Protecting & Preserving a Vital Natural Resource
The Chesapeake Bay—the largest estuary in the United States—is one of the mid-Atlantic region’s most precious natural resources.

The Chesapeake Bay watershed stretches across 64,000 square miles in six states and includes some 100,000 streams and rivers that serve as home to a complex network of plants and animals. Researchers at the University of Maryland at College Park have joined forces with local, state and federal agencies to conduct critical research to help guide Chesapeake Bay restoration and preservation efforts and ensure the health of the Bay for years to come.
Douglas Lipton and Ivar Strand, agricultural and resource economics, have studied the connection between poor water quality and blue crab harvests. The team analyzed the impact of lower levels of dissolved oxygen on crab harvesting, focusing on the trotline fishing method. Collecting data from three locations—the Choptank, Patuxtent and Chester rivers—the researchers found that productivity of trotline crabbers is reduced when they are fishing in tributaries with relatively poor water quality, defined by monthly average dissolved oxygen levels. The team also found that low-water-quality areas that do not lead to increased crab mortality may serve as refuge areas similar to no-fishing zones, allowing crabs to live longer and contribute to the species perpetuation. In a related study, Lipton has examined the impact of nutrient reduction policies using a spatially explicit three-dimensional model of water quality changes, simulating the benefits to recreational fishing from nutrient reduction.

www.arec.umd.edu/people/faculty/lipton_douglas/index.cfm

Denise Breitburg, biology, has conducted a number of research projects to closely examine the declining oyster, jellyfish and blue crab populations in the Chesapeake Bay. Using field and laboratory experiments, her team is testing the relationship between low oxygen in shallow Bay waters and the infection rate of oysters with the parasite that causes the disease blamed for devastating oyster populations throughout the Bay. The results will help scientists target locations for water quality and oyster restoration efforts. Breitburg has also examined how schooling behavior of larvae, the physical structure of oyster reefs, and hydrodynamics influence the settlement behavior of oyster reef fish. This research can shed light on how the interplay between behavior and physics enables larvae to transition from plankton to a reef habitat that supports growth and reproduction. Breitburg has studied how the pattern and magnitude of changes in the Bay’s sea nettle population affects the Chesapeake Bay food web and how juvenile blue crabs disperse, survive and grow in the Bay’s sub-estuaries, the results of which can assist fishery managers in their efforts to restore blue crab stocks.

www.life.umd.edu/biology/faculty/breitburg/index.html

Preserving the Ecosystem
Reducing Nutrient Loading

Nutrient reduction is a critical objective for the long-term health of the Chesapeake Bay. Spray irrigation of treated wastewater onto land surfaces may be a viable way to achieve that goal: Crop uptake of nutrients, such as nitrogen and phosphorus, can reduce their input to ground and surface waters, including the Chesapeake Bay and its tributaries. As reclaimed wastewater is increasingly used for irrigation activities, spray irrigation workers could be exposed to antibiotic-resistant bacteria and antimicrobials, such as Staphylococcus aureus (MRSA), that may remain in treated wastewater. **Amy R. Sapkota**, Maryland Institute for Applied Environmental Health and epidemiology and biostatistics, is evaluating potential inhalation and skin exposures to these agents among spray irrigation workers. **The findings will be important in assessing possible microbial and chemical risks from using reclaimed wastewater**, which is likely to become a common water source as the world experiences more severe droughts and water shortages.

[www.sph.umd.edu/miaeh/people/index.cfm](http://www.sph.umd.edu/miaeh/people/index.cfm)

Nutrients applied to agricultural lands, either as purchased fertilizers, animal manures, or municipal biosolids, can be utilized by the growing crop, retained in the soil or be lost from the soil by water transport or atmospheric processes. Nutrient losses from soil can be detrimental to surrounding natural waters, accelerating eutrophication, degrading the aquatic habitat, and lowering the quality of drinking water. **Frank Coale**, environmental science and technology, has explored the fate of nutrients in agro-ecosystems. Sustainable agriculture in the mid-Atlantic seaboard region is not possible without the use of sustainable nutrient management practices. Based on his research, **Coale is working to maximize the efficiency of crop nutrient utilization while minimizing the potential for nutrient losses from agricultural land**. Coale has also contributed to the development of nutrient management and environmental risk assessment software packages to meet the nutrient management planning requirements of the Maryland Water Quality Improvement Act of 1998, the most comprehensive such planning requirements in this country.

