THE CHESAPEAKE BAY PROGRAM 2013

In accordance with Clean Water Act § 117

Submitted By
U.S. Environmental Protection Agency
On Behalf Of
Chesapeake Bay Program
Annapolis, Maryland

Chesapeake Bay Program
A Watershed Partnership

Chesapeake Bay Watershed

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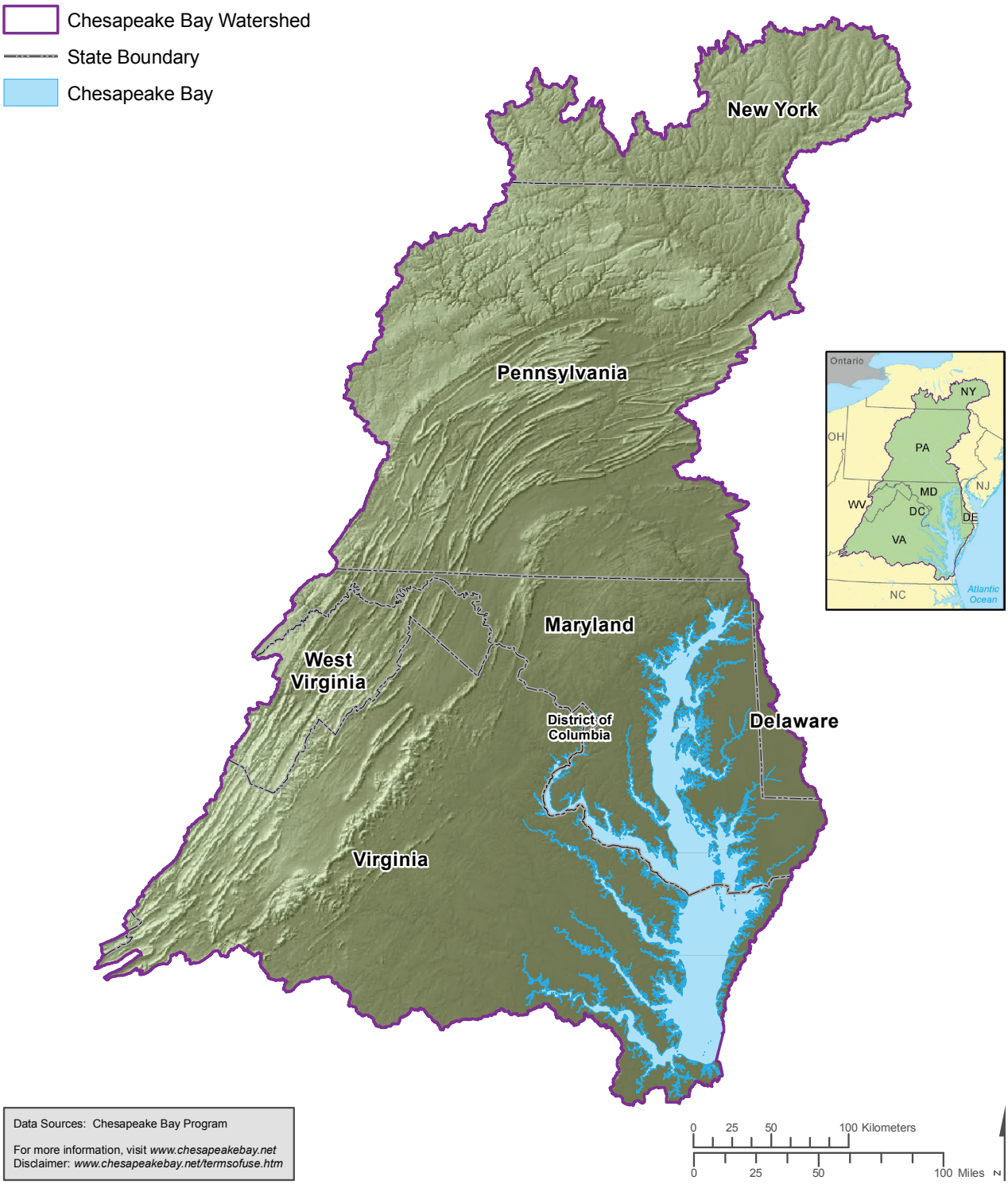

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Chesapeake Bay Program
A Watershed Partnership

Dear Members of Congress,

This report of the Chesapeake Bay Program 2013 is submitted in accordance with the requirements of Section 117(h) of the Clean Water Act. The Chesapeake Bay Program partnership has worked collaboratively for 30 years to guide efforts toward a restored Bay ecosystem in which civic responsibility and environmental stewardship are considered essential components of maintaining the high quality of life we enjoy in the watershed. Using state of the art science and ecological restoration techniques, the partnership has built upon successes while learning from the challenges related to restoring a varied and complex ecosystem covering a 64,000-square mile watershed and spanning seven political jurisdictions.

This 30-year mark serves as an opportunity for the existing Bay scientists, policy-makers and citizens to set the stage for generations to follow. While we examine the successes of the past three decades, as well as the challenges not yet solved, the time has come for the Chesapeake Bay Program to lay the foundation for transition. It is time for a new Bay Watershed agreement that builds on this incredible body of scientific knowledge, takes into account both existing conditions and emerging circumstances; and forge an agreement that brings all Bay partners together. To move forward, we need Delaware, the District of Columbia, Maryland, New York, Pennsylvania, Virginia, West Virginia, the Environmental Protection Agency and the Chesapeake Bay Commission, sharing responsibility and working toward the same goals. This is why the partners are crafting a new *Chesapeake Bay Watershed Agreement.*

The original Chesapeake Bay agreement signed in December 1983 was a simple 1-page document committing the signatories to work cooperatively to address pollution entering the Bay. Over the years, a number of subsequent agreements of greater complexity and detail have been executed, the most recent being *Chesapeake 2000*, with more than one hundred individual goals, commitments and outcomes. While many of these goals and commitments were met, the health of the Chesapeake Bay ecosystem has not sufficiently improved.

The currently proposed *Chesapeake Bay Watershed Agreement* will provide clearer goals and outcomes. It will provide an unprecedented level of transparency and accountability. It will be flexible, incorporating adaptive management decision making to address changing conditions and circumstances. Finally, it will provide the headwater states – Delaware, New York and West Virginia – the opportunity to join the partnership as full members.

While the 30th anniversary is cause to celebrate and reflect on our unique partnership and its accomplishments, it marks a transition to the next generation who will carry on the restoration efforts while adapting to a rapidly changing environment. As we honor our past achievements, the currently proposed *Chesapeake Bay Watershed Agreement* is our preparation for the future – a future where the Chesapeake Bay watershed remains an economic engine for the region, rebuilds a thriving and diverse ecosystem, and reclaims its status as a celebrated treasure for the citizens who live in the watershed and throughout the nation.

Respectfully submitted,

Nicholas A. DiPasquale
Director, Chesapeake Bay Program

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EXECUTIVE SUMMARY

A report on the Chesapeake Bay Program (CBP) is required every five years as a mandate of the Clean Water Act, Section 117(h). The report includes: the status and trends of the Bay ecosystem; the effectiveness of CBP in implementing management strategies; and recommendations for improved management, which we address through development of a new *Chesapeake Bay Watershed Agreement*.

Overall, the Chesapeake Bay remains in poor health, with poor water quality and clarity, uncertainty regarding the stability of native species and their habitats and continued pressures from development, population growth and climate change. However, there are positive signs from some of the headwater areas and other pockets around the watershed – recovery is under way and continued application of these proven practices will restore this treasured natural resource.

The blueprint toward achieving clean water is under way through the collaborative application of the Chesapeake Bay Total Maximum Daily Load (TMDL) by the seven Bay jurisdictions. Concurrently, the partnership continues to pursue restoration, creation and enhancement goals for habitat and living resources, as well as expanded stewardship though education and greater public access to all the natural wonders of the watershed.

Since the last assessment in 2008, President Obama issued Executive Order 13508 (EO) on Chesapeake Bay Protection and Restoration, and the federal partners issued their strategy (*Strategy for Protecting and Restoring the Chesapeake Bay Watershed*) to achieve the goals of the EO. Also, the U.S. Environmental Protection Agency (EPA) issued the Baywide TMDL. These steps have had a palpable effect on accountability and have increased collaboration and communication from the federal level, through the states and local governments, as well as non-governmental organizations (NGOs) and individual citizens.

Today, the federal and state agencies in concert with local governments, NGOs and academic institutions are forging the foundation for a new *Chesapeake Bay Watershed Agreement*. This new agreement will strengthen existing strategies that have proven effective and adopt new strategies that reflect emerging challenges. It will improve governance of Bay restoration efforts by better aligning the work of federal agencies to support the priorities of the jurisdictions. Most importantly, it will reemphasize the collective commitment to the more than 17 million citizens who call this watershed home.

INTRODUCTION

ABOUT THIS REPORT

This report is completed in accordance with the Clean Water Act (CWA) PL 109-169, Section 117(h). Section 117 (h) of the CWA requires the Environmental Protection Agency Administrator, in coordination with the Chesapeake Bay Executive Council, to complete a report to Congress every five years.

Section 117 of the Clean Water Act, as amended:

(h) Study of Chesapeake Bay Program

1. In general. Not later than April 22, 2003, and every 5 years thereafter, the Administrator, in coordination with the Chesapeake Executive Council, shall complete a study and submit to Congress a comprehensive report on the results of the study.
2. Requirements. The study and report shall:
    - A. Assess the state of the Chesapeake Bay ecosystem;
    - B. Compare the current state of the Chesapeake Bay ecosystem with its state in 1975, 1985, and 1995;
    - C. Assess the effectiveness of management strategies being implemented on the date of enactment of this section and the extent to which the priority needs are being met;
    - D. Make recommendations for the improved management of the Chesapeake Bay Program either by strengthening strategies being implemented on the date of enactment of this section or by adopting new strategies; and
    - E. Be presented in such a format as to be readily transferable to and usable by other watershed restoration programs.

THE CHESAPEAKE BAY PROGRAM

The CBP is a comprehensive cooperative effort by federal, state, and local governments, NGOs, academics, and other entities that share the mission of restoring and protecting the Chesapeake Bay and its watershed.

From 1984, the first year of funding for CBP through 2013, Congress enacted $734.2 million in funding through EPA to restore the Chesapeake Bay.

Created in 1983 and authorized by the CWA §117, CBP is directed by the Chesapeake Executive Council (EC). The CBP office is maintained by EPA, supported and staffed by its many partners; and it provides support to the EC and various CBP committees.

The original state signatories to Chesapeake Bay agreements (1983, 1987 and 2000) were Maryland, Pennsylvania, Virginia and the District of Columbia. In 2000, the CBP determined the headwater states of Delaware, New York and West Virginia were needed to meet the nutrient and sediment reductions necessary to remove the Bay from the impaired waters list. Subsequently, in 2002 the headwater states signed a Memorandum of Understanding (MOU) with EPA and the original four jurisdictions, committing them to fully participate in CBP's water quality efforts. The CBP is guided by the policy direction established by CWA §117 (Chesapeake Bay Restoration Act).

In 2009, President Obama signed Executive Order 13508 (EO): Chesapeake Bay Protection and Restoration, and in 2010 the federal agencies issued their strategy (*Strategy for Protecting and Restoring the Chesapeake Bay Waters hed*) to achieve the goals of the EO. In the transition years (further explained on page 39) from 2010 until now, the focus of the CBP has been on development and implementation of the Chesapeake Bay TMDL issued in December 2010 and the implementation of the EO Strategy by the federal partners.

In 2011, the EC and the Federal Leadership Committee (FLC) for the Chesapeake Bay acknowledged the need to integrate the goals, outcomes and actions of the Chesapeake Bay Program with those of the federal EO strategy. The partnership is now in the process of developing a new *Chesapeake Bay Watershed Agreement* expected to be signed by the EC in 2014. This new plan will clarify our vision, mission and values and establish shared goals and outcomes. It is intended to have more flexibility, increased accountability, and greater participation by all partners. The agreement will highlight the necessity of engaging local partners in the implementation of all goals. Current goals being considered by the partnership include:

Sustainable Fisheries Goal: Protect, restore, and enhance finfish, shellfish and other living resources, their habitats and ecological relationships to sustain all fisheries and provide for a balanced ecosystem in the watershed and Bay.

Vital Habitats Goal: Restore, enhance, and protect a network of land and water habitats to support high-priority species and to afford other public benefits, including water quality, recreational uses and scenic value across the watershed.

Water Quality Goal: Reduce pollutants to achieve the water quality necessary to support the aquatic living resources of the Bay and its tributaries and protect human health.

Healthy Watersheds Goal: Sustain state-identified healthy waters and watersheds, recognized for their exceptional quality and/or high ecological value.

Land Conservation Goal: Conserve landscapes treasured by citizens in order to maintain water quality and habitat; sustain working forests, farms and maritime communities; and conserve lands of cultural, indigenous and community value.

Public Access Goal: Expand public access to the Bay and its tributaries through existing and new local, state and federal parks, refuges, reserves, trails and partner sites.

Environmental Literacy Goal: Enable students in the region to graduate with the knowledge to use scientific evidence and citizenship skills to act responsibly to protect and restore their local watershed.

CHAPTER 1:
STATUS AND TRENDS OF THE CHESAPEAKE BAY ECOSYSTEM

SECTION A:
Signs of Continuing Recovery

As we commemorate 30 years of the CBP partnership, we have witnessed clear signs-from local streams and small watersheds to the deep waters of the Bay itself-of continuing recovery across the Chesapeake Bay ecosystem and throughout the surrounding six-state watershed.

The U.S. Geological Survey (USGS), in partnership with the Chesapeake Bay Program watershed water-quality monitoring partnership, routinely reports trends as well as monthly and annual loads for water-quality monitoring stations across the Chesapeake Bay Watershed.

The data from the monitoring network are used to help scientists and managers assess water-quality conditions and long-term trends as management practices are implemented to reduce the amount of nutrients (primarily nitrogen and phosphorus) and sediment reaching the streams in the watershed and the Bay. The data will also be used to help states and localities measure progress toward meeting their pollutant reduction responsibilities under the Chesapeake Bay TMDL.

Restoration Spotlight: Blue Plains Wastewater Treatment Plant

In the Potomac River estuary, wastewater treatment plant upgrades in the metropolitan Washington, D.C. area positively impacted the Potomac River estuary by decreasing phosphorus and nitrogen concentrations, and reducing the growth of harmful algal blooms (Buchanan et al. 1999).

Enhanced treatment of sewage and phosphate detergent bans in the '70s and '80s led to decreased summer algal blooms caused by phosphorus (Kemp et al. 2005), however nitrogen was still negatively affecting water quality. Upgrades at the Blue Plains Wastewater Treatment Plant to remove biological nitrogen in 1996 and 2000 led to significant decreases in nitrogen concentrations (Buchanan 2003).

These wastewater upgrades are also associated with the resurgence of underwater grasses. Research found decreases in nitrogen inputs, nutrientm concentrations, and total suspended sediment were highly correlated with increases in total underwater grasses' abundance (Ruhl and Rybicki 2010).

Trends through 2011 show over the past 25 years there have been decreasing nutrient and sediment concentrations indicating improving conditions in local streams and rivers. Nitrogen and phosphorus concentrations have decreased at almost 70 percent of the 31 long-term monitoring sites within the Bay watershed. Sediment has decreased at about 30 percent of the sites. However, several of the 31 sites had increasing sediment concentration trends over the last 25 years, which indicates degrading conditions. Three sites had increasing trends for nitrogen, four for phosphorus, and eight for sediment.

While jurisdictions are implementing management actions throughout the Bay watershed, there is a lag time between implementation and detection of water-quality improvement. Additional factors affecting water-quality changes include population increases, the influence of local watershed geological characteristics, as well as changes in nutrient sources and land use.

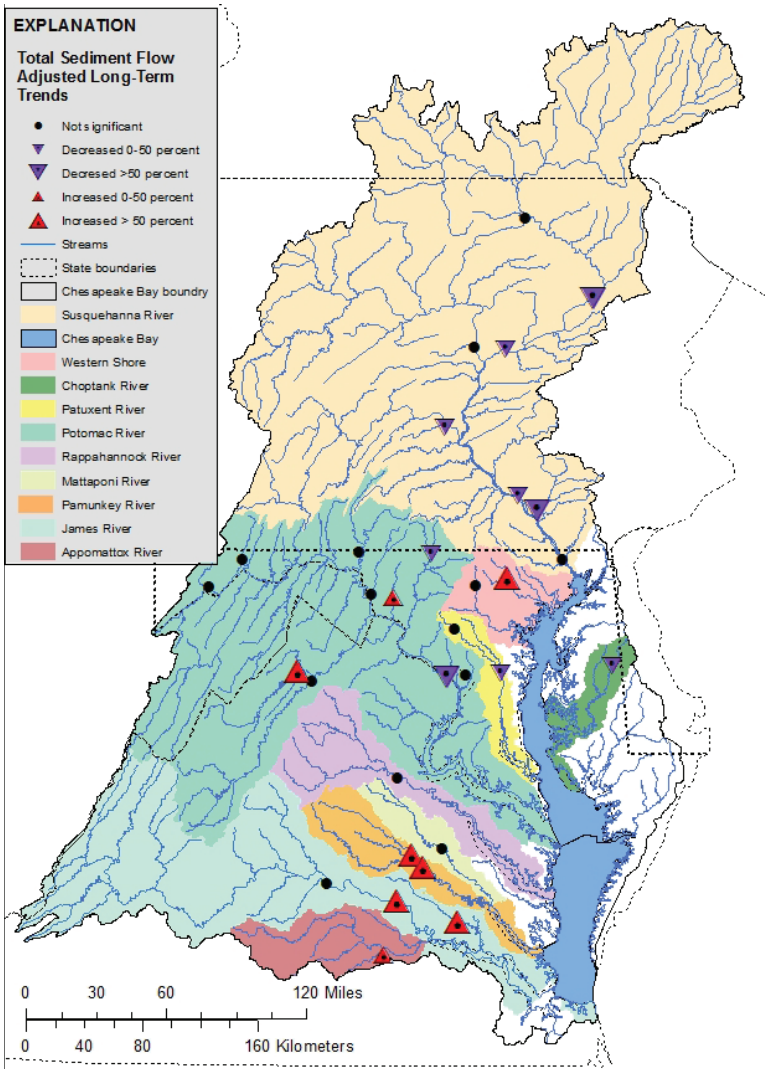
These long-term, multi-decade trends suggest pollution-reduction efforts, such as improved controls at wastewater treatment plants, reductions in nitrogen air emissions and practices to reduce nutrients and sediment from farms and suburban lands, are improving water-quality conditions in many areas of the watershed. However, nutrients, sediment, and contaminant pollutant loads still need to be further reduced to clean local streams and bring back a healthier Bay.

Photo of gull sittting on a piling in the Tred Avon River from www.chesapeakebay.net

What if it rains a lot… or not?

Nitrogen, phosphorus and sediment concentrations are highly variable, depending on the amount of water flowing in streams and rivers throughout the Bay watershed. To account for these variations, scientists calculate flow-adjusted trends to determine whether concentrations have changed over time.

By removing the effects of natural variations in streamflow, resource managers can evaluate the changes in stream health that may result from nutrient-reduction actions or other changes within the watershed.



Flow-adjusted trends for total nitroge for 31 sites in the Chesapeake Bay Watershed, 1985-2011

FLOW ADJUSTED CONCENTRATION TRENDS THROUGHOUT WATERSHED 1985-2011

Nitrogen

Changes in nitrogen concentrations were assessed from 1985-2011 at 31 stream sites in the Chesapeake Bay watershed. The majority of the flow-adjusted concentration trends were improving, with 21 sites improving, 3 sites degrading, and 7 sites where the trends were not statistically significant.

Phosphorus

Changes in phosphorus concentrations were also assessed from 1985-2011 at the 31 watershed stream sites. Again, the majority of the flow-adjusted concentration trends were improving, with 22 sites showing decreasing trends, 4 sites increasing, and 5 sites showing trends that were not statistically significant.

Sediment

Changes in suspended sediment concentrations were assessed at the same 31 stream sites from 1985-2011. Nearly half the sites (14) show concentration trends that were not statistically significant, with 9 sites improving, and 8 sites degrading.

Restoration Spotlight: Livestock Grazing Management

Cattle exclusion resulted in vegetation growth on land along rivers and streams, reduced suspended sediment loads, improved stream habitat, reduced nutrients and improved aquatic life in multiple locations through the Chesapeake Bay watershed.

Limiting livestock access to streams as well as improving vegetation and the land along the banks will reduce the direct cow manure input into the system, alleviate stream bank erosion and improve aquatic habitat (Teels et al. 2006).

In the Chesapeake Bay region, several studies in Pennsylvania, Maryland and Virginia showed that when conservation practices, including cattle exclusion, were implemented, the response time in vegetation growth was rapid, usually on the order of one year. Other benefits observed in Big Spring Run, Mill Creek Basin, Spring Creek, Lower Monocacy River and Lake Linganore—including a decrease in suspended sediment load and improved in-stream habitat, bank stability and vegetation—were observed within the first five years after practices were implemented (Galeone et al. 2006; Carline and Walsh 2007; U.S. EPA 2010b).

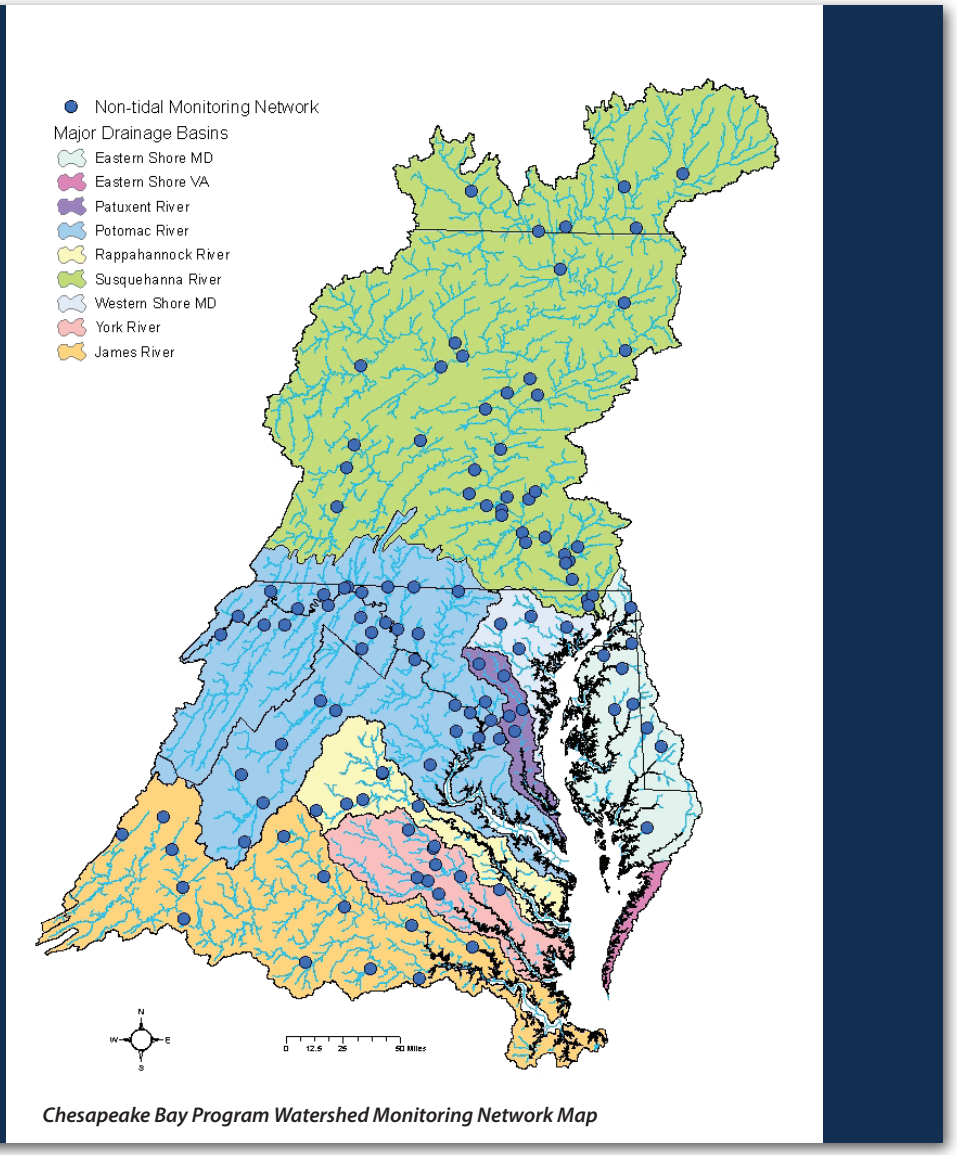
In Big Spring Run, Mill Creek Basin, Lower Monocacy River and Lake Linganore, the concentrations of key nutrients also decreased (Galeone et al. 2006; U.S. EPA 2010b). Furthermore, aquatic life metrics that included fish and benthic macro invertebrates increased in a short period of time in Big Spring Run, Mill Creek Basin, Occoquan River, Goose Creek and Spring Creek (Galeone et al. 2006; Teels et al. 2006; Carline and Walsh 2007).

