Policy Analysis of H.R. 258

The Chesapeake Bay Accountability and Recovery Act of 2011

Faculty Advisor: Howard Apsan
Manager: Kendall Singleton
Deputy Manager: Pablo Antón Díaz
Team Members: Valerie Askinazi, Holly Battelle, Gillian Duggin, Hanna Helsingen, Emily Hobbs, Anne Huang, Jared Messinger, Anastazia Neely, Gabriel Prudencio, Leeann Sinpatanasakul

Columbia University, MPA in Environmental Science and Policy
Summer Workshop 2012

Contents

Executive Summary

The Chesapeake Bay is the largest estuary in the United States. Spanning more than 200 miles from the top of the Susquehanna River to the Atlantic Ocean, the Chesapeake Bay and its watershed covers parts of six states Virginia, Maryland, Pennsylvania, Delaware, West Virginia, New York and the District of Columbia. This expansive watershed is home to 17 million people and over 2,700 different species of plants and animals (FWS 2012). However, the interaction between people and the Bay's ecology has resulted in the overall deterioration of the health of the Bay. Estuaries are complex ecosystems that provide fundamental wildlife habitats and important ecosystem services that communities rely on for economic and social purposes.

Figure 1: The Chesapeake Bay Watershed

Source: The Chesapeake Bay Program.

In recognition of the Chesapeake Bay's importance, the Chesapeake Bay Program (CBP) began comprehensive restoration efforts in 1983. The CBP is a partnership of Chesapeake Bay States, federal agencies, academic institutions and non-government organizations and is coordinated by the US Environmental Protection Agency (EPA). Unfortunately, despite restoration efforts during the last twenty-five years, the majority of the Chesapeake Bay and its tributaries remain on the EPA's list of impaired watersheds (EPA 2012*)*.

The Chesapeake Bay Accountability and Recovery Act of 2011 (H.R. 258) acknowledges the need for stronger unified action and authorizes the EPA to oversee all current and forthcoming Bay restoration activities. In addition, the Bill calls for the use of a cross-cut budget, an adaptive management plan, and an independent evaluator to enhance the overall accountability of the restoration and implement scientifically based practices.

The Chesapeake Bay watershed is a complex and diverse ecosystem. Restoration of the Bay is an immense task and the solutions will prove challenging. The use of adaptive management, if applied correctly, should allow policy-makers to incorporate new strategies through a process of trial-and-error and, as more data becomes available, through scientifically sound research. As such, objective, consistent, and high quality measurements are integral components of the adaptive management plan. Given the magnitude of the problem, the level of uncertainty, the cost of cleanup, and the large number of stakeholders, controversy is inevitable in restoration activities. However, to ensure the Bill's successful implementation, widespread support is needed from all stakeholders.

1. The Chesapeake Bay Accountability and Recovery Act of 2011

Introduced by Representative Rob Wittman (R-VA1), the purpose of the Chesapeake Bay Accountability and Recovery Act of 2011 (H.R. 258) is to aggregate all current and ongoing restoration efforts in the Chesapeake Bay watershed under the authority of the Environmental Protection Agency. The Bill identifies three main solutions: the use of a cross-cut budget, an adaptive management plan, and an independent evaluator.

1.1 Cross-Cut Budget

The cross-cut budget will collect all funding and expenditure information related to restoration and conservation projects in the Chesapeake Bay area and consolidate this information into an integrated budget. The Bill requires the Director of the Office of Management and Budget (OMB) to submit a financial report to Congress that includes an interagency cross-cut budget for all restoration projects on the Chesapeake Bay proposed for the upcoming fiscal year, as well as details of expenditures for all restoration activities carried out by both federal and state agencies in the current and preceding two fiscal years.

1.2 Adaptive Management Plan

Restoration efforts will be reviewed and evaluated under an adaptive management plan (AMP), and a comprehensive report will be submitted to Congress annually. Within the context of sustainable development, adaptive management is defined as natural resource management that involves testing, monitoring, and evaluating applied strategies; and incorporating new knowledge into restoration activities, based on scientific findings and the needs of society (Testimony on H.R.258. 2011).

Figure 2. Adaptive Management Plan

Source: CSIRO.

The AMP must include an accurate definition of specific and measurable objectives to improve water quality, habitat, and fisheries. In addition, the AMP must incorporate processes that:

- Modify restoration activities that do not meet these objectives
- Involve stakeholder participation
- Contribute to research, monitoring and evaluation practices

- Prioritize and categorize all restoration activities within the Chesapeake Bay watershed to which adaptive management will be applied.

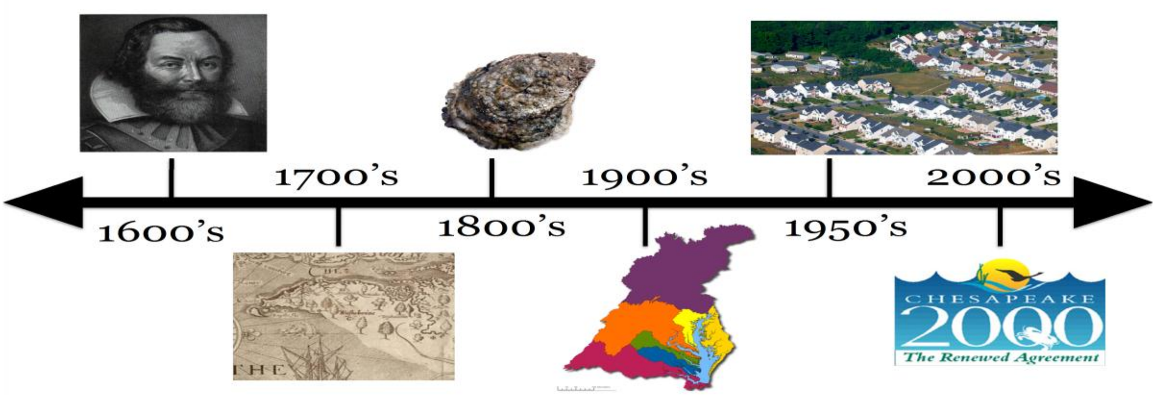
1.3 Independent Evaluator

The Bill calls for an independent evaluator to assess progress and deliver reports concerning the effectiveness and impact of all restoration activities and the use of adaptive management in the Chesapeake Bay watershed. The EPA's Administrator will select this evaluator from among four nominees submitted by the Chesapeake Executive Council. The evaluator will be required to submit a report to Congress every two years with findings and recommendations.

