Utilizing spatially intensive data in monitoring Maryland's Coastal Bays
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Abstract
Traditional monitoring programs collect periodic data at a small number of fixed sampling locations. These measurements provide a good baseline for watershed assessment and long-term trends, but may miss small-scale gradients in water quality. Spatially intensive data are useful for identifying localized areas of water quality concern, mapping the extent of harmful algal blooms, and linking degraded areas with adjacent land uses. High-density sampling locations allow the production of statistically valid interpolated maps, and maps which can be integrated over time, which are useful for reporting tools. This poster presents two methods of collecting and integrating spatially intensive data, as conducted in Maryland's Coastal Bays. The first is a study by UMCES-IAN utilizing traditional water quality parameters together with a biological monitoring technique using the isotopic signature of nitrogen (δ15N) in benthic communities to detect and integrate the effects of anthropogenic nitrogen, such as sewage, septic, and animal wastes. These data were collected at ~250 sites throughout Maryland's Coastal Bays in June 2004. The second method is used by Maryland DNR as part of their Water Quality Mapping program, and is a product of a Maryland DNR/UMCES-CBL partnership. The Water Quality Mapping system collects data every 3–4 seconds from a moving boat and is conducted monthly April–October.

This series of maps shows 2004 data from MD DNR's Water Quality Mapping program. Collected monthly, these interpolated maps show the change in salinity, dissolved oxygen, and turbidity from April to September. Data analysis and map production by M. Trice (MD DNR).

Conclusions
Spatially intensive data, when reported in conjunction with more traditional monitoring techniques, such as fixed station monitoring, provide an additional perspective on the state of a system. The sampling of water quality parameters can result in statistically valid and spatially explicit interpolated maps. These parameters can be integrated to provide an ecosystem health index map, which allows scientists to conduct adaptive sampling to detect and map areas that may be indicators of elevated nutrient concentrations. This method can be flexible in that the thresholds, or criteria, can be weighted differently to emphasize certain parameters that may be better indicators than others.

Data collected using MD DNR's Water Quality Mapping system, collected monthly, can be integrated over time for each parameter, to provide a status map for the whole year. These data can also be integrated to map areas that pass or fail specific reference values which, as above, can be linked to management objectives.

References

Acknowledgements
Preparation and analysis of the data conducted by the Maryland Coastal Bays Program. Special thanks to: University of Maryland Center for Environmental Science, additional support was provided by the Chesapeake Bay Program and the National Estuarine Research Reserve, Chincoteague. Funding and support of this project were provided by the Maryland Coastal Bays Program and the Chesapeake Bay Program.

Methods for obtaining spatially intensive data
• Interpolated maps were derived from fixed station monitoring, one example is shown here.
• Fixed station monitoring and other methods produce data that are collected in a discrete set of locations.
• The spatial interpolation was conducted by applying a method to these fixed station raw data to produce spatially interpolated maps. The interpolation method utilized is Inverse Distance Weighting (IDW). The exact method of interpolation is described by Data Inventory and Analysis Team (DIAT) at the Maryland Department of Natural Resources (MD DNR) (see also the 2004 Water Quality Index).

Ways to integrate spatially intensive data
• Spatially intensive data can be integrated into a quantifiable ‘snapshot’ of water quality status—the Water Quality Index—by assigning a value of 1 to each of the six indicators complying with a reference value, and 0 otherwise. The mean value for all parameters is the Water Quality Index for that site.
• The reference values for each parameter were determined through a series of indices by calculating the Water Quality Index. However, this method is flexible in that the reference values, or thresholds, can be weighted differently to emphasize certain parameters that may be better indicators than others.
• Data analysis and map production by F. Pantus (IAN and CSIRO).

The Water Quality Mapping system, modified from an original design by Maddon and Day (1992), collects quantitative intermittent water quality data along moving small boat. Water is continuously pumped from approximately 0.5 m below the surface, passed through a flow-cell, and monitored for dissolved oxygen, chlorophyll a, turbidity, water temperature, salinity, pH every four seconds by a YSI-6600 datasonde. Water-quality data are merged with concurrent GPS positional data by an onboard computer. The hardware system houses all electronic device (GPS depth sounder, computer, flowmeter) within a waterproof enclosure, and has a separate housing for the YSI monitor and water flow components. Past water-quality mapping systems by Maddon and URM-Chesapeake Biological Laboratory enabled visualization of numerical data on LCD screens, and further enhancements by the Virginia Institute of Marine Science allowed for viewing of data in on-screen gauges, chart, and text format.

MD DNR, through a grant awarded by the Cooperative Institute for Coastal and Estuarine Environmental Technology, has developed a new real-time monitoring system called DATAVIEW, which allows the data to be collected and immediately transferred to a laptop computer. The Dataview system automatically samples to delineate the extent of algal blooms, low dissolved oxygen, or impacted water clarity. Cruise tracks are usually conducted by alternating between shallow inshore and deeper offshore areas to obtain representative data across the range of habitats. These photos below show the new real-time mapping system, DATAVIEW (left and center), and the Water Quality Mapping system in action (right).

The average chlorophyll a map was derived from monthly water quality monitoring cruises, collected April through September 2004. The monthly cruises were collected on two consecutive days within the month, with the area north of the Ocean City, MD inlet (Assawoman and Isle of Wight bays, and St. Martin River) on the first day, and the southern area within Maryland (Chincoteague and Sinepuxent bays, and Tangier Creek) on the second day. Data from each monthly set of cruises were interpolated using the inverse distance squared method with ArcGIS 9.1 Geostatistical Analyst Extension. Each interpolated dataset was then calculated to a raster format with a 100-meter square pixel size. The six-cruise average chlorophyll a value for each pixel map was obtained using the ArcGIS 9.1 Spatial Analyst Extension raster calculator.

Similar methodology may be used to map areas that pass or fail specific reference values which can be linked to management objectives.

Data analysis and map production by M. Trice (MD DNR).

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