Photo by Matt Kofroth, Chesapeake Bay Foundation

Watershed Monitoring Network

The Chesapeake Bay Program partners have collected data on stream flow and water quality at 31 locations throughout the non-tidal portions of the watershed since the 1980s. In 2004, the states, D.C., EPA and the USGS signed an agreement to expand the network, which resulted in the network growing to nearly 90 sites by 2010. The goal of the expanded network was to monitor progress in lowering nutrients and sediment in the watershed as water-quality practices were implemented.

The monitoring network now includes measurements of streamflow, nitrogen, phosphorus, and suspended sediment concentrations from 123 freshwater river and stream sites throughout the watershed. The seven watershed jurisdictions, the Susquehanna River Basin Commission, and the USGS all use the same set of standardized CBP protocols based on USGS field sampling methods and EPA approved laboratory analysis methods.

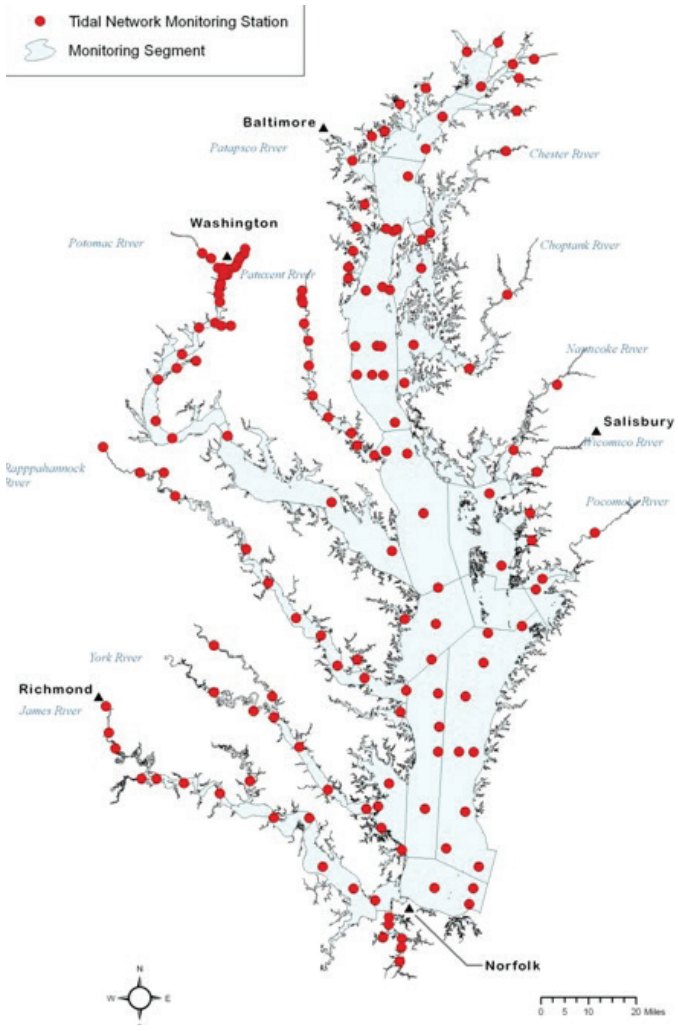


Chesapeake Bay Program Watershed Monitoring Network Map

Tidal Monitoring Network

Since 1985, 26 water-quality parameters have been measured by the Chesapeake Bay Program partners at 162 stations distributed over the 92 Chesapeake Bay tidal segments across Delaware, the District of Columbia, Maryland, and Virginia. The larger Chesapeake Bay tidal monitoring network also includes:

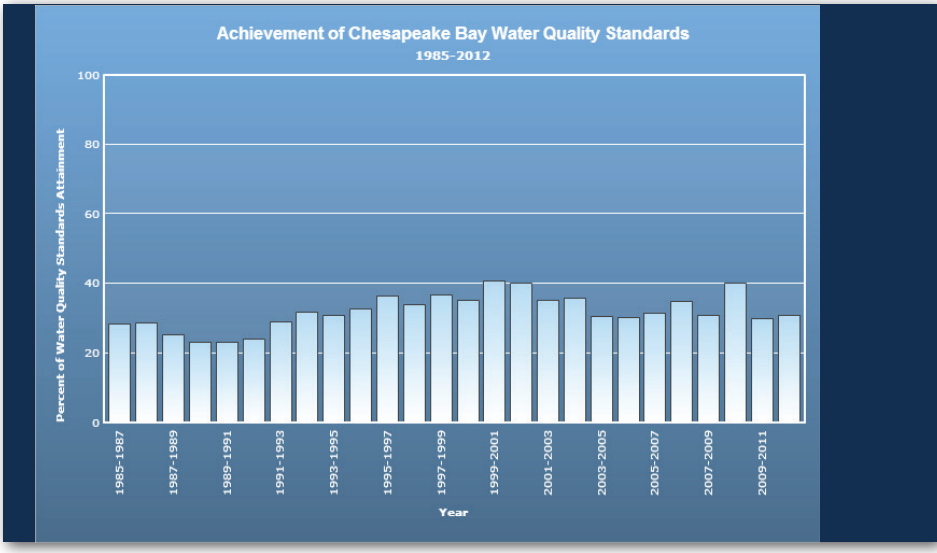
- Shallow-water monitoring addressing a select set of segments on a rotational basis;
- Benthic infaunal community monitoring at fixed and random stations across the tidal waters;
- Annual aerial and ground surveys of underwater Bay grasses;
- Decadal records of phytoplankton and zoo plankton monitoring; and
- Fisheries independent population monitoring programs and surveys.



Chesapeake Bay Program Tidal Water Quality Monitoring Network map

ACHIEVEMENT OF CHESAPEAKE BAY WATER QUALITY STANDARDS

In the *Chesapeake 2000* agreement, Bay partners agreed by 2010 to correct the nutrient- and sediment-related problems in the Chesapeake Bay and its tidal tributaries sufficiently to remove the Bay and the tidal portions of its tributaries from the list of impaired waters under the Clean Water Act. Further, the Chesapeake Bay EO water quality outcome calls for 60 percent of segments achieving Bay water-quality standards by 2025 through the implementation of 100 percent of pollution reduction actions for nitrogen, phosphorus and sediment no later than 2025.



At the recommendation of the partnership's Water Quality Goal Implementation Team, CBP adopted an indicator in September 2013 to track achievement of Chesapeake Bay water quality standards. The indicator measures progress toward the achievement of water quality standards for dissolved oxygen, water clarity/underwater bay grasses and chlorophyll-*a* for each three-year assessment period beginning in 1985. This indicator provides a means for illustrating improvements through time, and is fully consistent with how Delaware, the District of Columbia, Maryland, and Virginia currently list their portion of the Bay's tidal waters. The indicator will be used to illustrate incremental progress toward ultimately achieving each state's Chesapeake Bay water quality standards at small scales for the 291 designated use segments.

Preliminary results for 2010-2012 indicated 31 percent of the Bay was attaining water quality standards. These results are similar to those of the previous assessment period (2009-2011) in which 30 percent of the Bay was attaining water quality standards.

Restoration Spotlight: Stormwater Infiltration

Montgomery County, Maryland has shown that multiple redundant stormwater best practices and combinations of different practices are more effective than a single practice.

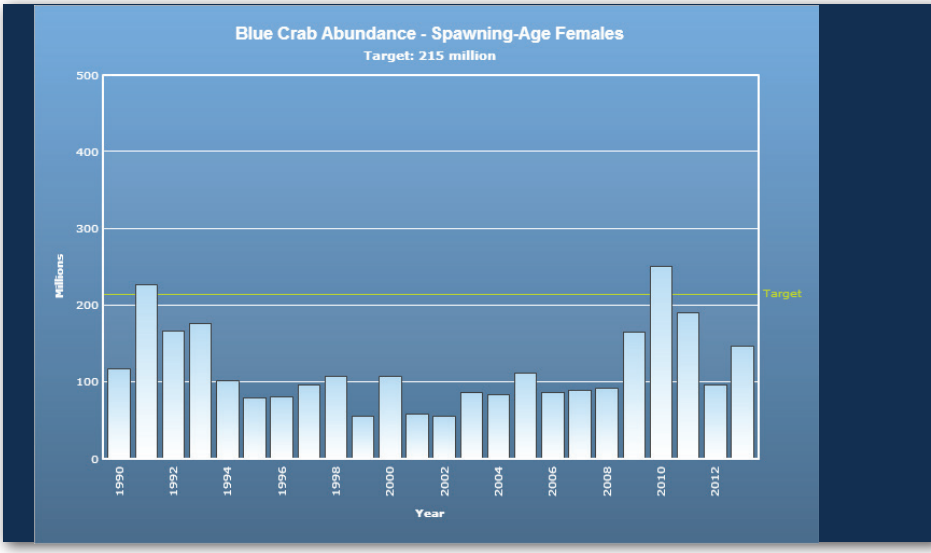
Clarksburg, Piney Branch, Upper Paint Branch, and Upper Rock Creek are designated as Special Protection Areas (SPAs) in Montgomery County. SPAs are geographic areas characterized by high quality or highly sensitive water resources that are also under threat of degradation by proposed land uses. Developers in these sites worked with county agencies in planning for the amount and location of impervious surfaces or alternatives, creating environmental buffers, conserving forests, controlling sediment and erosion, and managing stormwater.

During construction, sediment and erosion control measures included basins with forebays, filter fence baffles, floating skimmers, series of dual basins, and greater storage volumes. These practices were also used in combination as "treatment trains." After construction, stormwater management practices were created, including natural (green infrastructure) and constructed filtering systems, storage for excess water during storm events, and adequate recharge volume. Particularly when implemented in redundant trains, practices reduced runoff and decreased pollution loads to local streams.

The success in Montgomery County emphasizes the need for careful planning prior to development. However, the health of the biological aquatic communities within the SPAs did not always rebound with improvements in water quality and may require more time to respond to decreased pollution loads (MCDEP 2009). This delay in response highlights the urgent nature of effective practices as development rapidly expands.

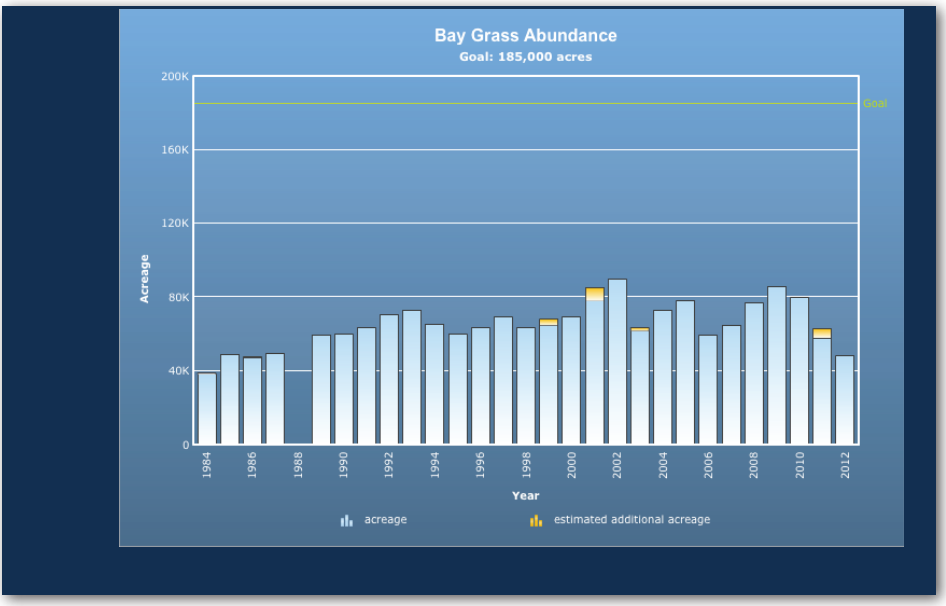
Blue Crabs

Another sign of recovery is the stabilization of blue crab populations. Perhaps no species is more closely associated with the Chesapeake Bay than the blue crab. Because they reproduce by the millions, eating virtually anything, crabs are one of the Bay's hardiest species.



However, water quality and adequate habitat are important for the crab's continued health. Led by the Chesapeake Bay Stock Assessment Committee and the National Oceanic and Atmospheric Administration's Chesapeake Bay Office, a 2011 benchmark assessment recommended establishing an overfished threshold number of 70 million female spawning-age crabs and replacing the interim target of 200 million male and female spawning-age crabs with a target of 215 million female spawning-age crabs.

Approximately 147 million female crabs over age 1 were estimated in the Bay at the start of the 2013 crabbing season. This number is below the recommended target but still above the new threshold and within the range of values observed for the 13 year period prior to implementation of the female-specific safeguards put in place in 2008.



Underwater Grasses

In 2003, the Bay Program adopted the *Strategy to Accelerate the Protection and Restoration of Submerged Aquatic Vegetation in the Chesapeake Bay*. The strategy included a new Baywide restoration goal of 185,000 acres, representing the approximate historic abundance from the 1930s. Scientists believe having more underwater grasses in the Bay and rivers will dramatically improve the entire ecosystem. The expectation is as nutrient and sediment pollution decrease and water clarity improves, underwater grass acreages should expand.

Underwater grasses provide significant benefits to aquatic life and serve many critical ecological functions in the Bay and its tributaries. Underwater grasses provide shelter for young striped bass, blue crabs and other species; improve water clarity by helping suspended sediment particles settle to the bottom; add oxygen to the water; and reduce shoreline erosion.

From 1984-2012, the abundance of underwater grasses increased from 38,958 to 48,195 acres. Acreage has averaged 65,666 and ranged from 38,958 to 89,659 acres.

"Dead Zones"

Further evidence of the benefits of nutrient and sediment reductions was presented in a study published in the November 2011 issue of Estuaries and Coasts, by researchers from Johns Hopkins University and the University of Maryland Center for Environmental Science, examining 60 years of Chesapeake Bay water-quality data.

The research team found the size of mid- to late-summer low to no oxygen areas, called "dead zones," leveled off in the Bay's deep channels during the 1980s and has been declining ever since. This is the same time the CBP formed and federal and state agencies set the Bay's first numeric pollution reduction goals. The study also found the duration of the dead zone - how long it persists each summer - is closely linked to the amount of nutrient pollution entering the Bay each year.

The study also eased fears surrounding an early summer jump in dead zones, determining they were influenced by stratification, not by the runoff of pollutants. Fresh water from rivers entering the Bay forms a layer on top of more dense salt water from the ocean. The two layers do not easily mix, so when air near the surface adds oxygen to the top layer, it does not reach the deeper salt water. Without oxygen at these lower depths, marine animals cannot live, and a dead zone is formed.

We are also seeing more and more stories of the recovery and restoration of free flowing creeks and rivers, tidal embayments, and small watersheds - waterbodies of importance to local communities as sources of economic growth, drinking water, swimming, boating, fishing, wildlife watching or other forms of recreation, aesthetic beauty, ecosystem services or other benefits.

Restoration Spotlight: Manure and Fertilizer Management

Reducing the application of phosphorus in commercial and manure fertilizer resulted in significant water quality improvements in Brush Run Creek in Pennsylvania's lower Susquehanna River basin.

The 0.63 square mile watershed in south-central Pennsylvania is dominated by agriculture. Reducing commercial and manure fertilizer decreased phosphorus and nitrogen loads by 57% and 14%, respectively. Total phosphorus and suspended sediment concentrations decreased at three water quality monitoring sites. Total nitrogenconcentrations decreased slightly, but not significantly.

At two of the sampling sites, the volatilization of ammonia from livestock manure likely added additional nutrient loads through atmospheric deposition.The reductions in phosphorus point to the effectiveness of nutrient management, but the insignificant decreases in nitrogen suggest the need for longer-term monitoring and the consideration of soil-nutrient interactions, nutrient transport mechanisms, and nitrogen transformations with changes in water quality (Langland and Fisher 1996). The monitoring period likely needs to be extended beyond three years post-nutrient load decreases to observe changes in nitrogen concentrations to reflect the delay in local water quality response due to the effects of groundwater time lags.

In 2010 and 2011, New York, Maryland and Virginia took the additional step of banning the use or sale of residential phosphorus fertilizers.

Photo of Pennsylvania Rt. 213 bridge over Brush Run Creek from bridgemapper.com

The recovery of these waterbodies located in communities and small watersheds people call home is the direct result of local actions by neighbors, homeowners, farmers, business owners, developers, municipalities, and many others working at the local scale.

Each of these local stories gives us new insights into how to better restore the next creek, river or watershed, how long until we should expect to see a positive water quality response downstream, what trajectory the restoration of other rivers and embayments will take and what signs we should be watching out for.

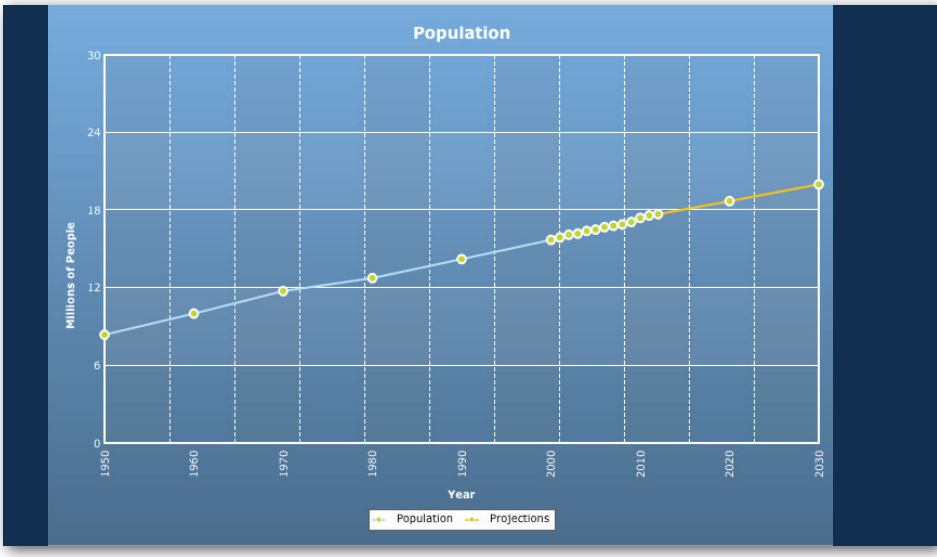
SECTION B: RESILIENCE

We have also observed a growing resilience in the Bay ecosystem, the ability of the natural system to withstand and bounce back from severe stresses and impacts – numerous major storms, lengthy droughts and record summer time temperatures, all while population growth and development in the watershed has more than doubled since the 1950s.

To provide for a qualitative measure of resilience, we have compared measurements of key ecosystem response indicators - underwater Bay grasses, dissolved oxygen, oysters - under extreme, often sustained weather events observed recently and decades ago. Compared to similar extreme conditions decades ago, when we would have observed a complete loss of underwater grass acreages or the collapse of a healthy oyster bar community for years to come, these ecosystem components have more recently withstood the adverse weather impacts and rapidly recovered to their previous health status.

Population Growth

In the face of significant increases in population across the Chesapeake Bay watershed, accompanied by continued development of the land, actions of the partnership have assisted in not only holding the line on pollutants loads - but improving water quality conditions. Given more than 5 million additional people now call the Bay watershed home since the partnership was established in 1983, the fact the Bay ecosystem is showing real signs of recovery is significant.



As of 2012, 17.7 million people were estimated to live in the Bay watershed, up from 17.6 million in 2011. Experts predict the watershed's population will increase to more than 20 million by 2030.

Major Storm Events

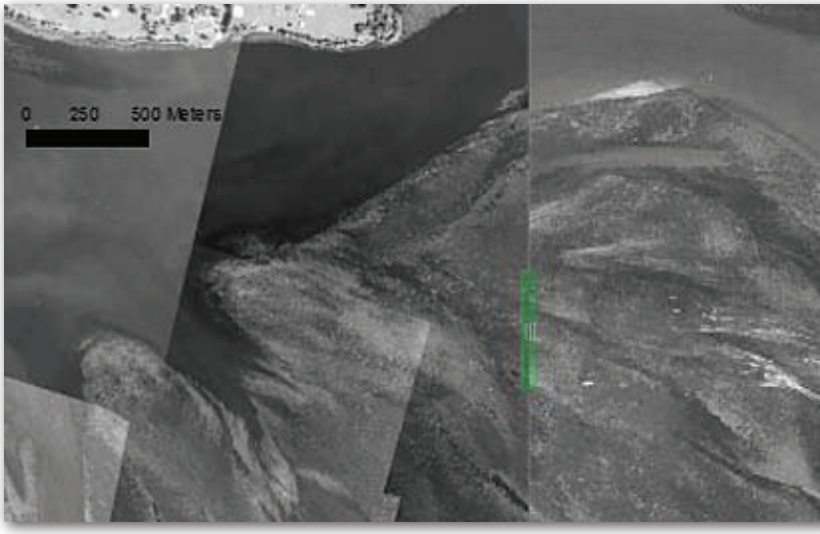
In August and September of 2011, Hurricane Irene and Tropical Storm Lee dumped a large amount of water in the Susquehanna River watershed, creating a muddy plume that extended down the Chesapeake Bay to the mid-bay islands and persisted for several months. Scientists working with the Chesapeake Bay Program acquired aerial imagery in early November 2011. The photos showed while some underwater grasses in the Susquehanna Flats were lost, the bed mostly survived.

These major storm events did not overwhelm the restoration progress made to date - impacts underwater grasses, oysters, and, dissolved oxygen levels from these and other tropical storms and hurricanes in years past were barely observed in the spring which followed. Compared with the devastating impacts of Tropical Storm Agnes in June 1972, from which the Bay only recovered a decade later, Bay and watershed restoration efforts have successfully re-built a level of resilience to withstand these extreme natural events.

A 2012 study by UMCES showed some positive effects of tropical storms, as well as negative impacts. The report points out oysters benefit from salinity reductions, reducing incidence of two major diseases. Low salinity also reduces the rate of infection as well as occurrence of parasites.

"Mixing" of Chesapeake Bay waters following high winds, like those of Hurricane Irene, was another positive effect found by the study. Coming on the heels of a large dead zone that summer, the high winds from the storm mixed the water, improving oxygen levels.

The effect on other species, such as blue crabs, was minimal as they are highly mobile and migrate to avoid areas with decreasing water temperatures or reduced salinity as a result of the storms.



The Virginia Institute of Marine Science's SAV blog has an interactive version of the above image comparing the Susquehanna Flats underwater grass bed from 2010 to post-storms 2011.

Lynnhaven River Oyster Restoration

In the past 100 years, the population of the native Eastern oyster (c. Crassotrea virginica) has fallen dramatically, due to over-harvesting, disease and poor water quality. Lynnhaven River has been the center of many community-based restoration and oyster shell recycling efforts over the past few decades. Agencies such as the National Oceanic and Atmospheric Administration (NOAA), the U.S. Army Corps of Engineers (USACE), state efforts like the Virginia Oyster Heritage Program, and nonprofit organizations including Lynnhaven River NOW, the Chesapeake Bay Foundation, and Oyster Reef Keepers of Virginia have performed smaller-scale restoration involving students and citizen groups. Most of these projects involved creation of artificial reefs and adding spat-on-shell to these reefs. NOAA is also supporting research on how fish use the oyster reefs in the river. These projects have seen some measurable progress and have increased the oyster population in the Lynnhaven dramatically.

Water's getting warmer…

The Potomac River, one of the Bay's largest tributaries, was one of 20 major U.S. rivers and streams showing statistically significant long-term warming. In Maryland's Patuxent River, University of Maryland Center for Environmental Science (UMCES) researchers have noted a 3°F increase since 1939.

"We are seeing the largest increases in the most highly urbanized areas which lead us to believe that the one-two punch of development and global warming could have a tremendous impact on stream and river ecosystem health," said Dr. Sujay Kaushal of UMCES.

Contractors working for the U.S. Army Corps of Engineers, Norfolk District, use high-pressure water cannons to spread fossilized oyster shell in the Lynnhaven River in Virginia Beach, Va., in an effort to build medium relief oyster reefs for an ongoing oyster restoration project.
(Photo courtesy USACE Norfolk)

Ten years ago, the Lynnhaven River oyster population was estimated to be only one percent of historic abundance, but a recent estimate suggests the current population has grown to approximately ten percent of historic numbers. USACE Norfolk District has played a large role in the restoration of native oyster populations through the construction of 58 acres (out of a total of 63 acres constructed) of new sanctuary oyster reefs in the Lynnhaven River.