Box 1. The History of the Environmental Problem

Key dates include:

- John Smith arrived in 1607. By 1650 Jamestown settlers had begun cutting trees and clearing land to farm tobacco.
- By the 1700s, colonists had stripped 20-30% of the region's forest, which subsequently led to erosion. Sediment filled bodies of water and created un-navigable shipping ports. Also during this time, fishing industries were developed.
- By the 1850s, oyster harvests had doubled.
- In the 1900s, scientists began to consider the Bay as a single entity rather than classify it by its individual water bodies.
- In the 1950s, the first suburbs were built.
- In 1973, the Chesapeake Bay Foundation formed.
- In 2000, the Foundation launched *Chesapeake 2000* – an ambitious goal to have the Bay removed from the EPA's list of impaired waters by 2010. This goal has still not been met.



Sources: Shmoop (John Smith), Learn NC (historic map), National Geographic (oyster), University of Virginia (watershed), Chesapeake Stormwater Network (suburbs), Chesapeake 2000 (logo).

2. Environmental Problems In The Chesapeake Bay

The Chesapeake Bay Accountability and Recovery Act of 2011 identifies four specific environmental problems that the Bill will address:

- Poor water quality
- Threats to water resources
- Threats to living resources
- Threats to habitat and biodiversity

Over the last ten years, water quality indicators, such as dissolved oxygen (DO), have been insufficient in 75% of the Chesapeake Bay and its tidal waters (CBF 2012). Bay grasses are considered an excellent indicator of bay health, as they require high DO and water clarity conditions. From 2010 to 2011, pollution and urban development caused an estimated loss of 16,590 acres of underwater bay grasses (CBP 2012a). The loss of underwater bay grasses can have dramatic effects on many marine wildlife species, including blue crabs, waterfowl, and juvenile fish, that seek refuge in this habitat. Oysters in the Chesapeake are also at great risk: currently, oysters are at less than 1% of 19th century population levels (NOAA 2012). As filter feeders, it is estimated that the historic population of oysters could filter the Bay's waters in a week. Today, it would take over a year (CBF 2012).

Box 2. Erosion in the Chesapeake Bay

Developing forested land eradicates vegetative roots that hold the soil together. Without these roots in place, loose sediment enters the waterways. This process is called ***erosion*** *(see Figure 3).*

Erosion in the Chesapeake Bay

Source: Patapsco River Basin Report.

Turbidity *refers to the clarity of the water. If the bottom of the water body is not visible or appears murky, the water is considered turbid (high turbidity).*

Once sediment enters the waterway through erosion, it contributes to the overall turbidity of the Bay.

2.1 Pollutants and their Impact on the Chesapeake Bay

The Bay is impacted by a range of pollutants, including bacterial waste, pesticides, oil, and other chemicals. The primary pollutants impacting the Bay are nitrogen, phosphorus and sediments (EPA 2010a). Nitrogen and phosphorus are critical elements for plant growth and are components of chemical fertilizers, manure, and soaps. When excess nitrogen and phosphorus enter the waterways, they allow an overabundance of algae to grow and die rapidly, known as an algal bloom (see Figure 3). Decaying algae leads to a depletion of oxygen in the surrounding water (NOAA 2010). This causes mortality rates to spike in fish and other aquatic species. These algal blooms can also block sunlight from reaching the bottom of an aquatic habitat and prevent the growth of bay grasses. Without sufficient bay grass, natural habitats for organisms, including juvenile fish and crabs, are destroyed and sediment accumulates in the water column (Stevenson et. al. 1979).

Figure 3: Algae Bloom in the Chesapeake Bay and Their Impact on Fish

Source: PilotOnline.com (left), OceanDoctor.org (right).

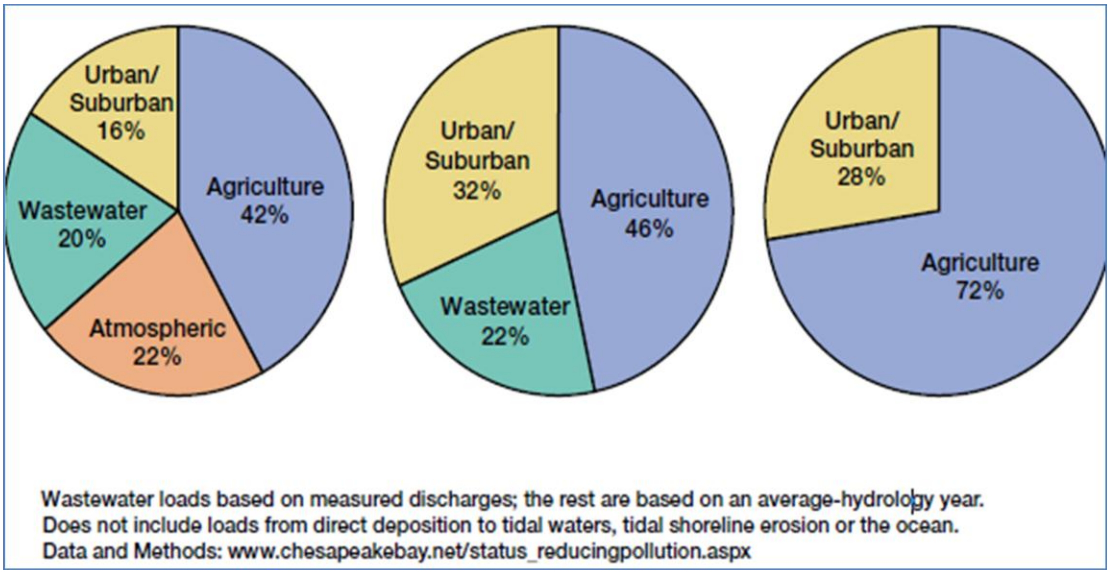
Sediments are another major pollutant to the Bay. Although some sediment in water bodies occurs naturally, excess sediment can clog fish gills, “suffocate fish eggs and aquatic insect larvae, and cause fish to modify their feeding and reproductive behaviors” (Klapproth and Johnson 2009). In addition, sedimentation blocks sunlight in a manner similar to algal blooms. Large sediment loads can also change the depth and water level and dry up previously filled water bodies (Klapproth and Johnson 2009).

