USGS Chesapeake Bay Watershed Accomplishments for Fiscal Year 2018

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 U.S. Department of the Interior (DOI), through the USGS, the U.S. Fish and Wildlife Service (USFWS), and the National Park Service (NPS), is providing leadership, expertise, and resources to carry out the Chesapeake Watershed Agreement (2014--2025), which was signed by the Chesapeake Bay Program (CBP), and includes the Federal Government, six 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 2018 are described below. The efforts are supported by multiple USGS Mission Areas (MAs) and partners.

New Directions for USGS Chesapeake Science Activities

The USGS has revised its Chesapeake science themes for 2019 and beyond. The revised science themes align strongly with new DOI and USGS priorities, the directions of USGS Mission Areas and Programs, and address important goals of the Chesapeake Watershed Agreement. Overall, the revised science themes focus USGS science to inform the management of recreational fish, waterbird species, and their habitats, as well as the lands important for the 18 million people across the watershed. The science themes are:

- Theme 1: Provide an integrated understanding of the factors affecting fish habitat, fish health, and landscape conditions.
- Theme 2: Assess the risks to coastal habitats, DOI lands, and migratory waterbirds.
- Theme 3: Characterize land use and change to assess the vulnerability and resiliency of vital lands and healthy watersheds.
- Theme 4: Integrate science and inform stakeholders.

Highlights include:

1. **Fish habitat and fish health**: habitat and introduced species affecting brook trout; effects of unconventional Oil and Gas on forests and brook trout; improved understand of stream health; and factors affecting health of fisheries
2. **Water quality and landscape conditions affecting fish habitat**: explaining trends to inform nutrient and sediment reductions; new tools to understand water-quality change; sediment sources and transport; watershed impacts on estuary conditions; effects of 2018 flow-flow events and a new research strategy for toxic contaminants
3. **Coastal habitats and water birds**: increasing habitat for water birds
4. **Land change and forecasting:** improving land classification; incorporating projected growth into water-quality targets

1. Fish Habitat and Fish Health

Restoring native recreational species by understanding competition with introduced species

Native fish conservation is a high priority for natural resource managers in the Chesapeake Bay watershed, and new research by USGS is assisting conservation planning for trust species. The USGS has been working with National Park Service (NPS) and the Maryland Department of Natural Resources to enhance a declining Brook Trout population in Maryland (Big Hunting Creek) by removing introduced Brown Trout. This on-the-ground management work stemmed from USGS, which demonstrated strong effects of Brown Trout competition for food resources with increasing stream temperatures. On-going USGS research in Shenandoah National Park is also contributing to a national research initiative on stream flow and drought to improve conservation planning. *Supported by the USGS Ecosystems and Water MAs*

The effects of unconventional oil and gas development on brook trout and forests

The USGS, in collaboration with researchers from West Virginia University completed a study of unconventional oil and gas (UOG) impacts on eastern brook trout occupancy in the upper Susquehanna River watershed. Modeling results predicted a 4% loss of brook trout in streams impacted by existing UOG and occurred most often in streams with intermediate levels of non-UOG stress (i.e., agriculture, residential and commercial development, and historic mining). Additionally, USGS researchers found that a large volume of forest canopy was removed by UOG activities in the study area, particularly caused by pipeline right of ways, and the impacts were more dispersed than other types of land conversion such as timber harvesting. *Supported by the USGS Ecosystems MA.*

Developing new approaches to assess fish habitat and stream conditions.

Understanding the multiple factors that affect fish habitat is critical to restore commercial and recreational species in the Bay and its watershed. The USGS, in collaboration with NOAA, led efforts for a STAC workshop, which brought together fishery managers and scientists, to develop new approaches to assess fish habitat. Based on data inventory, the participants identified key factors for a fish habitat assessment could further inform restoration activities for inter-related CBP goals for fisheries, habitat, and water quality. Additionally, the USGS, in collaboration with Interstate Commission on the Potomac River Basin, completed a study that predicted stream biological condition using the Chesapeake Basin-wide Index of Biotic Integrity (Chessie BIBI) for all small streams throughout the watershed. Results will help improve the tracking progress toward improving stream conditions. *Supported by USGS Ecosystems MA*

