

# ***Martin County's Nearshore Mitigation Reefs Year-7 Monitoring Report***

## **Part 2: Comparison of Benthic Communities on the Nearshore Martin County Mitigation Reefs and the Adjacent Natural Reefs**

*by Laura Herren*

Like other artificial reefs in Southeast Florida, the Martin County Mitigation Reefs support a suite of benthic organisms that appear to be similar to that of adjacent natural reef communities. Documentation of the physical and biological extent to which nearshore mitigation reefs are functioning similar to natural reef systems provides a foundation for making successful coastal management decisions. The work presented within this report represents the first analysis of the benthic composition on the Martin County Mitigation Reefs since its deployment in the summer of 2000. The results include a statistical comparison of the benthic organisms on the Mitigation Reefs and those on the adjacent natural reef tract.

Benthic species and general abundance were documented along the Mitigation Reefs in May 2004 (Mitigation Reefs B and C) and December 2006 (Mitigation Reefs A and C), but this effort was not extended to the adjacent natural reef (Harris 2004a, Harris 2004b, and Harris *et al.* 2007). Although species lists are useful in documenting presence and relative abundance of species on the Mitigation Reefs, a more scientifically-based and repeatable method is needed to provide a comprehensive look at the species composition at these sites. Video transects and random point count software (Coral Point Count with Excel extensions) were used to help establish a population baseline and general understanding of the benthic composition on the natural and adjacent artificial reef sites in Martin County.

### **Video Transects**

A modification of the Standard Operating Procedures for the Florida Wildlife Research Institute (FWRI) and the National Coral Reef Institute's (NCRI) joint Southeast Coral Reef Evaluation Monitoring Project (SECREMP) was used to establish and capture digital video along three discontinuous 22 m transects at the three artificial reef monitoring sites:



Figure 2. The videographer films a slate that identifies each site and transect prior to capturing the footage used for the analysis.

Mitigation A, B, and C and the natural reef adjacent to the artificial reef sites (FFWCC and NCRI 2007). Video was

captured using a Sony TRV-50 digital video camera. A Plexiglas rod was attached to an aluminum Amphibico underwater video camera housing to maintain a fixed distance of 40 cm from the bottom (Figure 1). Due to the piling length on the artificial reefs and patchiness of the natural reefs, it was necessary to add multiple (two to four) shorter, non-continuous transects to capture



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Figure 1. A Plexiglas rod helps the videographer maintain a fixed distance of 40 cm off the bottom.

22 m of reef at each transect site. To document the beginning of each transect and to allow time for the camera to focus on an object 40 cm away, the videographer filmed a slate which identified the site and transect name prior to capturing transect footage (Figure 2). Waypoints were recorded at the beginning of each of the transect sites using markers (weight and float) and a Standard Horizon GP150 (< 10 m accuracy) DGTS-WASS GPS system (Table 1). The initial compass heading, maximum depth of the transect site, horizontal visibility, and date were also recorded (Table 1).

**Table 1. Transect location, compass heading, and depth at each Martin County artificial and adjacent natural reef site in summer 2007.**

Site and Transect	Starting Waypoint	Compass Heading	Max Depth (feet)	Visibility (feet)	Date Video Recorded
Mitigation A					
A1	27° 14.429 N , 80° 11.104 W	80°	15	10	8/17/2007
A2	27° 14.419 N , 80° 11.104 W	75°	12	10	8/17/2007
A3	27° 14.414 N , 80° 11.091 W	275°	11	10	8/17/2007
Mitigation B					
B1	27° 13.592 N , 80° 10.636 W	120°	11	10	7/26/07
B2	27° 13.584 N , 80° 10.637 W	90°	15	10	7/26/07
B3	27° 13.582 N , 80° 10.651 W	70°	15	10	7/26/07
Mitigation C					
C1	27° 13.592 N , 80° 10.636 W	120°	19	10	8/3/2007
C2	27° 13.584 N , 80° 10.637 W	90°	22	10	8/3/2007
C3	27° 13.582 N , 80° 10.651 W	70°	20	10	8/3/2007
Natural Reef					
N1	27° 14.368 N , 80° 11.102 W	320°	14	5	8/18/07
N2	27° 14.392 N , 80° 11.108 W	140°	14	5	8/18/07
N3	27° 14.401 N , 80° 11.130 W	330°	12	5	8/18/07

### Analysis and statistics

Quicktime Pro 7.3 was used to sequence the captured video for analysis in Coral Point Count with Excel extensions (CPCe). The video was sequenced at a rate of two frames per second which resulted in an average of 1,650 images (\*.jpeg) per site (three transects). The sequenced images were manually filtered, using benthic features and the transect tape, to ensure minimal overlap along each 22 m transect. Sequencing resulted in approximately 85 frames per 22 m video transect. All images (\*.jpg) were enhanced using Expert Image 2000 from Sierra Imaging prior to analysis. Once the frames were sequenced and enhanced, 25 frames per transect (75 per site) were randomly selected for analysis using the random number generator in Microsoft Excel.

Population estimation software, Coral Point Count with Excel Extensions (CPCe) Version 3.3, was provided by the NCRI at Nova Southeastern University Oceanographic Center to analyze the benthic communities on natural and adjacent artificial reefs sites (Kohler and Gill 2006). CPCe software includes a coral code text file specific for Southeast Florida reefs. It was necessary to modify the code list to reflect species identified on Martin County reefs (Appendix A). Each randomly selected image was imported into the CPCe software where 50 random points (in the form of crosshairs) were displayed over the full image and the species or substrate

directly under the point was visually identified as one of the categories listed in the code list in Appendix A. The number of random frames and random points per frame were based on studies using similar video transect methodologies to study Hawaiian coral reef systems (NOAA 2003 and Jokiel *et al.* 2005).

After the point count data were entered, Prism 3.0 statistical software was used to compare sites and categories. The mean percent cover ( $\pm$  S.E.) was calculated for each category at each site. A comparison was initially made to determine whether the three Mitigation Reef sites could be lumped together for the analysis. Since the data failed Gaussian assumptions for normality, non-parametric tests were used. Significant differences were found in the amount of sand, macroalgae, and sponge material among the three sites (Kruskal-Wallis,  $p < 0.0001$ ,  $p = 0.007$ , and  $p < 0.001$ , respectively). As a result, the three sites could not be lumped together as one Mitigation Reef. The following categories: stony coral, gorgonian, sponge, tunicate, macroalgae, turf algae, and sand at each of the three Mitigation Reef sites (A, B, and C) were compared to the adjacent natural reef using Mann-Whitney U non-parametric t-tests.

## Species Lists

Benthic species at the three mitigation reef sites (A, B, and C) and the adjacent natural reef were identified using the roving diver technique (Schmitt and Sullivan 1996). This is a technique in which professionally trained divers hover over the reef sites looking specifically for benthic invertebrates and macroalgae for a documented period of time. Species and general abundance data recorded for each site augments the video transect data by documenting additional species that were not captured along the transects (Figure 3). All observed species were documented to the lowest recognizable taxon on an underwater slate and, when necessary, samples were taken for verification using reference guides and the professional expertise of other benthic ecologists. Photodocumentation using either a Canon PowerShot S500 Digital Elph or an Olympus Camedia C-50 Zoom was used to aid the species identification process. The most relevant guides for the Martin County area include: 1) Littler and Littler's Caribbean Reef Plants: An Identification Guide to the Reef Plants of the Caribbean, Bahamas, Florida and Gulf of Mexico, 2) Hendl, Miller, Pawson and Kier's Echinoderms of Florida and the Caribbean: Sea Stars, Sea Urchins, and Allies, 3) Paul Humann's Reef Creature Identification: Florida Caribbean and Bahamas, 4) Herman Wirshing's Key to the Identification of the Common Shallow Water Gorgonians of Florida and the Caribbean (Nova Southeastern University), and 5) A Simple Fool's Guide to Sponge Taxonomy (Kelly-Borges 1994). The following abundance measure was used during historic (2004 and 2006) benthic surveys and will continue to be used during future projects on the Mitigation Reef sites to facilitate long-term analysis: Single (1), Few (2-10), Many (11-100), and Abundant (>100).



Figure 3. The roving diver technique allows the diver to document species that may not be captured in video transects such as this colony of white telesto *Carijoa riisei* located along the underside of a piling.

## Video Transect Analysis Results

Turf algae, comprised of dense patches of diminutive species of algae capable of capturing and holding sand, were the dominant living organisms on both the natural and Mitigation Reef sites in summer 2007 (Table 2). The artificial sites supported significantly more turf algae and sponges and significantly less large, fleshy macroalgae and sand than the adjacent natural reef system (Table 2). No significant differences were documented in the abundance of tunicates on the artificial and natural reefs. Although observed on both natural and artificial reefs (see species lists below), gorgonians and stony corals were only documented in the video analysis on artificial reefs and wormrock was only documented on the natural reefs (Table 2). Stony corals were divided into three subcategories which represent the three species documented at the study sites: ivory bush coral *Oculina diffusa*, hidden cup coral *Phyllangia americana*, and knobby star coral *Solenastrea hyades*. *Oculina diffusa* and *Solenastrea hyades* were the only species documented using the point count methodology. Two subcategories of gorgonians, the regal sea fan *Leptogorgia hebes* and the yellow sea whip *L. virgulata*, were included to accurately document the abundance of each. Both were captured during the analysis (Figure 4).



