Aquatic Macroinvertebrate Identification Trainings for Volunteers: Results of a National Materials and Practices Inventory Survey

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Abstract

This report presents results from a nationally-administered online survey of citizen science training organizations in freshwater biomonitoring. The responses from 177 trainers detail information about their organizations' goals, their own background and experience in macroinvertebrate identification, the background and experience of training participants, the methods by which trainers train, the metrics for program evaluation and data reporting, and the materials used in trainings. This report presents a state-of-the-field of volunteer aquatic biomonitoring programs with the aim of informing the design of a digital teaching collection to support taxonomic identification training for benthic macroinvertebrates.

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Keywords: citizen science; taxonomy; macroinvertebrate identification; training practices

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EXECUTIVE SUMMARY

The data presented in this report were collected in support of a multi-year design research program funded by the National Science Foundation's Advancing Informal Science Learning (AISL) initiative seeking to improve and expand an online digital teaching collection of benthic macroinvertebrates, www.macroinvertebrates.org. One purpose of this website is to serve as a tool for trainers teaching citizen science volunteers to conduct aquatic macroinvertebrate identification for freshwater biomonitoring. To better understand the current needs and goals of trainers in the broader biomonitoring community, we conducted an online survey with the following specific goals: (1) to gather information about the current status of those who lead macroinvertebrate identification and biomonitoring training; (2) to characterize the design, materials, and practices of volunteer trainings. Findings of this survey will be used to establish the needs and characterize current training practices in order to prioritize design and system requirements of the online digital teaching collection macroinvertebrates.org.

The twenty-seven-question survey, built in Qualtrics, was developed by a team from Carnegie Mellon University's Learning Media Design Center as well as staff from the education department at the Stroud Water Research Center. The survey was launched on October 31, 2016 and was open for 10 weeks, ending on January 9, 2017. It was disseminated through a number of channels including list serves for volunteer monitoring (CitSci Discussion and Volmonitor), posted on several nationally related websites, and was directly sent to the staff of long-running volunteer biomonitoring organizations to send to their trainers. Reminder notifications of the survey were sent out every few weeks to the aforementioned groups. The survey was estimated as taking 15-30 minutes and we received 177 responses.

This report details findings in the six areas of focus of the survey. Section 1 reports data on the organizations giving volunteer macroinvertebrate trainings, such as the structure and research goals for their volunteer biomonitoring programs. Section 2 examines the background of the trainers at these organizations, including their status and role with the organization and their own experience in learning how to identify aquatic macroinvertebrates. Section 3 reports on the participants of the trainings, including the age ranges served by each organization and methods of recruitment. Section 4 reviews training methods. The eight survey questions reported in this section covered topics such as the size, duration, and structure of trainings, the frequency of trainings offered by the organization, and the taxonomic level to which volunteers are trained to identify. Section 5 covers evaluation and data reliability, and Section 6 details training resources.

Presented in the following pages are summary statistics of each of the questions. The original questions can be found in Appendix I. Questions enabled with an open-ended text entry field are summarized in this report, and the original full text responses are presented in Appendix II. Results showing that many organizations conduct trainings on an "as needed" basis and few programs currently incorporate online or digital tools demonstrate the potential for a high quality digital tool to impact training practices. Current resources used in Quality Assurance/Quality Control (QA/QC) and trainee evaluation could be supplemented with high-resolution annotated digital images. However, results also indicate that access to Internet connectivity during trainings cannot be assumed. Together these results suggest a need to consider flexible options for trainers and volunteers to utilize the collection before, during, and after macroinvertebrate identification trainings.

1 MACROINVERTEBRATE IDENTIFICATION TRAINING ORGANIZATIONS

A TYPES OF ORGANIZATIONS RESPONDING TO SURVEY (Q4, Q11)

Respondents were asked to select the category best describing their primary organization from a list (Q4). The list comprised ten organization types (e.g. Izaak Walton League chapter, University/Extension service) and an "Other (please describe)" option. Two researcher-provided organization types (Trout Unlimited Chapter and Advocacy Organization) received zero responses. Of the 107 responses, 30 identified themselves as "Other" organization types. User-entered descriptions of those organizations were consolidated by the research team into four additional categories: Conservation Nonprofit, Environmental Education Nonprofit, Informal Science Institution, and Local or Regional Government Program. Three "other" responses were classified by the researchers into existing categories based on how similar organizations had responded. See Appendix II for original text entry responses and final codes. Respondents were also asked whether they work for an organization that has an active biomonitoring program (Q11). 76 respondents answered yes; 26 answered no, and five did not answer the question. Table 1.1 provides the total number of organizations in each category and identifies how many in each category reported having an active biomonitoring program (Q11).

Table 1.1: Respondent organization types and if they have an active biomonitoring program.

		Active volunteer biomonitoring program?		
Organization Category	**Total**	**Yes**	**No**	**(blank)**
Advocacy Organization	0	0	0	0
Biological Field Station	3	2	0	1
City or County Conservation District	8	5	3	0
Federal Agency	3	0	2	1
Izaak Walton Chapter	3	3	0	0
Nature Center	9	5	4	0
Other: Conservation Nonprofit	3	3	0	0
Other: Environmental Education Nonprofit	15	7	7	1
Other: Informal Science Institution	2	1	1	0
Other: Local or regional government program	7	7	0	0
State Department of Natural Resources or Environmental Protection	17	13	3	1
Trout Unlimited Chapter	0	0	0	0
University/Extension Service	18	13	5	0
Watershed Association	19	17	1	1
Grand Total	**107**	**76**	**26**	**5**

B HISTORY AND PURPOSE OF ORGANIZATION'S BIOMONITORING PROGRAMS (Q12, Q13)

Respondents were asked in what year their organization began their biomonitoring program (Q12). Of the 74 responses, 59 were able to provide a specific year, 14 provided estimates (reported in Appendix II), and one indicated uncertainty about the question by typing "??". Numerical and text responses were aggregated by decade and are presented in Figure 1.1.

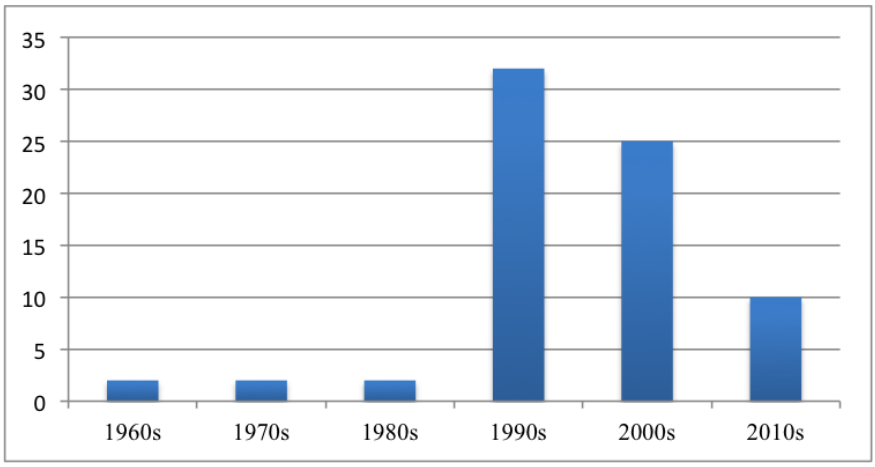


Figure 1.1. Decade reported as beginning of biomonitoring program.

Respondents were asked to report the extent to which their organization's purpose fell within each of four categories, from "Not Applicable" to "Very Important." Table 1.2 provides the distribution of importance of each purpose to the organizations. The four categories of purposes are:

1. **Action**: supporting civic agendas, such as concerns about environmental degradation due to petrochemical industry activities;
2. **Conservation**: supporting natural resource management, such as efforts to protect natural areas through regulation;
3. **Investigation**: supporting scientific research goals, such as collecting baseline data to understand regional ecology;
4. **Education**: supporting volunteers' understanding and engagement with the environment, such as projects centered on increasing awareness and experience of nature.

Table 1.2 Purpose of biomonitoring programs

	Action	Conservation	Investigation	Education
Very Important	25	41	47	68
Somewhat Important	29	28	26	7
Not Important	7	3	1	0
Not Applicable to our Program	12	2	1	0
(blank)	2	1	0	0
Total	**75**	**75**	**75**	**75**

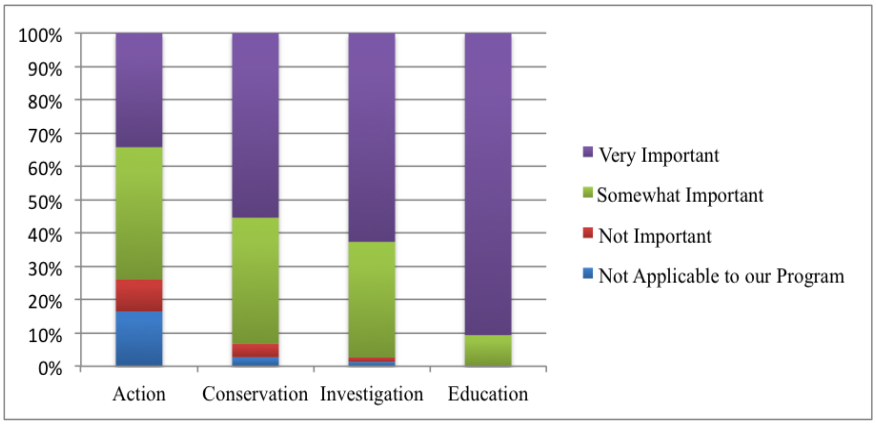


Figure 1.2. Percentage of responses by importance level for each category.

C ORGANIZATIONS' RESEARCH QUESTIONS (Q14)

Respondents were asked that if their biomonitoring program has specific research questions, to identify up to 3 research questions in order of importance (Q14). Of the 75 organizations with biomonitoring programs, 34 (45%) listed at least one research question. Sixteen organizations listed a second question, and five organizations listed a third. The 55 responses were coded with six mutually-exclusive descriptive codes, defined below. Twenty-six of the responses (47%) were used for training, and the remaining 29 responses were coded independently by two coders, with 100% agreement.

- **Overall quality (N = 18)**: Response indicates an interest in assessing the quality of water. Response is neutrally stated and does not indicate specific interest in change over time or monitoring effects of environmental stimuli (e.g. land development).
- **Quality over time (N = 10)**: Response indicates an interest in assessing long-term trends in water quality but does not mention monitoring effects of specific environmental stimuli (e.g. land development)
- **Effect (N = 15)**: Response indicates interest in correlating one or more specific external events (e.g. dam removal, land development) with changes in water quality. Can suggest a hypothesized nature of the correlation, e.g. whether shale-gas related development have adversely affected water quality or whether restoration projects have improved water quality over a baseline.
- **Education (N = 2)**: Response indicates a focus on helping participants understand aquatic biodiversity.
- **Scientific (N = 8)**: Response indicates investigation of a particular research question, for example the relationship between two variables, e.g. tributary health and main stem water quality.
- **Other (N = 2)**: Response does not fit into above categories, i.e. to support state monitoring efforts (N =1) or guide policy decisions (N = 1).