Understanding the Factors Affecting Health of Recreational Fisheries

Recreational fishing has an important economic impact within the Chesapeake Bay watershed, and the annual economic impact of smallmouth bass fishing alone is estimated to exceed $150 million. The USGS, together with state agencies, completed important field work and analysis looking at the effects of endocrine-disrupting compounds and other factors degrading fish health in the watershed. Risk factors, including pathogens (bacteria, largemouth bass virus, myxozoans, cestode and trematode parasites) and tissue contaminants (legacy and current-use pesticides, PCB, and others), associated with smallmouth bass young of year mortality were identified. Agricultural land-use had a probability of being positively correlated with prevalence of specific parasites and coinfections. Models were developed for quantifying temporal trends in smallmouth bass abundance, as well as population-level effects of water temperature, flow and chemical-induced

reproductive depression. Long-term spatial and temporal monitoring of water contaminant concentrations (pesticides, hormones, phytoestrogens) along with in-depth fish health assessments is continuing and will provide important exposure information during key developmental periods. The findings will be summarized in 2019 and used to inform integrated water-quality and habitat management approaches to improve the health of fisheries in the watershed. *Supported by USGS Environmental Health and Ecosystems MAs*

2. Water quality and landscape conditions affecting fish habitat

Explaining water-quality patterns and trends to inform nutrient and sediment management

To inform the CBP Midpoint Assessment of the Bay TMDL, the USGS completed several water-quality syntheses to explain patterns in water quality and inform watershed management. The synthesis topics included:

- Factors affecting yields and trends of nitrogen and phosphorus throughout the Chesapeake watershed.
- Long-term changes in nutrient and sediment inputs to Chesapeake Bay.
- Understanding sediment sources, transport, and delivery processes relevant to Chesapeake restoration efforts (see next accomplishment topic regarding sediment).
- Influence of Susquehanna Reservoirs on loads and water quality in the Bay and management implications under the Total Maximum Daily Load (TMDL).

New methods were developed to better explain the amount, and causes, of nutrient changes over the several decades in areas across the watershed. Two innovative methods, both extensions of the well-respected USGS SPAtially Referenced Regressions On Watershed attributes (SPARROW) model, were used to help explain change. Results from the Decadal SPARROW model and Spatiotemporal Watershed Accumulation of Net effects (SWAN) were used for the synthesis efforts and to improve the CBP watershed model.

The results from the synthesis are being used by jurisdictions and EPA to develop new approaches to reduce nutrients and sediment, that will be in the Phase III Watershed Implementation Plans, that will be released in 2019. Some initial examples of how the results are being applied include:

- Pennsylvania has decided to have a tiered approach for restoration, based on USGS finding showing areas with the greatest nutrient loads.
- The finding for the Conowingo Reservoirs revealed increases in nutrients and sediment, which resulted in EPA and states deciding to have a dedicated restoration plan to address Conowingo reservoirs.
- MD is using results to inform the targeting for their $50M Chesapeake Bay Restoration Fund.

Supported by the USGS Water and Ecosystems MAs.

Sediment sources, transport, and fate in priority watersheds

Sediment causes most stream impairments and degrades conditions for fisheries. New studies by the USGS have documented the importance of streambanks and floodplains to the sources and trapping of sediment in Chesapeake watersheds. In a suburban watershed (Difficult Run, VA), studies found:

- Over 90% of the suspended sediment load in the headwaters is due to erosion of streambanks
- Erosion in the headwaters can be nearly matched by floodplain deposition of sediment in the lower watershed; the value of floodplain trapping in this small watershed was estimated at $727,000/yr.

In an agricultural watershed (Smith Creek, VA):

- Streambanks contribute more than 70% of the suspended sediment in the watershed.
- Floodplain deposition exceeded streambank erosion throughout the larger streams

Together with long-term USGS monitoring of suspended sediment loads, these studies highlight the importance of streambank erosion in headwaters as a dominant source of suspended sediment, much of which can be trapped by floodplains along larger streams. This information is critical to efficiently target management actions that can reduce downstream sediment loading. *Supported by the Water and Ecosystems MAs*

USGS coordinates researchers on syntheses of estuarine conditions

Documenting estuary changes are critical for assessing progress in water-quality conditions and understanding the response to nutrient and sediment reduction efforts. Teams of researchers including Federal, State, and academic partners were formed under USGS leadership, with support from USEPA, to address these key topics:

- Developing and applying new techniques to evaluate trends in tidal waters.
- Estuarine water quality and dissolved oxygen responses to changes in nutrient inputs.
- Developing an integrated understanding of drivers of changes in water clarity in different settings.
- Factors controlling the distribution and abundance of submerged aquatic vegetation (SAV).
- Linking watershed and estuarine changes in the Potomac River.

