

2011 ANNUAL MONITORING REPORT

MARTIN COUNTY ARTIFICIAL REEFS

PERFORMED FOR:

MARTIN COUNTY ENGINEERING DEPARTMENT
2401 SE MONTEREY ROAD
STUART, FLORIDA 34996



(PHOTO OF THE GLASURD "BIG AL" ARTIFICIAL REEF TAKEN BY K. DILLON)

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1.0 INTRODUCTION

Martin County has one of the most active and well-developed artificial reef programs in the state of Florida. Since the early 1970s, private and not-for-profit groups have been deploying a wide variety of artificial substrate offshore to enhance local fishing and diving. More recently, the Martin County Coastal Engineering Division began administering a more innovative program that deploys artificial reef projects in cooperation with the Florida Fish and Wildlife Conservation Commission (FWC) and local citizens. Lessons learned from earlier efforts (including those of other groups and agencies) have refined the program significantly. For example, many materials that have historically been used to build artificial reefs are now known to be poor-quality reef substrate. Artificial reef construction is now limited almost exclusively to natural rock, concrete and steel materials. Figure 1 shows the location of the five Martin County permitted offshore reef sites.

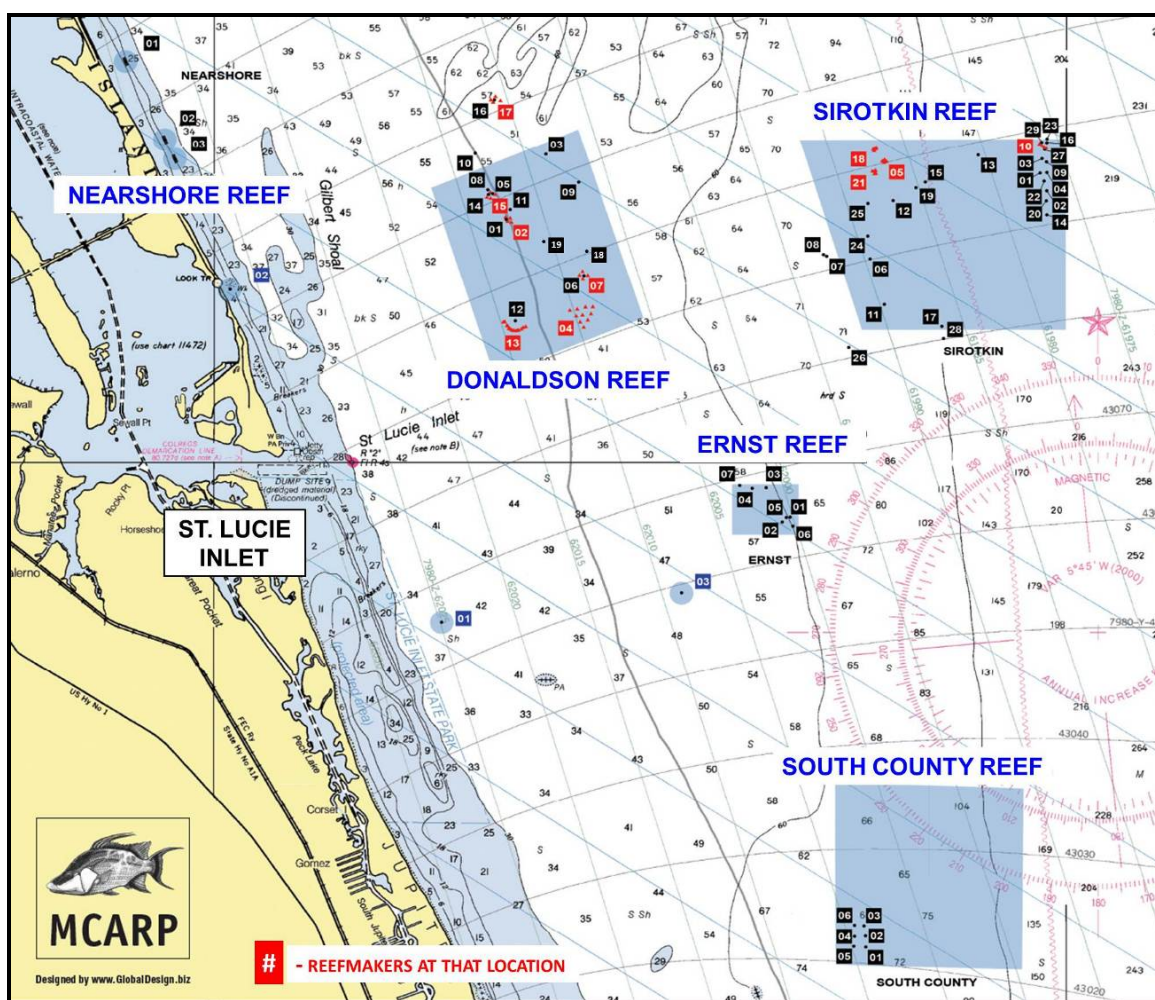


Figure 1. Location of Martin County's Permitted Offshore Reef Sites.

In July 2011, Maxwell Marine Consulting Engineers, Inc. (MMCE) and Sea Rover Services, Inc. were authorized by Martin County to perform monitoring services for nine reef sites, refer to Table 1.

Table 1. 2011 Monitoring Sites.

	Reefs to Monitor - 2011	Last Monitoring	Depth	Permit Area	Survey Type
1	Glasrud	n/a	187	Sirotkin	fathometer
2	Pirate's Cove	9/08/2010	187	Sirotkin	fathometer
3	Reefmaker Patch* N	3/06/2006	100	Sirotkin	in-water
4	Tree Barge	9/03/2007	190	Sirotkin	in-water
5	High Queen and Zeppo	9/15/2007	190	Sirotkin	in-water
6	Tension Barge	9/15/2007	190	Sirotkin	in-water
7	Concrete RR Tie Stack	8/05/2008	93	Sirotkin	in-water
8	Texas Reef	-	55	Donaldson	in-water
9	Texas Reef - Reefmakers	6/19/2008	50	Donaldson	in-water

2.0 BACKGROUND

Martin County has constructed in excess of 60 artificial reefs using discarded concrete and steel bridge components, steel-hulled derelict vessels and natural limestone rock. Within the last decade, dozens of purpose-built artificial reef modules have been deployed in varying arrays offshore to attract popular fish species. As the value and popularity of artificial reefs continue to grow, new strategies and reefing materials may be identified to further enhance local reef habitats. Annual artificial reef monitoring is required for two years following material placement. Refer to Table 2 for a list of all reefs deployed from 2000 to 2011, including the site location, materials and deployment date.

Table 2. Martin County artificial reefs deployed 2000 to 2011.

Reef Name	Materials	Site	Deployment Dates
Mitigation Site A	bridge pieces	Nearshore	Jul-Sep 2000
Mitigation Site B	bridge pieces	Nearshore	Jul-Sep 2000
Mitigation Site C	bridge pieces	Nearshore	Jul-Sep 2000
Evans Crary Bridge	bridge pieces	Ernst	Summer 2000
Tetrahedron Stack	concrete pyramids	Sirotkin	4,25 Apr 2001
Tetrahedron Patch-Yellow	concrete pyramids	Sirotkin	28 Mar 2002
Tetrahedron Patch-Pink	concrete pyramids	Sirotkin	28 Mar 2002
Tetrahedron Patch-Blue	concrete pyramids	Sirotkin	28 Mar 2002
Tetrahedron Patch-White	concrete pyramids	Sirotkin	28 Jun 2002
Tetrahedron Patch-Black	concrete pyramids	Sirotkin	28 Jun 2002
Tree Barge	140' barge	Sirotkin	19 Apr 2002
Wickstrom	168' cargo ship	Sirotkin	21 Jan 2003
Railroad Tie Stack	concrete RR ties	Sirotkin	Mar-Jun 2003
High Queen and Zeppo	tug & 120' barge	Sirotkin	7 Aug 2003
Five Peaks Patch-Blue	concrete RR ties	Sirotkin	2 Jun 2004
Five Peaks Patch-Orange	concrete RR ties	Sirotkin	2 Jun 2004
Five Peaks Patch-Yellow	concrete RR ties	Sirotkin	28-29 Jun 2004

Reef Name	Materials	Site	Deployment Dates
Five Peaks Patch-Pink	concrete RR ties	Sirotkin	28-29 Jun 2004
Five Peaks Patch-Black	concrete RR ties	Sirotkin	28-29 Jun 2004
Tension Barge	140' barge	Sirotkin	17 Jul 2004
Reefmaker Triangle	concrete & steel units	Donaldson	18 May 2005
Reefmaker Texas	concrete & steel units	Donaldson	20 May 2005
Reefmaker Cement Barge	concrete & steel units	Donaldson	20 May 2005
Reefmaker Traffic Barge	concrete & steel units	Donaldson	20 May 2005
Reefmaker Upside Down Barge	concrete & steel units	Donaldson	20 May 2005
Reefmaker Inlet Barge	concrete & steel units	Donaldson	20 May 2005
Reefmaker Patch N	concrete & steel units	Sirotkin	21 May 2005
Reefmaker Patch C	concrete & steel units	Sirotkin	21 May 2005
Reefmaker Patch S	concrete & steel units	Sirotkin	21 May 2005
Reefmaker Tree Barge	concrete & steel units	Sirotkin	21 May 2005
Clifton Perry Memorial	bridge pieces	Donaldson	Jan-May 2005
Frances Langford Memorial	bridge pieces	Sirotkin	Feb-Aug 2005
PCL Deep	bridge pieces	Sirotkin	Oct 2006
PCL Shallow	bridge pieces	Donaldson	Nov-Dec 2006
PCL River	bridge pieces	IR Lagoon	Nov 2006-Jan 2007
West 400	400 tons concrete	Ernst	15 Jun 2007
Mango	440 tons concrete	Ernst	15,26 Jun 2007
Grand Teton	728 tons concrete	Ernst	26,30 Jun 2007
KD Select	537 tons concrete	Sirotkin	9 Jul 2007
Ann Marie	260 tons concrete	S County	11 Jun 2008
Fogel Capital Management	245 tons concrete	S County	13 Jun 2008
The Heap	268 tons concrete	S County	20 Jun 2008
Jack MacDonald	272 tons concrete	S County	20 Jun 2008
Lentine	240 tons concrete	S County	13 Jun 2008
Shirley	249 tons concrete	S County	11 Jun 2008
American Custom Yachts Tower	Prefab steel tower	Sirotkin	27 Jun 2008
Bausch American Towers Tower	Prefab steel tower	Sirotkin	27 Jun 2008
Baratta Sight-See-Er Tower	Prefab steel tower	Sirotkin	27 Jun 2008
Deborah Schmidt Tower	Prefab steel tower	Sirotkin	27 Jun 2008
Pirate's Cove	500 tons concrete	Sirotkin	24 August 2009
Ballantrae Anglers	500 tons concrete	Sirotkin	24 August 2009
Corinthians Yacht Club	500 tons concrete	Sirotkin	24 August 2009
Glasrud	69 ft steel tugboat	Sirotkin	24 Feb 2010
Ralph Evinrude	concrete & steel from building demo	Donaldson	12 April 2011
Lee Harris Memorial	concrete & steel pieces	Donaldson	15,19 April & 9,11 May 2011

Table 3 presents the locations and water depths for the same artificial reef sites identified in Table 2.

Table 3. Locations of Martin County artificial reefs deployed between 2000 to 2009.

Reef Name	Latitude N	Longitude W	Water Depth (ft)	Reef Crest Depth (ft)
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
Evans Crary Bridge	27° 09.346'	80° 03.368'	75	49
Tetrahedron Stack	27° 12.814'	80° 02.329'	100	91
Tetrahedron Patch (Yellow)	27° 12.486'	80° 02.369'	95	87
Tetrahedron Patch (Pink)	27° 12.465'	80° 02.341'	95	87
Tetrahedron Patch (Blue)	27° 12.479'	80° 02.350'	95	87
Tetrahedron Patch (White)	27° 12.462'	80° 02.323'	98	95
Tetrahedron Patch (Black)	27° 12.432'	80° 02.360'	95	87
Tree Barge	27° 13.419'	80° 00.280'	190	178
Wickstrom Ship	27° 13.492'	80° 00.318'	188	133
Railroad Tie Stack	27° 12.201'	80° 02.310'	93	73
High Queen and Zeppo	27° 13.489'	80° 00.257'	190	175
Five Peaks Patch (Blue)	27° 11.688'	80° 02.120'	99	90
Five Peaks Patch (Orange)	27° 11.670'	80° 02.131'	97	88
Five Peaks Patch (Yellow)	27° 11.701'	80° 02.140'	97	91
Five Peaks Patch (Pink)	27° 11.717'	80° 02.141'	95	86
Five Peaks Patch (Black)	27° 11.707'	80° 02.122'	98	92
Tension Barge	27° 13.527'	80° 00.261'	190	178
Reefmaker Triangle	27° 11.595'	80° 05.716'	50	40
Reefmaker Texas	27° 11.414'	80° 06.523'	50	40
Reefmaker Cement Barge	27° 12.627'	80° 06.597'	60	50
Reefmaker Traffic Barge	27° 12.912'	80° 06.821'	60	50
Reefmaker Upside-Down Barge	27° 13.953'	80° 06.732'	60	50
Reefmaker Inlet Barge	27° 12.022'	80° 05.709'	60	50
Reefmaker Diamond N	27° 13.410'	80° 02.280'	100	90
Reefmaker Diamond C	27° 13.276'	80° 02.165'	105	95
Reefmaker Diamond S	27° 13.166'	80° 02.284'	100	90
Reefmaker Tree Barge	27° 13.425'	80° 00.274'	185	175
Clifton Perry Memorial	27° 13.339'	80° 06.131'	66	40 to 50
Frances Langford Memorial	27° 13.353'	80° 01.046'	150	118
PCL Deep	27° 12.924'	80° 01.774'	122	104
PCL Shallow	27° 13.045'	80° 05.743'	60	41
PCL River	27° 12.771'	80° 11.190'	10 – 17	7 @ MLW
West 400	27° 09.735'	80° 03.856'	62	46
Mango	27° 09.702'	80° 03.702'	61	48
Grand Teton	27° 09.708'	80° 03.535'	62	34
KD Select	27° 11.476'	80° 01.474'	124	113
Ann Marie	27° 04.657'	80° 02.297'	67	59
Fogel Capital Management	27° 04.773'	80° 02.297'	67	60
The Heap	27° 04.888'	80° 02.430'	68	63
Jack MacDonald	27° 04.885'	80° 02.314'	68	59
Lentine	27° 04.769'	80° 02.423'	68	62
Shirley	27° 04.663'	80° 02.440'	66	61

Reef Name	Latitude N	Longitude W	Water Depth (ft)	Reef Crest Depth (ft)
American Custom Yachts Tower	27° 13.148'	80° 00.338'	190	155
Bausch American Towers Tower	27° 13.152'	80° 00.259'	189	154
Baratta Sight-See-Er Tower	27° 13.301'	80° 00.307'	187	172
Deborah Schmidt Tower	27° 13.277'	80° 00.266'	187	152
Pirate's Cove	27° 12.814'	80° 00.289'	187	174
Ballantrae Anglers	27° 12.936'	80° 00.280'	187	181
Corinthians Yacht Club	27° 13.040'	80° 00.306'	185	175
Glasrud	27° 12.698'	80° 00.259'	191	162
Ralph Evinrude	27° 12.211'	80° 05.696'	56	42
Lee Harris Memorial	27° 12.330'	80° 06.198'	61	45

The artificial reef sites in Table 2 and Table 3 required annual monitoring for the first two to five years following their deployment. The 2010/2011 annual monitoring was performed for nine of the reefs created from 2000 to 2010.

In 2007, four new reefs were deployed using mixed concrete materials, one deeper site in the Sirotkin Reef area and three shallower sites in the Ernst Reef area. These sites are called KD Select, Grand Teton, West 400 and Mango Reef, respectively. In 2008, four steel towers in the Sirotkin Artificial Reef area and six concrete patch reefs in the South County Artificial Reef areas were deployed. In 2009, three more concrete patch reefs were deployed in the Sirotkin Artificial Reef area. Since 2009, three more artificial reefs have been deployed; the Glasrud or "Big Al" is a steel tugboat that was deployed in 2010 in the Sirotkin Artificial Reef area and two new concrete debris patch reefs, the Ralph Evinrude and the Lee Harris Memorial reefs were deployed in 2011 at the Donaldson Artificial Reef area. Table 4 presents the dates of the deployments and annual monitoring performed from 2004 to 2011.

