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Summary of Programs' Quality Assurance Issues

University of Rhode Island **University of Wisconsin**

As part of the Volunteer Water Quality Monitoring National Facilitation Project, we sent an inquiry in February 2002 to coordinators of existing Cooperative Extension (CE) sponsored/co-sponsored volunteer water quality monitoring programs that were identified through an inquiry in the fall of 2001. The program-level inquiry was designed to help us learn the ins and outs of existing Extension volunteer water quality monitoring programs so that we could compile and share that information through our website (www.usawaterquality.org/volunteer), list server, guidance materials, trainings, and general networking. There were six main sections of the inquiry that correspond with sections of the guidance documents we are preparing. The sections are: types of activities available, effective training techniques, quality assurance issues, volunteer management and support tools, outreach tools, and funding issues. This summary discusses quality assurance measures of 21 responding programs. We detail what types of quality assurance plans are used, how these plans were formulated, and what parameters are assessed with specific quality control procedures

Data credibility is essential to all monitoring programs, including those involving volunteer monitoring. Assessing quality needs to take place throughout a monitoring program. Quality assessment has two main components, quality assurance and quality control (QA/QC). Quality Assurance (QA) refers to the overall careful supervision and management of your program and data that are collected, including planning, data collection, quality control, documentation, evaluation, and reporting. Quality Control (QC) refers to the routine activities you perform to minimize errors. QC helps ensure data are precise, accurate, representative, complete and comparative by setting standards for and controlling technical errors in the field, laboratory and office. Different programs may have different degrees of QA/QC depending on their goal. For instance a program with the goal of providing data to a regulatory agency generally needs more stringent QA/QC procedures than a program looking to provide general public education of water quality issues. Programs with U.S. Environmental Protection Agency (EPA) funding must have an EPA-approved Quality Assurance Project Plan (QAPP). EPA's Volunteer Monitor's Guide for Quality Assurance Project Plans can be found at http://www.epa.gov/OWOW/monitoring/volunteer/qappexec.html). It contains specific guidelines and guidance in preparing one. Other programs may desire to prepare an EPA-approved QAPP or a

similar QA/QC plan to document their procedures. A QAPP is a written document that details the procedures a monitoring project will use to ensure that the samples participants collect and analyze, the data they store and manage, and the reports they write are of sufficient quality to meet their project goals.

Level of Quality Assurance Plans

The program-level inquiry found that eight of the 21 programs that responded have EPA-approved QAPPs (Table 1). These programs and one additional program also developed state-approved Quality Assurance (QA) plans. Four other programs have basic monitoring plans in place, which indicate where, when, how, and what is to be monitored. As of this inquiry IOWATER was in the process of writing a QAPP, while the Saint Louis River Watch program is expanding its basic plan into a QAPP. The Maine Shore Stewards and Volunteer Stream Monitoring Partnership act as umbrella programs, assisting local programs in writing their own plans. The New Hampshire Great Bay Coast Watch Program has project-specific QAPPs within the program. We also learned that a cooperating agency prepared a QAPP for Illinois Basin/Spring Creek Blue Thumb, showing the benefits of partnerships between organizations. The Great Bay Coast Watch Program noted the length of the process of developing a QAPP for EPA approval, which took their program four years to prepare and finalize.

Table 1: Volunteer water quality monitoring program Quality Assurance Plans: Level of Plan

State	Program	QAPP	State-Approved QA Plan	General Procedures Plan
AL	Alabama Water Watch	✓	✓	✓
CO	North Fork Volunteer Monitoring Project	✓	✓	✓
IN	Hoosier Riverwatch	✓	✓	✓
IA	IOWATER Volunteer Water Quality Monitoring	In process		
KS	Private well monitoring			
ME	Maine Shore Stewards			
MI	Lake Superior Lake Watch			✓
MN	Volunteer Stream Monitoring Partnership	✓	✓	✓
MN	St. Louis River- River Watch			✓
NV, CA	Tahoe-Truckee Snapshot		✓	✓
NH	NH Lake Lay Monitoring Program	✓	✓	✓
NH	Great Bay Coast Watch	✓	✓	✓
NY	Community Fly Fisher			
NC	Watershed Watch			
OK	Illinois Basin/Spring Creek Blue Thumb	✓	✓	✓
RI	URI Watershed Watch	✓	✓	✓
VT	Watershed Alliance			
WA	WSU Beach Watchers			✓
WA, ID, OR	Pacific Northwest Water Quality Monitoring Program			
WI	Wisconsin Lakes Partnership/Adopt-a-Lake			
WI	Water Action Volunteers			✓