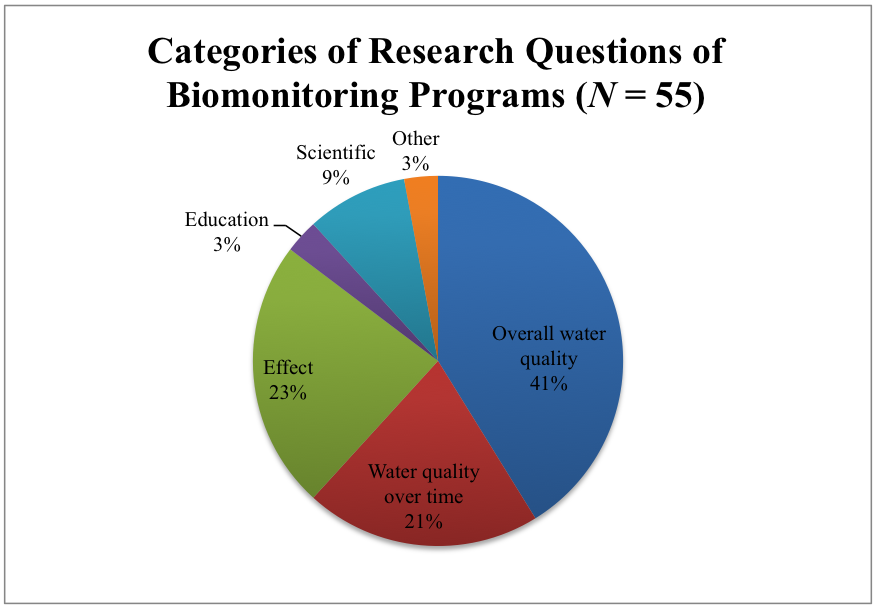


Figure 1.3 Research questions of biomonitoring programs (categories).

2 MACROINVERTEBRATE IDENTIFICATION TRAINERS

A ROLE AND STATUS AT ORGANIZATIONS (Q1, Q2)

Respondents were asked to list up to three organizations for which they conduct macroinvertebrate trainings. For each organization, respondents were asked whether their role is primarily organization management or educator/trainer and whether their position is paid or volunteer (Q1). Of the 107 respondents for this section of the survey, 106 listed primary organizations, 34 listed a second organization, and 17 respondents listed a third organization. One respondent did not indicate role or pay status at their primary organization. Two incomplete responses were given at both the secondary and tertiary levels, meaning that the respondent indicated either the role or the pay status but not both. Those three incomplete responses are not included in Table 2.1. Respondents' self-reported position titles (Q2) are presented in Appendix II.

Table 2.1 Role and status of respondents at primary, secondary, and tertiary organizations

	Primary Organization		Secondary Organization		Tertiary Organization	
	Organization Management	Trainer/ Educator	Organization Management	Trainer/ Educator	Organization Management	Trainer/ Educator
Paid	27	56	6	17	0	3
Volunteer	5	18	1	8	0	10

Of the 107 responses, 90 (84%) reported being paid by at least one organization. Eighteen (17%) were paid by more than one organization, and only 3 respondents were paid by all three reported organizations.

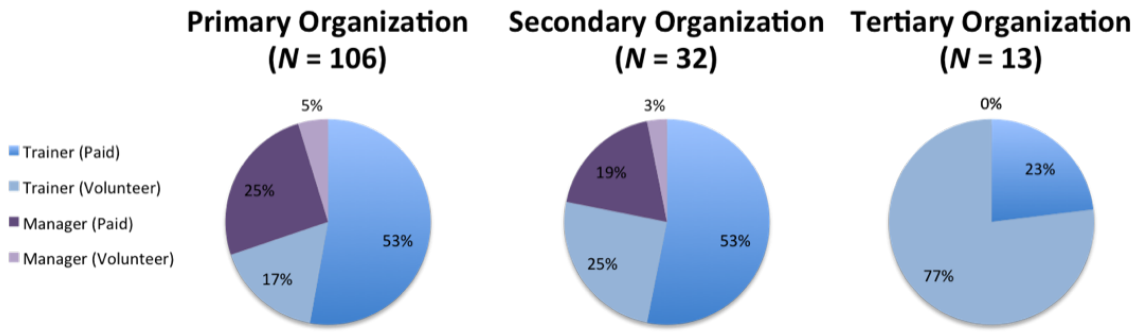
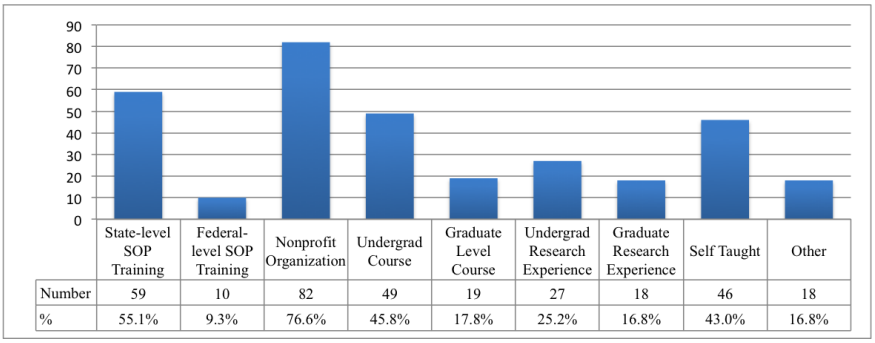


Figure 2.1 Role (trainer or educator) and status (paid or volunteer) of respondents at their primary, secondary, and tertiary organizations.

B TRAINING EXPERIENCES (Q3)

Respondents (trainers) were asked to indicate the types of macroinvertebrate training experiences in which they had participated by selecting all that applied from a list of eight options (plus "Other").

Q3 Check all of the aquatic macroinvertebrate identification training experiences you have participated in (e.g. University course, Trainer's Workshop). Select all that apply.



	State-level SOP Training	Federal-level SOP Training	Nonprofit Organization	Undergrad Course	Graduate Level Course	Undergrad Research Experience	Graduate Research Experience	Self Taught	Other
Number	59	10	82	49	19	27	18	46	18
%	55.1%	9.3%	76.6%	45.8%	17.8%	25.2%	16.8%	43.0%	16.8%

Figure 2.2 Training experience of trainers

Of the 107 responses, 95 (88%) selected more than one response. Of the twelve respondents listing only a single training experience, two identified as being only self-taught.

3 TRAINEE PARTICIPANTS

A AGE OF VOLUNTEERS (Q5)

Respondents were asked the age ranges of participants in all the macroinvertebrate identification events they facilitate. The age ranges from which respondents could select were: Children/Youth (age 18 and younger); Young Adults (age 19-24); Adults (age 25-64); and Senior Adults (age 65 and older). Respondents were asked to select all that apply.

Of the 106 responses, 51 (48%) reported working with all age ranges. Four of the respondents worked only with children (under 18), two respondents worked only with young adults (19-24), and three additional groups worked with children and young adults but not older adults. Five respondents work only with adults age 25-64.

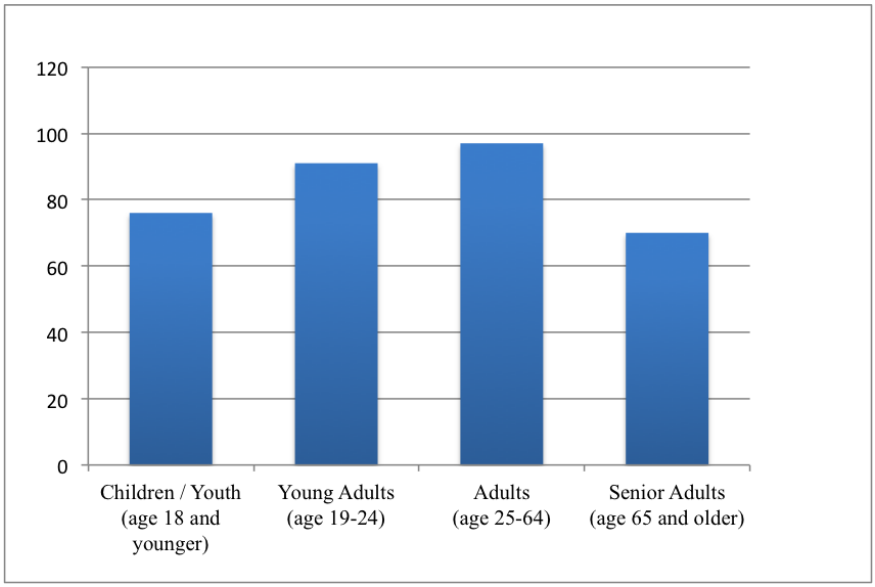


Figure 3.1 Age ranges of volunteers

B RECRUITMENT (Q6)

Respondents were asked how they recruited participants: through digital communications, in person, or print media (flyers, posters, and/or mailings). Of 102 responses, 8 reported exclusively recruiting through digital communications, 77 used digital and in-person recruitment, and 52 used all three.

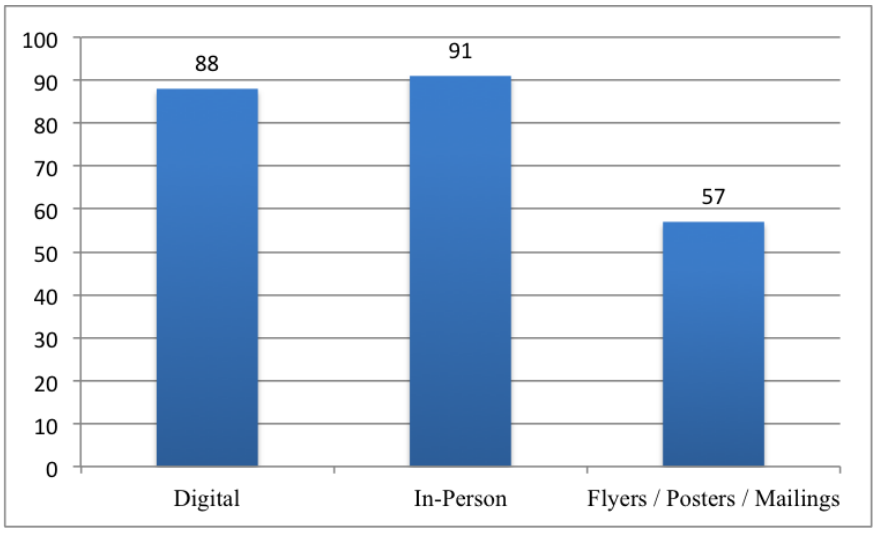


Figure 3.2 Methods of volunteer recruitment

4 TRAINING METHODS

A NUMBER OF PARTICIPANTS (Q7)

Respondents were asked how many trainees attend a training session, on average. 106 responses were received, with a majority reporting a mean of 5-10 or 10-15 participants per training session. Nearly 80% (84 of 106) reports between 5-20 participants in a session. Two responses indicated trainings with more than 25 individuals in attendance (See Table 4.1).

Table 4.1 Typical number of trainees per session

Average Number of Participants	Number of Organizations
Fewer than 5	10
5-10	35
10-15	35
15-20	14
20-25	10
25+	2
Total	106

B DURATION OF TRAINING (Q8)

Respondents were asked about the duration of a typical training session by their organization (single selection). We received 102 responses to this section, with most training sessions reported to run for half a day (2-4 hours). A large majority of trainings (82 of 102, or 80%) last four hours or less. The longest training sessions can go on for 2-3 days (1 response) or more than 3 days (3 responses).

