Monitoring Needs and Partnership Opportunities Assessment: A Report to the Chesapeake Bay Program Monitoring Re-Alignment Action Team

Chesapeake Bay Program
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Prepared for

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Summary of Recommendations for Partnering Opportunities for Enhancing Monitoring for Chesapeake Bay Program

- Staff resources should be allotted in 2010 to conduct a more comprehensive survey of monitoring activities in the Bay and its watershed and periodic up dates every five years there after. The data call for monitoring programs should include a well-defined definition of what is or is not a monitoring program. Programmatic needs for monitoring information extend beyond water quality and there needs to be an emphasis capturing monitoring efforts that address all CBP areas.
- The 2009 Monitoring Inventory has identified numerous potential candidate programs to establish monitoring partnerships with to expand our monitoring networks and meet programmatic information need. However to participate in these potential partnerships, the Bay Program would need to provide resources (money, technical expertise, staffing) for these efforts. The CBP needs to have a flexible source of funds to establish priority partnerships. The new Technical Support Services Team should oversee the funds.
- There are opportunities to better utilize on-going monitoring being conducted by federal, state, and local governments, and non-governmental organizations to address information needs for all Chesapeake Bay Program (CBP) goals: water quality, fisheries, habitat, and watershed. However, the CBP will have to greatly increase capacity to obtain, manage, and utilize appropriate information from these monitoring programs. CBP should develop or apply guidance documents which lay out analytical quality assurance requirements for a monitoring program to become a partner in our monitoring networks. Guidance for data management, data submission and metadata currently exists but will need modification for working with small data providers (CBP, 1998; CBP, 2001; and CBP 2006).
- There needs to be careful consideration of monitoring needs of the entire Chesapeake Bay program when re-aligning monitoring funds. It was noted during the monitoring needs assessment conducted across all goal implementation teams that changes to the water quality monitoring programs will have repercussions in other parts of the program. Decreases in tidal monitoring effort will degrade our abilities to insure habitat conditions favorable for the maintenance and expansion of SAV acreage and conduct ecosystem based fisheries management. However increases in the non-tidal monitoring program will enhance our abilities to assess stream health and target stream restoration.

Water-quality

- The current CBP tidal water-quality monitoring programs (water quality, benthic invertebrate, phytoplankton and submerged aquatic vegetation) provide the majority of the data to assess

water-quality criteria, the priority-monitoring objective. These programs also provide information to document status and trends, prepare communication products and support models. These programs need to be continued, because there are very limited partnering opportunities to support these programs.

- There are opportunities to enhance partnerships, mostly with citizen monitoring groups, to assess the status of water-quality conditions in selected tidal tributaries and shallow waters of the Bay. These partnerships do not currently address the needs for criteria assessment in shallow waters or change over time.
- There are opportunities to partner with on-going efforts in small watersheds to better evaluate the effectiveness of management practices. The CBP should increase resources to synthesize results from past and present small watershed studies to provide products on effectiveness of point source, agricultural, and storm-water management practices to reduce nutrients, sediment, and toxic contaminants. The CBP should select 6-18 small watersheds, which have on-going monitoring of best management practices (BMP's), land-use activities, and water quality, to co-locate long-term monitoring sites as part of the non-tidal water-quality network. These small watersheds would provide information to help provide on-going evaluation of different types of water-quality management actions.
- There are opportunities to partner with on-going programs to better assess the nutrient, sediment, contaminant, and bacterial conditions in the watershed to better target restoration and protection activities. However, these partnership opportunities will not address the needs of the CBP non-tidal network to monitor changes in nutrient and sediment loads and concentrations to help assess progress toward load allocations.
- Assessing criteria related to toxic contaminant impairments in the Bay is still a critical need of the CBP and there are limited opportunities for partners to help address this gap. Monitoring of toxic contaminant loads needs to be added to selected CBP Non-tidal Network (NTN) sites to assess progress toward reducing contaminant loads into the Bay.

Fisheries

- CBP has set a path towards ecosystem-based fisheries management. The Fisheries Goal Implementation Team- Quantitative Ecosystem Working group has identified the vital need to have monitoring information about habitat conditions and food-web interactions. Habitat conditions (e.g., water quality and submerged aquatic vegetation) are critical in all life stages of marine resources and can influence biomass production. Additionally an understanding of food web dynamics (phytoplankton, zooplankton, benthos and forage fish interactions) is a critical monitoring need for Ecosystem-based fisheries management in an ecosystem approach to management. The maintenance, enhancement and expansion of key non-fisheries monitoring

programs (water quality, submerged aquatic vegetation, phytoplankton, zooplankton, benthos and forage fish) needs to be coordinated with fishery monitoring to insure data on spatially and temporally compatible scales to support ecosystem-based fisheries management.

- Oyster restoration remains a central goal of the CBP. A recent analysis of native oyster restoration efforts over the past 18 years identified the need for methodologically consistent surveys of oysters Bay-wide for stock assessment as a critical step to understanding the oyster population and guide future restoration activities (ORET, 2009).
- Currently fisheries-dependent and -independent monitoring is conducted as a collaborative effort between the Federal, State and Regional/Inter-Jurisdictional agencies. Fishery-independent monitoring in the Chesapeake region yields reasonable coverage for some focal species. However, coverage required for marine spatial planning is inadequate. Current coverage is at a minimum for management needs for finfish and blue crab. Enhanced and expanded fishery-dependent surveys are needed to gain a better understanding of the impact of commercial and recreational fishing on key species.
- No single fishery independent survey can effectively capture all the monitoring needs for multispecies management. Ideally the Chesapeake Bay region fisheries management community would establish Bay-wide consistent methodology for 1) mainstem and tributary (>2.5 m) bottom trawl surveys, 2) shallow mainstem, tributary and littoral zone (< 2.5 m)beach seines and large-haul seines surveys and 3) long line surveys in the lower bay and near shore Atlantic (> 6m) in support of multispecies monitoring needs. There are partnership opportunities between Chesapeake Bay and offshore fisheries monitoring programs, such as the National Marine Fisheries Service offshore Atlantic trawl survey, to help meet these needs.

Habitat

- Submerged Aquatic Vegetation (SAV) serves as essential nursery and juvenile fish habitat. Continuation of the Annual Aerial Submerged Aquatic Vegetation Survey program is critical to meeting habitat goals and for assessing regulatory criteria. The existing CBP SAV monitoring program, coordinated through the Virginia Institute of Marine Sciences, utilizes partnership opportunities between federal, state and non-governmental agencies to expand its monitoring capacity and serves as a model for other partnership efforts. The monitoring of water quality needs to continue at frequency and density of stations adequate to insure program management actions are achieving habitat conditions favorable for the survival, propagation, and successful restoration of SAV.
- Wetlands provide critical habitat for fish and wildlife as well as serve as a natural BMP by slowing the flow of nutrient, sediment and toxic contaminants into adjacent waterways and controlling erosion. To protect this vital habitat more systematic monitoring of wetland acreage and condition (vegetation, hydrology, and soils) on regular time intervals is needed. Monitoring changes in

wetlands should continue through existing partnerships with US Fish and Wildlife Service-National Wetlands Inventory, National Oceanic and Atmospheric Administration-Coastal Change Analysis Program, United States Department of Agriculture- Agricultural Research Service and United States Geologic Survey.

- There is an overwhelming need for expansion of habitat monitoring for non-tidal fish and wildlife. The Bay Program developed a prototype non-tidal stream health indicator in 2008 based on benthic invertebrate data collected by different agencies in watershed. This indicator should be expanded to include other aspects of stream health, such as fish condition in streams. Enhancement of existing stream monitoring to include American eel and fresh water mussel monitoring components is an opportunity to add greater utility to ongoing monitoring efforts at a low cost. There needs to be improved data on habitat supporting migratory birds and address the introduction and expansion of the range of invasive species in the Bay watershed. The most promising partnerships to expand monitoring would be through the existing state programs of biological conditions in streams and federal programs such as the United States Geological Surveys-Biological Status and Trends Program and United States Fish and Wildlife Service-Fisheries Programs.

Watersheds

- The most critical monitoring need for watershed management is high-resolution land use/ land cover data collected at meaningful time intervals to track changes. Ancillary data needed to accompany the land imagery is high quality elevation data. Land data is used program wide but has no regular funding or long-term provisions for its acquisition and processing. The Bay Program needs to establish a monitoring plan for land data and allot resource to support this effort. There are numerous opportunities to establish partnerships with other federal entities to meet this program information need.

Acknowledgements

This *Monitoring Needs and Partnership Opportunities Assessment: A Report to the Chesapeake Bay Program Monitoring Re-Alignment Action Team* was developed through the collaborative efforts of the Monitoring Re-Alignment-Partnership Issue team: Scott Phillips, United States Geological Survey (Co-Chair); Jonathan Kramer, Maryland Sea Grant (Co-Chair); Jacqueline Johnson -Interstate Commission on the Potomac River Basin- Chesapeake Bay Program Office (Coordinator); Greg Allen, United States Environmental Protection Agency-Chesapeake Bay Program Office; Rich Batiuk, United States Environmental Protection Agency-Chesapeake Bay Program Office; Steve Bieber, Washington Council Of Governments; Nancy Butowski, Maryland Department of Natural Resources; Katie Foreman, University of Maryland Center for Environmental Science- Chesapeake Bay Program Office; Krystal Freeman, Chesapeake Research Consortium- Chesapeake Bay Program Office; Jake Goodwin, Chesapeake Research Consortium- Chesapeake Bay Program Office; Carlton Haywood, Interstate Commission on the Potomac River Basin; Rick Hoffman, Virginia Department of Environmental Quality; Fred Irani, United States Geological Survey-Chesapeake Bay Program Office; Cindy Johnson, Virginia Department of Environmental Quality; Heath Kelsey, EcoCheck National Oceanic and Atmospheric Administration- University of Maryland Center for Environmental Science; Richard Lacouture, Morgan State University Estuarine Research Center; Gunnar Lauenstein, National Oceanic and Atmospheric Administration-National Center for Coastal Assessment; Mary Ellen Ley, United States Geological Survey-Chesapeake Bay Program Office; Mike Mallonee, Interstate Commission on the Potomac River Basin- Chesapeake Bay Program Office; Bruce Michael, Maryland Department of Natural Resources; Tom Parham, Maryland Department of Natural Resources; Charles Poukish, Maryland Department of the Environment; Scott Stranko, Maryland Department of Natural Resources; Peter Tango, United States Geological Survey-Chesapeake Bay Program Office; William Reay, Virginia Institute of Marine Sciences; Caroline Wicks; EcoCheck National Oceanic and Atmospheric Administration- University of Maryland Center for Environmental Science; Julie Winters, United States Environmental Protection Agency-Chesapeake Bay Program Office; and Bob Wood, National Oceanic and Atmospheric Administration-Cooperative Oxford Laboratory. We would also like to thank the many Federal, State, Local governments and non-governmental agencies who responded to the data call for the 2009 Chesapeake Bay Program Monitoring Inventory.

Introduction

Partnership Issue Team Objectives

The Chesapeake Bay Program (CBP) Monitoring efforts have served to provide Bay water quality and living resource health assessments while guiding restoration efforts in the Bay community for over 25 years. As an outcome of a Chesapeake Bay Scientific and Technical Committee (STAC) monitoring review, the CBP monitoring objectives have shifted from a focus of characterizing estuarine health to delisting of the bay and assessing effectiveness of management actions in the watershed (Wardrop and Kirk, 2009). This change in focus is resulting in a shift of Environmental Protection Agency (EPA) CBP monitoring funding into non-tidal portions of the watershed. The Monitoring Re-Alignment Team (MRAT) was formed to provide strategic recommendations on how to shift monitoring resources and maintain the integrity of existing monitoring programs. Better partnering with existing monitoring efforts was identified as a potentially valuable tool in this resource realignment. Additionally, there is still a need to monitor selected living resources and their habitats since restoring and protecting fish and habitats are goals of the CBP. This partnership issue team has several objectives:

- Identify existing water quality and habitat monitoring programs in tidal and non-tidal areas that can meet CBP needs and better partner with them.
- Identify partner-monitoring programs in tidal areas that could fill water quality and habitat monitoring gaps created by funding redirection.
- Identify partner-monitoring programs which can meet monitoring needs to assess priority living resources (crabs, selected fish species, oysters) and their supporting habitats.
- Identify gaps where monitoring will not meet the needs for water quality, fisheries habitat, and watersheds.

Scope of Report

The outcomes from the MRAT partnering team will help to prepare the final MRAT report on options to re-balance the CBP monitoring programs. The monitoring inventory and gap analysis will also provide information to help prepare the report on “strengthening science for ecosystem management” required by Presidential Executive Order. The report provides recommendations for partnership opportunities for monitoring to help address the needs of several Chesapeake Action Plan (CAP) goals: water quality, habitat, living resources, and watersheds (CBP, 2008). The report provides an inventory of existing monitoring programs in the

Bay community that was used to help identify the partnership opportunities. Further examination of the partnership opportunities will need to be conducted to determine if the information meets quality assurance-criteria of the Chesapeake Bay Program.

Relation to the Presidential Executive Order

A Presidential Executive Order (E.O.) # 13508 (Chesapeake Bay Protection and Restoration), which was signed on May 12, 2009, requests that a report be developed for strengthening science and environmental monitoring of the Chesapeake Bay and its watershed. A draft of the report is due September 9, 2009 and to be released for public comment by November 9, 2009. This report will assess existing monitoring programs and gaps in data collection, and shall also include the following topics: (a) the health of fish and wildlife in the Chesapeake Bay watershed; (b) factors affecting changes in water quality and habitat conditions; and (c) using adaptive management to plan, monitor, evaluate, and adjust environmental management actions.

Information produced under the MRAT process and partnership activities will be useful to the E.O. Monitoring report in several ways:

- The monitoring inventory will be used to identify existing monitoring in the Bay and its watershed.
- The analysis of gaps and associated recommendations in relation to the CAP goals (fisheries, habitat, water quality, watersheds) will provide valuable information to support the wider scope to identify gaps and produce recommendations to improve monitoring for decision making for ecosystem management.

Monitoring Inventory Compilation

Methods

The initial 2009 Monitoring Inventory was compiled from three existing monitoring inventories. The only full inventory of water quality monitoring programs was conducted in 1989 (CBP, 1989a). Living Resource programs had been inventoried twice over the life of the Bay Program, once in 1989 and in 1997 (CBP, 1989a; CBP, 1997). Tidal Fisheries portion of living resources had an additional inventory in 2006 (Bonzek et.al. 2007). The draft 2009 inventory compiled from previous efforts consisted of 151 monitoring programs through out the watershed. This list of monitoring programs consisted mostly of the large state and federally funded monitoring efforts in the Chesapeake Bay region. There were numerous gaps in knowledge of national scale monitoring activities in the region, remote observation systems, wildlife programs and smaller scale state, county, city and volunteer monitoring programs. A one-month data call for monitoring programs was conducted in June 2009 to attempt to update information on programs in the draft inventory and obtain information on missing programs. Only the most basic of metadata information was requested (Table 1). A survey was sent to all participants in the Monitoring Re-alignment Workshops, members of the Bay Program's former Monitoring and Living Resources Subcommittees, the Virginia and Maryland water monitoring counsels, and known providers of monitoring data not otherwise contacted. A special effort was made to capture the smaller scale state, county, city and volunteer monitoring programs, which have been overlooked in past inventory efforts. These programs are collecting data at scales critical to tracking changes due to local/small scale efforts to protect and restore the watershed and have been long known to be an under utilized source of monitoring information.

Summary Inventory

Discussions within the Partnership Issue Team during the May 2009 MRAT workshop, revealed significant differences among participant as to what exactly constitutes a monitoring program suitable for inclusion on the inventory. After some consideration, the Partnership Issue Team leadership adopted the following criteria for the definition of a monitoring program : 1) Minimum of five years of data collection; 2) Data must be collected using a consistent scientifically sound methodology and 3) Program must be on going and planned to continue monitoring efforts into the foreseeable future. Short-term research studies and one time assessments were not included, but are being maintained on separate lists by Bay Program data managers and quality assurance personnel.

The final inventory as of 1 July 2009 consists of 295 monitoring programs spanning a broad spectrum of scales and Chesapeake Bay Program interests (Figure 1, Appendix A). Water-quality monitoring programs outnumber all others in the inventory. Numerous monitoring programs have multiple components and collect data in multiple subject areas. An evaluation of the inventory for meeting CAP needs indicates that all goals have programs that potentially fill information needs (Figure 2). The current CAP goals do not address climate change, freshwater inland fisheries, wildlife management and invasive species, which are issues of high importance among many Chesapeake Bay Program partners.

Geographically, Virginia and Maryland reported the largest number of programs (Figure 3). Forty-seven citizen monitoring programs appear in the inventory most of which were in Maryland and Virginia. We were unable to obtain an accounting of citizen monitoring programs for the states of Pennsylvania, New York and West Virginia. It should be noted that when individual citizen monitoring efforts were evaluated to see if they met our criteria as a monitoring program we found a large number of these programs had rigorous, well-documented sampling protocols, and used many of the same analytical laboratories that the larger local and state-government run programs.

The primary goal of the MRAT process was to develop a plan to strategically shift monitoring resources from tidal to non-tidal areas to better assess effectiveness of management actions. Based on inventory findings currently fifty-eight percent of all monitoring programs are focused in non-tidal area (Figure 4). This suggests that there is a large body of monitoring activity may be suitable for collaborating with in the non-tidal areas. Initial review of tidal monitoring programs suggests that opportunities for collaborating may already be fully exploited.

One shortcoming of the 2009 inventory effort was the under reporting or non-reporting of monitoring effort. As a whole, the survey for monitoring programs needed to go out to a larger audience to get a better representation of all the monitoring activities in the watershed. There was a significant under reporting of monitoring programs for terrestrial wildlife, vegetation and remote sensing (Figure 1). There was no reporting of monitoring for agricultural and other best management practices. A summary of reported federal monitoring programs is listed Appendix C, Table C1 and shown on figure 6. These results suggest an incomplete inventory of monitoring activities by some federal agencies. The inventory of state programs is focused on their water quality-monitoring program. This may in part in part be due to the MRAT's priority to focus on water quality monitoring efforts. Reporting of monitoring conducted by regional, county and local levels governments and non-governmental entities (NGO) was also not comprehensive.

A second known deficiency was the incomplete reporting of information. Estimates of annual project cost was the field most often left blank in the inventory. Fifty-two programs reported annual costs totaling 15.7 million dollars in monitoring effort. Cost information for the Chesapeake Bay-only portion from large national networks such as National Oceanic and

Atmospheric Administration (NOAA) Buoy or United States Geological Survey (USGS) Stream Gauge Networks or satellite -remote sensing missions is difficult to determine. The real cost of volunteer monitoring efforts is difficult to quantify. Between under reporting of programs and the difficulties associated with determining program cost, it is not possible to assess the total amount of funding being spent on monitoring in the bay and it watershed. It was possible to summarize funding, based on reported information, for major types of governmental and NGO organizations (Figure 5). The combination of Federal, State and Federal-State match funded programs accounts for 65% of monitoring effort.

Table 1. Requested Data fields in 2009 Monitoring Inventory Survey.

Program Type	Frequency Sampled
Tidal/Non-Tidal	Years Of Monitoring Record
Monitoring Program	Funding Source
Collecting Organization	Cost/Yr
Program Objective	Contact Name
Products Produced From Data	Contact Phone
Metrics Sampled	Contact Email
Spatial Coverage	Program Website
Number Of Sites	

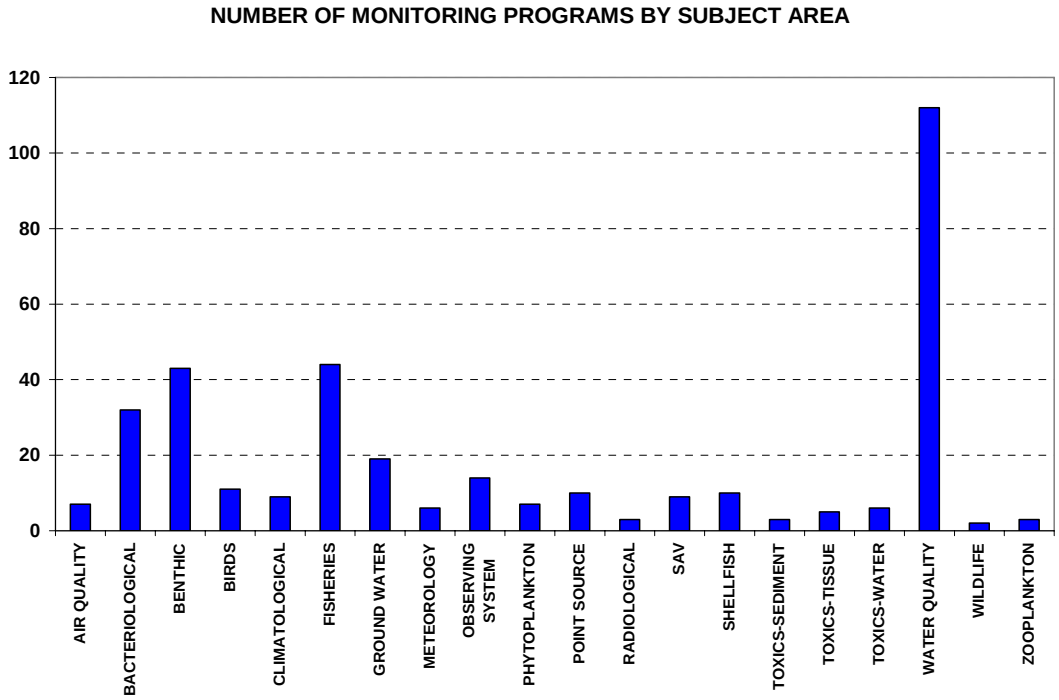

Figure 1. Summary of Reported Monitoring Programs by General Monitoring Subject. Note: many monitoring program have multiple components and collect data in multiple subject area.

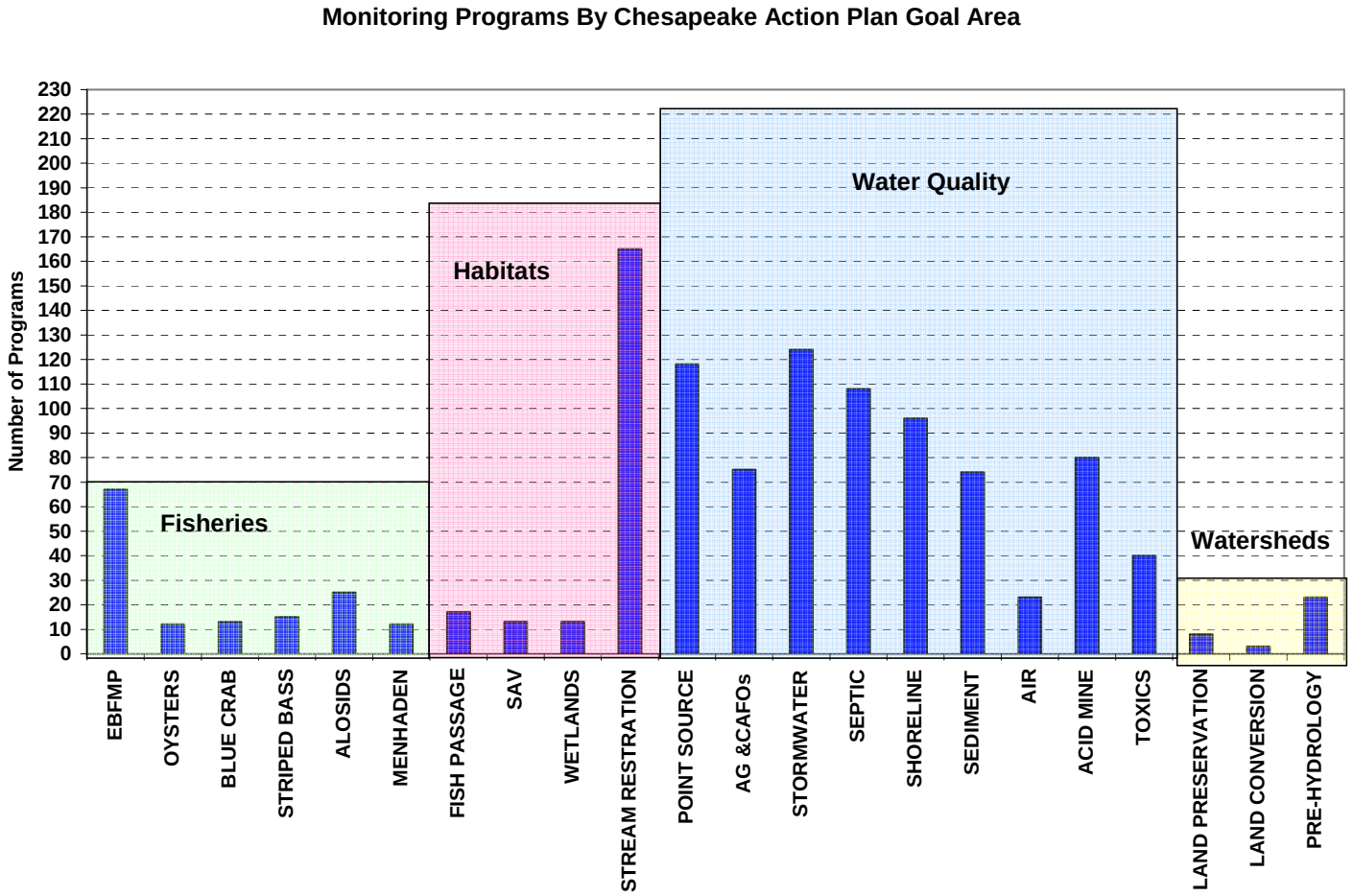

Figure 2. Break Down of Programs Meeting Chesapeake Action Plan Goal Area Monitoring Needs. The shaded areas denote Chesapeake Action Plan Goal Areas. Of the total of 295 reported monitoring programs: 71 met Fisheries needs, 185 met habitat need, and 223 met water quality need and 31 healthy watershed need.

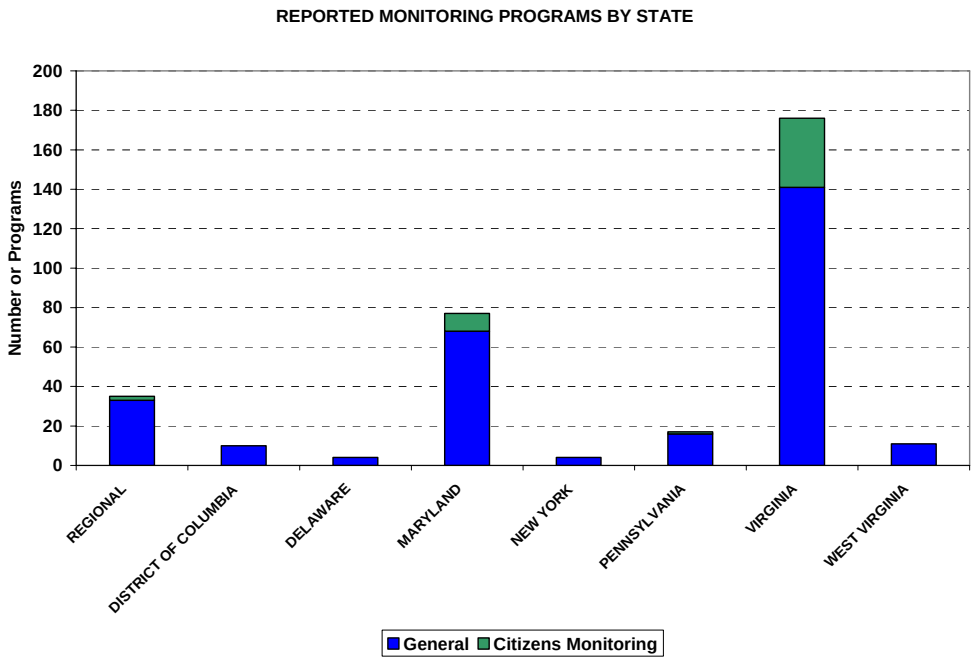

Figure 3. Breakdown of Monitoring Programs Reported by Jurisdiction. Programs in the regional category are programs that cover the entire bay or watershed.

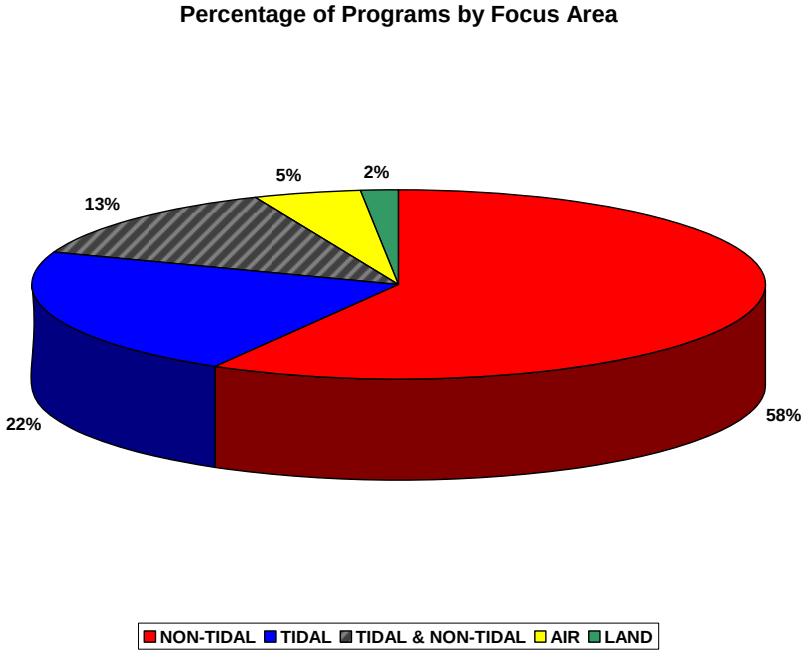

Figure 4. Breakdown of Monitoring Programs by Focus Area.

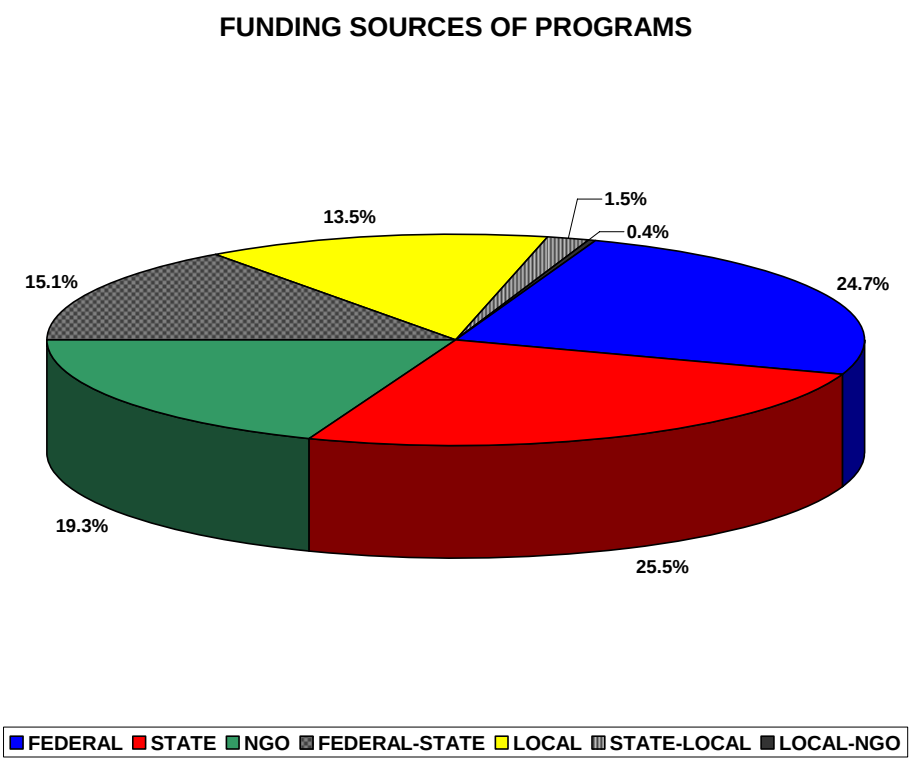

Figure 5. Summary of Reported Funding Sources for Monitoring Efforts in Chesapeake Bay Region.

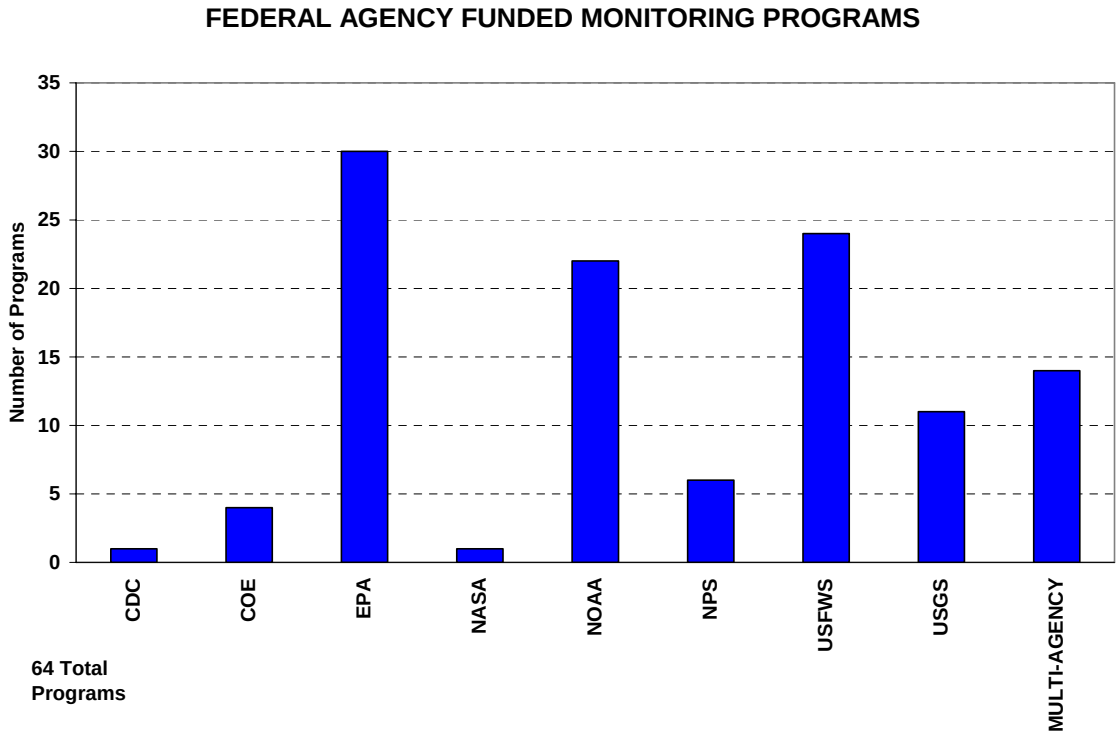

Figure 6. Summary of Federally Funded Monitoring Efforts in Chesapeake Bay Region.

Water Quality Partnership Opportunities

Management Goals and Priority Water Quality Monitoring Needs

The overarching objective of the CAP water-quality goal is to "Achieve and maintain the water quality necessary to support the aquatic living resources of the Bay and its tributaries and to protect human health" (CBP, 2008). One of the major outcomes is 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". The associated water-quality standards that must be met to "delist" the Bay (dissolved oxygen, water clarity and chlorophyll a) are based on the needs of fish, shellfish, and submerged aquatic vegetation in the Bay. The CAP outlines an approach to reduce nutrients and sediment from major "source sectors" and has these additional desired outcomes:

- Reduce loads from wastewater
- Reduce loads from agricultural lands and animal operations
- Reduce loads from developed lands
- Reduce loads from streamside and tidal shorelines
- Reduce loads from air emission
- Reduce loads of toxic contaminants

Progress toward water-quality management goals are assessed mostly through environmental indicators. The current indicators to assess progress toward "delisting" the Bay include: dissolved oxygen, water clarity, chlorophyll a, and toxic contaminants. Indicators are related to achieving the water quality standards are:

- Indicators of implementation of management actions for different "source sectors"
- Nitrogen, phosphorous, and sediment loads to the Bay
- Flow-adjusted change of nitrogen, phosphorous, and sediment concentrations in the watershed
- Number of toxic contaminant impaired Bay segments

A major conclusion from the STAC Monitoring Review (Wardrop and Kirk, 2009) was that "delisting the Bay and determining the success of CBP management actions are the responsibilities of the partnership and should be priorities of the monitoring program". Monitoring of delisting criteria must include (1) dissolved oxygen (DO), (2) water clarity/Submerged Aquatic Vegetation (SAV), (3) chlorophyll, and (4) aquatic life (Benthic community index of health). These criteria must be measured for 78 different portions (or segments) of the Bay. Needs were also identified to have information to:

- Assess the effectiveness of management actions
- Track progress toward load reduction goals and CAP 2-year milestones
- Better targeting restoration activities

- Better communicating the information to the public

In addition to addressing delisting the Bay and management actions to reduce nutrients and sediment, some of the other results from the STAC workshops included:

- Better relating local stream and river water quality standards to Bay water-quality standards.
- Convey information in terms of fishable and swimmable waters (both for the Bay and watershed streams). Supporting monitoring could include using state monitoring of watershed conditions including bacteria; benthic Indexes of Biotic Integrity (IBI) and fish IBI's.
- Increase monitoring on emerging issues such as new toxic contaminants of concern and effects of climate change.

