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FIELD OBSERVATION REPORT

COMM: 348705

DATE: May 29, 2018

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

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

1. INTRODUCTION

Coastal Systems International, Inc. (Coastal Systems) divers conducted a marine resource survey on April 26, 2018 at the Sirotkin Artificial Reef Site 2 (Reef) in Martin County, Florida between the hours of 1:42 pm and 2:15 pm to obtain general information on the ecological resources present and to document the physical conditions at the Reef. The Reef is located approximately 6.72 nautical 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 of Engineers Permit # SAJ-2006-1955(IP-JWH) Special Condition 16, which requires that the permittee submit a monitoring report annually for two years after each placement. This 2018 monitoring survey represents the second, and final, annual survey of South County Artificial Reef Site 2.

Sirotkin Site 2

- Location: 27° 05' 19.4" N and 80° 02' 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

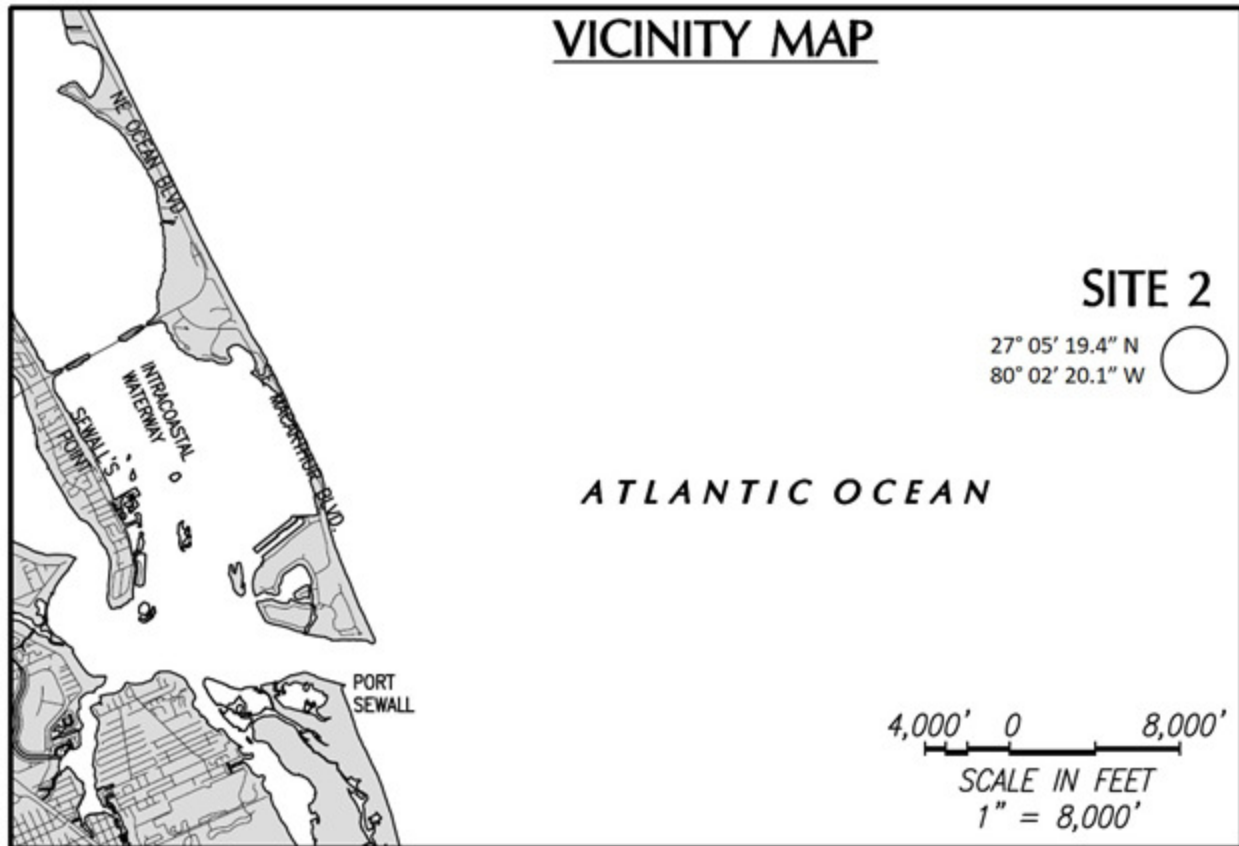


Figure 1. An overview of the location of the Sirotkin Site 2 Reef.

2. METHODOLOGY

Marine Resource Survey

Two Coastal Systems biologists performed the marine resource survey at the Reef. The area surveyed was approximately 17,047 square feet (Coastal Systems International 2017 Multi-beam data). Underwater photographs were taken to document the Reef from the four cardinal directions (north, south, east, and west views) and biologists visually assessed the overall condition (durability and stability) 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, Schmitt and Sullivan 1996) 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 data sheets. Four abundance categories were used based on the approximate number of fish observed throughout the dive [Single (1); Few (2-10), Many (11-100), and Abundant

(>100)]. The second biologist identified benthic invertebrate species and located cryptic fish species found within the interstitial spaces between the Reef components. Biologists were careful to look under various structures and note the details and morphology required to identify organisms to the lowest practical taxonomic level.

3. RESULTS

3.1 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 small amount of damage to the concrete structures was due to the condition before placement, impacts to the structures during placement, or increased corrosion after placement; however, the 2018 monitoring survey structural observations were similar to that of the 2017 monitoring survey. 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 2).



Photograph 1. No obvious damaged, exposed, or corroded rebar was observed on the concrete culverts and poles at the Sirotkin Artificial Reef Site 2.

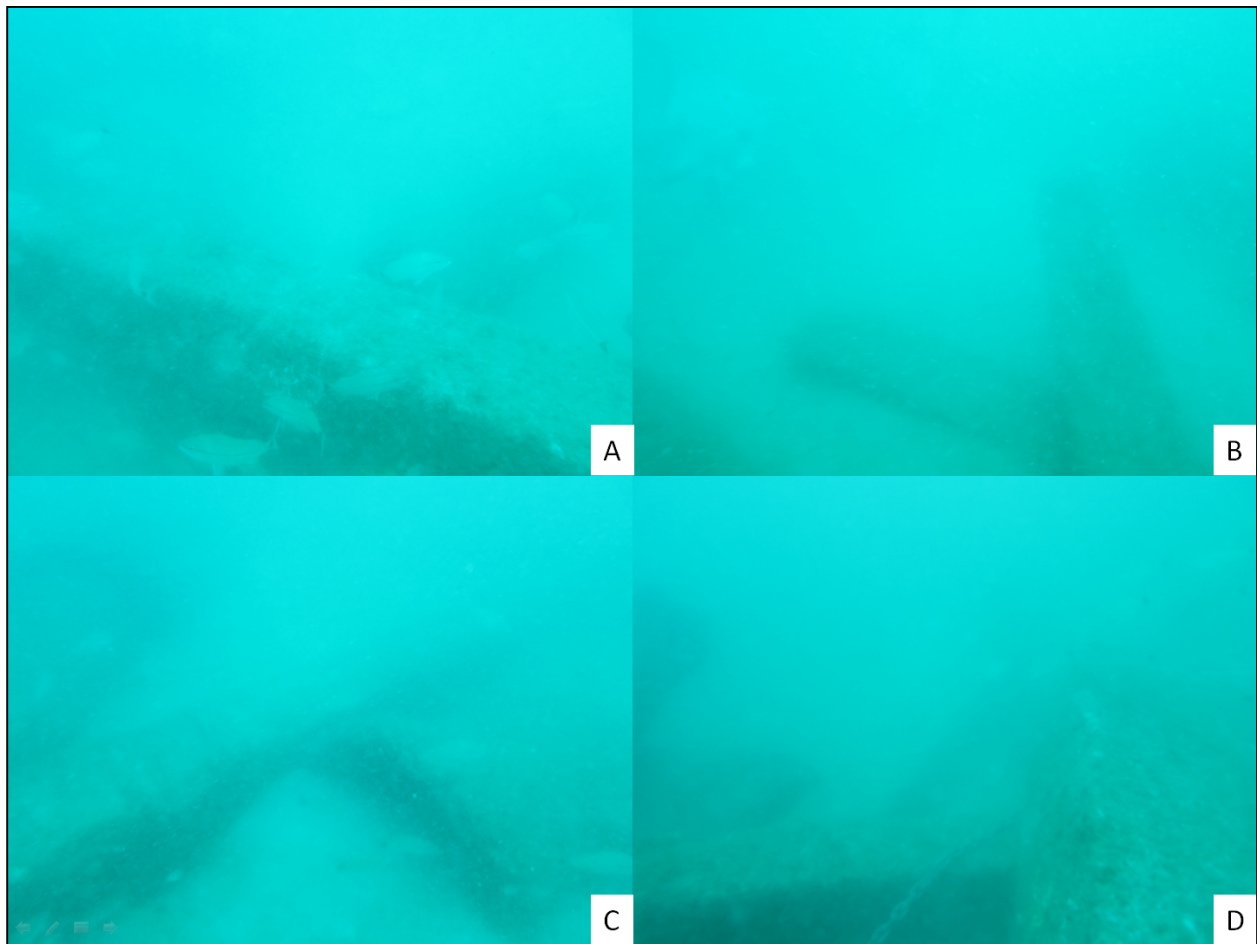


Figure 2. An overview of Sirotkin Artificial Reef Site 2 looking north (A), south, (B), east (C), and west (D) from above the tallest point on the Reef.

3.2 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. The Reef contained numerous crevices and small areas for sheltering both small and large fish species. Visibility at the Reef was unusually low during the time of the survey and averaged approximately 5-8 feet. Due to the reduced visibility, the number of species observed during the 2018 monitoring survey was lower than the 2017 monitoring survey. Typical species, which were observed on Site 2 during the 2017 monitoring survey, and also found on Sites 14 and 15 during the 2018 monitoring survey, were not directly observed on Site 2, include red lionfish (*Pterois volitans*), cocoa damselfish (*Stegastes variabilis*), and black grouper (*Mycteroperca bonaci*).

Species Observed

The fish identification and abundance survey resulted in the observation of 23 species, indicating a diverse population on the Reef. The most abundant fish observed in high numbers were tomtate (*Haemulon aurolineatum*, Photograph 2). Few goliath grouper (*Epinephelus itajara*, Photograph 3) were observed on the Reef, compared to the approximately 10 observed in 2017, as the 2018 survey was conducted outside of the spawning aggregation season (Robins, n.d.). Unlike the previous annual survey, no invasive exotic red lionfish (*Pterois volitans*) were observed among the concrete culverts; this was likely due to the very limited visibility during the time of the fish abundance survey and not a reduction in their prevalence. Many Atlantic spadefish (*Chaetodipterus faber*), gray snapper (*Lutjanus griseus*), and greater amberjack (*Seriola dumerili*) were observed. Several less common species were observed, including a single southern stingray (Photograph 4) and a few spotted scorpionfish (Photograph 5). The 23 fish species observed during the monitoring survey are presented in Table 1; 9 new species observed this year that were not observed in 2017 are noted in the table.