The results are part of the information being used by the jurisdictions to prepare their Phase III Watershed Implementation Plans. *Supported by the USGS Water and Ecosystems MAs.*

Summer 2018 high river flows, and effects, on the Chesapeake Bay

Every year a team of scientists from NOAA, University of MD, and USGS utilize the most recent streamflow and nutrient monitoring data from the Susquehanna and Potomac Rivers to predict the Bay's hypoxic (low-oxygen) and anoxic (oxygen-free) zones. These conditions occur in during the summer, and are largely driven by nutrients delivered from the watershed in the winter and spring. However, beginning in May 2018, the river flows to the Bay were above average and set records for the months of August and September. USGS monitoring programs were able to document the high flows and worked with partners to begin to predict the effects including:

- Higher nutrient and sediment loads contributing to low dissolved oxygen
- Potential reduction of submerged aquatic vegetation
- Probable morality of oysters due to fresh water delivery to the Bay
- Shifts in habitats being occupied by crabs and other recreational fisheries

The forecasts, and subsequent monitoring, provide resource managers valuable information for fisheries management decisions and serve as a clear public reminder that conditions in the Bay are driven by pollution in the watershed. *Supported by the USGS Water and Ecosystems MAs.*

USGS leads update on strategy for toxic contaminants research

The Chesapeake Bay Agreement has a goal to ensure that the Bay and its rivers are free of effects of toxic contaminants on living resources and human health. The two associated outcomes are (1) research and (2) policy and prevention. The strategy for the research outcome will improve information about the occurrence, concentrations, sources and effects of toxic contaminants on fish and wildlife. The findings will be used by the

CBP Toxic Contaminant Workgroup (TCW) and Water-Quality Goal Implementation Team to consider policy and prevention approaches to reduce the effects of contaminants on living resources in the Bay watershed and make them safer for human consumption. The USGS led the effort the research strategy, which will focus on:

- Supply information to make fish and shellfish safer for human consumption;
- Understand the influence of contaminants degrading the health, and contributing to mortality, of fish and wildlife;
- Document the sources, occurrence, and transport contaminants in different landscape settings.
- Provide science to help mitigate contaminants, and emphasize the co-benefits with nutrients and sediment reductions.
- Gather information on issues of emerging concern

3. Coastal habitats and water birds

Increasing habitat for migratory waterbirds

The Chesapeake provides critical habitat for migratory waterfowl in the Atlantic Flyway. The USGS completed models of how the availability of quality habitat for wintering black ducks in the refuges changes due to development and sea-level rise pressures. The USGS also continued data collection and began analysis of detailed light and water levels and vegetation surveys across key locations to better understand how marshes migrate in response to sea-level rise. Finally results of impacts of coastal land use and shoreline armoring along the Chesapeake Bay coast on the waterbird community integrity were published; our results show shoreline hardening and invasive *Phragmites* each have negative effects on the waterbird community. All of findings are being considered by USFWS and state agencies to consider approaches to protect and restore coastal wetlands. *Supported by the USGS Ecosystems and Land Resources MAs.*

4. Land change and forecasting to assess the vulnerability and resiliency

USGS improves land cover and use information needed to understand ecosystem conditions

Agencies and resource managers are working together to collect higher resolution land-cover information to focus restoration practices. The USGS supported the Chesapeake Conservancy to develop more current, higher-resolution information for the Bay watershed. Several areas were identified that needed light detection and ranging (LIDAR) to better define elevation changes that affect the movement of nutrients and sediment. The USGS partnered with Natural Resources Conservation Service (NRCS), through the National Map: 3-D Elevation Program (3DEP), to collect over 6,500 square miles of Quality Level 2 LIDAR data for 13 counties in the Susquehanna basin. The information will help inform NRCS to implement conservation practices and enhance the Chesapeake Conservancy effort to improve stream network information. *Supported by the USGS Core Science Systems and Land Resources MAs*.

Future growth in the Chesapeake watershed will increase nutrient loads so partners needed forecasts of development to inform water-quality management plans. The USGS, working with CBP partners, used the USGS' Chesapeake Bay Land Change Model in several ways:

- Contributed forecasts for newly developed Chesapeake Conservation Atlas, which will help the NPS and the Chesapeake Conservation Partnership focus land conservation efforts.

- Simulated future land-use scenarios out to 2025 to evaluate potential nutrient and sediment pollution to the Chesapeake Bay resulting from land conservation and land use planning actions. Four States and the District of Columbia are using USGS' model to develop custom future scenarios reflective of ongoing land-use policies and conservation programs. These scenarios will be incorporated into the jurisdictions Phase III WIPs to comply with Total Maximum Daily Load (TMDL) pollution limits.
- Using growth projections so partners could enable the formal crediting of land-use planning and land conservation practices towards avoiding future increases in pollution to meet the TMDL.
- Finally, the development scenarios are being utilized by the CBP Healthy Watershed Goal Implementation Team and other CBP groups to identify high quality natural resource areas that may be vulnerable to development.

The USGS also updated the protected lands data for the entire watershed to track progress toward the goal of conserving 2M acres. *Supported by the USGS Ecosystems MA and USEPA.*

For additional information

See the revised USGS Chesapeake Website… https://www.usgs.gov/chesapeake.

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