Figure 4. Regal sea fan surrounded by turf algae along a video transect.

**Table 2. Mean percent cover ( $\pm$  SE) of benthic organisms and substrate by major category on the three sections of Martin County’s Mitigation Reef and the adjacent natural reef in summer 2007. Asterisks indicate significant differences between the mitigation site and the natural reef within each category.**

Major Category	Mitigation A	Mitigation B	Mitigation C	Natural Reef
Turf Algae	77.24 $\pm$ 2.63*	73.64 $\pm$ 2.92*	69.37 $\pm$ 3.43*	61.98 $\pm$ 3.05
Sponges	11.37 $\pm$ 1.62*	16.57 $\pm$ 2.34*	4.33 $\pm$ 1.03*	0.90 $\pm$ 0.30
Sand	7.72 $\pm$ 2.32*	9.10 $\pm$ 1.73*	24.25 $\pm$ 3.59*	32.36 $\pm$ 3.31
Macroalgae	1.66 $\pm$ 0.70*	0.18 $\pm$ 0.12*	1.45 $\pm$ 0.74*	4.68 $\pm$ 1.05
Tunicates	0.28 $\pm$ 0.12	0.14 $\pm$ 0.08	0.09 $\pm$ 0.06	0.06 $\pm$ 0.06
Gorgonians	1.62 $\pm$ 1.34	-	0.52 $\pm$ 0.24	-
Stony Coral	0.09 $\pm$ 0.06	0.05 $\pm$ 0.04	-	-
Wormrock	-	-	-	0.02 $\pm$ 0.02
Total	100	100	100	100

## Species Lists

Species lists created for the three Mitigation Reef sites and the adjacent natural reef are located in Tables three through six below.

**Table 3. Species located on Martin County Mitigation Reef A in summer 2007.**

Species	Common Name	Abundance
<b>Cyanobacteria</b>		
Unidentified cyanobacteria	Black cyanobacteria	Few
<b>Green Algae</b>		
<i>Bryopsis pennata</i>		Few
<i>Caulerpa brachypus</i> *		Abundant
<i>Caulerpa mexicana</i> *		Many
<i>Caulerpa racemosa</i>		Few
<i>Caulerpa racemosa var. peltata</i>		Few
<i>Caulerpa sertularoides</i> *		Few
<i>Codium taylorii</i> *		Many
<i>Halimeda discoidea</i> *		Few
<i>Halimeda tuna</i> *		Few
<b>Red Algae</b>		
<i>Acanthophora specifera</i> *		Few
<i>Amphiroa</i> sp.		Few
<i>Botrycladia</i> sp.		Few
<i>Ceramium</i> sp.		Few
<i>Gracilaria mammillaris</i>		Few
<i>Gracilaria</i> spp.*		Few
<i>Hypnea musciformis</i>		Few
<i>Laurencia</i> sp.		Single
<i>Ligora</i> sp.*		Few
<i>Polysiphonia</i> sp.*		Few
<b>Brown Algae</b>		
<i>Dictyota menstrualis</i>		Many
<i>Dictyota pulchella</i>		Few
<i>Dictyota</i> spp.*		Few
<i>Padina</i> spp.*		Many

<i>Spatoglossum schroederi</i> *		Few
<b>Sponges</b>		
<i>Cliona lampa</i> *	Boring sponge	Few
Maybe <i>Cliona</i> sp.*	Unidentified yellow boring sponge	Many
<i>Ircinia stobilina</i>	Black ball sponge	Single
<i>Pseudaxinella lunaecharta</i> *	Orange sticky sponge	Many
Unidentified orange sponge*	Orange sponge	Many
Unidentified encrusting sponges*	Encrusting sponges	Many
<b>Mollusks</b>		
<i>Cerithium</i> sp.*	Cerith snail	Few
<i>Cypraea cervus</i> *	Atlantic deer cowrie	Single
<i>Elysia ornata</i>	Ornate Elysia (nudibranch)	Few
Unidentified snails*	Snails	Few
<b>Crustaceans</b>		
<i>Panulirus argus</i>	Caribbean spiny lobster	Few
<i>Stenorhynchus seticornis</i>	Yellowline arrowcrab	Single
Unidentified barnacles*	Barnacles	Abundant
<b>Cnidarians</b>		
<i>Aglaophenia latecarinata</i> *	Feather plume hydroid	Few
<i>Carijoa riisei</i> *	White telesto	Abundant
<i>Epicystis crucifer</i>	Beaded anemone	Single
<i>Leptogorgia hebes</i> *	Regal sea fan	Many
<i>Leptogorgia virgulata</i> *	Yellow sea whip	Many
<i>Oculina diffusa</i>	Ivory bush coral	Many
<i>Phyllangia americana</i> *	Hidden cup coral	Many
<i>Sertularella speciosa</i>	Branching hydroid	Single
<i>Solenastrea hyades</i>	Knobby star coral	Few
Unidentified anemone	Anemone	Few
<b>Worms</b>		
<i>Phragmatopoma lapidosa</i> *	Sabellariid wormrock	Few
Tubeworms		Few
Unidentified feather dusters*	Feather duster worms	Few
<b>Bryozoans</b>		
Maybe <i>Scrupocellaria</i> sp.*	Unidentified tan fan bryozoan	Many
Maybe <i>Bugula</i> sp.*	Unidentified purple fan bryozoan	Single
<b>Tunicates</b>		
<i>Phallusia nigra</i>	Black solitary tunicate	Few

<i>Botrylloides nigrum</i>	Flat tunicate	Many
<i>Eudistoma obscuratum</i> *	Black condominium tunicate	Few
Maybe <i>Styela</i> sp. or <i>Mogula</i> sp.*	Unidentified solitary globular tunicates	Many
Unidentified colonial tunicate*	Colonial tunicate	Many
<b>Echinoderms</b>		
<i>Arbacia punctulata</i>	Purple urchin	Single
<i>Echinometra lucunter</i> *	Rock-boring urchin	Few
<i>Holothuria</i> sp.*	Sea cucumber	Few
* Species documented on both the artificial and adjacent natural reef sites in summer 2007.		

**Table 4. Species located on Martin County Mitigation Reef B in summer 2007.**

Species	Common Name	Abundance
<b>Green Algae</b>		
<i>Caulerpa brachypus</i> *		Many
<i>Caulerpa mexicana</i> *		Few
<i>Caulerpa racemosa</i>		Many
<i>Codium</i> spp.*		Abundant
<i>Halimeda discoidea</i> *		Few
<i>Halimeda tuna</i> *		Few
<b>Red Algae</b>		
<i>Gracilaria</i> spp.*		Many
<i>Hypnea</i> sp.		Many
<b>Brown Algae</b>		
<i>Dictyota menstrualis</i>		Abundant
<i>Dictyota pulchella</i>		Abundant
<i>Padina</i> spp.*		Many
<i>Spatoglossum schroederi</i> *		Abundant
<b>Sponges</b>		
<i>Cliona lampa</i> *	Boring sponge	Many
Maybe <i>Cliona</i> sp.*	Unidentified yellow boring sponge	Many
<i>Pseudaxinella lunaecharta</i> *	Orange sticky sponge	Many
Unidentified orange sponge*	Orange sponge	Abundant
Unidentified encrusting sponges*	Encrusting sponges	Few
<b>Mollusks</b>		
<i>Perna viridis</i>	Green muscles	Few
<b>Cnidarians</b>		
<i>Aglaophenia latecarinata</i> *	Feather plume hydroid	Abundant

<i>Carijoa riisei</i> *	White telesto	Abundant
<i>Leptogorgia hebes</i> *	Regal sea fan	Abundant
<i>Leptogorgia virgulata</i> *	Yellow sea whip	Many
<i>Oculina diffusa</i>	Ivory bush coral	Many
<i>Phyllangia americana</i> *	Hidden cup coral	Few
<i>Solenastrea hyades</i>	Knobby star coral	many
Unidentified anemone	Anemone	Few
Unidentified hydroids*	Bipinate yellow hydroids	Abundant
<b>Worms</b>		
<i>Phragmatopoma lapidosa</i> *	Sabellariid wormrock	Few
Unidentified feather dusters*	Feather duster worms	Few
<b>Tunicates</b>		
<i>Phallusia nigra</i>	Black solitary tunicate	Single
Maybe <i>Styela</i> sp. or <i>Mogula</i> sp.*	Unidentified solitary globular tunicates	Abundant
Unidentified colonial tunicate*	Colonial tunicates	Many
<b>Echinoderms</b>		
<i>Arbacia punctulata</i>	Purple urchin	Single
<i>Holothuria</i> sp.*	Sea cucumber	Few
* Species documented on both natural and adjacent artificial reefs in summer 2007.		