Summary of Current Monitoring Programs to Address Water Quality Needs

The primary objectives of water-quality monitoring to meet the management needs are:

- Assess attainment of water-quality criteria in the Bay (DO, water clarity/SAV, chlorophyll, and toxic contaminants).
- Status and trends of water-quality conditions related to the criteria (nutrients)
- Status and trends on nutrients, sediment and toxic contaminants in the watershed
- Estimate non-tidal loads to help assess progress toward nutrient and sediment allocations
- Assess effectiveness of management actions
- Communicate results to managers and public
- Improve CBP models used to help plan management activities

The ability for existing CBP-funded WQ monitoring programs to meet one or more of these monitoring objectives is summarized below in Table 2-4. Table 2, *Utility of Data from Basin-wide State & Federal Monitoring Programs,* is a matrix of the major CBP monitoring networks and the data analyses and assessments needed to meet the primary monitoring objectives. Most of the tidal monitoring programs were designed to measure status and trends at the scale of a tidal segment and are useful for assessing water-quality criteria. The tidal monitoring information is also useful to communicate information to public through the environmental indicators and the Bay Barometer and to improve CBP estuary models. The current CBP monitoring programs do not adequately address assessing toxic contaminants in the Bay.

The sites in the non-tidal network, which represent drainage areas of several hundred to several thousand square miles, were designed to provide information on the status and trends of nutrient and

sediment concentrations within bay watershed and Tributary Strategy basins. The non-tidal network sites also are used to estimate nutrients and sediment loads. The load results are used to help identify areas to enhance management actions, assess progress toward allocation goals, and improve watershed models. The non-tidal data are also used in selected CBP indicators and the Bay Barometer to communicate information to the public.

Neither the current tidal or non-tidal monitoring programs meet the managers need to assess the effectiveness of best management practices (BMP). This objective is better done in smaller watersheds (less than 100 square miles) where the water-quality effects of BMP's can be better isolated and other data including land-use information and locations of management actions can be obtained. However, even in smaller watershed the effectiveness of an individual BMP is not possible unless field-scale studies are conducted (Simpson and Weammert, 2008).

Table 2. Utility of Data from Basin-wide State & Federal Monitoring Programs to meet CBP Objectives

Monitoring Program (State & Federal)	Water Quality Analyses & Assessments						
	Tidal WQ Criteria	BMP Effectiveness Ag. | Urban		Communication Products	Load Reductions	Status & Trends	Partner Models
Tidal							
Tidal WQ Network	X			X		X	X
Tidal Shallow Water Quality	X			X			
Tidal Benthic Invertebrate	X			X		X	X
Tidal Phytoplankton				X		X	X
SAV Survey	X			X		X	X
Non-Tidal							
Non-Tidal WQ Network				X	X	X	X
National Stream-Gauge Network				X	X	X	X
Ambient Surface Water Quality						X	
Non-Tidal Macro Benthic Invertebrate				X		X	

The 2009 monitoring inventory identified about 233 partner programs conducting water-quality monitoring in the Bay and its watershed (Figure 2). Many of the programs are focused in the watershed (Figure 7). The programs range from ambient water-quality monitoring in tidal and non-tidal waters to programs focused on different source sectors (such as point sources, agricultural areas and storm-water).

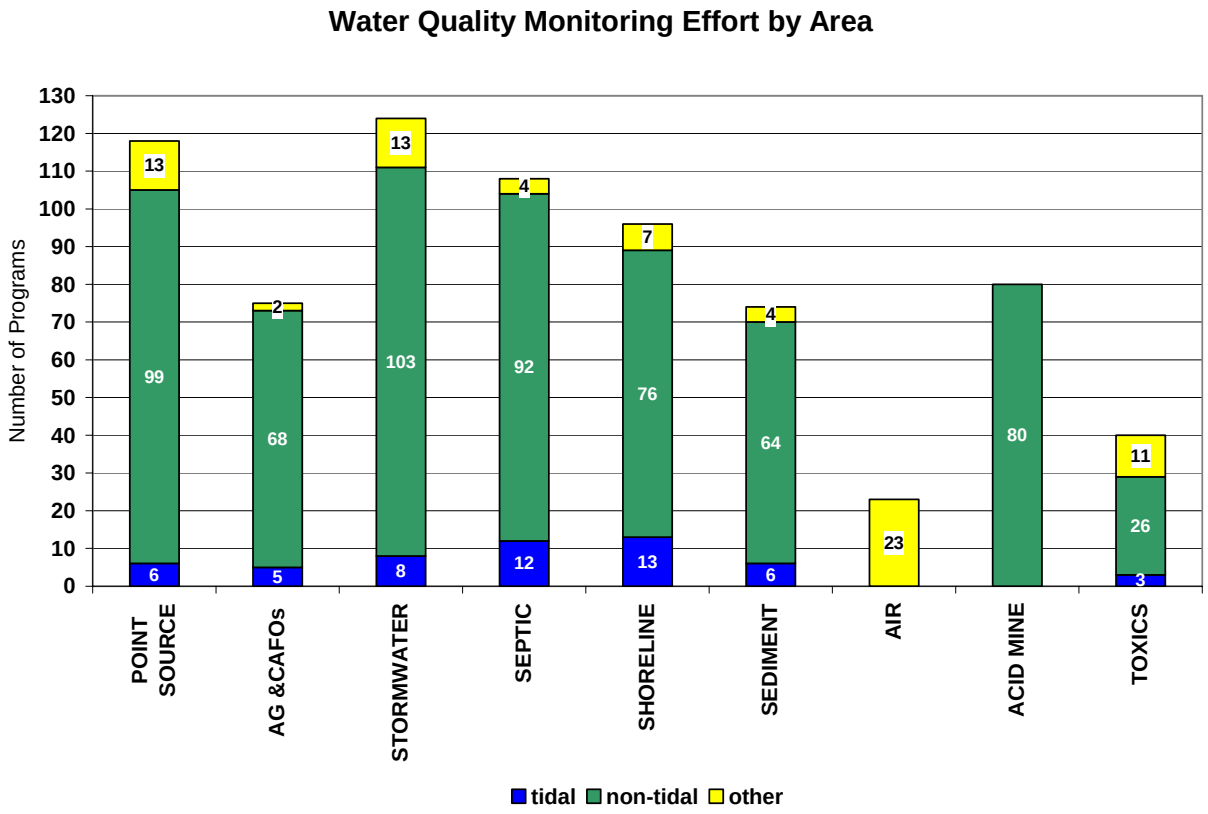

Figure 7. Summary of Water Quality Program Monitoring by Source Sector and Focus Area in the Region.

Case Study-Agricultural BMP Performance Studies

On a per-pound basis, the Chesapeake Bay Commission (CBC, 2004) determined that agricultural BMP's are the most cost-effective means to reduce nitrogen and phosphorus loads to the Bay. It is important to measure the actual change in loadings (if any) so that expectations for subsequent installations are realistic. Current effectiveness estimates for load allocations are based on field-scale research studies, and may not represent actual implementation conditions. "To capture a BMP's true performance across various temporal, spatial and management conditions we must ultimately rely on monitoring to accurately assess BMP impacts, not effectiveness estimates" (Simpson and Weammert, 2008).

Table 3, *Potential Data Sources for Agricultural BMP Performance Studies in Chesapeake Bay Small Watersheds*, lists numerous projects where some, if not all data have been collected for assessing water quality improvements due to BMP installation. Information from these studies may be applicable to future studies. In addition to water quality data, new BMP assessments will require a significant data acquisition effort such as the location and history each BMP installed, soil types, land use and land cover and other nearby pollution sources. The availability of these data types is indicated for each study. The selected BMP performance studies examine the effectiveness of one or more agricultural BMPs such as:

- Stream fencing in pastures
- Cover crops
- Animal waste management
- Stream restoration
- Nutrient management (fertilizer reduction)

Pennsylvania and Maryland agencies have collected both water quality and watershed data under their EPA §319 Nonpoint Source Programs to establish Total Maximum Daily Loads (TMDLs) of pollutants and to evaluate the effectiveness of implemented management practices to reduce pollutants. One of five goals of the 2008 Pennsylvania Nonpoint Source Management Program Update is to: "Improve and develop monitoring efforts to determine how projects and programs improve water quality and/or meet target pollution reductions including TMDLs" (PADEP, 2008). By the end of 2009, Pennsylvania Department of Environmental Protection (PADEP) plans to increase the accessibility of local, state and regional water quality data to decision makers, watershed organizations and producers to target water quality restoration and protection efforts; to establish a monitoring protocol for measuring environmental results of implementing Natural Stream Channel Design (NSCD) projects; and to establish local water-quality monitoring sites to both obtain baseline water quality data and assess the effectiveness of agricultural BMPs. These plans are very similar to the CBP desire to develop agricultural BMP monitoring protocols (below) and expand water-quality monitoring sites.

The Conestoga River in Lancaster County is an example where comparable data sets are available at several different spatial and temporal scales. From 2005-06, the Susquehanna River Basin Commission (SRBC) intensively monitored nutrient and sediment inputs in five Conestoga River sub-watersheds to support development of a TMDL. From 1993-2001, PADEP and USGS conducted a small watershed stream fencing study in the Mill Creek sub-watershed (Galeone et. al., 2006). The Lancaster County Conservation District prepared a Watershed Implementation Plan for Mill Creek, which states that the Senior Environmental Corps (SEC) may assist with the monitoring for BMP effectiveness. Finally, PADEP/SRBC will continue to monitor one Conestoga River station as part of the long-term CBP Non-tidal monitoring network. This watershed is an excellent opportunity for a BMP effectiveness partnership, especially because intensive BMP installation is planned in these sub-watersheds.

In Maryland, the Corsica River Study provides a complete set of data to evaluate the effectiveness of cover crops, animal waste removal and storm water management. Academic and research institutions have also conducted a number of BMP performance studies, often in partnership with the State agencies. For example, the Canaan Valley Institute (CVI), United States Department of Agriculture-Agricultural Research Service (USDA-ARS), University of Maryland (UM) and Virginia Tech (VT) have conducted specific studies from which both conclusions and existing data sets could be utilized.

A STAC workgroup is developing guidance and protocols for designing and monitoring agricultural BMP performance studies within the Chesapeake Bay watershed. The use of standard protocols "will avoid the inconsistencies among monitoring strategies that create comparability difficulties when estimating BMP effectiveness. This standard approach will also allow the use of monitoring to determine performance, rather than developing effectiveness estimates." (Simpson et. al. 2008) The STAC workgroup will recommend at least 3 candidate watersheds in each state which to conduct these studies. Once the number of watersheds is narrowed, a more rigorous data evaluation is feasible.

Table 3. Potential Data Sources for Agricultural BMP Studies in Chesapeake Bay Small Watersheds

Monitoring Program	BMP Effectiveness Data			N, P & Sediment Loads	Biota	References
	Type & Location	Land Use, Land Cover Soils, etc.	WQ Data			
STATE /EPA §319(h) TMDL MONITORING						
PDEP/ SRBC – Conestoga R. incl. Muddy, Cocalico, Mill, Little Conestoga and Lititz Creeks		X	X	X	X	http://www.srbc.net/pubinfo/techdocs/publication_257/techreport257.pdf
PDEP/USGS – Pequea-Mill Cr. NMP, (1993-01) Stream Fencing, Big Spring Run	X	X	X	X	X	http://www.depweb.state.pa.us/watershedmgmt/lib/watershedmgmt/nonpoint_source/monitoring/pequeamillcreekmonitor.pdf http://pa.water.usgs.gov/reports/wrir_00-4205.pdf http://pubs.usgs.gov/fs/2006/3112
PDEP– Stroud Preserve NMP Rip. Forest Buffers (1993-2002)	X	X	X	X		http://www.depweb.state.pa.us/watershedmgmt/lib/watershedmgmt/nonpoint_source/monitoring/stroudmonitor.pdf
MDE Corsica R. (cover crops, manure removal)	X	X	X	X		http://www.dnr.state.md.us/watersheds/surf/proj/wras.html
VDEQ Smith Creek TMDL	X	X			X	http://www.deq.virginia.gov/export/sites/default/tmdl/implans/smithip.pdf
VDEQ Cooks Creek (bacteria TMDL)		X	X		X	http://www.deq.virginia.gov/export/sites/default/tmdl/apptmdls/shenrvr/cooksfd1.pdf
VDEQ Muddy Creek TMDL Rockingham Co. (Livestock Fencing)	X	X	X			http://www.deq.virginia.gov/export/sites/default/tmdl/implans/nriverip.pdf
VPI Stony, Mill Creeks & N. Fork Shenandoah (bacteria TMDL)		X				http://www.deq.virginia.gov/tmdl/apptmdls/shenrvr/nfshen.pdf
OTHER COUNTY, STATE & FEDERAL BMP ASSESSMENTS						
Lancaster Co. Cons. District – Mill Cr. Watershed Implementation Plan (Conestoga R.)	X	X	X		X	http://www.eli.org/pdf/MillCreekPA_2006.pdf
USDA/PDEP/USGS - Conestoga Headwaters Rural Clean Water		X	X			http://www.water.ncsu.edu/watershedss/info/rcwp/paprof.html
USDA– Tuckahoe R. (Choptank) NFWF (Cover Crops)	X	X	X			http://www.mda.state.md.us/pdf/tuckahoe_factsheet.pdf
ARS CEAP – Choptank	X	X	X	X		ftp://ftp-fc.sc.egov.usda.gov/NHQ/nri/ceap/choptankriverceapfact.pdf
USDA/MDE Double Pipe Creek Rural Clean Water (1982-1992)	X		X	X		http://www.water.ncsu.edu/watershedss/info/rcwp/mdprof.html
MDNR Upper Pokomoke (Manure removal/cover crops)	X	X	X			http://dnr.maryland.gov/bay/czm/nps/publications/pocomoke_fact_sheet.pdf
Nomini Creek (1985-1997) Crop lands management (Va.)	X	X	X			http://water.usgs.gov/wrri/97grants/va97ner3.htm
Owl Run (1986-1996) Animal waste	X	X	X			http://scholar.lib.vt.edu/theses/available/et

Monitoring Program	BMP Effectiveness Data			N, P & Sediment Loads	Biota	References
	Type & Location	Land Use, Land Cover Soils, etc.	WQ Data			
management (Fauquier Co.)						d-51198-134142/unrestricted/FINISHED.PDF
USDA/PDEP/USGS - Conestoga Headwaters Rural Clean Water		X	X			http://www.water.ncsu.edu/watershedss/info/rcwp/paprof.html
USDA/ New Castle Co./U. Del. Appoquinimink R. Rural Clean Water Program (1980-1991)	X	X	X	X	X	http://www.water.ncsu.edu/watershedss/info/rcwp/deprof.html
ACADEMIC & RESEARCH INSTITUTION STUDIES						
UM St Mary's College – St. Mary's River Watershed		X	X	X	X	http://www.stmarysriver.org/pdfdocs/report_p and http://www.stmarysriver.org/pdfdocs/report_phase1_SS.pdf hase1_WC.pdf
SERC – Rhode R. Watershed		X	X			http://www.serc.si.edu/labs/ecological_modeling/landuse_trends.aspx
W.Va. DEP/ CVI - Mill Creek (Opequon) Fencing, Riparian Buffer, Bank Stabilization	X	X	X		X	http://www.opequoncreek.org/WatershedBasedPlan.html
NFWF/VPI – Stream Fencing in Shenandoah R. basin						http://www.nfwf.org/AM/Template.cfm?Section=Live_Stock_Exclusion
NFWF/ VPI – Innovative Cropping in Shenandoah R. Basin		X				http://www.nfwf.org/Content/NavigationMenu/ChesapeakeBayStewardshipFund/ConservationResults/AgriculturalConservation/CroplandConservation/default.htm
NFWF/VPI - Stream fencing in Rockingham & Augusta Co. (Va.)		X				Mossy, Naked & Long TMDL: http://www.deq.virginia.gov/export/sites/default/tmdl/implans/drafts/mossyip.pdf
Tri-County Conewago Creek Association (Pa.)		X			X	http://www.depweb.state.pa.us/watershedmgmt/lib/watershedmgmt/nonpoint_source/implementation/conewago_creek.pdf
CITIZEN MONITORING IN RURAL AREAS						
Smith Creek Va. - Friends of the N. Fork Shenandoah R.			**X**		**X**	http://www.fnfsr.org/whatwedo/monitoring.html
Sassafras River Keeper			**X**			http://www.sassafrasriver.org/whatwedo/2009_may_sop.pdf
Lancaster Co. Senior Environmental Corps			**X**			http://pawatersheds.org
Spring Creek Watershed Community			**X**	**X**	**X**	http://www.clearwaterconservancy.org/CWC%20files/2007_WRMP_Annual_Report_12042008.pdf ; http://www.springcreekwatershed.org/index.php?option=content&task=view&id=69&Itemid=88
Nanticoke Watershed Alliance Creekwatchers						http://www.nanticokeriver.org/Creekwatcher.html
West and Rhode River Keeper			**X**			http://www.westrhoderiverkeeper.org/reportcard/WR_Report_Card_09.pdf
Upper Rappahannock Stream Monitoring Program (quarterly			**X**			http://www.rappmonitor.va.nacdnet.org
Talbot County Creek Watchers			**X**			http://www.talbotrivers.org/waterquality.html http://www.talbotrivers.org/creekwatchers2008.pdf
Sherman's Creek Watershed Association			**X**			http://www.shermanscreek.org/monitoringprogram.htm#descriptions http://www.shermanscreek.org/ShermansCreekPortrait.pdf

Case Study-Urban and Suburban BMP Performance Studies

Selected urban and suburban BMP assessment studies conducted by local governments and watershed organizations were reviewed to better understand the extent of their monitoring programs. Many of these programs track BMP effectiveness through monitoring. The BMPs tracked include, but are not limited to:

- erosion and sediment controls
- stream restoration in urban areas
- nutrient management (fertilizer reduction)
- riparian forest buffers in urban areas
- increase wetland acreage

Many of the programs (e.g., Friends of Sligo Creek; the Anacostia Watershed Restoration Partnership; the South River Federation; and the Baltimore Ecosystem Study) focus monitoring to assess the concentrations of nitrogen, phosphorous, and sediment in the sub-watershed. The Occoquan Watershed Monitoring Program demonstrates how implementation and monitoring are occurring at a small watershed scale. The South River Federation and Chesterfield County studies present their efforts to assess the effectiveness of management actions or BMPs to reduce loads in the respective sub-watersheds. Many of the programs communicate information through websites and other outreach tools. The citizen monitoring groups, most often organized through a local watershed organization, are very keen on targeted communication efforts. In addition, the academic and research community and local governments also share their monitoring studies with the public. The following are a few examples of how theses groups use monitoring-related information in communications:

- report cards and state of the watershed annual reports to characterize the condition, state, and trends of the sub-watershed;
- fact sheets, list serves notices, web blogs, facebook pages, and graphic maps to relate status and trends to share information with their constituents to raise awareness and to stimulate participation in events to tackle restoration projects; and
- Publish reports and make presentations at conferences (e.g., Chesapeake Watershed Forum and River Rally) on factors affecting the root problem.

The Virginia Department of Environmental Quality (VADEQ) has a successful program for “citizen/non-agency monitoring activities” (includes local watershed and citizen monitoring organizations, academic institutions, non-VADEQ government agencies, private industries, and other monitoring groups) that is fully supported by a suite of standardized monitoring protocols. This suite of protocols covers quality control/quality assurance (QAQC) for a range of methodologies. Virginia provides grant funds to build capacity and support ongoing citizen/non-agency monitoring activities. Additionally, the state has

annual goals for miles of stream to be monitored through these efforts. The application and utility of state-wide monitoring activities established in Virginia is not consistent across the Chesapeake Bay Watershed.

Case Study- Sub-watershed Urban and Suburban BMP Effectiveness Monitoring

The Anacostia is an example of a priority watershed where there are several different sources of data available. The watershed is 176 square miles; contains 862,400 residents; is 70% developed; has 25% impervious area; contains fourteen (14) sub-watersheds; has six or more county, state and federal governments partnering to address problems that include: sediments, bacteria, low oxygen levels, trash, toxic contaminants, and low levels of biological diversity (MWCOG, 2008). The combined monitoring efforts of the sub-watershed organizations (citizens) and the county, state, and federal efforts track BMP (e.g., wetland restoration, fish passage, forest cover, and etc.) effectiveness (Table 4). These combined monitoring efforts measure (partial list):

- Total suspended solids
- combined sewer overflows
- total phosphorus and total nitrogen
- fecal coliform concentration and bacterial contamination
- dissolved oxygen
- biochemical oxygen demand
- secchi depth
- chlorophyll “a”
- temperature
- turbidity;
- pH;
- resident fish community health
- stream miles restored
- percent impervious surface
- percent of developed lands with storm water management controls
- created/restored tidal wetland acreage
- created/restored non-tidal wetland
- miles of created riparian forest buffer
- other measures/indicators

Taken together, the local watershed organizations and governments communicate with the concerned public through a variety of means. In order to communicate about the condition/state of the sub-watershed, trends, factors affecting the trends, restoration options and progress, and to share information, they use: state of the watershed reports; monitoring reports; published data sets; web sites; strategic plans; and many other means.

Table 4. Potential Data Sources for Urban and Suburban BMP Studies in Chesapeake Bay Small Watersheds

Monitoring Program	BMP Effectiveness Data			N, P & Sediment Loads	Biota	Reference
	Type & Location	Land Use Land Cover Soils, etc.	WQ Data			
URBAN AND SUBURBAN MONITORING						
NSF Baltimore LT Ecosystem Study	X	X	X	X	X	http://www.lternet.edu/vignettes/bes.html
Montgomery Co. WQ & Benthic	X	X	X	X	X	http://www.fosc.org/WaterQuality.htm http://www.anacostia.net/restoration/Reports_and_Data/Action_Agenda.pdf
DC-DOE WQ & Phytoplankton – Potomac & Anacostia Rivers	X	X	X		X	http://ddoe.dc.gov/ddoe/frames.asp?doc=/ddoe/lib/ddoe/information2/water.reg.leg/DC_IR_2008_Revised_9-9-2008.pdf
MWCOG Anacostia River	X	X	X	X	X	http://www.anacostia.net/restoration/Reports_and_Data/Action_Agenda.pdf http://www.fosc.org/WaterQuality.htm
MWCOG Potomac River	X	X	X	X		http://www.mwcog.org/uploads/committee-documents/bl5fXVpX20080118144813.pdf http://www.owml.vt.edu/projects.htm
DC DOE - Watts Branch Watershed Restoration Project	X	X	X		X	http://ddoe.dc.gov/ddoe/frames.asp?doc=/ddoe/lib/ddoe/information2/water.reg.leg/DC_IR_2008_Revised_9-9-2008.pdf
MDE 319 – Centerville Stormwater BMPs (Corsica River)	X	X	X	X		http://www.mde.state.md.us/assets/document/319-2008-Maryland-FINAL-NPS-Annual-Rpt-20090515.pdf
Villa Nova Urban Storm water Partnership (PA) – LID BMPs	X	X	X			
MDE 319 Frederick Co.- Toms & Bennett Creek Urban Wetlands	X	X	X	X	X	http://www.mde.state.md.us/assets/document/319-2008-Maryland-FINAL-NPS-Annual-Rpt-20090515.pdf
Fairfax Co. WQ & Phytoplankton – Gunston Cove			X	X	X	http://mason.gmu.edu/~rcjones/gc989rep.pdf http://mason.gmu.edu/~rcjones/GC0304Final.pdf
Occoquan Watershed Monitoring Program, and Chain Bridge	X	X	X	X		http://www.mwcog.org/uploads/committee-documents/bl5fXVpX20080118144813.pdf http://www.owml.vt.edu/projects.htm
USGS / Fairfax Co.	X	X	X	X	X	http://va.water.usgs.gov/projects/ffx_co_monitoring.htm
City of Portsmith,Va. – Storm Water Monitoring			X			
Chesterfield Co. Va. - Swift Creek Reservoir	X	X	X	X	X	http://www.chesterfield.gov/content.aspx?id=2854&ekmensel=c580fa7b_66_118_2854_18 http://www.chesterfield.gov/content2.aspx?id=2852
Calvert Co. Md. – Mill, St. John's, Back Creeks & Narrows			X			http://www.gonzo.cbl.umces.edu/PDFs/2007FinalReport07102008.pdf
NFWF / Opequon Creek						
NFWF / SRBC /PCWEA – Paxton Cr. Storm water Monitoring (Harrisburg)			X	X		
NFWF / CWP – James River Storm water BMPs			X			

Monitoring Program	BMP Effectiveness Data			N, P & Sediment Loads	Biota	Reference
	Type & Location	Land Use Land Cover Soils, etc.	WQ Data			
VDCR Polecat Creek (baseline, pre-development monitoring)			X	X		
VA DEQ Non-Agency/Citizen Monitoring Activities (state-wide and numerous local watershed organizations	X	X	X	X	X	http://www.deq.virginia.gov/cmonitor/guidance.html http://www.deq.virginia.gov/cmonitor/pdf/2008_Summary_of_Non-DEQ_Activity.pdf http://www.deq.virginia.gov/waterguidance/pdf/062010.pdf http://www.deq.state.va.us/cmonitor/pdf/summer07VCWQ_pres7-21-07.pdf
CITIZEN MONITORING						
Alliance for the Chesapeake Bay	X	X	X	X	X	http://www.acb-online.org/pubs/projects/deliverables-87-3-2004.PDF http://www.acb-online.org/monitoring/data/attribute.cfm?type=Water_Quality_Data http://www.acb-online.org/pubs.cfm
South River Fed. & River Keeper Monitoring	X	X	X	X		http://www.imrivers.com/southriver
Severn River Keeper monitoring	X	X	X			http://www.severnriverkeeper.org/monitoring.html http://www.severnriverkeeper.org/pdf/SevernReportCard2008.pdf http://www.severnriverkeeper.org/restoration.html http://www.severnriverkeeper.org/pdf/2006%20Severn%20Riverkeeper%20Monitoring%20Project.pdf
Magothy R. Volunteer Monitoring	X	X	X			http://www.magothyriver.org/wp-content/uploads/2007/08/magothy_river_index_08_newsletter_v61.pdf http://www.magothyriver.org/our-river/the-magothy-river-index/mri-2006/
Loudoun Stream Quality Project	X				X	http://www.loudounwildlife.org/Environmental_Monitoring.htm
Friends of Powhatan Creek WQ Monitoring Program	X	X	X		X	http://web.wm.edu/environment/FOPC/FOPC.html http://www.jccegov.com/pdf/stormwater/JCC%20Volunteer%20Water%20Quality%20Monitoring%20Program%20web%20powerpoint.pdf
Reston Association Stream Monitoring	X	X			X	https://www.reston.org/ParksRecreationEvents/StreamRestoration/MonitoringMaintenance/Default.aspx?genc=HzT9ACzZbNs%3d&fgenc=gJ0waUvthCNxSIKHN94QoQ%3d%3d http://www2.reston.org/parks_rec/Watershed%20Master%20Plan/Exec.%20Summary.pdf
West and Rhode River keeper	X		X	X	X	http://www.westrhoderiverkeeper.org/waterquality.php?newyear=2009 http://www.westrhoderiverkeeper.org/reportcard/WR_Report_Card_09.pdf
Potomac Conservancy	X	X	X			http://www.potomac.org/site/wp-content/uploads/pdfs/pc_sonr_web.512kb.pdf
James River Association	X	X	X	X		http://www.jamesriverassociation.org/what-we-do/watershed-restoration/
Upper Rappahannock Stream Monitoring Program (quarterly)			X			http://www.rappmonitor.va.nacdnet.org
Wicomico Creek Watchers			x			http://www.cbf.org/Document.Doc?id=262

Monitoring Gaps, Challenges, and Partnership Opportunities for Water Quality

A number of water quality monitoring programs listed in the inventory could be used to determine the status of nutrient and sediment levels in smaller Chesapeake Bay watersheds. Status information may be useful to help identify areas to enhance water-quality management actions for restoration or protection. The majority of non-tidal sampling sites lack stream flow data so cannot be used to assess load reductions or trends in loadings. There are a few partner monitoring programs in tidal waters which may be considered, mostly citizen and watershed association monitoring programs. These programs have the greatest potential to enhance information on status (or condition) of local tidal waters but must be further investigated to determine their comparability to Chesapeake Bay Program protocols. Below is a summary of partner challenges and opportunities for each monitoring objective.

Assess Attainment of Water-Quality Criteria in the Bay

The existing CBP tidal monitoring networks (Table 2) are the primary monitoring programs to assess water-quality standards and status and trends. There are no existing partner opportunities to assess attainment of dissolved oxygen, clarity and/or chlorophyll standards in the Bay and its tidal waters, while some exist to assess toxic contaminant conditions. Citizen monitoring is conducted in selected tidal tributaries but this is most useful for status of conditions but not assessment of standards.

- **Recommendation:** There may be substantial reductions in tidal monitoring effort as a result of the MRAT process. Existing NOAA-National Ocean Service supported observational systems may be the most viable partnering option for obtaining data to fill the information gaps which will be created by the re-allocation of funding. Buoy observing systems operated by NOAA may be a potential future partnership opportunity but the data needed for deep water (>2 m) water-quality assessment are not currently collected at a majority of the sites in the observing systems. CBP would also want to approach NOAA about adding additional instrumentation on selected buoys for selected parameters. (DO salinity, turbidity & pH). There are opportunities to develop partnerships with the National Oceanic and Atmospheric Administration-Coastal Prediction Center and National Aeronautics and Space Administration (NASA)/Goddard Space Flight Center. Goddard's ocean color group strives to coordinate with international satellite sensor groups to maintain a consistent and cohesive ocean-color record based on a variety of satellites which have potential for filling spatial and temporal gaps in Bay water quality monitoring. (chlorophyll, turbidity and sea surface temperature).
- **Recommendation**: There are about 40 partner monitoring programs addressing toxic contaminants in the Bay and its watershed. The CBP should continue to pursue partnerships to better assess toxic contaminant conditions in the Bay given their impact

on living resources and that almost 75% of the bay is considered impaired due to toxic contaminants. The CBP should pursue partnership to better assess toxic contaminant conditions in the watershed and loading of selected contaminants to the Bay.

- **Recommendation:** Citizen monitoring is conducted in selected tidal tributaries and is the most promising opportunity for enhanced partnerships to assess status. The monitoring may be useful for trends if collected for 10 or more years. The CBP should further explore establishing citizen monitoring partnerships in additional tidal tributaries.

Status and Trends of Nutrients and Sediment in the Watershed

Status-There are over 300 additional sites (in addition to the CBP non-tidal network) currently monitored on a consistent basis by state, federal and river basin commissions in the Chesapeake Bay watershed that could be considered to better define the status of water-quality conditions in the watershed. These programs offer opportunities to better define the status of nutrients, sediments, contaminants, and bacteria concentrations.

- **Recommendation:** The utility of these sites should be further investigated, especially for assessing toxic contaminant conditions in the watershed. However, the coordination and data management to synthesize thousands of data records to produce this kind of analysis would be extensive and should be incorporated into the costs. The benefit of using these data should also be evaluated, as much of the data are sufficient for analyzing water-quality condition (status) but not sufficient for evaluating the change in water quality over time (trends).

Trends and Loads-The CBP non-tidal network was established in 2004 to provide comparable data to assess status and trends in concentration and loads for nutrients and sediment. The partner programs discussed under status were already evaluated to determine which sites could be included in the non-tidal network. As of 2008 there were 87 sites in the NTN and the potential for new sites is evaluated annually. Therefore, the vast majority of partnering opportunities to support additional sites in the CBP non-tidal network by state, federal, and river basin commission organizations have been exhausted. The existing partnership of the CBP NTN (every state in the watershed, Interstate Commission on the Potomac River Basin Commission (ICPRB), SRBC, USGS, and EPA) coordinate partner funds and efforts for the network ($3 million/year) and receives $300,000 from the CBP to help support the network. There may be potential to use existing programs to determine changes in selected toxic contaminants that are impacting fish and wildlife in the Bay and its watershed.

- **Recommendations:** Continue to try to establish stream gages at existing water-quality monitoring sites to increase the number of sites in the network to better represent under-monitored areas such as urban and agricultural pollution source sectors and the coastal plain. High priority should be given to adding gauging stations to existing water-quality

monitoring sites with historical information. Consider having ground-water flux measurements to better address nitrogen loading from the Coastal Plain to the Bay. Assess potential partnerships to monitor selected contaminants impacting fish and wildlife in the Bay and its watershed.

Small Watersheds and Agriculture

The biggest gap in the current CBP monitoring programs is the ability to evaluate the effectiveness of management practices. This objective is better done in smaller watersheds (less than 100 square miles) where the water-quality effects of BMP's can be better isolated and other data including land-use information and locations of management actions can be obtained. However, even in smaller watersheds the effectiveness of individual BMPs is not possible unless field-scale studies are conducted. Conducting small watershed studies are data intensive, requiring information on stream flow, water-quality conditions, land-use, and BMP information and can cost up to $750,000/year. These watersheds also require a large change in the amount of management practices being applied to detect a change in water quality.

There are partnering opportunities with government agencies, academic institutions, and NGO's that conduct small watershed studies to better assess the effectiveness of management actions. The potential partnerships include existing federal-state programs (such as state TMDL and 319 grant programs), federal (USGS, USDA-ARS, EPA) agencies that are already working with state and local governments, academic institutions (such as Smithsonian Estuarine Research Center (SERC), UM, VT, PSU, Virginia Institute of Marine Science (VIMS)), and a large amount of citizen monitoring by watershed organizations. Many of the NGO grants (National Fish and Wildlife Foundation (NFWF)) and TMDL projects might be studies that only have funding over a selected period of time usually 1-5 years) and longer-term monitoring is needed to assess water-quality changes from management actions. Collaborating with these groups could allow for the Chesapeake Bay non-tidal network (NTN) to incorporate a site from the small study area that would allow for a long-term record to be developed for the project. This long-term site would benefit both the organizations and the NTN (by incorporating data from under-represented small drainage basins). Many of the partnering opportunities in these small study areas might be in data assessment and synthesis of multi-program results. Partnering activities in these watershed studies may include providing technical support to synthesize multi-agency results, adding a long-term monitoring site to help assess the effectiveness of management actions, conducting synoptic surveys an other specific monitoring support, obtaining and tracking land use and management actions at a small watershed scale, and developing tools to communicate results from multiple different projects to managers.

- **Recommendation:** Assess and synthesize available information on the effectiveness of management actions to reduce nutrient and sediment loadings in the watershed. This will result in short-term management products and the benefits of "lessons learned".
- **Recommendation:** Select 6-18 watersheds in different agricultural, urban and suburban land areas where different types of BMP are being applied, and co-locate NTN sampling sites. This would provide long-term information to understand the factors affecting water-quality change and evaluate the effectiveness of management actions. Be sure that there is a commitment by partners to collect information on watershed attributes (land use change management actions, etc.) to link to water quality results.
- **Recommendation:** Provide additional funding to supplement data collection or assessment in watersheds not addressed by the partners, and fund one or more small watershed specialists to synthesize information from multiple small watershed studies to provide summary information to CBP managers to they can better implement and adjust management actions throughout the watershed.
- **Recommendation:** Focus future agricultural BMP monitoring efforts are focused on the priority watersheds identified by the STAC workgroup. This will involve further identification of agencies and organizations that have collected data relevant to the BMP performance studies.
- **Recommendation:** Evaluate prospective water-quality monitoring data sets by comparing each agency's sampling design and protocols, measured parameters and methods to those appropriate for planned data analysis. The availability of flow data will be important because they are necessary for the direct calculation of loads

Urban and Suburban

This effort to review selected monitoring programs is general in nature and designed to better understand what is out there in the Chesapeake Bay sub-watersheds. Many examples of collaboration were found (e.g., between the multiple non- and government organizations working in the Anacostia sub-watershed and along the Potomac; also between Anne Arundel County and NGOs like the South River Federation and the Severn River Keeper; and VADEQ citizen/non-agency program). However it was not clear that there are standard, shared, clear, and consistent protocols in use across the entire Chesapeake Bay watershed for sampling, QAQC, and data management supporting status or trend characterization. Additionally, funding of monitoring efforts across this watershed does not appear to be consistent or coordinated.

- **Recommendation:** Further steps should be taken to ensure that local government and watershed organization monitoring protocols and sampling designs for characterizing status and establishing trends (including the protocols for sampling, QA/QC, and data management) are appropriate for the necessary data analysis.

- **Recommendation:** Additional funding is needed to support local government and watershed organizations in developing programmatic capacity to allow for partner opportunities in bringing their monitoring programs up to present CBP standards.

