Delaware Bay Benthic and Sub-Bottom Mapping for Coastal Resource Management

The Delaware Bay represents almost one quarter of the surface area of the State of Delaware. What lies under the bay is one of the least understood areas of the State. Coastal management decisions are routinely made with limited knowledge of the resources and how the related economics of commercial and recreational activities of the bay will be affected. These decisions may range from designating areas of essential fish habitat to issuing dredging permits.

Commercial vessel passing Fort Delaware (CAP image)

Thousands of hours are spent annually by the Delaware Department of Natural Resources and Environmental Control (DNREC) on issues concerning the Delaware Bay. Other State and Federal entities as well as non-governmental organizations (NGOs) are also hindered in their activities by the limited information available about the benthos of the Delaware Bay. Much of the existing benthic information is not readily accessible to the public or easily combined with other data sets. According to Delaware Coastal managers, "What is lacking is an integrated biologic, bathymetric, and sediment distribution data set of the Delaware Bay benthos."

Migratory shorebirds on Delaware Bay

To improve the ability to make scientifically sound management decisions for the Delaware Bay, the Delaware Coastal Programs of DNREC is undertaking a Delaware Bay benthic and sub-bottom mapping project. The mission is ***"To identify and map the benthic habitat and sub-bottom sediments of the Delaware Bay, and supply this information in a form decision makers and stakeholders can easily use that will aid them in their efforts to manage and conserve the Delaware Bay's resources."***

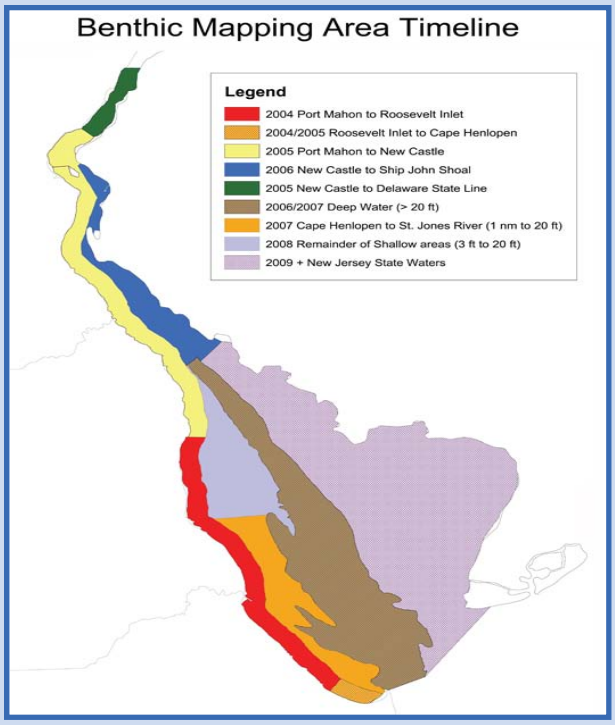
Preparing to dredge for horseshoe crabs

Background

Decisions are frequently made in regard to the Delaware Bay on numerous topics with sparse background information. A few examples of the topics of concern include: locating borrow sites for beach replenishment, examining the recovery rate of the benthos from dredging activities, identifying and managing essential fish habitat, monitoring the heath of shellfish beds, examining the effectiveness and longevity of artificial reefs, documenting the effects of bottom trawling, identifying submerged coastal hazards, mapping pre- and post-storm events to document benthic change, and supporting the assessment of anthropogenic induced events. A mapping effort was designed that integrated a wide variety of remote sensing techniques and field verification methods to effectively provide information for these topics. The project design provides high quality generalized mapping of the Delaware Bay with minimal staff effort. It allows for a more focused high resolution mapping of critical habitats or areas of special concern, as needed for decision making.

Mapping the Delaware Bay is a huge undertaking that will take from five to seven years, but may be shortened with the building of partnerships. To avoid duplication of efforts any available data from other sources is being incorporated into the database. However, relatively few surveys have been done on the Delaware Bay outside of the navigation channels or for dredging related activities. While bathymetry maps are available, wide area maps of the bottom type and sub-bottom stratigraphy are minimal and scattered among several State and Federal agencies. The Delaware Coastal Programs is partnering with the University of Delaware, Geology Department on the project for their expertise in sub-bottom stratigraphy. The research leaders will also enlist the help of other experts from academia, State and Federal agencies and NGOs whenever possible.