**Table 5. Species located on Martin County Mitigation Reef C in summer 2007.**

Species	Common Name	Abundance
<b>Green Algae</b>		
<i>Caulerpa brachypus</i> *		Many
<i>Caulerpa mexicana</i> *		Many
<i>Caulerpa prolifera</i> *		Single
<i>Caulerpa racemosa</i>		Many
<i>Caulerpa sertularoides</i> *		Few
<i>Codium taylorii</i> *		Many
<i>Halimeda discoidea</i> *		Many
<i>Halimeda tuna</i> *		
<b>Red Algae</b>		
<i>Acanthophora specifera</i> *		Few
<i>Botrycladia occidentalis</i>		Few
<i>Ceramium spp.</i>		Few
<i>Heterosiphonia gibbessii</i> *		Few
<i>Hypnea sp.</i>		Many
<i>Jania adherens</i>		Few
<i>Ligora sp.</i> *		Single



<b>Brown Algae</b>		
<i>Dictyopteris sp.</i>		Few
<i>Dictyota menstrualis</i>		Many
<i>Dictyota pulchella</i>		Many
<i>Dictyota spp.*</i>		Few
<i>Padina spp.*</i>		Few
<i>Rosenvingea intricata</i>		Single
<b>Sponges</b>		
<i>Cliona delitrix</i>	Orange boring sponge	Few
Maybe <i>Cliona sp.*</i>	Unidentified yellow boring sponge	Many
<i>Pseudaxinella lunaecharta*</i>	Orange sticky sponge	Many
Unidentified orange sponge*	Orange sponge	
Unidentified encrusting sponges*	Encrusting sponge	Many
<b>Mollusks</b>		
<i>Cyphoma gibbosum</i>	Flamingo tongue	Few
<i>Elysia ornata</i>	Ornate Elysia (nudibranch)	Few
<i>Perna viridis</i>	Green muscles	Single
<b>Crustaceans</b>		
<i>Petrochirus diogenes</i>	Giant hermit crab	Single
Unidentified barnacles	Barnacles	Abundant
Unidentified hermit crab*	Hermit crab	Many
<b>Cnidarians</b>		
<i>Aglaophenia latecarinata*</i>	Feather plume hydroid	
<i>Carijoa riisei*</i>	White telesto	Few
<i>Epicystis crucifer</i>	Beaded anemone	Single
<i>Leptogorgia hebes*</i>	Regal sea fan	Many
<i>Leptogorgia virgulata*</i>	Yellow sea whip	Many
<i>Oculina diffusa</i>	Ivory bush coral	
<i>Phyllangia americana*</i>	Hidden cup coral	Single
<i>Sertularella speciosa</i>	Branching hydroid	
<i>Solenastrea hyades</i>	Knobby star coral	Many
Unidentified anemone	Anemone	
Unidentified hydroid*	Hydroid	Many
<b>Worms</b>		
<i>Phragmatopoma lapidosa*</i>	Sabellariid wormrock	Many
Unidentified feather dusters*	Feather duster worms	Abundant

<b>Bryozoans</b>		
Maybe <i>Scrupocellaria</i> sp.*	Unidentified tan fan bryozoan	Many
Maybe <i>Bugula</i> sp.*	Unidentified purple fan bryozoan	Single
<b>Tunicates</b>		
<i>Phallusia nigra</i>	Black solitary tunicate	Single
<i>Botrylloides nigrum</i>	Flat tunicate	Many
<i>Eudistoma obscuratum</i> *	Black condominium tunicate	Few
Maybe <i>Styela</i> sp. or <i>Mogula</i> sp.*	Unidentified solitary globular tunicates	Many
Unidentified colonial tunicates*	Colonial tunicates	Many
<b>Echinoderms</b>		
<i>Holothuria</i> sp.*	Sea cucumber	Few
<i>Mellita isometra</i>	Sand dollar	Single
* Species documented on both natural and adjacent artificial reefs in summer 2007.		

**Table 6. Species located on Martin County’s nearshore natural reef located adjacent to Mitigation Reefs A, B, and C in summer 2007.**

Species	Common Name	Abundance
<b>Green Algae</b>		
<i>Acetabularia crenulata</i>		Few
<i>Caulerpa brachypus</i> *		Many
<i>Caulerpa mexicana</i> *		Few
<i>Caulerpa prolifera</i> *		Many
<i>Caulerpa sertularoides</i> *		Few
<i>Codium taylorii</i> *		Abundant
<i>Codium</i> spp.*		Few
<i>Halimeda discoidea</i> *		Abundant
<i>Halimeda</i> spp.*		Many
<i>Halimeda tuna</i> *		Few
<i>Penicillus capitatus</i>		Few
<i>Penicillus dumentosus</i>		Few
<i>Udotea</i> sp.		Few
<i>Ulva</i> sp.		Few
<b>Red Algae</b>		
<i>Acanthophora specifera</i> *		Abundant
<i>Gracilaria</i> spp.*		Abundant
<i>Heterosiphonia gibbesii</i> *		Abundant
<i>Ligora</i> sp.*		Few
<b>Brown Algae</b>		
<i>Dictyota</i> spp.*		Abundant

<i>Padina</i> spp.*		Abundant
<i>Spatoglossum schroederi</i> *		Abundant
<b>Sponges</b>		
<i>Cinachyra</i> sp.	Yellow ball sponge	Many
<i>Cliona lampa</i> *	Boring sponge	Few
Maybe <i>Cliona</i> sp.*	Unidentified yellow boring sponge	Many
<i>Pseudaxinella lunaecharta</i> *	Orange sticky sponge	Many
Unidentified orange sponge	Orange sponge	Many
Unidentified encrusting sponges*	Encrusting sponges	Many
<b>Mollusks</b>		
<i>Aplysia morio</i>	Spanish dancer (sea hare)	Few
<i>Cerithium</i> sp.*	Cerith snail	Single
<i>Cypraea cervus</i> *	Atlantic deer cowrie	Single
<i>Navanax aenigmaticus</i>	Nudibranch	Single
Unidentified snails*	Snails	Single
<b>Crustaceans</b>		
Unidentified barnacles*	Barnacles	Many
Unidentified hermit crab*	Hermit crabs	Few
Unidentified shrimp	Shrimp	Single
<b>Cnidarians</b>		
<i>Aglaophenia latecarinata</i> *	Feather plume hydroid	Abundant
<i>Carijoa riisei</i> *	White telesto	Few
<i>Leptogorgia hebes</i> *	Regal sea fan	Many
<i>Leptogorgia virgulata</i> *	Yellow sea whip	Few
<i>Phyllangia americana</i> *	Hidden cup coral	Few
Unidentified hydroid*	Yellow branched hydroid	Many
Unidentified hydroid	Bush hydroid	Few
<b>Worms</b>		
<i>Phragmatopoma lapidosa</i> *	Sabellariid wormrock	Abundant
Unidentified tubeworms*	Tubeworms	Few
Unidentified feather dusters*	Feather duster worms	Few
<b>Bryozoans</b>		
Maybe <i>Scrupocellaria</i> sp.*	Unidentified tan fan bryozoan	Few
Maybe <i>Bugula</i> sp.*	Unidentified purple fan bryozoan	Single
<b>Tunicates</b>		
Unidentified colonial tunicate*	Colonial tunicates	Many

<b>Echinoderms</b>		
<i>Echinometra lucunter</i> *	Rock-boring urchin	Single
<i>Holothuria</i> sp.*	Sea cucumber	Few
* Species documented on both natural and adjacent artificial reefs in summer 2007.		

## Discussion

The work presented above represents the first statistical analysis of the benthic composition on the Martin County Mitigation Reefs since its deployment in summer 2000. Incorporation of video transects to monitor the benthic community on this artificial reef provides a permanent snapshot record of the reef that can be used by others for future research. Although a widely accepted scientific method for studying marine environments, some key species, such as the hidden cup coral *Phyllangia americana* and wormrock *Phragmatopoma lapidosa*, were present but not captured on the Mitigation Reefs during the point count analysis. These species were, however, documented in the roving diver species lists created for each site (Tables 3-6). This study exemplifies the need for both complimentary methodologies to give a better understanding of the overall benthic diversity of the site.

Based on the statistical results of the point count analysis, the benthic composition of the Mitigation Reefs is significantly different than that of the adjacent natural reefs (except for tunicates). In summer 2007, the Mitigation Reefs supported significantly more sponges and more turf algae while the natural reef supported significantly more distinctive, fleshy macroalgae (e.g., *Gracilaria* spp., *Spatoglossum* sp., *Dictyota* spp., and *Halimeda* spp.). The natural reef also trapped significantly more sand than the Mitigation Reefs. These results can be seen in the representative photographs located in Appendix B. Gorgonians were only captured in the point count analysis along Mitigation Reefs A and C, but regal sea fans *Leptogorgia hebes* and yellow sea whips *L. virgulata* were also observed on the natural reefs (Table 6). In general, the Martin County natural and artificial reefs support a numerous and diverse amount of tunicates (Herren *unpublished data*). The point count analysis in this study showed a small percentage of tunicates at each site with no significant differences in the abundance on Mitigation and natural reefs. Stony corals were present on all Mitigation Reefs and the adjacent natural reef, but they were only documented at Mitigation Reefs A and B during the point count analysis (Table 2). During this study, *Solanastrea hyades* and *Oculina diffusa* were only observed on the Mitigation Reefs and *Phyllangia americana* was documented at all four sites. It is important to note that both *Solanastrea hyades* and *Oculina diffusa* are well documented on the nearshore reefs in Martin County and are included in the most current species list of the nearshore natural reefs located within St. Lucie Inlet Preserve State Park (Herren *et al.* 2007 and Appendix C).