Fisheries Partnership Opportunities

Management Goals and Priority Fisheries Monitoring Needs

Sustainable management of economically and ecologically important fish and shellfish species is a long-standing goal of the Chesapeake Bay Program (CBP, 1987; CBP, 2000). Strong incentives to achieve this goal are provided by stakeholders from commercial and recreational fisheries sectors as well as the general public who see viable populations of key species as an essential outcome of management and restoration efforts in the Bay. At present, the CAP captures fisheries related goals under the Protect and Restore Fisheries Goal Area (CBP, 2008) with particular emphasis on five species; oysters, blue crab, striped bass, Atlantic menhaden and alosines. Specific objectives include:

- Monitor and track population and stock health
- Monitor status of oyster stocks
- Build scientific infrastructure for ecosystem-based management and develop ecosystem based management plans

In addition, specific performance measures for fisheries have been identified in the CAP with the following targets:

- Implement oyster restoration on 2,466 acres of oyster bars by 2010
- Revise and implement existing fisheries management plans for the five targeted species to incorporate ecological, social and economic considerations, multispecies fisheries management, and ecosystem-based approaches
- Abundance of blue crab, oyster, and striped bass, American shad, and menhaden populations

In order to understand the monitoring/assessment needed to meet these goals, we engaged the chairs of the Quantitative Ecosystem Teams (Stock Assessment, Habitat, Food Webs and Socio-economics) who are working within the ecosystem based fisheries management (EBFM) planning effort for Chesapeake Bay. In addition, the following comments benefited greatly from a comprehensive analysis of Chesapeake Bay fish stock monitoring and a series of associated recommendations made in 2006 workshops facilitated by the Chesapeake Research Consortium (CRC) and NOAA Chesapeake Bay Office (Bonzek et. al 2007). The workshop proceeding report's recommendations remain relevant to ongoing discussions and provide an important consensus from key Chesapeake Bay fisheries managers and scientists. Historically funding for the bulk of the surveys examined in the report has come from the States of Maryland and Virginia (Maryland Department of Natural Resources (MD-DNR) and Virginia Marine Fisheries Commission (VMRC), Virginia saltwater license fees), the Potomac River Fisheries Commission (PRFC), the Commonwealth of Pennsylvania, the District of Columbia, Wallop-Breaux

Program (USFWS), the NOAA-Chesapeake Bay Office, NOAA (national level) and National Science Foundation (NSF).

Fish Stock Monitoring

With respect to fish stock monitoring, the report suggests that fishery-independent monitoring in the Chesapeake region yields reasonable coverage although this should be considered a minimum for management needs. It is important to recognize that such monitoring is required by regional management agencies (i.e., the Atlantic States Fisheries Management Commission) as a matter of compliance and therefore must be a priority. Of particular importance in this regard are bay-wide surveys (Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP) and surveys focused on providing guidance for management of blue crab. A number of these monitoring programs benefit from coordination among partners and funders.

Ecosystem-based Monitoring

Recognizing the complex interactions among aquatic species, water quality and habitats in the Chesapeake Bay watershed, and the economic importance of fish, CBP has set a path towards ecosystem-based fisheries management. It will be critical to have monitoring information about habitat conditions (water quality and SAV) in spawning, juvenile and adult habitats since these conditions can influence biomass production. Additionally an understanding of food web dynamics (phytoplankton, zooplankton, benthos and forage fish interactions) is a critical monitoring need for ecosystem-based fisheries management. There is a critical need to have fishery monitoring be coordinated with water quality and habitat monitoring so they are spatially and temporally compatible to support EBFM.

Summary of Current Monitoring Programs to Address Fisheries Needs

General Survey Needs

To better meet management goals, the 2007 report emphasized that priority should be placed on strengthening coordination among those performing surveys with an emphasis on maintaining “regular and dependable” data collections in the main Bay and tributaries (Bonzek et. al 2007). The report also emphasizes that no single survey can effectively capture all the monitoring needs for multispecies management and recommends that enhanced coordination and possible modification of extant efforts leading to the development of four survey platforms be implemented. These include:

- Deep mainstem and tributary (>6 m) surveys utilizing large bottom trawls that target adult and juvenile fish. In addition mid-water sampling should be considered as well as newer

survey technologies (hydroacoustics-based, electronic bottom typing, continuous plankton sampling etc.) that can enhance data collection

- Shallow mainstem tributary (2.5-6 m) surveys utilizing smaller trawl nets. A coordinated bay-wide effort conducted in parallel to the deep-water surveys should include all principal tributaries although rotation among some may be required
- Shallow mainstem, tributary and littoral zone (< 2.5 m) surveys. Both beach seines and large-haul seines are recommended at least four times a year to provide minimum coverage.
- Longline surveys in the lower bay and near shore Atlantic. Routine monitoring using this platform provides important information for those species not well sampled by trawl or seine (eg. Elasmobranchs, drum, cobia)

Special Purpose Surveys

The 2007 report notes that the general surveys will not be adequate to capture all the data needs for some species (Bonzek et. al 2007). When this occurs, purpose-designed surveys are required. Examples of special purpose surveys include assessing spawning area for anadromous species (shad, herring, and striped bass) that are mandated by regional management bodies and specialized juvenile abundance surveys for American eel and Atlantic menhaden.

Monitoring Essential to Ecosystem Based Fisheries Management

A key goal of the CBP is to adopt ecosystem based fisheries management (EBFM). Monitoring of stocks of the five target fish species while essential is just one part of this effort. Success in implementing EBFM will depend upon integrating a much wider array of data from surveys extending beyond fish stock monitoring to a wide array of living resources beyond recreational and commercial fish species to critical characteristics of food webs, habitats and a variety of important socioeconomic factors. Appendix B Table B5 appropriately notes that numerous surveys will impact the EBFM effort. An EBFM approach to fisheries management in the Chesapeake will require monitoring that includes:

- Spatial and temporal variations in critical habitats including SAV and water quality
- Spatial and temporal variations in key food web elements including zooplankton, phytoplankton, and benthos
- Multispecies sampling that tracks variations in juvenile and forage fish species
- Invasive species assessments targeting potential threats to key stocks (i.e., blue catfish, mitten crab etc)
- Socioeconomic factors and stakeholder elements of stakeholder engagement

Enhanced Coordination

The complexity of fish monitoring in the Bay suggests that enhanced coordination among the many partners would achieve greater efficiencies and leverage the combined investments being made. With this in mind, participants in the 2006 workshops were in consensus that institutional mechanisms were needed to bring together regional managers, scientists, and with national experts to further shape a comprehensive, coordinated monitoring program.

Freshwater Fisheries

Currently the CAP does not address the conditions of fresh water fisheries in the fisheries goal area. The habitats goal area tangentially addresses fresh water fisheries by restoring fish habitat. The 2009 monitoring inventory identified about 41 partner programs conducting fish stock monitoring in the region (Figure 2, Appendix A, Table A1) with effort equally divided between tidal and fresh waters (Figure 8). Based on reporting from USFWS in excess of 6 million dollars a year of state and federal funds are spent on monitoring of fresh water fish in the watershed. The recent Chesapeake Bay STAC-Monitoring Program review findings (Wardrop and Kirk, 2009) indicated Senior Managers of the CBP partnership placed a high priority on assessing effectiveness of management actions in the watershed. Basin-wide integration on the health and status measures for fresh water fish stocks should provide an important multi-scale indicator of restoration progress and be included in programmatic goals.

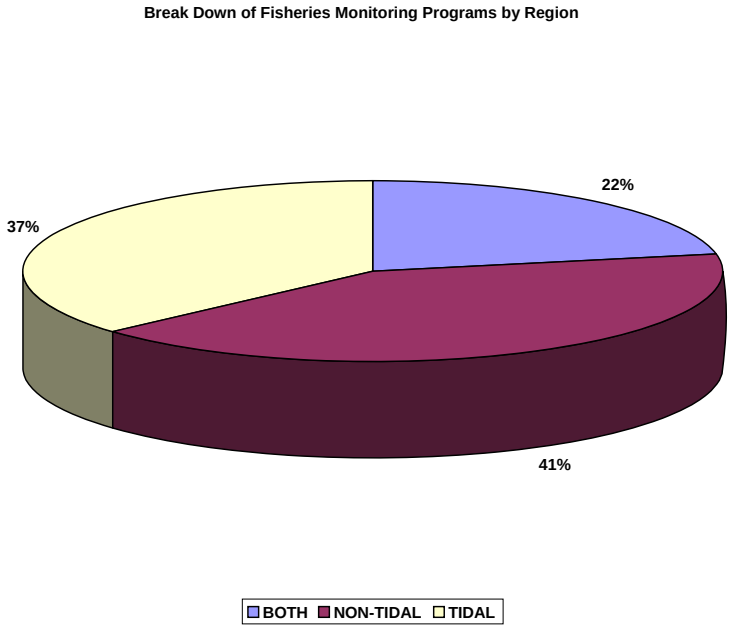

Figure 8. Reporting of Fisheries Monitoring Efforts in Chesapeake Bay Region.

Monitoring Gaps, Challenges, and Partnership Opportunities for Fisheries

Monitoring programs need to balance the need for ongoing decision-making for single species while continuing to build the capacity for newer ecosystem-based fisheries management. Appendix B Table B5 provides details on approximately 70 current monitoring programs that directly or indirectly contribute to goals related to fisheries management in the Bay and its watershed. While the Fisheries Goal Implementation Team is just beginning its work, several key opportunities and needs have been identified as priorities by the Quantitative Ecosystem Team chairs and others participating in the ecosystem-based fisheries management effort.

- **Recommendation:** The proposed reductions of tidal monitoring due to funding re-allocation will degrade our ability to do EBFM. There for the maintaince, enhancement and expansion key non-fisheries monitoring programs (water quality, SAV, phytoplankton, zooplankton, and benthos and forage fish) is needed to support ecosystem-based fisheries management. Fishery monitoring should be coordinated with water quality and habitat monitoring so they are spatially and temporally compatible to support EBFM.

Fisheries Dependent Surveys

The value of fishery independent surveys (FIS) has been clearly established. However, fisheries dependent surveys (FDS) and fish catch monitoring are less well developed in the Bay. This would include both commercial and recreational catch monitoring. An important aspect of FDS is the ability to collect data on bycatch, a sector that is not well quantified and needed for stock assessments. At present, the fishery-dependent information is less reliable and should be a focus of increased attention - particularly for the recreational sector for which extent surveys are chiefly designed to provide coast-wide estimates not regional ones.

- **Recommendation:** Enhance and expand fishery-dependent surveys to gain a better understanding of the impact of commercial and recreational fishing on key species

Bridge Chesapeake Bay and NMFS Offshore Surveys

The great value of Chesapeake Bay surveys would be enhanced by consideration of how best to link these efforts to the offshore National Marine Fisheries Service (NMFS) trawl survey. This recognizes that gear comparison studies would be needed prior to any anticipated changes.

- **Recommendation:** Develop better links between Chesapeake Bay and offshore fisheries monitoring programs

Assess Monitoring Program Performance

The continued success of these surveys would be enhanced by auditing their performance in a systematic manner. For instance, what is chance of detecting a 10% change in abundance on an annual or decadal scale in key species with a given survey? Power analysis of this nature has not been applied to any of the long-term survey methods, with exception of the winter dredge crab survey.

Oyster Stock Assessment

Oyster restoration remains a central goal of the CBP. Ongoing discussions in both Maryland and Virginia have framed a number of new approaches to this vexing problem. A recent analysis of native oyster restoration efforts over the past 18 years focuses attention on the need for a Bay-wide oyster stock assessment as a critical step to understanding the current distribution of the oyster population and future restoration activities (ORET 2009).

- **Recommendation:** Conduct methodologically consistent surveys of oysters Bay-wide for stock assessment

Habitat Partnership Opportunities

Management Goals and Priority Habitat Monitoring Needs

Habitat protection, enhancement and restoration for the benefit of living resources in estuarine, non-tidal water and terrestrial areas have been a long-standing corner stone of Chesapeake Bay Program efforts (CBP, 1987; CBP, 2000). In the 2008 CAP, this focus continues in the Protect and Restore Vital Aquatic Habitats Goal Area (CBP, 2008). In this section of the CAP the primary goal are for the protection and restoration migratory fish habitat, Submerged Aquatic Vegetation, wetlands and streams. Specific objectives include the following:

- Assess Quantity, Quality and Function of SAV, Wetlands and Stream Habitats
- Prioritize Restoration Opportunities for SAV, Wetlands and Streams
- Assess Effectiveness of Habitat Restoration Activities
- Prioritize Fish Passage Opportunities- with special emphasis on removing blockages on the James and Susquehanna Rivers
- Assess Effectiveness of New and Existing Fish Passages for restoring habitat range for diadromous fish

Additionally three performance measures of restoration progress were identified in the CAP with associated two-year realistic annual targets:

- Plant 1,000 acres of SAV by 2008
- Restore 28,500 acres of wetland by 2012
- Open 2,807 miles of migratory fish habitat and complete 100 dam removal projects by 2014

In order to meet these restoration and protection objectives and support the current Bay Program communication products, the former Living Resources Subcommittee and the new Aquatic Habitats Goal Implementation team have identified the following specific monitoring needs and activities.

SAV

- Continue the Annual Aerial Submerged Aquatic Vegetation Survey and associated ground-truthing programs to insure the ability to assess changes in the resource.
- Continue the Main-stem water quality-monitoring program with monitoring at frequency and density of stations adequate to insure habitat conditions favorable for the maintenance and expansion of SAV acreage.

Wetlands

- Continue support of the Sea Level Rise Affecting Marshes Model (SLAMM) for the Chesapeake Bay. This model simulates the dominant processes involved in wetland conversions and shoreline modifications during long-term sea level rise. Data requirement to run this model include tides, wetland mapping, and elevation data.
- Update the National Wetlands Inventory (NWI) database for the Chesapeake Bay Watershed. Monitoring requirements for NWI include vegetation assessment, hydrology and soils.
- Continue the acquisition and analysis of National Oceanic and Atmospheric Administration-Coastal Change Analysis Program (C-CAP) data for wetlands acreage change indicator.
- Obtain better wetlands monitoring data for acreage change assessment. C-CAP data is adequate to see wetland changes in select tidal areas of the Bay, but lacks resolution adequate to see changes in the resource over time on a bay wide scale.
- Obtain Synthetic Aperture Radar (SAR) and ground data during optimal ground hydrologic conditions (i.e., spring) before and after planned hydrologic restorations on the Eastern Shore of Maryland. These data will be used to create maps of wetland hydrology and extent for the periods before and after restoration. This effort will provide a better understanding of the effects of hydrologic restoration techniques, will improve accountability for both internal and external program requirements, and could become part of a protocol for implementing federal wetland restoration programs.

Stream Conditions and Fish Passage

- Utilize state and federal water quality, fish monitoring and benthic assessments in streams to better target fish passage, stream restoration projects, and assess post project effectiveness. Additionally expand existing monitoring efforts to include monitoring for fresh water mussels and American eel both critical measures of stream health.
- Enhance information to protect and restore habitats for other potential priority living resources (selected fish, bird, and wildlife species) and address the potential impacts of invasive species habitats. Some specific suggestions include: develop a Chesapeake Bay Marsh Bird monitoring protocol, develop and apply bird population habitat models for key habitat types, and predict impacts of urban growth and climate change.
- Assess and map the areas affected by invasive plants and animals in the Chesapeake Bay.
- Expand the Atlantic Coast flyway sea/diving ducks surveys to include the entire Chesapeake Bay and map the diving duck habitats.

- Improve monitoring to determine viral, bacterial, and parasite pathogens affecting fish and wildlife health, survival, reproduction, and sustainability in key tributaries and estuarine areas. Investigate the cause and effect of toxic algal blooms and their effects on migratory birds, declines in fish populations due to endocrine disruptors, and nutrient loading from non-point source runoff.
- Increase monitoring, evaluation and law enforcement efforts to prevent both intentional and unintentional introductions of terrestrial and aquatic invasive species. Special enforcement emphasis should be placed at the ports of Baltimore, Norfolk, and Dulles International Airport.

Summary of Current Monitoring Programs to Address Habitat Needs

Of the reported 295 monitoring programs in the 2009 monitoring inventory, approximately 185 programs appear to have some component, which may produce data useful for meeting Aquatic Habitats Goal Area information needs (Figure 2, Appendix B Tables B5 and B6). Many of the current federal, state, local and NGO monitoring stream water quality and benthos-monitoring programs are potentially valuable partnership opportunities to better target and assess the effectiveness of restoration and protection efforts. However, the programs will have to be further examined to determine data compatibility to for regional habitat assessment. The Habitat GIT has also expressed monitoring needs for birds, exotic species and climate monitoring for restoration and protection objectives that are not explicitly CAP goals but are needed for ecosystem management.

Monitoring Gaps, Challenges, and Partnership Opportunities for Habitat

Overarching Gaps, Challenges, and Recommendations

The Habitat Goal Implementation Team and its predecessor the Living Resources Subcommittee and its work groups have actively pursued partnership arrangements to meet their monitoring needs with large regional and national monitoring efforts. However, on numerous occasions in the past while partnership opportunities have been available there was a lack of funding to establish the partnership.

- **Recommendation**: The CBP needs to have a flexible source of funds to establish priority partnerships. The new Technical Support Services Team should oversee the funds.

While there are numerous opportunities to expand our monitoring networks by establishing partnerships, there will be costs to the Bay Program. Assessing the compatibility of information from

multiple partner programs to address monitoring needs is a critical and time-consuming process. The acquisition and management data deemed usable from multiple small providers will require extra data management effort.

- **Recommendation:** The CBP will need to increase capacity to assess comparability and manage information from partner programs. CBP should develop partnership guidance documents which layout analytical quality assurance requirements for a monitoring program to become a partner in our monitoring networks. Guidance for data management, data submission and metadata currently exists but will need modification for working with small data providers (CBP, 1998; CBP, 2001 and CBP, 2006).

SAV

The existing CBP SAV monitoring program, coordinated through the Virginia Institute of Marine Sciences (VIMS), already utilizes partnership opportunities between the states of Maryland and Virginia, other federal and non-governmental agencies. This program is critical to meeting habitat goals and no enhancements are needed at this time. Decreases in the Main-stem water quality-monitoring program will degrade our ability to insure habitat conditions favorable for the maintenance and expansion of SAV acreage.

Wetlands

More systematic monitoring of wetland acreage and condition (vegetation, hydrology, and soils) is needed to assess change over time. Funding for wetlands monitoring has always been problematic and needs to be addressed. The Sea Level Rise Affecting Marshes Model (SLAMM) for the Chesapeake Bay needs improvement to more accurately predict sea-level rise in areas of low relief.

- **Recommendation**: The SLAMM model could be improved by the USFWS and USGS providing information (such as more comprehensive elevation data) to improve the certainty of SLAMM model predictions in coastal areas with very low relief. The development or acquisition of a cohesive high vertical (V)/ horizontal (H) (~20-30cmV/1 meter H) spatial resolution Digital Elevation Model (DEM) basin-wide would facilitate model enhancement.
- **Recommendation**: Monitoring the changes in wetlands could be enhanced through a partnership to update the National Wetlands Inventory. The lead agency for this is USFWS. Partnerships with NOAA Coastal Change Analysis Program (C-CAP) need to be continued to provide data for the wetlands acreage change indicator. Other promising partnerships to improve wetland data include partnerships with USDA-Natural Resource

Conservation Service (USDA-NRCS), USGS, Ducks Unlimited and other non – governmental agencies.

Stream Conditions and Fish Passage

During 2008, the CBP NT workgroup developed a stream-health indicator based on benthic invertebrate data collected by different agencies in the 6 states in the Bay watershed. The reallocation of funding of non-tidal monitoring should enhase our ability to assess stream health. While there are partnership opportunities to expand the available data for assessing other aspects of stream health, such as fish condition in streams, the challenge will be to assess comparability and manage the data. There is also a need to be sure all of the potential federal and state programs have been reflected in the inventory.

- **Recommendation:** The CBP will need additional capability to assess and manage fish and other data from multiple partners. The partner opportunities to enhance data and assessment of stream health condition include the agencies in each state, which collect the fish and stream data, existing federal programs including the USFWS fisheries program and the USGS-Biological Status and Trends Program (USGS-BSTP), and new federal efforts that will occur under the National Wild Fish Health Survey. NGO and local government partnerships can also be used to acquire comparable data in selected areas.
- **Recommendation:** Enhancement of stream monitoring to include American eel and fresh water mussel monitoring components is an opportunity to add greater utility to on going monitoring efforts at a low cost. The most promising partnerships would be through the existing state programs of biological conditions in streams and federal programs such as the USGS-Biological Status and Trends Program and USFWS Fisheries Programs.

There is an overwhelming need for remote sensing imagery to meet habitat-monitoring needs. While there are numerous observing systems know to be available, historically the problem has been data acquisition and processing to create usable products.

- **Recommendation:** With the recent establishment of NOAA-Coast Watch East Coast Node at the NOAA Chesapeake Bay Office, there are many new opportunities to establish collaborative efforts to meet program remote sensing data needs. There are also viable partnering opportunities with Army Corp of Engineers National Coastal Mapping Program, USDA-NRCS and USGS.

Other Needs

The establishment of many local and NGO monitoring programs affords partnering opportunities to monitor the effectiveness of small-scale fish passage, wetlands and stream restoration projects. Frequently there is funding for the restoration effort but little or no funding available for monitoring project effectiveness.

- **Recommendation:** Select key watersheds to establish monitoring of stream restoration, fish passage, and wetland projects effectiveness. Attempt to align these watershed locations with small watersheds that are now being selected to better monitor the effectiveness of water quality actions in agricultural and urban areas.

There needs to be improved data on habitat supporting migratory birds and address the introduction and expansion of the range of invasive species in the Bay watershed. These objectives may best be achieved by better collaboration between federal program partners.

- **Recommendation:** Expand the capacity of the US Fish and Wildlife Service Chesapeake Bay Coastal Program and the Atlantic Coast Joint Venture partnership to collaboratively protect migratory bird habitats.
- **Recommendation:** Expand the capacity of the US Fish and Wildlife Service Chesapeake Bay Coastal Program to monitor invasive species and collaborate more closely with the USGS Invasive Species Program.

Watershed Partnership Opportunities

Management Goals and Priority Watershed Monitoring Needs

Activities on the land have a direct effect on the water quality as well as terrestrial and aquatic living resources in the watershed. Land cover, land use, and land management directly impact water quality in the Bay. Knowing the location of land cover, land use, and land management and the geographic factors affecting nutrient and sediment generation and transport to the Bay is critically important for managing the Bay restoration effort and for targeting restoration effects. In the 2008 CAP, activities insuring stewardship of the lands in the watershed are consolidated in the Maintain Healthy Watersheds goal area (CBP 2008). In this section of the CAP the primary goals for the maintenance of Healthy watersheds include the following:

- Preserve valuable resource lands
- Minimize Conversion of Forests, Wetlands, and Working Farms
- Minimize Impacts to Pre-Development Hydrology

Additionally there is one performance measure of watershed protection in the CAP with associated two-year realistic annual targets:

- Permanently protect 695,000 acres of forest land by 2020

In order to meet these Watershed objectives and support the current Bay Program communication products, the former Healthy Watersheds Goal Implementation team identified the following specific monitoring needs and activities.

- Geo-referenced tracking of land acreage, which has been placed in a protection status.
- In order to track change in the conversion of forests, wetlands, and working farms land basin wide, land use/land cover data, including forest and impervious cover, are needed on five year interval (2005, 2010, 2015,2020, 2025) at 30 meter resolution or better. Currently remote sensing data from the Landsat series of satellites is used to analyze for change.
- Impervious surface acreage for all HUC 14-digit watersheds on five year intervals (2005, 2010, 2015, 2020, and 2025) calculated from impervious cover data and geo-referenced storm water BMP implementation. Additionally USGS stream flow data are needed for all perennial streams in developed and developing areas.
- Official HUC 14-digit watersheds coverage for the entire watershed.
- Tracking of urban and storm water BMP implementation.

Summary of Current Monitoring Programs to Address Watershed Needs

In the 2009 monitoring inventory, 31 programs appear to have some component, which are useful for meeting Healthy Watersheds Goal Area information needs (Figure 2, Appendix B-Tables B8). Federally funded programs are currently meeting monitoring needs for watersheds pronominally. Local programs seem limited to the storm water and urban BMP tracking needs. Based on the 2009 Monitoring inventory there appears to be a lack of adequate monitoring for a number of needs in the Healthy watershed arena. At this point it is difficult to determine if this is due to a true lack of monitoring programs or gaps in our inventory.

Monitoring Gaps, Challenges, and Partnership Opportunities for Watersheds

In the 2007 STAC report "Potential Environmental Indicators for Assessing the Health of the Chesapeake Bay Watershed", STAC made recommendations for possible new environmental indicators in the Chesapeake Bay Watershed within the following categories: water quality, habitat and living resources. Under the watershed health indicator category there were recommendations for indicators including: acres of forest cover, acres of non-tidal wetlands, a landscape development index, and a channel ditching/altered hydrology indicator. Such indicators could be used in conjunction with The Resource Lands Assessment. The Resource Lands Assessment (RLA) provided a regional multi-state look at the most important remaining resource lands in the Chesapeake Bay Watershed. The RLA used Geographic Information Systems (GIS) models and expert knowledge to assess the value of resource lands within the watershed.

- **Recommendation:** Update the RLA to reflect new information and criteria for protecting lands and ecosystems (EPA, USGS, and USDA).
- **Recommendation:** Work done under the RLA should be incorporated with monitoring data to develop and improve watershed health indicators. Such indicators would promote healthy watersheds by helping to identify parts of the watershed in most need for restoration and protection.
- **Recommendation:** The RLA provides an indispensable tool for the identification and targeting of areas for preservation/protection activities. The establishment of partnerships with the federal, state, local and NGO partner who pursue land preservation/protection as primary or secondary objectives should be pursued.

- **Recommendation:** Need to employ new Light Detection and Ranging Radar (LiDAR) technologies to improve sea level inundation maps and to map small headwater streams and depressional areas that may serve as denitrification hot spots.
- **Recommendation:** Need to exploit recent technologies in airborne and Satellite Radar techniques to evaluate forested wetland condition, hydroperiocity, and perform synoptic carbon sequestration estimates and forest allometry via remote sensing.
- **Recommendation:** Work with the US Forest Service to discover and implement improved methods to monitor and track riparian and other important de-nitrophication area conditions basin-wide.

The best available land cover data for the Bay watershed are four new 30m resolution datasets derived from Landsat satellite imagery for 1984, 1992, 2001 and 2006. These data were created by MDA Federal under contract to USGS. The University of Maryland has also produced 30m resolution impervious cover maps for 1992 and 2001 for the Bay watershed. NOAA's Coastal Change Analysis Program (NOAA C-CAP) has produced 30m resolution land cover maps exist for 1996, 2001 and 2005 for the eastern half of the Chesapeake Bay Watershed. However, resources must be secured for acquisition and processing of future imagery.

- **Recommendation:** CBPO needs higher temporal frequency of land cover data to better understand causes of change on the landscape related to water quality. Hyperion satellite and airborne hyper spectral imagery across the watershed (including the water) are among the known possible solutions.
- **Recommendation:** States need to coordinate the acquisition of National Agriculture Imagery Program (NAIP) and leaf-off imagery so that the data include an infrared band and are temporally consistent and spectrally comparable across the Bay watershed.
- **Recommendation:** CBPO needs sampling protocols and affordable software to derive tree canopy and impervious cover from high-resolution imagery. The extent and pattern of both of these lands cover type's impacts water quality.
- **Recommendation:** The recent no-cost release to the public of the entire Landsat record dating back to Landsat 1, launched in 1972, needs to be exploited by developing or encouraging new automated techniques to identify and quantify annual or better landscape disturbances in forests and other land cover conversions in the last 35 years.

The acquisition and processing of remote sensing data for land use and land cover applications is expensive and requires high levels of technical expertise. However, this are two areas where there are numerous opportunities to establish partnerships with other federal entities to achieve program goals.

- **Recommendation:** Establish a partnership with the US Army Corps of Engineers (USACE) Joint Airborne LiDAR Bathymetry Technical Center of Expertise (JALBTCX) for

shallow and deep Bay waters bathymetry and estuary habitat monitoring and characterization. Mission is to perform operations, research, and development in airborne LiDAR bathymetry and complementary technologies to support the coastal mapping and charting requirements of the USACE, the US Naval Meteorology and Oceanography Command, and the NOAA. JALBTCX staff includes engineers, scientists, hydrographers, and technicians from the USACE Mobile District, the Naval Oceanographic Office (NAVOCEANO), the USACE Engineer Research and Development Center (ERDC), and NOAA National Geodetic Survey. To-date this data resource has not been exploited for water quality, coastline change/erosion mapping and habitat condition in the Chesapeake Bay Estuarine Area.

- **Recommendation:** Develop partnerships through USGS, USDA, and NOAA to obtain LIDAR for watershed applications including:
    - Perform a coverage and quality gap analysis of existing LiDAR data among the Bay states and assess its relative utility and cohesiveness.
    - Provide tools and analyses to demonstrate and assist in the use of multi-return and full waveform LiDAR technology for watershed analysis.
    - Provide tools and analyses to demonstrate and facilitate the use of Radar technology for mapping forested wetlands and measuring wetland services**.**

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Appendix A- The 2009 Chesapeake Bay Region Monitoring Inventory

Table A1. The 2009 Chesapeake Bay Program Monitoring Inventory

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
AIR QUALITY	Delaware Air Quality Monitoring Program	Delaware Department of Natural Resources and Environmental Control- Air Quality Management Section	Depends on site: ozone, TSP, Sulfur dioxide, ozone, gross radiation, pollen, precipitation	DE	9	depends, continuous to monthly	1965	USEPA
AIR QUALITY	District of Columbia Air Quality Monitoring Program	District of Columbia-Department of Health	Carbon Monoxide, Nitrogen Dioxide, Sulfur Dioxide, Ozone, TSP, SSI PM10, Lead, depending on station	DC	9	1/every 6 days	1980	USEPA
AIR QUALITY	Maryland Ambient Air Monitoring Program	Maryland Department of the Environment	Carbon Monoxide, Nitrogen Dioxide, Sulfur Dioxide, Ozone, TSP, SSI PM10, Lead, Nitrate, Sulfate, Arenic, depending on station	MD	26	1/every 6 days, depends on station	1970	USEPA
AIR QUALITY	New York Ambient Air Quality Monitoring	New York State Department of Environmental Conservation	Carbon Monoxide, Nitrogen Dioxide, Sulfur Dioxide, Ozone, TSP, SSI PM10, Lead, depending on station	NY	80	1/every 6 days, depends on station	1956	USEPA
AIR QUALITY	Pennsylvania Air Quality Monitoring Program	Pennsylvania Department of Environmental Protection - Bureau of Air Quality	Carbon Monoxide, Nitrogen oxides, Sulfur Dioxide, Ozone, TSP, SSI PM10, Lead, Nitrate, Sulfate, Arenic, settleable particulate, lead, others depending on station	PA	40	1/every 6 days and monthly	1970	USEPA
AIR QUALITY	Virginia Air Quality Monitoring Program	Virginia Department of Environmental Qualtiy	Carbon Monoxide, Nitrogen Dioxide, Sulfur Dioxide, Ozone, TSP, SSI PM10, Lead, depending on station	VA	13	continuous and 1/every 6 days	1970	USEPA
AIR QUALITY	West Virginia Air Quality Monitoring Program	West Virginia Department of Environmental Protection -Division of Air Quality	Carbon Monoxide, metals, carbonyls, VOCs, PM10, PM2.5, O3, SO2, Pb	WV	14			USEPA
BACTERIOLOGICAL-SHELLFISH	Anne Arundel County Maryland Shellfish Waters Program	Maryland Department of the Environment and Anne Arundel County Health Department	Fecal Coli forms	Anne Arundel County	30	Monthly- Labor day and Memorial Day, weekly- Memorial Day and Labor Day	1965	Maryland Department of the Environment and Anne Arundel County Health Department
Bacteriological	Anne Arundel County Maryland Recreational Waters Program	Maryland Department of the Environment and Anne Arundel County Health Department	Fecal Coli forms	Anne Arundel County	78	One weekly between Memorial Day and Labor day	1962	Maryland Department of the Environment and Anne Arundel County Health Department
Bacteriological	Appomattox River Virginia Water Quality Monitoring Program	Longwood University	Total Coliform, Fecal Coliform, and E. coli	Prince Edward (mainly) but also sites in Buckingham, Cumberland, and Nottoway counties of VA	12	monthly	1999	Program initiated through funding from the VA Environmental Endowment; maintained by funds from the VA Dept of Environmental Quality
Bacteriological-Shellfish	Maryland Shellfish Sanitation Monitoring Program	Maryland Department of the Environment	Water Column: Water Temperature, Dissolved Oxygen, Specific Conductivity, Salinity, Fecal Coliform Bacteria Shell stock: Fecal Coliform Bacteria, Heavy Metals & Pesticides (only at some stations)	800 Stations Bay Wide		Twice monthly	1930	Maryland Department of the Environment and USEPA Region 3

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Bacteriological	McClure River Restoration Project Coliform Monitoring	McClure River Restoration Project	Air temperature, organics, water temperature, weather, fecal coliform, bacterial	McClure River, Virginia	5	monthly	2006	Community
Bacteriological	Mechumps Creek Virginia-Ambient Watershed Water Quality Monitoring Program	Randolph Macon College	Bacteria monitoring (E. coli)	Mechumps Creek watershed	12			
Bacteriological	Occoquan Watershed Monitoring Program	Virginia Tech	Air temperature, BOD, chloride, conductivity, DO, flow, hardness, metals, Nitrogen, organics, pesticides, pH, Phosphorus, secchi, TSS/TDS, turbidity, VOCs, water temperature, weather, inorganic, carbon, bacterial, fish, chlorophyll		10	continuously, weekly, seasonally	1973	VA Tech
Bacteriological	Page County Virginia -Ambient water quality monitoring Program	Page County Department of Environmental Services	Bacteria monitoring (E. coli)	Hawksbill and Mill Creeks in Page County	18			
Bacteriological	Pennsylvania Recreational Use Survey	Pennsylvania Department of Environmental Protection and Citizen Volunteer Programs	Geometric mean of five samples collected over a thirty day period.	PA	100	Weekly- May to September	2007	PA DEP
Bacteriological	City of Purcellville Virginia-Water Monitoring System	Town Of Purcellville Virginia	Air temperature, flow, hardness, metals, Nitrogen, organics, pesticides, pH, turbidity, VOCs, water temperature, weather, inorganics, radiological, bacterial		6	weekly, annually	1986	State of Virginia
Bacteriological	Rockfish Watershed Study	Virginia Cooperative Extension	Air temperature, DO, flow, pH, secchi, turbidity, water temperature, weather, SAV, macro invertebrates, bacterial, fish, wildlife			seasonally	2004	Community
Bacteriological	Swift Creek Reservoir Monitoring Program	Chesterfield County Virginia-Department of Utilities	Air temperature, conductivity, DO, flow, metals, Nitrogen, pH, Phosphorus, secchi, TSS/TDS, turbidity, water temperature, weather, inorganics, carbon, macro invertebrates, bacterial, chlorophyll, algae		19	Weekly	1993	Chesterfield County
Bacteriological	Thumb Run E. coli monitoring	John Marshall SWCD	E. coli	Thumb Run, a tributary of the Rappahannock River in Fauquier County Virginia	10	monthly	2005	Virginia DEQ, John Marshall SWCD
Bacteriological	Virginia Department of Health Beach Monitoring Program	Virginia Department of Health and Counties	Fecal Coli forms	Virginia beaches on ocean and Chesapeake Bay	44	Weekly May-September	2004	State of Virginia
Bacteriological	Virginia Headwaters Soil and Water Conservation District-Ambient water quality monitoring	VA-Headwaters Soil and Water Conservation District	Bacteria monitoring (E. coli)		10			
Bacteriological-Shellfish	Virginia Shellfish Bacteriological Monitoring Program	Virginia Department of Health, Division of Shellfish Sanitation	Fecal Coliform, Wind Velocity, Salinity, Temperature, Tidal Stage, Wind Direction, Rain Occurrence	Virginia (excluding the oceanside of the Eastern Shore)	2350	Once monthly	1926	Virginia Department of Health, Division of Shellfish Sanitation

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Bacteriological	Arlington County Department of Environmental Services Stream Monitoring Program	Arlington County Virginia-Department of Environmental Services and volunteers	E. Coli using the Coliscan method	Four Mile Run	11	Once monthly	2005	Arlington County Department of Environmental Services
Bacteriological	Arlington County Virginia-Citizen Stream Monitoring Program	Arlington County Virginia-Department of Environmental Services	Bacteria monitoring (E. coli)	Four Mile Run watershed	10	monthly	2006	Arlington County, VADEQ grants
Bacteriological	Catoctin Watershed Project	Loudoun Watershed Watch	Water temperature, bacterial		12	monthly	2005	Private Non-profit
Bacteriological	Fox Mill Run Virginia- Water Quality Monitoring Program	Chesapeake Bay Governor's School	Air temperature, DO, pH, salinity, secchi, water temperature, weather, bacterial		2	monthly	2005	Public school
Bacteriological	Friends Of Powhatan Creek Water Quality Monitoring Program	Friends Of Powhatan Creek Watershed	Air temperature, DO, Nitrogen, pH, Phosphorus, salinity, turbidity, water temperature, Nitrate, Nitrite, bacterial		7	monthly	2000	Private Non-profit
Bacteriological	Friends of the Blacks Run Greenway-Bacteria volunteer monitoring program	Friends of the Blacks Run Greenway	Fecal Coliform, water temp	Blacks Run Watershed, Harrisonburg	14	Once monthly	2004	Citizen Monitoring Grant, Val DEQ
Bacteriological	Friends of the North Fork of the Shenandoah River and Friends of the Shenandoah River benthic and bacterial Monitoring Program	Friends of the North Fork of the Shenandoah River and Friends of the Shenandoah River	E. coli, macro invertebrate abundance, pH, water temperature, Habitat Assessments	Portions of Cedar Creek, Smith Creek, the North Fork of the Shenandoah River and the headwaters of the South Fork of the Shenandoah River	23	Monthly for E. coli, quarterly for benthic macro invertebrates	2009	VA Environmental Endowment, NORCROSS Foundation, Shenandoah Community Foundation, anonymous donors
Bacteriological	Friends of the North Fork of the Shenandoah River - Groundwater Monitoring Program	Friends Of The North Fork Shenandoah River	BOD, chloride, DO, Nitrogen, pH, Phosphorus, coliforms and virus			monthly	1993	
Bacteriological	Goose Creek Association bacterial and chemical monitoring program	Goose Creek Association	E. coli monthly; Benthic macroinvertebrate, dissolved oxygen, temperature, and pH quarterly in March, June, September & December	Goose Creek & its tribuitaries in Fauquier & Loudoun Counties	22	Monthly or quarterly	2003	DEQ
Bacteriological	Leesville Lake Association-Water quality Monitoring	Leesville Lake Association	Temp, dissolved oxygen, pH, Bacteria monitoring (E. coli), Secchi depth monthly for temp, DO & pH; E. coli & Secchi depth biweekly and after major rain events from	Leesville Lake	8	May to Sept.	2007	VADEQ and Leesville Lake Association
Bacteriological	Loudoun Stream Quality Project	Loudoun Wildlife Conservancy	Air temperature, DO, Nitrogen, pH, Phosphorus, turbidity, water temperature, weather, macro invertebrates, bacterial, habitat	Loudoun County	42	Quarterly to monthly depending on parameter	1996	grants, donations, membership dues