In addition to nitrogen, phosphorus and sediment, bacteria and pesticides are also significant sources of pollution in the Bay. Bacterial pollutants can cause disease and illness (Klapproth and Johnson 2009), and pesticides and oil are toxic to both aquatic life and humans (USFWS 2011).

2.2 Sources of Pollutants

Agriculture activities, such as field crops and livestock operations, comprise 22% of the total land use in the Bay area (EPA 2010b). Agriculture is the largest source of pollution in the Chesapeake Bay and contributes 42% of nitrogen pollution, 46% of phosphorus pollution and 72% of sediment pollution (see Figure 4). Atmospheric pollution, which originates from the burning of fossil fuels in power plants, cars, and other activities such as urban/suburban development and wastewater discharge are also key sources of pollution in the Bay (EPA 2010b).

Figure 4: Relative Responsibility for Pollution Loads to the Bay (2007)



Source: (CPB 2007).

2.3 Transport Mechanisms of Contaminants into the Bay

Nitrogen, phosphorus and sediment are transported into the Bay through two mechanisms: direct and indirect discharge.

i. Direct Discharge (Point Source Pollution)

Direct discharge occurs when a wastewater treatment plant, factory, power plant or Concentrated Animal Feeding Operations (CAFOs) discharges polluted water directly into a water body via a pipeline. In the Chesapeake Bay, most wastewater treatment plants do not undergo the tertiary treatment necessary to remove nitrogen and phosphorus and discharge these chemical directly into the water (DCWASA 2009).

Figure 5. Direct Discharge from Wastewater Treatment Plants, Industrial Facilities and CAFOs

Source: University of Maryland.

ii. Indirect Discharge (Non-Point Source Pollution)

Several mechanisms transport non-point source pollutants from the surface to tributary streams and ultimately into the Chesapeake Bay. During a rain event, pollutants such as fertilizers on a farm, herbicides and pesticides on lawns, street litter and loose soil from a construction or recently cleared site are all washed from the ground into the nearest body of water, typically a small stream in the area. This stormwater-carrying pollution is known as runoff (Klapproth and Johnson 2009). Runoff becomes a problem when it picks up these pollutants from storm drains and discharges the untreated water directly into the nearest stream, river, or lake. Storm drains are necessary to prevent flooding in areas with paved surfaces, especially in urban and suburban areas, but the runoff becomes contaminated when it picks up these pollutants. Moreover, the water travels much faster during a storm event, and this rapid water flow can impact stream banks or other landscapes. Because storm drains and pollutants are present in every urban and suburban community, seemingly small, individual choices can accumulate over a drainage area as large as the Chesapeake Bay.

2.4 Ecological Impacts

i. Habitat Loss

Land use change includes the conversion of forested areas into farmland or suburban developments. These changes have a profound effect not only on the immediate habitat loss for organisms, but also for the loss of such ecosystem services as the watershed's natural ability to control flood and filter sediment. The increased area of paved surfaces leads to greater amounts of sediment and chemical runoff into stream habitats (Goetz et. al. 2004). Erosion destroys habitats in streams and along their edges. In both cases, habitat destruction impacts ecology downstream by increasing the amount of sediment carried and decreasing prey available for consumption. Erosion and pollutants entering the Bay impede the growth of underwater bay grass and other vegetated habitats. This lack of habitat places additional stress on fish and shellfish populations that require clean water, ample aquatic habitat, and properly managed fisheries to survive and reproduce.

ii. Wildlife Loss

The loss of habitat in the Bay impacts the abilities of larger species to thrive and reproduce, leading to their decline. Oysters, blue crabs, American shad, striped bass, and juvenile menhaden have been identified as crucial indicators of health in the Bay, due to their important ecological functions and economic roles for commercial and recreational fishermen.

Figure 6: Oysters in Chesapeake Bay

Source: Chesapeake Bay News.

a. Oysters

Oysters can filter out nutrients and chemicals from the water. However, the magnitude of the pollution influx into the Bay is greater than the oyster population can handle, evident by an increase in mortality rates (CBF 2012). The decline in oysters in the Bay also stems from overharvesting, disease, and overall reduced water quality (CBP 2005).

b. Crabs

Poor water clarity and a lack of oxygen are the primary reasons for the decline in blue crabs (CBF 2012). While the overall number of crabs remains low, in 2008 Maryland and Virginia began restricting the harvest of female blue crabs. Their efforts proved successful, as the number of blue crabs in the Bay in 2011 is estimated to have tripled. Still, scientists believe that poor water quality continues to limit their full recovery (CBF 2012).

Figure 7: Crabs in Chesapeake Bay

Source: The Chesapeake Bay Program.

c. Fish

Due to their economic importance in the region, the Chesapeake Bay Program focuses on American shad, striped bass, and juvenile menhaden as three indicator fish species affected by the pollution entering the bay, in addition to overfishing. Preliminary scientific data indicates a potential decline in numbers for juvenile Menhaden, an important keystone species in the Bay, due to these activities (CPB 2012d). Striped bass numbers have rebounded significantly after a three-year moratorium in the 1980s, but American shad populations remain low due to human influences in the Bay watershed (CBP 2012c).

Figure 8: Fish in Chesapeake Bay

Source: The Chesapeake Bay Program.

3. The Need for Government Action

Should pollution continue unabated, there will be severe consequences to the environment, the economy, and the daily lives of Bay residents. Although addressed separately below, environmental, economic and social impacts are all closely intertwined and in many cases overlap. Federal action is imperative to promote collaboration between the Chesapeake Bay watershed states in their efforts to address these impacts.

3.1 Environmental Impacts

As discussed in the previous section, water quality in the Bay has yet to satisfy EPA standards. Without remedial measures water quality will continue to decline. This could result in a permanent loss of wildlife habitat. In addition to poor water quality, habitat loss, fragmentation, invasive species, contaminants, overharvesting of fisheries, disease and climate change all threaten fish, wildlife and habitats in the Bay ("Report to Recommend" 2009).