In addition to the 23 fish species observed, 13 benthic invertebrate organisms (Table 2) were documented on the Reef, including rock boring urchins (*Echinometra lucunter*), various hermit crabs, feather duster worms (*Sabellidae* sp.), and a bearded fireworm (*Hermodice carunculata*, Photograph 6). Growing directly on the Reef were 6 species of macroalgae such as *Dictyopteris justii*, *Dictyota* sp., *Laurencia* sp., *Botryocladia* sp., and turf algae (Table 3). A total of 42 unique species were observed during the 2018 monitoring survey.



Photograph 2. Numerous tomtoe (*Haemulon aurolineatum*) among the concrete culverts at the Reef.

Table 1. Fish species, stage, and abundance observed on the Sirotkin Site 2 Reef. Stage – Adult (A) or Juvenile (J). Abundance (Abd) Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A). Species observed during one monitoring survey but not the other are indicated in gray.

| Common Name | Scientific Name | 2017 | | 2018 | |
|--------------------|---------------------------------|-------|-----|-------|-----|
| | | Stage | Abd | Stage | Abd |
| Atlantic spadefish | <i>Chaetodipterus faber</i> | | | A | M |
| Bandtail puffer | <i>Sphoeroides spengleri</i> | | | J | F |
| Belted sandfish | <i>Serranus subligarius</i> | A | M | | |
| Black grouper | <i>Mycteroperca bonaci</i> | A | F | | |
| Black margate | <i>Anisotremus surinamensis</i> | | | A | F |
| Blue angelfish | <i>Holacanthus bermudensis</i> | A | F | A | F |
| Blue runner | <i>Caranx crysos</i> | A | F | A | S |
| Blue tang | <i>Acanthurus coeruleus</i> | A | F | A | S |
| Bluestriped grunt | <i>Haemulon sciurus</i> | | | A | S |
| Cobia | <i>Rachycentron canadum</i> | A | F | | |
| Cocoa damselfish | <i>Stegastes variabilis</i> | A | F | | |

Table 1. Cont.

| Table 1. Cont. | | 2017 | | 2018 | |
|---|------------------------------------|-------|-----|-------|-----|
| Common Name | Scientific Name | Stage | Abd | Stage | Abd |
| Cottonwick | <i>Haemulon melanurum</i> | A | F | | |
| Cubbyu | <i>Pareques umbrosus</i> | J, A | M | A | F |
| Doctorfish | <i>Acanthurus chirurgus</i> | A | F | A | F |
| French angelfish | <i>Pomacanthus paru</i> | A | F | | |
| Goliath grouper | <i>Epinephelus itajara</i> | A | F | A | F |
| Gray angelfish | <i>Pomacanthus arcuatus</i> | | | A | F |
| Gray snapper | <i>Lutjanus griseus</i> | J, A | A | A | M |
| Gray triggerfish | <i>Balistes capriscus</i> | A | F | | |
| Greater amberjack | <i>Seriola dumerili</i> | | | A | M |
| Highhat | <i>Pareques acuminatus</i> | | | A | F |
| Hogfish | <i>Lachnolaimus maximus</i> | | | A | S |
| Lane snapper | <i>Lutjanus synagris</i> | A | F | A | S |
| Porkfish | <i>Anisotremus virginicus</i> | A | M | J, A | F |
| 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 | A | F |
| Sheepshead porgy | <i>Calamus penna</i> | A | F | | |
| Southern stingray | <i>Dasyatis americana</i> | A | S | 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 | A | F |
| Tomtate | <i>Haemulon aurolineatum</i> | J, A | A | J, A | A |
| Two spot cardinalfish | <i>Apogon binotatus</i> | A | M | | |
| Whitefin sharksucker | <i>Echeneis naucratoides</i> | | | A | S |
| Whitespotted soapfish | <i>Rypticus maculatus</i> | A | M | A | F |
| Yellowtail snapper | <i>Ocyurus chrysurus</i> | A | M | | |
| Total | | 32 | | 23 | |
| Unique species over both monitoring surveys | | 41 | | | |

Table 2. Benthic invertebrate species and abundance observed on the Sirotkin Site 2 Reef. Abundance Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A). Species observed during one survey but not the other are in gray.

| Common Name | Scientific Name | 2017 | 2018 |
|--|---------------------------------|-----------|-----------|
| | | Abundance | Abundance |
| Algae hydroid | <i>Thyrosocyphus ramosus</i> | F | F |
| Barnacles | <i>Balanus</i> sp. | A | A |
| Bearded fireworm | <i>Hermodice carunculata</i> | | S |
| Caribbean spiny lobster | <i>Panulirus argus</i> | F | |
| Distaplia | <i>Distaplia bermudensis</i> | F | F |
| Encrusting sponge | Unidentified species | F | F |
| Feather duster worm | <i>Sabellidae</i> sp. | F | F |
| Hermit crabs | Unidentified species | F | F |
| Red netted barnacles | <i>Megabalanus</i> sp. | A | A |
| Rock boring urchin | <i>Echinometra lucunter</i> | F | F |
| Rock snails | <i>Muricidae</i> sp. | F | F |
| Slate pencil urchin | <i>Eucidaris tribuloides</i> | F | |
| Three rowed sea cucumber | <i>Isostichopus badionotus</i> | F | S |
| Variegated sea urchin | <i>Lytechinus variegates</i> | M | F |
| Yellowline arrow crab | <i>Stenorhynchus seticornis</i> | M | F |
| Total | | 14 | 13 |
| Unique species over both monitoring surveys | | 15 | |

Table 3. Algal species observed on the Sirotkin Site 2 Reef. Abundance Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A). Species observed during one monitoring survey but not the other are indicated in gray.

| Common Name | Scientific Name | 2017 | 2018 |
|--|----------------------------|-----------|-----------|
| | | Abundance | Abundance |
| Dictyopteris | <i>Dictyopteris justii</i> | F | M |
| Dictyota | <i>Dictyota</i> sp. | M | M |
| Green sea fingers | <i>Codium</i> sp. | F | A |
| Laurencia | <i>Laurencia</i> sp. | F | M |
| Macroscopic red algae | <i>Halymenia</i> sp. | F | F |
| Red grape kelp | <i>Botryocladia</i> sp. | A | A |
| Sargassum | Sargassum spp. | F | |
| Total | | 7 | 6 |
| Unique species over both monitoring surveys | | 7 | |



Photograph 3. A goliath grouper (*Epinephelus itajara*) in one of the concrete culverts at the site.



Photograph 4. One southern stingray (*Hypanus americana*) was observed on the sandy bottom near a concrete pole at the Reef.



Photograph 5. A spotted scorpionfish (*Scorpaena plumieri*) observed at the base of one of the concrete poles.



Photograph 6. A bearded fireworm (*Hermodice carunculata*) on the surface of a pole on the Reef site.

4. CONCLUSION

There were very few steel rebar and reinforcing components exposed, and the structural relief and sediment accumulation around the Reef did not vary from the previous year's monitoring. It was not apparent if the original damage was present before placement, but given the timeframe and little increase in deterioration, the Reef seems structurally sound. The Reef contained numerous crevices and spaces for both large and small fish species.

The fish identification and abundance survey resulted in the observation of 23 species, as compared to 32 species observed during the 2017 monitoring survey. Nine new fish species were observed during the 2018 monitoring survey, while 17 species were unique to 2017, for a total of 41 species over the two monitoring events.

In addition to the 23 fish species observed, 13 benthic invertebrate organisms were documented on the Reef, as compared to 14 species observed during the 2017 monitoring survey. Two new benthic invertebrate organisms were observed in 2018, while one was unique to the 2017 monitoring survey, for a total of 15 species over the two monitoring events.

Growing directly on the Reef components were 6 species of macroalgae, as compared to 7 species observed during the 2017 monitoring survey. One new macroalgae species was observed during the 2018 monitoring survey, while none were unique to the 2017 monitoring survey, for a total of 7 species over the two monitoring events.

Overall, the number of fish species, benthic invertebrates, and macroalgae decreased from the 2017 monitoring survey to the 2018 monitoring survey at the Sirotkin Reef Site 2. However, in all three cases, the number of new organisms observed increased over time. Although number of observed species decreased over time, the decrease is indicative of the very limited visibility during the 2018 monitoring survey and not a reduction in species diversity. While fish are mobile and the number of species observed can differ from year to year without indicating a decrease in diversity, a more accurate representation of diversity are benthic species and new benthic species, which have been stable or increasing.

Coastal Systems recommends continued monitoring efforts to determine continued success criteria of the Reef and species diversification. With additional monitoring data, statistical analyses can be performed to compare changes in species richness and diversity over time, and among the existing reef sites, to inform future artificial reef design criteria, structural materials, and placement location to ensure the most cost-effective planning for Martin County's Artificial Reef Program.

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>

Schmitt, E. F., and K. M. Sullivan. 1996. Analysis of a volunteer method for collecting fish presence and abundance data in the Florida Keys. *Bulletin of Marine Science*. 59(2): 404-416.



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Mr. Mark Hartman, Coastal Systems
Mr. Aaron Boehning, Coastal Systems

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

1. INTRODUCTION

Coastal Systems International, Inc. (Coastal Systems) divers conducted a marine resource survey on April 27, 2018 at the South County Artificial Reef Site 14 (Reef) in Martin County, Florida between the hours of 8:53 am and 9:26 am to obtain general information on the ecological resources present and to document the physical conditions at the Reef. The Reef is located 8.5 miles southeast by east (on a bearing of 123.5°) 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 of Engineers Permit # SAJ-2006-1955(IP-JWH) Special Condition 16, which requires that the permittee submit a monitoring report annually for two years after each artificial reef placement. This 2018 monitoring survey represents the second, and final, 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

