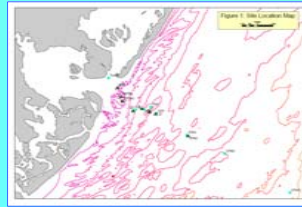


Study of the Physical Parameters of The Beach Haven Sand Ridge Area Using The Autonomous Underwater Vehicle REMUS

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Abstract- Developing an understanding of the oceans physical aspects is very important. The ocean's physical parameters can provide us with an understanding of marine habitats, how they formed, and also allow us to make predictions as to what will happen to them. This information is useful to fisheries management. It can help explain why certain species are attracted to specific areas. The physical parameters that are observed can be broken into specific aspects such as physical and physiochemical. Physical aspects is exploring features such as bottom topography, bottom composition, and currents, etc. The physiochemical is the salinity, suspended matter, and temperature of the observed areas. Traditionally oceanographic data was collected manually through techniques that involve humans attending equipment from the surface. But as of recent there has been a development of technology known as Remote Operated Vehicles (ROV) or Autonomous Underwater Vehicles (AUV). AUV's are excellent for collecting data because they operate with out constant supervision and human interference. AUV's can also perform multiple tasks at once. The Remote Environmental Measuring UnitS (REMUS) was used to collect data. REMUS possesses the ability to collect physiochemical data, side scan imagery and also bathymetric data during a single mission. Once the data is collected it can be compiled and graphed for interpretation.

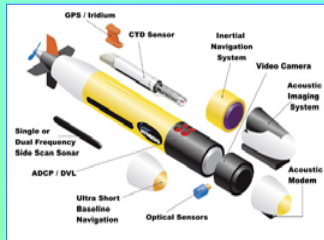


(Fig. 1) Trawl survey station locations in the area of the Beach Haven Sand Ridge.

Area of Study- Using the Autonomous Underwater vehicle, REMUS, surveys were conducted to observe the physical parameters of The Beach Haven Sand Ridge Area. The trawl survey is comprised of several stations LE, OT2, TOP, OT5, STAC, STAD, and STAG (fig. 1). The stations LE and TOP are two stations in which the most data has been accumulated. So these are the stations that were focused on primarily in this project. The survey results at station TOP indicated that there was a lack of species diversity (Able et al. 2003). One reason might be that the bottom type is comprised mainly of sand and waves continually cross the ridge creating a high energy environment (Able et al. 2003). Station LE has the greatest species diversity and abundance (Hales et al. 1992). Observations reveal that the bottom is comprised mainly of clay outcrops (Hales et al. 1992). TOP is within close proximity to the other stations that have relatively similar depths. It has the lowest species abundance and diversity in otter trawls while LE has the greatest amount of species diversity and abundance (fig. 2)(personal communication Jim Vasslides)



Remote Environmental Measuring Unit(S) (REMUS)



(Fig. 6) Schematic of REMUS showing the locations of the sensors and instruments (www.hydrodino.com)

REMUS- AUV's offer a new and very promising technology for studying the aquatic environment. One such vehicle is REMUS. REMUS is 62 in long and weights approximately 80 pounds. It possesses several sensor capabilities which are useful when exploring the aquatic environment. Missions parameters are programmed into REMUS through a computer (Hydroid, 2005). REMUS has a number of sensor capabilities which includes side scan sonar, OBS, CTD, and ADCP.

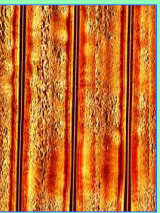
Navigation- REMUS has several methods in which it can navigate the aquatic environment. The first and most accurate is through transponders. Transponders are given GPS coordinates that are programmed in REMUS's memory it communicates with the transponders acoustically. So it can determine it's GPS location through trilateration it is capable of sub meter accuracy when it works off the transponders. It is also capable navigating of it's Global Positioning Unit (GPS) unit or using dead reckoning in which it uses it's electronic compass. Ideally the navigation precision is within 20 meters.

Side Scan Sonar- REMUS uses a Marine Sonics 900khz side scan system to produce sonic images of the bottom. The swath width to water depth is a 10:1 ratio. For every 1 unit of depth there is a swath width 10 e.g. two meters of the floor would mean a 20 meter area of seafloor would be captured. After the data is collected it can be used to create either side scan snapshots or complete mosaics of the bottom.

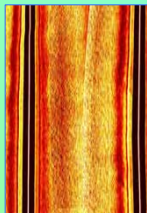
OBS- Remus has a WetLabs Light Backscattering Sensor (OBS) mounted on it's nose cone. The OBS measures light back scattering due to suspended particles. This information provides us with a measurement of the water's clarity or turbidity. The sensor can measure practically all suspended particle concentrations found in natural waters (wetlabs, 1999).

CTD- A CTD recorder is used to measure conductivity, temperature, and Depth. Conductivity is a measure of the flow of electrical current through the water and the flow of electrical current is affected by salinity, measurements of salinity can be recorded over the entire mission.

