

Annual Monitoring Report

Martin County Artificial Reefs

Deployed 2003 to 2008

by Richard H. Meeker and Kerry L. Dillon



Prepared for
Martin County Coastal Engineering Division
2401 SE Monterey Road
Stuart, Florida 34996

May 25, 2010



Table of Contents

1.0	Introduction.....	1
1.1	Project Objectives	6
1.2	Methodology	6
1.2.1	Physical Measurements.....	6
1.2.2	Biological Surveys	6
1.2.3	Photo/Video Documentation.....	7
2.0	Artificial Reef Locations.....	7
2.1	Donaldson Artificial Reef Site.....	9
2.2	Ernst Artificial Reef Site.....	10
2.3	Sirotkin Artificial Reef Site	10
2.4	South County Artificial Reef Site	12
2.5	Nearshore Mitigation Reefs	12
3.0	Results	13
3.1	Clifton Perry Memorial Artificial Reef.....	13
3.1.1	History of the Clifton Perry Memorial Reef	13
3.1.2	Structural Summary	14
3.1.3	Biological Survey Results.....	15
3.2	Texas Reefmaker Units.....	17
3.2.1	History of the Texas Reefmaker Units.....	17
3.2.2	Structural Summary	18
3.2.3	Biological Survey Results.....	20
3.3	PCL Shallow Reef.....	22
3.3.1	History of the PCL Shallow Reef	22
3.3.2	Structural Summary	22
3.3.3	Biological Survey Results.....	23
3.4	PCL Deep Reef	25
3.4.1	History of the PCL Deep Artificial Reef	25
3.4.2	Structural Summary	26
3.4.3	Biological Survey Results.....	27
3.5	Sirotkin Diamond South Artificial Reef	28
3.5.1	History of the Sirotkin Diamond Artificial Reef	28
3.5.2	Structural Summary	29
3.5.3	Biological Survey Results.....	30
3.6	Railroad Tie Stack Artificial Reef	31
3.6.1	History of the Railroad Tie Stack Artificial Reef	31
3.6.2	Structural Summary	32
3.6.3	Biological Survey Results.....	33
3.7	Railroad Tie Patches (Five Peaks) Artificial Reef	35
3.7.1	History of the Railroad Tie Patches Artificial Reef.....	35
3.7.2	Structural Summary	35
3.7.3	Biological Survey Results.....	37
3.8	KD Select Artificial Reef.....	39

3.8.1	History of the KD Select Artificial Reef.....	40
3.8.2	Structural Summary	40
3.8.3	Biological Survey Results.....	41
3.9	Frances Langford Memorial Reef.....	42
3.9.1	History of the Frances Langford Memorial Artificial Reef	42
3.9.2	Structural Summary	43
3.9.3	Biological Survey Results.....	44
3.10	American Custom Yachts Tower Artificial Reef.....	46
3.10.1	History of the American Custom Yachts Tower Reef	46
3.10.2	Structural Summary	47
3.10.3	Biological Survey Results.....	48
3.11	Mango Artificial Reef.....	48
3.11.1	History of the Mango Artificial Reef.....	48
3.11.2	Structural Summary	49
3.11.3	Biological Survey Results.....	50
3.12	Grand Teton Artificial Reef.....	51
3.12.1	History of the Grand Teton Artificial Reef.....	52
3.12.2	Structural Summary	52
3.12.3	Biological Survey Results.....	52
3.13	West 400 Artificial Reef.....	54
3.13.1	History of the West 400 Artificial Reef.....	54
3.13.2	Structural Summary	55
3.13.3	Biological Survey Results.....	55
3.14	Fogel Capital Management Artificial Reef.....	56
3.14.1	History of the Fogel Capital Management Artificial Reef.....	56
3.14.2	Structural Summary	57
3.14.3	Biological Survey Results.....	57
3.15	Jack MacDonald Artificial Reef	58
3.15.1	History of the Jack MacDonald Artificial Reef	59
3.15.2	Structural Summary	59
3.15.3	Biological Survey Results.....	59
3.16	Shirley Artificial Reef.....	60
3.16.1	History of Shirley Artificial Reef	61
3.16.2	Structural Summary	61
3.16.3	Biological Survey Results.....	62
3.17	The Heap Artificial Reef.....	63
3.17.1	History of the Heap Artificial Reef.....	64
3.17.2	Structural Summary	64
3.17.3	Biological Survey Results.....	65
3.18	Lentine Artificial Reef	66
3.18.1	History of the Lentine Artificial Reef.....	66
3.18.2	Structural Summary	67
3.18.3	Biological Survey Results.....	67
3.19	Ann Marie Artificial Reef.....	68
3.19.1	History of the Ann Marie Artificial Reef.....	69
3.19.2	Structural Summary	69
3.19.3	Biological Survey Results.....	70
3.20	PCL Indian River Lagoon Artificial Reef.....	71

3.20.1 History of the PCL Indian River Lagoon Artificial Reef	71
3.20.2 Structural Summary	72
3.20.3 Biological Survey Results.....	72

APPENDICES

A. 2008 and 2009 Monitoring Photographs (on CD)

List of Tables

Table 1. Martin County artificial reefs deployed 2000 to 2009.....	3
Table 2. Locations of Martin County artificial reefs deployed 2000 to 2009.....	4
Table 3. Annual monitoring dates for Martin County artificial reefs.....	5
Table 4. List of artificial reefs monitored in 2008 and 2009.	8
Table 5. Clifton Perry Memorial Reef fish census.	17
Table 6. Texas Reef Reefmaker module locations and depths.	19
Table 7. Texas Reefmaker Artificial Reef fish census.	21
Table 8. PCL Shallow Artificial Reef fish census.	25
Table 9. PCL Deep Artificial Reef fish census.....	28
Table 10. Sirotkin Diamond South Artificial Reef fish census.	31
Table 11. Railroad Stack Artificial Reef fish species census.	34
Table 12. Railroad Tie Patches Artificial Reef fish census.	39
Table 13. KD Select Artificial Reef fish census.....	42
Table 14. Frances Langford Memorial Reef fish species census.....	45
Table 15. American Custom Yachts Tower Artificial Reef fish species census.	48
Table 16. Mango Artificial Reef fish species census.....	51
Table 17. Grand Teton Artificial Reef fish species census.....	54
Table 18. West 400 Artificial Reef fish species census.....	56
Table 19. Fogel Capital Management Artificial Reef fish species census.	58
Table 20. Jack MacDonald Artificial Reef fish species census.	60
Table 21. Shirley Artificial Reef fish species census.	63
Table 22. The Heap Artificial Reef fish species census.	66
Table 23. Lentine Artificial Reef fish species census.....	68
Table 24. Ann Marie Artificial Reef fish species census.....	70
Table 25. PCL Indian River Lagoon Artificial Reef fish species census.	73

List of Figures

Figure 1. Location of Martin County's offshore reef sites.	1
Figure 2. Distances from St. Lucie Inlet sea buoy to the offshore artificial reef sites.....	8
Figure 3. Chart view of the Donaldson Reef site.....	9
Figure 4. Chart view of the Ernst Reef site.....	10
Figure 5. Chart view of the Sirotkin Reef site.	11
Figure 6. Chart view of South County Reef site.....	12
Figure 7. Chart view of NE corner of Donaldson Reef with locations of Perry and PCL Shallow reefs.....	13
Figure 8. Photographs of the Clifton Perry Memorial Reef.....	15
Figure 9. Chart view of Donaldson Reef area with Texas Reef location.	18
Figure 10. Reefmaker "Florida Special" artificial reef modules.	19

Figure 11. Texas Reefmaker module photographs, 2008.	20
Figure 12. Chart view of Donaldson Reef area with PCL Shallow Reef location.....	22
Figure 13. PCL Shallow Artificial Reef photographs from 2008 and 2009.	23
Figure 14. Chart view of Sirotkin Reef area with locations of PCL Deep and nearby reefs.	26
Figure 15. PCL Deep Artificial Reef photographs from 2008 (top) and 2009.	27
Figure 16. Sirotkin Diamond patch reefs.	29
Figure 17. Sirotkin Diamond South Reefmaker module 2008 photos.	30
Figure 18. Railroad tie and Tetrahedron reef locations.	32
Figure 19. Railroad Tie Stack Reef 2008 photographs.....	33
Figure 20. Configuration of the Railroad Tie Patches (5 Peaks) Reef.....	36
Figure 21. Railroad Tie Patches Artificial Reef 2009 photographs.....	37
Figure 22. KD Select photographs from 2008 (bottom) and 2009.	41
Figure 23. Chart view of Sirotkin Reef showing location of Langford Memorial Reef.....	43
Figure 24. Frances Langford Memorial Reef photographs from 2008 (not dated) and 2009.....	44
Figure 25. Chart view of Sirotkin Reef showing locations for American Custom Yachts Tower and other artificial reefs.	46
Figure 26. American Custom Yachts Tower 2009 photographs.....	47
Figure 27. Chart view of the Donaldson Reef with West 400, Grand Teton and Mango Artificial Reefs.	49
Figure 28. Mango Artificial Reef photographs from 2008 and 2009.	50
Figure 29. Grand Teton Artificial Reef photographs from 2008 and 2009.	52
Figure 30. West 400 Artificial Reef photographs from 2008.	54
Figure 31. Chart view of South County Artificial Reef area.	57
Figure 32. Jack MacDonald Reef photographs from 2009.	59
Figure 33. Shirley Artificial Reef 2009 photographs.....	62
Figure 34. The Heap Artificial Reef 2008 and 2009 photographs.....	64
Figure 35. Lentine Artificial Reef 2009 photographs.....	67
Figure 36. Ann Marie Artificial Reef 2008 and 2009 photographs.	69

The authors wish to acknowledge Dr. Lee Harris, PhD, P.E., for his invaluable assistance collecting 2008 monitoring data used to produce this report.

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 been used historically 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.

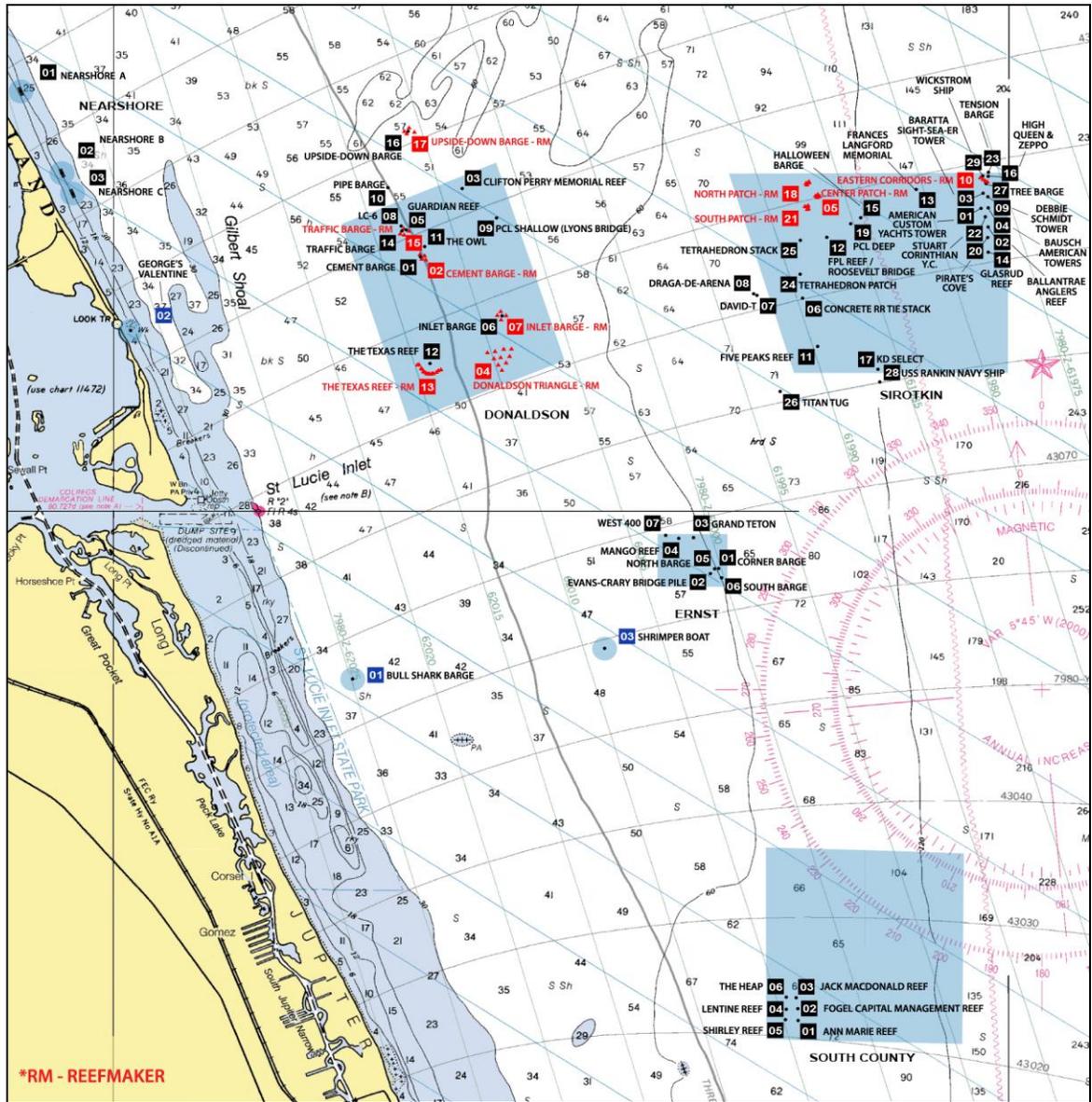


Figure 1. Location of Martin County's offshore reef sites.

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. Figure 1 shows the location of Martin County's five permitted offshore artificial reef sites and Figure 2 shows the distance to the offshore reef sites from St. Lucie Inlet. Annual artificial reef monitoring is required for two years following material placement. This report includes data collected in 2008 and 2009 for reefs created since 2003.

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
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
Sirotkin Diamond Patch N	concrete & steel units	Sirotkin	21 May 2005
Sirotkin Diamond Patch C	concrete & steel units	Sirotkin	21 May 2005
Sirotkin Diamond 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

Reef Name	Materials	Site	Deployment Dates
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

Table 1. Martin County artificial reefs deployed 2000 to 2008.

The artificial reefs in Table 1 require(d) annual monitoring for the first two years following their deployment. The 2008/2009 annual monitoring was performed for the reefs created from 2003 to 2008. Table 2 presents the locations and water depths for the artificial reef sites. Table 3 presents the dates of the annual monitoring performed from 2004 to 2009.

Reef Name	Latitude N	Longitude W	Water Depth (feet)	Reef Crest Depth (feet)
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

Reef Name	Latitude N	Longitude W	Water Depth (feet)	Reef Crest Depth (feet)
Sirotkin Diamond Patch N	27° 13.410'	80° 02.280'	100	90
Sirotkin Diamond Patch C	27° 13.276'	80° 02.165'	105	95
Sirotkin Diamond Patch 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
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

Table 2. Locations of Martin County artificial reefs deployed 2000 to 2008.

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. And in 2009, three more concrete patch reefs were deployed in the Sirotkin Artificial Reef area. Table 1 summarizes all artificial reef deployments performed since 2000 in Martin County's offshore reef sites.

Reef Name	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	no	no	no	no	6/17	5/10,23,30
Tetrahedron Stack	no	no	no	5/21	6/17	5/21, 6/11
Tetrahedron Patch-Yellow	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	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

Reef Name	2009	2008	2007	2006	2005	2004
Tree Barge	no	no	9/3	6/3	no [2]	no [2]
Wickstrom Ship	no	no	9/3	6/3	no [2]	8/18
Railroad Tie Stack	no	8/5	6/25	5/23	6/8	5/23 & 29
High Queen and Zeppo	no	no	9/15	no [2]	no [2]	8/27
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	no	no	9/15	no [2]	no [2]	deployed
Reefmaker Triangle	no	no	6/24	5/23	deployed	NA
Reefmaker Texas	no	7/24	6/25	4/21, 6/30	deployed	NA
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	no	no	6/21	no [3]	deployed	NA
Sirotkin Diamond Patch N	no	no	no [3]	3/6	deployed	NA
Sirotkin Diamond Patch C	no	no	7/10	no [3]	deployed	NA
Sirotkin Diamond 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	no	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	8/31	deployed	NA	NA	NA	NA
The Heap	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	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
Deborah Schmidt Tower	no [3]	deployed	NA	NA	NA	NA

Notes:

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

Table 3. Annual monitoring dates for Martin County artificial reefs.

1.1 Project Objectives

Artificial reefs are an increasingly valuable amenity for recreational fishing and diving. Florida registers more boats, has more certified scuba divers and more licensed resident and non-resident marine anglers than any other state. 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 for two consecutive years, which includes documenting associated flora and fauna, is required by the U.S. Army Corps of Engineers. 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.

1.2 Methodology

The monitoring techniques used to monitor Martin County's artificial reef sites in 2008 and 2009 were identical to the methodology used by Harris and Dillon in previous annual monitoring efforts. Divers made direct measurements of the reefs, recorded visual observations and collected still and video photography to document vital statistics for each artificial reef. Fieldwork was performed by the authors and other qualified divers to ensure that all pertinent engineering and biological data were collected.

1.2.1 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.

1.2.2 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.

1.2.3 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 2008 and 2009 are included in this report. Copies of all photographs are submitted on compact disk (CD) at the end of this report.

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.

2.0 Artificial Reef Locations

A total of 20 individual artificial reef sites were monitored in 2008 and 2009, scattered among four of the permitted offshore artificial reef sites and one estuary artificial reef site. The specific artificial reef sites listed in Table 4 were monitored, with physical surveys of the reef site and biological inventories performed for each.

Artificial Reef	Year Monitored	
	2008	2009
Clifton Perry Memorial Reef	✓	✓
Texas Reefmakers	✓	
PCL Shallow Reef	✓	✓
PCL Deep Reef	✓	✓
Sirotkin Diamond South	✓	
Railroad Tie Stack Reef	✓	
Railroad Tie Patches (Five Peaks)	✓	✓
KD Select Reef	✓	✓
Frances Langford Memorial Reef	✓	✓
American Custom Yachts Tower		✓
Mango Reef	✓	✓
Grand Teton Reef	✓	✓
West 400 Reef	✓	✓
Fogel Capital Management Reef		✓

Artificial Reef	Year Monitored	
	2008	2009
Jack MacDonald Reef		✓
Shirley Reef		✓
The Heap Reef		✓
Lentine Reef		✓
Ann Marie Reef		✓
PCL Indian River Reef		✓

Table 4. List of artificial reefs monitored in 2008 and 2009.

The following sections provide a summary of the five permitted artificial reef areas offshore of Martin County: the Ernst, Donaldson, Sirotkin, South County and nearshore artificial reef areas. The locations of the artificial reefs monitored for this report are shown on those charts, along with other known reef deployments. The permitted reef areas are located in water depths ranging from 15 to 200 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.

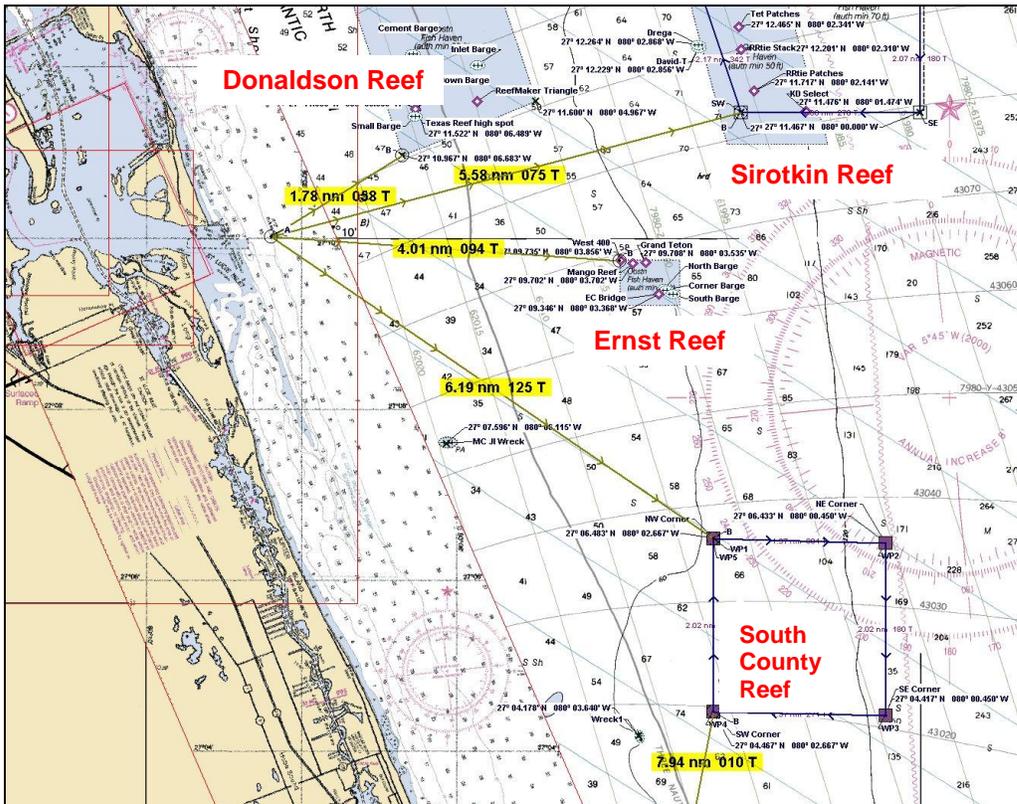


Figure 2. Distances from St. Lucie Inlet sea buoy to the offshore artificial reef sites.

2.1 Donaldson Artificial Reef Site

The nearest boundary of the Donaldson Artificial Reef area is located about 2 nautical miles NE of the St. Lucie Inlet sea buoy and is shown in Figure 3. 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.

The newest deployment in this site is the PCL Shallow Reef, constructed in 2006 of recycled bridge materials from the dismantled Lyons Bridge. Other notable reef units within the Donaldson Artificial Reef area include the Clifton Perry Memorial Reef and Texas Reef. Fifteen pyramid-shaped Reefmaker artificial reef modules were deployed along the southern edge of Texas Reef. Ten additional Reefmaker modules were deployed within the Donaldson Reef area as a patch reef in the SE portion of the permitted area, indicated as the *Reefmaker Triangle* in Figure 3. In 2005, sixteen Reefmaker modules were placed around four barges, four units at each, about 100 feet from each side of the barge. Due to its relatively shallow depths and close proximity to St. Lucie inlet, the Donaldson Artificial Reef area is very popular with fishermen and divers.

