Overview of USGS Chesapeake Bay Accomplishments for 2016

The U.S. Geological Survey (USGS) has the critical role of providing scientific information to improve the understanding and management of the Nation's largest estuary - the Chesapeake Bay ecosystem. The USGS works with Federal, State, and academic science partners to provide monitoring, research, and communication of results to enhance ecosystem management for both the Chesapeake and other critical ecosystems. The Department of Interior (DOI), through the USGS, the U.S. Fish and Wildlife Service (FWS), and the National Park Service (NPS), is providing leadership, expertise, and resources to carry out the President's Chesapeake Bay Executive Order (EO). The EO provided the foundation for the Chesapeake Watershed Agreement (2014-2025), which was signed by the Chesapeake Bay Program (CBP), and includes the Federal Government, 6 states and the District of Columbia. The DOI has a leadership role for carrying out 7 of the 10 goals described in the Agreement. Major USGS Chesapeake Bay accomplishments for 2016 are characterized below.

USGS implements Science Strategy to advance Chesapeake Bay restoration

The USGS Chesapeake Science Strategy (2015) was implemented to guide science activities in coordination with the Chesapeake Watershed Agreement, to support DOI priorities, and align with the USGS Mission Area science strategies. The USGS Chesapeake Science Strategy has four themes that address 7 of the 10 goals in the Chesapeake Bay Watershed Agreement: (1) provide science to support restoration, and conservation of fish, wildlife, and critical habitats, (2) characterize and explain changes in water quality, and its effect on freshwater and estuarine ecosystems, (3) assess and forecast effects of climate and land change on ecosystem conditions, and (4) synthesize and provide information to support ecosystem management. USGS is actively evolving projects to implement the science strategy. *Supported by the USGS Environments Program.*

Effects of stream temperature, groundwater inputs and invasive species on brook trout

The majority of streams in the Chesapeake Bay region are warming, and this warming will affect species distributions, as well as suitable habitat for brook trout and other cold-water species. Current studies are exploring how stream hydrogeology and overburden thickness are influencing the discharge of groundwater to streams, and how this groundwater discharge may be mitigating the effects of climate change by providing thermal buffering of stream-water temperature. Another USGS study examined the interactive effects of stream temperature and invasive species on brook trout behavior, physiology, and growth. Competition with brown trout decreased brook trout use of warmer streams and decreased movement rates into forage areas compared with areas with no brown trout. The FWS are using the information to inform brook trout conservation and restoration. *Supported by the USGS Fisheries and Environments Programs, as well as the Water Mission Area.*

Informing conservation and management of freshwater fisheries and streams

The USGS initiated several studies to understand the potential effects of unconventional oil and gas (UOG) development on brook trout and stream habitat. Using high-resolution spatial layers of watershed attributes and land-use disturbance signatures, new fine-scale (1:24,000) brook trout occupancy and abundance models were developed. Other studies are identifying biomarkers of brook trout response to contaminant exposure and molecular genomics of brook trout and macroinvertebrate populations in watersheds with UOG development. Results of this work will further inform a brook trout vulnerability assessment. One recently published collaborative study explored the transport of waste hydraulic fracturing fluids in Pennsylvania, and found that counties with oil and gas development experienced the most truck traffic and incurred the highest associated roadway costs. However, many counties outside the active development area also incurred roadway repair costs, highlighting the extension of UOG development's spatial footprint beyond the active development area. *Supported by the USGS Fisheries and Environments Programs.*

Increasing our understanding of the effects of contaminants and other stressors on fish

The USGS continues studies on the sources and effects of endocrine-disrupting compounds (EDCs), including chemicals of emerging concern, and other stressors on fish, so that partners will have improved information to reduce their effects on fisheries. A multi-year research and monitoring study is underway to assess the biological effects of complex mixtures through bioindicators, adverse outcome pathways and risk assessment

models, as well as to identify sources and pathways of exposure. During 2016, USGS publications highlighted that the occurrence of intersex fish was generally more widespread than expected, with eighty five percent of male smallmouth bass and 27 percent of male largemouth bass tested in waters in or near 19 National Wildlife Refuges in the Northeast U.S. were intersex. Another USGS study identified a fish pathogen (*Dermocystidium*) similar to one previously found in the United States only in Pacific salmonids (salmon and trout species) for the first time in the eastern United States and in a non-salmon species. Other USGS studies explored the spatial patterns in sources of EDCs and contaminants across the Chesapeake landscape. *Supported by the USGS Contaminant Biology, Toxic Substances Hydrology, and Environments Programs.*

Increasing our understanding of the effects of contaminants on wildlife

USGS efforts provide an improved understanding of the effects of contaminants and EDCs on wildlife. Recently completed USGS studies have documented that the world's largest breeding population of ospreys is coping well with the long-lasting residues of toxic chemicals that were banned decades ago but remain in the Chesapeake Bay food chain at varying levels, such as the pesticide DDT and insulating chemicals known as PCBs. Ospreys are also showing few effects from two other groups of chemicals that have become widespread in the estuary—flame retardant PBDEs and pharmaceuticals intended for human use. Other USGS scientists are completing a review of effects of EDCs on wildlife (birds, mammals, amphibians, and reptiles) to summarize our current understanding of the potential effects. *Supported by the USGS Contaminant Biology and Environments Program.*

