The development of this report was supported through a cooperative agreement with the EPA Chesapeake Bay Program; ACB CB96334901 – Citizen and Non-traditional Monitoring

Prioritization Report: How volunteer and nontraditional monitoring can help fill data gaps in the Chesapeake Bay Watershed

The Chesapeake Monitoring Cooperative has investigated spatial data gaps and data needs with respect to programs tracking water quality and benthic macroinvertebrates as condition indicators throughout the Chesapeake Bay watershed. This report summarizes the findings of the data needs assessment and identified avenues for nontraditional data to help meet some of the needs.

PRIORITIZATION REPORT

Produced by the Chesapeake Monitoring Cooperative

Working together to understand the health of our waters

March 31, 2017

The development of this report was supported through a cooperative agreement with the EPA Chesapeake Bay Program; ACB CB96334901 – Citizen and Nontraditional Monitoring

chesapeakemonitoringcoop.org

Prepared for:

Chesapeake Bay Program partnership: A regional partnership that leads and directs Chesapeake Bay restoration and protection. Bay Program partners include federal and state agencies, local governments, non-profit organizations and academic institutions.

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The CMC was formed for the Integration of Citizen-based and Nontraditional Monitoring into the Chesapeake Bay Program partnership.

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Executive Summary

The Chesapeake Monitoring Cooperative (CMC) was formed to help integrate water quality and nontidal benthic macroinvertebrate volunteer and nontraditional monitoring data into the Chesapeake Bay Program (CBP) partnership's decision-support system to better manage ecosystem recovery. This project was initiated by a Request for Proposals (RFP) from the U.S. Environmental Protection Agency's CBP Office. CBP is interested in engaging new partners that can augment and enhance the existing CBP partnership's long-term water quality monitoring networks. A priority area as defined for this report is any area with an identified need for more information that could conceivably be filled by volunteer or nontraditional data of known quality. This report showcases priority areas for water quality and benthic macroinvertebrate data as identified by the CBP partnership including federal agencies, interstate commissions, and state agencies. In addition, this report synthesizes results from the Chesapeake Monitoring Census, a survey of over 100 volunteer and nontraditional monitoring groups in the watershed, used to identify common goals and objectives of volunteer and nontraditional monitoring groups. The responses to this Census provided a preliminary assessment of possible partnerships between the diverse monitoring entities in the Chesapeake Bay watershed.

The CMC team facilitated opportunities to listen to diverse water quality stakeholders throughout the Chesapeake Bay watershed. Reoccurring outcomes of these discussions identified that water resource managers throughout the region want access to data of known quality to assist with: measuring long term trends, conducting short term assessments, informing public education, improving assessments to help target limited management resources, and identifying opportunities for research.

Tier designation

The data collected from this project will be categorized into Tiers to help account for the variability of methods, quality assurance procedures, and equipment used to collect water quality data. Classifying each data point will help data users understand how the data were collected. The CMC team developed a Tiered Framework (Table 1) which lists potential ways the data collected by volunteer and nontraditional monitoring groups can be used by the CBP partnership.

Table 1. Intended data use for the different Tier designated data

Tiers	Intended Data Use
Tier 1	Education, environmental health screening
Tier 2	Environmental health report cards, environmental health screening, targeting of management actions
Tier 3	Chesapeake Bay watershed trends and assessments to help inform policy and management decisions

Identified data needs in the Chesapeake Bay watershed

Through meetings with data users in Delaware, District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia, within the Bay watershed, the goals and objectives of their water quality and benthic macroinvertebrate monitoring programs were identified and acknowledged. Possible synergies for aligning monitoring approaches across jurisdictional boundaries were evaluated to support watershed-wide consistency in assessments and understanding of regional aquatic resource conditions while retaining support for local information needs. The goals and objectives for data use are, however, often unique to each state. Figure 1 shows the compilation of all priority areas identified for data integration in the Chesapeake Bay watershed by each jurisdiction. Additionally, CBP staff identified the Coastal Plain ecoregion as a priority area, which includes the entire Eastern Shore of Maryland, the Western Shore Uplands and Lowlands of Maryland and the areas east and south of the Piedmont Plateau in Virginia. While the CBP partnership identified the integration of Tier 3 data as a priority, the added value of Tier 1 and 2 data was recognized for the purpose of answering the myriad of watershed management questions and meeting the objectives of the Partnership.

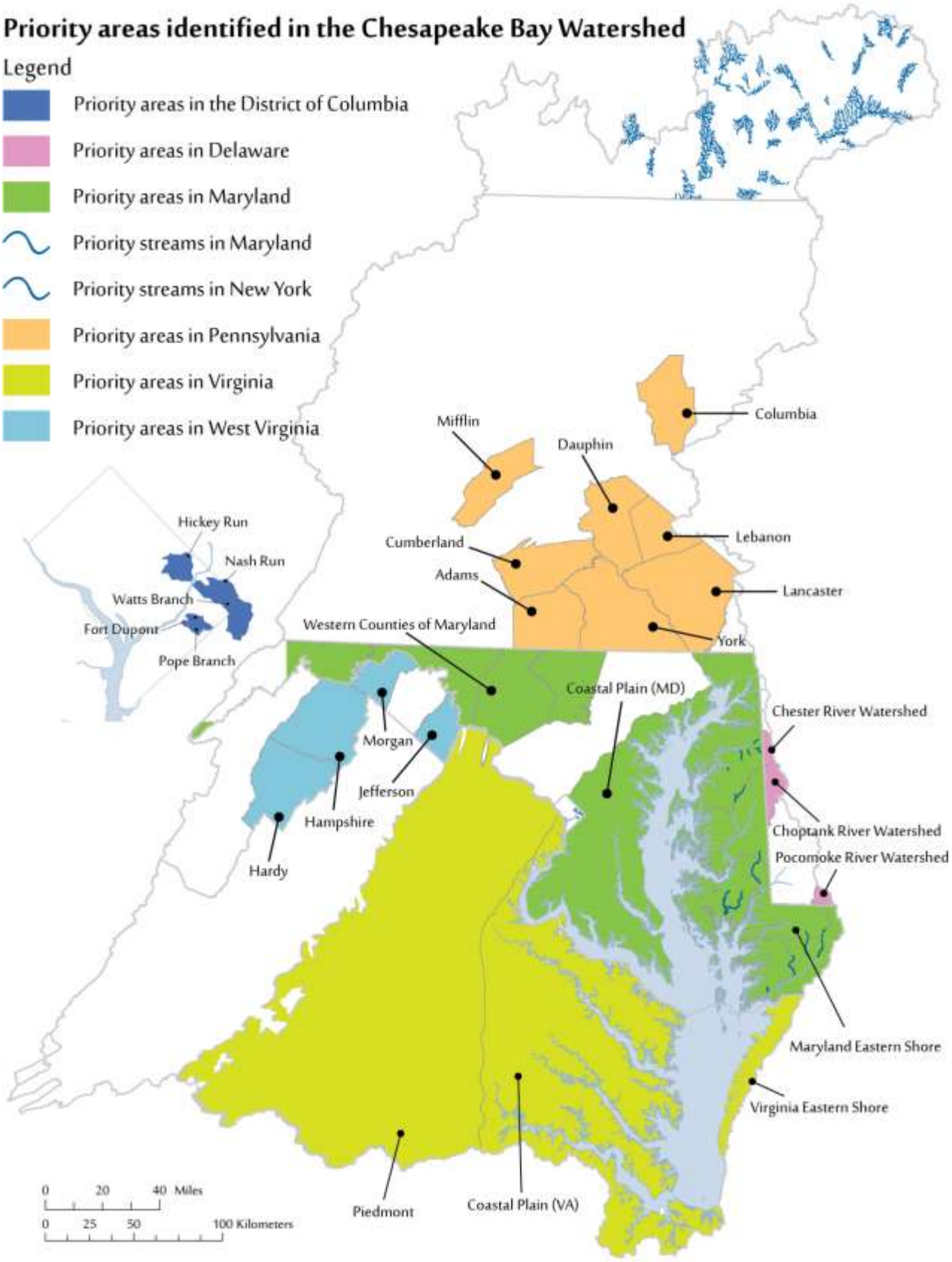
Priority areas identified in the Chesapeake Bay Watershed
Legend
Priority areas in the District of Columbia
Priority areas in Delaware
Priority areas in Maryland
Priority streams in Maryland
Priority streams in New York
Priority areas in Pennsylvania
Priority areas in Virginia
Priority areas in West Virginia
Columbia
Mifflin
Dauphin
Lebanon
Cumberland
Adams
Lancaster
York
Hickey Run
Nash Run
Watts Branch
Fort Dupont
Pope Branch
Western Counties of Maryland
Coastal Plain (MD)
Chester River Watershed
Morgan
Jefferson
Hampshire
Hardy
Choptank River Watershed
Pocomoke River Watershed
Maryland Eastern Shore
Virginia Eastern Shore
Piedmont
Coastal Plain (VA)
0 20 40 Miles
0 25 50 100 Kilometers

Figure 1. Priority areas identified by federal agencies, interstate commisions, and state agencies in the Chesapeake Bay watershed during the investigation for this report. Input was received from state agency staff in every Chesapeake Bay watershes jurisdiction (DC, DE, MD, NY, PA, VA, WV). The priority tidal creeks in Maryland are clearly defined in Figure 9. As are the HUC10 watersheds of the priority streams in New York in Figure 10.

Delaware

The Delaware Department of Natural Resources and Environmental Control (DNREC) is interested in reducing spatial and temporal data gaps for state water quality assessments and reporting. There is specific interest in integrating volunteer and nontraditional data in the Pocomoke, Chester, and Choptank River watersheds. The CMC will investigate groups already monitoring in those watersheds such as the Wicomico Environmental Trust, Chester River Association, and Midshore Riverkeeper Conservancy, as well as engaging other monitoring groups active in Maryland that extend across the Maryland/Delaware state boundary.

District of Columbia

The District of Columbia's Department of Energy and Environment (DOEE) is interested in baseline water quality and living resource data such as dissolved oxygen, water temperature, conductivity, pH, and benthic macroinvertebrates in five select watersheds: the Pope Branch, Nash Run, Hickey Run, Watts Branch, and Ft. Dupont. The CMC will investigate potential partnerships with the Smithsonian Anacostia Community Museum, Potomac Riverkeepers Network, Rock Creek Conservancy, and the Audubon Naturalist Society. Collectively, these groups conduct programs that collect data on chemical, biological, and aesthetic monitoring parameters in both tidal and nontidal waters.

Maryland

Maryland Department of Natural Resources (MDNR) and Maryland Department of the Environment (MDE) identified a need for data to fill spatial and temporal water quality information gaps, assess baseline conditions, support the identification of trends, assess project effectiveness, and help to redirect or target agency monitoring program resources. They have a key interest is in additional conductivity data throughout the state to assess the impacts of winter road salt application. Two broad areas of Maryland were highlighted for the integration of nontidal data such as dissolved oxygen, water temperature, conductivity, and pH for determining baseline conditions. Those areas are the western counties of Maryland and the Eastern Shore. The CMC will target volunteer engagement and outreach in those areas. The CMC identified Blue Water Baltimore and the Nanticoke Watershed Alliance as candidates for Tier 3 status for tidal water quality monitoring (i.e., monitoring program integrity level that supports data uses associated with Clean Water Act water quality standards attainment assessments). Blue Water Baltimore and Nanticoke Watershed Alliance programs were audited in the fall of 2016 and are adapting their protocols in 2017 to the CBP Tier 3 field and laboratory guidance.

New York

The New York State Department of Environmental Conservation (NYSDEC) is interested in detecting changes in water quality over time, identifying threats to streams, and targeting restoration activities.

Their Water Assessments by Volunteer Evaluators (WAVE) program keeps track of existing stream conditions. WAVE serves to provide critical information to the state that can red flag sites with potential water quality issues and deserve further investigation at the professional level. The CMC team is having ongoing conversations with NYSDEC and the Upper Susquehanna Coalition to identify how the CMC can support the great work of their WAVE program and increase participation.

Pennsylvania

Pennsylvania Department of Environmental Protection (PADEP) identified a need for data in five select watersheds: Chiques Creek, Octoraro Creek, South Branch Conewago Creek, Fishing Creek, and Kishacoquillas Creek. These are heavy agricultural areas, and PADEP is interested in detecting changes in water quality as a result of implemented land-based best management practices (BMPs) or following planned BMP implementation. PADEP provides direct assistance to volunteers through the Consortium for Scientific Assistance to Watersheds (CSAW) program. The CMC will support the monitoring efforts of CSAW and offer technical support and training to programs located in the select watersheds.

Virginia

Virginia Department of Environmental Quality (VADEQ) is interested in building partnerships and leveraging resources to fill data gaps. A need for more water quality information was identified in two broad areas of Virginia, the Piedmont region in central Virginia and the Chesapeake Bayside of the Virginia Eastern Shore. VADEQ is interested in basic water quality data such as dissolved oxygen, water temperature, and pH for determining baseline conditions. The CMC is researching potential partnerships with Soil and Water Conservation Districts in the Piedmont region, as several are already actively monitoring water quality. The Izaak Walton League's Virginia Save Our Streams program and Alliance for the Chesapeake Bay's RiverTrends program are based in Virginia and are strategically placed for building relationships with other organizations in the region.

West Virginia

The West Virginia Department of Environmental Protection (WVDEP) is interested in assessing water quality status and change in areas with current or future best management practice implementation plans. WVDEP is also interested in additional data to support baseline water quailty condition and habitat health assessments while also identifying areas of high nutrient and sediment loading. WVDEP identified a particular need for water quality data in a few select watersheds: Sleepy Creek and Warm Springs Run in Morgan County, West Virginia's tributaries to the Shenandoah River in Jefferson County, Cacapon River and its tributaries, the Lost River and North River in Hardy, Hampshire, and Morgan Counties, and Elks Run and Elk Branch in Jefferson County. The CMC plans to support the efforts of the WVDEP's West Virginia Save Our Streams program, as well as to help integrate and support active monitoring groups such as the West Virginia Rivers Coalition and the Blue Ridge Watershed Coalition. The CMC also plans to support a Pipeline Monitoring Program in WV developed by a partnership between Trout Unlimited and the West Virginia Rivers Coalition.

Extensive monitoring of the watershed

The Chesapeake Monitoring Census was used to identify common objectives, basic information (Appendix A), and potential synergies. The responses to the Census provided an overview of diverse monitoring entities in operation across the Chesapeake Bay watershed. With the preliminary assessment of what, where, and how monitoring activities are distributed, we have learned a lot about the types of opportunities for collaborations that might be pursued. For example, 22% of the respondents watershed-wide are monitoring with the intention of collecting baseline data and 27% are interested in monitoring water quality and habitat change in response to the progress of restoration activities.

