

Martin County's Nearshore Mitigation Reefs Year-6 Monitoring Report

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All photographs taken by Lee E. Harris in 2006 unless otherwise noted.

**Performed for
Martin County Engineering Department
2401 SE Monterey Road
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2006 Annual Monitoring Report Martin County's Nearshore Mitigation Reefs Year-6 Monitoring Report

1 Introduction

As part of the Martin County Beach Nourishment Project, nearshore mitigation reefs were constructed in the summer of 2000 offshore Martin County in water depths of 10 to 20 feet, with the GPS coordinates presented in Table 1 and the three locations shown in Figure 1.

Table 1. Locations of Martin County Nearshore Mitigation Reefs

Reef Name	Latitude, N [1]	Longitude, W [1]	Water Depth (feet) [2]	Reef Crest Depth (feet) [2]
Mitigation Site A	27° 14.412'	80° 11.098'	10 to 20	7 to 20
Mitigation Site B	27° 13.553'	80° 10.647'	10 to 20	7 to 20
Mitigation Site C	27° 13.335'	80° 10.513'	10 to 20	7 to 20

Notes:

1. Latitude and Longitude near reef site centers.
2. Water depths and reef crest depths as originally constructed, with changes discussed in the stability section of each reef monitoring report section.

Annual monitoring of these artificial reef deployments was required for the first five years following material placement, and monitoring was successfully performed in 2001, 2002, 2003, and 2004 (see Table 2 and previous monitoring reports). Due to the two hurricanes that made direct landfall in this area in September 2004 (slow moving Cat2 Hurricane Frances and Cat3 Hurricane Jeanne), and Hurricane Wilma passing through in October 2005, the 2005 monitoring was not possible, due to the lack of underwater visibility.

Diving was performed offshore Martin County in 2005 after the hurricanes, but the tremendous amount of silt and debris (including palmettos encountered offshore in 10-m water depths) precluded any monitoring efforts. Numerous attempts for monitoring the nearshore mitigation reefs were made many times throughout 2005, but visibility sufficient to dive, let alone to successfully perform the monitoring, did not occur until the spring of 2006, with monitoring performed for this report in May, June and December 2006.

Table 2. Annual Monitoring Dates for Martin County Mitigation Reefs

(Reefs deployed in summer 2000)

Reef Name	2005 Monitoring	2004 Monitoring	2003 Monitoring	2002 Monitoring	2001 Monitoring
Mitigation Site A	none	6/1	5/13	7/23	summer
Mitigation Site B	none	5/26 & 29	5/13	7/23	summer
Mitigation Site C	none	5/26 & 30	5/13	7/23	summer

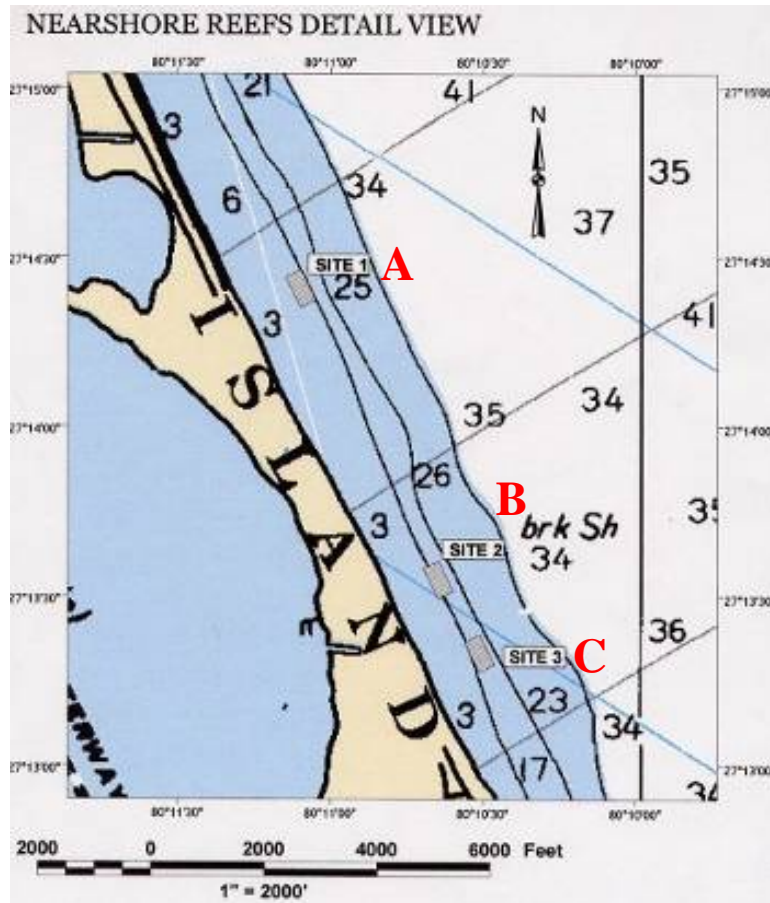


Figure 1. Location of Martin County’s Mitigation Reef Sites (Morgan & Ecklund)

2 Methodology

Annual monitoring of the artificial reef sites includes:

- find, verify, and document reef locations,
- document biological activity (benthic and pelagic communities), and
- evaluate engineering performance (stability and condition of the reef materials, scour and settlement, etc.).

