Case Study of Aquatic Macroinvertebrates Training in Identification Using Macroinvertebrates.org

Rockman et al

Research & Evaluation

Acknowledgements

Evaluation & Report Credits

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Project Credits

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About Rockman et al

Rockman et al is an innovative research, evaluation, and consulting company that specializes in examining critical issues in formal and informal education. The Rockman team includes evaluators with diverse backgrounds and skill sets who help clients answer critical questions in clear, direct, and honest ways. Rockman et al has served as the lead evaluation firm for numerous projects funded by the National Science Foundation, as well as several other public and private funding agencies. Learn more at www.rockman.com.

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Executive Summary

Learning to See, Seeing to Learn is a National Science Foundation-funded project to develop www.macroinvertebrates.org, a digital observation tool and set of informational resources that can supplement volunteer biomonitoring trainings and improve aquatic macroinvertebrates identification. Project researchers are interested in how trainers and volunteers use the tool, as well as how training that incorporates the tool impacts volunteers' confidence in and accuracy around aquatic macroinvertebrates identification. In November 2018, project partner, Stroud Water Research Center, conducted a three-hour aquatic macroinvertebrates identification pilot workshop at the family level that incorporated the macroinvertebrates.org website.

To explore the impacts of and experiences with the training and the website for volunteers and trainers, Rockman et al, an independent research and evaluation company, conducted trainer interviews and volunteer focus groups, and surveyed trainers and volunteers, and assessed volunteers accuracy during a macroinvertebrate identification task.

Key Findings

Volunteer Outcomes

- After the training, volunteers reported feeling significantly more confident IDing aquatic macroinvertebrates to the Family level
    - Trainers felt slightly more confident that volunteers could ID to the Order level and that volunteers could determine water quality based on their IDs
    - Trainers felt slightly less confident that volunteers could ID to the Genus level

- Volunteers reported similar levels of familiarity with and interest in aquatic macroinvertebrates after the training

- After the training, volunteers were slightly more accurate at IDing aquatic macroinvertebrates to the Order level than they had been before the training (88% vs. 78%)

- After the training, volunteers were slightly more accurate at IDing aquatic macroinvertebrates to the Family level than they had been before the training (63% vs. 53%)

- Most volunteers utilized their prior knowledge (60%, n=19) to help them ID macroinvertebrates before the training. They tended to use a dichotomous key (50%) or the macroinvertebrates.org website (58%) after the training

Trainer Outcomes

- After the training, trainers reported feeling slightly more confident in IDing aquatic macroinvertebrates to the Family and Genus level, training volunteers to ID to Order, and helping volunteers to determine water quality based on their IDs

Volunteers' Opinions of the Website

- Almost all volunteers (95%, n=19) thought that the website was easy to use

> ***"I could confirm the features I was looking for, and could also easily look up terms I was not familiar with and get both a written and visual explanation."***
>
> **- Volunteer**

•Almost all volunteers thought that the website made it easier for them to see macroinvertebrates' relevant features and the differences between insect groups (95%, N=19)

•The majority of volunteers felt that the website had increased their confidence (90%), accuracy (95%), and the quality of the data they produce (89%)

- After the training, most volunteers were confident (47%) or very confident (26%) that they could use the website to identify aquatic macroinvertebrates

- Volunteers felt that the website was most useful for viewing images of macroinvertebrates more closely
    - Volunteers thought that the zoomable photographs were the most helpful website feature
- Volunteers were least likely to use the website to look up a scientific term, and found the pollution tolerance information to be the least helpful overall
- All volunteers agreed or strongly agreed that the website made it easier for them to ID to Family
    - They were slightly more mixed regarding whether the website made it easier for them to ID to Order. Most used a dichotomous key to do so instead
- Volunteers suggested that integrating a dichotomous key into the website would be useful
- All volunteers planned to use the website in the future to ID macroinvertebrates or learn more about freshwater insects, in general

Trainers' Opinions of the Website

- Two out of the three trainers thought that the website was easy to use
    - All three trainers agreed or strongly agreed that the website made it easier for them to ID to Order and to Family
    - All three trainers agreed or strongly agreed that they were comfortable using the website in their trainings
- All three trainers were confident or very confident that they could use the website to identify aquatic macroinvertebrates.
    - However, they were mixed in their level of confidence that they could use the website to train volunteers to do ID work
    - Trainers were somewhat confident that volunteers would be able to use the website to ID specimens
- Trainers were most satisfied using the website to show an image of a macro invertebrate to volunteers

- Trainers thought that the zoomable photographs and the snapshot gallery of diagnostic characteristics were the most helpful website features

- Trainers were least likely to use the website to show a video, and found the pollution tolerance information to be the least helpful overall

- Trainers tended to use the website to refresh their memory of familial characteristics, to design ID activities for the training, and to pull images for presentations

> ***"For citizen scientists of all levels, the website acts as an excellent digital platform to equalize understanding of morphological and diagnostic features of macroinvertebrates."***
>
> **- Trainer**

- Trainers felt like the website provided better images than a dichotomous key

- Trainers liked that the website could be used in lieu of a voucher collection or when volunteers did not have access to live specimens

> ***"[The website helps me get intimately close to [the diagnostic characters] as if I was looking through a microscope…So I felt like I was in a better capacity to teach and train."*** **- Trainer**

- Trainers felt that it was difficult to use the website in tandem with a dichotomous key during training due to the the key being better for Order level ID and a lack of alignment between the familial characteristics shown in the key versus the website

- All three trainers felt that the website made it easier for volunteers to see macroinvertebrates' relevant features, in general

- All three trainers agreed or strongly agreed that the website had increased volunteers' confidence and accuracy

Volunteers' Opinions of the Training

- When asked what they liked best about the training, volunteers tended to mention the website

- Volunteers appreciated the knowledge and enthusiasm of the trainers

- Volunteers wished that the training session had been longer
  - They wanted more time to explore the website on their own and guided by the trainer
    - Volunteers suggested that future session attendees view the website video tutorial beforehand
  - They requested time to interact with live specimens
  - The wanted more time to practice IDing to Order and Family
  - They needed a refresher on how to use a dichotomous key

> ***"[The website] was streamlined for me. It really helped me identify. I was more comfortable with that."***
> **- Volunteer**

Trainers' Opinions of the Training

- Trainers wanted to reduce the number of participants overall

- Trainers also felt that the session could be longer, echoing the same areas that volunteers wanted to expand

- Trainers thought that they could provide more "homework" before and after the training to solidify the information presented and increase volunteers' comfort with the ID process using the resources being covered during the session

- Trainers thought that the research and evaluation activities had been slightly stressful for participants because of the tight timeframe and having to carry all of the resources with them from station to station

Conclusions & Next Steps

The family level pilot training that incorporated the macroinvertebrates.org website was successful on a number of metrics. After the training, volunteers felt significantly more confident in conducting family level IDs than they had beforehand. Most volunteers thought that the website was easy to use and had increased their confidence, accuracy, and the quality of the data they produced.

For the most part, participating trainers also felt more confident in IDing and in training volunteers to ID after the training. Trainers also felt that the website was easy to use and felt comfortable incorporating the website into trainings.

Future trainings sessions could be planned to ensure that both trainers and volunteers have plenty of opportunities to leverage the website and its features to practice doing macroinvertebrate identification.

Aquatic Macroinvertebrates Training Session

Project Description

Learning to See, Seeing to Learn is a National Science Foundation-funded project to develop www.macroinvertebrates.org, a digital observation tool and set of informational resources that can supplement volunteer biomonitoring trainings and improve aquatic macroinvertebrates identification. Project researchers are interested in how trainers and volunteers use the tool, as well as how training that incorporates the tool impacts volunteers' confidence in and accuracy around aquatic macroinvertebrates identification.

Aquatic Macroinvertebrates Training Session Description

In November 2018, project partner, Stroud Water Research Center, conducted a three-hour pilot aquatic macroinvertebrates identification workshop at the family level. The workshop included an introduction to and demo of the macroinvertebrates.org website, a discussion of tips for doing identification work, a refresher on using a dichotomous key, a presentation on Caddisfly families and their defining characteristics, and time for volunteers to work in groups and practice identifying macroinvertebrates to

family using the website and other available resources (A detailed breakdown of the training's foci and resources can be found in Appendix A).

Evaluation Data Collection

Rockman et al, the external evaluators for the *Learning to See, Seeing to Learn* project, collected and analyzed several types of data (trainer and volunteer surveys, a macroinvertebrate identification task for volunteers, interviews with trainers, and focus group responses from volunteers to explore the impacts of and experiences with the training and the website for volunteers and trainers.

Three participating trainers were asked to take a pre-survey online before they were introduced to the macroinvertebrates.org website. They took a post-survey approximately one week after the training session took place.

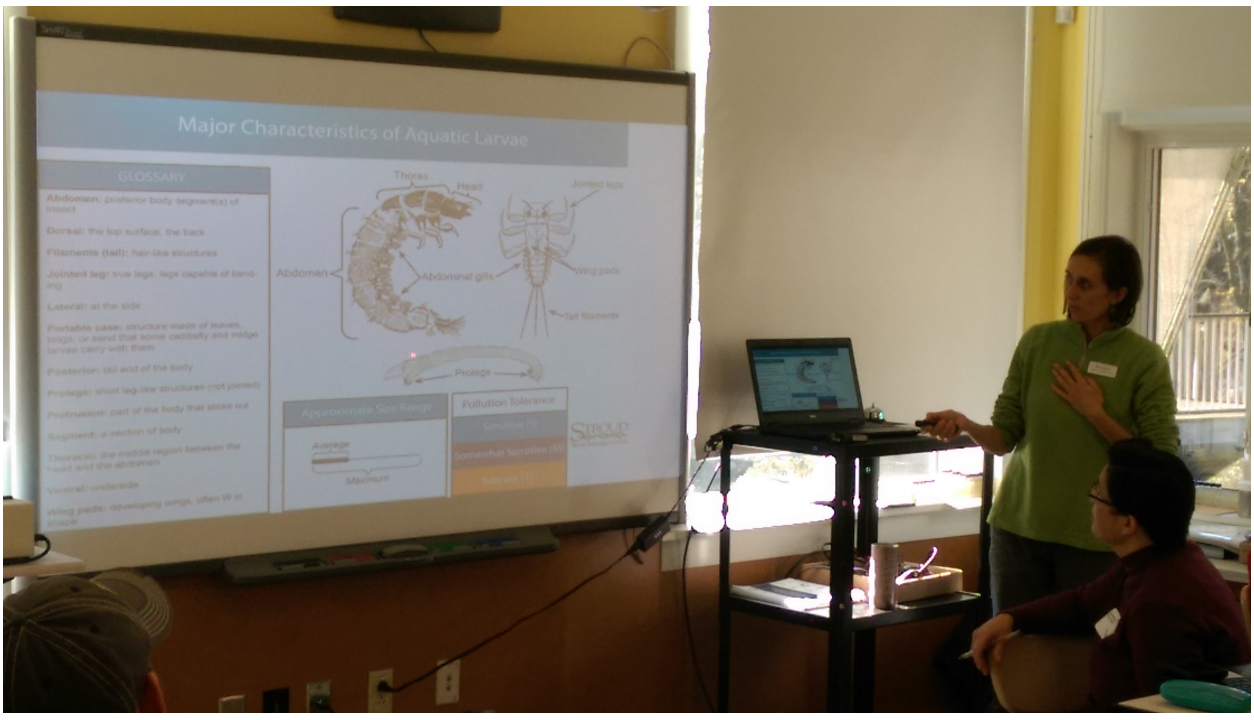
Before the date of the training session, 18 volunteers completed an online pre-survey. At the start of the training session, volunteers participated in a baseline accuracy task during which they examined four specimens preserved in lucite, and were asked to identify those aquatic macroinvertebrates, list the characteristics that made them think so, to indicate how confident they were in their ID, and to list the resources they used during the ID process. After the training, 19 volunteers completed a post-survey that also included questions about the macroinvertebrates.org website (resulting in 14 matched pre-post surveys). Volunteers then participated in a similar accuracy task, this time with eight specimens (two of which they discussed aloud while IDing as part of a separate research project). A subset of volunteers then participated in a focus group discussion about their experiences during the training and with the website.