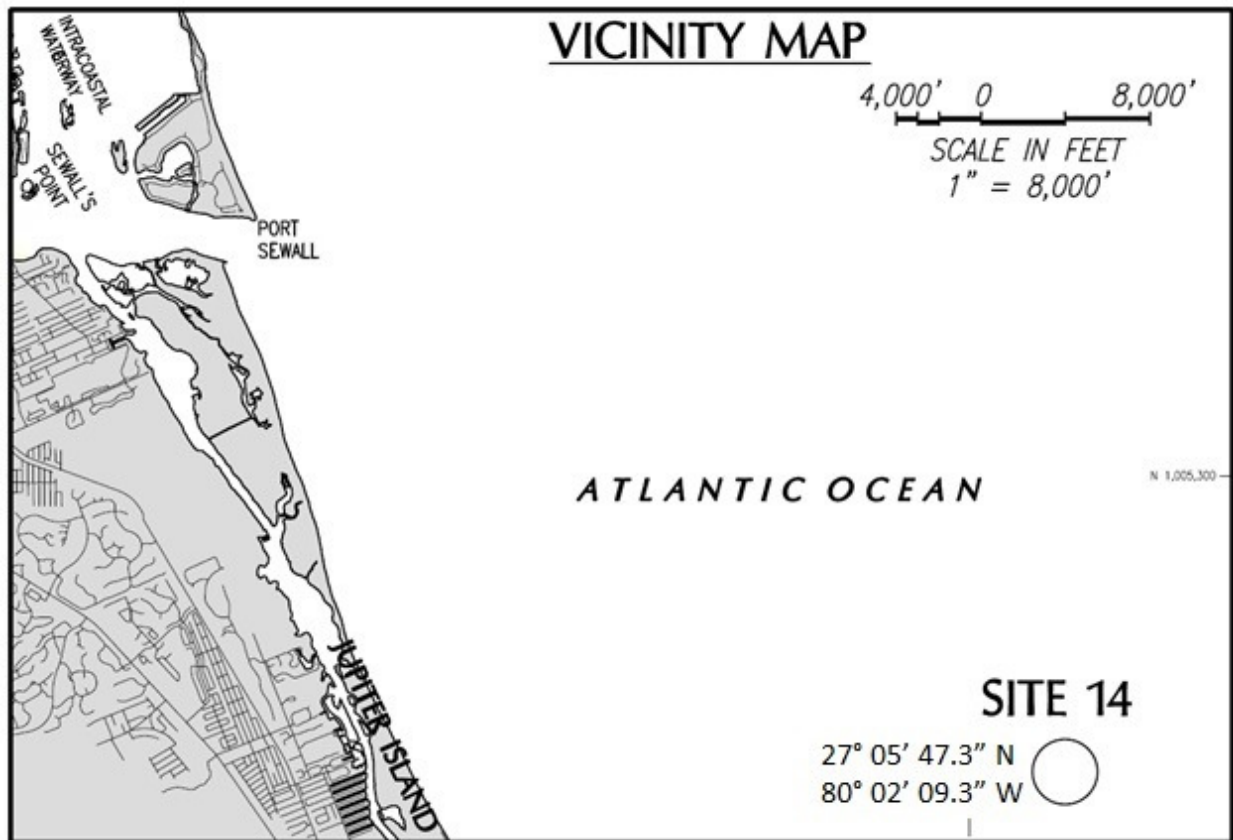


Figure 1. An overview of the location of the South County Site 14 Reef.

2. METHODOLOGY

Marine Resource Survey

Two Coastal Systems biologists performed the marine resource survey at the Reef. The area surveyed was approximately 10,295 square feet (Coastal Systems International 2017 Multi-beam data). Underwater photographs were taken to document the Reef from the four cardinal directions (north, south, east, and west views) and biologists visually assessed the overall and condition (durability and stability) of the Reef (Figure 2).

Fish identification and abundance was determined using the guidelines established by the Reef Environmental Education Foundation (REEF). The Roving Diver Technique (RDT, Schmitt and Sullivan 1996) 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 data sheets. Four abundance categories were used based on the approximate number of fish observed throughout the dive [Single (1); Few (2-10), Many (11-100), and Abundant

(>100)]. The second biologist identified benthic invertebrate species and located cryptic fish species found within the interstitial spaces between the Reef components. Biologists were careful to look under various structures and note the details and morphology required to identify organisms to the lowest practical taxonomic level.

3. RESULTS

3.1 Structural Summary

The concrete components of the culverts, poles, and slabs 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 due to the condition before placement, due to impacts sustained during placement, or the result of the combination of wave action, erosion, and corrosion after placement. Additionally, approximately two feet of primarily coarse sand was seen built up around the bases of the concrete culverts, poles, and slabs, and the Reef appears to lie in a shallow sandy depression, so some scouring seems to have occurred; however, the 2018 monitoring survey structural observations were similar to that of the 2017 monitoring survey.



Photograph 1. A view of the concrete culverts, poles, and slabs on the Reef.



Photograph 2. Damaged, corroded, and exposed rebar typical of many of the ends of the concrete culverts and poles on the South County Artificial Reef Site 14 showing growth.

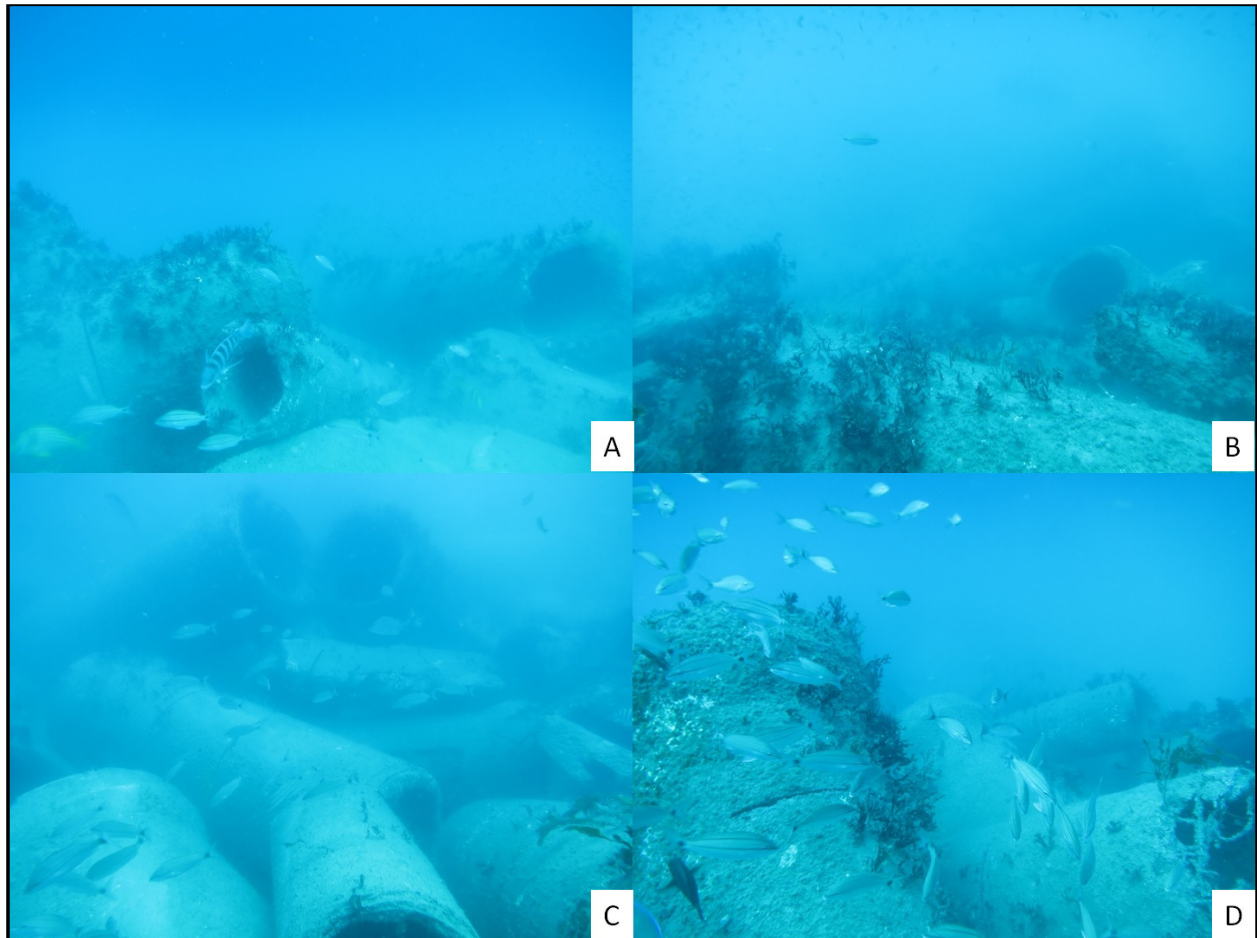


Figure 2. An overview of the South County Artificial Reef Site 14 looking north (A), south, (B), east (C), and west (D) from the tallest point on the Reef.

3.2 Marine Resource Survey Results

The submerged lands at the 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 34 species, indicating a diverse population on the Reef. The most abundant fish observed were tomtate (*Haemulon aurolineatum*, Photograph 3) and gray snapper (*Lutjanus griseus*). Many black margate (*Anisotremus surinamensis*), common snook (*Centropomus undecimalis*), glass gobies (*Gobiopterus chuno*), porkfish (*Anisotremus virginicus*), sheephead (*Archosargus probatocephalus*), and rainbow runner (*Elagatis bipinnulata*) were observed. Fewer black grouper (*Mycteroperca bonaci*) and a single gag grouper (*Mycteroperca microlepis*) were observed. Few goliath grouper (*Epinephelus itajara*) were observed on the Reef, compared to

approximately twenty observed during the 2017 monitoring survey, as the survey was conducted outside of the spawning aggregation season (Robins, n.d., Photograph 4). Few large, invasive exotic red lionfish (*Pterois volitans*) were also observed among the concrete culverts (Photograph 5). The 34 fish species observed during the monitoring survey are presented in Table 1.; 14 new species observed this year that were not observed in 2017 are noted in the table.

In addition to the fish species, 14 benthic invertebrate organisms (Table 2) were observed on the Reef, including barnacles, sponges, tunicates, hydroids, hermit crabs, and a Caribbean spiny lobster (*Panulirus argus*; Photograph 6). Sea urchins (*Arbacia punctulata* and *Echinometra lucunter*) and feather duster worms (*Sabellidae* sp.) were observed in the interstitial spaces between the culverts and poles. Growing directly on the Reef materials were 7 species of macroalgae such as *Dictyota* sp., *Laurencia* sp., *Botryocladia* sp., *Sargassum* sp., and turf algae (Table 3). A total of 55 unique species were observed during the 2018 monitoring survey.

Table 1. Fish species, stage, and abundance observed on the South County Site 14 Reef. Stage – Adult (A), Intermediate (I), or Juvenile (J). Abundance (Abd) Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A). Species observed during one monitoring survey but not the other are indicated in gray.

| Common Name | Scientific Name | 2017 | | 2018 | |
|------------------|---------------------------------|-------|-----|---------|-----|
| | | Stage | Abd | Stage | Abd |
| Bandtail puffer | <i>Sphoeroides spengleri</i> | | | J | S |
| Belted sandfish | <i>Serranus subligarius</i> | A | F | | |
| Black grouper | <i>Mycteroperca bonaci</i> | | | A | F |
| Black margate | <i>Anisotremus surinamensis</i> | A | M | A | M |
| Blue angelfish | <i>Holacanthus bermudensis</i> | A | F | A | F |
| Blue runner | <i>Caranx crysos</i> | A | F | | |
| Blue tang | <i>Acanthurus coeruleus</i> | A | F | A | F |
| Bluehead wrasse | <i>Thalassoma bifasciatum</i> | A | F | J, A | F |
| Cocoa damselfish | <i>Stegastes variabilis</i> | A | F | A | F |
| Common snook | <i>Centropomus undecimalis</i> | A | F | A | M |
| Cottonwick | <i>Haemulon melanurum</i> | A | F | A | F |
| Cubbyu | <i>Pareques umbrosus</i> | J, A | M | J, I, A | F |
| Doctorfish | <i>Acanthurus chirurgus</i> | A | F | A | F |
| Fairy basslet | <i>Gramma loreto</i> | | | A | F |
| French angelfish | <i>Pomacanthus paru</i> | A | F | | |
| Gag grouper | <i>Mycteroperca microlepis</i> | | | A | S |
| Glass gobies | <i>Gobiopterus chuno</i> | | | A | M |