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Bacteriological	Maury River Alliance Citizens Monitoring Program	Washington & Lee University	Chloride, conductivity, DO, metals, Nitrogen, pH, Phosphorus, TSS/TDS, water temperature, bacterial	MAURY RIVER and its tributaries	27	monthly	2000	Community/ Washington & Lee University
Bacteriological	Smith Creek Virginia- Citizens Monitoring Program	Friends Of The North Fork Shenandoah River	BOD, chloride, DO, Nitrogen, pH, Phosphorus, coli forms and virus	Smith Creek, VA	10	monthly	2001	grants, donations, membership dues
Bacteriological	Smith Mountain Lake Water Quality Monitoring Program	Smith Mountain Lake Association	Phosphorus, secchi, Nitrates, chlorophyll, bacterial		104	annually	1986	Smith Mountain Lake Association
Bacteriological	South River Keeper monitoring	South River Federation	enterococci counts	South River, MD	14	weekly- May-August	2004	South River Federation
Bacteriological	The GRAHEC Water Quality Monitoring Project	Greater Richmond Area Higher Education Consortium	Air temperature, DO, Nitrogen, pH, Phosphorus, turbidity, water temperature, bacterial			annually	1998	Private Non-profit
Bacteriological	West and Rhode River Keeper monitoring	West/Rhode River Keeper	enterococci counts	West and Rhode Rivers, MD	14	Weekly May-September	2007	West/Rhode River Association
Benthic-Point Source	Amherst Virginia Waste Water Treatment Plant Monitoring	Liberty University	Chloride, conductivity, DO, pH, TSS/TDS, water temperature, macro invertebrates, fish, tox tests with ceridphoris debris			annually		Liberty University
Benthic-Point Source	Bath County Power Station - Back Creek Stream Improvement Project Benthic Component	Virginia Power	Temperature, Dissolved Oxygen, Taxa Identification, Taxa Abundance	located downstream of the dam in the company's stream improvement area.	2	twice yearly	1988	Virginia Power and Virginia Department of Game and Inland Fisheries
Benthic	Buffalo River Virginia-Watershed Monitoring Program	Sweet Briar College	BOD, conductivity, DO, flow, hardness, nitrogen, pesticides, pH, phosphorus, TSS/TDS, turbidity, water temperature, aquatic vegetation, macroinvertebrates, bacterial, fish			seasonally, annually	2000	Sweet Briar College
Benthic	Chesterfield County Watershed Assessment and Stream Protection Program	Chesterfield County Virginia-Department of Environmental Engineering, Water Quality Section	EPA Rapid Bioassessment Protocol III (lowest possible taxa id; genus or species), total taxa richness, EPT taxa richness, %dominant taxa, HBI, %collector gatherers, %predators, %scrapers; Instream WQ Chemistries, Physical and Habitat Assessments	Chesterfield County	67	Once/year in spring	1999	Chesterfield County Department of Environmental Engineering
Benthic	Clinch River and Estonoa Wetland Monitoring	Globe Hydrology	Conductivity, DO, Nitrogen, pH, turbidity, water temperature, macro invertebrates		2	weekly	2000	Public
Benthic-Point Source	Dan River Virginia-Point Source Benthic Macro invertebrate Survey	City of Danville Virginia	Air temperature, conductivity, DO, pH, macro invertebrates			seasonally, annually	1998	City of Danville

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Benthic	District of Columbia Aquatic Macro invertebrate Monitoring Program	District of Columbia-Department of the Environment	Primary parameters: Benthic Taxa Identification and Abundance.	Potomac and Anacostia Rivers, Kingman Lake and Kenilworth Marsh-in District	30	bi-yearly	1977	U.S. EPA Region III
Benthic	Fairfax County-Gunston Cove Ecosystem Monitoring Program	George Mason University	Benthos count, abundance and composition	Gunston Cove, Potomac River	5	annual	1984	Fairfax County
Benthic	J.R. Horsley SWCO Monitors	J.R. Horsley Soil & Water Conservation District	DO, Nitrogen, pesticides, pH, Phosphorus, water temperature, weather, macroinvertebrates, wildlife		6	annually	1999	Private Non-profit
Benthic	Maryland Biological Stream Survey Benthic Component	MDDNR, Versar, Inc., C and University of Maryland	Benthic counts by species, Physical habitat measurements: flow, wetted width, velocity, rootwad count, large woody debris count, riparian buffer width and count, RBP subjective habitat survey: pH, ANC, conductivity, sulfate, nitrate, DOC, DO, temperature,	State of Maryland - number of sites varies by year -Average number of sites 170 per year	170		1993	Maryland Department of Natural Resources
Benthic	Maryland Chesapeake Bay Water Quality Monitoring Program Benthic Component	Versar Incorporated	Temperature Salinity, Conductivity, Dissolved Oxygen Concentration, pH, sediment, silt-clay, carbon content, total sediment carbon (TC), total organic carbon (TOC), total nitrogen (TN), Species abundances to the lowest practical taxon, Ash-free dry weight	Chesapeake Mainstem and selected Maryland tidal tributaries-27 long-term, 150 random samples	27	once annually in summer	1984	Maryland Department of Natural Resources (State Funds)-Match Program to EPA Funded Water Quality Monitoring Program
Benthic	Maryland Non-Tidal Benthic Macro invertebrate Monitoring Program	Maryland Department of Natural Resources	CORE/Trend - Identification to Genus or species, Diversity, Abundance, Biotic Index, EPT, %EPT, Number of taxa, %Dominant taxa. Rapid Bioassessment - Identification to Family, Number of Taxa, EPT, %EPT, Biotic Index, Similarity Index, %Dominant Taxa, % n	All Non-Tidal water in Maryland-48 CORE/TREND and 342 Rapid Bioassessement	390	Core Trends stations one annually. Bioassessment is random strata sampling	1976	Maryland Department of Natural Resources and U.S. EPA Region III
Benthic	Montgomery County Water Quality Monitoring Program Benthic Component	Montgomery County Maryland-Department of Environmental Protection	Benthic macro invertebrate count, genus or species identifications, In stream habitat measurements and rapid habitat assessment, Physiochemical parameters: pH, %sat, DO, cond., water temperature	Montgomery County, Maryland			1994	Montgomery County Department of Environmental Protection
Benthic	Mountain Run Headwaters	People Protecting Watershed Headwaters	Air temperature, DO, Nitrogen, organics, pH, Phosphorus, secchi, turbidity, water temperature, macro invertebrates			annually	2002	Private Non-profit
Benthic	New York State Stream Biomonitoring Program	New York State Department of Environmental Conservation	Species Richness, taxa counts, PCBs in invertebrate tissues, Biotic index value, Organo-chlorine pesticides in invertebrate tissues, EPT richness, Metals in invertebrate tissues, Percent model affinity	Chesapeake Bay water shed	11	unknown	1972	New York State Department of Environmental Conservation

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Benthic	Pennsylvania Benthic Macroinvertebrate Survey	Pennsylvania Department of Environmental Protection	Benthic Macro invertebrates: D-net samples with 200 (+/- 20%) count subsamples. Genus level IDs	PA-127 Standard stations. 25 Reference stations	152	Reference stations yearly. Standard stations every other year	1975	PA DEP
Toxics-Tissue	Poplar Island Monitoring Program	Army Corps of Engineers-Baltimore District	Mya arenaria, Macoma balthica and Tagelius plebius tissue examined for PCB Congeners,Chlorinated Pesticides,PAHs,Dioxin and Furans,Butyltins,Organophosphorus Pesticides,Semi-Volatile Organic Compounds, Volatile Organic Compounds, Lipids in Benthic tissue	area around Poplar Island reconstruction	6	varies by phase in project	1994	army corps of engineers-Baltimore District
Benthic	Rappahannock Friends and Lovers of Our Watershed Monitoring Program	Rappahannock Friends and Lovers of Our Watershed	Benthic macroinvertebrates using SOS methodology and E. Coli bacteria sampling using Coliscan kits.	Rappahannock County, VA	15	E. coli monthly, macroinvertebrates quarterly		Private donors and misc. grants
Benthic	Rhode River Watershed Environmental Monitoring Program	Smithsonian Environmental Research Center	Primary parameters: Benthic Taxa Identification and Abundance. Other Parameters: Bulk Precipitation, Wet Precipitation, Throughfall Chemistry Weather,Solar Irradiance, Dry Deposition Chemistry,Ground Water, Stream Water Discharge, Infiltration Chemistry,O	Rhodes River	2	eight times a year	1979	Smithsonian Environmental Research Center, U.S. Department of Energy, National Science Foundation
Benthic	Rockfish Watershed Study	Virginia Cooperative Extension	Air temperature, DO, flow, pH, secchi, turbidity, water temperature, weather, SAV, macroinvertebrates, bacterial, fish, wildlife			seasonally	2004	Community
Benthic	Susquehanna River Basin Commission Interstate Macroinvertebrate Monitoring Program	Susquehanna River Basin Commission	macroinvertebrate abundance, pH,Water temperature, Habitat Assessments	PA			1986	U.S. EPA Region III and Pennsylvania Department of Environmental Resources
Benthic	Swift Creek Reservoir Monitoring Program	Chesterfield County Virginia-Department of Utilities	Air temperature, conductivity, DO, flow, metals, Nitrogen, pH, Phosphorus, secchi, TSS/TDS, turbidity, water temperature, weather, inorganics, carbon, macroinvertebrates, bacterial, chlorophyll, algae		19	weekly, monthly, seasonally, annually	1993	Chesterfield County
Benthic	United States Forestry Service-Water quality Monitoring Program	United States Forestry Service	benthic monitoring	National Forests in Virginia	40	Annually to semiannually		
Benthic	Virginia Benthic Monitoring Program	Virginia Department of Environmental Quality	Temperature, Family Taxonomic Identifications, Dissolved Oxygen, Habitat Assessment, Conductivity, RBP II Metrics, pH	Non Tidal water of the State of Virginia	110	biennially in the spring and fall	1978	Virginia Department of Environmental Quality

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Benthic	Virginia Chesapeake Bay Benthic Monitoring Program	Old Dominion University	Benthic fauna: Taxa identification Taxa abundance Biomass (ash-free dry weight) Water Quality:Temperature,Dissolved Oxygen, Salinity,Specific Conductivity Sediment Size Frequency Particle Distribution Total Volatile Solids	Virginia Mainstem and tidal tributaries. 100 Random, 26 fixed	26	annual	1985	Virginia Department of Environmental Quality-Match Program to EPA Funded Water Quality Monitoring Program
Benthic	Virginia Save Our Streams Program	Virginia Save Our Streams Volunteers	macroinvertebrate abundance, pH,Water temperature, Habitat Assessments	Non Tidal water of the State of Virginia	200	quarterly	1989	Virginia Department of Conservation and Recreation and Izaak Walton League of America
Toxics-Sediment	Virginia Tidal Freshwater Toxics Monitoring	Virginia Institute of Marine Sciences	Conductivity, DO, hardness, metals, Nitrogen, organics, pesticides, pH, Phosphorus, salinity, TSS/TDS, water temperature, weather, macroinvertebrates		29	annually	2000	
Benthic	West Virginia Save Our Streams Program	West Virginia Save Our Streams Volunteers	macroinvertebrate abundance, pH,Water temperature, Habitat Assessments	West virginia Streams & rivers	32	unknown	1989	West Virginia Division of Environmental Protection and U.S. Environmental Protection Agency
Benthic	West Virginia Watershed Assessment Program (several ind. programs)-Benthic Monitoring	West Virginia Department of Environmental Protection-Division of Water and Waste Management	Family and genus level metrics. Habitat and WQ data dependant on program for which benthics collected.	statewide	450	Annually for Ambient and LiTMuS sites; once for probabilistic, pre-TMDL development, and targeted sites	1996	State funded
Benthic	Arlington County Deparment of Environmental Services Stream Monitoring Program	Arlington County Virginia-Deparment of Environmental Services and volunteers	Order level ID of macroinvertebrates, water temperature, dissolved oxygen, pH, nitrate and phospate.	Multiple locations on Four Mile Run, and one site each on Little Pimmit Run, Windy Run, Donaldson Run, and Gulf Branch.	8	quarterly	2001	Arlington County Department of Environmental Services
Benthic	Interactive Stream Assessment Resource (INSTAR)	Virginia Commonwealth University	Over 50 ecological and biotic integrity metrics for fish and aquatic macroinvertebrate assemblages	Virginia statewide, but data are concentrated in the Chesapeake Bay basin	2000	once, although some sites include multiple collections	1985	Virginia Department of Conservation and Recreation, Virginia Coastal Zone Management program, Virginia Department of Environmental Quality
Benthic	Potomac Appalachian Trail Club Water Quality Monitoring Program	Potomac Appalachian Trail Club	Benthic macro invertebrate identification to the family level and physiochemical parameters including water and air temp, pH, and nutrient levels.	One site is in PA and another in WV, with the seven others in VA.	9	Twice annually; early spring and fall.	2004	Virginia Department of Environmental Quality and PATC funding

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Benthic	Rappahannock River tributary macro invertebrate study	John Marshall SWCD	Nitrogen, Phosphorus, Dissolved Oxygen, pH, Virginia Save Our Streams Modified Macro invertebrate date	Eight tributaries of the Rappahannock River, 7 in Fauquier County, one in Rappahannock County	8	WQ-monthly; macro invertebrates-quarterly	2001	Virginia DEQ, John Marshall SWCD
Benthic	StreamWatch	Virginia StreamWatch	Benthic macro invertebrates, stream habitat, stream particle size (pebble counts), land use/land cover	Rivanna River watershed	34	3 times per year	1997	Albemarle and Fluvanna Counties, City of Charlottesville, Rivanna Water and Sewer Authority, Chesapeake Bay Restoration Fund, Private
Benthic	Alliance for Chesapeake Bay Citizen Monitoring Program	Alliance for the Chesapeake Bay	Air temperature, DO, pH, phosphorus, secchi, tide, TSS/TDS, water temperature, weather, aquatic vegetation, macro invertebrates, bacterial, wildlife, chlorophyll			weekly, seasonally	1985	Private Non-profit
Benthic	Arlington County Virginia-Citizen Stream Monitoring Program	Arlington County Virginia-Department of Environmental Services	Air temperature, pH, turbidity, water temperature, weather, macro invertebrates			annually	2001	Arlington County, VADEQ grants
Benthic	Audubon Naturalist Society Water Quality Program	Audubon Naturalist Society	Air temperature, flow, pH, turbidity, water temperature, weather, macro invertebrates		13	seasonally, annually	1997	Private Non-profit
Benthic	Fairfax County Virginia-Volunteer Stream Monitoring Program	Northern Virginia Soil & Water Conservation District	Air temperature, DO, Nitrogen, pH, turbidity, water temperature, weather, macro invertebrates		45	seasonally	1997	
Benthic	Friends of the North Fork of the Shenandoah River and Friends of the Shenandoah River benthic and bacterial Monitoroing Program	Friends of the North Fork of the Shenandoah River and Friends of the Shenandoah River	E. coli, macro invertebrate abundance, pH, water temperature, Habitat Assessments	Portions of Cedar Creek, Smith Creek, the North Fork of the Shenandoah River and the headwaters of the South Fork of the Shenandoah River	23	Monthly for E. coli, quarterly for benthic macro invertebrates	2009	VA Environmental Endowment, NORCROSS Foundation, Shenandoah Community Foundation, anonymous donors
Benthic	Holston Virginia Citizen Water Quality Monitoring Program		water temperature, macroinvertebrates			annually	2001	Watershed group
Benthic	Loudoun Stream Quality Project	Loudoun Wildlife Conservancy	Air temperature, DO, Nitrogen, pH, Phosphorus, turbidity, water temperature, weather, macroinvertebrates, bacterial, habitat	Waterbodies flowing through Loudoun County	42	Quarterly to monthly depending on parameter	1996	grants, donations, membership dues
Benthic	Reston Association Stream Monitoring	Reston Association	Air temperature, flow, Nitrogen, turbidity, water temperature, weather, macroinvertebrates		10	annually	1999	Reston Association

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Benthic	Upper Rappahannock Watershed Stream Monitoring Program	Rappahannock Conservation Council	Air temperature, DO, Nitrogen, pH, Phosphorus, TSS/TDS, water temperature, fecal coliforms, Nitrates, Nitrites, macroinvertebrates		43	seasonally	2001	Volunteer network
Birds	Annual Midwinter Waterfowl Survey	United States Fish & Wildlife Service- Office of Migratory Bird Management, Maryland Department of Natural Resources, Virginia Department of Game and Inland Fisheries, Pennsylvania Game Commission	population estimates for 30 species of waterfowl which over winter in the Chesapeake Bay region	chesapeake bay and adjacent coastal plain	53	winter for about a two-week period in early-January	1948	U.S. Fish & Wildlife Service
Birds	Bald and Golden Eagle Monitoring	United States Fish and Wildlife Service	bird counts Number and location	Chesapeake Bay watershed		yearly		
Birds	Fairfax County-Gunston Cove Ecosystem Monitoring Program	George Mason University	bird counts, species habitat preferences	Gunston Cove, Potomac River	4	two census four times ayear	1984	Fairfax County
Birds	International Breeding Bird Survey	United States Geological Survey-National Biological Survey and Canadian Wildlife Service	Sky condition, Temperature, Count of all species observed ,Wind speed	New York, Pennsylvania, Maryland, Delaware, Virginia, and West Virginia.	150	once annually-month of June	1966	United States Geological Survey-National Biological Survey and Canadian Wildlife Service
Birds	Maryland Waterfowl Breeding Survey	United States Fish and Wildlife Service and the Maryland Department of Natural Resources	size and densities of Mallard, Black Duck, Wood Duck, andCanada Goose breeding populations	Maryland	50	once annually- April	1963	U.S. Fish and Wildlife Service and the Maryland Department of Natural Resources
Birds	National Audubon Society Christmas Bird Count	National Audubon Society	species and individuals observed are included in the count.	Chesapeake Bay basin	64	once annually-December-January	1900	National Audubon Society
Birds	Peregrine Falcon Monitoring	United States Fish and Wildlife Service	bird counts Number and location	Chesapeake Bay watershed		yearly		
Birds	Virginia Bald Eagle Survey	Virginia Department of Game and Inland Fisheries and College of William and Mary	eagle counts	Virginia tributaries5 aerial transects along the Potomac Rappahannock, James, York and eastern shore	5	once annually-March to July	1977	Virginia Department of Game and Inland Fisheries and U.S. Fish and Wildlife Service
Birds	Virginia Colonial Bird Study	Virginia Department of Game and Inland Fisheries and College of William and Mary	Counts of Great Egrets, Great Blue Herons, Oystercatchers,Yellow-crowned Night Herons, Cattle Egrets, Black Skimmers, Least Terns Common Terns, Piping Plovers	coastal plain and Eastern Shore of Virginia		once annually, April to July	1975	Virginia Department of Game and Inland Fisheries and U.S. Fish and Wildlife Service

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Birds	Virginia Osprey Study	Virginia Department of Game and Inland Fisheries and College of William and Mary	Counts of Osprey	James,Chickahominy; York, Mattaponi, Pamunkey; Potomac; Rappahannock and Great Wicomico Rivers; Mobjack Bay, New Point Comfort; Fleets Bay; Lower Tidewater; Eastern Shore; and Inland Impoundments.		annualy-April to June	1971	Virginia Department of Game and Inland Fisheries and U.S. Fish and Wildlife Service
Birds	Wintering Waterfowl Survey	United States Fish and Wildlife Service	bird counts Number and location	Chesapeake Bay Mainstem		Once a year	1995	USFWS
Climatological	Deleware National Oceanic and Atmospheric Administration-National Weather Service Climatological Data Network	National Oceanic and Atmospheric Administration-Weather Service	Temp, precip,wind speed, wind direction, degrees days, barometric pressure, sunshine, sky cover, weather type, evaporation, soil temperature	DE	2	varies (daily, monthly, others)	1910	NOAA
Climatological	Maryland National Oceanic and Atmospheric Administration-National Weather Service Climatological Data Network	National Oceanic and Atmospheric Administration-Weather Service	Temp, precip,wind speed, wind direction, degrees days, barometric pressure, sunshine, sky cover, weather type, evaporation, soil temperature	MD	50	varies (daily, monthly, others)	1869	NOAA
Climatological	National Estuarine Research Reserve System-Monitoring Program	Chesapeake Bay National Estuarine Research Reserve in Virginia	Measured parameters include air temperature, relative hunidity, precipitation, PAR, barometric pressure, wind spedd and direction.	Sites throughout the bay	4	Continuous (15 min)	1997	NOAA/ERD
Climatological	National Oceanic and Atmospheric Administration-National Water Level Observation Network	National Oceanic and Atmospheric Administration-National Ocean Service	Water level, temperature, density, tidal datums	Chesapeake Bay area	13	every 6 months	1902	NOAA
Climatological	New York National Oceanic and Atmospheric Administration-National Weather Service Climatological Data Network	National Oceanic and Atmospheric Administration-Weather Service	Temp, precip,wind speed, wind direction, degrees days, barometric pressure, sunshine, sky cover, weather type, evaporation, soil temperature	NY	35	varies (daily, monthly, others)	1854	NOAA
Climatological	Pensylvania National Oceanic and Atmospheric Administration-National Weather Service Climatological Data Network	National Oceanic and Atmospheric Administration-Weather Service	Temp, precip,wind speed, wind direction, degrees days, barometric pressure, sunshine, sky cover, weather type, evaporation, soil temperature	PA	85	varies (daily, monthly, others)	1877	NOAA
Climatological	Susquehanna Steam Electric Station Monitoring Program	Pennsylvania Power and Light Company	Air temp, barometric pressure, precipitation, fog, cloud cover	Susquehanna River Basin	2	depends, continuous to monthly	1977	NOAA

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Climatological	Virginia National Oceanic and Atmospheric Administration-National Weather Service Climatological Data Network	National Oceanic and Atmospheric Administration-Weather Service	Temp, precip,wind speed, wind direction, degrees days, barometric pressure, sunshine, sky cover, weather type, evaporation, soil temperature	VA	83	depends, continuous to monthly	1837	NOAA
Climatological	West Virginia National Oceanic and Atmospheric Administration- NWS Climatological Data Network	National Oceanic and Atmospheric Administration-Weather Service	Temp, precip,wind speed, wind direction, degrees days, barometric pressure, sunshine, sky cover, weather type, evaporation, soil temperature	WV	12	depends, continuous to monthly	1894	NOAA
Fisheries-Point Source	Amherst Virginia Waste Water Treament Plant Monitoring	Liberty University	Chloride, conductivity, DO, pH, TSS/TDS, water temperature, macroinvertebrates, fish, tox tests with ceridphoris debris			annually		Liberty University
Fisheries-Point Source	Bath County Power Station-Fish Monitoring	Virginia Power	Quantitative methods (catch per unit effort) are used to determine relative abundance, and length frequency analysis is used to assess stock structure.	area around power plant	12	twice a year spring & fall	1988	Virginia Power and Virginia Department of Game and Inland Fisheries
Fisheries	Buffalo River Virginia-Watershed Monitoring Program	Sweet Briar College	BOD, conductivity, DO, flow, hardness, nitrogen, pesticides, pH, phosphorus, TSS/TDS, turbidity, water temperature, aquatic vegetation, macroinvertebrates, bacterial, fish			seasonally, annually	2000	Sweet Briar College
Fisheries	Chesapeake Bay Multispecies Monitoring and Assessment Program	Virginia Institute of Marine Sciences	Abundance estimates, sex ratios, growth rates, age structure, mortality rates, food habits are logged for approximately a dozen species.	Chesapeake Bay mainstem from Pooles Island, Maryland to the Bay mouth in Virginia	80	March, May, July, September, November	2002	NOAA- Chesapeake Bay Office, Virginia Marine Resources Commission,USFWL-Wallop Breaux
Fisheries	District of Columbia Sport-Fish Restoration Survey Program	District of Columbia-Department of the Environment	WQ:Temperature Redox Potential, Secchi Depth,Weather conditions, pH, Dissolved Oxygen Conductivity ,Tidal Stage, Air Temperature. All Fish: Total Count, Total Biomass, Species Identification. , Anadromous and Resident Sport-fish:Weight per individual	Anacostia and Potomac Rivers, and in the Washington Channel, as well occasional stations in Oxen Cove, Kenilworth Marsh, and Rock Creek.	12	Monthly- February and ending in December	1985	District of Columbia Department of the Environment AND U.S. Fish and Wildlife Service
Fisheries	Fairfax County-Gunston Cove Ecosystem Monitoring Program	George Mason University	fish count, abundance and composition	Pohick Creek, Dogue Creek,Gunston Cove, and the adjacent Potomac River	10	biweekly/semimonthly basis.	1984	George Mason University,County of Fairfax,VA

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Fisheries	Virginia Adult anadromous Fish Passage Monitoring Program	Virginia Department of Game and Inland Fisheries	fish count, relative abundance (electrofishing CPUE), spatio-temporal distribution	Virginia Chesapeake Bay tributaries (tidal and non-tidal sections)	15	Spring: weekly (main sites); bi-weekly and monthly for other sites.	1994	Through June 2009: Virginia Department of Game and Inland Fisheries and matching EPA CBP grant funds; some State Wildlife Grant funds. Future: VDGIF, SWG funds, uncertain due to EPA CBP cutting funding
Fisheries	Boshers Dam Vertical Slot Fishway Evaluation and Fish Passage Monitoring Program	Virginia Department of Game and Inland Fisheries	quantitative fish counts per unit of time; avg over 900 hours of video review per spring	Boshers Dam Vertical Slot Fishway at James River mile 113	1	Spring	1999	Through June 2009: Virginia Department of Game and Inland Fisheries and matching EPA CBP grant funds; some State Wildlife Grant funds. Future: VDGIF, SWG funds, uncertain due to EPA CBP cutting funding
Fisheries	Virginia Juvenile Alosine Fish Passage Monitoring Program	Virginia Department of Game and Inland Fisheries	fish count, quantitative abundance (per volume water sampled by pushnet), relative abundance (electrofishing CPUE); spatio-temporal distribution; visual counts (snorkel surveys in non-tidal alosine habitat)	Virginia Chesapeake Bay tributaries (tidal and non-tidal sections)	6	Summer and Fall - Weekly	1995	Through June 2009: Virginia Department of Game and Inland Fisheries and matching EPA CBP grant funds; some State Wildlife Grant funds. Future: VDGIF, SWG funds, uncertain due to EPA CBP cutting funding
Fisheries	Interjurisdictional Species Stock Assessment for Adult Migratory Fin Fish	Maryland Department of Natural Resources	Target species specimens are counted, measured and otoliths removed from weakfish and Atlantic croaker. Scales are removed from a sub-sample of Atlantic menhaden.	Mid/lower Maryland Chesapeake Bay, Honga River, Lower Potomac River	6	June through September, biweekly- 2 days a week	2003	Maryland Department of Natural Resources and USFWL-Wallop-Breaux funds
Fisheries	Maryland Adult American Shad Hook and Line Survey	Maryland Department of Natural Resources	All shad are sexed and measured (FL) with scales removed for later analysis. Fish in good physical condition are tagged with T-bar anchor tags.	Susuehanna River	1	Mid April to early June: Three to four days per week	1982	Maryland Department of Natural Resources and USFWL-Wallop-Breaux funds
Fisheries	Maryland Adult Shad and Herring Pound and Fyke Net Survey	Maryland Department of Natural Resources	American shad, hickory shad, alewife, and blueback herring are measured (TL), and sex and spawning condition recorded. Scales are taken for later analysis.	Nanicoke River 1 to 2 commercial pound net and 6 to 18 commercial fyke net sites	20	February through early May- One to two days per week	1987	Maryland Department of Natural Resources and USFWL-Wallop-Breaux funds
Fisheries	Maryland American eel population study- Silver eel survey	Maryland Department of Natural Resources	Length, weight, sex, age, and parasite infestation for all eels sampled. Ancillary data includes temperature and weather.	Gravel run-1st order stream to the Corsica River	1	October-November 3days/wk	2006	Noaa eel grant under ACA
Fisheries	Maryland American eel population study- Yellow eel survey	Maryland Department of Natural Resources	Length, weight for all eels sampled. Eels subsampled for age, sex, and parasite infestation. CPUE calculated for fishery independent sampling. Ancillary data includes temperature and salinity.	Maryland Chesapeake Bay tributaries and Turville Creek-Isle of Wight Bay	4	Turville Creek April-mid May (3 days/wk) Sassafras R June-July (3days/wk) Other commercially sampled tribs April-May (twice)	1997	Noaa eel grant under ACA

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Fisheries	Maryland American eel population study- Young of Year survey	Maryland Department of Natural Resources	eel counts, length, weight, pigmentation stage. Ancillary data includes water temp, salinity, water level, flow, moon phase, gear rating, weather	Turville Creek-Isle of Wight Bay	1	4 days/wk Early to mid Feb-early May	2000	Noaa eel grant under ACA
Fisheries	Maryland Biological Stream Survey Fish Component	Maryland Department of Natural Resources	Fish count by species, total length of gamefish species,Aggregate biomass of non-game and gamefish species,Fish anomalies, type and count	non-tidal, third order and smaller stream reaches in Maryland		Two basins are randomly selected from each region for sampling each year. One randomly selected basin in each region is visited twice, to quantify between year variability in the response variables. Sampling occurs on a five year cycle, with field samplin	1993	Maryland Department of Natural Resources
Fisheries	Maryland Fisheries Dependant Fyke Net Survey	Maryland Department of Natural Resources	All target species, and various other tidal freshwater species (e.g., largemouth bass, chain pickerel, bluegill), and up to 30 white perch are measured. Otoliths from a non-random sub-sample of white perch and yellow perch are taken for development of age	Choptank, Nanticoke, Gunpowder,Bush and Northeast Rivers		Mid February through mid April, Choptank and Nanticoke rivers (3 days per week) Upper Bay from March 1 to 10 (2 to 4 times — weather permitting)	1989	Maryland Department of Natural Resources and USFWL-Wallop-Breaux funds
Fisheries	Maryland Fisheries Dependent Striped Bass Hook and Line Survey	Maryland Department of Natural Resources	This survey monitors the post-spawning population as subject to a “trophy” fishery. High-use charter boat marinas and boat ramps are visited 6 to 7 days per week (weighted toward weekends). Hook-and-line fishers’ catch are characterized by number, length,	Upper and Middle Maryland Bay-number of sites varies by year		April through May, 4 to 5 days per week within the sampling period	2002	Maryland Department of Natural Resources and USFWL-Wallop-Breaux funds
Fisheries	Maryland Juvenille Shad and Herring Surveys	Maryland Department of Natural Resources	All fish are identified and enumerated.	Chester. Pocomoke and Susquehanna Rivers	8	Bi-weekly Early June through September	2005	Maryland Department of Natural Resources and USFWL-Wallop-Breaux funds
Fisheries	Maryland Largemouth Bass Surveys	Maryland Department of Natural Resources	Population estimates (CPUE/hr for adults; CPUE/hr or CPUE/100m for juveniles);fish condition (length, weight, condition factor); tag survival (tag/recapture rates); tournament effort, catch rates and catch quality.	Potomac River; Patuxent River; Upper Chesapeake Bay; Chester River; Choptank River		Varies by year and river; some sites surveyed annually, others less frequently; however all are sampled at least once every 5 years.	1999	Maryland Department of Natural Resources and USFWS (Dingell-Johnson/ Wallop-Breaux)

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Fisheries	Maryland Shoal Water Trawl Survey	Maryland Department of Natural Resources	Crabs- carapace width, weight, Missing chelipeds, Sex and maturity of females, molt stage. Finfish-counts. For striped bass, white perch, menhaden, shad, blueback herring, alewife, black drum, kingfish, croaker, summer flounder, winter flounder, blue fi	Chester, Choptank, Little Choptank, Patuxent, Nanticoke Rivers, Easter and Fishing Bays, Tangier and Pocomoke Sounds	37	Monthly-May through October.	1977	Maryland Department of Natural Resources and USFWL-Wallop-Breaux funds
Fisheries	Maryland Striped Bass Spawning Stock-Gill Net Survey	Maryland Department of Natural Resources	All striped bass enumerated, measured, sexed, and tagged. Specimens of other species captured (e.g., American shad, hickory shad, blueback herring, alewife, white perch, channel catfish, blue catfish, Atlantic menhaden) are also enumerated and measured.	Potomac River and Upper Bay		April through May, 5 to 7 days per week within the sampling period	1985	Maryland Department of Natural Resources and USFWL-Wallop-Breaux funds
Fisheries	Maryland Striped Bass Young of Year Beach Seine Survey	Maryland Department of Natural Resources	30 random age zero striped bass are measured individuals per site and round. All other finfish are identified and counted. Additional data collected: time of first haul, maximum distance from shore, weather, maximum depth, surface water temperature (°C),	Potomac, Patuxent,Choptank and Nanticoke Rivers and Upper Bay	22	Monthly-July through September	1958	Maryland Department of Natural Resources and USFWL-Wallop-Breaux funds
Fisheries	Maryland Survey of Coldwater Streams	Maryland Department of Natural Resources	Population estimates (adult and YOY trout/ha; trout/km); relative abundance (CPUE/hr); fish condition (length, weight, condition factor); water quality and physical habitat.	Statewide (coldwater streams and tributaries)		Varies by stream and population; some sites surveyed annually, others less frequently; however all are sampled at least once every 5 years.	1975	Maryland Department of Natural Resources and USFWS (Dingell-Johnson/ Wallop-Breaux)
Fisheries	Maryland Survey of Freshwater Impoundments	Maryland Department of Natural Resources	Relative abundance (CPUE/hr), size and/or age distribution, and condition factors for gamefish; presense of all species, habitat parameters including water quality (dissolved oxygen, temperature, pH, alkalinity, hardness and turbidity) and physical condit	Statewide. 115 impoundments with a surface area of approximately 25,000 acres.		Varies; populations in impoundments with heavily exploited fisheries are monitored every 1 to 3 and others are monitored 3 to 5 years	1975	Maryland Department of Natural Resources and USFWS (Dingell-Johnson/ Wallop-Breaux)
Water Quality	Poplar Island Monitoring Program	Army Corps of Engineers-Baltimore District	Metals,PCB Congeners,Chlorinated Pesticides,PAHs,Dioxin and Furans,Butyltins,Organophosphorus Pesticides,Semi-Volatile Organic Compounds (SVOCs),Volatile Organic Compounds (VOCs),Lipids,Biological Oxygen Demand,Chemical Oxygen Demand,Sulfide	area around Poplar Island reconstruction	29	varies by phase in project	1994	army corps of engineers-Baltimore District

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Water Quality	Potomac Fall Line Monitoring at Chain Bridge	Metropolitan Washington Council of Governments	Total Organic Carbon, Dissolved Organic Carbon, Chemical Oxygen Demand, Total Suspended Solids, Nitrate and Nitrite Nitrogen, Ammonia Nitrogen, Total Nitrogen, Total Soluble Nitrogen, Total Phosphorus, Total Soluble Phosphorus, Soluble Reactive Phosphorus	Fall line, Potomac River	1	biweekly manual grab samples (Dec - March) weekly manual grab, discrete storm and composite storm samples	1984	MWCOG/ OWML
Water Quality-Drinking Water	City of Purcellville Virginia-Water Monitoring System	Town Of Purcellville Virginia	Air temperature, flow, hardness, metals, Nitrogen, organics, pesticides, pH, turbidity, VOCs, water temperature, weather, inorganics, radiological, bacterial		6	weekly, annually	1986	State of Virginia
Water Quality-Drinking Water	Rivanna Water And Sewer Authority Source Water Protection Monitoring	Albemarle County Virginia	Conductivity, DO, Nitrogen, pH, Phosphorus, secchi, TSS/TDS, water temperature		3	seasonally	1975	Albemarle County
Water Quality	Rockfish Watershed Study	Virginia Cooperative Extension	Air temperature, DO, flow, pH, secchi, turbidity, water temperature, weather, SAV, macroinvertebrates, bacterial, fish, wildlife			seasonally	2004	Community
Water Quality-Power Plant	Safe Harbor Water Power Corportation-Water Quality Monitoring Program							
Water Quality	Shenandoah Watershed Study/VTSSS	University Of Virginia-Department of Environmental Sciences	Chloride, conductivity, flow, pH, water temperature, silica, major anions, major cations		67	weekly, annually	1979	University of Virginia
Water Quality	Smith River Virginia Study	Virginia Tech	Air temperature, water temperature		7	annually	1999	VA Tech
Water Quality	South Anna Monitoring Project-Ambient Water Quality Monitoring	Historic Green Springs, Inc.	DO,NITROGEN, PESTICIDES,PHOSPHORUS,TSS,WTEMP, WEATHER, pH	South Anna River	7	semi-monthly	2000	
Water Quality	State of Virginia TMDL Special studies	Virginia Department of Environmental Quality	Varies based on 303(d) listing.	Statewide	167	Station sample frequency is based on many factors such as the type of TMDL impairment or progress being made in the watershed.		
Fisheries	Maryland Upper Bay Trawl Survey	Maryland Department of Natural Resources	All fish are identified and enumerated, with 30 specimens of each species measured. Otoliths from a non-random sub-sample of the target species are taken for development of age-length keys.	Upper & Mid bay, Sassafrass and Elk Rivers	18	December through February-Six biweekly rounds in the survey period	1999	Maryland Department of Natural Resources and USFWL-Wallop-Breaux funds