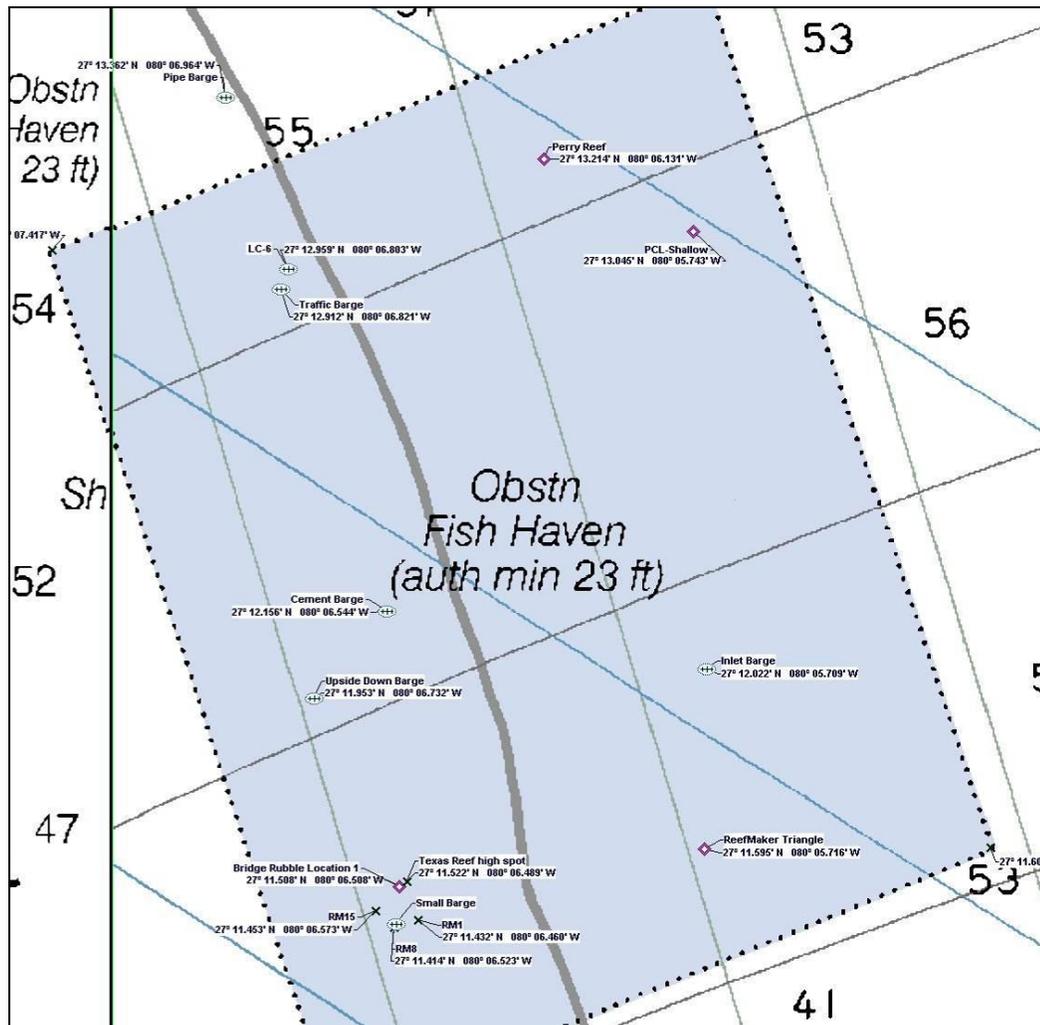


Figure 3. Chart view of the Donaldson Reef site.

2.2 Ernst Artificial Reef Site

The Ernst Artificial Reef area is located about 4 nautical miles due east of the St. Lucie Inlet sea buoy. There are seven known artificial reef sites within this area lying in 60 to 80 feet of water. The newest deployments (2007) in this area are the West 400, Mango, and Grand Teton artificial reefs, all located along the northern boundary of the permitted reef area as seen in Figure 4. Each of these newer artificial reefs was constructed of recycled concrete materials from the Martin County landfill.

Prior deployments to this artificial reef area include the Evans Crary Bridge Reef, an expansive, high relief structure constructed from recycled bridge materials. This artificial reef was deployed in 2000 and requires no further annual monitoring. Other known reefs located within this site include the remnants of three barges, which were deployed in 1972 near the southeast corner of the permitted artificial reef area. All of the artificial reefs in the Ernst Artificial Reef area are very popular with fishermen and scuba divers.

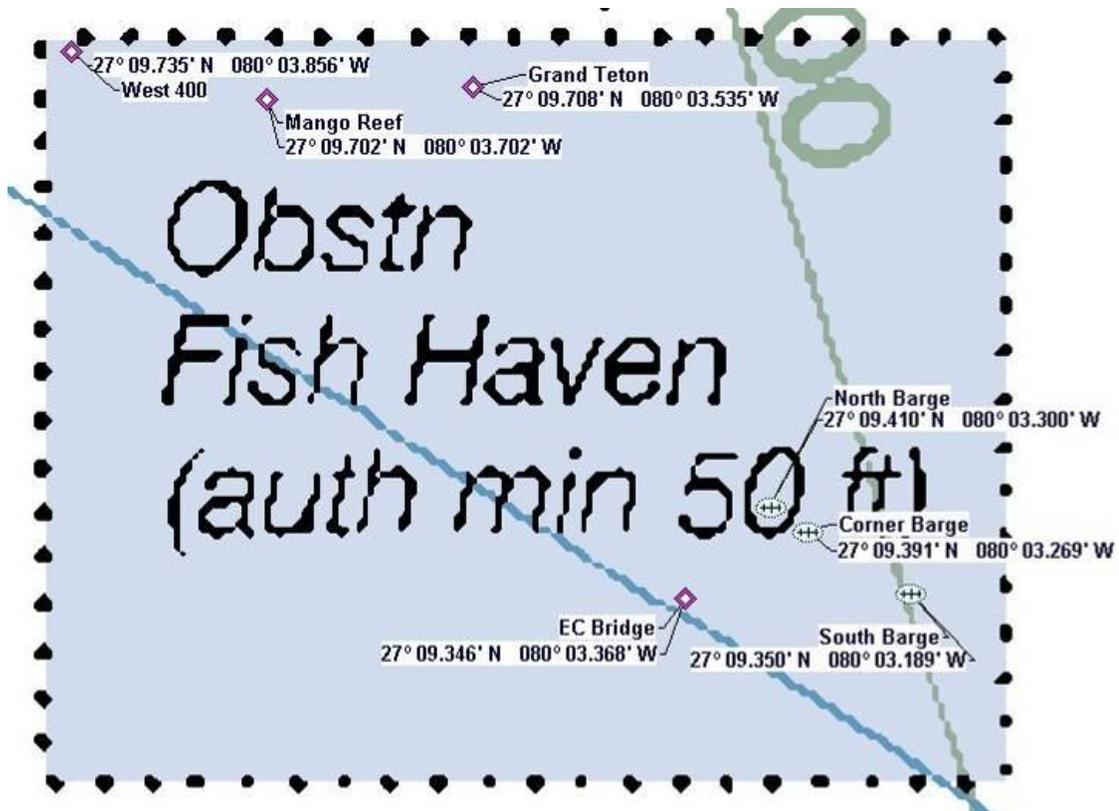


Figure 4. Chart view of the Ernst Reef site.

2.3 Sirotkin Artificial Reef Site

The Sirotkin Artificial Reef site is the largest and deepest of the permitted artificial reef areas offshore of Martin County (Figure 5). The western side 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 reef sites due to the dramatic underwater scenery and diversity of

demersal and pelagic fish species encountered there.

A variety of reefing materials has been deployed within the Sirotkin Artificial Reef area over the past several decades. The more recent deployments have consisted of various concrete rubble, dismantled bridge components, ships, barges and artificial reef modules. One of the newest deployments (2008) in 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. Three additional artificial reefs were deployed in 2009 in the northeast corner of the Sirotkin Artificial Reef area but were not yet eligible for annual monitoring.

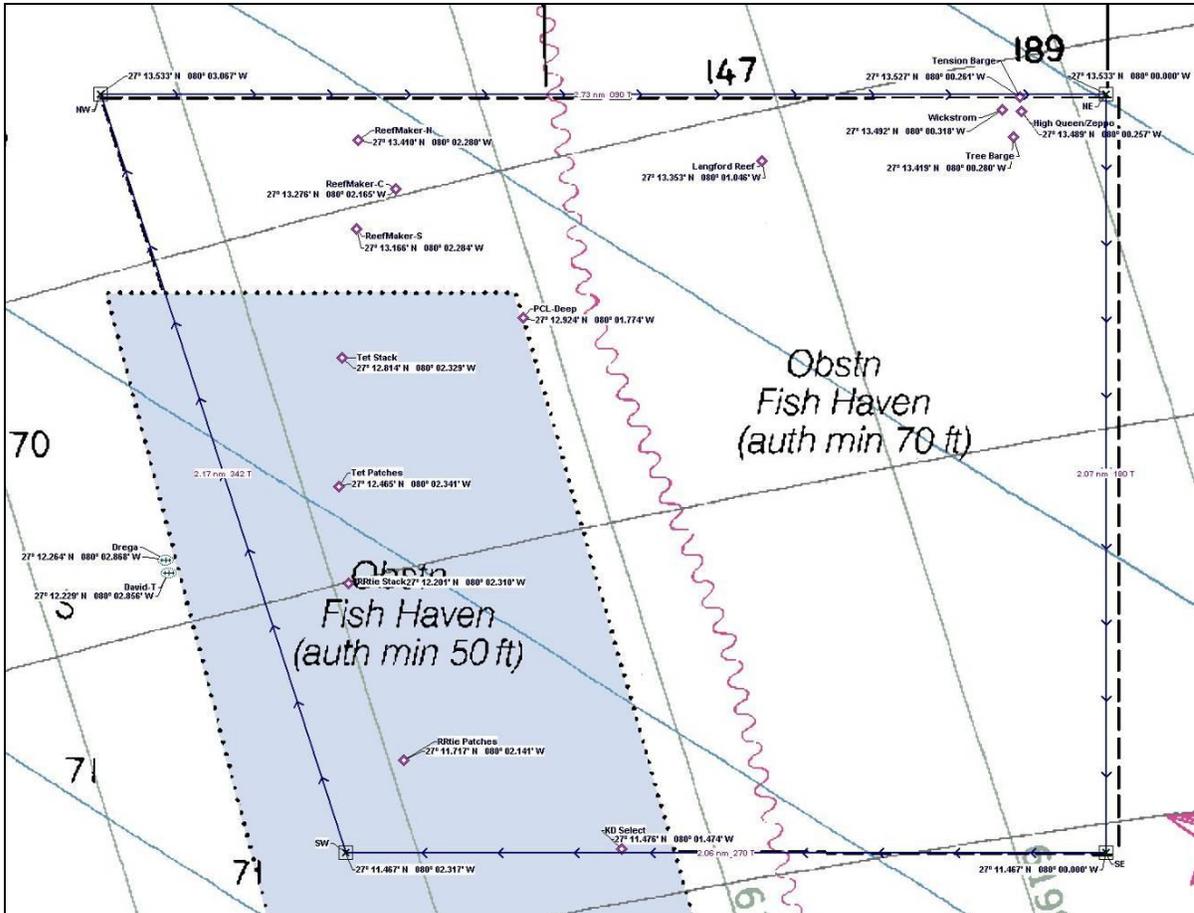


Figure 5. Chart view of the Sirotkin Reef site.

Sunken steel vessels such as the *Wickstrom*, *Tree Barge*, *High Queen/Zeppo*, and the *Tension Barge* have been deployed in the NE corner of the Sirotkin reef site. Four pyramid-shaped Reefmaker artificial reef units were also deployed in the NE corner, between the *Tree Barge* and the *Wickstrom*. Nineteen additional Reefmaker artificial reef units were deployed in 2005 within the Sirotkin Artificial Reef area. Four deployments (one each year from 2001 to 2004) of two different types of concrete shapes (tetrahedrons and railroad ties) were deployed along a N-S axis in the Sirotkin Artificial Reef area, as shown in Figure 5 and enlarged in Figure 18. 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. Approximately 1,500 tons of concrete was deployed at each of the four reef sites in order to determine whether different configurations result in differences in biological colonization rates, species diversity or fish biomass levels among artificial reefs with a constant mass.

2.4 South County Artificial Reef Site

The South County Artificial Reef is the most recently permitted artificial reef site offshore of Martin County and contains depths ranging from 65 to 150 feet. This low-relief artificial reef site is about halfway between St. Lucie and Jupiter Inlets in an effort to reduce recreational diving and angling pressure. The site currently contains six separate piles of large concrete and steel materials, all deployed during the same week in June, 2008 in about 70 feet of water (see Figure 6). First year monitoring data collected for all six reefs at this location are included in this monitoring report. The individual reef locations are called *The Heap*, *Shirley Reef*, *Lentine Reef*, *Fogel Capital Reef*, *Ann Marie Reef* and the *Jack MacDonal Reef*, all named by contributors to the artificial reef program.

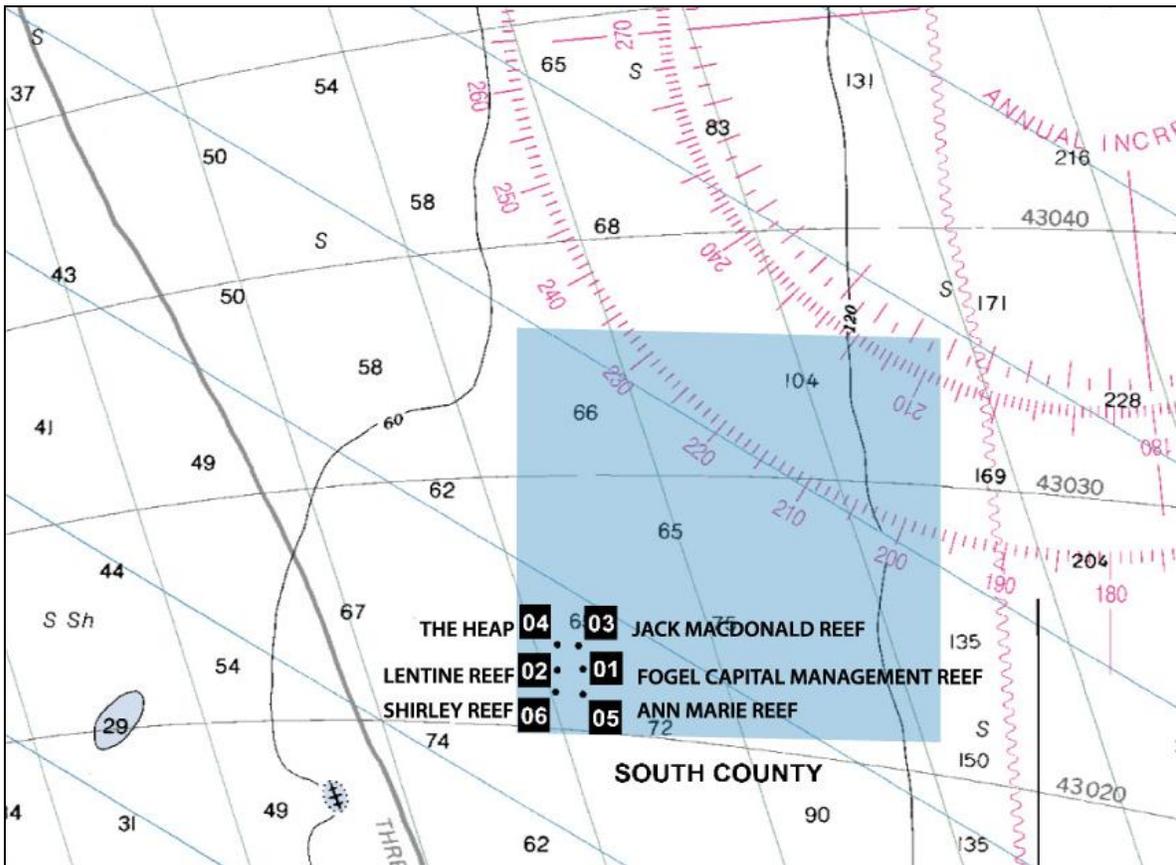


Figure 6. Chart view of South County Reef site.

2.5 Nearshore Mitigation Reefs

As part of the Martin County Beach Nourishment Project, nearshore mitigation reefs were constructed in the summer of 2000 offshore Martin County in water depths of 10 to 20 feet. See

Figure 1 for location and Tables 1, 2 and 3 for reef data. Annual monitoring at these artificial reef deployments was required for the first five years following material placement and was successfully completed in 2006.

3.0 Results

The following sections summarize the monitoring results for each artificial reef monitored in 2008 and 2009. 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. Each of the following artificial reefs was monitored by the authors and support staff during 2008 and 2009.

3.1 Clifton Perry Memorial Artificial Reef

- Reef Location: Donaldson Reef
- Materials: Concrete, steel
- Maximum Depth: 65 feet
- Reef High Point: 46 feet
- Year Created: 2004
- Monitoring Date: 7/24/2008; 9/28/2009

3.1.1 History of the Clifton Perry Memorial Reef

Nine barge loads of concrete and steel materials were deployed at the Clifton Perry Memorial Reef site in the winter and spring of 2005. The reef materials came from the dismantled Frank Wacha draw bridge that spanned the Indian River Lagoon at Jensen Beach. The new reef was named in honor of one of the Florida Oceanographic Society's (FOS) original founders. FOS was the first non-profit environmental advocacy group in the area and Mr. Perry's early efforts in the organization helped establish the original artificial reef deployments offshore of Martin County.

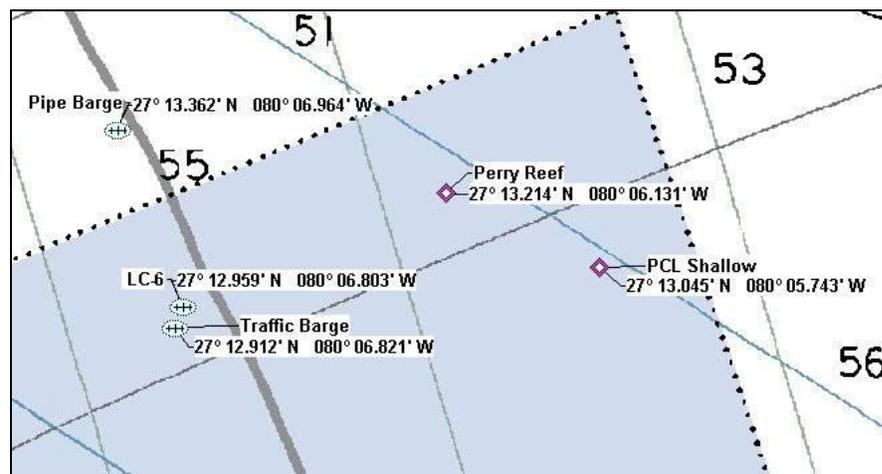


Figure 7. Chart view of NE corner of Donaldson Reef with locations of Perry and PCL Shallow reefs.

3.1.2 Structural Summary

This reef is located in the northeastern corner of the Donaldson Artificial Reef Site and lies in 67 feet of water. Figure 7 shows a chart with the location of the Perry reef within the permitted artificial reef area. The reef lies in an elliptical array on an east-southeast to west-northwest axis. The overall footprint gathered from GPS data is 330 feet by 280 feet, or approximately 2 acres. Reef measurements collected since 2005 indicate that this reef has settled vertically in several locations. The maximum vertical profile measured in 2005 was 25 feet at a prominent spot with a large concrete pile sticking up at a steep angle toward the NE from the seafloor. The maximum vertical profile in 2009 was 19 feet at this same location. This change occurred prior to 2006 and was most likely the result of storm effects from Hurricanes Frances, Jeanne and/or Wilma. The top of the reef at this location was at a depth of 40 feet in 2005 in 67 feet of seafloor depth. In 2006 and 2007 that same spot was at a depth of 47 feet. The average profile at this reef site is currently about 12-15 feet above the seafloor at other areas of stacked materials. There has been settlement of some of the reef units, with a change in maximum reef height of seven feet (from 27 to 20 feet). The horizontal footprint of the reef appears unchanged since deployment.





Figure 8. Photographs of the Clifton Perry Memorial Reef.

3.1.3 Biological Survey Results

Roving diver survey results show an increasing trend in both species diversity and total biomass on the Clifton Perry Memorial Reef since its deployment in 2005. Seabasses, snappers, jacks and grunts account for the greatest diversity of fish species observed each year to date. Baitfishes such as Atlantic bumper and round scad were particularly abundant above the reef structure. The numerous interstitial spaces within the reef were utilized extensively by fishes and invertebrates ranging in size from post-larval fishes and arthropods to mature goliath grouper. The reef itself supported a uniformly dense assemblage of sessile invertebrates and marine algae including sea urchins, barnacles, tunicates, hydroids, sea anemones, tube worms, encrusting sponges and sea cucumbers. Several crabs and gastropods were also observed. Table 5 lists the fish species observed, their relative abundance and size class (adult or juvenile) for the past three years.

Family/ Common Name	Species	2009		2008		2007	
		Abundance	Size	Abundance	Size	Abundance	Size
Elasmobranchs							
Nurse shark	<i>Ginglymostoma cirratum</i>	S	A				
Southern stingray	<i>Dasyatis americana</i>	F	A				
Muraenidae							
Spotted moray	<i>Gymnothorax vicinus</i>			S	A		
Ogcocephalidae							
Shortnose batfish	<i>Ogcocephalus nasutus</i>	S	A				
Centropomidae							
Common snook	<i>Centropomus undecimalis</i>	M	A	A	A,J	A	A
Serranidae							
Belted sandfish	<i>Serranus subligarius</i>	A	A,J	M	A		
Black seabass	<i>Centropristis striata</i>	M	A	M	A		
Goliath grouper	<i>Epinephelus itajara</i>	M	A,J	F	A		
Scamp	<i>Mycteroperca phenax</i>	M	A,J	S	J		
Grammistidae							
Whitespotted soapfish	<i>Rypticus maculatus</i>	M	A	F	A		

Family/ Common Name	Species	2009		2008		2007	
		Abundance	Size	Abundance	Size	Abundance	Size
Apogonidae							
Twospot cardinalfish	<i>Apogon pseudomaculatus</i>			M	A		
Rachycentridae							
Cobia	<i>Rachycentron canadum</i>	F	A				
Carangidae							
Almaco jack	<i>Seriola rivoliana</i>	F	A/J				
Amberjack	<i>Seriola dumerili</i>			M	A		
Atlantic bumper	<i>Chloroscombus chrysurus</i>	A	A				
Blue runner	<i>Caranx chrysos</i>	M	A	M	A	M	A,J
Round scad	<i>Decapterus punctatus</i>	A	A,J	A	A,J	M	A
Yellow jack	<i>Caranx bartholomaei</i>	S	J				
Lutjanidae							
Gray snapper	<i>Lutjanus griseus</i>	M	A	M	A	M	A,J
Lane snapper	<i>Lutjanus synagris</i>	M	A	M	A,J	M	A,J
Vermillion snapper	<i>Rhomboplites aurorubens</i>			M	A		
Yellowtail snapper	<i>Ocyurus chrysurus</i>	F	A,J				
Haemulidae							
Black margate	<i>Anisotremus surinamensis</i>	F	A			M	A,J
Pigfish	<i>Orthopristis chrysoptera</i>	M	A	M	A	A	A
Porkfish	<i>Anisotremus virginicus</i>	M	A	M	A,J	M	A,J
Tomtate	<i>Haemulon aurolineatum</i>	A	A,J	A	A,J	M	A,J
White grunt	<i>Haemulon plumieri</i>	F	A				
Sparidae							
Pigfish	<i>Orthopristis chrysoptera</i>	M	A				
Pinfish	<i>Lagodon rhomboides</i>	M	A				
Sheepshead	<i>Archosargus probatocephalus</i>	M	A	M	A	M	A,J
Sheepshead porgy	<i>Calamus penna</i>	M	A	M	A	F	A
Sciaenidae							
Cubbyu	<i>Equetus umbrosus</i>	A	A,J	A	A,J		
Striped croaker	<i>Bairdella sanctaeluciae</i>					M	A
Ephippidae							
Atlantic spadefish	<i>Chaetodipterus faber</i>	M	A			M	A
Chaetodontidae							
Reef butterflyfish	<i>Chaetodon sedentarius</i>	F	A	F	A		
Spotfin butterflyfish	<i>Chaetodon ocellatus</i>	F	A				
Pomacanthidae							
Blue angelfish	<i>Holocanthus bermudensis</i>	F	A	S	J		
French angelfish	<i>Pomacanthus paru</i>	S	A,J				
Gray angelfish	<i>Pomacanthus arcuatus</i>	F	A,J				
Queen angelfish	<i>Holocanthus ciliaris</i>	S	A				
Pomacentridae							
Beaugregory	<i>Pomacentrus leucostictus</i>	M	A,J	M	A,J	M	A,J
Bicolor damselfish	<i>Pomacentrus partitus</i>					M	J
Sergeant major	<i>Abudefduf saxatilis</i>	F	A				
Yellowtail reeffish	<i>Chromis enchrysurus</i>	M	A,J	M	J		
Labridae							
Bluehead	<i>Thalassoma bifasciatum</i>	F	A				
Puddingwife	<i>Halichoeres radiatus</i>			F	A		
Slippery dick	<i>Halichoeres bivittatus</i>	M	A,J	M	A		
Spanish hogfish	<i>Bodianus rufus</i>	F	A	F	A		

Family/ Common Name	Species	2009		2008		2007	
		Abundance	Size	Abundance	Size	Abundance	Size
Sphyraenidae							
Great barracuda	<i>Sphyraena barracuda</i>	F	A				
Guaguanche	<i>Sphyraena guachancho</i>	A	J			M	A
Acanthuridae							
Doctordfish	<i>Acanthurus chirurgus</i>	F	A				
Tetraodontidae							
Bandtail puffer	<i>Sphoeroides spengleri</i>	F	A	M	A		
Diodontidae							
Porcupine fish	<i>Diodon hystrix</i>	F	A				
	Total	46		28		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 5. Clifton Perry Memorial Reef fish census.