Table 4. Annual monitoring dates for Martin County artificial reefs.

Reef Name	2011	2010	2009	2008	2007	2006	2005	2004
Mitigation Site A			no	No	8/18	5/21, 6/30, 12/27	no [1]	6/1
Mitigation Site B			no	No	8/18	5/22	no [1]	5/26 & 29
Mitigation Site C			no	no	7/11	5/21, 12/27	no [1]	5/26 & 30
Evans Crary Bridge		YES	no	no	NA	NA	6/17	5/10,23,30
Tetrahedron Stack		YES	no	no	NA	5/21	6/17	5/21, 6/11
Tetrahedron Patch-Yellow		YES	no	no	7/18	4/26	6/7	5/24, 6/3
Tetrahedron Patch-Pink			no	no	7/18	4/26	6/7	5/24, 6/4
Tetrahedron Patch-Blue		YES	no	no	7/18	4/26	6/7	5/24, 6/5
Tetrahedron Patch-White			no	no	7/18	4/26	6/7	5/24, 6/6
Tetrahedron Patch-Black			no	no	7/18	4/26	6/7	5/24, 6/7
Tree Barge	YES		no	no	9/3	6/3	no [2]	no [2]
Wickstrom Ship		YES	no	no	9/3	6/3	no [2]	8/18
Railroad Tie Stack	YES		no	8/5	6/25	5/23	6/8	5/23 & 29
High Queen and Zeppo	YES		no	no	9/15	no [2]	no [2]	8/27

Reef Name	2011	2010	2009	2008	2007	2006	2005	2004
Five Peaks Patch-Blue			10/2	6/25	7/10	5/27	6/8	deployed
Five Peaks Patch-Orange			10/2	6/25	7/10	5/27	6/8	deployed
Five Peaks Patch-Yellow			10/2	6/25	7/10	5/27	6/8	deployed
Five Peaks Patch-Pink			10/2	6/25	7/10	5/27	6/8	deployed
Five Peaks Patch-Black			10/2	6/25	7/10	5/27	6/8	deployed
Tension Barge	YES		no	no	9/15	no [2]	no [2]	deployed
Reefmaker Triangle		YES	no	no	6/24	5/23	deployed	NA
Reefmaker Texas	YES		no	7/24	6/25	4/21, 6/30	deployed	NA
Texas Reef	YES	-	-	-	-	-	-	-
Reefmaker Cement Barge			no	no	6/22	4/21	deployed	NA
Reefmaker Traffic Barge			no	no	6/21	4/3	deployed	NA
Reefmaker Upside-down Barge			no	no	6/19	no [3]	deployed	NA
Reefmaker Inlet Barge		YES	no	no	6/21	no [3]	deployed	NA
Reefmaker Patch N	YES		no	no	no [3]	3/6	deployed	NA
Reefmaker Patch C			no	no	7/10	no [3]	deployed	NA
Reefmaker Patch S			no	12/21	no [3]	3/6	deployed	NA
Reefmaker Tree Barge			no	no	9/3	6/3	deployed	NA
Clifton Perry Memorial			9/28	7/24	6/24	4/3	deployed	NA
Frances Langford Memorial			10/8	12/21	8/8	6/2	deployed	NA
PCL Deep			10/2	12/20	10/29	deployed	NA	NA
PCL Shallow			9/28	6/25	9/20	deployed	NA	NA
PCL IRL			10/25		deployed	NA	NA	NA
West 400			8/26	6/27	deployed	NA	NA	NA
Mango			10/8	6/27	deployed	NA	NA	NA
Grand Teton			8/26	6/19	deployed	NA	NA	NA
KD Select			10/10	12/20	deployed	NA	NA	NA
Ann Marie			8/31	deployed	NA	NA	NA	NA
Fogel Capital Management		YES	8/31	deployed	NA	NA	NA	NA
The Heap		YES	10/8	deployed	NA	NA	NA	NA
Jack MacDonald			9/1	deployed	NA	NA	NA	NA
Lentine			9/1	deployed	NA	NA	NA	NA
Shirley			10/8	deployed	NA	NA	NA	NA
American Custom Yachts Tower		YES	10/15	deployed	NA	NA	NA	NA
Bausch American Towers Tower			no [3]	deployed	NA	NA	NA	NA
Baratta Sight-See-Er Tower			no [3]	deployed	NA	NA	NA	NA
Deborah Schmidt Tower			no [3]	deployed	NA	NA	NA	NA
Pirate's Cove	YES	YES	deployed	NA	NA	NA	NA	NA
Ballantrae Anglers		YES	deployed	NA	NA	NA	NA	NA
Corinthian Yacht Club			deployed	NA	NA	NA	NA	NA
Glasrud Reef - "Big Al"	YES	deployed	NA	NA	NA	NA	NA	NA
Ralph Evinrude	deployed	NA	NA	NA	NA	NA	NA	NA
Lee Harris Memorial	deployed	NA	NA	NA	NA	NA	NA	NA

Notes:

1. Mitigation reef monitoring not completed in 2005 due to poor visibility.
2. Annual in-water monitoring is not required for reef sites in water depths greater than 100 feet.
3. Not every Reefmaker unit is monitored every year.

3.0 PROJECT OBJECTIVES

Artificial reefs are an increasingly valuable amenity for recreational fishing and diving. Florida registers more boats annually than any other state (USCG, 2007-2011 Recreational Boating Statistics) and has many resident and visiting certified scuba divers and marine anglers that enjoy what the Florida waters have to offer. For several decades in Martin County, artificial reefs have been enhancing local fishing and diving while alleviating pressure on natural reef systems. While there is no scientific confirmation yet that artificial reefs enhance regional fish populations or reduce human impacts to natural reef and hard-bottom communities, many fisheries biologists believe they do, and regular monitoring may eventually describe their full contribution to the nearshore marine environment.

Annual monitoring of each artificial reef structure is required by the US Army Corps of Engineers for a minimum of two years which includes documenting associated flora and fauna. When permit requirements are satisfied, the reefs are monitored on a rotating basis, typically every 4-5 years. The primary objectives of the monitoring effort are to verify artificial reef locations, document biological activity (benthic flora and invertebrates, demersal and pelagic fish communities) and evaluate engineering performance (stability and condition of the reef materials, scour and settlement). Effective analysis of artificial reef monitoring data may result in a program that optimizes reef placement and engineering in ways that maximize both fisheries and recreational enhancement.

3.1 METHODOLOGY

The monitoring techniques used to monitor Martin County's artificial reef sites in 2011 were identical to the methodology used by L. Harris and K. Dillon in previous annual monitoring efforts. Divers made direct measurements of the reefs, recorded visual observations and collected still photos and video footage to document vital statistics for each artificial reef. Fieldwork was performed by the authors and other qualified divers (engineers and scientists) to ensure that all pertinent engineering and biological data were observed and documented.

3.1.1 Physical Measurements

Divers inspected and measured each artificial reef unit to determine changes in the reef structure, including scour, settlement, and other movement of reef components by repeating survey measurements established during previous 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. Changes in reef heights were used to assess settlement of the materials. The natural bottom depths 10 meters away from the reefs were compared to the maximum depths immediately adjacent to the reefs to assess scour. Measuring tapes and compass readings were used to measure horizontal distances on the reefs, as well as distances and bearings between the patch reefs, where applicable. Divers also used buoys at key locations in order to collect accurate GPS coordinates from the surface.

3.1.2 Biological Surveys

Data collection methods utilized the Roving Diver Technique (RDT) to perform fish counts to assess the diversity and density of demersal and pelagic fishes. Plant and invertebrate assessments were also performed by identifying benthic flora and fauna on and among the artificial reef substrate to the lowest practical taxa.

Unlike closer to shore and shallower artificial reef sites the deepwater offshore sites are located at the western edge of the Gulf Stream. The Gulf Stream meanders, sometimes daily, by many miles east or west. Generally the Gulf Stream shifts from closer to shore in the summer months to further offshore during the winter months. Many migratory fish species travel north in the summer and south in the winter. This means that on any given day one might see minimal fish species like in this event where only 11 were documented or 20 or more species during a dive on other days.

As well as the Gulf Stream fluctuations, other factors have an effect on how many and which species are seen during a monitoring event. The east central coast of Florida is very close to the continental slope where the relatively gradual sloping continental shelf drops quickly to the abyssal plains of the deep ocean. In the summer months a phenomenon known as cold-water upwelling occurs, most predominately along the east central coast of Florida in the summer months. Cold water upwelling is a phenomenon where normal ocean bottom temperatures will drop to temperatures well below normal for the location and time of year, temperatures as low as 46 degrees F have been documented. The surface temperatures are usually still in the 80s during these events but for divers and fish it can be a traumatic experience. The events usually last from 2 to 6 weeks; June and July are the worst months for these cold-water upwelling events. In some recent years large fish kills have occurred with 1000s of fish dying and either drifting away in the current or washing up on the beaches. These events sometimes bring very deep cold-water species up from the abyss onto the continental shelf. In summation there are many factors that affect the specific numbers and types of fish species documented on the deepwater reefs on any given week throughout the year.

3.1.3 Photo/Video Documentation

Underwater still and video cameras were used to document observations during the dives. Photography was used to help confirm identification of flora and fauna and to compare with still and video photographs collected during previous monitoring. Due to varying conditions (especially visibility at the bottom), underwater photographs for some sites or some dates are not of sufficient quality to include in this report. Selected photographs taken in 2011 are included in this report. In addition to the report copies of all photographs and videos shall be submitted on DVD.

Monitoring reports from prior years were reviewed prior to performing the fieldwork, and dive 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 were transferred into field journals to assure that correct and complete data were recorded and saved.

4.0 ARTIFICIAL REEF LOCATIONS

A total of nine individual artificial reef sites were monitored in 2011, dispersed among two of the permitted offshore artificial reef sites. The specific artificial reef sites listed in Table 5 were monitored, with physical surveys of the reef site and biological inventories performed for each site.

Table 5. List of artificial reefs monitored in 2011.

	Reefs to Monitor - 2011	2011 Monitoring Dates	Last Monitoring	Depth	Permit Area	Survey Type
1	Glasrud – “Big Al”	9/13/11	n/a	187	Sirotkin	in-water
2	Pirate’s Cove	10/1/11	9/08/2010	187	Sirotkin	in-water
3	Reefmaker Patch* N	7/24/11	3/06/2006	100	Sirotkin	in-water
4	Tree Barge	9/25/11	9/03/2007	190	Sirotkin	in-water
5	High Queen and Zeppo	9/29/11	9/15/2007	190	Sirotkin	in-water
6	Tension Barge	9/29/11	9/15/2007	190	Sirotkin	in-water
7	Concrete RR Tie Stack	7/24/11	8/05/2008	93	Sirotkin	in-water
8	Texas Reef	8/23/11	n/a	55	Donaldson	in-water
9	Texas Reef – Reefmakers	7/27/11	6/19/2008	50	Donaldson	in-water

The following sections provide a summary description of deployments on the Donaldson and Sirotkin areas. The locations of the artificial reefs monitored for this report are shown on location charts along with other known artificial reef deployments. The permitted reef areas are located in water depths ranging from 50 to 190 feet and include artificial reefs constructed using a variety of man-made and natural materials. The size of the individual artificial reefs is also quite variable due to the type and quantity of materials used.

Figure 2 shows the distances from the St. Lucie Inlet sea buoy to the four primary offshore artificial reef areas, the Ernst, Donaldson, Sirotkin and South County Artificial Reef areas.

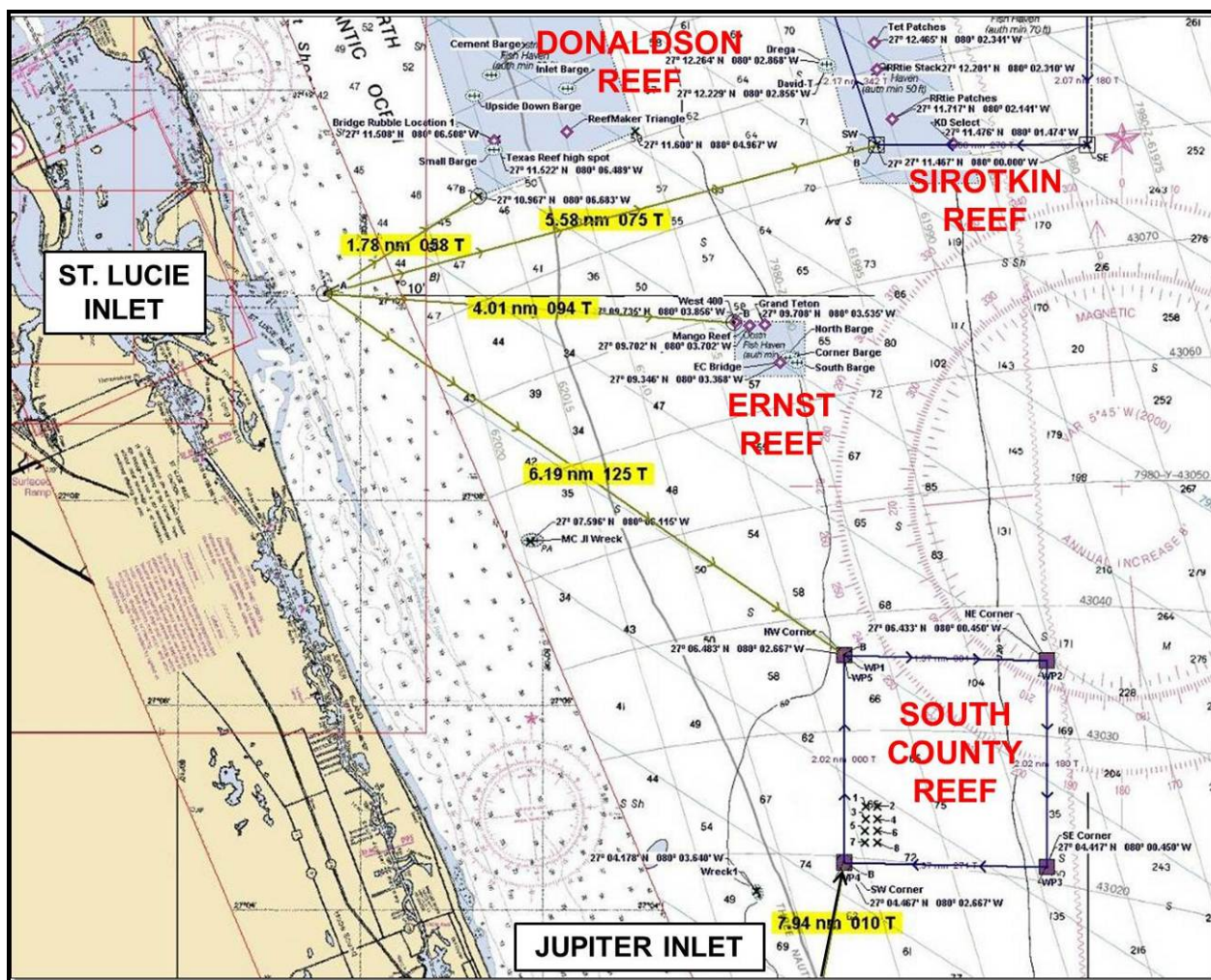


Figure 2. Bearing and distances from St. Lucie Inlet sea buoy to the offshore artificial reef sites.

4.1 DONALDSON ARTIFICIAL REEF SITE

The Donaldson Artificial Reef site is located about 2 nautical miles NE of the St. Lucie Inlet sea buoy as shown in Figure 2. Water depths vary from 50 to 68 feet within this area and it contains a variety of artificial reef structures, including several older barges, dredged limestone rubble, recycled bridge materials, concrete culverts, boxes and pilings and purpose-built artificial reef modules. Figure 3 shows the area of the permitted Donaldson Artificial Reef site and the locations of the artificial reefs within the site. The names to the individual reefs identified and numbered in Figure 3 are located in Table 6.

