Habitat Creation for Subadults of the Grouper-Snapper-Grunt Population in Tampa Bay

The Gulf of Mexico Community-based Restoration Partnership
Grant Agreement # 8002

Stillwater Research Group, Inc.[1]
October 22, 2009

Acknowledgments

Gulf of Mexico Foundation for funding, Hillsborough County for the use of the reef site, Maximo Marina for staging, Gator Dredging for the installation of the reef, Mendoza Boulders for rock, Kathleen Mine for rock, George F. Young, Inc., for 3D sonar images, Carroll Building Supply for concrete and space for construction, Marine Eco-Cruise for boat use, Reefmaker for molds, Reef Innovations for oyster domes, Delta Seven Inc., for office space, equipment, and other resources, and the volunteers.

Introduction

Mangrove forests, tidal streams, and seagrasses have been protected and are being managed as Essential Fish Habitat (EFH) specifically as it pertains to post larval and juvenile fisheries resources. In the Tampa Bay, Florida, area these resources are often members of the Grouper-Snapper-Grunt complex.[2] In contrast to the coral reefs 1 of South Florida, the reefs in the Tampa area are limestone with very low populations of Scleractinia. Natural reefs near Tampa Bay are protected but have been the subject of a much less intense management effort than those in southern Florida. Artificial reefs and mitigation reefs, while seen as assets to local ecosystems, are typically designed to provide habitat for adult resources. They are constructed with the goals of providing sites where large, mature,[3] fish will aggregate. Eight artificial reefs have been established in Tampa Bay to expand natural hard-bottom and enhance fishing, however these have all focused on recruiting adult fishes. Often times these reefs are not so

---

[2] Grouper-Snapper-Grunt complex: *Epinephelus itajara, E. morio, Mycteroperca bonaci, M. phenax, M. microlepis, Lutjanus griseus, Haemulon plumierii*; Jewfish (Goliath Grouper), Red Grouper, Black Grouper, Scamp, Gag Grouper, Grey Snapper, and White Grunt.

[3] Implying both sexual maturity and of a size which exceeds limits in the fishing regulations.

much a designed fish habitat, as a haphazard pile of rubble and typically have a vertical relief of 0.5-3 meters.

With respect to the Grouper-Snapper-Grunt complex, however, the hard bottom and natural ledges represent a critical and as yet to be managed habitat. Natural ledges of the bay range in vertical relief from 15 -35 cm. These ledges provide a necessary ontogenetic link between the nursery areas of the mangroves and grasses and the high relief reefs preferred by larger fishes. When juvenile fish do not have the option of migrating from nursery habitat to appropriate intermediate habitat, they are forced to recruit to structures with larger predatory fish, or overpopulate the limited natural habitat.

Hardbottom has only very recently been defined as a critical habitat by the TBEP in the TBEHMP: "Hard bottom habitat is a rare, unique, and important habitat type in Tampa Bay and thus is recognized as a habitat of special concern" (draft TBEHMP June 2008). A preliminary study conducted for the Tampa Bay National Estuary Program revealed only 850 acres of hardbottom habitat in Tampa Bay compared to over 25,000 acres of seagrass and 18,000 acres of mangroves and coastal marsh.

The Stillwater Research Group, Inc., along with private partners have undertaken this study to test the efficacy of design options for an artificial reef which would meet these intermediary habitat requirements.

Specifically, the following null statements are examined:

1. The shape and size of hard artificial structure has no effect on the timing, sequence, or sizes of recruited fish in the Grouper-Snapper-Grunt complex.

2. The size and abundance of cavities has no effect on the timing, sequence, or sizes of recruited fish in the Grouper-Snapper-Grunt complex.

3. Hard structures incorporating natural stone have no effect on the timing, sequence, or sizes of recruited fish in the Grouper-Snapper-Grunt complex.

4. Hard structures recruiting epilithos have no effect on the timing, sequence, or sizes of recruited fish in the Grouper-Snapper-Grunt complex.

5. Low relief structure located adjacent to high relief structure will not increase the rate of recruitment to the habitat suitable for larger fish.

Funding was provided by The Gulf of Mexico Foundation and several private partners.