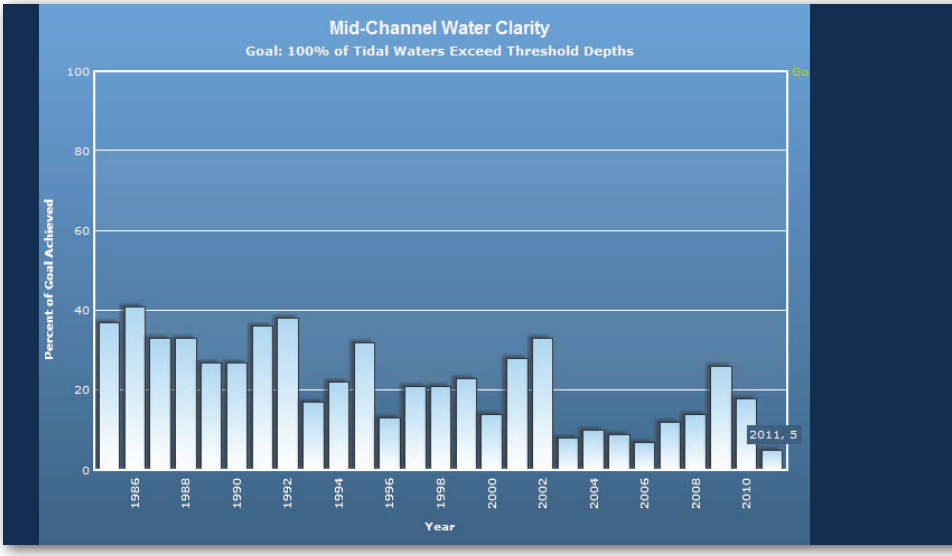
Oyster restoration efforts in the Lynnhaven River and elsewhere will be measured using the oyster metrics adopted by the Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team in December 2011.

SECTION C: NOT ALWAYS SEEING EXPECTED RESPONSE TO MANAGMENT ACTIONS

We have also observed key Bay and watershed ecosystem responses (or lack of responses) providing clear evidence where our restoration efforts have not progressed the way we would have expected given we are several decades into Bay and watershed restoration efforts.

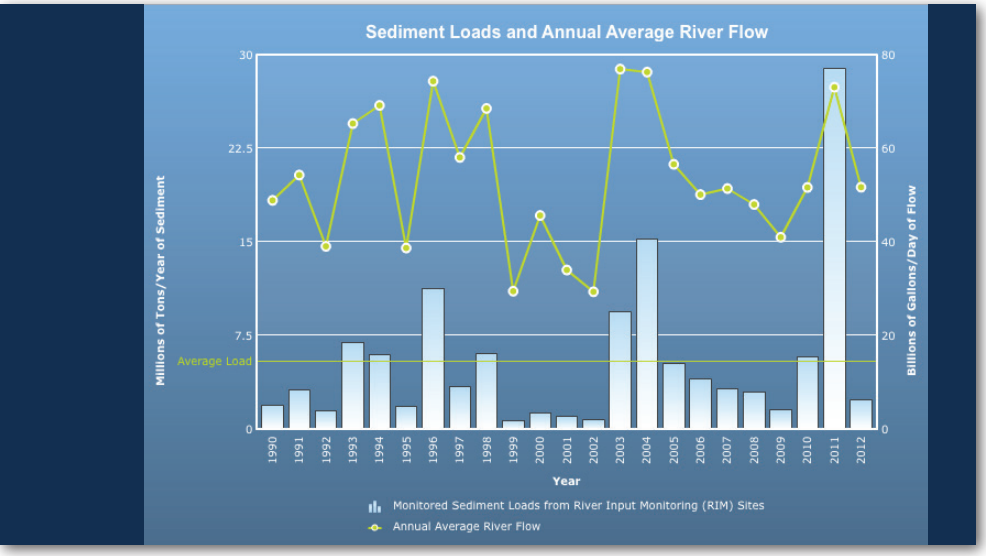
Water Clarity

Water clarity measures the depth to which light can penetrate into the water. It is routinely hindered by fine sediment, plankton and other debris suspended in the water. Greater water clarity generally leads to a healthier Bay.



Annual clarity levels can vary greatly, but the long-term trend indicates Bay water has become more turbid (less clear). Since 1985, goal achievement has averaged 22 percent and has ranged from 5 percent to 41 percent. In the most recent measurements for 2010-2011, the water clarity score decreased from 18 percent to 5 percent of goal achieved.

Water clarity data from deeper, mid-channel areas are used to indicate general conditions and trends, including for reporting on this goal. Systematic monitoring of water clarity in shallow water areas has been underway for only the past few years and there are not yet sufficient data to provide a Baywide assessment.



Sediment Loads and River Flow

We are witnessing water quality trends in the wrong direction not only in the case of reduced water clarity in the tidal waters but also with sediment loads at the river input monitoring stations.

Following heavy rains from Hurricane Irene and Tropical Storm Lee, preliminary estimates show 25.8 million tons of sediment from nontidal rivers reached the Bay during the 2011 water year (October 2010-September 2011). This was an 18.9 million ton increase from 2010 and significantly higher than the 4.7 million ton average load from 1990-2011. This marked the highest delivered yield of sediment to the Bay since 1990. Loads in 2012 returned to significantly reduced levels.

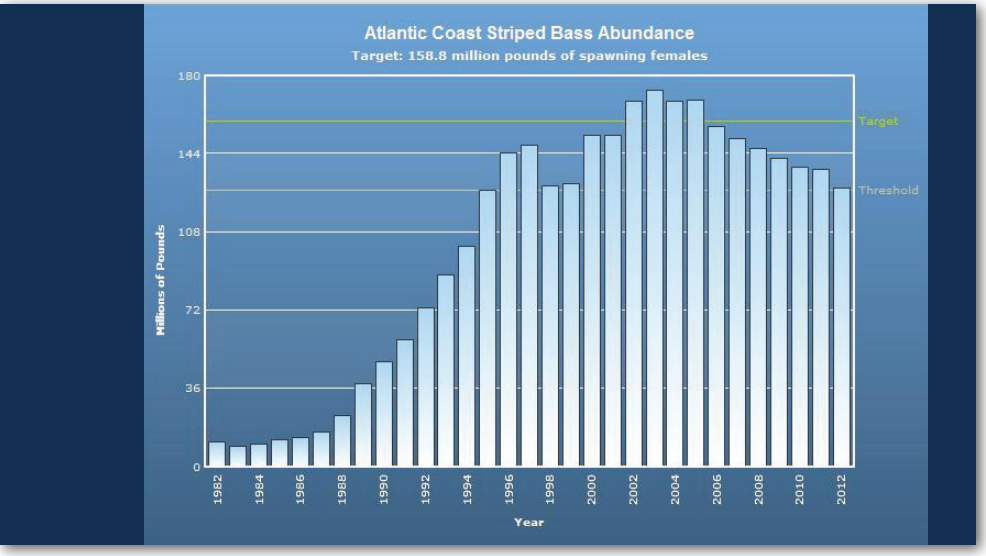
Smallmouth Bass

A smallmouth bass collected from the Susquehanna River near Selinsgrove displays the black spots that have anglers concerned. Photo by Pennsylvania Fish & Boat Commission.

Starting with severe losses in smallmouth bass populations in the Shenandoah River, where the Virginia Department of Game and Inland Fisheries estimated about 80 percent of the population was wiped out, reports of fish kills and similar population declines in this prized freshwater sport fish were reported in West Virginia's South Branch Potomac River, Virginia's Cowpasture River, Maryland's Monocacy River, and Pennsylvania's Susquehanna River. Specific causes of the observed lesions, abnormal sexual development, and resultant severe population declines remain unclear. Based on research by the USGS, there are indications a combination of elevated nutrient conditions, high water temperatures, and chemical contaminants may have weakened the natural immune systems of the fish, leaving them more susceptible to bacteria, viruses, and parasites living naturally in these river systems.

Striped Bass

For striped bass the message seems to be "proceed with caution." The Chesapeake Bay is the primary spawning and nursery habitat for striped bass on the East Coast. Striped bass support one of the most important commercial and recreational fisheries on the Atlantic seaboard. The striped bass population rebounded from historic lows in the mid-1980s to highs exceeding the population target. Multi-state fishing moratoria in the late 1980s, as well as commercial quotas and recreational harvest limits set in the 1990s, were successful at rebuilding the stock.



Female Atlantic striped bass spawning stock biomass measured 128 million pounds in 2012 and has exceeded the target since 1995. The stock is not overfished and overfishing is not occurring. The Atlantic States Marine Fisheries Commission (ASMFC) manages the coast wide striped bass stock and recently completed the 2013 Atlantic striped bass benchmark stock assessment.

While the population of striped bass continues to not be overfished, the overall health of the stock appears to show signs of stress. According to a study by the Virginia Institute of Marine Sciences (VIMS) published in 2012, scientists are now concerned about the high prevalence of disease (mycobacteriosis) and whether there are enough prey available to adequately support this predatory fish. The study of striped bass in the Chesapeake Bay from 2003-2007 shows evidence of mycobacteriosis increasing with age, peaking at age 5 for males and age 6 for females.

Mycobacteria are widespread in aquatic environments. A small fraction of mycobacterial species causes disease in animals and humans. Mycobacterial infections in humans are commonly known as "fish-handler's disease." Although the risk of contracting the disease is generally low (Panek and Bobo 2006), there is the potential for human infection from handling infected striped bass. There is no reported evidence humans can contract mycobacteriosis by consuming cooked fish.

Climate Change

The Chesapeake region is experiencing the effects of a changing climate. Historical records show increasing temperatures and sea level rise in the Chesapeake region over the past century. Long-term observations corroborate model projections that upward trends in temperature and sea level will continue, and even accelerate, in the watershed. Bay scientists are working to understand the possible effects of these changes on the Chesapeake Bay and its watershed, including how they affect Bay restoration efforts already in progress.

Hurricanes such as Isabel can lead to flooding throughout the Chesapeake Bay watershed. Photo of Annapolis harbor following the storm by Mike Land.

The influence of climate change and sea level rise is widespread, and adapting to changing conditions will require the involvement of all CBP partners in their particular areas of expertise. For example, the Interstate Commission on the Potomac River Basin is examining the viability of Washington, D.C.'s water supply in the face of increased water demand from increased temperatures and population, as well as the potential for less annual available river flow under climate change conditions in 2050. Elsewhere, the Department of the Navy is examining new pier designs for installations like Naval Station Norfolk to ensure force readiness despite continuing sea level rise. These and other activities at the federal, state, and local levels are ongoing in the watershed to allow adaptation to the changing conditions.

CBP is now engaged in estimating the influence climate change and sea level rise will have on the Chesapeake Bay TMDL. Partners will examine the estimated influence of temperature increases, sea level rise, the loss of tidal wetlands, changes in air quality, and other climate change influences on the TMDL. In 2017, the CBP partners will decide how to factor the effects of increased temperatures and sea level rise into the Bay TMDL.

CHAPTER 2:
MANAGEMENT STRATEGIES' EFFECTIVENESS

The CBP partnership has a history of building on what has worked and adding more facets to the efforts to achieve the overall goal of restoring and protecting the Chesapeake Bay. As a result of the 1975 EPA study of the Chesapeake Bay called for by Senator Charles "Mac" Mathias, which identified the key problems the Chesapeake faced, the partnership has led the Chesapeake Bay restoration effort through a series of agreements, each building on the accomplishments of the last.

Signed in 1983 by the governors of Maryland, Virginia, Pennsylvania, the mayor of the District of Columbia, the chair of the Chesapeake Bay Commission (a tri-state legislative assembly representing Maryland, Virginia and Pennsylvania), and EPA on behalf of the Federal Government, the first Chesapeake Bay Agreement was renewed twice, and amended once, each building off the last. The 1983 Agreement focused on building an engaged and effective partnership.

In 1987, a new Agreement was signed, this one building on the effective partnership but adding aggressive commitments the partners could work on to restore the Chesapeake Bay, most notably a call for a 40 percent nutrient reduction by 2000, the first time a measurable and time-bound goal was set for CBP. This Agreement was amended in 1992, when the partnership recognized they had to focus attention not only to the Bay itself, but the tributaries, calling for the Bay jurisdictions to develop individual tributary strategies, a standard used today for the jurisdictional Watershed Implementation Plans (WIPs) developed to achieve the goals of the Baywide TMDL restoration blueprint described below.

At the start of the new millennium, the partners signed *Chesapeake 2000*, building on earlier agreements, but focusing on additional time-bound and measurable goals focused on accelerating implementation and influencing change.

Currently, CBP is building on the success of previous Agreements and the progress made in the transition years following the last Agreement to develop a new *Chesapeake Bay Watershed Agreement* that will include a partnership strengthened by additional leadership from federal agencies, increased involvement of headwater states, and a more streamlined and flexible set of goals and outcomes aligned with the EO Strategy issued in 2010.

SECTION A: BUILDING AN EFFECTIVE PARTNERSHIP

The 1983 Agreement was a simple agreement focused on the notion the collective group could be more effective working together than apart. It established a Chesapeake Executive Council (EC) that would oversee CBP, assess progress on coordinated plans to "improve and protect the water quality and living resources of the Chesapeake Bay estuarine system." At the time, the EC was to be composed of cabinet members of the mayor and governors' administrations, as well as the Regional Administrator of the EPA, and it was to meet at least twice a year. The EC still exists to this day, but has been elevated to the level of the original Agreement signatories (governors, mayor, EPA Administrator, Chair of Chesapeake Bay Commission) and meets annually to oversee, set new or more specific direction, and adopt policies and strategies.

The original agreement also called for the establishment of an implementation committee, composed of agency representatives of all signatories who would coordinate the development and evaluation of the management plans. Advisory committees were established for citizens and scientists whose membership was composed of nominations by the governors. An advisory committee for local governments was later established when the partners recognized local governments were essential in the implementation of actions needed to restore the Bay. At the same time, EPA developed Memoranda of Understanding (MOU) with key Federal Agencies to articulate the ways in which EPA could represent them in the partnership. To develop individual management strategies, the Implementation Committee convened subcommittees for each key focus area of the Program. The structure set up early in the partnership still exists, fundamentally unchanged, today. The organization has been reorganized twice, in 1996 and in 2009, to face the future challenges of the restoration effort and accelerate implementation. CBP partners recognized the need to embrace an "adaptive management" approach to respond better to changing conditions and better information.

Key elements have remained consistent since the 1983-1987 time frame. There is still an Executive Council and its Principals' Staff Committee, the Implementation Committee became what is now the Management Board, there are three advisory committees, Citizens, Science and Technology, and Local Governments, and the Subcommittees are now called Goal Implementation Teams.

Two major expansions in the partnership have occurred since the 1983-1987 time frame. After the 1992 Amendments to the Agreement, the partnership recognized the need for involvement and engagement by the states in the headwaters of the watershed. In 2002-2003, New York, Delaware, and West

Signing ceremony for the original Chesapeake Bay Agreement in 1983. Photo from Chesapeake Bay Program archive.

Virginia signed on to the water quality commitments through an MOU. In addition, the EC representatives of the states and D.C. felt a strengthened leadership from the federal government was needed. In 2009, they wrote a letter to newly elected President Obama seeking that leadership. The upshot of that request became President Obama's first environmental executive order – the Chesapeake Bay Protection and Restoration Executive Order (EO 13508), followed closely by the development of the EO *Strategy for Protecting and Restoring the Chesapeake Bay Watershed*. The Transition Years section of this report contains an expanded discussion of the role of the EO Strategy.

SECTION B: MANAGEMENT STRATEGIES

Water Quality Requirements Necessary to Restore Living Resources

The Chesapeake Bay Program's priority attention for meeting water quality requirements to restore living resources has been on two key areas: (1) correcting the nutrient- and sediment-related problems in the Chesapeake Bay and its tidal tributaries sufficiently to remove the Bay and the tidal portions of its tributaries from the list of impaired waters under the Clean Water Act; and (2) fulfilling the 1994 goal of a Chesapeake Bay free of toxics by reducing or eliminating the input of chemical contaminants from all controllable sources to levels that result in no toxic or bioaccumulative impact on the living resources that inhabit the Bay or on human health

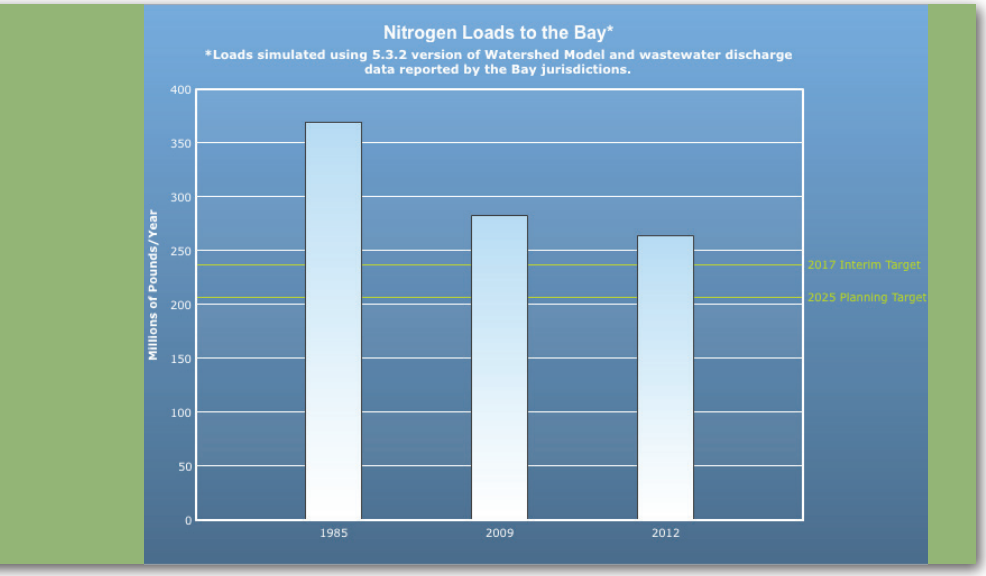
Achieving and Maintaining Nutrient goals of the Chesapeake Bay Agreement

The strategy set forth in the *Chesapeake 2000* agreement included defining water quality conditions necessary to protect aquatic living resources, aligning and, as necessary, adopting new or revised water quality standards, and monitoring progress toward meeting the standards. The strategy also included using models of the Chesapeake Bay and its watershed to set nutrient and sediment load allocations for each major tributary basin to meet those standards. Finally, the strategy called for Bay jurisdictions to develop tributary strategies that define and commit to the actions necessary to reduce nutrient and sediment pollution enough to meet those allocations. The progress in implementing the tributary strategies was tracked annually through collecting implementation information from the jurisdictions and processing that information through the Chesapeake Bay Watershed model.

In 2008, the EC directed the partnership to take an innovative approach toward improved accountability. In pursuit of the long-term goal set in 2009 for having all water quality restoration practices in place by 2025, the partners would begin to track their progress through short, two-year targets, starting with the years 2009 through 2011. These short-term checks on water quality restoration progress were a significant advancement from prior CBP tracking periods of ten or more years.

By 2009 it was apparent, although there were significant reductions in nitrogen and phosphorus loads, not enough progress would be made. Consistent with the Executive Order, which directed EPA to use the full range of its authorities under the Clean Water Act, a Baywide TMDL was developed to ensure all practices and pollution controls are in place by 2025 that would achieve water quality standards. This TMDL (see section on page 47) is like no other TMDL in the country, largely because it is based on the success of the partnership in developing the monitoring and modeling tools necessary to track progress, in developing and implementing tributary strategies that were the precursor to the jurisdictional WIPs, and in the commitment to develop shorter term two-year milestone commitments, and contains rigorous accountability measures and federal actions that can be employed if necessary to spur progress.

The original intent of the 2009-2011 water-quality milestones was to allow for flexibility so the partners could alter their management decisions based on what worked best. Success was to be measured against the end goal of reducing the pounds of pollutants entering the region's waters, rather than acres or miles of specific practices put in place. This "common currency" of expected pounds of pollution reduced allowed jurisdictions to establish an initial set of practices to implement and to adapt if the original practices were less effective than anticipated.



Between 2000 and 2010, this general strategy has been implemented, updated, and revised. New water quality criteria were developed for dissolved oxygen, chlorophyll-*a*, water clarity and submerged aquatic vegetation. Pollutant load allocations have been set and revised for each major tributary, tributary strategies were developed by the Bay jurisdictions and progress has been measured annually. As required by the EO, Federal Agencies prepare annual reports assessing implementation of annual action plans and reviewing indicators of environmental conditions in the Bay.

At the end of 2012, the jurisdictions were estimated to have made 25 percent of the overall watershed-wide reductions necessary to meet their combined 2025 TMDL tracking goal for nitrogen, relative to the 2009 TMDL baseline. The jurisdictions are 27 percent of the way towards their goal for phosphorous and 32 percent for sediment.

Chesapeake Bay Basinwide Toxins Reduction and prevention strategy goal

In December 2000, the EC adopted the *Toxics 2000 Strategy: A Chesapeake Bay Watershed Strategy for Chemical Contaminant Reduction, Prevention, and Assessment* (U.S. EPA 2000a). The agreement made substantial commitments to prevent and reduce chemical contaminants and eliminate toxic impacts on living resources inhabiting the Bay and rivers. The EC also committed to eliminating all chemical contaminant-related fish consumption bans and advisories, to clean up contaminants in the sediment in the three most urbanized areas referred to as "Regions of Concern" (Baltimore Harbor, Anacostia River, Elizabeth River), and to sustain progress in the face of increasing population and expanded development within the watershed.

Since adopting the *Toxics 2000 Strategy*, while CBP activities have focused primarily on reducing nutrient and sediment loads, some progress has been made by federal and state agencies as well as NGOs completing ongoing work to control chemical contaminants. EPA, for example, has continued numerous contaminated site cleanups, improving conditions in the Chesapeake Bay watershed. Jurisdictions have enforced permit conditions including industrial wastewater permits, and have also continued to monitor fish tissue for determining consumption advisories and impairment listings. Federal agencies such as USGS, NOAA, U.S. Fish and Wildlife Service (USFWS) and EPA continue to monitor for chemical contaminants and assess possible ecological effects.

Progress has been made in at least two of the three previously designated Regions of Concern, the Elizabeth River and Anacostia River, due in part to the leadership provided by the Elizabeth River Project and Anacostia Watershed Restoration Partnership. For example, in the Elizabeth River watershed contaminated soil at a former naval shipyard was removed and the site replanted to create a wetland. Multiple industrial sites are being cleaned up to reduce bottom sediment contaminated with PAHs and other pollutants.

In the Anacostia watershed, stormwater retrofit projects have been completed to allow for improved treatment of stormwater originating from hundreds of acres. The Anacostia is benefiting from a trash TMDL, which reduces contaminants from household products and industrial sources of waste. The multijurisdictional Anacostia Watershed Restoration Plan includes projects reducing toxic contaminants into the river. In 2012, EPA's Chesapeake Bay Program Office focused $1 million of grant funds toward the Anacostia watershed through the Innovative Nutrient and Sediment Reduction Grants program. Additionally, both the Anacostia watershed and Baltimore Harbor were included as pilots for EPA's Urban Waters Initiative, which is working to align federal programs and investments and build local capacity for improving ecological conditions in these watersheds.

In 2006, the CBP completed analysis of information that led to prioritization of organic pollutants targeted for reduction. Strategies for reducing those high priority pollutants were in development when the decision was made in 2007 to disband the former CBP Toxics Subcommittee to allow for greater focus on development of the Chesapeake Bay TMDL. Prior to 2007, the efforts of the Toxics Subcommittee focused on further characterizing the condition of the Bay with regard to ecological impacts from toxic contaminants.

Since the *Toxics 2000 Strategy* was written, the conditions that existed remain. According to the environmental indicator maintained by CBP, which measures the number of tidal segments with a partial or full jurisdiction-listed impairment due to toxic contaminants in 2012, 68 out of 92 tidal segments (74%) are fully or partially impaired. This represents a slight increase over the previous version of the indicator (72%), which was based on 2010 jurisdiction listings. Research has augmented our understanding of sublethal effects of contaminant mixtures and new issues, such as intersex characteristics in fish in the Bay watershed, have arisen. The focus of a report released by EPA, USFWS and USGS in December 2012 summarized the current conditions of extent and severity of effects from toxic contaminants. The report findings will be used to assist federal agencies in developing strategies to reduce toxic contaminants and will assist the partnership in considering goals and strategies to reduce risk to the Bay's biological resources. The report will provide an analysis of existing and ongoing efforts by EPA, other federal agencies and the Bay jurisdictions to address toxic contaminants.

Habitat Restoration, protection, creation, and enhancement goals

The restoration of critical wildlife habitats is an important component to a healthy Bay ecosystem. Habitats within the Chesapeake Bay watershed— including underwater grasses, streams, wetlands, and forests—have been degraded and in some cases no longer support an abundance of wildlife.