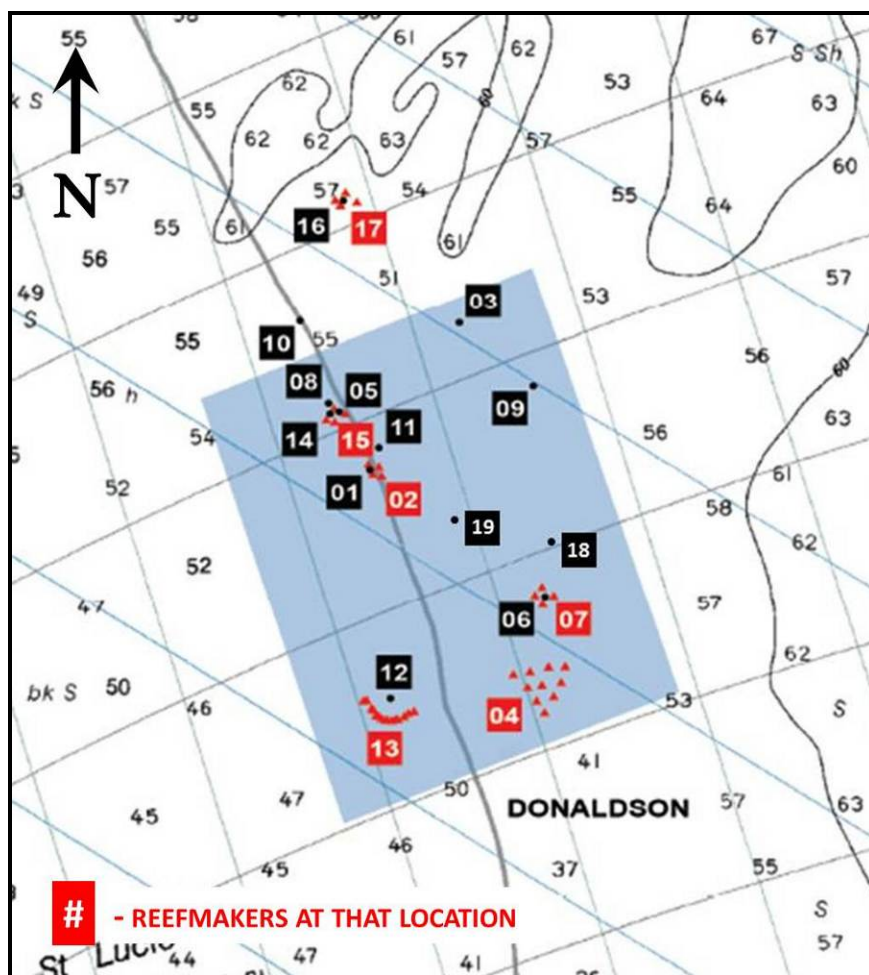


Figure 3. Chart view of the Donaldson Artificial Reef site.

Table 6. Summary of Donaldson Artificial Reef sites.

No.	Reef Name
01	Cement Barge
02	Cement Barge – Reefmakers (4)
03	Clifton Perry Memorial Reef
04	Donaldson Triangle – Reefmaker
05	Guardian Reef

No.	Reef Name
06	Inlet Barge
07	Inlet Barge – Reefmakers (4)
08	LC-6
09	PCL Shallow (Lyons Bridge)
10	Pipe Barge
11	The Owl
12	The Texas Reef
13	The Texas Reef – Reefmakers (15)
14	Traffic Barge
15	Traffic Barge (4)
16	Upside-Down Barge
17	Upside-Down Barge – Reefmakers (4)
18	Ralph Evinrude
19	Lee Harris Memorial

The newest Donaldson Artificial Reef deployments were in the spring of 2011, the Lee Harris Memorial Reef and the Ralph Evinrude Reef. The Lee Harris Memorial Reef is comprised of three patch reefs made from four barge loads of materials of 400 – 500 tons each. The reefs are made from concrete and steel segments that Martin County collected from several construction sites and building demolitions locally. The center reef is comprised of two barge loads of material placed directly on top of each other and created the highest profile of 16 feet.

The Ralph Evinrude site is about ¼ mile east of the Lee Harris Memorial Reef and consists of material from several building demolitions at Indian Riverside Park in Jensen Beach. This site had once been the Florida Institute of Technology School of Applied Marine Technology, a four year technical college that specialized in Marine related science programs. Mr. Evinrude donated very generously over the years to this college. The main science building there was named the Ralph Evinrude Science Center. Concrete roof beams and slabs from the building were utilized to form the Ralph Evinrude Artificial Reef.

4.2 SIROTKIN ARTIFICIAL REEF SITE

The Sirotkin Artificial Reef site is the largest and deepest of the permitted artificial reef sites offshore of Martin County (Figure 4). Of the five permitted sites the Sirotkin site also contains the largest number of artificial reefs, a total of 29. The western side of the site has water depths in the 70 foot range, while the eastern border includes water depths of just over 200 feet. Although depths in excess of 130 feet are not recommended for recreational diving, technical divers and offshore sport fishermen utilize the deeper artificial reefs because of the dramatic underwater scenery and diversity of demersal and pelagic fish species encountered there. The names to the individual reefs identified and numbered in Figure 4 are located in Table 7.

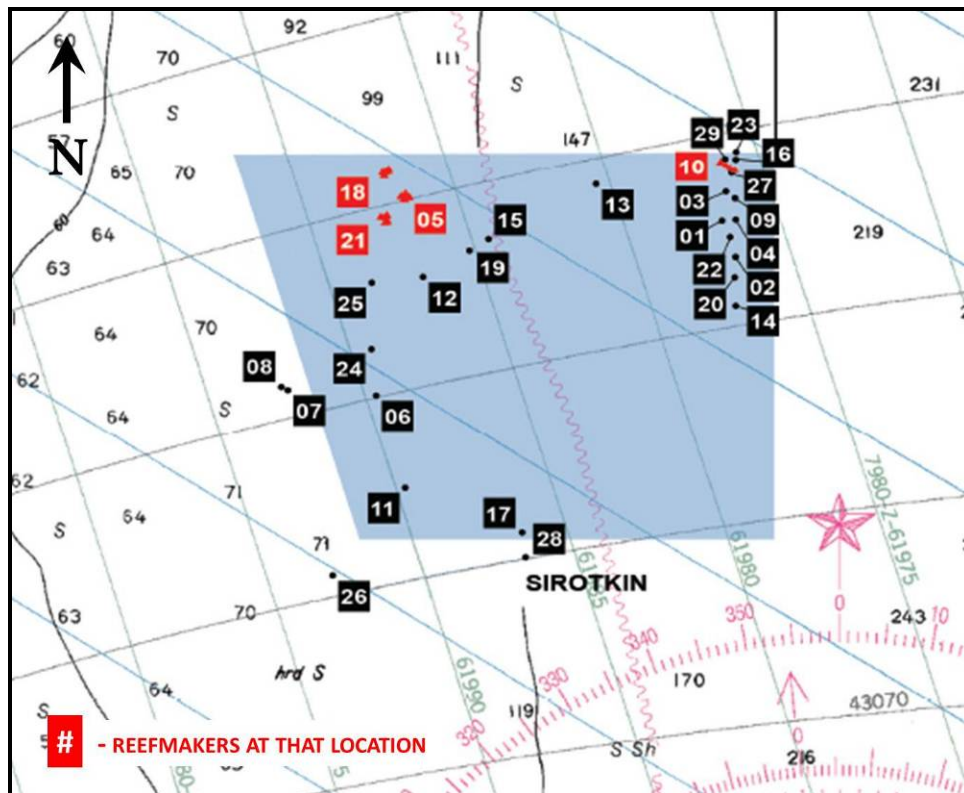


Figure 4. Chart view of the Sirotkin Artificial Reef site.

Table 7. Summary of Sirotkin Artificial Reef sites.

No.	Reef Name
01	American Custom Yachts Tower
02	Ballantrae Anglers
03	Baratta Sight-Sea-Er Tower
04	Bausch American Towers Tower
05	Center Patch – Reefmakers (5)
06	Concrete RR Tie Stack
07	David-T
08	Draga-de-Arena
09	Debbie Schmidt Tower

No.	Reef Name
10	Eastern Corridor – Reefmakers (4)
11	Five Peaks Reef (5)
12	FPL Reef/Roosevelt Bridge
13	Frances Langford Memorial
14	Glasrud (BIG AL Tug)
15	Halloween Barge
16	High Queen & Zeppo
17	KD Select
18	North Patch – Reefmakers (5)
19	PCL Deep (Lyons Bridge)
20	Pirate's Cove
21	South Patch – Reefmakers (5)
22	Stuart Corinthian Y.C.
23	Tension Barge
24	Tetrahedron Patch
25	Tetrahedron Stack
26	Titan Tug
27	Tree Barge
28	USS Rankin Navy Ship
29	Wickstrom Ship

A variety of reefing materials has been deployed within the Sirotkin Artificial Reef site over the past several decades. The more recent deployments have consisted of various concrete rubble, dismantled bridge components, ships, barges and artificial reef modules. In February 2010 a 69 ft long, ocean-going, steel tugboat was placed upright on the seafloor and has an impressive profile of 42 ft. This tugboat reef has since been named the Glasrud Reef and is located within the Sirotkin Artificial Reef site. Other steel vessels have been deployed in the NE corner of the Sirotkin reef site such as the Wickstrom, Tree Barge, High Queen/Zepo, and the Tension Barge.

Another recent addition (2008) to this permitted reef site is the Harbor Branch Towers formation, a group of four steel towers deployed upright in 190 feet of water. Each of the towers measures about 20 feet on a side by 35 feet tall. To complement existing artificial reefs pyramid-shaped artificial reef units, known as Reefmakers, have been utilized to increase structural diversity at chosen sites. Four Reefmaker artificial reef units have been deployed in the NE corner of the Sirotkin Artificial Reef site, between the Tree Barge and the Wickstrom. Nineteen additional Reefmaker artificial reef units were deployed in 2005 within the Sirotkin Artificial Reef area.

Additionally, two different types of concrete shapes (tetrahedrons and railroad ties) were deployed in four deployments (one each year from 2001 to 2004) along a N-S axis in the Sirotkin Artificial Reef, as shown in Figure 4. Concrete tetrahedrons were deployed both as a single stack and as five separate patch reefs. Likewise, the concrete railroad ties were also deployed as a single stack and as five separate patch reefs. Water depths are between 95 and 100 feet at all four of these sites.

5.0 RESULTS

The following sections summarize the monitoring results for each artificial reef monitored in 2011. A brief history and description of each artificial reef is followed by structural details and biological survey results along with selected photographs of each artificial reef.

5.1 GLASRUD – “BIG AL” REEF

- Location: Sirotkin Reef
- Materials: “Big Al” Tugboat (Steel)
- Maximum Depth: 191 feet
- Reef High Point: 162 feet
- Year Created: 2010
- Monitoring Date: 9/13/2011
- Total Cost: \$40,000 (MCAC)

5.1.1 History of the Glasrud “Big Al” Artificial Reef

On Wednesday February 24th 2010 the 69-foot steel tug boat “Big Al” was deployed offshore as an estimated 100 spectators aboard 20 boats watched, photographed and took video of the sinking. The deployment of the “Big Al” was made possible by a \$40,000 donation from the Martin County Anglers Club (MCAC), a non-profit organization, to cover the costs associated with the new reefs’ construction. The tug sank quickly after it was properly positioned in line with other artificial reefs created. The crews working aboard the “Regina T” tug and Molly work boat owned by McCulley Marine Services, and Treasure Coast reef consultant Kerry Dillon had to contend with current, wind and the edge of the severe midday squall during the deployment. The tug reached bottom in 187 feet of water near the Wickstrom, a 168 foot long steel freighter deployed in January 2003. It is part of Martin County's Sirotkin permitted reef area located in deep water. Figure 5 shows a chart with the location of the Glasrud Reef.

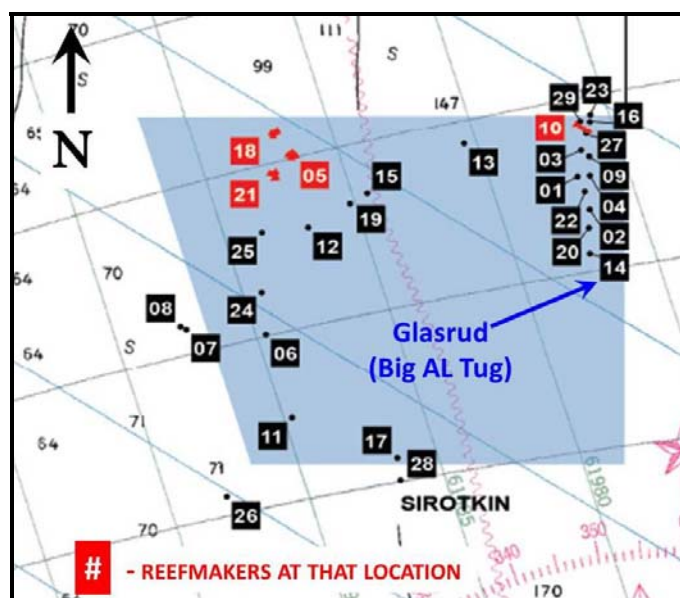


Figure 5. Chart view of the Glasrud Reef in the Sirotkin Reef site.

5.1.2 Structural Summary

The Glasrud appears to have suffered very little damage to the hull as it impacted the seafloor. During the deployment video cameras were attached to the railing on the aft wheelhouse deck to record the sinking. From the audio of that recording we were able to time the descent, 187 feet, to the seafloor. The tugboat took a total of 14 seconds to sink to the bottom once it had submerged. The video shows an explosion of bubbles and debris from the seafloor as the tugboat hit the bottom. Other than the steel sign bolted to the top of the wheelhouse being bent over at the legs from the impact, the tugboat was in good structural condition. The photographs in Figure 6 show the general condition of the Glasrud and some of the large schools of round scad observed around the vessel during the monitoring dive.



Figure 6. Glasrud Artificial Reef 2011 photographs.

5.1.3 Biological Survey Results

Although this site had only 10 fish species on it when monitored in 2011, the total biomass was very impressive. Thousands of round scad and hundreds of amberjack, vermillion snapper and black sea bass were observed during the monitoring dive. Table 8 and Table 9 list the species/taxa and the relative abundance and size class (adult, intermediate, and juvenile) observed during the monitoring dive.

Table 8. Glasrud Artificial Reef Fish Species Census.

Family/ Common Name	Species	2011	
		Abundance	Size
Carangidae			
Greater Amberjack	<i>Seriola dumerili</i>	M	A
Round scad	<i>Decapterus punctatus</i>	A (1000's)	A
Haemulidae			
Tomtate	<i>Haemulon aurolineatum</i>	M	J & A
Lutjanidae			
Vermilion Snapper	<i>Rhomboplites aurorubens</i>	A	A
Sciaenidae			
Cubbyu	<i>Pareques umbrosus</i>	F	J & A
Serranidae			
Bank sea bass	<i>Centropristis ocyurus</i>	M	J & A
Black sea bass	<i>Centropristis striata</i>	A	J & A
Anthiinae			
Anthias	<i>Anthias</i>	F	A
Sparidae			
Sheepshead porgy	<i>Calamus penna</i>	F	A
Sphyraenidae			
Great barracuda	<i>Sphyraena barracuda</i>	F	A
	Total	10	

Abundance Key: S=single, F=few (2-10), M=many (11-100), A=abundant (>100)

Size Key: A=adult, J=juvenile, A/J=intermediate

Table 9. Glasrud Artificial Reef Benthic Species Census.

Common Name		Scientific Name
Echinoderms	Rock Boring Urchin	<i>Echinometra lucunter</i>
	3 Rowed Sea Cucumber	<i>Isostichopus badionotus</i>
	Common Arbacia Urchin	<i>Arbacia punctulata</i>
	Sea Star	Unidentified species
Cnidarians	Sea Anemones	<i>Aptasia sp.</i>
	Hydroids	Unidentified species
Ascidians	Overgrowing Tunicates	<i>Didemnidae</i>
	Giant Tunicates	<i>Polycarpa spongiabilis</i>
	Button Tunicates	<i>Distaplia corolla</i>
Crustaceans	Yellowline Arrow Crab	<i>Stenorhynchus seticornis</i>
	Giant Hermit Crab	<i>Anomurans</i>
	Caribbean Spiny Lobster	<i>Panulirus argus</i>
	Rough Box Crab	<i>Calappa gallus</i>

	Common Name	Scientific Name
Mollusca	Rock Snails	<i>Muricidae</i> (Unidentified Species)
	Octopus	Unidentified Species
	Cowery Shell	
Ectoprocta	Encrusting Bryozoans	Unidentified Species
Anthozoa	Gorgonians	

5.2 PIRATE'S COVE REEF

- Location: Sirotkin Reef
- Materials: Baffle boxes, pipe sections, bridge railings, culverts, slabs and pillings (all concrete)
- Maximum Depth: 189 feet
- Reef High Point: 174 feet
- Year Created: 2009
- Monitoring Date: 10/01/2011
- Total Cost: \$21,125 (FWC & Martin County)

5.2.1 History of the Pirate's Cove Reef

In the fall of 2008 the FWC awarded a \$62,068 grant to Martin County's Engineering Department. Materials of opportunity were collected and stored until summer of 2009. Three bargeloads of material, approximately 500 tons each, were deployed on the Sirotkin site to create 3 new reefs. One of these reefs was the Pirate's Cove reef (Figure 7). The funds allocated specifically for the Pirate's Cove Reef from the FWC grant in addition to monies from Martin County totaled \$21,125. On August 24, 2009 the Pirates Cove Reef was built successfully in 187 ft of water and since has become another fine deepwater artificial reef offshore Martin County, Florida. On Sept. 8, 2010 a large steel sign with concrete bases was placed on the reef with the name Pirate's Cove Reef.

