

**PUERTO RICO ARTIFICIAL REEFS EVALUATION ON THE EAST COAST**

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**TO: DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES OF PUERTO RICO,  
MARINE RESOURCES DIVISION**

**FROM: JOSE CABALLERO, MARINE CONTRACTOR**

**RE: PROGRESS REPORT #1 - PUERTO RICO ARTIFICIAL REEFS EVALUATION ON  
THE EAST COAST. CONTRACT # 2013-000096**

## **ARTIFICIAL REEFS EVALUATION ON THE EAST COAST OF PUERTO RICO**

### **INTRODUCTION**

Puerto Rico's east coast is where most of our recreational marine activities take place. In fact, nearly all boating events and the majority of the marinas, are in Fajardo - our eastern town. This study takes place within an area designated as a nature reserve called "Reserva de los Cayos de la Cordillera". Composed of a group of small islands located within eight nautical miles from town, marinas, hotels, condominiums and restaurants, among other establishments.

Hundreds of tourists and locals alike visit the nature reserve on a daily basis. In addition to tourism, 3 fishing villages and 7 marinas are within 5 miles of the reserve. This high volume of marine activity for the past 50 years has generated numerous nautical debris. Among these, sunken boats and abandoned derelict hulls from past hurricanes, are a very common find while diving the area. These wrecks provide shelter to juvenile fish of our local fishing industry.

Some of the goals of this project include the assessment of the amount of wrecks, documenting its location and size, seabed classification, conducting fish census in the area and categorizing the structures as 'useful' or 'not useful' for our marine industry. The term 'not useful' will be used to categorize the wrecks that will require preparation work in order to be "useful" and not become hazardous for divers or to other nearby habitats during severe weather.

The Puerto Rico Department of Natural and Environmental Resources may upgrade the structures found to "artificial reefs" after determining that these wrecks are safe and do not represent a hazard to other ecosystems, divers or to navigation.

Consequently, the study was conducted with the following objectives:

- A. Evaluate nautical charts and aerial pictures to determine which areas have the most concentration of boating activity during weekends.
- B. Identify sunken man-made structures that may work as artificial reefs by use of a Side Scan Sonar (SSS).
- C. Study targets using video from a remotely operated vehicle (ROV) unit.
- D. Evaluate videos of targets for fish census purposes and categorize as per the submerged structure's stability and safety.

## **METHODS AND EQUIPMENT**

1. Imagenex Side Scan Sonar model 855  
Frequency 330 kHz, 75'umbilical, 12 volts
2. Humminbird 997si Side Imaging Sonar - GPS Chartplotter Combo  
Frequency 455khz/800khz, Gold Navionics Charts
3. Toshiba Satellite P755 Laptop Computer
4. Videoray PRO III GTO ROV, remotely operated vehicle equipped with high resolution video camera, adjustable halogen lighting, depth meter, three thrusters for forward/reverse/vertical propulsion, and 700 feet of umbilical cable.
5. Dusky 25' workboat with Honda 225BF Outboard.
6. Honda 2000i Generator
7. Coleman 800 watt auxiliary power supply inverter
8. Humminbird-PC Software
9. Diamond VC500 Software used to convert ROV -RCA signal to USB digital for recording and video editing purposes. Also used for taking still images.
10. Epiphany VGA2USB Hardware for converting SSS analog Images to digital.

## **METHODOLOGY**

Marine charts and aerial photos of the Fajardo Islands were examined. Specifically, keys that are part of the Nature Reserve called Reserva Natural de Los Cayos de la Cordillera de Fajardo. The evaluation had as its main purpose to determine which of these islands had the higher concentration of boating activity during weekends. Once the high concentration areas were identified, they were selected for further analysis. Personally interviewing commercial underwater-fishermen of the area, was another approach used during this study to find submerged structures. These men provided valuable information of wrecks and other structures that work as artificial reefs.

The selected areas have been visited during the following time period: May 5, 2013 to Sept 2, 2013. A workboat equipped with side imaging bottom sounder and chartplotter GPS was used. A side scan sonar was also deployed from the boat to increase search pattern width as the boat proceeds over the selected areas.

The side scan sonar is a marine geophysical technique that is used to provide an image or "see" the ocean floor. The method uses sound pulses (sonar) shot sub-horizontally across the sea bottom from a towed transducer mounted on a "tow fish". The sound pulses reflect off objects that project above the bottom.

The strength and travel time of reflected pulses are recorded and processed into an image or picture of the seafloor.

When conducting side-scan survey operations a search "block" is set up. These blocks contain many lines and when searching in these blocks the boat will pass over one line then turn around and pass over another line in the opposite direction, much like someone "mowing the lawn". During this initial survey, the side-scan sonar towfish is towed behind the research vessel above the seabed.