Aquatic Macroinvertebrates Training Session Participants

Trainers

Three female trainers helped facilitate the pilot workshop. Of these, two took a pre-survey. The main trainer had 15 years of experience and tended to train volunteers from first timers, those with some ID experience, and those with a lot of ID experience, other trainers, science professionals,

educators, and youth/students. The second trainer had 4 years of experience and tended to train first-volunteers and summer interns. Both trainers felt fairly knowledgeable about aquatic macroinvertebrate identification (averaging an 8.5 on a scale from 1 to 10). A description of their typical quality assurance measures and assessments used during trainings can be found in Appendix B.



Volunteers

Thirteen women and six men attended the pilot training. One volunteer was African-American, and the rest were Caucasian. Of the 14 volunteers who attended the training session and took the pre-survey, most self-identified as teachers (see Table 1). Many (79%) had participated in an aquatic macroinvertebrate identification training before, some as part of a college degree (3 individuals), some at Stroud Water Research Center (4 individuals), and some with other organizations (6 individuals).

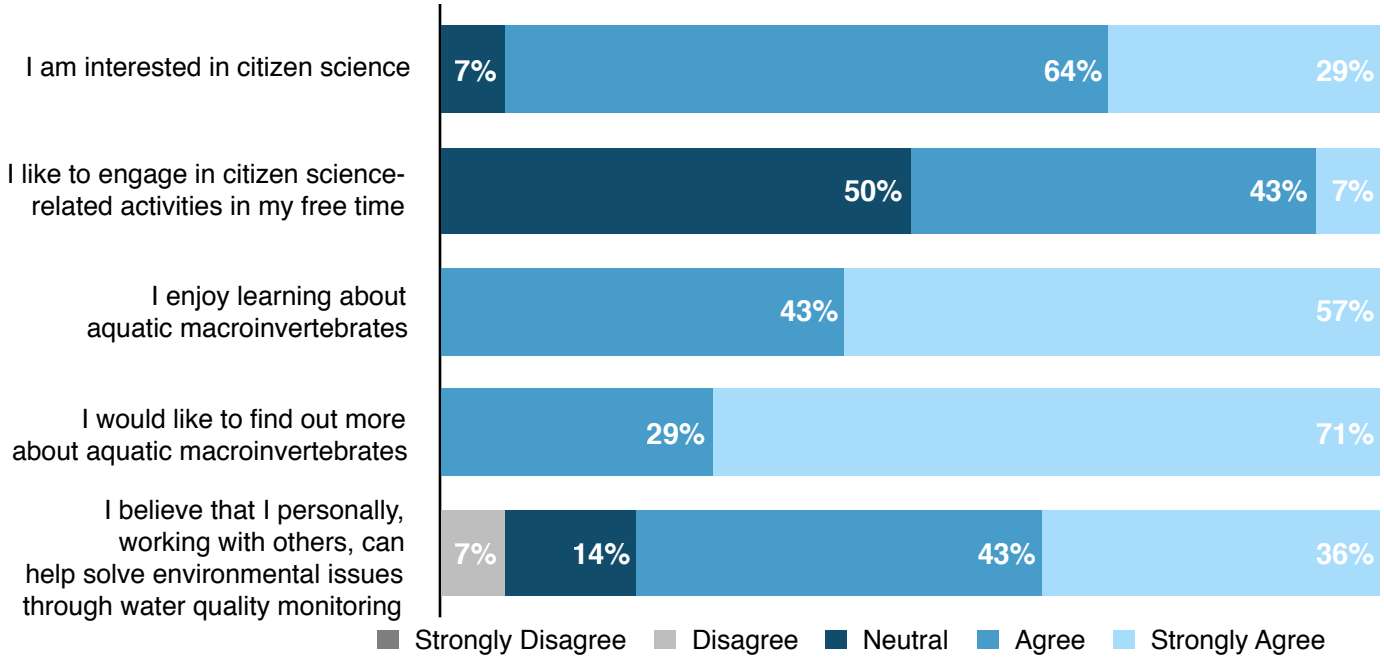
Before they attended the session, almost all volunteers (93%, N=14) were interested in citizen science, although only half engaged in citizen science activities in their free time (see Figure 1). All surveyed volunteers wanted to find out more about aquatic macroinvertebrates, and enjoyed learning about them. Most volunteers (79%) also felt that they could help solve environmental issues via water quality monitoring.

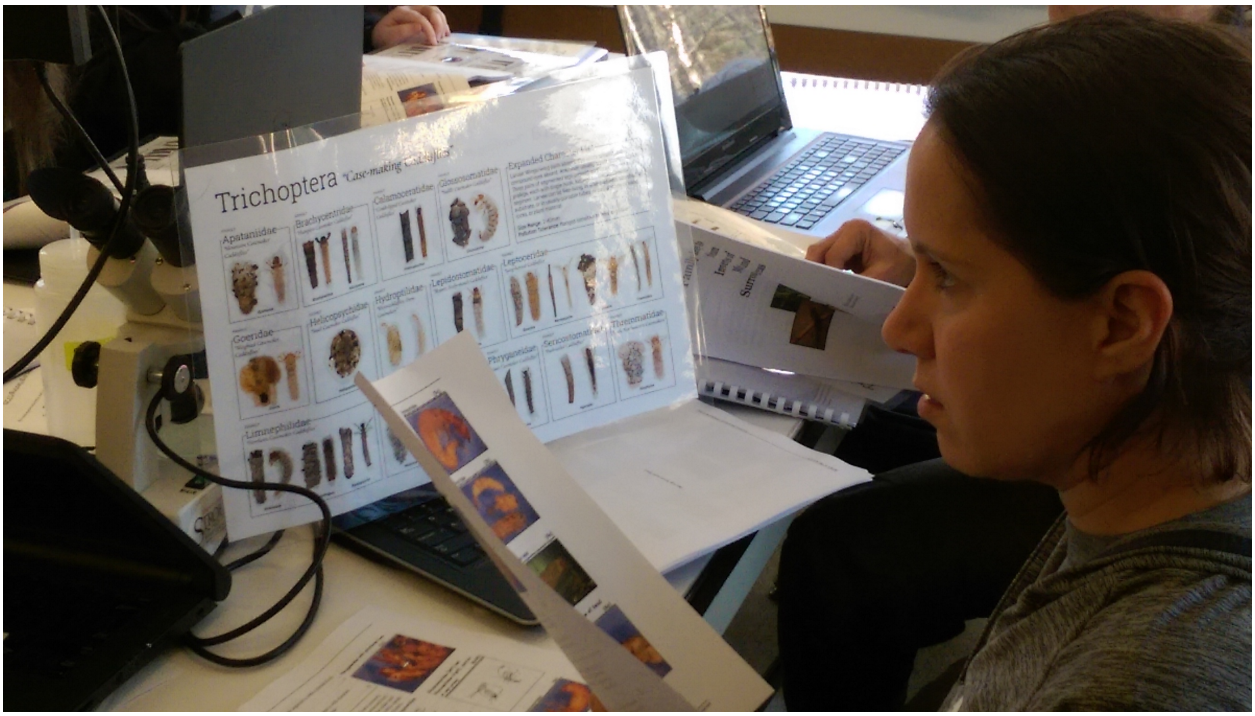
Table 1: Volunteers' Perceived Roles

Role	Number of Volunteers Who Specified (N=14)*
Teacher	8
Student	3
Trainer	1
Professional	0
Other**	6

** Note: Some volunteers listed more than one role.*
*** This category includes recent college graduates, stream monitors, informal educators, research assistants, and those with an in potentially volunteering in the future.*

Figure 1: Volunteers' Prior Interest in Citizen Science & Aquatic Macroinvertebrates Before Training



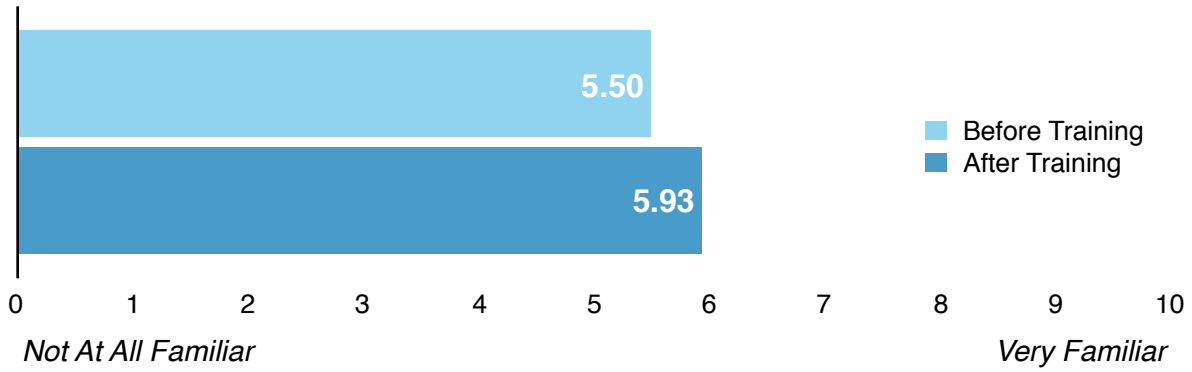


Volunteer Outcomes

Volunteers' Familiarity with Aquatic Macroinvertebrates

After the family level training, volunteers reported having similar familiarity with aquatic macroinvertebrates as they had before the training (see Figure 2).

