Development of a Spatially-Enabled Database in Support of Southeastern Tidal Creek Research at the NOAA Hollings Marine Laboratory

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NOAA Hollings Marine Laboratory

- National Centers for Coastal Ocean Science (NCCOS) located in Charleston, SC

- NOAA's Oceans and Human Health Initiative Center

- Three core research areas including marine pathogens, chemical contaminants, applied marine genomics with support from Ecological Research, Assessment and Prediction Program (ERAP)
Background

- Growing research focus on the interactions between ecological systems and human systems

- Support data archive and dissemination across spatial and temporal themes that in the past were perceived as distinct (i.e., socio-economic and environmental)

- Tasked to develop a database for Southeastern US tidal creek and watershed data originating from 1994 to the present
Objectives

• Establish a consistent approach in data collections and data management in support of interdisciplinary research

• Archival system for data and metadata to facilitate research objectives and provide a foundation for long-term data storage, discovery and export

• Disseminate data to stakeholders and scientists
Data Sources

• Data from multiple state and federal studies in GA, NC and SC dating back to 1994
  
  – Tidal Creek Project (TCP) (SCDNR)
  – South Carolina Estuarine and Coastal Assessment Program (SCECAP) (SCDNR)
  – May River Project (SCDNR/USGS/NOAA)
  – Land Use – Coastal Ecosystem Study (LU-CES) (SCSGC)
  – Oceans and Human Health (OHH) (NOAA/SCDNR/SCSGC)
    • FY ’05-’06 Includes biological, nutrients, contaminants and water quality data from SC, GA, & NC including NERRS
    • FY ’08 Gulf NERRS
Database Design

• MS SQL Server with MsSqlSpatial spatial extensions

• Uniqueness of the database is based on the concept of the *collection* that occurs in a tidal creek

• Overall structure of the database is realized with the use of three table types…. Attribute, Data and Reference
Database Design

- Attribute: describes the object *collection* by providing context (station, methods, watershed, contact) (13 tables)

- Data: record level results with units and methods for each *collection* (water quality, chemical contaminants, species counts) (4 tables)

- Reference: designed to minimize tables, by limiting character data types in tables (2 tables)
Data Types and Holdings

- **Watershed Attributes (Stressor)**
  - Boundaries, Impervious Cover and Land Use (NLCD)

- **Ecological Exposure**
  - water quality, nutrients, pigments, pathogens, physical, and chemical analytes of sediments (~127,954 records)
Data Types and Holdings

• **Ecological Response**
  - Species abundances in tidal creek waters and sediments (~72,614 records composed of ~1,500 species), tissue contaminants

• **Human Dimensions or Response**
  - Census 2000 (income, median income, population) and County Parcel data (e.g., density) (Quality of Life Index)
Metadata

- Parameter Vocabulary
  - Documents over 300 analytes (units, description, short-names, links to NIST Standard Reference Database)
  - Support understanding of data elements in an interdisciplinary research environment (semantic metadata)
  - Facilitate interoperability with other data providers
Metadata

• Metadata
  – “Dublin Core” metadata records created for each project (who, what, where and when)
  – Metadata records are built into relational database structure

• Collection and Analytical Methods are documented for each result in the relational database
Data Discovery and Access

- Primary user: MS Access using ODBC (forms, canned queries, import, export and edit data)

- Public user: Web-based applications founded on a tiered approach
  - Data Explorer: Web-GIS supports data discovery and visualization
  - Data Query: Access to data without the overhead
  - Watershed Explorer: Google Map API to support outreach
Participation in IOOS

- Pull data from SEACOOS and NOAA National Status and Trends Mussel Watch Program using WFS
- Pull data from NOAA NERRS CDMO with Web Service
- Support HML partner (SCDNR) by pushing near-real-time data up to Caro-COOPS/SEACOOS
- Push biological data to Ocean Biogeographic Information System (OBIS)
Infrastructure

- MS Windows database and web servers
- MS SQL Server database using the MsSQL spatial extension
- Mapserver – Web GIS
- Java Server Pages using the Apache Tomcat servlet container
- MS Windows Desktop with ArcGIS
Sampling Project: OHH Monitoring and Assessment Program
Date/Time: 2005-06-22 12:15:00-04 ET
Collection: 20056161  
Collection Type: nutrients, pigments
North: 33.580615  
South: 33.580615
East: -79.003016  
West: -79.003016

Collection Details
Contributed by: Denise Sanger | SC Sea Grant
Field Replicate: 1  
Tidal Stage: tide stage unknown
Collection Method: WQ Surface Grab stored in 2L plastic bottles and held on ice for >24 hours. Bottles sterilized for pathogens but not for nutrients.

Station Details
System: Murrells Inlet (Murrells Inlet, Main Creek)
Station: MI_11_3_1  
USGS Quad: Brookgreen USGS Quad
Watershed: Murrells Inlet  
Type: Intertidal

View Data
Nitrogen, Total  
0.6700 Milligrams per liter
Nitrogen, Total Dissolved  
0.3700 Milligrams per liter
Orthophosphate, Dissolved  
0.0079 Milligrams per liter
Phosphorus, Dissolved  
0.0294 Milligrams per liter
Phosphorus, Total  
0.1098 Milligrams per liter
Nitrogen Nitrite plus Nitrate, Dissolved  
0.0161 Milligrams per liter
Nitrogen Ammonium, Dissolved  
0.0000 Milligrams per liter
Silica, dissolved  
1.4400 Milligrams per liter
Chlorophyll a  
17.1603 µg/L
OHM Sampling Project: OHM Monitoring and Assessment Program

Title:
Center of Excellence in Oceans and Human Health at Hollings Marine Laboratory