This work was performed by divers using visual techniques plus still and video underwater photography of the reef areas. Dr. Lee Harris and Kerry Dillon performed the field work and report writing for this report, assisted by additional divers for performing the field work. The field work is described as follows:

1. Biological surveys – data collection methods included roaming diver fish counts to assess the relative fish species diversity and quantities. Benthic assessments were performed by identifying benthic growth on the reef materials, including relative percent coverage.
2. Physical reef structure – diver inspections and measurements were made to determine changes in the reef structure, including scour, settlement, spreading out, and movement of reef components. This was accomplished by repeating survey measurements taken on past monitoring surveys. Reef structure depths were measured using dive computers for measurements of the bottom and both the highest and average depths of the reef materials. The natural bottom depths away from the reefs were compared to the maximum depths adjacent to the reefs to assess scour, and changes in the reef heights were used to assess settlement of the materials. Divers also released buoys on tight lines to the surface at key locations in order to get GPS coordinates with the boat.
3. Photo-documentation – underwater digital still and video cameras were used to document the reef conditions and observations during the dives. These were used to compare with still and video photographs taken in prior reef surveys. Representative photographs are included in this report, with a copy of all photographs and video submitted on CD and/or DVD.

Backup photographic equipment was available during each diving day, so that additional equipment was available in the event of equipment failure. Monitoring reports from prior years were reviewed prior to performing the field work, and slates were prepared in advance with sketches of the dive sites and tables for recording measurements and observations. All data taken during each dive was thoroughly reviewed on the boat following each dive, and data was transferred into field books to assure that correct and complete data were recorded and saved. Data collected from each dive was compared to previous years' data to ensure reasonableness of the data.

3 Reef Materials

As part of the contract with the Florida Department of Transportation (FDOT) to construct the new Evans Crary Bridge in Stuart, Florida (for Highway A-1-A crossing from Sewalls Point to Hutchinson Island that was completed in 2000), the contractor was required to dismantle and dispose of the old bridge components. The contractor was required to transport these steel and concrete bridge components offshore to construct artificial reefs.

Some of the bridge components were used to create the three shallow water mitigation reefs close to the Stuart and Jensen Beach shorelines in water depths of 10-20 feet, while the larger bridge sections and the majority of the materials were deployed in the Ernst permitted reef site in water depths of 60-70 feet. The Ernst permitted reef site is located approximately 5 miles offshore Martin County, Florida, with GPS Coordinates: N27 09.346 / W80 03.368 (center of the reef at the high section of the reef materials). These artificial reef sites are shown in Figure 2, along with all the other artificial reef deployments made offshore Martin County from 2000 through 2005.

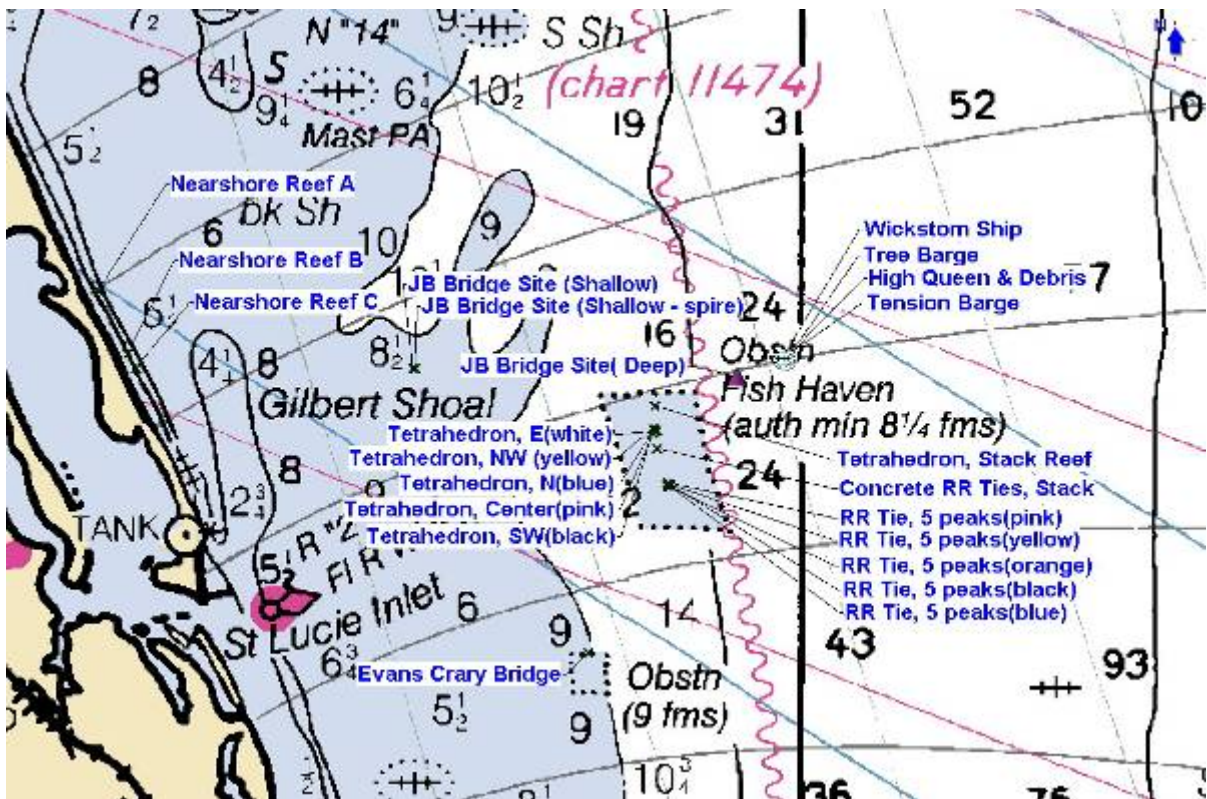


Figure 2. Artificial Reefs deployed 2000 to 2005 offshore Martin County

The fifth annual monitoring year of the required 5-year monitoring effort was completed for the Evans Crary Bridge in the Ernst Artificial Reef Site in 2005. Following the September 2004 Hurricanes Frances and Jeanne, and the October 2005 Hurricane Wilma, visibility nearshore Martin County was greatly impaired; prohibiting the monitoring of the nearshore mitigation sites until the spring of 2006, the results of which are presented in the remainder of this report.