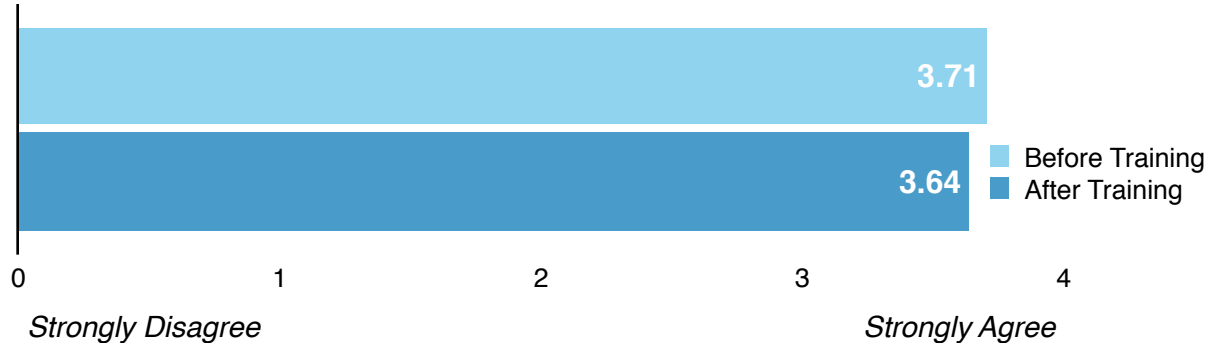
Figure 2: Volunteers' Familiarity with Aquatic Macroinvertebrates



Volunteers' Interest in Aquatic Macroinvertebrates

The training did not appear to significantly impact volunteers' interest in finding out more about aquatic macroinvertebrates (see Figure 3). They came into the training agreeing that they wanted to know more, and left the training with the same feeling.

Figure 3: Volunteers' Interest in Aquatic Macroinvertebrates



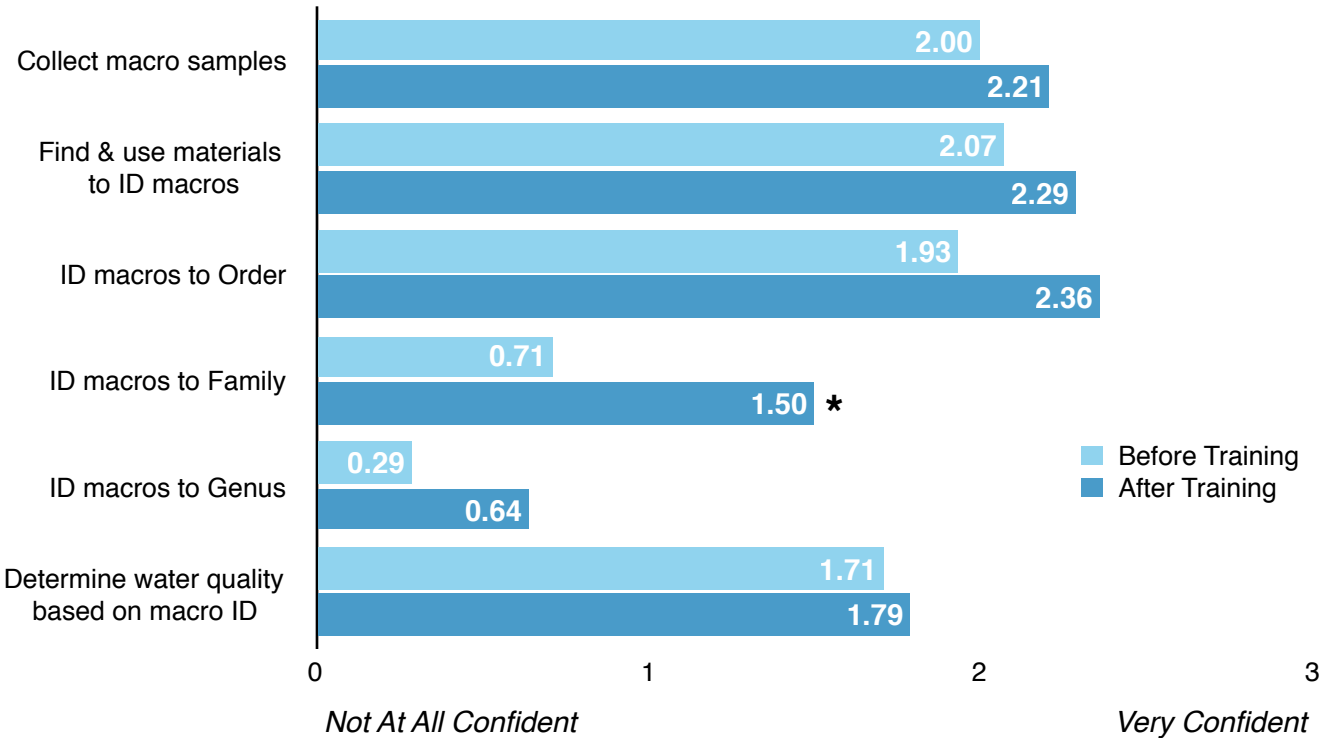
Volunteers' Process for Doing Aquatic Macroinvertebrates ID

Volunteers in the focus groups shared that when they have done ID work in the past, they first asked themselves, *"What's it look like? Have I seen it before?"* They indicated that they look for features like tails and jointed legs. Resources that they tend to use include dichotomous keys, such as the one from the University of Wisconsin, and EPT calculators. Focus group attendees revealed that they had mostly used dichotomous keys to ID during the training session due to time constraints, and tended to use the macroinvertebrates.org website to confirm their IDs. Volunteers in the focus groups acknowledged that ID work is challenging because *"Sometimes they don't look like they're supposed to. Like my first one, I had difficulty with because it was, 'Oh, there's only four legs.' There's no four-leg option when you're going through the key, so there's something wrong."* Another volunteer remembered that the trainers had hinted that they might have to go back in a key if they didn't see a feature.

Volunteers' Confidence in Doing Aquatic Macroinvertebrates ID

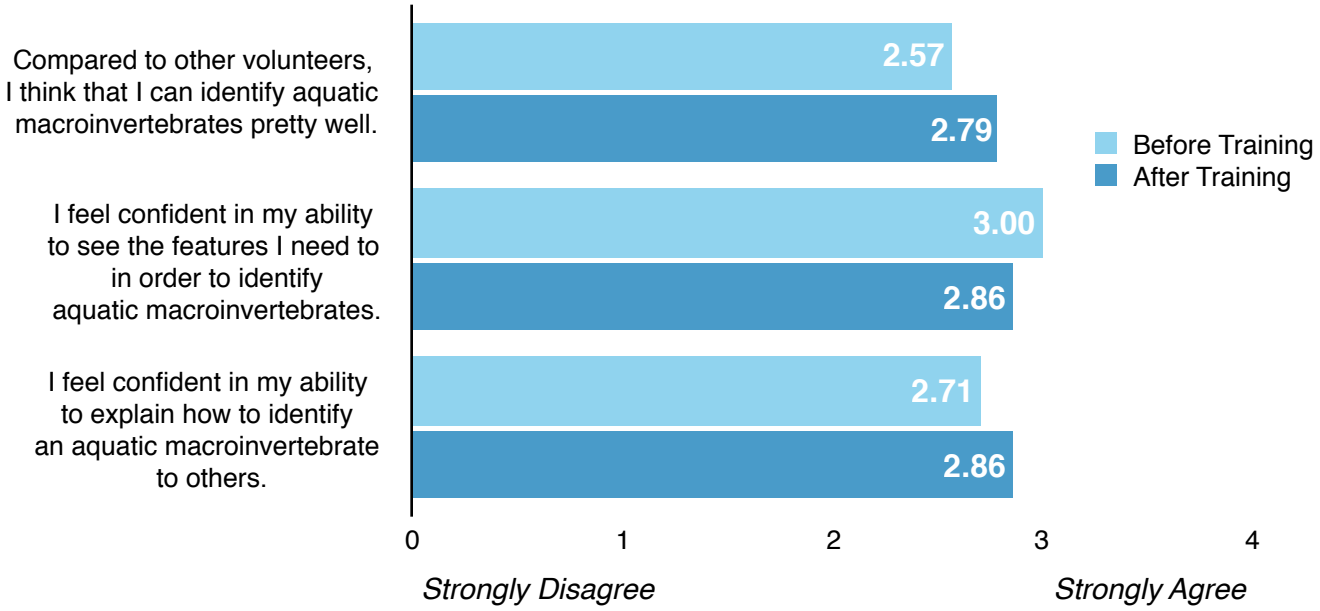
After the training, volunteers reported being significantly more confident in IDing aquatic macroinvertebrates to Family, which was the main purpose of the session (see Figure 4). Volunteers' confidence in IDing compared to other volunteers, in their ability to see relevant features needed to ID, and to explain how to ID to others was similar both before and after the training (see Figure 5). During the focus groups, volunteers specified that they felt better after the training in knowing how to ID to Order and Family and where to go to get information to help them do an ID: *"I feel like I now have the tools to know how to do it."*

Figure 4: Volunteers' Confidence Related to ID Activities



** Indicates a significant difference at the p<.05 level*

Figure 5: Volunteers' Confidence in Their ID Abilities



Volunteers' Accuracy in Aquatic Macroinvertebrates ID

Volunteers participated in an accuracy task before the training with four specimens and after the training with eight specimens. Two specimens showed up on both the pre- and post-accuracy assessments. There were no statistically significant differences in Order and Family level IDs from volunteers with matched pre-post responses (see Figures 6 & 7). However, volunteers did seem to improve their Order and Family level IDs of the second specimen after the training.

Out of the five specimens that volunteers could have identified before the training, volunteers tended to get 78% correct to Order and 53% correct to Family (see Appendix C for specifics). Out of the eight specimens that volunteers were asked to identify after the training, volunteers tended to get 88% correct to Order and 63% correct to Family. On average, volunteers were slightly less confident in the accuracy of their IDs after the training (M=3.57 on a 5-point scale) than beforehand (M=3.58). However, they tended to be fairly confident both before and after the training overall.