It is also important to note that although wormrock was documented through the point count analysis to be solely located on the natural reef, this species was observed at all four study sites in summer 2007 (Appendix B and Tables 3-6). Wormrock was also photodocumented on the Mitigation Reefs in June 2006, July 2007, and August 2007 (Appendix B). Interestingly, these formations were not observed during roving diver benthic surveys of the Mitigation Reefs in December 2006 (Harris *et al.* 2007). However, based on the observations made in summer 2006 and 2007, *Phragmatopoma lapidosa* (the Sabellariid worms creating wormrock formations) is

able to recruit to the Mitigation Reefs. Monitoring of select wormrock patches on the Mitigation Reef would help resource managers understand recruitment location and success and, ultimately, lead to better understanding of successful artificial reef design.

Two factors not tested in this benthic study, reef height and proximity of natural and artificial reefs, appeared to be influencing the abundance and diversity of benthic organisms. An increase in the density (i.e, number per unit of area) and diversity of gorgonians and sponges on the natural reef was observed in areas where the natural reef was located within a few meters of the artificial reef. This may have been due to recruitment of progeny from a concentrated number of adults located on the nearby artificial reefs. Sections of the natural reef that had a significant amount of elevation (> 1.5 m) and ledges also appeared to support more benthic diversity than other sections of the patch reef closest to the sand. Likewise, recruitment of benthic organisms appeared to be higher on sections of artificial pilings that were elevated from the sand bottom. Additional scientific studies would be needed to determine whether or not these factors are actually influencing the benthic ecology of the site. Better understanding of relationship between elevation and benthic composition on nearshore natural reefs may help to refine future artificial reef design.

Several organisms documented in the species lists during this study were unique to either the artificial or natural reefs (Table 7). Based on nearshore reef surveys conducted within St. Lucie Inlet Preserve State Park (immediately south of St. Lucie Inlet), several of the Mitigation Reef-specific species are likely found on the natural reef system as well (Appendix C).

**Table 7. Species documented on either the Mitigation Reefs only or the natural reef system only in summer 2007.**

Mitigation Reefs Only		Natural Reef Only	
Species	Common Name	Species	Common Name
<b>Cyanobacteria</b>			
	Unidentified black cyanobacteria		
<b>Green Algae</b>		<b>Green Algae</b>	
<i>Bryopsis pennata</i>		<i>Acetabularia crenulata</i>	
<i>Caulerpa racemosa</i>		<i>Halimeda</i> spp.	
<i>C. racemosa</i> var. <i>peltata</i>		<i>Penicillus capitatus</i>	
		<i>Penicillus dumentosus</i>	
		<i>Udotea</i> sp.	
		<i>Ulva</i> sp.	
<b>Red Algae</b>			
<i>Amphiroa</i> sp.			
<i>Botrycladia</i> sp.			
<i>Ceramium</i> sp.			
<i>Gracilaria mammillaris</i>			
<i>Hypnea</i> sp.			

<i>Hypnea musciformis</i>			
<i>Laurencia</i> sp.			
<b>Brown Algae</b>			
<i>Dictyota menstrualis</i>			
<i>Dictyota pulchella</i>			
<b>Sponges</b>		<b>Sponges</b>	
<i>Ircinia strobilina</i>	Black ball sponge	<i>Cinachyra</i> sp.	Yellow ball sponge
			Unidentified orange sponge
<i>Cliona delitrix</i>	Orange boring sponge		
<b>Mollusks</b>		<b>Mollusks</b>	
<i>Cyphoma gibbosum</i>	Flamingo tongue	<i>Aplysia morio</i>	Spanish dancer (sea hare)
<i>Elysia ornata</i>	Ornate Elysia (nudibranch)	<i>Navanax aenigmaticus</i>	Nudibranch
<i>Perna viridis</i>	Green muscles		
<b>Crustaceans</b>		<b>Crustaceans</b>	
<i>Panulirus argus</i>	Caribbean spiny lobster		Unidentified shrimp
<i>Petrochirus diogenes</i>	Giant hermit crab		
<i>Stenorhynchus seticornis</i>	Yellowline arrowcrab		
<b>Cnidarians</b>		<b>Cnidarians</b>	
<i>Epicystis crucifer</i>	Beaded anemone		Unidentified bush hydroid
<i>Oculina diffusa</i>	Ivory bush coral		
<i>Sertularella speciosa</i>	Branching hydroid		
<i>Solenastrea hyades</i>	Knobby star coral		
	Unidentified anemone		
<b>Worms</b>			
Tubeworms			
<b>Tunicates</b>			
<i>Ascidia niger</i>	Black solitary tunicate		
<i>Botrylloides nigrum</i>	Flat tunicate		
<b>Echinoderms</b>			
<i>Arbacia punctulata</i>	Purple urchin		
<i>Mellita isometra</i>	Sand dollar		

Two non-native species were documented on the Mitigation Reefs during the study (Figures 5 and 6). The green macroalga *Caulerpa brachypus* was found at all four sites (Mitigation A, B, C, and the adjacent natural reef) while the green muscle *Perna viridis* was documented at two of the artificial sites (Mitigation B and C). *Caulerpa brachypus* has been observed and documented on other artificial and natural reefs in Martin County and was, therefore, not surprising to see this species on all four sites (Appendix C and Herren *unpublished data*). The size (~ 5 cm) and limited number (two on Mitigation Reef B and one on Mitigation Reef C) of non-clumping green muscles on the Mitigation Reefs, however, suggest that this species remains in the early stages of invasion in Martin County. Green muscles have also been observed by the authors in the nearshore areas of St.



Figure 5. Atlantic deer cowrie surrounded by a non-native macroalga *Caulerpa brachypus* on Mitigation Reef C.

Lucie County to the north. Large clumps of green muscles were photographed and sampled along the underside of Florida Power and Light Nuclear Power Plant's intake canal cap located 365 m offshore in spring 2007 (Dillon *personal observation* and sample confirmation by the University of Central Florida Department of Biology). Two individuals were also observed in Fort Pierce Inlet attached to a navigation sign directly behind the restaurant Mangrove Matties in December 2007 (Herren *personal observation*).



Figure 6. The non-native green muscle *Perna viridis* on Mitigation Reef C.

#### Recommendations for Future Benthic Analysis Efforts:

1. **Avoid capturing excessive amounts of sand patches in video transects along nearshore patch reef.** Due to the patchy nature of the natural reef tract, large sandy areas were occasionally captured along natural reef video transects. Frames showing these patches were removed prior to analysis, but future precautions should be made to either avoid sand patches when capturing video along natural patch reef or capture a predetermined amount of additional footage along an extended random transect. Additional frames along a random transect site would allow for removing frames associated with sand patches and adding those capturing natural reef. This recommendation would not apply to future studies that have permanent transects that photodocument change along the same belt transect area over time.
2. **Manually sequence the captured video along each transect for use in analysis software.** Quicktime Pro 7.3 was used to grab sequential frames from the transect video. Due to software limitations, a minimum of two frames were able to be grabbed per second. This limitation resulted in excessive overlap which ultimately reduced the efficiency of the sequencing process. Future sequencing efforts should be done by manually grabbing frames directly off the video.

3. **Save the sequenced frames as high resolution image files.** Fifty random points were displayed on each randomly selected \*.jpg image during the analysis process. The CPCe software allows the analyst to zoom in on a particular area of interest to correctly identify the organism or substrate. This feature was not useful with a 75 KB image (the average image size used in this analysis). A higher resolution file will require additional memory and more space on a desktop computer or an external portable hard drive.
4. **Increase the number of transects per site and decrease the individual transect length.** A methodology that incorporates three permanent 22 m video transects per site works well for long term percent cover studies such as the SECREMP (FFWCC and NCRI 2007). Statistical comparisons of benthic composition between artificial reefs and adjacent natural reefs, however, require more than three replicate transects. This was addressed in the current study by pooling the 25 randomly selected frames per transect at each site resulting in 75 replicates per site. Limiting the transect length in future projects to 10 m would: 1) reduce or eliminate the need to use discontinuous transects due to shorter artificial reef materials, 2) reduce the amount of sand captured in the video along nearshore patch reef, 3) allow the analyst to use statistical tests, such as analysis of variance (ANOVA) or Kruskal Wallis, that require a minimum of five replicates, and 4) increase the number of transects along smaller artificial reefs and patch reef.
5. **Establish permanent transects along the mitigation reefs and adjacent natural reefs.** Permanent transects will facilitate documentation of the change in benthic community in an exact area over time. This would require additional funding and an environmental resource permit through Florida Department of Environmental Protection the year of installation and multi-year funding for subsequent annual monitoring.
6. **Establish permanent photostations to monitor the success of select wormrock formations on the Mitigation Reefs.** Wormrock reefs extend along southeast Florida from Brevard County down through Biscayne Bay. It is a prominent feature of nearshore reefs in Martin County. The ultimate management goal of any mitigation reef is to design an artificial structure that eventually functions as a healthy reef system. The Mitigation Reefs have been known to support recruitment and a limited amount of wormrock growth since summer 2006. Permanent photostations will enable resource managers to better understand the ability of the Mitigation Reefs to support long-term growth of this key species.



