

5 Tetrahedron Stack Reef

Monitoring Date: June 17, 2005

Location: Sirotkin permitted reef site

GPS coordinates: N27 12.814 / W80 02.329

LORAN coordinates: 43094.97 / 61988.84

Crewmembers: Lee Harris, Ph.D., Kerry Dillon, and Randal Bazemore

This is the 4th of a 5-year annual monitoring effort at this site. This report addresses four types of collected data: dive data, reef component stability, fish species & abundance, and benthic species identifications.

5.1 History of the Tetrahedron Stack Artificial Reef:

As part of a Florida Fish & Wildlife Conservation Commission construction grant (FWC Grant # 13821 for \$25,000) and with additional funding from Martin County, a single stacked concrete tetrahedron reef was constructed in April of 2001. To date, this is the deepest (statewide) that such a reef has been built made of concrete tetrahedrons. The materials utilized were 5-and 6-foot solid concrete tetrahedrons with a cast in place lifting eye of steel rebar.

The reef was constructed on April 4 & April 25, 2001 utilizing two barge loads of concrete modules. A total of 430 units were placed from an anchored barge, with approximately 215 units deployed on each date. The deployment resulted in a single reef with an elliptical shape oriented in a general northeast/southwest direction. When diving this site one cannot determine any separation of the first deployment's modules from the second.

These units are designed to interlock together and "stack" on top of each other to form many crevices, voids, and hiding places for fish, crustaceans, and other marine life. While some modules settled on their bases without stacking on top of other modules, approximately 40% landed on top of others. The large surface area of each module also provides habitat for benthic organisms to attach themselves.

5.2 Dive Data

Max. depth at bottom = 97 ft. (100 ft. in scoured areas)

Underwater visibility this day = 20 ft.

Bottom water temperature = 68°F

Surface water temperature = 80°F

Current speed & direction = ¾ knot to the north

Divers breathing mode & gases = open circuit scuba with nitrox 35%

GPS positioning of vessel determined by a Standard Horizon model CP150C

Shipboard fathometer used was a Furuno model LCD LS-6000 (200kHz)

5.3 Reef Components Stability

The individual tetrahedron concrete modules are solid units, which weigh up to 3600 lbs. each in air. At this depth of 100 feet they are designed to be stable against wave forces accompanying a 50-year storm event. In September of 2004 Martin County experienced two hurricanes (Frances cat.2 and Jeannie cat.3) that traveled right through the offshore waters of Martin County. After making landfall near the St. Lucie Inlet, they traveled inland causing substantial damages to the beaches, dunes, vegetation and structures county-wide. Offshore monitoring at this site performed in 2005 did not reveal substantial movement or shifting of units, nor was any major scouring or sinking into the bottom observed. The natural seafloor was scoured somewhat and the overall profiles of the peaks above the seafloor have changed compared to previous years data, as presented in Table 7.

Table 7. Tetrahedron Stack Reef Changes 2004 to 2005

<i>Specific Location</i>	<i>2004</i>	<i>2005</i>	<i>2004 profile height</i>	<i>2005 profile height</i>
Tops of summits	82 ft.	88 ft.	14 ft.	9 ft.
Surrounding seafloor	96 ft.	97 ft.		
Seafloor in scoured areas	98 ft.	100 ft.		

It appears the units are performing as designed and have become a very stable base for marine life development. Even though the maximum profile has changed at the summit, the overall shape is still a stack of tetrahedrons with an apex near the center of the reef. Around the perimeter mostly single units exist without stacking. This is where the scouring has occurred and the deepest depths of 100 ft. are found.

5.4 Fish Species & Abundance Findings:

Fish identification and abundance were determined utilizing the guidelines setup by the Reef Environmental Education Foundation, as previously described. Table 8 presents the fish species observed and documented during monitoring on June 17, 2005.

Table 8. Tetrahedron Stack Reef Fish Census

<i>Marine Species Identified</i>	<i>Quantity observed</i>	<i>Juvenile or Adult</i>
Sheepshead	10's	A
Belted Sandfish	1	A
Gag Grouper	1	A
Sheepshead Porgy	7	A
Gray triggerfish	10's	A
Porkfish	8	A
Greater Amberjack	7	A
Genuine Red Snapper	100's	A (8- 12")
Tomtate	10's	A
Lane Snapper	10's	A
*Black Seabass	10's	A
*Vermillion Snapper	100's	A
*Sailors Choice	1	A
*Reef Butterfly	1	A
*Highhat	4	J & A
*Blue Angelfish	2	A
*Shortnose Batfish	1	A
*Whitespotted Soapfish	2	A
*Scrawled Cowfish	2	A