Submerged Aquatic Vegetation

Underwater bay grasses, also known as submerged aquatic vegetation (SAV), can be found in the shallow waters of the Chesapeake Bay and its tidal streams, creeks and rivers, and are a critical part of the Bay ecosystem. They provide wildlife with food and habitat, add oxygen to the water, absorb nutrient pollution, trap sediment and reduce erosion. Improving water clarity is the most important step in bay grass restoration, because bay grasses need sunlight to grow. Because bay grasses are sensitive to pollution but quick to respond to improved water quality, CBP considers their abundance a good indicator of Bay health.

In 2011, CBP's SAV Workgroup requested a review of the partnership's SAV restoration program. In its request, the workgroup acknowledged CBP has fallen far short of its proximate SAV goal of direct restoration of 1,000 acres of SAV, further stating it is unclear whether or not direct restoration has or could advance the overall goal of achieving 185,000 acres of SAV Baywide.

Underwater grasses of the susquehanna Flats.
Photograph from Chesapeake Quarterly. Vol. II, No.4, December 2012.

Specifically, the workgroup requested the Science and Technical Advisory Committee (STAC) conduct a review of the effectiveness of direct SAV restoration efforts, evaluate the value of the direct restoration strategy for accelerating broader SAV recovery, and provide guidance on how CBP might improve restoration efforts. To conduct this review, STAC members and external SAV experts from outside the Chesapeake Bay watershed reviewed a number of published and unpublished scientific studies provided by the SAV workgroup.

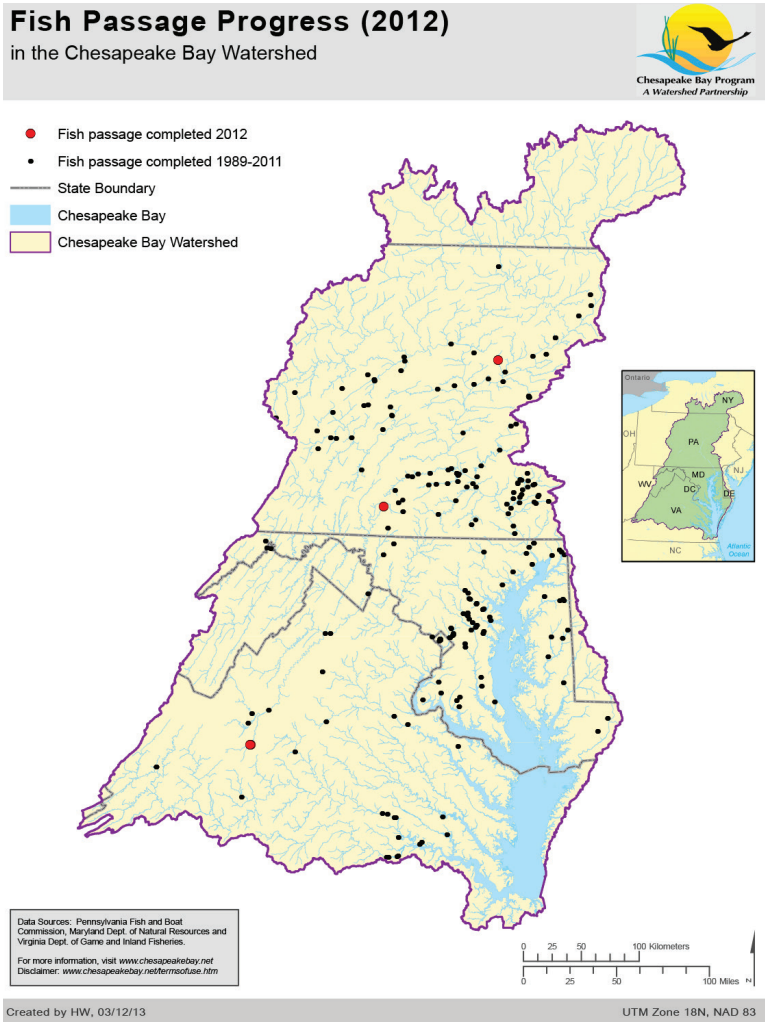
STAC recommended CBP discontinue widespread restoration of SAV until environmental conditions improve, while instead focusing on targeted restoration efforts, both to establish viable beds and to further understand site selection criteria. The committee also suggested development of SAV restoration strategies that are responsive to climate change, incorporate full adaptive management into restoration decision making, and build on successful research into restoration techniques.

As a result, the SAV Workgroup revised the SAV outcome and strategy document, shifting focus from direct planting efforts to research. The SAV Technical Synthesis III research project was recently funded to pull together and analyze the available SAV research to better understand how to achieve successful restoration efforts.

Fish Passage

Fish passage is a key component to the restoration of anadromous fish (shad and river herring) in the Chesapeake Bay watershed. These fish are blocked from much of their historic spawning areas, which included waters more than 200 miles from the Bay. Maryland, Virginia, Pennsylvania and the District of Columbia have set goals to provide fish passage to make much of those historic spawning areas once again accessible to migratory fish. Other species that benefit from the unblocking of streams include eels, native species such as brook trout and other resident species.

Chesapeake 2000 committed to identify the final initiatives necessary to achieve the goal of restoring fish passage for migratory fish to more than 1,357 miles of currently blocked river habitat by 2003 and establish a monitoring program to assess outcomes. It further called for the partnership to develop a new goal for fish passage. The new goal for an additional 1,000 miles was set by the EC in 2005.



As of 2012, more than 2,500 miles of streams have been re-opened through fish passage projects and about 1,500 of those miles have been since 2000. The current goal is to open an additional 1,000 miles during 2011-2025, with restoration success indicated by the presence of blueback herring, alewife, American shad, hickory shad, brook trout or American eel.

Throughout the Northeast, hundreds of dams have been removed over the last two decades, providing additional habitat for recreational and commercial fish species. Given the likelihood of future constraints on availability of funds and staff, it is critical to be more strategic about investments in fish passage restoration projects. One approach to strategic investment is to assess the likely ecological "return on investment" associated with a fish passage project.

Through the CBP's Fish Passage Work Group, federal, state and local partners have been working together to prioritize fish passage projects in the Chesapeake Bay. The Nature Conservancy, in concert with members of the Fish Passage Work Group, developed a geographic information system, known as the Fish Passage Prioritization Tool, to assist the Work Group in strategically identifying key barriers to fish passage.

American Shad

American shad once supported the most valuable finfish fishery in the Chesapeake Bay, however, commercial shad harvest has been banned for decades throughout the Chesapeake Bay and its rivers. Shad form an important link in the Chesapeake Bay food web – they feed on zooplankton and are preyed upon by larger fish, including bluefish, weakfish and striped bass. Shad populations are depleted due to pollution, historic overfishing, and dams that block access to the fish's freshwater spawning grounds.

Photo courtesy of James River Assocoation

Although Chesapeake Bay Program partners are working to remove dams, install fish passageways and stock rivers with hatchery-reared fish, shad populations remain very low due to the variety of factors described above.

Removing or bypassing key barriers will reconnect fragmented aquatic habitats, thereby, enhancing populations of fish including: fish species that migrate between salt and freshwater, coldwater species, and other species of concern. The project focused on collecting and processing spatial data and, using a consensus-based approach, developing a priority ranking for dam removals and fish passage projects.

In the end, a total of 39 metrics from five metric categories – Connectivity Status, Connectivity Improvement, Watershed and Local Condition, Ecological, and Size/System Type – were used in the analysis. These metrics were calculated using the tool and each dam ranked according to its potential benefit if removed or bypassed. The Fish Passage Work Group has begun using this ranking to identify dam removal projects that would produce the greatest ecological gain for target species in the Chesapeake Bay watershed.

Within the context of the Vital Habitat Protection and Restoration goal, the *Chesapeake 2000* agreement recognized the importance of local watershed management planning and natural infrastructure (habitat) protection as being key elements of the Bay ecosystem management strategy. While much remains to be done, states, local governments, community groups and watershed organizations across the watershed have demonstrated how locally driven planning, using modern geographic information system tools, can provide local-scale templates for targeting the implementation of natural infrastructure protection and restoration.

Invasive Species

Invasive species threaten critical wildlife habitat in the Chesapeake Bay watershed. Accordingly, habitat restoration and protection efforts pursued by CBP's Vital Habitats and Sustainable Fisheries Goal Implementation Teams consider the ecological relationships among native and non-native species. This includes both invasive aquatic species, such as blue and flathead catfish, and terrestrial invasive plant species such as phragmites, tree of heaven, bush honeysuckle and garlic mustard. These species have the potential to out compete native populations, increase sedimentation into the watershed, alter shade dynamics over tributaries, and spread propagules to neighboring coastal areas. Impacts of certain native species on habitat restoration are also a concern, such as resident Canada geese diminishing recruitment of wetland plants, and white-tailed deer diminishing native spring wildflowers and native tree recruitment.

Since 2003, the Chesapeake Bay Program has participated in and provided staff support to the Mid-Atlantic Panel on Aquatic Invasive Species, one of six regional panels established under the national Aquatic Nuisance Species Task Force, which is co-chaired by NOAA and USFWS, and authorized by the Non-Indigenous Aquatic Nuisance Prevention

and Control Act of 1990. The Panel works to prevent the introduction and spread of aquatic invasive species through science and management, policy, and education and outreach activities and initiatives across the mid-Atlantic region, including the Chesapeake Bay watershed. The Panel meets bi-annually to discuss current invasive species concerns, provide updates on management efforts, and make decisions on projects to fund through a Small Grants Competition. The Panel has supported numerous successful management programs including the removal of Water Chestnut from the Bird and Sassafras Rivers in Maryland's portion of the Chesapeake Bay.

Wetlands

The *Chesapeake 2000* agreement called for progress toward the wetland commitment to be re-assessed in 2005. That mid-point assessment found jurisdictions were counting wetland enhancement projects toward the restoration commitment, thereby inflating the rate of progress. The Principles' Staff Committee subsequently issued guidance that standard Federal tracking definitions had been adopted by the Management Board, and specified that going forward, those definitions should be used and, furthermore, enhanced acres would be tracked separately from restored acres.

2005-2010 WETLANDS RESTORATION GOAL (SIX YEAR TOTALS BASED ON 2005 EVALUATION)			
Jurisdiction	Progress through 2004	C2K Goal Allocation	C2K Remaining Allocation
Maryland	7,066 acres	15,000 acres	7,934 (1,322 acres/year)
Pennsylvania	1,766 acres	4,000 acres	2,234 (372 acres/year)
Virginia	1,165 acres	6,000 acres	4,835 (806 acres/year)
Totals	**9,997 (1,428 acres/year)**	**25,000 (2,500 acres/year)**	**15,003 (2,500 acres/year)**

The wetland commitment in *Chesapeake 2000* was based on past performance, but continued progress at that rate will not meet the current necessary jurisdiction Phase II WIP targets. To better align this outcome with state focus on agricultural land BMP practices, a new outcome of 85,000 acres is being considered based in the draft *Chesapeake Bay Watershed Agreement* on Phase II WIPs with a primary focus on restoring wetlands on agricultural lands. This outcome currently being considered expands on the EO strategy outcome to restore 30,000 acres of wetlands while retaining the outcome to enhance function on an additional 150,000 acres of wetlands.

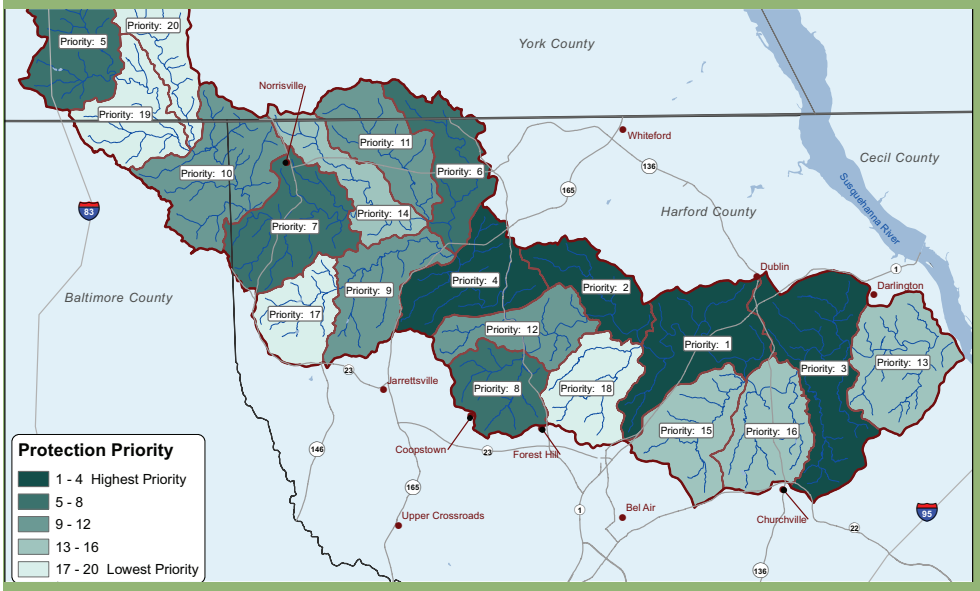
This aerial image of the Blackwater National Wildlife Refuge near Cambridge, Maryland shows stressed wetlands side by side with healthy wetlands.

Since 1938, approximately 8,000 acres of wetlands have been lost in Blackwater.

Photo by Jane Thomas, UMCES

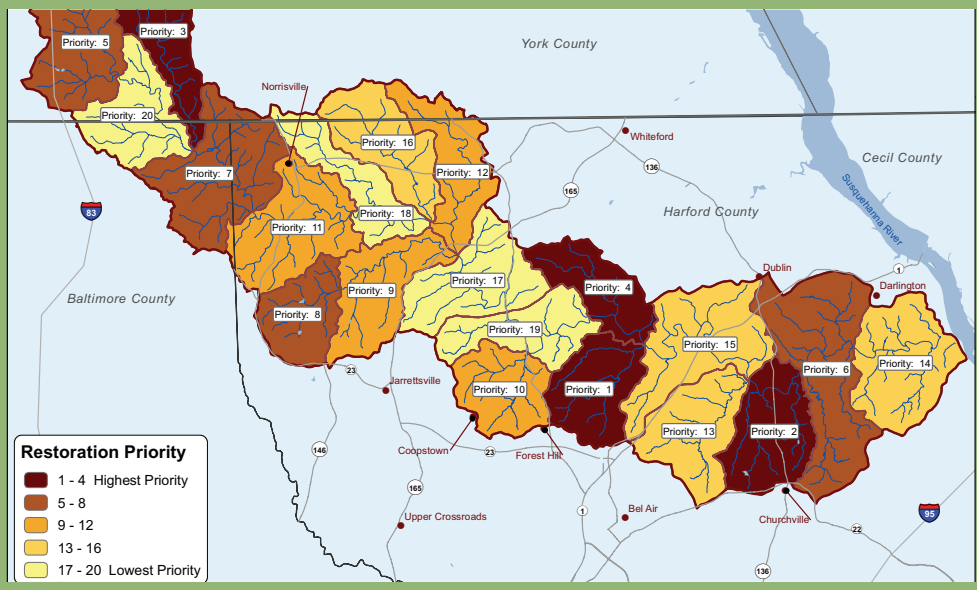
Deer Creek Healthy Watersheds Protection Plan

Deer Creek is a tributary to the Susquehanna in Harford County, Maryland. The county assessed the conditions of the watershed and created a protection prioritization method and a watershed restoration action strategy.



The majority of the watershed is characterized as "good" and "fair" for biological conditions and ranks third in the state for biodiversity. According to state antidegradation designations, there are several Tier II segments located along Deer Creek. A high percentage of the watershed is also listed as ecologically significant for sensitive species. The county considered projected land use changes including future impervious thresholds and used a weighted scale to prioritize both protection and restoration priorities at the subwatershed scale. See Map 1 for priority protection areas. The county is accomplishing preservation goals by increasing easements, expanding the Rural Legacy Area, and designating the watershed as a Priority Preservation Area.

In addition to a protection strategy, the assessment calls for a restoration plan. See Map 2 for priority restoration areas. The restoration strategy includes agricultural BMPs, created wetlands, stream restoration, and riparian and equine conservation plans. It also includes outreach activities such as workshops and site visits with property owners. By combining these two assessments and creating management strategies for both protection and restoration, the county was able to take a holistic look at the health of the watershed and plan for future growth with a balanced strategy.



Forest Buffers

CBP partners achieved their original riparian forest buffer restoration goal of 2,010 miles in 2002, 8 years ahead of schedule. In 2003, they set a new, long-term goal to conserve and restore forests along at least 70 percent of all streams and shoreline in the watershed, with a near-term goal of at least 10,000 miles in the watershed portions of Maryland, Pennsylvania, Virginia and the District of Columbia by 2010. This very ambitious goal was based on the early success – with a high point in 2002, when more than 1,000 miles of riparian forest buffer were put in the ground.

Many partners came together to prioritize riparian forest buffer restoration at that time because of their multiple ecosystem benefits. Effective management strategies included additional funding and outreach, elevated ranking for federal cost-share dollars, and outreach by multiple specialists (fisheries, forests, agriculture, habitat, etc).

In the past several years, the average amount of new forest buffers restored dropped to 245 miles, well below the earlier annual average of 829 miles between 2002-2006. It had become evident the buffers planted in the early years of the goal were not receiving the necessary site preparation and maintenance. Many of them needed to be replanted for successful establishment. Landowners and technical assistants became discouraged with the practice and this was reflected in the lower number of new projects. Subsequently, better strategies to remove competing vegetation, and improve post-planting care were implemented which increased the success rate for plantings by a factor of six, while the tree growth rate doubled.

In support of the Chesapeake Bay EO, and endorsed by the CBP partnership, the U.S. Forest Service coordinated teams with more than 30 federal, state, and nongovernmental organizations to craft the *Chesapeake Forest Restoration Strategy*, published in December 2012. The strategy builds on earlier commitments to restore streamside forested buffers at a rate of 900 miles per year and support community tree canopy expansion goals. In addition, a review of Chesapeake riparian forest buffer restoration goals has been drafted which is the basis for a new Task Force to be formed by USDA and EPA leadership in 2014 to reverse the declining trend in this important practice.

Restoration, protection, enhancement goals for living resources

Success in protecting and restoring the Chesapeake Bay ecosystem will ultimately be measured by the vitality and richness of its living resources and the health and well-being of the people who rely on them.

Crabs

The CBP partnership has made significant advances in Baywide blue crab management, since the Chesapeake Bay blue crab stock was declared a federal disaster in 2008. These advances have resulted in more effective coordination between jurisdictions with fisheries management responsibilities (Maryland, Virginia, and the Potomac River Fisheries Commission), an improved management framework, and overall improvements in the sustainability of the blue crab stock.

The improved management framework is being facilitated by the CBP's Sustainable Fisheries Goal Implementation Team (SFGIT) which serves as a forum for interjurisdictional blue crab management. Through the SFGIT, the jurisdictions have established a management framework based on scientifically derived abundance targets and exploitation fractions (harvest targets and thresholds). The current management framework complements the original *Chesapeake 2000* strategy to "establish harvest targets for the blue crab fishery and begin complementary state fisheries management strategies Baywide."

A short-term interim target of 200 million adult (age 1+) blue crabs Baywide was in effect from 2008-2011. The 2011 benchmark stock assessment of the blue crab population provided updated data and knowledge of the blue crab population. This became the scientific foundation of a new blue crab management scheme in the Bay based on female-specific reference points.

Based on the 2011 stock assessment, the Chesapeake Bay Stock Assessment Committee (CBSAC), a science advisory workgroup under the SFGIT, recommended a new blue crab abundance target of 215 million adult females (age 1+) and an overfished threshold of 70 million adult females. The new targets were implemented Baywide in 2012.

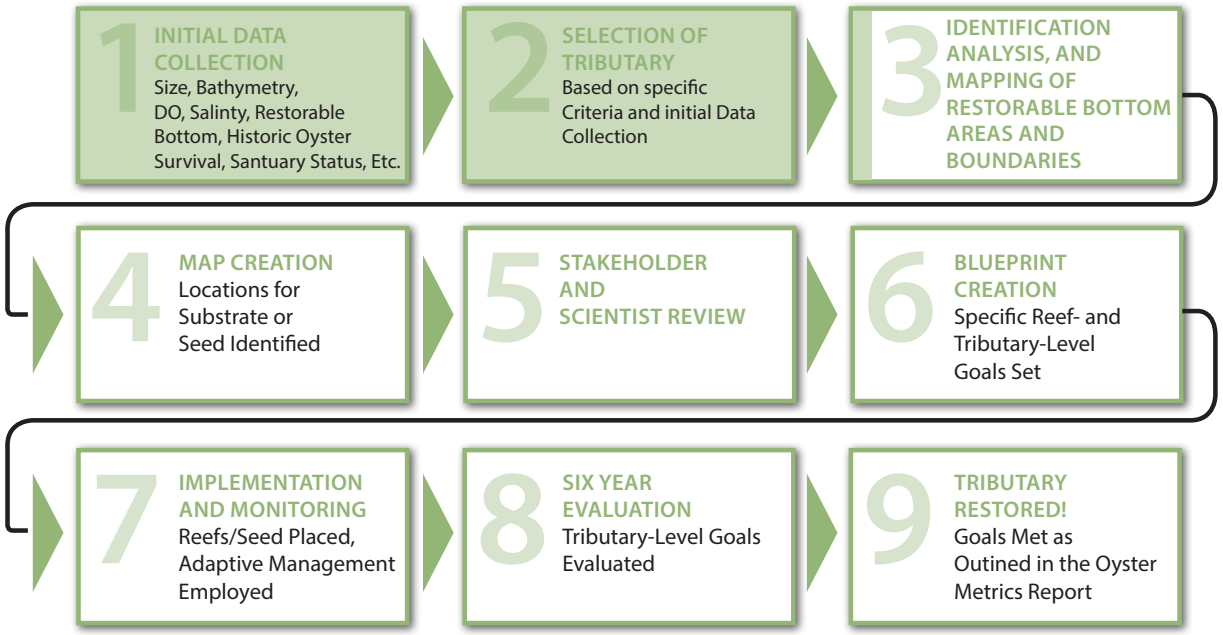
The 2013 CBSAC Blue Crab Advisory Report and Figures states the current population status of blue crabs in the Bay is not overfished and overfishing is not occurring. Following the female-specific targets, CBSAC has recommended new male-specific conservation triggers that were adopted by the SFGIT in 2013.

Baywide adaptive management of blue crabs will continue as CBSAC produces their annual report with management recommendations based on blue crab population data from the annual Winter Dredge Survey in Maryland and Virginia waters. Access to reliable, high-quality data on the blue crab population, scientific analysis and advice and coordinated management by the jurisdictions is essential for successful adaptive management of the blue crab fishery.

Oysters

Since the *Chesapeake 2000* agreement, oyster restoration efforts have shifted to a tributary-based strategy instead of a Baywide oyster abundance approach. This tributary-based strategy is a more targeted approach focused on integrating restored oyster reefs into tributary ecosystems and recovering the ecological benefits healthy oyster reefs provide, including habitat for fish species and water quality benefits.

How Close Are Oysters to Being "Restored"?



The EO Strategy called for this tributary-based approach with a goal of 20 restored tributaries by 2025. The CBP partnership recognized planning tributary restoration needed to be informed by best available science. In order to define the term "restored" in scientific, measurable terms, the Oyster Metrics Workgroup was created under the SFGIT in 2010 to reach a Baywide consensus on the definition of "restored reef" and "restored tributary." The resulting Oyster Restoration Success Metrics are the scientific basis for planning tributary restoration and determining restoration success.

After these metrics were developed, the SFGIT tasked the newly assembled Maryland and Virginia Oyster Interagency Teams to identify priority tributaries for oyster restoration. As of 2013, five tidal tributaries have been identified in Virginia and three identified in Maryland. Restoration work is currently in progress on Harris Creek in Maryland.

After tributaries are selected, CBP partners provide restorable bottom mapping and analysis to determine best restoration site locations within each tidal tributary. This data allows for the most effective use of restoration resources and ensures the best chance of oyster survival and growth from restoration efforts. This data is compiled into a 'Tributary Blueprint' describing which areas will be targeted for restoration work, the seed and reef-building materials required to restore the tributary, monitoring plans, and associated costs.

After considering progress on tributary-based oyster restoration to date and required financial and physical resources, the SFGIT has recommended an amended target of 10 restored tributaries by 2025. This new target is based on actual costs and implementation realized after implementation began.

Ecosystem-based fisheries management

Ecosystem-based fisheries management continues to be an important component of CBP living resource initiatives. While not fully achieved, CBP, through collaboration with the Goal Implementation Teams (primarily the Sustainable Fisheries, Habitat, and Healthy Watersheds GITs), is making progress toward incorporation of "ecological, social, and economic considerations, multi-species fisheries management and ecosystem approaches" in living resource management as stated in *Chesapeake 2000*.

This evolution in approach is needed because traditional management has not been effective in addressing the multiple factors influencing fish stocks. EBFM takes into account environmental stressors, like degraded water quality, fish diseases, species interactions, habitat loss and other environmental factors that have damaged the Bay's major commercial and recreational fisheries.