Pirate's Cove Resort & Marina is a locally operated facility in the Manatee Pocket section of Port Salerno, Florida. Many of the guests at the resort and sport fishing fleet in the marina have fished the waters of Martin County for decades. Figure 7 shows a chart with the location of the Pirate's Cove Reef.

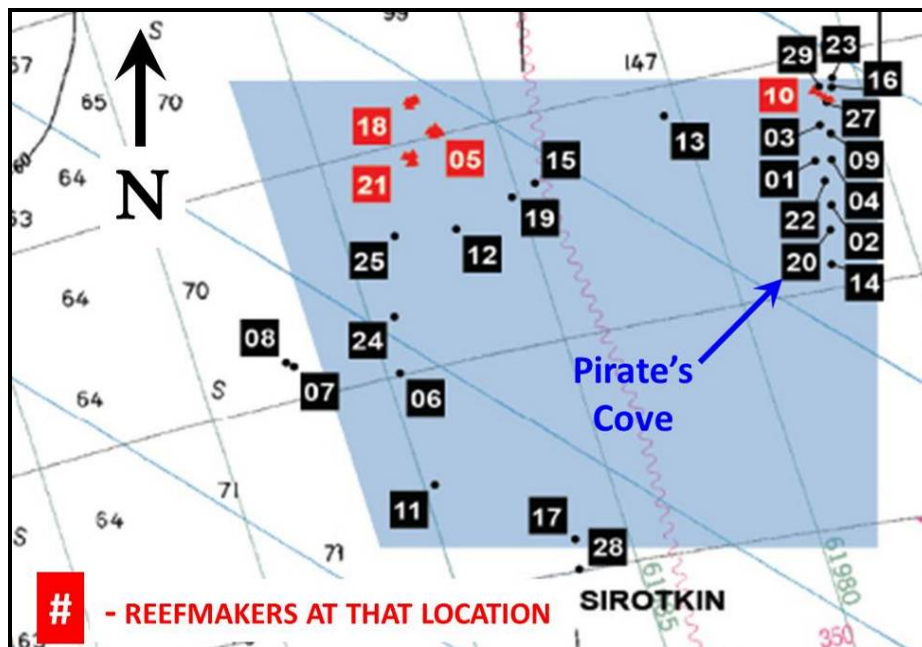


Figure 7. Chart view of the Sirotkin Reef showing the Pirate's Cove Reef location.

5.2.2 Structural Summary

During the 2011 monitoring no major changes were observed to have occurred since the 2010 monitoring. Baffle boxes are still stacked on top of each other providing a high profile of 15 ft. No major scouring exists at the site and materials are still in a tight grouping. As opposed to the shallower artificial reefs that can be effected by large ocean swells and seasonal sediment shifting, the deep water sites seem to only be effected by hurricanes with very large (>3 meter) long period swells. Since the construction of the artificial reef in 2009 no major hurricanes have hit the area. The photograph in Figure 8 shows the general condition of some of the materials observed during the monitoring dive of Pirate's Cove Reef.



Figure 8. Pirate's Cove Artificial Reef 2011 photograph.

5.2.3 Biological Survey Results

During the 2011 monitoring 10 fish species were identified. Three species observed that are specific to deepwater sites were snowy grouper, red barbier, and banks butterflyfish. The notable sport fish at this site were: gag grouper, black sea bass, and greater amberjack. As is often seen on the deeper than 130 ft deep sites less total species are documented but more quantities of each species is evident. The deeper sites still have 100's to 1000's of individual fish just less species diversification than at the shallower artificial reef sites. Table 10 and Table 11 list the species/taxa, the relative abundance and size class (adult, intermediate, and juvenile) observed during the monitoring dive.

Table 10. Pirate's Cove Artificial Reef Fish Species Census.

Family/ Common Name	Species	2011	
		Abundance	Size
Carangidae			
Greater Amberjack	<i>Seriola dumerili</i>	M	A
Chaetodontidae			
Banks butterflyfish	<i>Chaetodon aya</i>	F	A
Pomacentridae			
Yellowtail reeffish	<i>Chromis enchrysurus</i>	M	J & A
Balistidae			
Ocean Triggerfish	<i>Canthidermis maculata</i>	S	A
Serranidae			
Bank sea bass	<i>Centropristis ocyurus</i>	F	J & A
Black sea bass	<i>Centropristis striata</i>	M	J & A
Snowy grouper	<i>Epinephelus niveatus</i>	F	J & A
Red Barbier	<i>Hemanthias vivanus</i>	F	A
Gag grouper	<i>Mycteroperca microlepis</i>	F	A
Sparidae			
Sheepshead porgy	<i>Calamus penna</i>	M	A
	Total	10	

Abundance Key: S=single, F=few (2-10), M=many (11-100), A=abundant (>100)

Size Key: A=adult, J=juvenile, A/J=intermediate

Table 11. Pirate's Cove Artificial Reef Benthic Species Census.

Common Name	Scientific Name
Echinoderms	
Rock Boring Urchin	<i>Echinometra lucunter</i>
3 Rowed Sea Cucumber	<i>Isostichopus badiionotus</i>
Common Arbacia Urchin	<i>Arbacia punctulata</i>
Cnidarians	
Sea Anemones	<i>Aptasia sp.</i>
Hydroids	Unidentified species
Ascidians	
Overgrowing Tunicates	<i>Didemnidae</i>
Giant Tunicates	<i>Polycarpa spongiabilis</i>
Crustaceans	
Yellowline Arrow Crab	<i>Stenorhynchus seticornis</i>
Mollusca	
Rock Snails	<i>Muricidae</i> (Unidentified Species)
Ectoprocta	
Encrusting Bryozoans	Unidentified Species

	Common Name	Scientific Name
Porifera	Star Encrusting Sponge	<i>Halisarca sp.</i>
	Orange Encrusting Sponge	<i>Ulosa ruetzleri</i>
Anthozoa	Gorgonians	
Phaeophyta	Brown Algae	<i>Sargassum natans</i>
	Several Unidentified Algal Species (Green and Brown)	

5.3 REEFMAKER PATCH - NORTH

- Location: Sirotkin Reef
- Materials: Concrete
- Maximum Depth: 101 feet
- Reef High Point: 92 feet
- Year Created: 2005
- Monitoring Date: 7/24/2011
- Total Cost: \$3,975 (FWC 89% & Martin County 11%)

5.3.1 History of the Reefmaker Patch - North

Martin County received a \$47,700 grant in 2005 from the FWC to enhance existing artificial reef sites by deploying sixty Reefmaker “Florida Special” artificial reef modules adjacent to existing reef materials in the Donaldson and Sirotkin reef sites and four stand-alone sites. The Reefmaker modules are large three-sided pyramids fabricated using concrete and steel. The Reefmaker Patch – North was one of three patch reefs (North, Center, and South – 5 Reefmaker units at each) where 5 Reefmaker “Florida Special” units were deployed utilizing \$3,975 of the FWC grant. A chart showing the placement of the modules at the reef location for the North Patch is shown in Figure 9.

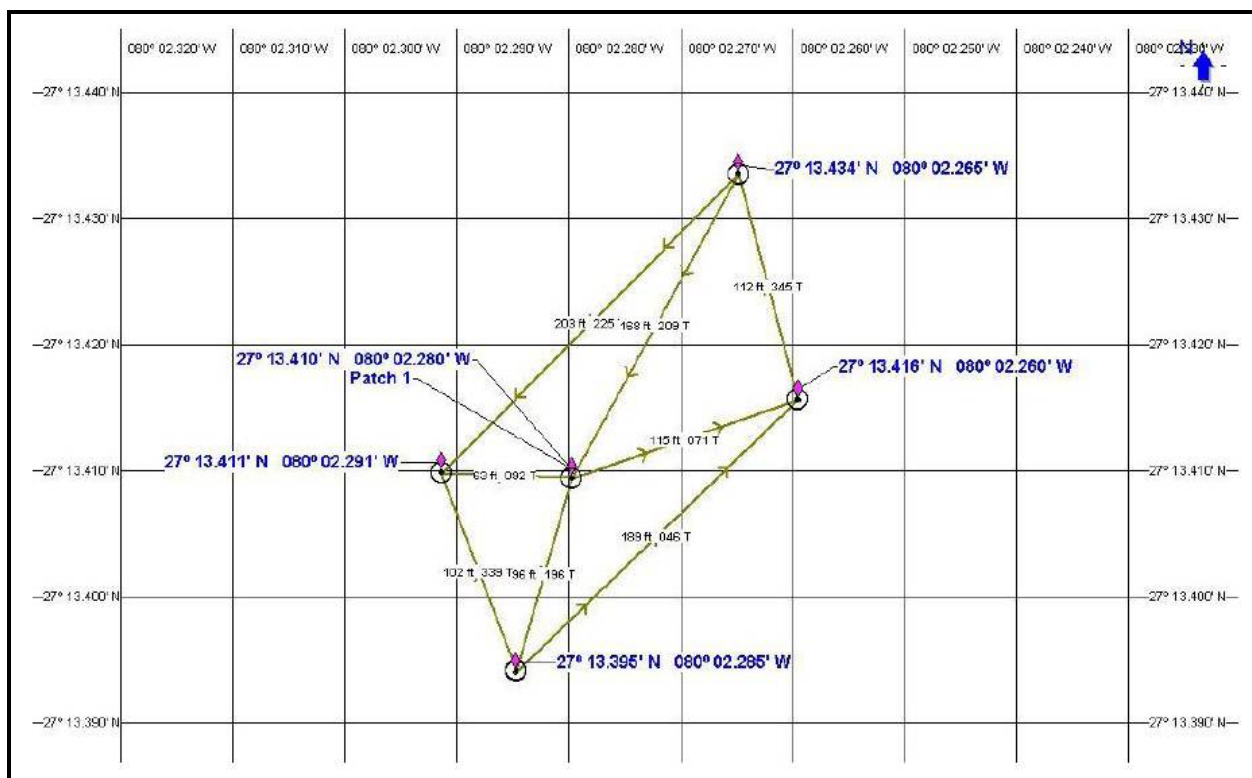


Figure 9. Sirotkin Reef chart showing the Reefmaker Patch - North unit locations.

5.3.2 Structural Summary

These 5 Reefmaker units were deployed at a depth of 101 ft and although this site received a direct hit from Hurricane Wilma (Category 2) in Oct. 2005, five months after the deployment of the units, all 5 units have remained stationary. The only noticeable change overtime has been some steel corrosion and erosion on the lower 2 ft. of the steel side panels. This is minor as compared to other Reefmaker units deployed in 60 feet or less which show severe corrosion and erosion probably resulting from higher oxygen content, increased wave action and sand abrasion.

The concrete appears to be holding up well with little sign of deterioration. Each of the 5 units has settled into the seafloor a nominal 1-foot, therefore reducing the total profile from 10 ft. down to 9 feet. The photographs in Figure 10 show the general condition of the Reefmaker Patch - North and the area surrounding the Reefmakers observed during the monitoring dive.



Figure 10. Reefmaker Patch - North 2011 photographs.

5.3.3 Biological Survey Results

Sport fish seen during this monitoring were black sea bass, greater amberjack, and vermillion snapper along with 1000's of baitfish in the water column above the Reefmaker units. One protected species, a goliath grouper, was seen inside one of the units. A rarely observed fish, an adult red hind, was also observed. On the ascent above the reef the divers noted a large school (> 50) of cownose rays. For the relatively small size of this artificial reef (5 units) the type and amount of marine life attracted to this reef is impressive. Table 12 and Table 13 list the species/taxa, their relative abundance and size class (adult, intermediate, and juvenile) observed during the monitoring dive.

Table 12. Reefmaker Patch - North Fish Species Census.

Family/ Common Name	Species	2011	
		Abundance	Size
Carangidae			
Round scad	<i>Decapterus punctatus</i>	M	A
Greater Amberjack	<i>Seriola dumerili</i>	F	J & A
Lutjanidae			
Vermilion snapper	<i>Rhomboplites aurorubens</i>	F	A
Sciaenidae			
Cubbyu	<i>Pareques umbrosus</i>	S	A
Scorpaenidae			
Spotted scorpionfish	<i>Scorpaena plumeiri</i>	F	A
Serranidae			
Bank sea bass	<i>Centropristis ocyurus</i>	M	A
Black sea bass	<i>Centropristis striata</i>	M	J & A
Goliath grouper	<i>Epinephelus itajara</i>	S	A
Red hind	<i>Epinephelus guttatus</i>	S	A
Whitespotted soapfish	<i>Rypticus maculatus</i>	S	J/A
Sparidae			
Sheepshead porgy	<i>Calamus penna</i>	F	A
Myliobatidae			
Cownose ray	<i>Rhinoptera bonasus</i>	M (50+)	J & A
Tetraodontidae			
Bandtail puffer	<i>Sphoeroides spengleri</i>	F	J
	Total	13	

Abundance Key: S=single, F=few (2-10), M=many (11-100), A=abundant (>100)

Size Key: A=adult, J=juvenile, A/J=intermediate

Table 13. Reefmaker Patch – North Benthic Species Census.

Common Name		Scientific Name
Echinoderms	Rock Boring Urchin	<i>Echinometra lucunter</i>
	3 Rowed Sea Cucumber	<i>Isostichopus badiotus</i>
	Common Arbacia Urchin	<i>Arbacia punctulata</i>
	Notched Sand Dollar	<i>Encope aberrans</i>
Cnidarians	Sea Anemones	<i>Aptasia sp.</i>
	Hydroids	Unidentified species
Ascidians	Overgrowing Tunicates	<i>Didemnidae</i>
	Button Tunicates	<i>Distaplia corolla</i>
Crustaceans	Yellowline Arrow Crab	<i>Stenorhynchus seticornis</i>

	Common Name	Scientific Name
	Sessile barnacles	<i>Thoracica</i>
Mollusca	Rough Fileclam	<i>Lima scabra</i>
Ectoprocta	Encrusting Bryozoans	Unidentified Species
Anthozoa	Gorgonians	
Porifera	Star Encrusting Sponge	<i>Halisarca sp.</i>
	Orange Encrusting Sponge	<i>Ulosa ruetzleri</i>
Phaeophyta	Brown Algae	<i>Sargassum natans</i>
Annelida	Variegated Feather Duster	<i>Bispira variegata</i>

5.4 TREE BARGE

- Location: Sirotkin Reef
- Materials: Steel barge & one Reefmaker unit
- Maximum Depth: 190 feet
- Reef High Point: 172 feet
- Year Created: 2002
- Monitoring Date: 9/25/2011
- Total Cost: There was no cost to Martin County

5.4.1 History of the Tree Barge Artificial Reef

The Tree barge was nicknamed such because a young Australian pine tree had grown on top of the deck while the barge lay idle for approx. 4 years in the Okeechobee waterway several miles west of the St. Lucie Locks. Martin County acquired this barge when the owner abandoned it where it was grounded on the north embankment of the waterway. On Friday April 19, 2002 the Tree barge was intentionally sunk in 188 feet of water in the northeast quadrant of the Sirotkin artificial reef site. It became the first component of the newly created deepwater extension of the Sirotkin artificial reef site which extends out to 200-foot water depths. Although these depths are not recommended for normal recreational diving, the local offshore sport fishing interests prefer these depths for their blue water angling adventures because of the specific pelagic species encountered there.

The Tree barge settled on the bottom in an upright position with the deck level; no notable listing. The bow, damaged during deployment, faces easterly at 80° and the stern faces westerly at 260°. Some minimal scouring of the sand/shell bottom has occurred, especially on the western end. There has been no apparent movement of the barge since original deployment in 2002.

