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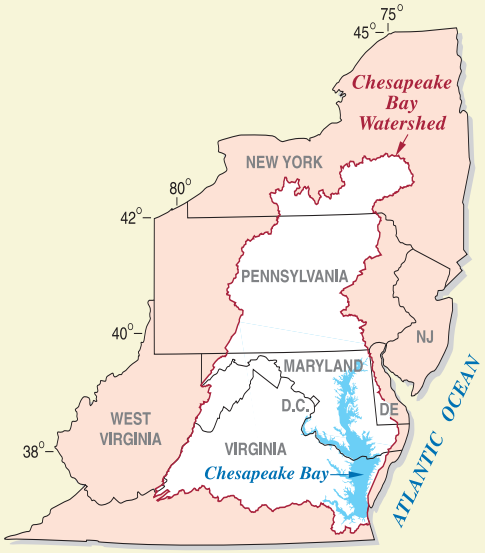
U.S. Geological Survey Chesapeake Bay Studies:
Scientific Solutions for a Healthy Bay and Watershed

by Scott W. Phillips



The Role of the U.S. Geological Survey in Restoring the Nation's Largest Estuary

The U.S. Geological Survey (USGS), the science agency for the Department of Interior (DOI), has the critical role of providing objective science to document and understand ecosystem change in the Chesapeake Bay and its watershed. The human population in the Bay watershed, which grew from 8.1 million in 1950 to almost 16 million in 2000, has resulted in degraded water quality, loss of habitat, and declines in fish and bird populations. USGS scientists are leaders in understanding cause and effect of human activities and natural changes on water quality and the health of the ecosystem. The USGS interacts with resource managers and policy makers to use the science to adapt approaches for implementation, and assess effectiveness of, management actions for ecosystem conservation, restoration, and sustainability.

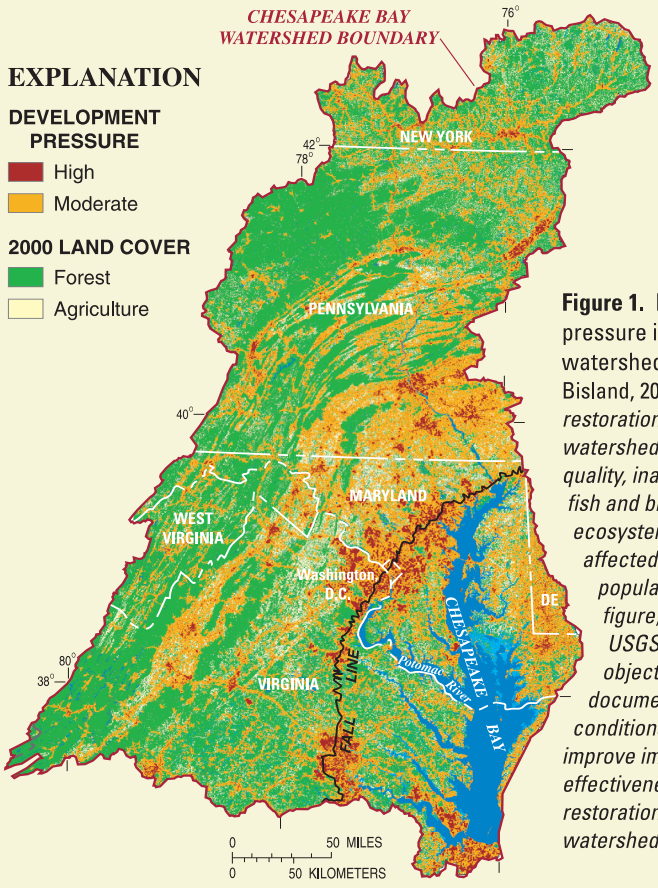


Figure 1. Potential future development pressure in the Chesapeake Bay watershed in 2010 (from Claggett and Bisland, 2004). *[In spite of 20 years of restoration efforts, the Bay and its watershed continue to have poor water quality, inadequate habitat, and threatened fish and bird populations. Future ecosystem conditions will be further affected by projected patterns of human-population increase (shown on the figure) and the associated impact. The USGS has the critical role of providing objective scientific information to document and understand ecosystem conditions. This information is used to improve implementation, and assess the effectiveness of, conservation and restoration strategies in the Bay and its watershed.]*