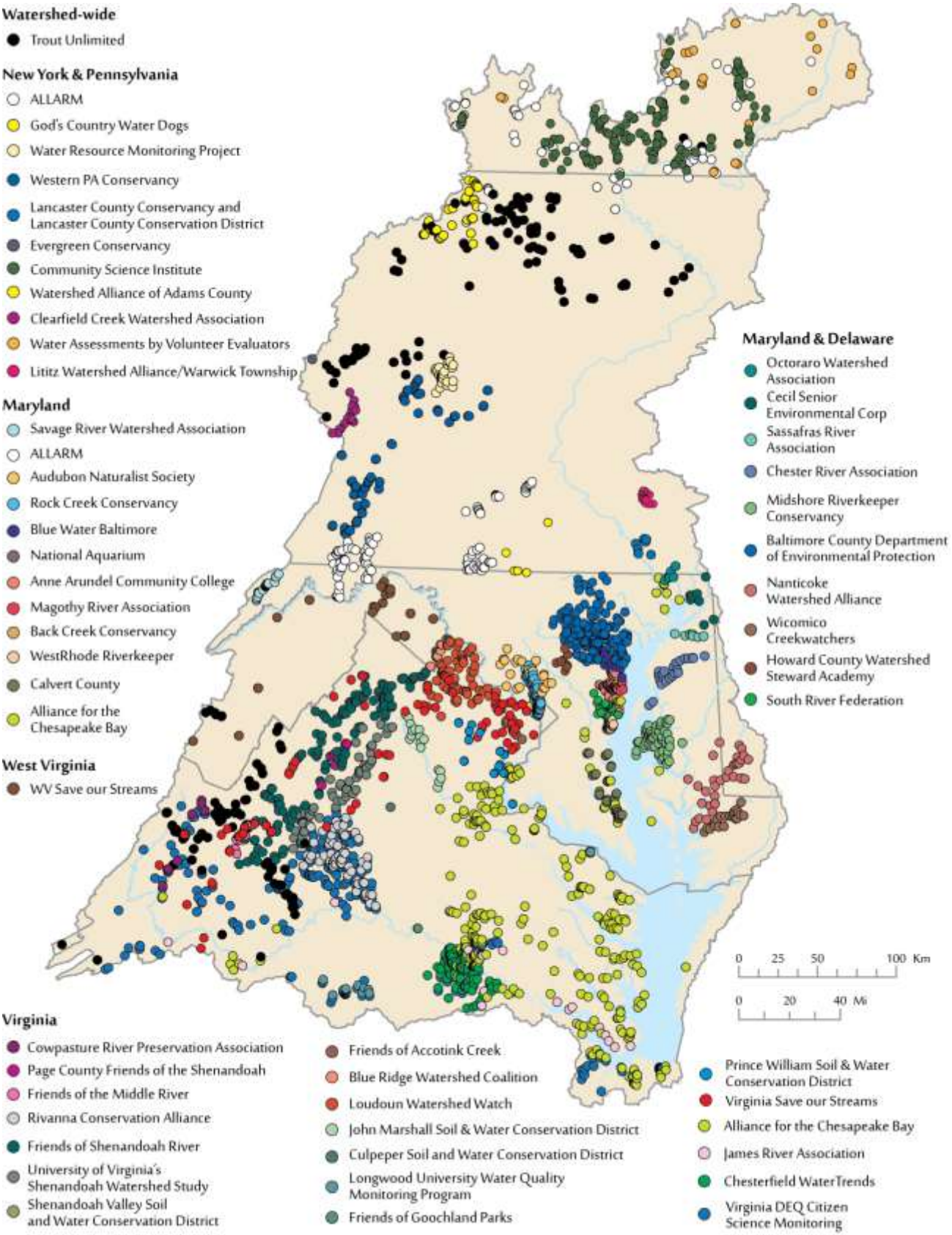
Watershed-wide
Trout Unlimited
New York & Pennsylvania
ALLARM
God's Country Water Dogs
Water Resource Monitoring Project
Western PA Conservancy
Lancaster County Conservancy and Lancaster County Conservation District
Evergreen Conservancy
Community Science Institute
Watershed Alliance of Adams County
Clearfield Creek Watershed Association
Water Assessments by Volunteer Evaluators
Lititz Watershed Alliance/Warwick Township
Maryland
Savage River Watershed Association
ALLARM
Audubon Naturalist Society
Rock Creek Conservancy
Blue Water Baltimore
National Aquarium
Anne Arundel Community College
Magothy River Association
Back Creek Conservancy
WestRhode Riverkeeper
Calvert County
Alliance for the Chesapeake Bay
West Virginia
WV Save our Streams
Maryland & Delaware
Octoraro Watershed Association
Cecil Senior Environmental Corp
Sassafras River Association
Chester River Association
Midshore Riverkeeper Conservancy
Baltimore County Department of Environmental Protection
Nanticoke Watershed Alliance
Wicomico Creekwatchers
Howard County Watershed Steward Academy
South River Federation
0 25 50 100 Km
0 20 40 Mi
Virginia
Cowpasture River Preservation Association
Page County Friends of the Shenandoah
Friends of the Middle River
Rivanna Conservation Alliance
Friends of Shenandoah River
University of Virginia's Shenandoah Watershed Study
Shenandoah Valley Soil and Water Conservation District
Friends of Accotink Creek
Blue Ridge Watershed Coalition
Loudoun Watershed Watch
John Marshall Soil & Water Conservation District
Culpeper Soil and Water Conservation District
Longwood University Water Quality Monitoring Program
Friends of Goochland Parks
Prince William Soil & Water Conservation District
Virginia Save our Streams
Alliance for the Chesapeake Bay
James River Association
Chesterfield WaterTrends
Virginia DEQ Citizen Science Monitoring

Figure 2. Preliminary results from the Chesapeake Monitoring Census show a snapshot of where active volunteer and nontraditional monitoring sites are located. It is important to remember that not all monitoring groups have GPS coordinates for their sites, and some groups have yet to contribute their site locations. Additionally, there are active and historical monitoring sites in Maryland from state-run volunteer monitoring programs not included in this figure due to their extensive spatial coverage of the state (Figure 6).

CMC approach to integrating new partners

The identified groups have diverse needs and incentives for participating in the CMC. Monitoring programs among citizen groups further vary in their investments for quality assurance and quality control of their data collections. The CMC is offering a suite of technical support and services to accommodate the range of needs of these volunteer and nontraditional monitoring groups. The CMC will work with existing and new monitoring groups, groups that adopt the CMC protocols or use their own unique protocols, but in different capacities. The data collected from this project will be categorized into Tiers (Table 1). The CMC also created a rubric to evaluate the diverse monitoring practices of existing groups to help determine the appropriate Tier classification. Tier 3 data for example have data requirements which adhere to the Chesapeake Bay Program's monitoring requirements supporting sufficient integrity that is legally defensible with regulatory water quality standards attainment assessments. The CMC will provide technical support and assistance to help monitoring groups advance to the next Tier when viable.

Chesapeake Environmental Communications is a contractor to the Alliance for the Chesapeake Bay for the purpose of developing the Chesapeake Data Explorer, a database for the integration of all volunteer and nontraditional monitoring groups' water quality data in Chesapeake Bay Watershed states. Clear instructions for interacting with the database will be available online. The CMC will support many of the states' priority objectives within the scope of the project; specifically the integration of water quality and nontidal benthic macroinvertebrate data into the Chesapeake Data Explorer.

The Prioritization Process

The CMC has investigated the data gaps and needs of the CBP partnership by meeting with data users including federal and state agencies, watershed jurisdictions, and inter-state commissions (Appendix C). Additionally, the CMC team has surveyed nontraditional data producers and has met with monitoring stakeholders to determine what is currently being monitored and what volunteers want to monitor in the watershed. This report summarizes the findings of these two investigations. In addition, the identified priority areas, any area with an identified need for more information that could conceivably be filled by volunteer or nontraditional data of known quality, are guiding the CMC's pathway forward to target integration of new monitoring data. This report outlines opportunities for collaboration in water quality monitoring available to the CBP partnership with new partners in the watershed.

A CMC-organized workshop in October 2016 brought together data users and key players in the volunteer and nontraditional monitoring community to discuss data needs throughout the watershed. This workshop, known as the Prioritization Workshop, served as a key information gathering opportunity and was designed to meet the following objectives:

- Provide an overview of the CMC and the jurisdiction's role in making it a success;
- Discuss the jurisdiction's needs for more data, at a higher frequency, and how the Cooperative intends to help meet agencies' goals for monitoring in the Chesapeake Bay Watershed; and
- Collaborate with jurisdiction's and volunteer monitoring organizations to build a stronger, more robust water quality monitoring networks for the Chesapeake Bay and its watershed.

Participants thought critically about where the CBP partners see opportunities for collaboration and areas where they would like to increase the frequency and availability of monitoring data. The outcomes from the Prioritization Workshop[1] are summarized in this report.

[1] The overview and outcomes of the Prioritization Workshops are summarized and can be found at the following link: https://www.allianceforthebay.org/wp-content/uploads/2016/08/Overview-and-Next-Steps_Prioritization-Workshop_v3.pdf

Identified Data Needs in the Chesapeake Bay Watershed

Overall opportunities for the integration of volunteer and nontraditional water quality monitoring data identified by key stakeholders are listed in Table 2. There are several identified data needs that are shared between jurisdictions. Table 2 identifies the data needs that each state/jurisdiction prioritized, which provides guidance for the CMC team for future outreach and engagement.

Table 2. Priority objectives for volunteer and nontraditional data use identified by environmental agencies in the Chesapeake Bay watershed

Monitoring Data Use/Need	State/Jurisdiction
Fill data gaps for Clean Water Act 305(b)/303(d) assessments	DE, DC, MD, NY, VA
Monitor restoration progress and conservation effectiveness or conduct impact assessment (pre- and post-implementation)	DE, DC, MD, NY, PA, WV
Stormwater MS4 monitoring	PA
Collect longitudinal data and monitor trends over time	MD, NY
Establish baseline water quality data (tidal)	DE, DC, MD, VA
Establish baseline water quality data (nontidal)	DE, DC, MD, PA, VA
Monitor the impacts of road salt (conductivity)	MD
Marcellus Shale natural gas and acid mine drainage mitigation	MD, PA
Determine if a TMDL is needed	MD
Higher frequency monitoring of impaired waters	DC, NY, VA
Promote stewardship and provide opportunities for community outreach and engagement	DE, DC, MD, NY, PA, VA, WV
Identify areas of high nutrient and sediment loading	NY, WV
Monitor areas undergoing change (i.e. development)	DC, WV
Climate change resiliency	NY, PA, VA, WV
Monitor the impacts of pipelines	PA, VA, WV
Monitor areas with high concentrations of agriculture	PA
Monitor presence of aquatic invasive species	MD

The CMC team met with data users in every watershed jurisdiction (DE, DC, MD, NY, PA, VA, and WV) to discuss the goals and objectives and possible synergies for consistent, regional monitoring coverage, spatially and temporally. The process began with identifying basic monitoring objectives in each state. This was followed by exploring the potential for using data that may be collected using differing monitoring protocols from those used by the state agency. Discussions acknowledged that volunteer and nontraditional data use can help reduce the uncertainty in state water quality standards assessments, and/or alert an agency to a harmful practice or nutrient loading hot spot that needs further investigation.

Delaware

The Nanticoke Watershed Alliance has a strong presence in Delaware and was one of the first volunteer monitoring groups to undergo the Tier 3 auditing process as a candidate for Tier 3 data classification. The CMC team met with the DNREC to identify how the CMC can provide support for the current operations and desired growth of the Nanticoke Watershed Alliance. Additionally, the group brainstormed some gap-filling solutions beyond the Nanticoke Watershed. The most immediate need of DNREC for the integration of volunteer and nontraditional data is data accessibility.

To reiterate, the data needs identified by key stakeholders (Table 2) in Delaware are:

- Fill data gaps for Clean Water Act 305(b)/303(d) assessments
- Monitor restoration progress and conservation effectiveness or conduct impact assessment (pre- and post-implementation)
- Establish baseline water quality data (tidal)
- Establish baseline water quality data (nontidal)
- Promote stewardship and provide opportunities for community outreach and engagement

Priority watersheds and data needs

The Nanticoke Watershed Alliance, with the aim to accumulate long-term, scientifically credible data and to monitor the health of the Nanticoke River and the Fishing Bay headwaters, collects tidal and nontidal water quality data. The Nanticoke Watershed Alliance has worked with a number of CBP partners who have provided a degree of rigor and accountability to the data, including the implementation of the Mid-Atlantic Tributary Assessment Coalition (MTAC) protocols. There is a need for additional tidal and nontidal monitoring data in the Pocomoke, Chester, and Choptank River watersheds (Figure 3). DNREC is interested in identifying volunteer or nontraditional monitoring groups that can contribute to the reduction of spatial and temporal data gaps for state assessments and reporting.

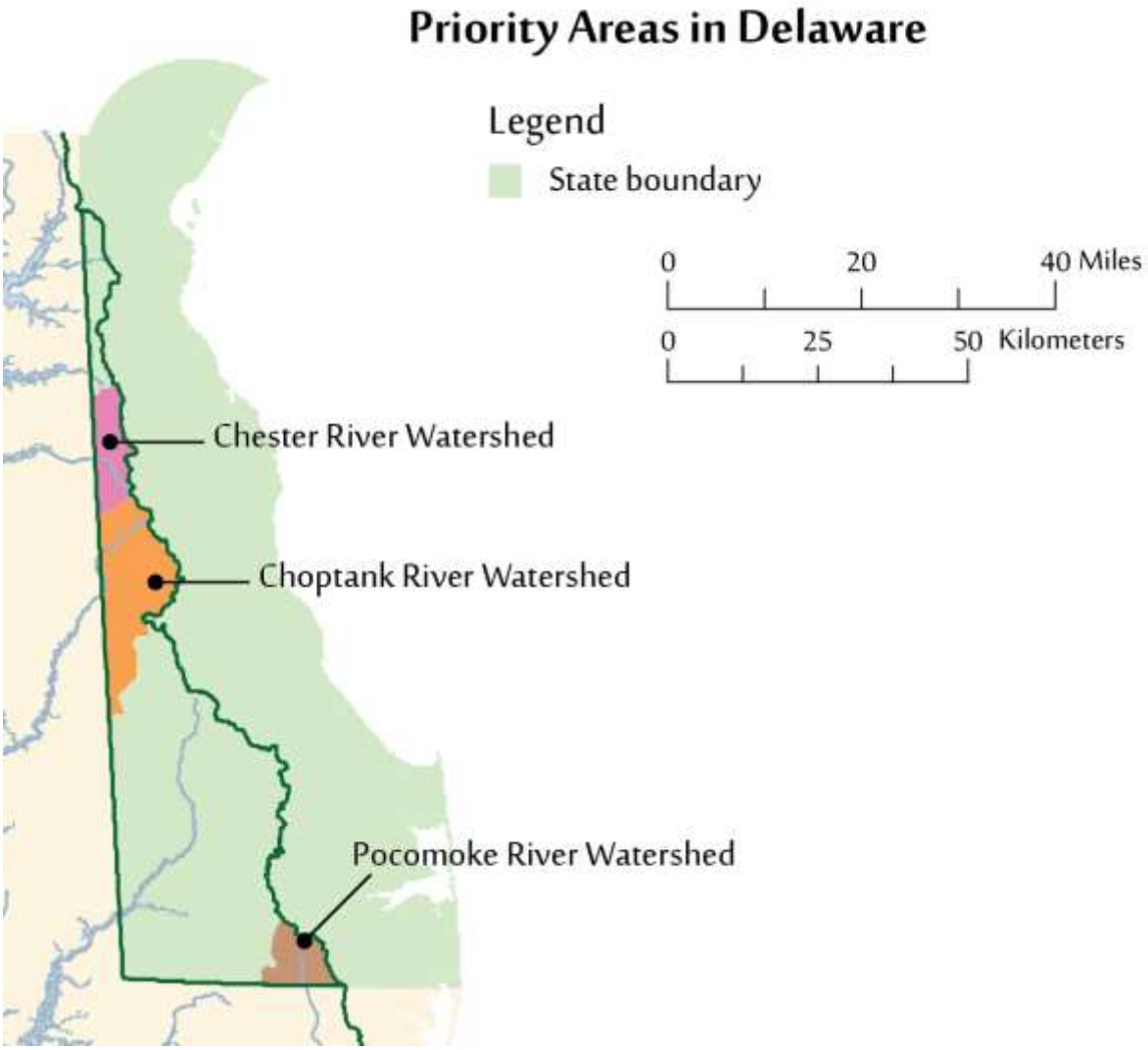

Figure 3. Priority watersheds were identified by Delaware Department of Natural Resources and Environmental Control for targeted CMC outreach and data integration.

CMC Preliminary Plan of Action

The CMC plans to support the needs of DNREC primarily through training and QA/QC protocol review. The CMC will also connect with monitoring groups already monitoring the Pocomoke, Chester, and Choptank Rivers, such as the Wicomico Environmental Trust, the Chester River Association, and Midshore Riverkeeper Conservancy (in Maryland). These monitoring groups may not directly target DNREC's watersheds of interest; however, they either border or overlap as seen in Figure 4. Due to the cross-state nature of the CMC, DNREC would like the CMC team to identify watershed groups that could feasibly expand to monitor across state boundaries. There are no specific Delaware-focused volunteer monitoring groups at this time. However, there are substantive Maryland-based monitoring programs that may be able to integrate efforts across state borders to gain Delaware coverage.