Figure 6: Volunteers' Accuracy in IDing Macroinvertebrates to Order

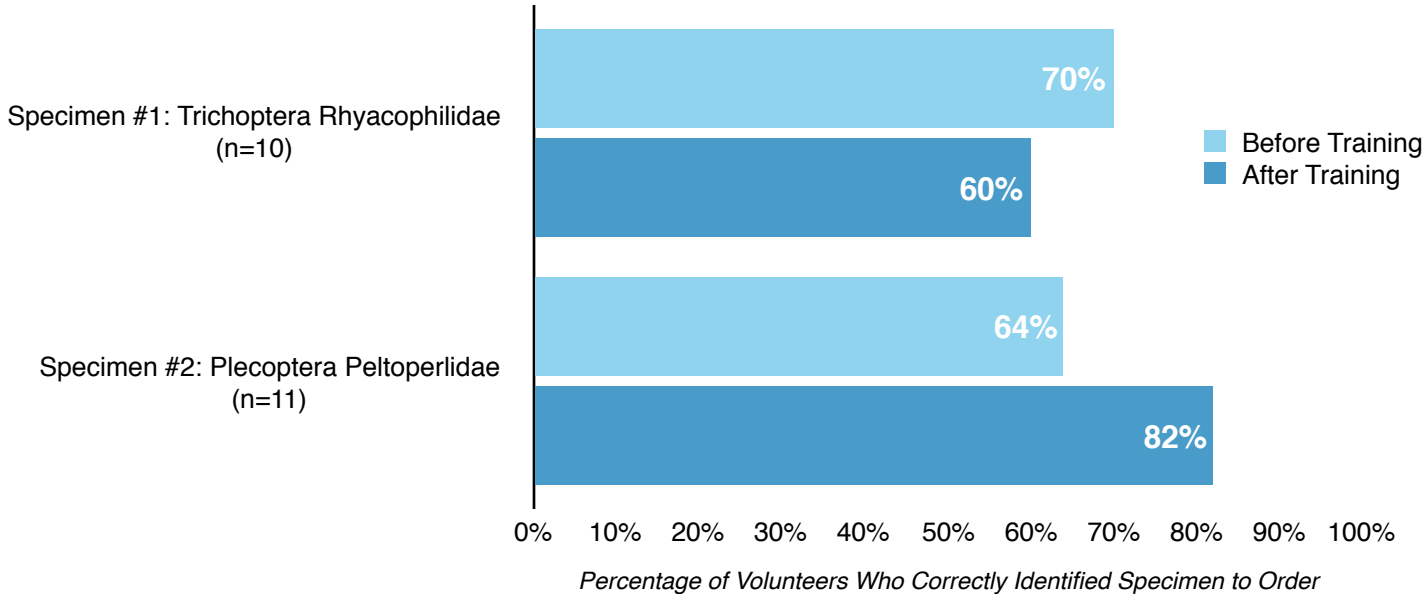
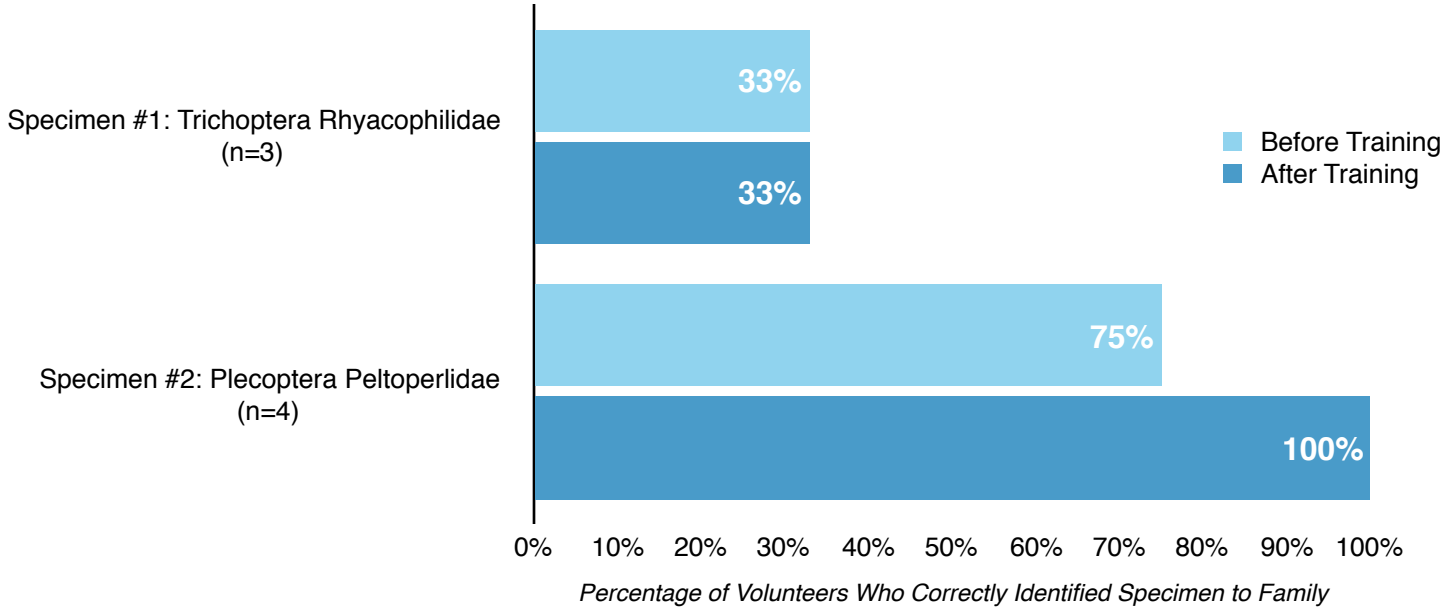


Figure 7: Volunteers' Accuracy in IDing Macroinvertebrates to Family



Most volunteers utilized their prior knowledge to help them ID macroinvertebrates during the accuracy task before the training, and the macroinvertebrates.org website or a dichotomous key after the training (see Table 2).

Table 2: Volunteers' Resource Use During Their IDs*

	Field Guide	Dichotomous Key	Macroinvertebrates.org Website	Prior Knowledge	Other**	Did Not Specify Resource
Before Training	10%	26%	44%	60%	2%	0%
After Training	14%	50%	58%	30%	9%	4%

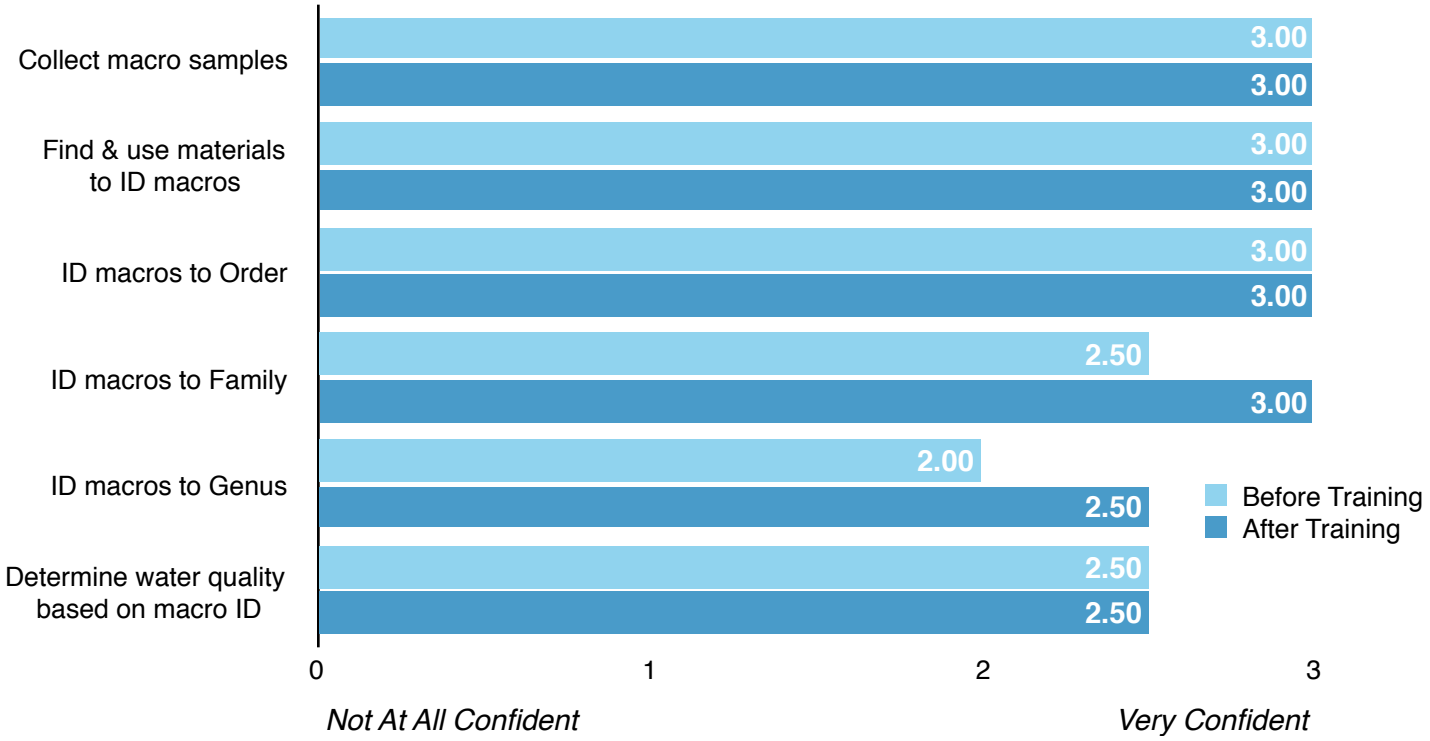
** Note: Some volunteers listed more than one resource.*
*** "Other" resources that volunteers reported using included Google images, notes from the training, the Caddisfly placemat, the Encyclopedia of Life, and Nature.MDC Isopod webpage.*

Trainer Outcomes

Trainers' Confidence in Doing Aquatic Macroinvertebrates ID

Two trainers completed both a pre- and a post-survey before and after the training. Due to the small sample size, statistical significance was not calculated. However, a few trends did appear. Specifically, after the training, trainers indicated feeling more confident in IDing to Family and Genus (see Figure 8).