Models to manage waterbirds and their habitats

The USGS is supporting partners with science to restore coastal wetlands to increase waterfowl populations, with a focus on increasing habitat for Black Ducks. The USGS continued development of models so USFWS can assess different options for wetland restoration on the Bay refuges. USGS continued a study to predict future impacts of sea-level rise on coastal wetlands, which provide habitat for almost 1 million waterfowl wintering in the Bay region. Particularly noteworthy progress was made on both a wetland habitat layer for the refuges and the calibration of a black duck bioenergetics model, which will be foundational to the overall project. *Supported by the USGS Environments, Wildlife, and Climate Research and Development Programs.*

New updates inform managers of changing water-quality patterns

A new USGS update provided loads, yields, and trends in water quality at up to 81 nontidal monitoring sites, revealing spatial patterns in nitrogen, phosphorus and sediment loads and trends across the Chesapeake watershed (http://cbrim.er.usgs.gov/summary.html). Overall the results indicated many improving water-quality patterns; however, degrading conditions still exist for a number of key rivers and reaches within the network. These load and trend results provide our Chesapeake Bay partners with their best indication of where conditions are improving or degrading, and where management actions are likely having the greatest effects. Following the release of 2014 results for the entire nontidal network, the 2015 load and trend results were released for a subset of the downstream monitoring sites (http://cbrim.er.usgs.gov/). *Supported by the USGS Environments and National Water Quality Programs.*

Major contributions to CBP Midpoint Assessment (explaining trends)

The USGS leads monitoring of nutrients and sediment in the nontidal portions of the Bay watershed and is working to explain water-quality patterns throughout the entire watershed. In support of the 2017 Midpoint Assessment, the USGS is contributing a number of water-quality-synthesis activities to explain patterns in water quality and inform watershed management. For each synthesis activity, USGS is summarizing available research for each topic and assembling this understanding into a management-relevant context to assist resource managers as they develop future Watershed Implementation Plans (WIPs). USGS is working to contribute synthesis materials on the following topics:

1. Explaining loads and trends at the long-term, downstream monitoring sites
2. Influence of Susquehanna reservoirs on loads and water quality in the Bay
3. Explaining yields and trends at monitoring sites throughout the watershed

4. Influence of groundwater contributions on surface-water trends
5. Sediment sources, transport, and delivery

Supported by the USGS Environments and National Water Quality Programs.

Understanding hydrologic-transport and water-quality processes

A number of USGS water-quality papers on a range of subjects and spatial scales were published to further our understanding of hydrologic-transport and water-quality processes throughout the Chesapeake Watershed. One study evaluated long-term changes in sediment and nutrient delivery from Conowingo Dam to Chesapeake Bay with an emphasis on the effects of reservoir sedimentation. Another evaluated the temporal and spatial patterns in nutrients and sediment in small intensively monitored watersheds with extensive BMP implementation. Results of yet another study showed that collection and interpretation of high-frequency nitrate-concentration data from streams in the bay watershed can be used to quantify time-varying sources and in-stream retention of nitrate. USGS scientists contributed to a series of factsheets regarding urban landscape hydrology, chemistry, and ecology. All these studies improved our understanding of fundamental processes throughout the Chesapeake Watershed and will contribute to the Midpoint Assessment synthesis topics described above. *Supported by the USGS Environments and National Water Quality Program.*

Results of USGS climate studies highlighted by other federal agencies

As one of the principle drivers of environmental change in the Chesapeake, USGS continues to advance climate science. Results from the recently published USGS stream-water-temperature trends in the Chesapeake Bay region were highlighted in an EPA report on climate change indicators in the United States. Ongoing USGS studies are documenting how climate change is affecting stream-flow and precipitation patterns across the watershed. *Supported by the USGS Environments and Water Use and Availability Science Programs.*

On the fate of riverine sediment transport and wetland resilience to sea-level rise

Two recent USGS investigations have measured sedimentation rates along the barely perceptible slope of rivers as they empty into estuaries. The findings of these studies have important implications for the restoration of estuaries and their resilience to sea-level rise. The studies compared the sedimentation rates found in upriver tidal freshwater swamps (located at the furthest inland reach of tides) to the rate found in brackish water marshes downstream at the lowest reaches of the rivers. One study identified minimal sediment availability to tidal freshwater wetlands just below the head-of-tide, producing a "sediment shadow" that reduces the resilience of wetlands to the impacts of sea-level rise. Another study found a difference in the basic chemistry of sediment deposited in tidal freshwater swamps compared to brackish wetlands, a determination that further supports the conclusion that watershed sediment is trapped out by tidal freshwater wetlands while estuarine sediment is delivered upstream to brackish wetlands. *Supported by the National Water Quality and Environments Programs.*

Improved land cover information and forecasting to inform science and conservation

The USGS continued to collaborate with CBP partners to improve land-cover classifications for the 64,000 square mile drainage basin that touches six States and the District of Columbia. The USGS worked with the Chesapeake Conservancy on new approaches, including the use of LiDAR, to develop high-resolution information for land classifications. The improved land-cover data are a critical piece of information needed to revise the CBP watershed model that is used for TMDL decision making. The USGS also revised a land-change model that uses historical information to provide scenarios of future development in the Bay watershed. The forecasts will be used by NPS and non-governmental organizations to assess the vulnerability of healthy watersheds and inform land conservation efforts, including those funded by the DOI Land and Water Conservation Fund. *Supported by the Land Change Science and Environments Programs.*

For additional information

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