3.2 Economic Impacts

The Chesapeake Bay is an economic engine worth an estimated $1 trillion dollars (CBF 2012). The Chesapeake Bay Foundation estimates that nearly 500 million pounds of seafood are caught in the Bay annually (CBF 2012). In addition to fishing, tourism is another large economic driver in the Bay states, approx. 8 million wildlife watchers spent $636 million, $936 million and $1.4 billion in Maryland, Virginia, and Pennsylvania, respectively. In 2006, approximately 8 million wildlife watchers spent $636 million, $936 million and $1.4 billion in Maryland, Virginia, and Pennsylvania, respectively, on trip related expenses and equipment (CBF 2012). By neglecting the health of the Chesapeake, these industries all face risk of decline, with potentially devastating impact on local and regional economies.

Figure 9. Fishery in the Chesapeake Bay

Source: Walt Hubis, "The Traveling Photographer".

3.3 Social Impacts

Home to more than 17 million people, the Chesapeake Bay is an immense resource for recreational activities including fishing, boating, hiking, and swimming (see Figure 10). As development and pollution continue to grow, recreational access to the Bay may be diminished. The unhealthy state of the Bay may also have serious consequences for human health. High bacteria levels and harmful algal blooms have forced municipalities in Maryland, Pennsylvania, and Virginia to issue no-swimming advisories in recent years. There have been reports of nausea, vomiting, fevers, and skin rashes from people who have come into direct contact with these blooms while swimming (CBF 2009).

Figure 10. Swimming in the Chesapeake Bay

Source: Explore Virginia Outdoors.

4. Impacts of the Proposed Solution

In response to the problems associated with ongoing restoration efforts and CBP noted above, the Bill's approach focuses on enhancing accountability and implementing improved and scientifically based management practices. As mentioned before, the Bill uses three distinct tools:

- Cross-cut Budget
- Adaptive Management Plan
- Independent Evaluator

4.1 Impacts of the Cross-Cut Budget

The cross-cut budget will likely improve transparency and accountability of restoration efforts by making budget information from multiple agencies readily comprehensive, accessible to Congress, and available to the public. This will enable Congress to easily compare agencies' activities and identify potential funding gaps and overlaps. The cross-cut budget intends to improve the allocation of limited financial resources to more effective programs and enhance institutional coordination because it will treat the watershed as one entity, rather than as a group of distinct jurisdictions (CBP 2008).

4.2 Impacts of the Adaptive Management Plan

AMP can address complex environmental problems, because it is well suited for highly uncertain activities such as the large-scale ecosystem restoration effort of the Chesapeake Bay (Gunderson et al 2006). It will modify CBP's previously traditional, less flexible management approach to one that emphasizes modeling, experimentation, evaluation and learning (Lee 1999 and Gunderson et al 2006). The AMP should also improve the dialogue between decision-makers and scientific experts (Testimony on H.R.258. 2011). Overall, the AMP is expected to have greater long-term success compared to traditional approaches due to its focus on continual monitoring, evaluation and improvement.

In practice, however, the adaptive management (AM) can be difficult to implement. Government agencies tend to be justifiably resistant to implementing policy in a context of scientific uncertainty. This may present a barrier for operating flexibly and across institutional boundaries (Lee 1999). Chesapeake Bay stakeholders can also potentially create obstacles for implementation. For example, scientists may view AM as a threat to existing scientific research programs. Environmental interests groups may feel threatened by uncertainty and experimentation, which can be seen as too risky especially if the area contains sensitive or endangered species (Walters 1997 and Lee 1999). Technical issues can also hinder progress, including limited data and knowledge about key ecological relationships, and how to model them (Walters 1997). Additionally, AM can be more costly than traditional management due to its emphasis on monitoring (see Figure 12). There is also a risk that other economic interests may be damaged or delayed through the installment of large-scale field experiments (Walters 1997). Long-term experiments often do not lend themselves to intermediate reporting, and do not allow enough time to assess the impacts on the ecosystem (Lee 1999). In spite of these challenges, AM still offers a very positive model for improving management practices in the Bay. To ensure the successful implementation of the AMP, widespread agency and stakeholder support will be needed.

In conjunction with the activities already underway, the Bill should significantly improve the accountability and recovery of the Chesapeake Bay's restoration effort, and do so at a relatively modest cost. The Congressional Budget Office estimates that implementing the legislation would require approximately $1 million annually over the 2012-2016 period (Testimony on H.R.258 2011). However, the restoration of the Bay will continue to be an immense task that requires significant additional funding from the independent organizations involved.

4.3 Impacts of an Independent Evaluator

The independent evaluation process will verify the accuracy of the information and will employ scientifically rigorous approach to evaluate the success of restoration activities, and can unify statistics into a comprehensive, easy to understand source. If evaluators' recommendations are applied, overall effectiveness and efficiency of the program will be measured. This process is also likely to restore credibility and trust among stakeholders (Dawes 2009). There is always a risk that the appointee may not act 'independently' if s/he is too personally close to the relevant agencies (Bennear, et al). Moreover, if recommendations are not incorporated into subsequent decision-making processes, the evaluator will be of limited use.

5. The Science Behind Chesapeake Bay Accountability and Recovery Act of 2011

The Bill provides a framework to restore the Bay in a scientifically sound manner. The legislation addresses the scientific process by promoting continuous monitoring, research, forecasting, and independent evaluations of all restoration efforts. Monitoring and research will be performed by non-profit organizations, state and federal agencies, and academic institutions (Phillips 2005). The United States Geological Survey (USGS) has been given the lead responsibility of synthesizing monitoring information so that the EPA, US Department of Agriculture (USDA), and each of the six Chesapeake Bay states and Washington, D.C. can more effectively implement restoration strategies (Phillips 2011). Ultimately, the AMP recognizes the uncertainty associated with such a complex ecosystem by striving to continually improve the strategies discussed below.

5.1 Implemented Strategies and Impacts

An understanding of how sediment, nutrients, vegetation, wildlife and humans interact to create a complex wetland system will aid in the restoration of the Bay. For example, reducing sediment and nutrient pollution can improve water quality, while restoring aquatic habitats can increase fish and oyster populations (Interstate Commission on the Potomac River Basin 2012). A combination of old and new scientific methods are used in order to set these positive processes in motion. Current strategies can be divided in to four areas: physical, chemical, biological, and ecological.

Figure 11. Physical Solutions: Stone Wall (above) and riparian buffer (below)

Source: Environmental Land Improvements, Inc.