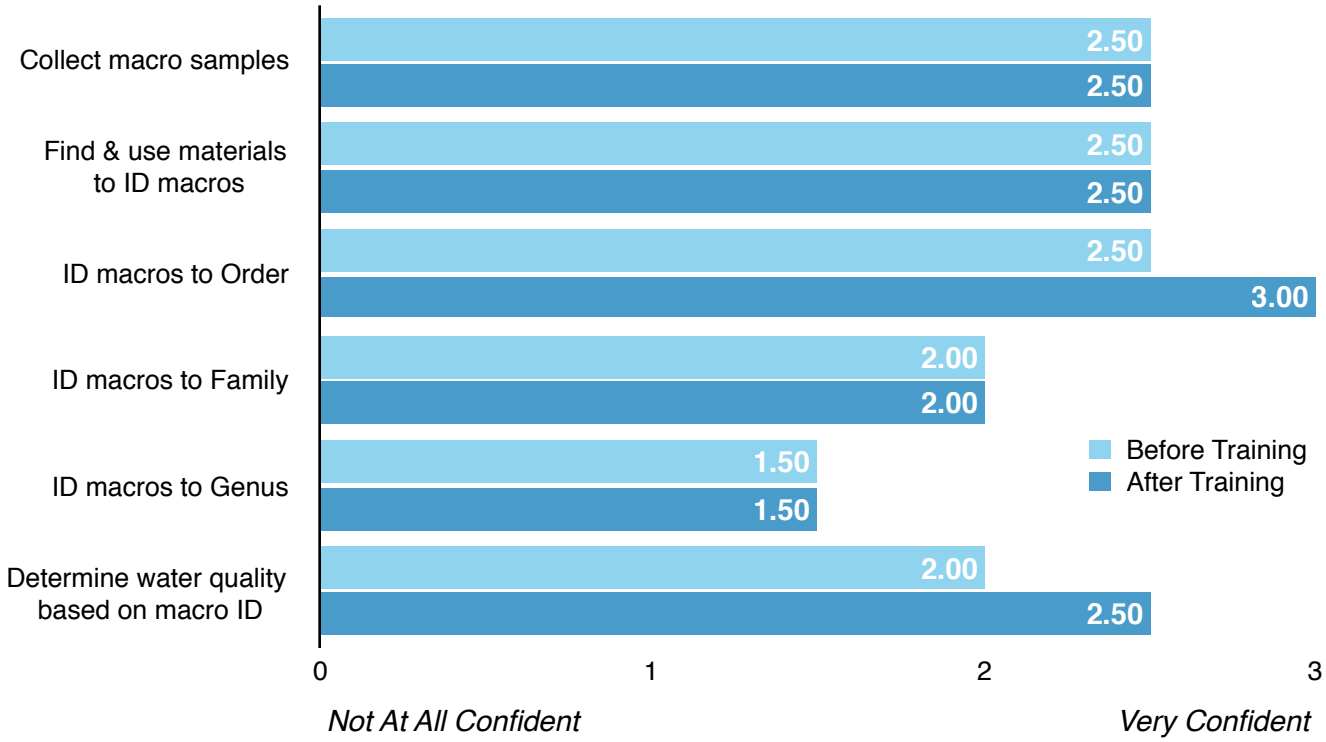
Figure 8: Trainers' Confidence Related to ID Activities



Trainers' Confidence in Doing Aquatic Macroinvertebrates ID Facilitation

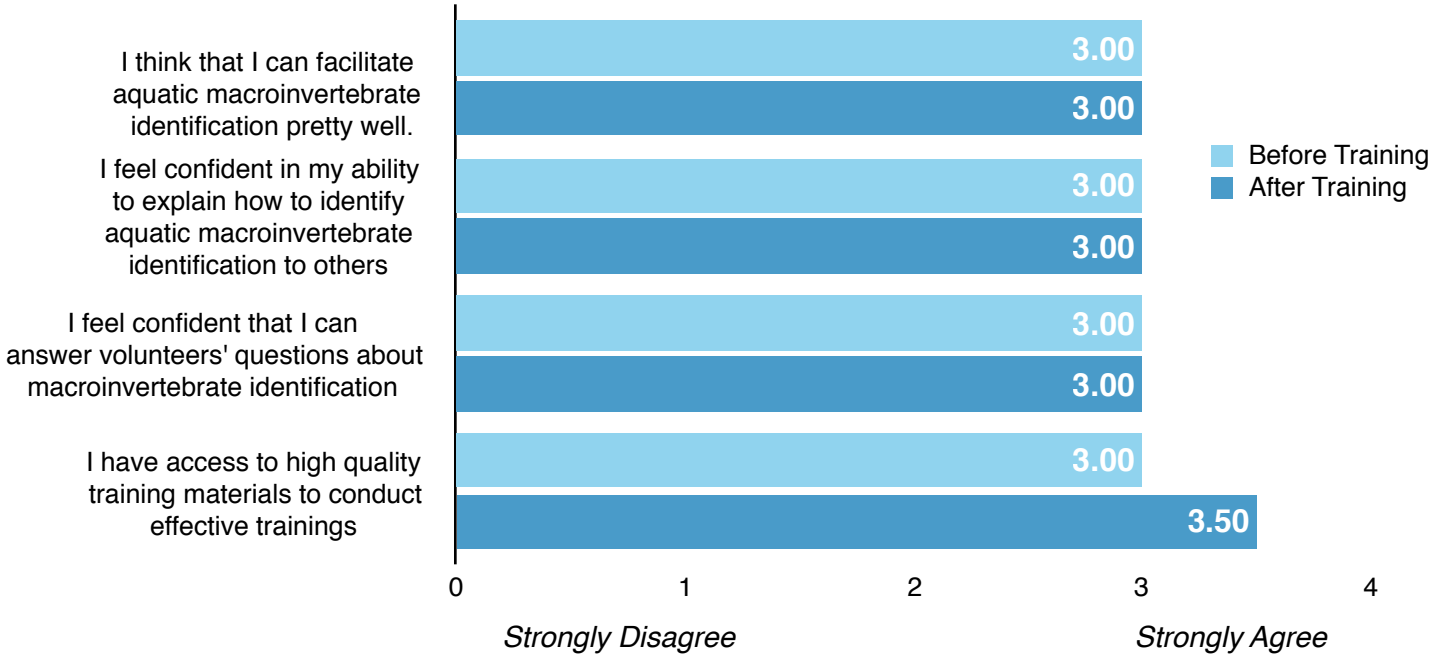
After the training, trainers also felt slightly more confident in their ability to train volunteers to ID to Order and to determine water quality based on their IDs (see Figure 9).

Figure 9: Trainers' Confidence in Their Ability to Train Volunteers



Overall, the two trainers' maintained their confidence in their ability to facilitate macroinvertebrates' identification trainings, with one trainer agreeing more strongly that she had access to high quality training materials after the training took place (see Figure 10). Although both trainers felt that they were highly knowledgeable about aquatic macroinvertebrate identification, one trainer qualified her answer to state that her confidence in facilitating ID work was high at the "citizen science/ volunteer level, and a little rusty when it comes to the species level."

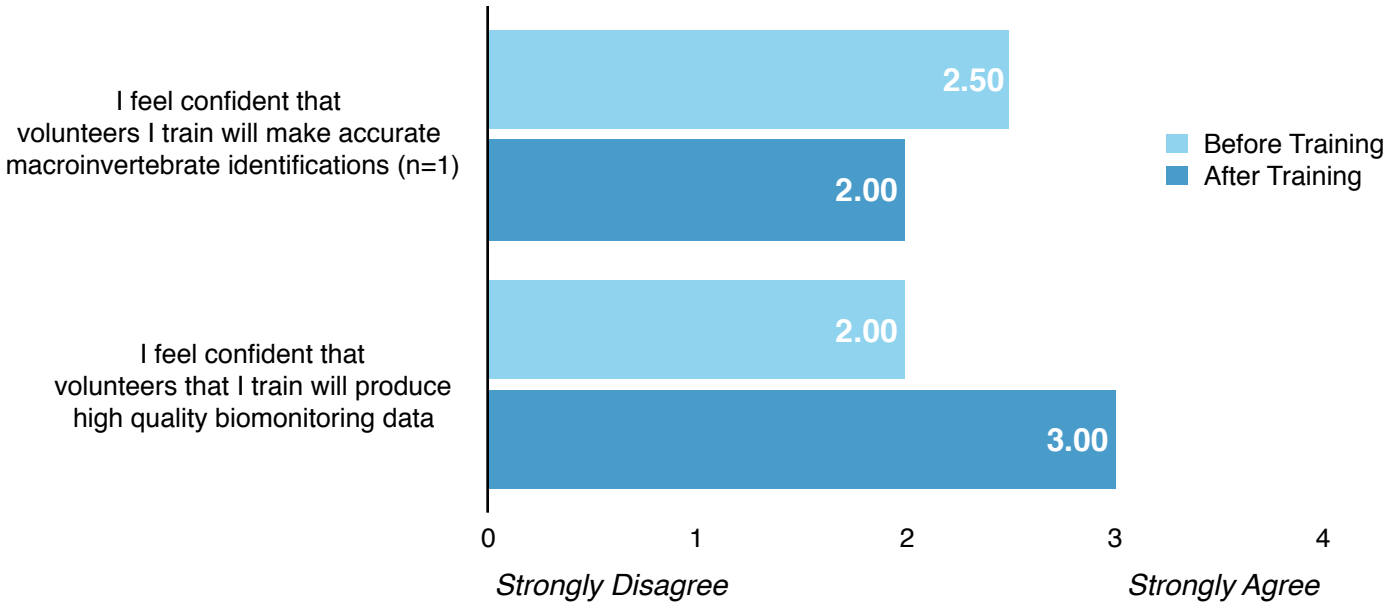
Figure 10: Trainers' Confidence in Their Own ID Facilitation



Trainers' Confidence in Volunteers' Aquatic Macroinvertebrates ID Abilities

The two trainers who completed both pre- and post-surveys felt that the materials available during typical trainings were easy for volunteers to use. They had mixed feelings about volunteers' ID abilities. After the training, participating trainers were slightly less confident that volunteers would make accurate IDs, in general, and more confident that they could produce high quality biomonitoring data (see Figure 11).

Figure 11: Trainers' Confidence in Volunteers' ID Abilities



Specifically, trainers felt slightly more confident that volunteers could ID to Order and determine water quality after the training, and slightly less confident that they could ID to Genus (see Figure 12). During a post-interview, one trainer elaborated, *"I wouldn't feel confident in saying that anybody should be IDing at the Family level after that workshop unless they had extensive practice ahead of time. I wouldn't trust any of that data. It just wasn't enough time to understand morphology…It just needs a lot more time, and people need to see a lot of specimens to be really comfortable with IDing."* In general, however, trainers felt that volunteers

"came away with some good take homes and another layer to their knowledge and abilities, which is empowering and important."