During this study, the use of the side scan sonar was combined with a chartplotter GPS device in order to provide navigation while towing, therefore sweeping the study area. The chartplotter provided key data in order to resume search any other day at the exact position paused.

Targets that showed up in the side scan sonar monitor that had manmade characteristics, were saved in the chart plotter memory and given a target number. Their Lat /Long position and a snapshot of their shape was also recorded. Targets with obvious man made shape were swept with sonar various times and documented as such. Snapshots of these were saved on SD cards that the onboard electronics use. Please see attached SD Card Images #1, #2.

At this point in time, during Phase II of this project, side scan sonar has not been deployed in all of the studied areas due to technical problems powering the unit onboard combined with rough marine conditions. This Phase is scheduled to occur during October 2013.

During our next phase, a remotely operated vehicle (ROV) will be used to video the targets found in our previous search. A ROV, is a mobile robot used for sub aquatic work equipped with cameras, lights and thrusters for propulsion. Remote control is carried out by a tether or umbilical cord that connects the operator/pilot from a surface (boat) station. The control console provides the pilot with a monitor to see what the robot sees. Video and still images can be captured and saved to hard discs or other data storing devices. The ROV allows our project to evaluate further while maintaining low costs in lieu of the expenses when using divers.

After selecting a target on the chart plotter screen, a surface mark will be set in order to facilitate finding the underwater structures with the ROV. In other words, a small buoy or float with a sinker is deployed when the boat is directly on top of the chosen target. By doing this, the boat can be anchored as closed as possible to our mark. Once the boat anchor is set, we control the boat position with the amount of anchor line paid out. The ROV is launched after checking the pre-dive check list and connected via USB to a laptop pc for recording purposes.

The videos and still images captured are stored in the onboard PC hard disc for future evaluation. The ROV pilot will try to film the structure's surroundings as to portray what the structure is. Accessible compartments and holds must also be illuminated in order to appreciate overall condition of the hulk. The video will also concentrate in the marine life associated with the structure, since a mayor goal is to use the film for analyzing the extent of the wreck's fish diversity.

A survey of the surroundings is also required. The survey will determine if the wreck represents a threat to a neighboring coral reef or other valuable ecosystem. The ROV video will additionally reveal if the wreck should be anchored or secured to the seabed in the event of a tropical system. The information from the ROV is to be used in determining safety for divers (such as snag cables, sharp edges, openings, etc.) .

## **RESULTS - PROGRESS REPORT #1**

### **PHASE I : EVALUATION OF MARINE CHARTS**

After examining multiple marine charts of the Puerto Rico East Coast and various visits to the locations, with the objective of determining which areas had the most marine activity concentration within 8 nautical miles of the zone designated as a nature reserve called "Reserva Natural de los Cayos de la Cordillera de Fajardo", the following was found:

1. During the period from May 1, 2013 to August 31, 2013 the study determined that four of the islands within the reserve; Palomino, Palominito, Cayo Icacos and Cayo Lobos, had the highest concentration of boaters. See Aerial photos #1,2,3.

These four islands provide the recreational mariner with protected waters adequate for a beach day as well as diverse marine ecosystems. Among these; coral reef, sandy beaches, rocky shores, sea grass beds, and plenty vegetation to be enjoyed as shade from their evergreen coastal forests, especially in Cayo Icacos and Palomino. These resources also provide boaters with satisfactory sea bottom for anchoring, diving and water sports.

Another reason for the high concentration, is that the mentioned islands have available mooring buoys for the daily use of the local tourism vessels. Day charter catamarans, snorkeling tours, and dive schools use 100% of the existing mooring buoys in Icacos and Lobos.

Following is a brief description of the 4 islands within the reserve with the highest concentration of boaters:

#### **A.PALOMINO**

Located 3.5 nautical miles east from the Fajardo marinas. Palomino is the tallest of the islands in the Fajardo nature reserve. Very easy to see from 20 miles away because of her size, height and greenness. West side offers lee protected bay, with ample space for swing while at anchor or mooring ball. The bay is semicircular with a length of 0.5 nautical miles, from Punta Aguila demarcating its north end, and small patches of coral on its south boundary. Consists mainly of uniform seabed of mostly sea grass with a depth ranging from 12 to 30 feet. Palomino's bay has approximately 25 mooring balls.

## B. PALOMINITO

Small island approximately 400 X 250 feet, 0.25 nautical miles from Palomino with abundant white sand beaches. The small island's northwest shore is the most used because of its calm and crystal clear waters. A coral reef surrounds the southern half of this island. Very few trees remain standing, all located in a small area in the center of the isle.

## C. LOBOS

Located directly 1.5 nautical miles north from Palomino. This privately owned island offers protected waters on its western side. Because of private ownership, beach use is restricted. A manmade canal and small marina is found on the island's, north shore. A total of only 4 mooring balls were found, all being used by tourism vessels. The island's main attraction is the coral reef that borders the west shore and its schools of yellow tail snappers and blue tangs.