[www.enst.umd.edu/people/coale/index.cfm](http://www.enst.umd.edu/people/coale/index.cfm)
The climate of the mid-Atlantic region is being altered by changes in the composition of the global and local atmosphere as well as changes in local land use. Forecasts for the middle to the end of this century show higher mean temperatures, which could affect air quality. As head of the Regional Atmospheric Measurement Modeling and Prediction Program (RAMMPP), Russell Dickerson and his colleagues work with the Maryland Department of Environment and the Maryland Department of Natural Resources to measure and study air pollution and air quality in the mid-Atlantic region. Through the development of models, Dickerson is leading efforts to better understand the physical processes at work in different weather systems found from the Atlantic coastal regions to the mountains. For example, the new forecasting models are helping researchers estimate atmospheric transport of photochemical smog, acid deposition and haze as well as the flux of nitrogen and other pollutants to the Chesapeake Bay and its watershed.

www.atmos.umd.edu/~russ/, http://www.atmos.umd.edu/~rammpp

Measuring & Analyzing Atmospheric & Land Use Changes

The expansion of roads and houses associated with urban growth disrupts the hydrology and ecology of waterways, with more overland transport of pollutants and increasing sediment loads associated with stream erosion. Scott Goetz, geography, applies satellite imagery to analyze these changes. He has developed hydrological models, based on current and future projections of land cover of the region, to chart run-off estimates, nutrient transport into the Chesapeake Bay and other adverse affects of urbanization for the Chesapeake Bay watershed region. As a principal investigator for the mid-Atlantic Regional Earth Science Applications Center (RESAC), he has used remotely sensed data to create new mapping technologies for the Chesapeake Bay watershed. His analysis can help address chemical runoff to the Chesapeake Bay, urban and residential sprawl, farm and forest productivity, and land management. Access to high resolution imagery, for example, can assist in the discrimination of various densities of residential development and buffers that have important implications for land use planning and nutrient runoff to the Bay.

www.geog.umd.edu/resac/
Raghu Murtugudde is leading the effort to develop an end-to-end expert forecast system for the Chesapeake Bay that will provide a 16-day forecast of the bay watershed, including its circulation and pathogens. The Chesapeake Bay Forecast System is a flexible expert prediction tool for decisionmakers that will provide customizable, user-specified forecasts showing multiple aspects of the region’s climate, air and water quality, local chemistry and ecosystems. Users can configure their own “what-if” scenarios and see the results of specific land-use choices, climate trends, development, demographic or environmental conditions. Researchers are monitoring key indicators of Bay health, studying interactions between atmosphere, land, and both inland and coastal waters of the Bay watershed, and analyzing massive sets of climate data to develop this multivariate model for predicting the local ecological, meteorological and oceanic events. This integrated approach will provide policymakers with the scientific and socioeconomic foundation to make policy decisions on the state and health of the Chesapeake Bay and its watershed, including the development of sustainable fishery management policies and predictions on the locations of flooding, storm surges and hurricane paths.

HTTP://ESSIC.UMD.EDU/~RAGU/

Creating Forecasting Systems & Developing State Policies

With more than 3,000 miles of shoreline, Maryland is the fourth most vulnerable state in the nation to the effects of climate change and rising sea levels. Scientists worldwide agree that early carbon reductions of at least 25 percent are needed to avoid the worst impacts of climate change. As director of the Center for Integrative Environmental Research (CIER), Matthias Ruth is spearheading the university’s involvement in two broad efforts to protect the environment: the State of Maryland’s Climate Action Plan and the Regional Greenhouse Gas Initiative, including states in the Northeast and mid-Atlantic. Researchers at CIER are exploring ways to reduce emissions of greenhouse gases from residential natural gas use. Their analysis examines potential emissions reductions and consumer energy savings, impacts on the Maryland economy, as well as environmental and health effects. CIER is also helping to develop state policies for nutrient trading with carbon benefits in the Chesapeake Bay region, which will help improve water quality and achieve Maryland’s Climate Mitigation Plan.