Since the mid-1980s, the USGS has been an active partner in the Chesapeake Bay Program (CBP), a multi-agency partnership led by the U.S. Environmental Protection Agency, working to achieve the restoration goals set forth in the Chesapeake 2000 agreement. This agreement established over 100 restoration commitments to be addressed by 2010. In 2005, which was the mid-point of the agreement, there was growing concern at all levels of government and by the public that ecological conditions in the Bay and its watershed had not significantly improved. The slow rate of improvement, coupled with the projected impact of human-population increase in the Bay watershed (fig. 1), implied that many desired ecological conditions will not be achieved by 2010. To address these challenges, the USGS wrote a new science plan for 2006-2011, and is synthesizing key findings to highlight the accomplishments from science activities for 2000-2005.

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U.S. Geological Survey Science Plan

The revised Chesapeake Bay science plan for 2006-2011 (Phillips, 2005) is designed to **provide integrated science for effective ecosystem conservation and restoration**. After assessing needs and priorities of the CBP and DOI partners, the USGS developed four science themes based on its capabilities and strengths:

- ***Impact of human activities on land use;***
- ***Factors affecting water quality and quantity;***
- ***Ability of habitat to support fish and bird populations; and***
- ***Synthesis and forecasting to improve ecosystem assessment, conservation, and restoration.***

For each science theme, the USGS established objectives (table 1) that will be achieved through a combination of monitoring, modeling, research, and assessment to provide science that can be used for more effective management actions to address the impact of human activities (fig. 2) on the ecosystem. To meet the science theme objectives, the USGS will: (a) provide an improved understanding of the ecosystem to better target implementation of current conservation and restoration strategies, (b) assess ecosystem change to help evaluate the effectiveness of management activities, (c) forecast the potential impacts of increasing human population and climate variability, and (d) synthesize the findings and provide implications to help policy makers and resource managers adapt improved approaches for ecosystem conservation, restoration, and sustainability.

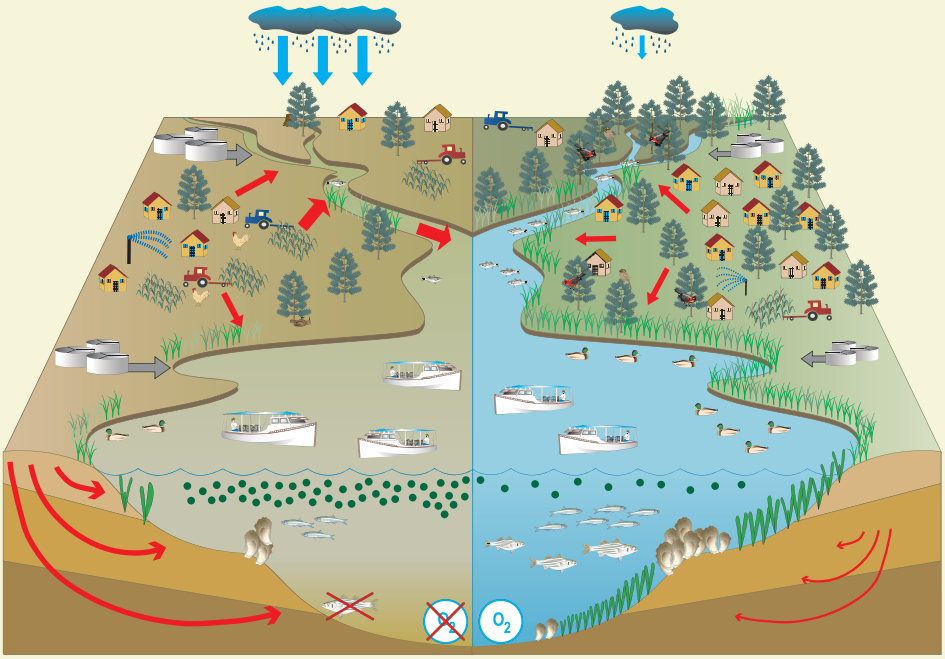
The USGS is focusing the majority of its efforts on addressing the science themes in the Bay watershed because (a) most conservation and restoration activities will be implemented in the watershed, (b) understanding the function of the different hydrologic settings (fig. 3) and habitats in the watershed in processing nutrients and sediment will provide a more cost-effective approach to implementing management actions, and (c) land-use change in the watershed will continue to be the greatest stress on the health of biological communities in the watershed and the Bay. Additionally, the USGS is addressing the relation between conditions in the watershed and impacts to water quality and habitat in the nearshore areas of the estuary.

