High Resolution Underwater Mapping of the Osborne Tire Reef (OTR), Fort Lauderdale, Florida

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In the 1970s and early 80s, waste tires were placed offshore Ft Lauderdale as fishing enhancement reefs....
2,000,000 +
- Little to no benthic recruitment
- Dispersal of tires over adjacent seafloor and reef and beyond...
- Physical damage to shoreward reef tract

Credit: Pat Quinn, Ph.D., Broward County
• ~ 1 mile offshore of Fort Lauderdale Beach

• Between 2nd and 3rd reef tracts

• ~ 70 feet of water
Past Removal Efforts

• **2001** - Small project  
  (NSUOC – NOAA grant)

• **2005** - First mapping effort  
  (Broward County)

• **2007,08,09** - Three large missions.  
  Broward, NOAA, DoD Innovative Readiness Training Program.  
  72,000 tires removed

• **2015** - Commercial Contract
• 341,000 tires removed (est.)

• $17 / tire (current estimate)
  - does not include disposal fee and Port fees

• Past estimates have put the cost as high as $70 per tire. ($49M total project cost…)

FDEP and other agencies are evaluating more cost effective removal programs
CSA assessed the current condition of the Osborne Tire Reef (OTR) using multibeam, side-scan, towed video, and diver surveys to create high resolution underwater maps.

Approach:

- Remotely sense entire area
- Visualize with towed video
- Conduct diver mapping to provide ground-truthing
- Record *in-situ* measurements of density and abundance
• Multibeam original OTR extent
• Expanded area - tires outside OTR
• R2 Sonic 2024 Multibeam echo sounder
  o 450 kHz
  o Applanix POS MV Wavemaster: real time motion-corrected location data
  o Micro X SV Base X2 sound velocity profiler used to refine soundings in post-processing
24 Parallel transects

- Oriented North-South
- Spaced at 40 m
- 300 m buffer area around OTR
- Extended buffer: 1000 m N, 500 m E & S
- Multibeam critical first step:
  - Instrumental in determining depth and location of hardbottom features
  - Easily located larger shipwrecks, manmade structures
  - Provided framework of survey area to build on with finer-scale sampling
  - Lower resolution not diagnostic for tires

Multibeam Survey
• Side-scan sonar data recorded simultaneously with multibeam
• Dual-frequency Klein 3900 side-scan sonar
  o 445 kHz
  o Slant range 150 m
  o Imaged at 100% overlap
• High resolution
Side-scan Sonar Survey
Side-scan data = most valuable due to high resolution (~8 cm), necessary to effectively image tires

Quality of side-scan imagery combined with surveying during calm seas were critical factors in the success of the project
Towed Video Survey Rationale:

• Transect lines: N-S & E-W
• Visual overview of survey area
• Determination of key features
  o Identified tires outside OTR boundaries
• Guidance for diver survey effort
  o Ensured best use of in-water time
  o Noted targets for diver verification of multibeam and side-scan data
Divers were deployed to:

- Groundtruth side-scan target areas
  - Underwater GPS

- Map extent of tires among the reef features
  - Transect surveys

- Determine tire density in accumulations
  - Quadrat-based abundance
The Shark Navigator: submersible display, continuous GPS location and interface for diver data entry

- Geographic data from side scan preprogrammed
- Pre-plotted targets of interest and transects assessed by divers
- Annotated map *in-situ* to refine ground truth results
- Collected geographic locations of additional objects of interest
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**Shark Navigator Display**

**Diver Mapping – Underwater GPS**
Final GIS mapping products:

- Large number of habitat classes encompassing important data points
- Geographic extent of tires
- Diver-verified tire densities
- Large geographic dataset of man-made debris, artificial reefs, and shipwrecks
The geophysical survey found tire accumulations much further from the original tire reef than expected.

Survey team mapped tires, artificial reefs and quantified tire density within the extensive area.

Large GIS dataset = guidance for future removal efforts.

Multiple technologies + diver verification = thorough & precise dataset
Questions?