <https://www.martin.fl.us/martin-county-services/artificial-reef-locations>

Robins, R. H. (n.d.). Goliath Grouper . Retrieved October 16, 2017, from <https://www.floridamuseum.ufl.edu/fish/discover/species-profiles/epinephelus-itajara>









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## FIELD OBSERVATION REPORT

**COMM:** 348704

**DATE:** October 25, 2017

**INSPECTORS:** Ms. Megan Reising, Coastal Systems International, Inc. (Coastal Systems)  
Mr. Mark Hartman, Coastal Systems and Mr. Aaron Boehning, Coastal Systems

**RE:** **FIELD OBSERVATION REPORT FOR THE MARINE RESOURCE AND STRUCTURAL SURVEY OF THE SOUTH COUNTY ARTIFICIAL REEF SITE 15 IN MARTIN COUNTY, FLORIDA**

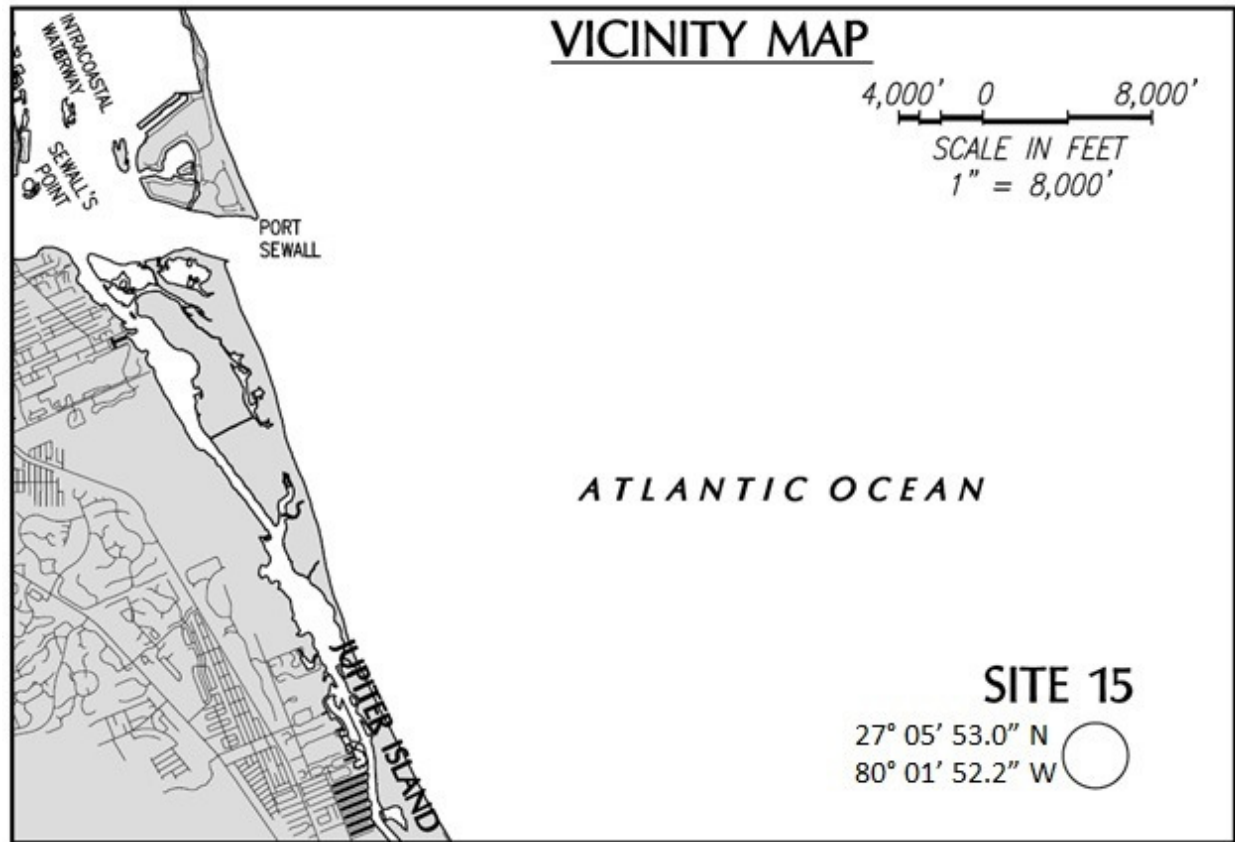
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### 1. INTRODUCTION