Table 1. Cont.

| Table 1. Cont. | | 2017 | | 2018 | |
|---|------------------------------------|-------|-----|-------|-----|
| Common Name | Scientific Name | Stage | Abd | Stage | Abd |
| Goliath grouper | <i>Epinephelus itajara</i> | A | F* | A | F |
| Gray angelfish | <i>Pomacanthus arcuatus</i> | A | F | J, A | F |
| Gray snapper | <i>Lutjanus griseus</i> | J, A | A | A | A |
| Gray triggerfish | <i>Balistes capriscus</i> | A | S | | |
| Highhat | <i>Equetus acuminatus</i> | A | F | A | S |
| Mackerel scad | <i>Decapterus macarellus</i> | A | A | | |
| Neon goby | <i>Elacatinus oceanops</i> | | | A | F |
| Palehead blenny | <i>Labrisomus gobio</i> | A | F | | |
| Porkfish | <i>Anisotremus virginicus</i> | A | F | J, A | M |
| Queen angelfish | <i>Holacanthus ciliaris</i> | A | F | | |
| Rainbow runner | <i>Elagatis bipinnulata</i> | | | A | M |
| Red lionfish | <i>Pterois volitans</i> | A | F | A | F |
| Redband parrotfish | <i>Sparisoma aurofrenatum</i> | | | I | S |
| Reef butterflyfish | <i>Chaetodon sedentarius</i> | | | J | S |
| Scamp | <i>Mycteroperca phenax</i> | | | A | F |
| Sergeant major | <i>Abudefduf saxatilis</i> | A | F | A | F |
| Sheepshead | <i>Archosargus probatocephalus</i> | J, A | M | A | M |
| Sheepshead porgy | <i>Calamus penna</i> | A | F | A | F |
| Spotfin hogfish | <i>Bodianus pulchellus</i> | | | J | F |
| Spotted scorpionfish | <i>Scorpaena plumieri</i> | A | F | A | F |
| Three spot damselfish | <i>Stegastes planifrons</i> | | | A | F |
| Tomtate | <i>Haemulon aurolineatum</i> | J, A | A | A | A |
| Whitespotted soapfish | <i>Rypticus maculatus</i> | | | A | S |
| Yellowtail reeffish* | <i>Chromis enchrysur</i> | | | A | F |
| Total | | 27 | | 34 | |
| Unique species over both monitoring surveys | | 41 | | | |

Table 2. Benthic invertebrate species and abundance observed on the South County Site 14 Reef. Abundance Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A). Species observed during one monitoring survey but not the other are indicated in gray.

| | | 2017 | 2018 |
|--|---------------------------------|-----------|-----------|
| Common Name | Scientific Name | Abundance | Abundance |
| Algae hydroid | <i>Thyroscyphus ramosus</i> | F | F |
| Ascidian tunicates | <i>Polyandrocarpa</i> sp. | S | |
| Barnacles | <i>Balanus</i> sp. | A | A |
| Bearded fireworm | <i>Hermodice carunculata</i> | | F |
| Black tunicates | <i>Ascidia nigra</i> | | F |
| Branching hydroid | <i>Sertularella speciosa</i> | | F |
| Bulb tunicate | <i>Clavelina</i> sp. | | F |
| Button tunicates | <i>Distaplia corolla</i> | F | |
| Caribbean spiny lobster | <i>Panulirus argus</i> | | S |
| Clavelina tunicates | <i>Clavelina</i> sp. | F | |
| Distaplia | <i>Distaplia bermudensis</i> | F | |
| Encrusting sponge | Unidentified species | F | F |
| Feather bush hydroid | <i>Dentitheca dendritica</i> | | M |
| Feather duster worm | <i>Sabellidae</i> sp. | F | F |
| Half-naked pen shell | <i>Atrina seminude</i> | S | |
| Hermit crabs | Unidentified species | F | F |
| Purple sea urchin | <i>Arbacia punctulata</i> | | S |
| Red netted barnacles | <i>Megabalanus</i> sp. | A | |
| Rock boring urchin | <i>Echinometra lucunter</i> | | F |
| Sand dollar | <i>Clypeaster subdepressus</i> | M | M |
| Sea biscuit | <i>Clypeaster rosaceus</i> | M | |
| Yellowline arrow crab | <i>Stenorhynchus seticornis</i> | M | |
| Total | | 14 | 14 |
| Unique species over both monitoring surveys | | 22 | |

Table 3. Algal species observed during the South County Site 14 Reef. Abundance Categories – Single (1, S); Few (2-10, F), Many (11-100, M), and Abundant (>100, A). Species observed during one monitoring survey but not the other are indicated in gray.

| Common Name | Scientific Name | 2017 | 2018 |
|--|--------------------------------|-----------|-----------|
| | | Abundance | Abundance |
| Dictyopteris | <i>Dictyopteris justii</i> | M | M |
| Dictyota | <i>Dictyota</i> sp. | M | M |
| Fuzzy finger alga | <i>Dasycladus vermicularis</i> | | F |
| Green sea fingers | <i>Codium</i> sp. | A | |
| Laurencia | <i>Laurencia</i> sp. | M | M |
| Macroscopic red algae | <i>Halymenia</i> sp. | F | F |
| Oval-blade alga | <i>Caulerpa prolifera</i> | | A |
| Red grape kelp | <i>Botryocladia</i> sp. | A | |
| Sargassum | <i>Sargassum</i> sp. | M | M |
| Total | | 7 | 7 |
| Unique species over both monitoring surveys | | 9 | |



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 red lionfish (*Pterois volitans*) were among the concrete culverts at the Reef.



Photograph 6. A Caribbean spiny lobster (*Panulirus argus*) under the culverts and pipes on the Reef.

4. CONCLUSION

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 two feet of 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, indicating some scouring seems to have occurred. This is consistent with the condition of the Reef during the 2017 monitoring survey.

The fish identification and abundance survey resulted in the observation of 34 species, indicating a diverse population on the Reefs compared to 27 species observed during the 2017 monitoring survey. Fourteen new fish species were observed in 2018, while 7 species were unique to 2017, for a total of 41 species over the two monitoring events.

In addition to the 34 fish species, 14 benthic invertebrate organisms were observed on the Reef, the same number as observed during the 2017 monitoring survey. Seven new benthic invertebrate organisms were observed in 2018, while 8 were unique to 2017, for a total of 22 species over the two monitoring events.

Growing directly on the Reef were 7 species of macroalgae, the same number as observed during the 2017 monitoring survey. Two new macroalgae was observed in 2018, and two were unique to 2017, for a total of 9 species over the two monitoring events.

Overall, the number of fish species increased from the 2017 monitoring survey to the 2018 monitoring survey, and the number of benthic invertebrates and macroalgae remained the same, at the South County Reef Site 14. Additionally, the number of fish species observed increased over time. Given the increased diversity of species observed during the 2018 monitoring event, the Reef is showing increased attraction/recruitment. If monitoring of the Reef were continued, it is assumed that there will be an increasing number of species every year. Furthermore, the Reef is exhibiting a good variety of cryptic/reef dependent fish species, coastal/pelagic fish species, and recreationally and commercially important fish species, in addition to a good range of juvenile and adult stages.

While fish are mobile and the number of species observed can differ from year to year without indicating a decrease in diversity, a more accurate representation of diversity are the non-mobile benthic species and new benthic species, which have been stable or increasing.

Coastal Systems recommends continued monitoring efforts to determine continued success criteria of the Reef and species diversification. With additional monitoring data, statistical analyses can be performed to compare changes in species richness and diversity over time, and among the existing reef sites, to inform future artificial reef design criteria, structural materials, and placement location to ensure the most cost-effective planning for Martin County's Artificial Reef Program.

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>

Schmitt, E. F., and K. M. Sullivan. 1996. Analysis of a volunteer method for collecting fish presence and abundance data in the Florida Keys. *Bulletin of Marine Science*. 59(2): 404-416.



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FIELD OBSERVATION REPORT

COMM: 348705

DATE: May 29, 2018

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

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

1. INTRODUCTION

Coastal Systems International, Inc. (Coastal Systems) divers conducted a marine resource survey on April 26, 2018 at the South County Artificial Reef Site 15 (Reef) in Martin County, Florida between the hours of 11:30 am and 12:00 pm to obtain general information on the ecological resources present and to 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 of Engineers Permit # SAJ-2006-1955(IP-JWH) Special Condition 16, which requires that the permittee submit a monitoring report annually for two years after each placement. This 2018 monitoring survey represents the second, and final, annual survey of South County Artificial Reef Site 15.

Sirotkin 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

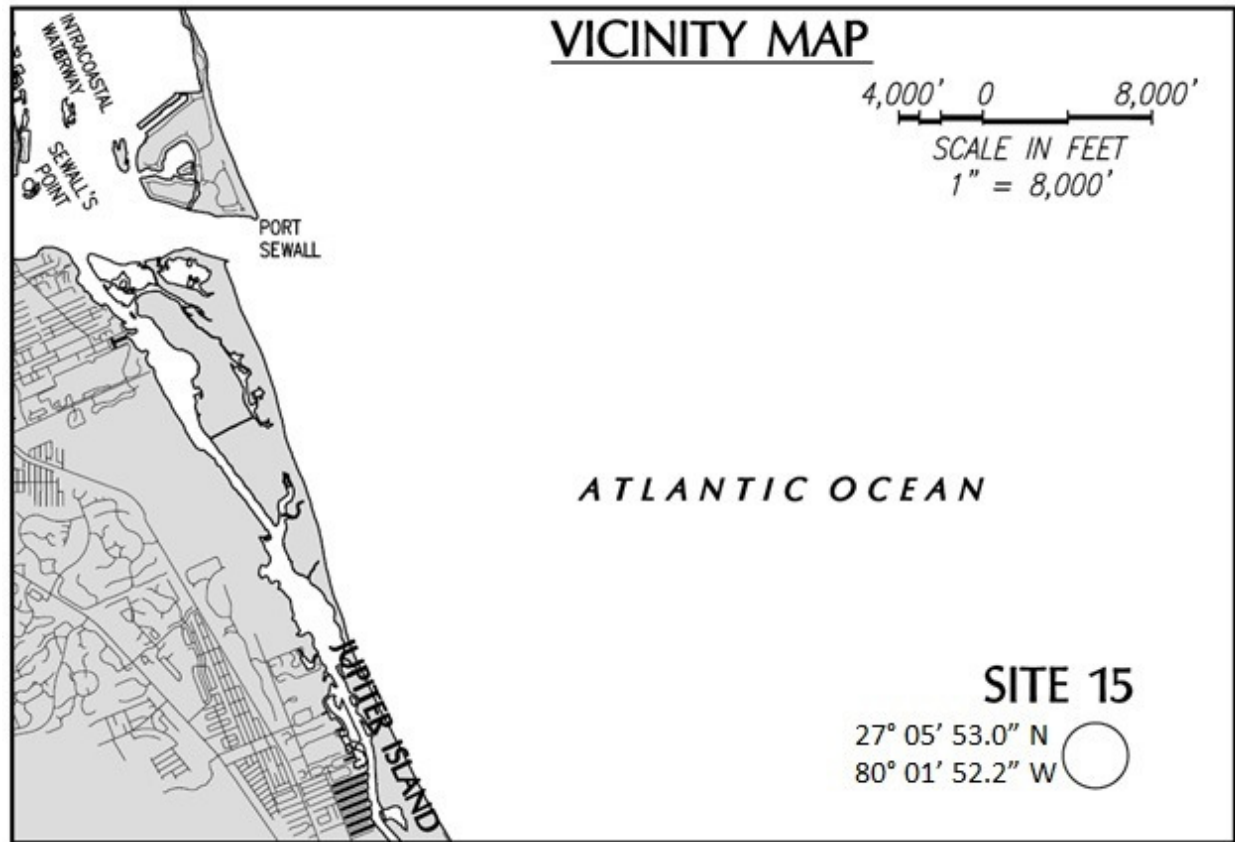


Figure 1. An overview of the location of the South County Site 15 Reef.