Source: University of Maryland.

i. Physical

Structural stabilization of shorelines can provide erosion control. In addition to conserving fish and wildlife habitats, engineered structures prevent sediment from being transported downstream, which would otherwise increase stream turbidity and block sunlight for marine organisms. Barrier structures include bulkheads and stone walls, as well as off-shore structures such as breakwaters, groins and jetties. All reduce the physical severity of water hitting the shoreline (MD Department of the Environment 2008). The root systems of vegetated riparian buffers (see Figure 11) lock in soil bordering waterways, and hold shoreline sediment in place (USDA Forest Service 2012). Creating more meandering bends in the stream will slow water flow and have a stabilizing effect on the shoreline (Burke 2010). Furthermore, physical infrastructure modifications such as permeable pavement and vegetated roofs increase the availability of rainwater absorption and reduce storm water runoff (Chesapeake Stormwater Network 2012). Rainwater harvesting methods also reduce the volume of stormwater runoff reaching the Bay. Diverting polluted rainwater from storm drains decreases nutrient and pollutant input to the Bay from urban areas, thereby improving the overall water quality in the Bay.

ii. Chemical

The Chesapeake Bay Total Maximum Daily Load (TMDL) values set a limit of acceptable nutrient and pollutant inputs to the Chesapeake Bay (see Box 3 for more information). The AMP will assist the Bay states in meeting these designated levels. One example of an innovative solution is spreading manure from poultry operations over abandoned mine lands in a two-fold effort to restore the land's productivity and decrease runoff of agricultural nutrients (Burke 2010). Nitrogen pollution in particular could be reduced by minimizing the impact of combined sewer overflows (CSOs). Renovating wastewater treatment plants can help to ensure that wastewater is treated before reaching the Bay. For example, the Blue Plains Wastewater Treatment Plant (which serves the Washington, DC area) is currently undergoing renovations that will result in an 83% reduction in the amount of nitrogen in wastewater released from this plant by 2014 (Courtney 2011).

Box 3. Total Maximum Daily Load

In 2010, the U.S. EPA established the Chesapeake Bay Total Maximum Daily Load (TMDL). The purpose of setting TMDLs is to limit the amount of nitrogen, phosphorus and sediment – considered the three most pervasive and detrimental pollutants in the Bay – that can be released by Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia and the District of Columbia in order to meet reduction goals. The Chesapeake Bay TMDL is the largest and most complex TMDL ever developed by EPA.

By 2025, all necessary pollution control measures that are needed to fully restore the Bay and its tidal rivers should be in place, and at least 60% of the actions should be completed by 2017. The Chesapeake Bay TMDL sets overall limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus and 6.45 billion pounds of sediment per year. These limits strive for a 25% reduction in nitrogen, 24% in phosphorus, and 20% in sediment by 2025 from the 2009 baseline. In addition, the TMDL grants EPA the federal authority to control pollution allocations through discharge permits and federal contingency actions to ensure compliance at the state level. (EPA 2010a)

iii. Biological

Reducing pollutants and increasing dissolved oxygen content will enhance biological activity in the Bay. The creation of fish and oyster reserve areas promote the restoration of native populations, which consequently improves water quality through natural oyster filtering activity. Maryland's Department of Natural Resources plants an average of 2.5 million bushels of dredged shell every year (see Figure 12), which provides a setting substrate for oyster larvae (Campbell 2008). The seeds are then distributed to areas where oyster populations are low. Submerged aquatic vegetation (SAV) is essential for fish habitats, therefore increased SAV planting and removal of invasive plants will revitalize the biological diversity of the Bay (CBP 2003).

Figure 12. Oyster Shells Put Back into the Bay to Restore Oyster Habitat

Source: Chesapeake Bay Foundation.

iv. Ecological

A fundamental strategy for avoiding ecological loss in the Chesapeake Bay watershed is to protect undeveloped land through programs such as the Conservation Easement Program, which provides tax incentives for private landowners to protect their land ("Private Lands Conservation" 2012). Alternatively, reclamation of wetlands is possible through excavation and conversion of drainage ditches and abandoned land. The natural hydrology of an altered wetlands area can be restored by creating plunge pools and sediment traps, which will prevent sediment from moving downstream. Aquatic habitat revitalization in the estuary itself is possible through artificial reef creation efforts (Loftus and Stone 2007). For example, sinking of "reef balls" (spherical concrete structures with openings for aquatic organisms, see Figure 13) provide an underwater habitat for benthic organisms and larger aquatic life.

Figure 13. Reef Ball Used for Artificial Habitat Restoration

Source: Stevenson University.

5.2 New Strategies and Solutions

Command-and-control policies and market based incentive programs are continually evolving to help restore the Bay. Command-and-control suggests a rigid, top-down approach, whereas market based policies usually allow industry to participate in finding the most economically sensible solution for reaching an overall goal. Both forms have advantages and disadvantages, and for an ecosystem as complex as the Chesapeake Bay, a combination of both is likely needed. Geographic Information Systems (GIS) provides an increasingly useful tool for mapping where restoration programs are needed, most feasible, or most successful. Implementation of a nutrient trading program has been successful in some local watersheds, and may be more widely implemented in the future to limit effluent nutrients. Conversion of excess agricultural manure to heat and energy is in the research stage as a strategy to decrease manure-nutrient release to local waters while providing an energy alternative in the Chesapeake Bay watershed (Chesapeake Bay Commission 2012).

6. Measuring the Program's Success

Pollution reduction goals agreed upon among CBP states have often been missed, in part due to insufficient enforcement by the EPA. The CBP states failed to meet the 2010 pollutant reduction goal set in *Chesapeake 2000* – an agreement designed to guide restoration efforts (Fahrenthold 2009). The states only met 54% of the nitrogen reduction goal and 68% of the phosphorous reduction target (CBP 2012b), causing the Bay to remain on EPA's list of impaired waters despite numerous restoration efforts over the past thirty years (Blankenship 2006).

Figure 14. Monitoring Ocean Waters

Source: NASA.

The root issue is not a lack of measurements, but rather a lack of uniform standards and a portal to synthesize the data (U.S. Government Office of Accountability 2011). Currently, various environmental research institutions, educational centers, as well as government entities such as the USGS, National Oceanic and Atmospheric Administration (NOAA), and National Aeronautics and Space Administration (NASA), all take measurements of the Bay, but the data collected is not analyzed and reported uniformly and consistently.

6.1 Measurement Indicators

The pollutant reduction goals for nitrogen, phosphorous, and sediments are set in place by the EPA's Chesapeake Bay TMDL, (see Box 3 for more information) and assess water quality through the three indicator species: underwater bay grass, crabs and oysters.