Horseshoe crabs on Bowers Beach



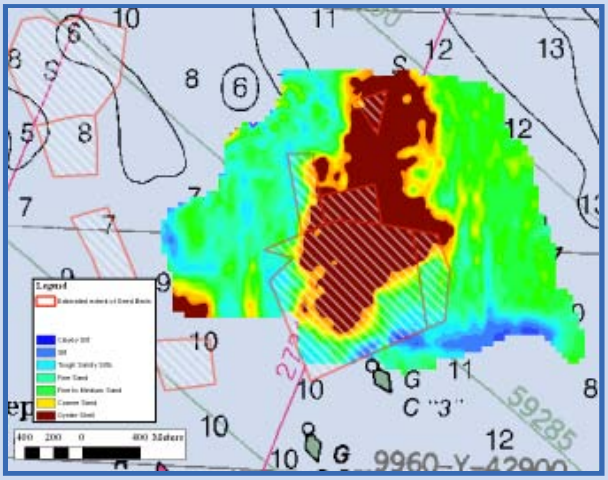
Timeline for mapping the Delaware Bay

Methods

This project, now in year two of its five year implementation plan, integrates three types of acoustical instruments: a RoxAnn seabed classification system, a multibeam bathymetric imager, and a chirp sub-bottom profiler. Field verification is performed through the collection of surface grab samples, deep core samples and underwater video images. All of this information is compiled into a geographic information system (GIS) database which will enable coastal decision makers to manage this coastal resource effectively. Macro-invertebrate samples are being collected with each sediment grab sample throughout the bay; these samples are cataloged with salinity, depth, temperature, and season data. This information will be used to develop habitat maps.

RoxAnn Seabed Classification System

The RoxAnn seabed classification system is a 200-Khz single-beam remote acoustic sounder that can be used to develop classifications of the sea floor based on hardness and roughness values of the bottom sediments. The values are interpreted by the system and categorized into a user-defined classification of the bottom. To relate the roughness and hardness data to actual bottom types, grab samples are collected at locations that correspond to regions where hardness and roughness values are clustered. The grab samples are analyzed for their sand, silt, and clay content to determine sediment type and any macro-invertebrate organisms present are documented. These hardness and roughness value ranges are used to create a sediment classification scheme. The sediment classification scheme consists of 32 classifications which range from soft fluidized mud to cobbles and other hard features.

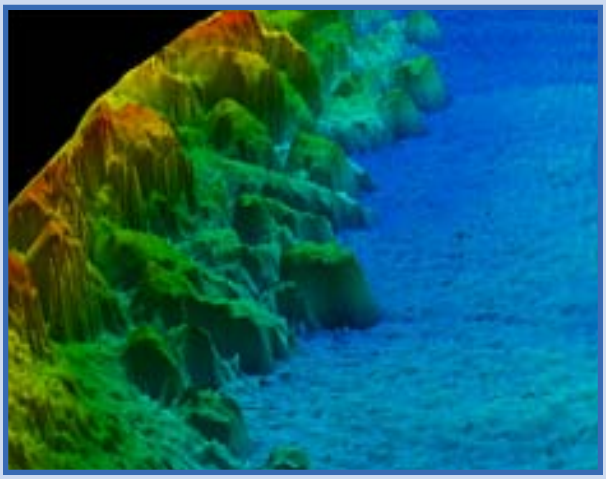


RoxAnn seabed classification of oyster beds off Port Mahon

Multibeam Bathymetric Imager

The morphology (e.g., relief) of the benthic surface is imaged using a Reson 8124, high-resolution, shallow water depth, multibeam bathymetric sonar. The system images a swath of the bay bottom 3.5 times the water depth. The optional side scatter feature of the unit enhances objects with the appearance of shadows to help the user visualize the true surface of the bottom.

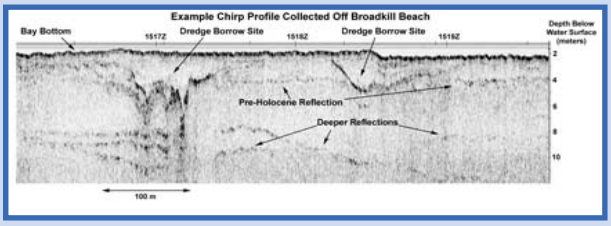
The multibeam bathymetric imager is used to map selected high-interest areas of the bay. Potential target areas include: *Sabellaria vulgaris* and *Hydroides dianthus* reef-like habitats, oyster beds, artificial reefs, trawl impacted areas, and natural geomorphic features. Another potential use includes identifying and locating submerged coastal hazards.