2. METHODOLOGY

Marine Resource Survey

Two Coastal Systems biologists performed the marine resource survey at the Reef. The area surveyed was approximately 3,247 square feet (Coastal Systems International 2017 Multi-beam data). Underwater photographs were taken to document the Reef from the four cardinal directions (north, south, east, and west views) and biologists visually assessed the overall and condition (durability and stability) of the Reef (Figure 2).

Fish identification and abundance was determined using the guidelines established by the Reef Environmental Education Foundation (REEF). The Roving Diver Technique (RDT, Schmitt and Sullivan 1996) 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 data sheets. Four abundance categories were used based on the approximate number of fish observed throughout the dive [Single (1); Few (2-10), Many (11-100), and Abundant

(>100)]. The second biologist identified benthic invertebrate species and located cryptic fish species found within the interstitial spaces between the Reef components. Biologists were careful to look under various structures and note the details and morphology required to identify organisms to the lowest practical taxonomic level.

3. RESULTS

3.1 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 small amount of damage to the concrete structures was due to the condition before placement, impacts to the structures during placement, or increased corrosion after placement; however, the 2018 monitoring survey structural observations were similar to those of the 2017 monitoring survey. 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.



Photograph 1. No obvious damaged, exposed, or corroded rebar was observed on the concrete culverts and poles at South County Artificial Reef Site 15.



Figure 2. An overview of the South County Artificial Reef Site 2 looking north (A), south, (B), east (C), and west (D) from above the tallest point on the Reef.

3.2 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 averaged approximately 30-40 feet at the time of the survey.

Species Observed

The fish identification and abundance survey resulted in the observation of 43 species, indicating a diverse population on the Reef. The most abundant fish observed in high numbers were tomtate (*Haemulon aurolineatum*, Photograph 2). Bay anchovy (*Anchoa mitchilli*, Photograph 3), gray snapper (*Lutjanus griseus*), mackerel scad (*Decapterus macarellus*), and rainbow runner (*Elagatis bipinnulata*) were also found in abundance. Few goliath grouper (*Epinephelus itajara*) were observed on the Reef, compared to approximately twenty observed in 2017, as the survey was conducted outside of the spawning aggregation season (Robins, n.d.). Few townsend angelfish (*Holacanthus townsendi*), many porkfish (*Anisotremus virginicus*, Photograph 4) and

many sheepshead (*Archosargus probatocephalus*, Photograph 5) were present on the Reef. Like the previous annual survey, invasive exotic red lionfish (*Pterois volitans*) were observed among the concrete culverts. The 43 fish species observed during the monitoring survey are presented in Table 1; 21 new species observed this year that were not observed during the 2017 monitoring survey are noted in the table.

In addition to the 43 fish species observed, 15 other benthic invertebrate organisms (Table 2) were documented on the Reef, including hydroids, sea cucumbers, hermit crabs, feather duster worms, (*Sabellidae* sp.) and bearded fireworms. Additionally, one very small soft coral was observed colonizing the reef, a sea rod (*Eunicea* sp., Photograph 6). Growing directly on the Reef were 6 species of macroalgae such as *Dictyopteris justii*, *Dictyota* sp., *Laurencia* sp., and *Sargassum* sp. (Table 3). A total of 64 unique species were observed during the 2018 monitoring survey.



Photograph 2. Tomtate (*Haemulon aurolineatum*), in the background, and a porkfish (*Anisotremus virginicus*), in the foreground, on the Reef site.

Table 1. Fish species, stage, and abundance observed on the South County Site 15 reef. Stage – Adult (A) or Juvenile (J). Abundance (Abd) Categories – Single (1, S), Few (2-10, F), Many (11-100, M), and Abundant (>100, A). Species observed during one monitoring survey but not the other are indicated in gray.

| Common Name | Scientific Name | 2017 | | 2018 | |
|----------------------|---------------------------------|-------|-----|-------|-----|
| | | Stage | Abd | Stage | Abd |
| Atlantic trumpetfish | <i>Aulostomus strigosus</i> | | | J | S |
| Bandtail puffer | <i>Sphoeroides spengleri</i> | | | J | F |
| Bar jack | <i>Caranx ruber</i> | A | F | | |
| Barred hamlet | <i>Hypoplectrus puella</i> | A | F | | |
| Bay anchovy | <i>Anchoa mitchilli</i> | | | A | A |
| Belted sandfish | <i>Serranus subligarius</i> | A | M | A | F |
| Black grouper | <i>Mycteroperca bonaci</i> | | | A | F |
| Black margate | <i>Anisotremus surinamensis</i> | A | M | A | M |
| Blue angelfish | <i>Holacanthus bermudensis</i> | A | F | A | F |
| Blue runner | <i>Caranx crysos</i> | A | F | A | F |
| Blue tang | <i>Acanthurus coeruleus</i> | A | F | A | F |
| Bluehead wrasse | <i>Thalassoma bifasciatum</i> | | | J, A | M |
| Bull shark | <i>Carcharhinus leucas</i> | A | S | | |
| Cocoa damselfish | <i>Stegastes variabilis</i> | | | A | F |
| Cottonwick | <i>Haemulon melanurum</i> | A | F | | |
| Cubby | <i>Pareques umbrosus</i> | J, A | M | A | M |
| Doctorfish | <i>Acanthurus chirurgus</i> | A | F | A | M |
| Fairy basslet | <i>Grama loreto</i> | | | A | F |
| French angelfish | <i>Pomacanthus paru</i> | A | F | A | S |
| Gag grouper | <i>Mycteroperca microlepis</i> | | | A | S |
| Glass goby | <i>Gobiopterus chuno</i> | | | A | M |
| Goliath grouper | <i>Epinephelus itajara</i> | A | M* | A | S |
| Gray angelfish | <i>Pomacanthus arcuatus</i> | A | F | A | F |
| Gray snapper | <i>Lutjanus griseus</i> | J, A | A | J, A | A |
| Gray triggerfish | <i>Balistes capriscus</i> | A | S | A | F |
| Graysby | <i>Cephalopholis cruentata</i> | A | S | | |
| Greater amberjack | <i>Seriola dumerili</i> | | | A | F |
| Highhat | <i>Equetus acuminatus</i> | A | F | A | F |
| Longfin damselfish | <i>Stegastes diencaeus</i> | | | A | S |
| Mackerel scad | <i>Decapterus macarellus</i> | A | F | A | A |
| Porkfish | <i>Anisotremus virginicus</i> | J, A | M | J, A | M |

Table 1. Cont.

| Table 1. Cont. | | 2017 | | 2018 | |
|---|------------------------------------|-------|-----|-------|-----|
| Common Name | Scientific Name | Stage | Abd | Stage | Abd |
| Queen triggerfish | <i>Balistes vetula</i> | | | A | S |
| Rainbow parrotfish | <i>Scarus guacamaia</i> | A | F | | |
| Rainbow runner | <i>Elagatis bipinnulata</i> | A | F | A | A |
| Red grouper | <i>Epinephelus morio</i> | A | S | | |
| Red lionfish | <i>Pterois volitans</i> | A | M | J, A | F |
| Rockhind | <i>Epinephelus adscensionis</i> | | | A | S |
| Sergeant major | <i>Abudefduf saxatilis</i> | | | A | F |
| Sharksucker | <i>Echeneis naucrates</i> | A | F | | |
| Sharpnose puffer | <i>Canthigaster rostrata</i> | | | A | S |
| Sheepshead | <i>Archosargus probatocephalus</i> | J, A | M | A | M |
| Slippery dick | <i>Halichoeres bivittatus</i> | | | J | M |
| Spanish hogfish | <i>Bodianus rufus</i> | | | J, A | F |
| Spotfin butterflyfish | <i>Chaetodon ocellatus</i> | | | A | F |
| Spotfin hogfish | <i>Bodianus pulchellus</i> | | | J | F |
| Spotted eel | <i>Gymnothorax moringa</i> | A | S | | |
| Spotted scorpionfish | <i>Scorpaena plumieri</i> | A | F | A | F |
| Tomtate | <i>Haemulon aurolineatum</i> | J, A | A | J, A | A |
| Townsend angelfish | <i>Holacanthus townsendi</i> | | | A | F |
| White grunt | <i>Haemulon plumierii</i> | A | F | | |
| Whitefin sharksucker | <i>Echeneis naucratoides</i> | A | F | | |
| Whitespotted soapfish | <i>Rypticus maculatus</i> | A | M | A | F |
| Yellow jack | <i>Caranx bartholomaei</i> | A | F | A | F |
| Yellowtail reeffish | <i>Chromis enchrysur</i> | | | A | F |
| Total | | 33 | | 43 | |
| Unique species over both monitoring surveys | | 54 | | | |

Table 2. Benthic invertebrate species and abundance observed on the South County Site 15 Reef. Abundance Categories – Single (1, S), Few (2-10, F), Many (11-100, M), and Abundant (>100, A). Species observed during one monitoring survey but not the other are indicated in gray.

| Common Name | Scientific Name | 2017 | 2018 |
|--|---------------------------------|-----------|-----------|
| | | Abundance | Abundance |
| Algae hydroid | <i>Thyroscyphus ramosus</i> | F | F |
| Ascidian tunicates | <i>Polyandrocarpa</i> sp. | S | |
| Barnacles | <i>Balanus</i> sp. | A | A |
| Bearded fireworm | <i>Hermodice carunculata</i> | | F |
| Black tunicates | <i>Ascidia nigra</i> | | F |
| Branching hydroid | <i>Sertularella speciosa</i> | | F |
| Button tunicates | <i>Distaplia corolla</i> | F | |
| Caribbean spider crab | <i>Mithrax spinosissimus</i> | | S |
| Clavelina tunicates | <i>Clavelina</i> sp. | F | |
| Distaplia | <i>Distaplia bermudensis</i> | F | |
| Encrusting sponge | Unidentified species | F | F |
| Feather bush hydroid | <i>Dentitheca dendritica</i> | | M |
| Feather duster worm | <i>Sabellidae</i> sp. | F | F |
| Half-naked pen shell | <i>Atrina seminude</i> | S | |
| Hermit crabs | Unidentified species | F | F |
| Marine snail | Unidentified Species | | F |
| Netted olive | <i>Oliva reticularis</i> | | S |
| Red netted barnacles | <i>Megabalanus</i> sp. | A | |
| Sand dollar | <i>Clypeaster subdepressus</i> | M | |
| Sea biscuit | <i>Clypeaster rosaceus</i> | M | |
| Sea cucumber | Unidentified Species | | F |
| Sea rod | <i>Eunicea</i> sp. | | S |
| Three-rowed sea cucumber | <i>Isostichopus badionotus</i> | | F |
| Yellowline arrow crab | <i>Stenorhynchus seticornis</i> | M | |
| Total | | 14 | 15 |
| Unique species over both monitoring surveys | | 24 | |