Table 4.2 Duration of typical training program

Duration	Number of Organizations	%
0-2 hours	31	30%
Half Day (2-4 hours)	51	50%
Full Day (5-8 hours)	16	17%
1-2 days	0	0%
2-3 days	1	1%
More than 3 days	3	3%

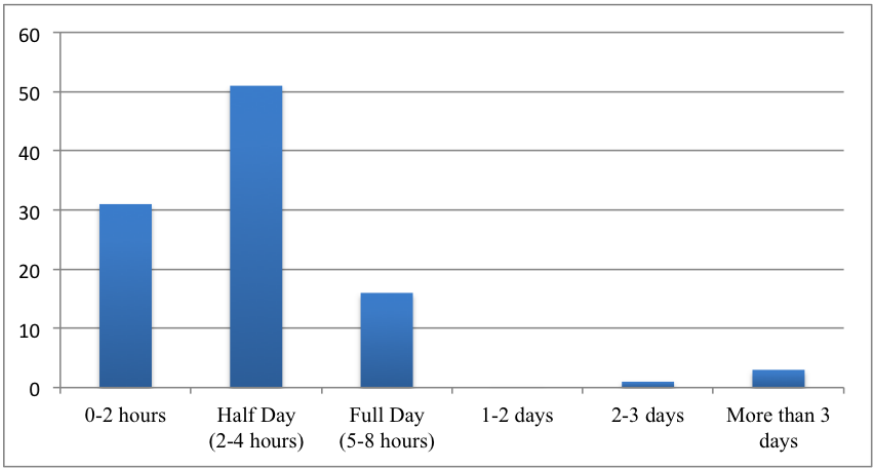


Figure 4.1 Duration of typical trainings

C FREQUENCY OF TRAININGS (Q9)

Respondents were asked to indicate the frequency at which their organizations offer macroinvertebrate training. Of the 102 responses received, close to half of the organizations (40) offer training sessions only when needed/requested. For organizations that hold regularly scheduled training sessions, most organize them on an annual (24 responses) or bi-annual (23 responses) basis.

Table 4.3 Frequency of trainings offered by organization

Frequency of Training Sessions	Number of Organizations
As Needed or Requested	40
Monthly	2
Bi-Monthly (approx. 6x/year)	0
Quarterly	6
Bi-Annually (e.g. Spring and Fall)	23
Annually	24
Other (please describe)	7

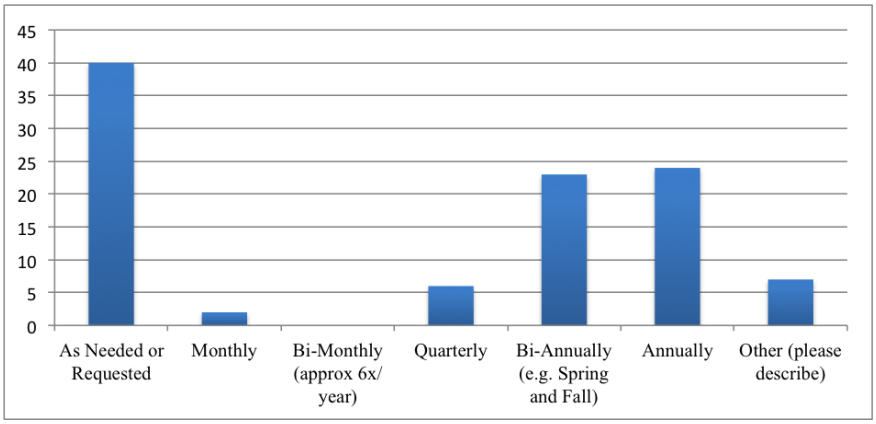


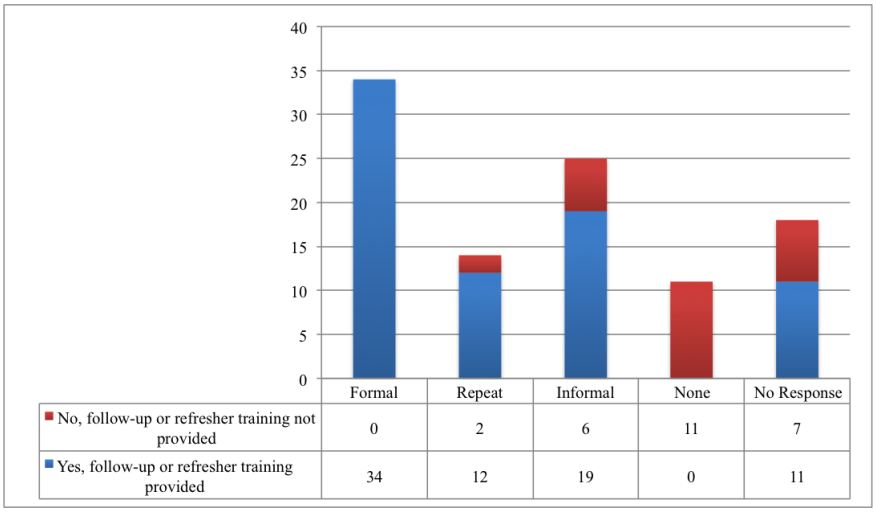
Figure 4.2 Frequency of trainings

D FOLLOW UP AND REFRESHER TRAININGS (Q10)

Respondents were asked whether their organization provides follow up or refresher training sessions. Respondents were able to select yes or no and then write in an explanation. We received 102 responses to this section, with 76 saying Yes and 26 saying No. Explanations were provided from 84 respondents (19 from those who answered No and 65 who answered Yes), and those were coded into four categories:

- **Formal (N = 31)**: Organization offers a training and/or certification test specifically designed as a follow up or refresher course building on the introductory training.
- **Repeat (N = 16)**: Volunteers are encouraged or required to repeat initial training courses, but no specifically designed refresher or advanced courses are offered.
- **Informal (N = 25)**: Ongoing training and support is provided through mentoring and supervising in the field or through repeated contact but not in a formal training session.
- **None (N = 10)**: No follow up or refresher opportunities are offered, for example response states students are new each time.

Some responses mentioned both informal and formal refresher training opportunities; those were coded as formal. A subset of 15 responses was used for inter-coder training, and the remaining 69 were coded independently by 2 coders, with initial 87% agreement. Coder disagreements were resolved through discussion to establish coder consensus. Full text responses are provided in Appendix II.



	Formal	Repeat	Informal	None	No Response
No, follow-up or refresher training not provided	0	2	6	11	7
Yes, follow-up or refresher training provided	34	12	19	0	11

Figure 4.3 Type of follow-up training offered, by response to whether or not follow-up was available (Yes or No).

E TRAINING OBJECTIVES (Q20)

Respondents were asked via check all that apply to name their objectives for their macroinvertebrate biomonitoring training. 101 Respondents answered the question. The most common objectives were found to be teaching macroinvertebrate identification (93, responses, 93%) and teaching sampling procedures and protocols (87 responses, 87%).

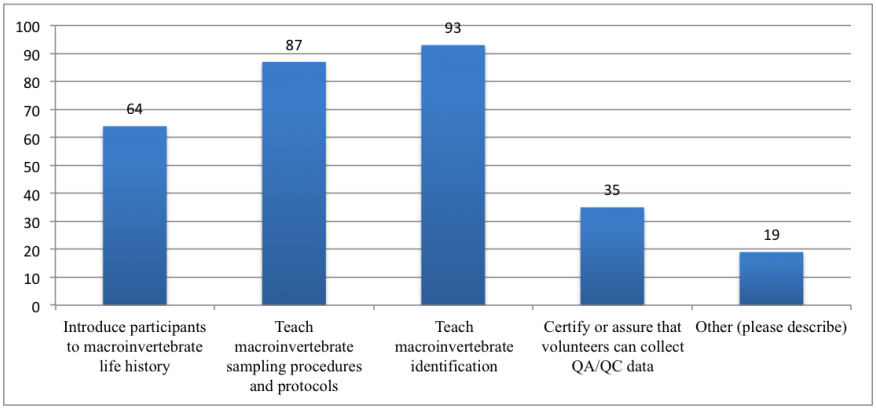


Figure 4.4 Training objectives

Text responses describing "Other" training objectives (19 responses) generally focused on educational goals related to biodiversity and the relation of biodiversity to the health of a waterway and overall ecosystem, and interpretation and use of data. Some of these goals include awareness of how macroinvertebrate populations can be used to monitor water quality, and how the quality of local water sources is impacted by human activities such as land use and pollution. See Appendix II for complete text responses.

F TAXONOMIC ID LEVEL (Q21, Q22)

Respondents were asked to what taxonomic level volunteer trainees were expected to be proficient. Of 101 responses, 21 train only to Order, and another 44 identified as training to Order with some Families. Table 4.4 reports the lowest taxon level reported, where a respondent marking both "Order with some Families" and "Family" is tallied as Family.

Table 4.4 Lowest level identified for volunteer proficiency

Taxonomic Level	Number of Organizations
Order	19
Order with some families	44
Family	5
Family with some genera	15
Genus	0
Species	11
Other (please describe)	7

The seven "Other" responses provided text descriptions. Four of those responses indicated that identification was a low priority, with two listing common names as the goal, one stating it was primarily important for volunteers to recognize the difference between benthic macroinvertebrates and vertebrates in order to keep vertebrates from the sample, and one indicating the goal was for volunteers to ID "whatever they can." The remaining three responses provided clarification to the selections, including that only a few volunteers get proficient at family (one response), the goal is to family but some options of genera (one response), and volunteers are encouraged to family but taxonomists do genus and species (one response).

Respondents were also asked whether they were interested in training volunteers to identify to a deeper taxonomic order than they currently train to (Q22). Of the 65 responses, 31 (48%) said no, 20 (31%) said they would like to train to family, and 14 (21%) said they would like to train to genus.

G STRUCTURE OF TRAINING (Q23)

Respondents were asked to use sliders to indicate the percentage of their typical trainings that were spent in each of four locations: classroom, laboratory, field, and online. Responses are broken down by duration of training. Three of the 103 responses to these questions (duration of training and training structure) were incomplete, with respondent answering one but not both questions. These responses have been removed from the below table.

Table 4.5 Percentage of trainings spent in four locations: classroom, laboratory, field, and online.