Multi-beam image of rip-rap along Mispillion jetty

Chirp Sub-Bottom Profiler

An Edgetech X-Star chirp sonar system is used to collect sub-bottom data. The boundaries between sub-bottom sediment deposits cause spatial changes in the amplitude, continuity, and geometry of the chirp acoustic reflections. The reflections caused by these boundaries are then used to identify the layering of different sub-bottom sediments. The chirp sub-bottom profiles are being used to study the deposition and/or erosion of sediments and the natural evolution of the Delaware Bay over the past 10,000 years. The chirp sub-bottom profiles are also being used to map potential, and past, off shore sand borrow sites that can be or have been used for beach replenishment.



Chirp image off Broadkill Beach

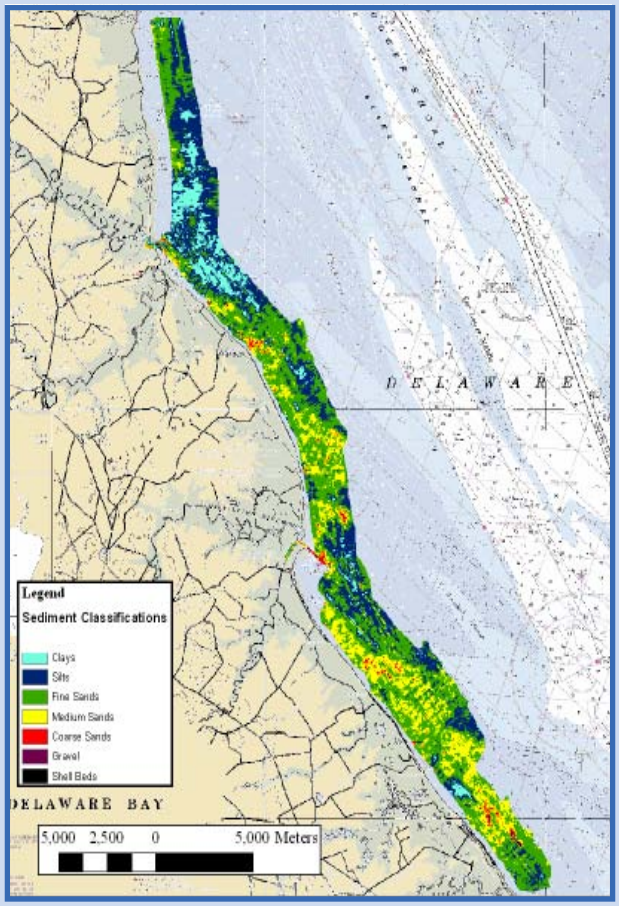
Verification

All remotely sensed data is calibrated and verified with benthic sampling. A petit ponar grab is used to collect a sample from the top 10 cm of the bay bottom. These samples are split: half are used for sediment classification and the other half for macro-invertebrate cataloging. A push corer is used for samples up to one meter in depth and vibra-cores for samples up to 10 meters. The cores are used to characterize and date the sub-bottom stratigraphy. The information collected from the sampling is geo-referenced and included in the GIS database.

Underwater imaging is also used to determine the extent and the distribution of the bottom sediments and macro-invertebrate communities. A Fisher Tov-1 is used to collect the underwater video, and is digitally recorded with the latitude and longitudinal position. The video is broken down into useful segments and images, which are cataloged and accessible through the GIS.

Final Products

The acoustic and "ground-truthed" data collected during this benthic mapping project will be integrated into four major categories of GIS coverages. Primarily there will be a bay wide benthic substrate coverage classifying the sediment in up to 32 categories. Secondly, 2-D and 3-D sub-bottom stratigraphy maps of the bay will be developed to identify geological features and sediment deposits up to a depth of 15 meters below the bay bottom. Multibeam images of key features of the Delaware Bay will be processed and geo-referenced into the GIS database. A map showing the distribution of the grab samples and their macro-invertebrate assemblages of the Bay will be developed. Finally, by combining the sediment classifications, macro-invertebrate maps and various physical parameters of the system, habitat suitability models of critical and endangered species will be developed.



Sediment classification of Delaware Bay nearshore

For more information contact:

David Carter, Program Manager
david.carter@state.de.us
DNREC/DSWC/DCP
89 Kings Highway
Dover, DE 19901
(302) 739-9283

or

Dr. Robert Scarborough, Research Coordinator
bob.scarborough@state.de.us
DNREC/DSWC/DNERR
818 Kitts Hummock Road
Dover, DE 19901
(302) 739-3436

DCMP
DELAWARE COASTAL MANAGEMENT PROGRAM