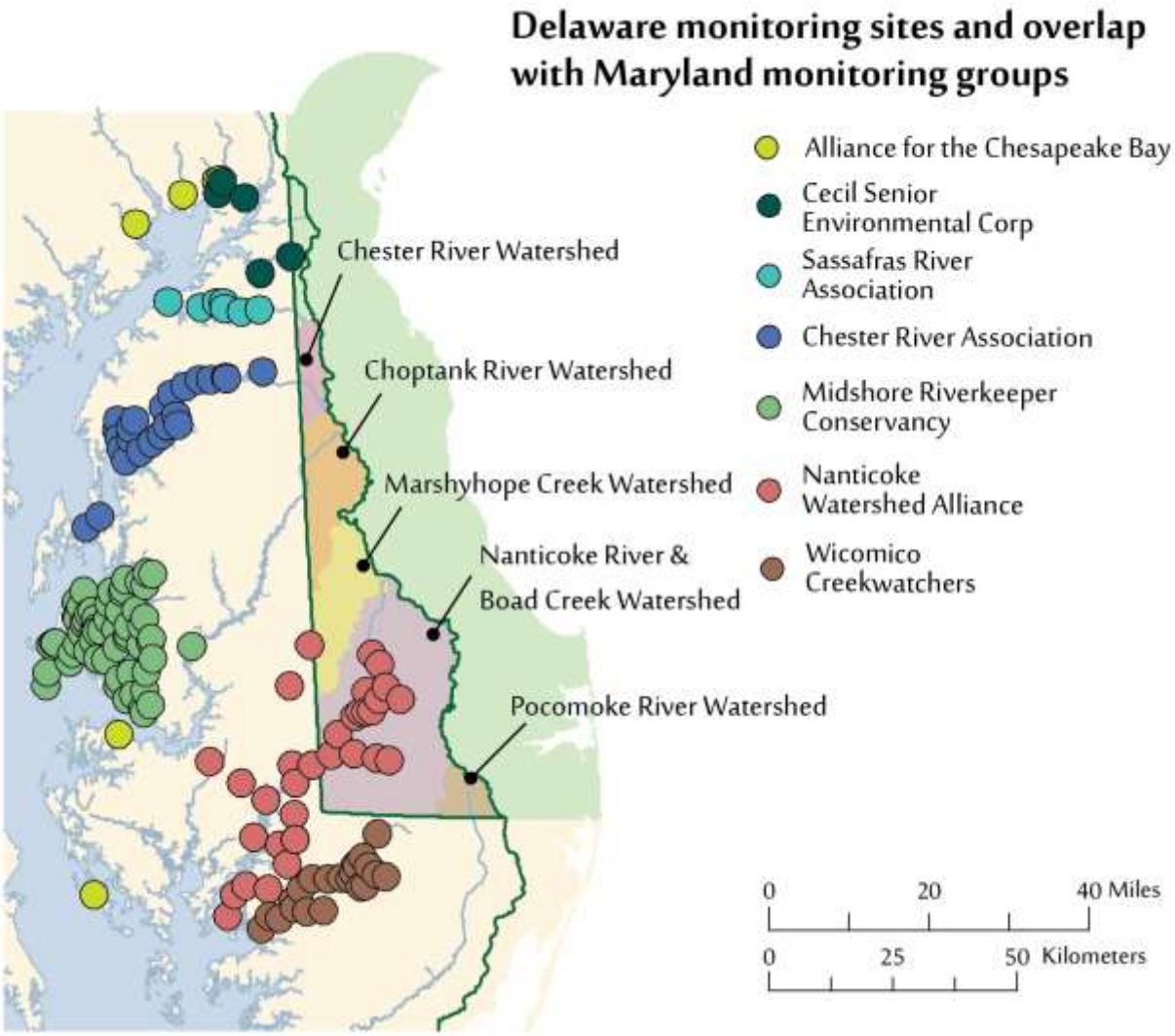

Figure 4. Examples of volunteer monitoring groups that monitor tributaries in or bordering Delaware.

The primary technical support the CMC plans to offer the Nanticoke Watershed Alliance is to review their current nontidal water quality monitoring program and identify the potential for classifying the data into a higher Tier. The CMC may provide financial support to update equipment, and/or provide training for the Nanticoke Watershed Alliance Coordinator on CMC nontidal water quality methods and associated QA/QC protocols.

District of Columbia

The District of Columbia Department of Energy and Environment (DOEE) recently updated their water quality monitoring strategy.

To reiterate, the data needs identified by key stakeholders (Table 2) in the District of Columbia are:

- Fill data gaps for Clean Water Act 305(b)/303(d) assessments
- Monitor restoration progress and conservation effectiveness or conduct impact assessment (pre- and post-implementation)
- Establish baseline water quality data (tidal)
- Establish baseline water quality data (nontidal)
- Higher frequency monitoring of impaired waters
- Promote stewardship and provide opportunities for community outreach and engagement
- Monitor areas undergoing change (i.e. development)

Priority watersheds and data needs

The Department of Energy and Environment (DOEE) identified five small watersheds (Figure 5) for the integration of volunteer and nontraditional water quality and aquatic living resource monitoring data into their water quality assessments:

1. Pope Branch
2. Nash Run
3. Hickey Run
4. Watts Branch
5. Ft. Dupont

DOEE is interested in baseline data such as dissolved oxygen, water temperature, conductivity, pH, and benthic macroinvertebrates.

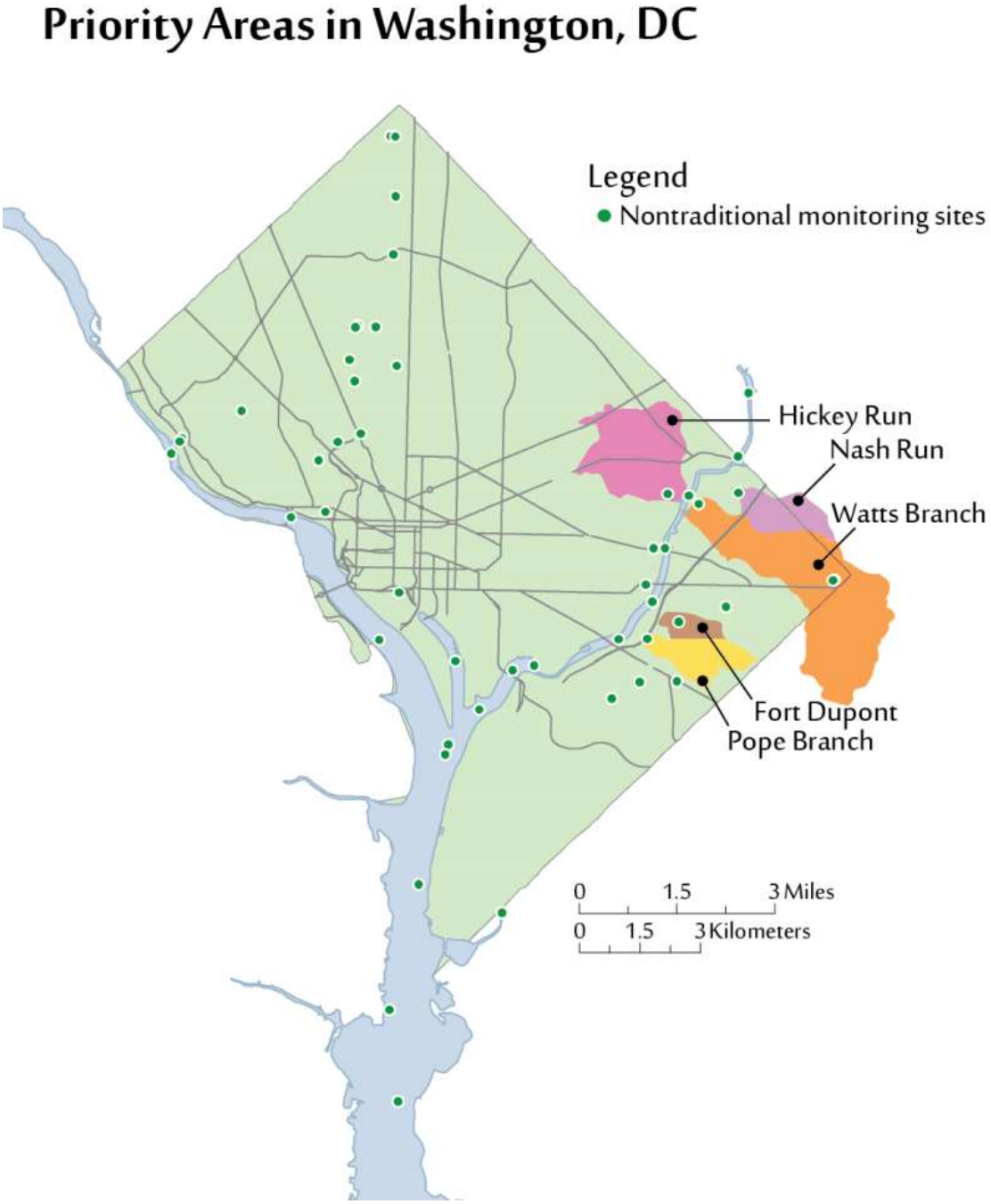

Figure 5. DOEE identified five watersheds in the District of Columbia where DOEE is seeking more water quality and benthic macroinvertebrate monitoring data. The CMC will investigate volunteer and nontraditional monitoring occurring within those five watersheds.

CMC Preliminary Plan of Action

The CMC will investigate potential partnerships with the Smithsonian Anacostia Community Museum, Potomac Riverkeepers Network, Rock Creek Conservancy, and the Audubon Naturalist Society. Collectively, these groups monitor in both tidal and nontidal waters, as well as collect chemical, biological, and aesthetic feature monitoring parameters. Working with DOEE, the CMC will identify volunteer and nontraditional monitoring sites within the small watersheds of interest with the hopes of integrating these sites into the next phase of the DOEE monitoring strategy. The CMC will also investigate reinvigorating monitoring efforts of the Anacostia Watershed Society and the Anacostia Riverkeeper.

Maryland

The Maryland Department of Natural Resources (MDNR) operates two widespread biological monitoring programs (Figure 6). The Maryland Biological Stream Survey (MBSS) is managed and run by professional MDNR biologists. The Stream Waders benthic macroinvertebrate sample collection program, also managed by MDNR staff, serves as the volunteer "arm" of the MBSS, with volunteers conducting the field sampling and MDNR biologists conducting the sample analysis.

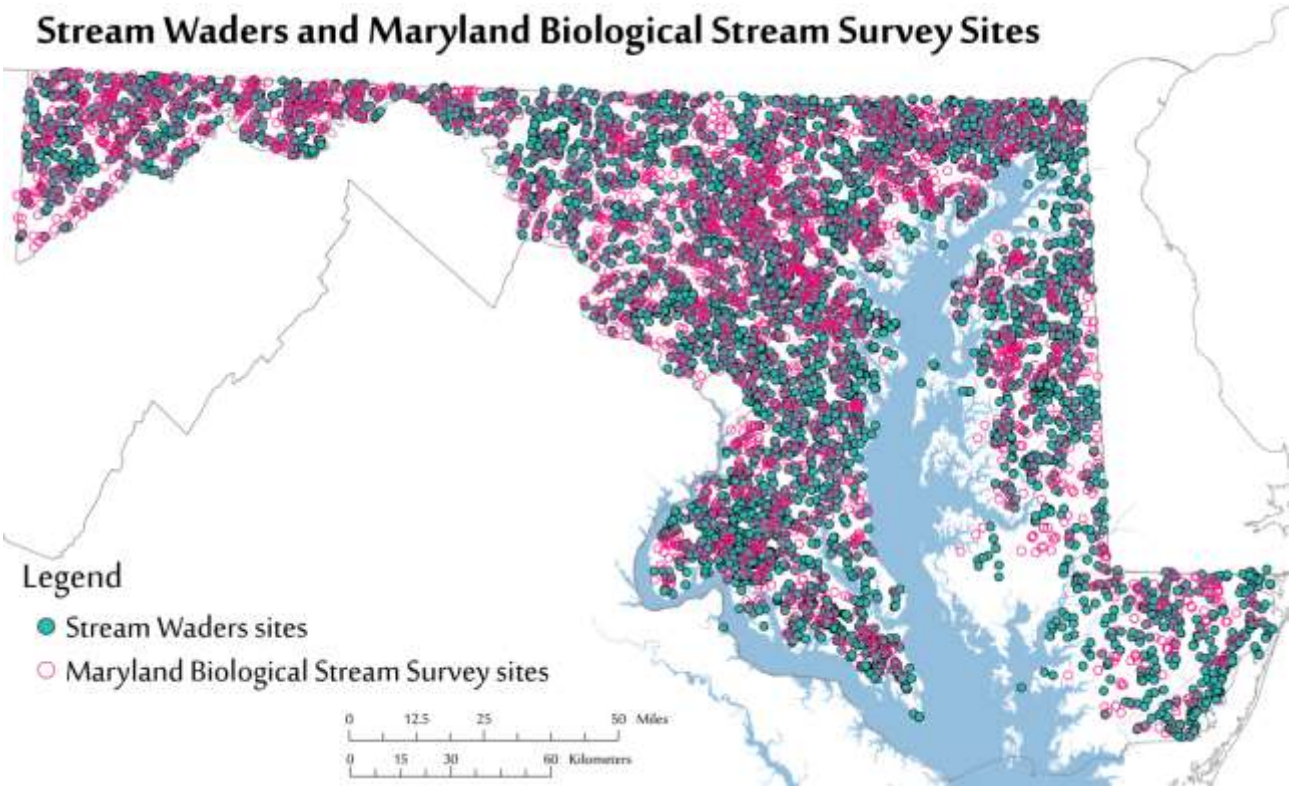

Figure 6. The Maryland Biological Stream Survey was started by the Maryland Department of Natural Resources in 1993. The MBSS was Maryland's first probability-based or random design stream sampling program to monitor stream conditions with known precision at various spatial scales. In 2000, Stream Waders was established. These two programs are used as a cost-effective way to characterize Maryland's 10,000+ miles of freshwater streams.

Maryland state agencies and the CBP identified tidal and non-tidal areas of Maryland that had data gaps as well as areas that are current priorities for the state.

To reiterate, the data needs identified by key stakeholders (Table 2) in Maryland are:

- Fill data gaps for Clean Water Act 305(b)/303(d) assessments
- Monitor restoration progress and conservation effectiveness or conduct impact assessment (pre- and post-implementation)
- Collect longitudinal data and monitor trends over time
- Establish baseline water quality data (tidal)
- Establish baseline water quality data (nontidal)
- Monitor the impacts of road salt (conductivity)
- Marcellus Shale natural gas and acid mine drainage mitigation
- Determine if a TMDL is needed
- Promote stewardship and provide opportunities for community outreach and engagement
- Monitor presence of aquatic invasive species

Priority watersheds and data needs

Data users in Maryland identified a need for data to fill spatial and temporal gaps in water quality and benthic macroinvertebrate assessments, assess baseline conditions, identify trends, assess project effectiveness, and help to redirect or target agency water quality monitoring programs. A high priority for Maryland data users is to collect more conductivity data throughout the state. Based on the results from the Chesapeake Monitoring Census, there are at least 24 volunteer or nontraditional monitoring groups in Maryland collecting conductivity data. As seen in Figure 7, there are volunteer and nontraditional monitoring groups collecting conductivity data in over half of the counties in Maryland.

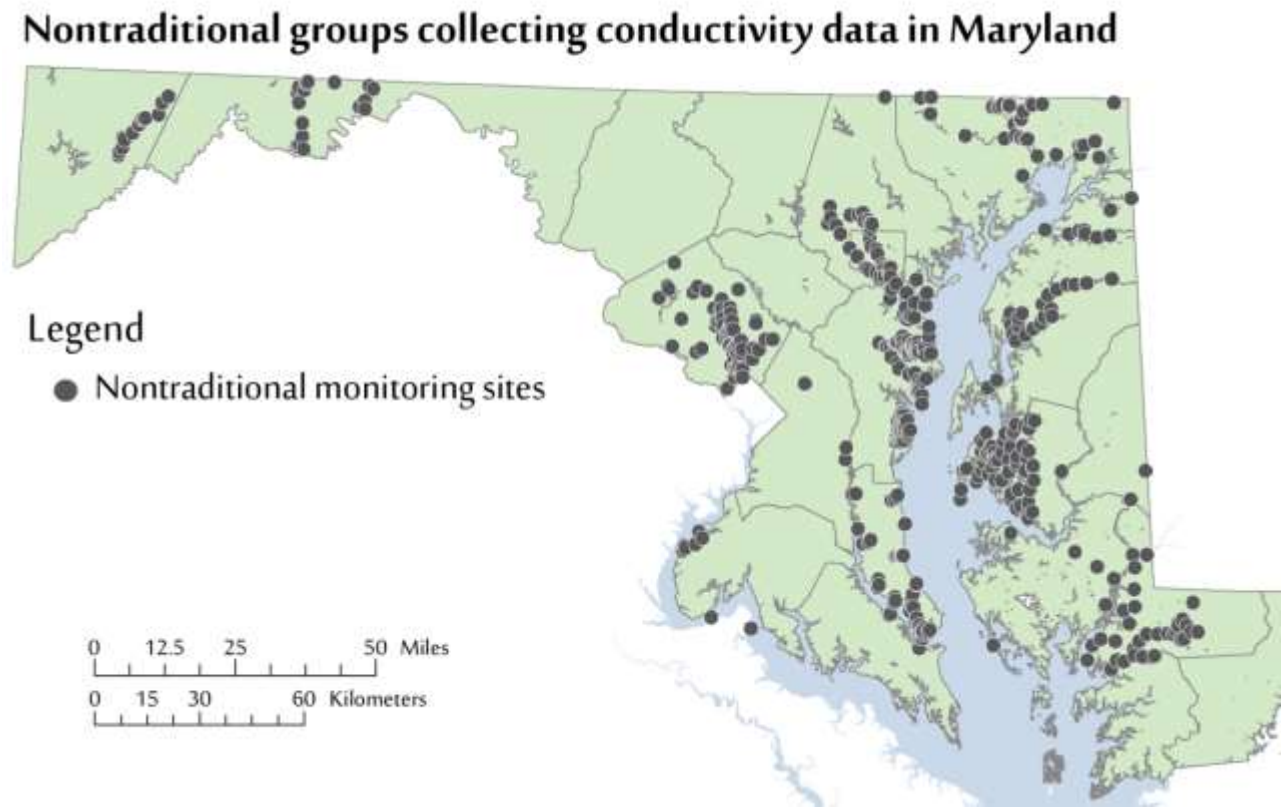

Figure 7. As a priority for Maryland Department of Natural Resources and Maryland Department of the Environment, the CMC evaluated a sample of volunteers and nontraditional monitoring groups to get a spatial picture of where conductivity data are currently collected.