Materials and Methods

The site is located just offshore of the Egmont Key National Wildlife Refuge, just south of the Boca Ciega Bay Aquatic Preserve, and just north of the Terra Ceia Aquatic Preserve (figures 1 and 2). There are three other GEMS sites within the Tampa Bay system, the Pinellas County Aquatic Preserve, the Cockroach Bay Aquatic Preserve, and the Pinellas National Wildlife Refuge. In addition, the project is located within the Tampa Bay Estuary Program (TBEP) Management Area and is consistent with restoration goals adopted by the *Comprehensive Conservation and Management Plan* (CCMP) and the *Tampa Bay Estuary Habitat Master Plan* (TBEHMP) of that program.

The location is on the edge of a popular five acre artificial fishing reef which was designed to attract adult (catchable) fish for anglers. The project site is a designated artificial reef site already permitted and in its second 5 year cycle. The permit boundaries are significantly larger than the area already used allowing the proposed installation to be placed within the site while not interfering with the existing use.

Four low-profile artificial Ledge Mimic Modules (figure 3. Marketed as EcoSystemTM, hereafter, LMM) and 20 low-profile reef balls (figure 4. Marketed as *oyster domes*, hereafter LPRB) were constructed and installed in an area of 50m2. The configuration was designed to provide a variety of habitats and spacings.

The LMM is configured based on poured concrete with limestone boulders embedded. One LMM consists of one 5 or 6 foot (1.5 or 1.8 m) diameter concrete slab with a pillar rising from its center (figure 5). Disks, each with a hole in the center, of concrete with limestone embedded are positioned to settle onto the pillar (figure 6). Spacers between disks can be adjusted to select the height of the overhang of the upper disk relative to the one lower.

Variables in the LMM design include rock placement, size, and the number of disks. Placing a larger disk (5ft) over a smaller disk (4ft, 1.2m) serves to mimic a natural ledge with an average over hang of about 6 inches. Vertical relief of the module, after settling, is 0.3 to 1m depending on the number of disks.

Of the four sets of disks installed, two are in configuration 1, and one each are in configuration 2 and 3. Figure 7 is a composite sketch of the variables. Configuration one consists of a five foot diameter disk (with limestone embedded) on a five foot diameter pedestal with no limestone embedded in the basal disk. Configuration two consists of a six foot diameter base (no limestone), a four foot diameter disk (with limestone), and a second five foot diameter disk (with limestone). Configuration three is the same as configuration two except that the base unit has limestone rock embedded in it.

One unit in configuration 3 was further modified to subdivide the space between the disks into even smaller cavities. This was achieved by placing taller rocks in the disk aligned radially from the center. These rocks blocked or partially blocked passage creating several pie shaped spaces which mimicked cavities in contrast to the ledge mimic of the original configuration.

The LPRB are poured concrete domes of 45cm in diameter and 18 to 28cm in vertical relief. The LPRB will allow penetration by fishes no greater than 10 to 15 cm in their dorso-ventral dimension. The 20 LPRBs are arranged in two patterns, one closely spaced and one more widely spaced. The spacing has been selected based on suspected distances which smaller fish will be willing to travel over open sandy areas from one LPRB to the next. These were deployed and arranged by hand using SCUBA.

The four LMMs were arranged in a manner that creates 19m of ledge proximal to both the 4 LPRBs and bare substrate. The base arrangement was augmented by the LPRBs (figure 8).

Monitoring

Data collection was conducted by both scientists and volunteers. Volunteers were trained prior to entering the water to assure protocols would be followed and fish identifications were reliable. Where possible, volunteers were paired (dive teams) with scientific divers.

The observational protocol was designed to minimize disturbance to reef residents. Divers approached the site from down current very slowly. Upon reaching a distance where visual identification was possible (varied with visibility) the divers would lie prone in the sands and remain motionless. The low profile and relaxed breathing allowed the resident fish to become accustomed to the divers very quickly (5 min). The divers then simply observed species, size, location on the structure and movement or behaviour. Divers were equipped with cameras to document their observations.

After observing the structure for at least ten minutes after acclimation, divers would reposition themselves to observe other portions of the structure. After observing fish from a distance for the designated time, divers would then approach more closely to allow observation within cavities or between disks. Once fish observations were complete, the divers would take notes on epilithos and indicators of the physical stability of the installation.

<u>Results</u>

None of the units of either type showed any signs of settling over time. Currents did create minor (2-3 cm) excavations along the edges of the large disks. Crabs and other burrowing organisms did excavate burrows beneath the edges of the disks.