Table 1. USGS Chesapeake Bay science themes, objectives, and management applications.

USGS SCIENCE THEME	OBJECTIVES	MANAGEMENT APPLICATIONS AND BENEFITS
Impact of Human Activities on Land Use	• Enhance monitoring of, and further define the factors causing past and present land-use change patterns. • Develop approaches to integrate land-use change findings and forecasts with water-quality, quantity, and environmental impact models. • Synthesize findings and provide implications for land conservation providing water quality and ecological benefits.	• Improved monitoring will better quantify changes in critical habitats (stream corridors, wetlands, forest buffers) and land use. • Enhanced analysis and tools to explain and forecast land-use change will be used to improve conservation and protection of critical habitats and lands.
Factors Affecting Water Quality and Quantity	• Improve monitoring and simulation of, and further define the processes affecting, the occurrence, transport, residence time, and changes of nutrients and sediment in the watershed. • Better define the function of key habitats to absorb and store nutrients and sediment. • Relate the delivery of nutrients and sediment from the watershed to water clarity in the estuary. • Synthesize information and conduct forecasts to provide implications and tools for improved targeting and assessment of water quality and quantity.	• Enhanced understanding and simulation of processes affecting water quality and quantity will provide improved targeting of water-quality management actions to implement the tributary strategies. • Additional monitoring will provide an improved assessment of the effectiveness of water-quality management actions. • Improved assessments and forecasting of future conditions will allow resource managers to adapt strategies for water-quality restoration and water availability for ecological needs of streams.
Ability of Habitat to Support Fish and Bird Populations	• Address the ability of habitat to support fish and bird populations in stream corridors and near-shore estuary environments. • Identify other factors (in addition to habitat condition) impacting the health of fish and bird populations. • Synthesize findings, and use forecasts of land-use change and water availability, to provide implications and improve tools for conservation and restoration of habitat.	• A more integrated understanding of the factors affecting habitat condition and loss will improve habitat restoration. • Understanding the multiple factors affecting the condition of and changes in fish and bird populations will allow resource managers to adapt new approaches for restoration of key species.
Synthesis and Forecasting to Improve Ecosystem Assessment, Conservation, and Restoration	• Enhance assessment by developing improved CBP environmental indicators and explanation of ecosystem condition and change. • Improve approaches to integrate predictions of land use, water quality and quantity, and habitat to forecast potential changes of the ecosystem. • Synthesize findings, and provide implications for improving ecosystem conservation, restoration, and sustainability.	• Enhanced environmental indicators and approach will improve assessment of the ecosystem condition of watersheds. • Integrated understanding of ecosystem condition and change will improve targeting of conservation and restoration actions that provide the highest water-quality and ecological benefit. • Forecasting the potential of impacts on human-population growth and climate variability will allow managers to adapt improved strategies for ecosystem conservation, restoration, and sustainability.

Implementing U.S. Geological Survey Chesapeake Bay Studies

The success of implementing projects to address the science themes is achieved through collaboration between multiple USGS National Programs, Science Centers, and partners (fig. 4). Projects are designed by scientists to meet the objectives of the USGS Chesapeake Bay science themes and missions of the contributing USGS National Programs. The efforts of multiple USGS scientists under each science theme are closely coordinated through the USGS Integrated Synthesis and Forecasting Team, and with the staff of USGS Regional offices and Science Centers. Appropriate Federal, State, local, and academic CBP partners work with the USGS to jointly conduct monitoring, modeling, research, and assessment activities associated with each science theme. The USGS interacts with resource managers and policy makers to make informed decisions for conservation and restoration activities based on USGS findings, and to consider future strategies to promote an ecologically sustainable ecosystem.