Two broad areas of Maryland were highlighted for their data gaps in nontidal water quality information. Those areas are the western counties (Garrett, Allegheny, Washington, Frederick, and Carroll) and the Eastern Shore (Cecil, Kent, Queen Anne's, Talbot, Caroline, Dorchester, Wicomico, Somerset and Worcester Counties), illustrated in Figure 8.

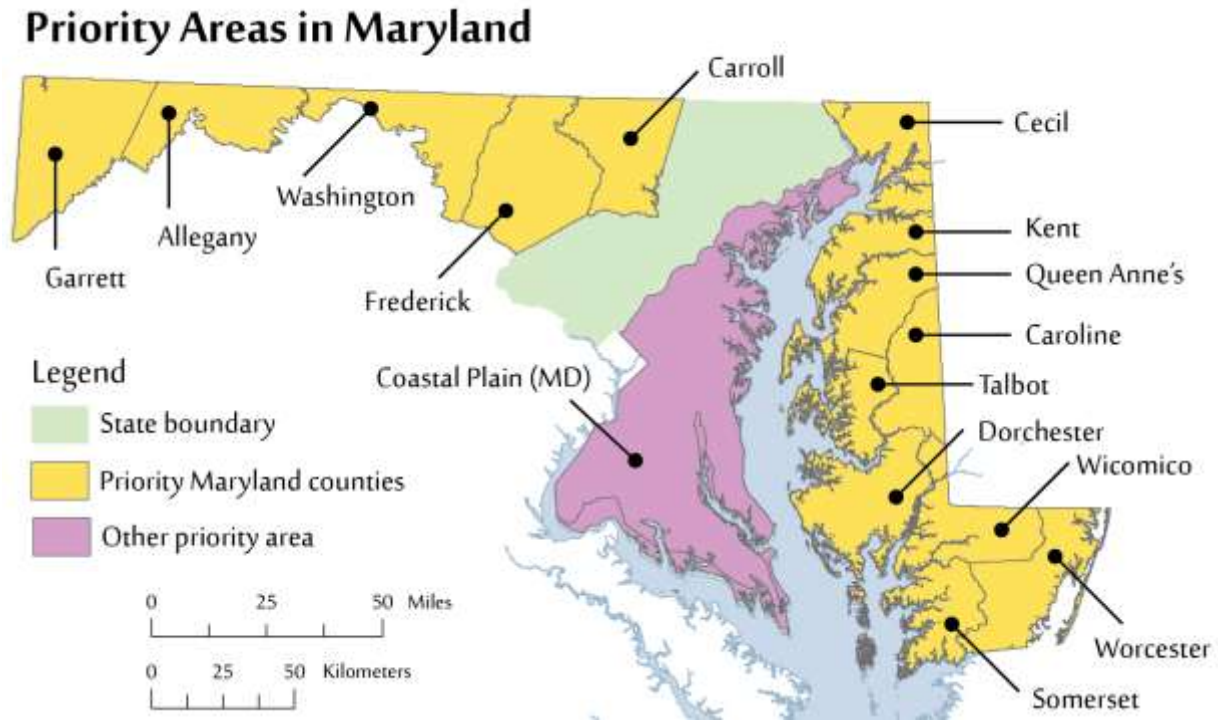

Figure 8. Priority counties were identified by Maryland Department of Natural Resources and Maryland Department of the Environment for targeted CMC outreach and data integration. In addition, CBP staff identified the Coastal Plain ecoregion as a priority area, which includes the entire Eastern Shore and the Western Shore Uplands and Lowlands of Maryland. Several tidal creeks on the Eastern Shore were also identified as priority areas, which are clearly defined in Figure 9.

In the western counties, water quality data such as dissolved oxygen, water temperature, conductivity, and pH are needed to establish baseline conditions. Additionally, Marcellus Shale natural gas well impact monitoring and acid mine drainage mitigation monitoring of water quality were identified as needs in specific areas within the western counties.

On the Eastern Shore, basic water quality data such as dissolved oxygen, water temperature, conductivity, and pH are needed to determine baseline conditions. The Coastal Plain ecoregion, which includes the entire Eastern Shore of Maryland, was identified as needing more data.

Specific areas identified as priority areas in Maryland included Marshyhope Creek, the Little Choptank River, Harris Creek, the Pocomoke River, the creeks along the northern shore of the Potomac River, and the area around southern St. Mary's County. Additionally, the Coastal Plain, which includes many small tidal creeks, is another priority for additional data. There are gaps in information about these small tidal creeks because they are difficult to access by motorized boats used by agencies for monitoring. These small tidal creeks are in the tidal fresh and oligohaline areas of most tributaries in Maryland, and would benefit from additional environmental health information from on-the-ground volunteer monitors.

Areas where more data would be helpful to better understand nutrient exporting from certain watersheds are shown in Figure 9. Parameters that Maryland Department of the Environment is interested in are dissolved oxygen, Biological Oxygen Demand, chlorophyll *a*, pH, Total Suspended Solids, turbidity, water temperature, nitrogen, and phosphorus.

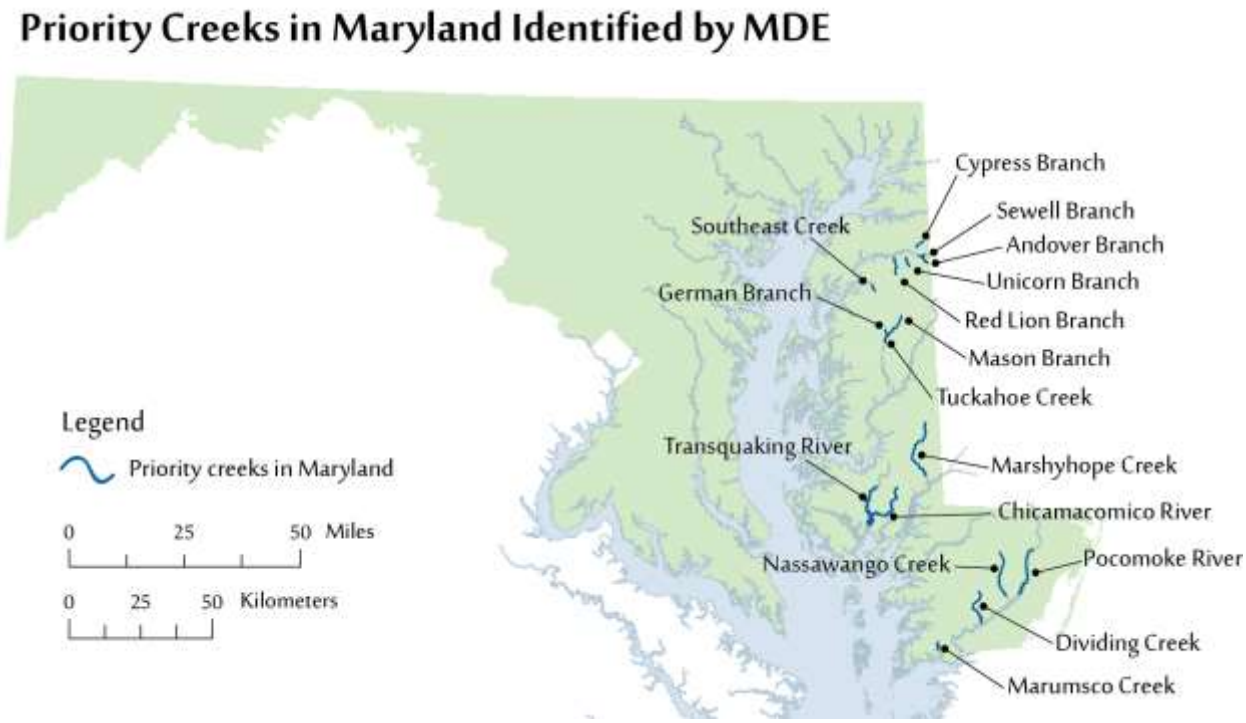

Figure 9. Tidal Creeks highlighted by Maryland Department of the Environment as specific watersheds of interest, seeking additional water quality data to better understand nutrient exporting.

Priority areas for Maryland state agencies cover a variety of targeted monitoring goals. For example, monitoring water quality both before and after best management practice implementation in order to measure and evaluate the effect of management actions is a priority for several agencies. Maryland's Chesapeake & Atlantic Coastal Bays Trust Fund leverages funds and resources to accelerate restoration of the Chesapeake and Coastal Bays. However, monitoring the effectiveness of those restoration projects is limited. There is a need for pre- and post-restoration monitoring at such sites.

Other priority areas for Maryland state agencies are Maryland's 8-digit scale watersheds that are impaired for water temperature standards. These watersheds could be monitored by volunteer or nontraditional groups using Maryland Department of the Environment's (MDE) protocol which would contribute greatly to understanding temperature trends and could potentially delist some of these watersheds.

CMC Preliminary Plan of Action

The CMC has contacted multiple tidal water quality monitoring groups to encourage their participation in the Cooperative. Blue Water Baltimore and the Nanticoke Watershed Alliance were identified as candidates for Tier 3 (for use in Clean Water Act water quality standards attainment assessments) data collection. These two groups were audited in the fall of 2016 to evaluate how their programs meet or need to be adapted in order to meet the Tier 3 assessment protocols for select water quality parameters (e.g., dissolved oxygen). See Appendix B for more information. Furthermore, the CMC partnered with the Maryland Water Monitoring Council (MWMC), MDE, and others to provide a *Data to Decisions Workshop* that targeted Maryland watershed organizations for better inclusion in Maryland state water quality assessments and reporting. These reports are traditionally funneled to the CBP partnership. The CMC has also participated in the MWMC annual meeting and will continue to participate in many networking events with the agency and volunteer monitoring communities in Maryland. Additionally, the CMC has connected several monitoring groups directly with Maryland state agencies based on identified priority areas such as the Nanticoke Watershed Alliance and MDE.

The Chesapeake Monitoring Census identified volunteer and nontraditional groups collecting data of interest in the identified priority areas (Appendix A). Several of these groups have also identified interest in using the new Chesapeake Data Explorer (i.e. the database being developed for the CMC) for storing and visualizing their data and adapting to the CMC standardized protocols and quality assurance project plans. The CMC will target outreach and training to the groups accordingly. In a later section, Table 4 lists the number of monitoring groups in Maryland who responded to the census, and are collecting priority biological, physiochemical, and visual monitoring parameters, providing some insight into the vast under-utilized data available in the state.

New York

The New York State Department of Environmental Conservation (NYSDEC) developed a citizen-based program, the Water Assessments by Volunteer Evaluators (WAVE), in 2012 to collect benthic macroinvertebrate data to assess water quality of wadable streams. NYSDEC through the WAVE program offers training to volunteers for sample collection, and the WAVE coordinator identifies all the benthic macroinvertebrates to the family level. NYSDEC is interested in detecting change in water quality over time, identifying threats to streams, and targeting restoration activities. The WAVE program keeps track of existing stream conditions and flags sites for the NYSDEC that show potential water quality issues which may deserve further investigation at the professional level. WAVE data is also used for:

- State and Federal Reporting - No Known Impact sites are included in the NYS Waterbody Inventory and EPA's Clean Water Act Section 305(b) reporting.
- Monitoring Reports - WAVE data are included in the Trend Monitoring and basin reports.
- Rotating Integrated Basin Studies - WAVE data are considered when sites are selected for DEC's monitoring program.
- Non-point Source Discharges Issues - WAVE data provide basic background information on water quality conditions for NYSDEC staff working on non-point discharge sources.

There are a number of monitoring stakeholders in the Upper Susquehanna including the New York Water Sentinels (organized by the Mid-Atlantic chapter of the Sierra Club), Trout Unlimited, and the Upper Susquehanna Coalition, which works with the Soil and Water Conservation Districts and watershed organizations on stream assessments and restoration projects.

To reiterate, the data needs identified by key stakeholders (Table 2) in New York are:

- Fill data gaps for Clean Water Act 305(b)/303(d) assessments
- Monitor restoration progress and conservation effectiveness or conduct impact assessment (pre- and post-implementation)
- Collect longitudinal data and monitor trends over time
- Higher frequency monitoring of impaired waters
- Promote stewardship and provide opportunities for community outreach and engagement
- Identify areas of high nutrient and sediment loading
- Climate change resiliency

CMC Preliminary Plan of Action

The CMC team is having ongoing conversations with NYSDEC (including WAVE), the Upper Susquehanna Coalition (USC), and the Community Science Institute, a nonprofit state-certified water quality testing lab which partners with volunteers to monitor water quality in New York's Finger Lakes and Southern Tier regions. NYSDEC would like to see additional participation in their WAVE program and USC would like to see additional community monitoring efforts in the upper Susquehanna River watershed. NYSDEC prepares a map each year of the monitored and unmonitored streams (Figure 10), which will serve as the starting point for outreach and engagement. A strong desired outcome from NYSDEC of the CMC is the expanded community engagement that volunteers monitoring their local waterways can provide. The CMC intends to support that objective in all outreach and engagement in New York.

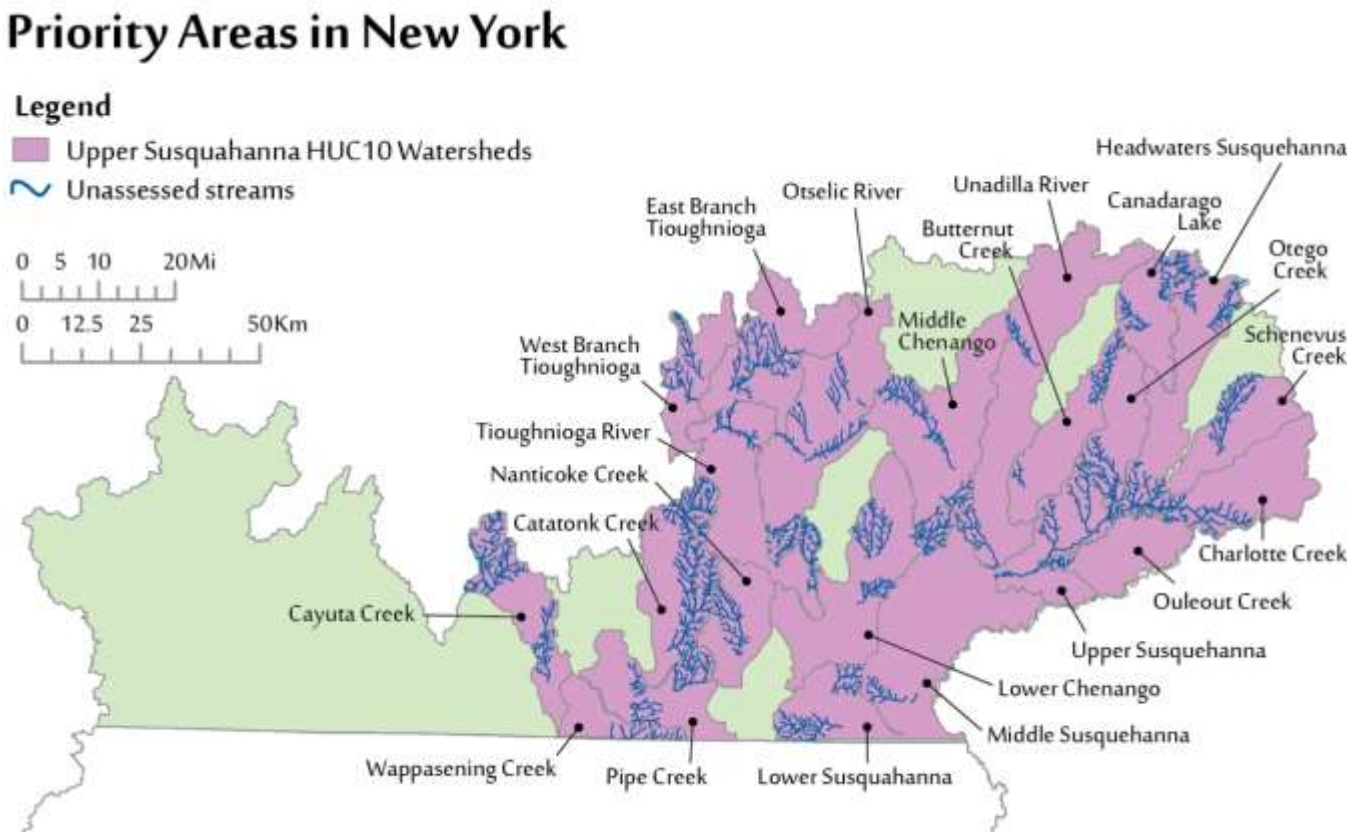

Figure 10. Depicted in this figure are the New York State Department of Environmental Conservation identified unassessed stream segments as of spring 2016. To provide some spatial context for the unassessed streams, smaller watershed (10-digit Hydrologic Unit Code, or HUC10 Watersheds) boundaries are labeled.