Coastal Systems International, Inc. (Coastal Systems) divers conducted a marine resource survey on September 30, 2017 at the South County Reef artificial reef Site 15 (Reef) in Martin County, Florida (Reef) between the hours of 9:40 and 10:15 am to provide general information on the ecological resources present and document the physical conditions at the Reef. The Reef is located approximately 8.7 miles southeast by east (on a bearing of 123°) from Port Sewall at the mouth of the St. Lucie Inlet. See Figure 1 for a map of the Reef location and survey area. The survey was conducted pursuant to the U.S. Army Corps Permit # SAJ-2006-1955(IP-JWH) Condition 16 which requires that the permittee submit a monitoring report annually for 2 years after each placement. This monitoring represents the first annual survey of Site 15.

#### Site 15

- Location: 27° 05' 53.0" N and 80° 01' 52.2" W
- Materials: 203 concrete culverts and 112 concrete poles (Martin County, n.d.)
- Maximum Depth: 77'
- Highest Reef Elevation: 67'
- Deployment Date: August 5, 2016



**Figure 1.** An overview of the location of the South County Site 15.

## 2. METHODOLOGY

### Multi-beam Survey

Coastal Systems performed a multi-beam survey of Site 15 on June 27th, 2017 with sufficient overlap to ensure full coverage of the entire Reef. The survey was conducted using a Reson SeaBat 7125 multi-beam survey system using an Applanix Oceanmaster POS-MV inferential motion unit. Data was logged and verified using survey-grade transducers and HYPACK navigation software.

### Marine Resource Survey

Two Coastal Systems biologists performed the marine resource survey at the Reef. Underwater photographs were taken to document the Reef from the four cardinal directions (north, south, east, and west) and the biologists visually assessed the overall durability and condition of the Reef.