Table 3. Algal species and abundance observed the South County Site 15 Reef. Abundance Categories – Single (1, S), Few (2-10, F), Many (11-100, M), and Abundant (>100, A). Species observed during one monitoring survey but not the other are indicated in gray.

| Common Name | Scientific Name | 2017 | 2018 |
|--|----------------------------|-----------|-----------|
| | | Abundance | Abundance |
| Dictyopteris | <i>Dictyopteris justii</i> | M | M |
| Dictyota | <i>Dictyota</i> sp. | M | M |
| Green sea fingers | <i>Codium</i> sp. | A | |
| Laurencia | <i>Laurencia</i> sp. | M | M |
| Macroscopic red algae | <i>Halymenia</i> sp. | F | F |
| Oval-blade alga | <i>Caulerpa prolifera</i> | | A |
| Red grape kelp | <i>Botryocladia</i> sp. | A | |
| Sargassum | <i>Sargassum</i> sp. | M | M |
| Total | | 7 | 6 |
| Unique species over both monitoring surveys | | 8 | |



Photograph 3. A school of bay anchovy (*Anchoa mitchilli*) above the Reef site.



Photograph 4. Townsend angelfish (*Holacanthus townsendi*) and porkfish (*Anisotremus virginicus*) among the concrete poles at the site.



Photograph 5. Sheepshead (*Archosargus probatocephalus*) observed on the sandy bottom near a concrete pole at the Reef.



Photograph 6. A sea rod (*Eunicea* sp.) on the Reef site.

4. CONCLUSION

There were very few steel rebar and reinforcing components exposed, but the structural relief and sediment accumulation around the Reef did not vary from the 2017 monitoring survey. It was not apparent if the original damage was present before placement, but given the timeframe and little increase in deterioration, the Reef seems structurally sound. The Reef contained numerous crevices and spaces for both large and small fish species.

The fish identification and abundance survey resulted in the observation of 43 species, as compared to 33 species observed during the 2017 monitoring survey. Twenty-one new fish species were observed in 2018, while 11 species were unique to 2017, for a total of 54 species over the two monitoring events.

In addition to the 43 fish species observed, 15 other benthic invertebrate organisms were documented on the Reef, as compared to 14 species observed during the 2017 monitoring survey. Nine new benthic invertebrate organisms were observed in 2018, while 10 were unique to 2017, for a total of 24 species over the two monitoring events.

Growing directly on the Reef components were 6 species of macroalgae, as compared to 7 species observed during the 2017 monitoring survey. Two new macroalgae species were observed in 2018, while one was unique to 2017, for a total of 8 species over the two monitoring events.

Overall, the number of fish species and benthic invertebrates increased from the 2017 monitoring survey to the 2018 monitoring survey, and the number of macroalgae decreased slightly, at the South County Reef Site 15. Additionally, the number of new fish species and macroalgae observed increased over time. Given the increased diversity of species observed during the 2018 monitoring event, the Reef is showing increased attraction/recruitment. If monitoring of the Reef were continued, it is assumed that there will be an increasing number every year. Furthermore, the Reef is exhibiting a good variety of cryptic/reef dependent fish species, coastal/pelagic fish species, and recreationally and commercially important fish species, in addition to a good range of juvenile and adult stages.

While fish are mobile and the number of species observed can differ from year to year without indicating a decrease in diversity, a more accurate representation of diversity are the non-mobile benthic species and new benthic species, which have been stable or increasing. In particular, one soft coral, a sea rod (*Eunicea* sp.) was observed colonizing the structure, indicating that subsequent colonization by coral species is likely to occur over time. Stony coral recruitment and growth is a topic still under investigation, given its dependence on many factors including light attenuation, wave action, and water temperature. However, artificial reefs are measured in their ability to recruit marine flora and fauna. With the new presence of an octocoral, the Reef appears to be recruiting new species and showing signs of success.

Coastal Systems recommends continued monitoring efforts to determine continued success criteria of the Reef and species diversification. With additional monitoring data, statistical analyses can be performed to compare changes in species richness and diversity over time, and among the existing reef sites to inform future artificial reef design criteria, structural materials, and placement location to ensure the most cost-effective planning for Martin County's Artificial Reef Program.

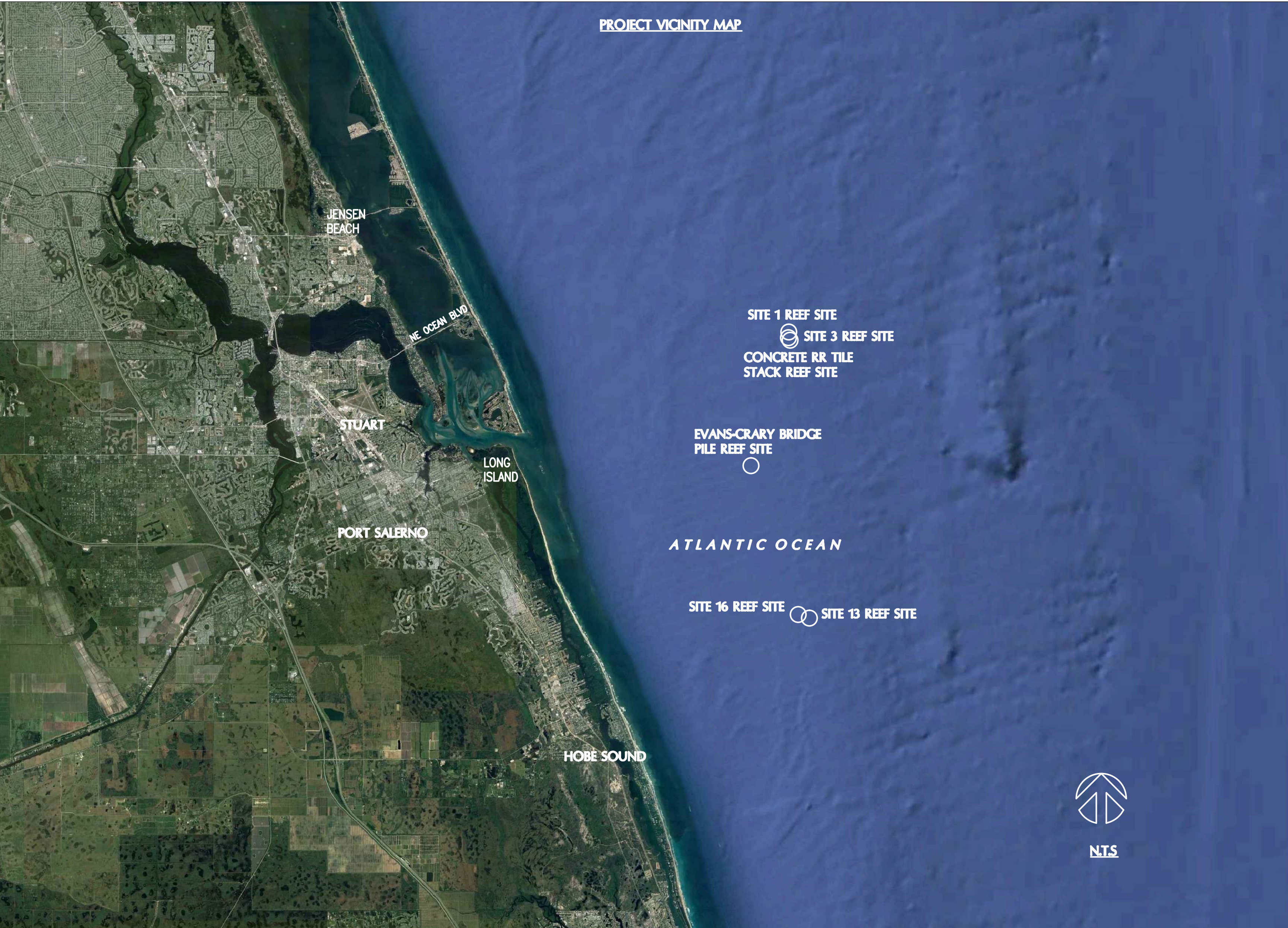
5. REFERENCES

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>

Schmitt, E. F., and K. M. Sullivan. 1996. Analysis of a volunteer method for collecting fish presence and abundance data in the Florida Keys. *Bulletin of Marine Science*. 59(2): 404-416.

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| REEF | EASTING | NORTHING | LATITUDE | LONGITUDE | MAX EL. |
|--------------------------|-----------|-------------|-------------|-------------|---------|
| EVANS--CRARY BRIDGE PILE | 963,104.7 | 1,027,001.6 | 27°09'21.3" | 80°03'21.9" | -52.0' |
| SITE 13 | 971,401.7 | 1,005,480.5 | 27°05'47.6" | 80°01'51.9" | -70.0' |
| SITE 16 | 969,835.2 | 1,006,016.1 | 27°05'53.0" | 80°02'09.2" | -69.0' |
| CONCRETE RR TILE REEF | 968,702.5 | 1,044,273.7 | 27°12'11.9" | 80°02'18.5" | -76.0' |
| SITE 1 | 968,461.3 | 1,045,406.0 | 27°12'23.1" | 80°02'21.1" | -89.0' |
| SITE 3 | 968,632.5 | 1,044,687.8 | 27°12'16.0" | 80°02'19.2" | -83.0' |

1. BATHYMETRIC DATA COLLECTED BY COASTAL SYSTEMS INTERNATIONAL INC. BETWEEN JUNE 26 AND JUNE 29, 2017.
2. MULTI-BEAM DATA COLLECTED WITH A RESON SEABAT T50-R CONNECTED TO A VALEPORT SWIFT SVP PROFILER AND AN APPLANIX 220 WAVEMASTER POS MV INU.
3. AUXILIARY TIDE DATA COLLECTED WITH A HOBO LEVELLOGGER ELECTRONIC TIDE GAUGE.
4. REFERENCE MONUMENT IS PID DF9408. MONUMENT ELEVATION IS 1.00 FT NAVD 88.
5. HORIZONTAL POSITIONING OF BATHYMETRIC SURVEYS WAS OBTAINED USING DUAL TRIMBLE RTK GPS WITH POSITIONING DERIVED FROM VRS.
6. ALL REAL-TIME MULTI-BEAM AND POSITIONING DATA WERE COLLECTED IN HYPACK MAX AND HYSWEEP SOFTWARE.
7. HORIZONTAL COORDINATES ARE IN FEET AND BASED STATE PLANE NORTH AMERICAN DATUM 1983, FLORIDA EAST ZONE.
8. ELEVATIONS ARE IN FEET AND REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88).
9. THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF THE SURVEY ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS AN INDICATION OF THE GENERAL CONDITIONS EXISTING AT THAT TIME.