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## Appendices

- A. Code file used in the analysis software CPCe.
- B. Representative Photographs of Mitigation Reefs A, B, C and the adjacent natural reef.
- C. St. Lucie Inlet Preserve State Park Benthic species list.
- D. St. Lucie Inlet Preserve State Park Fish and Sea Turtle Species List.

## Appendix A. CPCe code file used for analysis of Martin County artificial and natural reefs.

10

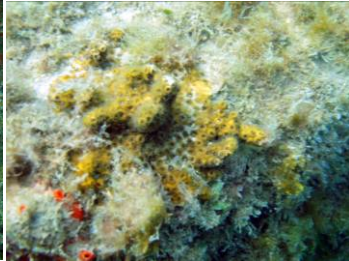
"C", "coral"  
"G", "Gorgonians"  
"S", "Sponges"  
"W", "Wormrock"  
"ASC", "Ascidian"  
"MA", "Macroalgae"  
"OL", "Other live"  
"SUB", "Substrate"  
"U", "Unknowns"  
"TWS", "Tape, wand, shadow, weight"  
"OCUL", "Oculina diffusa", "C"  
"PHYL", "Phyllangia americana", "C"  
"SOLEN", "Solenastrea hyades", "C"  
"REGAL", "Regal sea fan", "G"  
"WHIP", "Yellow sea Whip", "G"  
"SPO", "Sponge", "S"  
"WORM", "Wormrock", "W"  
"TUN", "Ascidian", "ASC"  
"UNMAC", "Unidentified macroalage", "MA"  
"RMAC", "Red macroalage", "MA"  
"GMAC", "Green macroalgae", "MA"  
"BMAC", "Brown macroalgae", "MA"  
"OTHER", "Other live", "OL"  
"RUB", "Rubble", "SUB"  
"SAND", "Sand", "SUB"  
"TURF", "Turf algae", "SUB"  
"UNK", "Unknown", "U"  
"TAPE", "Tape", "TWS"  
"WAND", "Wand", "TWS"  
"SHAD", "Shadow", "TWS"  
"WGT", "Weight", "TWS"  
NOTES, NOTES, NOTES  
"BL", "Bleached coral point", "NA"  
"DIS", "Other disease", "NA"

**Appendix B. Representative Photographs of each Study Site.**

**Mitigation Reef A**



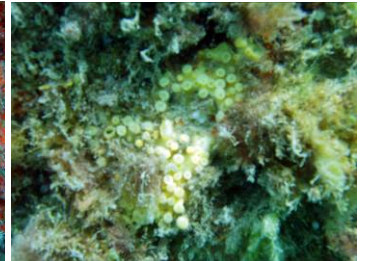
*Arbacia punctulata*  
purple sea urchin



*Oculina diffusa*  
ivory bush coral

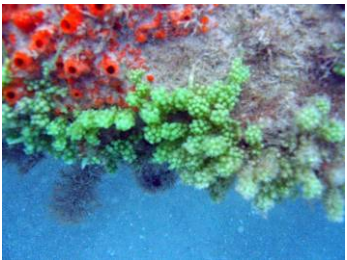


Unidentified orange sponge



Yellow boring sponge  
(Maybe *Cliona* sp.)

**Mitigation Reef B**



Clionid sponge and *Caulerpa racemosa* (green grape alga)



Unidentified orange sponge



*Phyllangia americana* (hidden cup coral) and *Holothuria* sp. (sea cucumber)



*Phragmatopoma lapidosa*  
wormrock

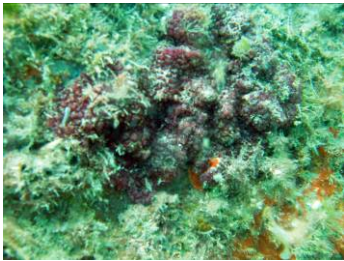
**Mitigation Reef C**



*Eudistoma* sp. (colonial tunicate) and *Phallusia nigra* (black solitary tunicate)



Unidentified hydroids



Unidentified Colonial Tunicate

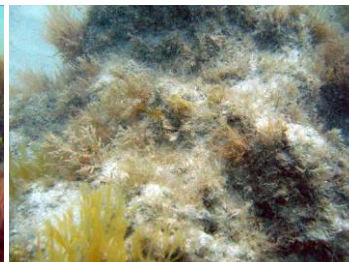


*Leptogorgia virgulata*  
yellow sea whip

**Natural Reef**



*Halimeda* sp., *Codium* sp., and *Gracillaria* sp.



*Dictyota cervicornis* and *Padina* sp.



*Phragmatopoma lapidosa*  
wormrock



*Dictyota cervicornis* and turf algae on patch reef

**Appendix C. Cumulative St. Lucie Inlet Preserve State Park Benthic Species List as of July 30, 2007**

<b>MACROALGAE (Attached)</b>	
<b>Chlorophyta (Green Algae)</b>	
Alga	<i>Bryopsis pennata f. secunda</i>
Alga	<i>Caulerpa mexicana</i>
Green Grape Alga	<i>Caulerpa racemosa</i>
Alga	<i>Caulerpa racemosa f. macrophyso</i>
Feather Alga	<i>Caulerpa sertularioides</i>
Non-native Alga	<i>Caulerpa brachypus</i>
Alga	<i>Caulerpa verticillata</i>
Alga	<i>Codium sp.</i>
Large disk Alga	<i>Halimeda discoidea</i>
Alga	<i>Halimeda tuna</i>
Scalloped Disk Alga	<i>Halimeda tuna f. platydisca</i>
Blade Alga	<i>Udotea sp.</i>
<b>Phaeophyta (Brown Algae)</b>	
Y-Branched Alga	<i>Dictyota menstrualis</i>
Y-Branched Alga	<i>Dictyota pulchella</i>
Scroll Alga	<i>Padina sanctae-crucis</i>
Alga	<i>Padina perindusiata</i>
<b>Rhodophyta (Red Algae)</b>	
Coralline Alga	<i>Amphiroa sp.</i>
Red Tube Alga	<i>Galaxaura marginata</i>
Alga	<i>Halymenia echinophysa</i>
Alga	<i>Halymenia floresia</i>
Alga	<i>Jania sp</i>
Red Bush Alga	<i>Laurencia poiteaui</i>
Red Alga	<i>Bryothamnion triquetrum</i>
<b>PORIFERANS</b>	
Erect Rope Sponge	<i>Amphimedon compressa</i>
Brown Variable Sponge	<i>Anthosigmella varians</i>
Yellow Tube Sponge	<i>Aplysina fistularis</i>
Branching Vase Sponge	<i>Callyspongia sp.</i>
Orange Ball Sponge	<i>Cinachyra sp.</i>
Red Boring Sponge	<i>Cliona deletrix</i>
Red Boring Sponge	<i>Cliona lampa</i>
Orange Sieve Encrusting Sponge	<i>Diplastrella sp.</i>
Leathery Barrel Sponge	<i>Geodia sp.</i>

Lumpy Overgrowing Sponge	<i>Holopsamma</i> sp.
Vase Sponge	<i>Ircinia campana</i>
Sponge	<i>Ircinia fasciculata</i>
Stinker sponge	<i>Ircinia felix</i>
Black Ball Sponge	<i>Ircinia strobolina</i>
Pink Lumpy Sponge	<i>Monachora</i> sp.
Lavender Rope Sponge	<i>Niphates erecta</i>
Rope Sponge	<i>Niphates</i> sp.
Sponge	<i>Poecilosclerida</i> spp.
Sticky Orange Sponge	<i>Pseudaxinella lunaecharta</i>
Blue Caribbean Sponge	<i>Sigmadocia caerulea</i>
Loggerhead Sponge	<i>Spheciospongia vesparium</i>
<b>CNIDARIANS</b>	
<b>Scleractinia (Hard Corals)</b>	
Elliptical Star Coral	<i>Dichocoenia stokesii</i>
Knobbed Brain Coral	<i>Diploria clivosa</i>
Symmetrical Brain Coral	<i>Diploria strigosa</i>
Golfball Coral	<i>Favia fragum</i>
Sinuuous Cactus Coral	<i>Isophylla sinuosa</i>
Ten-Ray Star Coral	<i>Madracis decactis</i>
Maze Coral	<i>Meandrina meandrites</i>
Great Star Coral	<i>Montastrea cavernosa</i>
Mountain Star Coral	<i>Montastrea faveolata</i>
Knobby Cactus Coral	<i>Mycetophyllia aliciae</i>
Difuse Ivory Bush Coral	<i>Oculina diffusa</i>
Robust Ivory Tree Coral	<i>Oculina robusta</i>
Delicate Ivory Bush Coral	<i>Oculina tenella</i>
Large Ivory Coral	<i>Oculina varicosa</i>
Hidden Cup Coral	<i>Phyllangia americana</i>
Mustard Hill Coral	<i>Porites astreoides</i>
Finger Coral	<i>Porites porites</i>
Disk Coral	<i>Scolymia</i> spp.
Lesser Starlet Coral	<i>Siderastrea radians</i>
Greater Starlet Coral	<i>Siderastrea siderea</i>
Knobby Star Coral	<i>Solenastrea bournoni</i>
Smooth Star Coral	<i>Solenastrea hyades</i>
Blushing Star Coral	<i>Stephanocenia intercepts</i>
<b>Octocoralia (Soft Corals)</b>	
Corky Sea Finger	<i>Briarium asbestinum</i>
White Telesto	<i>Carijoa riisei</i>
Knobby Sea Rods	<i>Eunicea</i> sp.
Common Sea Fan	<i>Gorgonia ventalina</i>
Regal Sea Fan	<i>Leptogorgia hebes</i>