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Fisheries	Maryland Warmwater Rivers Survey	Maryland Department of Natural Resources	Relative abundance (CPUE) measured by single-pass electrofishing for adults and beach seining for young of year.	Statewide. 27 major river basins.		Varies by river; some sites surveyed annually, others less frequently; however all are sampled at least once every 5 years.	1975	Maryland Department of Natural Resources and USFWS (Dingell-Johnson/ Wallop-Breaux)
Fisheries	Montgomery County Water Quality Monitoring Program Fish Component	Montgomery County Maryland-Department of Environmental Protection	Fish count, genus or species identifications, Instream habitat measurements and habitat assessment, Physiochemical parameters: pH, %sat, DO, cond., water temperature	Montgomery County, Maryland		Not given	1994	Montgomery County Department of Environmental Protection
Fisheries	United States Envrionmental Protection Agency-National Study Of Chemical Residue In Lake Fish	United States Environmental Protection Agency	Organics, pesticides, pH		9	seasonally	1998	USEPA
Fisheries-Point Source	North Anna Power Station Monitoring Program Fish Component	Virginia Power and Virginia Department of Game and Inland Fisheries	fish count, abundance and composition	North Anna River	19	quarterly	1994	Virginia Power and Virginia Department of Game and Inland Fisheries
Fisheries	Occoquan Watershed Monitoring Program	Virginia Tech	Air temperature, BOD, chloride, conductivity, DO, flow, hardness, metals, Nitrogen, organics, pesticides, pH, Phosphorus, secchi, TSS/TDS, turbidity, VOCs, water temperature, weather, inorganics, carbon, bacterial, fish, chlorophyll		10	continuously, weekly, seasonally	1973	VA Tech
Fisheries	Pennsylvania Juvenile Alosids Survey	Pennsylvania Fish and Boat Commission	Counts of Juvenile Alosids; total length; otolith analysis to detect tetracycline mark.	Susuehanna River		Not given	1984	Pennsylvania Fish and Boat Commission, U.S. Fish and Wildlife Service
Fisheries	Pennsylvania Smallmouth Bass Survey	Pennsylvania Fish and Boat Commission	fish abundance and length	Susuehanna River basin		990 for adults survey started 1990	1988	Pennsylvania Fish and Boat Commission, U.S. Fish and Wildlife Service
Fisheries	Potomac River Shad Monitoring	The Interstate Commission on the Potomac River Basin	CPUE = Number of shad captured per net	Potomac River, Tidal Freshwater	1	Approx 16 days/mid-April to Mid May	1995	varies, currently supported with EPA, VA Department of Game & Inland Fisheries funds.
Fisheries	Rhode River Watershed Environmental Monitoring Program	Smithsonian Environmental Research Center	Primary parameters: Benthic Taxa Identification and Abundance. Other Parameters: Bulk Precipitation, Wet Precipitation, Throughfall Chemistry Weather,Solar Irradiance, Dry Deposition Chemistry,Ground Water, Stream Water Discharge, Infiltration Chemistry,O	Rhodes River	2	eight times a year	1979	Smithsonian Environmental Research Center, U.S. Department of Energy, National Science Foundation
Fisheries	Rockfish Watershed Study	Virginia Cooperative Extension	Air temperature, DO, flow, pH, secchi, turbidity, water temperature, weather, SAV, macroinvertebrates, bacterial, fish, wildlife			seasonally	2004	Community

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Fisheries-Point Source	Susquehanna Steam Electric Station Monitoring Program	Pennsylvania Power and Light Company, Ecology III, Inc.	Fish Abundance,Taxa Identification and Length/Weight	area adjacent to Susquehanna Steam Electric Station	8	5 times a year	1976	Pennsylvania Power and Light Company and Allegheny Electric Cooperative, Inc.
Fisheries	Virginia American Eel Young of Year Survey	Virginia Institute of Marine Sciences	Eel counts, lengths, weights, and pigmentation stage, ancillary data: Water temperature, pH, air temperature, wind direction and speed, and precipitation .	York, Rappahannock and James Rivers	4	Daily during Spring run	2000	Virginia Marine Resources Commission and USFWL-Wallop-Breaux funds
Fisheries	Virginia Juvelille Fish and Blue Crab Survey	Virginia Institute of Marine Sciences	Crabs- carapace width, weight, Missing chelipeds, Sex and maturity of females, molt stage. Finfish-counts and total length.. Site-Temperature, salinity, depth at the beginning and end of trawl, trawl duration recorded.	Virginia bay and major tidal tributaries-Random strata samples monthy	110	Monthly-year round	1955	Virginia Marine Resources Commission and NOAA Chesapeake Bay Office
Fisheries	Virginia Shad and Herring Gill Net Survey	Virginia Institute of Marine Sciences	Adult fish captured are measured, sexed, and staged for reproductive condition) as well as aged and OTC-scanned.	York, Rappahannock and James Rivers		February – April, twice weekly	1998	Virginia Marine Resources Commission and USFWL-Wallop-Breaux funds
Fisheries	Virginia Shark Long Line Survey	Virginia Institute of Marine Sciences	Each fish captured is measured and sexed; biological samples are taken for genetic, age/growth, trophic, and reproduction analyses. Healthy specimens not needed for these analyses are tagged and released for long-term studies on migration, habitat utiliza	Lower Bay and Virginia coastal Atlantic ocean	8	Montly May- October Record some what discontinueous due to funding gaps	1973	NOAA- Congressional Earmark
Fisheries	Virginia Striped Bass Monitoiring and Tagging survey	Virginia Institute of Marine Sciences	All fish: length, weight, age, sex, spawning condition, and other characteristics determined. Two pound nets in the Rappahannock River have all striped bass > 457mm are tagged, as part of the coast-wide tagging program	Rappahannock and James rivers		twice per week	1987	USFWL- Wallop-Breaux funds
Fisheries	Virginia Striped Bass Young of Year Beach seine survey	Virginia Institute of Marine Sciences	All fish are counted, striped bass and at least 25 individuals of other species, are measured to fork length Ancillary data: salinity, water temperature, pH, dissolved oxygen, sampling time, tidal stage, and weather conditions.	York, Rappahannock and James Rivers, Virginia Coastal Bays	45	Bi-weekly , June through September-gap 1974-1979	1967	Virginia Marine Resources Commission and USFWL-Wallop-Breaux funds
Fisheries	West Virginia Watershed Assessment Program-Fish Monitoring	West Virginia Department of Environmental Protection-Division of Water and Waste Management	community data (to species) collected via single pass electrofishing. Habitat and WQ data dependant on program for which benthics collected.	statewide	25	once	2007	State funded / EPA 106 Grant
Ground Water	Albermale County Virginia-Groundwater Assessment Program	University of Virginia, School of Engineering and Applied Sciences	pH and nitrite	Albermale County VA		Unspecified	2005	
Ground Water	Augusta County Virginia-Groundwater Asssessment	Augusta County Virginia-Service Authority	chloride, conductivity, flow,metals, hardness, organics, pesticides ph, nutrients, inorganics, radiolocial, TSS, VOCs carbon	Agusta County, VA	15	Unspecified	1966	

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Ground Water	City of Bristol Virginia-Groundwater Monitoring Program	City of Bristol Virgina	Chloride, conductivity, DO, hardness, metals, organics, pH, TSS/TDS, turbidity, VOCs, water temperature, weather, inorganics		24	seasonally, weekly	1992	City of Bristol
Ground Water	City of Newport New Virginia-Brackish Groundwater Monitoring Program	City of Newport News Virginia	Chloride,Conductivity,DO, Hardness, Metals, Nitrogen, Organics, Pesticides, pH, Phosphorus, Salinity, Inorganics, Radiological ,TSS/TDS, Turbidity, VOCs, Water Temp, Weather, Carbon	Newport News, VA	17	Unspecified	1997	
Ground Water	City of Suffolk Virginia-Groundwater Withdrawal Permit Monitoring Program	City of Suffolk Virginia	Chloride,Conductivity,DO,Flow, Hardness, Metals, organics, pesticides, pH, Phosphorus, inorganics ,TSS, Water Temp	Suffolk VA	2	Unspecified	2005	
Ground Water	Commonwealth Chesapeake Power Station-Ground Water Monitoring Program	MSA, P.C.	Chloride,Flow, Hardness, Metals, Nitrogen, pH, Phosphorus, inorganics , Water Temp,	VA	4	Unspecified	1998	
Ground Water	United States Geological Survey-Groundwater Observation Well Network, Deleware	United States Geological Survey Geological Survey	water level	DE	5	about 1/month	1957	USGS
Ground Water	United States Geological Survey-Groundwater Observation Well Network, Maryland	United States Geological Survey Geological Survey	water level	MD	157	varies, every 4-6 weeks	1943	USGS
Ground Water	United States Geological Survey-Groundwater Observation Well Network, Southern Maryland	United States Geological Survey Geological Survey	water level	Anne Arundel, Calvert, Charles, Prince Georges, and St. Marys Counties	384	semi-annual	1950	USGS
Ground Water	United States Geological Survey-Groundwater Observation Well Network, Virginia	United States Geological Survey Geological Survey	water level	VA	139	varies (weekly, monthly, quarterly, continuous)	1966	USGS
Ground Water	Hampton Roads Virginia-Chloride Monitoring in Coastal Plain Aquifers	Hampton Roads Planning District Commission	Chloride,Conductivity,DO, Flow, Hardness, Metals, Nitrogen, pH, Phosphorus, salinity ,TSS/TDS, Turbidity, Water Temp, Carbon	Hampton Roads VA	107	Unspecified	1997	
Ground Water	Ivy MUC- Albemarle County VA	Environmental Standards, Inc.	BOD,Conductivity, hardness, Pesticides, pH, Turbidity, VOCs, Water Temp, Weather	Albemarle County VA	70	Unspecified	1997	
Ground Water	Mountain Run Headwaters	People Protecting Watershed Headwaters	Conductivity, DO,Nitrogen, Organics, pH, Phosphourous,TSS,Wtemp, in ground Water	Mountain Run Watershed VA		Unspecified	2003	
Ground Water	National Park Service-ground water Internal Compliance monitoring	National Park Service	Bacteria,Chloride,Conductivity,DO, Hardness, Metals, Nitrogen, Organics, Pesticides, pH, Phosphorus, Inorganics, Radiological ,TSS/TDS, Turbidity, VOCs, Water Temp,	VA	3	Unspecified	1988	

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Ground Water	North Rivanna Virginia-Groundwater monitoring program	Environmental Standards, Inc.	DO, pH, NITROGEN, CHLORIDE, CONDUCTIVITY, TURBIDITY, WTEMP, Fluoride, Sulfate	Albemarle County VA	3	Unspecified	2004	
Ground Water	Solid and Hazardous Waste Facility Monitoring	Draper Aden Associates	BOD,Chloride,Conductivity,DO, Flow, Hardness, Metals, Nitrogen, Organics, Pesticides, pH, Phosphorus, Inorganics, Radiological ,TSS/TDS, Turbidity, VOCs, Water Temp, Weather, Carbon	VA		Unspecified	1990	
Ground Water	Wintergreen Mountain Ground Water Well Monitoring	Nelson County Service Authority	flow, pH, Inorganics	Nelson County VA	4	Unspecified	2002	
Ground Water	Friends of the North Fork of the Shenandoah River - Groundwater Monitoring Program	Friends Of The North Fork Shenandoah River	BOD, chloride, DO, Nitrogen, pH, Phosphorus, coliforms and virus			monthly	1993	
Meteorology	Little Stony Creek Liming Project	James Madison University	Air temperature, chloride, flow, hardness, metals, pH, water temperature, weather, acid anions, aluminum, base cations		6	monthly	1987	James Madison University
Meteorology	Maryland Acid Precipitation Monitoring Program	Maryland Department of Natural Resources	pH, selected metals and nutrients, acidity	MD	2	depends (weekly, etc.)	1984	
Meteorology	National Atmospheric Deposition Program-National Trends Network	Chesapeake Bay National Estuarine Research Reserve in Virginia	pH, sulfate, nitrate, ammonium, chloride, base cations, and rainfall amounts	Va. Southern Bay	1	Weekly	2004	NOAA/ERD
Meteorology	National Oceanic and Atmospheric Administration-National Weather Service Solar Radiation Network	National Oceanic and Atmospheric Administration	Radiation, meterorlogical parameters	Chesapeake Bay Basin	1	hourly	1953	NOAA
Meteorology	Pennsylvania Atmospheric Deposition Monitoring Program	Pennsylvania Department of Environmental Protection	pH, sulfate, nitrate, ammonium, chloride, calcium, magnesium, potassium, sodium, and specific conductance	Pennsylvania-11 acid rain and 8 mercury monitoring sites.	19	weekly	1981	
Meteorology	Virginia Acid Precipitation Network	Virginia Department of Environmental Quality	pH (laboratory), conductivity (laboratory), ammonium, chloride, bromide, nitrate, sulfate, and phosphate in wet precipitation	VA	13	varies (weekly, following rain etc.)	1982	
Observing System	Chesapeake Bay Observing System	University of Maryland Chesapeake Biological Laboratory	wind speed & direction, solar radiation, humidity, air temp, some bouys have additional parmeters	Maryland Waters of Chesapeake bay	2	real time data		
Observing System	Eyes On The Bay	Maryland Department of Natural Resources	water temperature, salinity, dissolved oxygen (DO) saturation, DO concentration, pH, turbidity, and fluorescence (a measure of chlorophyll-a present in the water	Maryland Waters of Chesapeake bay	52	continuous monitiring	2001	MDDNR, USEPA, NOAA

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Observing System	National Aeronautics and Space Adminstration-MODIS (Moderate Resolution Imaging Spectroradiometer)-Mission	National Air and Space Administration	36 spectral bands between 0.405 and 14.385 µm, and it acquires data at three spatial resolutions -- 250m, 500m, and 1,000m.	Global		daily coverage	1999	NASA
Observing System	National Aeronautics and Space Adminstration- SeaWifs Mission	National Air and Space Administration	Normalized water-leaving radiance at 412, 443,490,510,555,670 nm, Aerosol optical thickness at 865 nm, Epsilon of aerosol correction at 765 and 865 nm	Global		daily coverage	1997	NASA
Meteorology	National Weather Service-Airport Weather Monitoring Network	National Oceanic and Atmospheric Administration-Weather Service	varies by site Typical parmeters include:Wind,Visibility,Weather, Sky Cond., Air Temperature, Pressure, Precipitation	Chesapeake Bay Watershed	63	continuous monitiring availability varies by site		NOAA
Observing System	National Oceanic and Atmospheric Administration-Coastal Prediction Center	National Oceanic and Atmospheric Administration-Chesapeake Bay Office		Annapolis Harbour Buoy	1	real time data		NOAA-NCBO
Observing System	National Oceanic and Atmospheric Administration-National Data Bouy Center-National Weather Service	National Oceanic and Atmospheric Administration-Weather Service	Wind Direction, Wind Speed, Wind Gust, Atmospheric Pressure,Pressure Tendency, Air Temperature, Water Temperature, Dew Point	Chesapeake Bay	7	real time data	1990	NOAA
Observing System	National Oceanic and Atmospheric Administration-Physical Oceanographic Real-Time System	National Oceanic and Atmospheric Administration-National Ocean Service	water levels, currents, salinity, and meteorological parameters (e.g., winds, atmospheric pressure, air and water temperatures)	Chesapeake Bay	60	real time data	1984	NOAA
Observing System	National Oceanic and Atmospheric Administration-Coastal Change Analysis Program	National Oceanic and Atmospheric Administration-National Ocean Service	Coastal counties 1984, 1988/89, 1996, 2001, 2005, change 1996-2001, change 2001-2005	Coatal counties 30m resolution. Watershed nearly coverage completed		1988/89, 1996, 2001, 2005, change 1996-2001, change 2001-2005	1984	NOAA NOS, USGS
Observing System	University of Maryland's Regional Earth Science Applications Center-Impervous Surface Monitoring	University of Maryland's Regional Earth Science Applications Center	Impervious cover change, impervious surface extent by watershed	Chesapeake Bay watershed and intersecting counties		1990, 2001	1990	Univeristy of Maryland
Observing System	University of Maryland's Regional Earth Science Applications Center-Land Use Change Monitoring	University of Maryland's Regional Earth Science Applications Center	Urban, Forest, Agriculture, and Tidal wetland patterns and extent (2001)	Chesapeake Bay watershed and intersecting counties		2001	2001	Univeristy of Maryland
Observing System	United States Geological Survey-Land Cover Change Monitoring	United States Geological Survey Geological Survey	Urban, Forest, Agriculture, and Tidal wetland patterns, extent, and change over time (1984 - 2006)	Chesapeake Bay watershed and intersecting counties		1984, 1992, 2001, 2006	1984	USGS
Observing System	United States Park Service-Chesapeake Bay Interpretive Buoy System	National Oceanic and Atmospheric Administration, United States Park Servive	Varies by bouy -Air Temperature, Barometric Pressure, Chlorophyll A, Dissolved Oxygen, Maximum Wave Height, Mean Wave Direction, Relative Humidity, Significant Wave Height, Significant Wave Period, Turbidity, Water Conductivity, Salinity, Water Temper	Chesapeake Bay	6	real time data	2007	NOAA, CBF, Conservation trial, Frends of John Smith Trail, USPark Service

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Observing System	Virginia Estuarine and Coastal Observing System	Virginia Institute of Marine Sciences	wind speed & direction, solar radiation, humidity, air temp, some bouys have additional parmeters	Virginia Portions of Chesapeake bay	4	real time data		
Phytoplankton	District of Columbia Phytoplankton Monitoring Program	District of Columbia-Department of the Environment	Phytoplankton Identification to lowest possible taxa (genus or species) with Abundance and Percent composition by major groups	Potomac and Anacostia Rivers in DC	16	Once monthly howvever sampling record is erratic	1983	US EPA Region 3
Phytoplankton	Fairfax County-Gunston Cove Ecosystem Monitoring Program	George Mason University	Phytoplankton Identification to lowest possible taxa (genus or species) with Abundance	Gunston cove, VA	5	biweekly	1984	Fairfax County, Virginia
Phytoplankton	Maryland Chesapeake Bay Water Quality Monitoring Program Phytoplankton Component	Morgan State University	Phytoplankton Identification to lowest possible taxa (genus or species), abundances, Primary Production estimate and Vertical & Horzontal Fluorescence	MD Tidal waters	14	Once monthy March, June, Sept-December Twice monthly April,May and July	1984	Maryland Department of Natural Resources-Match Program to EPA Funded Water Quality Monitoring Program
Phytoplankton	Maryland Phytoplankton Monitoring Program	Maryland Department of Natural Resources	Phytoplankton Identification to lowest possible taxa (genus or species) with Abundance and Percent composition by major groups	Maryland Chesapeake Bay-Mainstem and tributaries.	18	Once monthy between November and February, Twice monthly between March and September	1984	Maryland Department of Natural Resources
Phytoplankton	Virginia Harmful Algal Bloom Surveillance Program	Old Dominion University, Virginia Institute of Marine Science, Virginia Department of Health, Divisions of Environmental Epidemiology and Shellfish Sanitation, Virginia Department of Environmental Quality	Genus or species, abundance	VA	20		1998	Centers for Disease Control and Prevention
Phytoplankton	Virginia Phytoplankton Monitoring Program	Old Dominion University	Phytoplankton Identification to lowest possible taxa (genus or species), abundances and Primary Production estimate	VA	13	Once monthly	1985	Virginia Department of Environmental Quality-Match Program to EPA Funded Water Quality Monitoring Program
Phytoplankton	Reston Association-Lakes Monitoring	Reston Association	Conductivity, DO, pH, Phosphorus, secchi, water temperature, weather, chlorophyll, phytoplankton, zooplankton			monthly	1982	Reston Association
Point Source	Maryland NPDES Enforcement Program	Maryland Department of the Environment	vary based on NPDES requirements	MD	711	at least quarterly	1974	Maryland Department of the Environment
Point Source	Maryland Point Source Sampling Program	Maryland Department of the Environment	vary based on NPDES requirements	MD	341	monthly, quarterly, or seasonal	1972	Maryland Department of the Environment
Point Source	District of Columbia-Point Source Compliance Monitoring Program	District of Columbia-Department of Consumer and Regulatory Affairs	vary based on NPDES requirements	DC	13	1 or 2 times/year	1978	USEPA

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Point Source	Deleware Point Source Compliance Monitoring Program	Delaware Department of Natural Resources and Environmental Control-Division of Water Resources	vary based on NPDES requirements	DE	9	annual inspections, sampling 4 times/yr	1974	DNREC
Point Source	Maryland Industrial-Point Source Compliance Monitoring Program	Maryland Department of the Environment	vary based on NPDES requirements	MD	600	Annual	1974	Maryland Department of the Environment
Point Source	Maryland Municipal-Point Source Compliance Monitoring Program	Maryland Department of the Environment	vary based on NPDES requirements	MD	341	monthly, quarterly, or seasonal	1972	Maryland Department of the Environment
Point Source	New York-Point Source Compliance Monitoring Program	New York Deparment of Environmental Conservation, Bureau of Water Permits	vary based on NPDES requirements	NY				NYDEP
Point Source	Pennsylvania Point Source Compliance Monitoring Program	Pennsylvania Department of Environmental Protection	2ndary parameters and nutrients	PA	184	Facility size dependent weekly to monthly - Discharge monitoring reports filed with Pa DEP monthly		PA DEP
Point Source	Virginia-Point Source Compliance Monitoring Program	Virginia Water Control Board	vary based on NPDES requirements	VA	1830	annual	1975	Virginia Water Control Board
Point Source	West Virginia-Point Source Compliance Monitoring Program	West Virginia Department of Environmental Protection-Division of Water and Waste Management	vary based on NPDES requirements	WV	132	annual inspections, sampling every 3-4 months for some	1974	West Virginia DEP
Radiological	Maryland Radionuclide Monitoring Program	Maryland Department of the Environment						
Radiological	Pennsylvania Radiological Monitoring Program							
Radiological	Philidelphia Electric Company Peach Bottom Radiological Monitoring Program							
Sav	Buffalo River Virginia-Watershed Monitoring Program	Sweet Briar College	BOD, conductivity, DO, flow, hardness, nitrogen, pesticides, pH, phosphorus, TSS/TDS, turbidity, water temperature, aquatic vegetation, macroinvertebrates, bacterial, fish			seasonally, annually	2000	Sweet Briar College

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Sav	Chesapeake Bay Submerged Aquatic Vegetation Aerial Survey	Virginia Institute of Marine Sciences	SAV acerage and Density	Chesapeake bay. tidal tributaries, some MD and VA coastal bays.		annually Present with gaps in 1988 and partial surveys between 1979-1984	1978	U.S. EPA Chesapeake Bay Program Office, U.S. Fish and Wildlife Service, Maryland Department of Natural Resources, Virginia Department of Environmental Quality, Virginia Institute of Marine Science, N.O.A.A. - Coastal Resources Management Program
Sav	Citizens Submerged Aquatic Vegetation Hunt Program	United States Fish and Wildlife Service	Weather Conditions, Tide, SAV Location, SAV Species presence and density	Chesapeake bay. tidal tributaries, some MD and VA coastal bays.		annually	1985	U.S. Fish and Wildlife Service
Sav	District of Columbia: Aquatic Vegetation Monitoring	District of Columbia-Department of the Environment	SAV Location by species, Percent of each SAV Species in each SAV bed encountered, Cover class (density) of each SAV bed encountered	DC tidal waters		annually	1994	District of Columbia Department of Health
Sav	Rockfish Watershed Study	Virginia Cooperative Extension	Air temperature, DO, flow, pH, secchi, turbidity, water temperature, weather, SAV, macroinvertebrates, bacterial, fish, wildlife			seasonally	2004	Community
Sav	Poplar Island Monitoring Program	Army Corps of Engineers-Baltimore District and United States Fish and Wildlife Service		Chesapeake Bay		yearly	2004	USFWS/COE
Sav	Virginia Nearshore Sav Habitat Monitoring Program	Virginia Institute of Marine Sciences	Air temperature, conductivity, DO, salinity, TSS/TDS, water temperature, inorganics, NO3, NO2, NH4		7	annually	1974	VADEQ
Sav	Alliance for Chesapeake Bay Citizen Monitoring Program	Alliance for the Chesapeake Bay	Air temperature, DO, pH, phosphorus, secchi, tide, TSS/TDS, water temperature, weather, aquatic vegitation, macroinvertebrates, bacterial, wildlife, chlorophyll			weekly, seasonally	1985	Private Non-profit
Shellfish	Maryland Annual Oyster Spat Index and Disease Survey	Maryland Department of Natural Resources	Depth; Bottom Type Salinity; Number of live spat, smalls, and markets; Number/stage of dead spat, smalls, and markets; Temperature; Size distribution at selected sites;; meat quality; Reproductive stage; Relative density and type of fouling organisms;Prev	Maryland waters	250	Not given	1939	Maryland Department of Natural Resources and National Oceanic and Atmospheric Administration
Shellfish	Maryland Baywide Winter Crab Study	Maryland Department of Natural Resources and Virginia Institute of Marine Science	crab abundance, lengths and condition	Baywide-1500 randoms strata tows	1500	annualy-December, January and February.	1990	States of Maryland and Virginia

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Shellfish	Maryland Blue Crab Monitoring Program	Maryland Department of Natural Resources	crab abundance, lengths and condition	Chester, Choptank, Patuxent, Pocomoke and Tangier sounds, and Eastern Bay	35	monthly from May to October.	1975	Maryland Department of Natural Resources
Shellfish	Maryland Oyster Stock Assessment Program	Maryland Department of Natural Resources	Depth Number of live and dead oysters per unit area ,Bottom Type, Size class distribution of live and dead oysters, Salinity, Volume of shell per unit area: live, dead, blank surface, Temperature subsurface, clam, and mussel, Volume of live clams (soft a	Maryland waters		Not given	1975	Maryland Department of Natural Resources,National Oceanic and Atmospheric Agency
Shellfish	Rhode River Watershed Environmental Monitoring Program	Smithsonian Environmental Research Center	Primary parameters: Benthic Taxa Identification and Abundance. Other Parameters: Bulk Precipitation, Wet Precipitation, Throughfall Chemistry Weather,Solar Irradiance, Dry Deposition Chemistry,Ground Water, Stream Water Discharge, Infiltration Chemistry,O	Rhodes River	2	eight times a year	1979	Smithsonian Environmental Research Center, U.S. Department of Energy, National Science Foundation
Shellfish	Virginia Blue Crab Megalopae Monitoring Program	Virginia Institute of Marine Sciences	Surface Temperature, Surface Salinity, Megalopae Abundance	Gloucester Point, VA	1	daily-July 1 through November 15	1985	Virginia Institue of Marine Science
Shellfish	Virginia Juvenile Blue Crab Survey	Virginia Institute of Marine Sciences	Crabs- carapace width, weight, Missing chelipeds, Sex and maturity of females, molt stage. Finfish-counts and total length.. Site-Temperature, salinity, depth at the beginning and end of trawl, trawl duration recorded.	Virginia bay and major tidal tributaries-Random strata samples monthy	110	Monthly-year round	1955	Virginia Marine Fisheries Commission and NOAA Chesapeake Bay Office
Shellfish	Virginia Oyster Disease Survey	Virginia Institute of Marine Sciences and Virginia Marine Resources Commission	Percent occurrence of Dermo and MSX in oyster tissue.	James York, Rappahannock, Great Wicomico Rivers and Virginia embayments of the Potomac River.	10	three times a year on June 1, August 1, and October 1.	1960	Commonwealth of Virginia
Shellfish	Virginia Oyster Spat Survey	Virginia Institute of Marine Sciences and Virginia Marine Resources Commission	Count of spat on each shell	James, York, Piankatank, Rappahannock, and Potomac rivers, along with Mobjack Bay.	44	Weekly-June to October	1946	Commonwealth of Virginia

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Shellfish	Virginia Spring and Fall Oyster Bar Survey	Virginia Institute of Marine Sciences and Virginia Marine Resources Commission	Temperature, Salinity Count of Spat, Small and Market Oysters: Estimate of Condition of Bar, Description of Predators	Virginia waters of the Chesapeake Bay, James, York, Piankatank, Rappahannock, Great Wicomico rivers, and Mobjack Bay.	30	Thirteen oyster bars are sampled once in May and 29 bars are sampled once in October of each year.	1960	Commonwealth of Virginia
Toxics-Point Source	Amherst Virginia Waste Water Treament Plant Monitoring	Liberty University	Chloride, conductivity, DO, pH, TSS/TDS, water temperature, macroinvertebrates, fish, tox tests with ceridphoris debris			annually		Liberty University
Toxics-Tissue	James River Monitoring of Fish Tissue for Kepone	Virginia Department of Environmental Quality	Kepone	Statewide	5	Sampled once every two years.		
Toxics-Sediment	Maryland Chesapeake Bay Sediment Toxicant Monitoring Program	Maryland Department of the Environment						
Toxics-Tissue	United States Envrionmental Protection Agency-National Study Of Chemical Residue In Lake Fish	United States Environmental Protection Agency	Organics, pesticides, pH		9	seasonally	1998	USEPA
Benthic	Poplar Island Monitoring Program	Army Corps of Engineers-Baltimore District	organisms were identified and enumerated, and community composition, abundance, and diversity was measured and reported. Results of the benthic community characterization were compared to established benchmarks (Chesapeake Bay Restoration Goal Index).	area around Poplar Island reconstruction	29	varies by phase in project	1994	army corps of engineers-Baltimore District
Toxics-Sediment	Poplar Island Monitoring Program	Army Corps of Engineers-Baltimore District	Metals,PCB Congeners,Chlorinated Pesticides,PAHs,Dioxin and Furans,Butyltins,Organophosphorus Pesticides,Semi-Volatile Organic Compounds (SVOCs),Volatile Organic Compounds (VOCs),Lipids,Biological Oxygen Demand,Chemical Oxygen Demand,Sulfide, Cyanide, Tot	area around Poplar Island reconstruction	44	varies by phase in project	1994	army corps of engineers-Baltimore District
Toxics-Water	City of Purcellville Virginia-Water Monitoring System	Town Of Purcellville Virginia	Air temperature, flow, hardness, metals, Nitrogen, organics, pesticides, pH, turbidity, VOCs, water temperature, weather, inorganics, radiological, bacterial		6	weekly, annually	1986	State of Virginia
Toxics-Water	United States Geological Survey-National Stream Quality Accounting Networks	United States Geological Survey Geological Survey	Temperature, Specific conductance, Dissolved oxygen, pH, Alkalinity, Calcium, Magnesium, Sodium, Potassium, Chloride, Sulfate, Fluoride, Silica, Arsenic, Boron, Iron, Strontium, Vanadium, Lithium, Selenium, ammonia, nitrite, Total Dissolved Nitrogen, Tot	PA, MD, DC, VA, WV	2	daily stream flow, bi-weekly monitoring	1974	USGS

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Toxics-Sediment	Virginia Department of Environmental Quality-Kepone Sediment Monitoring Program	Virginia Department of Environmental Quality						VADEQ
Toxics-Water	Virginia Department of Environmental Quality-Chesapeake Bay Mainstem Sediment Monitoring Program	Virginia Department of Environmental Quality						VADEQ
Toxics-Tissue	Virginia Department of Environmental Quality-Fish Tissue And Sediment Containment Monitoring	Virginia Department of Environmental Quality	Metals, organics, pesticides, fish and shellfish tissue		90	annually	1970	VADEQ
Toxics-Water	Virginia Department of Environmental Quality Kepone Ground Water Contaminants Monitoring Program	Virginia Department of Environmental Quality	Kepone					VADEQ
Toxics-Tissue	Virginia Department of Environmental Quality-Tidal Bay And Tributaries Fish Tissue Monitoring	Virginia Institute of Marine Sciences	Organics, pesticides, inorganics, fish tissue			annually	1993	VADEQ
Toxics-Sediment	Virginia Estuarine Probabilistic Monitoring in minor Chesapeake Bay and coastal tidal tributaries	Virginia Department of Environmental Quality	Dissolved oxygen, pH, temperature, nutrients, chlorophyll-a, Sediment triad (chemistry, toxicity, benthos), fish tissue chemistry	Estuary portions of the Virginia portion of the Chesapeake Bay Watershed	50	Some stations are sampled every year. Most other stations are moved each year to provide probabilistic characterizations of benthos.		
Toxics-Water	Virginia Tidal Freshwater Toxics Monitoring	Virginia Institute of Marine Sciences	Conductivity, DO, hardness, metals, Nitrogen, organics, pesticides, pH, Phosphorus, salinity, TSS/TDS, water temperature, weather, macroinvertebrates		29	annually	2000	
Water Quality-Point Source	Amherst Virginia Waste Water Treament Plant Monitoring	Liberty University	Chloride, conductivity, DO, pH, TSS/TDS, water temperature, macroinvertebrates, fish, tox tests with ceridphoris debris			annually		Liberty University
Water Quality-Storm Water	Arlington County Virginia Stormwater Permit Monitoring	Arlington County Virginia-Department of Environmental Services	Chloride, nitrogen, pH, water temperatue, phenols/fluoride		100	annually		Arlington County

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Water Quality-Storm Water	Baltimore County Chemical Monitoring Program	Baltimore County Maryland-Department of Environmental Protection and Resource Management	TSS, TS, TKN, Nitrate/Nitrite, Total Phosphorus, Ortho-phosphorus, Cadmium, Copper, Lead, Zinc, BOD, COD, Chlorides, Sodium, Hardness, Magnesium and Calcium, Temperature and pH	Baltimore County31 sites for the Patapsco/Back River screened in odd years. 53 sites for Gunpowder Basin/Deer Creek screened in even years. Four storm monitoring sites	31	6 to 8 times a year for baseflow, 12 times per year for storm flow	1999	Baltimore County
Point Source	Baltimore County-Illicit Connections Program	Baltimore County Maryland-Department of Environmental Protection and Resource Management	Includes a quantitative analysis of the storm drain outfall effluent. This includes measuring the effluent flow rate, temperature and pH, and field-testing with the LaMotte NPDES test kit. This includes parts per million tests for copper, chlorine, and p	Baltimore County	150	minimum of 150 outfall screened per year, plus citizen complaints that are reported	1997	Baltimore County
Water Quality	Baltimore Ecosystem Study	Cary Institute of Ecosystem Studies	DO, O2, N, Temperature, Coliform, Turbidity	The Gwynns Falls watershed	6	Weekly	2002	National Science Foundation, US Department of Agriculture Forest Service
Water Quality-Power Plant	Bath County Pumped Storage Station Little Back Creek Stream Survey – Water Quality Component	Virginia Power						Virginia Power and Virginia Department of Game and Inland Fisheries
Water Quality-Power Plant	Bath County Pumped Storage Station Recreation Pond Monitoring Program – Water QualityComponent	Virginia Power						Virginia Power and Virginia Department of Game and Inland Fisheries
Water Quality	Broad Run Water Quality Monitoring Program	Loudoun Water, OWML	suspended sediment, nutirents, dissolved oxygen, coliforms and trace metals.	Northern VA - Broad Run	1	biweekly/monthly grab samples	1990	Louden County Virginia
Water Quality-Power Plant	Brunner Island Steam Electric Station Environmental Monitoring and Surveillance Program – WQ Component	PPL Corporation	Fish, macroinvertebrates, temperature, DO, pH, conductivity, turbidity	Susquehanna River Basin	10	2 surveys per year: one in winter and one in summer (until 2013)	2008	PPL Corporation
Water Quality	Buffalo River Virginia-Watershed Monitoring Program	Sweet Briar College	BOD, conductivity, DO, flow, hardness, nitrogen, pesticides, pH, phosphorus, TSS/TDS, turbidity, water temperature, aquatic vegetation, macroinvertebrates, bacterial, fish			seasonally, annually	2000	Sweet Briar College

