

6.11 VRML-BASED VISUALIZATION OF GIS DATA FOR A MARINE SANCTUARY

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1. INTRODUCTION

Visualizations of spatially complicated datasets are increasingly used to enable scientists and the general public to understand complex physical and biological processes. These geo-visualizations are also becoming a way to disseminate the data as a coherent package. Rather than distributing discrete datasets, a project can disseminate a view of the data with the recipient having the ability to move through the data, add and remove layers and to query to datasets at specific three-dimensional locations. Increases in the collection of three and four dimensional data, increasing bandwidth for distribution and the increasingly savvy user, raised on video games and interactivity, make it possible to distribute the visualization as another easily used and understood form of "data". Once a visualization is created, there are standard tools and plug-ins within browsers (VRML players, animation players such as RealPlayer, javascript tools) to enable users to manipulate the data. Visualizations are widely accepted by scientists and the public but tools to create and modify can be complicated, hard to locate and disparate.

NOAA's Cordell Bank Marine Sanctuary is a 526-square mile sanctuary located 50 miles northwest of San Francisco. The Sanctuary encompasses Cordell Bank - a pinnacle rising from the seafloor to within 120 feet of the sea surface - and the surrounding waters. As a part of a review of management plans for the Sanctuary, an extensive GIS has been created. Data layers include bathymetry, topography, Sanctuary boundaries and coastlines, sea surface

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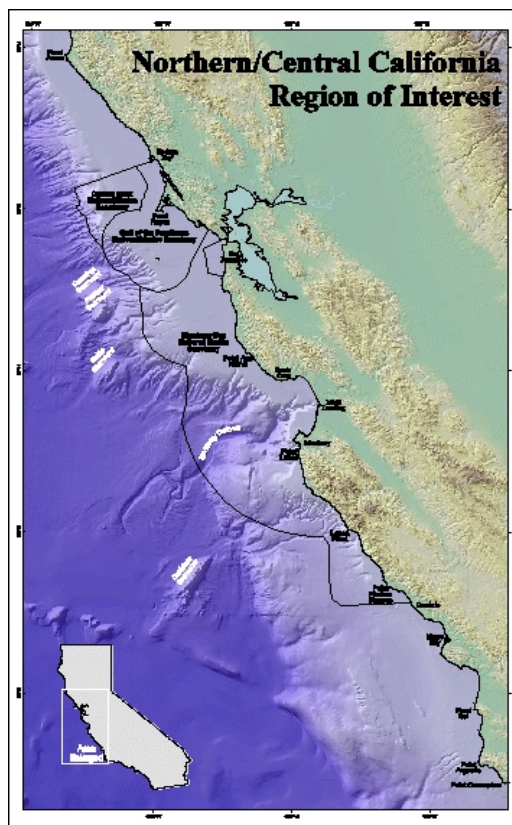


Fig. 1 Location of Cordell Bank NMS

temperature, conductivity-temperature-depth (CTD) data, bottom type, and hydroacoustic and other datasets for fish abundances. To improve the ability of Sanctuary managers, scientists and the general public to understand the patterns and processes occurring at the Sanctuary, we have created a 3D virtual world with these datasets. The goal of this project is to enable users to visualize the Sanctuary as a 3D entity rather than as a series of 2-dimensional maps.

For the visualizations in this project we have used a variety of packages to create VRML files that have been meshed to produce the final view. VRML was chosen for its flexibility, ease of transfer and for the viewing options it allows users.

ESRI's ArcView has been used to create VRML files for the coastlines, shorelines, bottom type and the bathymetry. CTech's EVS has created files for the CTD data and the hydroacoustic data. A web page using a Java applet and the VRML External Authoring Interface (EAI) allows the user to change the VRML scene graph depending on the choice of data. We are also packaging a number of the techniques we have developed to make them easily used as a part of a GeoViz toolkit.

This paper will discuss the datasets, the technologies we have used and developed to create the visualizations and plans for future implementations and the creation of a GeoViz toolkit.

2. DATASETS

Bathymetry data are from NOS surveys. CTD data are from a variety of sources. Fish abundance data are from hydroacoustic and trawl surveys conducted by the Northwest and Alaska Fisheries Science Centers of NOAA. Bottom type data are from the USGS and university sources. SST data are from satellite images gathered by NOAA. Coastlines and boundaries are from the Sanctuary.

3. VRML GENERATION

VRML scenes of Cordell Bank conditions were created in ArcView 3.2 and 3D Analyst by taking existing bathymetry, Digital Elevation Model (DEM) output, in-situ observations taken around Cordell Bank and marine sanctuary boundaries and creating 3D shapes out of the point data or by draping the bathymetry and DEM data over gridded data that were assigned a realistic exaggeration factor. 3D scenes were exported either into VRML 2.0 by ArcView Spatial Analyst as full scenes with bathymetry, topography and in-situ data or as discrete pieces that were later edited using standard VRML editing routines. ESRI's 3D Analyst and the new ArcScene provide the novice user the ability to change viewpoints, scale and horizons in the scene prior to exporting it into VRML.