Anglers aboard the charter boat "My Desire" show off their haul of striped bass. Also known as "rockfish" or "stripers" around the Chesapeake Bay, striped bass is the Maryland state fish and one of the most popular commercial and recreational catches.

To clarify how ecosystem approaches for fisheries will work in the Chesapeake Bay, scientists at the NOAA Chesapeake Bay Office participated on the Chesapeake Fisheries Ecosystem Plan Technical Advisory Panel, which included fisheries scientists from institutions around the Bay as well as federal and state agencies. The Panel developed *Fisheries Ecosystem Planning for Chesapeake Bay.*

Fisheries Ecosystem Planning for Chesapeake Bay describes the structure and function of the Chesapeake Bay ecosystem, including key habitats and species interactions. Further, it serves as a guide to ecosystem approaches to individual fishery management plans, and includes recommendations for implementing these plans. It also recommends specific research that will help scientists in the future use their knowledge to support the entire ecosystem.

At the ground level, multiple GITs and other partners have begun discussions on the connection between the aquatic habitat of key fish and shellfish species to land use decisions. Further collaboration on land use and linking fisheries, habitat and water quality is set to continue through the development and implementation of the currently proposed *Chesapeake Bay Watershed Agreement*.

In addition to linking living resources to habitat and environmental factors, ecosystem-based management also considers the ecological relationships among species. The CBP partnership and the SFGIT have begun exploring these relationships between invasive blue and flathead catfish and native Chesapeake Bay fish and shellfish species.

In January 2012, the SFGIT Executive Committee signed the Invasive Catfish Policy Adoption Statement as a call to action to examine mitigating the spread and impacts of invasive blue and flathead catfish, especially on native fish species. Efforts are currently aimed at improving scientific understanding of catfish biology, population dynamics, and impacts on the native fish community in order to develop mitigation strategies.

Stewardship

America has a long history of stewardship. Unfortunately, increased pressures and competing interests have resulted in a degraded Chesapeake Bay. The citizens of this region have yet to find the elusive balance between conservation and growth development—and the need for increased stewardship of the Chesapeake Bay watershed is great.

Education

Like any other successful long-term strategy, natural resource management must be built on the collective wisdom of citizens, gained through targeted education. The National Science Foundation's Advisory Committee for Environmental Research and Education stated in a 2003 report "in the coming decades, the public will more frequently be called upon to understand complex environmental issues, assess risk, evaluate proposed environmental plans and understand how individual decisions affect land air and water at local and global scales. Creating a scientifically informed citizenry requires a concerted, systematic approach to environmental education."

CBP has formally supported environmental literacy since 1998 (Education Directive 98-1), with coordination for these efforts occurring through the Education Workgroup, currently under the Fostering Chesapeake Stewardship Goal Implementation Team.

In 2000, the Meaningful Watershed Educational Experience or MWEE (a pedagogical student experience that includes classroom preparation, outdoor learning, and reflection on the outdoor learning experience as part of a comprehensive unit of study) was identified as a keystone commitment of the *Chesapeake 2000* agreement and was signed onto by Maryland, Pennsylvania, and Virginia and the District of Columbia. By adopting MWEE, states agreed to provide one experience per student prior to their high school graduation. Several states have since expanded that goal to providing three MWEEs (elementary, middle, and high school) as suggested in the Stewardship and Meaningful Watershed Educational Experience Policy Memorandum (2001).

MWEE program in Albemarle County and Charlottesville, Virginia. Photo courtesy of Thomas Jefferson Soil & Water Conservation District.

As a result of the EC's Chesapeake Watershed Education Agreement: Fostering Chesapeake Stewardship (2005), the Education Workgroup developed K-12 grade education tracking mechanisms to articulate progress toward *Chesapeake 2000* MWEE commitment. Through 2009, approximately 81 percent of elementary, 81 percent of middle, and 80 percent of high school students were reported as receiving MWEEs. Revised metrics are currently being developed by the Education Workgroup in recognition of the non-uniform methods and rigor being used by states.

To evaluate effectiveness of the MWEE model, the NOAA Bay Watershed Education and Training (B-WET) Program, with support from Chesapeake Bay Trust and the Keith Campbell Foundation for the Environment, completed an intensive multi-year evaluation in 2007 that showed students are more knowledgeable about the watershed and more likely to take action to protect the Bay after participating in B-WET supported programs. The study also showed B-WET trained teachers are more confident about and more likely to use field experiences to teach about the watershed.

In 2010, the EO strategy directed NOAA to pursue engagement from additional federal and state partners to initiate a robust environmental literacy initiative that expands upon the meaningful watershed educational experience objective.

Accordingly, in 2012 NOAA and the CBP's Education Workgroup developed the Mid-Atlantic Elementary and Secondary Environmental Literacy Strategy. This strategy draws on the full strength of the federal government to support state efforts to transform their schools to provide the next generation of citizen stewards the knowledge and skills they need to make informed environmental decisions and calls on partners to advance shared priorities in four key areas – students, educators, schools, and the environmental education community.

In addition, many states in the region have had a focus on environmental education for many years. However, over the past several years there has been an effort to renew and strengthen these programs. Successful management strategies will take into consideration these existing state and federal efforts and work to advance and scale up model programs. Recent state actions towards developing student environmental literacy plans are outlined below:

- The *D.C. Healthy Schools Act of 2010* required District Department of the Environment to draft an environmental literacy plan as part of a broad effort to "substantially improve the health, wellness, and nutrition of the public and charter school students in the District of Columbia." Mayor Vincent Gray submitted the plan to the Council in July 2012.
- Delaware passed a resolution in 2011 supporting the No Child left Inside/Children in Nature Initiative. A taskforce with representatives from the Delaware Department of Natural Resources and Environmental Control, Department of Education, and other public and nongovernmental organizations formed a taskforce "to develop a statewide plan to increase opportunities for children to engage in nature, both in school, at home, and on public lands."
- In 2011, Maryland passed the nation's first environmental literacy graduation requirement mandating schools to implement a multidisciplinary environmental education program, with a specific focus on the state's natural resources.
- Pennsylvania has long had rigorous, stand-alone environment and ecology standards, which include content about the Chesapeake, watersheds, and the environment. This content is included in standardized tests in the state. The Pennsylvania Advisory Council on Environmental Education completed a draft environmental literacy plan in July 2012.
- The Virginia Science Standards of Learning adopted in 2003 and revised in 2010 integrate environmental literacy concepts throughout K-12 education. The Virginia Resource-Use Education Council, an interagency team of state and federal partners along with NGOs and universities, works to implement the standards through Virginia Naturally, the Commonwealth's environmental education program.
- West Virginia recently established a green school certification program and is in the early stages of development for an environmental literacy plan. The state has also been taking part in the Department of Education's Green Ribbon Schools awards recognition program since its inception in 2012.
- In addition to the state plans, the state affiliates of the North American Association for Environmental Education have completed a plan that outlines how they will support the Mid-Atlantic Elementary and Secondary Environmental Literacy Strategy.

Public access

Open, green spaces and waterways with ample public access bolster public health and quality of life. People rely on these special places to exercise, relax, and recharge their spirits. Outdoor time strengthens family bonds and nurtures fit, creative children. At the same time, it builds personal connections with the very places that have shaped life in the region for centuries – especially its streams, rivers, and bays. This has a distinct economic value too, as tourism, much of it associated with the area's waters, is a potent force in the region.

The sense of place that evolves from outdoor experiences along Chesapeake waters often leads to a feeling of shared responsibility for the resources. People who enjoy the outdoors are more likely to become active citizen stewards, engaged in the many conservation and stewardship efforts taking place throughout the region. Despite this, physical access to the Bay and its tributaries is limited.

Increasing public access opportunities has been a formally recognized priority of the CBP partnership since the 1987 Chesapeake Bay Agreement established a goal, and associated objective and commitments, to "promote increased opportunities for public appreciation and enjoyment of the Bay and its tributaries."

Signatories of the *Chesapeake 2000* agreement identified several commitments associated with expanding the network of bay-related access opportunities available to the public:

- Bay Gateways Designated: By 2003, develop partnerships with at least 30 sites to enhance place-based interpretation of Bay-related resources and themes and stimulate volunteer involvement in resource restoration and conservation. *(Status: This goal was accomplished and surpassed in 2001. 173 Gateways sites had been added to the Network by 2010.)*
- Water Trails in the Bay Watershed: By 2005, increase the number of designated water trails in the Chesapeake Bay region by 500 miles. *(Status: This goal was accomplished and surpassed in 2002. A total of 2,184 miles of water trails had been designated by 2010.)*
- Public Access Sites in the Bay Basin: By 2010, expand by 30 percent the system of public access points to the Bay, its tributaries and related resource sites in an environmentally sensitive manner by working with state and federal agencies, local governments and stakeholder organizations. *(Status: by 2010, 95% of this goal had been accomplished. From 2000 to 2010, a total of 148 public access sites are known to have been opened to the public.)*

Several actions by Congress have helped spur development of public access since 1998 and engaged the National Park Service as a principal partner in the effort. These include passage of the Chesapeake Bay Initiative Act (1998), establishment of the Captain John Smith Chesapeake National Historic Trail (2006) and establishment of the Star-Spangled Banner National Historic Trail (2008). These three partnership entities span thousands of miles of the Chesapeake Bay and its tributaries and are helping advance water trail development in the region and the addition of new public access sites.

The EO strategy established a watershed-wide goal to "increase public access to the Bay and its tributaries by adding 300 new public access sites by 2025" and called for the National Park Service, in conjunction with the states, the U.S. Fish and Wildlife Service, and other federal agencies to develop a plan to expand public access.

The resulting *Chesapeake Bay Watershed Public Access Plan* , finalized in June 2013, was developed by a team of staff involved in public access planning and implementation at each of the Chesapeake watershed states, the District of Columbia, and the National Park Service. The plan was designed to assess the demand for public access; describe (inventory) the existing public access facilities; assess barriers to public access; determine gaps in the public access system; identify opportunities for new access sites; and help direct federal, state, and local funding toward public access opportunities.

As a result of the in-depth inventory conducted for the plan and the switch to watershed-wide tracking, a revised 2010 baseline of 1,138 public access sites was established. At the end of 2012, a cumulative total of 1,171 public access sites were identified as having been opened to the public.

Though existing access opportunities are not insignificant, the number of access sites is very low in comparison to the amount of shoreline in the Chesapeake watershed. There are just 770 existing access sites along the shorelines of the Bay and tidal portions of its tributaries, a combined length of 11,684 miles – equivalent to the distance along the United States' west coast from Mexico to Canada. Sites average about 15 miles apart, creating significant stretches of shoreline with no access. Long, inaccessible stretches make it difficult to plan trips along water trails and reduce the benefits of ecotourism. A lack of public access also leads to trespassing, as users have no other option for getting on or off the water.

In support of resolving these issues, 320 potential new public access sites were identified during the development of the *Chesapeake Bay Watershed Public Access Plan.* Additionally, the plan sets out a series of actions for moving access development forward. Implementing these actions and responding to the specific opportunities for adding access sites will expand the number of places for people to get to the water by more than 20 percent by 2025.

Land Use

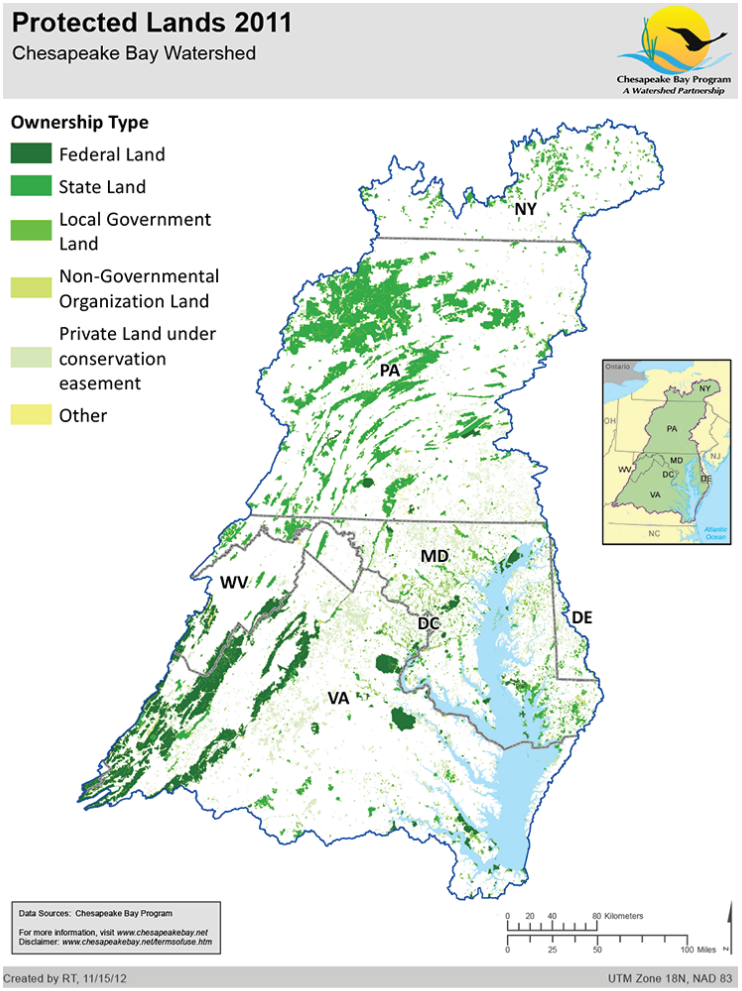
Partners in the Bay watershed benefit from a shared understanding of what landscapes citizens value most and how agencies charged to protect and manage them can do so most effectively. *Chesapeake 2000* put forward a two-pronged strategy for sound land use that included both identifying and permanently preserving from development the most valued lands and slowing the rate and impact of harmful sprawl development. With population continuing to grow, along with its associated impervious surfaces such as roofs, driveways and roads, the strategy to preserve lands was more successful than the strategy to slow the rate of harmful sprawl.

Development, Redevelopment and Revitalization

The *Chesapeake 2000* agreement called on partners, by 2012, to reduce the rate of harmful sprawl development in the Chesapeake Bay watershed by 30 percent measured as an average over five years from the baseline of 1992-1997, with measures and progress reported regularly to the EC.

Changes to the monitoring tool intended to be used to measure this commitment made it impossible to measure whether all jurisdictions met this goal. However, while impervious surface extent continues to rise in many areas of the watershed due to growth in population, some progress at slowing down the rate of sprawl has been achieved in individual jurisdictions, including Maryland's Sustainable Growth & Agricultural Preservation Act and through Virginia's Chesapeake Bay Preservation Act. Recently better tools have become available to measure the extent and impact of growth and development, but metrics to measure its impact have not yet been developed. In the draft Agreement, outcomes have been added to develop such a measure.

In addition, efforts such as low impact development and the use of green infrastructure to allow for infiltration of stormwater runoff into the ground have gained traction in all of the watershed jurisdictions. Examples of successful implementation of green infrastructure can found in Bladensburg and elsewhere in Prince Georges County, Maryland. Creative efforts to slow and infiltrate runoff while revitalizing the city can be found in Lancaster, Pennsylvania.



Land preservation – goal met

Population in the Chesapeake Bay watershed continues to grow and is expected to reach nearly 20 million people by 2030. Development and land conversion anticipated to support this growth ranks among the top stressors to the Bay's ecosystem and a major threat to its restoration and protection. One strategy to combat loss of high value lands is to permanently protect them from development.

States, local governments, federal agencies and NGOs have identified millions of acres of lands with important conservation values – lands key to working farms and forests, to maintaining water quality, to sustaining fish and wildlife, to preserving our history, and to providing for outdoor recreation. These lands are what form the ecological and cultural heritage of the Chesapeake watershed.

For decades, CBP partners have pursued land conservation efforts through permanently protecting important conservation lands by buying key properties, accepting donations, arranging for easements and purchasing development rights. Accordingly, land conservation goals have been included in CBP agreements for many years.

The *Chesapeake 2000* agreement contained several commitments for land conservation. Specifically, the agreement called for partners to, "strengthen programs for land acquisition and preservation within each state that are supported by funding and target the most valued lands for protection. Permanently preserve from development 20 percent of the land area in the watershed by 2010." This goal was achieved and surpassed in 2007.

The Directive 06-1: Protecting the Forests of the Chesapeake Bay Watershed and its 2007 response expanded on *Chesapeake 2000*, setting a goal to "permanently protect an additional 695,000 acres of forest from conversion, targeting forests in areas of highest water quality value" by 2020.

The EO strategy carried over the forest protection goal when it established a watershed-wide land conservation outcome to "protect an additional two million acres of lands throughout the watershed currently identified as high conservation priorities at the federal, state or local level by 2025."

Meeting annually since 2009, the "Chesapeake Large Landscape Conservation Partners" includes more than sixty representatives of local land trusts, conservation organizations, state and federal agencies, and regional landscape conservation initiatives within the watershed. These partners have developed specific land conservation and public access recommendations, advised on land conservation and public access goals and outcomes, established action teams for implementing initiatives, and set out next steps for enhancing collaboration. This group functions to support strategic collaboration on a large landscape scale, recognizing it can provide avenues to fulfill goals in ways individual organizations' efforts might not.

One specific initiative intended to facilitate strategic land conservation and collaboration is development of LandScope Chesapeake. In late 2010, Chesapeake watershed land conservation partners began collaborating on development of a watershed-wide land conservation priority system. The intent was to create a means for fostering further joint conservation efforts, supporting strategic conservation and tracking progress.

LandScope Chesapeake launched in 2012 through a broad partnership among NatureServe, watershed states, the National Park Service, USGS and many others. This effort has improved information on the status of land protection and sharing of conservation priorities. This includes priorities associated with conservation of wildlife habitat, scenic resources, cultural and historic resources, sensitive species, working lands, and ecological value (including value for supporting water quality). LandScope partners are continuously working to expand and update this data.

USGS undertook a data collection effort between December of 2011 and July 2012 to complete an updated watershed-wide protected lands GIS layer. Cumulatively, the resulting GIS data indicates 8,013,132 acres of land have been permanently protected in the Chesapeake Bay watershed through 2011. These results form a new "working baseline" of geospatial protected lands data from which to measure future watershed-wide land conservation progress.

State agencies are the largest entity contributing to land protection; they own approximately 49 percent of the protected acres in the Chesapeake Bay watershed. Watershed-wide, the federal government owns approximately 28 percent of the protected acres. Private organizations, NGOs, local governments, and other entities have also been very active in land conservation, and will remain critical partners in protection efforts that will be counted towards the two million acre goal.

Chesapeake Action Plan

In July 2008, EPA released a Report to Congress titled "Strengthening the Management, Coordination, and Accountability of the Chesapeake Bay Program" [CBP/TRS-292-08]. This document constituted the CBP's response to Congress for a report on the implementation of actions recommended by the 2005 GAO report titled "Chesapeake Bay Program: Improved Strategies Are Needed to Better Assess, Report, and Manage Restoration Progress" [GAO-06-96]. The report also describes the program's development and refinement of an action plan for the Chesapeake Bay.

The document included:

- A strategic framework unifying the program's planning documents
- An activity integration plan identifying activities of CBP partners and the funding committed to those activities
- A series of "dashboards" to track and measure progress on the partners' actions
- An adaptive management process specifying how program partners would track and improve progress in restoring the Chesapeake Bay

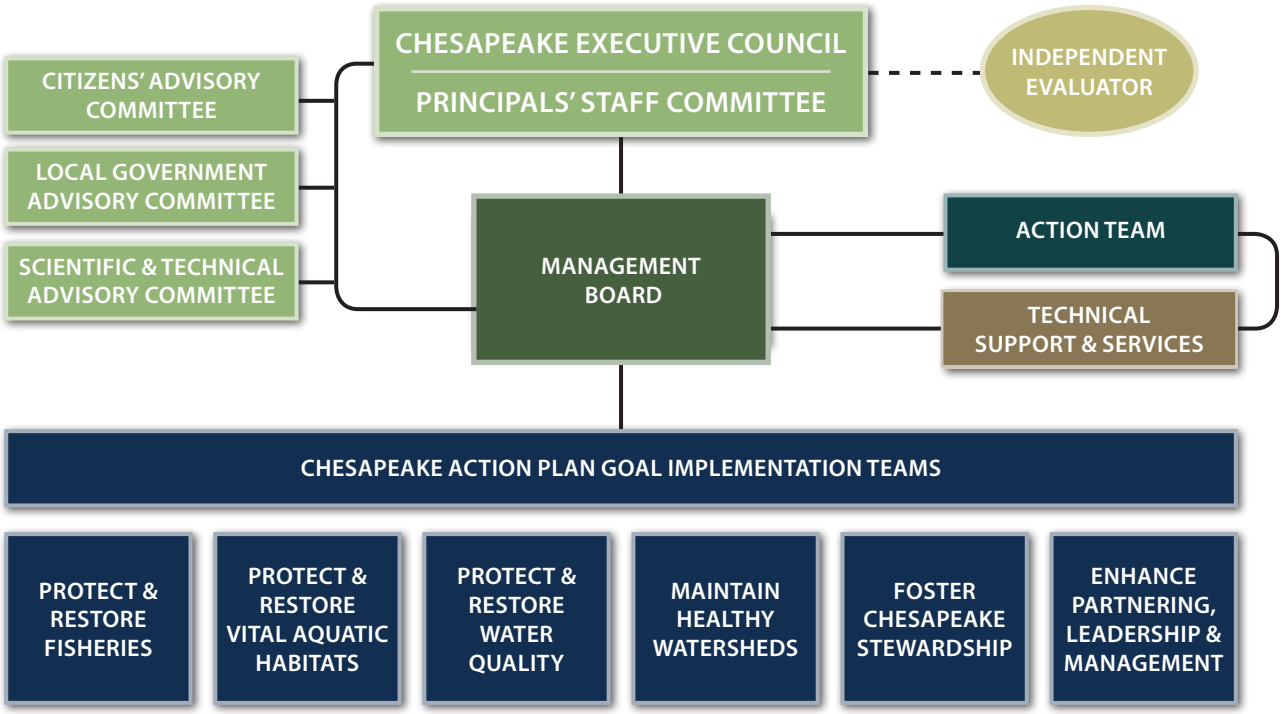
This Report to Congress builds on the 2008 report by providing additional, up-to-date information on restoration progress and the effectiveness of CBP management strategies through the implementation of *Chesapeake 2000* through 2010 and the EO Strategy and TMDL during the transition years leading to a new Bay Agreement.

Chesapeake Bay Program Partnership Reorganization

Beginning in August 2006, the partnership began a process to reorganize in response to the need to make the CBP organization more able to accelerate implementation of restoration efforts and to face future and emerging challenges of the restoration effort. Two major reviews of the CBP structure were undertaken to reach the current organizational construct. First, a series of more than fifty stakeholder interviews and approximately sixty surveys were completed from August through October 2006 to prepare for initial planning. Key stakeholders interviewed and surveyed included state agencies, academics, non-profits, federal partners, subcommittee and advisory committees, contractors, and others.

A parallel effort was led by the Keith Campbell Foundation. The Foundation convened a series of meetings from September 2006 to January 2007. The meeting participants shared a wealth of Bay-related experience and knowledge in policy, science, communications, advocacy, philanthropy, and all levels of government. The result was a report outlining operating principles and offering concepts for a framework aimed at accelerating implementation of Bay restoration.

At the Principals' Staff Committee (PSC) meeting in May 2007, the Chair, Secretary Griffin, directed formation of an ad hoc Reorganization Workgroup to develop new organizational options for CBP. A group comprised of federal and state partners, advisory committee chairs, and other stakeholders, reviewed the previous efforts and discussed reorganization options and procedures.



CBP Organization Chart Approved by the PSC on September 22, 2008

The Reorganization Workgroup put forth a proposed structure to the PSC in June 2008. The PSC asked the workgroup to provide more detail on how the new structure would operate and to delineate roles and membership of each individual structure. The workgroup created a document describing functions, roles, and membership of each box in the organization and shared it with Subcommittee Chairs in August and early September 2008. The reorganization structure was refined based on feedback from the groups. The CBP organization chart and an outline of roles, functions and membership were presented to the PSC at their September 2008 meeting, and the committee approved the basic structure of the reorganization, shown in the CBP Organization Chart.

Following approval of the organization structure, a Transition Team was commissioned to more fully describe the governance and implementation of the new organization.

Executive Order 13508

On May 12, 2009 President Obama issued Executive Order 13508 *Chesapeake Bay Protection and Restoration*. It is the first-ever presidential directive on the Chesapeake Bay and was the first Executive Order of the Obama administration related to the environment. In the EO, President Obama declared the Chesapeake Bay a "national treasure" and ushered in a new era of federal leadership, action and accountability.

The purpose of the EO is "to protect and restore the health, heritage, natural resources, and social and economic value of the nation's largest estuarine ecosystem and the natural sustainability of its watershed." The EO recognized the efforts of the past 25 years were not making sufficient progress in restoring the Chesapeake Bay and its watershed, and success will require responsible government agencies to make dramatic policy changes and initiate bold new actions.