Fish of several species were observed to orient to the structure within weeks of the installation. Not all fish with juveniles and subadults known to the area were observed. Of those observed, size classes were observed within the observation period. Partitioning of the structural habitat was distinct under most conditions but much less so during periods of higher current velocities. Since current is a factor in determining habitat, the observations during high and low current conditions can be considered to be observations of different habitats.

Archosargus probatocephalus (Sheepshead) was observed in sizes from 20 to 35 cm and occurred throughout the structure. Even in high current conditions, this fish showed no preferences in location.

Epinephelus morio (Red grouper) was observed in sizes from 20 to 38 cm. Larger specimens preferred the lower ledges only (directly over the base plate) and only seldom ventured into the upper level ledge. Larger specimens also preferred the base plate without embedded rock. Some larger specimens would tilt away from the vertical in orientation in order to be able to fit under the ledge while others oriented to the ledge but outside the overhang. Smaller (20cm) specimens preferred the lower ledge but were seen exclusively in the configuration where the base plate included embedded rock. Larger members of the species were occasionally observed making excursions out over the sands.

Haemulon flavolineatum (French Grunt) was observed in sizes of 1 to 10 cm. This species exhibited the greatest degree of size related habitat partitioning. They occurred both singly and in schools and in all of the offered habitats except under ledges, within the cavities of the LPRBs, and over the base plate without embedded rock. When over the rock of basal disk, they were not schooling and tended not to approach ledges closer than 15 to 20 cm. When over the upper disk, they behaved as individuals, not schooling.

When associated with the LPRBs, all exhibited schooling behaviour. Schools were located between the LPRB. Schools would extend vertically to be slightly above the crest of the LPRB, but seldom occurred directly above an LPRB. In these schools, there were occasional *H.*
plumierii and *Lutjanus synagris* (see discussion of latter below) mixed in.

The species also exhibited size related partitioning. Very small (1cm) fish were observed to school adjacent to (neither above, nor below the upper disk) the upper disk of LMM in configuration 3 only. Below that, 2-3 cm fish were observed and below that, 4-5 cm fish creating a vertical sorting with smaller fish at the top and larger fish near the base. At the base, fish schooling behaviour became loose or nonexistent.

Among the LPRBs, when larger specimens (10 cm) were present, schools would occur between the units and include smaller (2-5cm) fish, but when the larger members were not present, the smaller fish oriented to the angle of the crest of the LPRB.

The behaviour of this fish was also influenced by currents. Very strong currents caused the fish to seek individual refuge at the bases of structure. Once currents subsided, schooling behaviour or individual partitioning recurred.

Haemulon plumierii (White Grunt). Fish of 5 to 10 cm occurred singly over the upper deck or outer edges of the base. They did not occur on bases without embedded rock. When many were present (not single), the fish did not exhibiting schooling behaviour, but just a greater abundance. Occasionally, members of this species were intermixed within the larger loose schools of *H. flavolineatum* located between and slightly above the crest of LPRBs.

When occurring over rock of base deck, they did not typically venture under the ledge and were not schooling. Unlike *H. flavolineatum*, specimens occupying the space above the rock of the base plate frequently approached the overhang of the ledge.

Clupeidae. Herring were observed only infrequently and always in large schools. Schools were observed to occupy the water column above the structure under most conditions. Schools would drop down into the spaces between the structure, but not into cavities, when predators approached from above (Lookdown, Yellowtail Snapper).

Lutjanus griseus (Grey Snapper). Members of this species were all greater than 15 cm and all occupied the upper ledges. These fish did not occupy the ledge in configurations with only one disk. They occurred severally, making occasional excursions out over the sand or switching ledges. Some were large enough that they were required to tilt away from the vertical in order to get under the ledge. When under the ledge, they took a position with their tails to the center, positioning their snout just beneath the overhang in an apparent ambush position.

Lutjanus synagris (Lane Snapper). Only a few juveniles of this species were observed. All were approximately 10 cm in size and all at first appeared to be part of loose schools of *H. flavolineatum* between the LPRBs. On close observation, however, they appeared to be occupying their own space near the sand and between the LPRBs. The *H. flavolineatum* were schooling around and past them.

Mycteroperca bonaci (Black Grouper) was observed rarely and occupied the interior cavity of the LPRB.