3.2 Texas Reefmaker Units

- Location: Donaldson Reef
- Materials: Reef modules (steel and concrete)
- Maximum Depth: 54 feet
- Reef High Point: 40 feet
- Year Created: 2005
- Monitoring Date: 6/19/2008

3.2.1 History of the Texas Reefmaker Units

In 2005 Martin County received a grant from FFWCC 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. These modules are large three-sided pyramids fabricated using concrete and steel (Figure 10). Fifteen Reefmaker artificial reef modules were deployed within the Donaldson Reef Site along the southern face of the Texas Reef on May 20, 2005. The location of the Texas Reef Reefmaker units is shown in Figure 9.

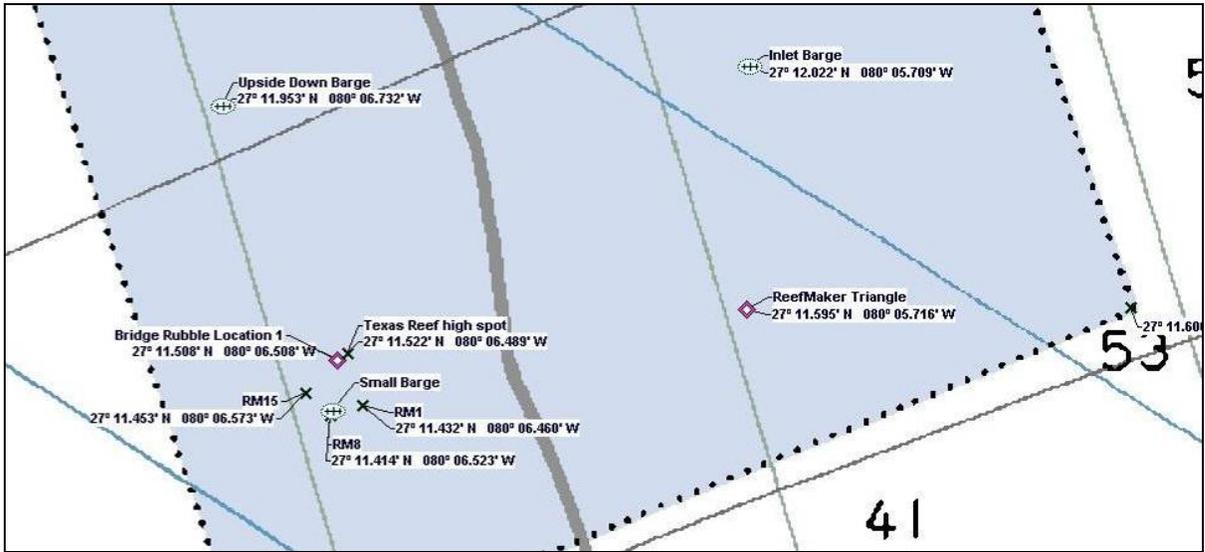


Figure 9. Chart view of Donaldson Reef area with Texas Reef location.

3.2.2 Structural Summary

Figure 9 shows the layout of the Reefmaker Units as deployed along the southern face of the Texas Reef. A single unit was deployed south of the Texas Reef, and the remaining units in a chevron pattern, with seven units placed on the eastern side heading to the NE at 50-ft. intervals, and seven units heading to the NW on the western side.

Underwater measurements between the units were performed, with the results shown in Table 6. Figure 11 shows representative photographs of the Reefmaker units at the Texas Reef. 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.



Figure 10. Reefmaker “Florida Special” artificial reef modules.

Unit Number	GPS Latitude	GPS Longitude	Depth at Top (feet)	Bottom Depth (feet)	Condition	Distance to Next Unit (feet)
1	27 11.432 N	80 6.460 W	46	55	Intact	42
2	27 11.428 N	80 6.471 W	46	55	Intact	70
3	27 11.421 N	80 6.481 W	46	55	Intact	31
4	27 11.415 N	80 6.496 W	46	55	Intact	70
5	27 11.416 N	80 6.501 W	46	55	Intact	38
6	27 11.413 N	80 6.508 W	46	56	Intact	50
7	27 11.415 N	80 6.518 W	47	55	Intact	25
8	27 11.414 N	80 6.523 W	47	56	Intact	40
9	27 11.417 N	80 6.530 W	47	56	Intact	73
10	27 11.422 N	80 6.538 W	45	53	Intact	16
11	27 11.423 N	80 6.544 W	46	53	Intact	95
12	27 11.434 N	80 6.549 W	43	50	Intact	47
13	27 11.437 N	80 6.554 W	43	51	Intact	77
14	28 11.454 N	81 6.564 W	42	50	Intact	39
15	27 11.453 N	80 6.573 W	40	49	Intact	na

Table 6. Texas Reef Reefmaker module locations and depths.



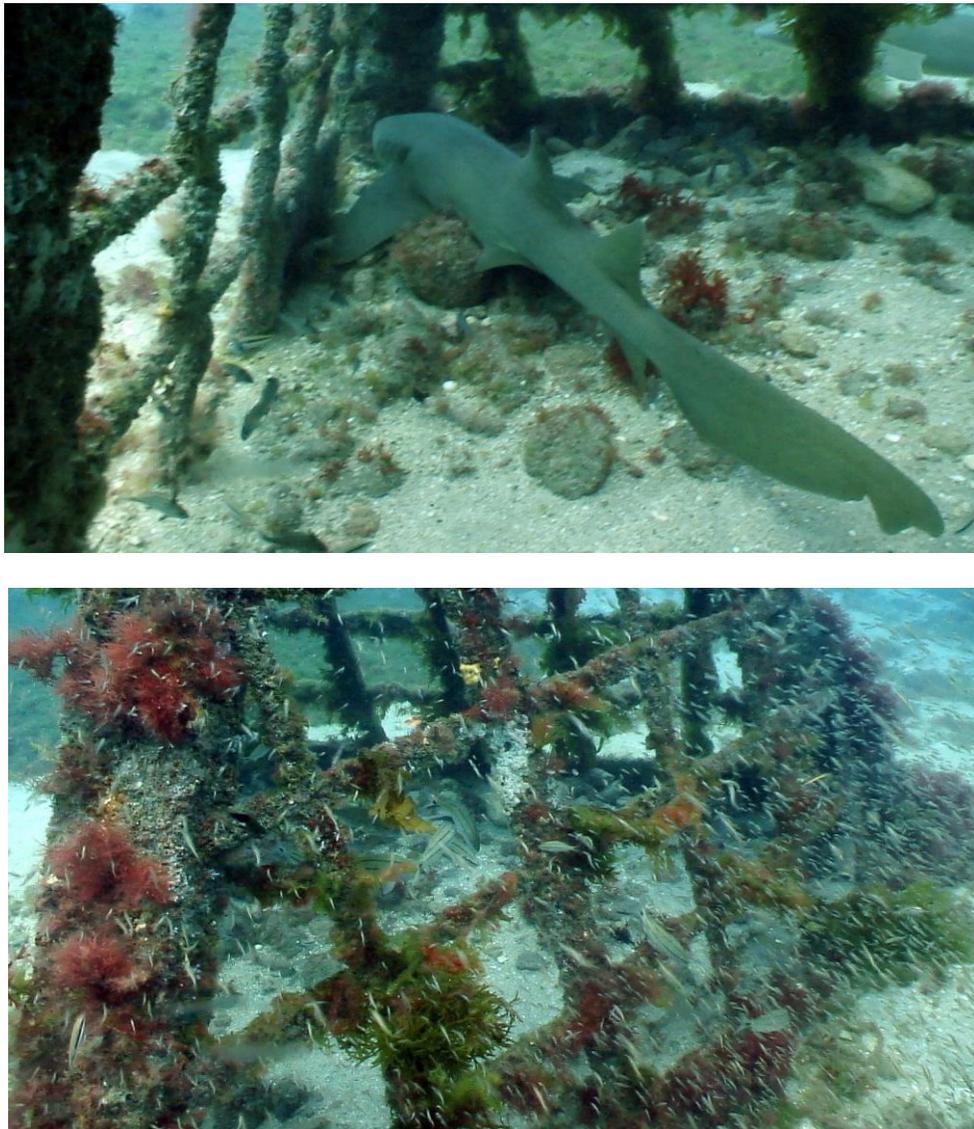


Figure 11. Texas Reefmaker module photographs, 2008.

3.2.3 Biological Survey Results

Roving diver survey results show an increasing trend in both fish species diversity and total biomass on the Texas Reefmaker Reef since its deployment in 2005. Seabasses and snappers are the most diverse families but the abundant grunts and jacks appeared to compose the greatest biomass of fishes. Large and small fishes alike were observed inside the reef modules, such as tomtates, seabasses, nurse sharks and goliath grouper. The reef modules supported red, brown and green algae and numerous sessile invertebrates on both the concrete and steel surfaces of the modules. Table 7 lists the species/taxa observed, their relative abundance and size class (adult or juvenile) if applicable for the past three years.

Family/ Common Name	Species	2008		2007		2006	
		Abundance	Size	Abundance	Size	Abundance	Size
Elasmobranchs							
Nurse shark	<i>Ginglymostoma cirratum</i>	S	A				
Spotted eagle ray	<i>Aetobatus narinari</i>	S	A				

Family/ Common Name	Species	2008		2007		2006	
		Abundance	Size	Abundance	Size	Abundance	Size
Centropomidae							
Common snook	<i>Centropomus undecimalis</i>	F	A				
Serranidae							
Belted sandfish	<i>Serranus subligarius</i>	M	A	M	A		
Black seabass	<i>Centropristis striata</i>	M	A,J	F	A,J	F	
Goliath grouper	<i>Epinephelus itajara</i>	F - 2	A	S	J		
Scamp	<i>Mycteroperca phenax</i>	S	A				
Apogonidae							
Twospot cardinalfish	<i>Apogon pseudomaculatus</i>	F	A				
Carangidae							
Amberjack	<i>Seriola dumerili</i>	M	A,J	M	A,J		
Blue runner	<i>Caranx chrysos</i>			F	J		
Round scad	<i>Decapterus punctatus</i>			A	A		
Lutjanidae							
Gray snapper	<i>Lutjanus griseus</i>	F	A				
Lane snapper	<i>Lutjanus synagris</i>	F	A,J	M	A		
Mutton snapper	<i>Lutjanus analis</i>	S	A				
Haemulidae							
Black margate	<i>Anisotremus surinamensis</i>			F	A		
Porkfish	<i>Anisotremus virginicus</i>	M	A,J	M	A,J	F	
Tomtate	<i>Haemulon aurolineatum</i>	A	A	A	A,J	F	
Sparidae							
Sheepshead	<i>Archosargus probatocephalus</i>	M	A	F	A	F	
Sheepshead porgy	<i>Calamus penna</i>	F	A	M	A		
Sciaenidae							
Cubbyu	<i>Equetus umbrosus</i>	F	A,J	M	A	F	
Ephippidae							
Atlantic spadefish	<i>Chaetodipterus faber</i>	F	A	M	A	A	
Chaetodontidae							
Reef butterflyfish	<i>Chaetodon sedentarius</i>	F	A	F	A		
Pomacentridae							
Beaugregory	<i>Pomacentrus leucostictus</i>	F	A,J	F	J		
Labridae							
Slippery dick	<i>Halichoeres bivittatus</i>			F	A		
Spanish hogfish	<i>Bodianus rufus</i>	F	A				
Sphyraenidae							
Great barracuda	<i>Sphyraena barracuda</i>	F	A				
Clinidae							
Hairy blenny	<i>Labrisomus nuchipinnus</i>			F	A		
Acanthuridae							
Doctorfish	<i>Acanthurus chirurgus</i>	F	A				
Balistidae							
Gray triggerfish	<i>Balistes capriscus</i>	F	A				
Tetraodontidae							
Bandtail puffer	<i>Sphoeroides spengleri</i>	F	A,J				
	Total	25		18		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 7. Texas Reefmaker Artificial Reef fish census.

3.3 PCL Shallow Reef

- Location: Donaldson Reef
- Materials: Concrete, steel
- Maximum Depth: 62 feet
- Reef High Point: 43 feet
- Year Created: 2006
- Monitoring Date: 6/25/2008, 9/28/2009

3.3.1 History of the PCL Shallow Reef

In the winter of 2006, five barge loads of concrete and steel materials totaling approximately 2,800 tons were deployed in 60 feet of water within the Donaldson reef site. These materials came from the decommissioned Ernest Lyons draw bridge that spanned the Indian River Lagoon between Sewalls Point and Hutchinson Island. The new reef was named for the construction company that built the new bridge, demolished the old bridge and built the new reef, covering all costs for the new reef construction.

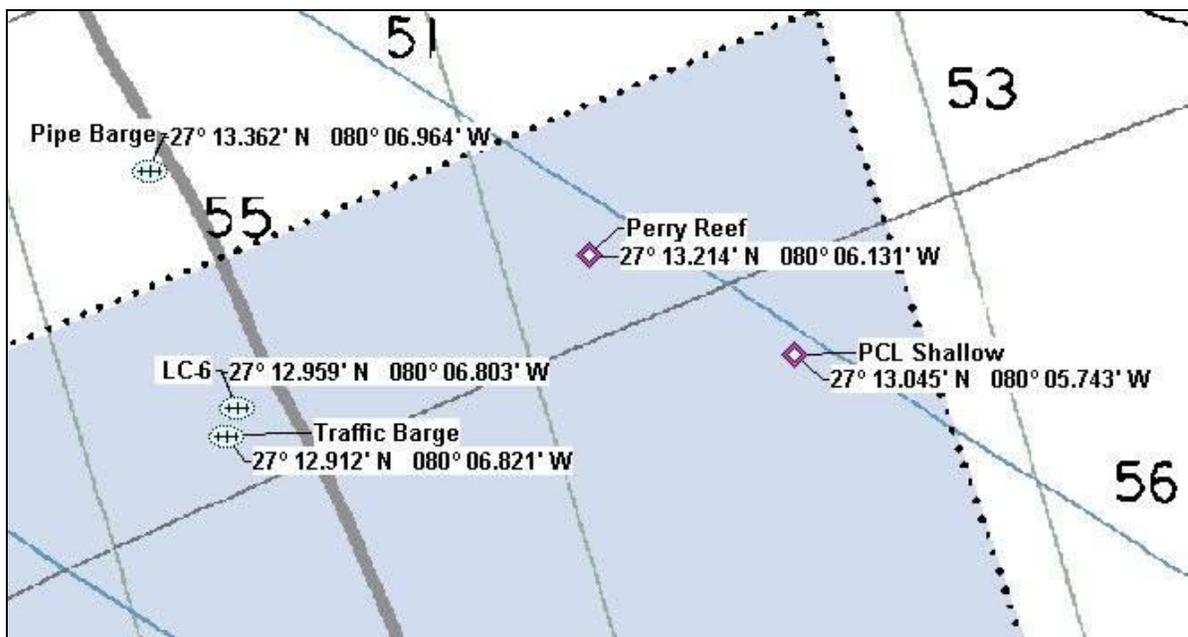


Figure 12. Chart view of Donaldson Reef area with PCL Shallow Reef location.

3.3.2 Structural Summary

The footprint of this reef is roughly ovoid with a north-to-south axis measuring 240 feet by 200 feet, occupying just over one acre of seafloor. Immediately after construction, the maximum profile above the seafloor was 19 feet with an average of about 14 feet. Minor settling has occurred since, but the maximum profile is still 18 feet above the seafloor and still averages 14 feet in most areas. A diverse array of materials in varying sizes and shapes has created a very complex reef structure, including crevices, overhangs, large caverns, scour holes and flat

expanses of reef. Many of the individual reef components are interlocked with one another and help to enhance reef stability. Figure 12 shows a chart with the location of the PCL Shallow reef in the northeastern area of the Donaldson Reef Site.



Figure 13. PCL Shallow Artificial Reef photographs from 2008 and 2009.

3.3.3 Biological Survey Results

Fish surveys indicate an increasing trend in species diversity since 2007, the first annual monitoring period. Jacks, grunts and seabasses represented the most numerous species over the last two years. Vast schools of round scad and Atlantic bumper were observed around and above the reef crest, while numerous snappers, groupers and porgies were observed using the reef structure and cavities for hiding and foraging. Invertebrate biomass on the artificial reef also appeared to have increased steadily since deployment. Some of the most common taxa included sea urchins, barnacles, tunicates, hydroids, sea anemones, tube worms, encrusting sponges and sea cucumbers. Numerous crabs and gastropods were also observed. Table 8 presents the fish species observed during 2007, 2008 and 2009.

Family/ Common Name	Species	2009		2008		2007	
		Abundance	Size	Abundance	Size	Abundance	Size
Elasmobranchs							
Southern stingray	<i>Dasyatis americana</i>	S	A	S	A	F	
Ogcocephalidae							
Shortnose batfish	<i>Ogcocephalus nasutus</i>	S	A				
Centropomidae							
Common snook	<i>Centropomus undecimalis</i>	M	A	M	A	M	
Serranidae							
Bank seabass	<i>Centropristis ocyurus</i>						
Belted sandfish	<i>Serranus subligarius</i>	M	A,J	M	A	F	
Black seabass	<i>Centropristis striata</i>	M	A	M	A	F	
Gag grouper	<i>Mycteroperca microlepis</i>					S	
Goliath grouper	<i>Epinephelus itajara</i>	M	A,J	M	A	F	
Scamp	<i>Mycteroperca phenax</i>	M	A,J			F	
Grammistidae							
Whitespotted soapfish	<i>Rypticus maculatus</i>	M	A	F	A	S	
Apogonidae							
Flamefish	<i>Apogon maculatus</i>	F	A				
Twospot cardinalfish	<i>Apogon pseudomaculatus</i>			F	A		
Rachycentridae							
Cobia	<i>Rachycentron canadum</i>	S	A				
Carangidae							
Almaco jack	<i>Seriola rivoliana</i>	F	A/J				
Amberjack	<i>Seriola dumerili</i>			M	A	F	
Atlantic bumper	<i>Chloroscombus chrysurus</i>	A	A				
Bar jack	<i>Caranx ruber</i>	S	J				
Blue runner	<i>Caranx chrysos</i>	M	A	M	A	M	
Rainbow runner	<i>Elegatis bipinnulata</i>	F	A				
Round scad	<i>Decapterus punctatus</i>	A	A,J	A	A	A	
Yellow jack	<i>Caranx bartholomaei</i>	S	J				
Lutjanidae							
Gray snapper	<i>Lutjanus griseus</i>	M	A	M	A	M	
Lane snapper	<i>Lutjanus synagris</i>	M	A	M	A,J	M	
Yellowtail snapper	<i>Ocyurus chrysurus</i>	F	A			F	
Haemulidae							
Black margate	<i>Anisotremus surinamensis</i>	F	A	M	A	F	
Pigfish	<i>Orthopristis chrysoptera</i>	F	A	A	A		
Porkfish	<i>Anisotremus virginicus</i>	F	A	A	A,J	M	
Tomtate	<i>Haemulon aurolineatum</i>	A	A,J	A	A,J	A	
White grunt	<i>Haemulon plumieri</i>	F	A				
Sparidae							
Pinfish	<i>Lagodon rhomboides</i>	F	A				
Sheepshead	<i>Archosargus probatocephalus</i>	M	A	M	A	F	
Sheepshead porgy	<i>Calamus penna</i>	M	A	F	A	F	
Sciaenidae							
Cubbyu	<i>Equetus umbrosus</i>	A	A,J	F	A,J	M	
Ephippidae							
Atlantic spadefish	<i>Chaetodipterus faber</i>	F	A	M	A		
Chaetodontidae							
Reef butterflyfish	<i>Chaetodon sedentarius</i>	F	A	F	A	F	
Spotfin butterflyfish	<i>Chaetodon ocellatus</i>	F	A				
Pomacanthidae							
Blue angelfish	<i>Holocanthus bermudensis</i>	S	A	F	A		
French angelfish	<i>Pomacanthus paru</i>	S	A	S	A		

Family/ Common Name	Species	2009		2008		2007	
		Abundance	Size	Abundance	Size	Abundance	Size
Gray angelfish	<i>Pomacanthus arcuatus</i>			S	A		
Pomacentridae							
Beaugregory	<i>Pomacentrus leucostictus</i>	M	A,J	F	A,J	F	
Bicolor damselfish	<i>Pomacentrus partitus</i>					F	
Sergeant major	<i>Abudefduf saxatilis</i>			F	A	F	
Yellowtail reeffish	<i>Chromis enchrysurus</i>	M	A,J	M	J		
Labridae							
Painted wrasse	<i>Halichoeres caudalis</i>	S	A				
Slippery dick	<i>Halichoeres bivittatus</i>	M	A,J	A	A,J	M	
Spanish hogfish	<i>Bodianus rufus</i>	F	A	S	A	F	
Sphyraenidae							
Great barracuda	<i>Sphyraena barracuda</i>	S	A				
Guaguanche	<i>Sphyraena guachancho</i>	M	J				
Clinidae							
Hairy blenny	<i>Labrisomus nuchipinnus</i>	F	A	M	A	F	
Acanthuridae							
Blue tang	<i>Acanthurus coeruleus</i>					S	
Doctorfish	<i>Acanthurus chirurgus</i>	F	A	F	A	F	
Scorpaenidae							
Spotted scorpionfish	<i>Scorpaena plumeiri</i>	F	A				
Balistidae							
Gray triggerfish	<i>Balistes capriscus</i>					F	
Tetraodontidae							
Bandtail puffer	<i>Sphoeroides spengleri</i>	F	A	M	A,J	F	
Sharpnose puffer	<i>Canthigaster rostrata</i>	F	A	F	A		
Diodontidae							
Porcupine fish	<i>Diodon hystrix</i>	S	A				
	Total	47		35		31	

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 8. PCL Shallow Artificial Reef fish census.

3.4 PCL Deep Reef

- Location: Sirotkin Reef
- Materials: Concrete, steel
- Maximum Depth: 120 feet
- Reef High Point: 104 feet
- Year Created: 2006
- Monitoring Date: 12/20/2008, 10/2/2009
-

3.4.1 History of the PCL Deep Artificial Reef

In October 2006, seven barge loads of concrete and steel materials totaling approximately 3,900 tons were deployed in 120 feet of water within the Sirotkin reef site. These materials came from the decommissioned Ernest Lyons draw bridge that spanned the Indian River Lagoon between Sewalls Point and Hutchinson Island and included some of the largest concrete and steel structural members removed from the old bridge. The new reef was named for the construction

company that built the new bridge, demolished the old bridge and built the artificial reef, covering all costs for transportation and construction.

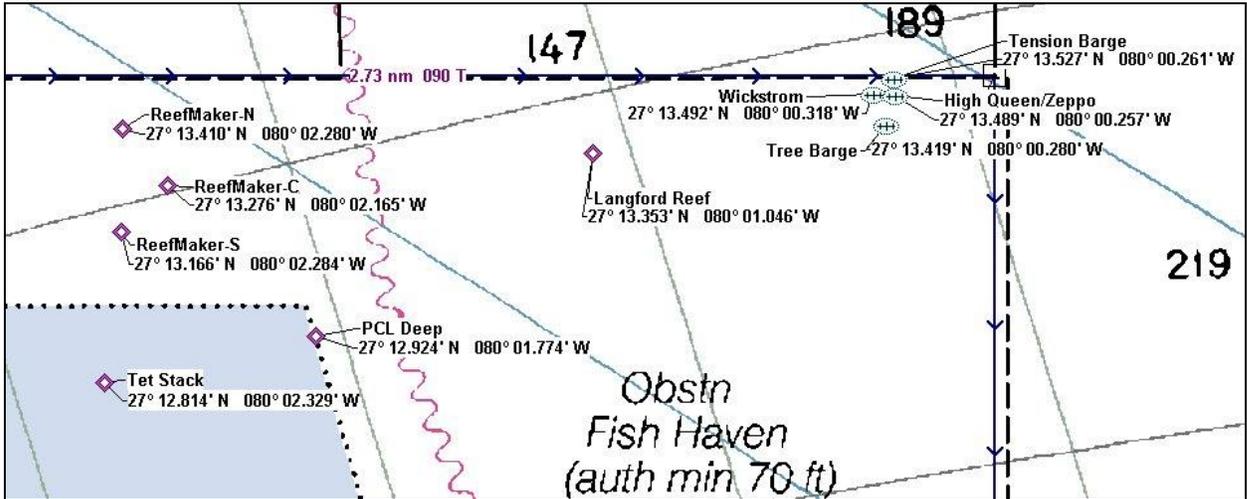


Figure 14. Chart view of Sirotkin Reef area with locations of PCL Deep and nearby reefs.