Pennsylvania

Pennsylvania has a rich history of watershed group engagement and volunteer monitoring. To help ensure that communities were conducting question-driven programs and matching the appropriate equipment with the intended data use, the Pennsylvania Department of Environmental Protection (PADEP) provided direct assistance through its Citizen Volunteer Monitoring Program (CVMP) established in 1996 and through the Consortium for Scientific Assistance to Watersheds (CSAW) established in 2001. In July 2009, due to budget constraints, PADEP eliminated its CVMP, which coordinated volunteer monitoring activities and data use at the agency. It continued to fund technical support to volunteer monitors by renewing grant funding for the CSAW at a reduced level. As a result, volunteer monitoring efforts dwindled. Today, PADEP would like to use volunteer monitoring data to screen streams for water quality issues to highlight in their integrated reports as well as assess potential progress from stream restoration projects, best management practices, and abandoned mine land remediation projects.

PADEP recruits volunteers from across the state for bacteria monitoring for the purpose of Recreational Use assessments. Volunteers are trained by PADEP in adherence to sampling protocol and quality assurance plans. All fecal coliform laboratory analysis is completed by PADEP certified laboratories. The bacteria data collected by various citizen volunteer groups in 2014 and 2015 resulted in the assessment of approximately 250 stream miles for Recreational Use.

In addition to CSAW, there are other organizations who work with volunteer monitors such as: Nature Abounds, Pennsylvania Senior Environment Corps, Trout Unlimited (with 53 chapters in the state), and Penn State Extension (recently developed a Master Watershed program).

The CMC will help identify the quality and potential use of water quality and benthic macroinvertebrate data collected throughout the state of Pennsylvania. With input from data users, the CMC has identified the priority objectives where CMC can provide assistance.

To reiterate, the data needs identified by key stakeholders (Table 2) in Pennsylvania are:

- Monitor restoration progress and conservation effectiveness or conduct impact assessment (pre- and post-implementation)
- Stormwater MS4 monitoring
- Establish baseline water quality data (nontidal)
- Marcellus Shale natural gas and acid mine drainage mitigation
- Promote stewardship and provide opportunities for community outreach and engagement
- Climate change resiliency
- Monitor the impacts of pipelines
- Monitor areas with high concentrations of agriculture

Priority watersheds and data needs

At the Prioritization Workshop, a number of watersheds were identified as high priority areas for more data collection. These watersheds include:

1. Chiques Creek
2. Octoraro Creek
3. South Branch Conewago Creek
4. Fishing Creek
5. Kishacoquillas Creek

These watersheds are within the counties of Lancaster, York, Lebanon, Dauphin, Adams, Cumberland, Mifflin, and Columbia (Figure 11). They are mostly heavy agricultural areas; however, agencies do not have the resources to monitor with enough frequency to support effective water quality change detection from implementation of current BMPs or planned BMP implementation.

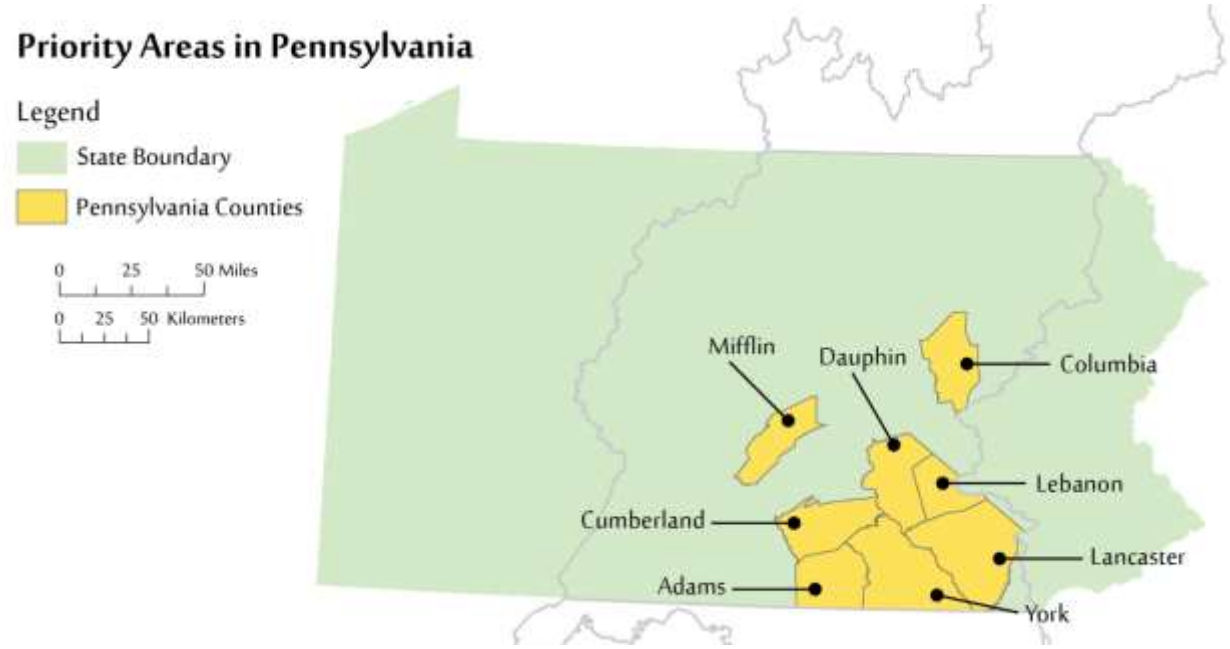

Figure 11. Priority watersheds were identified by Pennsylvania Department of Environmental Protection and the Susquehanna River Basin Commission within eight counties with high levels of agricultural land use.

Data users are also interested in monitoring coal mining legacy areas to determine the effectiveness of remediation actions on water quality.

CMC Preliminary Plan of Action

The CMC will review programs and offer technical support and training to water quality monitoring programs located in the target watersheds. Additionally, there is the potential for volunteers to collect and report aesthetic feature/visual integrity assessments of BMP maintenance. The CMC will explore recommending tools or providing support for this need.

Virginia

In 2002, the Virginia General Assembly codified a law that Virginia Department of Environmental Quality (VADEQ) had to establish a citizen water quality monitoring program and provide technical assistance and grant funding to support citizen water quality monitoring groups. Currently, VADEQ has a Quality Assurance Coordinator to review submitted data and a Water Quality Data Liaison to support the integration of volunteer monitoring data, and also provides funding to groups which allows them to purchase more sensitive equipment and therefore provide more accurate data. The CMC team has learned a great deal from the successes with volunteer monitoring in Virginia, and seeks to provide ongoing support for VADEQ's continued efforts.

To reiterate, the data needs identified by key stakeholders (Table 2) in Virginia are:

- Fill data gaps for Clean Water Act 305(b)/303(d) assessments

- Establish baseline water quality data (tidal)
- Establish baseline water quality data (nontidal)
- Higher frequency monitoring of impaired waters
- Promote stewardship and provide opportunities for community outreach and engagement
- Climate change resiliency
- Monitor the impacts of pipelines

Priority watersheds and data needs

VADEQ is interested in connecting with more organizations that can help increase the amount of water quality and benthic macroinvertebrate data collected and fill some of the current data gaps. Two broad areas of Virginia were highlighted that have data gaps in water quality information, the Piedmont region in central Virginia and the Bay side of the Virginia Eastern Shore (Figure 12). In the Piedmont region, Soil and Water Conservation Districts (SWCD), such as Monacan, Piedmont, Tri County/City, Henricopolis and Peter Francisco were identified as excellent potential partners for the VADEQ. In addition, the Tri-county/City SWCD has a volunteer monitoring program called the Fredericksburg Area Monitoring for the Environment (FAME), which includes a Bacteria monitoring QAPP with VADEQ. Also with a VADEQ approved volunteer water quality monitoring QAPP, is the Henricopolis SWCD program, called the Henrico Area Water Quality Samplers (HAWQS). These are examples of a partnership opportunity where the CMC can leverage already existing relationships.

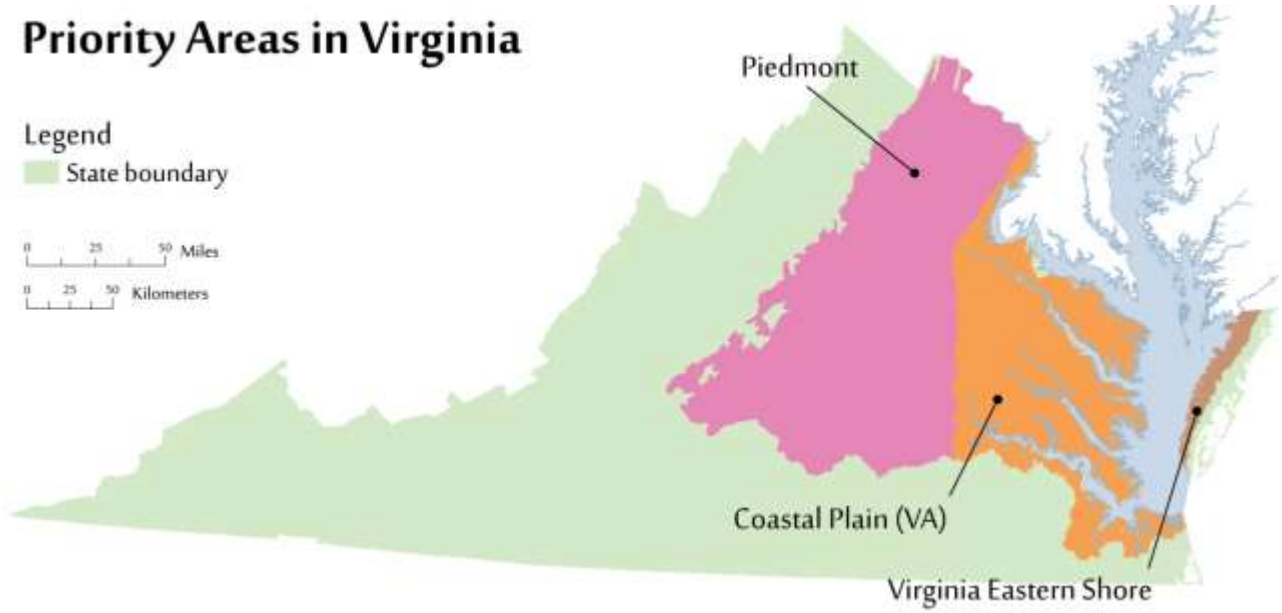

Figure 12. The Piedmont region in central Virginia and the Chesapeake Bay side of the Virginia Eastern Shore were identified as having significant water quality data gaps by Virginia Department of Environmental Quality. Per their recommendation, the CMC is researching potential partnerships with Soil and Water Conservation Districts in the Piedmont region, as they are already actively monitoring water quality. In addition, CBP staff identified the Coastal Plain ecoregion as a priority area, which

includes the area east and south of the Piedmont Plateau in Virginia. The unassessed creeks in VA were also identified as a priority, which are clearly defined in Figure 13.

VADEQ is interested in basic water quality data (dissolved oxygen, water temperature, and pH) needed to determine baseline conditions specifically of second order streams and under-monitored impaired waters. These waters are represented as priority creeks in Virginia in Figure 13. As shown in Figure 13, a number of priority creeks in Virginia are currently being monitored by volunteers. In addition to the aforementioned priorities, VADEQ is open to any water quality data submitted by volunteers, such as benthic macroinvertebrates, fecal indicator bacteria, and others.

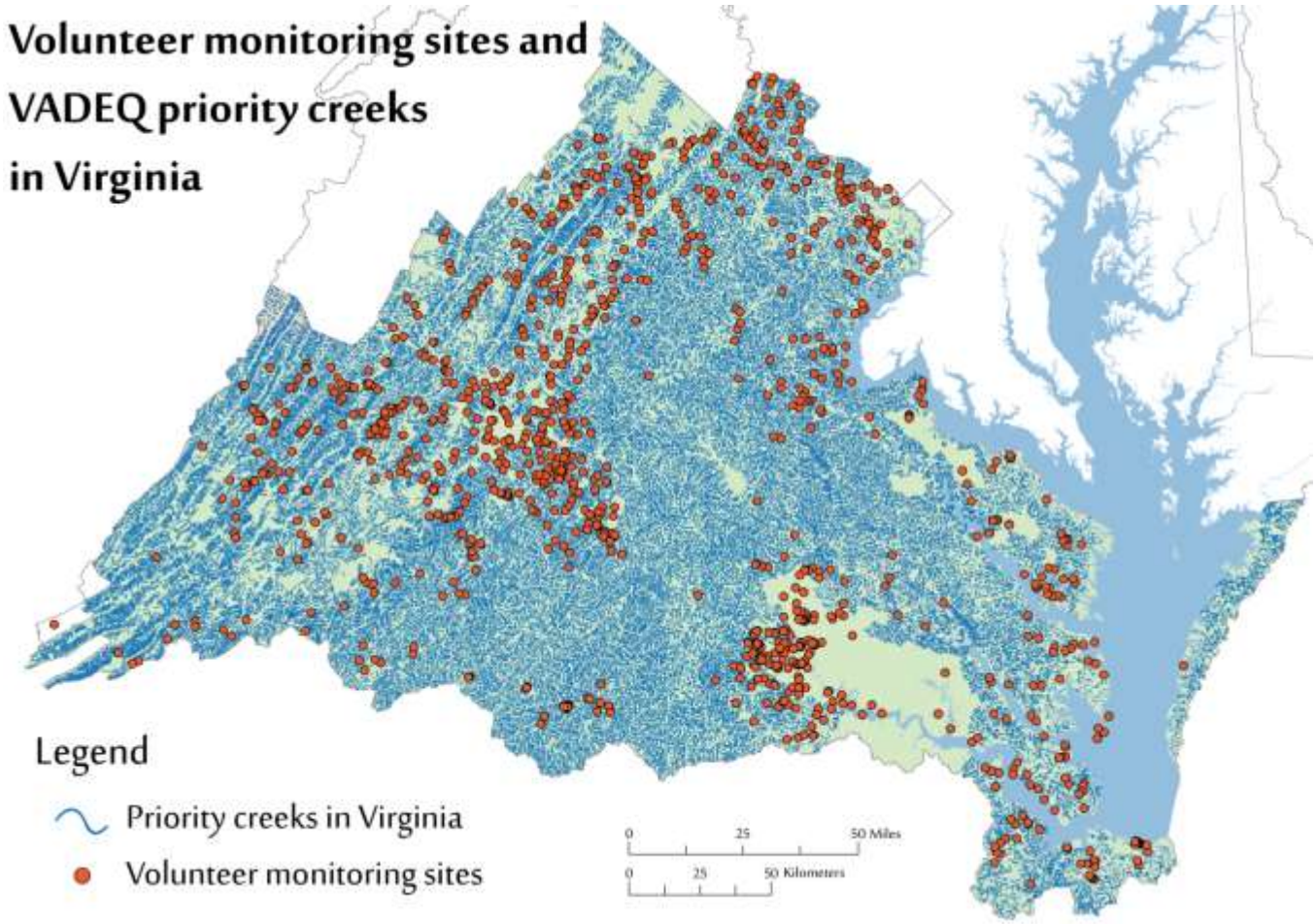

Figure 13. Virginia Department of Environmental Quality provided the location of priority creeks in Virginia. The volunteer monitoring sites are a sample of where volunteer or nontraditional monitoring groups are actively monitoring in Virginia based on the response to the Chesapeake Monitoring Census. Engaging and partnering with SWCDs in Virginia may help address the spatial gap in the Piedmont region seen in this figure.

VADEQ also identified the lower Rappahannock and York Rivers as priority areas for increased outreach and engagement for the CMC, and the need for increased reliability (data quality) in water temperature, dissolved oxygen, pH, and chlorophyll *a* (only in lakes/large rivers) data watershed-wide.

CMC Preliminary Plan of Action

The CMC connected with VADEQ to organize the Virginia Citizens for Water Quality summit that targeted Virginia watershed organizations for better inclusion in Virginia state water quality reporting. VADEQ identified interest in working with the Waterman's Museum, James River Watch, the U.S. Coast Guard Auxiliary, Lynnhaven River NOW, Elizabeth River Project, Friends of the Appomattox (historical group with potential to reinvigorate), Virginia Aquarium, Virginia Master Naturalist Chapters, the Nansemond River Preservation Alliance, and Trout Unlimited. VADEQ also encouraged the CMC team to research potential partnerships with waste water treatment plants and universities that have certified laboratories with the potential to process volunteer collected water samples at a reasonable rate.

Based on VADEQ's suggestions, the Alliance's RiverTrends program is currently working on building a relationship with the Waterman's Museum. The Izaak Walton League of America is currently working with the James River Watch to develop a benthic macroinvertebrate monitoring program. The CMC opened discussions with Trout Unlimited for expanding their pipeline monitoring program in Virginia to support the monitoring of local cold-water streams for impacts from shale gas and pipeline development, specifically using the CMC benthic macroinvertebrate monitoring protocols. Furthermore, the CMC has begun researching potential models for partnerships between volunteers and certified laboratories (i.e. The Community Science Institute in Albany, NY).