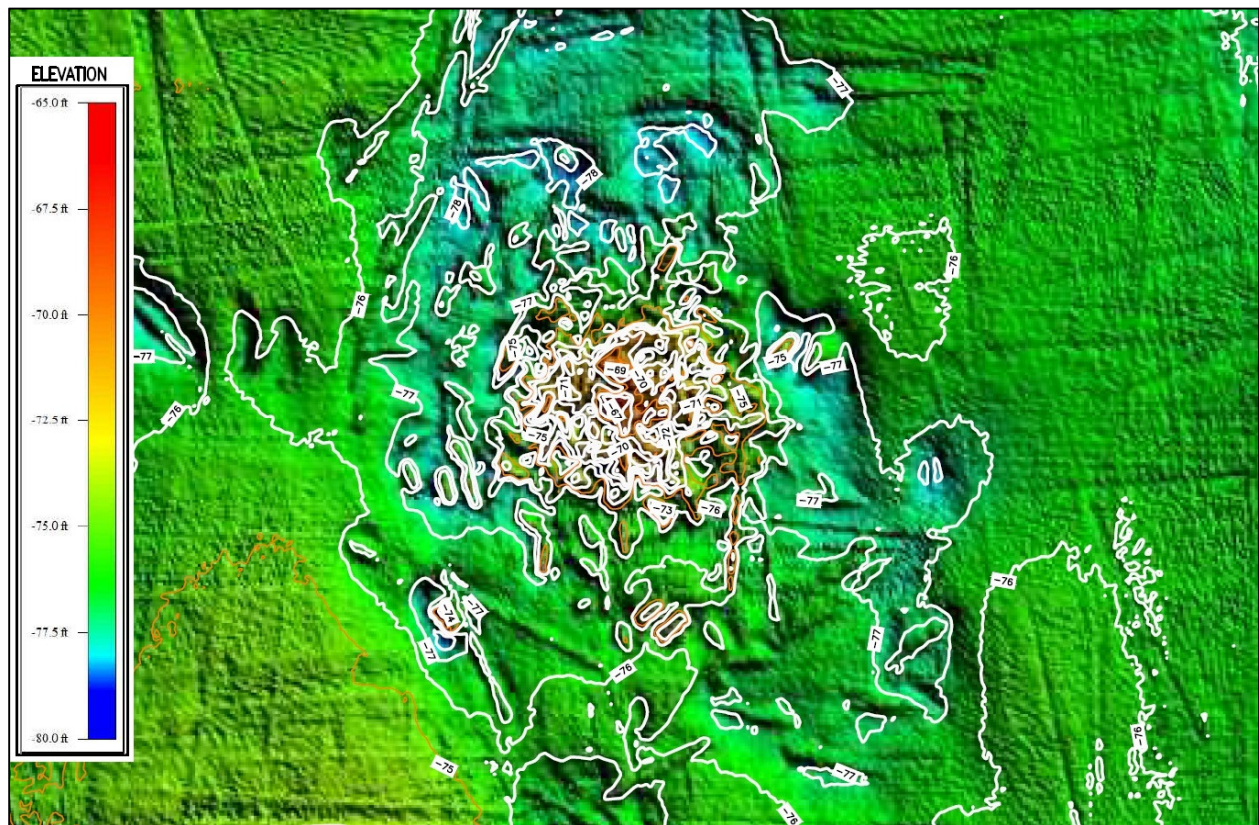
Fish identification and abundance was determined using the guidelines established by the Reef Environmental Education Foundation (REEF). The Roving Diver Technique (RDT) was used for a set time period of 20 minutes at the Reef. The first biologist swam in a completely random pattern around the Reef focusing on locating fish species on the Reef structure and in the water

column above the Reef. The biologist identified fish species, noted the abundance of species on the Reef, and recorded physical condition data for the Reef structure on underwater slates. Four abundance categories were used based on approximately how many fish were seen throughout the dive [Single (1); Few (2-10), Many (11-100), and Abundant (>100)]. Following the dive, each diver recorded the species abundance data, survey time, depth, temperature, and other environmental information on previously prepared data sheets. The second biologist focused on benthic invertebrate species identification and locating cryptic fish species found in the interstitial spaces between the Reef components with careful attention paid to looking under various structures and noting the information needed to identify the organisms to the lowest practical taxonomic level.

### 3. RESULTS

#### 3.1 Multi-beam Survey Results

The multi-beam survey of the Reef was completed on June 27<sup>th</sup>, 2017. The Reef is approximately 70 feet in diameter. Water depths within the Reef area ranged from 67 to 77 feet deep at the time of the survey, with the shallowest water occurring just west of the center of the Reef (Figure 2).



