Tiered Framework for Data Collection and Integration for Nontraditional Monitoring

Introduction

The Alliance for the Chesapeake Bay (Alliance), Izaak Walton League of America (League), Dickinson College's Alliance for Aquatic Resource Monitoring (ALLARM), and the University of Maryland Center for Environmental Science Integration and Application Network (UMCES IAN) (referred to as the "Project Team" in this document) are partnering to provide technical, logistical, and outreach support for the integration of citizen-based and non-traditional (i.e., non-agency) monitoring data into the Chesapeake Bay Program (CBP) partnership. The integration of these data into the CBP monitoring networks will provide additional cost-effective data and information that supports shared decision-making and adaptive management by the CBP partners focused on restoration of the Chesapeake Bay and its watershed.

The Project Team, using their background, expertise, and knowledge with the nontraditional monitoring community, are working with CBP STAR (Scientific, Technical Assessment and Reporting Team) to: 1) establish institutional structures and procedures, such as the tiered data use framework; 2) facilitate development of consistent monitoring and training protocols, technical guidance, data gathering tools, quality assurance mechanisms, and data analysis and communication tools; 3) inventory, prioritize and recruit monitoring groups; and 4) provide training and technical support to monitoring entities. This comprehensive approach will ensure a consistent submittal of known quality data to the CBP.

Purpose of the Framework

The Tiered Framework for Data Collection and Integration for Nontraditional Monitoring identifies recommended categories of data quality and their associated end uses. Broad data quality requirements for each category are identified. This framework also provides recommendations of existing resources to inform data production protocols.

For the development of this framework and associated data collection and management protocols, the Project Team is working with experienced nontraditional monitoring programs, state agency programs, and the STAR Data Integrity workgroup to incorporate best practices and lessons learned. Additionally, the Project Team has examined thirteen states' volunteer monitoring programs, and identified five states to best inform the development of this tiered framework. The Project Team will seek adoption of the tiered data use framework, monitoring protocols, and Quality Assurance Project Plans (QAPPs) by the CBP.

The framework is meant to be a guiding document that will be subject to change and refinement once the Project Team receives data from a watershed monitoring census (to document the most commonly used monitoring techniques in the Bay Watershed) which will inform equipment testing and the development ofncorresponding monitoring method manuals and QAPPs. Once those key monitoring tools are established, the framework document will be updated (Fall 2016) to reflect the monitoring that is and will be taking place in the watershed.

Monitoring Questions

Non-traditional monitoring entities typically develop study designs, in part to identify their research questions and objectives. Most non-traditional monitoring entities have been monitoring for water quality status and trends using three lines of evidence:

- Water quality/chemistry
- Biological – macroinvertebrates and submerged aquatic vegetation
- Physical – habitat and stream bank assessments

Although the issues addressed are almost always locally-based, the data collected can also be utilized, along with other Bay-wide data, to address the status and trends of waterway health in the Chesapeake Bay watershed. Some examples of Bay-wide priority research questions that local non-traditional monitoring data can inform include:

- What is the effectiveness of management actions?
- What are the relationships in space and time between watershed health and bay health?
- What are the effects of emerging contaminants and climate change on the status and recovery of bay and watershed health?
- Where should natural resource managers prioritize restoration efforts?
- How does the inclusion of citizen science data change individual behaviors and increase environmental stewardship?

Once the data are organized and entered into a database, CBP may use the non-traditional data to help answer these and additional questions.

Intended Data Use

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	Regulatory Assessments of Water Quality Standards Attainment

Tier Descriptions and Framework for Determining Tiers

There are diverse motivations for monitoring and diverse projects where non-traditional data are collected. In the aquatic citizen science field/volunteer monitoring, most organizations developing monitoring programs answer the question “how do they intend to use their data” prior to identifying parameters, appropriate techniques, and corresponding quality assurance measures. This process is done with the goal to match the data quality with the intended use. For the integration of non-traditional data into the Bay program, the Project Team has identified Tiers for data use. If data do not meet the data requirements of the different tiers, those data will not be included in this project.

Tier 1 – Education and Environmental Health Screening:

Definition: Tier 1 data include programs whose data do not meet the requirements of Tier 2 and Tier 3 but are of known quality, have written study designs, documented quality assurance/quality control measures, and as a result still contribute to understanding of the health of the Bay watershed.

Data Uses:
These data can be used to:

- Provide location information on where monitoring is taking place;
- Provide on-the ground information for future site development;
- Indicate potential pollution hot spots;
- Prioritize sites for follow-up monitoring;
- Target restoration projects;
- Inform sub watershed report cards; and
- Highlight local, community projects that are implemented to improve the health of the Bay watershed.

Data Requirements: Clearly documented monitoring methodology, site locations, and written study designs.

Tier 2 - Environmental Health Report Cards, Environmental Health Screening, Targeting of Management Actions:

Definition: Tier 2 data are data with clearly defined and approved methodology (using the volunteer monitoring EPA QAPP guidelines) but do not meet Tier 3 data requirements.