Colorful Sea Whip	<i>Leptogorgia virgulata</i>
Spiny Sea Rod	<i>Muricea</i> sp.
Slit-Pore Sea Rod	<i>Plexaurella dichotoma</i>
Slit-Pore Sea Rod	<i>Plexaurella grisea</i>
Slit-Pore Sea Rod	<i>Plexaurella</i> sp.
Sea Plume	<i>Psuedopterogorgia</i> sp.
Angular Sea Whip	<i>Pterogorgia anceps</i>
Yellow Sea Whip	<i>Pterogorgia citrina</i>
Grooved-Blade Sea Whip	<i>Pterogorgia guadalupensis</i>
<b>Hydroids</b>	
Feather Plume Hydroid	<i>Aglaophenia lateccarinata</i>
Branching Fire Coral	<i>Millepora alcicornis</i>
Blade Fire Coral	<i>Millepora complanata</i>
Branching Hydroid	<i>Sertullarella speciosa</i>
Yellow Branch Hydroid	
<b>Anenomes</b>	
Corkscrew Anemone	<i>Bartholomea annulata</i>
Giant Anemone	<i>Condylactis gigantea</i>
Mat Anemone	<i>Zoanthus pulchellus</i>
<b>Zoanthids</b>	
White Encrusting Zoanthid	<i>Palythoa caribaeorum</i>
Sun Zoanthid	<i>Palythoa grandis</i>
Maroon Sponge Zoanthid	<i>Parazoanthus puertoricense</i>
Zoanthid	<i>Zoantharia</i> sp.
<b>CTENOPHORES</b>	
Sea Walnut	<i>Mnemiopsis mccradyi</i>
<b>POLYCHAETES</b>	
Split-Crown Feather Duster	<i>Anamobaea orstedii</i>
Black Spotted Feather Duster	<i>Brachioma nigromaculata</i>
Spaghetti Worm	<i>Eupolymnia crassicornis</i>
Bearded Fireworm	<i>Hermodice carunculata</i>
Worm Rock	<i>Phragmatopoma lapidosa</i>
Magnificent Feather Duster	<i>Sabellastarte magnifica</i>
Christmas Tree Tube Worm	<i>Spirobranchus giganteus</i>
<b>CRUSTACEANS</b>	
Boxed Blue Crab	<i>Calappa</i> sp.
Orange Claw Hermit Crab	<i>Calcinus tibicen</i>
Blue Crab	<i>Callinectes sapidus</i>
Land Crab	<i>Cardisoma guanhumi</i>

Batwing Coral Crab	<i>Carpilius corallinus</i>
Mangrove Crab	<i>Goniopsis cruentata</i>
Calico Crab	<i>Hepatis epheliticus</i>
Spider Crab	<i>Libinia dubia</i>
Horseshoe Crab	<i>Limulus polyphemus</i>
Stone Crab	<i>Mennipe mercenaria</i>
Florida Spiny Lobster	<i>Panularis argus</i>
Spotted Spiny Lobster	<i>Panularus guttatus</i>
Giant Hermit Crab	<i>Pterochirus diogenes</i>
Slipper Lobster	<i>Scyllarides aequinoctialis</i>
Banded Coral Shrimp	<i>Stenopus hispidus</i>
Arrow Crab	<i>Stenorhyncus seticornis</i>
Fiddler Crab	<i>Uca mordax</i>
<b>ECHINODERMS</b>	
<b>Sea Cucumbers</b>	
Five Toothed Sea Cucumber	<i>Actinopygia agassizii</i>
Florida Sea Cucumber	<i>Holothuria floridana</i>
	<i>Holothuria spp.</i>
Three-Rowed Sea Cucumber	<i>Isostichopus badionotus</i>
Hidden Sea Cucumber	<i>Pseudothyone belli</i>
<b>Sea Urchins</b>	
Common Arbacia Urchin	<i>Arbacia punctulata</i>
Long-Spined Sea Urchin	<i>Diadema antillarum</i>
Rock-Boring Urchin	<i>Echinometra lucunter</i>
Reef Urchin	<i>Echinometra viridis</i>
Slate Pencil Urchin	<i>Eucidaris tribuloides</i>
Variiegated Urchin	<i>Lytechinus variegatus</i>
West Indian Sea Egg	<i>Tripluustes ventricosus</i>
<b>Sea Stars</b>	
Blunt-spined Brittle Star	<i>Opheocoma echinata</i>
Cushion Sea Star	<i>Oreaster reticulatus</i>
<b>Crinoids</b>	
Golden Crinoid	<i>Davidaster rubiginosa</i>
Black and White Crinoid	<i>Nemaster grandis</i>
<b>TUNICATES</b>	
Black Tunicate	<i>Ascidia nigra</i>
Black Condominium Tunicate	<i>Eudistoma obscuratum</i>
Purple Berry Compound Tunicate	<i>Eudistoma sp.</i>
Smooth Condominium Tunicate	<i>Eudistoma sp.</i>
Hard Purple/Brown Tunicate	<i>Eudistoma sp.</i>

<b>MOLLUSKS</b>	
<b>Gastropods</b>	
Flamingo Tongue	<i>Cyphoma gibbosum</i>
Regal Sea Goddess	<i>Hypselodoris edenticulata</i>
Florida Horse Conch	<i>Pleuroploca gigantea</i>
Florida Fighting Conch	<i>Strombus alatus</i>
<b>Bivalves</b>	
File Clam	<i>Lima sp.</i>
Amber Penshell	<i>Pinna carnea</i>
<b>Cephalopods</b>	
Caribbean Reef Squid	<i>Sepioteuthis sepiodea</i>



**Appendix D. Fish and sea turtle species documented within St. Lucie Inlet Preserve State Park as of July 3, 2007.**

<b>FISHES</b>	
<b>Surgeonfishes</b>	<b>Acanthuridae</b>
Ocean Surgeonfish	<i>Acanthurus bahianus</i>
Doctorfish	<i>Acanthurus chirurgus</i>
Blue Tang	<i>Acanthurus coeruleus</i>
<b>FLATFISHES</b>	
<b>American Soles</b>	<b>Achiridae</b>
Hogchoker	<i>Trinectes maculatus</i>
<b>Large-tooth Flounders</b>	<b>Paralichthyidae</b>
Spotted Whiff	<i>Citharichthys macrops</i>
<b>Sand Flounders</b>	<b>Paralichthyidae</b>
Gulf Flounder	<i>Paralichthys albigutta</i>
Southern Flounder	<i>Paralichthys lethostigma</i>
<b>Bonefishes</b>	<b>Albulidae</b>
Bonefish	<i>Albula vulpes</i>
<b>Cardinalfishes</b>	<b>Apogonidae</b>
Barred Cardinalfish	<i>Apogon binotatus</i>
Flamefish	<i>Apogon maculatus</i>
Two-Spot Cardinalfish	<i>Apogon psuedomaculatus</i>
Blackfin Cardinalfish	<i>Astropogon puncticulatus</i>
Belted Cardinalfish	<i>Apogon townsendii</i>
Dusky Cardinalfish	<i>Phaeoptyx pigmentaria</i>
<b>Sea Catfishes</b>	<b>Ariidae</b>
Hardhead Catfish	<i>Arius felis</i>
Gafftopsail Catfish	<i>Bagre marinus</i>
<b>Trumpetfishes</b>	<b>Aulostomidae</b>
Trumpetfish	<i>Aulostomus maculatus</i>
<b>Triggerfishes</b>	<b>Balistidae</b>
Gray Triggerfish	<i>Balistes capriscus</i>
Queen Triggerfish	<i>Balistes vetula</i>
Ocean Triggerfish	<i>Canthidermis sufflamen</i>
Leatherjacket	<i>Oligoplites saurus</i>
<b>Needlefishes</b>	<b>Belonidae</b>