		Classroom			Laboratory			Field			Online		
Training Duration	N	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
0-2 hours	31	29%	0%	50%	11%	0%	58%	60%	0%	100%	1%	0%	10%
Half Day (2-4 hours)	50	31%	0%	70%	9%	0%	82%	58%	0%	100%	1%	0%	50%
Full Day (5-8 hours)	16	33%	0%	65%	25%	0%	70%	43%	20%	95%	0%	0%	0%
2-3 days	1	8%*	8%*	8%*	20%*	20%*	20%*	61%*	61%*	61%*	11%*	11%*	11%*
More than 3 days	2	15%*	10%*	19%	66%*	61%*	70%*	20%*	20%*	20%*	0%*	0%*	0%*
Grand Total	100	30%	0%	70%	13%	0%	82%	56%	0%	100%	1%	0%	50%

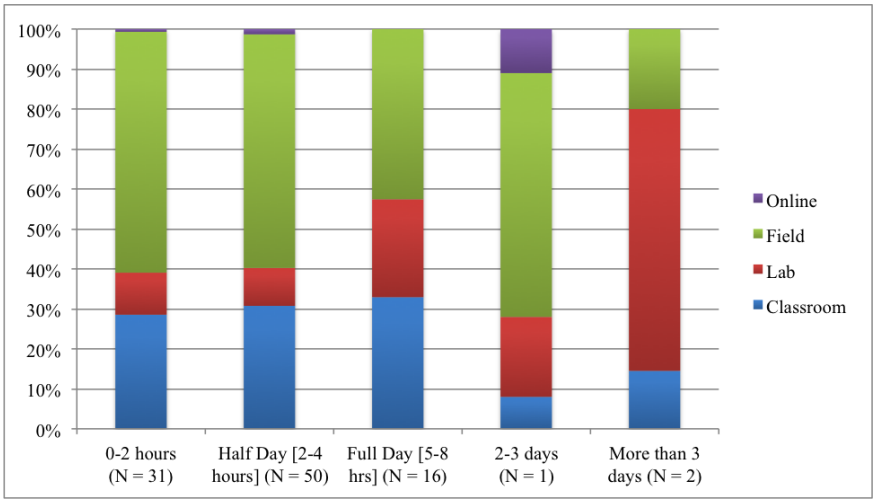


Figure 4.5 Average time spent in four locations, by duration of training.

Note that two training types - those lasting 2-3 days and those lasting more than 3 days - were underrepresented in the sample, with sample sizes of 1 and 2, respectively. Conclusions about these types of training should be made sparingly from this data set.

5 TRAINING EVALUATION

A TYPES OF EVALUATION (Q16)

Respondents were asked to select all applicable evaluation methods they use with trainees. We received 100 responses to this question. 32 respondents indicated they do not conduct any evaluation. 22 reported "Other" means of evaluation, with several responses mentioning close supervision or double-checking by an experienced taxonomist.(See Appendix II.)

Table 5.1 Evaluation methods for volunteers

Evaluation Method	Number of Organizations
Unknown Real Specimen ID Tests (preserved or live)	45
No evaluation	32
Unknown Image Test (e.g. PowerPoint or color photos)	18
Paper Test (descriptions or illustrations only)	23
Surveys of Participants	18
Pre/Post Tests	11
Other (please describe)	22

B MACROINVERTEBRATE ID RELIABILITY (Q17, Q15, Q18, Q19)

Respondents were also asked whether evaluations were used to determine whether volunteers are qualified to collect or identify macroinvertebrate samples. Of 68 responses to that question, 31 (46%) said yes, 13 (19%) said sometimes, and 24 (35%) said no.

Additionally, respondents were asked (Q15) to select all that apply of three difficulties they experience when implementing volunteer macroinvertebrate biomonitoring. 75 responses were recorded for this question, of which the two most common difficulties experienced are ensuring volunteer biomonitoring data are valid and reliable (42 responses, 56%) and bolstering volunteers' confidence in identifying macroinvertebrates (39 responses, 52%).

Table 5.2 Difficulties experienced when implementing volunteer biomonitoring programs

Difficulties Experienced	Number of Organizations
Ensuring that volunteer biomonitoring data are valid and reliable	42
Bolstering volunteers' confidence in identifying macroinvertebrates	39
Training volunteers to identify macroinvertebrates	25

When asked whether volunteers were trained in Quality Assurance/Quality Control (QA/QC), 100 responses indicated that 43% were trained, 37% were not, and 20% were sometimes trained (Q18).

When asked to select all QA/QC measures that apply (Q19), 63 responses indicated that requiring training prior to monitoring or data submission was very common (57 responses). Other common QA/QC measures included using a local field guide (45 responses), using a reference collection (33), and side-by-side testing with trained personnel (33). See full results in Table 5.3.

Table 5.3 QA/QC Measures included in macroinvertebrate volunteer monitoring programs

QA/QC Measures Used	Number of Organizations
Required training before monitoring or data submission	57
Use of a local field guide for known taxa	45
Use of a reference collection for ID	33
Side by side testing with trained staff or personnel	33
Flagging questionable data	30
Verification of vouchers (specimens or photos)	27
Follow-up monitoring by a professional to assess questionable findings	25
Compare sample of raw data to reported data in database	9
Other (please describe)	11

6 TRAINING RESOURCES

A MATERIALS (Q24)

Respondents were asked to identify the resources used during trainings (101 responses). Resources include informational materials to introduce key information (e.g. slide presentations and videos, shown in blue below), reference materials for completing an identification (e.g. dichotomous keys and flashcards, shown in red), and tools for collecting and identifying specimens (e.g. kick nets and hand lenses, shown in green).

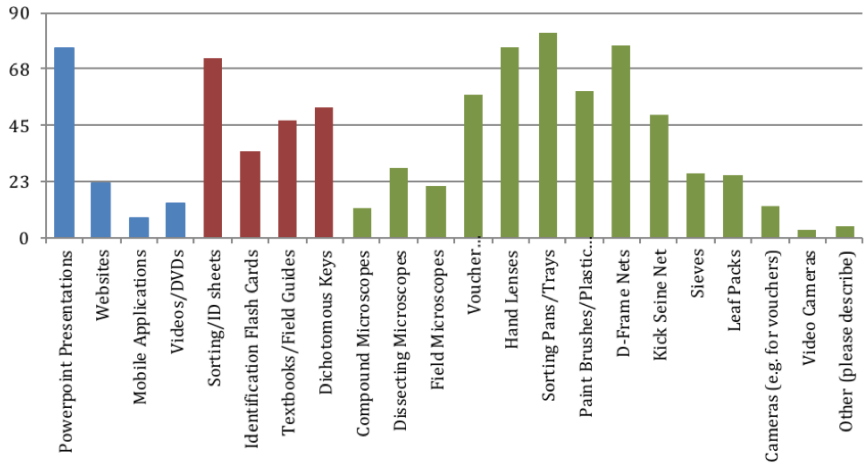


Figure 6.1 Resources used in trainings

B INTERNET ACCESSIBILITY (Q26)

Respondents were asked to estimate the percent of their trainings locations where Internet is available in the classroom and stream side. Responses were grouped as High Access if it was reported that 75% or more trainings had Internet access; Some Access if between 25-74% were reported as having Internet, and Low Access if zero to 24% of trainings had Internet access. Eighty-five respondents provided answers for classroom access (44), stream side (1), or both (40). Only five responses indicated high Internet access both in the classroom and stream side.

Table 6.1 Internet access in classroom and stream side.

	Classroom	Stream side
Low	19 (23%)	19 (46%)
Some	23 (27%)	16 (39%)
High	42 (50%)	6 (14%)

APPENDIX I : ORIGINAL SURVEY QUESTIONS

Q1 List up to three organization(s) for which you conduct aquatic macroinvertebrate identification training. For each organization, please indicate if your efforts are as a volunteer or paid employee, and whether your position is mainly organizational management or as a trainer/educator.

	Please enter the name and zip code for each organization		Please identify your status at each organization		Please categorize your role at at each organization	
	Organization Name (1)	Zip Code (2)	Paid (1)	Volunteer (2)	Organization Management (1)	Trainer / Educator (2)
Primary Organization (1)			❍	❍	❍	❍
Secondary Organization (2)			❍	❍	❍	❍
Tertiary Organization (3)			❍	❍	❍	❍

Q2 Enter your job or position title at your primary organization:

Q3 Check all of the aquatic macroinvertebrate identification training experiences you have participated in (e.g. University course, Trainer's Workshop). Select all that apply.

- ☐ Training for State-level Standard Operating Procedures (SOPs) in biomonitoring (1)
- ☐ Training for Federal-level Standard Operating Procedures (SOPs) in biomonitoring (2)
- ☐ Nonprofit Organization (3)
- ☐ Undergraduate Course in Entomology or Aquatic Macroinvertebrates (4)
- ☐ Graduate Level Course in Entomology or Aquatic Macroinvertebrates (5)
- ☐ Undergraduate Research Experience in Entomology or Aquatic Macroinvertebrates (6)
- ☐ Graduate Research Experience in Entomology or Aquatic Macroinvertebrates (7)
- ☐ Self Taught (8)
- ☐ Other(s) (please describe) (9) _____

Q4 Select the category from below that best describes your primary organization type:

- ☐ Watershed Association (1)
- ☐ City or County Conservation District (2)
- ☐ State Department of Natural Resources or Environmental Protection (3)
- ☐ Federal Agency (4)
- ☐ Trout Unlimited Chapter (5)
- ☐ Izaak Walton Chapter (6)
- ☐ Biological Field Station (7)
- ☐ Nature Center (8)
- ☐ Advocacy Organization (9)

☐ University/Extension Service (10)

☐ Other (please describe) (11) _____

For the following questions, please think of the macroinvertebrate identification trainings you conduct for your primary organization.

Q5 Please identify the age groups of participants in all of the macroinvertebrate identification training events that you facilitate (Select all that apply).

☐ Children / Youth (age 18 and younger) (1)

☐ Young Adults (age 19-24) (2)

☐ Adults (age 25-64) (3)

☐ Senior Adults (age 65 and older) (4)

Q6 How are volunteers / participants in your macroinvertebrate training events recruited? Select all that apply.

☐ Digital (email, websites, social media, etc) (1)

☐ In-Person (presentations, meetings, trainings, etc) (2)

☐ Flyers / Posters / Mailings (3)

Q7 What is the average number of participants in a training event?

☐ Fewer than 5 (1)

☐ 5-10 (2)

☐ 10-15 (3)

☐ 15-20 (4)

☐ 20-25 (5)

☐ 25+ (6)

For the next two questions, please respond only with regard to the specific parts of your water quality training that pertain to macroinvertebrate identification and collection (not water chemistry or physical environmental assessment training).

Q8 What is the duration of the typical macroinvertebrate identification training?

☐ 0-2 hours (2)

☐ Half Day (2-4 hours) (3)

☐ Full Day (5-8 hours) (6)

☐ 1-2 days (9)

☐ 2-3 days (7)

☐ More than 3 days (8)

Q9 How often do you typically offer macroinvertebrate identification training for your primary organization?

☐ Annually (1)

☐ Bi-Annually (e.g. Spring and Fall) (2)

☐ Quarterly (3)

☐ Bi-Monthly (approx 6x/year) (4)

☐ Monthly (5)

☐ As Needed or Requested (6)

☐ Other (please describe) (7) _____

Q10 Would you characterize any repeat contact with participants or volunteers in a training context as "follow-up" or "refresher" training?

☐ No (please explain) (1) _____

☐ Yes (please explain) (2) _____

Q11 Do you work or volunteer for an organization that has an active volunteer biomonitoring program?

☐ Yes (1)

☐ No (2)

If Yes Is Selected, Then Skip To For the following questions, please t...If No Is Selected, Then Skip To How do you evaluate your trainees? (C...

For the following questions, please think of the organization for which you work or volunteer that has an active macroinvertebrate biomonitoring program.

Q12 In what year did your organization begin collecting volunteer macroinvertebrate data?

Q13 How would you characterize the purpose of your organization's volunteer macroinvertebrate program?