3.4.2 Structural Summary

The maximum depth at this artificial reef site is about 120 feet with a maximum relief of about 16 feet. The footprint of the site is an irregular form with a southeast-to-northwest axis and occupies about 2.5 acres of seafloor. The deployment barge was securely moored at two points when the reef materials were dropped and the large concrete and steel bridge components settled in a scattered fashion, although some of the longer pieces are stacked or interlocked with one another. The massive bridge pieces used on this reef created large overhangs and cavernous recesses that are used extensively by large and small fish alike. The seafloor at this site is comprised of a shell/coarse sand mixture and appears to provide a solid base for the heavy concrete and steel pieces, as scouring is not significant. Figure 14 shows a chart with the location of the PCL Deep Reef.



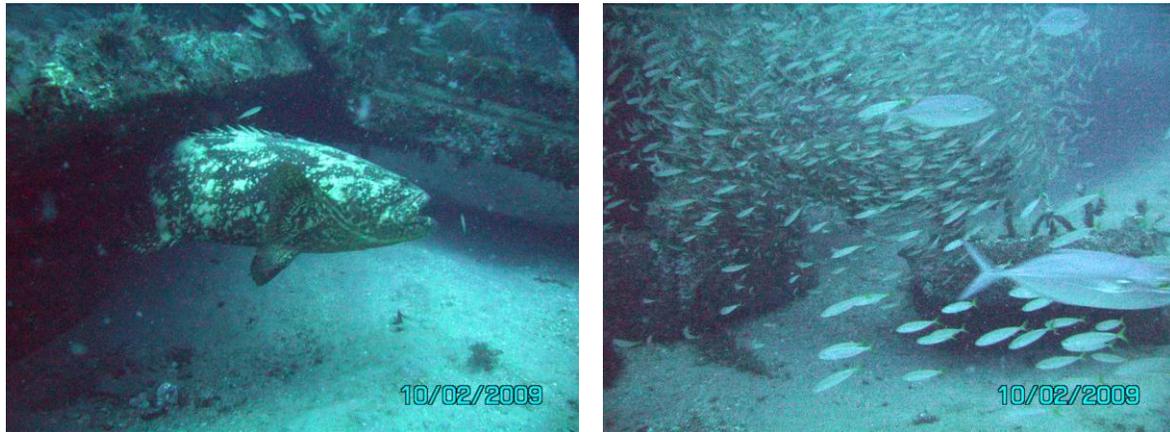


Figure 15. PCL Deep Artificial Reef photographs from 2008 (top) and 2009.

3.4.3 Biological Survey Results

Fish surveys indicate an increasing trend in species diversity since 2007, the first annual monitoring period. Seabasses and jacks represented the most numerous species in both 2008 and 2009, although grunts, wrasses and snappers were also common. Vast schools of adult and juvenile round scad were observed around and above the reef crest, while some formed tight schools around individual goliath grouper, possibly protecting them from the faster predatory jacks. Invertebrate biomass on the artificial reef had visibly increased in both 2008 and 2009 when compared to the previous monitoring efforts. The most common species included sea urchins, hydroids, sea anemones, tube worms, barnacles, encrusting sponges and sea cucumbers. Spiny lobsters and various crabs were also observed. Table 9 presents the fish species observed during 2007, 2008 and 2009.

Family/ Common Name	Species	2009		2008		2007	
		Abundance	Size	Abundance	Size	Abundance	Size
Elasmobranchs							
Southern stingray	<i>Dasyatis americana</i>	S	A	S	A		
Centropomidae							
Common snook	<i>Centropomus undecimalis</i>	F	A				
Serranidae							
Bank seabass	<i>Centropristis ocyurus</i>	F	A	M	A	F	
Belted sandfish	<i>Serranus subligarius</i>	M	A,J	M	A,J	F	
Black seabass	<i>Centropristis striata</i>	M	A	A	A,J	M	
Gag grouper	<i>Mycteroperca microlepis</i>			F	J		
Goliath grouper	<i>Epinephelus itajara</i>	F	A			M	
Scamp	<i>Mycteroperca phenax</i>	F	A/J	M	A,J	F	
Carangidae							
Almaco jack	<i>Seriola rivoliana</i>	F	A/J				
Amberjack	<i>Seriola dumerili</i>	M	J	A	A,J		
Bar jack	<i>Caranx ruber</i>					M	
Blue runner	<i>Caranx chrysos</i>	A	A	A	A	A	
Round scad	<i>Decapterus punctatus</i>	A	A,J				
Lutjanidae							
Gray snapper	<i>Lutjanus griseus</i>	F	A			F	
Lane snapper	<i>Lutjanus synagris</i>	M	A	M	A,J		
Red snapper	<i>Lutjanus campechanus</i>					F	

Family/ Common Name	Species	2009		2008		2007	
		Abundance	Size	Abundance	Size	Abundance	Size
Vermillion snapper	<i>Rhomboplites aurorubens</i>			A	A	F	
Haemulidae							
Black margate	<i>Anisotremus surinamensis</i>			F	A		
Pigfish	<i>Orthopristis chrysoptera</i>	F	A	M	A		
Tomtate	<i>Haemulon aurolineatum</i>	A	A,J	A	A	A	
Sparidae							
Sheepshead	<i>Archosargus probatocephalus</i>	M	A	F	A	F	
Sheepshead porgy	<i>Calamus penna</i>	M	A	M	A	F	
Sciaenidae							
Cubbyu	<i>Equetus umbrosus</i>	M	A	M	A,J	S	
Chaetodontidae							
Reef butterflyfish	<i>Chaetodon sedentarius</i>					F	
Spotfin butterflyfish	<i>Chaetodon ocellatus</i>			S	A		
Pomacanthidae							
Blue angelfish	<i>Holocanthus bermudensis</i>	F	A,J				
Pomacentridae							
Beaugregory	<i>Pomacentrus leucostictus</i>			F	A		
Bicolor damselfish						F	
Yellowtail reeffish	<i>Chromis enchrysurus</i>	M	A,J	F	A		
Labridae							
Slippery dick	<i>Halichoeres bivittatus</i>	M	A				
Spanish hogfish	<i>Bodianus rufus</i>	F	A				
Spotfin hogfish	<i>Bodianus pulchellus</i>	M	A				
Scorpaenidae							
Spotted scorpionfish	<i>Scorpaena plumeiri</i>	F	A				
Tetraodontidae							
Bandtail puffer	<i>Sphoeroides spengleri</i>	F	A	F	J	F	
	Total	25		19		17	

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. PCL Deep Artificial Reef fish census.

3.5 Sirotkin Diamond South Artificial Reef

- Location: Sirotkin Reef
- Materials: Reef modules (steel and concrete)
- Maximum Depth: 100 feet
- Reef High Point: 90 feet
- Year Created: 2005
- Monitoring Date: 12/21/2008

3.5.1 History of the Sirotkin Diamond Artificial Reef

Martin County received a grant in 2005 from the FFWCC 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. These modules are large three-sided pyramids fabricated using concrete and steel. Fifteen of these modules were deployed in three groups of five modules within the Sirotkin Reef site on May 21, 2005. The placement pattern is roughly diamond-shaped with one central module surrounded by the remaining four, spaced about 100 feet away. Color coded zip ties at the top of each unit help to simplify identification of individual modules during monitoring.

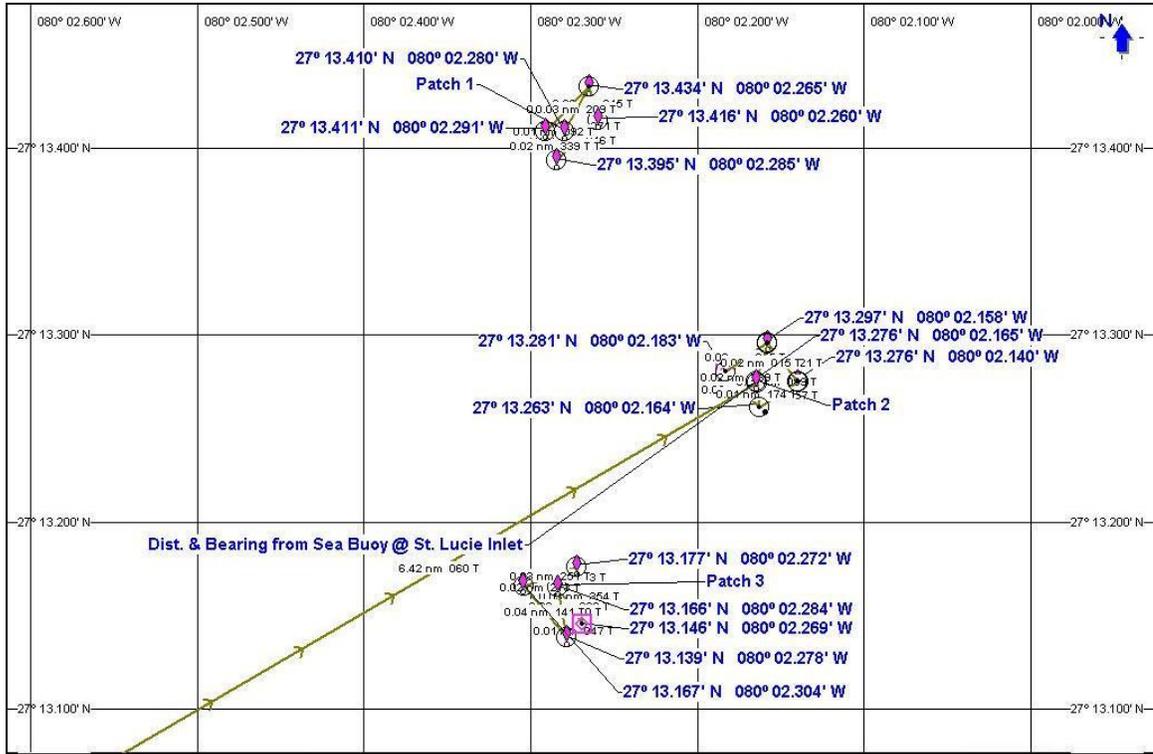


Figure 16. Sirotkin Diamond patch reefs.

3.5.2 Structural Summary

Each of the five modules at the Sirotkin Diamond South location was observed and found to be standing upright, stable and in their original positions. Minimal settling was noted around the feet and/or bases of some modules, ranging from several inches to almost the top of the horizontal footer beam. The bottom substrate is quite firm and composed of coarse sand and shell hash. Each of the three reef areas are separated by approximately 1000 feet. A chart showing the locations of the Reefmaker modules in the three Sirotkin Diamond patch reefs is shown in Figure 16.

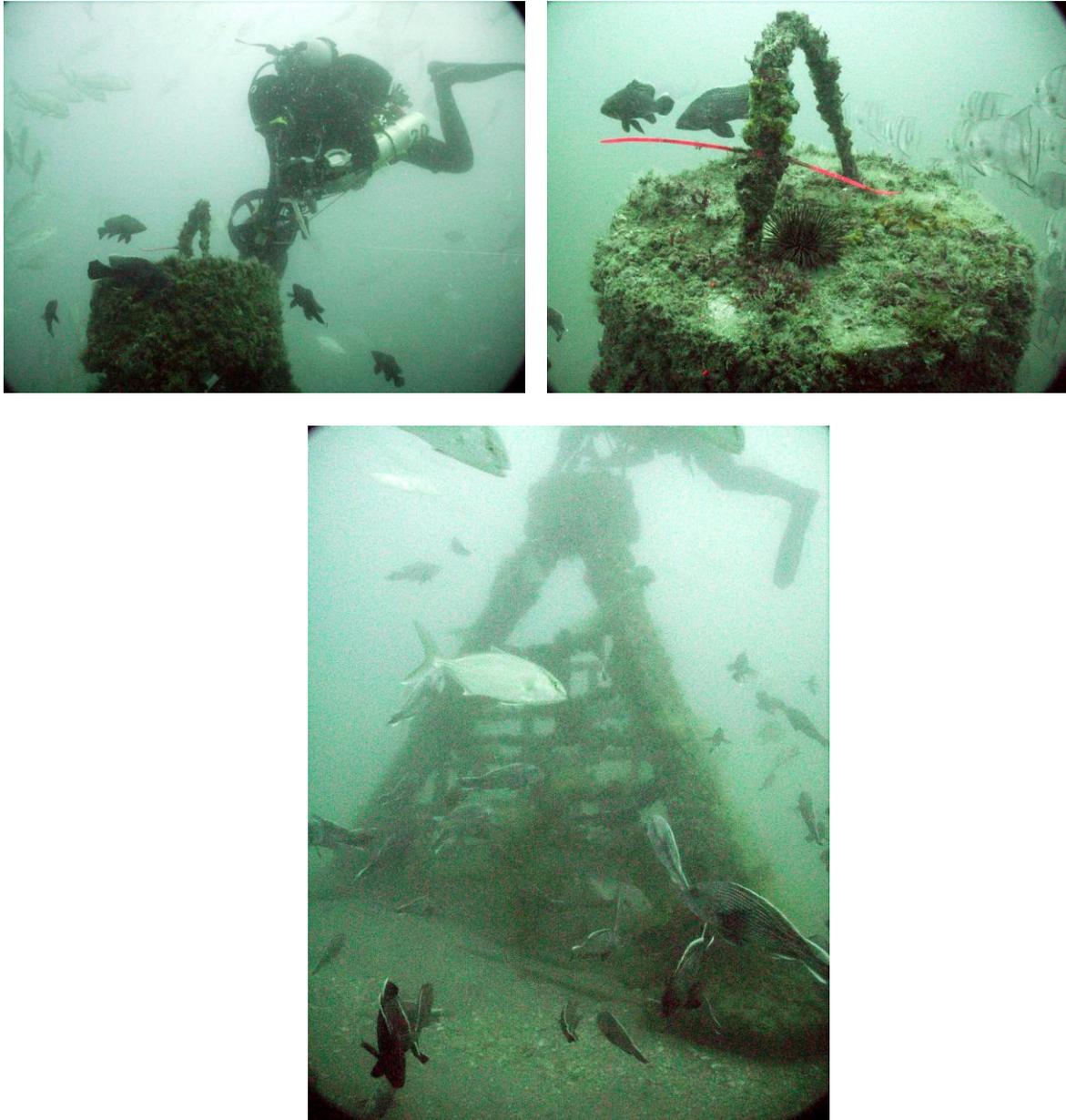


Figure 17. Sirotkin Diamond South Reefmaker module 2008 photos.

3.5.3 Biological Survey Results

Fish surveys indicate an increasing trend in species diversity since 2006 with seabasses and jacks representing the most numerous species in 2008 and 2007, although porgies, grunts and snappers were also common. Large schools of round scad and blue runner were observed around and above the reef modules. Invertebrate biomass on the artificial reef also appeared to have increased since deployment. Some of the most common species included sea urchins, hydroids, tube worms, encrusting sponges, tunicates and sea cucumbers. Various crabs were also observed. Table 10 shows the fish species and abundance observed during 2008 and 2007.

Family/ Common Name	Species	2008		2007	
		Abundance	Size	Abundance	Size
Elasmobranchs					
Southern stingray	<i>Dasyatis americana</i>			S	A
Serranidae					
Bank seabass	<i>Centropristis ocyurus</i>	F	A	F	A
Black seabass	<i>Centropristis striata</i>	M	A,J		
Sand perch	<i>Diplectrum formosum</i>	F	A		
Grammistidae					
Whitespotted soapfish	<i>Rypticus maculatus</i>			F	J
Carangidae					
Amberjack	<i>Seriola dumerili</i>	A	A,J	M	A,J
Blue runner	<i>Caranx crysos</i>	A	A		
Round scad	<i>Decapterus punctatus</i>	A	A		
Lutjanidae					
Lane snapper	<i>Lutjanus synagris</i>	F	A	F	A
Red snapper	<i>Lutjanus campechanus</i>	M	A	M	A
Vermilion snapper	<i>Rhomboplites aurorubens</i>			F	A
Haemulidae					
Porkfish	<i>Anisotremus virginicus</i>			M	A
Tomtate	<i>Haemulon aurolineatum</i>	M	A	M	A
Sparidae					
Sheepshead porgy	<i>Calamus penna</i>	F	A	F	A
Sciaenidae					
Cubbyu	<i>Equetus umbrosus</i>	M	A	M	A
Ephippidae					
Atlantic spadefish	<i>Chaetodipterus faber</i>	A	A,J		
Pomacentridae					
Yellowtail reeffish	<i>Chromis enchrysurus</i>	M	A,J	M	J
	Total	13		12	

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 10. Sirotkin Diamond South Artificial Reef fish census.

3.6 Railroad Tie Stack Artificial Reef

- Location: Sirotkin Reef
- Materials: Concrete railroad ties
- Maximum Depth: 93 feet
- Reef High Point: 72 feet
- Year Created: 2003
- Monitoring Date: 8/5/2008

3.6.1 History of the Railroad Tie Stack Artificial Reef

As part of a grant from the Florida Fish and Wildlife Conservation Commission (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 was placed forming a single pile in three separate deployments. Figure 18 shows the configuration of the Railroad Tie Stack and Railroad Tie Patches Artificial Reefs.

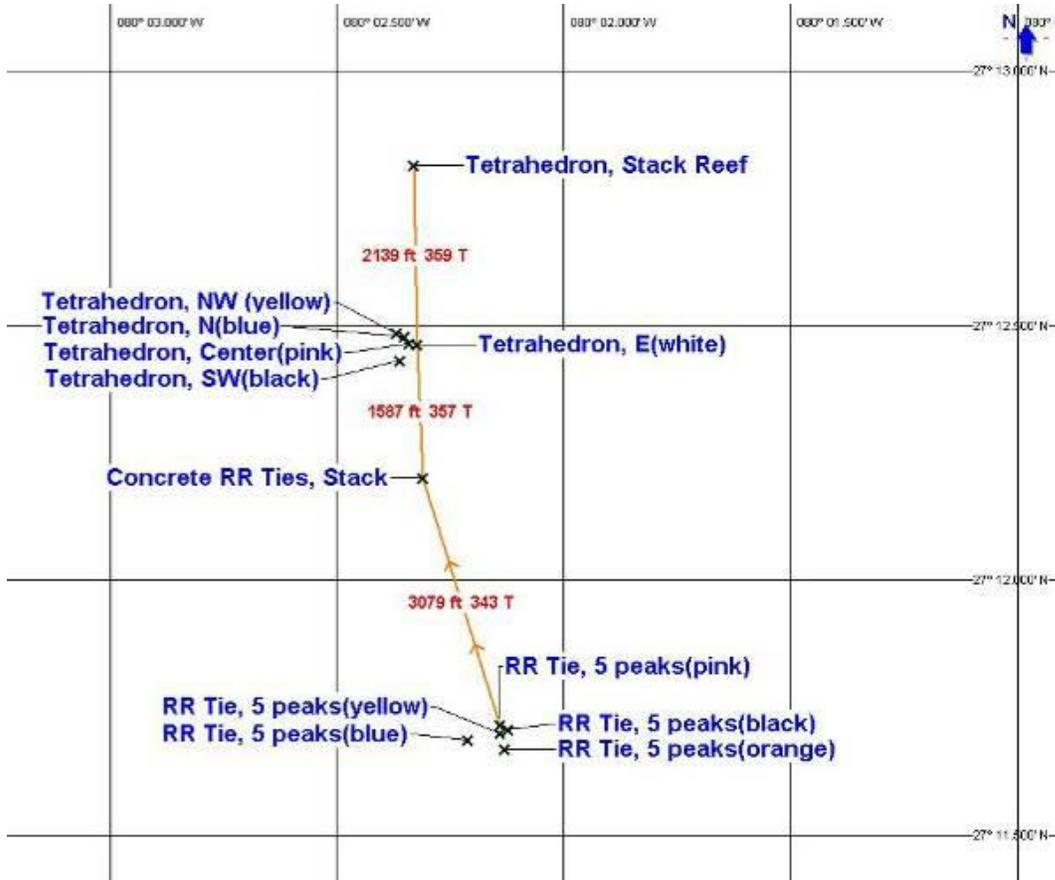


Figure 18. Railroad tie and Tetrahedron reef locations.

3.6.2 Structural Summary

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. The only measurable change was that the depth of the reef summit is now 72 feet beneath the surface, three feet lower than when measured prior to the hurricanes of 2004. Each observation of the reef since 2006 has confirmed that the reef occupies the same footprint on the bottom that it did since construction, essentially a cone-shaped jumble of railroad ties. Local divers and fishermen nicknamed this site “The Matterhorn” due to its steep, prominent profile. The reef structure is quite complex with many interstitial voids and refugia where various marine life can hide from predators. Even on bright sunny days with good visibility, many dark recesses were observed which required using a light in order to view the internal spaces.



Figure 19. Railroad Tie Stack Reef 2008 photographs.

3.6.3 Biological Survey Results

With the exception of 2008, fish surveys indicate an increasing trend in species diversity since its deployment in 2003. Seabasses, jacks, grunts, porgies and snappers accounted for a large number of the species observed, many of which included juveniles as well as adults. Large schools of round scad and blue runner were observed around and above the reef crest. Most other fish species were more closely associated with the reef structure, seeking shelter within cavities when approached by the divers. Invertebrate biomass on the artificial reef also appeared to have increased since deployment. Most common species included spiny lobsters, arrow crabs, hermit crabs, sea urchins, hydroids, sea anemones, *Oculina* coral, tube worms, encrusting sponges, tunicates and sea cucumbers. The growth rate of epifauna such as hydroids and barnacles on the railroad ties has been quite rapid since immersion in 2003. The upper surfaces of the pile continue to exhibit much more growth compared to the lower surfaces, most likely due to more exposure to sunlight. Table 11 presents the fish and invertebrate data collected from 2007 and 2008.

Family/ Common Name	Species	2008		2007	
		Abundance	Size	Abundance	Size
Centropomidae					
Common snook	<i>Centropomus undecimalis</i>			F	A
Serranidae					
Bank seabass	<i>Centropristis ocyurus</i>	M	A,J	F	A
Belted sandfish	<i>Serranus subligarius</i>	A	A	M	A
Black seabass	<i>Centropristis striata</i>	M	A,J		
Gag grouper	<i>Mycteroperca microlepis</i>	S	A		
Grammistidae					
Whitespotted soapfish	<i>Rypticus maculatus</i>			F	A
Carangidae					
Amberjack	<i>Seriola dumerili</i>	M	A	M	A
Blue runner	<i>Caranx chrysos</i>			M	A
Round scad	<i>Decapterus punctatus</i>			A	A,J
Lutjanidae					
Gray snapper	<i>Lutjanus griseus</i>	F	A	F	A
Lane snapper	<i>Lutjanus synagris</i>			M	A,J
Vermilion snapper	<i>Rhomboplites aurorubens</i>	A	A		
Haemulidae					
Pigfish	<i>Orthopristis chrysoptera</i>	A	A	A	A
Porkfish	<i>Anisotremus virginicus</i>			M	A,J
Tomtate	<i>Haemulon aurolineatum</i>	M	A	A	A
Sparidae					
Sheepshead	<i>Archosargus probatocephalus</i>	M	A	F	A
Sheepshead porgy	<i>Calamus penna</i>	M	A	M	A
Sciaenidae					
Cubbyu	<i>Equetus umbrosus</i>	M	A,J	M	A,J
Chaetodontidae					
Reef butterflyfish	<i>Chaetodon sedentarius</i>	F	A	F	A
Spotfin butterflyfish	<i>Chaetodon ocellatus</i>			S	A
Pomacanthidae					
Blue angelfish	<i>Holocanthus bermudensis</i>	F	A,J	F	A
Gray angelfish	<i>Pomacanthus arcuatus</i>			S	J
Pomacentridae					
Beaugregory	<i>Pomacentrus leucostictus</i>	M	A,J	F	A,J
Bicolor damselfish	<i>Pomacentrus partitus</i>			M	J
Sergeant major	<i>Abudefduf saxatilis</i>			F	A
Yellowtail reeffish	<i>Chromis enchrysurus</i>	F	A		
Labridae					
Hogfish	<i>Lachnolaimus maximus</i>	S	A		
Slippery dick	<i>Halichoeres bivittatus</i>			M	A
Spanish hogfish	<i>Bodianus rufus</i>			F	J
Scombridae					
King mackerel	<i>Scomberomorus cavalla</i>			F	A
Tetraodontidae					
Bandtail puffer	<i>Sphoeroides spengleri</i>	M	A,J	F	J
	Total	18		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 11. Railroad Stack Artificial Reef fish species census.