Figure 12: Trainers' Confidence in Volunteers' Abilities

Reactions to Macroinvertebrates.org

Volunteers' Opinions of the Website

Although they were all provided with a link to the website, most volunteers (58%, N=19) had not explored macroinvertebrates.org before the training. When asked who they felt the website was for, one focus group participant said, *"I think it was really for advanced teachers. It wasn't broken down far enough for layperson."*

After the training, volunteers were asked to indicate how useful they felt that the website was for various tasks (see Figure 13). Volunteers felt that the website was most useful for viewing images of macroinvertebrates more closely, and every surveyed volunteer used the website for this purpose. In the focus groups, several participants elaborated:

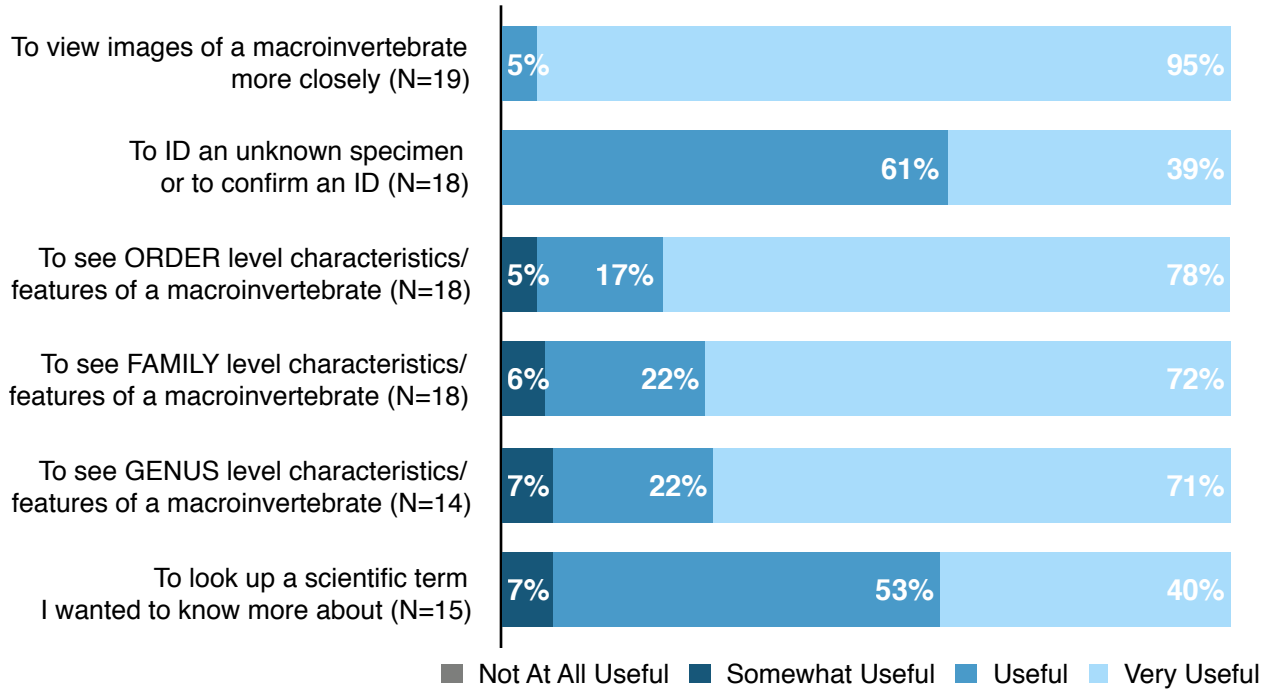
> *"The way they had all the pictures laid out. You could go to that one button and you know what your sample looks like, and it's easy to say, 'Oh that looks pretty close, and that looks pretty close,' and then you can dive in deeper and open up two tabs and compare from that."*

"The little water droplet thing, being able to click on it and click on it, zoom in on that particular feature. That was really cool too."

However, one focus group participant did not realize until the middle of the training that the shading on the "teardrop" indicated Order, Family, and Genus level characteristics.

Volunteers were least likely to use the website to look up a scientific term, but still found this feature to be relatively useful overall. One survey respondent wrote, *"I could confirm the features I was looking for and could also easily look up terms I was not familiar with and get both a written and visual explanation."*

Figure 13: Volunteers' Opinions on the Website's Usefulness



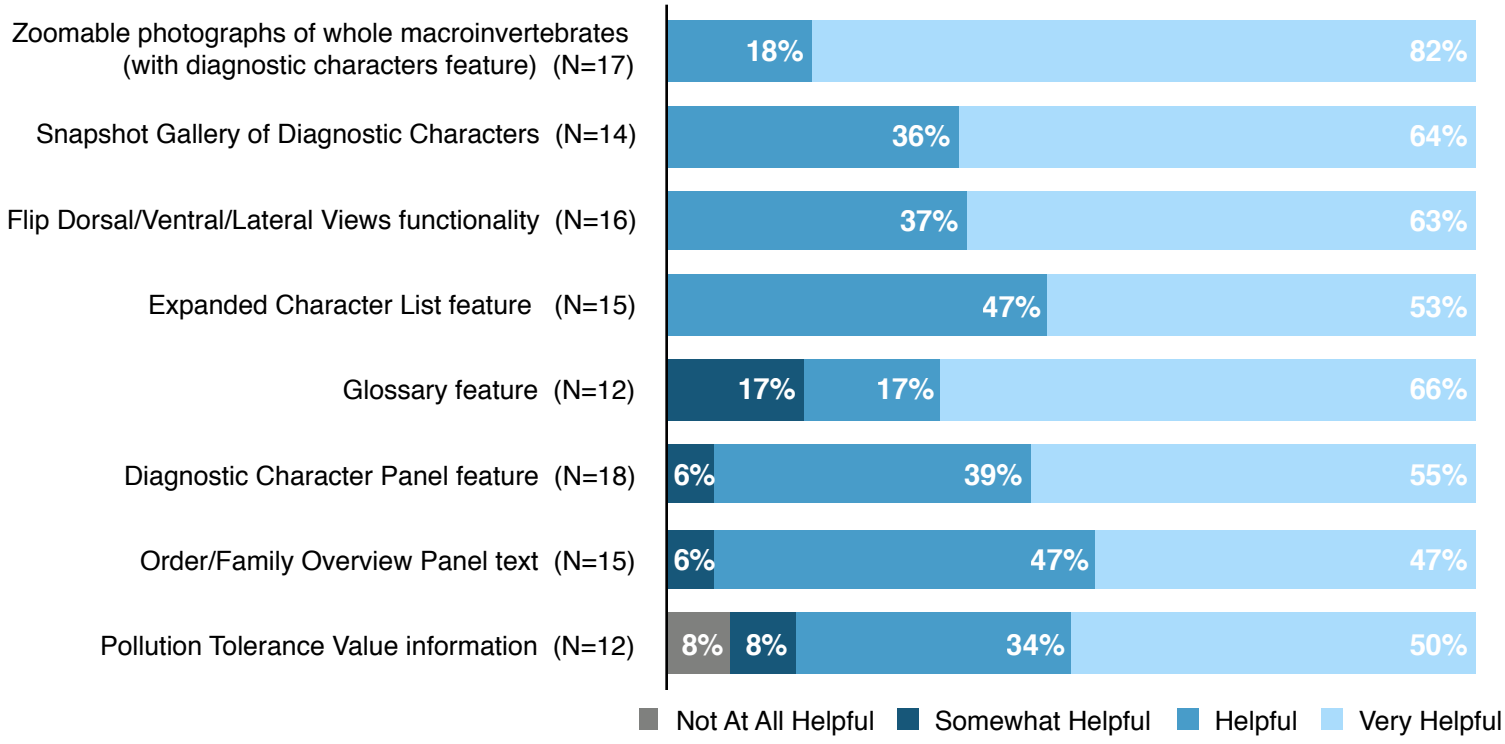
After the training, volunteers were also asked how helpful they felt various website features were for doing macroinvertebrate identification (see Appendix C for images of these features). Volunteers felt that the zoomable photographs were the most helpful feature, whereas the pollution tolerance information was viewed as least helpful for surveyed volunteers overall (see Figure 14). However, one focus group participant stressed the importance of the pollution tolerance information for her work: *"Those things help to derive meaning from what we found in the field and interpret it and what could we do to maybe change this."*

On the survey, one participant also called out the landing page as having been particularly helpful: *"It was nice to see all of the Orders on one page. The attention to detail was very impressive and the photos were very high quality."* However, in the focus groups, volunteers felt that it was difficult to navigate between the main page and the paper-based dichotomous key to narrow down an ID. In particular, volunteers felt that the website *"presumes that you know where you're going, where you're headed first,"* when users may not know how to figure out the Order yet:

"I had trouble using it as ID. I started with the key, and then if I had trouble with the key, then I went to the website. But the website was more for the Family level and below from what I could tell, unless I didn't understand it right. I would've liked something a little bit higher like the Order level, the key, the characteristics of that Order, which I never found because then I would have used the website more."

In addition, two focus group participants revealed that they had not realized that the images on the front page of the website could be selected to navigate to a specific macroinvertebrate.