	Not Applicable to our Program (1)	Not Important (2)	Somewhat Important (3)	Very Important (4)
Action: supporting civic agendas, such as concerns about environmental degradation due to petrochemical industry activities (1)	❍	❍	❍	❍
Conservation: supporting natural resource management, such as efforts to protect natural areas through regulation (2)	❍	❍	❍	❍
Investigation: supporting scientific research goals, such as collecting baseline data to understand regional ecology (3)	❍	❍	❍	❍

Q14 If your macroinvertebrate biomonitoring program has specific research questions, up to 3 in order of importance:

Research Question 1 (1)
Research Question 2 (2)
Research Question 3 (3)

Q15 What difficulties do you experience in implementing volunteer macroinvertebrate biomonitoring?

- ☐ Training volunteers to identify macroinvertebrates (1)
- ☐ Bolstering volunteers' confidence in identifying macroinvertebrates (2)
- ☐ Ensuring that volunteer biomonitoring data are valid and reliable (3)
- ☐ Other (please describe) (4) _____

Q16 How do you evaluate your macroinvertebrate identification trainees? (Select all that apply)

- ☐ Paper Test (descriptions or illustrations only) (1)
- ☐ Surveys of Participants (2)
- ☐ Pre/Post Tests (3)

☐ Unknown Real Specimen ID Tests (preserved or live) (4)

☐ Unknown Image Test (e.g. PowerPoint or color photos) (5)

☐ No evaluation (6)

☐ Other (please describe) (7) _____

If No evaluation Is Selected, Then Skip To Does your organization utilize or tra...

Q17 Are evaluations used to determine whether volunteers are qualified to collect or identify macroinvertebrate samples?

☐ Yes (1)

☐ Sometimes (please explain) (2) _____

☐ No (3)

Q18 Does your organization utilize or train volunteers in Quality Assurance / Quality Control measures for macroinvertebrate data?

☐ Yes (1)

☐ Sometimes (please explain) (3) _____

☐ No (2)

If No Is Selected, Then Skip To End of Block

Q19 Please select all Quality Assurance / Quality Control measures that may apply:

☐ Required training before monitoring or data submission (1)

☐ Use of a reference collection for ID (2)

☐ Use of a local field guide for known taxa (3)

☐ Verification of vouchers (specimens or photos) (4)

☐ Side by side testing with trained staff or personnel (5)

☐ Flagging questionable data (6)

☐ Compare sample of raw data to reported data in database (7)

☐ Follow-up monitoring by a professional to assess questionable findings (8)

☐ Other (please describe) (11) _____

Q20 What are your macroinvertebrate biomonitoring training objectives? (Select all that apply)

☐ Introduce participants to macroinvertebrate life history (1)

☐ Teach macroinvertebrate sampling procedures and protocols (2)

☐ Teach macroinvertebrate identification (3)

☐ Certify or assure that volunteers can collect QA/QC data (4)

☐ Other (please describe) (5) _____

Q21 To what taxonomic level are volunteers asked to be proficient in? Select all that apply.

☐ Order Level (1)

☐ Order Level with some Families (2)

☐ Family Level (3)

☐ Family Level with some Genera (4)

☐ Some Order, Family, Genus, Species levels (6)

☐ Other (please describe) (5) _____

Q22 Are you interested in training volunteers to identify macroinvertebrates to a deeper level of identification?

☐ No (1)

☐ Yes, I'd like to train volunteers to ID to family (2)

☐ Yes, I'd like to train volunteers to ID to genus (3)

Q23 About how much of a typical macroinvertebrate training you teach is spent in each of the following contexts:
_____ Classroom/Meeting Space (1)
_____ Laboratory (2)
_____ Field (3)
_____ Online (4)
_____ Other (5)

Q24 Which of the following do you use in your macroinvertebrate training events? Select all that apply.

☐ Powerpoint Presentations (please paste URL if slides are available online) (10) _____

☐ Websites (please paste URLs) (1) _____

☐ Mobile Applications (please list names) (2) _____

☐ Videos/DVDs (please name/describe) (9) _____

☐ Sorting/ID sheets (please name/describe) (11) _____

☐ Identification Flash Cards such as Lamotte, and Voshell (please name/describe) (12) _____

☐ Textbooks/Field Guides (please name) (14) _____

☐ Dichotomous Keys (please name) (15) _____

☐ ompound Microscopes (3)

☐ Dissecting Microscopes (4)

☐ Field Microscopes (5)

☐ Voucher Collections/Preserved Specimens (13)

☐ Hand Lenses (6)

☐ Sorting Pans/Trays (17)

☐ Paint Brushes/Plastic Spoons/Pipettes (16)

☐ D-Frame Nets (19)

☐ Kick Seine Net (20)

☐ Sieves (18)

☐ Leaf Packs (21)

☐ Cameras (e.g. for vouchers) (7)

☐ Video Cameras (8)

☐ Other (please describe) (22) _____

Q25 What training resources and materials do you give participants **to own and use after the workshop** to assist with their identification and monitoring activities? Please provide links if possible.

Q26 Please estimate the percent of your trainings where internet access is available.
_____ Percent of trainings where internet access is available in the classroom (1)
_____ Percent of trainings where internet access is available streamside (8)

Q27 Thank you for participating in our study! If you would like updates on our work or are interested in providing feedback on the expanding and improving www.macroinvertebrates.org site, please provide your email address:

APPENDIX II : WRITTEN RESPONSES TO OPEN-ENDED QUESTIONS

This appendix lists verbatim text entry responses from participants to open-field questions, including responses to "Other (please describe)" options.

Q2: ENTER YOUR JOB OR POSITION TITLE AT YOUR PRIMARY ORGANIZATION:

All responses:

- 4-H Youth Development Educator
- Adopt-A-Stream Coordinator
- Adopt-a-stream volunteer trainer/ but i am a professor and teach invertebrate zoology, however my students don't generally do biomonitoring
- Adult Programs Manager
- Aquatic Biologist
- Aquatic Ecologist
- Aquatic Research Coordinator
- Aquatic Scientist
- Area Water Educator – Assistant Professor
- Assistant Director
- Assistant Director
- Assistant Professor
- Baykeeper
- Bio-monitoring Coordinator
- Biologist
- Board Member and Data Manager
- Camps and Adventure Program Coordinator
- Citizen Science Coordinator
- Clean Water Fellow
- Community Coordinator/Trainer
- Conservation Associate
- Conservation Education Coordinator
- Conservation Specialist
- Consultant-biologist
- Coordinator, Water Quality Monitoring Program
- Coordinator, Water Quality Monitoring Program
- Director
- Director and Educator
- Director of Education and Environmental Learning
- Director of Programming and Conservation Action
- Director of the Watershed Ecology Center
- Director of Water Quality Programs
- Ecologist/ Director
- Education Coordinator
- Education Director
- Education Program Coordinator
- Education Specialist
- Emeritus Professor of Biology
- Environmental Analyst (State RBV Program Coordinator)
- Environmental Compliance Specialist 2
- Environmental Program Coordinator
- Environmental Programs Specialist
- Environmentalist
- Executive Director
- Extension Educator
- Four Rivers Basin Coordinator
- Freshwater Entomologist
- GA Adopt-A-Stream Macroinvertebrate Trainer
- Geographer
- Georgia Adopt-A-Stream Trainer
- Hoosier Riverwatch Coordinator
- Information and Education Manager
- Instructor
- Interim Watershed and Lake Education Coordinator at Lake Champlain Sea Grant
- Invertebrate Zoologist
- IOWATER Coordinator (I do both of the functions above – management and trainer)
- Lab Manager
- Lead Educator
- local Georgia Adopt-a-Stream coordinator
- Master Naturalist
- Mid-Atlantic Angler Science Coordinator
- Naturalist
- Naturalist/Program Specialist
- Nature Center Manager, Educator
- Pittsburgh Educator & Camp Director
- Primary Investigator
- Professor of Biology

- Professor of Environmental Sciences and Biology
- Program Coordinator
- Program Coordinator
- Program Coordinator
- Program Director
- Program Director
- Program Manager
- Programs Coordinator
- Project Director
- Project Watershed Volunteer Coordinator
- Regents Professor
- research and administration
- Resource Educator
- Retired Professor of Biology
- RiverWatch Biologist
- Senior Water Resource Planner
- soil scientist
- Stream Team Biologist
- Stream Team Coordination Biologist/ Fisheries Staff Biologist
- Stream Team Coordnation Biologist
- Technical Coordinator
- Trainer
- Volunteer
- volunteer
- Volunteer (previous board member and education committee chair)
- Volunteer & Stewardship Coordinator
- Volunteer instructor
- Volunteer Monitoring Program Manager
- Volunteer Trainer
- Water Action Volunteers Statewide Coordinator
- water pollution biologist
- Water Quality Program Coordinator
- Water Quality Program Manager
- Water Resource Educator
- Water Resource Specialist
- Water Specialist
- Watershed Conservation Project Manager
- Watershed Protection Specialist
- Watershed Science Fellow
- WAVE coordinator

Q3: Check all of the aquatic macroinvertebrate identification training experiences you have participated in (e.g. University course, Trainer's Workshop). Select all that apply.

Other (Please describe):

- AmeriCorps New Jersey Watershed Ambassador Program
- Clemson Teaching KATE educator, other EE programs
- Co-author of Streamkeepers Field Guide: Watershed Inventory and Stream Monitoring Methods
- Development of training tools
- Does this mean training I have received? Or training I have given? This question is unclear... did you run this by an experienced survey researcher?
- Georgia's Adopt a Stream Program - citizen science
- internship in museum collection
- Lessons taught in Environmental Science or Ecology college courses
- On the job training
- On the job training/field training
- Special ID workshop led by regional taxonomic experts
- State level (Maryland DNR) training, not SOP's. Watershed Report Card program through Explore and Restore Maryland Streams funding.
- Taxonomic identification for state Resource Assessment Monitoring Program; EPA Wadeable Streams Assessment (2004-2005)

- The Xerces Society workshops
- Trained by other University, Extension, and DNR professionals
- Trained mainly by previous macro trainer for program
- Training and Experience in Watershed Level Macroinvertebrate Studies (multi-county)
- University of Wisconsin Field Guide materials
- WAA family level identification course
- Watershed Assessment Associates EPT Training
- Working with Peers

Q4: SELECT THE CATEGORY FROM BELOW THAT BEST DESCRIBES YOUR PRIMARY ORGANIZATION TYPE:

Thirty respondents selected "Other (please describe)" in response to this question. Members of the research team consolidated the text responses received into groups as shown below. The left column contains the original text responses (with identifying information, e.g. name of locality, redacted), and the right column contains the researcher-generated category.