Atlantic Needlefish	<i>Strongylura marina</i>
Redfin Needlefish	<i>Strongylura notata</i>
<b>BLENNIES</b>	
<b>Combtooth Blennies</b>	<b>Blenniidae</b>
Seaweed Blenny	<i>Blenius marmoreus</i>
Barred Blenny	<i>Hypleurochilus bermudensis</i>
Redlip Blenny	<i>Ophioblennius atlanticus</i>
Molly Miller	<i>Scartella cristatus</i>
<b>Tube Blennies</b>	<b>Chaenopsidae</b>
Yellowface Pikeblenny	<i>Chaenopsis limbaughi</i>
Blackhead Blenny	<i>Coralliozetus bahamensis</i>
<b>Scaly Blennies</b>	<b>Labrisomidae</b>
Palehead Blenny	<i>Labrisomus gobio</i>
Downy Blenny	<i>Labrisomus kalisherae</i>
Spotcheek Blenny	<i>Labrisomus nigricinctus</i>
Hairy Blenny	<i>Labrisomus nuchipinnis</i>
Rosy Blenny	<i>Malacoctenus macropus</i>
Saddled Blenny	<i>Malacoctenus triangulatus</i>
Banded Blenny	<i>Paraclinus fasciatus</i>
Checkered Blenny	<i>Starksia ocellata</i>
<b>Dragonets</b>	<b>Callionymidae</b>
Dragonet	<i>Callionymus spp.</i>
<b>Jacks</b>	<b>Carangidae</b>
Scad	<i>Carangidae spp.</i>
Yellow Jack	<i>Caranx bartholomaei</i>
Blue Runner	<i>Caranx chrysos</i>
Jack Crevalle	<i>Caranx hippos</i>
Horse-Eye Jack	<i>Caranx latus</i>
Bar Jack	<i>Caranx ruber</i>
Atlantic Bumper	<i>Chlororscombrus chrysurus</i>
Round Scad	<i>Decapterus punctatus</i>
Cigar Minnow	<i>Sardinella anchovia</i>
Bigeye Scad	<i>Selar crumenophthalmus</i>
Lookdown	<i>Selene vomer</i>
Greater Amberjack	<i>Seriola dumerili</i>
Amberjack	<i>Seriola rivoliana</i>
Pompano	<i>Trachinotus carolinus</i>
Permit	<i>Trachinotus falcatus</i>

Palometa	<i>Trachinotus goodei</i>
<b>Snooks</b>	<b>Centropomidae</b>
Fat Snook	<i>Centropomus parallelus</i>
Common Snook	<i>Centropomus undecimalis</i>
<b>Butterflyfishes</b>	<b>Chaetodontidae</b>
Four-eye Butterflyfish	<i>Chaetodon capistratus</i>
Reef Butterflyfish	<i>Chaetodon sedentarius</i>
Banded Butterflyfish	<i>Chaetodon striatus</i>
Spotfin Butterflyfish	<i>Chaetodon ocellatus</i>
<b>Herrings</b>	<b>Clupeidae</b>
Atlantic Menhaden	<i>Brevoortia tyrannus</i>
Scaled Sardine	<i>Harengula jaguana</i>
Herrings	<i>Harengula</i> spp.
Threadfin Herring	<i>Opistonema oglinum</i>
Spanish Sardine	<i>Sardinella aurita</i>
<b>RAYS</b>	
<b>Stingray</b>	<b>Dasyatidae</b>
Southern Stingray	<i>Dasyatis americana</i>
Atlantic Stingray	<i>Dasyatis sabina</i>
Bluntnose Stingray	<i>Dasyatis say</i>
Spiny Butterfly Ray	<i>Gymnura altavela</i>
Smooth Butterfly Ray	<i>Gymnura micrura</i>
Yellow Stingray	<i>Urolophus jamaicensis</i>
<b>Manta</b>	<b>Mobulidae</b>
Manta Ray	<i>Manta birostris</i>
<b>Eagle Ray</b>	<b>Myliobatidae</b>
Spotted Eagle Ray	<i>Aetobatus narinari</i>
<b>PUFFERFISHES, ETC.</b>	
<b>Porcupinefishes</b>	<b>Diodontidae</b>
Striped Burrfish	<i>Chilomycterus schoepfi</i>
Balloonfish	<i>Diodon holocanthus</i>
Porcupinefish	<i>Diodon hystrix</i>
<b>Pufferfishes</b>	<b>Tetraodontidae</b>
Sharpnose Puffer	<i>Cabthigaster rostrata</i>
Bandtail Puffer	<i>Shoeroides splengleri</i>
Southern Puffer	<i>Sphoeroides nephelus</i>
Checkered Puffer	<i>Sphoeroides testudineus</i>
<b>Tarpons</b>	<b>Elopidae</b>
Ladyfish	<i>Elops saurus</i>

Tarpon	<i>Megalops atlanticus</i>
<b>Anchovies</b>	<b>Engraulididae</b>
Anchovies	<i>Anchoa</i> spp.
<b>Spadefishes</b>	<b>Ephippidae</b>
Atlantic Spadefish	<i>Chaetodipterus faber</i>
<b>Flyingfishes/Halfbeaks</b>	<b>Exocoetidae</b>
Flyingfish	<i>Exocoetidae</i> spp.
Balao	<i>Hemiramphus balao</i>
Ballyhoo	<i>Hemiramphus brasiliensis</i>
<b>Mojarras</b>	<b>Gerreidae</b>
Irish Pompano	<i>Diapterus auratus</i>
Striped Mojarra	<i>Diapterus plumieri</i>
Silver Jenny	<i>Eucinostimus gula</i>
Mottled Mojarra	<i>Eucinostimus lefroyi</i>
Flagfin Mojarra	<i>Eucinostomus melanopterus</i>
Mojarra	<i>Eucinostomus</i> spp.
Yellowfin Mojarra	<i>Geres cinereus</i>
<b>Gobies</b>	<b>Gobiidae</b>
Colon Goby	<i>Coryphopterus dicrus</i>
Bridled Goby	<i>Coryphopterus glaucofraenum</i>
Masked Goby	<i>Coryphopterus personatus</i>
Goldspot Goby	<i>Gnatholepis thompsoni</i>
Orangesided Goby	<i>Gobiosoma dilepsis</i>
Yellowline Goby	<i>Gobiosoma horsti</i>
Spotlight Goby	<i>Gobiosoma louisae</i>
Neon Goby	<i>Gobiosoma oceanops</i>
Blue Goby	<i>Ioglossus calliurus</i>
Hovering Goby	<i>Ioglossus helenae</i>
<b>Grunts</b>	<b>Haemulidae</b>
Black Margate	<i>Anisostremus surinamensis</i>
Porkfish	<i>Anisostremus virginicus</i>
White Margate	<i>Haemulon album</i>
Tomtate	<i>Haemulon aurolineatum</i>
Caesar Grunt	<i>Haemulon carbonarium</i>
Smallmouth Grunt	<i>Haemulon chrysargyreum</i>
French Grunt	<i>Haemulon flavolineatum</i>
Spanish Grunt	<i>Haemulon macrostomum</i>
Cottonwick	<i>Haemulon melanurum</i>
Sailors Choice	<i>Haemulon parrai</i>

White Grunt	<i>Haemulon plumieri</i>
Bluestriped Grunt	<i>Haemulon sciurus</i>
Grunt	<i>Haemulon</i> spp.
Unidentified Juvenile Grunt	<i>Haemulon</i> spp. (juvenile)
Striped Grunt	<i>Haemulon striatum</i>
<b>Squirrelfishes</b>	<b>Holocentridae</b>
Longspine Squirrelfish	<i>Holocentrus rufus</i>
Squirrelfish	<i>Holocentrus</i> spp.
Blackbar Soldierfish	<i>Myripristis jacobus</i>
<b>Bonnetmouths</b>	<b>Inermiidae</b>
Bonnetmouth	<i>Emmelichthyops atlanticus</i>
<b>Chubs</b>	<b>Kyphosidae</b>
Bermuda Chub	<i>Kyphosus sectatrix</i>
Sea Chub	<i>Kyphosus</i> spp.
<b>Wrasses/Hogfishes/Razorfishes</b>	<b>Labridae</b>
Spotfin Hogfish	<i>Bodianus pulchellus</i>
Spanish Hogfish	<i>Bodianus rufus</i>
Creole Wrasse	<i>Clepticus parrae</i>
Slippery Dick	<i>Halichoeres bivittatus</i>
Yellowhead Wrasse	<i>Halichoeres garnoti</i>
Clown Wrasse	<i>Halichoeres maculipinna</i>
Rainbow Wrasse	<i>Halichoeres pictus</i>
Blackear Wrasse	<i>Halichoeres poeyi</i>
Puddingwife	<i>Halichoeres radiatus</i>
Pearly Razorfish	<i>Hemipteronotus novacula</i>
Green Razorfish	<i>Hemipteronotus splendens</i>
Hogfish	<i>Lachnolaimus maximus</i>
Bluehead Wrasse	<i>Thalassoma bifasciatum</i>
<b>Snappers</b>	<b>Lutjanidae</b>
Mutton Snapper	<i>Lutjanus analis</i>
Schoolmaster Snapper	<i>Lutjanus apodus</i>
Gray Snapper	<i>Lutjanus griseus</i>
Dog Snapper	<i>Lutjanus jocu</i>
Mahogany Snapper	<i>Lutjanus mahogoni</i>
Lane Snapper	<i>Lutjanus synagris</i>
Yellowtail Snapper	<i>Ocyurus chrysurus</i>
Glasseye Snapper	<i>Priacanthus arenatus</i>
<b>Filefishes</b>	<b>Monacanthidae</b>