6.2 Performance Measurements in the Bill

Consistent performance measurement standards among the states and federal agencies are essential because they 1) enable measurements taken by different organizations to be comparable and complementary; 2) illustrate an in-depth outlook of the Bay by incorporating different interpretations from participating scientific communities; and 3) provide better assessments of the program's successes and shortcomings by promoting continuous improvement of the AMP. Through a standardized assessment, the Bill can better measure the progress of the Bay's restoration effort.

i. Cross-Cut Budget

The cross-cut budget examines the funding allocations and expenditures from past, current and future restoration activities. Standardized measurement is crucial to ensure impartiality when reviewing the financial accountability of each state and to ensure appropriate future funding for each state's restoration projects.

ii. Adaptive Management Plan

Measurements provide clear evidence to indicate the effects of a program, and guide the assessment on its general success or failure. This evidence is also critical in informing how the strategies and goals can promote continuous improvement. Possessing common performance standards to measure the outputs and outcomes of each individual strategy will provide the consistency necessary to make the best possible adjustments to the plan (see Figure 15 for more on outputs and outcomes).

Figure 15. Measuring Outputs, Outcomes and Goals

iii. Independent Evaluator

An independent evaluator reviews and reports to Congress on the use of an AMP in the restoration activities. This third-party evaluation will ensure the scientific rigor and external validity of the performance measurements used in the AMP. The use of common measurement standards in the AMP throughout the entire Chesapeake watershed will help facilitate the evaluator's auditing process.

7. Political Debate and Scientific Controversies

The legislators who introduced H.R. 258 to Congress have a variety of concerns, ranging from agricultural pollution to natural gas drilling and fracking, and they are working closely with the Chesapeake Bay Commission to address the issues.

Other supporters of the legislation include an array of non-governmental organizations such as the Chesapeake Bay Foundation and the Chesapeake Bay Trust. Opponents of the legislation, while in agreement that the Bay needs to be cleaned-up, are often advocates for urban development or traditional energy production. Given the vast number of stakeholders involved in restoration activities, the number and diversity of controversies surrounding the Chesapeake Bay are extensive. This section will highlight some of the key controversies: population growth, climate change, oyster restoration and TMDLs.

7.1 Population Growth and Climate Change

The global issues of population growth and climate change are two concerns that the communities within the Chesapeake watershed must address. Rapid growth in the region over the next 20 years is projected to lead to a population increase of 58%, from 17.5 million in 2011 to 20 million in 2030 (Chesapeake Bay 2012). This growth will strain infrastructure and likely result in an increase in discharged pollutants. In addition, the projected impacts from climate change, including rising sea levels, increased intensity of storms, and property loss due to flooding are all expected to greatly impact Chesapeake Bay communities.

7.2 Oyster Restoration

Due to high levels of pollution and overharvesting, the population of the Eastern oyster has decreased dramatically in the past 30 years (CBF 2010). The decline of the oyster populations over the last 30 years has resulted in economic losses of more than $4 billion in Virginia and Maryland. Furthermore, goals like the CBP commitment to a tenfold increase in oyster populations have not been met. An oyster management plan (OMP) was instituted by CBP to specifically address the goal of increasing populations.

Figure 16. Local Chesapeake Bay Oyster

Source: US Army Corp of Engineers.

The prided local Crassotera Virginica shown above is an environmental indicator of the state of the bay. TMDLs are in place to decrease pollution, improve water quality, and aid in creating a better habitat for this species. Oyster restoration proves vital to the ecosystem due to the many benefits provided by the organism. However, populations are low. The use of nonnative species was proposed for oyster restoration projects, but has so far been rejected on the grounds of unforeseen consequences.

Currently, the local Eastern oyster, the Crassotera Virginica, is neither self-sustaining nor as hardy as some other species. Virginia and Maryland lawmakers proposed the introduction of Asian species, such as Crassotera Ariakensis. Proponents assure communities that the Crassotera Ariakensis is more resistant to diseases, could withstand high salinity characteristic of the Chesapeake Bay, are bred to sterility, and can therefore be contained in aquaculture (Lei 2012). A fraction of fishermen are proponents of the introduction of non-native species, after years of lower yield harvests and the introduction of “no fish” oyster sanctuaries used to increase populations. Opponents of nonnative species introduction, including environmentalist groups, academics and sport fisherman, argue that this new species could possibly escape from containment in caged aquaculture, reproduce despite claims of sterility, and lead to potentially adverse side effects for the entire ecosystem.

In a five-year investigation, the Environmental Impact Statement (EIS) evaluated stakeholder's position on the matter. The United States Army Corps of Engineers (USACE) signed a Record of Decision prohibiting the introduction of non-native species. Research for more disease resistant crossbreeds continues.

7.3 Total Maximum Daily Load (TMDL)

In December 2010, the EPA released updated discharge standards for the watershed's TMDL. The Chesapeake Bay TMDL, comprised of 92 sub-TMDLs assigned to tidal streams throughout the watershed, limits the amount of pollutants (including nitrogen, phosphorous, and sediments) that enter the Chesapeake Bay watershed through point sources and non-point sources (Godwin 2012). The ultimate goal of the TMDL is to meet federal water quality standards by 2025 (EPA 2012).

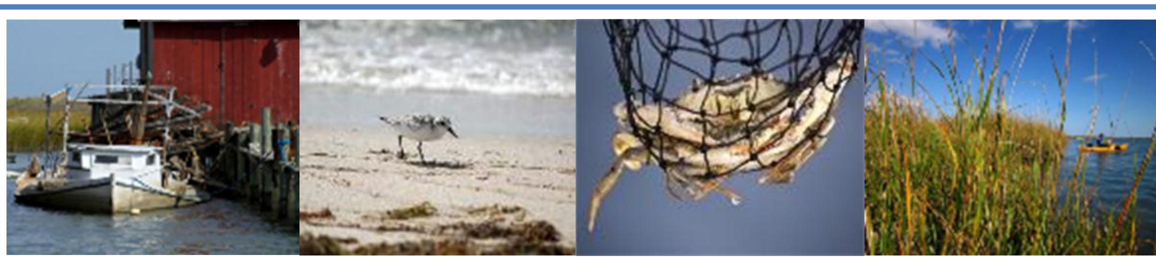
City, state, and county governments, in conjunction with federal agencies such as the U.S. Fish and Wildlife Service, were involved in the development of the sub-TMDLs. Jurisdictions with limited tax revenue are concerned with the cost of implementing and complying with these new TMDL requirements. Shortly after the institution of the TMDLs, a group of agricultural businesses in Pennsylvania filed a lawsuit opposing the institution of TMDLs (Godwin 2012). Public agencies, nonprofits, and environmental organizations filed a counter motion.