3.7 Railroad Tie Patches (Five Peaks) Artificial Reef

- Location: Sirotkin Reef
- Materials: Concrete
- Maximum Depth: 93 feet
- Reef High Point: 72 feet
- Year Created: 2004
- Monitoring Date: 6/25/2008, 10/2/2009

3.7.1 History of the Railroad Tie Patches Artificial Reef

As part of a FWC construction grant and with additional funding from Martin County, a 5-unit patch reef composed of donated concrete railroad ties was constructed in late June of 2004. There are five patches or “peaks” on the reef, each composed of 300 tons of railroad ties, lying on a flat sand/shell hash seafloor. Distances vary between the peaks, but average 120 feet on center between clusters. Colored nylon tie wraps have been added to the top of each pile to help identify each and to aid future monitoring efforts. Figure 5 shows the Railroad Tie Patches Reef in the southwest portion of the Sirotkin Artificial Reef area.

This reef is the fourth in a series of four that were built in 90 to 100-foot water depths intended to evaluate how material shape and configuration affect a reef’s biomass and diversity characteristics. This reef was built in 2004 approximately 0.75 mile south of the Railroad Tie Stack Reef that was constructed in 2003. One half mile north of the Railroad Tie Stack Reef is the Tetrahedron Patch Reef, a 5-unit patch reef built in 2002 using pyramid-shaped concrete tetrahedrons. And one half mile north of that is the Tetrahedron Stack Reef, constructed using the same concrete shapes, but deployed in 2001 as a single large pile. Each of these 4 reefs consists of 1500 tons of concrete, sits on a sandy seafloor and is located in a similar depth of water about 6.5 miles off the Martin County shoreline.

3.7.2 Structural Summary

Each of the five reef patches is made up of about 900 concrete railroad ties. Due to the elongated shape and high relative mass of the railroad ties, the reef piles formed as jumbled but fairly stable cone-shaped heaps of concrete. Each reef pile forms a circle about 50 feet in diameter with a vertical profile of about 7.5 feet. Figure 20 shows the configuration of the five reef piles that make up this artificial reef. Distances and bearings between the five peaks are shown, based on GPS coordinates and diver observations.

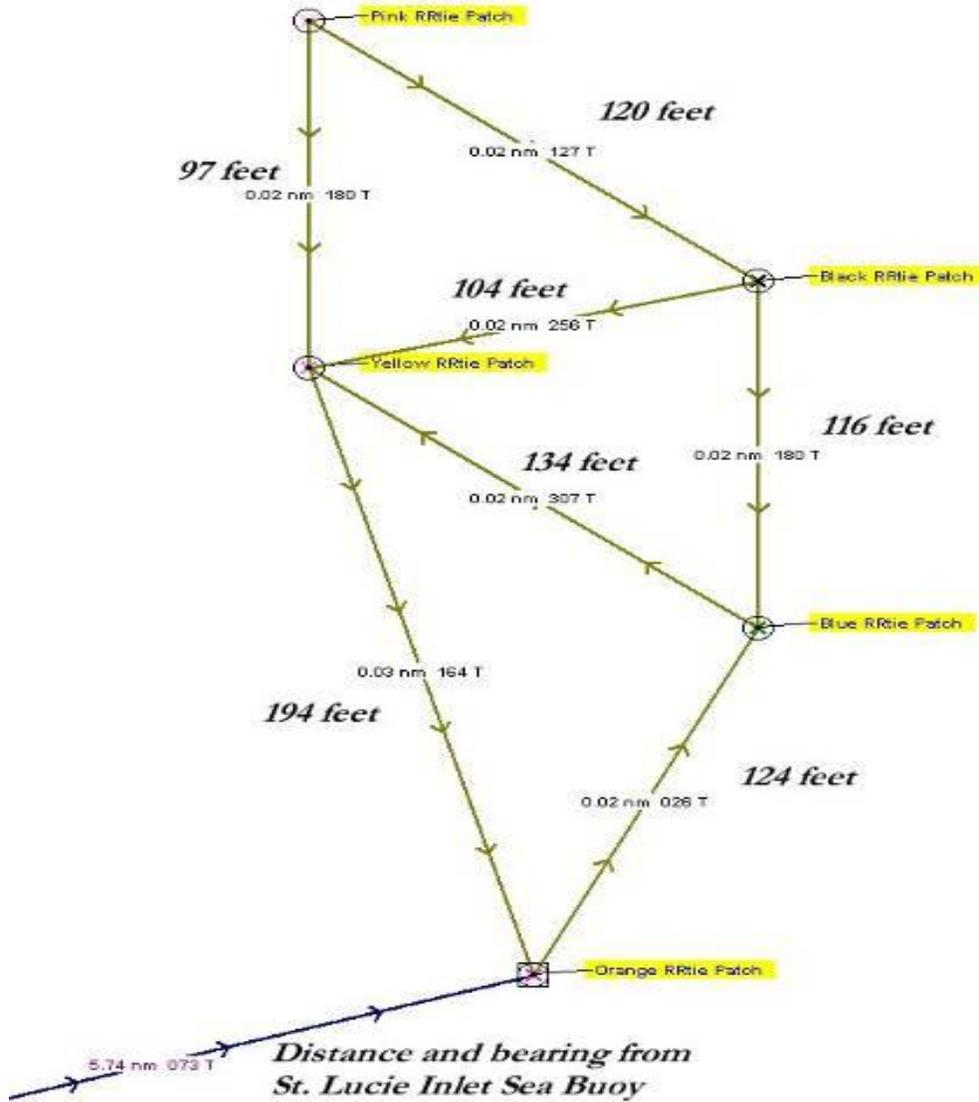


Figure 20. Configuration of the Railroad Tie Patches (5 Peaks) Reef





Figure 21. Railroad Tie Patches Artificial Reef 2009 photographs.

3.7.3 Biological Survey Results

Fish surveys indicate a generally increasing trend in fish species diversity since 2004. Wrasses, jacks and seabasses are the best represented families. Vast schools of round scad and blue runner were observed around and above the reef crest. Most other fish species were more closely associated with the reef structure, seeking shelter within cavities when approached by the divers. Other species were observed swimming between the individual reef piles over the flat, sandy seafloor. The compact arrangement of these five reef units may function as a single reef to many of the fish species observed. Invertebrate biomass on the artificial reef had visibly increased in both 2008 and 2009 when compared to the previous monitoring efforts. Most common species included sea urchins, hydroids, tube worms, encrusting sponges, tunicates and sea cucumbers. The numerous interstitial spaces within the reef provide refugia for large numbers of fish and invertebrates, however, it appears that a relative lack of sunlight reaching the deeper recesses may limit the growth of encrusting flora and fauna. Table 12 presents the fish species observed from 2007 through 2009.

Family/ Common Name	Species	2009		2008		2007	
		Abundance	Size	Abundance	Size	Abundance	Size
Elasmobranchs							
Southern stingray	<i>Dasyatis americana</i>			S	A	S	A
Muraenidae							
Spotted moray	<i>Gymnothorax moringa</i>					S	A
Serranidae							
Bank seabass	<i>Centropristis ocyurus</i>			M	A		
Belted sandfish	<i>Serranus subligarius</i>	M	A,J	A	A		
Black grouper	<i>Mycteroperca bonaci</i>			S	J		
Black seabass	<i>Centropristis striata</i>	F	A	F	A	M	A,J
Gag grouper	<i>Mycteroperca microlepis</i>			F	A	S	A
Scamp	<i>Mycteroperca phenax</i>	F	A/J			F	A
Grammistidae							
Whitespotted soapfish	<i>Rypticus maculatus</i>			F	A	F	A
Apogonidae							
Twospot cardinalfish	<i>Apogon pseudomaculatus</i>			F	A		
Rachycentridae							
Cobia	<i>Rachycentron canadum</i>					S	A
Carangidae							
Almaco jack	<i>Seriola rivoliana</i>	F	A/J				
Amberjack	<i>Seriola dumerili</i>	M	A			F	A
Bar jack	<i>Caranx ruber</i>	M	J				
Blue runner	<i>Caranx chrysos</i>	A	A	M	A	M	A
Round scad	<i>Decapterus punctatus</i>	A	A,J	A	A	A	A
Yellow jack	<i>Caranx bartholomaei</i>	S	J				
Lutjanidae							
Gray snapper	<i>Lutjanus griseus</i>	M	A	F	A	F	A
Lane snapper	<i>Lutjanus synagris</i>			M	A,J	F	A
Red snapper	<i>Lutjanus campechanus</i>			F	A	M	A,J
Yellowtail snapper	<i>Ocyurus chrysurus</i>	F	A				
Haemulidae							
Black margate	<i>Anisotremus surinamensis</i>	F	A,J				
Pigfish	<i>Orthopristis chrysoptera</i>	M	A	M	A		
Porkfish	<i>Anisotremus virginicus</i>			F	A	M	A,J
Tomtate	<i>Haemulon aurolineatum</i>	A	A,J	A	A	M	A,J
Sparidae							
Pinfish	<i>Lagodon rhomboides</i>	F	A				
Sheepshead	<i>Archosargus probatocephalus</i>	M	A	M	A	M	A
Sheepshead pogy	<i>Calamus penna</i>	A	A	M	A	F	A
Spottail pinfish	<i>Diplodus holbrooki</i>					F	A
Sciaenidae							
Cubby	<i>Equetus umbrosus</i>	M	A	M	A,J	M	A,J
Ephippidae							
Atlantic spadefish	<i>Chaetodipterus faber</i>			F	A		
Chaetodontidae							
Reef butterflyfish	<i>Chaetodon sedentarius</i>			F	A		
Spotfin butterflyfish	<i>Chaetodon ocellatus</i>					F	A
Pomacanthidae							
Blue angelfish	<i>Holocanthus bermudensis</i>	F	A,J			F	A
Pomacentridae							
Beaugregory	<i>Pomacentrus leucostictus</i>	M	A,J	M	A,J		
Sergeant major	<i>Abudefduf saxatilis</i>					F	A
Yellowtail reeffish	<i>Chromis enchrysurus</i>	M	A	F	A		

Family/ Common Name	Species	2009		2008		2007	
		Abundance	Size	Abundance	Size	Abundance	Size
Labridae							
Bluehead wrasse	<i>Thalassoma bifasciatum</i>			F	A		
Hogfish	<i>Lachnolaimus maximus</i>			F	A		
Painted wrasse	<i>Halichoeres caudalis</i>	S	A				
Slippery dick	<i>Halichoeres bivittatus</i>	M	A,J				
Spanish hogfish	<i>Bodianus rufus</i>	M	A,J				
Spotfin hogfish	<i>Bodianus pulchellus</i>	F	A,J	F	A,J	M	A,J
Clinidae							
Hairy blenny	<i>Labrisomus nuchipinnus</i>			F	A		
Acanthuridae							
Doctorfish	<i>Acanthurus chirurgus</i>	F	A				
Scaridae							
Stoplight parrotfish	<i>Sparisoma viride</i>	S	J				
Scombridae							
Little tunny	<i>Euthynnus alletteratus</i>					F	J
Scorpaenidae							
Spotted scorpionfish	<i>Scorpaena plumeiri</i>	M	A	F	A		
Balistidae							
Gray triggerfish	<i>Balistes capriscus</i>	F	A			F	A,J
Tetraodontidae							
Bandtail puffer	<i>Sphoeroides spengleri</i>			M	A	F	A,J
Diodontidae							
Porcupine fish	<i>Diodon hystrix</i>	S	A				
	Total	30		28		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 12. Railroad Tie Patches Artificial Reef fish census.

3.8 KD Select Artificial Reef

- Location: Sirotkin Reef
- Materials: Concrete, steel
- Maximum Depth: 129 feet
- Reef High Point: 117 feet
- Year Created: 2007
- Monitoring Date: 12/20/2008, 10/10/2009

3.8.1 History of the KD Select Artificial Reef

This artificial reef was deployed in 120 feet of water in July 2007 along the southern boundary of the Sirotkin Artificial Reef area. The reef was created using approximately 537 tons of waste concrete recovered from the Martin County landfill and stockpiled until enough material was available to create several artificial reefs at once. This reef was named by a local diver and marine services specialist who has worked on Martin County's artificial reef program for three decades.

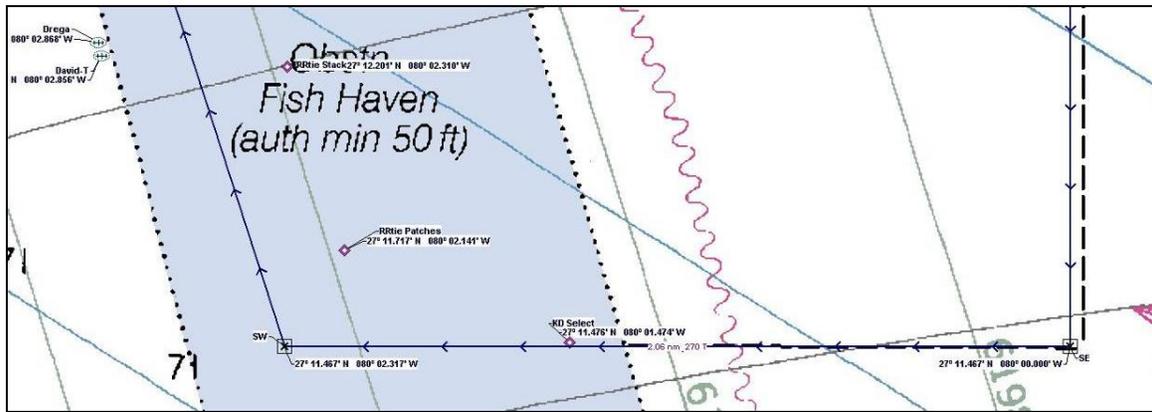


Figure 22. Chart view of the southern Sirotkin Reef area showing location of KD Select Artificial Reef.

3.8.2 Structural Summary

The maximum depth at this artificial reef site is about 129 feet with a maximum relief of about 12 feet. The footprint of the site is generally round with a southeast-to-northwest axis and occupies about 0.3 acres of seafloor. The deployment barge was securely moored at two points when the reef materials were dropped and the large concrete components settled in a single pile, although a few pieces settled to the bottom a short distance from the reef pile. Several large culvert sections provide cavernous recesses that are used extensively by large and small fish alike. The seafloor at this site is comprised of a shell/coarse sand mixture and appears to provide a solid base for the heavy concrete and steel pieces, as scouring is not significant.



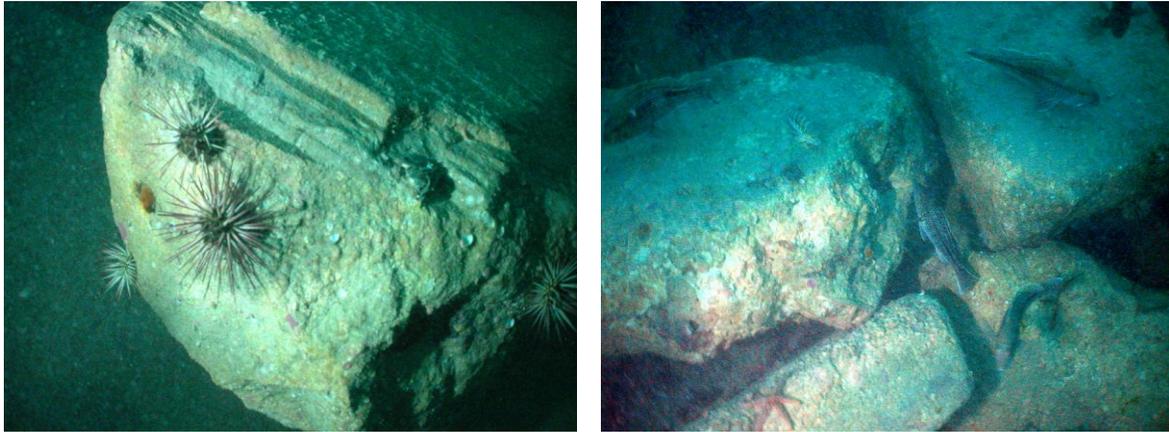


Figure 22. KD Select photographs from 2008 (bottom) and 2009.

3.8.3 Biological Survey Results

Fish surveys indicate an increasing trend in species diversity since 2008, although 2009 was only the second year of monitoring since deployment. Seabasses and jacks represented the most numerous species in both 2008 and 2009, although grunts, wrasses and snappers were also common. Vast schools of adult and juvenile round scad were observed around and above the reef crest. An adult smalltooth sawfish (federally endangered) was observed at this artificial reef in 2009 and was reported to FWC and the National Sawfish Encounter Database and the FWRI field office in Port Charlotte. Invertebrate biomass on the artificial reef also appeared to have increased since deployment. Most common species included sea urchins, hydroids, tube worms, barnacles, encrusting sponges and sea cucumbers. Fire worms, sea anemones and various crabs were also observed. Table 13 presents the fish species observed during 2008 and 2009.

Family/ Common Name	Species	2009		2008	
		Abundance	Size	Abundance	Size
Elasmobranchs					
Smalltooth sawfish	<i>Pristis pectinata</i>	S	A		
Southern stingray	<i>Dasyatis americana</i>	S	A	S	A
Clupeidae					
Spanish sardine	<i>Sardinella aurita</i>	A	J		
Centropomidae					
Common snook	<i>Centropomus undecimalis</i>	F	A		
Serranidae					
Bank seabass	<i>Centropristis ocyurus</i>			A	A,J
Belted sandfish	<i>Serranus subligarius</i>	M	A		
Black seabass	<i>Centropristis striata</i>	A	A,J	M	A,J
Gag grouper	<i>Mycteroperca microlepis</i>	S	A		
Goliath grouper	<i>Epinephelus itajara</i>	F	A		
Sand perch	<i>Diplectrum formosum</i>	A	A,J	M	A,J
Scamp	<i>Mycteroperca phenax</i>			M	A
Snowy grouper	<i>Epinephelus niveatus</i>	S	J		
Grammistidae					
Whitespotted soapfish	<i>Rypticus maculatus</i>	M	A		
Rachycentridae					
Cobia	<i>Rachycentron canadum</i>	F	A		

Echeneididae					
Sharksucker	<i>Echeneis naucrates</i>	F	A/J		
Carangidae		2009		2008	
Family/ Common Name	Species	Abundance	Size	Abundance	Size
Amberjack	<i>Seriola dumerili</i>			M	A,J
Blue runner	<i>Caranx chrysos</i>	A	A		
Round scad	<i>Decapterus punctatus</i>	A	A,J	A	A,J
Haemulidae					
Tomtate	<i>Haemulon aurolineatum</i>	A	A,J	A	A,J
Sparidae					
Pinfish	<i>Lagodon rhomboides</i>	F	A		
Sheepshead	<i>Archosargus probatocephalus</i>				
Sheepshead porgy	<i>Calamus penna</i>	M	A		
Sciaenidae					
Cubbyu	<i>Equetus umbrosus</i>	M	A		
Mullidae					
Yellow goatfish	<i>Mulloidichthys martinicus</i>	M	A		
Ephippidae					
Atlantic spadefish	<i>Chaetodipterus faber</i>	S	A		
Pomacanthidae					
Blue angelfish	<i>Holocanthus bermudensis</i>	S	A		
Pomacentridae					
Yellowtail reeffish	<i>Chromis enchrysurus</i>	M	A,J		
Labridae					
Painted wrasse	<i>Halichoeres caudalis</i>	F	A		
Balistidae					
Gray triggerfish	<i>Balistes capriscus</i>	F	A		
Total		25		8	

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. KD Select Artificial Reef fish census.

3.9 Frances Langford Memorial Reef

- Location: Sirotkin Reef
- Materials: Concrete, steel
- Maximum Depth: 152 feet
- Reef High Point: 118 feet
- Year Created: 2005
- Monitoring Date: 12/21/2008, 10/10/2009

3.9.1 History of the Frances Langford Memorial Artificial Reef

Between 2000 and 2005, several drawbridges in Martin County were decommissioned and replaced with fixed-span bridges to improve traffic flow and marine navigation. The Frank Wacha drawbridge spanned the Indian River Lagoon at Jensen Beach before it was dismantled and the materials secured for deployment as an artificial reef. Nine barge loads of these concrete and steel materials were deployed on the Frances Langford Memorial Reef in 150 feet of water within the Sirotkin Artificial Reef site. This reef was named in honor of Frances Langford, a

former Hollywood actress and long-time Martin County resident, conservationist and supporter of the Florida Oceanographic Society. Ms. Langford’s support for the Society helped establish the FOS Coastal Science Center on Hutchinson Island.

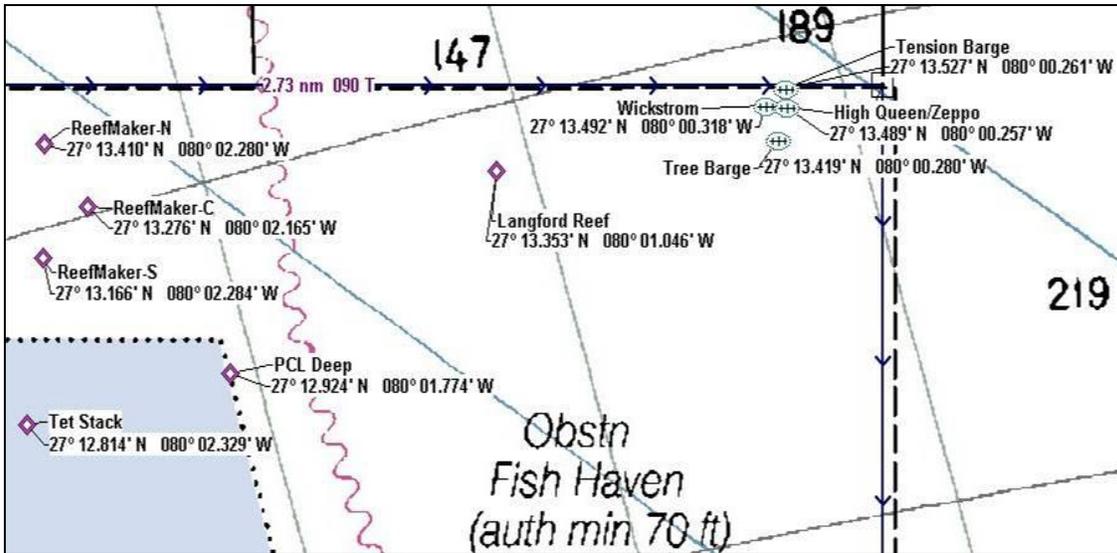


Figure 23. Chart view of Sirotkin Reef showing location of Langford Memorial Reef.

3.9.2 Structural Summary

This artificial reef is a sprawling field of large concrete and steel bridge debris on a flat, sandy seafloor. Because this reef was deployed over a period of several weeks using numerous separate loads of material (3,500 tons), the footprint is long and irregular. The large debris field is scattered over a north to south axis and varies considerably in both width and maximum relief along its length. Many components of the old bridge are plainly visible, including the bridge tender’s house, concrete support columns and sections of steel roadway grating. Some of these larger components rise 20 feet above the seafloor. The reef components appear to be stable, despite random and haphazard stacking that occurred during deployment. Reef settling remains minor and sand scouring is not significant along any of the reef margins. Figure 23 shows a chart with the location of the Langford Memorial Reef.