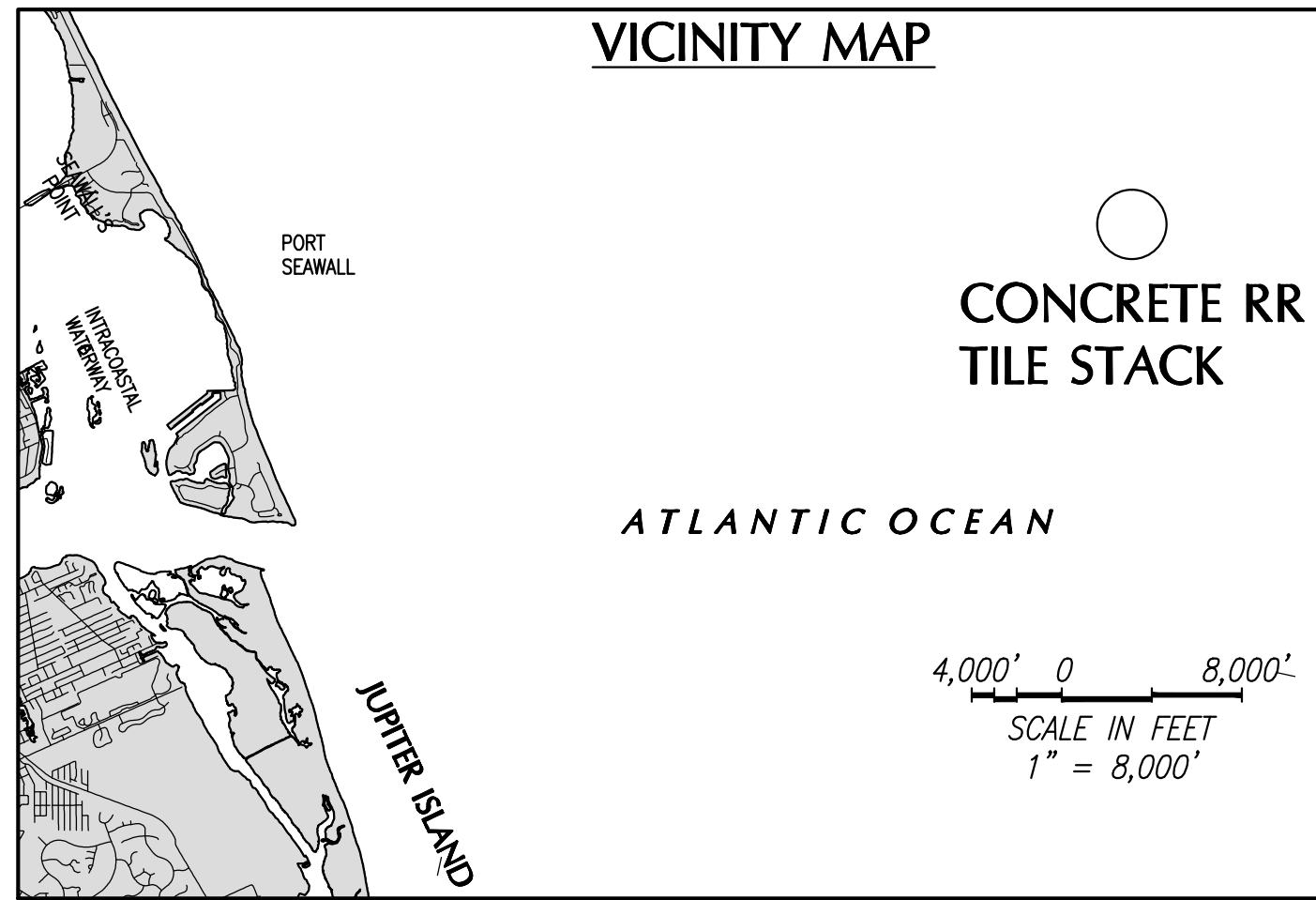
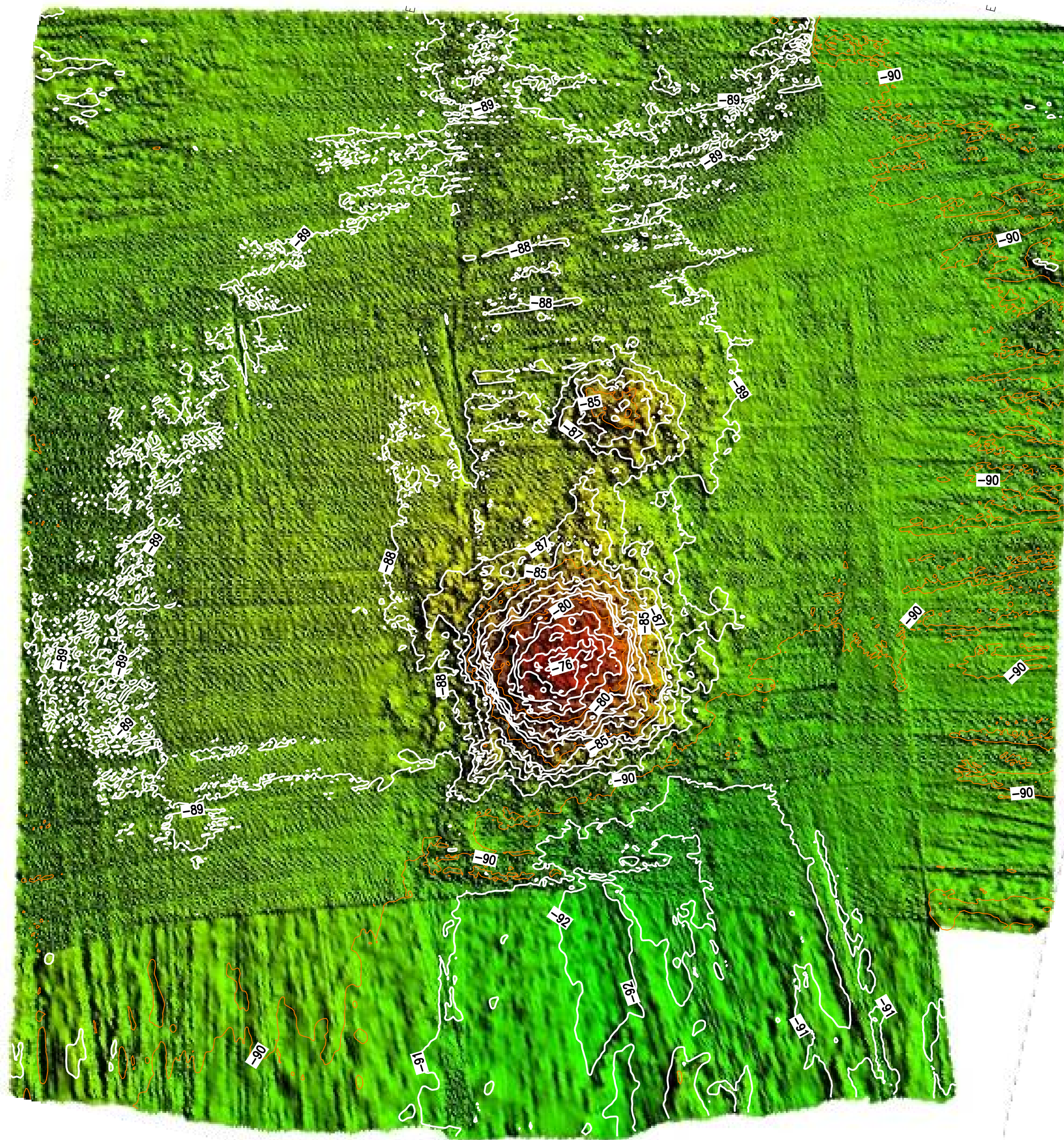
NOTE:
ALL SCALES INDICATED PERTAIN TO FULL
SIZE DRAWINGS (24"x36")

1 of 7



- ## SURVEY NOTES

1. BATHYMETRIC DATA COLLECTED BY COASTAL SYSTEMS INTERNATIONAL INC. BETWEEN JUNE 26 AND JUNE 29, 2017.
2. MULTI-BEAM DATA COLLECTED WITH A RESON SEABAT 750-R CONNECTED TO A VALEPORT SWIFT SVP PROFILER AND AN APPLANIX 220 WAVEMASTER POS MV INU.
3. AUXILIARY TIDE DATA COLLECTED WITH A HOBO LEVELLOGGER ELECTRONIC TIDE GAUGE.
4. REFERENCE MONUMENT IS PID DF9408. MONUMENT ELEVATION IS 1.00 FT NAVD 88.
5. HORIZONTAL POSITIONING OF BATHYMETRIC SURVEYS WAS OBTAINED USING DUAL TRIMBLE RTK GPS WITH POSITIONING DERIVED FROM VRS.
6. ALL REAL-TIME MULTI-BEAM AND POSITIONING DATA WERE COLLECTED IN HYPACK MAX AND HYSWEEP SOFTWARE.
7. HORIZONTAL COORDINATES ARE IN FEET AND BASED STATE PLANE NORTH AMERICAN DATUM 1983, FLORIDA EAST ZONE.
8. ELEVATIONS ARE IN FEET AND REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88).
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| REFE INFORMATION TABLE | | | | | |
|------------------------|-----------|-------------|-------------|-------------|---------|
| REEF | EASTING | NORTHING | LATITUDE | LONGITUDE | MAX EL. |
| CONCRETE RR TILE STACK | 968,702.5 | 1,044,273.7 | 27°12'11.9" | 80°02'18.5" | -76.0' |

NOTE:
ALL SCALES INDICATED PERTAIN TO FULL
SIZE DRAWINGS (24"x36")



MARTIN COUNTY REEFS

**MARTIN COUNTY
ARTIFICIAL REEF
MONITORING
2017-2018**



COASTAL SYSTEMS INTERNATIONAL, INC.