West Virginia

West Virginia Save Our Streams (WVSOS) provides the state with enhanced ability to monitor and protect surface waters through increased volunteer-collected water quality data. This program is run by WVDEP with the support of a WVDEP hired coordinator. WVSOS aims to collect information on watersheds where the state is unable to discern current impacts from nonpoint source pollution or to determine areas that may improve after installation of BMPs.

The CMC team received input from West Virginia Department of Environmental Protection (WVDEP), WVSOS, Trout Unlimited, West Virginia Rivers Coalition, and the Blue Ridge Watershed Coalition, outside of the Prioritization Workshop. Additional spatial and temporal coverage needs were identified based on the objectives of the WVDEP that cannot be met with the existing state monitoring networks.

To reiterate, the data needs identified by key stakeholders (Table 2) in West Virginia are:

- Monitor restoration progress and conservation effectiveness or conduct impact assessment (pre- and post-implementation)
- Promote stewardship and provide opportunities for community outreach and engagement
- Identify areas of high nutrient and sediment loading
- Monitor areas undergoing change (i.e. development)
- Climate change resiliency

- Monitor the impacts of pipelines

Priority watersheds and data needs

WVDEP identified five priority watersheds for volunteer and nontraditional data integration: Sleepy Creek and Warm Springs Run in Morgan County, West Virginia's tributaries to the Shenandoah River in Jefferson County, Cacapon River and its tributaries, the Lost River and North River in Hardy, Hampshire, and Morgan Counties, and Elks Run and Elk Branch in Jefferson County (Figure 14).

Figure 14. West Virginia Department of Environmental Protection identified watersheds for volunteer and nontraditional data integration within the four WV counties of Jefferson, Morgan, Hampshire, and Hardy.

Trout Unlimited identified a need for more water and air temperature monitoring data to support the community's understanding of climate change impacts and trout habitat assessments, as well as more support for their (in cooperation with West Virginia Rivers Coalition) pipeline monitoring program. WVDEP acknowledged the need for technical support to integrate data from active volunteer monitoring groups into their networks. One example is the Blue Ridge Watershed Coalition. WVDEP is

seeking support in evaluating their quality assurance procedures in comparison with current WVDEP guidelines.

CMC Preliminary Plan of Action

The CMC team plans to support the valuable work already underway such as the Potomac River headwaters initiative of the WVSOS, as well as to help integrate active groups such as the West Virginia Rivers Coalition and Blue Ridge Watershed Coalition. Additionally, the expansion of the Trout Unlimited and West Virginia Rivers Coalition pipeline monitoring program (including water quality and benthic macroinvertebrate monitoring), by helping to establish reference sites and sites downstream, along the Potomac, from established pipelines, will be a focus of the CMC in West Virginia.

Trout Unlimited and West Virginia Rivers Coalition surveyed West Virginia residents and identified volunteer monitoring interest areas. The CMC team can leverage that information to help support the expansion of active programs in West Virginia based on the objectives and interest of potential volunteers.

Extensive Monitoring of the Watershed

The Chesapeake Monitoring Census was used to identify common goals and objectives of volunteer and nontraditional monitoring groups. The responses to this Census provided an assessment of the potential for collaboration between the diverse monitoring entities in the Chesapeake Bay watershed. The Census received 93 responses to the question "why do you monitor?" from April 1 – November 23, 2016.

The responses varied widely in specificity and content, but nine major goals emerged and responses were sorted into these categories. If responses listed several goals, they were broken into segments and sorted appropriately. If responses applied to two categories, they were listed within each appropriate category. The 93 responses from Census respondents were broken into 173 sub-responses, which were sorted into the nine goal categories. Goal categories ranged in popularity among respondents—For example, 22% of the 93 respondents expressed a desire to establish baseline data, which was a commonly cited response with 20 mentions and a common objective of state agencies within the Chesapeake Bay watershed.

Each of the nine goals listed in Table 3 is accompanied by a list of relevant monitoring parameters and/or style of data collection that can be compared to volunteer and nontraditional monitoring groups in Appendix A.

Table 3. Nine major goals identified by volunteer and nontraditional monitoring groups:

Major Goals	Associated monitoring parameters	Percentage of respondents who mentioned goal
1. Learn about the environment, educate and communicate environmental issues to community members	Parameters that are easy to collect and data that are easy to interpret that give a picture of the environment's total health	30%
2. Monitor restoration progress and conservation effectiveness or conduct impact assessment	Nutrients and sediments, benthic macroinvertebrates, fish population/community	27%
3. Address general concern for habitat and water quality	Parameters that measure community biodiversity or habitat suitability of environment, such as benthic macroinvertebrates, water clarity, and SAV	25%
4. Establish baseline water quality data	Water quality, nutrients, water clarity, chlorophyll *a*, dissolved oxygen	22%
5. Identify impaired waters to advocate for or assess compliance and influence policy	Nutrients, ammonia, trash, sediment, bacteria, benthic macroinvertebrates	20%
6. Collect longitudinal data and monitor trends over time	pH and nutrients	18%
7. Discover if public health and human recreation are safe (drinking, swimming, fishing)	E. coli, bacteria, enterococcus, fish tissue toxicity, fish community	16%

8. Promote stewardship and provide opportunities for community outreach and engagement	Parameters that are easy to measure and interpret data, inexpensive to promote maximum involvement, such as macroinvertebrates and water clarity	16%
9. Provide scientists and agencies with credible data for their work	All parameters, but with higher quality assurance/quality control, more expensive sample processing and more frequent sampling	12%

In order to identify the potential for collaboration beyond observable shared goals and objectives, Table 4 provides a preliminary assessment of the number of volunteer and nontraditional monitoring groups measuring diverse parameters by jurisdiction. Each of these groups may be collecting data at anywhere between 1-1,000 locations within the jurisdiction.

Table 4. Number of volunteer or nontraditional monitoring groups measuring biological, physiochemical, and visual assessment/aesthetic feature parameters by jurisdiction.

Monitoring Parameter	DC	MD	DE	NY	PA	VA	WV
Biological Parameters							
Algae	1	13			3	5	2
Bacteria		16	1	1	2	15	1
Benthic macroinvertebrates	2	17		1	13	13	3
Birds		5			1	2	
Fish		12			3	2	
Salamanders		3				1	1
SAV		8			2	3	
Biological: Other	2	9	1	1	3	2	
Physiochemical Parameters							
% Saturation		12	1	1	2	3	2
Alkalinity		6		1	7	2	2
Ammonium		9		1	3	5	2
Biological oxygen demand		4			2		
Chlorophyll *a*		14	1	1	2	3	
Conductivity		24		1	14	7	3
Dissolved oxygen		29	1	1	14	13	3
Nitrates		15		1	14	9	3
Nitrites		9		1	3	5	3
Orthophosphate		9		1	12	7	1
pH		29		1	16	15	4
Salinity		21	1			8	1

Stream flow		13		1	12	15	4
Temperature		34	1	1	17	21	4
Total dissolved solids		7		1	8	2	2
Total nitrogen		16	1	1	5	3	1
Total phosphorus		17	1	1	6	4	1
Total suspended solids		12		1	4	2	1
Turbidity		15		1	10	13	4
Water clarity		24	1	1	4	5	2
Physicochemical: Other		8			6	4	
Visual Assessment Parameters							
Direct measurements of stream bed and bank		6			4	4	3
Trash	1	12			4	11	1
Visual habitat assessment	1	13		1	9	10	2
Visual observations of stream bed and bank	1	17		1	11	15	4
Physical/visual: Other	1	8			4	6	

How the CMC Will Approach the Integration of Monitoring Partners

CMC will engage with a variety of volunteer and nontraditional groups that are interested in monitoring surface water within the Chesapeake Bay Watershed. These groups will fall into one of two categories, depending on the monitoring methods and Quality Assurance procedures they choose to follow:

1. CMC Group – new or existing group that adopts the CMC Monitoring Program (i.e. non-tidal water quality, tidal water quality, and/or benthic macroinvertebrate quality assurance project plan(s) (QAPPs) and method(s)). All CMC Monitoring Programs follow an EPA-approved Quality Assurance Project Plan and Methods Manual to collect monitoring data. In addition, input from state agency staff was incorporated into the development of all monitoring methods and Quality Assurance procedures.
2. Conditional-CMC Group – group that does not follow the standardized CMC monitoring protocols and quality assurance procedures, but contributes data to the Chesapeake Data Explorer.

CMC will work with both CMC and Conditional-CMC Groups, but in different capacities.

New Monitoring Groups (CMC)

Groups looking to begin a water quality or benthic macroinvertebrate monitoring program will work with a CMC Partner to develop a study design that best meets the group's goals and answers their monitoring question(s), while fitting in with CMC goals. The customization will include selecting appropriate monitoring sites, parameters, and equipment, as described in the CMC Monitoring QAPPs. Following the study design process (Appendix B), the CMC Partner will provide the following assistance:

- Water quality and/or benthic macroinvertebrate monitoring training workshops
- Monitoring equipment support – maintenance, troubleshooting, loaned/reduced cost supplies
- Quality assurance and quality control support
- Data management – Chesapeake Data Explorer
- Data interpretation and report card development

CMC Partners will mentor new monitoring groups to ensure they implement a CMC Monitoring Program successfully.

Existing Monitoring Groups (CMC & Conditional-CMC)

When the CMC engages with a group that has an existing monitoring program in place, a CMC Partner will evaluate the program (methods, Quality Assurance procedures, and equipment) and identify changes that need to be made to align their program with the CMC Monitoring Program. Input from state agency staff and the CBP was incorporated into the development of CMC evaluation tools. If the group makes the changes necessary to follow the CMC Monitoring Program, they will become a CMC Group. If they choose to continue their program without incorporating the suggested changes, they will be a Conditional-CMC Group. CMC Groups will have access to the support offered to new monitoring groups; Conditional-CMC Groups will have access to support using the Chesapeake Data Explorer.

CMC technical support and services for CMC and Conditional-CMC groups are dependent on the types of services requested and geographical location (Figure 15).

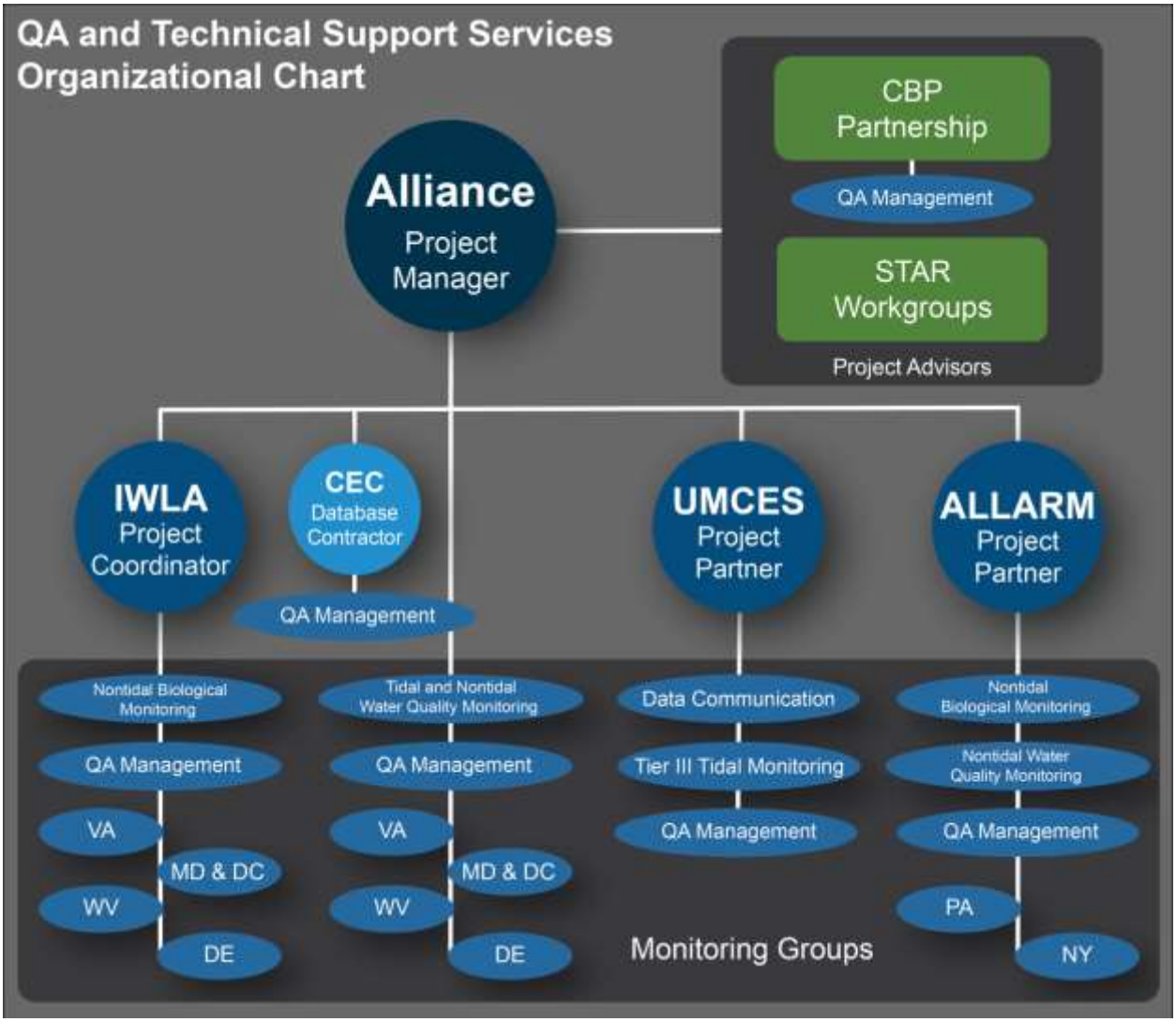

Figure 15. Organizational chart for data quality assurance and technical support services for CMC partners and interested parties. Volunteer and nontraditional monitoring groups will engage with the CMC through the application for assistance that will be available online (chesapeakemonitoringcoop.org) and submitted to the Alliance for the Chesapeake Bay. The Alliance for the Chesapeake Bay will connect the monitoring group with the appropriate CMC lead based on the above organizational chart. If a group is monitoring: water quality parameters in DC, DE, MD, VA, and/or WV, the CMC lead and point of contact is the Alliance for the Chesapeake Bay (ACB), monitoring benthic macroinvertebrates in DC, DE, MD, VA, and/or WV, the CMC lead and point of contact is the Izaak Walton League of America (IWLA), and monitoring water quality and/or benthic macroinvertebrates in NY and/or PA, the CMC lead and point of contact is the Alliance for Aquatic Resource Monitoring (ALLARM). For Tier 3 tidal verification

auditing and data interpretation workshops the point of contact is the University of Maryland Center for Environmental Science (UMCES), Integration and Application Network. ACB oversees all aspects of the project and is the main point of contact for all CMC project leads, the CBP partnership, and Chesapeake Environmental Communications (CEC) the developer of the Chesapeake Data Explorer.

Tier designation

The data collected from this project will be categorized into Tiers to help account for the variability of methods, quality assurance procedures, and equipment used to collect stream data. Classifying each data point will help data users understand how the data were collected. The CMC developed a Tiered Framework (Table 1) which lists potential ways the data collected by volunteer and nontraditional monitoring groups can be used by the CBP partnership. Tier 3 data have data requirements which adhere to the Chesapeake Bay Program's monitoring requirements for trends and assessments (Table 5).

Table 5. Required Methods and QA Protocols for CMC Groups by Tier

Tiers	Monitoring Methods and QA Procedures for CMC Groups
Tier 1 & 2	CMC developed QAPPs and methods manuals for tidal water quality monitoring, nontidal water quality monitoring, and/or benthic macroinvertebrate monitoring in nontidal streams
Tier 3	Chesapeake Bay Program's tidal water quality field and laboratory procedures

The CMC also created a rubric to help determine the appropriate Tier classification for Tier 1 and Tier 2 data. There are diverse monitoring practices used throughout the Chesapeake Bay watershed. As a result, the rubric is a data classification tool to help CMC review the monitoring techniques, quality assurance measures, and metadata of the volunteer and nontraditional data that will be integrated in the Chesapeake Data Explorer. Thus the rubric focuses on Tier 1 and Tier 2 data. The rubric, and corresponding tools such as checklists, will help to inform conversations that CMC will have with potential data contributors about data requirements. Finally, the rubric will facilitate a process that CMC will use to ensure that there is enough information corresponding with CMC datasets for users of the Chesapeake Data Explorer to make informed choices.

The rubric serves two needs:

- Determine if the data collected are suitable to be included in the Chesapeake Data (minimum requirements)
- Classify the data into Tiers (specific requirements)

A CMC Partner will use the rubric to determine the Tier for data collected in their region for both CMC and Conditional-CMC Groups. For more information about the resources and technical support the CMC is offering to data contributors, see Appendix B.

Prioritizing the Cooperative in States' Actions

Resources permitting, the CMC will support as many of the aforementioned priority objectives outlined by data users. The following recommendations reflect ideas discussed regarding how CBP partners and key stakeholders of the CMC can support the success of this project.