Description:
As a Center in NOAA's Oceans and Human Health Initiative, the Hollings Marine Lab (HML) is developing new methods and approaches to identify and characterize chemical and microbial threats to marine ecosystems and human health and to evaluate the health responses of marine organisms to stress. To accomplish these objectives the HML works in three core research areas. These are source tracking of marine pathogens, chemical contaminants, and applied marine genomics. OHM is supported by additional programs to validate and test the sensitivity of the new tools being developed, manage the data to facilitate interdisciplinary analyses, and disseminate results and tools to environmental and public health managers, teachers, university students and citizens of all ages through a comprehensive education and outreach program. Oceans and Human Health projects at HML are for five years. Partnerships for the projects include NOAA, the National Institute of Standards and Technology, the South Carolina Department of Natural Resources, the College of Charleston, and the Medical University of South Carolina. This unique partnership integrates basic, applied and biomedical scientists into multi-disciplinary research teams and establishes programs that link environmental conditions in the coastal zone to human health and socio-economic well being. The data can support other area projects. A strong component of the HML Program is a data management system that supports the core research programs through the development various applications to document, upload, analyze and retrieve data from the OHM database.

Contributor:
Fred Holland/NOAA Hollings Marine Laboratory
### HML Parameter Vocabulary: Nutrients

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>DON</td>
<td>Nitrogen, Dissolved Organic</td>
<td>mg/L as N</td>
</tr>
<tr>
<td>NH4</td>
<td>Nitrogen Ammonium, Dissolved</td>
<td>mg/L as N</td>
</tr>
<tr>
<td>NO2</td>
<td>Nitrogen Nitrite, Dissolved</td>
<td>mg/L as N</td>
</tr>
<tr>
<td>NO2+NO3</td>
<td>Nitrogen Nitrite plus Nitrate, Dissolved</td>
<td>mg/L as N</td>
</tr>
<tr>
<td>NO3</td>
<td>Nitrogen Nitrate, Dissolved</td>
<td>mg/L as N</td>
</tr>
<tr>
<td>NP</td>
<td>Nitrogen, Particulate, W F, Suspended</td>
<td>mg/L</td>
</tr>
<tr>
<td>PO4</td>
<td>Orthophosphate, Dissolved</td>
<td>mg/L as P</td>
</tr>
<tr>
<td>Si</td>
<td>Silica, dissolved</td>
<td>mg/L SiO2</td>
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<tr>
<td>TAN+DON</td>
<td>Nitrogen Ammonia plus Organic Nitrogen, Dissolved</td>
<td>mg/L as N</td>
</tr>
<tr>
<td>TAN+TON</td>
<td>Nitrogen Ammonia plus Organic Nitrogen, Total</td>
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<tr>
<td>TDN</td>
<td>Nitrogen, Total Dissolved</td>
<td>mg/L as N</td>
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<tr>
<td>TDP</td>
<td>Phosphorus, Dissolved</td>
<td>mg/L as P</td>
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<tr>
<td>TN</td>
<td>Nitrogen, Total</td>
<td>mg/L as N</td>
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<td>TON</td>
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</tr>
<tr>
<td>TP</td>
<td>Phosphorus, Total</td>
<td>mg/L as P</td>
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</table>

**Export options:**  [CSV]  [Excel]  [XML]  [PDF]
OHH Watershed Details - Murrells Inlet

Census 2000 Population: 6975
Census 2000 Number of households with Income less than 25,000: 901
Census 2000 Number of households with Income equal to 75,000 and greater: 523
Census 2000 Number of households with Income equal to 25,000 and less than 75,000: 2138
Census 2000 Median Income: 39489
County Parcel Data Total Parcels in Watershed: 7030
County Parcel Data Median Parcel Value: 229500
Land Use Classifications: Urban Class
OHH Analytical Methods: Nitrogen, Total Dissolved

Short Description:
TDN (total dissolved nitrogen)

Long Description:
Sample is initially filtered through a 0.7 μm GFF. The sample is then digested using a persulfate oxidation technique for nitrogen where, under initially alkaline conditions, nitrate is the sole nitrogen product. Digested samples are passed through a granulated copper-cadmium column to reduce nitrate to nitrite. The nitrite then is determined by diazotizing with sulfanilamide and coupling with N-1-naphthylethylenediamine dihydrochloride to form a colored azo dye. Color is proportional to nitrogen concentration. Read on a Technicon AutoAnalyzer II.

Processed by:
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OHH Data Query Tools

**Data Type Query**

The data type query tool will allow users to filter down to a particular dataset based on the research core, sampling projects, and available parameter classes. This tool will provide data from all locations and time periods available within the OHH database. Click here for a list of all available sampling projects or use the menu below to select sampling projects by research core.

- Emerging Chemical Contaminants
- Environmental Monitoring and Assessment
- Pathogen Source Tracking

**Spatial Query**

The spatial data query tool will allow users to filter down to a particular dataset based on the states that have available data and the systems contained within those states. This tool will provide all data types available for all time periods within the OHH database. Click here for a list of all available systems or use the menu below to view systems by state.

- North Carolina
- South Carolina
- Georgia

**Temporal Query**

The temporal data query tool will allow the user to access all available data types and all available locations based on a particular time period.
OHH defines exposure data as a suite of chemical, biological, and landscape stressors that are characterized by type and magnitude in the environment that alter or damage biological populations and affect physical processes in an ecosystem.

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>NO2+NO3</th>
<th>PO4</th>
<th>Si</th>
<th>TDN</th>
<th>TDP</th>
<th>TN</th>
<th>TP</th>
<th>NH4</th>
<th>NO2+NO3</th>
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</table>
Current Efforts & Future Directions

• Focused on improving and expanding mapping and query applications

• Providing data and metadata to NOS Data Explorer, Geospatial One Stop