464 South Dixie Highway
Coral Gables, Florida 33146
Tel: 305-661-3655
Fax: 305-661-1914
www.CoastalSystemsInt.com
State of Florida EB #7087
Coastal, Environmental,
Civil Engineering and Managemen

CONSULTANTS

SUBMITTAL

[illegible]

PROJECT NO: 348704
 DATUM: NAVD 88
 DRAWN BY: SR
 CHECKED BY: NR

BATHYMETRIC SURVEY BASEMAP

**CONCRETE RR_TILE
STACK REEF SITE**

464 South Dixie Highway
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Tel: 305-661-3655
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www.CoastalSystemsInt.com
State of Florida EB #7087
Coastal, Environmental,
Civil Engineering and Manageme

CONSULTANTS

SUBMIT

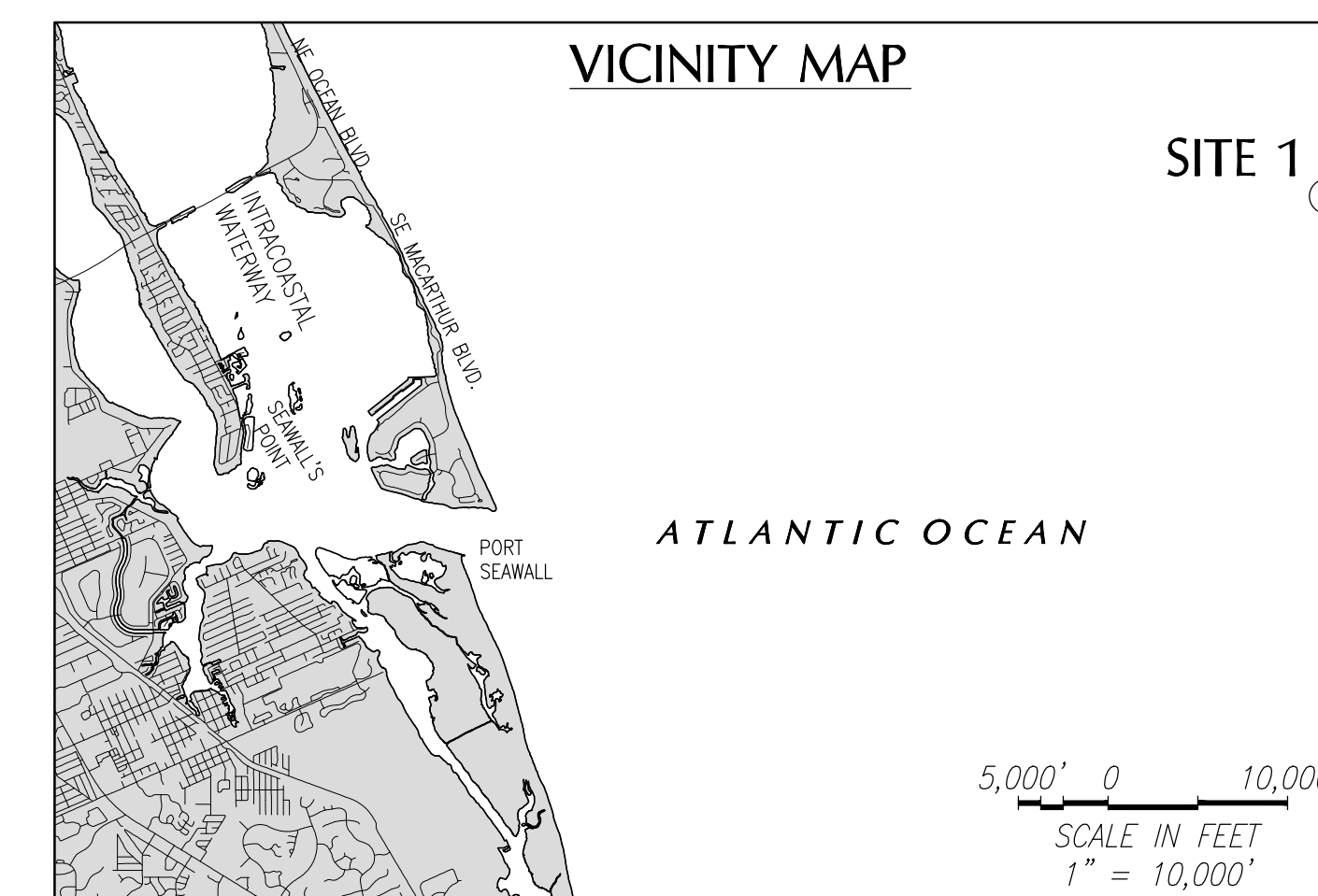
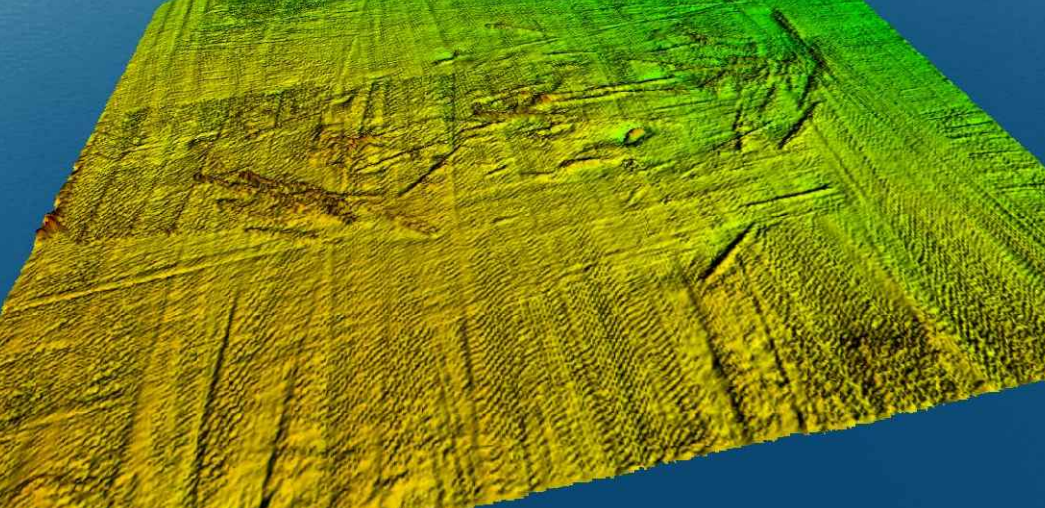
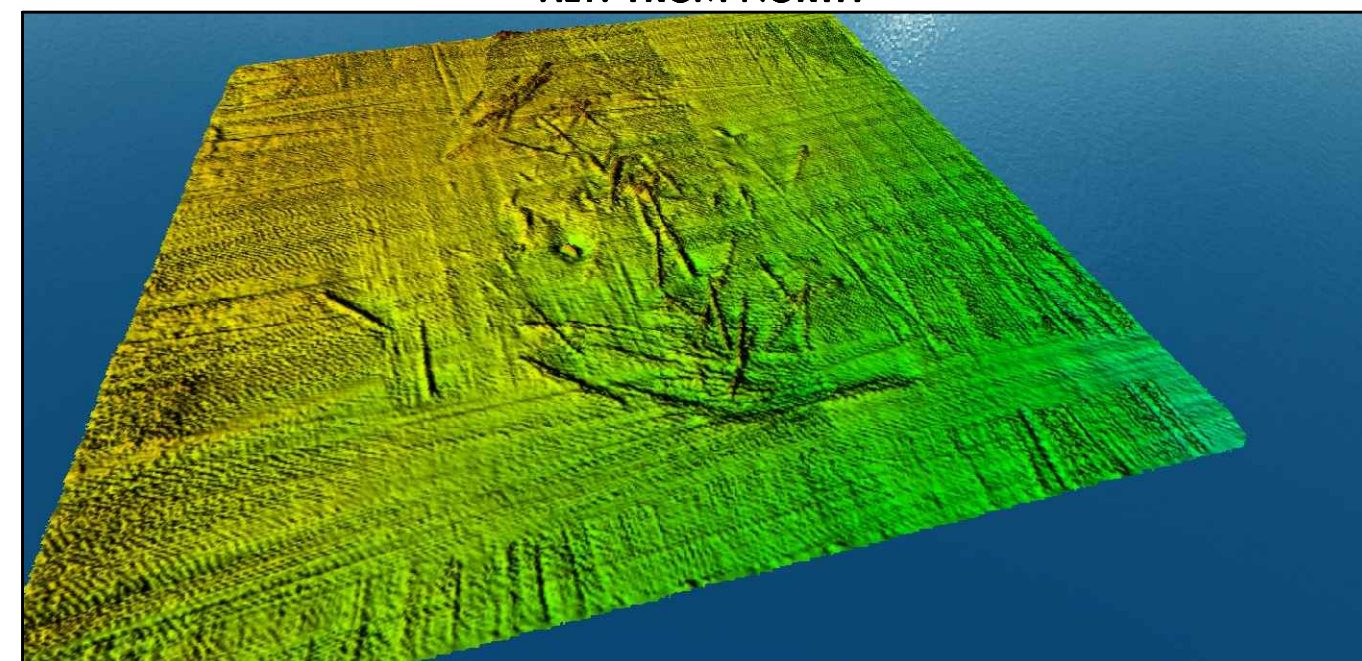
PROJECT NO: 348704
 DATUM: NAVD 88
 DRAWN BY: SR
 CHECKED BY: NR



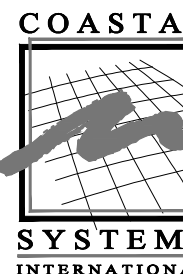
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| REEF | EASTING | NORTHING | LATITUDE | LONGITUDE | MAX EL |
|--------|-----------|-------------|-------------|-------------|--------|
| SITE 1 | 968,461.3 | 1,045,406.0 | 27°12'23.1" | 80°02'21.1" | -89.0' |

NOTE:
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SIZE DRAWINGS (24"x36")



MARTIN COUNTY ARTIFICIAL REEF MONITORING 2017 - 2018



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Coastal, Environmental,
Civil Engineering and Management

CONSULTA

VICINITY MAP

SITE 3

ATLANTIC OCEAN

REEF INFORMATION TABLE

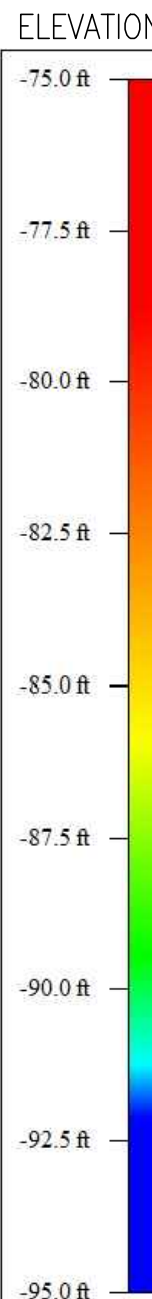
| REEF | EASTING | NORTHING | LATITUDE | LONGITUDE | MAX I |
|--------|-----------|-------------|-------------|-------------|-------|
| SITE 3 | 968,632.5 | 1,044,687.8 | 27°12'16.0" | 80°02'19.2" | -83.0 |

NOTE:
ALL SCALES INDICATED PERTAIN TO FULL
SIZE DRAWINGS (24"x36")

| | |
|-------------|---------|
| PROJECT NO: | 348704 |
| DATUM: | NAVD 88 |
| DRAWN BY: | SR |
| CHECKED BY: | NR |

BATHYMETRIC SURVEY BASEMAP

SITE 3 REEF SITE



SURVEY NOTE

1. BATHYMETRIC DATA COLLECTED BY COASTAL SYSTEMS INTERNATIONAL INC. BETWEEN JUNE 26 AND JUNE 29, 2017.
2. MULTI-BEAM DATA COLLECTED WITH A RESON SEABAT T50-R CONNECTED TO A VALEPORT SWIFT SVP PROFILER AND AN APPLANIX 220 WAVEMASTER POS MV INU.
3. AUXILIARY TIDE DATA COLLECTED WITH A HOBO LEVELLOGGER ELECTRONIC TIDE GAUGE.
4. REFERENCE MONUMENT IS PID DF9408. MONUMENT ELEVATION IS 1.00 FT NAVD 88.
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VIEW FROM EAST

VIEW FROM WI