Figure 14: Volunteers' Opinions of Website Feature's Helpfulness

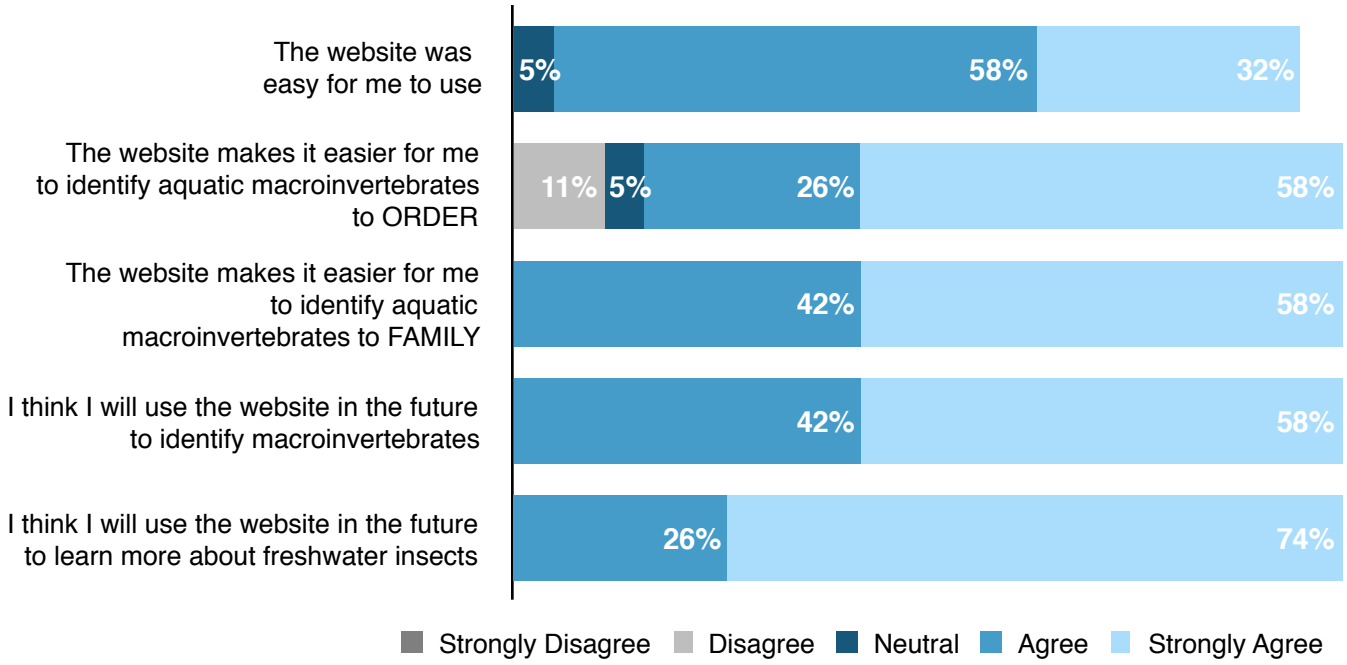


After the training, most volunteers were confident (47%) or very confident (26%) that they could use the website to identify aquatic macroinvertebrates. Almost all volunteers (95%, N=19) thought that the website was easy to use. One survey respondent felt that *"the ease of identification process is streamlined, so that someone like me with very*

little knowledge can easily navigate between the different family and genera."

All volunteers agreed or strongly agreed that the website made it easier for them to ID to Family (see Figure 15). Volunteers were slightly more mixed regarding whether the website made it easier for them to ID to Order. Regardless, all volunteers planned to use the website in the future to ID macroinvertebrates or learn more about freshwater insects in general.

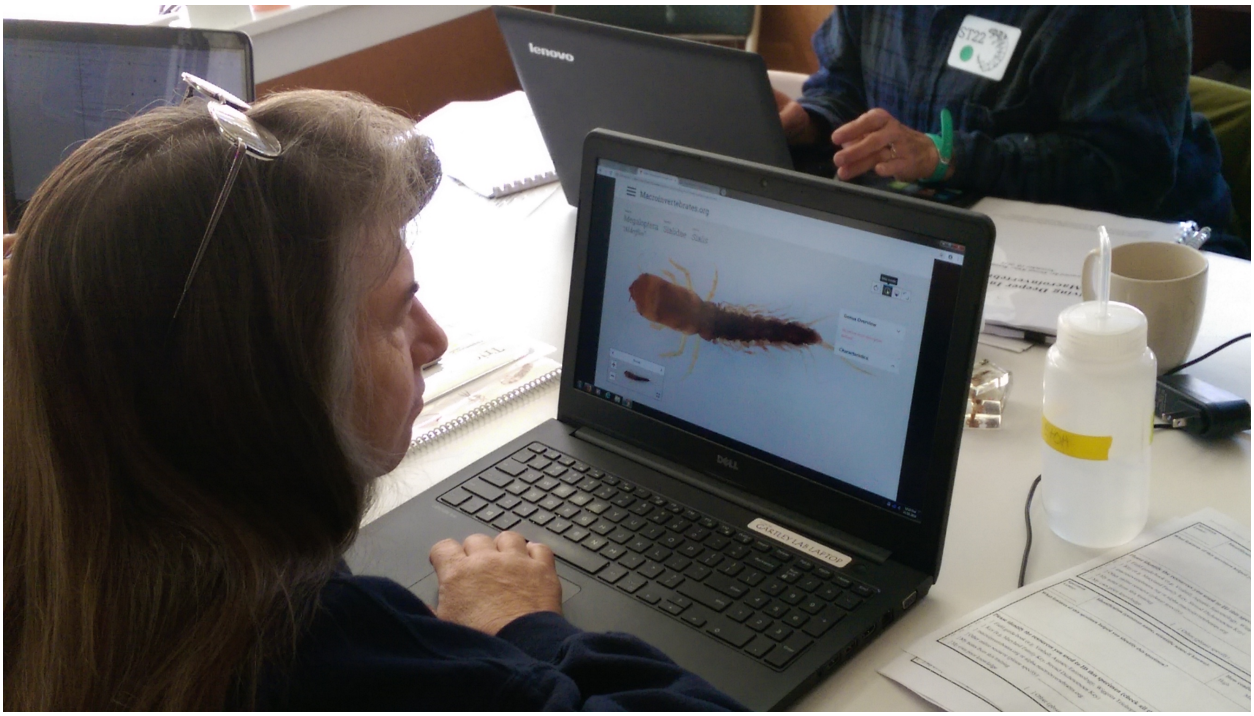
Figure 15: Volunteers' Opinions About the Website Overall



Volunteers' Current & Planned Use of the Website

Participating volunteers felt that the website was useful for visualizing differences between specimens, and survey respondents appreciated being able to *"view specific body parts"* and *"hard to see features": "The website had markers on the main diagnostic points of the macro, to help identify which parts of the macro were important and what to look for in that section."*

Survey respondents noted that the website was good for confirming an ID they made using other sources. One focus group participant felt that the website was particularly effective *"for the tricky situations…when you're not sure what the terminology means, and what part of the animal, or where to find it. That was really helpful."* Another focus group participant shared that he had previously mentored a group of high school students to create 3D printed models of various Orders, using the website as a resource: *"Right now, they go to this site. They do the magnification to have the details."*



Several survey respondents discussed how they might use the website as a teaching and training tool in the future:

> *"I thought it was great for being able to find and identify body parts and learn additional information about species. I would use it in a classroom setting. For K-3, I'd use the website's photos to teach learning standards, like parts of an insect, compare/contrast colors, shapes, etc. For older students, I'd have them use it as a resource for research projects, or to ID macros collected during school field investigations."*

“Demonstrating to laymen the breadth of aquatic biodiversity. I'd definitely share with canoeists, fishermen, landowners abutting stream, for it will enhance awareness and appreciation!!”

“I think the website would be good for citizen scientist programs as it is easy to use for those not that familiar with insect taxonomy. The website could also be used in class that focus on aquatic insects (as it shows the diversity for identifying insects) and insect anatomy (as it show the various features).”

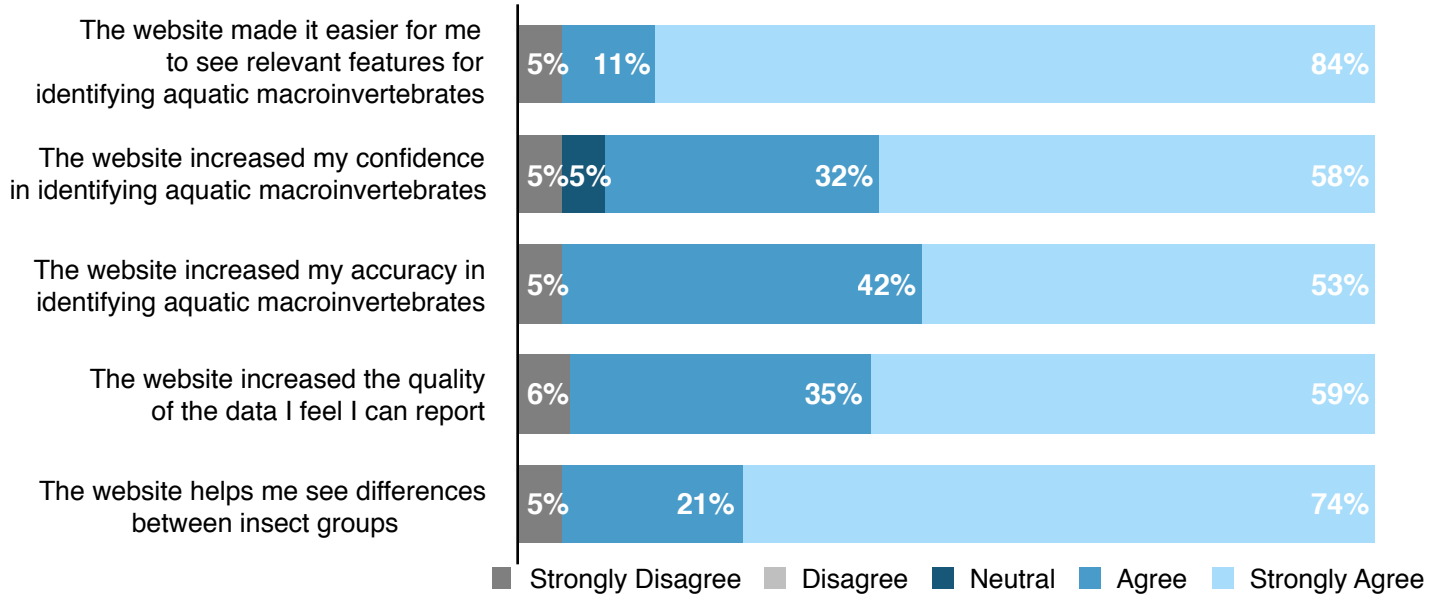
Focus group participants noted that they might use the website in the future with students as well:

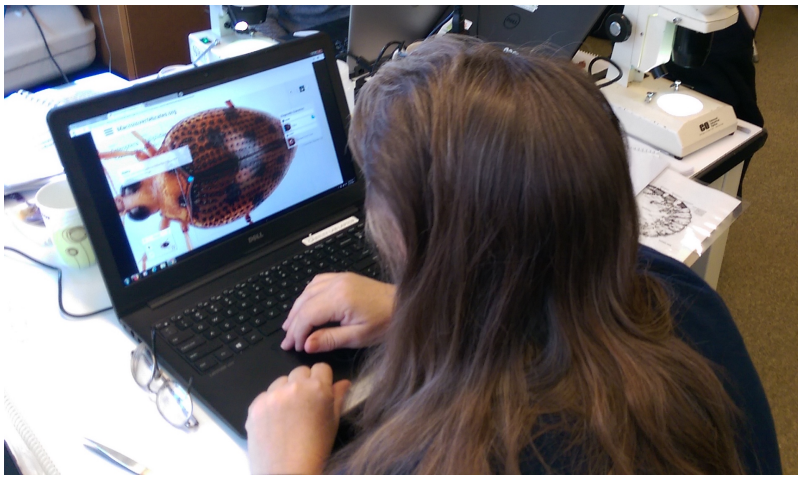
“Using the photos, I think, is going to be big to show kids how cool it is! I think that will really fascinate some of the kids in my school. Instead of just seeing the cards from Stroud Water Research Center - Those are awesome - but to be able to see those photos is so much, so cool, and you could start with kindergartners and go through, ‘Which color is it? How many legs does it have?’ But also get really detailed with the high schoolers.”