The Tree barge was considered a derelict abandoned vessel and was in poor condition with holes in its deck. As a working barge this is not a favorable asset but underwater as an artificial reef the holes provide access for fish and marine life. Since the deployment this site has seen one Category 3 hurricane (2004) and two Category 2 hurricanes (2004 & 2005) pass directly over the reef which it is believed that one of these hurricanes caused part of the steel deck to lift up and fold over on itself.

In May 2005, four Reefmaker units were deployed in a line between the Tree Barge and the Wickstrom as a part of an FWC grant that placed sixty Reefmaker units throughout the Donaldson and Sirotkin artificial reef sites. Four of the Reefmaker units were placed between the Tree Barge and Wickstrom to provide a corridor between the two artificial reefs for fish and tech divers. The closest Reefmaker unit was placed approximately 72 ft NNE of the Tree Barge. Figure 11 shows the location of the Tree Barge in the Sirotkin Artificial Reef area and Figure 12 shows the locations of the nearby Reefmaker units between the Tree Barge and the Wickstrom.

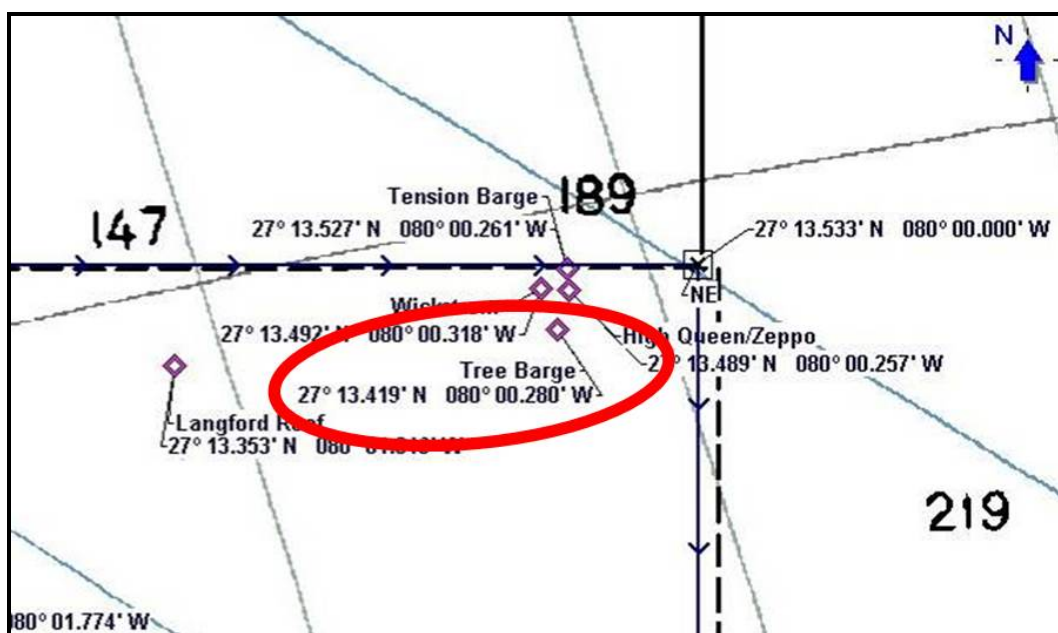


Figure 11. Sirotkin Reef site showing the Tree Barge location.

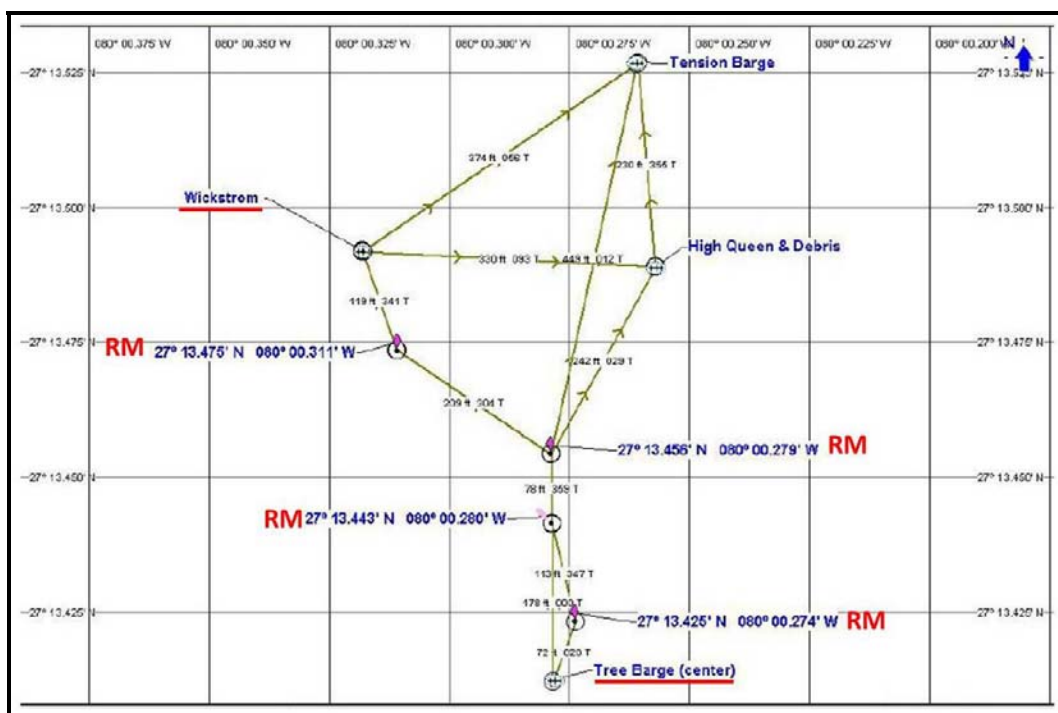


Figure 12. Sirotkin Reefmaker Corridor from the Tree Barge to the Wickstrom.

5.4.2 Structural Summary

As mentioned above, the Tree Barge shows some hurricane damage to the north center part of the steel deck plates. A large (30 ft. by 12 ft.) section of steel deck was observed having been peeled back lying on top of itself. The Tree Barge otherwise appeared structurally sound, the steel support members show little change except for some marine growth. The photographs in

Figure 13 show the general condition of the Tree Barge, the Reefmaker unit closest to the Tree Barge and some of the species observed during the monitoring dive.

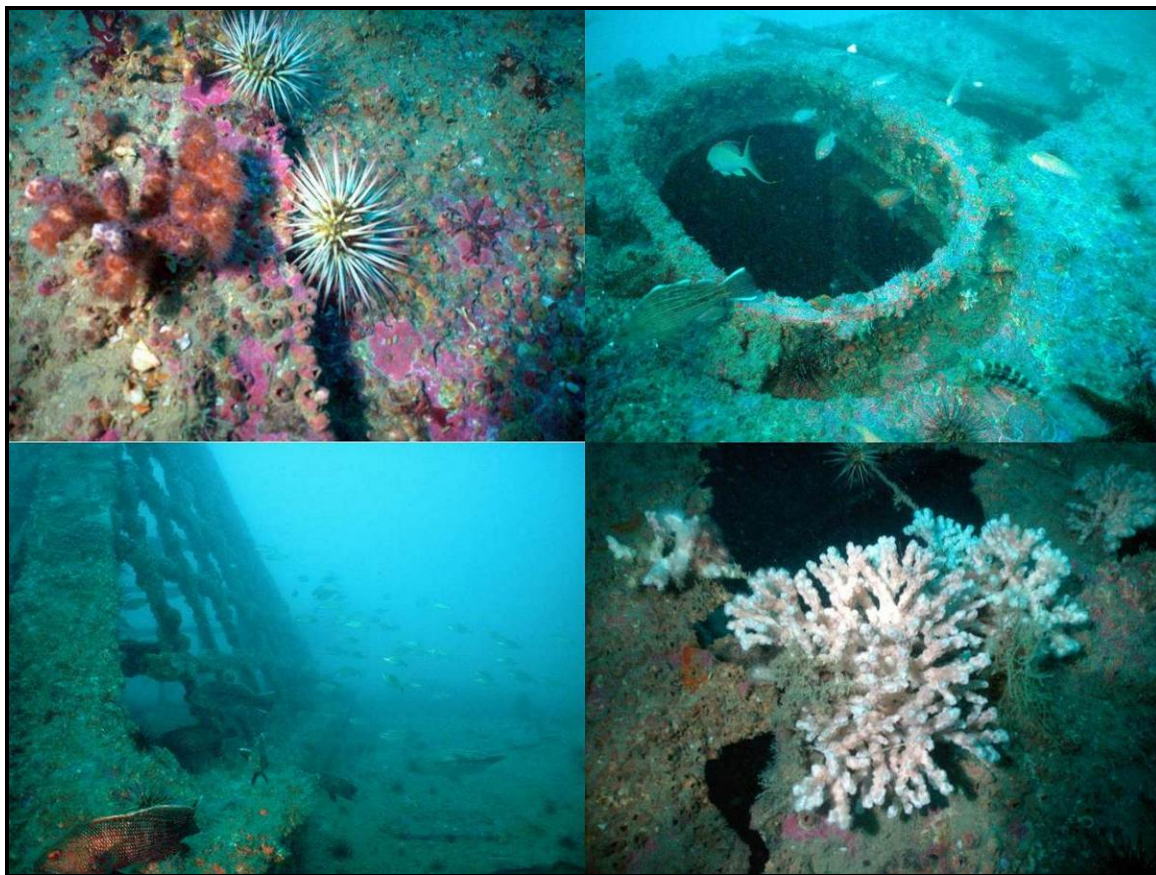


Figure 13. Tree Barge Artificial Reef photographs from 2011.

5.4.3 Biological Survey Results

Several important sport fish were documented during this monitoring event including black grouper, black sea bass, gag grouper, greater amberjack, and scamp. Three adult goliath grouper, which are federally protected species, were seen and photographed. In addition, a large unidentified pelagic shark was seen and approached the divers before swimming off unconcerned. Two deepwater species rarely seen and photographed were red barbiere and rough-tongue sea bass, these species are rarely seen above depths of 200 ft in Florida waters. Table 14 and Table 15 list the species/taxa, their relative abundance and size class (adult, intermediate, and juvenile) observed during the monitoring dive.

Table 14. Tree Barge Artificial Reef Fish Species Census.

Family/ Common Name	Species	2011		
		Abundance	Size	Comments
Carangidae				
Greater Amberjack	<i>Seriola dumerili</i>	M	A	
Istiophoridae				
Atlantic sailfish	<i>Istiophorus albicans</i>	S	A	

Family/ Common Name	Species	2011		
		Abundance	Size	Comments
Haemulidae				
Tomtate	<i>Haemulon aurolineatum</i>	A	A	
Pomacentridae				
Yellowtail reeffish	<i>Chromis enchrysurus</i>	M	J & A	
Sciaenidae				
Cubbyu	<i>Pareques umbrosus</i>	M	J & A	
Serranidae				
Bank sea bass	<i>Centropristis ocyurus</i>	M	J & A	
Black sea bass	<i>Centropristis striata</i>	A	J & A	
Red Barbier	<i>Hemanthias vivanus</i>	F	J & A	
Roughtongue Sea bass	<i>Pseudogramma gregoryi</i>	M	J & A	
Black grouper	<i>Mycteroperca bonaci</i>	F	J	
Belted sandfish	<i>Serranus subligarius</i>	F	J & A	
Goliath grouper	<i>Epinephelus itajara</i>	F(3)	A(5 ft)	>250 lbs
Scamp	<i>Mycteroperca phenax</i>	F	A	
Gag grouper	<i>Mycteroperca microlepis</i>	F	A	
Whitespotted soapfish	<i>Rypticus maculatus</i>	S	A	
Carcharhinidae (Requiem)				
Shark	(Unidentified Pelagic type)	S	A(6 ft)	
	Total	16		

Abundance Key: S=single, F=few (2-10), M=many (11-100), A=abundant (>100)

Size Key: A=adult, J=juvenile, A/J=intermediate

Table 15. Tree Barge Artificial Reef Benthic Species Census.

Common Name		Scientific Name
Echinoderms	Common Arbacia Urchin	<i>Arbacia punctulata</i>
	Sea Star	Unidentified species
Cnidarians	Sea Anemones	<i>Aptasia sp.</i>
	Algae Hydroids	<i>Thyroscyphus ramosus</i>
	Hydroids – several species	Unidentified species
Crustaceans	Sessile barnacles	<i>Thoracica</i>
Mollusca	Rock snails	<i>Muricidae (Unidentified species)</i>
Ectoprocta	Encrusting Bryozoans	Unidentified Species
Scleractinia	Large ivory coral	<i>Oculina varicose</i>

	Common Name	Scientific Name
Porifera	Sponges – several species	<i>Demospongiae</i>
Annelida	Bearded Fireworm	<i>Hermodice carunculata</i>

5.5 HIGH QUEEN AND ZEPPO REEF

- Location: Sirotkin Reef
- Materials: Steel Tugboat and 120' barge
- Maximum Depth: 190 feet
- Reef High Point: 175 feet
- Year Created: 2003
- Monitoring Date: 9/29/2011
- Total Cost: There was no cost to Martin County

5.5.1 History of the High Queen and Zeppo Reef

In Dec. 2002 a 57-foot tugboat known as the “High Queen”, a converted Navy LCM-6, sank at the St. Lucie Inlet in rough seas while towing an empty 120-foot long steel barge through the inlet which also sank. Fortunately all crewmembers survived without serious injuries and were rescued after being washed up upon the rocks of the north jetty. Both vessels floundered up against the north jetty’s large boulders and sank within hours.

Seas that day were in the 3-5 foot range, and rough seas continued for several days after the accident. Water depths immediately offshore of the north jetty are 8 – 18 feet, so that both sunken vessels protruded above the water surface for several months. The hulls began to break apart and in March and April of 2003 the salvage contractor utilized commercial divers to cut the hulls apart into smaller sections and raise the pieces up onto a salvage barge for disposal. Once cleaned of all hazardous materials and inappropriate components were removed; the material was sunk along with the salvage barge in 190 feet of water.

Although the cut up remnants of both the tugboat “High Queen” and the steel barge it had been towing were secured on top of the barge “Zeppo” with chains and cables, the “High Queen” and barge remnants on top of the “Zeppo” barge did not sink as one component as planned. During the flooding of the salvage barge, the barge lifted-up and rolled to one side just prior to sinking allowing the steel components of the other two vessels to break the hold-down cables and slide off the barge. Therefore there was a scattering of the materials on the bottom just to the east and around the whole barge. Part of the High Queen’s hull hit the seafloor first and the Zeppo landed partially on top of it and created a narrow angular space under the Zeppo’s hull providing an ideal habitat for large black and gag grouper to hide. On the south side of the Zeppo most of the steel remnants lie in a 10 ft high pile of interlocking pieces of twisted steel. This seems to have created a perfect hiding place for smaller fish to hide and escape larger predators’ advances. A chart showing the location of the High Queen and Zeppo reef is shown in Figure 14.



Figure 14. Chart view of the Sirotkin Reef site showing the High Queen and Zeppo location.

5.5.2 Structural Summary

An assessment of the artificial reef shows that both raked ends of the Zeppo are partially collapsed probably caused when it hit the seafloor. The intact hull of the Zeppo is upside down and cracks in the hull can be seen at each end. A pre-deployment inspection of the Zeppo revealed existing cracks in the hull. There is no way to determine which, if any, cracks are new, but as found with most barges used for artificial reef materials eventually the barge will begin to collapse as the side plates give way to the forces of the ocean environment. The photographs in Figure 15 show the general condition of the High Queen and Zeppo reef observed during the monitoring dive.