Developing QA Procedures

Developing QA procedures varied between programs (Table 2). Two of the queried programs adopted QA procedures directly from an existing program. Eleven programs modified them from existing programs. Eight programs developed new ones for at least part of their program. One

program did not consider QA issues when developing their program. Program Coordinators also cited use of Standard Methods and review of scientific methods to draft QA procedures. While most programs did not indicate specifics about development of their methods, the (Minnesota) Volunteer Stream Monitoring Partnership indicated they received guidance and assistance from state and local agencies in the development process.

Table 2: Development of QA Procedures varied among programs.

State	Program	Methods Adopted	Methods Modified	New QA Methods	Other
AL	Alabama Water Watch		✓	✓	
CO	North Fork Volunteer Monitoring Project		✓	✓	
IN	Hoosier Riverwatch		✓		
IA	IOWATER Volunteer Water Quality Monitoring		✓	✓	
KS	Private well monitoring				
ME	Maine Shore Stewards		✓		✓ Standard Methods
MI	Lake Superior Lake Watch			✓	
MN	Volunteer Stream Monitoring Partnership		✓		
MN	St. Louis River- River Watch				✓ Unknown
NV, CA	Tahoe-Truckee Snapshot		✓		
NH	NH Lake Lay Monitoring Program			✓	
NH	Great Bay Coast Watch		✓	✓	
NY	Community Fly Fisher				
NC	Watershed Watch		✓		
OK	Illinois Basin/Spring Creek Blue Thumb	✓			
RI	URI Watershed Watch		✓	✓	
VT	Watershed Alliance	✓			
WA	WSU Beach Watchers			✓	
WA, ID, OR	Pacific Northwest Water Quality Monitoring Program				
WI	Wisconsin Lakes Partnership/Adopt-a-Lake				✓ Scientific Methods
WI	Water Action Volunteers		✓		

Quality Control Methods

There was a wide range of responses between programs regarding the QC methods employed when monitoring certain parameters (Figure 1). We suggested 13 types of QC procedures that programs might use. The most often used was replicate field measurements or samples (11 programs). Nine programs take duplicate field measurements. Two programs use calibration blanks and spiked samples during analyses and one program analyzes unknown standards. In one program, some of

the suggested QC procedures are completed for educational purposes (to compare methods) rather than for QC purposes. One program specified they had none of the listed QC methods in place for their program.

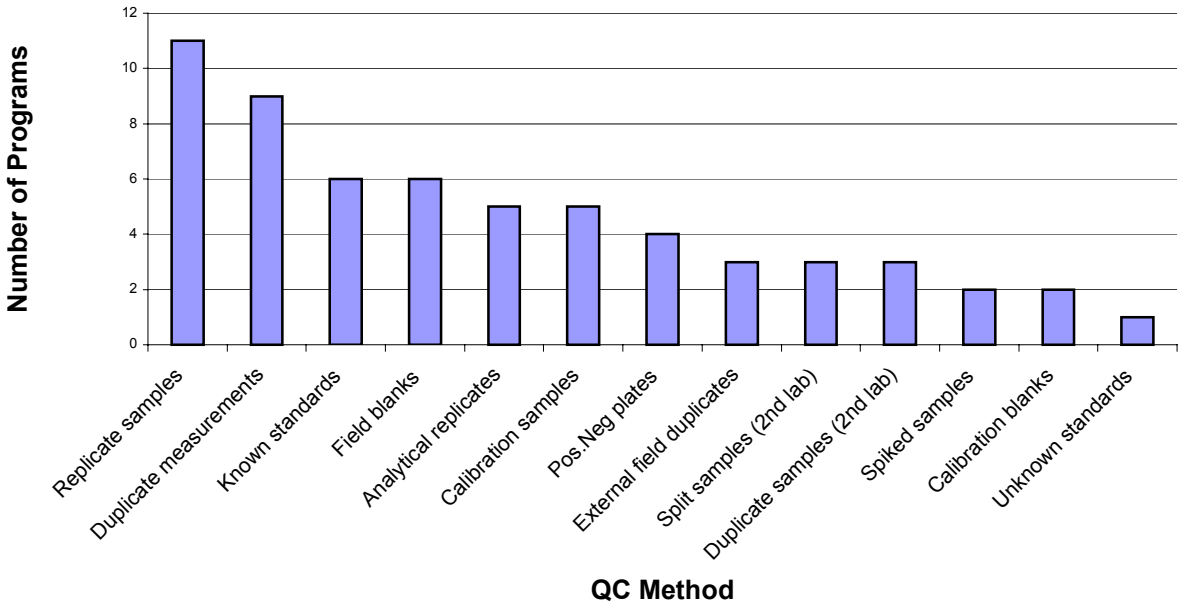

Figure 1: These volunteer water quality monitoring programs utilize a number of different QA/QC measures.