(Modified from CBP and IAN, 2005)

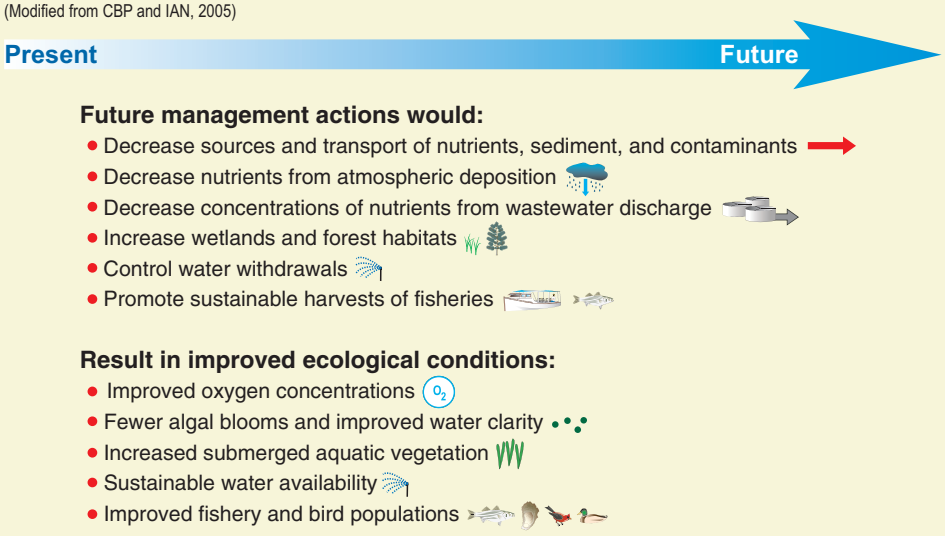


Figure 2. Conceptual diagram of present and potential future conditions of the Chesapeake Bay ecosystem (from Phillips, 2005, modified from CBP and IAN, 2005). *[The conceptual diagram shows present and potential future conditions in the watershed and estuary. Future conditions of the watershed will be affected by human-population increase and the associated impact on land use, water quality, water availability, and habitat loss and fragmentation. All of these factors will continue to have negative impacts on habitats and biological communities in both the watershed and the estuary. The degree to which water-quality and ecological conditions improve in the future will likely depend on the degree of implementation and effectiveness of management actions. The USGS conducts an integrated scientific approach to provide better targeting of management actions to provide the maximum water-quality and ecological benefit to the Bay and its watershed.]*