**Figure 2.** An overview of the South County Site 15 depths and layout of concrete material.

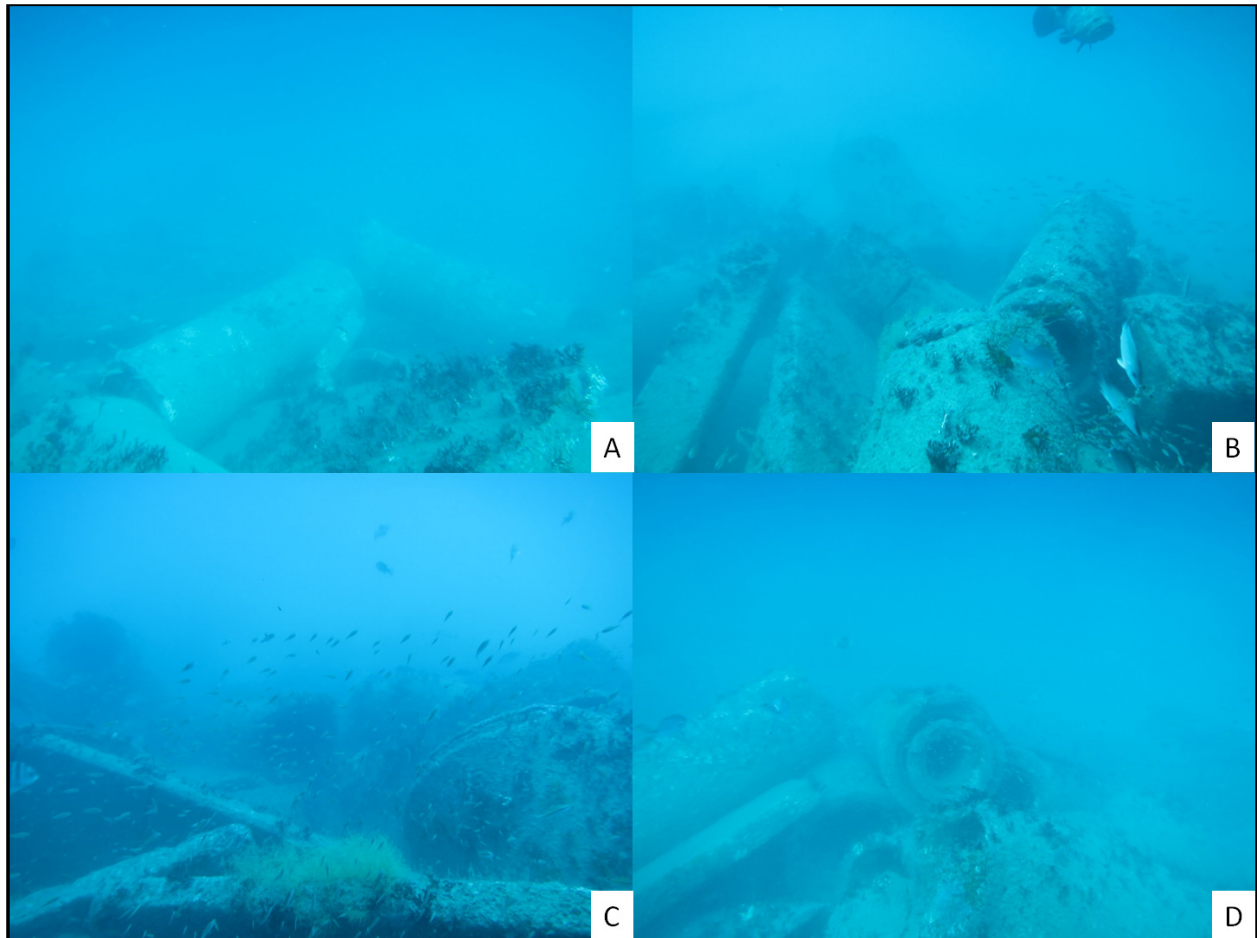


### 3.2 Structural Summary

The concrete components of the culverts and poles were intact; however, the steel rebar and reinforcing components were exposed and corroded on many of the structures (Photograph 1). It was not apparent if the damage was there before placement, due to impacts sustained during placement, or the result of wave action, erosion and corrosion after placement. Approximately 2 feet of primarily coarse sand was noted around the bases of the concrete culverts and poles, but no settlement/sinking of the Reef as a whole was apparent during the survey (Figure 3).



**Photograph 1.** Damaged, exposed and corroded rebar typical of many of the concrete culverts and poles at South County Site 15.



**Figure 3.** An overview of South County artificial reef Site 15 looking north (A), south, (B), east (C), and west (D) from the tallest point on the reef.

### 3.3 Marine Resource Survey Results

The submerged lands at the Reef site consisted mostly of beach quality sand with silt, shell hash, sand dollar fragments, occasional concrete rubble, and various man-made debris. Visibility at the Reef was generally 20-25 feet. However, movement of the large Goliath Groupers (*Epinephelus itajara*), when startled by the divers presence, would suspend sediment in the water column reducing visibility in their vicinity to less than 5 feet.