4 Nearshore Mitigation Reef Site A

Monitoring Dates: May 21, June 30, and Dec. 27, 2006

Location: approximately 900 feet offshore; south of the Holiday Inn and Jensen Public Beach, Martin County, Florida

GPS Coordinates: **N27 14.412 / W80 11.098** (center of the reebsite)

Crewmembers: Lee Harris, Kerry Dillon, Laura Herren, Kathy Fitzpatrick, Seth Dillon, Mark Cloer

4.1 History of Mitigation Reef A:

This reef site was constructed during the summer of 2000. Materials utilized were from dismantled concrete and steel components from the old Evans Crary Bridge. Larger sections were placed in the Ernst permitted offshore reebsite in 60 to 70 feet of water, while smaller sections were utilized for the shallower nearshore mitigation reebsites.

Nearshore reef A was constructed on 8/2, 8/16, and 9/15/2000 with three total barge loads of the following materials:

- 70 concrete piles from 20 – 40 ft. long each
- 16 concrete pilecaps approx. 30 ft. x 4 ft. x 5 ft. each
- 18 steel/concrete roadway sections approx. 40 ft. x 5 ft. x 4 ft. each

These materials were deployed from an unanchored barge using several temporary surface buoys to mark the areas for material deployment. Nearshore reebsite A is approximately 900 feet offshore of the beach, with water depths to natural bottom 14 – 22 ft. deep. The shallowest spot to the top of the reef components was measured as 6 feet, with the average water depth above reef components being 12 – 15 feet.

4.2 Reef Components Stability

It was observed that most all components are still close to the same position as when first deployed in the summer of 2000 and monitored in 2001 through 2004. This area is subject to seasonal and storm induced beach profile changes, with some covering and uncovering of the nearshore natural and artificial reefs. There has been some settlement (and/or burial) and scour around the bridge pieces. The scour provides habitat similar to that provided by similar scour around nearshore natural reefs in the area.

The individual pilings that were placed horizontally on the flat sandy bottom have been partially buried into the sand, due to either sinking of the unit in the sand or sand accretion (or a combination of both). Many of the components that stacked on top of each other appear to be stable, and are providing many overhangs and crevices, which provide excellent habitat for a variety of marine organisms. Some materials have shifted since last seen in 2004 due to major Hurricanes Frances & Jeanne in September 2004 and Hurricane Wilma in October 2005. Minimum depths recorded during this survey were 8 to 10 feet at the apex of several pilings that were stacked in an interlocking matrix of other pilings and concrete segments. In previous years the shallowest spot located was 6 feet. Around some of the larger clusters of materials scour has occurred, which was also observed in prior years. The seafloor substrate in this area is a mix of fine sand and shell fragments with some pockets of mud and silt in the depressions of the seafloor.

4.3 Fish Species & Abundance Findings:

The fish species census is shown in Table 3 for Mitigation Reef A.

Table 3. Mitigation Reef A Fish Census

Species	2004	2006	Juvenile or Adult
Barracuda	1	10's	J (1-1.5 ft. long)
Porkfish	10's	10's	A & J
Sailors Choice	>10	0	A
Grey snapper	10's	7	A
Beaugregory	2	1	A
Spottail pinfish	10's	10's	A & J
Blue runner	100's	0	A
Common Snook	8	3	A
Atlantic Spadefish	10's	10's	A & J
Doctorfish	1	0	A
Black Margate	10's	10's	A & J
Red Porgy	3	0	A
Dwarf Goatfish	1	0	A 4"
Highhat	1	4	J
Gray Angelfish	1	0	A
Lane Snapper	1	0	A
Gag Grouper	2	1	J (5 lbs)
French Angelfish Intermediate	2	0	J/A
Cardinalfish	4	0	J
Spotted Moray Eel	1	0	A
Blue Angelfish	1	2	A
Fry(unidentified species)	100's	10's	½" – ¾" long
Spiny Lobster	0	8	from 2 – 5 lbs
Goliath Grouper	0	1	A
King Mackerel	0	1	A
Stripped Croaker	0	5	A
Southern Flounder	0	2	A
Sheepshead	0	3	A
Scorpianfsh	0	2	A
Cubby	0	2	J
Tomtates	0	10's	J
Hairy Blenny	0	2	A

4.4 Benthic Species Identification

On December 27, 2006 divers spent 75 minutes on Mitigation Reef A photographing benthic invertebrates and macroalgae. Sabellariid wormrock reef was photographed on Mitigation Reef A on June 30, 2006, and at that time, there appeared to be several well-established colonies. Wormrock was absent from the site on December 27, 2006. One individual of *Oculina diffusa* was impacted by monofilament fishing line. Benthic species listed in Table 4 were identified using the roving diver technique on December 27, 2006. Representative benthic species from Mitigation Reef A are shown in Figure 3.

Table 4. Mitigation Reef A Benthic Species Census

Benthic Species Identified	Common Name	Abundance
Green Algae		
<i>Caulerpa mexicana</i>		Abundant
<i>Bryopsis pennata</i>		Abundant
<i>Codium</i> spp.		Single
Red Algae		
<i>Gracilaria mammillaris</i>		Many
<i>Gelidium americanum</i>		Abundant
<i>Bryothamnion triquetrum</i>		Few
<i>Botryocladia occidentalis</i>		Few
Brown Algae		
<i>Dictyota</i> spp.	Y-branched alga	Few
<i>Padina</i> spp.	Scroll alga	Few
Sponges		
<i>Pseudaxinella lunaecharta</i>	Orange sticky sponge	Abundant
Unidentified orange sponge		Abundant
Encrusting sponges		Abundant
Yellow encrusting sponge		Many
Cnidarians		
<i>Aglaophenia latecarinata</i>		Feather plume hydroid
<i>Leptogorgia hebes</i>	Regal sea fan	Abundant
<i>Leptogorgia virgulata</i>	Yellow sea whip	Few
<i>Carijoa riisei</i>	White telesto	Many
<i>Oculina diffusa</i>	Ivory bush coral	Many
<i>Phyllangia americana</i>	Hidden cup coral	Few
Worms		
Tubeworms		Few
<i>Phragmatopoma</i> spp.	Sabellariid wormrock	Many
Tunicates		
<i>Eudistoma obscuratum</i>	Black condominium tunicate	Many
<i>Ascidia niger</i>	Black solitary tunicate	Many
Globular tunicates (<i>Styela</i> spp. – like)	Solitary tunicates	Abundant
White colonial tunicate		Many
Sea Urchins		
<i>Arbacia punctulata</i>	Purple urchin	Few
<i>Echinometra lucunter</i>	Rock-boring urchin	Few