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Water Quality	Chesapeake Bay Program non-tidal water quality network	United States Geological Survey Geological Survey, Maryland Department of Natural Resources, Virginia Department of Environmental Quality,West Virginia Department of Environmental Protection, DEDNRC, PADEP, NYDEC, SRBC	Total Nitrogen as N, Ammonium, as N., Nitrate+Nitriate as N, Total Phosphorus P, Phophate as P, Total Suspended Solids, Suspended Sediment Concentration (storm flow only), and field parameters DO, Temperature, pH, and Specific Conductance.	Entire Chesapeake Bay Watershed	88	1/month all stations, plus 8 storm samples at primary stations	1998	funded mostly by states 106 funds, CBP (only $300,000)
Water Quality	Chesterfield County Watershed Assessment and Stream Protection Program	Chesterfield County Virginia-Department of Environmental Engineering, Water Quality Section	Dissolved Oxygen, pH, Conductivity, TDS, Temperature, Flow, Turbidity, Phosphate, Ammonia, Nox, Hardness, Alkalinity	Chesterfield County	59	Approximately 10 sites per month with an additional 10 long term sites assessed quarterly	2002	Chesterfield County Department of Environmental Engineering
Water Quality-Drinking Water	City of Baltimore Maryland-Drinking Water Supply Reservoir Water Quality Monitoring	City of Baltimore Maryland-Department of Public Works	water temperature, air temperature, dissolved oxygen, pH, conductivity, total suspended solids, volatile suspended solids, turbidity, true color, total phosphorus, nitrate nitrogen, ammonia nitrogen, TKN, alkalinity, hardness, chlorophyll a, total algae c	Loch Raven and Liberty Reservoir watersheds-12 in-lake stations; 17 dry weather tributary stations; 6 wet weather tributary stations	36	in-lake: once or twice per month; dry weather tributaries: once per month; wet weather tributaries: 4 to 6 times per year	1982	City of Baltimore
Water Quality-Storm Water	City of Baltimore Maryland-Stream and Harbor water quality monitoring associated with NPDES discharge permit for storm water	City of Baltimore Maryland-Department of Public Works	water temperature, dissolved oxygen, pH, conductivity, total suspended solids, volatile suspended solids, total phosphorus, nitrate+nitrite nitrogen, ammonia nitrogen, TKN, hardness, e. coli counts, enterococci counts, total copper, total lead, total zinc	City of Baltimore (which lies within the Patapsco and Back River watersheds)	116	small set of metrics done weekly at 48 stations; larger set of metrics done monthly at 36 stations; wet weather monitoring at 7 stations 8 to 12 times each year; about 25 stations for macroinvertebrates and fish each year	1995	City of Baltimore
Water Quality-Drinking Water	City of Newport News Virginia-Ambient Water Quality Monitoring Program	City of Newport News Virginia	Dissolved oxygen, pH, temperature	several stations upstream of raw water intake on the Chickahomony River.	6			
Water Quality-Drinking Water	City of Norfolk Virginia-Reservoir Monitoring Program	City of Norfolk Virginia	Dissolved oxygen, pH , temperature	Various reservoirs in and around Norfolk, VA.	20			
Water Quality-Storm Water	City of Portsmouth Virginia-Storm Water Monitoring Program	City of Portsmouth Virginia	Flow, nitrogen, phosphorus, salinity, TSS/TDS		2	seasonally	2001	City of Portsmouth

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Water Quality	Clinch River and Estonoa Wetland Monitoring	Globe Hydrology	Conductivity, DO, Nitrogen, pH, turbidity, water temperature, macroinvertebrates		2	weekly	2000	Public
Water Quality	Coordinated Anacostia Monitoring Program	Metropolitan Washington Council of Governments	Water temp, DO, Specific Condl, pH, nutrients, bacteria, others	Anacostia watershed	42	depends (2/month to monthly)	1985	Metropolitan Washington Council of Governments, MDE, PG County, Montgomery Co.
Water Quality-Point Source	Dan River Virginia- Instream Monitoring Program	City of Danville Virginia	Air temperature, conductivity, DO, pH, turbidity, ORP		1	annually	1974	City of Danville
Water Quality	Delaware Water Quality Monitoring Network	Delaware Department of Natural Resources and Environmental Control-Division of Water Resources	Total Phosphorus, Soluble Ortho-phosphorus, Ammonia Nitrogen , Nitrite+Nitrate , Total N, Total Organic Carbon, Dissolved Organic Carbon, Chlorophyll-a , BOD5, BOD20, Dissolved oxygen , Total Suspended Solids, Alkalinity, Hardness, pH, Conductivity, Sali	DE-number of sites varies by year		Monthly	1970	Delaware Department of Natural Resources and Environmental Control
Water Quality	District of Columbia water quality monitoring program	District of Columbia-Department of Health	Temp, DO, series of metals, nutrients, bacteria, Secchi, Specific Condu, Salinity and pH, depending on the station	DC	76	Monthly, some stations 20x/year	1979	DC Department of Health
Water Quality	Virginia Intitute of Marine Sciences-Enhanced Tributary Monitoring Program	Virginia Institute of Marine Sciences	Conductivity, DO, Nitrogen, salinity, secchi, TSS/TDS, water temperature, chlorophyll		12	annually	2001	
Water Quality	Fairfax County-Gunston Cove Ecosystem Monitoring Program	George Mason University	BOD5, CBOD5, CHLA, CHLORIDE, COND, DO, FCOLI, NH3_N, NO2_N, NO3_N, OP, OX_N, PH, SECCHI, TALK, TEMP, TKN, TP, TSP, TSS, VSS	Northern VA Fairfax County (Gunston Cove, Accotink Bay, Pohick Creek)	4	monthly from November - March Bimonthly from April - October		Fairfax County Virginia
Ground Water	Hog Island Bay Monitoring Program	Virginia Institute of Marine Sciences	BOD, chloride, DO, flow, hardness, organics, Phosphorus, salinity, TSS/TDS, water temperature, weather, inorganics, carbon, SAV, chlorophyll		23	monthly	2001	
Water Quality	J.R. Horsley SWCO Monitors	J.R. Horsley Soil & Water Conservation District	DO, Nitrogen, pesticides, pH, Phosphorus, water temperature, weather, macroinvertebrates, wildlife		6	annually	1999	Private Non-profit
Water Quality	Maryland Chesapeake Bay Water Quality Monitoring Program: Ecosystem Processes-Sediment Oxygen Nutrient Exchange Component	University of Maryland Chesapeake Biological Laboratory	Variable	Variable	4	Variable	1984-Present	Maryland Department of Natural Resources (State Funds)-Match Program to EPA Funded Water Quality Monitoring Program

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Water Quality	Maryland Chesapeake Bay Water Quality Monitoring Program: Mainstem chemical/physical components	Maryland Department of Natural Resources	Water temperature, salinity, conductivity, dissolved oxygen, pH, Secchi depth, Chlorophyll a, total dissolved nitrogen, particulate nitrogen, nitrite, nitrite + nitrate, ammonium, total dissolved phosphorus, particulate phosphorus, orthophosphate, particu	Tidal reaches of Maryland's Chesapeake Bay	21	Twice monthly in April, May, July, and August and once monthly during the remaining months for a total of 16 samplings per year; east and west transect stations not collected from November through February, resulting in only 12 samplings a year.	1984	USEPA Chesapeake Bay Program
Water Quality	Maryland Chesapeake Bay Water Quality Monitoring Program: River Input Chemical/Physical Component	United States Geological Survey	TPN, TDN, NH3, NO2, NO23, TP, TDP, PO4, DOC, TPC, PIC, TSS, VSS, SSC, s-fine, Silica, Chla	One station on each of the Susquehanna, Potomac, Patuxent, and Choptank Rivers.	4	Variable	1984-Present	Maryland Department of Natural Resources (State Funds) $145,000- Match Program to EPA Funded Water Quality Monitoring Program, $8000 from EPA for gage support, USGS funds $137,000
Water Quality	Maryland Nontidal Tributary Water Quaity Monitoring Program-Core Trend Program	Maryland Department of Natural Resources	Dissolved Oxygen,pH, Specific Conductance, Secchi, Dissolved Organic Carbon, Particulate Carbon, Ammonium, Particulate Nitrogen, Total Dissolved Nitrogen, Nitrate + Nitrite, Nitrite, Orthophosphate, Particulate Phosphorus, Total Dissolved Phosphorus, BOD,	Maryland Non-Tidal Tributaries	51	monthly	1974	MDDNR
Water Quality	Maryland Chesapeake Bay Water Quality Monitoring Program: Long-term Tidal Tributary Chemical/Physical Component	Maryland Department of Natural Resources	water temperature, salinity, conductivity, dissolved oxygen, pH, Secchi depth, Chlorophyll a, total dissolved nitrogen, particulate nitrogen, nitrite, nitrite + nitrate, ammonium, total dissolved phosphorus, dissolved organic carbon, particulate phosphoru	Maryland tidal tributaries-13 Patuxent stations, 11 Potomac stations, 44 minor tributary stations	68	Water column samples are collected at least once a month at most stations, for a minimum of 12 samplings per year. Potomac sampling is twice monthly in Mar-Oct and once monthly during the remaining months for a total of 20 samplings per year. Patuxent	1984-Present	Maryland Department of Natural Resources (State Funds)- portions of the monitoring program are used as match to EPA funds

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Water Quality	Maryland Shallow Water Quality Monitoring Program	Maryland Department of Natural Resources	Water temperature, salinity, conductivity, dissolved oxygen, turbidity, fluorescence, pH, Secchi depth, photosynthetic active radiation measurements, Chlorophyll a, total dissolved nitrogen, particulate nitrogen, nitrite, nitrite + nitrate, ammonium, tota	Chesapeake Mainstem, Maryland tidal tributaries, Maryland Coastal Bays	50	Continuous monitoring is generally conducted April-October with automated measurements every 15 minutes and in situ calibration samples and profiles taken every 2 weeks. A subset of sentinel sites are deployed year-round. Water quality mapping is conducte	1997	Maryland Department of Natural Resources, the U.S. Environmental Protection Agency, the National Oceanic and Atmospheric Administration, and local governments.
Water Quality	National Estuarine Research Reserve System-Monitoring Program	Chesapeake Bay National Estuarine Research Reserve in Virginia	Measured parameters include water level, temperature, pH, specific conductance, dissolved oxygen, Chl, turbidity, and dissolved nutrients	Sites throughout the bay	6	Continuous (15 min) to monthly	1997	NOAA/ERD
Water Quality	New York State Water Quality Assessment Program	New York State Department of Environmental Conservation	Temperature, Dissolved oxygen, Conductivity,pH, Alkalinity, Nitrogen, Nitrite,Nitrate, Phosphorus,Orthophosphate, TOC, Hardness, Magnesium, Calcium, TSS, Sodium, Chloride, Sulfate, Iron, Manganese, Aluminum, Turbidity	NY	23	5x/year or 9-10 times	1987	NY State Department of Environmental Conservation
Water Quality	National Park Service-Fredericksburg and Spotsylvania National Military Parks-Water quality monitoring	National Park Service-Fredericksburg and Spotsylvania National Military Parks	Dissolved oxygen, pH, temperature, nutrients	Streams flowing through the Fredericksburg and Spotsylvania Battlefield Parks	17			
Water Quality	National Park Service- National Capital Region Network-Water quality monitoring	National Park Service- National Capital Region Network	Benthic monitoring, general water quality monitoring	Streams flowing through NPS parks in the Washington DC area	21			
Water Quality	National Park Service-Richmond Area National Parks-Water quality monitoring	National Park Service- Richmond Area National Parks	Benthic monitoring, dissolved oxygen, pH, temperature	Streams flowing through Richmond Battlefield Parks	9			
Water Quality	National Park Service-Shenandoah National Park-Water quality monitoring	National Park Service-Shenandoah National Park	Benthic monitoring, dissolved oxygen, pH, temperature, nutrients	Streams flowing through the Shenandoah National Park				
Water Quality-Drinking Water	Occoquan Reservoir-Water quality Monitoring Program	Occoquan Watershed Monitoring Laboratory	Dissolved oxygen, pH, temperature	Occoquan Reservoir	4			

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Water Quality	Occoquan Watershed Monitoring Program	Virginia Tech	Air temperature, BOD, chloride, conductivity, DO, flow, hardness, metals, Nitrogen, organics, pesticides, pH, Phosphorus, secchi, TSS/TDS, turbidity, VOCs, water temperature, weather, inorganics, carbon, bacterial, fish, chlorophyll		10	continuously, weekly, seasonally	1973	VA Tech
Water Quality-Point Source	Opequon Creek Targeted Watershed Grant	Virginia Polytechnic Institute and State University	nutrients, temp, DO, turbidity, Conductivity, pH	Opequon Creek watershed	45	bi-weekly	2006	National Fish and Wildlife Foundation grant
Water Quality	Pennsylvania Water Quality Network	Pennsylvania Department of Environmental Protection	Temp, DO, series of metals, nutrients, bacteria, Secchi, Specific Conduct, Salinity and pH, flow, and others	PA 103 Standard stations. 24 Bay loading stations. 25 Reference stations	152	Standard stations 6X/yr. Bay loading and Reference stations 12X/yr	1975	PA DEP
Water Quality-Power Plant	Susquehanna Steam Electric Station Monitoring Program	Pennsylvania Power and Light Company	water level, flow, temp, DO, Specific Conduct., pH, alkalinity, nutrients, metals, others	Susquehanna River Basin	2	varies (continuously, bimonthly, etc.)	1971	PPL Corporation
Water Quality	Susuahana River Basin Commision Nutrient Monitoring Program	Susquehanna River Basin Commission	Temperature, Dissolved oxygen, Conductivity,pH, Alkalinity, Nitrogen, Nitrite,Nitrate, Phosphorus,Orthophosphate, TOC, Hardness, Magnesium, Calcium, TSS, Sodium, Chloride, Sulfate, Iron, Manganese, Aluminum, Turbidity	Susquehanna River Basin	23	Varies by year a	1984	Susquehanna River Basin Commission
Water Quality	Swift Creek Reservoir Monitoring Program	Chesterfield County Virginia-Department of Utilities	Air temperature, conductivity, DO, flow, metals, Nitrogen, pH, Phosphorus, secchi, TSS/TDS, turbidity, water temperature, weather, inorganics, carbon, macroinvertebrates, bacterial, chlorophyll, algae		19	weekly, monthly, seasonally, annually	1993	Chesterfield County
Water Quality	United States Geological Survey-Fairfax County Monitoring Network	United States Geological Survey Geological Survey and Fairfax County Stormwater Planning Division	Nutrient concentrations, suspended-sediment concentrations, basic physical and chemical parameters, streamflow, benthic macroinvertebrates	Fairfax County, VA	14	Monthly and storm event water-quality sampling, periodic streamflow measurement, continuous water-quality parameters (water temp, SC,pH,turbidity), continuous streamgage. All are year round.	2007	Fairfax County and USGS Coop
Water Quality	United States Geological Survey-National Hydrolic Bench Mark Program	United States Geological Survey Geological Survey	Flow, Air temp, Water temp.Discharge, Spec.cond. pH, Calcium, Magnesium, Sodium, Potassium, Ammonium, Alkalinity, Sulfate, Chloride, Nitrite plus nitrate, Silica	Young Woman's Creek (PA), Holiday Creek, (VA)	2	Quarterly	1960	USGS

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Water Quality	United States Geological Survey-National Stream Quality Accounting Networks	United States Geological Survey Geological Survey	Temperature, Specific conductance, Dissolved oxygen, pH, Alkalinity, Calcium, Magnesium, Sodium, Potassium, Chloride, Sulfate, Fluoride, Silica, Arsenic, Boron, Iron, Strontium, Vanadium, Lithium, Selenium, ammonia, nitrite, Total Dissolved Nitrogen, Tot	PA, MD, DC, VA, WV	2	daily stream flow, bi-weekly monitoring	1974	USGS
Water Quality	United States Geological Survey-Streamflow Gaging Station Network	United States Geological Survey Geological Survey	Flow, gage height, others depending on station	Entire Chesapeake Bay Watershed	360	Continuous flow	1970	USGS
Water Quality	Virginia Institute of Marine Sciences Chesapeake Bay Initiative: Open and Deep Water Monitoring Program	Virginia Institute of Marine Sciences	Temperature, Salinity, Dissolved Oxygen, Chlorophyll-a, Turbidity	YRKPH, YRKMH		ACROBAT: twice monthly in 2007; monthly in 2008; Profiler: hourly profiles from June 1 - Sept 30 each year	2007	Virginia Department of Environmental Quality
Water Quality	Virginia Ambient WQ Monitoring Program	Virginia Department of Environmental Quality	Temp, DO, series of metals, nutrients, bacteria, Secchi, Specific Conduct, Salinity and pH, pesticides and others	non-tidal and tidal portions of VA	508	Monthly	1968	VADEQ, EPA
Water Quality	Virginia Chesapeake Bay Water Quality Monitoring Program: Mainstem and Tidal Tributary chemical/physical components	Virginia Department of Environmental Quality and Old Dominion Univeristy	Temp, DO, Spec Conductivity, Salinity, pH, Secchi depth, TKN, Nitrite, Nitrate+Nitrite, Ammonium, Total P, TDP, Particulate Phosphorus, Dissolved Inorganic Phosphorus, Total Organic Carbon, Dissolved Silica, Chlorophyll a, Phaeophytin	Tidal reaches of major Virginia Western shore tributaries Bay	83	20X /year	1985	USEPA Chesapeake Bay program,VADEQ
Water Quality	Virginia Eastern Shore Tributary Strategy Program	Virginia Institute of Marine Sciences	DO, SALINITY, TEMPERATURE, PAR, pH, NH3, NO2, NO3, OP, TDN, TDP, TSS, DON, DOP, AND CHLOROPHYLL.		12	Weekly	2001	
Water Quality	Virginia Lake Monitoring Program	Virginia Department of Environmental Quality	Various: field, nutrient, hardness, sediment, metals, pesticides, algae	VA	81	1-2 times/season	1974	VADEQ, EPA
Water Quality	Virginia Probabilistic Monitoring Program	Virginia Department of Environmental Quality	Dissolved oxygen, pH, temperature, dissolved metals, sediment metals, organic compounds, bacteria, benthic macroinvertebrates	Statewide	40	Sampled once		
Ground Water	Virginia Irrigation Water Quality Assessment	Virginia Tech	Chloride, conductivity, Nitrogen, pH, Phosphorus, salinity, TSS/TDS			Annually	1999	VA Tech
Water Quality	Mill Creek Maryland -Water Qualtiy Montioring Program	University of Maryland-Chesapeake Bay Biological Laboratory	Depth,Temp, Cond, Sal, DO, Chl, weather	Mill Creek, St. John's Creek, Back Creek, The Narrows	10	Once in May, twice in June, July and August, once in September	1987	Calvert County with assistance from UMCES-CBL

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Water Quality	West Virginia Water Quality Monitoring Program-Agricultural Monitoring	West Virginia Department of Agriculture	Temperature, pH, Conductivity, Dissolved Oxygen, Nitrate, Nitrite, Ammonia, Total Phosphorous, Ortho-Phosphate, Turbidity, Total Suspended Solids, Fecal Coliform	Eastern Panhandle of West Virginia including Pendleton, Grant, Hardy, Mineral, Hampshire, Morgan, Jefferson and Berkeley Counties	154	Once per month - minimum	1998	State of West Virginia
Water Quality	West Virginia Watershed Assessment Program - Ambient Water Quality Monitoring	West Virginia Department of Environmental Protection-Division of Water and Waste Management	Field parameters (DO, pH, temp, and Sp. cond.) Nutrients, basic canions/ cations, metals	statewide at largest rivers / streams (most sites at USGS stream gage)	4	bi-monthly	1960	State funded / EPA 106 Grant
Water Quality	West Virginia Watershed Assessment Program - Long-Term Monitoring Sites	West Virginia Department of Environmental Protection-Division of Water and Waste Management	Field parameters (DO, pH, temp, and Sp. cond.) Nutrients, basic canions/ cations, metals	Statewide	13	annually	2007	State funded
Water Quality	West Virginia Watershed Assessment Program - Pre-TMDL Monitoring	West Virginia Department of Environmental Protection-Division of Water and Waste Management	dependent on known or perceived stressors	Statewide - One or 2 8-digit HUC per year	200	monthly for a year prior to TMDL development	2001	State funded
Water Quality	West Virginia Watershed Assessment Program - Probabilistic Monitoring	West Virginia Department of Environmental Protection-Division of Water and Waste Management	Field parameters (DO, pH, temp, and Sp. cond.) Nutrients, basic canions/ cations, metals	statewide - stratified by Level 3 ecoregion (Omernik)	26	once (with half of sites revisited in subsequent survey round)	1997	State funded
Water Quality	West Virginia Watershed Assessment Program - Targeted Monitoring	West Virginia Department of Environmental Protection-Division of Water and Waste Management	Fecal coliform plus other parameters dependent on known or percieved stressors	Statewide - Five or six 8-digit HUC per year (5-yr cycle)	100	once	1996	State funded
Ground Water	Virginia Karst Spring Monitoring	United States Geological Survey Geological Survey	Dissolved oxygen, carbon dioxide, alkalinity, hardness, nutrients, pH, conductivity, temperature, turbidity, E. coli	western Virginia Karst areas	30	quarterly	2009	grants
Water Quality	Alliance for Chesapeake Bay Citizen Monitoring Program	Alliance for the Chesapeake Bay	Air temperature, DO, pH, phosphorus, secchi, tide, TSS/TDS, water temperature, weather, aquatic vegitation, macroinvertebrates, bacterial, wildlife, chlorophyll			weekly, seasonally	1985	Private Non-profit
Water Quality	Assateague Coastal Trust Water Monitoring	Assateague Coastal Trust	Air temperature, nitrogen, pH, phosphorus, salinity, secchi, tide, water temperature, weather			annually	2001	Private Non-profit
Water Quality	Audubon Naturalist Society Water Quality Program	Audubon Naturalist Society	Air temperature, flow, pH, turbidity, water temperatue, weather, macroinvertebrates		13	seasonally, annually	1997	Private Non-profit
Water Quality	Cat Point Creek Virginia Project	Tidewater Resource Conservation & Development	Air temperature, DO, pH, salinity, secchi, tide, turbidity, water temperature		4	monthly	1995	Federal

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Water Quality	Chesapeake Beach Civic League-Citizen Volunteer Monitoring	Chesapeake Beach Virginia-Civic League	pH, temperature, nutrients	Pleasure House, Chubb, Joyce, and Bradford Lakes	16	monthly	2008	
Water Quality	Chester River Keeper Monitoring	Chester River Association	dissolved oxygen, pH, temperature, water clarity, nutrients	Chester River, MD	16	bi-monhly	1993	Chester River Association & corporate sponsors
Water Quality	Chesterfield County River Trends Program	Friends of Chesterfields Riverfront	Dissolved oxygen, pH, temperature, Bacteria monitoring (E. coli), nutrients, water clarity	Lakes and major tributaries in Chesterfield County	28	Monthly	2004	grants, donations, membership dues
Water Quality	Chesterfield WaterTrends	Chesterfield County Virginia-Department of Environmental Engineering, Water Quality Section & Friends of Chesterfield's Riverfront	Dissolved Oxygen, pH, Temperature, Turbidity, Low Gradient Habitat Assessment	Chesterfield County	26	Creek sites-monthly, Lake sites-monthly Spring-Fall.	1997	Virginia Department of Environmental Quality
Water Quality	Fairfax County Virginia-Volunteer Stream Monitoring Program	Northern Virginia Soil & Water Conservation District	Air temperature, DO, Nitrogen, pH, turbidity, water temperature, weather, macroinvertebrates		45	seasonally	1997	
Water Quality	Fox Mill Run Virginia- Water Quality Monitoring Program	Chesapeake Bay Governor's School	Air temperature, DO, pH, salinity, secchi, water temperature, weather, bacterial		2	monthly	2005	Public school
Water Quality	Friends Of Powhatan Creek Water Quality Monitoring Program	Friends Of Powhatan Creek Watershed Friends Of Powhatan Creek Watershed	Air temperature, DO, Nitrogen, pH, Phosphorus, salinity, turbidity, water temperature, Nitrate, Nitrite, bacterial		7	monthly	2000	Private Non-profit
Water Quality	Friends of Stafford Creeks-Alliance for Chesapeake Bay Citizen Monitoring Program	Friends of Stafford Creeks	DO, pH, turbidity by Secchi depth and total depth or turbidity tube readings, air and water temperature, salinity in tidal waters as well as visual observations.	Tributaries of the Potomac River in Stafford County Virginia	14	Once monthly	2002	Val DEQ and Chesapeake Bay Restoration Fund Match Program
Water Quality	Friends of the Shenandoah River-Ambient Water Quality Monitoring Program	Friends of the Shenandoah River	Dissolved oxygen, pH, temperature, nitrate, phosphate, ammonia, turbidity	Shenandoah River Watershed	288	monthly	1997	grants, donations, membership dues
Water Quality	Goose Creek Association bacterial and chemical monitoring program	Goose Creek Association	E. coli monthly; Benthic macro invertebrate, dissolved oxygen, temperature, and pH quarterly in March, June, September & December	Goose Creek & its tribuitaries in Fauquier & Loudoun Counties	22	monthly	2003	DEQ
Water Quality	Lake Anna Civics Association Monitoring Program	Lake Anna Civics Association	Air temperature, conductivity, DO, Nitrogen, pH, Phosphorus, turbidity, water temperature		28	monthly	2000	grants, donations, membership dues
Water Quality	Leesville Lake Associaton-Water quality Monitoring	Leesville Lake Association	Temp, dissolved oxygen, pH, Bacteria monitoring (E. coli), Secchi depth	Leesville Lake	8	monthly for temp, DO & pH; E. coli & Secchi depth biweekly and after major rain events from May to Sept.	2007	VADEQ and Leesville Lake Association

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Water Quality	Loudoun Stream Quality Project	Loudoun Wildlife Conservancy	Air temperature, DO, Nitrogen, pH, Phosphorus, turbidity, water temperature, weather, macro invertebrates, bacterial, habitat	Loudoun County	42	Quarterly to monthly depending on parameter	1996	grants, donations, membership dues
Water Quality	Magothy River Volunteer Monitoring Program	Magothy River Association	Secchi depth, surface salinity & temperature (all sites); some sites add DO, pH, and bottom samples for all but Secchi depth, and some sites have depth profiles. In the past, surface nutrients, TSS, and CHLA at some sites.	Most of lower tidal river; fewer on north shore-number of sites varies by year	28	From weekly to once a month (varies by site)	1991	CBT (primary)
Water Quality	Maury River Alliance Citizens Monitoring Program	Washington & Lee University	Chloride, conductivity, DO, metals, Nitrogen, pH, Phosphorus, TSS/TDS, water temperature, bacterial		27	monthly	2000	Community/ Washington & Lee University
Water Quality	Mountain Run Headwaters	People Protecting Watershed Headwaters	Air temperature, DO, Nitrogen, organics, pH, Phosphorus, secchi, turbidity, water temperature, macroinvertebrates			annually	2002	Private Non-profit
Water Quality	Dividing Creek Association-Citizen Volunteer Water Quality Monitoring Program	Dividing Creek Association	Date, Time of Day, Air and Water Temperature, Tidal Activity, Previous 24 hour Rainfall, Wind and Wave Action, Visible Physical Water Properties, Dissolved Oxygen (Digital and Winkler), pH (Digital and Chemical Wide Range Octet Comparison), Turbidity (Sec	The entire Dividing, Prentice and Jarvis Creek Tidal Estuary including their Coves and Tributaries as well as the waters at the mouth of these Estuaries as they enter the Chesapeake Bay	30	Monitoring occurs monthly from April through December	2006	Virginia Department of Environmental Quality Mini Grant Program and dues paid by The Membership of the Dividing Creek Association
Water Quality	Patuxent River Keeper Monitoring	Patuxent River Keeper		Patuxent River, MD				Patuxent River Association
Water Quality	Pennsylvania Allicance for Aquatic Resource Monitoring Program	Alliance for Aquatic Resource Monitoring at Dickinson College	PA					
Water Quality	Poquoson River Citizen Monitoring	York County Virginia Waterways Alliance	Cyanide,Total Organic Carbon,Particulate Carbon,Dissolved Organic Carbon,Total Suspended Solids,Ammonia,Total Kjeldahl Nitrogen, Nitrite+Nitrate,Total Dissolved Nitrogen,Particulate Nitrogen,Total Phosphorus,Total Dissolved Phosphorus,Particulate Phosphor	Poquoson River and tributaries	4	Twice monthly May - September	2008	Volunteers
Water Quality	City of Portsmouth Virginia - Citizen's Water Quality Monitoring Program	Hoffler Creek Wildlife Foundation	DO, Nitrogen, pH, Phosphorus, turbidity, water temperature		8	monthly	1999	Private

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Water Quality	Reston Association Stream Monitoring	Reston Association	Air temperature, flow, Nitrogen, turbidity, water temperature, weather, macroinvertebrates		10	annually	1999	Reston Association
Water Quality	Sassafras River Keeper monitoring	Sassafras River Keeper	Nitrate, Ammonium, Phosphate, Copper,Turbidity,air temp, salinity,Dissolved Oxygen	Sassafras River, DE & MD	23	April-October-at least 3X per year	2006	Sassafras River Association
Water Quality	Severn River Keeper monitoring	Severn Riverkeeper Monitoring Project	DO, salinity, temperature profiles plus Secchi depth	15 Stations throughout tidal Severn & creeks	15	Approx biweekly May-Sept	2006	Severn Riverkeeper
Water Quality	Smith Creek Virginia- Citizens Monitoring Program	Friends Of The North Fork Shenandoah River	BOD, chloride, DO, Nitrogen, pH, Phosphorus, coliforms and virus		10	monthly	2001	
Water Quality	Smith Mountain Lake Water Quality Monitoring Program	Smith Mountain Lake Association	Phosphorus, secchi, Nitrates, chlorophyll, bacterial		104	annually	1986	Smith Mountain Lake Association
Water Quality	South River Keeper monitoring	South River Federation	temperature, pH, dissolved oxygen by depth, salinity, water clarity, and nitrate	South River, MD	16	Weekly May-September	2006	South River Federation
Water Quality	Stafford Creeks Water Quality Monitoring Project		Air temperature, DO, pH, salinity, secchi, turbidity, water temperature		9	monthly	2003	Community
Water Quality	Talbot County Creekwatchers	Talbot County Creekwatchers	Dissolved Oxygen, Water Clarity, pH, Nitrogen (Before 2004 dissolved nitrogen - 2004 and after total nitrogen), Phosphorus (Before 2004 dissolved phosphorus - 2004 and after total phosphorus)	Talbert County Maryland-Broad Creek, Harris Creek, Island Creek, Miles River, Tred Avon River, Choptank River (Denton to Frazier Point), Wye River, LaTrappe Creek	65	twice monthly March-November	2001	Chesapeake Bay Foundation, the Chesapeake Bay Maritime Museum and Talbot River Protection Association
Water Quality	The GRAHEC Water Quality Monitoring Project	Greater Richmond Area Higher Education Consortium	Air temperature, DO, Nitrogen, pH, Phosphorus, turbidity, water temperature, bacterial			annually	1998	Private Non-profit
Water Quality	Upper Rappahannock Watershed Stream Monitoring Program	Rappahannock Conservation Council	Air temperature, DO, Nitrogen, pH, Phosphorus, TSS/TDS, water temperature, fecal coliforms, Nitrates, Nitrites, macroinvertebrates		43	seasonally	2001	Volunteer network
Water Quality	West and Rhode River Keeper monitoring	West/Rhode River Keeper	Weather, Total Depth, Color of Water, Secchi, Water Temp ,Dissolved Oxygen, DO Saturation, Conductivity	West and Rhode Rivers, MD	29	Weekly Year round	2007	West/Rhode River Association
Water Quality	Wicomico Creekwatchers	Wicomoco Creekwatchers	Dissolved Oxygen, Water Clarity, pH, total Nitrogen, nitrate,nitrite , total Phosphorus, PO4.weather, ari temp, chlorophyll	Wilcomoco River	24	twice monthly March-November	2002	Chesapeake Bay Foundation, the Chesapeake Bay Maritime Museum and Talbot River Protection Association

Program Area	Monitoring program	Collecting organization	Metrics sampled	Spatial coverage	SITES	Frequency	Year	Funding source
Wildlife	Bog Turtle Monitoring in Maryland	United States Fish and Wildlife Service and Maryland Department of Natural Resources	Populations	Chesapeake Bay watershed			2000	MD-DNR & USFWS
Wildlife	Tiger Beetle Monitoring	United States Fish and Wildlife Service	Populations	Chesapeake Bay watershed				
Zooplankton	District of Columbia Zooplankton Monitoring Program	District of Columbia-Department of the Environment	Micro and Mesozooplankton Identification to lowest possible taxa (genus or species) with Abundance	3 stations in the District of Columbia		monthly mesozooplankton, microzooplankton started 1993	1983	EPA Region 3
Zooplankton	Fairfax County-Gunston Cove Ecosystem Monitoring Program	George Mason University	Icthyoplankton and Mesozooplankton Identification to lowest possible taxa (genus or species) with Abundance	5 Stations in Gunston cove		biweekly	1984	Fairfax County, Virginia
Zooplankton	Reston Association-Lakes Monitoring	Reston Association	Conductivity, DO, pH, Phosphorus, secchi, water temperature, weather, chlorophyll, phytoplankton, zooplankton			monthly	1982	Reston Association
Benthic	Delaware Water Quality Monitoring Network	Delaware Department of Natural Resources and Environmental Control-Division of Water Resources	Total Phosphorus, Soluble Ortho-phosphorus, Ammonia Nitrogen , Nitrite+Nitrate , Total N, Total Organic Carbon, Dissolved Organic Carbon, Chlorophyll-a , BOD5, BOD20, Dissolved oxygen , Total Suspended Solids, Alkalinity, Hardness, pH, Conductivity, Sali	DE-number of sites varies by year		Monthly	1970	Delaware Department of Natural Resources and Environmental Control
Water Quality-Drinking Water	Patuxent Reservoirs WQ Monitoring Program	Washington Suburban Sanitary Commission	Temp, DO, Spec cond., pH , TDS, ORP, Alkalinity, Ammonia, TKN, Nitrate+Nitrite, Total P, Soluble ortho P, Chlorophyll a, Fecal Coliform, Iron, Manganese, TOC, Turbidity	Triadelphia and Rocky Gorge Reservoirs, Upper Patuxent River	6	Monthly	1993	Washington Suburban Sanitary Commission
Fisheries	National Oceanic and Atmospheric Administration-National Fisheries Service Commercial Fisheries Landing Surveys	National Oceanic and Atmospheric Administration-Fisheries Service	Commercial fisheries landing by species, weight and monetary value	Nation Wide		monthy	1880	NOAA

Appendix B- Chesapeake Action Plan Monitoring Needs Gap Analyses

Table B1. Gap Analysis of Federal and Federal Partner Monitoring Programs to Meet CAP Water Quality-Monitoring Data Needs. Note that category Partner models includes all water quality, fisheries and ecosystem models from all participating bay program agencies. Programs meeting trends needs have a minimum of ten years of continuous data.