Ocyurus chrysurus (Yellowtail Snapper) was observed in passing schools as much as 1.5 meters above the top of the structure.

Opsanus beta (Gulf Toadfish). One specimen was observed to have taken up residence within one of the LPRBs.

Pareques umbrosus (Equetus umbrosus) (Cubbyu). Small specimens (juvenile form, 10 cm) preferred the lower ledge (selecting the edge over the interior) of the LMM and the apertures in the LPRB units. Larger specimens (mature form) also preferred the lower ledge, but would penetrate well beneath the ledge. Never observed in LPRB units. The fish exhibited no aversion to the base with no embedded rock.

Selene vomer (Lookdown) was observed in a small school of 6 fish cruising over the top of the structure (1m above the top) trailing a school of herring.

Serranus subligarius (Belted Sandfish) were observed at the base of the edge of the bases of the LMM or at stations above the rock, near the lower ledge of the LMM. These fish are territorial and set up stations or small home territories from which they will occasionally depart for only short periods.

Menippe mercenaria (Stone Crab) were observed in burrows under the edges of the base plates but were more commonly encountered within the cavities of the LPRBs. There is only one record of a stone crab within the ledge crevices.

Tunicates were the first invertebrate to colonize the structure. Only *Styella plicata* was identified to species. Different species selected the concrete over the rock and vise versa and different species selected the undersurface of the ledges over the upper surfaces.

Leptogorgia virgulata had colonized the surface during the later part of summer and in October, individuals were 1 to 3 cm tall.

Discussion

Both recruitment (*L. griseus*) of larger fish and of very small juveniles occurred within the first 30 days after deployment. Recruitment preceded epilithic colonization by either algae or epilithic fauna reinforcing the attractant as the physical structure over the associated fauna. Of greatest significance in this report is the observations of habitat partitioning and the effects of habitat variability within an artificial reef. It is often argued in the marketplace that one structure is better or more valuable than another. It is clear, at least from the presentation of refuge versus overall community structure, that variability is the most valuable asset.

It is also significant that larger predators, readily observable on culvert structure less than 20 meters from the test installation, did not recruit to the habitat. The time allowed for observation is insufficient to draw definitive conclusions, but the structure does seem to provide the habitat intended, specifically that for intermediate subadult and juvenile members of the groupersnapper- grunt complex.

The behaviour exhibited by larger members of both *E. morio* and *L. griseus* may indicate that the sizes of these fish are making the habitat limiting and these fish can be expected to migrate to larger structure.

The project meets the intent to construct an artificial reef designed to structurally mimic natural reefs in Tampa Bay which were lost to fill activities. The information gathered through continued monitoring will help in overall understanding of the importance of artificial reef design, the importance of mimicking local natural habitat structure, and providing for all life stages of a population.

Conclusions

In reference to the stated purpose of the project (Italics), the following null statements were examined:

1. The shape and size of hard artificial structure has no effect on the timing, sequence, or sizes of recruited fish in the Grouper-Snapper-Grunt complex.

Rejected: The shape clearly affects the sizes of the recruited members. Timing and sequence could not be evaluated.

2. The size and abundance of cavities has no effect on the timing, sequence, or sizes of recruited fish in the Grouper-Snapper-Grunt complex.

Rejected: Cavity size strongly affected the recruited fish. LPRB cavities were largely uninhabited and species were selective in occupying other cavities.

3. Hard structures incorporating natural stone have no effect on the timing, sequence, or sizes of recruited fish in the Grouper-Snapper-Grunt complex.

Rejected: Most fish preferred the stone embedded disks to the bare concrete disks, but others selected the concrete. It may, however, be that the lack of embedded stone created a larger cavity and that was the controlling factor. The lack of stone in the LPRB did not seem to play a role with respect to fish, but the epilithos colonized stone earlier than the LPRB. The smooth concrete of the LMM base, which was not colonized at all, is probably a result of rugosity over composition.

4. Hard structures recruiting epilithos have no effect on the timing, sequence, or sizes of recruited fish in the Grouper-Snapper-Grunt complex.

Accepted within limitations. The project could not continue long enough for a definitive conclusion to be drawn. In future years as the epilithic community matures, there may yet be an effect on the complex.