#### Species Observed

The fish identification and abundance survey resulted in the observation of 33 species, indicating a diverse population on the Reef. The most abundant fish observed were Tomtate (*Haemulon aurolineatum*) and Gray Snapper (*Lutjanus griseus*) which were present in high numbers as both juveniles and adults (Photograph 2). Approximately 20 Goliath Grouper (*Epinephelus itajara*) were seen on the Reef as they had been aggregating to spawn in the area (Robins, n.d.; Table 1; Photograph 3). A large Bull Shark (*Carcharhinus leucas*) was also observed at the Reef, but quickly retreated once the divers approached the Reef (Photograph 4). Many large, invasive

exotic Lionfish (*Pterois volitans*) were also observed among the concrete culverts (Photograph 5). In addition to the fish species, several other benthic invertebrate organisms were observed on the Reef including various Hermit Crabs and Yellowline Arrow Crabs (*Stenorhynchus seticornis*). Sand Dollars (*Clypeaster subdepressus*) and Sea Biscuits (*Clypeaster rosaceus*) were observed in the interstitial spaces between the culverts and poles (Table 2, Photograph 6). Growing directly on the substrate were several species of macroalgae such as *Dictyota* sp., *Laurencia* sp., *Botryocladia* sp., *Sargassum* spp., and turf algae (Table 3).



**Photograph 2.** Numerous Tomtate (*Haemulon aurolineatum*) and Gray Snappers (*Lutjanus griseus*) among the concrete culverts at the Reef.



**Table 1.** Fish species and abundance observed on South County Site 15. Stage – Adult (A) or Juvenile (J). Abundance Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A).

Common Name	Scientific Name	Stage	Abundance
Bar Jack	<i>Caranx ruber</i>	A	F
Barred Hamlet	<i>Hypoplectrus puella</i>	A	F
Belted Sandfish	<i>Serranus subligarius</i>	A	M
Black Margate	<i>Anisotremus surinamensis</i>	A	M
Blue Angelfish	<i>Holacanthus bermudensis</i>	A	F
Blue Runner	<i>Caranx crysos</i>	A	F
Blue Tang	<i>Acanthurus coeruleus</i>	A	F
Bull Shark	<i>Carcharhinus leucas</i>	A	S
Cottonwick	<i>Haemulon melanurum</i>	A	F
Cubby	<i>Pareques umbrosus</i>	J, A	M
Doctorfish	<i>Acanthurus chirurgus</i>	A	F
French Angelfish	<i>Pomacanthus paru</i>	A	F
Goliath Grouper	<i>Epinephelus itajara</i>	A	M*
Gray Angelfish	<i>Pomacanthus arcuatus</i>	A	F
Gray Snapper	<i>Lutjanus griseus</i>	J, A	A
Gray Triggerfish	<i>Balistes capriscus</i>	A	S
Graysby	<i>Cephalopholis cruentata</i>	A	S
Highhat	<i>Equetus acuminatus</i>	A	F
Mackerel Scad	<i>Decapterus macarellus</i>	A	F
Porkfish	<i>Anisotremus virginicus</i>	J, A	M
Rainbow Parrotfish	<i>Scarus guacamaia</i>	A	F
Rainbow Runner	<i>Elagatis bipinnulata</i>	A	F
Red Grouper	<i>Epinephelus morio</i>	A	S
Red Lionfish	<i>Pterois volitans</i>	A	M
Sharksucker	<i>Echeneis naucrates</i>	A	F
Sheepshead	<i>Archosargus probatocephalus</i>	J, A	M
Spotted Eel	<i>Gymnothorax moringa</i>	A	S
Spotted Scorpionfish	<i>Scorpaena plumieri</i>	A	F
Tomtate	<i>Haemulon aurolineatum</i>	J, A	A
White Grunt	<i>Haemulon plumieri</i>	A	F
Whitefin Sharksucker	<i>Echeneis naucratoides</i>	A	F
Whitespotted Soapfish	<i>Rypticus maculatus</i>	A	M
Yellow Jack	<i>Carangoides bartholomaei</i>	A	F

\*Goliath Grouper had spawning aggregations in the area and their numbers were inflated as a result.