Different programs use each of the QC methods described in Figure 1 differently. To address this, a brief summary of each of those QC methods and its use by responding volunteer water quality monitoring programs follows.

Collecting Replicate Field Samples (Duplicates)

Replicate field samples, often called duplicates, are sets of samples that are collected using identical methodology as close in space and time as possible. They are then handled, processed and analyzed as identically as possible. They are designed to measure sampling precision and account for natural variability. Eleven programs take replicate field samples during monitoring (Table 3). Seven of these programs collect replicate field samples to monitor nutrients. Six programs use replicate samples for bacteria (*E. coli*, fecal coliforms) monitoring. Three programs use this QC method to monitor dissolved oxygen or pH. Two programs use replicate field samples to monitor macroinvertebrates, BOD, and/or chlorophyll. Turbidity, metals, chloride, alkalinity and conductivity are monitored using this method by one program each.

Table 3. Replicate field sample use by programs.

Parameter Assessed	Program
Nutrients (Including: Nutrients analyzed with this QC method include: NO_3, NH_4, PO_4, Cl^-, total P, SRP, N)	North Fork Volunteer Monitoring Project, Hoosier Riverwatch, St. Louis River- River Watch, Tahoe-Truckee Snapshot, New Hampshire Lake Lay Monitoring Program, Illinois Basin/Spring Creek Blue Thumb, URI Watershed Watch
Bacteria	Alabama Water Watch, North Fork Volunteer Monitoring Project, Hoosier Riverwatch, Maine Shore Stewards, New Hampshire Lake Lay Monitoring Program, URI Watershed Watch
Dissolved Oxygen	Hoosier Riverwatch, St. Louis River- River Watch, Illinois Basin/Spring Creek Blue Thumb, URI Watershed Watch, Adopt-A-Lake (WI)
pH	St. Louis River- River Watch, New Hampshire Lake Lay Monitoring Program, Illinois Basin/Spring Creek Blue Thumb, Adopt-A-Lake (WI)
Macroinvertebrates	St. Louis River- River Watch, Water Action Volunteers
BOD	Hoosier Riverwatch, St. Louis River- River Watch
Chlorophyll	New Hampshire Lake Lay Monitoring Program, URI Watershed Watch
Turbidity	Alabama Water Watch
Metals	North Fork Volunteer Monitoring Project
Alkalinity	New Hampshire Lake Lay Monitoring Program
Conductivity	New Hampshire Lake Lay Monitoring Program
Chloride	Illinois Basin/Spring Creek Blue Thumb
Temperature	Adopt-A-Lake (WI)

Duplicate Field Measurements

Duplicate field measurements are multiple measurements that are taken immediately after each other using the same methodology at the same location. For instance, a Secchi disk is lowered into a lake twice with separate water clarity depths recorded. Duplicate field measurements are designed to measure sampling precision and account for natural variability. Volunteers in nine programs take duplicate field measurements during monitoring (Table 4). Duplicate measurements for Secchi depth are taken in six of these programs and for turbidity tube measurements in two additional programs. Eight programs take duplicate measurements when monitoring temperature. Three programs (all in states that have ocean coastlines) indicated making duplicate field measurements when monitoring salinity. (Note: Of the 21 programs that responded, nine are in states that have ocean coastlines.) Other parameters for which duplicate measurements are made include dissolved oxygen (two programs), chlorophyll (one program), coliforms (two programs), and pH (two programs). The New Hampshire Lakes Lay Monitoring Program also indicated that monitors make duplicate field measurements when utilizing any electronic field meter.