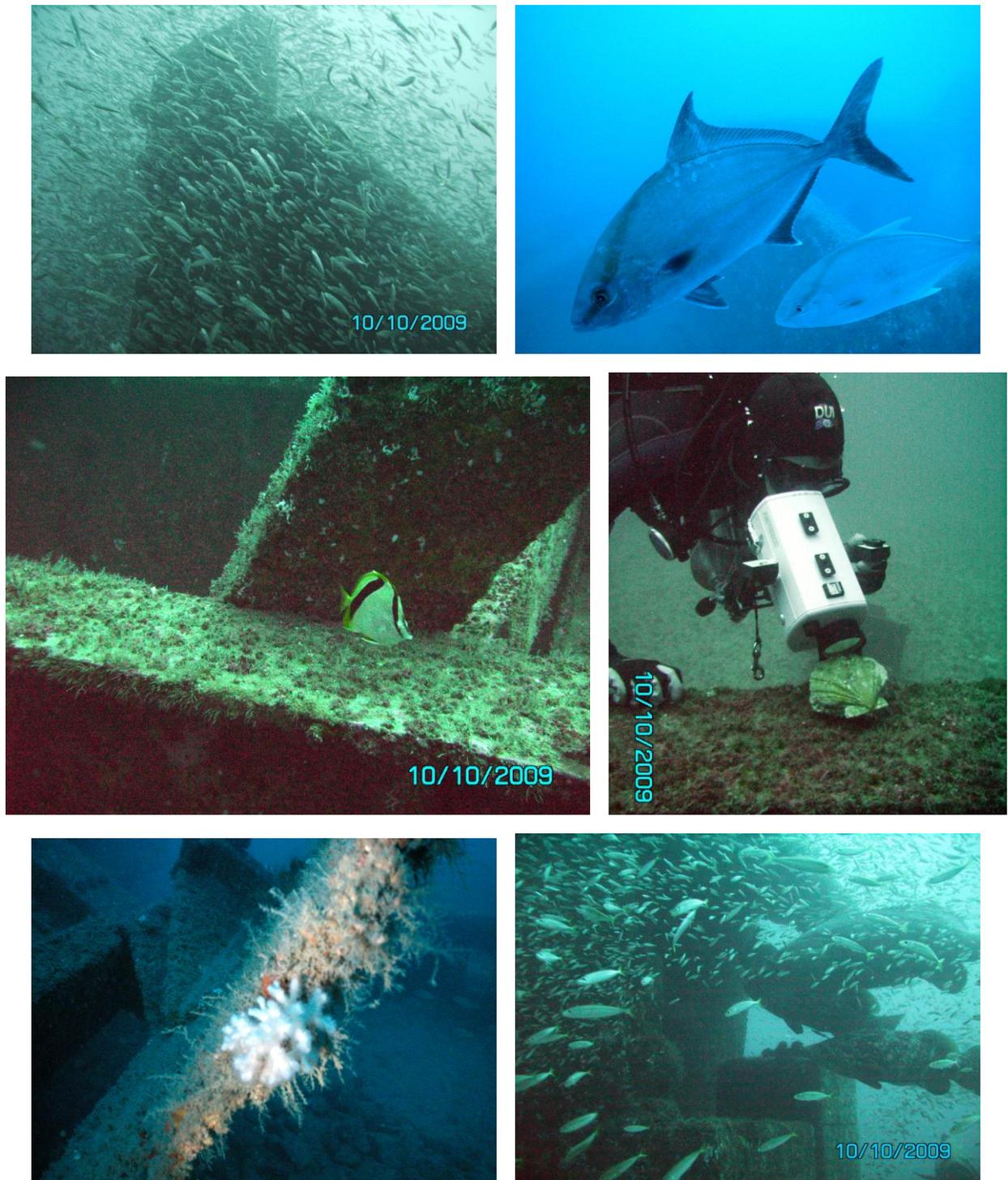


Figure 24. Frances Langford Memorial Reef photographs from 2008 (not dated) and 2009.

3.9.3 Biological Survey Results

With the exception of 2008, fish surveys indicate an increasing trend in species diversity since 2006. Seabasses and jacks are the best represented families with six and five species respectively. Vast schools of round scad were observed around and above the reef crest, while some formed tight schools around individual goliath grouper, possibly protecting them from the

faster predatory jacks and other large fishes. Most other fish species were more closely associated with the reef structure, seeking shelter within cavities when approached by the divers. Invertebrate biomass on the artificial reef had visibly increased in both 2008 and 2009 when compared to the previous monitoring efforts; some examples include sea urchins, hydroids, tube worms, tunicates, encrusting sponges, sea scallops and sea cucumbers. Numerous small colonies of *Oculina* coral were observed growing on the reef surface. Table 14 presents the fish species observed from 2006 through 2009.

Family/ Common Name	Species	2009		2008		2007	
		Abundance	Size	Abundance	Size	Abundance	Size
Elasmobranchs							
Southern stingray	<i>Dasyatis americana</i>	S	A			F	
Serranidae							
Bank seabass	<i>Centropristis ocyurus</i>	M	A	F	A	F	
Belted sandfish	<i>Serranus subligarius</i>	M	A				
Black seabass	<i>Centropristis striata</i>	M	A	M	A	M	
Gag grouper	<i>Mycteroperca microlepis</i>	F	A	M	A	M	
Goliath grouper	<i>Epinephelus itajara</i>	M	A				
Scamp	<i>Mycteroperca phenax</i>	M	A	M	A	F	
Carangidae							
Almaco jack	<i>Seriola rivoliana</i>	M	A/J	M	A		
Amberjack	<i>Seriola dumerili</i>	F	A	A	A	M	
Blue runner	<i>Caranx chrysos</i>	M	A				
Round scad	<i>Decapterus punctatus</i>	A	A,J				
Lutjanidae							
Gray snapper	<i>Lutjanus griseus</i>	M	A				
Lane snapper	<i>Lutjanus synagris</i>			F	A	F	
Vermillion snapper	<i>Rhomboplites aurorubens</i>			F	A		
Yellowtail snapper	<i>Ocyurus chrysurus</i>	F	A				
Haemulidae							
Tomtate	<i>Haemulon aurolineatum</i>	A	A	A	A		
Sparidae							
Sheepshead	<i>Archosargus probatocephalus</i>	M	A	M	A	F	
Sheepshead porgy	<i>Calamus penna</i>	M	A	M	A		
Sciaenidae							
Cubbyu	<i>Equetus umbrosus</i>	M	A,J			M	
Chaetodontidae							
Bank butterflyfish	<i>Chaetodon aya</i>	F	A	F	A	S	
Reef butterflyfish	<i>Chaetodon sedentarius</i>					F	
Pomacanthidae							
Blue angelfish	<i>Holocanthus bermudensis</i>					F	
Pomacentridae							
Yellowtail reeffish	<i>Chromis enchrysurus</i>	M	A,J				
Labridae							
Slippery dick	<i>Halichoeres bivittatus</i>	M	A				
Spotfin hogfish	<i>Bodianus pulchellus</i>	F	A			A	
Scorpaenidae							
Spotted scorpionfish	<i>Scorpaena plumeiri</i>	S	A				
Balistidae							
Gray triggerfish	<i>Balistes capriscus</i>					F	
	Total	22		12		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 14. Frances Langford Memorial Reef fish species census.

3.10 American Custom Yachts Tower Artificial Reef

- Location: Sirotkin Reef
- Materials: Steel
- Maximum Depth: 187 feet
- Reef High Point: 155 feet
- Year Created: 2008
- Monitoring Date: 10/15/2009

3.10.1 History of the American Custom Yachts Tower Reef

This artificial reef is one of four almost identical steel towers that were constructed by Harbor Branch Oceanographic Institution for the United States Navy. The navy planned to deploy these towers and use them for submarine acoustic and navigation exercises, however, the towers were never used for their original purpose and were secured by Martin County for inclusion in the artificial reef program. The towers were deployed in 2008 from a secured barge in the northeast corner of the Sirotkin reef site, near several other ships and barges. Figure 25 shows the location of the American Custom Yachts Tower in the Sirotkin Artificial Reef area.

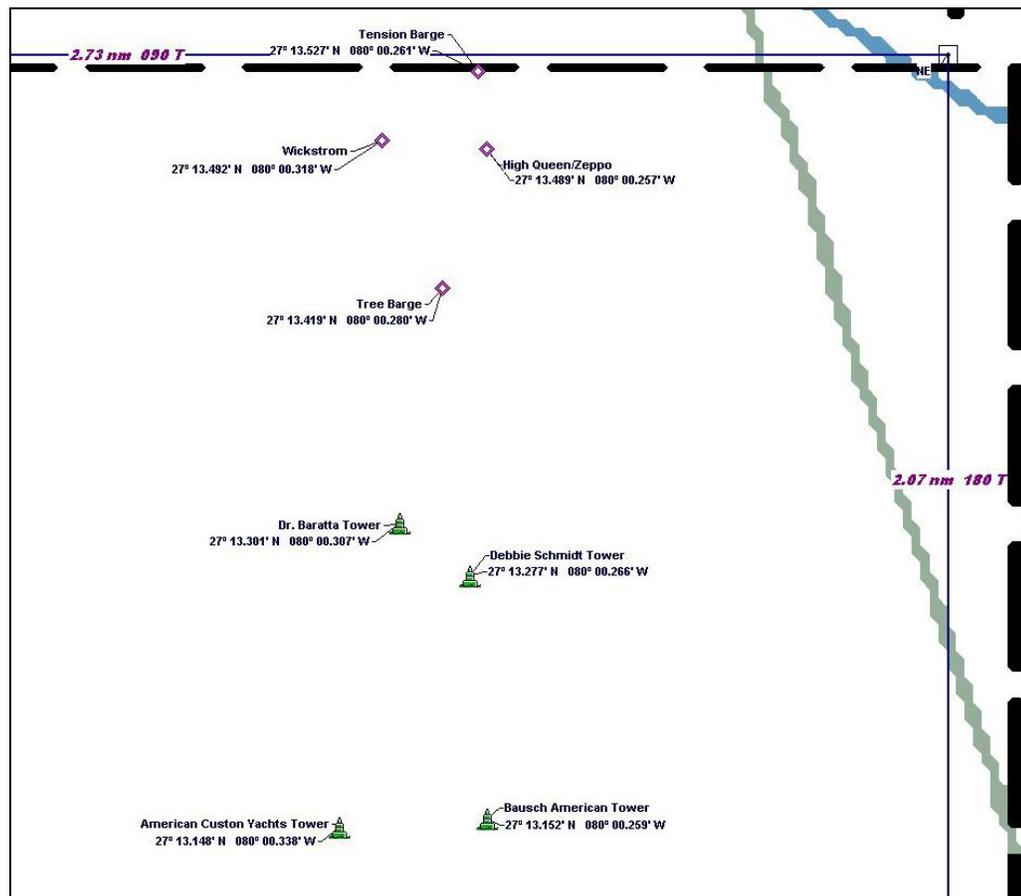


Figure 25. Chart view of Sirotkin Reef showing locations for American Custom Yachts Tower and other artificial reefs.

3.10.2 Structural Summary

Each tower was constructed from heavy tubular and plate steel with a tall latticed spire supported by three heavy, braced legs. To help ensure an upright deployment and promote stability, a bouy was affixed to the top of the tower and continues to float slightly above the tip of the spire. The maximum seafloor depth at this artificial reef site is about 187 feet and the tower stands 35 feet from the bottom. The seafloor at this site is quite firm and composed of a shell and coarse sand mixture that appears to provide a solid base for the heavy tower, as scouring is not significant around the tower's three feet.



Figure 26. American Custom Yachts Tower 2009 photographs. Note small colony of *Oculina* coral above dive computer in lower right photo.

3.10.3 Biological Survey Results

Because this tower was deployed in 2008, this report contains data from the first annual monitoring event for this reef. Fish species consisted mainly of seabasses and jacks. Black and bank seabasses were common around the tower feet and greater amberjacks patrolled the tower legs and mast. A single snowy grouper juvenile was photographed at the base of the tower (Figure 26). Vast schools of unicorn filefish were observed around the rope and barrels above the tower. Because of the strong Gulf Stream current, these filefish were all facing into the current. Invertebrate biomass on the artificial reef was already well established with barnacles, hydroids, tunicates, tube worms and numerous small colonies of *Oculina* coral. Table 14 presents the fish species observed during 2009.

Family/ Common Name	Species	2009	
		Abundance	Size
Serranidae			
Bank seabass	<i>Centropristis ocyurus</i>	M	A
Black seabass	<i>Centropristis striata</i>	M	A
Snowy grouper	<i>Epinephelus niveatus</i>	S	J
Carangidae			
Almaco jack	<i>Seriola rivoliana</i>	M	A
Amberjack	<i>Seriola dumerili</i>	M	A
Chaetodontidae			
Bank butterflyfish	<i>Chaetodon aya</i>	F	A
Balistidae			
Unicorn filefish	<i>Aluterus monoceros</i>	M	A
	Total	7	

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. American Custom Yachts Tower Artificial Reef fish species census.

3.11 Mango Artificial Reef

- Location: Ernst Reef
- Materials: Concrete
- Maximum Depth: 61 feet
- Reef High Point: 48 feet
- Year Created: 2007
- Monitoring Date: 6/27/2008, 10/8/2009

3.11.1 History of the Mango Artificial Reef

Staff from Martin County Engineering sought to simplify the collection and transport of materials of opportunity to aid artificial reef construction. Arrangements were made to allow local contractors to drop acceptable reef materials at the Martin County Landfill with no tipping fees. These materials were taken to Harbor Pointe Park in Ft. Pierce, loaded on barges, and brought to the north end of the Ernst Artificial Reef area. On June 15 and 26, 2007, 440 tons of concrete culverts, bridge components, and other large forms were unloaded from an anchored barge to form the Mango Artificial Reef.

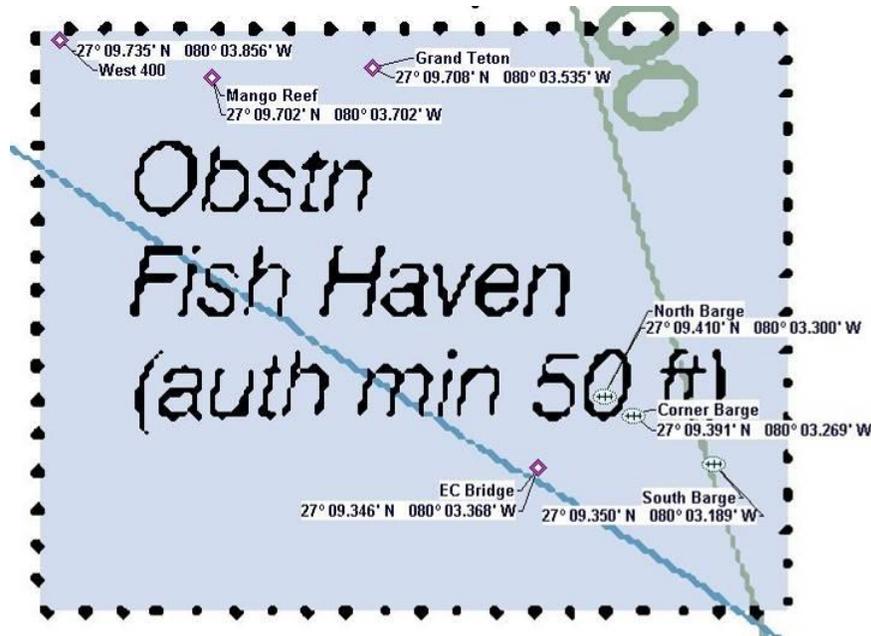


Figure 27. Chart view of the Donaldson Reef with West 400, Grand Teton and Mango Artificial Reefs.

3.11.2 Structural Summary

The maximum depth at this artificial reef site is about 61 feet with a maximum relief of about 13 feet. The footprint of the site is generally round and occupies about 2.0 acres of seafloor. The deployment barge was securely moored at two points when the reef materials were dropped and the large concrete components settled in a single pile, although a few pieces settled to the bottom a short distance from the reef pile. Several large culvert sections provide cavernous recesses that are used extensively by large and small fish alike. The seafloor at this site is comprised of fine sand and appears to have sunken or subsided in the years since deployment, so that it now sits within a bowl-like depression. Scouring does not appear to be a significant factor at this reef site. Figure 27 shows a chart with the location of the Mango Reef.

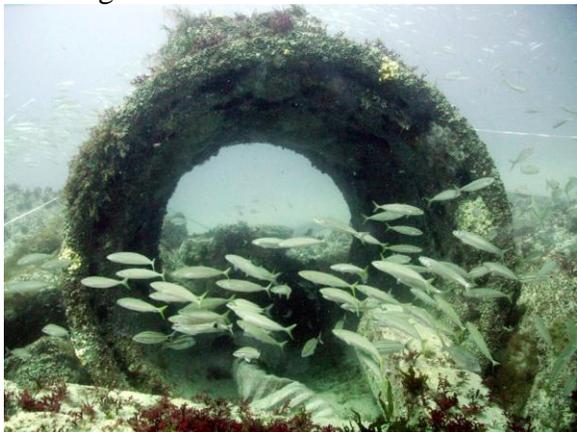




Figure 28. Mango Artificial Reef photographs from 2008 and 2009.

3.11.3 Biological Survey Results

Fish surveys indicate an increasing trend in species diversity since 2008, although 2009 was only the second year of monitoring since deployment. Seabasses and jacks represented the most numerous species in both 2008 and 2009, although grunts and snappers were also common. Vast schools of adult and juvenile round scad were observed around and above the reef crest. Like most of the artificial reef locations offshore of Martin County, several adult and sub-adult goliath grouper were observed on the Mango Reef. Invertebrate biomass on the artificial reef also appeared to have increased since deployment. The most common species included sea urchins, hydroids, sea anemones, tube worms, fire worms and encrusting sponges. Sea cucumbers, tunicates and various crabs were also observed. Table 16 presents the fish species observed during 2008 and 2009.

Family/ Common Name	Species	2009		2008	
		Abundance	Size	Abundance	Size
Muraenidae					
Purplemouth moray	<i>Gymnothorax moringa</i>	S	A		
Spotted moray	<i>Gymnothorax vicinus</i>	S	A		
Serranidae					
Bank seabass	<i>Centropristis ocyurus</i>			M	A
Belted sandfish	<i>Serranus subligarius</i>	M	A,J	M	A
Black grouper	<i>Mycteroperca bonaci</i>	S	J		
Black seabass	<i>Centropristis striata</i>	M	A,J	M	A,J
Goliath grouper	<i>Epinephelus itajara</i>	F	A,J	S	A
Harlequin bass	<i>Serranus tigrinus</i>	S	A		
Scamp	<i>Mycteroperca phenax</i>	M	J		
Grammistidae					
Whitespotted soapfish	<i>Rypticus maculatus</i>	F	A		
Apogonidae					
Twospot cardinalfish	<i>Apogon pseudomaculatus</i>	M	A		
Echeneididae					
Sharksucker	<i>Echeneis naucrates</i>	S	J		
Carangidae					
Almaco jack	<i>Seriola rivoliana</i>	F	A/J		
Bar jack	<i>Caranx ruber</i>	S	J		

Family/ Common Name	Species	2009		2008	
		Abundance	Size	Abundance	Size
Blue runner	<i>Caranx chrysos</i>	M	A	M	A
Rainbow runner	<i>Elegatis bipinnulata</i>	F	A		
Round scad	<i>Decapterus punctatus</i>	A	A,J		
Yellow jack	<i>Caranx bartholomaei</i>				
Lutjanidae					
Gray snapper	<i>Lutjanus griseus</i>	M	A	F	A
Lane snapper	<i>Lutjanus synagris</i>	M	A,J	M	A
Red Snapper	<i>Lutjanus campechanus</i>			F	J
Vermillion snapper	<i>Rhomboplites aurorubens</i>			M	A
Yellowtail snapper	<i>Ocyurus chrysurus</i>	F	A,J		
Haemulidae					
Pigfish	<i>Orthopristis chrysoptera</i>	F	A		
Porkfish	<i>Anisotremus virginicus</i>	F	A		
Tomtate	<i>Haemulon aurolineatum</i>	A	A,J	M	A
White grunt	<i>Haemulon plumieri</i>	F	A		
Sparidae					
Sheepshead	<i>Archosargus probatocephalus</i>	M	A	F	A
Sheepshead pogy	<i>Calamus penna</i>	M	A	F	A
Sciaenidae					
Cubbyu	<i>Equetus umbrosus</i>	M	A	M	A,J
Pomacanthidae					
Blue angelfish	<i>Holocanthus bermudensis</i>	F	A		
Pomacentridae					
Beaugregory	<i>Pomacentrus leucostictus</i>	M	A,J	M	A,J
Yellowtail reeffish	<i>Chromis enchrysurus</i>	M	A		
Labridae					
Slippery dick	<i>Halichoeres bivittatus</i>	M	A,J	F	A
Spanish hogfish	<i>Bodianus rufus</i>	F	A,J		
Sphyraenidae					
Sennet	<i>Sphyraena guachancho</i>			M	A
Acanthuridae					
Doctorfish	<i>Acanthurus chirurgus</i>	F	J		
Scombridae					
Little tunny	<i>Euthynnus alletteratus</i>			M	A
Tetraodontidae					
Bandtail puffer	<i>Sphoeroides spengleri</i>			M	A
Balistidae					
Gray triggerfish	<i>Balistes capriscus</i>	S	A		
	Total	33		18	

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 16. Mango Artificial Reef fish species census.

3.12 Grand Teton Artificial Reef

- Location: Ernst Reef
- Materials: Concrete, steel
- Maximum Depth: 62 feet
- Reef High Point: 34 feet
- Year Created: 2007
- Monitoring Date: 6/19/2008, 9/26/2009

3.12.1 History of the Grand Teton Artificial Reef

Staff from Martin County Engineering sought to simplify the collection and transport of materials of opportunity to aid artificial reef construction. Arrangements were made to allow local contractors to drop acceptable reef materials at the Martin County Landfill with no tipping fees. These materials were taken to Harbor Pointe Park in Ft. Pierce, loaded on barges, and brought to the north end of the Ernst Artificial Reef area. On June 15 and 26, 2007, 728 tons of concrete culverts, bridge components, and other large forms were unloaded from an anchored barge to form the Grand Teton Artificial Reef.

3.12.2 Structural Summary

The maximum depth at this artificial reef site is about 62 feet with a maximum relief of about 28 feet. The footprint of the site is generally round but has an irregular margin and occupies about 0.5 acres of seafloor. The sheer volume and variety of materials placed at this site occupy a relatively small footprint. The deployment barge was securely moored at two points when the reef materials were dropped and the large concrete components settled in a single pile, although a few pieces settled to the bottom a short distance from the reef pile. Numerous concrete light posts were placed on this reef and several project upward from the reef pile prominently. Several large culvert sections provide cavernous recesses that are used extensively by large and small fish alike. The seafloor at this site is comprised of a shell/coarse sand mixture and appears to provide a solid base for the heavy concrete and steel pieces, as scouring is not significant. Figure 27 shows a chart with the location of the Grand Teton Artificial Reef.



Figure 29. Grand Teton Artificial Reef photographs from 2008 and 2009.

3.12.3 Biological Survey Results

Fish surveys indicate an increasing trend in species diversity since 2008, although 2009 was only the second year of monitoring since deployment. Seabasses and jacks represented the most numerous species in both 2008 and 2009, although grunts, wrasses and snappers were also common. Vast schools of adult and juvenile round scad were observed around and above the

reef crest. Additionally, two adult red lionfish were observed on this reef and may constitute the first sightings of this invasive species off the coast of Martin County. Invertebrate biomass on the artificial reef also appeared to have increased since deployment. The most common species included sea urchins, hydroids, tube worms, sea anemones, encrusting sponges and sea cucumbers. Fire worms and various crabs were also observed. Table 17 presents the fish species observed during 2008 and 2009.