Data Uses: These data will:

- Be used for Bay Program report cards;
- Be used to help target stream segments for water quality standards attainment assessments and Clean Water Act 305(b) reports;
- Be used for screening for Clean Water Act 303(d) stream segments;
- Target new priority agency sites;
- Track the performance of Total Maximum Daily Load (TMDL) implementation projects; and
- Be used for all uses identified in Tier 1.

Data Requirements: Program, at minimum, has an approved volunteer monitoring Quality Assurance Project Plan (http://www.epa.gov/sites/production/files/2015-06/documents/vol_qapp.pdf). Data collected, uses approved field or laboratory standard operating procedures with defined levels of precision and accuracy for the measurements, or program can be participating in an umbrella monitoring initiative that has an approved QAPP or field/lab standard operating procedures.

Tier 3 - Attainment:

Definition: Tier 3 data are regulatory, decision-making, legally defensible data.

Data Uses: These data will be used for:

- Attainment purposes, Clean Water Act 305 (b) reports, Clean Water Act 303 (d) listing and delisting; and
- All uses identified in Tier 1 and Tier 2.

Data Requirements: United States Environmental Protection Agency (EPA) or CBP approved QAPP and field/lab standard operating procedures.

The Project team will be refining data requirements (Fall 2016) criteria after monitoring method manuals and QAPPs are developed to add additional information on types of monitoring techniques, their precision, accuracy, and sensitivity as well as quality assurance measures.

Examples of Non-traditional Data Contributor Success Stories within Each Tier

There a number of existing success stories that highlight the diverse ways that nontraditional data can be used to inform education, screening of pollution problems, long-term trend analysis, and water quality standards attainment.

Tier 1 - Education:

Data collection is inherently educational for participants. Beyond the educational development of the data collector/analyzer, a typical goal for watershed organizations and programs is to use the data collected to educate municipal officials, community members, and other stakeholders about water quality in their community. Most data-collecting entities use the stories found in their data for local education.

One successful case study in Pennsylvania is the work accomplished by the Antietam Watershed Association (AWA). When AWA developed their study design with technical support from ALLARM, they were primarily concerned with the effect of non-point source runoff in the watershed; agricultural runoff was the primary issue in the West Branch of the Antietam and stormwater runoff was the primary issue in the East Branch of the Antietam. Three years into their baseline data collection, there were three large farms that were sold in the West Branch for housing subdivisions. Using the data they collected, AWA was able to illustrate the impact of agricultural runoff on the West Branch as well as the impacts of stormwater runoff in the East Branch. As a result, AWA was able to work with the local municipality, Washington Township, to develop a buffer ordinance for the new housing subdivision.

The South Anna Monitoring Project is a citizen water quality monitoring volunteer group that operates under a VA DEQ-approved QAPP to monitor water quality parameters at designated sites along the South Anna Creek and its tributaries in Louisa County, Virginia. Volunteers have been collecting data and noting land use changes in the upper portion of the watershed for the past 10 years. With this data, an educational report was developed to illustrate land use change impacts.

Tier 2 - Screening, Report Cards, Targeting:

A common product of watershed monitoring activities are reports and report cards that outline findings as well as recommendations on data use, sites for further investigation, and additional questions to answer in the watershed.

The Shermans Creek Conservation Association (SCCA) was a watershed group located in Perry County, Pennsylvania (one of Pennsylvania's more rural counties). SCCA formed in 1998 and conducted baseline chemical, biological, and physical stream monitoring from 1999 – 2008 with technical support and mentoring from ALLARM. Throughout their nine years of water quality data collection they went through three rounds of data interpretation and data use. The first watershed report on Shermans Creek was published in 2004 and it was the impetus and primary content used for the development of a Rivers Conservation Plan. As a primarily agricultural county, the watershed data were particularly useful in identifying locations for best management practices to be installed to address a variety of issues from faulty manure storage facilities to lack of riparian buffers. Another result of the 2004 report was a petition to the Pennsylvania Department of Environmental Protection (PADEP) to upgrade the stream designation of a portion of the main stem of Shermans Creek, based on the citizen-collected data. The SCCA data which were submitted to the state helped the state target their own monitoring to inform the designated use upgrade process.

The Reedy Creek Coalition (RCC), a watershed group in Richmond, Virginia, with training and technical assistance from the Alliance, has been collecting water quality data to help identify pollution hotspots and potential sources. Through regularly monthly monitoring along the creek and streamwalks, the Coalition has identified several illicit discharges over the span of the monitoring program. In 2011, during a streamwalk, a dry weather discharge was detected at a large stormwater pipe, along with a strong sanitary sewer odor and bacterial growth. This, along with follow-up testing from Randolph Macon College students which showed very high levels of *E. coli*, prompted the City of Richmond to investigate. They discovered a damaged sanity sewer line nearby and repaired it. Also, in 2012, the water quality monitors identified foul odors and elevated *E. coli* counts at a monitoring site on Crooked Branch, a tributary of Reedy Creek. The RCC notified the City of Richmond's Department of Public Utilities (DPU) regarding their observations and the DPU Pretreatment Program began an investigation. Their monitoring confirmed the volunteers' findings and they traced the contamination to a blocked sanitary sewer line. This was fixed, and follow up sampling showed much lower concentrations of *E. coli.*

Tier 3/Tier 2 - Water Quality Standards Attainment:

Typically for monitoring programs interested in attainment, there is a strong reliance upon state-approved protocols and certified laboratories for data analysis. However, there are success stories of nontraditional data being used to inform Clean Water Act violations as well as the listing and delisting of streams.