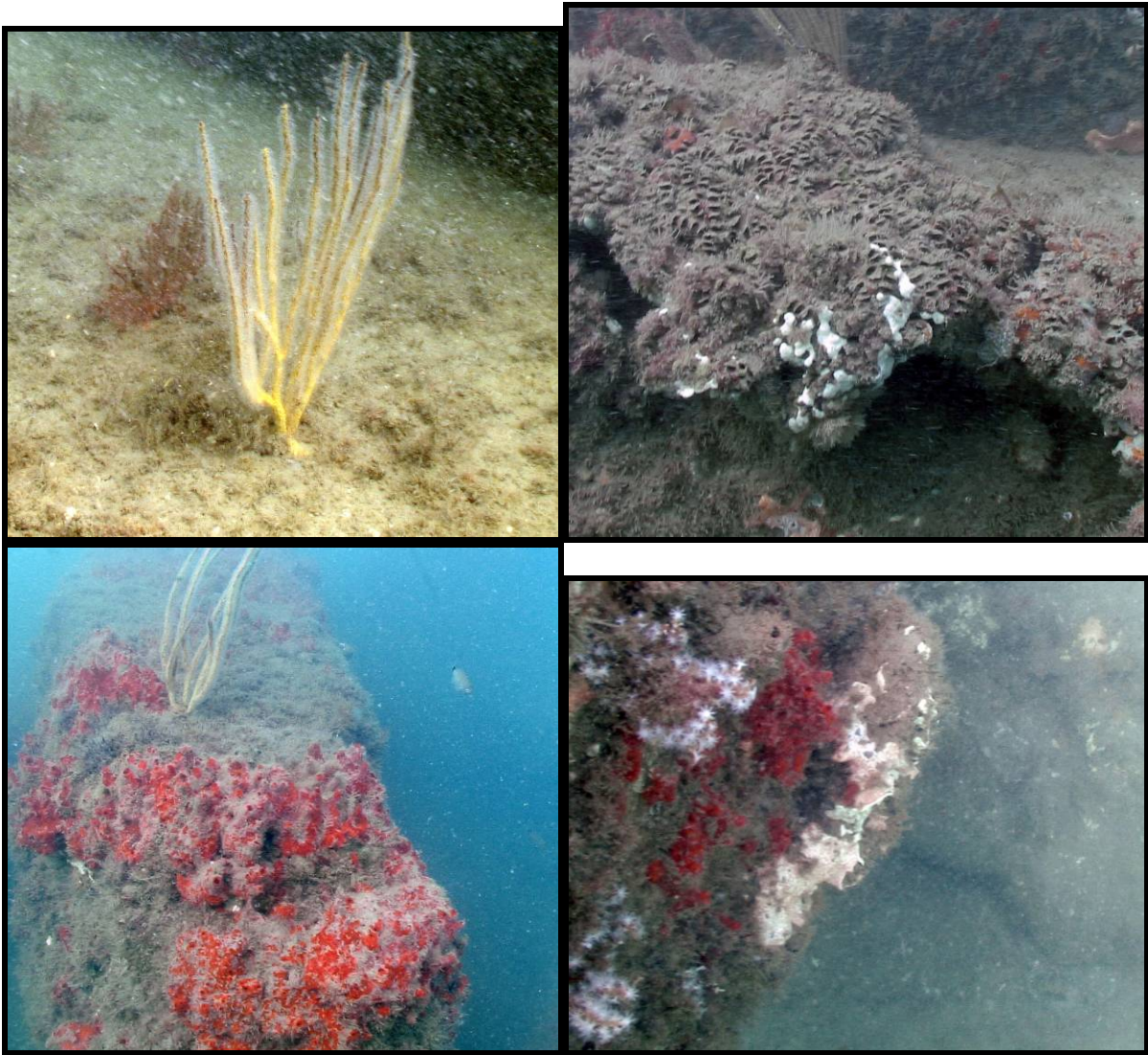


Figure 3. Representative benthic growth on Martin County Mitigation Reef A

a) upper left - yellow sea whip (*Leptogorgia virgulata*) and regal sea fans (*Leptogorgia hebes*), b) upper right - sabellariid wormrock reef (*Phragmatopoma* spp.) found in June 2006, c) lower left - yellow sea whip and unidentified orange sponge, and d) lower right - white telesto (*Carijoa riisei*).

4.5 Mitigation Reef A Summary

Site A is the northernmost of the nearshore reef sites, and is farthest from the St. Lucie Inlet. Site A had the fewest barge loads of materials; therefore the reef is smaller and less dense than the other two-nearshore reef sites. Observations at Site A in 2006 include 21 total fish species identified as opposed to 23 from 2004. Spiny lobster was identified in 2006 and had not been documented there before. Sport fishes seen in 2006 were up to 8 species, the most ever at this site in 6 years of data collection. Two federal protected species, goliath grouper and a species of special concern the stripped croaker were documented. Extensive worm reef has been observed during all spring and summer monitoring events. However, in December 2006 the absence of worm reef was noted.