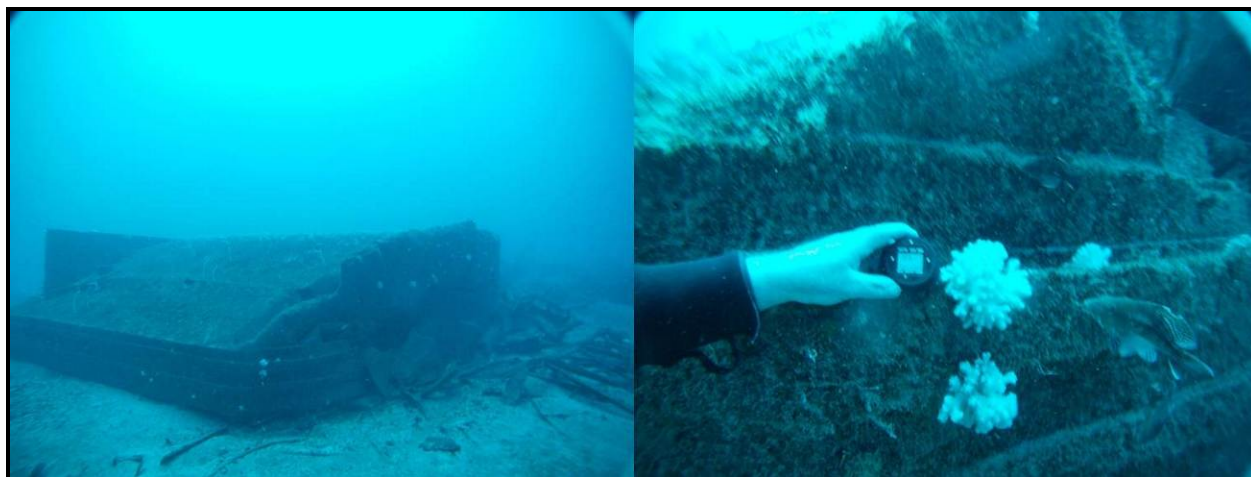


Figure 15. High Queen and Zeppo Artificial Reef 2011 photos.

5.5.3 Biological Survey Results

Five of the nine fish species documented at this site are considered important sport fish: warsaw grouper, greater amberjack, black sea bass, gag grouper, and king mackerel. The overall complexity of this artificial reef with its diverse assortment of surfaces, shapes, and voids makes it a truly unique deepwater artificial reef structure. Table 16 and Table 17 list the species/taxa, their relative abundance and size class (adult, intermediate, and juvenile) observed during the monitoring dive.

Table 16. High Queen and Zeppo Artificial Reef Fish Species Census.

Family/ Common Name	Species	2011	
		Abundance	Size
Carangidae			
Greater Amberjack	<i>Seriola dumerili</i>	M	A
Dasyatidae			
Southern Stingray	<i>Dasyatis americana</i>	S	A
Pomacentridae			
Yellowtail reeffish	<i>Chromis enchrysurus</i>	M	A
Serranidae			
Bank sea bass	<i>Centropristis ocyurus</i>	M	J & A
Black sea bass	<i>Centropristis striata</i>	M	A
Roughtongue Sea bass	<i>Pseudogramma gregoryi</i>	M	J & A
Warsaw grouper	<i>Epinephelus nigritus</i>	S	A
Gag grouper	<i>Mycteroperca microlepis</i>	F(4)	A
Scombridae			
King mackerel	<i>Scomberomorus cavalla</i>	F	A
	Total	9	

Abundance Key: S=single, F=few (2-10), M=many (11-100), A=abundant (>100)

Size Key: A=adult, J=juvenile, A/J=intermediate

Table 17. High Queen and Zeppo Artificial Reef Benthic Species Census.

Common Name		Scientific Name
Echinoderms	Rock Boring Urchin	<i>Echinometra lucunter</i>
	3 Rowed Sea Cucumber	<i>Isostichopus badiotus</i>
	Common Arbacia Urchin	<i>Arbacia punctulata</i>
	Sea Star	Unidentified species
Cnidarians	Sea Anemones	<i>Aptasia sp.</i>
	Hydroids	Unidentified species
Ascidians	Overgrowing Tunicates	<i>Didemnidae</i>
	Giant Tunicates	<i>Polycarpa spongiabilis</i>
	Button Tunicates	<i>Distaplia corolla</i>

	Common Name	Scientific Name
Crustaceans	Yellowline Arrow Crab	<i>Stenorhynchus seticornis</i>
	Giant Hermit Crab	<i>Anomurans</i>
	Rough Box Crab	<i>Calappa gallus</i>
	Caribbean Spiny Lobster	<i>Panulirus argus</i>
Mollusca	Rock Snails	<i>Muricidae</i> (Unidentified Species)
	Octopus	Unidentified Species
	Cowery Shell	
Ectoprocta	Encrusting Bryozoans	Unidentified Species
Anthozoa	Gorgonians	
Porifera	Star Encrusting Sponge	<i>Halisarca sp.</i>
	Orange Encrusting Sponge	<i>Ulosa ruetzleri</i>

5.6 TENSION BARGE ARTIFICIAL REEF

- Location: Sirotkin Reef
- Materials: 140 ft steel barge
- Maximum Depth: 188 feet
- Reef High Point: 179 feet
- Year Created: 2004
- Monitoring Date: 9/29/2011
- Total Cost: There was no cost to Martin County

5.6.1 History of the Tension Barge Artificial Reef

The tension barge was so named because of much “tension” that went into the acquisition, cleanup, storage issues, towing contractor, Coast Guard approval and final moment while she was sinking. Each artificial reef has its own unique personality from initial concept to final placement on the seafloor but once in place it can become a thriving complete ecosystem full of fish and benthic marine species. The location of the Tension Barge and adjacent artificial reefs is shown in Figure 16.



Figure 16. Chart view of the Tension Barge Reef within the Sirotkin Artificial Reef site.

5.6.2 Structural Summary

The Tension Barge lies completely upside down in a north/south orientation. Unlike the High Queen/Zeppo about 100 yards to the south, the Tension Barge's deck is flat on the seafloor. The side hull plates of the barge are buckled in many places, but otherwise it is intact. The steel is heavily rusted and small holes exist in many places on the hull and sides. In contrast to the High Queen/Zeppo, the Tension Barge has very little complexity. Fish were seen swimming into the holes that allow access to the dark confines of the barge's interior. Over time it is expected the sides will collapse allowing much more surface area to become available for marine life to occupy. The photographs from the monitoring dive in Figure 17 show the general condition of the Tension Barge as it sits on the seafloor.

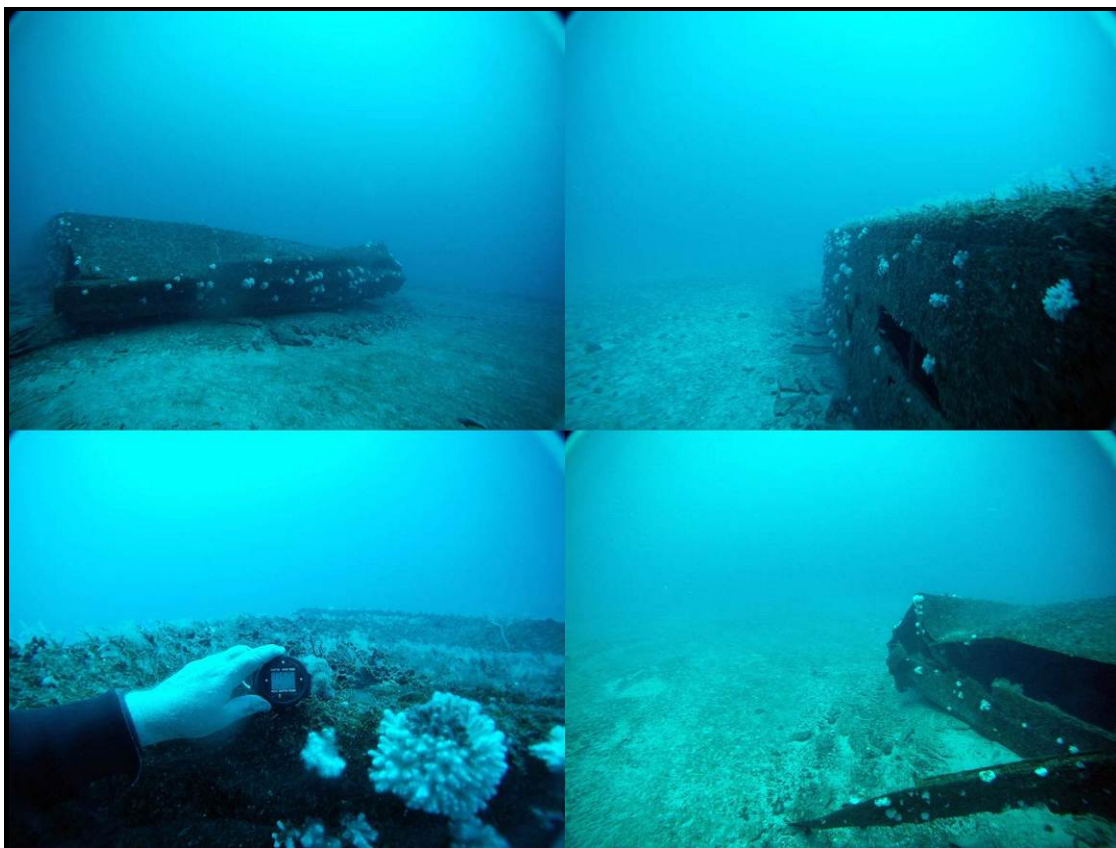


Figure 17. Tension Barge Reef 2011 photographs.

5.6.3 Biological Survey Results

The fish species census for this reef documents observing only 6 fish species, this could be attributed to the site's lack of structural complexity. Three of the six species identified are considered important sport fish in the Grouper/Snapper complex including black sea bass, snowy grouper, and greater amberjack. Although not many fish species were seen this day, the federally protected deepwater coral species *Oculina varicosa* is growing quite prolifically on the large steel hull plates of the Tension Barge. Most of these coral colonies are found on the sides, although some do exist on the flat hull surfaces as well but are smaller in size. Table 18 and Table 19 list the species/taxa, their relative abundance and size class (adult, intermediate, and juvenile) observed during the monitoring dive.

Table 18. Tension Barge Artificial Reef Fish Species Census.

Family/ Common Name	Species	2011	
		Abundance	Size
Carangidae			
Greater Amberjack	<i>Seriola dumerili</i>	M	A
Pomacentridae			
Yellowtail reeffish	<i>Chromis enchrysurus</i>	M	A
Serranidae			
Bank sea bass	<i>Centropristis ocyurus</i>	F	A
Black sea bass	<i>Centropristis striata</i>	M	J & A
Snowy grouper	<i>Epinephelus niveatus</i>	F(2)	J/A
Sparidae			
Sheepshead porgy	<i>Calamus penna</i>	F	A
	Total	6	

Abundance Key: S=single, F=few (2-10), M=many (11-100), A=abundant (>100)

Size Key: A=adult, J=juvenile, A/J=intermediate

Table 19. Tension Barge Artificial Reef Benthic Species Census.

Common Name		Scientific Name
Echinoderms	Rock Boring Urchin	<i>Echinometra lucunter</i>
	3 Rowed Sea Cucumber	<i>Isostichopus badiotus</i>
	Common Arbacia Urchin	<i>Arbacia punctulata</i>
	Sea Star	Unidentified species
Cnidarians	Sea Anemones	<i>Aptasia sp.</i>
	Hydroids	Unidentified species
Ascidians	Overgrowing Tunicates	<i>Didemnidae</i>
	Giant Tunicates	<i>Polycarpa spongiabilis</i>
	Button Tunicates	<i>Distaplia corolla</i>
Crustaceans	Yellowline Arrow Crab	<i>Stenorhynchus seticornis</i>
	Giant Hermit Crab	<i>Anomurans</i>
	Rough Box Crab	<i>Calappa gallus</i>
	Caribbean Spiny Lobster	<i>Panulirus argus</i>
Mollusca	Rock Snails	<i>Muricidae</i> (Unidentified Species)
	Octopus	Unidentified Species
	Cowery Shell	

	Common Name	Scientific Name
Scleractinia	Large ivory coral	<i>Oculina varicosa</i>
Ectoprocta	Encrusting Bryozoans	Unidentified Species
Anthozoa	Gorgonians	
Porifera	Star Encrusting Sponge	<i>Halisarca sp.</i>
	Orange Encrusting Sponge	<i>Ulosa ruetzleri</i>

5.7 CONCRETE RAILROAD TIE STACK ARTIFICIAL REEF

- Location: Sirotkin Reef
- Materials: Concrete railroad ties
- Maximum Depth: 94 feet
- Reef High Point: 73 feet
- Year Created: 2003
- Monitoring Date: 7/24/2011
- Total Cost: \$62,000 (FWC 84% & Martin County 16%)

5.7.1 History of the Concrete Railroad Tie Stack Artificial Reef

As part of a \$62,000 grant from the FWC and with additional funding from Martin County, the Railroad Tie Stack Reef was constructed between March and June, 2003 utilizing discarded concrete railroad ties donated by the Florida East Coast Railroad. This was the first artificial reef site built in Martin County using concrete railroad ties. Each railroad tie is approximately 11' x 14" x 10" and weighs about 650 pounds. A total of approximately 1500 tons of concrete railroad ties were placed forming a single pile from three separate deployments. During deployment, the railroad ties that comprise this reef were pushed off the anchored barge and settled to the seafloor in a random, interlocking fashion. The substantial mass of the concrete railroad ties and numerous contact points within the stack has resulted in a stable reef pile. The two hurricanes that struck Martin County in September 2004 and another in October 2005 seemed to have little effect on this reef. Figure 18 shows the location of the Concrete Railroad Tie Stack artificial reefs as well as the Tetrahedron reefs.

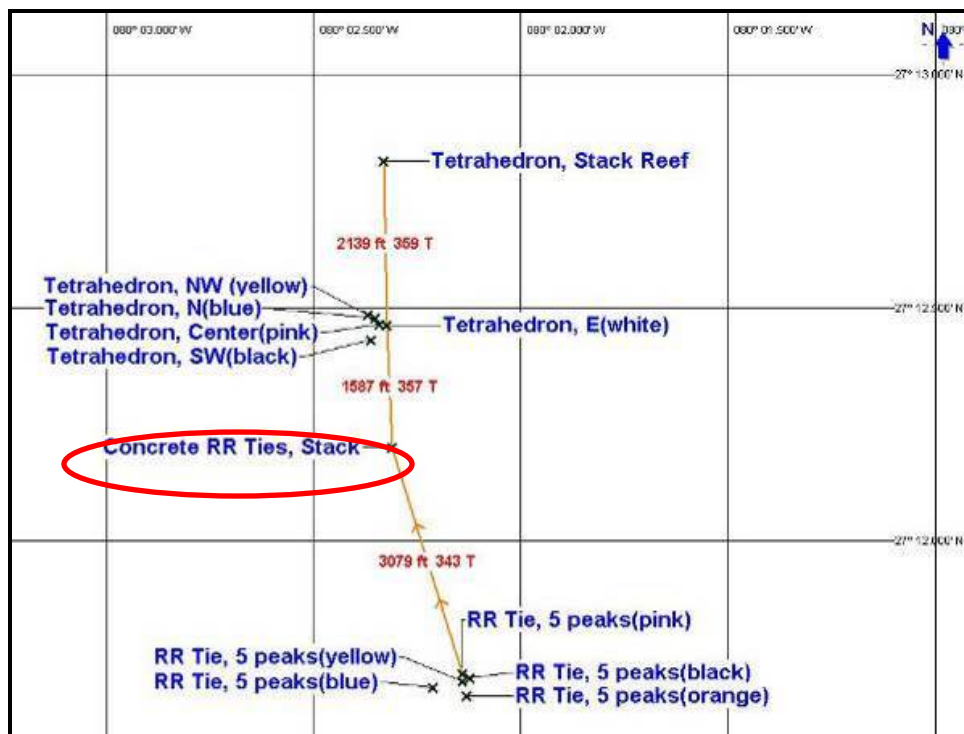


Figure 18. Chart view showing the Concrete Railroad Tie Stack reef location.

5.7.2 Structural Summary

Overall it appears the reef has changed very little since the last monitoring in 2009. The structure is a mound of concrete railroad ties with a complex arrangement of surfaces and voids. The depth to the highest part of the pile was measured at 73 ft in 2011, one foot deeper than in 2009 which could be due to the shifting of material over time. In comparison to previous dives on this reef it appeared that the slope of the mound had decreased slightly, although this could not be confirmed. The photographs in Figure 19 show the general condition of the Concrete Railroad Tie Stack Reef and some of the species observed during the monitoring dive including a school of tomtates and a lionfish.