Text Entry	**Category**
state Conservation Department (different mandate than natural resources or environmental protection/non-regulatory	Conservation Nonprofit
Conservation Non-Profit	Conservation Nonprofit
Non-profit managing entity for a National Heritage Corridor	Conservation Nonprofit
Regional nonprofit engaged in outdoor nature experiences, environmental education, and advocacy	Environmental Education Nonprofit
Non-profit Environmental Education Center	Environmental Education Nonprofit
Environmental Education Nonprofit	Environmental Education Nonprofit
Education Foundation	Environmental Education Nonprofit
Non-profit, XX state certified water testing lab that partners with volunteers to monitor water quality	Environmental Education Nonprofit
Environmental Education Non-Profit	Environmental Education Nonprofit
Non-profit	Environmental Education Nonprofit
Regional Nonprofit for Environmental Education and Conservation Advocacy	Environmental Education Nonprofit
Non-profit with grant money from State agency to run program	Environmental Education Nonprofit
educational out reach into schools and into the adult population. Water and watershed education program into primary and Secondary schools. we also participate in any water related activity.	Environmental Education Nonprofit
Environmental Education/Stream Restoration Organiztion	Environmental Education Nonprofit
Educator primarily for MS & HS... some general public	Environmental Education Nonprofit
RiverWatch	Environmental Education Nonprofit
Non-formal Environmental Education	Environmental Education Nonprofit
Nonprofit Educational Organization	Environmental Education Nonprofit
Nature Museum	Informal Science Institution
Zoo	Informal Science Institution
Izaak Walton League National Headquarters	Izaak Walton
County Stormwater department	Local or regional government program
County water quality partnership	Local or regional government program
Local government	Local or regional government program
county water system/utility	Local or regional government program
Regional Government	Local or regional government program
Local government outreach program	Local or regional government program
CIty of XX & XX County funded program serving schools in XX County	Local or regional government program
Non profit research center	State Department of Natural Resources or Environmental Protection
College	University/Extension Service

Q9: How often do you typically offer macroinvertebrate identification training for your primary organization?

Other (Please describe)

- It is part of our Introductory Training sessions - usually 6-10 sessions in the spring of the year
- Spring, Fall and Summer
- Two sessions each spring
- We offer introductory classes 3 (field) and 4 (lab) times a year. In addition, we have a series of 5 aquatic insect family-level classes and a quiz offered once or twice a year. Each class lasts 2 to 2.5 hours.
- We offer weekly BMI open lab hours where volunteers can come to work on samples and refine their ID skills
- We offer weekly classes from January-March, supplemented by more general classes in May and September
- with every basic, full-day workshop (20 per year)

Q10: WOULD YOU CHARACTERIZE ANY REPEAT CONTACT WITH PARTICIPANTS OR VOLUNTEERS IN A TRAINING CONTEXT AS "FOLLOW-UP" OR "REFRESHER" TRAINING?

Response	Explanation	Code
No (please explain)	followup may or may not include additional training	informal
No (please explain)	Most volunteers who really learn macroinvertebrate ID only learn it after a lot of experience of working on samples - we don't always offer "training," per say, but rather opportunities to practice ID skills with help from others with more experience	informal
No (please explain)	No formal refresher unless they ask for it	informal
No (please explain)	We like to keep people as fresh as possible; folks who retain lots of knowledge can help train newbies.	informal
No (please explain)	We often use volunteers/employees with previous experience to train new volunteers/employees	informal
No (please explain)	We typically answer questions during/after ID events	informal
No (please explain)	At this time we do not conduct refresher trainings in our Stream Biomonitoring training.	none
No (please explain)	I teach a course in macroinvert ID. Student don't repeat it.	none
No (please explain)	Our participants are usually school children seeing the subject for the first time	none
No (please explain)	Repeat contact with participants are for actual "testing". Neither follow up or refresher, though they might certainly be reminded of that which they forgot since the training.	none
No (please explain)	seldom have repeated contact	none
No (please explain)	Some are but were trained years ago and not familiar with new portocols	none
No (please explain)	training is done in the context of the school classroom, new students each year	none
No (please explain)	Typically we train volunteers once in field sampling and once in identification.	none
No (please explain)	We are working towards follow up but are still building our volunteer base	none
No (please explain)	We do not cover macro training twice...although we should offer refresher courses which are shorter than typical courses	none

No (please explain)	We have discussed refresher training, but have yet to implement it.	none
No (please explain)	I do not offer follow-up or refresher training. If a participant attends a workshop for a second time they get the same basic training.	repeat
No (please explain)	My part of the program focuses on training teachers. Often times they are attending the session to receive training on a new element that has been added (ex. geomorphology). Repeat contact may result in a "refresher" but that was not the point of their attendance for the day.	repeat
No (please explain)		
No (please explain)		
No (please explain)		
No (please explain)		
No (please explain)		
No (please explain)		
No (please explain)		
Yes (please explain)	annual recertificaton is required as a Georgia Adopt-a-Stream volunteer. I also conduct an annual stream day with a local high-school, part of which is devoted to macroinvertebrat sampling	formal
Yes (please explain)	annual training, site visits	formal
Yes (please explain)	At annual site visit with volunteer organization or individuals	formal
Yes (please explain)	At every training level we "refresh" on macroinvertebrate ID	formal
Yes (please explain)	Follow up with a training for conducting water quality tests using water chemistry	formal
Yes (please explain)	Generally, repeat contact focuses on how to put data to use,e.g., effectively presenting data to desired audiences such as city and town councils	formal
Yes (please explain)	I offer to attend monitoring events to support new volunteers. We also offer "refresher" training (shorter in duration than initial training)	formal
Yes (please explain)	I often have people come for a refresher before taking the certification test	formal
Yes (please explain)	In class	formal
Yes (please explain)	Infrequent nature of work requires refresher training for most volunteers	formal
Yes (please explain)	Mandatory re-training every 3 years. Additional trainings at the interest of the volunteer.	formal

Yes (please explain)	Many come to advanced training for EPT identification that I hold periodically (every 2-3 years or so) - we often know the volunteers well and also re-validate their certification every 3 years if Level 2 or higher	formal
Yes (please explain)	Re-certification - once a year	formal
Yes (please explain)	recertification is required	formal
Yes (please explain)	Refresher course for experienced volunteers on an annual basis	formal
Yes (please explain)	refresher trainings offered yearly, additional trainings offered for those who need/want it	formal
Yes (please explain)	refresher, many experience though few utilize the training	formal
Yes (please explain)	refresher, usually with regard to use of equipment	formal
Yes (please explain)	Required by the QAPP	formal
Yes (please explain)	returning volunteers and all as new information becomes available	formal
Yes (please explain)	Teachers in the Testing the Waters program get yearly refresher	formal
Yes (please explain)	They become a part of our citizen science network and we will also offer advanced training	formal
Yes (please explain)	VASOS volunteers required to get a refresher course every 2 years.	formal
Yes (please explain)	Volunteers are encouraged to get refresher training every few years.	formal
Yes (please explain)	Volunteers are req. to re-certify annually. These annual trainings could certainly be viewed as refreshers.	formal
Yes (please explain)	Volunteers are required to pass on online refresher test every 2 years to verify macroinvertebrate identification skills	formal
Yes (please explain)	Volunteers for whom I organize training present 30 - 50 minute BMI Idenitification station to youth (ages 9 - 18). After training they shadow an experienced presenter before soloing with kids.	formal
Yes (please explain)	we do annual re-certification.	formal
Yes (please explain)	we offer refresher trainings, but not everyone comes	formal
Yes (please explain)	We utilize a 'train-the-trainer' model; our QAPP requires regular audits of certified trainers	formal
Yes (please explain)	Yes, annual follow-up re: QA/QC	formal
Yes (please explain)	Yes, especially for sampling techniques for volunteers who have participated in the prior year.	formal

Yes (please explain)	Yes, follow-up training allows for a more in depth and applied training.	formal
Yes (please explain)	Yes, I hold follow-up meetings with participants regularly and hold refresher trainings often.	formal
Yes (please explain)	After training, I will attend the volunteers first monitoring at their site and help them complete the first assessment including macroinvertebrates	informal
Yes (please explain)	As one of the facilitators for a regional monitoring program, I receive notifications when a groups is going out to sample a stream. I pass that information on to other groups so they can tag along and get more experience sampling.	informal
Yes (please explain)	can provide additional information and resources	informal
Yes (please explain)	Constant Contact for their data and encouraging local level stewardship/ participating	informal
Yes (please explain)	During a volunteers first outing they are shadowing either myself, another staff member or a previously trained volunteer and then they are shadowed to ensure they are following protocol and understand identification.	informal
Yes (please explain)	either building upon previous knowledge (beginning to intermediate), or supporting first few field collections, or annually refreshing before new season begins	informal
Yes (please explain)	Have more time with individual	informal
Yes (please explain)	I often go out with the main groups every time they monitor because their projects require accuracy in identification. I am there to support them and make sure they are doing things correctly.	informal
Yes (please explain)	I will often go out to a monitoring event to help until they feel comfortable/confident on their own, especially with schools	informal
Yes (please explain)	i'm torn, yes and no. yes because I'm always helping people work through macro key, but no because they are using key, not "really" being trained	informal
Yes (please explain)	in-field follow-up	informal
Yes (please explain)	Long term activities help keep constituents in the loop	informal

Yes (please explain)	Volunteer educators shadow staff educators once or twice after primary training	informal
Yes (please explain)	Volunteers are encouraged to brush up on skills and assist with identification of specimens collected at events	informal
Yes (please explain)	Volunteers are periodically supervised during field trips with youth at the park to refresh knowledge and check for continued understanding.	informal
Yes (please explain)	WE often go with the volunteers to their sampling sites help but only on or 2 times. This helps with their comfort level.	informal
Yes (please explain)	we often have repeat contact with citizen-scientist that test water	informal
Yes (please explain)	We provide ongoing support to volunteers but do not hold refresher trainings for all trained volunteers. That said, some have attended multiple trainings.	informal
Yes (please explain)	Working with communities to utilize the data locally. Rarely do participants repeat the ID portion of the training. Since we confirm all identifications with voucher collections, it's not necessary	informal
Yes (please explain)	annual retraining	repeat
Yes (please explain)	Attendees are encouraged to repeat classes for refresher. Team leaders often repeat for refresher because they must pass an annual certification quiz.	repeat
Yes (please explain)	Every year we see some of the same faces who are there for fellowship, updating, new information and practice, Trout Unlimited Chapter, Non-profit River Stewards	repeat
Yes (please explain)	If participant has had earlier training, repeat training would be refresher training.	repeat
Yes (please explain)	Many of our volunteers have verbally told us that is why they are retaking trainings is for a refresh on the macros	repeat
Yes (please explain)	MWS are always welcome to refresh their assessment techniques for free at any training workshops.	repeat
Yes (please explain)	My volunteers typically take the course annually, either as a refresher or to maintain GA Adopt-A-Stream QA/QC status.	repeat
Yes (please explain)	Occasional repeat participants to refresh training from previous year	repeat

Yes (please explain)	some retake the course since they only id macroinvertebrates maybe once a year.	repeat
Yes (please explain)	Sometimes people repeat classes because they did not pass the qualifying test to become a team leader. Others take classes as refreshers before taking the test, which they must pass annually to remain team leaders. Others simply want to refresh or increase their knowledge.	repeat
Yes (please explain)	We have volunteers who return to our training classes to brush up on skills	repeat
Yes (please explain)	While our training workshops cover the same material each time, we encourage volunteers to come to multiple workshops to hone their skills since practice makes perfect in the invertebrate identification world. we also hold our workshops at different streams, so a volunteer is likely to see a very different set of organisms from workshop to workshop.	repeat
Yes (please explain)		
Yes (please explain)		
Yes (please explain)		
Yes (please explain)		
Yes (please explain)		
Yes (please explain)		
Yes (please explain)		
Yes (please explain)		
Yes (please explain)		
Yes (please explain)		
Yes (please explain)		

Q12: In what year did your organization begin collecting volunteer macroinvertebrate data?