5 Nearshore Mitigation Reef Site B

Monitoring Dates: May 22, 2006

Location: approximately 1,000 feet offshore of the Buttonwood Condominium just north of Tiger Shores (Virginia Forest Beach), Martin County, Florida

GPS Coordinates: **N27 13.553 / W80 10.647** (center of the reebsite)

Crewmembers: Dr. Lee Harris, Kerry Dillon, Mark Cloer

5.1 History of Mitigation Reef B:

This reef site was constructed during the summer of 2000. Materials utilized were from dismantled concrete and steel components from the old Evans Crary Bridge. Larger sections were placed in the Ernst permitted offshore reebsite in 60 to 70 feet of water, while smaller sections were utilized for the shallower nearshore mitigation reebsites.

Nearshore reef B was constructed on 7/28, 8/2, 8/10, 8/28 & 9/5/2000 with five total barge loads of the following materials:

- 115 concrete piles from 20 – 40 ft. long each
- 20 concrete pilecaps approx. 30 ft. x 4 ft. x 5 ft. each
- 15 steel/concrete roadway sections approx. 40 ft. x 5 ft. x 4 ft. each

These materials were deployed from an unanchored barge using several temporary surface buoys to mark the areas for material deployment. Nearshore reebsite B is approximately 1000 feet offshore of the beach, with water depths to natural bottom 16 – 24 ft. deep. The shallowest spot to the top of the reef components was measured as 7 feet in 2004. In 2006 the shallowest spot located was 8 feet.

5.2 Reef Components Stability

It was observed that most all components are still close to the same position as when first deployed in the summer of 2000 and monitored in 2001 through 2004. This area is subject to seasonal and storm induced beach profile changes, with some covering and uncovering of the nearshore natural and artificial reefs. There has been some settlement (and/or burial) and scour around the bridge pieces. The scour provides habitat similar to that provided by similar scour around nearshore natural reefs in the area.

The individual pilings that were placed horizontally on the flat sandy bottom have been partially buried into the sand, due to either sinking of the unit in the sand or sand accretion (or a combination of both). Many of the components that stacked on top of each other appear to be stable, and are providing many overhangs and crevices, which provide excellent habitat for a variety of marine organisms. Some materials have shifted since last seen in 2004 due to major Hurricanes Frances & Jeanne in September 2004 and Hurricane Wilma in October 2005. Minimum depths recorded during this survey were 8 to 10 feet at the apex of several pilings that were stacked in an interlocking matrix of other pilings and concrete segments. In previous years the shallowest spot located was 6 feet. Around some of the larger clusters of materials scour has occurred, which was also observed in prior years. The seafloor substrate in this area is a mix of fine sand and shell fragments with some pockets of mud and silt in the depressions of the seafloor.

5.3 Fish Species & Abundance Findings:

The fish species census is shown in Table 5 for Mitigation Reef B.

Table 5. Mitigation Reef B Fish Census

Species	2004	2006	Juvenile or Adult
Porkfish	10's	10's	J & A
Barracuda	1	1	A
Atlantic Spadefish	2	10's	A
Sheepshead	4	5	A
Gray Triggerfish	7	1	A
Fry (unidentified species)	100's	100's	J
Blue Runners	100's	3	A
White Spotted Soapfish	0	1	A
Lane Snapper	1	2	A
Spanish Grunt	0	2	A
Unidentified (Looks like baby barracuda)	0	1	J (3" long)
Stripped Croaker	10's	0	--
Grey snapper	10's	0	--
French Angelfish (Intermediate phase)	1	1	--
Spottail pinfish	10's	0	--
Common Snook	10's	0	--
Lane Snapper	1	0	--
Black Margate	5	0	--
Doctorfish	10's	0	--
Sailors Choice	10's	0	--
Southern Flounder	1	0	--
Porcupinefish	1	0	--
Goliath Grouper	1	0	--
Spotted Moray Eel	1	0	--

In the 2006 monitoring 17 fish species were identified as compared to 20 for 2004. Also the federal species of concern (Striped Croaker) that was identified at this site in 2004 was still present in 2006. This species is of special concern because of its limited habitat Florida range. The only known breeding population in North America is in Brevard, Indian River, & St. Lucie counties (Gilmore 1992). This species is dependent on the nearshore rock alga reefs for most of its lifespan.

5.4 Benthic Species Identification

Benthic species for both Sites B and C were the same, as these two sites lie immediately north and south of one another in the same water depths. Benthic species listed in Table 7 were identified using the roving diver technique on December 27, 2006 for Site C, which are indicative of the benthic species found at Site B.

5.5 Mitigation Reef B Summary

Site B is the middle one of the three nearshore reef sites, and is located north of Site C. In the summer of 2000, Site B had the same number of barge loads and almost as much material deployed as Site C.

During the 5 deployments at this site the contractor did a better job of keeping the 5 deployments closer to the set buoys, therefore a tighter grouping was obtained. This allowed for closer clusters of materials to occur. When diving this site a diver can swim from one cluster to another with minimal difficulty. The gaps of flat sand seafloor are shorter than at site C just to the south. The clusters of materials appeared to have stayed together in an interlocking matrix. Some movement has occurred due to the hurricanes, but overall the reefsite is intact and providing a good habitat for marine life to thrive. As was seen in the other sites, some horizontal pilings are almost completely buried in the sand/shell substrate. Although not providing much profile they still serve to stabilize the seafloor in the immediate area around the reefsite.

In 2006 the total number of fish species documented was 17, which is down from 20 in 2004. The total benthic coverage has increased between 2004 and 2006 as can be seen on the digital videodocumentation images. One substantial change in the benthic species diversification at this site has occurred. The invasive exotic green algae species *Caulerpa brachypus* that was seen drifting and attached to the substrates in 2004, was not seen in 2006. Recent findings (Feb. 2007) from Harbor Brach Foundation scientists have confirmed sightings of this invasive exotic alga species in Martin Counties waters in deeper waters 70 – 80 ft. and approx. 7 miles to the southeast of site B. It is widely believed that the hurricanes of 2004/2005 temporarily displaced the species from Martin County waters but it now appears to be spreading into the area again from the southern SE Florida counties.