Orange Filefish	<i>Aluterus schoepfii</i>
Scrawled Filefish	<i>Aluterus scriptus</i>
Whitespotted Filefish	<i>Cantherhines macrocerus</i>
Orangespotted Filefish	<i>Cantherhines pulles</i>
Planehead Filefish	<i>Monacanthus hispidus</i>
Slender Filefish	<i>Monacanthus tuckeri</i>
<b>Mulletts</b>	<b>Mugilidae</b>
Black Mullet	<i>Mugil cephalus</i>
Silver Mullet	<i>Mugil curema</i>
<b>Goatfishes</b>	<b>Mullidae</b>
Yellow Goatfish	<i>Mulloidichthys martinicus</i>
Spotted Goatfish	<i>Psuedopeneus maculatus</i>
<b>EELS</b>	
<b>Morays</b>	<b>Muraenidae</b>
Green Moray	<i>Gymnothorax funebris</i>
Spotted Moray	<i>Gymnothorax moringa</i>
Purplemouth Moray	<i>Gymnothorax vicinus</i>
Goldentail Moray	<i>Muraena miliaris</i>
<b>Snake Eel</b>	<b>Ophichthidae</b>
Sharptail Eel	<i>Myrichthys breviceps</i>
Goldspotted Eel	<i>Myrichthys ocellatus</i>
<b>BATfishes</b>	<b>OGCOCEPHALidae</b>
Batfish	<i>Ogcocephalus spp.</i>
<b>Jawfishes</b>	<b>Opistognathidae</b>
Yellowhead Jawfish	<i>Opistognathus aurifrons</i>
Phantom Jawfish	<i>Opistognathus cuvieri</i>
Banded Jawfish	<i>Opistognathus macrognathus</i>
Spotfin Jawfish	<i>Opistognathus robinsi</i>
<b>Boxfishes</b>	<b>Ostraciidae</b>
Scrawled Cowfish	<i>Lactrophys quadricornis</i>
<b>Sweepers</b>	<b>Pempheridae</b>
Glassy Sweeper	<i>Pempheris schomburgki</i>
<b>Threadfins</b>	<b>Polynemidae</b>
Barbu	<i>Polydactylus virginicus</i>
<b>Angelfishes</b>	<b>Pomacanthidae</b>
Blue Angelfish	<i>Holacanthus bermudensis</i>
Queen Angelfish	<i>Holacanthus ciliarus</i>
Rock Beauty	<i>Holacanthus tricolor</i>

Townsend Angelfish	<i>Holocanthus</i> spp.
Gray Angelfish	<i>Pomacanthus arcuatus</i>
French Angelfish	<i>Pomacanthus paru</i>
<b>Damselfishes/Chromis</b>	<b>Pomacentridae</b>
Seargent Major	<i>Abudefduf saxatilis</i>
Blue Chromis	<i>Chromis cyaneus</i>
Yellowtail Reeffish	<i>Chromis enchrysur</i>
Sunshinefish	<i>Chromis insolata</i>
Brown Chromis	<i>Chromis multilineata</i>
Yellowtail Damselfish	<i>Microspathodon chrysurus</i>
Dusky Damselfish	<i>Stegastes adustus</i>
Longfin Damselfish	<i>Stegastes diencaeus</i>
Scarlet Damselfish	<i>Stegastes dorsopunicans</i>
Beaugregory	<i>Stegastes leucostictus</i>
Bicolor Damselfish	<i>Stegastes partitus</i>
Threespot Damselfish	<i>Stegastes planifrons</i>
Cocoa Damselfish	<i>Stegastes variabilis</i>
<b>Bluefishes</b>	<b>Pomatomidae</b>
Bluefish	<i>Pomatomus saltatrix</i>
<b>Bigeyes</b>	<b>Priacanthidae</b>
Bigeye	<i>Priacanthus arenatus</i>
<b>Cobias</b>	<b>Rachycentridae</b>
Cobia	<i>Rachycentro canadum</i>
<b>SHARKS</b>	
<b>Carpet Sharks</b>	<b>Rhincodontidae</b>
Nurse Shark	<i>Ginglymostoma cirratum</i>
<b>Guitarfishes</b>	<b>Rhinobatidae</b>
Atlantic Guitarfish	<i>Rhinobatos lentiginosus</i>
<b>Hammerhead Sharks</b>	<b>Sphyrnidae</b>
Great Hammerhead	<i>Sphyrna mokarran</i>
<b>Parrotfishes</b>	<b>Scaridae</b>
Midnight Parrotfish	<i>Scarus coelestinus</i>
Blue Parrotfish	<i>Scarus coeruleus</i>
Striped Parrotfish	<i>Scarus croicensis</i>
Rainbow Parrotfish	<i>Scarus guacamaia</i>
Parrotfish	<i>Scarus</i> spp.
Princess Parrotfish	<i>Scarus taeniopterus</i>
Queen Parrotfish	<i>Scarus vetula</i>
Greenblotch Parrotfish	<i>Sparisoma atomarium</i>

Redband Parrotfish	<i>Sparisoma aurofrenatum</i>
Redtail Parrotfish	<i>Sparisoma chrysoptera</i>
Redfin Parrotfish	<i>Sparisoma rubripinne</i>
Yellowtail Parrotfish	<i>Sparisoma rubripinne</i>
Unidentified Juvenile Parrotfish	<i>Sparisoma</i> spp. (juvenile)
Stoplight Parrotfish	<i>Sparisoma viride</i>
<b>Drums</b>	<b>Sciaenidae</b>
Striped Croaker	<i>Bairdiella santalucia</i>
Silver Seatrout	<i>Cynoscion nothus</i>
Highhat	<i>Equetus acuminatus</i>
Spotted Drum	<i>Equetus punctuatus</i>
Cubby	<i>Equetus umbrosus</i>
Jacknife	<i>Equetus umbrosus</i>
Spot	<i>Leiostomus xanthurus</i>
Atlantic Croaker	<i>Micropogon undulatus</i>
Reef Croaker	<i>Odontoscion dentex</i>
Black Drum	<i>Pogonias cromis</i>
Red Drum	<i>Sciaenops ocellatus</i>
<b>Tunas/Mackerels</b>	<b>Scombridae</b>
Little Tunny	<i>Euthynnus alletteratus</i>
Atlantic Bonita	<i>Sarda sarda</i>
King Mackerel	<i>Scomberomorus cavalla</i>
Spanish Mackerel	<i>Scomberomorus maculatus</i>
Cero Mackerel	<i>Scomberomorus regalis</i>
<b>Scorpionfishes</b>	<b>Scorpaenidae</b>
Spotted Scorpionfish	<i>Scorpaena plumieri</i>
<b>Groupers/Seabasses/Hamlets</b>	<b>Serranidae</b>
Black Seabass	<i>Centropristes striata</i>
Sand Perch	<i>Diplectum formosum</i>
Rock Hind	<i>Epinephelus adscensionis</i>
Graysby	<i>Epinephelus cruentatus</i>
Coney	<i>Epinephelus fulvus</i>
Goliath Grouper	<i>Epinephelus itajara</i>
Red Grouper	<i>Epinephelus morio</i>
Nassau Grouper	<i>Epinephelus striatus</i>
Blue Hamlet	<i>Hypoplectrus gemma</i>
Barred Hamlet	<i>Hypoplectrus puella</i>



Butter Hamlet	<i>Hypoplectrus unicolor</i>
Wrasse Bass	<i>Liopropoma eukrines</i>
Black Grouper	<i>Mycteroperca bonaci</i>
Gag Grouper	<i>Mycteroperca microlepis</i>
Tiger Grouper	<i>Mycteroperca tigris</i>
Whitespotted Soapfish	<i>Rypticus maculatus</i>
Greater Soapfish	<i>Rypticus saponaceus</i>
Spotted Soapfish	<i>Rypticus subbifenatus</i>
Lantern Bass	<i>Serranus baldwini</i>
Pygmy Seabass	<i>Serranus pumilio</i>
Belted Sandfish	<i>Serranus subligarius</i>
Tobaccofish	<i>Serranus tabacarius</i>
Harlequin Bass	<i>Serranus tigrinus</i>
Chalk Bass	<i>Serranus tortugarum</i>
<b>Porgies</b>	<b>Sparidae</b>
Sheepshead	<i>Archosargus probatocephalus</i>
Sea Bream	<i>Archosargus rhomboidalis</i>
Jolthead Porgy	<i>Calamus bajonado</i>
Saucereye Porgy	<i>Calamus calamus</i>
Sheepshead Porgy	<i>Calamus penna</i>
Silver Porgy	<i>Diplodus argenteus</i>
Spottail Pinfish	<i>Diplodus holbrooki</i>
Pinfish	<i>Lagodon rhomboides</i>
<b>Barracudas</b>	<b>Sphyraenidae</b>
Great Barracuda	<i>Sphyraena barracuda</i>
Northern Sennet	<i>Sphyraena borealis</i>
Guaguanche	<i>Sphyraena guachancho</i>
Southern Sennet	<i>Sphyraena picudilla</i>
Unidentified Juvenile Barracuda	<i>Sphyraena</i> spp. (juvenile)
<b>Lizardfishes</b>	<b>Synodontidae</b>
Inshore Lizardfish	<i>Synodus foetens</i>
Sand Diver	<i>Synodus intermedius</i>
<b>REPTILES</b>	
Loggerhead Sea Turtle	<i>Caretta caretta</i>
Green Sea Turtle	<i>Chelonia mydas</i>
Hawksbill Sea Turtle	<i>Eretmochelys imbricata</i>