## D. ICACOS

The largest in area of the four, 0.7 nm x 0.5nm. With approximately 0.7 nautical miles of sandy beach, has been the favorite for many families for a beach day. Boats concentrate in the south shore beaches. The island offers excellent anchor holding sandy bottom. Coral reefs are found in both ends of the island ( north & south ).

## **PHASE II. Use of SSS ( side scan sonar) to Locate Underwater Structures**

From May 2013 to Sept 2013, an Imagenex Side Scan Sonar model 855 was used in order to expand search width on the seabed of the selected areas. The seabed survey has not been totally completed during this phase. The study requires proper marine conditions ( sea state 2 or less ), due to onboard electronics, generator and other sensitive equipment. Nevertheless, some areas were studied during calm weather and some structures have been located so far. Please see Table #1.

Among the found targets, three objects similar to boats ranging from 25 to 40 feet in length resting on a sea grass bed in a depth of 34 feet near Punta Aguila in Palomino Island. These targets are within 200 feet of each other. During the next phase a ROV will be used to investigate and video the associated marine life on these structures.

A smaller target was marked off Icacos Island in approximate 50 feet depth. This object has a shape of a power boat and rests on a sandy bottom. Because of the proximity to Icacos's busy south shore, is very probable that the found structure is a small cabin cruiser.

An additional mark was saved on GPS off the southern shore of Lobos Island. The object on the screen appeared to be a medium size power vessel with a substantial amount of debris scattered in the vicinity. The debris can very well be parts of the hull, cabin top or aluminum pipes from a hard top.

## CABEZA DE PERRO - WRECK

A steel hull commercial fishing vessel wreck was found between Cayo Largo and Cabeza de Perro Island. The target is located approximately seven nautical miles south of the nature reserve.

After interviewing various fishermen and a few dozen hours of scanning the area, this wreck famous for lobster was finally located. The hull lies in 40' depth on a sea grass bottom. The wreck was verified with the use of scuba gear.

These five targets will be visited for further evaluation during the next phase :  
ROV for close-up inspection and video recording.

## PHASE II Results

Tabla #1

Reference	Pos Lat/Long	Type of structure	Aprox.LOA	Depth	Recommended use
Isla Palomino	18 21.146/65 34.624	Wreck - boat	25'	34.6'	TBD
Isla Palomino	18 21.996/65 34.598	Wreck - boat	30'	35'	TBD
Isla Palomino	18 21.994/65 34.566	Wreck - boat	40'	45'	TBD
Isla Icacos	18 23 /65 35	Wreck - boat	25'	50'	TBD
Isla Lobos	18 22 /65 34	Wreck - boat	30'	30'	TBD
Cabeza de Perro	18 15.882 /65 34.045	Wreck - Steel hull boat	60'	43.2'	TBD

## WORK SCHEDULE

- |   |                    |
|---|--------------------|
| 1.Complete side scan scanner phase                | Start October 2013 |
| 2.ROV use on targets selected from previous phase | Start January 2014 |
| 3.Evaluate ROV videos                             | Start March 2014   |

Aerial Photo #1  
Palomino & Palominito



Aerial Photo #2  
Cayo Lobos



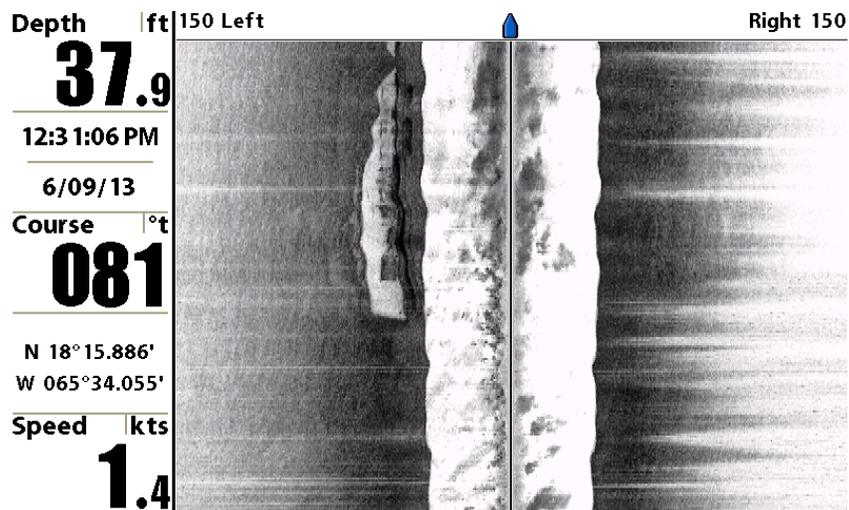
Aerial Photo #3

Icacos



SD CARD IMAGE #1

Larger Wreck-Look alike structure



SD Card Image #2  
Sunken Sailboats