Monitoring Program	Nutrient & Sediment Concentrations					Toxics Concentrations			Restoration Targeting		Restoration Effectiveness		Air Emissions	Communication Product	303(d) or TMDL	Status	Trends	Partner Models
	Point	AG	Septic	Shoreline	Urban	Point	AG	Urban	Shoreline	AMD	Shoreline	AMD						
Federal																		
Baltimore Ecosystem Study	X			X	X	X		X	X		X					X		
Cat Point Creek Virginia Project			X	X	X				X		X					X	X	
Delaware Air Quality Monitoring Program													X			X	X	X
Delaware National Oceanic And Atmospheric Administration-National Weather Service Climatological Data Network													X			X	X	X
District Of Columbia Air Quality Monitoring Program													X			X	X	X
District Of Columbia Aquatic Macro Invertebrate Monitoring Program	X				X				X		X							
District Of Columbia-Point Source Compliance Monitoring Program	X					X			X		X				X	X	X	X
Maryland Ambient Air Monitoring Program													X			X	X	X
Maryland Chesapeake Bay Water Quality Monitoring Program: Long-Term Tidal Tributary Chemical/Physical Component				X					X		X			X	X	X	X	X
Maryland Chesapeake Bay Water Quality Monitoring Program: Mainstem Chemical/Physical Components				X					X		X			X	X	X	X	X
Maryland Chesapeake Bay Water Quality Monitoring Program: River Input Chemical/Physical Component	X			X					X	X	X			X	X	X	X	X
Maryland National Oceanic And Atmospheric Administration-National Weather Service Climatological Data Network													X			X	X	X
National Aeronautics And Space Administration- Seawifs Mission	X			X					X		X					X	X	
National Aeronautics And Space Administration-Earth Observing System-AM & PM Missions	X			X					X		X					X		
National Atmospheric Deposition Program-National Trends Network													X			X	X	X
National Estuarine Research Reserve System-Monitoring Program				X					X		X					X	X	
National Oceanic And Atmospheric Administration- National Weather Service Solar Radiation Network													X			X	X	X
National Oceanic And Atmospheric Administration-Coastal Change Analysis Program	X	X		X	X				X		X					X	X	X
National Oceanic And Atmospheric Administration-National Water Level Observation Network				X					X		X					X	X	X
National Park Service- Fredericksburg And Spotsylvania National Military Parks-Water Quality Monitoring				X					X		X					X		
National Park Service- National Capital Region Network-Water Quality Monitoring	X			X					X		X					X		
National Park Service- Richmond Area National Parks-Water Quality Monitoring	X			X					X		X					X		
National Park Service- Shenandoah National Park-Water Quality Monitoring	X			X					X		X					X		
National Park Service-Ground Water Internal Compliance Monitoring	X		X	X												X		

Monitoring Program	Nutrient & Sediment Concentrations					Toxics Concentrations			Restoration Targeting		Restoration Effectiveness		Air Emissions	Communication Product	303(d) or TMDL	Status	Trends	Partner Models
	Point	AG	Septic	Shoreline	Urban	Point	AG	Urban	Shoreline	AMD	Shoreline	AMD						
National Weather Service-Airport Weather Monitoring Network													X			X	X	X
New York Ambient Air Quality Monitoring													X			X	X	X
New York National Oceanic And Atmospheric Administration-National Weather Service Climatological Data Network													X			X	X	X
Pennsylvania Air Quality Monitoring Program													X			X	X	X
Pennsylvania National Oceanic And Atmospheric Administration-National Weather Service Climatological Data Network													X			X	X	X
Poplar Island Monitoring Program	X			X		X			X		X					X	X	
United States Environmental Protection Agency-National Study Of Chemical Residue In Lake Fish						X	X	X							X	X	X	
United States Forestry Service-Water Quality Monitoring Program				X					X		X					X		
United States Geological Survey-Fairfax County Monitoring Network	X			X	X				X		X					X		
United States Geological Survey-Land Cover Change Monitoring	X	X		X	X				X		X					X	X	X
United States Geological Survey-National Hydraulic Bench Mark Program	X	X	X	X	X				X		X					X	X	X
United States Geological Survey-National Stream Quality Accounting Networks	X			X					X		X					X	X	X
United States Geological Survey-Stream Flow Gauging Station Network	X	X	X	X	X				X		X			X		X	X	X
Virginia Air Quality Monitoring Program													X			X	X	X
Virginia Chesapeake Bay Water Quality Monitoring Program: Mainstem And Tidal Tributary Chemical/Physical Components				X					X		X			X	X	X	X	X
Virginia National Oceanic And Atmospheric Administration-National Weather Service Climatological Data Network													X			X	X	X
West Virginia National Oceanic And Atmospheric Administration- National Weather Service Climatological Data Network													X			X	X	X
Combined State & Federal																		
Chesapeake Bay Program Non-Tidal Water Quality Network	X	X	X	X														
District Of Columbia Water Quality Monitoring Program	X			X	X				X		X			X	X	X	X	X
Friends Of Stafford Creeks-Alliance For Chesapeake Bay Citizen Monitoring Program				X	X				X		X				X	X		
Maryland Non-Tidal Tributary Water Quality Monitoring Program-Core Trend Program	X	X	X	X					X		X			X	X	X	X	X
Susquehanna River Basin Commission Interstate Macro Invertebrate Monitoring Program				X					X		X			X	X	X	X	
Susquehanna River Basin Commission Nutrient Monitoring Program	X	X	X	X					X		X			X	X	X	X	X
University Of Maryland's Regional Earth Science Applications Center-Impervious Surface Monitoring	X	X	X	X	X				X		X			X		X	X	X
University Of Maryland's Regional Earth Science Applications Center-Land Use Change Monitoring	X	X	X	X	X				X		X			X		X	X	X
Virginia Ambient Wq Monitoring Program	X	X	X	X					X		X				X	X	X	
Virginia Lake Monitoring Program	X			X					X		X				X	X	X	

Table B2. Gap Analysis of State Monitoring Programs to Meet CAP Water Quality Monitoring Data Needs. Note that category Partner models includes all water quality, fisheries and ecosystem models from all participating bay program agencies. Programs meeting trends needs have a minimum of ten years of continuous data.

Monitoring Program	Nutrient & Sediment Loads					Toxics Loads			Restoration Targeting		Restoration Effectiveness		Air Emmissions	Communication Product	303(d) or TMDL	Status	Trends	Partner Models
	Point	AG	Septic	Shoreline	Urban	Point	AG	Urban	Shoreline	AMD	Shoreline	AMD						
State																		
Appomattox River Virginia Water Quality Monitoring Program		X	X	X			X		X		X					X	X	
City Of Purcellville Virginia-Water Monitoring System	X				X			X								X	X	
Delaware Water Quality Monitoring Network	X	X	X	X	X				X		X				X	X	X	X
Delaware Point Source Compliance Monitoring Program	X					X										X	X	X
Goose Creek Association Bacterial And Chemical Monitoring Program	X	X	X	X					X		X				X	X		
Interactive Stream Assessment Resource (Instar)	X	X	X	X					X		X				X	X	X	
James River Monitoring Of Fish Tissue For Kepone						X	X	X								X	X	
Maryland Biological Stream Survey	X	X	X	X					X		X			X	X	X	X	X
Maryland Chesapeake Bay Water Quality Monitoring Program Benthic Component				X					X		X			X	X	X	X	X
Maryland Chesapeake Bay Water Quality Monitoring Program Phytoplankton Component				X					X		X			X	X	X	X	
Maryland Acid Precipitation Monitoring Program						X	X	X					X			X	X	
Maryland Chesapeake Bay Sediment Toxicant Monitoring Program						X	X	X								X	X	
Maryland Industrial-Point Source Compliance Monitoring Program	X					X										X	X	X
Maryland Municipal-Point Source Compliance Monitoring Program	X					X										X	X	X
Maryland Non-Tidal Benthic Macro Invertebrate Monitoring Program				X					X		X			X	X	X	X	
Maryland Npdes Enforcement Program		X	X	X	X		X	X	X		X				X	X	X	
Maryland Point Source Sampling Program	X				X	X		X								X	X	
Maryland Shellfish Sanitation Monitoring Program	X		X						X		X					X	X	
New York State Stream Bio-Monitoring Program	X			X					X		X			X	X	X	X	
New York State Water Quality Assessment Program	X	X	X	X					X		X			X	X	X	X	X
New York-Point Source Compliance Monitoring Program	X					X			X		X					X	X	
Pennsylvania Atmospheric Deposition Monitoring Program													X			X	X	
Pennsylvania Benthic Macro Invertebrate Survey				X					X		X			X	X	X	X	
Pennsylvania Point Source Compliance Monitoring Program	X					X										X	X	
Pennsylvania Recreational Use Survey	X	X	X						X		X				X	X	X	
Pennsylvania Water Quality Network	X	X	X	X	X				X		X			X	X	X	X	X
Virginia Acid Precipitation Network									X		X		X			X	X	
Virginia Estuarine Probabilistic Monitoring In Minor Chesapeake Bay And Coastal Tidal Tributaries				X					X		X					X		
Virginia Benthic Monitoring Program		X	X	X					X		X			X	X	X	X	

Monitoring Program	Nutrient & Sediment Loads					Toxics Loads			Restoration Targeting		Restoration Effectiveness		Air Emmissions	Communication Product	303(d) or TMDL	Status	Trends	Partner Models
	Point	AG	Septic	Shoreline	Urban	Point	AG	Urban	Shoreline	AMD	Shoreline	AMD						
Virginia Chesapeake Bay Benthic Monitoring Program				X					X		X			X	X	X	X	
Virginia Department Of Health Beach Monitoring Program	X						X	X	X		X					X	X	
Virginia Department Of Environmental Quality Kepone Ground Water Contaminants Monitoring Program						X	X	X								X	X	
Virginia Department Of Environmental Quality-Chesapeake Bay Mainstem Sediment Monitoring Program						X	X	X								X	X	
Virginia Department Of Environmental Quality-Fish Tissue And Sediment Containment Monitoring						X	X	X								X	X	
Virginia Department Of Environmental Quality-Kepone Sediment Monitoring Program						X	X	X								X	X	
Virginia Department Of Environmental Quality-Tidal Bay And Tributaries Fish Tissue Monitoring						X	X	X								X	X	
Virginia Headwaters Soil And Water Conservation District-Ambient Water Quality Monitoring	X	X	X	X					X		X					X	X	
Virginia Shellfish Bacteriological Monitoring Program	X		X	X					X		X					X	X	
Virginia Tidal Freshwater Toxics Monitoring						X	X	X								X	X	
Virginia Irrigation Water Quality Assessment		X					X									X	X	
Virginia-Point Source Compliance Monitoring Program	X					X			X		X					X	X	
West Virginia Air Quality Monitoring Program													X			X	X	X
West Virginia Water Quality Monitoring Program-Agricultural Monitoring	X	X					X		X		X				X	X	X	
West Virginia Watershed Assessment Program - Ambient Water Quality Monitoring	X	X	X	X					X	X	X	X		X	X	X	X	
West Virginia Watershed Assessment Program - Long-Term Monitoring Sites	X	X	X	X					X	X	X	X		X	X	X	X	
West Virginia Watershed Assessment Program - Pre-Tmdl Monitoring	X	X	X	X					X	X	X	X		X	X	X	X	
West Virginia Watershed Assessment Program - Probabilistic Monitoring	X	X	X	X					X	X	X	X		X	X	X	X	
West Virginia Watershed Assessment Program - Targeted Monitoring	X	X	X	X					X	X	X	X		X	X	X	X	
West Virginia Watershed Assessment Program -Benthic Monitoring				X					X	X	X	X		X	X	X	X	
West Virginia-Point Source Compliance Monitoring Program	X					x				X		X			X	X	X	

Table B3. Gap Analysis of Local Government Monitoring Programs to Meet CAP Water Quality Monitoring Data Needs. Note that category Partner models includes all water quality, fisheries and ecosystem models from all participating bay program agencies. Programs meeting trends needs have a minimum of ten years of continuous data.

Monitoring Program	Nutrient & Sediment Loads					Toxics Loads			Restoration Targeting		Restoration Effectiveness		Air Emissions	Communication Product	303(d) or TMDL	Status	Trends	Partner Models
	Point	AG	Septic	Shoreline	Urban	Point	AG	Urban	Shoreline	AMD	Shoreline	AMD						
Local																		
Albermale County Virginia- Groundwater Assessment Program	X	X	X													X	X	
Amherst Virginia Waste Water Treatment Plant Monitoring	X															X	X	
Anne Arundel County Maryland Recreational Waters Program	X		X	X					X		X					X	X	
Anne Arundel County Maryland Shellfish Waters Program	X		X	X					X		X					X	X	
Arlington County Department Of Environmental Services Stream Monitoring Program	X			X	X				X		X				X	X	X	
Arlington County Virginia- Citizen Stream Monitoring Program	X			X	X				X		X				X	X	X	
Arlington County Virginia Storm Water Permit Monitoring Program	X				X			X								X	X	
Baltimore County Chemical Monitoring Program	X				X			X								X	X	
Baltimore County-Illicit Connections Program	X				X	X		X								X	X	
Broad Run Water Quality Monitoring Program	X			X					X		X				X	X	X	
Chesterfield County Watershed Assessment And Stream Protection Program	X	X	X	X					X		X				X	X		
City Of Baltimore Maryland-Drinking Water Supply Reservoir Water Quality Monitoring	X				X			X								X		
City Of Baltimore Maryland-Stream And Harbor Water Quality Monitoring Associated With NPDES Discharge Permit For Storm Water	X				X	X		X								X	X	
City Of Bristol Virginia- Groundwater Monitoring Program	X				X			X								X	X	
City Of Newport News Virginia-Ambient Water Quality Monitoring Program	X			X	X										X	X	X	
City Of Norfolk Virginia-Reservoir Monitoring Program	X				X			X								X		
City Of Portsmith Virginia-Storm Water Monitoring Program	X			X	X			X								X		
City Of Portsmouth Virginia -Citizen's Water Quality Monitoring Program				X	X				X		X				X	X	X	
Coordinated Anacostia Monitoring Program	X			X	X			X	X		X				X	X	X	
Dan River Virginia- In Stream Monitoring Program	X	X	X	X					X		X				X	X	X	
Fairfax County Virginia-Volunteer Stream Monitoring Program			X	X	X				X		X				X	X	X	
Fairfax County-Gunston Cove Ecosystem Monitoring Program	X			X				X	X		X				X	X	X	
Fox Mill Run Virginia- Water Quality Monitoring Program	X	X	X	X					X		X				X	X		
Montgomery County Water Quality Monitoring Program				X	X				X		X				X	X	X	
Mountain Run Headwaters		X	X	X					X		X				X	X		
Page County Virginia -Ambient Water Quality Monitoring Program	X	X	X	X					X		X				X	X		
Potomac Fall Line Monitoring At Chain Bridge	X																	
Rappahannock River Tributary Macro Invertebrate Study		X	X	X					X		X				X	X		
Rivanna Water And Sewer Authority Source Water Protection Monitoring			X	X	X				X		X				X	X		
Streamwatch		X	X	X					X		X				X	X	X	

Monitoring Program	Nutrient & Sediment Loads					Toxics Loads			Restoration Targeting		Restoration Effectiveness		Air Emissions	Communication Product	303(d) or TMDL	Status	Trends	Partner Models
	Point	AG	Septic	Shoreline	Urban	Point	AG	Urban	Shoreline	AMD	Shoreline	AMD						
Swift Creek Reservoir Monitoring Program	X	X	X	X					X		X				X	X	X	
Thumb Run E. Coli Monitoring	X						X		X		X				X	X		
Virginia Save Our Streams Program		X	X	X			X		X		X				X	X	X	

Table B4. Gap Analysis of NGO Monitoring Programs to Meet CAP Water Quality Monitoring Data Needs. Note that category Partner models includes all water quality, fisheries and ecosystem models from all participating bay program agencies. Programs meeting trends needs have a minimum of ten years of continuous data.

Monitoring Program	Nutrient & Sediment Loads					Toxics Loads			Restoration Targeting		Restoration Effectiveness		Air Emissions	Communication Product	303(d) or TMDL	Status	Trends	Partner Models
	Point	AG	Septic	Shoreline	Urban	Point	AG	Urban	Shoreline	AMD	Shoreline	AMD						
NGO and Other Funding																		
Alliance For Chesapeake Bay Citizen Monitoring Program		X	X	X					X	X	X	X			X	X	X	
Assateague Coastal Trust Water Monitoring			X	X					X		X					X		
Audubon Naturalist Society Water Quality Program		X	X	X	X				X	X	X	X			X	X	X	
Bath County Power Station -Back Creek Stream Improvement Project Benthic Component	X			X					X		X				X	X	X	
Bath County Pumped Storage Station Little Back Creek Stream Survey – Water Quality Component	X			X					X		X				X	X	X	
Bath County Pumped Storage Station Recreation Pond Monitoring Program – Water Quality Component	X			X					X		X				X	X	X	
Brunner Island Steam Electric Station Environmental Monitoring And Surveillance Program – Wq Component	X																	
Buffalo River Virginia-Watershed Monitoring Program		X	X	X					X	X	X	X						
Catoctin Watershed Project	X	X	X	X					X	X	X	X			X	X	X	
Chesapeake Beach Civic League-Citizen Volunteer Monitoring			X	X	X										X	X		
Chesterfield County River Trends Program	X	X	X	X	X				X	X	X	X			X	X		
Chesterfield Watertrends			X		X										X	X	X	
Clinch River And Estonoa Wetland Monitoring			X	X	X				X		X				X	X		
Commonwealth Chesapeake Power Station-Ground Water Monitoring	X																	
Dividing Creek Association-Citizen Volunteer Water Quality Monitoring			X	X					X		X				X	X		
Friends Of Powhatan Creek Water Quality Monitoring Program	X	X	X	X	X				X		X				X	X		
Friends Of The Blacks Run Greenway-Bacteria Volunteer Monitoring Program	X	X	X	X					X		X				X	X		
Friends Of The North Fork Of The Shenandoah River And Friends Of The Shenandoah River Benthic And Bacterial Monitoring Program	X	X	X	X					X		X				X	X	X	
Friends Of The North Fork Of The Shenandoah River -Groundwater Monitoring Program	X	X	X	X												X	X	
Friends Of The Shenandoah River-Ambient Water Quality Monitoring Program	X	X	X	X					X	X	X	X			X	X	X	
Holston Virginia Citizen Water Quality Monitoring Program				X					X		X				X	X		
Ivy Muc- Albemarle County Va	X														X	X	X	
J.R. Horsley Swco Monitors	X	X	X	X	X				X		X				X	X	X	
Lake Anna Civics Association Monitoring Program			X	X	X											X		
Leesville Lake Association-Water Quality Monitoring	X		X	X	X											X		
Little Stony Creek Liming Project				X					X	X	X	X			X	X		
Loudoun Stream Quality Project	X	X	X	X	X				X		X				X	X	X	

Monitoring Program	Nutrient & Sediment Loads					Toxics Loads			Restoration Targeting		Restoration Effectiveness		Air Emissions	Communication Product	303(d) or TMDL	Status	Trends	Partner Models
	Point	AG	Septic	Shoreline	Urban	Point	AG	Urban	Shoreline	AMD	Shoreline	AMD						
Magothy River Volunteer Monitoring Program			X	X	X				X		X					X		
Maury River Alliance Citizens Monitoring Program	X	X	X	X	X										X	X		
Mcclure River Restoration Project Coli Form Monitoring	X	X	X		X										X	X		
Mechumps Creek Virginia- Ambient Watershed Water Quality Monitoring Program	X	X	X	X											X	X		
North Rivanna Virginia-Groundwater Monitoring Program	X															X		
Occoquan Reservoir-Water Quality Monitoring Program	X															X		
Occoquan Watershed Monitoring Program	X	X	X	X	X										X	X	X	
Opequon Creek Targeted Watershed Grant	X														X	X		
Pennsylvania Alliance For Aquatic Resource Monitoring Program			X	X	X											X		
Poquoson River Citizen Monitoring																		
Potomac Appalachian Trail Club Water Quality Monitoring Program		X	X	X					X		X				X	X		
Rappahannock Friends And Lovers Of Our Watershed Monitoring Program		X	X	X					X		X				X	X		
Reston Association Stream Monitoring	X		X	X	X				X		X					X	X	
Rhode River Watershed Environmental Monitoring Program				X					X		X					X		
Rockfish Watershed Study	X	X	X	X											X	X		
Safe Harbor Water Power Corporation-Water Quality Monitoring Program	X																	
Sassafras River Keeper Monitoring		X	X	X					X		X					X		
Severn River Keeper Monitoring	X		X	X	X				X		X					X		
Shenandoah Watershed Study/VTSS	X	X	X	X											X	X	X	
Smith Creek Virginia- Citizens Monitoring Program	X	X	X	X					X		X					X		
Smith Mountain Lake Water Quality Monitoring Program	X	X	X	X												X	X	
Smith River Virginia Study	X	X	X	X					X		X				X	X		
Solid And Hazardous Waste Facility Monitoring	X																	
South Anna Monitoring Project-Ambient Water Quality Monitoring	X	X	X	X					X		X				X	X		
South River Keeper Monitoring	X		X	X					X		X					X		
Stafford Creeks Water Quality Monitoring Project			X	X					X		X				X	X		
Susquehanna Steam Electric Station Monitoring Program	X									X		X				X	X	
Talbot County Creekwatchers		X	X	X												X		
The GRAHEC Water Quality Monitoring Project	X															X	X	
Upper Rappahannock Watershed Stream Monitoring Program		X	X	X					X		X				X	X		
Virginia Institute Of Marine Sciences Enhanced Tributary Monitoring Program				X													X	
West And Rhode River Keeper Monitoring	X																	
West Virginia Save Our Streams Program	X	X	X	X					X	X	X	X			X	X	X	
Wicomico Creekwatchers		X	X	X					X		X					X		

Table B5. Gap Analysis of Federal, State, Local and NGO Agency Monitoring Programs to Meet CAP Fisheries Monitoring Data Needs. Note that category Partner models includes all water quality, fisheries and ecosystem models from all participating bay program agencies. Programs meeting trends needs have a minimum of ten years of continuous data.

Monitoring Program	EBFMP	Fisheries Stock Assessment						Essential Habitat	Fish Food	Fish Health	Communication Product	Criteria or TMDL	Status &/or Trends	Partner Model
		Oyster	Blue Crab	Striped Bass	Alosids	Menhaden	Other							
State and Federal														
Boshers Dam Vertical Slot Fishway Evaluation And Fish Passage Monitoring Program	X				X						X		X	
Chesapeake Bay Multispecies Monitoring And Assessment Program	X		X	X	X	X	X			X			X	X
Chesapeake Bay Submerged Aquatic Vegetation Aerial Survey	X							X			X	X	X	X
District Of Columbia Zooplankton Monitoring Program	X								X					
District Of Columbia: Aquatic Vegetation Monitoring	X							X			X		X	X
Interactive Stream Assessment Resource							X	X					X	
Interjurisdictional Species Stock Assessment For Adult Migratory Fin Fish	X				X		X						X	X
Maryland Adult American Shad Hook And Line Survey	X				X						X		X	X
Maryland Adult Shad And Herring Pound And Fyke Net Survey	X				X						X		X	X
Maryland American Eel Population Study- Silver Eel Survey	X						X						X	X
Maryland American Eel Population Study- Yellow Eel Survey	X						X						X	X
Maryland American Eel Population Study- Young Of Year Survey	X						X						X	X
Maryland Annual Oyster Spat Index And Disease Survey	X	X								X			X	X
Maryland Baywide Winter Crab Study	X		X										X	X
Maryland Blue Crab Monitoring Program	X		X										X	X
Maryland Chesapeake Bay Water Quality Monitoring Program Benthic Component	X								X		X	X	X	X
Maryland Chesapeake Bay Water Quality Monitoring Program Phytoplankton Component	X								X		X		X	
Maryland Chesapeake Bay Water Quality Monitoring Program: Long-Term Tidal Tributary Chemical/Physical Component	X							X			X	X	X	X
Maryland Chesapeake Bay Water Quality Monitoring Program: Mainstem Chemical/Physical Components	X							X			X	X	X	X
Maryland Fisheries Dependant Fyke Net Survey	X						X							X
Maryland Fisheries Dependent Striped Bass Hook And Line Survey							X						X	
Maryland Juvenille Shad And Herring Surveys	X				X						X		X	X

Monitoring Program	EBFMP	Fisheries Stock Assessment						Essential Habitat	Fish Food	Fish Health	Communication Product	Criteria or TMDL	Status &/or Trends	Partner Model
		Oyster	Blue Crab	Striped Bass	Alosids	Menhaden	Other							
Maryland Largemouth Bass Surveys							X						X	
Maryland Oyster Stock Assessment Program	X	X									X		X	X
Maryland Phytoplankton Monitoring Program	X								X	X	X		X	
Maryland Shellfish Sanitation Monitoring Program	X	X					X			X		X	X	X
Maryland Shoal Water Trawl Survey	X		X	X	X	X	X				X		X	X
Maryland Striped Bass Spawning Stock-Gill Net Survey	X			X			X						X	X
Maryland Striped Bass Young Of Year Beach Seine Survey	X		X	X	X	X	X				X		X	X
Maryland Survey Of Freshwater Impoundments							X						X	X
Maryland Upper Bay Trawl Survey	X		X	X	X	X	X						X	X
National Oceanic And Atmospheric Administration-National Fisheries Service Commercial Fisheries Landing Surveys	X	X	X	X	X	X	X				X		X	X
Pennsylvania Juvenile Alosids Survey	X				X						X		X	X
Pennsylvania Smallmouth Bass Survey							X						X	X
Potomac River Shad Monitoring	X				X						X		X	X
United States Environmental Protection Agency-National Study Of Chemical Residue In Lake Fish										X	X		X	
Virginia Adult Anadromous Fish Passage Monitoring Program	X				X		X	X			X		X	X
Virginia American Eel Young Of Year Survey	X						X						X	
Virginia Blue Crab Megalopae Monitoring Program	X		X								X		X	X
Virginia Chesapeake Bay Benthic Monitoring Program	X								X		X	X	X	X
Virginia Chesapeake Bay Water Quality Monitoring Program: Mainstem And Tidal Tributary Chemical/Physical Components	X							X			X	X	X	X
Virginia Juvelille Fish And Blue Crab Survey	X		X	X	X	X	X			X	X		X	X
Virginia Juvenile Alosine Fish Passage Monitoring Program	X				X			X			X		X	X
Virginia Juvenile Blue Crab Survey	X		X								X		X	X
Virginia Nearshore Sav Habitat Monitoring Program	**X**							**X**			**X**		**X**	X
Virginia Oyster Disease Survey	**X**	**X**								**X**	**X**		**X**	X
Virginia Oyster Spat Survey	**X**	**X**									**X**		**X**	X
Virginia Phytoplankton Monitoring Program	**X**								**X**		**X**	**X**	**X**	X
Virginia Shad And Herring Gill Net Survey	**X**				**X**								**X**	X
Virginia Shark Long Line Survey	**X**						**X**				**X**		**X**	
Virginia Shellfish Bacteriological Monitoring Program	**X**	**X**					**X**							

Monitoring Program	EBFMP	Fisheries Stock Assessment						Essential Habitat	Fish Food	Fish Health	Communication Product	Criteria or TMDL	Status &/or Trends	Partner Model
		Oyster	Blue Crab	Striped Bass	Alosids	Menhaden	Other							
Virginia Spring And Fall Oyster Bar Survey	X	X											X	X
Virginia Striped Bass Monitoring And Tagging Survey	X			X									X	X
Virginia Striped Bass Young Of Year Beach Seine Survey	X			X	X	X	X						X	X
West Virginia Watershed Assessment Program-Fish Monitoring							X			X		X	X	
County, Local And NGO														
Alliance For Chesapeake Bay Citizen Monitoring Program				X	X	X	X						X	
Anne Arundel County Maryland Shellfish Waters Program							X			X		X	X	X
Bath County Power Station- Fish Monitoring							X						X	
Citizens Submerged Aquatic Vegetation Hunt Program	X							X					X	
Montgomery County Water Quality Monitoring Program Fish Component							X					X	X	
North Anna Power Station Monitoring Program Fish Component							X						X	
Rhode River Watershed Environmental Monitoring Program			X	X	X	X	X	X			X		X	
Susquehanna Steam Electric Station Monitoring Program					X						X		X	

Table B6. Gap Analysis of Federal, State, Local and NGO Agency Monitoring Programs to Meet CAP Fish Passage Monitoring Data Needs. Note that category Partner models includes all water quality, fisheries and ecosystem models from all participating bay program agencies. Programs meeting trends needs have a minimum of ten years of continuous data.

Monitoring Program	Prioritize Passage opportunities			Assess Passage Effectiveness	Communication Product	Criteria or TMDL	Status	Trends	Partner Models
	James	Susquehanna	Other						
State and Federal									
Boshers Dam Vertical Slot Fish way Evaluation and Fish Passage Monitoring Program			X	X	X		X	X	
Maryland Adult American Shad Hook and Line Survey		X			X			X	X
Maryland Adult Shad and Herring Pound and Fyke Net Survey			X		X		X	X	X
Maryland American eel population study- Silver eel survey		X	X	X	X		X		X
Maryland American eel population study- Yellow eel survey		X	X	X			X	X	X
Maryland American eel population study- Young of Year survey		X	X	X			X		X
Maryland Biological Stream Survey Fish Component		X	X	X		X	X	X	
Maryland Juvenile Shad and Herring Surveys			X		X		X		X
Maryland Survey of Coldwater Streams			X			X	X	X	
Maryland Survey of Freshwater Impoundments			X			X	X	X	
Maryland Warm Water Rivers Survey			X			X	X	X	
Pennsylvania Juvenile Alosids Survey		X	X	X	X		X	X	X
Susquehanna Steam Electric Station Monitoring Program		X		X	X		X	X	X
Virginia Adult Anadromous Fish Passage Monitoring Program	X		X	X	X		X		X
Virginia Juvenile Alosine Fish Passage Monitoring Program	X		X	X	X		X	X	X
West Virginia Watershed Assessment Program-Fish Monitoring			X	X		X	X	X	
County, Local and NGO									
Buffalo River Virginia-Watershed Monitoring Program	X			X			X		
Fairfax County-Gunston Cove Ecosystem Monitoring Program			X			X	X	X	
Montgomery County Water Quality Monitoring Program Fish Component				X		X		X	
North Anna Power Station Monitoring Program Fish Component			X	X			X		
Occoquan Watershed Monitoring Program						X	X	X	
Potomac River Shad Monitoring			X	X	X		X	X	
Rhode River Watershed Environmental Monitoring Program							X	X	

Table B7. Gap Analysis of Federal, State, Local and NGO Agency Monitoring Programs to Meet CAP Habitat Protection and Restoration Monitoring Data Needs. Note that category Partner models includes all water quality, fisheries and ecosystem models from all participating bay program agencies. Programs meeting trends needs have a minimum of ten years of continuous data.

Monitoring Program	Assess Habitat Quality	Prioritize Restoration opportunities			Assess Restoration Effectiveness	Acreage Assessment		Communication Product	303(d) or TMDL	Status	Trends	Partner Models
		SAV	Wetlands	Stream		SAV	Wetland					
State and Federal												
Bog Turtle Monitoring In Maryland	X				X							
Chesapeake Bay Program Non-Tidal Water Quality Network	X		X	X	X			X	X	X	X	X
Chesapeake Bay Submerged Aquatic Vegetation Aerial Survey		X			X	X		X	X	X	X	X
Coordinated Anacostia Monitoring Program	X			X	X	X	X	X	X	X		X
Delaware Water Quality Monitoring Network	X		X	X	X		X	X	X	X	X	X
District Of Columbia Aquatic Macroinvertebrate Monitoring Program	X		X	X	X			X	X	X	X	?
District Of Columbia Phytoplankton Monitoring Program	X			X	X			X	X	X		
District Of Columbia Sport-Fish Restoration Survey Program	X			X								
District Of Columbia Water Quality Monitoring Program	X	X		X	X			X	X	X	X	?
District Of Columbia: Aquatic Vegetation Monitoring	X	X			X	X		X	X	X	X	X
Maryland Shallow Water Quality Monitoring Program	X	X			X					?		
Maryland Adult American Shad Hook And Line Survey	X				X			X		X	X	X
Maryland Adult Shad And Herring Pound And Fyke Net Survey	X				X			X		X	X	X
Maryland American Eel Population Study- Silver Eel Survey	X				X							X
Maryland American Eel Population Study- Yellow Eel Survey	X				X						X	X
Maryland American Eel Population Study- Young Of Year Survey	X				X							X
Maryland Biological Stream Survey Benthic Component	X			X	X			X	X	X	X	
Maryland Biological Stream Survey Fish Component	X			X	X			X	X	X	X	
Maryland Chesapeake Bay Sediment Toxicant Monitoring Program	X			X					X	X	X	
Maryland Chesapeake Bay Water Quality Monitoring Program: Long-Term Tidal Tributary Chemical/Physical Component	X	X	X	X	X			X	X	X	X	X
Maryland Chesapeake Bay Water Quality Monitoring Program: Mainstem Chemical/Physical Components	X	X			X			X	X	X	X	X
Maryland Chesapeake Bay Water Quality Monitoring Program: River Input Chemical/Physical Component	X		X	X	X			X	X	X	X	X
Maryland Juvenille Shad And Herring Surveys					X			X		X		X
Maryland Largemouth Bass Surveys	X			X	X				X	X	X	

Monitoring Program	Assess Habitat Quality	Prioritize Restoration opportunities			Assess Restoration Effectiveness	Acreage Assessment		Communication Product	303(d) or TMDL	Status	Trends	Partner Models
		SAV	Wetlands	Stream		SAV	Wetland					
Maryland Non-Tidal Benthic Macroinvertebrate Monitoring Program	X			X	X			X	X	X	X	
Maryland Nontidal Tributary Water Quaity Monitoring Program-Core Trend Program	X		X	X	X			X	X	X	X	
Maryland Survey Of Coldwater Streams	X			X	X					X	X	
Maryland Survey Of Freshwater Impoundments	X			X	X					X	X	
Maryland Warmwater Rivers Survey	X			X	X					X	X	
National Aeronautics And Space Adminstration-Earth Observing System- AM & PM Missions	X	X			X					X		
National Estuarine Research Reserve System-Monitoring Program	X	X	X		X	X	X			X	X	
National Oceanic And Atmospheric Administration-Coastal Change Analysis Program	X		X		X		X	X		X	X	
National Park Service- Fredericksburg And Spotsylvania National Military Parks-Water Quality Monitoring	X		X	X	X					X		
National Park Service- National Capital Region Network-Water Quality Monitoring	X		X	X	X					X		
National Park Service- Richmond Area National Parks-Water Quality Monitoring	X		X	X	X					X		
National Park Service- Shenandoah National Park-Water Quality Monitoring	X		X	X	X					X		
New York State Stream Biomonitoring Program	X		X	X	X			X	X	X	X	
New York State Water Quality Assessment Program	X		X	X	X			X	X	X	X	
Pennsylvania Benthic Macroinvertebrate Survey	X		X	X	X		X	X	X	X	X	
Pennsylvania Juvenile Alosids Survey	X			X	X			X		X	X	
Pennsylvania Smallmouth Bass Survey	X			X	X				X	X	X	
Pennsylvania Water Quality Network	X		X	X	X			X	X	X	X	
Poplar Island Monitoring Program	X	X	X		X	X	X				X	
Potomac Fall Line Monitoring At Chain Bridge	X			X	X				X	X	X	
Rhode River Watershed Environmental Monitoring Program	X	X	X		X	X	X			X	X	
Shenandoah Watershed Study/Vtsss	X			X	X				X	X	X	
Smith River Virginia Study	X			X	X				X	X	X	
Susquehanna River Basin Commission Interstate Macroinvertebrate Monitoring Program	X			X	X			X	X	X	X	
Susuahana River Basin Commision Nutrient Monitoring Program	X			X	X			X	X	X	X	
United States Forestry Service-Water Quality Monitoring Program	X		X	X	X				X	X		
United States Geological Survey-Fairfax County Monitoring Network	X			X	X				X	X		

Monitoring Program	Assess Habitat Quality	Prioritize Restoration opportunities			Assess Restoration Effectiveness	Acreage Assessment		Communication Product	303(d) or TMDL	Status	Trends	Partner Models
		SAV	Wetlands	Stream		SAV	Wetland					
United States Geological Survey-Land Cover Change Monitoring	X			X	X			X		X		X
United States Geological Survey-National Hydrolic Bench Mark Program	X		X	X	X			X		X	X	X
United States Geological Survey-National Stream Quality Accounting Networks	X		X	X	X			X	X	X	X	X
United States Geological Survey-Streamflow Gaging Station Network	X		X	X	X			X		X	X	X
University Of Maryland's Regional Earth Science Applications Center-Impervous Surface Monitoring	X			X	X			X		X		X
University Of Maryland's Regional Earth Science Applications Center-Land Use Change Monitoring	X			X	X			X		X		X
Virginia Adult Anadromous Fish Passage Monitoring Program	X			X	X			X		X	X	
Virginia Ambient Wq Monitoring Program	X		X	X	X			X	X	X	X	X
Virginia Benthic Monitoring Program	X	X	X		X			X	X	X	X	X
Virginia Chesapeake Bay Water Quality Monitoring Program: Mainstem And Tidal Tributary Chemical/Physical Components	X	X			X			X	X	X	X	X
Virginia Eastern Shore Tributary Strategy Program	X	X	X		X				?	X		?
Virginia Estuarine Probabilistic Monitoring In Minor Chesapeake Bay And Coastal Tidal Tributaries	X		X	X	X			?	?	X		?
Virginia Intitute Of Marine Sciences Enhanced Tributary Monitoring Program	X			X	X					X		
Virginia Juvenile Alosine Fish Passage Monitoring Program	X			X	X			X		X	X	X
Virginia Lake Monitoring Program	X			X	X				X	X	X	
Virginia Nearshore Sav Habitat Monitoring Program	X	X			X	X		X	X	X	X	X
West Virginia Water Quality Monitoring Program-Agricultural Monitoring	X		X	X	X				X	X	X	X
West Virginia Watershed Assessment Program - Ambient Water Quality Monitoring	X		X	X	X			X	X	X	X	X
West Virginia Watershed Assessment Program - Long-Term Monitoring Sites	X		X	X	X			X	X	X	X	X
West Virginia Watershed Assessment Program - Pre-Tmdl Monitoring	X		X	X	X			X	X	X	X	X
West Virginia Watershed Assessment Program - Probabilistic Monitoring	X		X	X	X			X	X	X	X	X
West Virginia Watershed Assessment Program - Targeted Monitoring	X		X	X	X			X	X	X	X	X
West Virginia Watershed Assessment Program (Several Ind. Programs)-Benthic Monitoring	X		X	X	X			X	X	X	X	X

Monitoring Program	Assess Habitat Quality	Prioritize Restoration opportunities			Assess Restoration Effectiveness	Acreage Assessment		Communication Product	303(d) or TMDL	Status	Trends	Partner Models
		SAV	Wetlands	Stream		SAV	Wetland					
West Virginia Watershed Assessment Program-Fish Monitoring	X		X	X	X			X	X	X	X	X
County, Local And NGO												
Alliance For Chesapeake Bay Citizen Monitoring Program	X	X									X	
Arlington County Deparment Of Environmental Services Stream Monitoring Program	X			X	X			X	X	X		
Arlington County Virginia- Citizen Stream Monitoring Program	X			X	X				X	X		
Assateague Coastal Trust Water Monitoring	X	X			X					X		
Audubon Naturalist Society Water Quality Program	X			X	X					X		
Baltimore Ecosystem Study	X			X	X				X	X		
Bath County Power Station -Back Creek Stream Improvement Project Benthic Component	X			X	X					X	X	
Bath County Power Station- Fish Monitoring	X			X	X					X	X	
Broad Run Water Quality Monitoring Program	X		X	X	X					X	X	
Buffalo River Virginia-Watershed Monitoring Program	X		X	X	X					X		
Cat Point Creek Virginia Project	X		X	X	X					X	X	
Chesapeake Beach Civic League-Citizen Volunteer Monitoring	X	X	X		X					X		
Chesterfield County River Trends Program	X		X	X	X					X		
Chesterfield County Watershed Assessment And Stream Protection Program	X		X	X	X					X		
Chesterfield Watertrends	X		X	X	X				X	X		
Citizens Submerged Aquatic Vegetation Hunt Program	X	X			X	X		X	X	X	X	
City Of Portsmouth Virginia -Citizen's Water Quality Monitoring Program	X		X	X	X				X	X	X	
City Of Purcellville Virginia-Water Monitoring System	X			X	X					X	X	
Clinch River And Estonoa Wetland Monitoring	X		X	X	X		X			X		
Dan River Virginia-Point Source Benthic Macroinvertebrate Survey	X			X	X				X	X	X	
Dividing Creek Association-Citizen Volunteer Water Quality Monitoring Program	X			X	X				X	X		
Fairfax County Virginia-Volunteer Stream Monitoring Program	X		X	X	X				X	X	X	
Fairfax County-Gunston Cove Ecosystem Monitoring Program	X		X	X	X				X	X	X	
Fox Mill Run Virginia- Water Quality Monitoring Program	X		X	X	X				X	X		
Friends Of Powhatan Creek Water Quality Monitoring Program	X		X	X	X				X	X		
Friends Of Stafford Creeks-Alliance For Chesapeake Bay Citizen Monitoring Program	X		X	X	X				X	X		

Monitoring Program	Assess Habitat Quality	Prioritize Restoration opportunities			Assess Restoration Effectiveness	Acreage Assessment		Communication Product	303(d) or TMDL	Status	Trends	Partner Models
		SAV	Wetlands	Stream		SAV	Wetland					
Friends Of The North Fork Of The Shenandoah River And Friends Of The Shenandoah River Benthic And Bacterial Monitoroing Program	X		X	X	X				X	X	X	
Friends Of The Shenandoah River-Ambient Water Quality Monitoring Program	X		X	X	X				X	X	X	
Goose Creek Association Bacterial And Chemical Monitoring Program	X		X	X	X				X	X		
Holston Virginia Citizen Water Quality Monitoring Program	X		X	X	X				X	X		
Interactive Stream Assessment Resource (Instar)	X		X	X	X					X	X	
J.R. Horsley Swco Monitors	X		X	X	X				X	X	X	
Lake Anna Civics Association Monitoring Program	X		X	X	X				X	X		
Leesville Lake Associaton-Water Quality Monitoring	X		X	X	X				X	X		
Loudoun Stream Quality Project	X		X	X	X				X	X	X	
Magothy River Volunteer Monitoring Program	X		X	X	X				X	X	X	
Maury River Alliance Citizens Monitoring Program	X		X	X	X				X	X		
Mill Creek Maryland -Water Qualtiy Montioring Program	X		X	X	X				X	X	X	
Montgomery County Water Quality Monitoring Program Benthic Component	X		X	X	X				X	X	X	
Montgomery County Water Quality Monitoring Program Fish Component	X		X	X	X				X	X	X	
Mountain Run Headwaters	X		X	X	X				X	X		
North Anna Power Station Monitoring Program Fish Component	X		X	X	X				X	X		
Occoquan Watershed Monitoring Program	X		X	X	X				X	X	X	
Pennsylvania Allicance For Aquatic Resource Monitoring Program	X		X	X	X				X	X		
Poquoson River Citizen Monitoring	X		X	X	X				X	X		
Potomac Appalachian Trail Club Water Quality Monitoring Program	X		X	X	X				X	X		
Potomac River Shad Monitoring	X			X	X					X	X	X
Rappahannock Friends And Lovers Of Our Watershed Monitoring Program	X		X	X	X				X	X		
Rappahannock River Tributary Macroinvertebrate Study	X		X	X	X				X	X		
Reston Association Stream Monitoring	X		X	X	X				X	X	X	
Reston Association-Lakes Monitoring	X		X	X	X				X	X	X	
Rockfish Watershed Study	X		X	X	X				X	X		
Sassafras River Keeper Monitoring	X		X	X	X				X	X		
Severn River Keeper Monitoring	X		X	X	X				X	X		
Smith Creek Virginia- Citizens Monitoring Program	X		X	X	X				X	X		

Monitoring Program	Assess Habitat Quality	Prioritize Restoration opportunities			Assess Restoration Effectiveness	Acreage Assessment		Communication Product	303(d) or TMDL	Status	Trends	Partner Models
		SAV	Wetlands	Stream		SAV	Wetland					
Smith Mountain Lake Water Quality Monitoring Program	X		X	X	X				X	X	X	
South Anna Monitoring Project-Ambient Water Quality Monitoring	X		X	X	X				X	X		
South River Keeper Monitoring	X		X	X	X				X	X		
Stafford Creeks Water Quality Monitoring Project	X		X	X	X				X	X		
Streamwatch	X		X	X	X				X	X	X	
Susquehanna Steam Electric Station Monitoring Program	X		X	X	X				X	X	X	X
Swift Creek Reservoir Monitoring Program	X		X	X	X				X	X	X	
Talbot County Creekwatchers	X		X	X	X				X	X		
The GRAHEC Water Quality Monitoring Project	X		X	X	X				X	X		
Upper Rappahannock Watershed Stream Monitoring Program	X		X	X	X				X	X		
Virginia Save Our Streams Program	X		X	X	X				X	X	X	
West And Rhode River Keeper Monitoring	X		X	X	X				X	X		
West Virginia Save Our Streams Program	X		X	X	X				X	X	X	
Wicomico Creekwatchers	X		X	X	X				X	X		

Table B8. Gap Analysis of Federal, State, Local and NGO Agency Monitoring Programs to Meet CAP Healthy Watershed Monitoring Data Needs. Note that category Partner Models includes all water quality, fisheries and ecosystem models from all participating bay program agencies.