6 Nearshore Mitigation Reef Site C

Monitoring Dates: May 22 and December 27, 2006

Location: approximately 1,000 feet offshore of Tiger Shores (Virginia Forest Beach), just north of the Stuart Public Beach, Martin County, Florida

GPS Coordinates: **N27 13.335 / W80 10.513** (center of the reefsite)

Crewmembers: 5/22/06 – Dr. Lee Harris, Kerry Dillon, Mark Cloer
12/27/06 – Dr. Lee Harris, Kerry Dillon & Laura Herren

6.1 History of Mitigation Reef C:

This reef site was constructed during the summer of 2000. Materials utilized were from dismantled concrete and steel components from the old Evans Crary Bridge. Larger sections were placed in the Ernst permitted offshore reefsite in 60 to 70 feet of water, while smaller sections were utilized for the shallower nearshore mitigation reefsites.

Nearshore reef C was constructed on 7/19, 22, 25, 28 & 8/16 2000 with five total barge loads of the following materials:

- 120 concrete piles from 20 – 40 ft. long each
- 24 concrete pilecaps approx. 30 ft. x 4 ft. x 5 ft. each
- 19 steel/concrete roadway sections approx. 40 ft. x 5 ft. x 4 ft. each

These materials were deployed from an unanchored barge using several temporary surface buoys to mark the areas for material deployment. Nearshore reefsite C is approximately 1000 feet offshore of the beach, with water depths to natural bottom 15 – 24 ft. deep. The shallowest spot to the top of the reef components measured in 2000 was 7 feet, with the average water depth above reef components being 12 – 15 feet. In 2006 the shallowest spot located was 9 feet.

6.2 Reef Components Stability

This area appeared to have the most changes following the 2004 and 2005 hurricanes. The clusters of material located were fewer and farther apart. The water depths to the sand bottom were significantly shallower than during the previous monitoring events, so that burial of a significant amount of the material in this area is suspected. There has been some settlement (and/or burial) and scour around the bridge pieces that were located in 2006. The scour provides habitat similar to that provided by similar scour around nearshore natural reefs in the area. Many of the components that are stacked on top of each other appear to be stable, and are continuing to provide many overhangs and crevices, which are an excellent habitat for a variety of marine organisms to thrive.

6.3 Fish Species & Abundance Findings:

The fish species census is shown in Table 6 for Mitigation Reef C.

Table 6. Mitigation Reef C Fish Census

Species	2004	2006	Juvenile or Adult
Porkfish	100's	10's	J & A
Porkfish	100's	10's	A
Reef Croaker	10's	0	--
Stripped Croaker	0	100's	A
Grey snapper	10's	2	A
Sheepshead	7	0	--
Beaugregory	2	10's	A
Spottail pinfish	1	3	A
Common Snook	2	1	A
Atlantic Spadefish	2	0	--
Highhat	1	3	J
Blue Runners	10's	0	--
Gray Triggerfish	1	0	--
Barracuda	1	0	--
Lane Snapper	1	0	--
Red Pogy	4	0	--
Fry (unidentified species)	100's	0	--
Nurse shark	2	0	--
Gag Grouper	1	0	--
Black Margate	10's	10's	A & J
Porcupinefish	1	0	--
Scamp	1	0	--
Atlantic Bumper	10's	0	--
Hairy Blenny	0	4	A
Cubaru	0	10's	A & J
Round Scad (Cigar Minnow)	0	100's +	A
Tomtates	0	10's	J & A
Unidentified species of snapper	0	1	A
Spiny Lobster	0	2	A
Townsend Angelfish	0	1	A
Goliath Grouper	0	2	A

6.4 Benthic Species Identification

On December 27, 2006 divers spent 42 minutes on Mitigation Reef C photographing benthic invertebrates and macroalgae. Benthic species listed in Table 7 were identified using the roving diver technique on December 27, 2006.

Table 7. Mitigation Reef C Benthic Species Census

Benthic Species Identified	Common Name	Abundance
Green Algae		
<i>Bryopsis pennata</i>		Abundant
Red Algae		
<i>Gracilaria mammillaris</i>		Many
<i>Gelidium americanum</i>		Abundant
<i>Bryothamnion triquetrum</i>		Few
Sponges		
<i>Pseudaxinella lunaecharta</i>	Orange sticky sponge	Abundant
Encrusting sponges		Abundant
Unidentified yellow sponge		Few
Cnidarians		
<i>Aglaophenia latecarinata</i>	Feather plume hydroid	Abundant
<i>Leptogorgia hebes</i>	Regal sea fan	Abundant
<i>Leptogorgia virgulata</i>	Yellow sea whip	Abundant
<i>Phyllangia americana</i>	Hidden cup coral	Few
<i>Carijoa riisei</i>	White telesto	Many
Solitary anemome		Few
Mat anemone		Single
Worms		
Tubeworms		Few
Gastropods		
<i>Terebra salleana</i>	Eastern augers	Many
Bryozoans		
<i>Bugula turrita</i>	Fan bryozoan	Single
Tunicates		
<i>Eudistoma obscuratum</i>	Black condominium tunicate	Many
<i>Ascidia niger</i>	Black solitary tunicate	Many
Globular tunicates (<i>Styela</i> spp. – like)	Solitary tunicates	Abundant
White colonial tunicate		Many

A dramatic change in the benthic community documented in May 2004 was observed in December 2006. A greater variety of attached macroalgae was documented in 2004 than 2006. The green algae (*Codium*, *Caulerpa*, and *Halimeda*) documented in 2004 were replaced by *Bryopsis pennata* by December 2006. Most importantly, high concentration of the exotic invasive green alga *Caulerpa brachypus* documented in May 2004 (pre-Hurricane Francis) was absent in December 2006. In May 2004, four genera of brown algae (*Sargassum*, *Dictyota*, *Spatoglossum*, and *Padina*) were documented. No brown algae were located during the 2006 survey. The number of species of red algae also decreased significantly by December 2006. One of the greatest transitions between 2004 and 2006 was the percent cover of sponges (especially *Pseudaxinella lunaecharta*). The abundance and species of

tunicates did not differ much between the 2004 and 2006 surveys. No sea urchins or sea cucumbers were documented on Mitigation Reef C during the December 2006 survey. Representative benthic species from Mitigation Reef C are shown in Figure 4.