Family/ Common Name	Species	2009		2008	
		Abundance	Size	Abundance	Size
Elasmobranchs					
Southern stingray	<i>Dasyatis americana</i>			F	A
Centropomidae					
Snook	<i>Centropomus undecimalis</i>	F	A	M	A
Serranidae					
Belted sandfish	<i>Serranus subligarius</i>	A	A	M	A
Black seabass	<i>Centropristis striata</i>	F	A	M	A
Goliath grouper	<i>Epinephelus itajara</i>	F-4	A	F-4	A
Grammistidae					
Whitespotted soapfish	<i>Rypticus maculatus</i>	F	A		
Apogonidae					
Twospot cardinalfish	<i>Apogon pseudomaculatus</i>	F	A		
Carangidae					
Amberjack	<i>Seriola dumerili</i>			M	A
Blue runner	<i>Caranx chrysos</i>	A	A	M	A
Rainbow runner	<i>Elegatis bipinnulata</i>	M	A		
Round scad	<i>Decapterus punctatus</i>	A	A	A	A
Lutjanidae					
Gray snapper	<i>Lutjanus griseus</i>	F	A	M	A
Lane snapper	<i>Lutjanus synagris</i>	F	A	M	A
Red snapper	<i>Lutjanus campechanus</i>			F	J
Vermillion snapper	<i>Rhomboplites aurorubens</i>			M	A
Haemulidae					
Pigfish	<i>Orthopristis chrysoptera</i>	M	A	F	A
Tomtate	<i>Haemulon aurolineatum</i>	A	A,J	A	A
Sparidae					
Sheepshead	<i>Archosargus probatocephalus</i>	M	A	M	A
Sheepshead porgy	<i>Calamus penna</i>	F	A	F	A
Sciaenidae					
Cubbyu	<i>Equetus umbrosus</i>	M	A,J	M	A,J
Ephippidae					
Atlantic spadefish	<i>Chaetodipterus faber</i>	F	A	M	A
Chaetodontidae					
Reef butterflyfish	<i>Chaetodon sedentarius</i>	F	A		
Pomacentridae					
Beaugregory	<i>Pomacentrus leucostictus</i>			M	A,J
Yellowtail reeffish	<i>Chromis enchrysurus</i>	M	A,J		
Clinidae					
Hairy blenny	<i>Labrisomus nuchipinnus</i>			M	A
Scombridae					
Little tunny	<i>Euthynnus alletteratus</i>			M	A
Scorpaenidae					
Red lionfish	<i>Pterois volitans</i>	F-2	A		

Family/ Common Name	Species	2009		2008	
		Abundance	Size	Abundance	Size
Balistidae					
Gray triggerfish	<i>Balistes capricus</i>			F	A
Tetraodontidae					
Bandtail puffer	<i>Sphoeroides spengleri</i>	F	A,J	M	A,J
Sharpnose puffer	<i>Canthigaster rostrata</i>	F	A,J		
	Total	22		23	

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. Grand Teton Artificial Reef fish species census.

3.13 West 400 Artificial Reef

- Location: Ernst Reef
- Materials: Concrete
- Maximum Depth: 62 feet
- Reef High Point: 46 feet
- Year Created: 2007
- Monitoring Date: 6/27/2008, 9/26/2009

3.13.1 History of the West 400 Artificial Reef

Staff from Martin County Engineering sought to simplify the collection and transport of materials of opportunity to aid artificial reef construction. Arrangements were made to allow local contractors to drop acceptable reef materials at the Martin County Landfill with no tipping fees. These materials were taken to Harbor Pointe Park in Ft. Pierce, loaded on barges, and brought to the north end of the Ernst Artificial Reef area. On June 15, 2007, 400 tons of concrete culverts, bridge components, and other large forms were unloaded from an anchored barge to form the West 400 Artificial Reef.

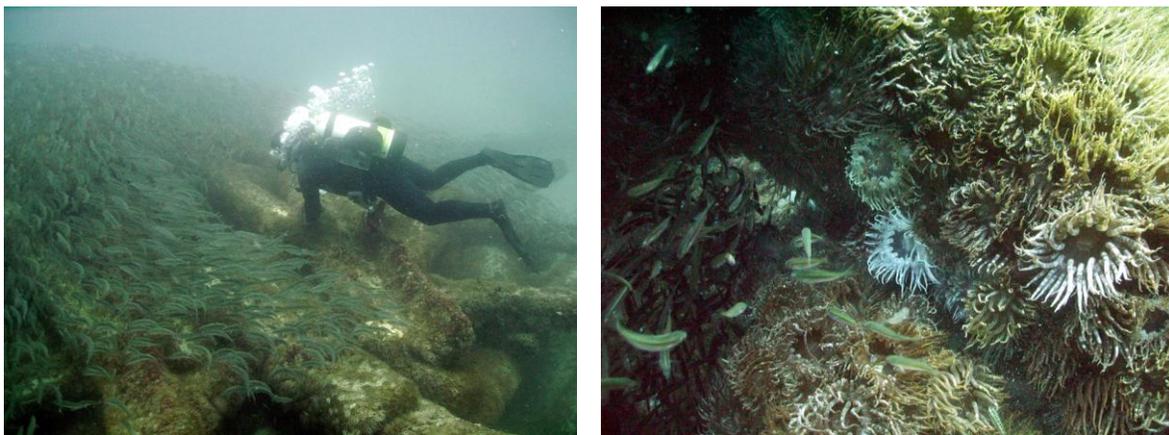


Figure 30. West 400 Artificial Reef photographs from 2008.

3.13.2 Structural Summary

The maximum depth at this artificial reef site is about 62 feet with a maximum relief of about 12 feet. The footprint of the site is generally round with an irregular margin and occupies about 0.5 acres of seafloor. The deployment barge was securely moored at two points when the reef materials were dropped and the large concrete components settled in a single pile, although a few pieces settled to the bottom a short distance from the reef pile. Several large culvert sections provide cavernous recesses that are used extensively by large and small fish alike. The seafloor at this site is comprised of a shell/coarse sand mixture and appears to provide a solid base for the heavy concrete and steel pieces, as scouring is not significant. Figure 27 shows a chart with the location of the West 400 Artificial Reef.

3.13.3 Biological Survey Results

Fish surveys indicate an increasing trend in species diversity since 2008, although 2009 was only the second year of monitoring since deployment. Seabasses and jacks represented the most numerous species in both 2008 and 2009, although grunts, wrasses and snappers were also common. Vast schools of adult and juvenile round scad were observed around and above the reef crest. Invertebrate biomass on the artificial reef also appeared to have increased since deployment. Most common species included sea urchins, hydroids, tube worms, encrusting sponges and sea cucumbers. Fire worms and various crabs were also observed. Table 18 presents the fish species observed during 2008 and 2009.

Family/ Common Name	Species	2009		2008	
		Abundance	Size	Abundance	Size
Elasmobranchs					
Southern stingray	<i>Dasyatis americana</i>	S	A		
Centropomidae					
Common snook	<i>Centropomus undecimalis</i>	F	A	F	A
Serranidae					
Belted sandfish	<i>Serranus subligarius</i>	M	A	M	A
Black seabass	<i>Centropristis striata</i>	M	A,J	M	A,J
Goliath grouper	<i>Epinephelus itajara</i>	F-7	A	F	A
Scamp	<i>Mycteroperca phenax</i>	S	J		
Grammistidae					
Whitespotted soapfish	<i>Rypticus maculatus</i>	F	A,J		
Echeneididae					
Sharksucker	<i>Echeneis naucrates</i>	F	A		
Carangidae					
Blue runner	<i>Caranx chrysos</i>	A	A	F	A,J
Round scad	<i>Decapterus punctatus</i>	A	A	A	A
Lutjanidae					
Gray snapper	<i>Lutjanus griseus</i>			F	A
Lane snapper	<i>Lutjanus synagris</i>			F	A,J
Yellowtail snapper	<i>Ocyurus chrysurus</i>	S	A	F	A
Haemulidae					
Tomtate	<i>Haemulon aurolineatum</i>	A	A,J	M	A
Sparidae					
Sailor's choice	<i>Lagodon parra</i>			F	J
Sheepshead	<i>Archosargus probatocephalus</i>	M	A	F	A

Family/ Common Name	Species	2009		2008	
		Abundance	Size	Abundance	Size
Sciaenidae					
Cubbyu	<i>Equetus umbrosus</i>	M	A	M	A
Ephippidae					
Atlantic spadefish	<i>Chaetodipterus faber</i>	F	A		
Chaetodontidae					
Reef butterflyfish	<i>Chaetodon sedetarius</i>			F	A
Pomacanthidae					
Blue angelfish	<i>Holocanthus bermudensis</i>	F	A,J		
Pomacentridae					
Beaugregory	<i>Pomacentrus leucostictus</i>	F	A,J	F	A,J
Yellowtail reeffish	<i>Chromis enchrysurus</i>	S	J	F	J
Labridae					
Slippery dick	<i>Halichoeres bivittatus</i>	F	J		
Clinidae					
Hairy blenny	<i>Labrisomus nuchipinnus</i>			F	A
Scombridae					
Little tunny	<i>Euthynnus alletteratus</i>			M	A
Spanish mackerel	<i>Scomberomorus maculatus</i>	F	A		
Istiophoridae					
Saifish	<i>Istiophorus platypterus</i>	S	A		
Scorpaenidae					
Spotted scorpionfish	<i>Scorpaena plumeiri</i>			F	A
Balistidae					
Bandtail puffer	<i>Spheroides spengleri</i>			F	A
Orangespotted filefish	<i>Cantherhines pullus</i>	S	J		
	Total	22		20	

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 18. West 400 Artificial Reef fish species census.

3.14 Fogel Capital Management Artificial Reef

- Location: South County Reef
- Materials: Concrete
- Maximum Depth: 67 feet
- Reef High Point: 60 feet
- Year Created: 2007
- Monitoring Date: 8/31/2009

3.14.1 History of the Fogel Capital Management Artificial Reef

Nearly 2,000 tons of large concrete and steel construction waste was delivered to Harbour Pointe Park in Ft. Pierce in 2007 and early 2008 and stockpiled prior to deployment offshore of Martin County. In June 2008, it was loaded on barges and shipped to the South County Artificial Reef area. A total of 245 tons of these materials were dropped in the southwest corner of the reef area from the anchored barge to form the Fogel Capital Management Artificial Reef.

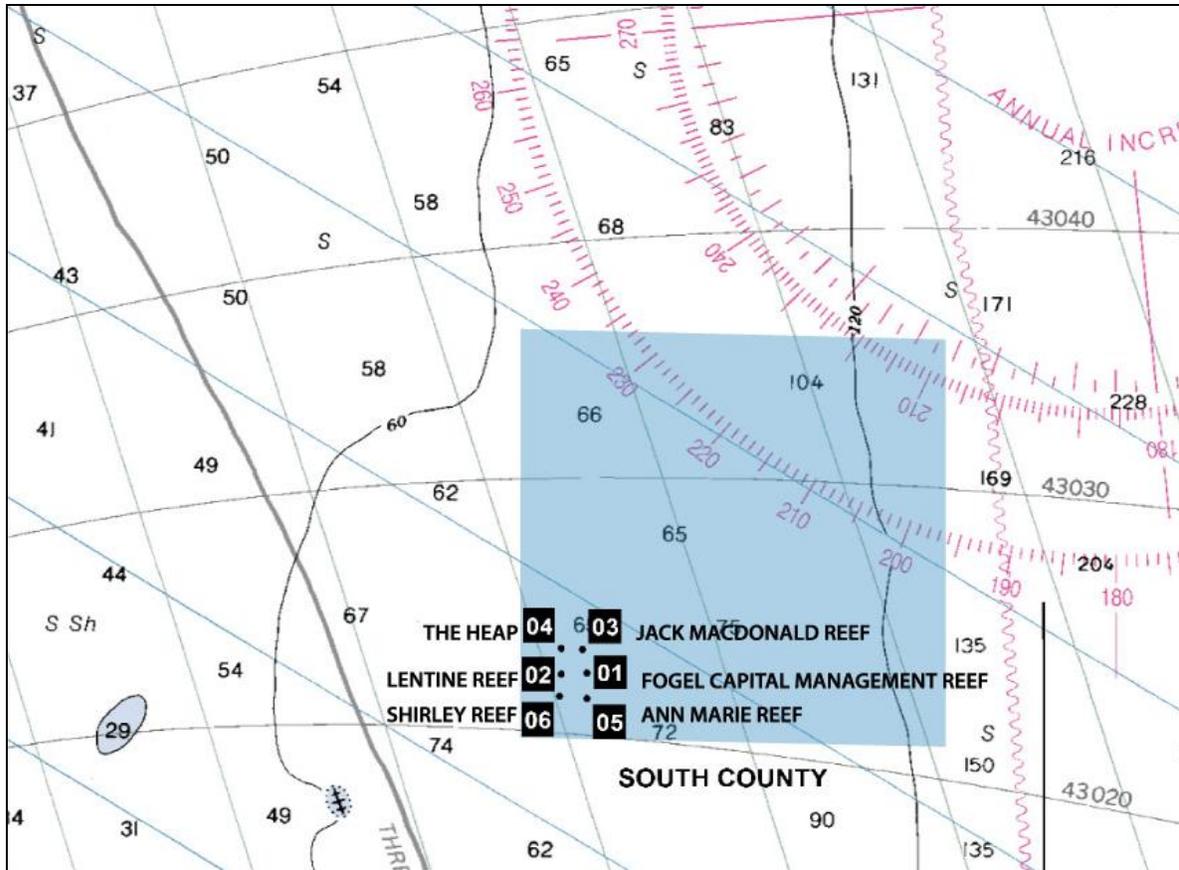


Figure 31. Chart view of South County Artificial Reef area.

3.14.2 Structural Summary

The maximum depth at this artificial reef site is about 67 feet with a maximum relief of about 7 feet. The footprint of the site is an irregular form with a southeast-to-northwest axis and occupies about 0.5 acres of seafloor. The deployment barge was securely moored at two points when the reef materials were dropped and the large concrete components settled in a single pile, although a few pieces settled to the bottom a short distance from the reef pile. Several large culvert sections provide cavernous recesses that are used extensively by large and small fish alike. The seafloor at this site is comprised of a shell/coarse sand mixture and appears to provide a solid base for the heavy concrete and steel pieces, as scouring is not significant. Figure 31 shows a chart with the location of the Fogel Capital Management Reef.

3.14.3 Biological Survey Results

Fish surveys indicate a diverse assemblage of fishes, although 2009 was only the first year of monitoring since deployment. Seabasses, snappers and grunts represented the most numerous species of fishes at this reef. As at most of the South County Reef sites, vast schools of adult and juvenile round scad were abundant around and above the reef crest, while the demersal species showed an affinity for the reef itself and the numerous crevices and refugia. Plants and invertebrates observed on the artificial reef included red, brown and green algae, hydroids, sea

anemones, sea urchins, barnacles, sea cucumbers, arrow crabs, hermit crabs and encrusting sponges. Table 19 presents the fish species observed during 2009.

Family/ Common Name	Species	2009	
		Abundance	Size
Elasmobranchs			
Spotted eagle ray	<i>Aetobatus narinari</i>	F	A
Centropomidae			
Common snook	<i>Centropomus undecimalis</i>	F	A
Serranidae			
Black seabass	<i>Centropristis striata</i>	M	A,J
Goliath grouper	<i>Epinephelus itajara</i>	S	A
Scamp	<i>Mycteroperca phenax</i>	M	A/J
Tobaccofish	<i>Serranus tabacarius</i>	F	A
Carangidae			
Amberjack	<i>Seriola dumerili</i>	F	A
Round scad	<i>Decapterus punctatus</i>	A	A
Lutjanidae			
Gray snapper	<i>Lutjanus griseus</i>	F	A,J
Red snapper	<i>Lutjanus campechanus</i>	F	J
Yellowtail snapper	<i>Ocyurus chrysurus</i>	F	A,J
Haemulidae			
Porkfish	<i>Anisotremus virginicus</i>	F	A,J
Tomtate	<i>Haemulon aurolineatum</i>	M	A,J
White margate	<i>Haemulon album</i>	F	A,J
Sparidae			
Sheepshead	<i>Archosargus probatocephalus</i>	F	A
Sheepshead porgy	<i>Calamus penna</i>	F	A,J
Sciaenidae			
Cubbyu	<i>Equetus umbrosus</i>	M	A,J
Pomacentridae			
Beaugregory	<i>Pomacentrus leucostictus</i>	F	A,J
Scorpaenidae			
Spotted scorpionfish	<i>Scorpaena plumeiri</i>	F	A
	Total	19	

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. Fogel Capital Management Artificial Reef fish species census.

3.15 Jack MacDonald Artificial Reef

- Location: South County Reef
- Materials: Concrete
- Maximum Depth: 70 feet
- Reef High Point: 63 feet
- Year Created: 2008
- Monitoring Date: 9/1/2009

3.15.1 History of the Jack MacDonald Artificial Reef

Nearly 2,000 tons of large concrete and steel construction waste was delivered to Harbour Pointe Park in Ft. Pierce in 2007 and early 2008 and stockpiled prior to deployment offshore of Martin County. In June 2008, it was loaded on barges and shipped to the South County Artificial Reef area. A total of 272 tons of these materials were dropped in the southwest corner of the reef area from the anchored barge to form the Jack MacDonald Artificial Reef.



Figure 32. Jack MacDonald Reef photographs from 2009.

3.15.2 Structural Summary

The maximum depth at this artificial reef site is about 68 feet with a maximum relief of about 9 feet. The footprint of the site is an irregular form with a southeast-to-northwest axis and occupies about 0.5 acres of seafloor. The deployment barge was securely moored at two points when the reef materials were dropped and the large concrete components settled in a single pile, although a few pieces settled to the bottom a short distance from the reef pile. Several large culvert sections provide cavernous recesses that are used extensively by large and small fish alike. The seafloor at this site is comprised of a shell/coarse sand mixture and appears to provide a solid base for the heavy concrete and steel pieces, as scouring is not significant. Figure 31 shows a chart with the location of the Jack MacDonald Reef.

3.15.3 Biological Survey Results

Fish surveys indicate a diverse assemblage of fishes, although 2009 was only the first year of monitoring since deployment. Seabasses and jacks represented the most numerous species of fishes. As at most of the South County Reef sites, vast schools of adult and juvenile round scad were abundant around and above the reef crest, while the demersal species showed an affinity for the reef itself and the numerous crevices and refugia. Adult and juvenile tomtate grunts were abundant on this reef as at most other artificial reefs off Martin County. Plants and invertebrates observed on the artificial reef included red, brown and green algae, hydroids, sea anemones, sea urchins, barnacles, sea cucumbers, arrow crabs, hermit crabs and encrusting sponges. Table 20 presents the fish species observed during 2009.

Family/ Common Name	Species	2009	
		Abundance	Size
Centropomidae			
Common snook	<i>Centropomus undecimalis</i>	S	A
Serranidae			
Bank seabass	<i>Centropristis ocyurus</i>	F	A
Belted sandfish	<i>Serranus subligarius</i>	F	A
Black seabass	<i>Centropristis striata</i>	M	A,J
Gag grouper	<i>Mycteroperca microlepis</i>	S	J
Goliath grouper	<i>Epinephelus itajara</i>	S	A
Apogonidae			
Twospot cardinalfish	<i>Apogon pseudomaculatus</i>	F	A
Carangidae			
Amberjack	<i>Seriola dumerili</i>	M	A,J
Blue runner	<i>Caranx chrysos</i>	A	A
Round scad	<i>Decapterus punctatus</i>	A	A
Lutjanidae			
Gray snapper	<i>Lutjanus griseus</i>	F	A
Lane snapper	<i>Lutjanus synagris</i>	F	J,A
Haemulidae			
Black margate	<i>Anisotremus surinamensis</i>	F	A
Tomtate	<i>Haemulon aurolineatum</i>	A	A,J
Sparidae			
Sheepshead	<i>Archosargus probatocephalus</i>	F	A
Sheepshead porgy	<i>Calamus penna</i>	F	A
Sciaenidae			
Cubbyu	<i>Equetus umbrosus</i>	F	A,J
Chaetodontidae			
Reef butterflyfish	<i>Chaetodon sedentarius</i>	F	A
Pomacanthidae			
Blue angelfish	<i>Holocanthus bermudensis</i>	S	A
French angelfish	<i>Pomacanthus paru</i>	S	A
Pomacentridae			
Yellowtail reeffish	<i>Chromis enchrysurus</i>	M	A,J
Labridae			
Slippery dick	<i>Halichoeres bivittatus</i>	M	J
Scorpaenidae			
Spotted scorpionfish	<i>Scorpaena plumeiri</i>	F	A
Tetraodontidae			
Bandtail puffer	<i>Sphoeroides spengleri</i>	F	A
Sharpnose puffer	<i>Canthigaster rostrata</i>	F	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 20. Jack MacDonald Artificial Reef fish species census.

3.16 Shirley Artificial Reef

- Location: South County Reef
- Materials: Concrete, steel

- Maximum Depth: 66 feet
- Reef High Point: 61 feet
- Year Created: 2007
- Monitoring Date: 10/8/2009

3.16.1 History of Shirley Artificial Reef

Nearly 2,000 tons of large concrete and steel construction waste was delivered to Harbour Pointe Park in Ft. Pierce in 2007 and early 2008 and stockpiled prior to deployment offshore of Martin County. In June 2008, it was loaded on barges and shipped to the South County Artificial Reef area. A total of 249 tons of these materials were dropped in the southwest corner of the reef area from the anchored barge to form the Shirley Artificial Reef.

3.16.2 Structural Summary

The maximum depth at this artificial reef site is about 66 feet with a maximum relief of about 5 feet. The footprint of the site is generally round with an irregular margin and occupies about 0.4 acres of seafloor. The deployment barge was securely moored at two points when the reef materials were dropped and the large concrete components settled in a single pile, although a few pieces settled to the bottom a short distance from the reef pile. Several large culvert sections provide cavernous recesses that are used extensively by large and small fish alike. The seafloor at this site is comprised of a shell/coarse sand mixture and appears to provide a solid base for the heavy concrete pieces, as scouring is not significant. Figure 31 shows a chart with the location of the Shirley Reef.





Figure 33. Shirley Artificial Reef 2009 photographs. Note the juvenile snowy grouper in the lower left photo.

3.16.3 Biological Survey Results

Fish surveys indicate a particularly diverse assemblage of fishes, although 2009 was only the first year of monitoring since deployment. Jacks, seabasses and wrasses represented the most numerous species of fishes. As at most of the South County Reef sites, vast schools of adult and juvenile round scad were abundant around and above the reef crest, while the demersal species showed an affinity for the reef itself and the numerous crevices and refugia. Plants and invertebrates observed on the artificial reef included red, brown and green algae, hydroids, sea anemones, sea urchins, barnacles, sea cucumbers, arrow crabs, hermit crabs and encrusting sponges. Table 21 presents the fish species observed during 2009.

Family/ Common Name	Species	2009	
		Abundance	Size
Serranidae			
Belted sandfish	<i>Serranus subligarius</i>	M	A,J
Black seabass	<i>Centropristis striata</i>	M	A,J
Goliath grouper	<i>Epinephelus itajara</i>	F	A
Snowy grouper	<i>Epinephelus niveatus</i>	S	J
Apogonidae			
Flamefish	<i>Apogon maculatus</i>	F	A
Twospot cardinalfish	<i>Apogon pseudomaculatus</i>	F	A
Echeneididae			
Sharksucker	<i>Echeneis naucrates</i>	S	A
Carangidae			
Almaco jack	<i>Seriola rivoliana</i>	F	A/J
Amberjack	<i>Seriola dumerili</i>	F	J
Bar jack	<i>Caranx ruber</i>	S	J
Blue runner	<i>Caranx chrysos</i>	M	A
Rainbow runner	<i>Elegatis bipinnulata</i>	F	A
Redtail scad	<i>Decapterus tabl</i>	M	A
Round scad	<i>Decapterus punctatus</i>	A	A,J

Family/ Common Name	Species	2009	
		Abundance	Size
Lutjanidae			
Gray snapper	<i>Lutjanus griseus</i>	M	A
Lane snapper	<i>Lutjanus synagris</i>	M	A,J
Yellowtail snapper	<i>Ocyurus chrysurus</i>	F	A,J
Haemulidae			
Black margate	<i>Anisotremus surinamensis</i>	F	A
Tomtate	<i>Haemulon aurolineatum</i>	A	A,J
Sparidae			
Sheepshead	<i>Archosargus probatocephalus</i>	M	A
Sheepshead porgy	<i>Calamus penna</i>	M	A
Sciaenidae			
Cubby	<i>Equetus umbrosus</i>	F	A
Pomacanthidae			
Blue angelfish	<i>Holocanthus bermudensis</i>	F	A,J
French angelfish	<i>Pomacanthus paru</i>	S	A
Pomacentridae			
Beaugregory	<i>Pomacentrus leucostictus</i>	M	A,J
Blue chromis	<i>Chromis cyaneus</i>	F	A
Yellowtail reeffish	<i>Chromis enchrysurus</i>	M	A,J
Labridae			
Bluehead	<i>Thalassoma bifasciatum</i>	S	A
Slippery dick	<i>Halichoeres bivittatus</i>	M	A,J
Spanish hogfish	<i>Bodianus rufus</i>	F	A
Spotfin hogfish	<i>Bodianus pulchellus</i>	F	A
Scaridae			
Stoplight parrotfish	<i>Sparisoma viride</i>	S	J
Acanthuridae			
Doctorfish	<i>Acanthurus chirurgus</i>	F	A,J
Scorpaenidae			
Spotted scorpionfish	<i>Scorpaena plumeiri</i>	F	A
Tetraodontidae			
Bandtail puffer	<i>Sphoeroides spengleri</i>	F	A
Sharpnose puffer	<i>Canthigaster rostrata</i>	S	A
	Total	36	

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. Shirley Artificial Reef fish species census.