The Codorus Creek Watershed Association was formed in 1998 to implement watershed assessments. One of the group's concerns centered on the Glatfelter Paper Plant, whose discharge led to the community nickname of the Codorus as the "inky stinky." Upstream of the plant's effluent the Codorus is classified as a High Quality Cold Water Fishery (the second highest designated use in PA). As a result of the temperature and color of the plant's discharge the creek downstream only met criteria for a Warm Water Fishery. Using two parameters, temperature and color, the group produced data that illustrated the plant was in violation of the Clean Water Act and the Pennsylvania Chapter 93 code. The Pennsylvania Department of Environmental Protection then sued the plant, which resulted in $2.5 million in penalties and required the plant to install $32 million worth of new equipment to improve the clarity and temperature of the discharge.

Existing Tools

There are a number of existing tools to help identify appropriate chemical water quality monitoring procedures that will be helpful for this project:

- To inform non-tidal monitoring procedures, the Project Team will use the VA DEQs Virginia Citizen Water Quality Monitoring Program's Methods Manual and the Mid Atlantic Tributary Assessment Coalition Nontidal Protocols http://www.deq.state.va.us/Portals/0/DEQ/Water/WaterQualityMonitoring/CitizenMonitoring/Citmon_Manual.pdf;
- To inform tidal monitoring procedures, the Project Team will use the Mid Atlantic Tributary Assessment Coalition Tidal Protocols; and
- To inform attainment data use, the Project Team will use the Chesapeake Bay Program's Recommended Guidelines for Sampling and Analysis as well as the 2015 Technical Addendum for Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity, and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries.

Areas for Development and Consideration

For chemical data, the VA DEQ methods will have to be examined and the Project Team will have to confirm that those tiers fit in appropriately with this project.

The questions that nontraditional data will help answer are expansive and will require integrative data. One consideration here is how the program will diversify the information inputs into the tiered framework to better integrate additional parameters such as benthic macroinvertebrates, physical habitat, and submerged aquatic vegetation.

Metadata Requirements

As a part of the tiered approach, data producers will need to submit accompanying metadata alongside their monitoring data. All data of known quality are valuable as long as the end use matches the data quality; metadata are crucial to ascertain the quality of data.. The metadata provide additional information as to how the measurements were obtained and the level of precision and accuracy. Typically metadata includes, but is not limited to: equipment and materials used, storage methods, holding times, and analysis methods.

There are a number of approaches to determining what metadata is needed, including relying on existing tools and frameworks, such as:

- EPA Volunteer Monitoring QAPP Development guidelines http://www.epa.gov/sites/production/files/2015-06/documents/vol_qapp.pdf;
- VA DEQ established metadata protocols for their databases; and
- Conversations with the Chesapeake Bay Program teams that are discussing required metadata for different data uses.

Below is an example of metadata from a Pennsylvania Watershed Group's Study Design:

Parameter	Equipment	Holding Container	Storage	Maximum Holding Time	Method
Temperature	LaMotte Hg-Free Thermometer	Measured at stream	N/A	Immediate	Field Thermometer
Conductivity	LaMotte Tracer PocketTester	500 ml Nalgene	N/A	Immediate	Field meter
pH	EMD Millipore ColorpHast pH strips	Measured at stream	Refrigerate	2 hours	pH strips
Dissolved Oxygen	LaMotte Kit #5860	60 ml glass container	N/A	Fixed at streamside, titrate within 8 hours	Winkler Titration
Water Clarity	LaMotte Transparency Tube			Immediate	Visual
Ortho-Phosphates	Hach Kit #PO-19	500 ml Nalgene	Refrigerate	Within 48 hours	Ascorbic Acid
Nitrate- Nitrogen	Hach Kit #NI-14	500 ml Nalgene	Refrigerate	Within 48 hours	Cadmium Reduction
Benthic Macro-invertebrates	Kick net or D-net with 500-micron mesh	Identify at stream side; OR Preserve in wide mouth 1 liter plastic screw cap container	Preserved in at least 70% ethanol	Indefinite	EASI or VA SOS protocol
Streamwalk	Field data sheet, camera	N/A	N/A	N/A	Adaptation of Tier I of USDA Visual Assessment Protocol
Stream Reach Survey	Field data sheet, camera	N/A	N/A	N/A	Adaptation of EPA Volunteer Stream Monitoring Protocol
Heavy Metals	Professional lab	500 ml container	Preserve with nitric acid to a pH < 2		Atomic Absorption Spectroscopy or Inductively Coupled Plasma Mass Spectrometry