Table 4. Programs that use duplicate field measurements for quality control

Parameter Assessed	Program
Secchi depth	Alabama Water Watch, Maine Shore Stewards, Lake Superior Lakewatch, New Hampshire's Lakes Lay Monitoring Program and Great Bay Coast Watch, and URI Watershed Watch
Turbidity tube measurements	Hoosier Riverwatch, Water Action Volunteers
Temperature	Alabama Water Watch, Hoosier Riverwatch, Maine Shore Stewards, Lake Superior Lakewatch, New Hampshire's Lakes Lay Monitoring Program and Great Bay Coast Watch, St. Louis River-Riverwatch, and URI Watershed Watch
Salinity	Alabama Water Watch, Great Bay Coast Watch, and URI Watershed Watch
Dissolved Oxygen	Alabama Water Watch, Great Bay Coast Watch
Chlorophyll	URI Watershed Watch
Coliforms and pH	Great Bay Coast Watch, URI Watershed Watch

External or Known Standards

External or known standards are samples with known concentrations of specific substances that are run on analytical equipment as if they were samples to ensure calibration. Six programs analyze known standards for QC (Table 5). These programs commonly (four of six programs) use known standards when analyzing nutrient samples. Other parameters for which known standards are used during analyses include pH, total suspended solids (TSS), biochemical oxygen demand (BOD), metals, alkalinity, chloride, salinity, and hardness.

Table 5. Programs analyze for a variety of parameters using known standards for QC

Parameter Assessed	Program
Nutrients (Including; Dissolved P, total P, PO_4, total N, NO_3-N, NH_4-N, and Cl^-)	Northfork Volunteer Monitoring Project, New Hampshire Lakes Lay Monitoring Program, Illinois Basin/Spring Creek Blue Thumb, and URI Watershed Watch
Total Suspended Solids	URI Watershed Watch
Biochemical Oxygen Demand	URI Watershed Watch
Metals	Northfork Volunteer Monitoring Project
Alkalinity	Alabama Water Watch, URI Watershed Watch
Chloride	Illinois Basin/Spring Creek Blue Thumb, URI Watershed Watch
Hardness	Alabama Water Watch
pH	Alabama Water Watch
Salinity	Maine Shore Stewards

Field Blanks

Field blanks are analyte-free samples that are brought to a field site, exposed to the same conditions as other field samples, and later analyzed in the same fashion as other samples collected in the field. Field blanks are used to detect problems that might occur during sampling, transportation, or laboratory analysis. Six programs use field blanks to monitor bacteria, chlorophyll, metals, turbidity, nutrients, and dissolved oxygen (Table 6).

Table 6. Programs that use field blanks for QC

Parameter Assessed	Program
Bacteria	Northfork Volunteer Monitoring Project, Tahoe-Truckee Snapshot, and URI Watershed Watch
Chlorophyll	New Hampshire Lakes Lay Monitoring Program
Metals	Northfork Volunteer Monitoring Project
Turbidity	Tahoe-Truckee Snapshot
Nutrients (Including N, NO3, NH4, P, PO4, and Cl)	Illinois Basin/Spring Creek Blue Thumb, St. Louis River-Riverwatch, and URI Watershed Watch
Dissolved Oxygen	St. Louis River-Riverwatch

Analytical Replicates

Analytical replicates, multiple samples taken from a single sample container and analyzed separately are used to assess the precision of field kit or laboratory analysis. Samples can be divided in the field and analyzed as separate samples, or divided in the lab and then processed. Five of the 21 programs (Table 7) employ analytical replicates in their QA/QC procedures. The only parameter in this category of QC procedures that is common between any of the five programs is nutrients. Other parameters for which analytical replicates are run include bacteria, dissolved oxygen, salinity, invertebrate bioassessment, and chlorophyll.

Table 7. Programs that analytical replicates for QC

Parameter Assessed	Program
Nutrients	New Hampshire Lakes Lay Monitoring Program and Tahoe-Truckee Snapshot, URI Watershed Watch
Bacteria	Northfork Volunteer Monitoring Project
Dissolved Oxygen	URI Watershed Watch
Salinity	URI Watershed Watch
Macroinvertebrates	Illinois Basin/Spring Creek Blue Thumb
Chlorophyll	New Hampshire Lakes Lay Monitoring Program, URI Watershed Watch

Calibration Samples

Five programs use calibration samples, which are samples with known concentrations that are used to calibrate equipment, as a method of QC (Table 8). Four use this method to assess pH, two assess nutrients, one assesses pesticides, one assesses turbidity, temperature, and dissolved oxygen, and one assesses chlorophyll.