ADCP- The REMUS has two Acoustic Doppler Current Profilers (ADCP), it has and upward looking and a downward looking unit. The ADCP is used in navigation it helps the vehicle maintain its position in the water column in reference to either the ground or the water surface. It also provides bathymetric information along with current velocity and Direction.



(Fig. 3a) Snapshot from side scan mosaic at station LE.



(Fig. 3b) Snapshot from side scan mosaic at station TOP.

Introduction- For the past eighteen years the Rutgers University Marine Field Station has been conducting fish trawl surveys in the vicinity of the Beach Haven Sand Ridge. The sand ridge is an area of interest due to its location. The sand ridge is on the near shore of the continental shelf and is within a few miles of the coastline. A substantial amount of biological data has been collected During the trawl Surveys over the years, but there is not a lot of data that explains the physical parameters and processes around the ridge. The Ridge area offers several different types of habitats for marine life in an otherwise topographically flat area. It can also be a route for migrating fishes or utilized as a spawning ground. The trawl survey data is broken up by station and large variations in species abundance and diversity between stations has been observed (J. Vasslides, personal communication). The explanation for the diversity of this area has not been fully explained.

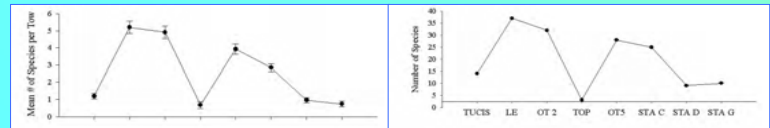
Methods and Procedures-

REMUS (Remote Environmental Measuring Unit(S)) was used to create a side scan mosaic of stations LE and TOP. This information will allow us to make observations about the physical features of area that might contribute to the species diversity observed in Otter trawl surveys.

REMUS navigated a series of parallel transects over the stations LE and TOP. During the parallel transects REMUS performed a side scan survey recording the bottom information. This parallel pattern is referred to as mowing the grass.

REMUS was used to record bottom bathymetry and current velocities and directions using the upward and downward looking ADCP. The amount of suspended material in the water column was obtained using REMUS's Optical Backscatter Sensor (OBS) mounted on REMUS. In addition, Conductivity, Temperature, and Depth (CTD) data were collected using an Ocean Systems CTD (OS200) sensor installed on the REMUS vehicle.

After the side scan survey was performed at stations LE and TOP, REMUS was used to gather physiochemical data as was described above for the other trawl stations LE, OT5, and STAC.



(fig. 2) Charts displaying trawl survey statistics on species diversity by station from 1997 to 2005.

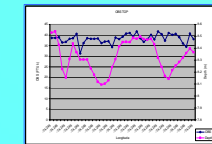
Discussion and conclusion- Figures 4a and 4b are plots of the obs data with reference to Longitude. Depth is plotted on the secondary axis. The data was collected from the stations LE and TOP. The OBS data indicates that there is a great difference in the turbidity between stations. The value at LE was 100FTU's while values at TOP were around 41.7 NTU's. Since the OBS values are measurements of suspended material in the water column, it may also indicate a resuspension of nutrients offering a potential reason for the variation in species amount and Diversity observed in fig. 2. The resuspension of nutrients would attract smaller species of aquatic life and then in turn attract larger species to feed upon the smaller ones. More extensive water testing would be required to prove this but with REMUS it is possible to get broad data that can provide ideas as to what might be the explanations for the trawl surveys results.

Figures 3a And 3b are the snapshots from the side scan mosaics developed for stations LE and TOP. The snapshots of the bottom structure at LE has great topographic variation where as TOP is predominantly sand. TOP's snapshot shows strong ripples which indicate that it is a high energy area due to wave effect. These sand ridges show us that there is little protection for marine life.

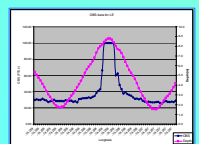
The side scan imagery indicates lots of structure at station LE. Since there was no groundtruthing involved in this project, it is difficult to determine the nature of these structures. It is believed however that some of the "mounds" or sudden changes or rises in depth are polychaete worm mounds which are a food source to fishes. If these are indeed polychaete worm mounds they would attract fishes to the area.

Figures 5 a and 5b are plots of the salinity with reference to longitude. Temperature and pressure were being plotted on a secondary axis for stations LE and TOP. The bottom salinity at station LE was 31.84ppt and station TOP is 31.86ppt. These salinity differences are insignificant and not a factor in the diversity and abundance observed between the stations.

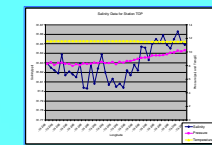
Data collected during this project seems to indicate that the resuspension of materials and the bottom structure may be the main reasons for the diversity and abundances of species observed in Fig. 2.



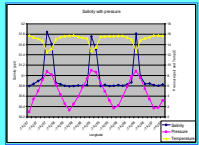
(Fig. 4a) OBS data for trawl survey station TOP.



(Fig. 4b) OBS data for trawl survey station LE.



(Fig. 5a) Salinity, Temperature, and Pressure at trawl station TOP.



(Fig. 5b) Salinity, Temperature, and Pressure at trawl stations LE.