3.17 The Heap Artificial Reef

- Location: South County Reef
- Materials: Concrete
- Maximum Depth: 68 feet
- Reef High Point: 63 feet

- Year Created: 2007
- Monitoring Date: 10/8/2009

3.17.1 History of the Heap Artificial Reef

Nearly 2,000 tons of large concrete and steel construction waste was delivered to Harbour Pointe Park in Ft. Pierce in 2007 and early 2008 and stockpiled prior to deployment offshore of Martin County. In June 2008, it was loaded on barges and shipped to the South County Artificial Reef area. A total of 268 tons of these materials were dropped in the southwest corner of the reef area from the anchored barge to form the Heap Artificial Reef.



Figure 34. The Heap Artificial Reef 2008 and 2009 photographs.

3.17.2 Structural Summary

The maximum depth at this artificial reef site is about 68 feet with a maximum relief of about 5 feet. The footprint of the site is generally round with an irregular margin and occupies about 0.4 acres of seafloor. The deployment barge was securely moored at two points when the reef materials were dropped and the large concrete components settled in a single pile, although a few pieces settled to the bottom a short distance from the reef pile. Several large culvert sections provide cavernous recesses that are used extensively by large and small fish alike. The seafloor

at this site is comprised of a shell/coarse sand mixture and appears to provide a solid base for the heavy concrete and steel pieces, as scouring is not significant. Figure 31 shows a chart with the location of the Heap artificial reef.

3.17.3 Biological Survey Results

Fish surveys indicate a diverse assemblage of fishes, although 2009 was only the first year of monitoring since deployment. Seabasses, jacks, snappers, grunts and damselfish represented the most numerous species of fishes. As at most of the South County Reef sites, vast schools of adult and juvenile round scad were abundant around and above the reef crest, while the demersal species showed an affinity for the reef itself and the numerous crevices and refugia. Plants and invertebrates observed on the artificial reef included red, brown and green algae, hydroids, sea anemones, sea urchins, barnacles, sea cucumbers, arrow crabs, hermit crabs and encrusting sponges. Table 22 presents the fish species observed during 2009.

Family/ Common Name	Species	2009	
		Abundance	Size
Centropomidae			
Common snook	<i>Centropomus undecimalis</i>	M	A
Serranidae			
Bank seabass	<i>Centropristis ocyurus</i>	F	A
Belted sandfish	<i>Serranus subligarius</i>	M	A,J
Black seabass	<i>Centropristis striata</i>	M	A,J
Goliath grouper	<i>Epinephelus itajara</i>	F	A
Sand perch	<i>Diplectrum formosum</i>	S	A
Scamp	<i>Mycteroperca phenax</i>	M	J
Snowy grouper	<i>Epinephelus niveatus</i>	F	J
Apogonidae			
Twospot cardinalfish	<i>Apogon pseudomaculatus</i>	F	A
Echeneididae			
Sharksucker	<i>Echeneis naucrates</i>	S	J
Carangidae			
Almaco jack	<i>Seriola rivoliana</i>	F	J
Blue runner	<i>Caranx chrysos</i>	M	A
Rainbow runner	<i>Elegatis bipinnulata</i>	F	A
Round scad	<i>Decapterus punctatus</i>	A	A,J
Lutjanidae			
Gray snapper	<i>Lutjanus griseus</i>	M	A
Lane snapper	<i>Lutjanus synagris</i>	M	A,J
Schoolmaster	<i>Lutjanus apodus</i>	S	A
Yellowtail snapper	<i>Ocyurus chrysurus</i>	F	J
Haemulidae			
Black margate	<i>Anisotremus surinamensis</i>	F	A
Porkfish	<i>Anisotremus virginicus</i>	F	A
Tomtate	<i>Haemulon aurolineatum</i>	A	A,J
White grunt	<i>Haemulon plumieri</i>	F	A
Sparidae			
Sheepshead	<i>Archosargus probatocephalus</i>	M	A
Sheepshead pogy	<i>Calamus penna</i>	M	A
Sciaenidae			
Cubbyu	<i>Equetus umbrosus</i>	M	A

Family/ Common Name	Species	2009	
		Abundance	Size
Chaetodontidae			
Reef butterflyfish	<i>Chaetodon sedentarius</i>	F	A
Pomacanthidae			
Blue angelfish	<i>Holocanthus bermudensis</i>	M	A,J
Pomacentridae			
Beaugregory	<i>Pomacentrus leucostictus</i>	M	A,J
Blue chromis	<i>Chromis cyaneus</i>	F	A/J
Sergeant major	<i>Abudefduf saxatilis</i>	F	A,J
Yellowtail reeffish	<i>Chromis enchrysurus</i>	M	A,J
Labridae			
Slippery dick	<i>Halichoeres bivittatus</i>	M	A,J
Spanish hogfish	<i>Bodianus rufus</i>	F	A,J
Spotfin hogfish	<i>Bodianus pulchellus</i>	S	A
Acanthuridae			
Blue tang	<i>Acanthurus coeruleus</i>	F	J
Doctorfish	<i>Acanthurus chirurgus</i>	M	A,J
	Total	36	

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 22. The Heap Artificial Reef fish species census.

3.18 Lentine Artificial Reef

- Location: South County Reef
- Materials: Concrete
- Maximum Depth: 68 feet
- Reef High Point: 62 feet
- Year Created: 2007
- Monitoring Date: 9/1/2009

3.18.1 History of the Lentine Artificial Reef

Nearly 2,000 tons of large concrete and steel construction waste was delivered to Harbour Pointe Park in Ft. Pierce in 2007 and early 2008 and stockpiled prior to deployment offshore of Martin County. In June 2008, it was loaded on barges and shipped to the South County Artificial Reef area. A total of 240 tons of these materials were dropped in the southwest corner of the reef area from the anchored barge to form the Lentine Artificial Reef.



Figure 35. Lentine Artificial Reef 2009 photographs.

3.18.2 Structural Summary

The maximum depth at this artificial reef site is about 68 feet with a maximum relief of about 6 feet. The footprint of the site is an irregular form with a southeast-to-northwest axis and occupies about 0.4 acres of seafloor. The deployment barge was securely moored at two points when the reef materials were dropped and the large concrete components settled in a single pile, although a few pieces settled to the bottom a short distance from the reef pile. Several large culvert sections provide cavernous recesses that are used extensively by large and small fish alike. The seafloor at this site is comprised of a shell/coarse sand mixture and appears to provide a solid base for the heavy concrete and steel pieces, as scouring is not significant. Figure 31 shows a chart with the location of the Lentine Reef.

3.18.3 Biological Survey Results

Fish surveys indicate a diverse assemblage of fishes, although 2009 was only the first year of monitoring since deployment. Snappers and damselfish represented the most numerous species, although vast schools of adult and juvenile round scad were abundant around and above the reef crest while tomtate grunts were very abundant on the reef itself. Plants and invertebrates observed on the artificial reef included red, brown and green algae, hydroids, sea anemones, sea

urchins, barnacles, sea cucumbers, arrow crabs, hermit crabs and encrusting sponges. Table 23 presents the fish species observed during 2009.

Family/ Common Name	Species	2009	
		Abundance	Size
Muraenidae			
Spotted moray	<i>Gymnothorax moringa</i>	S	A
Serranidae			
Bank seabass	<i>Centropristis ocyurus</i>	F	A
Black seabass	<i>Centropristis striata</i>	M	A,J
Apogonidae			
Twospot cardinalfish	<i>Apogon pseudomaculatus</i>	M	A,J
Carangidae			
Amberjack	<i>Seriola dumerili</i>	M	A
Blue runner	<i>Caranx chrysos</i>	A	A
Round scad	<i>Decapterus punctatus</i>	A	A
Lutjanidae			
Lane snapper	<i>Lutjanus synagris</i>	F	A
Vermillion snapper	<i>Rhomboplites aurorubens</i>	M	A
Yellowtail snapper	<i>Ocyurus chrysurus</i>	F	A
Haemulidae			
Tomtate	<i>Haemulon aurolineatum</i>	A	A,J
Sparidae			
Sheepshead porgy	<i>Calamus penna</i>	M	A
Sciaenidae			
Cubbyu	<i>Equetus umbrosus</i>	M	A,J
Mullidae			
Yellow goatfish	<i>Mulloidichthys martinicus</i>	F	A
Chaetodontidae			
Reef butterflyfish	<i>Chaetodon sedentarius</i>	F	A
Pomacentridae			
Beaugregory	<i>Pomacentrus leucostictus</i>	M	A,J
Blue chromis	<i>Chromis cyaneus</i>	M	A,J
Yellowtail reeffish	<i>Chromis enchrysurus</i>	A	A,J
Labridae			
Clown wrasse	<i>Halichoeres maculipinna</i>	S	A
Slippery dick	<i>Halichoeres bivittatus</i>	M	A,J
Opistognathidae			
Moustache jawfish	<i>Opistognathus lonchurus</i>	S	A
Tetraodontidae			
Bandtail puffer	<i>Sphaeroides spengleri</i>	F	A,J
Sharpnose puffer	<i>Canthigaster rostrata</i>	F	A,J
	Total	23	

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. Lentine Artificial Reef fish species census.

3.19 Ann Marie Artificial Reef

- Location: South County Reef
- Materials: Concrete
- Maximum Depth: 67 feet

- Reef High Point: 59 feet
- Year Created: 2007
- Monitoring Date: 8/31/2009

3.19.1 History of the Ann Marie Artificial Reef

Nearly 2,000 tons of large concrete and steel construction waste was delivered to Harbour Pointe Park in Ft. Pierce in 2007 and early 2008 and stockpiled prior to deployment offshore of Martin County. In June 2008, it was loaded on barges and shipped to the South County Artificial Reef area. A total of 260 tons of these materials were dropped in the southwest corner of the reef area from the anchored barge to form the Ann Marie Artificial Reef.

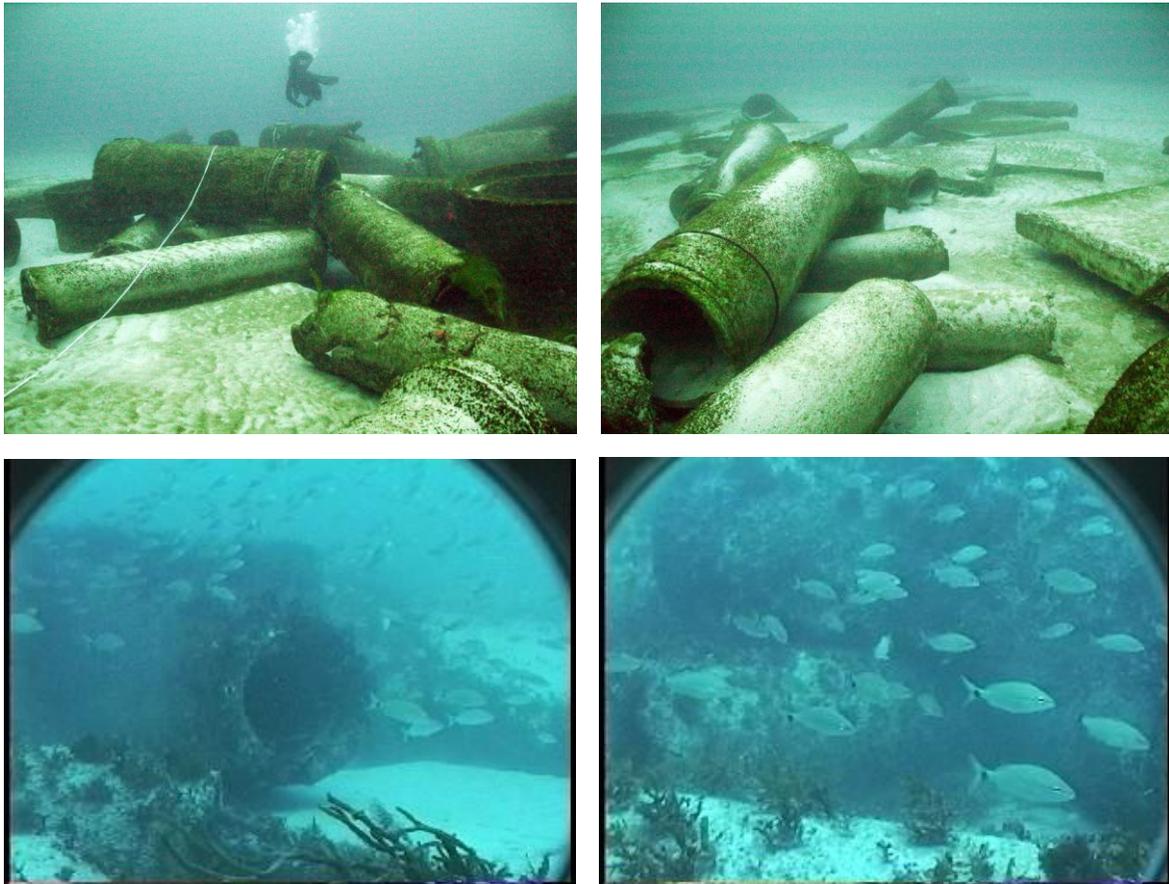


Figure 36. Ann Marie Artificial Reef 2008 and 2009 photographs.

3.19.2 Structural Summary

The maximum depth at this artificial reef site is about 67 feet with a maximum relief of about 8 feet. The footprint of the site is generally round with an irregular margin and occupies about 0.4 acres of seafloor. The deployment barge was securely moored at two points when the reef materials were dropped and the large concrete components settled in a single pile, although a few pieces settled to the bottom a short distance from the reef pile. Several large culvert sections provide cavernous recesses that are used extensively by large and small fish alike. The seafloor at this site is comprised of a shell/coarse sand mixture and appears to provide a solid base for the

heavy concrete and steel pieces, as scouring is not significant. Figure 31 shows a chart with the location of the Ann Marie Reef.

3.19.3 Biological Survey Results

Fish surveys indicate a diverse assemblage of fishes, although 2009 was only the first year of monitoring since deployment. Seabasses and grunts represented the most numerous species, although jacks were abundant due to the vast schools of adult and juvenile round scad observed around and above the reef crest. Plants and invertebrates observed on the artificial reef included red, brown and green algae, hydroids, sea anemones, sea urchins, barnacles, sea cucumbers, arrow crabs, hermit crabs and encrusting sponges. Table 24 presents the fish species observed during 2009.

Family/ Common Name	Species	2009	
		Abundance	Size
Elasmobranchs			
Spotted eagle ray	<i>Aetobatus narinari</i>	S	A
Centropomidae			
Common snook	<i>Centropomus undecimalis</i>	F	A
Serranidae			
Black seabass	<i>Centropristis striata</i>	M	A,J
Goliath grouper	<i>Epinephelus itajara</i>	F	A
Scamp	<i>Mycteroperca phenax</i>	F	A/J
Snowy grouper	<i>Epinephelus niveatus</i>	S	J
Tobaccofish	<i>Serranus tabacarius</i>	S	A
Carangidae			
Amberjack	<i>Seriola dumerili</i>	F	A
Round scad	<i>Decapterus punctatus</i>	A	A
Lutjanidae			
Gray snapper	<i>Lutjanus griseus</i>	F	A,J
Yellowtail snapper	<i>Ocyurus chrysurus</i>	F	J
Haemulidae			
Porkfish	<i>Anisotremus virginicus</i>	F	A,J
Tomtate	<i>Haemulon aurolineatum</i>	M	A,J
White margate	<i>Haemulon album</i>	F	A,J
Sparidae			
Sheepshead	<i>Archosargus probatocephalus</i>	F	A,J
Sheepshead porgy	<i>Calamus penna</i>	F	A,J
Sciaenidae			
Cubbyu	<i>Equetus umbrosus</i>	M	A,J
Pomacentridae			
Beaugregory	<i>Pomacentrus leucostictus</i>	F	A,J
Scorpaenidae			
Spotted scorpionfish	<i>Scorpaena plumeiri</i>	S	A
Balistidae			
Gray triggerfish	<i>Balistes capriscus</i>	F	A
Tetraodontidae			
Sharpnose puffer	<i>Canthigaster rostrata</i>	S	A
	Total	21	

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 24. Ann Marie Artificial Reef fish species census.

3.20 PCL Indian River Lagoon Artificial Reef

- Location: Indian River Lagoon
- Materials: Concrete, steel
- Maximum Depth: 17 feet
- Reef High Point: 8 feet
- Year Created: 2007
- Monitoring Date: 10/21/2009

3.20.1 History of the PCL Indian River Lagoon Artificial Reef

Between November 2006 and January 2007, approximately 4,400 tons of steel and concrete rubble were placed into a large scour hole in the Indian River Lagoon just west of Hutchinson Island. The 2.5 acre scour hole was created during construction of the Stuart causeway/bridge and was up to 17 feet deep in places. The materials came from the decommissioned Ernest Lyons draw bridge that spanned the Indian River Lagoon between Sewalls Point and Hutchinson Island. The new reef was named for the construction company that built the new bridge, demolished the old bridge and built the new reef, covering all costs for the new reef construction. This is the first time such an artificial reef has been constructed within an estuary in Martin County.

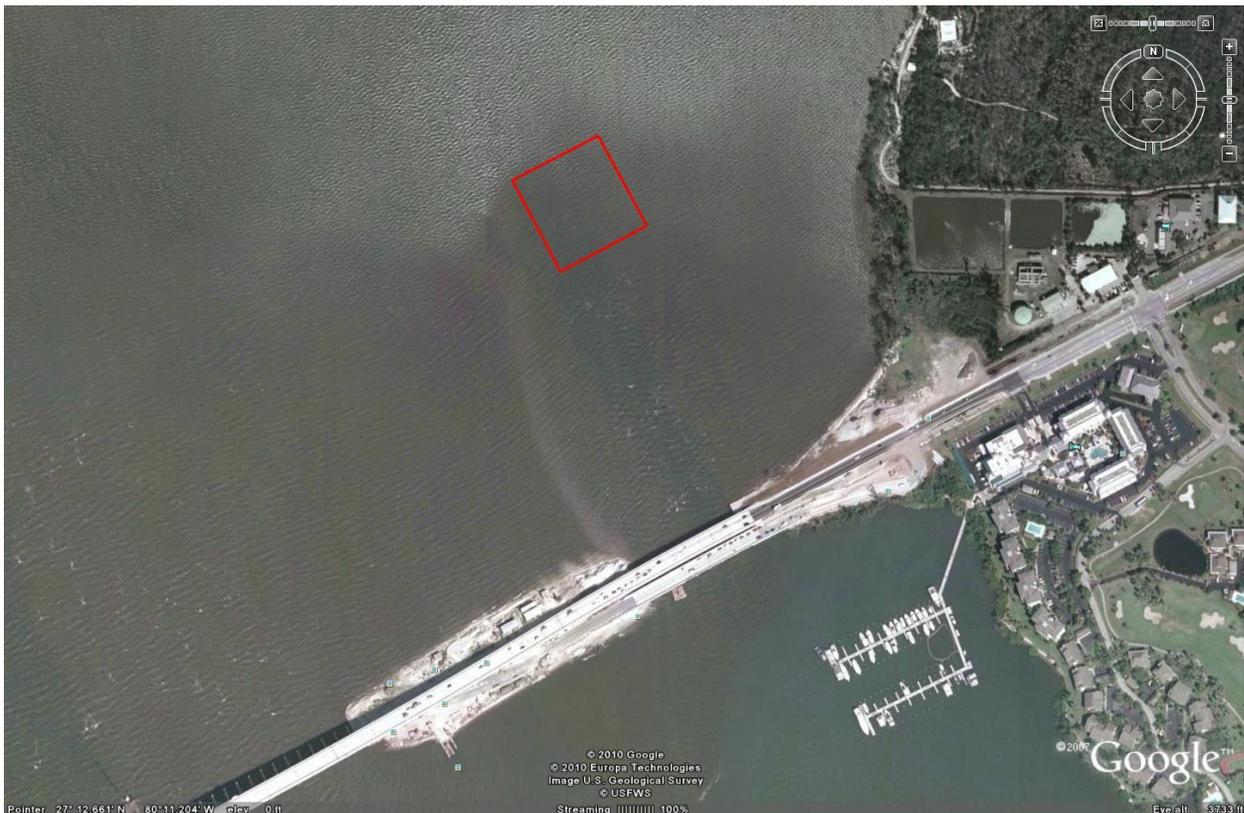


Figure 37. Aerial photo of Indian River Lagoon and South Hutchinson Island, showing approximate location of PCL IRL artificial reef, outlined in red.

3.20.2 Structural Summary

The materials deployed varied in size and included concrete pilings, broken rubble, concrete slabs, steel pipe, steel plates and grating, sidewalk guardrails, and Jersey barriers. The maximum profile above the lagoon bottom is 8 feet with a nominal average of 4 feet, providing a minimum clearance of 6 feet at mean low water between the reef summit and the surface. Any reef projections that were deemed too close to the surface were pulled over by divers or heavy equipment to provide at least six feet of clearance. Hydro Engineering & Mapping, Inc performed both pre and post construction bathymetric surveys to verify that the finished reef conformed to US Army Corps of Engineers permit requirements.

3.20.3 Biological Survey Results

Jacks and grunts represented the most numerous species of fishes, although lane snappers, sheepshead and puffers were quite numerous. Plant and invertebrate diversity was noted and included red, brown and green algae, barnacles, hydroids, sea anemones, arrow, blue and hermit crabs, Caribbean spiny lobsters, sea cucumbers, urchins and encrusting sponges. Poor visibility prohibited video and still photography. Table 25 presents the fish species observed during monitoring.

Family/ Common Name	Species	2009	
		Abundance	Size
Elasmobranchs			
Southern stingray	<i>Dasyatis americana</i>	F	J
Spotted eagle ray	<i>Aetobatus narinari</i>	S	J
Synodontidae			
Inshore lizardfish	<i>Synodus foetens</i>	S	J
Serranidae			
Gag grouper	<i>Mycteroperca microlepis</i>	F	J
Carangidae			
Atlantic bumper	<i>Chloroscombus chrysurus</i>	F	A
Creville jack	<i>Caranx hippos</i>	F	A
Lookdown	<i>Selene vomer</i>	S	J
Lutjanidae			
Lane snapper	<i>Lutjanus synagris</i>	M	J
Haemulidae			
Porkfish	<i>Anisotremus virginicus</i>	F	J
Tomtate	<i>Haemulon aurolineatum</i>	A	J
Sparidae			
Sheepshead	<i>Archosargus probatocephalus</i>	A	A, J
Sciaenidae			
Cubbyu	<i>Equetus umbrosus</i>	F	J
Ephippidae			
Atlantic spadefish	<i>Chaetodipterus faber</i>	F	A
Pomacanthidae			
French angelfish	<i>Pomacanthus paru</i>	F	J
Bothidae			
Southern flounder	<i>Paralichthys lethostigma</i>	F	A/J
Tetraodontidae			
Bandtail puffer	<i>Sphoeroides spengleri</i>	A	A, J
	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 25. PCL Indian River Lagoon Artificial Reef fish species census.