Table 8: Programs that use calibration samples for QC

Parameter Assessed	Program
Nutrients (including ORP, NH_4, NO_3, TN, TP, DP)	New Hampshire Lakes Lay Monitoring Program and URI Watershed Watch
pH	Hoosier Riverwatch, New Hampshire Lakes Lay Monitoring Program, URI Watershed Watch, and Tahoe-Truckee Snapshot
Pesticides	Illinois Basin/Spring Creek Blue Thumb
Turbidity, temperature, and dissolved oxygen	Tahoe-Truckee Snapshot
Chlorophyll	New Hampshire Lakes Lay Monitoring Program, URI Watershed Watch

Positive/Negative Plates

Positive and negative plates are used in microbiological monitoring to detect errors in procedure at the laboratory and to detect bacterial contamination of the sample in the lab respectively. Therefore the responses from program coordinators to this question were uniform, with all four programs using this QC method to analyze coliforms (fecal coliforms or *E. coli*) (Table 9).

Table 9. Programs that use positive/negative plates for QC

Parameter Assessed	Program
Coliforms	North Fork Volunteer Monitoring Project, Maine Shore Stewards, New Hampshire Lake Lay Monitoring Program, and URI Watershed Watch

Split Samples

Split samples are two or more samples that are collected from a single field or laboratory sample and analyzed by different analysts or laboratories. They assess the variability and comparability of the analytical methods and between analysts or laboratory. Of the three programs that use split samples, two assess nutrients and the third assesses fecal coliforms (Table 10).

Table 10. Programs that use split samples for QC

Parameter Assessed	Program
Nutrients	Maine Shore Stewards, New Hampshire Lakes Lay Monitoring Program, and Tahoe-Truckee Snapshot
Fecal coliforms	Maine Shore Stewards

Duplicate Samples Analyzed By Second Lab

Duplicate samples analyzed by a second lab are two separate samples collected with same methods in as close space and time as possible analyzed by separate labs. Three programs, the St. Louis River–Riverwatch, Great Bay Coast Watch and the New Hampshire Lakes Lay Monitoring Program, indicated they use duplicate samples that are analyzed by a second laboratory as part of their QC procedures (Table 11). Macroinvertebrates, water chemistry samples and nutrients are assessed in this fashion by these programs.

Table 11. Programs that have duplicate samples analyzed by a second laboratory for QC

Parameter Assessed	Program
Macroinvertebrates	St. Louis River-Riverwatch
Water chemistry	St. Louis River-Riverwatch
Nutrients	New Hampshire Lakes Lay Monitoring Program

Spiked Samples

Spiked samples are those to which a known concentration of the substance to be analyzed is added. This is also known as the method of standard addition. They are used to assess accuracy of measurements, and if the sample is spiked in the field it can be very effective for assessing the effects of preservation, shipping and laboratory processes. Two programs (New Hampshire Lakes Lay Monitoring and the St. Louis River – Riverwatch Program) use spiked samples during analyses of volunteer monitors' samples. The St. Louis River – Riverwatch Program indicated that schools that participate in the main program sometimes used spiked samples, but that overall program does not use this QC method. The New Hampshire program uses spiked samples to analyze nutrient samples, including total P, NO_3, and total N.

Calibration Blanks

Calibration blanks are samples that have zero concentrations of specific substances; typically de-ionized or distilled water is used. They are used to calibrate analytical equipment by helping set the instrument to 'zero', and assess for 'drift'. Three programs, New Hampshire Lakes Lay Monitoring Program, the Illinois Basin/Spring Creek Blue Thumb, and the URI Watershed Watch program use

calibration blanks to analyze nutrient samples, including NO_3, PO_4, Cl, and NH_4. The New Hampshire Lakes Lay Monitoring Program and URI Watershed Watch Program also use calibration blanks when analyzing chlorophyll.

Unknown QC Standards

Unknown QC standards are those samples of a specific concentration, which is unknown to the analyst, but known by the supplier, which are used to assess accuracy and precision of laboratory analysis. URI Watershed Watch and Illinois Basin/Spring Creek Blue Thumb indicated using this method of QC to analyze nutrients, pH, alkalinity, total suspended solids, and BOD. Nutrients analyzed include: dissolved P, total P, total N, NO_3-N, NH_4-N, and Cl^-. This is known as an EPA WP/WS study. The unknown samples are purchased from vendors at certain times of the year. Analyte measurement results are sent in within a certain time period, with results returned in a month. Participation in WP/WS studies is required of certified laboratories in many states. Once the results have been certified these samples can continue to be used as external standards.

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