To bring the full weight of the federal government to address the Chesapeake's challenges, the EO established the Federal Leadership Committee for the Chesapeake Bay (FLC), which is chaired by the EPA Administrator and includes senior representatives from the departments of Agriculture, Commerce, Defense, Homeland Security, Interior and Transportation.

The federal agencies were charged with developing recommendations to address seven key challenges: water quality, targeting of resources, stormwater management on federal land, climate change, land conservation and public access, scientific tools and monitoring, and protection of habitat, fish and wildlife. Seven draft reports containing the initial recommendations were completed in September 2009 and refined in updates published in November 2009.

The initiatives in the seven draft reports now form the core of the final EO *Strategy for Protecting and Restoring the Chesapeake Bay Watershed*. The strategy also identifies goals for environmental improvement, outlines federal coordination with state activities, creates a process for reporting on progress and explains how efforts will be adapted based on science and resources.

A Collective Effort: EO Strategy for Protecting and Restoring the Bay

The EO acknowledges although the federal government should assume a strong leadership role in the restoration of the Bay, success depends on a collaborative effort involving state and local governments, businesses, non-government organizations and the region's residents. Pursuant to the EO, representatives of the FLC agencies have consulted with the six Bay watershed states (Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia), the District of Columbia, and the Chesapeake Bay Commission. The federal government has also reached out to key stakeholders in the private sector, held public meetings and created a web site to promote government transparency and public engagement. Citizens provided comments on the draft strategy and on proposed environmental measures and goals. A summary of public comments and the final strategy is available online. The final *Strategy for Protecting and Restoring the Chesapeake Bay Watershed* was forged through this collaborative process and published by May 12, 2010 as required by the EO.

Structure of the EO Strategy

The EO directed federal agencies to "define environmental goals for the Chesapeake Bay and describe milestones for making progress toward attainment of these goals." For the strategy, federal agencies identified the four most essential goals for a healthy ecosystem and developed 12 key environmental outcomes that reflect progress toward these goals:

- **Goal: Restore Clean Water**
  Outcomes: restoration of Bay water quality, stream restoration, agriculture conservation
- **Goal: Recover Habitat**
  Outcomes: wetlands restoration, expanded forest buffers, improved fish passage
- **Goal: Sustain Fish and Wildlife**
  Outcomes: sustainable populations of oysters, blue crab, brook trout, black ducks
- **Goal: Conserve Land and Increase Public Access**
  Outcomes: expanded land conservation and public access to the Bay and its tributaries

These four goals and associated actions are presented in the strategy. Each chapter describes the overall goal, such as restoring water quality, and explains why it is vital to the Chesapeake Bay ecosystem. The specific measures of progress supporting the goal are also presented, including numerical targets for future progress compared to current conditions. The heart of the strategy is a description of the actions that will be taken to accomplish the goals.

The strategy also includes four supporting strategies, which contain actions that provide invaluable cross-cutting support to achieving overall goals or are critical complementary efforts in the restoration and protection of the Chesapeake Bay and watershed. The supporting strategies are:

- **Expand Citizen Stewardship**
- **Develop Environmental Markets**
- **Respond to Climate Change**
- **Strengthen Science**

The strategy also focuses on implementation and accountability. It outlines the role and responsibilities of the FLC in implementing the strategy, as well as the federal government's commitment to meet milestones every two years. Also outlined are a series of accountability tools and processes to promote transparency in the planning, tracking, reporting, evaluating and adapting of restoration activities. These tools include:

- **Federal Two-Year Milestones**
- **Annual Action Plan**
- **Annual Progress Report**
- **Independent Evaluation**
- **Adaptive Management**

Federal Agency EO Strategy Progress

The Executive Order signed by President Obama in May 2009 reinvigorated federal agencies' efforts to collaborate on protection and restoration of the Chesapeake Bay. To track progress, the FLC, on behalf of the federal agencies, is required to release annual action plans and progress reports.

The following information highlights some of the key accomplishments in implementing the EO Strategy for each of the four Executive Order Goals (Restore Clean Water; Recover Habitat; Sustain Fish and Wildlife; and Expand Citizen Stewardship) and component Outcomes. Updates are also included for the supporting strategies: Expand Citizen Stewardship; Develop Environmental Markets; Respond to Climate Change, and Strengthen Science. Appendix B is a table of detailed progress. These highlights identify the specific role of the EO and the FLC in improving the effectiveness of management strategies discussed earlier in this chapter.

Progress highlights toward EO Goals

Restore Clean Water

All seven Bay jurisdictions submitted Phase II WIPs and two-year milestones. The final Phase II WIPs committed to additional strategies to restore local waters and the Chesapeake Bay and represent the strongest blueprints to guide real implementation in the Chesapeake Bay Watershed to date. The milestones, also submitted by several federal agencies, commit to specific actions to improve water quality over 2012 and 2013.

In direct support to the jurisdictions' implementation of their WIPs, EPA provided $20.3 million in grants to the states for implementation and regulatory and accountability actions in the watershed. The agency leveraged grant programs, providing $10 million to the National Fish and Wildlife Foundation's (NFWF) Chesapeake Bay Stewardship Fund, including $4 million for local governments and $1 million for the Anacostia. EPA further provided Clean Water Act (CWA) grants to Bay jurisdictions totaling an estimated $8.2 million in CWA Section 319 Nonpoint Source Program grants; an estimated $4.2 million in CWA Section 106 Water Pollution Control Program grants; and an estimated $160 million in EPA Clean Water State Revolving Fund loans.

EPA also completed a comprehensive work plan for offset and trading programs in support of the Chesapeake Bay TMDL. The work plan calls for development of approximately one dozen technical memoranda in 2013-2014 in coordination with the states, Chesapeake Bay Program Trading and Offsets workgroup, and others.

NRCS and EPA have partnered on the new National Water Quality Initiative (NQWI) to help producers in priority watersheds improve water quality and aquatic habitat in impaired streams. NRCS provided technical and financial assistance through EQIP to qualified landowners in Chesapeake Bay states for the implementation of conservation and management practices through a systems approach to control and trap nutrient and manure runoff.

Recover Habitat

USDA and the Department of Interior (DOI) announced the Working Lands for Wildlife Initiative. This partnership between NRCS and FWS uses technical expertise combined with financial assistance from NRCS programs, such as the WHIP and the Wetlands Reserve Program (WRP) to combat the decline of seven species whose decline can be reversed and will benefit other species with habitat needs.

The Conservation Fund and Audubon Maryland-District of Columbia are protecting the long-term persistence of extensive tidal marsh habitat in and around Blackwater National Wildlife Refuge and Maryland Department of Natural Resources' (DNR) Fishing Bay Wildlife Management Area, due to a partnership between FWS, Maryland DNR and other key partners and with grant support from the Town Creek Foundation. With funds awarded by the Wildlife Conservation Society's Climate Adaptation Fund, demonstration projects were initiated to test techniques enabling salt marshes to adapt successfully to sea level rise. This project serves as a model for long-term preservation of coastal habitats.

Restoration Spotlight: Harris Creek

Beginning in 2013, Maryland, NOAA, USACE and partners began unprecedented large scale restoration in Harris Creek. Harris Creek was chosen based on consideration of salinity levels, available restorable bottom, protection from harvest, historical spat set, and other factors. An Oyster Restoration Tributary Plan was drafted documenting clear restoration targets.

To date, new oyster reef construction and planting of baby oysters in Harris Creek is more than 50 percent of the way toward achieving 377 acres of restored oyster reef target.

Cluster from oyster sanctuary. Photo courtesy NOAA.

A stream restoration workgroup under the CBP Habitat Goal Team, co-chaired by FWS and Maryland DNR, worked to facilitate information transfer on effective stream restoration techniques among the states and to promote tools that assist practitioners in designing projects that will be successful in meeting intended project objectives.

FWS, NOAA, and state and NGO partners in the Fish Passage Workgroup opened 205.5 miles of fish passage to benefit migratory and resident fish species. Calculated using the new Fish Passage Tool, this mileage includes the functional network of habitat re-opened to the fish and will be modified based on additional information provided by Pennsylvania.

Sustain Fish and Wildlife

USACE, NOAA, and Maryland partners worked together to streamline issuance of new aquaculture permits in Maryland by revising the Corps' General Permit for Shellfish Aquaculture. As a result, there are now more than 3,600 acres in more than 310 shellfish aquaculture bottom leases in Maryland, which will provide ecosystem services, jobs, and a safe sustainable source of domestic seafood. NOAA also developed a mass-balanced Oyster Reef Ecosystem Model (OREM), used to develop simulations for exploring oyster ecosystem services.

The Sustainable Fisheries GIT completed and adopted an invasive catfish policy, to address potential risks posed to native species by blue and flathead catfish, and to identify actions to reduce their populations and mitigate adverse ecological effects. The final policy is available online.

The FWS Partners for Fish and Wildlife and Fisheries Programs in West Virginia made progress on brook trout restoration projects with Trout Unlimited and other partners in the South River, Virginia and Seneca Creek, Kitchen Creek, South Fork Potts Creek, Whitethorn Creek, Blackthorn Creek, Harlan Run, South Fork of the Potomac River, and Knapps Creek in West Virginia.

Conserve Land and Increase Public Access

The National Park Service (NPS) and USGS collaborated with NatureServe to develop and release LandScope Chesapeake, a decision tool to help identify priority areas for land conservation. The tool reflects land conservation priorities of states and federal agencies and will be used to help identify areas were conservation would provide benefit for multiple partners.

The Department of Defense working through the Readiness and Environmental Protection Initiative (REPI), completed projects to conserve/protect 1,360 acres adjacent to two installations in the Bay watershed.

NPS developed the Chesapeake Bay Watershed Public Access Plan to inform and guide expansion of Chesapeake watershed public access. The plan was prepared in collaboration with a "Public Access Planning Action Team" composed of staff involved in public access planning and implementation at each of the Chesapeake watershed states, the District of Columbia, and NPS.

Four connecting trails were designated by NPS as components of the Captain John Smith Chesapeake National Historic Trail, adding the Susquehanna River from Conowingo Dam to Cooperstown, New York, the Chester River, the Upper Nanticoke River, and the Upper James River from Richmond to Iron Gate, Virginia – a total of nearly 900 miles. NPS also funded thirteen public access projects in the watershed and worked with partners to develop four others for a total of 17 projects totaling more than $870,000.

Progress highlights toward EO Supporting Strategies

Climate Change

NOAA and USGS collaborated to update 2011 land cover information for the coastal plain region of the watershed. These updates provide comprehensive coverage of land cover change from the 1980s through 2010. This information along with information on climate change will be used to support efforts to assess potential effects on water quality and other CBP goals.

The Vulnerability Support System (VASS) research study conducted under NOAA support reached a successful conclusion and has a new openly accessible web page. The page enables users to validate personal experiences and lessons learned by searching and analyzing several decades-long county records of severe storms, for selected counties.

Citizen Stewardship

Led by NOAA, the partnership released the federal Mid Atlantic Elementary and Secondary Environmental Literacy Strategy to coordinate and guide the federal engagement in state environmental literacy planning and implementation.

NPS developed the Chesapeake Youth Corps intern program and awarded funds to four youth corps organizations for summer youth crews to develop public access and other projects along the Captain John Smith Chesapeake Trail and Star-Spangled Banner National Historic Trail and Byway.

The War of 1812 Virtual Resource Center was also launched by NPS. The Resource Center is an easy to use, on-line tool that provides teachers, students and families one place to go to find lesson plans, video clips, primary source documents and trip planning ideas. The project was completed in partnership with Fort McHenry National Monument and Historic Shrine and Maryland Public Television.

Environmental Markets

The interdepartmental Chesapeake Bay Environmental Markets Team (EMT) hosted several workshops to advance development and implementation of infrastructure and policies for environmental markets. Topics included providing environmental services through agriculture, developing biodiversity markets, tool development for water quality markets, and integrating conservation and environmental markets, among others. EMT materials are available on the USDA OEM website.

Phases I and II of the USDA-funded economic study on the Chesapeake Bay TMDL cost to Agriculture were completed. The study focuses on the cost-effectiveness of BMPs, ranking of practices by cost-effectiveness and development of algorithms for distributing BMP adoption across space and time. Phase II of the economic study characterized the economic implications of nutrient credit trading and other policy approaches to reducing agriculture's nutrient discharge into the Chesapeake Bay Watershed. Phase III will evaluate how the time lags inherent in the movement of nutrients affect targeting management practices and credit trading programs.

Strengthen Science

Federal agencies worked with state and academic partners first to provide critical science to support the needs of the Goal Teams and the Executive Order (EO) outcomes, and second to enhance management of the growing amount of environmental information through the Data Enterprise. The agencies also provided new understanding of important issues, such the sediment loads from the Conowingo Dam, that will be considered by the CBP as they refine goals. The science activities were coordinated through the CBP Scientific Technical Assessment and Reporting (STAR) Team to ensure efficient efforts to support the CBP Goal Teams.

Federal funding

Federal Agencies have invested nearly 1.4 billion in Chesapeake Bay protection and restoration activities under the Executive Order between 2011 and 2013. The following table summarizes the FY 2011 – FY 2013 funding levels for implementation for Executive Order 13508 *Chesapeake Bay Protection and Restoration.*

Executive Order Federal Funding Summary

Department/Agency	FY 2011	FY 2012*	FY 2013
USDA Total	**$153,578,000**	**$121,488,000**	**$158,986,000**
Farm Service Agency	$11,423,062	($37,081,000)	$35,981,000
NRCS**	$149,740,000	$119,828,000	$119,760,000
Office of Chief Economist	$150,000	$350,000	$350,000
USFS	$3,688,000	$1,310,000	$2,895,000
U.S. Department of Commerce / NOAA	**$19,346,250**	**$9,208,425**	**$6,719,000**
DoD Total	**$17,434,075**	**$84,827,963**	**$76,477,000**
Services	$11,423,062	$64,619,963	$56,877,000
USACE	$6,011,013	$20,208,000	$19,600,000
DOI Total	**$42,817,218**	**$23,906,000**	**$26,597,000**
FWS	$15,161,274	$10,146,000	$10,294,000
NPS	$19,169,640	$6,411,000	$6,454,000
USGS	$8,486,304	$7,349,000	$9,849,000
DOT	**$8,501,000**		
EPA	**$248,873,881**	**$184,010,730**	**$178,975,300**
Total	**$490,550,424**	**$423,441,118**	**$447,754,300**

**** The 2012 Agriculture Appropriations Act extended several mandatory conservation programs included in the Food, Conservation, and Energy Act of 2008 (110-246) through the end of FY13. Additionally, the FY12 Agriculture Appropriations Act extended several conservation programs through the end of FY14.***

EPA Chesapeake Bay Compliance and Enforcement Strategy Highlights: 2009-2012

Executive Order 13508 *Chesapeake Bay Protection and Restoration* required EPA to implement a compliance and enforcement strategy for the Chesapeake Bay. The Chesapeake Bay Compliance and Enforcement Strategy, published in 2009, guides the use of EPA's compliance and enforcement tools to target sources of pollution impairing the Bay. It is a multi-year and multi-state strategy combining our water, air and waste enforcement authorities to address violations of federal environmental laws resulting in nutrient, sediment and other pollution in the Bay.

Under the strategy, EPA identifies and addresses industrial, municipal, and agricultural sources releasing significant amounts of pollutants in excess of the amounts allowed by the Clean Water Act, the Clean Air Act and other applicable environmental laws, as well as identifies nutrient and sediment impaired sub-watersheds.

EPA also identifies key regulated business sectors that, when in non-compliance with current applicable environmental regulations, contribute significant amounts of nutrients, sediment and other pollutants to the Bay. The key regulated sectors, some of which are also National Enforcement Initiatives for EPA, include Concentrated Animal Feeding Operations (CAFO), Municipal and Industrial wastewater facilities, Stormwater National Pollution Discharge Elimination System (NPDES) point sources including Municipal Separate Storm Sewer System (MS4s) and stormwater discharges from construction sites and other regulated industrial facilities, and Air deposition sources of nitrogen regulated under the Clean Air Act, including power plants.

The strategy also calls on EPA to analyze the compliance records for facilities in the key regulated business sectors to target investigations and inspections, and to investigate and inspect facilities in the key regulated business sectors and pursue appropriate enforcement actions to ensure compliance. EPA further identifies appropriate opportunities for compliance and enforcement activities related to the Clean Water Act wetlands protection program, federal facilities, and Superfund sites, including remedial action and removal sites, and Resource Conservation Recovery Act (RCRA) corrective action facilities.

Finally, the strategy states EPA will explore opportunities for the use of imminent and substantial endangerment authorities under the Clean Water Act, Safe Drinking Water Act, Resource Conservation and Recovery Act, Superfund and the Clean Air Act.

Since 2009, the Agency has entered into 17 civil judicial settlements and issued 169 administrative orders, including one emergency order, to sources contributing to the Bay's impairment.

These enforcement actions cover more than 400 facilities in nine states and the District of Columbia; and will reduce approximately 4,000 pounds of nutrients (nitrogen and phosphorus) and 360 million pounds of sediment to the Bay watershed, along with 32 million pounds of nitrogen oxides to the Bay airshed annually once all required controls are fully implemented. Additionally, settling companies have agreed to invest more than an estimated $778 million in actions and equipment to reduce pollution to the Bay; as well as pay civil penalties of more than $13 million.

Chesapeake Bay Total Maximum Daily Load (TMDL)

EPA has established the Chesapeake Bay TMDL, a historic and comprehensive "pollution diet" with rigorous accountability measures to initiate sweeping actions to restore clean water in the Chesapeake Bay and the watershed's streams, creeks and rivers.

Most of the Chesapeake Bay and its tidal waters are listed as impaired because of excess nitrogen, phosphorus and sediment. These pollutants cause algae blooms that consume oxygen and create "dead zones" where fish and shellfish cannot survive, block sunlight needed for underwater Bay grasses, and smother aquatic life on the bottom. The high levels of nitrogen, phosphorus and sediment enter the water from agricultural operations, urban and suburban stormwater runoff, wastewater facilities, air pollution and other sources, including onsite septic systems.

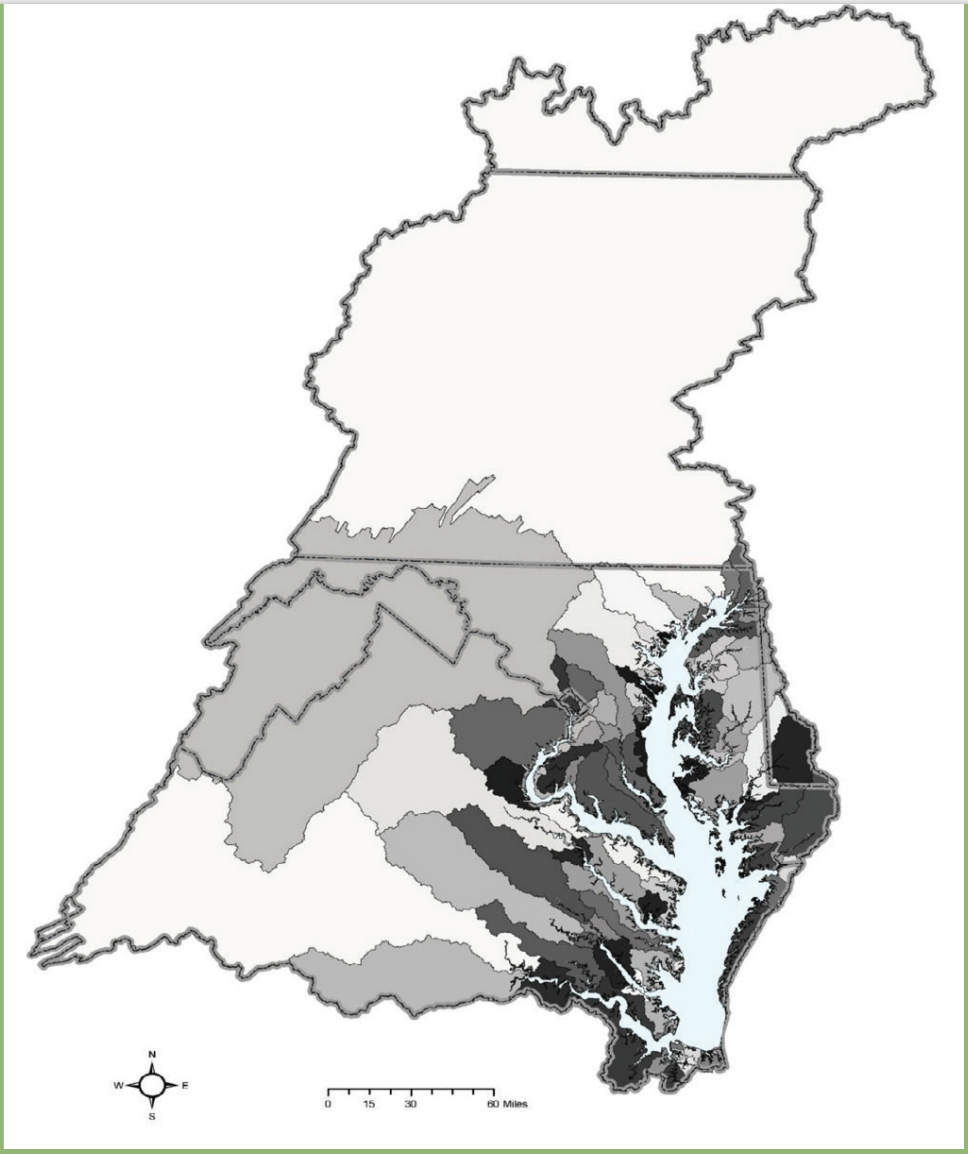


Figure ES-1: A nitrogen, phosphorus and sediment TMDL has been developed for each of the 92 Chesapeake Bay segment watersheds.

Despite extensive restoration efforts during the past 30 years, the TMDL was prompted by insufficient progress and continued poor water quality in the Chesapeake Bay and its tidal tributaries. The TMDL is required under the federal Clean Water Act and responds to consent decrees in Virginia and the District of Columbia from the late 1990s. It is also a keystone commitment of a federal strategy to meet President Barack Obama's Executive Order to restore and protect the Bay.

The TMDL – the largest and most complex of more than 45,000 TMDLs developed by or approved by EPA – identifies the necessary pollution reductions of nitrogen, phosphorus and sediment across Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia and the District of Columbia and sets pollution limits necessary to meet applicable water quality standards in the Bay and its tidal rivers and embayments. Specifically, the TMDL sets Bay watershed limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus and 6.45 billion pounds of sediment per year – a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment. In addition, EPA has committed to reducing air deposition of nitrogen to the tidal waters of the Chesapeake Bay from 17.9 to 15.7 million pounds per year. The reductions have begun through implementation of ongoing federal air regulations.

These pollution limits are further divided by jurisdiction and major river basin based on state-of-the-art modeling tools, extensive monitoring data, peer-reviewed science and close interaction with jurisdiction partners. The TMDL is actually a combination of 92 smaller TMDLs for individual Chesapeake Bay tidal segments and includes pollution limits sufficient to meet state water quality standards for dissolved oxygen, water clarity, underwater Bay grasses and chlorophyll-*a*, an indicator of algae levels (Figure ES-1). It is important to note the pollution controls employed to meet the TMDL will also have significant benefits for water quality in tens of thousands of streams, creeks, lakes and rivers throughout the region.

The TMDL is designed to ensure all pollution control measures needed to fully restore the Bay and its tidal rivers are in place by 2025, with practices in place expected to achieve at least 60 percent of the load reductions by 2017. The TMDL is supported by rigorous accountability measures to ensure cleanup commitments are met, including short-and long-term benchmarks, a tracking and accountability system for jurisdiction activities, and federal contingency actions that can be employed if necessary to spur progress.

Developing the Chesapeake Bay TMDL

Development of the Chesapeake Bay TMDL required extensive knowledge of stream flow characteristics of the watershed, sources of pollution, distribution and acreage of various land uses, appropriate best management practices, the transport and fate of pollutants, precipitation data and many other factors. The TMDL was informed by a series of models, calibrated to decades of water quality and other data, and refined based on input from dozens of Chesapeake Bay region scientists. Modeling is an approach that uses observed and simulated data to replicate what is occurring in the land, air and water to make future predictions, and was a critical and valuable tool in developing the Chesapeake Bay TMDL. For further details on the CBP suite of models, see Appendix C.

Since nitrogen and phosphorus loadings from all parts of the Bay watershed have an impact on the impaired tidal segments of the Bay and its rivers, it was necessary for EPA to work with the jurisdictions to allocate nitrogen and phosphorus loadings in an equitable manner to the states and basins. EPA used three basic principles to divide these loads.