**Table 2.** Benthic invertebrate species and abundance observed on South County Site 15. Abundance Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A).

Common Name	Scientific Name	Abundance
Algae Hydroid	<i>Thyrosocyphus ramosus</i>	F
Ascidian Tunicates	<i>Polyandrocarpa</i> sp.	S
Barnacles	<i>Balanus</i> sp.	A
Button Tunicates	<i>Distaplia corolla</i>	F
Clavelina Tunicates	<i>Clavelina</i> sp.	F
Distaplia	<i>Distaplia bermudensis</i>	F
Encrusting Sponge	Unidentified species	F
Feather Duster Worm	<i>Sabellidae</i> sp.	F
Half-naked Pen Shell	<i>Atrina seminude</i>	S
Hermit Crabs	Unidentified species	F
Red Netted Barnacles	<i>Megabalanus</i> sp.	A
Sand Dollar	<i>Clypeaster subdepressus</i>	M
Sea Biscuit	<i>Clypeaster rosaceus</i>	M
Yellowline Arrow Crab	<i>Stenorhynchus seticornis</i>	M

**Table 3.** Algal species observed during the marine resource survey. Abundance Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A).

Common Name	Scientific Name	Abundance
Dictyota	<i>Dictyota</i> sp.	M
Green Sea Fingers	<i>Codium</i> sp.	A
Laurencia	<i>Laurencia</i> sp.	M
Macroscopic Red Algae	<i>Halymenia</i> sp.	F
Red Grape Kelp	<i>Botryocladia</i> sp.	A
Sargassum	Sargassum spp.	M



**Photograph 3.** A Goliath Grouper (*Epinephelus itajara*) among the concrete culverts at the site.



**Photograph 4.** A large Bull Shark (*Carcharhinus leucas*) among several Goliath Groupers (*Epinephelus itajara*) at the Reef site.



**Photograph 5.** Many large Lionfish (*Pterois volitans*) were among the concrete culverts at the Reef.



**Photograph 6.** Living and dead Sand Dollars (*Clypeaster subdepressus*) were observed between the culverts and poles.



#### 4. CONCLUSION

The multi-beam survey of the Reef showed the Reef is approximately 70 feet in diameter, and ranged from 67 to 77 feet deep with the shallowest water occurring just west of the center of the Reef. The concrete of the culverts and poles making up the Reef were intact; however, the steel rebar and reinforcing components were exposed and corroded on many of the structures. Additionally, approximately 2 feet of primarily coarse sand was noted around the bases of the concrete culverts and poles.

The fish identification and abundance survey resulted in the observation of 33 species, indicating a diverse population on the Reef. The most abundant fish observed were Tomtate (*Haemulon aurolineatum*) and Gray Snapper (*Lutjanus griseus*) which were present in high numbers as both juveniles and adults. Approximately 20 Goliath Grouper (*Epinephelus itajara*) were seen on the Reef, as well as a large Bull Shark (*Carcharhinus leucas*), and many large, invasive exotic Lionfish (*Pterois volitans*). In addition to the fish species, several other benthic invertebrate organisms were observed on including Hermit Crabs, Yellowline Arrow Crabs (*Stenorhynchus seticornis*), Sand Dollars (*Clypeaster subdepressus*), and Sea Biscuits (*Clypeaster rosaceus*). Growing directly on the substrate were several species of macroalgae such as *Dictyota* sp., *Laurencia* sp., *Botryocladia* sp., *Sargassum* spp., and turf algae.

## 5. REFERENCES

Martin County. (n.d.). Retrieved October 16, 2017, from <https://www.martin.fl.us/martin-county-services/artificial-reef-locations>

Robins, R. H. (n.d.). Goliath Grouper. Retrieved October 16, 2017, from <https://www.floridamuseum.ufl.edu/fish/discover/species-profiles/epinephelus-itajara>