Monitoring Program	Assess Resource Lands	Land Protection		Land Conversion			BMPS		Stream Flow	Pre-Development Hydrology	Communication Product	303(d) or TMDL	Status	Trends	CBP Models
		Targeting	Tracking	land use	land cover	impervious	Urban	Storm water							
State and Federal															
National Park Service-Ground Water Internal Compliance Monitoring										X			X		X
Poplar Island Monitoring Program		X	X										X	X	
United States Geological Survey-Groundwater Observation Well Network, Delaware										X			X		X
United States Geological Survey-Groundwater Observation Well Network, Maryland										X			X	X	X
United States Geological Survey-Groundwater Observation Well Network, Southern Maryland										X			X	X	X
United States Geological Survey-Groundwater Observation Well Network, Virginia										X			X	X	X
United States Geological Survey-Land Cover Change Monitoring	X	X	X	X	X	X					X		X	X	X
United States Geological Survey-National Hydraulic Bench Mark Program									X	X			X	X	X
United States Geological Survey-Stream flow Gauging Station Network									X		X		X	X	X
University Of Maryland's Regional Earth Science Applications Center-Impervious Surface Monitoring	X	X	X	X		X					X		X	X	X
University Of Maryland's Regional Earth Science Applications Center-Land Use Change Monitoring	X	X	X	X	X						X		X	X	X
Virginia Irrigation Water Quality Assessment									X	X			X	X	
Virginia Karst Spring Monitoring									X	X			X		
County, Local And NGO															
Albermale County Virginia- Groundwater Assessment Program										X			X		
Arlington County Virginia Storm water Permit Monitoring Program								X					X		
Augusta County Virginia-Groundwater Assessment										X			X		
Baltimore County Chemical Monitoring Program								X					X	X	
Baltimore County-Illicit Connections Program							X	X					X	X	
City Of Bristol Virginia- Groundwater Monitoring Program										X			X	X	
City Of Newport New Virginia-Brackish Groundwater Monitoring Program										X			X	X	
City Of Portsmith Virginia-Storm Water Monitoring Program								X					X		
City of Suffolk Virginia-Groundwater Withdrawal Permit Monitoring Program										X			X		
Commonwealth Chesapeake Power Station-Ground Water Monitoring Program										X			X	X	
District of Columbia water quality monitoring program							X	X					X	X	

Monitoring Program	Assess Resource Lands	Land Protection		Land Conversion			BMPS		Stream Flow	Pre-Development Hydrology	Communication Product	303(d) or TMDL	Status	Trends	CBP Models
		Targeting	Tracking	land use	land cover	impervious	Urban	Storm water							
Friends Of The North Fork Of The Shenandoah River -Groundwater Monitoring Program										X			X	X	
Hampton Roads Virginia-Chloride Monitoring In Coastal Plain Aquifers										X			X	X	
Hog Island Bay Monitoring Program										X			X		
Ivy Muc- Albemarle County Va								X					X		
Mountain Run Headwaters										X			X		
North Rivanna Virginia-Groundwater Monitoring Program										X			X		
Solid And Hazardous Waste Facility Monitoring								X					X	X	
Wintergreen Mountain Ground Water Well Monitoring										X			X		

Appendix C- Summary of Federally Funded Monitoring Programs

Table C1. Summary of Federally Funded Monitoring Programs Reported to the 2009 Chesapeake Bay Program Monitoring Inventory as of 1 July 2009. CDC=Center for Disease Control, COE-Army Corps of Engineers, EPA-Environmental Protection Agency, NASA-National Aeronautics and Space Agency, NOAA-National Oceanic and Atmospheric Agency, NPS-National Park Service, NSF- National Science Foundation, USDA-United States Department of Agriculture, USFWS-United States Fish and Wildlife Service, USGS-United States Geological Survey. An Asterisk next to an agency name denotes a program, which was submitted to the inventory after 1 July 2009 and has not yet been verified to meet the current working definition of a monitoring program.

Agency	Monitoring Program
CDC	Virginia Harmful Algal Bloom Surveillance Program
COE	Poplar Island Monitoring Program-Benthic Monitoring
COE	Poplar Island Monitoring Program-SAV Monitoring
COE	Poplar Island Monitoring Program-Toxics Monitoring
COE	Poplar Island Monitoring Program-Water Quality Monitoring
EPA	Cat Point Creek Virginia Project
EPA	Chesapeake Bay Program Non-Tidal Water Quality Network
EPA	Delaware Air Quality Monitoring Program
EPA	District Of Columbia Air Quality Monitoring Program
EPA	District Of Columbia Aquatic Macro Invertebrate Monitoring Program
EPA	District Of Columbia Phytoplankton Monitoring Program
EPA	District Of Columbia Water Quality Monitoring Program
EPA	District Of Columbia Zooplankton Monitoring Program
EPA	District Of Columbia-Point Source Compliance Monitoring Program
EPA	Friends Of Stafford Creeks-Alliance For Chesapeake Bay Citizen Monitoring Program
EPA	Maryland Shallow Water Quality Monitoring Program
EPA	Maryland Ambient Air Monitoring Program
EPA	Maryland Chesapeake Bay Water Quality Monitoring Program: Long-Term Tidal Tributary Chemical/Physical Component
EPA	Maryland Chesapeake Bay Water Quality Monitoring Program: Mainstem Chemical/Physical Components
EPA	Maryland Chesapeake Bay Water Quality Monitoring Program: River Input Chemical/Physical Component
EPA	Maryland Non-tidal Tributary Water Quality Monitoring Program-Core Trend Program
EPA	New York Ambient Air Quality Monitoring
EPA	Pennsylvania Air Quality Monitoring Program
EPA	Potomac River Shad Monitoring
EPA	Susquehanna River Basin Commission Interstate Macro invertebrate Monitoring Program
EPA	Susquehanna River Basin Commission Nutrient Monitoring Program
EPA	United States Environmental Protection Agency-National Study Of Chemical Residue In Lake Fish
EPA	Virginia Air Quality Monitoring Program
EPA	Virginia Ambient WQMonitoring Program
EPA	Virginia Chesapeake Bay Water Quality Monitoring Program: Mainstem And Tidal Tributary Chemical/Physical Components
EPA	Virginia Lake Monitoring Program
EPA	Virginia Striped Bass Monitoring And Tagging Survey
EPA*	National Coastal Assessment Survey/National Coastal Condition Survey
EPA*	National Rivers And Streams Survey/Wade Able Streams Assessment/ EMAP-Mid-Atlantic Highlands Area/Mid-Atlantic Integrated Assessment
EPA,NOAA,NASA	Eyes On The Bay
EPA,USFWLS, NOAA	Chesapeake Bay Submerged Aquatic Vegetation Aerial Survey
NASA	National Aeronautics And Space Administration- Earth Observing System- AM And PM Missions
NASA	National Aeronautics And Space Administration- Seastar Mission
NOAA	Chesapeake Bay Multispecies Monitoring And Assessment Program

Agency	Monitoring Program
NOAA	Delaware National Oceanic And Atmospheric Administration-National Weather Service Climatological Data Network
NOAA	Maryland American Eel Population Study- Silver Eel Survey
NOAA	Maryland American Eel Population Study- Yellow Eel Survey
NOAA	Maryland American Eel Population Study- Young Of Year Survey
NOAA	Maryland National Oceanic And Atmospheric Administration-National Weather Service Climatological Data Network
NOAA	Maryland Oyster Stock Assessment Program
NOAA	National Atmospheric Deposition Program-National Trends Network
NOAA	National Estuarine Research Reserve System-Monitoring Program
NOAA	National Estuarine Research Reserve System-Monitoring Program
NOAA	National Oceanic And Atmospheric Administration- National Weather Service Solar Radiation Network
NOAA	National Oceanic And Atmospheric Administration-Coastal Prediction Center
NOAA	National Oceanic And Atmospheric Administration-National Data Buoy Center- National Weather Service
NOAA	National Oceanic And Atmospheric Administration-National Water Level Observation Network
NOAA	National Oceanic And Atmospheric Administration-Physical Oceanographic Real-Time System
NOAA	National Weather Service-Airport Weather Monitoring Network
NOAA	New York National Oceanic And Atmospheric Administration-National Weather Service Climatological Data Network
NOAA	Virginia Juvenile Blue Crab Survey
NOAA	Virginia Juvenile Fish And Blue Crab Survey
NOAA	Virginia National Oceanic And Atmospheric Administration-National Weather Service Climatological Data Network
NOAA	Virginia Shark Long Line Survey
NOAA	West Virginia National Oceanic And Atmospheric Administration- NWS Climatological Data Network
NOAA,NPS	United States Park Service-Chesapeake Bay Interpretive Buoy System
NOAA,USGS	National Oceanic And Atmospheric Administration-Coastal Change Analysis Program
NPS	Chesapeake Bay Observing System
NPS	National Park Service- Fredericksburg And Spotsylvania National Military Parks-Water Quality Monitoring
NPS	National Park Service- National Capital Region Network-Water Quality Monitoring
NPS	National Park Service- Richmond Area National Parks-Water Quality Monitoring
NPS	National Park Service- Shenandoah National Park-Water Quality Monitoring
NPS	National Park Service-Ground Water Internal Compliance Monitoring
NPS*	Mid-Atlantic Inventory and Monitoring Network-Benthic Bird Monitoring
NPS*	Mid-Atlantic Inventory and Monitoring Network-Benthic Forest Vegetation Monitoring
NPS*	Mid-Atlantic Inventory and Monitoring Network-Benthic Invertebrate Monitoring
NPS*	Mid-Atlantic Inventory and Monitoring Network-Water Quality Monitoring
NPS*	Northeast Coastal And Barrier Inventory And Monitoring Network-Assateague Island National Seashore/George Washington Birthplace NM Fish Monitoring
NPS*	Northeast Coastal And Barrier Inventory And Monitoring Network-Assateague Island National Seashore/George Washington Birthplace NM- Salt Marsh Vegetation Monitoring
NPS*	Northeast Coastal And Barrier Inventory And Monitoring Network-Assateague Island National Seashore/George Washington Birthplace NM- SAV Monitoring
NPS*	Northeast Coastal And Barrier Inventory And Monitoring Network-Assateague Island National Seashore/George Washington Birthplace NM- Water Quality Monitoring
NPS*	Northeast Coastal And Barrier Inventory And Monitoring Network-Colonial National Historical Park- Fish Monitoring
NPS*	Northeast Coastal And Barrier Inventory And Monitoring Network-Colonial National Historical Park- Salt Marsh Vegetation Monitoring
NPS*	Northeast Coastal And Barrier Inventory And Monitoring Network-Colonial National Historical Park- Water Quality Monitoring
NPS*	Northeast Coastal And Barrier Inventory And Monitoring Network-George Washington Birthplace – Forest Vegetation Monitoring
NSF,USDA	Baltimore Ecosystem Study
USFWS	Bald And Golden Eagle Monitoring
USFWS	Bog Turtle Monitoring In Maryland

Agency	Monitoring Program
USFWS	Citizens Submerged Aquatic Vegetation Hunt Program
USFWS	Interjurisdictional Species Stock Assessment For Adult Migratory Fin Fish
USFWS	Maryland Adult American Shad Hook And Line Survey
USFWS	Maryland Adult Shad And Herring Pound And Fyke Net Survey
USFWS	Maryland Fisheries Dependant Fyke Net Survey
USFWS	Maryland Fisheries Dependent Striped Bass Hook And Line Survey
USFWS	Maryland Juvenile Shad And Herring Surveys
USFWS	Maryland Largemouth Bass Surveys
USFWS	Maryland Shoal Water Trawl Survey
USFWS	Maryland Striped Bass Spawning Stock-Gill Net Survey
USFWS	Maryland Striped Bass Young Of Year Beach Seine Survey
USFWS	Maryland Survey Of Coldwater Streams
USFWS	Maryland Survey Of Freshwater Impoundments
USFWS	Maryland Upper Bay Trawl Survey
USFWS	Maryland Warm Water Rivers Survey
USFWS	Maryland Waterfowl Breeding Survey
USFWS	Peregrine Falcon Monitoring
USFWS	Tiger Beetle Monitoring
USFWS	Virginia American Eel Young Of Year Survey
USFWS	Virginia Shad And Herring Gill Net Survey
USFWS	Virginia Striped Bass Young Of Year Beach Seine Survey
USFWS	Wintering Waterfowl Survey
USFWS*	Blackwater NWR Monitoring Program-Bald Eagle Mid-Winter Survey
USFWS*	Blackwater NWR Monitoring Program-Bald Eagle Nest Count
USFWS*	Blackwater NWR Monitoring Program-Christmas Bird Count
USFWS*	Blackwater NWR Monitoring Program-Delmarva Peninsula Fox Squirrel Benchmark Site Monitoring
USFWS*	Blackwater NWR Monitoring Program-FWS Water Quality
USFWS*	Blackwater NWR Monitoring Program-National Amphibian Monitoring Program
USFWS*	Blackwater NWR Monitoring Program-Water Quality Monitoring
USFWS*	Blackwater NWR Monitoring Program-Waterfowl Survey (non-breeding)
USFWS*	DC Bird Survey Program
USFWS*	DC Wildlife Survey
USFWS*	District of Columbia Angler Survey
USFWS*	District of Columbia Habitat Monitoring And Enhancement Survey
USFWS*	District of Columbia Resident And Anadromous Fish Survey
USFWS*	Eastern Neck NWR Monitoring Program-Christmas Bird Count
USFWS*	Eastern Neck NWR Monitoring Program-National Amphibian Monitoring Program
USFWS*	Eastern Neck NWR Monitoring Program-Non-Breeding Waterfowl Survey
USFWS*	Eastern Neck NWR Monitoring Program-SAV and Marsh Vegetation Monitoring
USFWS*	Land bird Breeding Point Count Surveys – Rappahannock River Valley, Presquile, and James River NWRs
USFWS*	Land bird Fall Migration Surveys – Rappahannock River Valley NWR
USFWS*	Monitoring Of Bog Turtle Colonies At Sites In Immediate Proximity To Development In Southeastern Pennsylvania
USFWS*	NWRC Monitoring Programs-Bald Eagle Nest Count
USFWS*	Patuxent NWR Monitoring Programs-Deer dusk index survey
USFWS*	Patuxent NWR Monitoring Programs-Deer night-light index survey
USFWS*	Patuxent NWR Monitoring Programs-Frog call survey
USFWS*	Patuxent NWR Monitoring Programs-Gypsy moth egg mass survey
USFWS*	Patuxent NWR Monitoring Programs-Waterbird survey
USFWS*	Patuxent NWR Monitoring Programs-Whip-poor-will survey
USFWS*	Patuxent NWR Monitoring Programs-Woodcock survey
USFWS*	Pennsylvania Angler Use, Harvest, and Opinions on Warm/Cool water Resources
USFWS*	Pennsylvania Pond, Lake and Reservoir Inventory, Reporting and Management

Agency	Monitoring Program
USFWS*	Pennsylvania River Inventory, Reporting and Management
USFWS*	Pennsylvania Trout Stream Inventory, Data Entry, and Management Plans
USFWS*	Pennsylvania Warm water/Cool water Stream Inventory, Reporting and Management
USFWS*	Plum Tree Island NWR -NE Beach Tiger Beetle Surveys
USFWS*	Prothonotary Warbler Nest Box Productivity and Banding Project – Presquile
USFWS*	Rappahannock River Valley NWR -Secretive Marsh bird Callback Survey
USFWS*	Rappahannock River Valley NWR -Winter Grassland Bird Surveys
USFWS*	Rappahannock River Valley NWR-Anuran Callback Surveys –
USFWS*	Rappahannock River Valley NWR-Bald Eagle Winter Trapping, Banding, and Tracking Project
USFWS*	State of Virginia Annual Piping Plover survey
USFWS*	Summer and Winter Bald Eagle Shoreline Surveys within the Rappahannock River Bald Eagle Concentration Area
USFWS*	Summer Bald Eagle Shoreline Surveys at James River NWR and adjoining lands
USFWS*	Timber Rattlesnake Site Assessment and Inventory Project
USFWS*	TNC, Virginia Annual Oystercatcher survey
USFWS*	Virginia Coldwater Stream Investigations (Trout stream mgmt)
USFWS*	Virginia Large Impoundment Creel Surveys
USFWS*	Virginia Large Impoundment Investigations
USFWS*	Virginia Small Impoundment Creel Surveys
USFWS*	Virginia Small Impoundment Investigations (Sampling)
USFWS*	Virginia Trout Angler Surveys
USFWS*	Virginia Trout stream acidification investigation
USFWS*	Virginia Trout Stream Classification Review And Update
USFWS*	Virginia Warm water Stream Creel Surveys
USFWS*	Virginia Warm Water Stream Investigations (Sampling)
USFWS/COE	Poplar Island Monitoring Program-SAV Monitoring
USFWS\NOAA*	Eastern Neck NWR Monitoring Program-SAV Monitoring
USFWS\USDA*	Eastern Neck NWR Program-Gypsy Moth Monitoring
USFWS\USGS*	Blackwater NWR Monitoring Program-USGS/MDE Hydrologic Monitoring
USGS	International Breeding Bird Survey
USGS	United States Geological Survey-Fairfax County Monitoring Network
USGS	United States Geological Survey-Groundwater Observation Well Network, Delaware
USGS	United States Geological Survey-Groundwater Observation Well Network, Maryland
USGS	United States Geological Survey-Groundwater Observation Well Network, Southern Maryland
USGS	United States Geological Survey-Groundwater Observation Well Network, Virginia
USGS	United States Geological Survey-Land Cover Change Monitoring
USGS	United States Geological Survey-National Hydraulic Bench Mark Program
USGS	United States Geological Survey-National Stream Quality Accounting Networks
USGS	United States Geological Survey-Stream Flow Gauging Station Network
USGS/NASA	University Of Maryland's Regional Earth Science Applications Center-Impervious Surface Monitoring And Land Use Change Monitoring

Appendix D- Summary of Priority Monitoring Partnership Opportunities

Table D1. Summary of High Priority Partnership Opportunities. A review of all identified monitoring programs was conducted to assess partnership potential should resources become available to pursue these opportunitites. The five or six most promiseing candidates were identified from each CAP goal area and ranked. The ranking criteria included 1) probability collaborating success, 2) utility of data across multiple CAP goal areas, 3) potential participation costs 4) is data of sufficient data quality for CBP applications, 5) is data of spatial and temporal resolution adequate for CBP use and 6) Stability of funding from partner organization. Based on the evaluation and ranking process the following programs were identified as high priority candidates for collaboration.

Program Area	**Monitoring Program**	**Rank**
OBSERVING SYSTEM	Extend Land Cover Data to 2011	HIGH
OBSERVING SYSTEM	Ecological Resource Assessment-Update Resource Lands Assessment to '06 + 5 year increments thereafter	HIGH
FISHERIES	United States Fish and Wildlife and National Oceanographic and Atmospheric Administration Fisheries Programs	HIGH
WATER QUALITY	ARS CEAP - Choptank River monitoring	HIGH
OBSERVING SYSTEM	National Oceanic and Atmospheric Administration-Coastal Prediction Center in conjunction with National Aeronautics and Space Adminstration-Earth Observing System- AM & PM Missions, and SeaStar Mission	HIGH
WATER QUALITY	St. Mary's College WQ Monitoring Program	HIGH
WATER QUALITY	NSF Baltimore LT Ecosystem Study	HIGH
OBSERVING SYSTEM	National Oceanic and Atmospheric Administration-Physical Oceanographic Real-Time System and National Data Bouy Center-National Weather Service	HIGH
WATER QUALITY	DC Water Quality Monitoring Programs	HIGH
WATER QUALITY	Fairfax Co. BMP study	HIGH
WILDLIFE	United States Fish and Wildlife Service-National Wetland Inventory	HIGH
WATER QUALITY	Conestoga River TMDL monitoring	MID
WATER QUALITY	VDEQ Smith Creek TMDL	MID
FISHERIES	United States Fish and Wildlife Service-National Wild Fish Health Survey	MID
WATER QUALITY	MWCOG Anacostia River	MID
WILDLIFE	United States Geological Survey Biological Sciences Program	MID
WATER QUALITY	Virginia Institute of Marine Sciences Chesapeake Bay Initiative	MID
WATER QUALITY	MDE Corsica River monitoring	MID
OBSERVING SYSTEM	Full waveform LiDAR	LOW
OBSERVING SYSTEM	USACE National Coastal Mapping Program	LOW
WATER QUALITY	Montgomery Co. WQ and Benthic monitoring	LOW
OBSERVING SYSTEM	MODIS/ AWIFS equivalent	LOW
OBSERVING SYSTEM	LandSat	LOW
WATER QUALITY	Watershed Association and Volunteer Monitoring Programs	LOW

Table D2. Complete summary of High priority Parthership opportunity programs.

Monitoring Program	Potential Partner	Primary Data Products	Benifits of Partership	CBP Contributions	Partner Contributions	Est. Participation Costs($)
United States Fish and Wildlife and National Oceanographic and Atmospheric Administration Fisheries Programs	USFWS, NOAA-FS	Fisheries independant surveys of ecologically and commerically valuble fish.	Would provide opportunity to better coordinate water quality, habitat and fisheries monitoring activites. Facilitate regular data exchange between programs.	CBP would need more data management staff in the data center to handle data aquesiton and analysis.	USFWS fisheries program provides or admisters funding for numerous tidal and non-tidal fish monitoring programs. NOAA provides program coordination for fisheries surveys and stock management.	$100,000.00
United States Fish and Wildlife Service-National Wild Fish Health Survey	USFWS	Geographically referenced occurance of a varity of pathgens in fish	Data on pathogen occurrence in free-ranging (wild) populations of fish to assess fish and watershed health.	TBD	USFWL funds, and coordinate with state, local and NGO partners to conducts these surveys as part of a nation wide program	TBD
National Oceanic and Atmospheric Administration-Coastal Prediction Center in conjunction with National Aeronautics and Space Adminstration-Earth Observing System- AM & PM Missions, and SeaStar Mission	NOAA-NOS, NASA	Sea surface temperature, chlorophyll, turbidity and other products under development	Data provides wide geographic coverage on a daily basis and could potentially be used to fill gaps created by decreased funding for monitoring for clarity, phytoplankton and basic hydrographic parmeters in tidal waters.	In order for more CBP analysist to be able to effectively use these product, they will need computer hardware and software upgrades and training in data use.	Satellite imagery is available at no cost from NASA, NOAA-NOS currently funds Coastal Prediction Center who provides all data processing service.	TBD
National Oceanic and Atmospheric Administration-Physical Oceanographic Real-Time System and National Data Bouy Center- National Weather Service	NOAA-NOS, NOAA-WS	water levels, currents, salinity,Wind Direction, Wind Speed, Wind Gust, Atmospheric Pressure,Pressure Tendency, Air Temperature, Water Temperature, Dew Point	Data could potentially be used to fill gaps created by decreased funding for continuous water quality monitoring in tidal areas.	CBP would need more data management staff in the data center to handle data aquesiton.	NOAA currently provides strong funding for maintenance of buoys and provides data management with well established data mangement and QA protocols.Due to requirements to maintain ship navigational sytems program is viewed as stable.	TBD

Monitoring Program	Potential Partner	Primary Data Products	Benifits of Partership	CBP Contributions	Partner Contributions	Est. Participation Costs($)
Extend Land Cover Data to 2011	USGS NOAA	land Cover Change maps for 2010/2011	Meets ongoing needs for cohesive land cover change inforamtion	Hardware, Methodology, Expertise, QC	NOAA may have overlapping interest in this product	TBD
Ecological Resource Assessment-Update Resource Lands Assessment to '06 + 5 year increments thereafter	USGS, USDA, and NOAA	Target parts of the watershed in most need for restoration and protection and provide new information and critieria for protecting lands and ecosystems	provides an indispensable tool for the identification and targeting of areas for preservation/protection activities.	GIS and Land Cover Land Use Database Development	Current and historic land cover/land use information and environmental indicator survey information	TBD
MODIS/ AWIFS equivalent	USGS, USDA, and NOAA	Higher temporal frequency of land cover data to better understand causes of change on the landscape related to water quality. MODIS or AWIFS satellite, imagery	Shared resources and expertise	TBD	Processing and Analysis of imagery	TBD
LandSat	USGS, USDA, and NOAA	Exploit the recent no-cost release to the public of the entire Landsat record dating back to Landsat 1, launched in 1972, via new automated techniques to identify and quantify annual or better landscape disturbances in forests and other land cover conversions in the last 35 years.	Shared resources and expertise	TBD	Processing and Analysis of imagery	TBD
Full waveform LiDAR	USGS, USDA, and NOAA	LiDAR data gap analysis, tools and analyses to use multi-return and full waveform LiDAR for watershed vegetation analysis, for mapping forested wetlands and measuring wetland services.	Shared resources and expertise	TBD	Processing and Analysis of imagery	TBD

Monitoring Program	Potential Partner	Primary Data Products	Benifits of Partership	CBP Contributions	Partner Contributions	Est. Participation Costs($)
USACE National Coastal Mapping Program	USACE JALBTCX	Joint Airborne LiDAR Bathymetry Technical Center of Expertise shallow and deep Bay waters bathymetry and estuary habitat monitoring and characterization	Matching requirements for Water quality, coastline change/erosion mapping and habitat condition in the Chesapeake Bay Estuary	Funding	Processing and Analysis of imagery	TBD
DC Water Quality Monitoring Programs	DC Department of Environment (DCDE), Washington Council of Governments, Annacostia Watershed Society, USGS, citizen groups, etc.	DCDE: Long-term, monthly or biweekly WQ measurements (DO, clarity, ammonia, nitrate, BOD) at 50+ stations in the Potomac and Anacostia Rivers.	DCDE has the best spatial coverage of monitoring stations among monitoring groups. DO data are presently used by CBP for WQ criteria assessments. Additional testing for TN, TP and chlorophyll would make the dataset useful for evaluating the effectiveness of wastewater treatment, stormwater controls and other urban BMPs.	New funding for additional parameters: total nitrogen, phosphorus, chlorophyll. Continue to store DCDE data in Chesapeake Information Management System.	DCDE operates & manages activities such as sampling, lab analysis and data management. Staff prepares quality control samples for comparing results from 8 regional laboratories.	$50,000.00
Virginia Institute of Marine Sciences Chesapeake Bay Initiative	VIMS, through Viginia DEQ	High resolution, 3-D measurements of dissolved oxygen, turbidity and chlorophyll, temp. and salinity in tidal segments.	VIMS has developed a new technology that can directly measure WQ criteria parameters throughout the entire depth and breadth of a tributary. These direct measurements will provide an accurate assessment of the dissolved oxygen in all designated use areas.	CBP has reviewed the concept and determined that its application is promising.		TBD

Monitoring Program	Potential Partner	Primary Data Products	Benifits of Partership	CBP Contributions	Partner Contributions	Est. Participation Costs($)
St. Mary's College WQ Monitoring Program	St. Mary's College of Maryland (SMCM)	Water quality, loading and land use/land cover data for St. Mary' s River, a tributary to the Potomac. WQ stations are placed ~ 2 kM apart in tidal & non-tidal reaches.	SMCM has developed an exemplary program for collecting, interpreting and communicating environmental data for local land use planning. WQ data were collected rom 1999-2006 using CBP methods; all data are available on CIMS and have multiple uses: Baseline for assessing land use changes, WQ criteria assessments, nutrient and sediment loads, sources of excessive loads, county gov't planning.	Previous funding for WQ sampling and data management efforts	Project planning and mangement, analysis & interpretation of WQ, land use and soil data, comprehensive reports and outreach to county planners	$200,000.00
Watershed Association and Volunteer Monitoring Programs	Virginia Citizen/Non-Agency Level III Monitoring Programs (Alliance for the Chesapeake Bay, Friends of the Shenandoah, etc.) Maryland Riverkeeper Monitoring (Severn, South, West & Rhode, Chester, Nanticoke, etc.)	Typically, dissolved oxygen, secchi and temperature; some nutrients. Organizations produce communications products such as report cards, websites and reports.	These groups may monitor at smaller scales and higher frequency than state monitoring programs. Several groups have intensive land use inventories in addition to water quality, and have in-depth interpretive reports.	Quality assurance, data management and data analysis coordination would be necessary to evaluate and use these data.	Basic WQ data. Local knowledge and interest will be important for assessing the effectiveness of management actions on a small watershed scale. Good for accountability.	TBD
Conestoga River TMDL monitoring	SRBC, PADEP, USDA	landuse, landcover data, soils data, water quality data, nutrient and sediment loads and biologic data	Monitoring is in a priority agricultural watershed, this group could help monitor in other priority agricultural watersheds such as the Conowago Creek watershed in PA.		PADEP and SRBC would coordinate monitoring and help with data analysis for small watershed sampling	TBD

Monitoring Program	Potential Partner	Primary Data Products	Benifits of Partership	CBP Contributions	Partner Contributions	Est. Participation Costs($)
MDE Corsica River monitoring	MDE, MDNR	Implementation data, landuse, landcover data, soils data, water quality data, nutrient and sediment loads and biologic data	Corsica River watershed project is a project for evaluating the effectiveness of management actions, which fits into the CBP's priorities	Data analysis??	WQ Monitoring, implementation tracking, evaluation and enforcement	TBD
VDEQ Smith Creek TMDL	Virginia Tech, VDEQ, GMU	Implementation data, landuse, landcover data, soils data, biologic data	Smith Creek is a NRCS priority watershed. This watershed is in line for increased implementation	Monitoring support	WQ and biological monitoring, implementation tracking, evaluation and enforcement, data analysis	TBD
ARS CEAP - Choptank River monitoring	USDA ARS CEAP, MDDNR	Implementation data, landuse, landcover data, soils data, water quality data, nutrient and sediment loads	Choptank River has a long historical dataset, CEAP focus is on evaluating the effectiveness of management actions. USGS projects and others are also involved in watershed studies in the Choptank	Monitoring support, analytical support	WQ monitoring, implementation tracking, evaluation and enforcement, effectiveness monitoring	TBD
NSF Baltimore LT Ecosystem Study	Baltimore Ecosystem Study, USGS, US Forest Service	landuse/landcover, soils data, water quality data, nutrient and sediment load data, biological data	Long-term project, looks at water quality trends in urban areas	Data analysis and interpretation	WQ monitoring and data analysis	TBD
Montgomery Co. WQ and Benthic monitoring	MDDNR, Montgomery Co.	Implementation data, landuse/landcover, soils data, water quality data, nutrient and sediment load data, biological data	Long-term project, looks at water quality trends in urban areas	Data synthesis	WQ monitoring and data analysis	TBD
MWCOG Anacostia River	MWCOG	Implementation data, landuse/landcover, soils data, water quality data, nutrient and sediment load data, biological data	Long-term project, looks at water quality trends in urban areas	Monitoring support	WQ monitoring, implementation tracking, evaluation and enforcement	TBD
Fairfax Co. BMP study	USGS, Fairfax Co.	Implementation data, landuse/landcover, soils data, water quality data, nutrient and sediment load data, biological data	Unique project looking at urban areas and suburban areas and urbanizing and suburbanizing areas	Data synthesis and reporting	Small watershed effectiveness WQ monitoring, implementation tracking, evaluation and enforcement, data analysis	TBD

Monitoring Program	Potential Partner	Primary Data Products	Benifits of Partership	CBP Contributions	Partner Contributions	Est. Participation Costs($)
United States Geological Survey Biological Sciences Program	USGS	Status and trends Survey for abundance, distribution and ecological health status of multiple groups including:ambhibians, reptiles, birds, fish and invertebrates	Could provide valuble data to meet multiple Habitat and Watershed Goal Implementation monitoring needs.	CBP would need more data management staff in the data center to handle data aquesiton and analysis.	USGS funds and conducts these surveys as part of a nation wide program	TBD
United States Fish and Wildlife Service-National Wetland Inventory	USFWS	Provides USGS 1:24,000 or 1:100,000 topographic quadrangle mapping of wetland using classified using Cowardin etal 1979, with periodic updates.	Data would provide wetlands assessment at resolution adequate to accuratly track changes in acerage bay wide.	Funding would need to be provided to move priority of water shed in update cycle.	Analysis of available satellite imagery for wetlands	TBD