* - These species were not seen during 2004 monitoring

5.5 Benthic Species Identification:

The roving diver method was used for benthic species identification, as described previously. The benthic growth at this site is quite prolific. Many tetrahedrons have long strands of the brown marine algae sargassum attached directly to the concrete surfaces. These extend up and wave in the currents providing additional habitat for fish to hide and feed. The strands are between 3 to 6 feet long and add substantially to the overall vertical component of the reef profile. The benthic species data are shown in Table 9. The quantity & diversity of the coverage has significantly increased over the years, as can be seen when comparing the videos and still photographs from the four monitoring years to date.

Table 9. Tetrahedron Stack Reef Benthic Species Census

Several species of sponges (Orange & White encrusting)
Several species of green, red and brown marine algae
Pinshell Oysters
Barnacles (Red & White)
Black tunicates
Anemones
Crustaceans (Barnacles, Spiny Lobster & Hermit Crabs)
Hydroids
Sea Cucumbers
Sea Urchins

5.6 Tetrahedron Stack Reef Summary

The tetrahedron stack reef appears to have fared well during the two hurricanes that passed overhead during September 2004, although some loss of profile occurred as well as scouring of the seafloor around the reefs perimeter. The reef is located at the same GPS coordinates as before the storms and from the original construction in 2001. Nineteen fish species were identified at this site during the 2005 monitoring. This is down by 2 from 21 in 2004. Nine species were documented in 2005 that were not recorded in 2004, the most notable sport & food fish species being Black Seabass & Vermilion Snapper. Eleven species were not observed in 2005 that were recorded in 2004, the most notable being Gray Snapper. The most significant sport & food fish species observed on this reef in 2005 were Red Snapper, Gag Grouper, Lane Snapper, Black Seabass, Greater Amberjack, and Vermilion Snapper.

6 Tetrahedron Patches Reef

Monitoring Date: June 7, 2005

Location: Sirotkin permitted reef site.

GPS coordinates: N27 12.465 / W80 02.341 center patch (Pink)

Crewmembers: Lee Harris, Kerry Dillon, Randal Bazemore, Grayson Kyte

This is the 3rd of a 5-year annual monitoring effort at this site. This report addresses four types of collected data: dive data, reef component stability, fish species & abundance, and benthic species identifications.

6.1 History of the Tetrahedron Patches Artificial Reef:

As part of a Florida Fish & Wildlife Conservation Commission construction grant (FWC Grant #00190 for \$15,000) and with additional funding from Martin County, five patch reefs using concrete tetrahedron modules were constructed in March and June 2002. The materials utilized were 4 feet and 5 feet solid concrete tetrahedrons with a steel rebar lifting eye. This reef is approximately ½ mile south of an existing tetrahedron stack reef constructed in April 2001. The patch reef was built with the same total tonnage as the stack reef, and is located in similar water depth and same distance offshore of the Martin County shoreline (6.5 miles).

The tetrahedron patch reef was built on March 28 & June 28, 2002 utilizing one barge load of concrete modules for each deployment. A total of approximately 460 units were placed from an anchored barge, approximately 230 units each deployment. There are five patches or "clusters" on the reef, each separated by a sand/shell seafloor. Distances vary between the clusters and are a nominal 80 to 100 feet from outer edges of each cluster. Color-coded tie wraps were added to tetrahedron modules in each of the patch areas to aid future monitoring efforts. Sub-surface buoys also were added in 2003 at each patch to aid in monitoring.

6.2 Dive Data

Max. depth at bottom in sand = 98 ft.

Min. depth at top of shallowest tetrahedron (pink patch) = 90 ft.

Underwater visibility this day = 25 ft.

Bottom water temperature = 68° F

Surface water temperature = 79° F

Current direction & speed = < ½ knot to the north

Divers breathing mode & gases = open circuit scuba with nitrox 36%

6.3 Tetrahedron Patches Orientation:

Figure 7 shows a detailed chart and map of the five concrete tetrahedron patch reefs. To construct the desired reef layout, the barge position was maintained by anchors and was closely monitored during deployment, and modules were dropped from the same spot on the barge during the deployment of each patch reef. Three patches (central, north and northwest) have roughly elliptical patterns, with the major axis oriented generally from east to west. The east and southwest patches are roughly circular in shape. Although each patch is a separate entity with sand/shell bottom between them, a few isolated tetrahedrons exist around the perimeters of each patch.