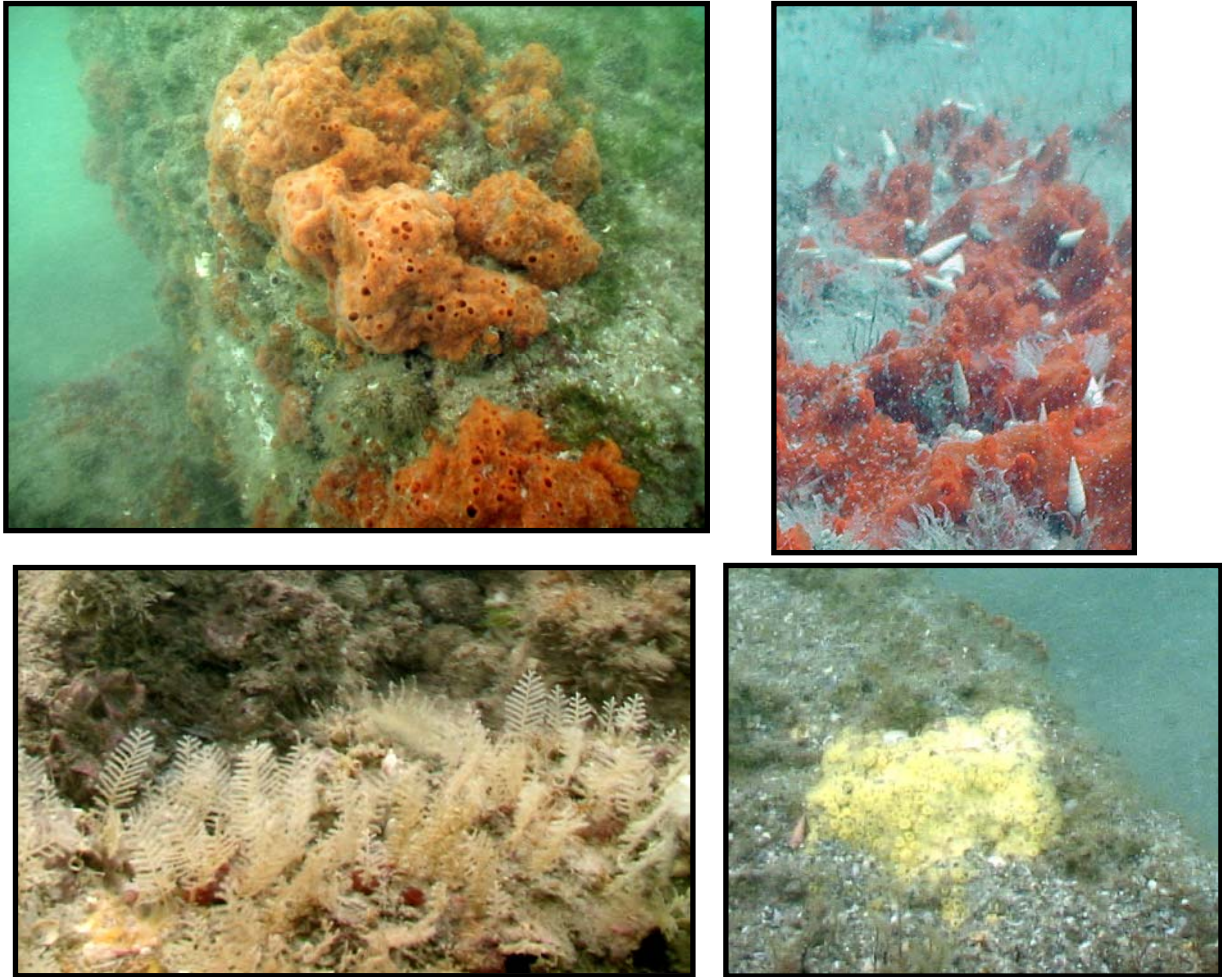


Figure 4. Representative benthic growth on Martin County Mitigation Reef C

a) upper left - orange sponge *Pseudaxinella lunaecharta*, b) lower left - feather plume hydroids *Aglaophenia latecarinata*, c) upper right - Eastern augers *Terebra salleana*, and d) lower right - unidentified yellow sponge.

6.5 Mitigation Reef C Summary

Of the three Martin County mitigation reefs, Site C had the largest quantity of concrete and steel materials deployed. This site was built with 5 total barge loads using fully loaded barges. Although site C had the most total amount of material deployed, it is more spread out, and so the footprint area is larger. At sites A & B it is relatively easy for a diver to find and swim from one grouping of materials to the others, but at site C larger gaps exist for the divers to traverse from one section to another.

As was reported in the 2004 report, many of the original pilings in these areas between stacked materials are now mostly and/or completely covered with sand. The grain size of the sand in 2006 was much coarser at site C than at site A, which could indicate more of the coarser beach sand that eroded from the beaches during the storms covering the material in Reef C than at the other 2 sites.

The total fish species count was down from 20 in 2004 to 14 species identified and 1 additional unidentified species for a total of 15 species in 2006. Spiny lobster was seen in 2006, which was never reported there before. The most notable finding in 2006 was the continued increase in attached benthic organisms thickness and coverage on all steel and concrete surfaces. The absence of the invasive species *Caulerpa brachypus* was also noted and has been a consistent finding up and down the Florida coast where the hurricanes passed, so that it is believed that this invasive species has been flushed away from the area.