Some New York State lawmakers opposed the TMDL goals as "unattainable" and that the EPA is "overstepping its bounds" (Godwin 2012). The National Home Builders Association says the plan could detract from other options such as nutrient trading. Supporters of the TMDL claim suits only delay action and environmental remediation.

8. Conclusions

In conjunction with all the restoration activities currently under way, the Bill should significantly improve the accountability and recovery of the Chesapeake Bay restoration effort, and at a relatively modest cost. The Bill attempts to set realistic goals to restore the environmental quality of the bay. The restoration of the Bay will require stakeholders to incorporate acquired knowledge and revise implementation strategies in a swift manner. The Bill will assist organizations such as NOAA and the Chesapeake Bay Foundation to constantly improve their restoration strategies and monitor their own success. Solutions may range in magnitude, but both small- and large-scale restoration strategies will have a measurable impact on water quality.

Chesapeake Bay will continue to face existing and new challenges in coming years, including rapid urban growth and climate change impacts. As the problems affecting the Bay continue to grow in complexity, the solutions will require more sophistication and coordinated stakeholder collaboration if restoration activities are expected to achieve the proposed positive impacts in the long term.



Source: Chesapeake Bay Program

9. Works Cited

Bennear, Lori, and Katherine L. Dickinson. “The Role of Program Evaluation in Environmental Policy: A. Critical Evaluation of Incentives Created by GPRA and PART.” Web. 15 August 2012. <www.duke.edu/~lds5/Papers/Bennear_Dickinson_GPRA_PART.pdf>.

Burke, David G., and Joel E. Dunn. *A Sustainable Chesapeake: Better Models for Conservation*. Arlington, VA: Conservation Fund, 2010. Print.

Campbell, Eric. "Maryland Recreational Fisheries." *Oyster Restoration in Maryland*. Maryland DNR, Aug. 2008. Web. 12 July 2012. <http://www.dnr.state.md.us/fisheries/recreational/articles/oysterrestoration.html>.

Chesapeake Bay. National Geographic. n.d. Web 5 Aug 2012. <http://www.chesapeakeadaptation.org/>.

Chesapeake Bay Commission, Chesapeake Bay Foundation, MD Technology Development Corporation, and Farm Pilot Project Coordination Inc. "Sustainable Solutions for the Chesapeake Bay Region." *Manure to Energy*. Chesapeake Bay Commission, Jan 2012. Web. 12 July 2012. <http://www.chesbay.us/Publications/manure-to-energy%20report.pdf>.

Chesapeake Bay Foundation (CBF). "Bad Water 2009: The Impact on Human Health in the Chesapeake Bay Region." Chesapeake Bay Foundation, 2009. Web. 15 August 2012. <http://www.cbf.org/document.doc?id=328>.

Chesapeake Bay Foundation (CBF). *CBF Report Finds Bay Pollution Is Killing Jobs and Slowing Economy - Chesapeake Bay Foundation*. n.p., 29 Nov. 2010. Web. 09 June 2012. <http://www.cbf.org/page.aspx?pid=2168>.

Chesapeake Bay Foundation (CBF). 2012. "The Economic Argument for Cleaning Up the Chesapeake Bay and Its Rivers." Chesapeake Bay Foundation, May 2012. Web. 15 June 2012. <http://www.cbf.org/page.aspx?pid=2168>.

Chesapeake Bay Program (CBP). 2005. "2004 Chesapeake Bay Oyster Management Plan." Chesapeake Bay Program, 2005. Web. 14 June 2012. <http://www.chesapeakebay.net/content/publications/cbp_12889.pdf>.

Chesapeake Bay Program (CBP). “2008 Congressional Research Service, Crosscut Budgets in Ecosystem Restoration Initiatives: Examples and Issues for Congress.” 22 January 2008. Web. 15 August 2012. <http://www.chesapeakebay.net/>.

Chesapeake Bay Program (CBP). 2012a. "Chemical Contaminants." Chesapeake Bay Program, 2012. Web. 14 June 2012. <http://www.chesapeakebay.net/issues/issue/chemical_contaminants#inline>.

Chesapeake Bay Program (CBP), 2012b “About ChesapeakeStat,” “Partner Coordination & Support ,” “Water Quality: Overview” ChesapeakeStat. Web July 14, 2012.

Chesapeake Bay Program (CBP). 2012c. "Shad." Chesapeake Bay Program, 2012. Web.14 June 2012. <http://www.chesapeakebay.net/issues/issue/shad#inline>.

Chesapeake Bay Program (CBP). 2012d. "Menhaden." Chesapeake Bay Program, 2012. Web. 14 June 2012. <http://www.chesapeakebay.net/issues/issue/menhaden#inline>.

Chesapeake Bay Program (CBP). "Strategy to Accelerate the Protection and Restoration of Submerged Aquatic Vegetation in the Chesapeake Bay." *Executive Summary*. Chesapeake Bay Program, Dec. 2003. Web. 12 July 2012. <http://www.chesapeakebay.net/content/publications/cbp_12608.pdf>.

Chesapeake Stormwater Network. "Design Specifications." *Publications*. Chesapeake Stormwater Network, Mar 2012. Web. 12 July 2012. <http://chesapeakestormwater.net/category/publications>.

Courtney, Shaun. "Blue Plains Receives $104 Million from Maryland for Wastewater Treatment Upgrades - Gaithersburg, MD Patch." *Gaithersburg Patch*. n.p., Aug 2011. Web. 12 July 2012. <http://gaithersburg.patch.com/articles/blue-plains-receives-104-million-from-maryland-for-wastewater-treatment-upgrades-2>.

Dawes, Katherine. ‘Environmental Program Evaluation in Government: A Perspective from the US,’ presentation given to Environmental Evaluators Network-Canada Ottawa, Canada September 2009. (online).