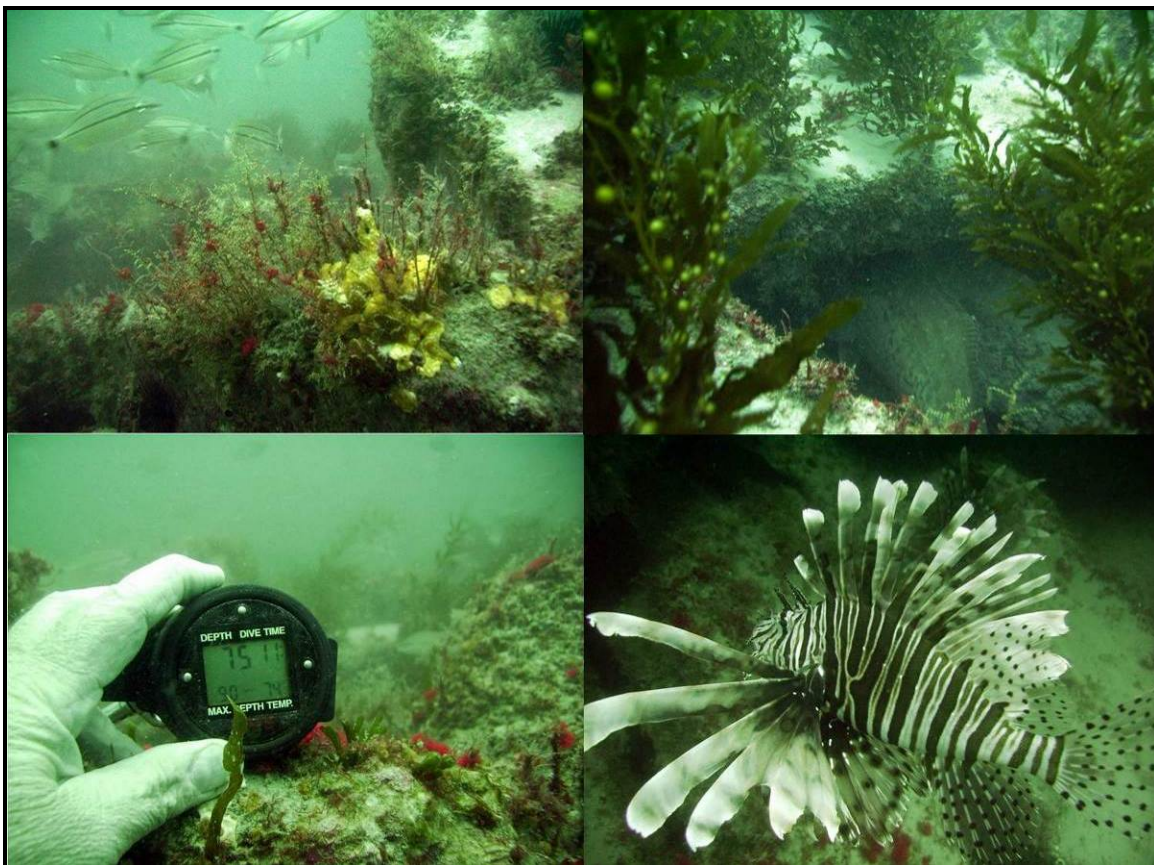


Figure 19. Concrete Railroad Tie Stack Reef 2011 photographs.

5.7.3 Biological Survey Results

In contrast to the diversity of fish observed on the deeper reefs monitored for this report this shallow artificial reef displayed 24 fish species. Four important sport fish species in the Grouper/Snapper Complex were identified including the black sea bass, greater amberjack, vermilion snapper, and yellowtail snapper. Other notable fish species observed were 1000's of baitfish (round scad) and 100's of pigfish. On a negative note, 9 lionfish were counted swimming inside and on top of the pile of railroad ties. The local population of these exotic invasive species from the Indo-Pacific region seems to be on the increase. Table 20 and Table 21 list the species/taxa, the relative abundance and size class (adult, intermediate, and juvenile) observed during the monitoring dive.

Table 20. Concrete Railroad Tie Stack Artificial Reef Fish Species Census.

Family/ Common Name	Species	2011	
		Abundance	Size
Ostraciidae			
Scrawled cowfish	<i>Acanthostracion quadricornis</i>	S	A
Diodontidae			
Bridled burrfish	<i>Chilomycterus antennatus</i>	F	J & A
Serranidae			
Bank sea bass	<i>Centropristis ocyurus</i>	F	J & A
Belted sandfish	<i>Serranus subligarius</i>	M	J & A
Black sea bass	<i>Centropristis striata</i>	F	J & A
Whitespotted soapfish	<i>Rypticus maculatus</i>	F	J & A
Carangidae			
Greater Amberjack	<i>Seriola dumerili</i>	F	A
Round scad	<i>Decapterus punctatus</i>	A(1000's)	A
Lutjanidae			
Yellowtail snapper	<i>Ocyurus chrysurus</i>	S	A
Vermilion snapper	<i>Rhomboplites aurorubens</i>	F	A
Haemulidae			
Pigfish	<i>Orthopristis chrysoptera</i>	A(100's)	A
Tomtate	<i>Haemulon aurolineatum</i>	A	J & A
Sparidae			
Sheepshead	<i>Archosargus probatocephalus</i>	F	A
Sheepshead porgy	<i>Calamus penna</i>	F	A
Sciaenidae			
Cubbyu	<i>Pareques umbrosus</i>	F	J
Chaetodontidae			
Reef butterflyfish	<i>Chaetodon sedentarius</i>	F	A
Pomacanthidae			
Blue angelfish	<i>Holocanthus bermudensis</i>	S	A
Pomacentridae			
Beaugregory	<i>Stegastes leucostictus</i>	F	A
Yellowtail reef fish	<i>Chromis enchrysurus</i>	F	A
Labridae			
Slippery dick	<i>Halichoeres bivittatus</i>	M	J & A
Spanish hogfish	<i>Bodianus rufus</i>	F	A
Scorpaenidae			
Spotted scorpionfish	<i>Scorpaena plumieri</i>	M	J & A
Red lionfish	<i>Pterois volitans</i>	F(9)	J & A
Ogcocephalidae			
Shortnose batfish	<i>Ogcocephalus nasutus</i>	F(3)	J & A
	Total	24	

Abundance Key: S=single, F=few (2-10), M=many (11-100), A=abundant (>100)

Size Key: A=adult, J=juvenile, A/J=intermediate

Table 21. Concrete Railroad Tie Stack Artificial Reef Benthic Species Census.

	Common Name	Scientific Name
Echinoderms	Rock Boring Urchin	<i>Echinometra lucunter</i>
	3 Rowed Sea Cucumber	<i>Isostichopus badionotus</i>
	Common Arbacia Urchin	<i>Arbacia punctulata</i>
	Sea Star (5 legged)	Unidentified species
	Notched Sand Dollar	<i>Encope aberrans</i>
Cnidarians	Sea Anemones	<i>Aptasia sp.</i>
	Hydroids	Unidentified species
	Colorful Sea Whip	<i>Leptogorgia virgulata</i>
Ascidians	Overgrowing Tunicates	<i>Didemnidae</i>
	White & Black Condominium Tunicates	<i>Eudistoma sp.</i>
	Button Tunicates	<i>Distaplia corolla</i>
Crustaceans	Yellowline Arrow Crab	<i>Stenorhynchus seticornis</i>
	Red Netted Barnacles	<i>Megabalanus sp.</i>
	Rough Box Crab	<i>Calappa gallus</i>
	Caribbean Spiny Lobster	<i>Panulirus argus</i>
	Sessile Barnacles	<i>Thoracia</i>
Mollusca	Rock Snails	<i>Muricidae</i> (Unidentified Species)
	Atlantic Deer Cowrie	<i>Cypraea zebra</i>
Ectoprocta	Encrusting Bryozoans	Unidentified Species
Annelida	Bearded Fireworm	<i>Hermodice carunculata</i>
Porifera	Star Encrusting Sponge	<i>Halisarca sp.</i>

5.8 THE TEXAS REEF

- Location: Donaldson Reef
- Materials: Limestone rubble, steel, and concrete from bridge demolition
- Maximum Depth: 38 feet sloping down to 52 feet
- Reef High Point: 26 feet
- Year Created: 2002
- Monitoring Date: 8/23/2011
- Total Cost: This was no cost to the County

5.8.1 History of the Texas Reef

This artificial reef was constructed in 2002 using rock excavated from the St. Lucie Inlet during an Army Corps of Engineers project to increase the capacity of Inlet's impoundment basin. The approximately 300,000 cyds of rock that created this reef was excavated by Great Lakes Dock and Dredge using the dredge, Texas. The site is at the southwest corner of the Donaldson Reef Site within the Three Nautical Mile State Waters Boundary (3-nm State Line), in a water depth of approximately 17 m (55 ft).

Additional materials placed in May 2005 at the Texas Reef Site included 15 "Florida Special" Reefmaker artificial reef units and bridge rubble including structural concrete, steel spans and associated mechanisms from the original Jensen Beach Causeway drawbridge. "Florida Special" units were arranged around the southern boundary of Texas Reef; additional "Florida Special" Units were placed within the Donaldson Reef Site seaward of the State Line.

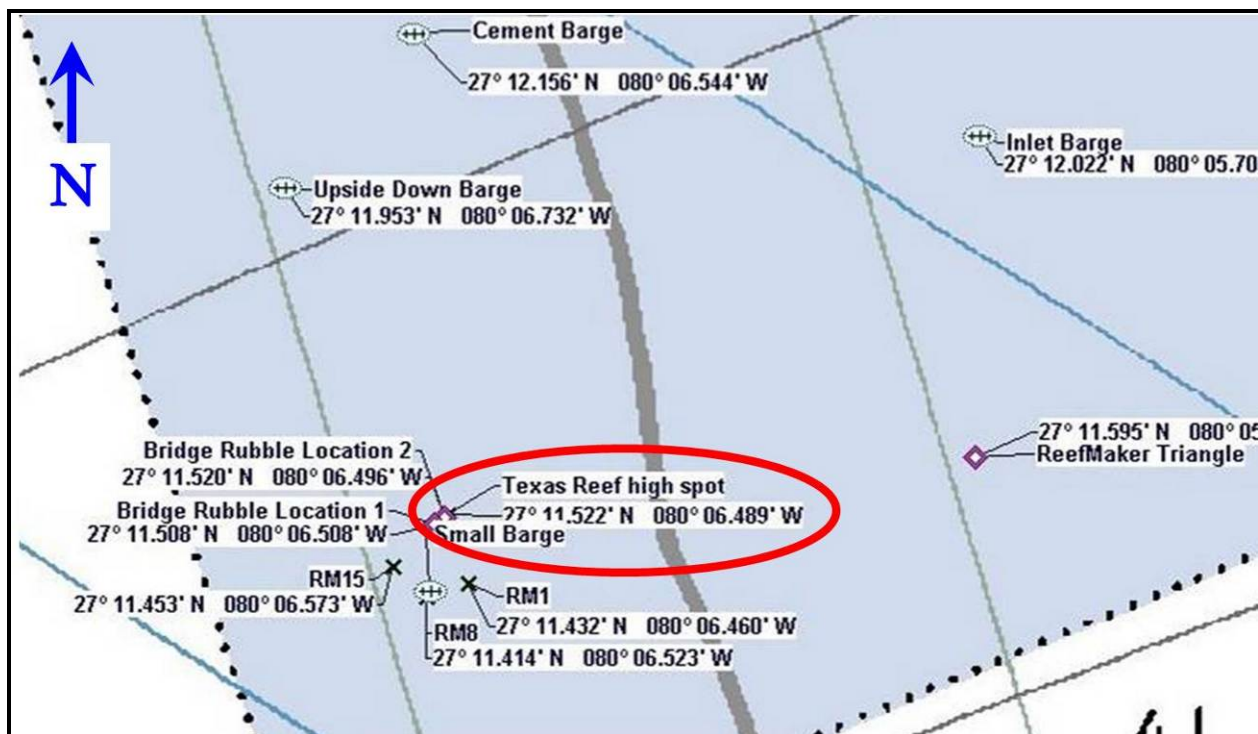


Figure 20. Chart view of the Donaldson Reef site showing the Texas Reef location.

5.8.2 Structural Summary

The limestone portion of the reef measures approx. 1000 ft long from south to north and 300 ft wide from east to west. Continental Shelf & Associates, Inc. (CSA) spent 6 years completing detailed monitoring of this site and did a comprehensive study of the biology of the site for Martin County from the years 2003 – 2009; CSA's reports can be found on both their website and Martin County's website for reference. Maxwell Marine Consulting Engineers was contracted to monitor the newest section of the site in 2011 which is comprised of steel and concrete materials.

The steel and concrete portion of the Texas Reef sits just east of the uppermost summit of the Texas Reef where the reef starts to slope downward. So far all components appear to be holding up well with the exception of anticipated corrosion of the steel components. Because of the shallow characteristic of this site, much seasonal shifting of sediments occurs resulting in some changes in appearance over time. Although this is a dynamic site it appears to be doing very well as an artificial reef as the biological section below describes. The photographs in Figure 21 show the general condition of this section of the Texas Reef and some of the species observed during the monitoring dive.



Figure 21. Texas Reef 2011 photographs.

Identification of species in the photographs shown above in clockwise order from the upper-left photograph are (1) spotted moray eel, (2) bar jacks, (3) loggerhead turtle, and (4) spadefish.

5.8.3 Biological Survey Results

At 38 species, this reef has come close to equaling the current Martin County record of 40 species on a single artificial reef. At a depth of 38 ft this site is an amazing display of fish and benthic species. The most notable sport fish species identified were: common snook, gray snapper, and greater amberjack. The federally protected species seen were goliath grouper. Other notable species include 1000's of baitfish with schools so thick they would temporarily block out the sunlight, spotted and purple mouth moray eels at every crevice, a nurse shark, and unfortunately at least 10 invasive lionfish. This site is a constant flurry of activity of marine life hiding, fleeing, chasing, and eating. This is a five star artificial reef. Table 22 and Table 23 list the species/taxa, the relative abundance and size class (adult, intermediate, and juvenile) observed during the monitoring dive.

Table 22. Texas Reef Artificial Reef Fish Species Census.

Family/Common Name	Species	2011	
		Abundance	Size
Acanthuridae			
Doctorfish	<i>Acanthurus chirurgus</i>	M	A
Ocean Surgeonfish	<i>Acanthurus bahianus</i>	F	A
Apogonidae			
Twospot cardinalfish	<i>Apogon pseudomaculatus</i>	M	A
Atherinidae			
Silversides	<i>Atherinidae</i>	A	A(1,000's)
Carangidae			
Greater amberjack	<i>Seriola dumerili</i>	M	A
Round scad	<i>Decapterus punctatus</i>	A	A(1000's)
Blue runner	<i>Caranx crysos</i>	A	A
Bar jack	<i>Carangoides ruber</i>	A	A
Centropomidae			
Common snook	<i>Centropomus undecimalis</i>	M	A
Chaetodontidae			
Reef butterflyfish	<i>Chaetodon sedentarius</i>	F	A
Cheloniidae			
Loggerhead sea turtle	<i>Caretta caretta</i>	S	J
Ephippidae			
Atlantic spadefish	<i>Chaetodipterus faber</i>	A	A
Ginglymostomatidae			
Nurse shark	<i>Ginglymostoma cirratum</i>	S	A
Gobiidae			
Neon goby	<i>Gobiosoma oceanops</i>	F	A
Haemulidae			
Tomtate	<i>Haemulon aurolineatum</i>	A	J & A
Black margate	<i>Anisotremus surinamensis</i>	F	A
Porkfish	<i>Anisotremus virginicus</i>	M	J & A
Labridae			
Bluehead wrasse	<i>Thalassoma bifasciatum</i>	F	A
Spanish hogfish	<i>Bodianus rufus</i>	F	A

Family/Common Name	Species	2011	
		Abundance	Size
Clown wrasse	<i>Halichoeres maculipinna</i>	F	J
Labrisomidae			
Hairy blenny	<i>Labrisomus nuchipinnis</i>	A	A
Lutjanidae			
Gray snapper	<i>Lutjanus griseus</i>	M	J & A
Muraenidae			
Spotted moray eel	<i>Gymnothorax moringa</i>	M	A
Purplemouth moray eel	<i>Gymnothorax vicinus</i>	M	A
Opistognathidae			
Yellowheaded jawfish	<i>Opistognathus gilbert</i>	F	A
Pomacanthidae			
Queen angelfish	<i>Holacanthus ciliaris</i>	F	A
French angelfish	<i>Pomacanthus paru</i>	F	A
Pomacentridae			
Yellowtail reeffish	<i>Chromis enchrysurus</i>	F	A
Beaugregory	<i>Pomacentrus leucostictus</i>	F	J & A
Sergeant Major	<i>Abudefduf saxatilis</i>	M	A
Sciaenidae			
Cubbyu	<i>Equetus umbrosus</i>	A	A
High hat	<i>Equetus acuminatus</i>	M	J & A
Scorpaenidae			
Red Lionfish	<i>Pterois volitans</i>	F	A
Serranidae			
Goliath grouper	<i>Epinephelus itajara</i>	S	A
Whitespotted soapfish	<i>Rypticus maculatus</i>	F	A
Sparidae			
Pigfish	<i>Orthopristis chrysoptera</i>	M	A
Sphyrnidae			
Great baracuda	<i>Sphyrna barracuda</i>	F	A
Tetraodontidae			
Sharpnose puffer	<i>Canthigaster rostrata</i>	F	J & A
	Total	38	

Abundance Key: S=single, F=few (2-10), M=many (11-100), A=abundant (>100)

Size Key: A=adult, J=juvenile, A/J=intermediate

Table 23. Texas Reef Artificial Reef Benthic Species Census.