7 Mitigation Reef Survey Summary

The Martin County Nearshore Mitigation Reefs have provided extensive habitat for fish and benthic growth since their deployment in the summer of 2000. The large concrete pilings and other large bridge components were stacked in water depths of 10 to 20 feet, with maximum heights initially within 6 feet of the surface. Most if not all of the concrete pieces are still in approximately the same position as when first deployed in 2000, except for some minor shifting, settlement, and scouring around the reef materials. Water depths to the tops of the reefs are now in the 7 to 10-foot range.

In some cases, especially in Site C, there were significant decreases in water depths after the 2004 and 2005 hurricanes in the areas in which the reef materials were deployed, so that the reef materials were no longer observed, indicating that much of the reef materials in that area may now be buried. However, during the mitigation reef monitoring, the periodic covering and uncovering of the nearby natural reefs due to seasonal changes and storm-impacts was also observed, so that this burial may be temporary.

Another interesting phenomenon was the exposure of previously buried existing hard bottom beneath the deployed concrete reef material, due to scour and settlement of the placed reef materials. The reef materials were placed on sand, where prior jet probes revealed sand cover of 1 to 3 feet and greater. This phenomenon increases the reef creation, in that both the newly placed concrete reef materials and the exposed natural reef materials combine to create larger exposed hard bottom areas than prior to the placement of the concrete reef materials. The scour around the concrete reef materials produces desirable habitat such as crevices and ledges, exactly as the scour around natural reef materials provides.

The Martin County coast was severely impacted by major hurricanes Frances (Cat.2) and Jeanne (Cat.3) in September 2004 and Hurricane Wilma (Cat.3) in October 2005, which produced the largest waves recorded along the central east coast of Florida in the past 10 years. Wave data from offshore Sebastian Inlet measured in water depth of 28 feet at a location approximately 50 miles north of the mitigation reefs are shown in Figure 5, with the three largest significant wave height peaks occurring during the 2004 and 2005 hurricanes being much greater than for any other time periods. Extremely strong currents were also measured during the 2004 and 2005 hurricanes (Harris and Flanary, 2007).

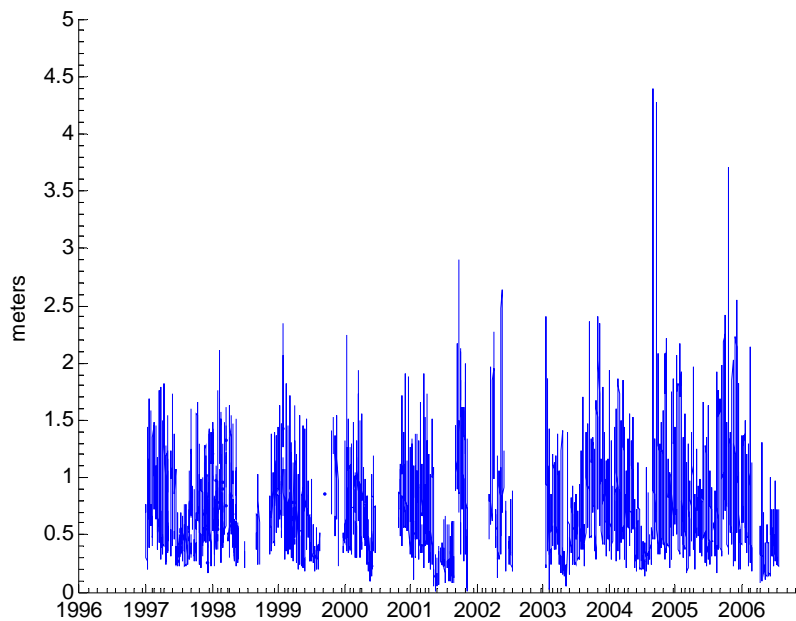


Figure 5. Significant Wave Height Data from Sebastian Inlet, FL (Harris and Flanary, 2007)

Data from co-located ADCP current meters with directional wave data capability.

The 2004 hurricanes were particularly damaging to the Martin County coast, causing breaches in Hutchinson Island, and extensive beach and dune erosion as well as damages to oceanfront and inland buildings. Following the 2004 hurricanes and reinforced by Hurricane Wilma in 2005, the lack of any underwater visibility in the nearshore waters precluded monitoring of the nearshore reefs until the spring of 2006. Erosion of the beaches with deposition of the sand out in the mitigation reef areas was observed, especially in Site C.

Significant numbers of fishes were observed during all surveys over the 6-years of monitoring, including important sportfish species (grouper, snapper, flounder, sheepshead, triggerfish, etc.) and tropical species. The variety and numbers of fish observed were influenced by seasonal and storm impacts, examples including the colder than usual seawater temperatures during the summers of 2003 and 2006. Variations in underwater visibility and diurnal variations in fish activity also affect the fish census data.

Changes in the benthic community were documented from May 2004 to December 2006. No sea urchins or sea cucumbers were documented on Mitigation Reef C during the December 2006 survey, and worm reef growth was greatly reduced from amounts seen during previous years' spring and summer surveys. A greater variety of attached macroalgae was documented in 2004 than in 2006. The green algae (*Codium*, *Caulerpa*, and *Halimeda*) documented in 2004 were replaced by *Bryopsis pennata* in December 2006. Most importantly, high concentrations of the exotic invasive green alga *Caulerpa brachypus* documented in May 2004 (pre-Hurricanes Francis, Jeanne and Wilma) was absent in December 2006. In May 2004, four genera of brown algae (*Sargassum*, *Dictyota*, *Spatoglossum*, and *Padina*) were documented, but no brown algae were located in December 2006. The number of species of red algae also decreased significantly by December 2006. One of the greatest transitions between 2004 and 2006 was the increased percent cover of sponges (especially *Pseudaxinella lunaecharta*).