WWW.CIER.UMD.EDU/MRUTH.HTML
The State of Maryland is supporting the Chesapeake Bay Seed Capital Fund, a new annual fund for start-up, Maryland-based companies that develop innovative technologies to help improve water quality in the Chesapeake Bay. The fund, administered by the Maryland Technology Enterprise Institute, or Mtech, a unit of the A. James Clark School of Engineering, invests $250,000 annually to encourage regional researchers and entrepreneurs to find solutions to the man-made problems of the bay and to escalate efforts to improve the quality of the Chesapeake Bay watershed and reduce nutrient runoff. Recent fund recipients, who are selected by Mtech and Maryland Department of Natural Resources staff, include Baltimore-based Furbish Company, which developed a vegetated living retaining wall system, and Traffax, a start-up technology to monitor traffic patterns and travel, improving the flow of traffic and enabling engineers to optimize the timing of stoplights to ease congestion. Much of the nitrogen that enters the Bay comes from nitrogen oxides released from car traffic.

WWW.MTECH.UMD.EDU/FUNDING/CBSC/

Pioneering Technological Solutions

A rare cellulose-eating bacterium found in the Chesapeake Bay more than 20 years ago, saccharophagus degradans, is now being used as a fuel source. Steve Hutcheson, cell biology and molecular genetics, found that the bacterium has an enzyme that can quickly break down plant materials into sugar, which can then be converted to biofuel. Researchers discovered how to produce the enzyme in their laboratories: The result was Ethazyme, which degrades the tough cell walls of cellulosic materials and breaks down the entire plant material into bio-fuel ready sugars in one step at a significantly lower cost with fewer caustic chemicals than current methods. Hutcheson's company, Zymetis, has received support from the Chesapeake Bay Seed Capital Fund. When fully operational, the Zymetis process could potentially lead to the production of 75 billion gallons a year of carbon neutral ethanol.

WWW.LIFE.UMD.EDU/CBMG/FACULTY/HUTCHeson/HUTCheson2.html
SELECTED ADDITIONAL RESEARCH ON THE CHESAPEAKE BAY

Gary Coleman
Plant Science and Landscape Architecture
HTTP://WWW.PSLA.UMD.EDU/FACULTY/COLEMAN.CFM

Gary Felton
Environmental Science and Technology
HTTP://WWW.ENST.UMD.EDU/PEOPLE/FELTON/index.cfm

Eric Haag
Biology
HTTP://WWW.LIFE.UMD.EDU/BIOLOGY/FACULTY/HAAG/

William Kenworthy
Plant Science and Landscape Architecture
HTTP://WWW.PSLA.UMD.EDU/FACULTY/KENWORTHY.CFM

Robert Kratochvil
Plant Science and Landscape Architecture
HTTP://WWW.PSLA.UMD.EDU/FACULTY/KRATOCHVL.CFM

Paul Leisnham
Environmental Science and Technology
HTTP://WWW.ENST.UMD.EDU/PEOPLE/LEISNHAM/index.cfm

Marla McIntosh
Plant Science and Landscape Architecture
HTTP://WWW.PSLA.UMD.EDU/FACULTY/MCINTOSH/index.cfm

Charles Mitter
Entomology
HTTP://CHEM.LIFE.UMD.EDU/FACULTYRESEARCH/FACULTYDIRECTORY/CHARLESMITTER

Edward Orlando
Animal and Avian Sciences
HTTP://ANSC.UMD.EDU/FACULTY/ORLANDO/

Margaret Palmer
Entomology
HTTP://WWW.PALMERLAB.UMD.EDU/

Martin Rabenhorst
Environmental Science and Technology
HTTP://WWW.ENST.UMD.EDU/PEOPLE/RABENHORST/index.cfm

Adel Shirmohammadi
Agricultural Experiment Station
HTTP://EXTENSION.UMD.EDU/DIRECTORY/BIO.CFM?ID=ASHIRO

Gerald Wilkinson
Biology
HTTP://WWW.LIFE.UMD.EDU/FACULTY/WILKINSON/

Stephen Wolniak
Cell Biology and Molecular Genetics
HTTP://WWW.CLFS.UMD.EDU/CBMG/FACULTY/WOLNIAK/MARSILEA/index.html

In-Young Yeo
Geography
HTTP://WWW.GEOG.UMD.EDU/PEOPLE/YEO/

Satellite photos courtesy of NASA
Fishing on the bay, Ben Fertig, Ian Image Library, ian.umces.edu/imagelibrary/