Open responses:

- 1970s?
- 1990's - can't be more specific at this time.
- 1996, I think
- 1996??
- 1997?
- 1997. Stopped in 2002 and resumed in 2011 to the present.
- 2010 I think, may have been earlier
- Approximately 1994
- Approximately 2000
- at least 2006, though i believe volunteers did some collection prior to that
- early 1990s
- GAAS has been collecting for a long time, here at Henry Co. Stormwater we have been collecting for GAAS for about 2 years
- Not sure (at least 15 years ago)
- Unknown. Organization began in 1959. Likely that local chapters were conducting biomonitoring in the 60s or 70s.

Q:14: IF YOUR MACROINVERTEBRATE BIOMONITORING PROGRAM HAS SPECIFIC RESEARCH QUESTIONS, LIST UP TO 3 IN ORDER OF IMPORTANCE:

Primary Research Question

Text Entry	Code
Understanding natural biodiversity	education
Are benthic macroinvertebrate communities changing in response to shale-gas related development?	effect
Changes due to local and upstream land use changes	effect
concerns over adverse effects of chemicals such as chlorides	effect
Effect of Land use changes	effect
Evaluating stream restoration projects	effect
How does the aquatic macroinvertebrate community respond to restorations?	effect
How is the stream responding to restoration projects?	effect
How is water quality changing in response to development	effect
Supporting the state monitoring efforts which are various	other
An analysis of quality based on biotic index and correlation with physical and chemical parameters	overall quality
Are aquatic macroinvertebrate fauna impaired?	overall quality
Condition, status, health of ecosystem (baseline and CWA stds)	overall quality
Does the macroinvertebrate community meet the rating of non-impaired, which would be expected in a headwaters stream?	overall quality
Does this stream meet CT aquatic life use support standards?	overall quality
gather baseline data for the diversity and distribution of Odonata in Minnesota	overall quality
Is the water healthy?	overall quality
quality of streams within Hennepin County	overall quality
Supports state and federal water quality assessments (e.g. is this waterbody meeting aquatic life use standards for water quality?)	overall quality
what is the baseline water quality in our county?	overall quality
What is the status of macroinvertebrate populations in rivers/streams (using IBI calculations)	overall quality
What is the status of tributary health throughout the watershed?	overall quality
what is the water quality	overall quality
What is the water quality of local rivers and streams? What local efforts can be done to improve local water quality?	overall quality
How does water quality in the Charles River watershed change over time?	quality over time
How is water quality changing over time?	quality over time
Long-term aquatic resource monitoring	quality over time
long-term changes in abundance, distribution, life history	quality over time
Monitor long term stream health trends in our county	quality over time
Overall assessment of stream health as it varies from year to year	quality over time
What are the long term water quality trends of wadeable streams in Illinois?	quality over time
How do macro invertebrate communities to stream reconnection through culvert replacement?	scientific
how does substrate composition affect macroinvertebrate communities	scientific
What are the effects of low river flows on the benthic macroinvertebrate community?	scientific

Secondary Research Question

Text Entry	Code
What lives in the water?	education
Assessment of specific impacts or restoration work	effect
Changes due to dam removal	effect
Effect of Rusty crayfish	effect
Have stream restoration efforts helped to improve water quality	effect
How are development decisions affectimg water quality?	effect
What evidence from the data on biological indicators can be useful to guide policy decisions?	other
Are measurements of pH, temperature, DO, nitrate, phosphate, turbidity, fecal coliform, and specific conductance within a range that supports sensitive EPT species? What are likely sources for chemicals out of the range for supporting a healthy macro community?	overall quality
Evaluating water quality using biodiversity	overall quality
quality of wetlands in Hennepin County	overall quality
What is the general health of the aquatic macroinvertebrate community in the watershed?	overall quality
How is the macroinvertebrate community changing over time?	quality over time
Is condition changing over time (trend)	quality over time
What are trends in macroinvertebrate populations (using IBI above)	quality over time
How does tributary health relate to main stem water quality?	scientific
What are the correlations with the biotic index and presence/ absence of Ganges River Dolphin	scientific

Tertiary Research Question

Text Entry	Code
site specific questions related to a restoration, spill, etc.	effect
What is water quality upstream and downstream/before and after implementation of BMPs, restorations, dam removals and stormwater management practices?	effect
How do biological sampling results compare to EPA habitat assessments?	scientific
How do dragonfly larvae reflect mercury levels in the water?	scientific
What are the anthropogenic impacts on biotic indices	scientific

Q15: What difficulties do you experience in implementing volunteer macroinvertebrate biomonitoring?

Other (please describe):

- comparing order- or family-level data with species-level professional data
- Consistent monitoring
- Coordinating the network.
- Databasing information

- Ensuring that volunteers return samples, data sheets, equipment.
- Establishig sufficiet interest in participation
- Finding individuals that will take the time to do macroinvertebrate monitoring and finding areas for them to preform the monitoring.
- Finding optimal times to offer the training and attract participation
- Getting and keeping consistent monitors over a set number of years to remain consistent in methods and monitoring segments
- I concentrate on training volunteers to identify BMIs and have a QA/QC to ensure that data are valid/reliable. I don't really consider these difficulties but part of the job
- if it completed when necessary
- Keeping consistency in collection protocol and housing data.
- Long term (more than two years running) consistent data collection.
- maintaining contact with trained volunteers, and finding opportunities for using their training
- maintaining long term team leaders and trained volunteers
- na - things are going reasonably well.
- Our program requires volunteers submit a voucher specimen that is IDed by CT DEEP staff; the accuracy of volunteer IDs is therefore not critical to the program. Consequently we (State) to not place high priority on detailed volunteer ID trainings, however vols, in particular, experienced vols, often want more indepth training. It can be difficult to manage resources in a manner that is efficient and makes everyone happy.
- Recruiting new volunteers can be difficult- they often see the information overwhelming, mainly because monitoring is conducted on a quarterly basis, confidence in accurate identification seems to be a hangup, though when I am with volunteers whop monitor, they seem to do just fine with ID by taxa Order
- Recruitment and retention
- recruitment and retention of volunteers
- Retaining trained volunteers and data submission
- To go along with the above choice, knowing that they are collecting the sample correctly.
- volunteer retention. finding volunteers with the willingness to commit the time and effort needed to assist with ongoing research.
- We don't train to ID for final use, we just train to ID for education, use taxonomist for real ID, don't have resources to support training, QAQC, etc.
- We emphasize training in macroinvertebrate identification and have controls in place to ensure that data are valid and reliable. I would not describe these as difficulties, but as key efforts.
- We have a good quality assurance program to correct mis-identifications and provide feedback to volunteers
- We want participants to utilize the data locally to address preservation and restoration needs as well as contribute data for traditional clean water act efforts. We are working to provide clearer direction on how to do so

Q16: How do you evaluate your macroinvertebrate trainees? (Select all that apply)

Other (please describe):

- a lot of our training is group centered. novices learn from experts over several field and lab interactions/experiences. eventually novices are capable of leading monitoring activities on their own
- A subset of the most common samples are QAQC'd by a local University Freshwater Ecology Lab.
- Conversation
- Feedback from participants in programs
- Field demonstration of skills
- field evaluation
- I check their findings in person to make sure ID is correct
- mentorship/co-learning w other experts
- on-site visit with them for follow up
- Our BMI training is in conduction with training on how to map a stream reach, and how to monitor physical and chemical characteristics of streams. That is followed up with training on putting data to use
- Our volunteers learn mainly by working on real samples and one of our certified taxonomists always verifies identification by volunteers until they show that they can accurately ID organisms on their own
- Participant observation and direct involvement until volunteer becomes confident
- Since educational, give them resources to test themselves, reference collections but don't test, have a standard protocol for taxonomist
- test with preserved specimens
- This isn't necessary since all identifications are confirmed with voucher collections
- Trainers check IDs done by volunteers; some sites are re-sampled
- Volunteers must submit a voucher of specimens to the State for each location monitored. Final IDs are those of the state expert analyzing the voucher not of the volunteer.
- we ask volunteers if they have done sampling before and most have worked in a lab or taken a class collecting macro samples
- We had staff duplicate 10% of the samples that were collected by volunteers in order to compare the results.
- We have an expert verify all the collected samples
- We send a subset of samples to a local university to be identified there for QA/QC
- working with a veteran monitor until comfortable with the identification

Q17: ARE EVALUATIONS USED TO DETERMINE WHETHER VOLUNTEERS ARE QUALIFIED TO COLLECT OR IDENTIFY MACROINVERTEBRATE SAMPLES?

Sometimes (please explain)

- Depends on the group and the reason we are training
- I am unclear about what this question is asking. I use exams as an evaluation to determine if the volunteer is qualified. They are encouraged to evaluate me and the workshop, but their comments on those evaluations haven't caused me to question if they are qualified.
- I follow up to check the IDs of live samples
- If volunteers express need for additional training
- Introductory and Level 1 volunteers are not evaluated. Level 2 and Level 3 are evaluated.
- New volunteers are paired with an experienced volunteer, intern, or staff for their first year.
- No formal evaluation but volunteers sample and identify with others who have more experience until they have enough experience to do it on their own. When volunteers work on their own they often ask for verification of ID's.
- our volunteers are always accompanied by trained GSWA staff so even if they are not completely confident we are there to assist if they feel ready
- See answer to previous question
- we are just starting training programs for citizen scientists
- Yes, if they wish to collect samples on their own.

Q18: Does your organization utilize or train volunteers in Quality Assurance/Quality Control for macroinvertebrate data?

Sometimes (please explain)

- again, depends on the group and the reason we are training
- Correction of incorrect ID's.
- Do this in an advanced college class but not in the volunteer organization
- hope to in the future, ideas under development
- Interns to our program inhouse are observed during their internship to assure satisfactory job performance.
- Intro into QAQC, dependent on purpose of data collection
- it depends on the purpose of the survey. education and outreach vs data collection for an agency
- Level 2 and Level 3 training levels are considered our QAQC levels of training
- Not incredibly in depth
- provide awareness, no formal training
- Qaqc is Enfield into the method bit not described explicitly
- utilized in VASOS, nothing in place for SOS Quality Control
- we are just starting training programs for citizen scientists
- We collect for both educational and data collection purposes if collecting for data then yes
- We have a small subcommittee that does QA/QC
- we prefer to have QA/QC volunteers but don't have enough to cover every monitoring event
- We use checklists that volunteers must complete
- When numbers of volunteers drop due to age, availability sample sizes drop
- Yes, they do collect duplicate sample and other bug qa samples that are ID'd by taxonomist

Q19: PLEASE SELECT ALL QUALITY ASSURANCE/QUALITY CONTROL MEASURES THAT MAY APPLY:

Other(please describe)

- 10% reidentification of all taxa
- 2 replicate samples and QA/QC form filled out for each sample (with check list of sampling protocols) along with physical survey forms
- dichotomous keys and other I.D. material provided during training and online
- One field duplicate selected at random by the program coordinator with the goal of <= 50% relative percent difference for family richness with the volunteer sample.
- Requires an experienced team leader at all monitoring events.
- side by side monitoring with trained individuals with consensus of ID
- Someone who has passed the certification test must be present during monitoring and is responsible for identification
- The above are not standard for every volunteer, but each does occur to some extent. Required training before data submission is non-negotiable.
- The other unchecked items we do have taxonomist utilize but no volunteers
- The Streamkeepers Field Guide is the text for our training program. It has an entire chapter devoted to QA/QC.
- Volunteers are given protocols to collect ten kicks, verify that there are at least 120 bugs in the sample, and the entire collect sample is jarred and sent to a lab for analysis

Q20: What are your macroinvertebrate training objectives? Select all that apply.