- Allocated loads should protect living resources of the Bay and its tidal tributaries and should result in all segments of the Bay mainstem, tidal tributaries and embayments meeting water quality standards for dissolved oxygen, chlorophyll-*a*, water clarity and underwater Bay grasses.
- Tributary basins that contribute the most to the Bay water quality problems must do the most to resolve those problems (on a pound-per-pound basis) (Figure ES-2).
- All tracked and reported reductions in nitrogen, phosphorus and sediment loads are credited toward achieving final assigned loads.

Accountability and Goals

The Chesapeake Bay TMDL is unique because of the extensive measures EPA and the Bay jurisdictions have adopted to ensure accountability for reducing pollution and meeting target dates for progress. The Bay jurisdictions' implementation of the TMDL will be assisted by an accountability framework that includes WIPs, two-year milestones, EPA's tracking and assessment of restoration progress and, as necessary, specific federal contingency actions if the jurisdictions do not meet their commitments. This accountability framework is established in part to provide demonstration of the reasonable assurance provisions of the Chesapeake Bay TMDL pursuant to both the Clean Water Act and the Chesapeake Bay Executive Order, but is not part of the TMDL itself.

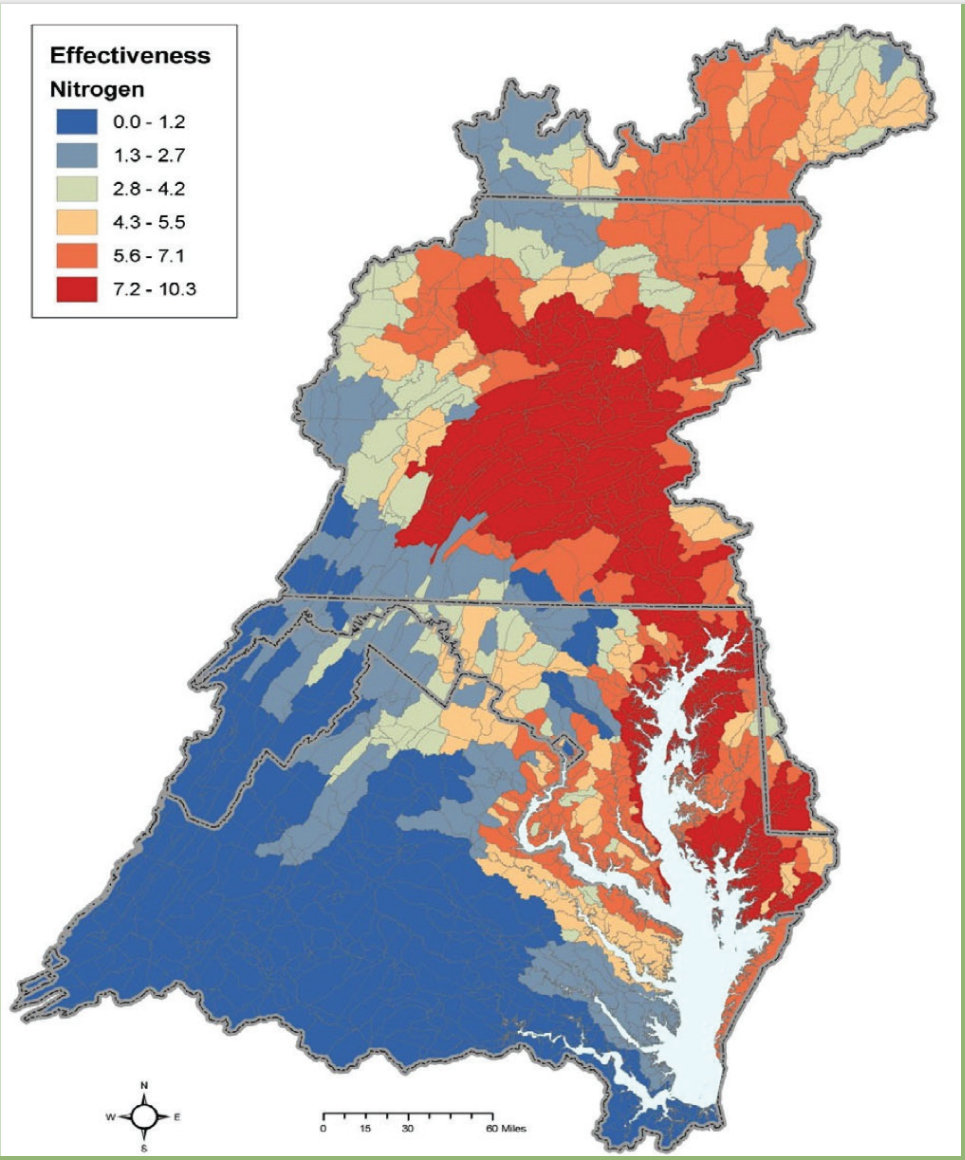


Figure ES-2: Sub-basins across the Chesapeake Bay watershed with the highest (red) to lowest (blue) pound for pound nitrogen pollutant loading effect on Chesapeake Bay water quality.

Beginning in 2012, the Bay jurisdictions and the federal government began to follow two-year milestones to track progress toward reaching the TMDL's goals. In addition, the milestones will demonstrate the effectiveness of the jurisdictions' WIPs by identifying specific near-term pollutant reduction controls and a schedule for implementation. EPA reviews these two-year milestones and evaluates whether they are sufficient to achieve necessary pollutant reductions and, through the use of a Chesapeake Bay TMDL Tracking and Accountability System, determines if milestones are met.

Implementing the Chesapeake Bay TMDL

WIPs, which detail how and when the seven Bay jurisdictions will meet their respective allocations, played a central role in shaping the TMDL. Each of the Bay jurisdictions also submitted Phase II WIPs in 2012 that provide planning targets for implementation on a more local scale. Phase III WIPs in 2018 are expected to provide additional detail regarding restoration actions beyond 2017 and to ensure the 2025 goals are met.

The focus is now on the Bay jurisdictions' implementation of their WIP policies and programs that will reduce pollution on-the-ground and in-the-water.

EPA will continue oversight of WIP implementation and jurisdictions' progress toward meeting two-year milestones. If progress is insufficient, EPA is committed to taking appropriate contingency actions including targeted compliance and enforcement activities, expansion of requirements to obtain NPDES permit coverage for currently unregulated sources, increasing oversight of state-issued NPDES permits, revision of the TMDL allocations and additional controls on federally regulated sources of pollution, such as wastewater treatment plants, large animal agriculture operations and municipal stormwater systems, prohibiting new or expanded pollutant loads, redirecting EPA grants, and revising water quality standards to better protect local and downstream waters.

National Academies report: Achieving Nutrient & Sediment Reduction Goals in the Chesapeake Bay

Over the past five years, there have been a number of independent evaluations of various components of the Chesapeake Bay Program. In 2008, GAO concluded CBP's actions had fallen short of the GAO 2005 recommendation to establish an independent and objective reporting process. As a result, the EC requested the CBP partnership be evaluated by a nationally recognized independent science organization to accelerate implementation and increase the level of accountability.

Installed as an organizational function in the new CBP structure, the Independent Evaluator reported directly to the EC and the Principals' Staff Committee.

First pilot study

The first independent evaluation was a pilot which began in December 2009. It was conducted through an EPA contract with the National Academies of Science (NAS). The purpose of the study was to evaluate the CBP implementation efforts toward needed nutrient and sediment reduction goals for water quality. Specifically, the NAS study panel looked at ***Tracking and Accountability*** and ***Milestones.***

With regards to ***Tracking and Accountability***, the panel addressed whether tracking for implementation of nutrient and sediment point and non-point source pollution best management practices appears reliable, accurate and consistent. Within each jurisdiction, the panel considered which efforts and systems appeared to be working, or not working, including implementation of federal programs and funding – and how to strategically improve the system to address gaps. Finally, the panel examined how gaps and inconsistencies appeared to impact reported program results.

The strategy of two-year ***Milestones*** was examined to determine if the level of implementation was likely to achieve the CBP nutrient and sediment reduction goals for that milestone period. The panel considered whether CBP agencies had developed adaptive management approaches to help meet program goals for nutrient and sediment reduction. They further analyzed potential improvements to the development, implementation, and accounting of the strategies to ensure achieving the goals.

National Academies of Science Report

In May 2011, the NAS delivered the committee report: Achieving Nutrient and Sediment Reduction Goals in the Chesapeake Bay: An Evaluation of Program Strategies and Implementation. The following are highlights of the Committee's findings:

The committee declared tracking is of paramount importance because CBP relies upon data to estimate current and future loads, however the current data on practice implementation was, at best, an estimate. Current accounting of practices was found to be inconsistent across jurisdictions. The jurisdictions and CBP partnership as a whole were credited for making strides toward improving reporting, however the scope of the task with limited resources has proved difficult. The committee recommended third-party auditing to ensure reliability of state and local data.

The two-year milestone strategy was noted for committing states to tangible, near-term implementation goals and improving accountability, but cautioned the strategy does not guarantee goals will be met and the consequences for nonattainment are unclear. The committee advised timely updates and synthesis of progress are required for states to receive the data necessary to make appropriate mid-point adjustments.

As for implementation of the milestones, the committee found the first milestones represented a sizeable increment of implementation and presumed the first milestones would likely be the easiest to achieve. Progress toward implementation was mixed across jurisdictions based on July 2009 reporting.

The committee did not feel EPA or the jurisdictions exhibited a clear understanding of adaptive management and how to apply it. As such, they deemed the current two-year milestone strategy largely a "trial and error" process.

Chesapeake Bay Program Partnership Response

The Principals' Staff Committee made recommendations for implementation and response to the NAS report in November 2011, as well as outlining key challenges. The partnership has addressed the report's findings through in-depth consideration and implementation of specific activities and program policy changes, including:

- BMP effectiveness monitoring, tracking and accountability
- Adaptive management of the Chesapeake Bay Program
- An Action Team to explore a Chesapeake Bay modeling laboratory
- The ongoing function of the independent evaluator

CHAPTER 3:
RECOMMENDATIONS FOR IMPROVED MANAGEMENT

New Chesapeake Bay Watershed Agreement

In 2011, both the EC and the FLC acknowledged the need to look at potentially integrating the goals, outcomes and actions of the CBP partnership (*Chesapeake 2000)* with those set forth in the EO strategy. Most of the outcomes and commitments in the *Chesapeake 2000* agreement have expired and there is now a need to update and refresh them in order to accelerate progress in achieving the water quality and living resource goals of the program.

This new plan for collaboration across the Bay's political and geographical boundaries will clarify our vision, mission and values and establish shared goals and outcomes for the protection, restoration and stewardship of the Bay, its tributaries and the lands that surround them. The current draft agreement includes goals and outcomes for sustainable fisheries, habitat restoration, water quality, healthy watersheds, land conservation, public access and environmental literacy. The agreement, now being drafted, is intended to encourage a forward-looking approach to conservation and restoration, focusing on immediate results and recognizing our long-term effort must be sustained by and for future generations. It is intended the new *Chesapeake Bay Watershed Agreement* will have more flexibility, increased accountability and greater participation by all partners, including the Headwaters states of Delaware, New York and West Virginia.

If consensus can be reached by all of the signatories, the current schedule calls for the new Watershed Agreement to be signed by the EC in late Spring of 2014.

Strengthening and Adopting New Strategies

Overview

The CBP partnership continues to address new complex issues, including those previously recognized by the partnership, which can affect actions necessary to restore the Chesapeake Bay watershed. Examples include: accounting for the potential consequences of population growth and continuing climate change; accounting for innovative, new technologies; factoring in new understanding of the Susquehanna River dams' influence on nutrient and sediment pollutant loads; invasive species; understanding and recognizing year-to-year variability of rainfall-driven nutrient and sediment loads and their impact on Bay water quality; and taking full advantage of living resources (i.e., natural infrastructure) as natural filters. This is part and parcel of the adaptive management commitment of the partnership to consider new knowledge and updates in information which can best inform our watershed restoration strategies and management.

In recent years, CBP has begun using a decision framework to fully integrate an adaptive management process into Chesapeake Bay restoration. For example, the partnership will provide input on and review changes in decision-support tools, such as the models and methods used to assess progress, and weigh the effects of these proposed changes against the impacts to meeting the ultimate goal of having all practices on the ground by 2025 to meet water quality standards. To enable this level of adaptive management throughout the program, CBP partners need to work together to ensure there are adequate resources to maintain the integrity of the monitoring program for both tidal and non-tidal networks.

Further, the partnership will consider the need for updates to the current TMDL to address any needed modifications informed by the changes to the decision-support tools, as well as jurisdictions' implementation experience to date. EPA's expectations for the scope and content of the Phase III WIPs may vary depending on their jurisdictions' implementation progress through 2017. The CBP partnership will carefully consider scientific, technical, financial, social, political and other implementation factors during this review, called the Chesapeake Bay TMDL Midpoint Assessment. Using this assessment, jurisdictions will be expected to make necessary adjustments in their Phase III WIPs to achieve the 2025 goal.

Guiding Principles for the 2017 Chesapeake Bay TMDL Midpoint Assessment

The Chesapeake Bay TMDL called for an assessment in 2017 to review our progress toward meeting the identified nutrient and sediment pollutant load reductions for the TMDL, Phase I and Phase II WIPs and milestones, recognizing change is inevitable over a 15-year period in a dynamic environment like the Bay. The Bay TMDL 2017 midpoint assessment has three primary objectives: 1) gather input from the partnership on issues and priorities to be addressed in order to help meet the goal of all practices in place by 2025 to meet water quality standards; 2) based on these priorities, review the latest science, data, tools and best management practices (BMPs), incorporate as appropriate into the decision-support tools that guide implementation, and consider lessons learned; and 3) help jurisdictions prepare Phase III WIPs, which will guide milestones and implementation from 2018 to 2025. In parallel, EPA will continue its oversight role on the implementation of the Bay TMDL and determine if the 2017 interim goal is on track.

The purpose of the guiding principles is to help direct the partnership through the midpoint assessment and Phase III WIP development process. The following are the five principles guiding the Midpoint Assessment were approved by the Principals' Staff Committee in 2012:

1: Continue implementation, tracking progress and reporting results, with stable tools through at least 2017

2: Enhance decision support and assessment tools to enable successful engagement of local partners

3: Incorporate new or refined BMPs and verification of practices into existing accountability tools and reporting protocols

4: Address emerging issues that may impact current strategies and future plans

5: Prioritize midpoint assessment actions and use adaptive management to ensure water quality goals are met

Chesapeake Bay Program partnership's BMP Verification Principles

Another important priority of the CBP partnership is implementation of the Chesapeake Bay TMDL, the jurisdictions' WIPs, and two-year milestones. The partnership has committed to development of a basinwide BMP verification framework for use by the seven watershed jurisdictions to assure data quality for BMP reporting for annual Model Progress runs. The CBP partnership established an independent BMP Verification Review Panel in September 2012, charged with the responsibility for examining the degree to which a jurisdiction's BMP verification program meets the parameters established by the partnership's BMP verification framework. This review will include an examination of existing BMP measurements, accounting, and inspection systems and any proposed improvements to those systems submitted for partnership review. The partnership recognizes some jurisdictional programs may already achieve some of these principles and may not require significant modification or enhancements.

The CBP partnership has defined BMP verification as the process through which agency partners ensure practices, treatments, and technologies resulting in reductions of nitrogen, phosphorus, and/or sediment pollutant loads are implemented and operating correctly. The process for verifying credits for use in trading or offsets is a separate, distinct process not addressed either by these principles or through the partnership's BMP Verification Framework.

Working to verify practices are properly designed, installed, and maintained over time is a critical and integral component of transparent, cost efficient, and pollutant reduction effective program implementation. Verification helps assure the public of achievement of the expected nitrogen, phosphorus, and sediment pollutant load reductions over time. The CBP partnership will build from existing BMP tracking and reporting systems and work towards achieving or maintaining the following principles – 1) Practice Reporting; 2) Scientific Rigor; 3) Public Confidence; 4) Adaptive Management; and 5) Sector Equity.

Offset and Trading Programs – Focusing on Keeping Healthy Watersheds Healthy

EPA expects the Bay jurisdictions to offset any new or increased loads above the level of the TMDL allocations. In addition, EPA believes water quality trading can be a cost-effective way to reduce nutrient and sediment pollution and achieve water quality goals. In 2003, EPA issued a policy on water quality trading, followed up by a toolkit in 2007.

The Bay jurisdictions are exploring whether to develop offset and trading programs or, where applicable, expand existing programs. Understanding technical challenges and policy issues need to be addressed in order to establish credible and transparent water quality trading programs, EPA is working with state, private and other interested partners to ensure programs are developed that meet the common elements of Section 10 and Appendix S of the Bay TMDL.

EPA's work plan includes five major components: (1) addressing assessment findings; (2) oversight program; (3) program development and guidance; (4) outreach, education and integration; and (5) data and tracking.

EPA's primary focus of activity at this time is developing a series of technical memoranda that elaborate on the elements of Appendix S and Section 10 of the Chesapeake Bay TMDL with which the Bay jurisdictions' trading and offset programs are expected to be consistent. These memoranda will address topics such as: baseline demonstration, sector growth demonstration, representative sampling, credit calculation methodology, credit permanence, trading ratio based on uncertainty, and verification.

To focus and support trading and offset efforts in Bay jurisdictions, CBP established in 2011 a Trading and Offsets Workgroup under the Water Quality Goal Implementation Team that has three functions: (1) provide a forum for discussion and information exchange among trading and offsets stakeholders; (2) evaluate and facilitate strategies to exchange loads among affected source sectors; and (3) build consensus on common approaches to some program design elements.

Improving Governance of the Program

Overview

EO 13508 established the FLC, chaired by the Administrator of the Environmental Protection Agency and including senior representatives of the Departments of Agriculture, Commerce, Defense, Homeland Security, Interior, and Transportation. The EO further directs the FLC to carry out a series of responsibilities. In addition to producing the EO strategy, ongoing implementation responsibilities include:

- Oversee development, coordination and implementation of new federal programs and activities for Chesapeake Bay restoration.
- Collaborate with state partners to ensure federal actions are closely coordinated with actions by state and local agencies and resources are used efficiently.
- Consult with stakeholder groups and the general public.
- Define milestones for meeting goals. Track and report restoration activities and spending.

Aligning FLC and CBP Functions

The EO recognized the federal government cannot achieve the goals and outcomes needed to restore and protect the Chesapeake Bay and its watershed without significant collaboration with state and local government, NGOs and citizens. The FLC also recognizes the longstanding roles and functions of the CBP, which includes the states in the watershed, the District of Columbia, the Chesapeake Bay Commission and EPA (representing the federal government). A number of CBP's roles and functions dovetail or overlap with those of the FLC. Given this, and the long-standing participation of federal agencies in the partnership, the FLC plans to take steps toward enhanced collaboration with CBP partners to further align the responsibilities of both parties and implement this strategy.

The process for aligning federal, state and local actions has begun through the consultation called for in the EO. The FLC and the EC acknowledge the need to more clearly define the role of the Chesapeake Bay Program in implementation of the EO strategy. In 2011, the FLC and EC convened a group of federal and state partners to recommend steps for coordinating and, where appropriate, integrating the goals, outcomes and actions of the CBP partnership with the goals, outcomes and actions described in this strategy. The group's recommendations will aim to produce the most efficient coordination mechanisms feasible that encompass the following principles:

- Mechanisms for reporting information on actions should not require multiple entries of the same data in different systems.
- There should be a coordinated, consistent mechanism for reporting progress to the public.
- There should be a consistent, coordinated adaptive management process for making changes to goals or outcomes that includes all partners.
- The systems should be mutually beneficial to partner agencies.

Photo overlooking a marsh and shallow water pond at Fisherman Island National Wildlife Refuge on Virginia's Eastern Shore, from www.chesapeakebay.net

Since 2011, the Bay jurisdictions and federal agencies have been working together through the CBP Goal Implementation Teams, Management Board and Principals' Staff Committee and have undertaken the following steps:

1. Review vision, goals and outcomes identified in the EO strategy with the goals and commitments of the CBP partnership.

2. Identify issues and make specific recommendations for aligning EO goals and outcomes with existing CBP commitments.

3. Review indicators of health, restoration and protection currently used in the Bay Barometer and recommend appropriate changes for purposes of tracking progress and assessing success. Review existing monitoring information and other data sources currently utilized in the CBP and assess their alignment with the goals and objectives resulting from the above.

4. Review the means to coordinate and integrate federal, state and local actions. Evaluate the use of the annual federal action plan to incorporate state and local annual actions.

5. Recommend options to clarify the operational relationship between the FLC and the EC.

   Identify issues with and propose solutions to the current CBP structure related to implementing, monitoring, and supporting the integrated approach identified above; identify potential changes to the current CBP governance document.

It is anticipated the new *Chesapeake Bay Watershed Agreement* to be signed in 2014 will reflect the results of completing Steps 1-3 above. The CBP Governance Document (issued in 2009) will also be updated in 2014 to address Steps 4 and 5 as well as clarifying EPA's regulatory role related to the Bay TMDL and CBP partnership.

CHAPTER 4:
CONCLUSION

The past 30 years of scientific discovery, collaborative decision making, taking local actions, and monitoring the responses of the Bay ecosystem and its surrounding watershed have reinforced clear direction for the Chesapeake Bay Program partnership.

We are not only holding our own in the face of continued population growth and development in the watershed, we are making progress. We have seen that our actions, taken locally and in enough places, can lead to recovery and restoration of local waters and waterbodies.

The evidence demonstrates our pollutant reduction goals set more than a decade ago, now in the form of more specific regulatory allocations, are still the right ones to restore local and Bay water quality conditions. We know we must do more and do it now to further build back the resilience of local ecosystems to withstand increasing extreme variations in weather and climate.

Advances in improving water quality driven by the EO strategy and the Chesapeake Bay TMDL have been achieved in conjunction with concurrent efforts to restore living resources and habitat, protect and enhance the ecosystem, while raising citizen access, awareness and stewardship.

Development of the new *Chesapeake Bay Watershed Agreement* will ensure progress continues by coordinating the priorities and responsibilities of all seven jurisdictions within the watershed. The currently proposed new agreement allows the flexibility needed to adaptively manage the process through better alignment of federal, state and local efforts.

President Obama rightfully has recognized the Chesapeake Bay as a national treasure. Recovery of this resource will serve as both an economic engine for growth in the region as well as a model for ecosystem based multi-jurisdictional recovery efforts worldwide.

APPENDICES

APPENDIX A: Links to "Bay Barometers"

1. Bay Barometer: Spotlight on Health and Restoration in the Chesapeake Bay and its Watershed 2011-2012
2. Bay Barometer: A Health and Restoration Assessment of the Chesapeake Bay and Watershed in 2010
3. Bay Barometer: A Health and Restoration Assessment of the Chesapeake Bay and Watershed in 2009
4. Bay Barometer: A Health and Restoration Assessment of the Chesapeake Bay and Watershed in 2008 - Executive Summary and Bay Barometer: A Health and Restoration Assessment of the Chesapeake Bay and Watershed in 2008
5. Chesapeake Bay 2007 Health and Restoration Assessment
6. Chesapeake Bay 2006 Health and Restoration Assessment
7. Chesapeake Bay 2005 Health and Restoration Assessment Part One: Ecosystem Health and Chesapeake Bay 2005 Health and Restoration Assessment Part Two: Restoration Efforts
8. The State of the Chesapeake Bay and Its Watershed: A Report to the Citizens of the Bay Region (2004)
9. 2002-The State of the Chesapeake Bay: A Report to the Citizens of the Bay Region
10. 1999 State of the Chesapeake Bay
11. The State of the Chesapeake Bay 1995
12. The Chesapeake Bay...A Progress Report 1990-1991
13. State of the Chesapeake Bay: Third Biennial Monitoring Report - 1989
14. State of the Chesapeake Bay: Second Annual Monitoring Report 1984-1985

Links to all CBP indicators are available on the program website. Indicators are organized as follows:

Bay Health: Scientists evaluate the Chesapeake Bay's health by monitoring important habitats, fish and shellfish and water quality measures. These indicators are useful tools to gauge overall health of the Bay and the animals that live in it.

Habitats and Lower Food Web

- Bay Grasses
    - Underwater Bay Grass Abundance (Upper, Middle and Lower Bay Zones)
    - Underwater Bay Grass Density
- Bottom Habitat
- Tidal Wetlands

Fish and Shellfish

- Blue Crabs
- Oysters
- Striped Bass
- American Shad
- Atlantic Menhaden

Water Quality

- Achievement of Chesapeake Bay Water Quality Standards
- Chemical Contaminants

Watershed and River Health: CBP uses the most current monitoring data to assess forest and stream health.