DCWASA. 2009. "Combined Sewer Overflow (CSO) Control Activities." *DCWater.com*. District of Columbia Water and Sewer Authority. Web. 14 June 2012. < http://www.dcwater.com/news/publications/cso_fall09x.pdf>.

Fahrenthold, David A. “Chesapeake Bay Cleanup Fails Again.” The Washington Post. 3 Jan 2009. Web. 20 July 2012. <http://www.washingtonpost.com/wpdyn/content/article/2009/01/02/AR2009010202087.html>.

EPA. 2010a. "Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus and Sediment: Chapters 1-3." *EPA.gov*. Environmental Protection Agency. Web. 14 June 2012. <http://www.epa.gov/reg3wapd/pdf/pdf_chesbay/FinalBayTMDL/CBayFinalTMDLExecSumSection1through3_final.pdf>.

EPA. 2010b. "Chesapeake Bay TMDL: 4. Sources of Nitrogen, Phosphorus and Sediment to the Chesapeake Bay." Environmental Protection Agency. Web. 14 June 2012. <http://www.epa.gov/reg3wapd/pdf/pdf_chesbay/FinalBayTMDL/CBayFinalTMDLExecSumSection1through3_final.pdf>.

EPA. *Frequently Asked Questions about the Bay TMDL.* Environmental Protection Agency. n.d. Web. 1 Aug 2012. <http://www.epa.gov/reg3wapd/tmdl/ChesapeakeBay/FrequentlyAskedQuestions.html>.

Fish and Wildlife Service (FWS). "Chesapeake Bay Coastal Program, Chesapeake Bay Field Office, Northeast Region, U.S. Fish and Wildlife Service." n.p., 28 Jan. 2011. Web, 9 June 2012. <http://www.fws.gov/chesapeakebay/coastpgm.html>.

Godwin, A. Proposed 'Pollution Diet' Spurs Controversy. *Urban Water Management*. n.d, Web,31 July 2012.

Goetz, Scott J., Claire A. Jantz, Stephen D. Prince, Andrew J. Smith, Dmitry Varlyguin, and Robb K. Wright. "Integrated Analysis of Ecosystem Interactions With Land Use Change: The Chesapeake Bay Watershed." *American Geophysical Union*. (2004): 263-275. Web. 14 Jun. 2012. <ftp://ftp.whrc.org/Mid-Atlantic/GOETZ-PUBS/Goetz-2004-ChapmanBook.pdf>.

Gunderson, L. and Stephen S. Light, *Adaptive management and adaptive governance in the everglades ecosystem.* Policy Science. (2006)39:323–334.

Interstate Commission on the Potomac River Basin. "The 2012 User's Guide to Chesapeake Bay Program Biological Monitoring Data." *Publications*. Chesapeake Bay Program, June 2012. Web.,12 July 2012. <http://www.chesapeakebay.net/documents/guide2012_final.pdf>.

Klapproth, Julia C., and James E. Johnson. "Understanding the Science Behind Riparian Forest Buffers: Effects on Water Quality." *Understanding the Science Behind Riparian Forest Buffers: Effects on Water Quality*. Virginia Tech Cooperative Extension. 2009. Web. 14 June 2012. <http://pubs.ext.vt.edu/420/420-151/420-151.html>.

Lee, K. N.. *Appraising adaptive management*. Conservation Ecology 3(2): 3. 1999. Web. 15 August 2012. <http://www.consecol.org/vol3/iss2/art3/>.

Loftus, Andrew J., and Richard B. Stone. "Artificial Reef Management Plan for Maryland." *Artificial Reef Management Plan for Maryland*. Maryland DNR, June 2007. Web. 12 July 2012. <http://www.dnr.state.md.us/irc/docs/00009000.pdf>.

NOAA. "Nutrient Pollution - Eutrophication." National Oceanic and Atmospheric Agency. 2010. Web. 14 June 2012. <http://oceanservice.noaa.gov/education/tutorial_estuaries/media/supp_est09b_eutro.html>.

NOAA. "Oysters - Fish Facts." National Oceanic and Atmospheric Administration. 2012. Web. 14 June 2012. <http://chesapeakebay.noaa.gov/fish-facts/oysters>.

Phillips, Scott. "The Role of Science in Environmental Restoration." *USGS Circular 1220: The U.S. Geological Survey and the Chesapeake Bay*. United States Geological Survey, Dec 2005. Web. 12 July 2012. <http://pubs.usgs.gov/circ/c1220/>.

Phillips, Scott. "USGS Fact Sheet 2010-3081." *USGS Science for the Chesapeake Bay Restoration*. United States Geological Survey, Feb 2011. Web. 12 July 2012. <http://pubs.usgs.gov/fs/2010/3081/>.

"Private Lands Conservation." *Conservation Easements*. The Nature Conservancy, 2012. Web. 13 Aug. 2012. <http://www.nature.org/aboutus/privatelandsconservation/conservationeasements >.

"Report to Recommend Strategies to Protect the Bay's Fish and Wildlife Species and Habitats.". N.p., 8 Sept. 2009. Web. 15 Aug. 2012. <http://executiveorder.chesapeakebay.net/default.aspx?page=4>.

Stevenson, J. Court, Catherine B. Piper, and Nedra Confer. "Decline of Submerged Plants in Chesapeake Bay." U.S. Fish and Wildlife Service., 1979. Web. 14 June 2012. <http://www.fws.gov/chesapeakebay/savpage.html>.

Testimony on H.R. 258. Chesapeake Bay Accountability and Recovery Act of 2011 Submitted to Committee on Natural Resources U.S. House of Representatives By Professor Roger Mann Director for Research and Advisory Services Virginia Institute of Marine Science College of William and Mary. Thursday April 7, 2011.

USDA Forest Service. "Chesapeake Forest Restoration Strategy." *Draft Forest Restoration Strategy for the Chesapeake Watershed*. Chesapeake Bay Executive Order, July 2012. Web. 12 July 2012. <http://executiveorder.chesapeakebay.net/ChesapeakeForestRestorationStrategy_120706.pdf>.

U.S. Government Accountability Office, "Chesapeake Bay: Restoration Effort Needs Common Federal and State Goals and Assessment." GAO-11-802: Congressional Committees Report, Sep 2011.

Walters, C. *Challenges in adaptive management of riparian and coastal ecosystems. Conservation Ecology* 1(2):1, 1997. Web. 15 August 2012. <http://www.consecol.org/vol1/iss2/art1>