Isosurfaces and vertical fence line plots that were used to look at CTD transects and zooplankton abundance on and off Cordell Bank were created using CTech's EVS-Pro software package. Once the visualizations were created and scaled, EVS-PRO allows the user to export

the scene to VRML2.0. Fence line visualizations, 3D temperature plumes and isosurfaces were exported individually and combined with the VRML output from ArcView's 3D analyst to create the visualizations used by the Sanctuary managers.

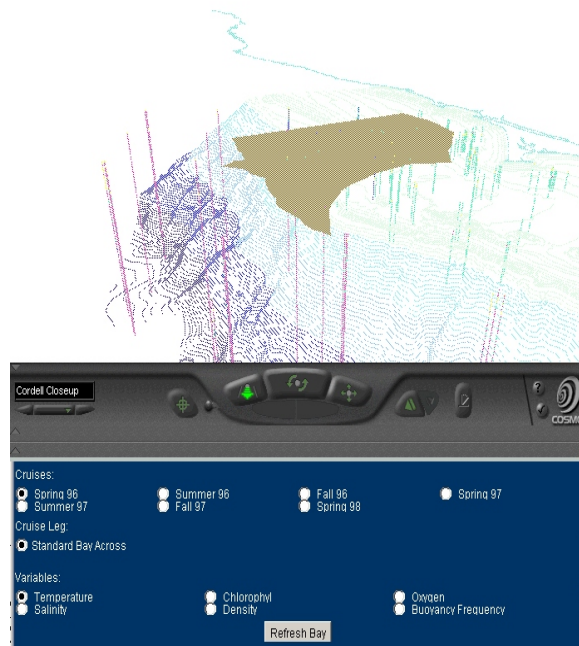


Fig. 2. VRML output with JAVA navigation

4. VISUALIZATION GENERATION

The VRML content is navigated through an HTML page with an embedded VRML world and linked Java applet. The user loads the visualization into a VRML- and Java-aware web browser (Netscape or Internet Explorer), and is presented with coastline, bathymetry and topography data in the VRML window. The user has typical 3-D navigation control in the VRML window, and can load, view, and (in the case of time-dependent data), animate data as the scene is rotated and scaled. Simple radio-button choices are given for dataset choices, and animation controls appear as time-dependent data sets are loaded. The VRML world and Java applet communicate with one another through the External Authoring Interface (EAI). This interface allows the user to select different data representations, or VRML "objects" (eg, isosurfaces, color-coded contour slices, vector fields, etc) for each data set. The EAI allows the controlling Java applet access to nodes (objects) in a VRML scene using the VRML event model.

This model allows for output events generated by a node to be routed to the input event of another node. The input event is notified so the receiving node can process that event. A script node is a special VRML node containing Java, JavaScript, or any of several other language bindings, and can dynamically change the VRML world in response to user inputs. A script node, when given a reference to a given node, can pass events directly to and from the referenced node. The EAI allows external environments (our Java applet) to pass references and events to the VRML world and behave as a VRML script node.

The EAI allows the applet to instantiate objects by node reference, change attributes of VRML objects, create and destroy objects, move them through space or time, or change their shape. The controlling Java applet allows the user to select different data representations and load the corresponding VRML objects into the VRML world. Data that is time-dependent is linked through the EAI as a Java-script embedded VRML object, with animation controls written in VRML2.0 and ECMAScript. Animation is controlled through the use of an external prototype node (see [VRMLspec.http://www.web3d.org/fs_specifications .htm](http://www.web3d.org/fs_specifications.htm)). This external prototype node is served from our web site at http://www.pmel.noaa.gov/vrml/html/tools/ctrl_lib.wrl, and can be downloaded, modified, and embedded into the visualization if a free-standing package is needed.

5. CONCLUSIONS

Visualizations of spatially complicated datasets enable scientists and the general public to understand complex physical and biological processes. These geo-visualizations are also becoming a way to disseminate the data as a coherent package. Standard GIS packages provide some tools for the generation of VRML-based visualizations. As PMEL has developed visualizations using VRML and other techniques such as animations, a number of tools and procedures and applications have been needed to create the visualizations. These tools have been developed on an ad hoc basis for specific projects.

It has also become apparent that the lack of easy ways to create and modify visualizations has hindered the ability of less technically savvy groups to develop needed visualizations. Future work will continue to implement tools for easier generation of visualizations and the packaging of all the tools in a single GeoViz toolkit.

For further details and to view sample visualizations please see <http://plover.pmel.noaa.gov/Cordell/home.html> .