5. Low relief structure located adjacent to high relief structure will not increase the rate of *recruitment to the habitat suitable for larger fish.*

Indeterminate. The funding (from other sources) for the long term monitoring and determination of this aspect of the project was not available. Future funding will be sought. It is apparent, however, that habitat was provided for subadult and juveniles of the targeted species and it is reasonable to expect that they will migrate to the adjacent structure as they mature.

Community Involvement

Community Involvement during construction consisted of participation during the manufacture of the units (Walter Marine) the installation of the units (Gator Dredging, Hillsborough County, Volunteer Commercial Divers, Maximo Marine) and the donation of materials. Delta Seven has supported the effort with scientific divers, office space, equipment use, and Delta Seven volunteers have prepared the website. Abstracts have been submitted for presentation at local reef conferences. ScubaNauts were unable to participate due to insurance problems. Students from Eckerd College, other local divers, and a graphics technician were recruited. In addition to the volunteer hours noted in the proposal, Marine Eco Cruise has donated their Captain's time at the rate of $55.00/hr and Walter Marine assisted in manufacturing the structure at the rate of $45.00/hr.

References:

Hixon and Beets 1993, Ecological Monographs, 63: 77 – 101

http://delta-seven.com/Stillwater_Research_Group/Egmont_Exp_Reef_v2.html

Figures:

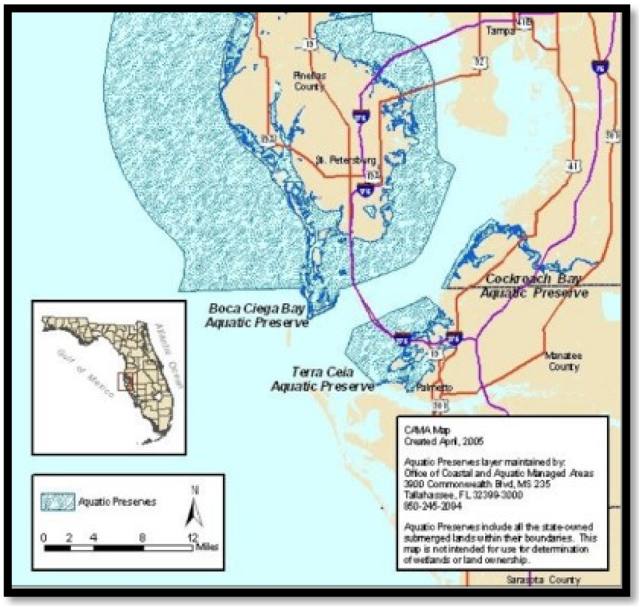

Figure 1: General Location map and extent of local area Preserves.

Figure 2: Location of Egmont Key in the mouth of Tampa Bay, West Central Florida. The approximate location of the reef is east of the south third of Egmont Key.

Figure 3: Typical EcoSystem reef module. Installation used in the study was modified to create overhanging ledges.

Figure 4: “Oyster Dome” used as the LPRB.

Figure 5a: Pedestal (Base disk) without embedded rock.

Figure 5b: Disk. Note taller rocks creating subdivisions (cavities).

Figure 5c: Base pedestal with embedded rock being prepared for deployment. Upper disks are added underwater once the base is set in place.

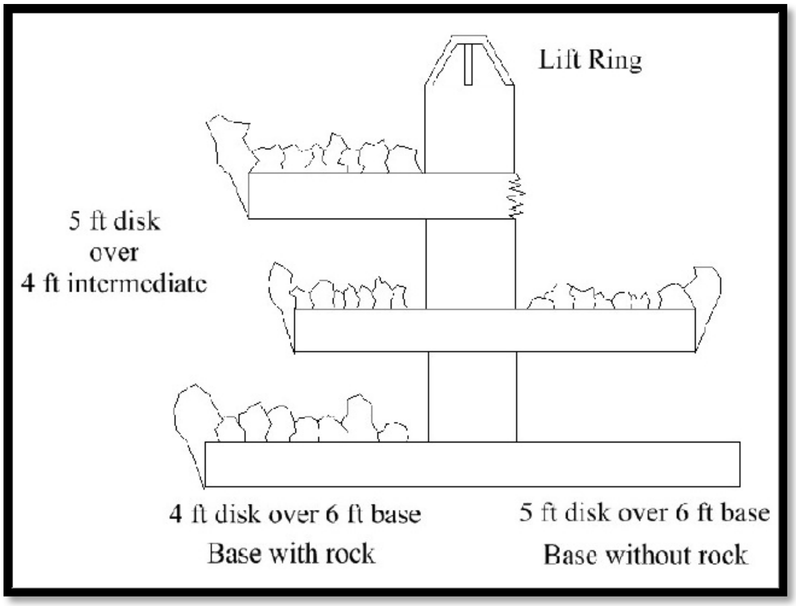

Figure 6: Composite sketch of LMM showing different configuration options.