Other (please describe)

- Connect macroinvert diversity to water quality
- Educate students that macroinvertebrates are used in biomonitoring and are an important component of the ecosystem
- Educate the public about the health of local streams and what can be done to improve them
- Educating volunteers regarding land use impacts on water quality.
- Experiential Environmental Education for fostering local level stewardship
- For educational purposes only
- Introduce importance as biodindicators of environment.
- Introduce volunteers to the wide range of biota in a stream system
- My sub-group within HRWC only does BMI Identification as part of school age programming. We do not report our data.
- Other (please describe) - Text
- Our training varies from simply making kids aware of the variety of underwater life to individuals who want to convince a local government to not approve removal of a riparian zone as part of a development project.
- Raise awareness about non-point source pollution to change behaviors that have adverse affects on water quality/habitat.
- Show volunteers how macroinvertebrates are indicators of water quality so they take a more active role in protecting water quality
- Teach efective sampling techniques
- Understand their role in assessing condition along with chemical, phys hab and other indicators
- utilizing the biodiversity for ecosystem health measurement
- Volunteers need to have a basic understanding of macro identification to describe to youth visiting Deerassic Park what can be found in the creek on the property
- Water quality assessment.
- We also train data interpretation and application
- We introduce the volunteers to the macroinvertebrates via a powerpoint so they at least know the types of bugs we expect them to collect, but they do not need to identify them down to order or family because the samples are sent to a lab.

Q21: To what taxonomic level are volunteers asked to be proficient in? Select all that apply.

Other (please describe)

- Common Name
- Common name
- Done by taxonomist, vol we encourage to go to family
- Not required, just need to recognize what a benthic macroinvertebrate is and to avoid vertebrates in the sample
- Only a few volunteers really get very proficient at family-level ID, others take ID as far as they can go and then ask for help
- Our goal is to identify to family level. For some aquatic insects monitors have the option to identify to genus level. Obviously, if monitors know the family, they also know the order.
- whatever they can

Q23: About how much of a typical macroinvertebrate training you teach is spent in each of the following contexts:

Other

- We have separate field classes in which 100% of time is in the field

Q24: Which of the following do you use in your macroinvertebrate training events? Select all that apply.

Other (please describe)

- ice cube trays
- kicknet
- Surber Sampler
- surber sampler
- The nets we use are actually not D-frame nets, but they're not seine nets either. They're 18" 800-900 micron rectangular nets which are the same as our state regulatory agency uses (NYSDEC).
- Two-way magnifing viewer
- Xerxes Key

Q25: What training resources and materials do you give participants to own and use after the workshop to assist with their identification and monitoring activities? Please provide links if possible.

- A folder that contains basic information on macro identification and a copy of the Macroinvertebrate Identification sheet described above. "
- A Guide to Aquatic Insects and Crustaceans Creek Freaks Curriculum (Watershed Education for Youth)"

- A PowerPoint our organization has created, a digital copy of the dichotomous key, links to videos of aquatic macroinvertebrates.
- All materials are borrowed.
- All materials are retained by the organization and used only at training and identification events supervised by the program coordinator. "
- All materials listed here: http://mostreamteam.org/wqresources.asp

  For advanced (EPT) trainees, they get : Aquatic Insects of the Upper Midwest (electronic) Aquatic Insects of Wisconsin (Hilsenhoff) (electronic) Taxonomic Levels for Macroinvertebrate Identification (Missouri) - http://dnr.mo.gov/env/esp/SOP/MDNR-ESP-209.pdf

  We also provide an in-house-created EPT taxa notebook, EPT color photo guide, and Powerpoint presentation slides"
- All of the above except microscopes
- AWW Stream Biomonitoring Manual, sorting sheets
- CT DEEP offers kits on loan that include RBV Field protocols, sorting guide, and field identification cards along with required collection and sorting equipment.
- d-frame net, boots, dish pan, trays, spoons, hand lens, Water Action Volunteers identification key, WI wildcards of aquatic macroinvertebrates
- D-frame net, sorting trays and instruments, hand lens, key, Wonderful Wacky Water Critters booklet (a UW-Extension, WAV publication)
- D-net, sieve, keys (photo guide, dichotomous key, manual), forceps, sorting tub. www.iowadnr.gov/iowater
- dichotomous key
- Dichotomous Key "
- Each kit awarded to an organization (school, nonprofit, etc.) receives D-frame and kick nets, sorting pans and trays, bug sorting board, pipettes/spoons/etc., various magnifiers.

  Citizens who are trained but cannot receive a kit awarded to qualifying organizations have the opportunity to borrow loaner kits around the state which are outfitted as mentioned above." "
- Equipment to loan: -tweezers -ethyl alcohol -sorting trays -hand lenses -sieve -glass bottles -ice cube trays -tape -resistall paper " "
- Field Manual (protocols and ID guides) Dichotomous Key Kick Net Sorting trays Tweezers, pipettes and brushes"
- Georgia Adopt-A-Stream ID card, Equipment can be borrowed from multiple organizations
- Graduates of the 10-hour Streamkeeper Field Training are provided a copy of the Streamkeepers Field Guide: Watershed Inventory and Stream Monitoring Methods
- Hoosier Riverwatch Training Manual. Can check out loaner equipment (borrow) or apply for equipment grant (keep) after training.
- HRW workshop hand book
- http://clean-water.uwex.edu/pubs/pdf/riverkey.pdf
- http://dnr2.maryland.gov/streams/Publications/ea-99-2_rev2003.pdf

- http://extension.usu.edu/waterquality/files-ou/macroinvertebrate-key/macrokeyfor Utah.pdf
- http://watermonitoring.uwex.edu/pdf/level1/riverkey.pdf
- http://www.dec.ny.gov/docs/water_pdf/waveinstructions.pdf
- I make copies of the AAS field guide that they can take. If I have laminated ones from AAS, I will give them those. I also provide a copy of the powerpoint so they can take notes.
- ID Sheets/ Tax Key "
- Izaak Walton League website with guide to macroinvertebrate ID's Kick seine net Hand lens IWLA Guide book"
- Key guides from Vermont program, access to Aquatic Insects of N America, few local books sort of, we don't have a good local reference book, with pictures, etc. needed. "
- Laminated copies of:

  http://vaswcd.org/wp-content/uploads/2011/10/Key-to-Stream-Macroinverts.pdf

  http://4.bp.blogspot.com/-6brotb4W4wM/UWvnbwcieKI/AAAAAAAAB8M/17WFlqEyKF0/s1600/Picture+002.jpg"
- laminated field guide
- Laminated id cards that use keys to identify macroinvertebrates (https://docs.google.com/file/d/0B8Fr5Lm-RmgRQVhneEhBN1dyMzg/edit)
- laminated ID field sheet
- Macro key, hand lense, d-net, tubs, specimen trays, pipettors, spoons, tweezers, small dip nets
- Macroinvertebrate keys, training workbooks, access to website
- N/A
- na
- None
- none
- none
- None
- None - without a Scientific Collection Permit they can't survey on their own.
- Nothing for invertebrates except the adopt-a-stream handbook
- One organization that supervises local AAS participants provides field and sampling gear. Don't know how much quality control they employ.
- Our organization has loaner kits for groups who go through training for us. The loaner kits contain all the sampling equipment needed.
- Paper keys and illustrations
- Paper materials, macro ID guide sheet

- Participants are allowed to keep the copies of the dichotomous key (http://www.mwpubco.com/titles/iwlaaquaticinsects.htm) and Field ID guide (http://www.mwpubco.com/titles/iwlainverts.htm). All monitors who become certified are encouraged to take advantage of our reimbursement program to acquire all their necessary tools.
- PowerPoint presentations, sorting/ID sheets, dichotomous keys
- PPT, keys, ID handouts
- Quick Field Reference Guide http://thelastgreenvalley.org/wp-content/uploads/2014/08/RBV_VolunteerField QuickReferenceGuide_2016.pdf RBV site Photo instructions http://thelastgreenvalley.org/wp-content/uploads/2014/08/RBV_SitePhoto Instructions_2016.pdf
- RiverWatch Manual ID cards
- RiverWatch manual with dichotomous key, macroinvertebrate identification cards
- Save our Streams Benthic Macroinvertebrate key, MiCorps SAQ form, copy of J. Reese Voshell "A Guide to Common Freshwaer macroinvertebrates," training presentation, collecting tips and habitat descriptions
- Self developed keys to fauna
- Simple keys and field guides, D-net, sorting tray and hand lens
- Small, laminated 2-sided handout with sizes, descriptions, habitats, and drawings of 20 Macros that are used as indicator species.
- Sorting sheets (both types, laminated), dichotomous key (laminated), handbook, links to all of the above information, link to the IDAH2O QAPP
- SOS websites
- Stream Monitoring Manual
- The field guides listed above. "
- The macroinvertebrate key from GA Adopt-A-Stream Powerpoints and other resource materials"
- The teachers have androis and access to the Watershed Watch application, a mobile app for minimal to zero level of literacy for various stakeholder submission.
- They receive the Americorp handouts and a copy of the power point. We also direct them various macroinvetebrate field guides available. "
- This is taking a bit too much time Just a variety of sources that I right now don't have time to fill in"
- Training Manual and Voshell book
- typically provide photocopies of materials. much of it originally collected and produced by Bob DuBois (author of Damselflies of the North Woods) and similar experts with approval.
- Vials for specimen collection, Streamkeepers Guide, Freshwater Invertebrates - Voshell, Blue Bug Card, Key to River Life, Critter Cards, Kick Net, Forceps, Magnifiers
- Virginia Save Our Streams website: www.vasos.org
- Voshell flash cards, but I'm not sure if those are give to ALL participants or just when funds allow.
- Watershed Watch in Kentucky flip cards

- We give copies of our own keys and data collection form for macroinvertebrates, as well as copies of the PowerPoint presentations
- We give out copies of the PowerPoint presentations; documents comparing the features of aquatic insect orders; articles on the reasons to study macroinvertebrates; an Izaak Walton key to Stream Insects and Crustaceans"; keys we have produced to the families we find in each of the aquatic insect orders; copies of our benthic taxonomic list; and lists of online monitoring resources and YouTube videos.
- We give them everything they need to monitor from sorting pans, trays, D-nets, keys, to spoons, pipets.
- we have a curriculum we developed with help of the Smithsonian Natural History Museum biocube project.
- We have a publication called "Rough Guide to BMI with CSI" that outlines our sampling and analysis protocols and gives some help with organism ID (includes a reprint of the Stroud dichotomous key and an overview of the most common families of organisms we find in our local streams).
- We have created our own. Also iNaturalist and GLEDN apps
- We have loaner trunks