Further exploration into Virginia's codified law on volunteer monitoring

Prior to 2003, VADEQ had limited opportunities to use submitted volunteer and nontraditional data. This led to frustration by all parties due to seeing valuable data being underutilized. VADEQ was able to increase the standards for volunteer monitors in Virginia when the Virginia General Assembly approved the following law: § 62.1-44.19:11. In 2007, Part B of the law was added, which stimulated the development of a tracking tool to determine the specific geographic contributions volunteers provide to the agency. The CMC and key stakeholders are interested in exploring lessons learned from VADEQ's success with a codified law.

§ 62.1-44.19:11

A. The Department of Environmental Quality shall establish a citizen water quality monitoring program to provide technical assistance and may provide grants to support citizen water quality monitoring groups if (i) the monitoring is done pursuant to a memorandum of agreement with the Department, (ii) the project or activity is consistent with the Department of Environmental Quality's water quality monitoring program, (iii) the monitoring is conducted in a manner consistent with the Virginia Citizens Monitoring Methods Manual, and (iv) the location of the water quality monitoring activity is part of the water quality control plan required under § 62.1-44.19:5. The results of such citizen monitoring shall not be used as evidence in any enforcement action.

B. It shall be the goal of the Department to encourage citizen water quality monitoring so that 3,000 stream miles are monitored by volunteer citizens by 2010.

Adopt nontraditional data integration into regional monitoring strategies

State and regional government agencies who develop monitoring strategies should consider adopting a section on volunteer and nontraditional data integration, if applicable. This section could define a system for evaluation and permitted use of solicited volunteer and nontraditional data. The CMC has developed a suggested Tiered framework for data use and a data quality rubric for evaluation; however, the CMC team suggests that each jurisdiction modify and adopt a system based on their specific data needs. Additionally, the CMC team recommends a transparent system.

Identify the point of contact

The CMC team encourages each data user of the Chesapeake Data Explorer to identify a point of contact for the CMC team for ongoing conversations about metadata needs and potential for new partnerships.

Share our success stories

As the Chesapeake monitoring community, we need to identify success stories to share to bring more awareness to the great work of volunteers in our region and the benefits of collaboration between volunteer and nontraditional groups and government agencies. These success stories can be shared through a variety of outreach mechanisms such as the CMC quarterly e-newsletter, social media, and those used by CBP partnership communications team using a host of approachable multimedia applications.

Conclusion

The CBP partnership leads and directs Chesapeake Bay watershed restoration and protection, and there is an abundance of underutilized volunteer and nontraditional water quality data collected throughout the watershed available to aid in better understanding of Bay watershed health. However, the existing framework for integrating citizen science data into the CBP to help inform policy management decisions was previously limited. Therefore, the CMC developed a framework to categorize volunteer and nontraditional data into three tiers to identify the variability of methods, quality assurance procedures that help define program integrity, and equipment used to collect water quality monitoring data. The CMC recommends potential ways the water quality data collected by volunteer and nontraditional monitoring groups can be used by the CBP partner jurisdictions based on the tier classification, generated by input from the diverse partners of the CBP.

Investigating the priorities of the Chesapeake Bay watershed jurisdictions as summarized in this report provides basis and direction for the CMC's outreach and engagement. Moving forward, the water quality data that will be available to Chesapeake Bay watershed data users will undoubtedly lead to additional capabilities in assessment and management. This timely initiative has the potential to further enhance watershed implementation plans/objectives outlined in the 2014 Chesapeake Bay Watershed Agreement.

Glossary

Acid mine drainage – the result of water flowing over or through rocks containing sulfur-bearing minerals. The resulting chemical reaction is highly acidic waters. Typically occurs in connection with mining activity

Alkalinity – the ability of water to absorb acid (buffer capacity), the higher the pH (7-14 on the pH scale) the more alkaline the water is.

Ammonium – a form of nitrogen which aquatic plants and algae can absorb for growth

Baseline – initial collection of data that serves as a basis for comparisons of future data

Benthic Macroinvertebrate – organisms that live underwater in streams and rivers that do not have a backbone and can be seen by the naked eye. The diversity of organisms found are indicators of stream/river health.

Best Management Practice (BMP) – practice(s) that have been determined to be an effective and practical means of preventing or reducing pollution

Biological Oxygen Demand – the amount of oxygen consumed by microorganisms during oxidation of organic matter such as the decomposition of plant matter.

Chlorophyll *a* – the predominant green pigment found in microscopic algae in fresh and saltwater ecosystems, and used as a measure of microalgae abundance.

Coastal Plain – the level land downstream of the Piedmont and fall line, where soils are generally finer and fertile and rivers are influenced by the tide.

Conductivity – ability of water to conduct an electrical current due to the presence of charged particles,

Dissolved Oxygen – the amount of oxygen gas that is present in the water.

Impaired waters – waterways that do not meet water quality standards set by jurisdictions and/or the Clean Water Act.

Marcellus Shale – sedimentary rock formation thousands of feet below the surface stretching from upstate New York through Pennsylvania to West Virginia and parts of Ohio containing natural gas.

Nitrate – a form (ion) of nitrogen used by plants and animals

Nitrite – a form (ion) of nitrogen used by plants and animals

Nitrogen – an essential nutrient for all life, can be a limiting factor

Non-point source – sources of pollution that come from many diffused sources and cannot be traced to a single source. For example: runoff from lawns, farmland or streets.

Nontraditional monitoring – for the sake of this project, nontraditional monitoring refers to efforts by monitoring groups who do not traditionally submit their data to the Chesapeake Bay Program.

Nutrient – any substance that provides for essential growth and life

Orthophosphate – a form of phosphorous that can be absorbed by living organisms, used to provide an estimation of the amount of phosphorus available for plant growth.

pH – a measure of how acidic or basic water is. The pH scale ranges from 0-14, with 7 being neutral. pH less than 7 indicates acidity, and a pH greater than 7 indicates a base.

Phosphorus – an essential nutrient for all growth and reproduction.

Phycoerythrin – photosynthetic pigment found in certain algaes

Piedmont – uplands or hill country located above the fall line. Rivers and streams in the Piedmont region are not influenced by the tide.

Priority area – any area with an identified need for more information that could conceivably be filled by volunteer or nontraditional data of known quality.

QAPP – Quality Assurance Project Plan – documentation that provides the framework and procedures used to meet quality assurance standards

Salinity – a measure of the salt content of water, the weight of salt per volume of water measured in parts per thousand (ppt)

Submerged aquatic vegetation (SAV) – technical term for underwater bay grasses. SAV help improve water quality and provide important food and habitat for fish, shellfish, invertebrates, and waterfowl.

Shale gas – natural gas that either resides or has been extracted from a shale formation such as the Marcellus Shale

Spatial – relating to space or geographic spread of sampling

Stormwater MS4 – Stormwater Municipal Separate Storm Sewer System permitting

Study Design – The process of making choices and decisions about your monitoring program, such as: What are your primary watershed concerns? What parameters and/or methods are appropriate to answer your monitoring question? Where to monitor?

Temporal – relating to time or frequency of sampling

Total Maximum Daily Load (TMDL) – the total maximum amount of pollutant allowed in a water body in order to meet water quality standards

Total suspended solids (TSS) – solids within a water column that can be trapped by filtration

Turbidity – a measure of the clarity of a water body; the cloudiness of the water

Appendix A: Catalogue of Volunteer Monitoring Groups who Participated in the Chesapeake Monitoring Census

This includes the basic information for groups who participated in the Census. There are still more groups throughout the Watershed that need focused attention.

Table A-1. Catalogue of Volunteer and Nontraditional monitoring groups

Name of Organization	Physicochemical parameters	Biological Parameters	State	County/City/Township/ Ecoregion
Potomac Riverkeeper Network	Metals	Algae	DC	Potomac River
Rock Creek Conservancy	None	Benthic macroinvertebrates	DC	Rock Creek Watershed
Smithsonian Anacostia Community Museum	DO, Nitrates, Nitrites, pH, TP, Cond, Turb	Benthic macroinvertebrates	DC	Anacostia Watershed
Anne Arundel Community College	DO, Temp, pH, TSS, Cond, Salinity	Benthic macroinvertebrates, Bacteria	MD	Dividing Creek, Anne Arundel County
Anne Arundel Community College Environmental Center	DO, Temp, pH, TN, TP, TSS, Cond, Water Clarity, Salinity, Chla	Bacteria	MD	Spa Creek on the Severn Mill River and Dividing Creek on the Magothy River
Audubon Naturalist Society	Temp, pH	Benthic macroinvertebrates	MD and DC	Montgomery County, MD, and Washington, DC
Back Creek Conservancy	DO, Temp, % Sat, pH, TSS, BOD, Cond, Turb, Water Clarity, Salinity	Benthic macroinvertebrates, Bacteria, Fish, Algae, SAV, Birds, Turtles, Rays, Snakes	MD	Back Creek, Annapolis, Anne Arundel County
Baltimore County Dept of Environmental Protection & Sustainability	DO, Temp, % Sat, pH, Ammonium, Nitrates, Nitrites, TN, Ortho-P, TP, TSS, BOD, Cond, Salinity	Benthic macroinvertebrates, Bacteria, Fish, SAV, Salamanders	MD	Baltimore County
Bird River Restoration Campaign		Bacteria	MD	Bird River, Windlass Run, Honeygo Run, Whitemarsh Run, Gunpowder River
Blue Water Baltimore	DO, Temp, % Sat, pH, Nitrates, Nitrites, TN, TP, Cond, Turb, Water Clarity, Salinity, Chla, Phycoerythrin	Bacteria	MD	Jones Falls and Gwynns Falls, Patapsco River

Calvert County	DO, Temp, pH, Ammonium, Nitrates, Nitrites, Ortho-P, TDS, TSS, Cond, Water Clarity, Salinity, Chla	Algae	MD	Streams and creeks in Calvert County
CAT-N	DO, Temp, % Sat, pH, Alkalinity, Ammonium, Nitrates, Nitrites, TN, Ortho-P, TP, TDS, TSS, Cond, Turb, Water Clarity, Salinity, Chla, CDOM, Oil, Optical Brighteners	Benthic macroinvertebrates, Bacteria, Fish, SAV, Birds	MD	Severn River and South River Tidal and Watershed
Cecil Senior Environment Corps	DO, Temp, pH, Alkalinity, Nitrates, Ortho-P, Cond, SO4	Benthic macroinvertebrates	MD	Cecil County
Chesapeake Bay Foundation	DO, Temp, pH, Nitrates, Ortho-P, Water Clarity, Salinity, Cond	Fish	MD	Chesapeake Bay in and around Tangier Sound and near Bishop's Head (Accomack Co., VA, Somerset/Dorchester Cos., MD), Anacostia River (Washington DC), Potomac River (Washington DC), Susquehanna River (Cecil Co., MD, Lancaster Co., PA), Patapsco River/Baltimore Inner Harbor, Creeks and streams in Southern PA (Mountain Creek, Hammer Creek, Swatara Creek, Long Pine Run), James River (Charles City, VA), Lynnhaven River/Chesapeake Bay (Virginia Beach)
Chesapeake Bay National Estuarine Research Reserve (MD Dept of Natural Resources)	DO, Temp, pH, Nitrates, TN, Ortho-P, TP, TSS, Cond, Turb, Salinity, Chla	Fish, Algae, SAV, Birds	MD	Bush River (Harford County), Patuxent River (Anne Arundel and Prince George's counties) Little Monie Creek (Somerset County)

City of Baltimore	DO, Temp, % Sat, pH, Alkalinity, Ammonium, Nitrates, Nitrites, TN, Ortho-P, TP, TDS, TSS, Cond, Turb, Water Clarity, Chla	Bacteria, Algae	MD	City of Baltimore
Fox Haven Organic Farm & Learning Center	Water Clarity	Benthic macroinvertebrates, Algae	MD	Lewis Creek and Catoctin Creek (Frederick County, MD)
Friends of the Bohemia	DO, Temp, pH, TN, TP, Cond, Turb, Water Clarity, Salinity, Chla, (For Tidal, different for Nontidal)	Benthic macroinvertebrates, SAV	MD	Bohemia River Watershed
Gunpowder Riverkeeper	DO, Temp, pH, TSS, Cond, Turb, Water Clarity, Salinity	Benthic macroinvertebrates, Bacteria, Fish, Algae	MD	Carroll, Baltimore and Harford Counties
Hood College Center for Coastal & Watershed Studies	DO, Temp, % Sat, pH, Ammonium, Nitrates, TN, Ortho-P, TP, TSS, Cond, Water Clarity, Chla, Phycocyanin Fluorescence, occasional algal toxins	Bacteria, Algae	MD	Frederick, Montgomery, and Howard Counties
Howard County Conservancy		Benthic macroinvertebrates	MD	Howard County, Lower Patapsco River, Middle Patuxent River, and Little Patuxent River
Howard County Watershed Steward Academy	DO, Temp, pH, Nitrates, Cond	Benthic macroinvertebrates	MD	Little Patuxent, Middle Patuxent, and Patapsco (Howard County)
IWLA-WAC	DO, Temp, pH, Alkalinity, Ammonium, Nitrates, Nitrites, TP, Turb, Water Clarity	Fish, Algae, SAV, Salamanders, Birds	MD	Monocacy River at Michael's Mill by Buckeystown
Koolhof Earth/Restore Rock Creek	DO, Temp, % Sat, pH, BOD, Cond, Water Clarity, Salinity	Bacteria	MD	Rock Creek on the tidal Patapsco River in Pasadena

Little Falls Watershed Alliance	Temp, pH	Benthic macroinvertebrates, Fish	MD	Little Falls Branch in Montgomery County
Living Classrooms Foundation	DO, Temp, pH, Nitrites, TP, Turb, Salinity	Fish	MD	Patapsco River Watershed in Baltimore City
Magothy River Association	DO, Temp, % Sat, pH, Cond, Water Clarity, Salinity	Bacteria, SAV, Oysters	MD	Magothy River and tributaries
Maryland Department of Natural Resources (Stream Waders and MBSS)	pH, Alkalinity, Ammonium, Nitrates, Nitrites, TN, Ortho-P, TP, TDS, Cond, Turb, Acid Neutralizing Capacity	Benthic macroinvertebrates, Fish, Salamanders, and other organisms, Exotic plants	MD	State of Maryland
Maryland Department of the Environment	DO, Temp, pH, Ammonium, TN, TP, Cond, Turb, Water Clarity, Salinity, Chla	Benthic macroinvertebrates, Bacteria, Fish, Algae	MD	State of Maryland
Mattawoman Watershed Society	DO, Temp, Cond, Salinity	Benthic macroinvertebrates, Fish eggs and larvae	MD	Mattawoman Creek, Charles and Prince George's Counties
Midshore River Conservancy	DO, Temp, % Sat, pH, Water Clarity, Salinity	Bacteria	MD	Wye River, Queen Anne's County
Nanticoke Watershed Alliance (CreekWatchers)	DO, Temp, % Sat, TN, TP, Water Clarity, Salinity, Chla	Bacteria, will be starting MusselWatchers program in DE in 2016, separate from CreekWatchers	MD and DE	Nanticoke River in MD and DE (Sussex, Dorchester, and Wicomico Counties)
National Aquarium	DO, Temp, TN, TP, BOD, Cond, Turb, Water Clarity, Salinity, Chla	Bacteria	MD	Patapsco River
Octoraro Watershed Association	Temp, Nitrates, Cond, Water Clarity	Benthic macroinvertebrates	MD	Octoraro Mainstem in PA and in Cecil County MD
Osborn Cove	DO, Temp, pH, Water Clarity, Salinity		MD	St. Leonard Creek and Osborn Cove on the Patuxent River (Calvert County)
Phillips Wharf Environmental Center	DO, Temp, pH, Ammonium, Nitrates, Nitrites	Benthic macroinvertebrates, Fish, Algae	MD	Talbot County

