Gulf of Mexico Restoration Decision Support project

In response to the Deepwater Horizon oil spill in April 2010, The Nature Conservancy in collaboration with multiple partners including NOAA, the University of Southern Mississippi, Stanford University, and ESRI, has developed an online web mapping application and robust Gulf of Mexico spatial database to help facilitate restoration and recovery decisions. Primarily targeted to help our state programs and the state agencies and partners they work with, the Gulf Restoration Decision Support project is being advanced to inform the identification of oyster reef restoration projects with maximum ecological, social and economic benefits. The Oyster Restoration Dashboard allows users to explore this database to identify potential restoration investments within each of the Gulf states of Florida, Alabama, Mississippi, Louisiana and Texas.

The Oyster Restoration Dashboard is organized by state and permits users to easily visualize locations most appropriate for oyster restoration investment using a suite of ecological, social and economic criteria. The suitability criteria vary somewhat between states due to differences in data availability, however all states include basic ecological measures such as depth, salinity and historic oyster distribution.

How the Oyster Restoration Dashboard works

The aim of the Oyster Restoration Dashboard is to help with scenario planning at a state scale. When a user interacts with the Oyster Restoration Dashboard for a particular state they have the ability to assign a number of weights to the various criteria or individual parameters. These weights are assigned through the interface by sliding a bar to select a value between 0 and 10. When the user assigns a weight in this manner the predefined values for each parameter are then multiplied by the weight assigned to it. The pre-defined values for each parameter can be found in the Map Layers panel, under each state in the category called Oyster Restoration Dashboard Data. The user-defined weighted parameters are combined to produce an overall score of restoration suitability in the following equation:

$$\text{Score} = \sum_{i=1}^{n} \text{weight}_i * \text{paramater value}_i$$

Where *n* in the above equation is the number of parameters.

Sliding the bar to 0 eliminates the parameter from being included in the suitability analysis. A user assigning a weight of 1 will cause the original parameter value to carry through into the score sum equation. The score is what is displayed to the user on the map, however the raw score cannot be displayed directly because the cartography depends on the scores always maintaining a constant range.

In this case the values are rescaled to a range of 0 – 100. Values in the range from 0 – 20 are assigned "Low", 40 – 60 "Medium", 80 – 100 "High" and then assigned a color for display as referenced in the Legend. Values from 20 – 40 are assigned a color between the Low and Medium classes, and values from 60 – 80 a color between the Medium and High classes. The "others" class has no meaning here as no regions will ever fall into this range.

When the user exports a scenario, the weights displayed on the web mapping application will be captured in the attribute table of the dataset. The values that are present in the table include fields for each parameter ("Score") as well as a rescaled (0-100) overall score value ("Dash_Score").

Suitability parameters included in the Louisiana Oyster Restoration Dashboard:

Ecological

Salinity Score

Source: Salinity Zones in Estuaries along the Gulf of Mexico – NOAA/NCDDC;
Resolution of source data: 1:24000.
Explanation: Both the high season and low season polygon layers were used to identify high and low salinity areas appropriate for oyster restoration. The optimal salinity range for oysters on the LA coast are cited by the literature as (?), however, oysters can survive in salinity equivalent to that of ocean water (~25ppt). Oysters are not able to handle much freshwater inflow either, so salinities less than 5ppt and greater than 25ppt were considered unsuitable and were eliminated from the analysis.
GIS Processing: Polygons representing salinities from 5-25 (ppt) were scored 1 with the remaining areas scored 0 and converted to 10m, 10m grid.

Depth Score

Source: Bathymetry of Texas-Louisiana Continental Shelf and Coastal Regions (Digital Vector Bathymetric Data), by US Coast Survey available from NOAA, compiled by Texas Parks and Wildlife Department (1930-2005).
Resolution of source data: 1:100000
Explanation: Oysters are able to thrive at a variety of depths, however, for the objectives of this project, the depth of placement was restricted to a maximum of 10 feet.
GIS Processing: All areas less than 10ft deep or less were scored 1 with remaining areas scored 0. Grid size = 10m, 10m with processing extent, snap to raster, and raster analysis mask set to analysis area.

Historic Reefs Score

Source: Chris Shepard (TNC) digitization of historic maps in Vermilion Bay, Melissa Jenks (TNC) digitization of historic 1920s Coast Line and Oyster Bottoms of Louisiana Historic Map - compiled under the direction of the Department of Conservation of Louisiana via Ashby Nix (LSU).
Resolution of source data: varies from 1:24,000 to 1:200,000.
Explanation: This is an important data layer to include as it demonstrates where oysters have historically been successful and thus likely will be successful again. Of course, it is always important to remember that conditions may have changed in the given time span such that reefs may not be suitable in all the areas identified by this layer.
GIS Processing: All current and historic oyster reef polygon layers were merged and areas with reef were scored 1 and areas with no data scored a 0. Polygons were converted to 10m, 10m grid, processing extent set, snap to raster, and raster analysis mask set to analysis area.

Distance to Marsh Score

Source: USFWS Classification of Wetlands and Deepwater Habitats of the US.
Resolution of source data: 1:24000
Explanation: Since a large part of TNC's goals for oyster restoration is to mitigate shoreline erosion of vulnerable areas, we used a layer identifying all marsh areas in Louisiana to help site reefs. Wetlands tend to be located in low elevation areas and are an essential ecosystem due to their role as nurseries and natural filtration systems. Thus, placing oyster reefs in front of such areas will ensure that they are not lost due to erosion or sea level rise.
GIS Processing: ArcGIS Spatial Analyst straight line distance tool was used to allocate proximity to wetlands. The data was then reclassified so that distances from 0- 50m received a 1 and distances greater than 50 meters received a 0.

Social and Economic

Project Permit Feasibility Score

Source: Public and Private Oyster Leases (Louisiana Oil Spill Coordinator's Office) (LOSCO 2006 and 2001 respectively). For more information you can access: http://www.losco.state.la.us/
Resolution of source data: 1:24000
Explanation: Placement of reefs in areas where public and private oyster leases exist were not considered suitable due to harvesting of shellfish in those areas. Areas outside of the lease areas are considered to be more suitable for restoration.
GIS Processing: All areas that are in public or private oyster leases were excluded from the analysis and were scored a 0. All other areas are considered suitable and were scored a 1.

Natural Resource Job Dependence Score

Source: 2000 US Census Block Data
Resolution of source data: Block group
Explanation: Positive socio-economic impacts and ecosystem services are provided by oyster restoration.
GIS Processing: Percent employed in agriculture, forestry, and fishing was calculated by dividing raw number employed in sector by the total workforce per block group in counties touching the shoreline. The Euclidean allocation tool was used to assign nearest values to cells within the study area 2 km off the coast.

Shoreline Erosion Score

Source: USGS Coastal Vulnerability Index (Raw Erosion Values Used)
Resolution of source data: ?
Explanation: Oyster reefs provide a cheap alternative to shoreline erosion issues and protect important marsh areas that are vulnerable to erosion and pollution.
GIS Processing: Index clipped to state and reclassified into quartiles with scores of .25, .5, .75, and 1. Then used Euclidean Allocation Tool to allocate scores to raster cells within 2 km of shoreline. Environment settings for Euclidean Allocation included processing extent, snap to raster, and raster analysis mask set to analysis area grid. Zero values (those cells farther than 2 km from shoreline) were not symbolized.