References

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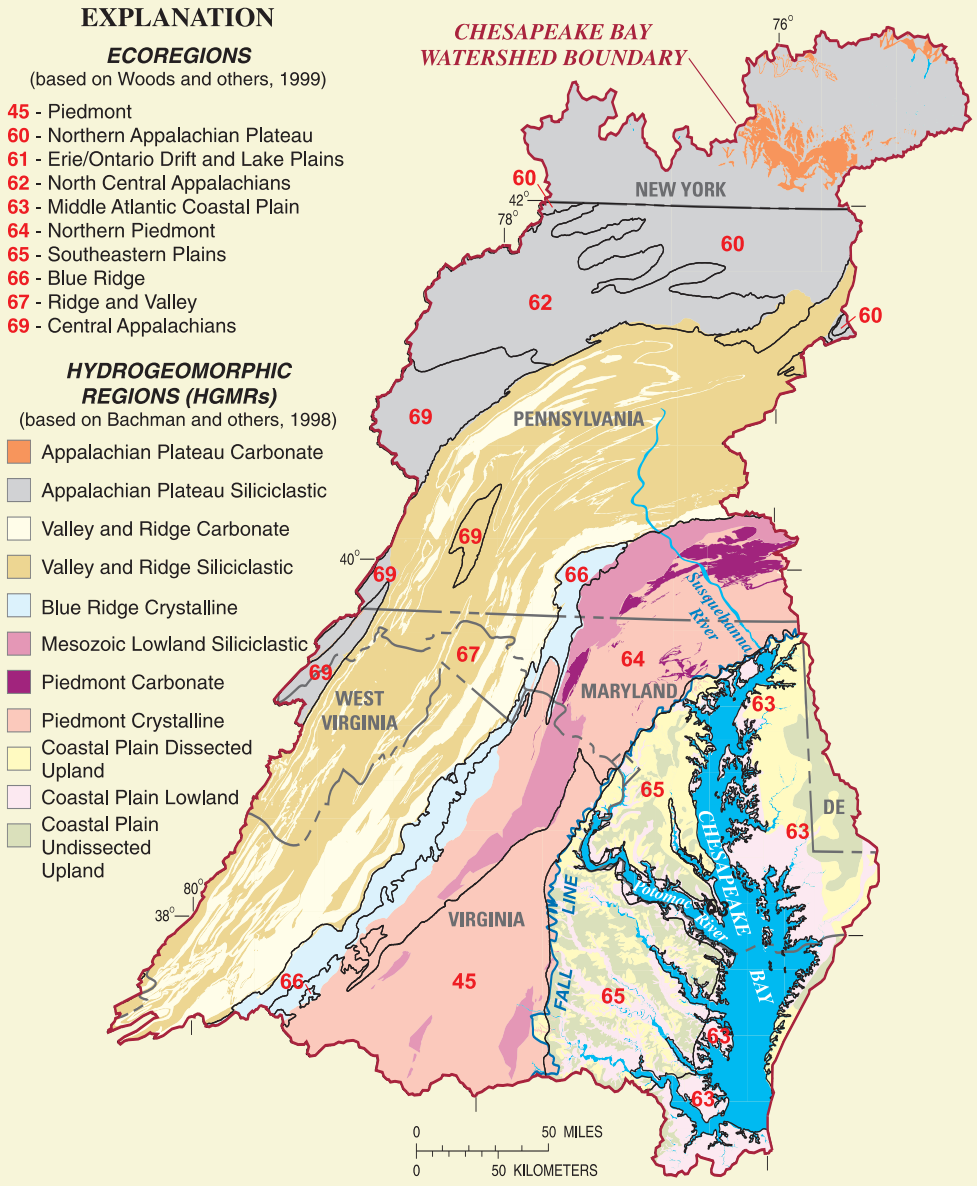

Figure 3. Different landscape settings in the Chesapeake Bay watershed (modified from Phillips, 2005). *[The movement of nutrients, sediment, and contaminants in the watershed and their delivery to the estuary are influenced by the different landscape settings, which have unique combinations of physical and biological characteristics. The USGS is providing a better understanding of the influence of landscape settings on water quality, habitat, and fish and bird populations to improve implementation and assessment of conservation and restoration activities. The USGS will conduct the majority of its activities in the watershed because (1) human-population growth and land-use change will continue to be the greatest threats to the ecosystem, and (2) the majority of conservation and restoration actions will be implemented on land. The USGS will work with partners to relate the changes in the watershed to the changes in the Bay and its tidal estuaries.]*

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or visit the USGS Chesapeake Bay homepage on the World Wide Web at:
http://chesapeake.usgs.gov/

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Chesapeake Bay Program
A Watershed Partnership

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- Priority Ecosystem Science (PES)

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- Geology
- National Cooperative Geologic Mapping

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- Land Remote Sensing
- Science Impact

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- Hydrologic Research and Development
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- Ground Water
- National Stream Information

GEOSPATIAL INFORMATION OFFICE
- Cooperative Topographic Mapping

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Geology Teams: Earth Surface Processes, Woods Hole
Geographic Science Center: Eastern Region
Water Science Centers: MD-DE-DC, NY, PA, VA, WVA, and Eastern Region Research

USGS CHESAPEAKE BAY STUDIES and SCIENCE THEMES

HUMAN ACTIVITIES AND LAND USE ↔ WATER QUALITY AND QUANTITY ↔ HABITAT TO SUPPORT FISH AND BIRD POPULATIONS ↔ SYNTHESIS AND FORECASTING

Figure 4. USGS programs, offices, and Chesapeake Bay studies. *[The USGS jointly plans and implements scientific activities between multiple USGS National Programs, offices, and partners to enhance interdisciplinary studies for each of the Chesapeake Bay science themes.]*