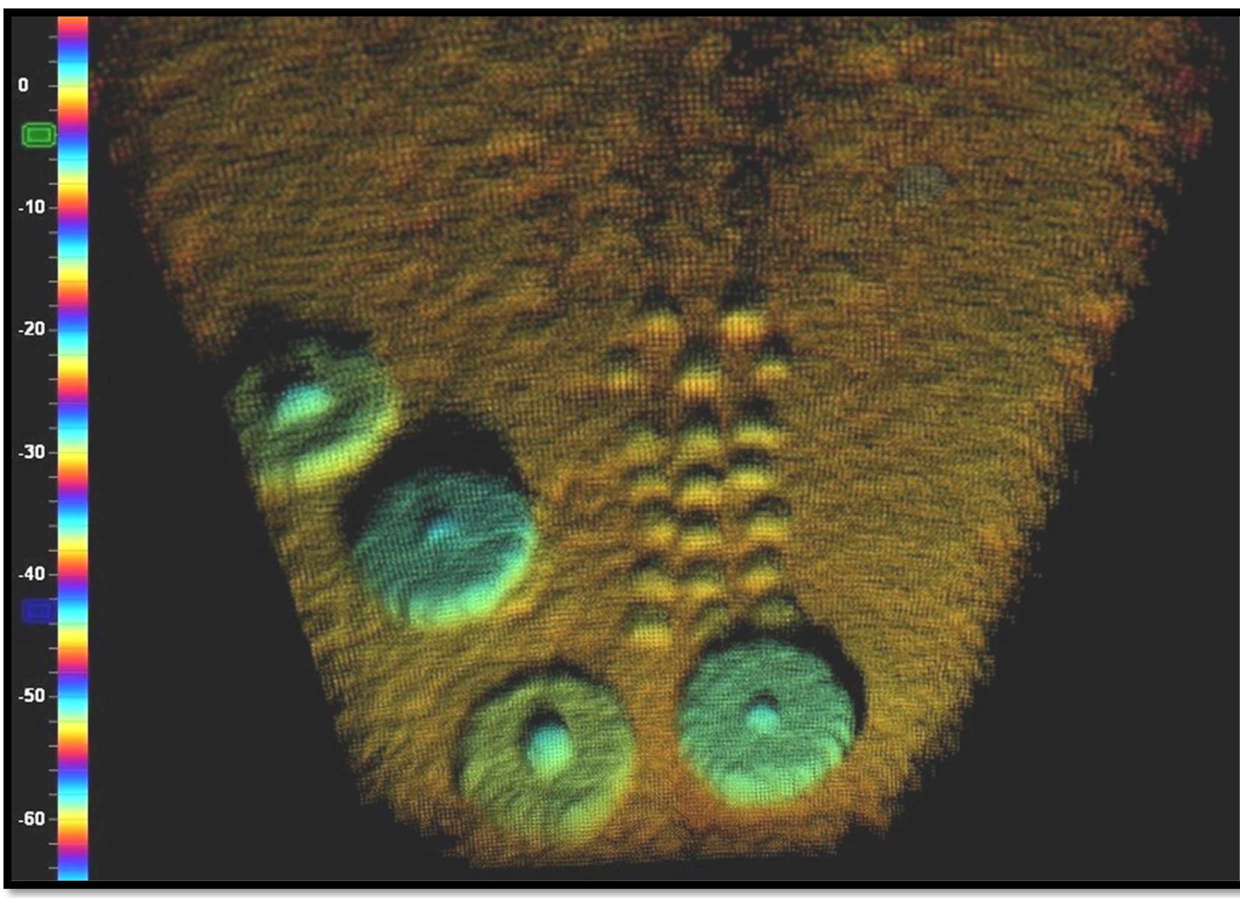

Figure 7: 3D Sonar image, courtesy G.F. Young, Inc.