Common Name		Scientific Name
Echinoderms	Rock Boring Urchin	<i>Echinometra lucunter</i>
	Common Arbacia Urchin	<i>Arbacia punctulata</i>
	Sea Star	Unidentified species
Cnidarians	Tube Dwelling Anemones	<i>Ceriantharia</i>

	Common Name	Scientific Name
	Hydroids – several species	<i>Thecatae</i>
Ascidians	Overgrowing Tunicates	<i>Didemnidae</i>
	Giant Tunicates	<i>Polycarpa spongiabilis</i>
	Button Tunicates	<i>Distaplia corolla</i>
	Other Unidentified Tunicates	<i>Ascidacea</i>
Crustaceans	Giant Hermit Crab	<i>Petrochirus Diogenes</i>
	Caribbean Spiny Lobster	<i>Panulirus argus</i>
Mollusca	Atlantic Triton's Trumpet	<i>Charonia zariiegata</i>
	Atlantic Deer Cowrie	<i>Cypraea zebra</i>
	Octopus - Caribbean Reef	<i>Octopus briareus</i>
Ectoprocta	Encrusting Bryozoans	Unidentified Species
Anthozoa	Gorgonians – several species	<i>Holaxonia</i>
Porifera	Star Encrusting Sponge	<i>Halisarca sp.</i>
	White Lumpy Encrusting Sponge	<i>Ptilocaulis sp</i>
	Unidentified Sponge species	<i>Demospongiae</i>

5.9 TEXAS REEF - REEFMAKERS

- Location: Donaldson
- Materials: Reefmaker “Florida Specials” Reef Units
- Maximum Depth: 54 feet
- Reef High Point: Varies greatly with unit, 15 monitored
- Year Created: 2005
- Monitoring Date: 7/27/2011
- Total Cost: \$11,925 (FWC 89% & Martin County 11%)

5.9.1 History of the Texas Reef – Reefmakers Chevron

As previously mentioned, in 2005 Martin County received a \$47,700 grant from the FWC to enhance existing artificial reef sites by deploying sixty Reefmaker “Florida Special” units adjacent to existing reef materials in the Donaldson and Sirotkin reef sites. The funding was divided among several different sites between the two permitted areas. The Texas Reef – Reefmakers site utilized \$11,925 of the FWC grant to deploy 15 Reefmaker “Florida Special” units along the south side of the Texas Reef site in a chevron shape on May 20, 2005. Figure 22 shows a representative photograph of these large three-sided pyramid Reefmaker units fabricated using concrete and steel that were deployed at the Texas Reef. The location of the Texas Reef Reefmaker units is shown in Figure 23.



Figure 22. Reefmaker “Florida Special” artificial reef units.

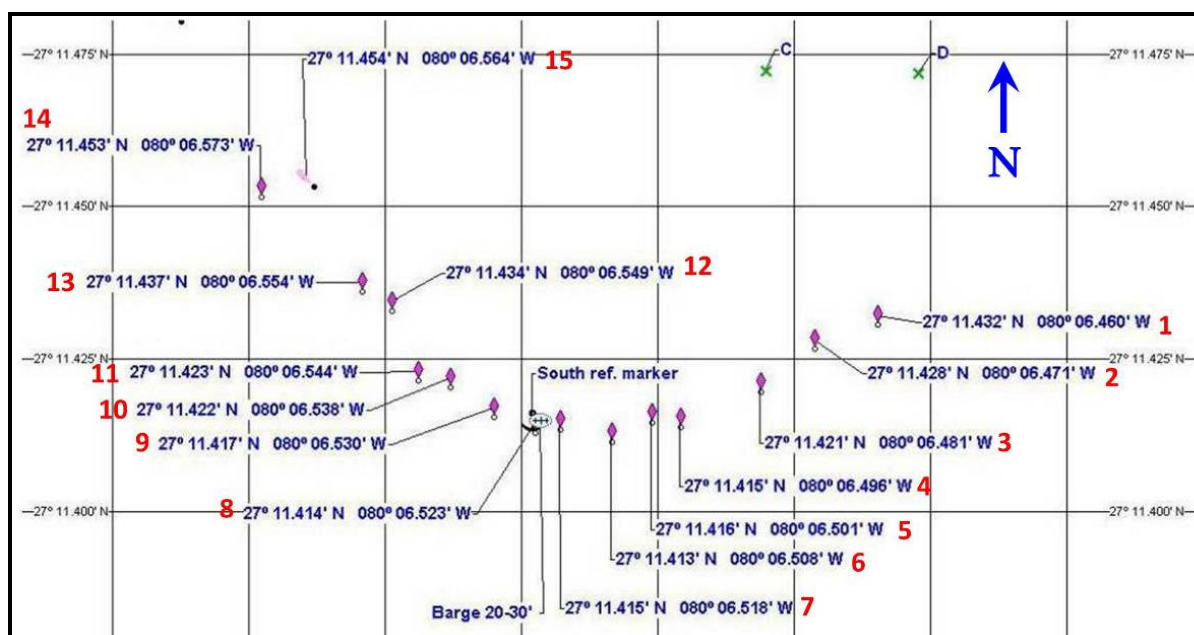


Figure 23. Chart view of Donaldson Reef showing the Texas Reef – Reefmaker locations.

5.9.2 Structural Summary

The Reefmaker Units were deployed along the southern face of the Texas Reef where a single unit was deployed south of the Texas Reef (No. 8, South ref. marker) and the remaining units in a chevron pattern, with seven units placed on the eastern side heading to the NE at approximate 50 ft intervals, and seven units heading to the NW on the western side. All of the Reefmaker units are intact and standing upright. Some settlement of the concrete bases into the bottom was observed and varied from minimal to almost complete burial of the concrete feet or footer beam. Table 24 gives the latitude and longitude for each of the fifteen Reefmaker units.

Table 24. Texas Reef – Reefmaker module locations and depths.

Unit Number	GPS Latitude	GPS Longitude
1	27° 11.432 N	80° 06.460 W
2	27° 11.428 N	80° 06.471 W
3	27° 11.421 N	80° 06.481 W
4	27° 11.415 N	80° 06.496 W
5	27° 11.416 N	80° 06.501 W
6	27° 11.413 N	80° 06.508 W
7	27° 11.415 N	80° 06.518 W
8	27° 11.414 N	80° 06.523 W
9	27° 11.417 N	80° 06.530 W
10	27° 11.422 N	80° 06.538 W
11	27° 11.423 N	80° 06.544 W
12	27° 11.434 N	80° 06.549 W
13	27° 11.437 N	80° 06.554 W
14	28° 11.454 N	81° 06.564 W
15	27° 11.453 N	80° 06.573 W

It was also observed that some of the steel sidepieces are corroding and eroding away in the lower portion (within several feet of the seafloor interface) of the Reefmaker units. This is believed to be caused by high currents in this area, the high oxygen content in the water because of shallow depth, and the constant movement of coarse sand on the bottom. These factors are thought to be contributing to a higher rate of corrosion and erosion of the steel components of these Reefmaker units. No movement other than slight settling has occurred since deployments in 2005. The photographs in Figure 24 show the general condition of the Texas Reef – Reefmaker units and some of the species observed during the monitoring dive.

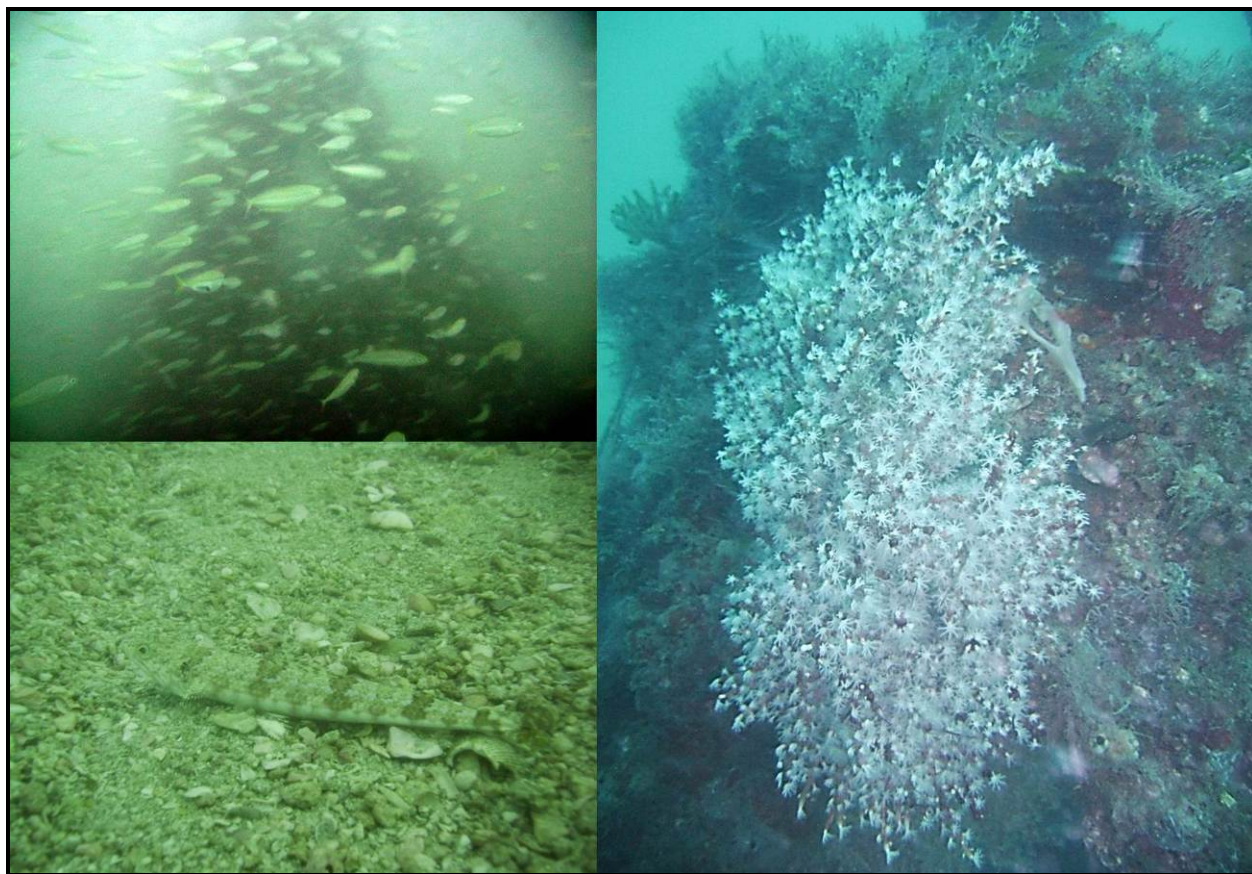


Figure 24. Texas Reef - Reefmaker 2011 photographs.

5.9.3 Biological Survey Results

During the 2011 monitoring 26 fish species were identified, 4 of which are on the grouper/snapper complex for sport fish of Florida. These were black sea bass, gulf flounder, greater amberjack, and lane snapper. Species of note are 1000's of unidentified fry of approx ¼ - ½" long each, 1000's of baitfish (round scad), and unfortunately 15 juvenile and adult invasive Pacific Lionfish. The reef modules supported numerous sessile invertebrates on both the concrete and steel surfaces of the modules. Table 25 and Table 26 list the species/taxa, the relative abundance and size class (adult, intermediate, and juvenile) observed during the monitoring dive.

Table 25. Texas Reef - Reefmakers Artificial Reef Fish Species Census.

Family/Common Name	Species	2011	
		Abundance	Size
Acanthuridae			
Doctorfish	<i>Acanthurus chirurgus</i>	F	A
Apogonidae			
Twospot cardinalfish	<i>Apogon pseudomaculatus</i>	M	A
Carangidae			
Greater amberjack	<i>Seriola dumerili</i>	M	J/A
Round scad	<i>Decapterus punctatus</i>	A(1,000's)	A
Chaetodontidae			
Reef butterflyfish	<i>Chaetodon sedentarius</i>	F	A
Spotfin butterflyfish	<i>Chaetodon ocellatus</i>	F	A
Dasyatidae			
Southern stingray	<i>Dasyatis americana</i>	S	A
Grammistidae			
Whitespotted soapfish	<i>Rypticus maculatus</i>	F	A
Haemulidae			
Tomtate	<i>Haemulon aurolineatum</i>	A	J & A
Porkfish	<i>Anisotremus virginicus</i>	M	J & A
Lutjanidae			
Lane snapper	<i>Lutjanus synagris</i>	M	J & A
Ostraciidae			
Scrawled cowfish	<i>Acanthostracion quadricornis</i>	F	A
Opistognathidae			
Yellowheaded jawfish	<i>Opistognathus gilberti</i>	F	A
Paralichthyidae			
Gulf flounder	<i>Paralichthys albigutta</i>	F	A
Pomacanthidae			
Gray angelfish	<i>Pomacanthus arcuatus</i>	S	A
Pomacentridae			
Yellowtail reeffish	<i>Chromis enchrysurus</i>	M	J
Beaugregory	<i>Pomacentrus leucostictus</i>	M	J & A
Sergeant Major	<i>Abudefduf saxatilis</i>	M	J & A
Sciaenidae			
Cubbyu	<i>Equetus umbrosus</i>	M	J & A
Scorpaenidae			
Red Lionfish	<i>Pterois volitans</i>	M(15)	J & A
Serranidae			
Black sea bass	<i>Centropristis striata</i>	A	J & A
Belted sandfish	<i>Serranus subligarius</i>	M	A
Sparidae			
Sheepshead	<i>Archosargus probatocephalus</i>	F	A
Whitespotted soapfish	<i>Rypticus maculatus</i>	F	A
Sheepshead porgy	<i>Calamus penna</i>	F	A
Synodontidae			
Sand diver	<i>Synodus intermedius</i>	F	A

Family/Common Name	Species	2011	
		Abundance	Size
Tetraodontidae			
Sharpnose puffer	<i>Canthigaster rostrata</i>	F	A
	Total	26	

Abundance Key: S=single, F=few (2-10), M=many (11-100), A=abundant (>100)

Size Key: A=adult, J=juvenile, A/J=intermediate

Table 26. Texas Reef – Reefmakers Artificial Reef Benthic Species Census.

Common Name		Scientific Name
Echinoderms	Rock Boring Urchin	<i>Echinometra lucunter</i>
	Common Arbacia Urchin	<i>Arbacia punctulata</i>
	Sea Star	Unidentified species
	3 Rowed Sea Cucumber	<i>Isostichopus badionotus</i>
Cnidarians	Sea Anemones	<i>Aptasia sp.</i>
	Hydroids – several species	Unidentified Species
Ascidians	Overgrowing Tunicates	<i>Didemnidae</i>
	Giant Tunicates	<i>Polycarpa spongiabilis</i>
	Button Tunicates	<i>Distaplia corolla</i>
Crustaceans	Giant Hermit Crab	<i>Petrochirus diogenes</i>
	Caribbean Spiny Lobster	<i>Panulirus argus</i>
	Yellowline Arrow Crab	<i>Stenorhynchus seticomis</i>
	Florida Stone Crab	<i>Menippe mercenaria</i>
	2 Unidentified Small Crabs	<i>Brachyura</i>
Mollusca	Rock Snails	<i>Muricidae</i> (Unidentified Species)
Ectoprocta	Encrusting Bryozoans	Unidentified Species
Porifera	Star Encrusting Sponge	<i>Halisarca sp.</i>
	Orange Lumpy Encrusting Sponge	<i>Ulosa ruetzleri</i>