The Chesapeake Bay Forecast Modeling System

The Chesapeake Bay, the defining geographic and economic feature of Maryland, is a vital but threatened resource. The impact of industry, fishing, agriculture, development, and climate change raise significant and persistent questions. What is a sustainable blue crab harvest? Can the rockfish rebound? What level of nutrient run-off will trigger an algal bloom? Will climate change make the Bay warmer, saltier, and a haven for cholera? Can we predict storm surge patterns to protect coastal communities?

The Chesapeake Bay Forecast Modeling System is a new pilot program that can answer these questions. By monitoring key indicators of Bay health and analyzing massive sets of climate data, researchers at the University of Maryland are developing a multivariate model for predicting local ecological, meteorological, and oceanic events. To develop the model, Maryland experts are studying interactions between atmosphere, land, and both inland and coastal waters of the Bay watershed. This integrated approach will provide policy makers with sound science for pressing challenges such as forecasting weather, developing sustainable fishery-management policies, anticipating noxious species populations, and predicting specific locations of flooding, storm surges, and hurricane paths. This modeling system is now yielding important real-time data for Maryland scientists and citizens. The benefits will be broader, however, since the Chesapeake Bay Forecasting Modeling System is a proof-of-concept project applicable to the country. Regions built around watersheds – by some estimates, more than two-thirds of the population – will watch this system closely.

Though the forecasting model is still in the early stages of development, researchers are moving forward with innovative approaches to assessing the health of the Chesapeake.

Christopher Brown tracks sea nettles, an important indicator species. Understanding nettles will help predict *Pfiesteria* events—toxic algal blooms that can devastate fragile fish stocks.

Rita Colwell uses bioinformatics methods to model the emergence of pathogens like cholera. Cholera risk is increasing worldwide due in part to global shipping. Will cholera find a home in the warming estuarine waters of the Chesapeake?

Ragu Murtugudde uses satellite images of ocean color to detect the presence of fish species and to estimate their numbers. This information is useful in setting allowable catch levels for the increasingly scarce blue crab and the rebounding Chesapeake rockfish.

**Sea Nettles in the Chesapeake Bay: Aquatic Canaries in an Estuarine Coal Mine**

Christopher Brown, an oceanographer with the National Oceanic and Atmospheric Administration (NOAA) and an adjunct associate professor with the Department of Atmospheric and Oceanic Science, tracks sea nettles, providing weekly information on nettle location and cover. Bay scientists track sea nettles for two reasons: to warn about nettle location and to monitor the conditions giving rise to this indicator species. Sea-nettle population surges reveal a wealth of data about the Chesapeake, which can help to predict population blooms of other aquatic species, including the toxic *Pfiesteria*. Think of sea nettles as “canaries in the mine,” alerting researchers to emerging problems with this sensitive water ecosystem.

Brown’s ecological approach for predicting sea-nettle extent and location can be applied to similar events in other local ecosystems.

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Modeling Local Climate Effects to Predict Pandemic Disease in the Bay

As climate modelers anticipate weather and ecosystem changes, Bay scientists expect changes in both fish stocks and populations of harmful bacterial species. For example, cholera in the bilge water of international ships could gain a foothold in warming estuaries of the Chesapeake Bay. Tracking water variables of temperature and salinity can help scientists and policymakers anticipate such events. Advances in bioinformatics can help build better models of disease spread and refine detection methods.

Biologist Rita Colwell uses bioinformatics—advanced computational techniques for biological research—to build models for predicting the emergence and extent of water-born health risks. In the Chesapeake Bay Forecast Modeling System project, Colwell will explore statistical links between cholera occurrences, changes in estuarine and river temperatures, and plankton blooms. When some species increase rapidly in numbers, other species—including noxious ones—may act similarly. By tying together localized climate change conditions and disease incidence, Colwell can help sound an alert before a crisis occurs.

Colwell’s tools can help protect Marylanders from waterborne disease. For example, monitoring for cholera in the Bay can provide public health officials with timely information that can help them preempt widespread infection. Sustained monitoring of the Bay could provide background science for shaping new port guidelines in Baltimore on bilge-water practices.

Using Satellite Data to Set Fishing Limits

Ragu Murtugudde, assistant director of the Earth System Science Interdisciplinary Center, uses satellite imaging of ocean color to predict fish location and to monitor climate. Satellite observations of ocean color typically track chlorophyll—the green chemical in plants—among other biological factors visible at the water surface. Murtugudde can use chlorophyll data as an indicator of fish populations, because green phytoplankton is the first link in many aquatic food chains. This information can be used to highlight and set the geographic ranges of fish populations. Fishery establishment is important for setting catch limits and for preserving seafood resources over time.

Murtugudde’s work also contributes to species restoration. For example, since the 1980s Maryland officials have been concerned about fragile populations of rockfish, the most valuable finfish in the Bay. Murtugudde’s color data can help determine if the Chesapeake rockfish is making enough of a comeback to reset catch limits.

Murtugudde’s ocean color data is also useful for monitoring climate change because phytoplankton populations are very sensitive to temperature, salinity, and currents. Shifts in the patterns of ocean-color data can indicate local climate change.