Forests

- Forest Cover

Health of Freshwater Streams

- Health of Freshwater Streams in the Chesapeake Bay Watershed

Flow-adjusted Pollution Trends

- Nitrogen in Rivers Entering Chesapeake Bay: Long-term Flow-adjusted Concentration Trends
    - Nitrogen Short-Term Flow Adjusted Concentration Trends Measured in Watershed Streams and Rivers
    - Nitrogen Yields Measured in Watershed Streams and Rivers

- Phosphorus in Rivers Entering Chesapeake Bay: Long-term Flow-adjusted Concentration Trends
    - Phosphorus Short-Term Flow Adjusted Concentration Trends Measured in Watershed Streams and Rivers
    - Phosphorus Yields Measured in Watershed Streams and Rivers
- Sediment in Rivers Entering Chesapeake Bay: Long-term Flow-adjusted Concentration Trends
    - Sediment Short-Term Flow Adjusted Concentration Trends Measured in Watershed Streams and Rivers
    - Sediment Yields Measured in Watershed Streams and Rivers

Factors Impacting Bay and Watershed Health: CBP uses the most current monitoring data to track major factors influencing the health of the Bay and its watershed.

Pollutants

- Nitrogen
- Phosphorus
- Sediment

Land Use

- Population Growth
- Forest Cover

Natural Factors

- River Flow

Restoration and Protection Efforts: The most current monitoring and tracking data gathered by CBP partners and computer simulations are used to assess partners' efforts to restore the health of the Bay and its watershed.

Reducing Pollution

- Reducing Nitrogen Pollution
    - Wastewater
- Reducing Phosphorus Pollution
    - Wastewater
- Reducing Sediment Pollution
    - Wastewater

Restoring Habitats

- Planting Bay Grasses
- Restoring Wetlands
- Reopening Fish Passage
- Restoring Oyster Reefs

Managing Fisheries

- Blue Crab Fishery Management

Protecting Watersheds

- Planting Forest Buffers
- Developing Watershed Management Plans
- Protected Land

Fostering Stewardship

- Public Access
- Education and Interpretation (Meaningful Watershed Educational Experiences)

Additional Pertinent Links

Susquehanna River Study Updates

NAS/NRC Report in Brief: Achieving Nutrient and Sediment Reduction Goals in the Chesapeake Bay

Modeling the Chesapeake Bay

2012 EO Progress Report

2013 EO Action Plan

Table A: FY 2012/2013 Programmatic Milestones – Progress		
Target Date	**Programmatic Milestone**	**2013 Progress**
RESTORE CLEAN WATER		
	TMDL/WIPs	
2013	Develop and implement a Best Management Practices Operation and Maintenance Policy to meet permit and water quality requirements for each Service. (DoD)	**In progress.**
May 2013	Provide mid-term evaluation of 2012 milestones progress to jurisdictions. (EPA)	**Complete.** Issued in May 2013.
Jan. 2012 – Feb. 2012	Evaluate and announce federal and jurisdictional 2012-2013 two-year milestones. (EPA)	**Completed in 2012.**
Jan. 2012 – June 2012	Evaluate draft and final Phase 2 WIPs. (EPA)	**Completed in 2012.**
June 2012	Assess progress made to implement the May 2009 – December 2011 two-year milestones. (EPA)	**Completed in 2012.**
2012	Participate in jurisdictions' Phase 2 WIP processes: provide DoD installation information to jurisdictions and disseminate jurisdiction information throughout DoD to support the most effective implementation of future WIP requirements on DoD installations. (DoD)	**Completed in 2012.**

Table A: FY 2012/2013 Programmatic Milestones – Progress		
Target Date	**Programmatic Milestone**	**2013 Progress**
Agriculture		
2013	Publish follow up Chesapeake Bay CEAP cropland report. (USDA)	**In progress.** This report was drafted in 2013 and will be published in 2014.
2013	Assess progress made in the showcase watersheds. (USDA)	**In progress.** States with Showcase watershed are currently evaluating progress towards meeting the resource concerns in the Watershed.
2013	Create a network among Bay watershed Conservation Innovation Grant awardees to help stimulate environmental markets. (USDA)	**Complete.** The USDA established a network of Chesapeake Bay Water Quality Trading Conservation Innovation Grant awardees. Network participants include representatives from state and local government, non-governmental organizations, EPA and USDA. The Network is focused on developing robust water quality trading programs in the Chesapeake Bay and with removing barriers to market development and reducing uncertainty in water quality trading programs.
2013	Evaluate and publish a report on the CBWI program contained in the Food, Conservation, and Energy Act of 2008 (110-246). (USDA)	**Delayed.** The authority for CBWI was extended thru 2013, analysis and the report will be completed in 2014.
2013	Continue to pursue the development of agricultural certainty programs in Bay watershed states. (USDA)	**In progress.** Two states have legislative authority for Certainty programs and one State is exploring a certainty program.
2013	Continue to fund construction of treatment and distribution facilities, replacing or improving existing systems that are impacting the Bay. (USDA)	**In progress.** NRCS installed about 300 waste Storage Facilities in 2013.

Table A: FY 2012/2013 Programmatic Milestones – Progress		
Target Date	**Programmatic Milestone**	**2013 Progress**
	Agriculture (cont.)	
2013	Evaluate revisions to the national CAFO rule. (EPA)	**Complete.** Conducting AFO and CAFO Program Assessments and permit reviews in Bay jurisdictions.
July 2012	Develop and implement tracking, reporting and verification mechanisms for voluntary conservation practices and other BMPs installed on agricultural lands. (EPA, USDA co-lead)	**Completed in 2012.**
2012	Update the CEAP Cropland Report for the Bay region; increase the spatial resolution of model results and account for changes in conservation adoption since 2006. (USDA)	**Completed in 2012.**
2012	Direct up to $5 million to stimulate innovative conservation approaches, including the development of ecosystem markets in the watershed. (USDA)	**Completed in 2012.**
2012	Pilot the Conservation Delivery Streamlining Initiative's Conservation Desktop for national use; integrate resource concerns, selected inventory and analysis tools, electronic signature, and geospatial information into conservation planning tools. (USDA)	**Completed in 2012.**

Table A: FY 2012/2013 Programmatic Milestones – Progress		
Target Date	**Programmatic Milestone**	**2013 Progress**
Atmospheric – Rules, Deposition, Allocations		
2013	Significantly reduce nitrogen deposition to the Bay and watershed by 2020. (EPA) • Tier 3 Light-Duty Vehicle Emission and Fuel Standards final rule (criteria and toxic pollutants). (EPA)	**Ongoing.**
2012	Significantly reduce nitrogen deposition to the Bay and watershed by 2020. (EPA) • NOxSOx Secondary National Ambient Air Quality Standards finalized. (EPA)	
2012	• New air deposition modeling for the Chesapeake Bay watershed incorporating the most recent finalized rules with significant NOx reductions. (EPA)	
2012	• EPA/DOT 2017–2025 Model Year Light-Duty Vehicle GHG Emissions and CAFÉ Standards final rule. (EPA)	
Stormwater		
2013	Evaluate revisions to the national stormwater rule. (EPA)	**Ongoing.**
Onsite (Septic) Systems		
June 2013	Develop a model program for states with voluntary general recommendations for activities to reduce pollution from onsite (septic) systems. (EPA)	**Complete.**

Table A: FY 2012/2013 Programmatic Milestones – Progress		
Target Date	**Programmatic Milestone**	**2013 Progress**
Toxic Contaminants		
Jan. 2013	Issue a report summarizing the extent and severity of toxic contaminants in the Bay and its watershed that will include an assessment of progress on the Chesapeake Bay Basinwide Toxins Reduction and Prevention Strategy. (USGS, FWS, EPA co-lead)	**Complete.**
Dec. 2013	Work with DOI (FWS, USGS), the Bay states, the District of Columbia and stakeholders to consider toxic contaminant reduction goals. (EPA)	**In progress.** Draft reduction outcome developed and being considered by partnership for new Bay Agreement
Oversight and Enforcement		
	Permit and Enforcement Oversight – Stormwater, Wastewater, Agriculture, Trading/ Offsets, Air.	
Dec. 2012	• Review Chesapeake Bay states' technical standards for nutrient management to ensure they meet CAFO regulations. (EPA)	**Complete for 2012.**
Dec. 2012 and 2013	• NPDES Permit Reviews – Report annually on number of permits reviewed. (EPA)	**Ongoing for 2013.**
Dec. 2013	• Inspections and Case Development – Report annually on results and/or status. (EPA)	**Ongoing for 2013.**

Table A: FY 2012/2013 Programmatic Milestones – Progress		
Target Date	**Programmatic Milestone**	**2013 Progress**
Monitoring and Science Support		
Dec. 2012	Implement year two expansion (20 sites) of the non-tidal monitoring network to support TMDL. (EPA, USGS co-lead) Evaluate water quality changes and progress to adjust management actions in support of the TMDL/WIPs and milestone progress evaluation. (EPA, USGS, NOAA co-lead)	**Complete.** Several sites discontinued due to budget sequestration.
Dec. 2012	• USGS will issue an annual update of nutrient and sediment concentration trends based on the CBP non-tidal monitoring network and release a new supplemental technique looking at trends in nutrient and sediment loads.	**Complete.**
Dec. 2012	• EPA will provide annual updates of trends in estuary monitoring data to assess progress toward water quality standards.	**Complete.**
Dec. 2013	• EPA will work with USGS and jurisdictions to apply the new technique for trends in loads to assess progress toward reductions.	**Ongoing.**
EPA Grant Support to States and the District of Columbia		
2013	Provide financial support to jurisdictions by maintaining funding, as authorized, through EPA's assistance programs including CWA Section 319, SRF, CBIG and CBRAP. (EPA)	**Complete.**

Table A: FY 2012/2013 Programmatic Milestones – Progress		
Target Date	**Programmatic Milestone**	**2013 Progress**
HABITAT		
Wetlands		
Spring 2013	Develop initial estimates of restored and enhanced coastal wetlands needed to support energetic carrying capacity metric for revised black duck goal, with spatial specificity. Circulate for review, critique and revision by appropriate scientists and subject matter experts. (FWS)	**In progress.** Biomass sample collection was completed and foraging trials were initiated. Analysis of samples and completion of foraging trials expected for FY14 along with building the foraging energetics model by late FY14.
Dec. 2013	Engage wildlife and natural resource agencies in strategic wetland action teams in interested Bay states during 2013. (FWS)	**Complete.** Resulted in successful multi-state proposal submitted by TNC and DU for a NFWF grant to accelerate wetland restoration.
Dec. 2013	Continue Chesapeake Bay island and wetlands restoration construction management, monitoring, stakeholder coordination and design of wetland cells at Poplar Island. (USACE)	**In progress.** To date, more than 176 acres of tidal wetlands have been restored.
Fish Passage		
Dec. 2013	Conduct outreach on use of the Baywide fish passage prioritization tool in Maryland, Virginia and Pennsylvania. (FWS, NOAA)	**Complete.** Presentations were given at the Chesapeake Bay Program's Habitat Goal Implementation Spring 2013 meeting, State of Maryland Dam Safety Division, and Maryland Dam Removal Workshop (Hosted by AR). The tool has also been highlighted on Md., Va., and Pa. Fish Passage Websites such as: http://www.dgif.virginia.gov/fishing/tnc-chesapeake-bay-fish-passage/.

Table A: FY 2012/2013 Programmatic Milestones – Progress		
Target Date	**Programmatic Milestone**	**2013 Progress**
Riparian Forest		
Dec. 2012	Complete a strategy to accelerate forest restoration in priority areas. (USFS)	**Complete.**
March 2013	Produce a White Paper on Riparian Forest Restoration in the Chesapeake Bay. (USFS)	**Complete.**
June 2013	Complete pilot of Land Image Analyst, a tool for improved monitoring of riparian forest buffers. (USFS, USGS)	**Complete.**
Dec. 2013	Conduct outreach using completed strategy to accelerate forest restoration in priority areas. (USFS)	**In progress.** Will be continued in 2014.

Table A: FY 2012/2013 Programmatic Milestones – Progress		
Target Date	**Programmatic Milestone**	**2013 Progress**
Additional Milestones		
Dec. 2013	Initiate feasibility studies focused on the Anacostia River watershed immediately with Montgomery and Prince George's counties in Maryland. (USACE)	**In progress.** Cost sharing Agreement was executed in October 2013.
Dec. 2013	Continue to work closely with the City of Virginia Beach at Lynnhaven River Basin, Virginia, to complete design for restoration of wetlands, submerged aquatic vegetation, bay scallops and essential fish habitat. (USACE)	**In progress.**
Dec. 2013	Continue to work closely with the Commonwealth of Virginia and localities in the Rappahannock watershed to identify water resource issues and develop a study that will come up with innovative restoration solutions. (USACE)	**In progress.**
Dec. 2013	Prepare reconnaissance report and begin scoping follow on efforts with non-federal partners in preparation for the Chesapeake Bay Comprehensive Plan (USACE).	**In progress.**
Dec. 2013	CBP partners are developing a methodology to calculate trends in stream health over time using the Stream Health Index. This methodology will be used to track progress toward achieving the Stream Health Outcome. (EPA, CBP Monitoring Team)	**In progress.**

Table A: FY 2012/2013 Programmatic Milestones – Progress		
Target Date	**Programmatic Milestone**	**2013 Progress**
SUSTAIN FISH AND WILDLIFE		
Oysters		
March 2013	Complete and release Native Oyster Restoration Master Plan. (USACE)	**Complete.**
Dec. 2014	Complete Baywide Oyster Population Assessment. (NOAA)	**In progress.**
Dec. 2014	Conduct a study of existing and potential future oyster restoration activities. (USACE)	**In progress.** Construction of 56 acres of alternative substrate (granite and/or mixed shell) reefs funded by USACE and planting of 300 million spat on shell funded by NOAA completed. 209 acres completed overall. The Oyster Recovery Partnership has seeded a total of 131 acres so far.
2013	Conduct monitoring of the constructed sanctuary reefs in the Great Wicomico and Lynnhaven tributaries. (USACE)	**Complete.**

Table A: FY 2012/2013 Programmatic Milestones – Progress		
Target Date	**Programmatic Milestone**	**2013 Progress**
Blue Crabs		
June 2013	Establish and adopt new Baywide management targets for adult male crabs through the Chesapeake Bay Stock Assessment Committee and the Fisheries GIT. (NOAA)	**Complete.**
June 2013	Assess the extent to which the population is sustainable (i.e., between the abundance and exploitation targets and thresholds) by preparing and delivering the Chesapeake Bay Blue Crab Advisory Report annually (2012 and 2013) and convening the Sustainable Fisheries GIT to approve the report and adapt management approaches when necessary. (NOAA)	**Complete.**
Brook Trout		
May 2013	Host working session of Eastern Brook Trout Joint Venture to prioritize patches in Va., Md., N.Y., Pa. and W.Va. for brook trout habitat restoration and protection. (FWS, USGS)	**In progress.** Hosted working session with EBTJV in November 2012. Prioritization ongoing.
June 2013	Work with CBP's STAR and Eastern Brook Trout Joint Venture to adapt the brook trout outcome based on latest science. (USGS, FWS)	**Complete.** The metric and outcome were revised with input from EBTJV and based on latest science. Revised Outcome: "Restore naturally reproducing brook trout populations in Chesapeake headwater streams with an 8 percent increase in occupied habitat by 2025."

Table A: FY 2012/2013 Programmatic Milestones – Progress		
Target Date	**Programmatic Milestone**	**2013 Progress**
Black Ducks		
March 2013	Work with STAC and the Habitat GIT to host workshop on Targeting Restoration of Coastal Habitat Complexes, resulting in management guidelines for local governments on how to minimize impacts to waterfowl wintering habitat. (FWS, USGS)	**Complete.** April 2013- STAC workshop titled "Designing Sustainable Coastal Habitats" to assess the current status and trending condition of coastal ecosystems and identify habitat components that will be sustainable under increasing human impacts and a changing climate.
June 2013	Work with Joint Ventures and North Atlantic Landscape Conservation Cooperative to apply results of research on energetic carrying capacity of Bay habitats to articulate two-year milestones in terms of black duck habitat. (FWS, USGS)	**In progress.** Created a habitat layer for Marshlands Complex and PWRC for wintering black ducks which was used along with stratified random sampling to determine locations for biomass sampling. Samples are currently being analyzed while standardizing methodologies. Foraging trials have also been initiated and will conclude in FY14.
CONSERVE LAND AND INCREASE PUBLIC ACCESS		
Dec. 2012	Complete initial build-out of the Land Conservation Priority Mapping Tool. (NPS, USGS)	**Complete.**
Dec. 2012	Finalize public access plan. (NPS)	**Complete.**
Dec. 2012	Complete strategy to reduce the loss of working lands. (USFS)	**In progress.** Draft Strategy completed in 2013, will be finalized in 2014

Table A: FY 2012/2013 Programmatic Milestones – Progress		
Target Date	**Programmatic Milestone**	**2013 Progress**
EXPAND CITIZEN STEWARDSHIP		
Dec. 2012	Chesapeake Conservation Corps strategy will be finalized. (NPS)	**Complete.**
July 2013	Complete a set of research-based best practices in support of the meaningful watershed educational experience and develop metrics to monitor implementation of these practices by signatory states and the Chesapeake Bay Program. (NOAA)	**In progress.** In final review.
Oct. 2013	Serve on the Leadership Team for the Maryland Partnership for Children in Nature to ensure federal priorities are included in the nation's first effort to define a high school graduation requirement for environmental literacy. (NOAA)	**Ongoing.**
Nov. 2011	NOAA will convene a Mid-Atlantic Environmental Literacy Summit to focus on the intersection of science education and environmental literacy priorities, and to solicit state input on the draft federal K-12 Environmental Literacy Strategy. (NOAA)	**Completed in 2012.**
Nov. 2012	Work with the Chesapeake Bay Trust to build capacity for environmental education in the region, including supporting a workshop focused on incorporating best practices into metrics and self-assessment tools to support environmental education. (EPA)	**Completed in 2012.**

Table A: FY 2012/2013 Programmatic Milestones – Progress		
Target Date	**Programmatic Milestone**	**2013 Progress**
DEVELOP ENVIRONMENTAL MARKETS		
Sept. 2013	Hold a workshop to conduct knowledge assessments on drought and the Chesapeake Bay watershed (NOAA and USGS). These assessments will serve as the basis for establishing a Chesapeake Bay Watershed Regional Drought Early Warning Information System.	**Complete.**
Sept. 2013	Draft a Chesapeake Bay sentinel site cooperative implementation plan, focused on sea level rise in collaboration with federal, state, local, university and nonprofit partners. (USGS)	**Complete.**
Dec. 2013	Complete improvements to Chesapeake Land Change Model (version 3) to enhance assessments of the combined impact of climate and land change on the Bay and its watershed. Results from the model will also be used to assess vulnerability of conserved lands to future development. (USGS)	**In progress.**

Table A: FY 2012/2013 Programmatic Milestones – Progress		
Target Date	**Programmatic Milestone**	**2013 Progress**
SCIENCE		
Dec. 2012	Implement the CBP decision framework through interaction with all GITs. Summarize the information in Chesapeake*Stat* (EPA) and provide the science and monitoring needed to help support this adaptive management process. (USGS, NOAA, EPA)	**Complete.** For selected goal teams.
July 2013	As part of the Monitoring Alliance, engage local jurisdictions and NGOs on partnerships to expand the use of their water quality monitoring to assess conditions in the Bay and its watershed. (EPA) Integrate federal and state dissolved oxygen data across tidal, non-tidal and main stem monitoring data through the Data Enterprise to advance understanding of hypoxia and progress toward water quality standards. (EPA, USGS, NOAA)	**In progress.** Interacting with local partners and NGOs is ongoing. Nontidal data integration into Data Enterprise is complete.
Dec. 2013	Implement the Chesapeake Monitoring Alliance by producing more recent land cover (2011 data) for the Bay watershed that can be used to support the implementation of EO goals. (USGS)	**In progress.** USGS processing 2011 data for watershed. NOAA has completed coastal land cover data.

APPENDIX C:

Chesapeake Bay Models and other Decision Making Support Tools

Because the Chesapeake Bay and its watershed are so large and complex, scientists and restoration managers rely on a suite of linked computer models for critical information about the ecosystem's characteristics and for estimating the impact of various environmental actions on reducing pollution and improving water quality. Models are vital tools that help guide decision-making for reducing pollution and meeting water quality standards.

Chesapeake Bay model simulations, which are called scenarios, project pollution loads and flow. Scenarios simulate how various changes or pollution-reduction actions could affect the Bay ecosystem, especially water quality, wildlife and aquatic life.

Although model simulations are an important part of the Chesapeake Bay restoration effort, they are not considered to be perfect forecasts. Rather, model simulations are best estimates based on state-of-the-art, extensively peer-reviewed science. Modeling is part of a broader toolkit that includes research and monitoring to gain the highest possible level of accuracy in projecting future responses to actions.

CBP partners and stakeholders use a suite of linked computer models that are among the most sophisticated, studied and respected in the world. These models provide a comprehensive view of the Chesapeake Bay ecosystem from the deepest depths of the Bay to the upper reaches of the watershed, and from the air to the land to water.

Watershed Model

The Watershed Model incorporates information about land use, fertilizer applications, wastewater plant discharges, septic systems, air deposition, human populations, farm animal populations, weather and other variables to estimate the amount of nutrient and sediment pollution reaching the Chesapeake Bay and where these pollutants originate.

The Watershed Model divides the 64,000-square-mile Chesapeake Bay watershed into more than 2,000 segments delineating political and physical boundaries. Each segment contains information generated by several sub-models:

- The hydrologic sub-model uses rainfall, evaporation and meteorological data to calculate runoff and sub-surface flow for all land uses, including forest, agricultural and urban lands.
- The surface and sub-surface flows ultimately drive the non-point source sub-model, which simulates soil erosion and pollutant loads from the land to rivers.
- The river sub-model routes stream and river flow and associated pollutant loads from the land through lakes, reservoirs, streams and rivers to the Chesapeake Bay.

Estuary Model

The Estuary Model examines the effects nutrient and sediment pollution loads generated by the Watershed Model have on water quality. In the Estuary Model, the Chesapeake Bay is represented by more than 57,000 computational cells and is built on two sub-models:

- The hydrodynamic sub-model simulates the mixing of waters in the Bay and its tidal tributaries.
- The water quality sub-model calculates the Bay's biological, chemical and physical dynamics in response to nutrient and sediment loads to the Bay.

Scenario Builder

Scenario Builder is a tool which can generate simulations of the past, present or future state of the Chesapeake Bay watershed to explore potential impacts of management actions and evaluate alternatives.

Scenario Builder produces inputs for the Watershed Model based on factors from a wide range of land uses and management actions. For example, information such as acres of different crops, numbers of animals and extent of conservation practices is used to generate Watershed Model inputs for use types on working farms and ranches.

Airshed Model

The Airshed Model uses information about nitrogen emissions from power plants, vehicles and other sources to estimate the amount of and location where these pollutants are deposited on the Chesapeake Bay and its watershed. That information is fed into the Watershed Model.

Land Change Model

The Land Change Model analyzes and forecasts the effects of urban land use and estimates population effects on sewer and septic systems in the Chesapeake Bay watershed.

The forecasts are based on:

- Reported changes from the U.S. Census Bureau in housing, population and migration
- Land cover trends derived from satellite imagery
- Sewer service areas
- County-level population projections
- Conversion of forests and farmland development is based on a thorough examination of urban development and land conversion trends derived from satellite imagery dating back more than 25 years.

Determining Land Uses and Pollution Loads

To accurately simulate the Chesapeake ecosystem, models are built on current and specific uses of land in the watershed, such as forests, farms and development. Land uses are determined using authoritative sources such as satellite imagery and the USDA Census of Agriculture. Models are further refined by inputting land management features such as cover crops on farm fields and stormwater controls in urban areas.

The types and amounts of nutrient and sediment pollution that run off a particular land use are based on comprehensive reviews of the latest scientific literature. For example, the pollution loads incorporated into the Watershed Model are based on research from more than 100 academic papers. This comprehensive literature review provides the average pollution loads that various land uses contribute.

Pollution loads are also cross-checked with previous versions of the Watershed Model and other regional and national models. Pollution loads are further adjusted based on in-stream monitoring data, which increases accuracy for land use and location. Conservation practices, management actions and pollution controls that are implemented in specific places are then entered into the model to simulate reductions from these factors.

Incorporating Improvements to the Models

The suite of Chesapeake Bay models has been developed throughout nearly 30 years of collaboration by federal, state, academic and private partners. Chesapeake Bay model developers include EPA, USGS, USDA Natural Resources Conservation Service, USACE, the University of Maryland, Virginia Tech, Penn State University and Chesapeake Research Consortium. Advisers include Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia and the District of Columbia.

The Chesapeake Bay Program partnership continues to improve the quality of the data in the models by involving a wide range of partners, stakeholders and experts. Revised versions of the models are regularly shared with partners throughout the Chesapeake Bay community to allow for review, testing and suggestions. Anyone can participate in improving the Bay models, including working with the CBP partnership to have credible data and restoration practices incorporated. The models also undergo extensive independent scientific peer review by federal, state and academic scientists, as well as modeling experts.