Sassafras River Association	DO, Temp, pH, TN, TP, Cond, Turb, Salinity, Chla	Algae, SAV	MD	Sassafras River and tributaries
Savage River Watershed Association	Temp, TDS, Cond, Turb, Water Clarity	Benthic macroinvertebrates	MD	Savage River and tributaries
Spa Creek Conservancy	DO, Temp, % Sat, pH, Alkalinity, Nitrates, TN, TDS, TSS, Water Clarity	Bacteria	MD	Spa Creek
USGS-Patuxent Wildlife Restoration Center	None	Birds	MD	Chesapeake Bay and many tributaries
Watershed Protection and Restoration Program - Anne Arundel County Public Works	Water quality monitoring for regulatory compliance		MD	Anne Arundel County
Wicomico Creekwatchers	Temp, TN, TP, Water Clarity, Chla	Algae	MD	Wicomico River system
The Community Science Institute, Inc.	DO, Temp, % Sat, pH, Alkalinity, Ammonium, Nitrates, Nitrites, TN, Ortho-P, TP, TDS, TSS, Cond, Turb, Water Clarity, Chla	Benthic macroinvertebrates, Bacteria	NY	Upstate NY, near Albany (more info on their database: *database.communityscience.org*)
Water Assessments by Volunteer Evaluators (WAVE)		Benthic macroinvertebrates	NY	State of New York
Alliance for Aquatic Resource Monitoring (ALLARM)	DO, pH, Nitrates, TP, Cond	Algae, SAV	PA	LeTort Spring Run, Carlisle, Cumberland County
Bradford County Monitors	TDS, Cond, Ba and Sr (via a certified lab)	None	PA	Bradford County
Clearfield Creek Watershed Association	Temp, pH, Alkalinity, Nitrates, TDS, TSS, Cond, Fe, Mn, Al, SO4, and others	Special studies	PA	Cambria and Clearfield County, in Clearfield Creek Watershed
Conococheague Watershed Alliance	DO, Temp, pH, Nitrates, Ortho-P, Turb	Benthic macroinvertebrates	PA	Mainstem Conococheague River in Chambersburg
Dauphin County Conservation District	Baseline water chemistry parameters, Turb	Benthic macroinvertebrates	PA	Dauphin County
Evergreen Conservancy	Temp, Cond, Water level	Benthic macroinvertebrates	PA	Susquehanna and Allegheny River watersheds

				in Indiana County
Friends of Tom's Creek	Water Clarity	Benthic macroinvertebrates	PA	Tom's Creek (Adams County)
God's Country Water Dogs (Potter County PA)	TDS, Cond, Ba and Sr (via a certified lab)	None	PA	Potter County
Lake Carey Welfare Association	DO, Temp, pH, Ammonium, Nitrates, Nitrites. TN, Ortho-P, TP, TDS, TSS, BOD, Turb, Water Clarity, Chla	Benthic Macroinvertebrates, Algae, SAV	PA	Lake Carey and Flow Pond (Wyoming County)
Lower Penns Creek Watershed Association	Temp, pH, Nitrates, Ortho-P, Cond, Turb		PA	Synder and Union Counties
Luzerne Conservation District	water quality monitoring for acid deposition impacts and mitigation measures on naturally reproducing brook trout		PA	Bowmans Creek headwaters
Middle Spring Watershed Association	DO, Temp, pH, Nitrates, Ortho-P, Cond, Water Clarity	Benthic macroinvertebrates	PA	Mainstem Middle Spring Stream
Mifflin County Conservation District	DO, Temp, % Sat, pH, Alkalinity, Nitrates, Nitrites, TN, TP, TDS, TSS, Cond, Turb	Benthic macroinvertebrates, Fish	PA	Kishacoquillas Creek and Hungry Run
Nature Abounds (Senior Environment Corps Program)	DO, Temp, pH, Alkalinity, Nitrates, Ortho-P, TP, Cond, SO4, Fe, Mn	Benthic macroinvertebrates	PA	Mostly throughout the state of Pennsylvania but also in Maryland
Renfrew Institute for Cultural & Environmental Studies	DO, Temp, pH, Alkalinity, Nitrates, Ortho-P, Turb	Benthic macroinvertebrates	PA	Various streams throughout the state of Pennsylvania
Shermans Creek Conservation Association		Benthic macroinvertebrates	PA	Shermans Creek
Susquehanna River Basin Commission	DO, Temp, pH, Alkalinity, Ammonium, Nitrates, Nitrites, TN, Ortho-P, TP,	Benthic macroinvertebrates, Fish, Algae	PA	Susquehanna River Watershed

	TDS, TSS, BOD, Cond, Turb, Chla			
Trout Unlimited	Temp, pH, Cond, Turb	Benthic macroinvertebrates	PA VA and WV	various streams in the Chesapeake Bay Watershed
Warwick Township	DO, Temp, Nitrates, TP, Turb	Benthic macroinvertebrates, Bacteria, Fish, Birds	PA	Lancaster County
Water Resource Monitoring Project	DO, Temp, pH, Ammonium, Nitrates, Ortho-P, TDS, Cond, Turb	None	PA	Spring Creek Watershed, Centre County
Watershed Alliance of Adams County	DO, Temp, pH, Alkalinity, Nitrates, Ortho-P, Cond, Water Clarity	None	PA	Rock Creek, Marsh Creek, Little Marsh Creek, and Alloway Creek (Adams County)
Watershed Alliance of York	DO, Temp, pH, TN, Ortho-P	Benthic macroinvertebrates	PA	Codorus Creek and Muddy Creek
Western Pennsylvania Conservancy	DO, Temp, pH, Nitrates, Ortho-P, TDS, Cond, Turb	Benthic macroinvertebrates	PA	
WQVC : Lancaster County Conservancy and Lancaster County Conservation District	DO, Temp, pH, Alkalinity, Ammonium, Nitrates, Ortho-P, TDS, Cond, Salinity	Benthic macroinvertebrates	PA	Lancaster County
York County Conservation District	DO, Temp, % Sat, pH, Alkalinity, TN, Ortho-P	Benthic macroinvertebrates	PA	Codorus and Muddy Creeks
Alliance for the Chesapeake Bay	DO, Temp, pH, Ammonium, Nitrates, Nitrites, TN, Ortho-P, TP, TDS, TSS, Turb, Water Clarity, Salinity	None	VA	Chesapeake Bay watershed of VA
Chesterfield WaterTrends	DO, Temp, pH, Turb, Water Clarity, Salinity	Bacteria	VA	Chesterfield County
Cowpasture River Preservation Association	DO, Temp, % Sat, pH, Nitrates, Ortho-P, TP, Cond, Water Clarity, Salinity, Chloride	Benthic macroinvertebrates, Bacteria	VA	Bullpasture River (Highland County) and Cowpasture River (Highland, Bath, Alleghany, and Botetourt Counties)

Culpeper SWCD	Temp	Benthic macroinvertebrates	VA	Various streams in Culpeper, Greene, Madison, Orange and Rappahannock
Fairfax County Stormwater Planning Division	Water quality monitoring for regulatory compliance		VA	Fairfax County
Friends of Accotink Creek	None	Benthic macroinvertebrates	VA	Fairfax County
Friends of Goochland Parks	Temp, Turb	Bacteria	VA	James River (Goochland County)
Friends of Shenandoah	Temp, Nitrate, Ortho-P, Ammonia, DO, pH, Turb		VA	Augusta, VA
Friends of the Middle River	None	Benthic macroinvertebrates, Bacteria	VA	Middle River watershed
Friends of the Rappahannock, Tri-County Soil & Water District		Bacteria	VA	Fredericksburg area with Fredericksburg Area Monitors for the Environment (FAME) volunteers, and Claiborne Run, located in Stafford County
G2 Associates	Temp, pH, Ammonium, Nitrates, Ortho-P, Salinity, Chla	Algae	VA	Antipoison Creek (Lancaster County) and Potomac River in Great Falls
GMU's Potomac Environmental Research & Education Center	basic water chemistry parameters for middle school education	Benthic macroinvertebrates	VA	
Henricopolis Soil & Water Conservation District	Temp, Nitrites, TP, Turb	Bacteria	VA	Middle James River watershed
James River Association	Temp, Cond, Turb	Bacteria	VA	James River and tributaries
John Marshall Soil & Water Conservation District	DO, Temp, pH, Nitrates, Ortho-P	Benthic macroinvertebrates, Bacteria	VA	Fauquier County
Longwood University Water Quality Monitoring Program	DO, Temp, % Sat, pH, TN, Cond, Salinity, Chla, DOC	Bacteria	VA	
Lord Fairfax Soil & Water Conservation District	Unknown	Unknown	VA	Frederick, Clarke, Warren, and Shenandoah Counties, and the City of Winchester

Loudoun Watershed Watch	Temp, Turb	Benthic macroinvertebrates, Bacteria	VA	Loudoun County
Master Naturalist	DO, Temp, pH, TN, TP, Turb, Water Clarity, Salinity	Bacteria, Algae, SAV, Birds	VA	Tributaries to the James River, cities of Poquoson and Hampton
McClure River Restoration Project	DO, Temp, pH	Bacteria	VA	Dickenson and Wise County
New River Conservancy	Temp, Water Clarity, Water Depth, DO, pH		VA	New River Watershed
Northern Virginia Soil and Water Conservation District	None	Benthic macroinvertebrates	VA	Fairfax County
ODU OEAS	DO, Temp, % Sat, pH, Ammonium, Nitrates, Nitrites, Ortho-P, Cond, Turb, Salinity, Chla	Algae	VA	Lafayette River
Page County Monitors	DO, Temp, pH, Ammonium, Nitrates, Nitrites, Ortho-P, Turb	None	VA	Page County
Peninsula Master Naturalist	DO, Temp, pH, Turb, Salinity	Bacteria, Fish, Algae, SAV, Birds	VA	James River, Warwick River, Hampton Roads, Back River in the cities/counties of Newport News, Hampton, Poquoson, and York. Expanding to Gloucester.
Peter Francisco SWCD	DO, Temp, pH, Alkalinity, Nitrates, Ortho-P, Cond, Turb	Benthic macroinvertebrates, Bacteria	VA	Horsepen Creek in the city of Buckingham
Prince William Soil and Water Conservation District	DO, Temp, pH, Nitrates, Nitrites, Turb	Benthic macroinvertebrates	VA	Potomac River Watershed (Prince William County)
Reston Association	None	Benthic macroinvertebrates	VA	City of Reston
Rivanna Conservation Alliance	Temp, Turb	Benthic macroinvertebrates, Bacteria	VA	Rivanna River Watershed
Shenandoah Valley Soil and Water Conservation District	DO, Temp, pH, TDS, TSS, Cond, Turb, Water Clarity	Benthic macroinvertebrates, Bacteria	VA	Linville Creek Watershed

Shenandoah Watershed Study-Virginia Trout Stream Sensitivity Study	Temp, pH, Alkalinity, Ammonium, Nitrates, Cond, Acid Neutralizing Capacity, Ca, Chloride, Mg, K, Silica, Na, SO4, Total Monomeric Al	None	VA	Shenandoah River Watershed
VA Save Our Streams	Turb, pH	Benthic macroinvertebrates	VA	Mostly in the state of Virginia but some in Maryland
Virginia DEQ	DO, pH, Temp, Cond, TN, TP, Turb, Chla, and other nutrients at certain sites	Benthic macroinvertebrates, Bacteria, Fish, Algae, SAV	VA	State of Virginia
Virginia Master Naturalist - Historic Southside Chapter	None	Benthic macroinvertebrates, Salamanders	VA	Vernal pools
Blue Ridge Watershed Coalition	DO, Temp, pH, Ammonium, Nitrates, Nitrites, Ortho-P, TP, TDS, Cond, Turb	Bacteria	WV	Shenandoah River
Sleepy Creek Watershed Association	DO, Temp, % Sat, pH, Alkalinity, Ammonium, Nitrates, Nitrites, TN, TDS, TSS, Cond, Turb, Water Clarity, Salinity	Benthic macroinvertebrates, Algae	WV	Sleepy Creek (Morgan County)
The Mountain Institute		Benthic Macroinvertebrates (Partnership with WV Save Our Streams)	WV	School groups awarded mini-grants for various stream monitoring projects
Warm Springs Watershed Association	DO, Temp, % Sat, pH, Alkalinity, Nitrates, Nitrites, Turb, Water Clarity	Benthic macroinvertebrates, Algae, Salamanders	WV	Morgan County
West Virginia Rivers Coalition (Trout Unlimited)	Temp, pH, Cond, Turb	Benthic macroinvertebrates	WV	State of West Virginia

WVDEP Nonpoint Source Program	Water quality monitoring for regulatory compliance	Benthic macroinvertebrates (Oversees the WV Save Our Streams Program)	WV	State of West Virginia

Glossary of Abbreviations:

Abbreviation	Parameter
% Sat	Percent Saturation
Al	Aluminum
Ba	Barium
BOD	Biological oxygen demand
Ca	Calcium
DO	Dissolved oxygen
DOC	Dissolved organic carbon
Fe	Iron
K	Potassium
Mg	Magnesium
Mn	Manganese
Na	Sodium
Ortho-P	Orthophosphate
pH	Potential of hydrogen
SO4	Sulfate
Sr	Strontium
TDS	Total dissolved solids
Temp	Water temperature
TN	Total nitrogen
Total Monomeric Al	Total monomeric aluminum
TP	Total phosphorus
TSS	Total suspended solids
Turb	Turbidity

Appendix B: Resources and Technical Support Offered by the CMC

Tier 3 Data Audit

Tier 3 groups are those that are following the CBP Monitoring and Field Procedures, have an audit of their program completed by CBP's Data Integrity Workgroup, and have made recommended changes to their program based on the audit. Based on monitoring groups' field methods, the CMC team identifies candidates for Tier 3 status. Candidates are referred to the Data Integrity Workgroup for an audit. The Data Integrity Workgroup created an auditing checklist that is used to thoroughly question and examine potential candidates' field and lab practices and methods. This checklist includes review of the monitoring group's Quality Assurance Project Plan, field equipment list, and lab equipment list (if applicable) before the audit. The auditors will prepare a report following the audit with recommendations for the monitoring group. Once the group shows that they've incorporated the auditors' recommendations, their data will be classified as Tier 3 in the Chesapeake Data Explorer.

Provide Quality Assurance Project Plan for groups to use

Volunteer monitoring groups who are using a monitoring procedure that fit the Tier 1 or Tier 2 criteria, but do not have the technical documentation, will be incorporated into the CMC Quality Assurance Project Plans (QAPPs) developed for benthic macroinvertebrate, non-tidal, and tidal monitoring. When a group decides to adopt a CMC QAPP, they will need to participate in training by one of the CMC partners, and become certified under the QAPP. CMC participants who fall under the QAPPs will receive training to incorporate quality control measures into their monitoring approaches. If a participant is unable to meet the quality control requirements their data will be classified as a lower Tier.

Host trainings

If a volunteer or nontraditional monitoring group wants to join the CMC and follow the methods and QA/QC protocols they will be invited to a training workshop. If there are individuals interested in participating in volunteer monitoring, the CMC will help connect them with a local group and encourage them to participate in a CMC training workshop. There are several types of trainings that the CMC is offering, including:

- Supporting development of study designs
- Teaching monitoring methods
- Facilitating database use, and
- Conducting data interpretation workshops

Support development of study designs

The first step for an organization or individual interested in starting a monitoring group is to develop a study design, which is a ten-step process that outlines the key steps in developing a monitoring program. Study designs (originally developed by River Network) are standard monitoring tools for service providers to use with communities interested in monitoring. By developing a study design, CMC will be able to insure that data of known value are collected by partners and that community goals are in line with the spirit of the project. Questions answered in the study design include:

Step 1: What are your organizations major objectives?
Step 2: Why are you monitoring?
Step 3: How will you use the data that you collect?
Step 4: What will you monitor?
Step 5: How will you monitor?
Step 6: Where will you monitor?
Step 7: When will you monitor?
Step 8: What are your Quality Assurance/ Quality Control
Step 9: How will you manage and present the data?
Step 10: What are the tasks and who will do them?

Expertise within the CMC partnership will support the development of study designs that support the objectives of the volunteer and design a plan for monitoring, data management, and assessment.

Teach monitoring methods

The CMC prepared standardized methods for the most popular water quality and biological monitoring parameters monitored by volunteer groups in the Chesapeake Bay watershed in accordance with the QAPPs. ALLARM and the League will be offering training sessions for benthic macroinvertebrate monitoring and identification to order level. The Alliance and ALLARM will offer training sessions on collecting water quality parameters.

Facilitate database use

Chesapeake Environmental Communications is developing the Chesapeake Data Explorer, a database for all volunteer and nontraditional monitoring groups in Chesapeake Bay Watershed states. Monitoring groups that have connected with the CMC, and are ready to submit data, will have the option of taking a workshop on how to use the Chesapeake Data Explorer. Clear instructions for interacting with the Chesapeake Data Explorer will also be available.

Conduct data interpretation workshops

The data interpretation workshops will focus on communicating a monitoring group's data to a wide variety of audiences through print and digital products and includes both principles and practical application of science communication, data visualization, and synthesis. Groups that have Tier 2 data can generate geographically specific ecosystem assessments (e.g., a report card) for their data. Report card generation includes a specific set of analyses that will be determined by each group. The training will help each group determine the framework for their analyses. Groups that have Tier 1 data can use that data to produce education materials for their constituents and to tell stories using the data they collect. Synthesizing data is important for key messaging and outreach.

Help acquire equipment

If a volunteer group is close to meeting the criteria for Tier 1 or Tier 2 monitoring and is within a priority area, but needs upgraded equipment, the CMC team will evaluate the availability of resources to see if an equipment upgrade is possible to integrate the new volunteer or nontraditional monitoring group.

Survey monitoring groups

Based on the identified needs of the CBP partnership, if there is a volunteer or nontraditional group monitoring in a priority region, the CMC team will identify the group's needs and potential for collaboration with the CMC, and encourage that group to fill out the Chesapeake Monitoring Census (i.e. survey) to share key information about their program for evaluation.

Appendix C: Contributors

Below is a list of the many contributors to this research through participation in workshops, meetings, or participation in the Chesapeake Monitoring Census.

Name	Affiliation	State
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