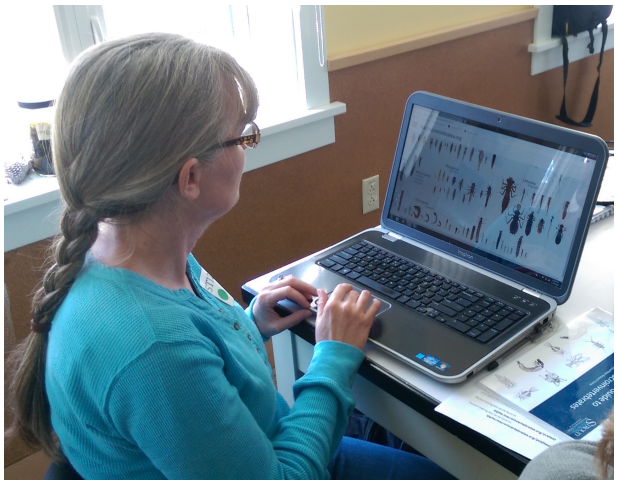
Website Impacts on Volunteers

Almost all volunteers thought that the website made it easier for them to see macroinvertebrates' relevant features and the differences between insect groups (95%, N=19; see Figure 16). The majority of volunteers also felt that the website had increased their confidence (90%), accuracy (95%), and the quality of the data they produce (89%).

Figure 16: Website Impacts on Volunteers (n=17-19)







Trainers' Opinions of the Website

Three trainers provided their opinions of the website. One trainer revealed, *"The site, I'm in love with it. It makes me nerd out. I just say that as someone who loves bugs and being able to get up close to them in a way that you can't always."* She noted that *"there's others like me, who would love to go home and practice and work on their confidence level because it's something on your laptop."*

After the training, these trainers were asked via survey to indicate how satisfied they felt using the website for various tasks (see Table 3). Trainers were most satisfied using the website to show an image of a macroinvertebrate to volunteers.

Table 3: Trainers' Satisfaction With Using the Website

Website Use	Not At All Useful	Somewhat Useful	Useful	Very Useful	Did Not Use Website For This Purpose
To show images of a macroinvertebrate to volunteers	0	0	0	3	0
To point out ORDER level characteristics/ features of a macroinvertebrate to volunteers	0	0	1	2	0
To look up the correct spelling of a macro invertebrates name	0	0	1	1	1
To point out FAMILY level characteristics/ features of a macroinvertebrate to volunteers	0	1	2	0	0
To answer a volunteer's question	0	1	2	0	0
To ID an unknown specimen or to confirm an ID	0	2	1	0	0
To point out GENUS level characteristics/ features of a macroinvertebrate to volunteers	1	0	1	0	1
To show a video	1	0	0	0	2

During her interview, one trainer elaborated, *"It definitely helps me to engage with people differently in that it did make it faster and more simplistic to point out a trait instead of me trying to finagle a microscope and me hold a specific feature in place and try to have the person see it. Instead you can project it on the larger screen. You have the features there and to point it out as a group and really engage in that way, I think is*

extremely beneficial." Another trainer noted that by familiarizing themselves with the website, trainers could point volunteers towards and translate relevant information for them.

Trainers were least likely to use the website to show a video. Instead, they played a Caddisfly video from another source, while the research and evaluation team were setting up the post-quiz stations at the end of the training.

After the training, trainers were also asked via survey how helpful they felt various website features were for doing macroinvertebrate identification (see Appendix C for images of these features). Trainers felt that the zoomable photographs and snapshot gallery of diagnostic characters were the most helpful features (see Table 4). For example, one trainer shared that the gallery was useful because she could hypothetically point volunteers to a set of tarsal claw snapshots in order to help them better differentiate between Stoneflies and Mayflies.

Table 4: Trainers' Opinions of Website Features' Helpfulness

Website Feature	Not At All Helpful	Somewhat Helpful	Helpful	Very Helpful	Did Not Use Website For This Purpose
Zoomable photographs of whole macroinvertebrates (with diagnostic characters feature)	0	0	0	3	0
Snapshot Gallery of Diagnostic Characters	0	0	0	3	0
Diagnostic Character Panel feature	0	0	0	2	1
Flip Dorsal/Ventral/Lateral Views functionality	0	0	1	2	0
Expanded Character List feature	0	0	0	2	1
Order/Family Overview Panel text	0	0	1	1	1
Glossary feature	0	0	1	1	1
Pollution Tolerance Value information	0	1	0	1	1

The pollution tolerance information was viewed as least helpful or went unused by some surveyed trainers.

After the training, two trainers were “confident” and one trainer was “very confident” that they could use the website to identify aquatic macroinvertebrates. However, they had more mixed perceptions of their ability to use the website to train volunteers to do ID work: one trainer was “somewhat confident,” one was “confident”, and one was “very confident” that they could do so. All three trainers were only “somewhat confident” that volunteers could use the website to ID specimens.

Two out of the three trainers agreed that the website was easy to use (see Table 5). All three trainers agreed or strongly agreed that the website made it easier for them to ID to Order and to Family. They also all agreed or strongly agreed that they were comfortable using the website in their trainings. One trainer summarized that the website enhanced her training by *“[providing a digital specimen collection and 'one stop shop' for a focused center of images and guides to morphology.”*

Table 5: Trainers’ Opinions About the Website Overall

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The website was easy for me to use.	0	0	1	2	0
The website makes it easier for me to train volunteers to identify aquatic macroinvertebrates to ORDER.	0	0	0	2	1
The website makes it easier for me to train volunteers to identify aquatic macro invertebrates to FAMILY.	0	0	0	3	0
I am comfortable using the website during my trainings.	0	0	0	2	1

Trainers’ Current & Planned Use of the Website

During their post-interviews, trainers indicated that they had used the website in preparation for the training to design hands-on ID activities and pull images to use in the session. Two trainers utilized the site beforehand to remind themselves about important Caddisfly familial characteristics that might come up during the training:

"[The website] helped me as a trainer to get more familiarity with the tidbits, the diagnostic characters that you don't always have right in front of you, at the forefront of your memory. It helps me get intimately close to them as if I was looking through a microscope or even better than that, so I felt like I was in a better capacity to teach and to train, and to assist anyone that had a question. And I think that's the point of the website, no matter your level of expertise with macros, we all get a little rusty and it's really great way to dust off your knees and get back into the nitty gritty of it again because of how close you can get to the critters."

"[The website] *is a helpful resource and refresher for our own understanding of diagnostic characters as scientists and our own ability to interact with diagnostic characters on animals that we may not be able to see in our own stream. You know not every animal represented here on macro.org has been something that I've been able to encounter. Maybe a bunch of them I have, but your samples is entirely based in your own stream and water setting and experience, so I think it's great for that reason."*

During the training itself, one trainer shared that it was difficult to use the website alongside the Maryland dichotomous key due to missing diagnostic characters:
"There would be a scenario, say a caddisfly family that they couldn't see if it had all three dorsal plates on the scope because it was so small. Then I brought up macro.org and showed them on that site that family. The Limnephilidae didn't have that diagnostic character there, so I had to say that, 'Don't worry if it doesn't say that. Let's see if there's two versus three here. I had to be knowledgeable in the website to know, 'Okay, it's not written there. There is a diagnostic character that didn't have that,' so that was kind of a hiccup, I thought."

Trainers indicated that they had also used the website outside of the training session to familiarize themselves with its functionality and see changes that were made over time, to show the website off to attendees at conferences, and to gather images for other presentations or workshops. One trainer indicated that she used the website in the same way she uses a voucher collection. During post-interviews, a trainer elaborated on this idea, indicating that the website could be used in tandem with a key to practice IDing when you already know the answer:

> *"I could feasibly sit in my bed at home, Netflix style, and pull up a specimen on macro.org, and pretend it's a live one in front of me, or even one in a vial in front of me, and still work through a key by being able to rotate it all the degrees around, be able to get really intimate with it, in a way that I couldn't even do with my hand…We're trying to ID something knowing essentially I'm going to be pointed in the right direction, and I thought that was really validating."*

One trainer indicated that in the future, she might use the website during trainings where she is unable to give volunteers time with live critters: *"Especially when we're doing future workshops, where they don't always have the ability to go out into the field. Sometimes we have to bring the field to the kids, and macro.org makes that a little bit easier."* Another trainer felt that the website also *"works nicely as a voucher collection for places that do not have easy access to a voucher collection or people with experience to ask questions to."*

Trainers' Perceptions of the Website Impacts on Volunteers

Trainers noted that the website was flexible enough to work for different volunteer use cases:

> *"[The website] is another resource out there that you can put in your toolkit on a citizen science level or beyond maybe, as a hobbyist if you want to get better…because it can do a lot of different things. It can validate an ID you already have. It can get up close to see a character to learn, 'What is this supposed to look like in the first place?', so that I can better ID things under a microscope then."*

All three trainers felt that the website made it easier for volunteers to see macroinvertebrates' relevant features, in general (see Table 6). All three trainers also agreed or strongly agreed that the website had increased volunteers' confidence and accuracy. Two trainers felt that the website had increased the quality of data volunteers produce, while the third trainer indicated that she had not used the website for this purpose.

Table 6: Trainers' Opinions of the Website's Impacts on Volunteers

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The website makes it easier for volunteers to see relevant features for identifying aquatic macroinvertebrates.	0	0	0	2	1
The website increases volunteers' confidence in identifying aquatic macroinvertebrates.	0	0	0	2	1
The website increases volunteers' accuracy in correctly identifying aquatic macroinvertebrates.	0	0	0	3	0
The website increases the quality of the data we collect. (n=2)	0	0	0	1	1

Trainers indicated that a challenge for volunteers with using a dichotomous key is that the photographs or drawings aren't very detailed, and that a challenge of using real specimens is that they can be incomplete. One trainer shared that the website provided volunteers with an accessible way to practice identification with high quality specimens:

> *"You know, a lot of it, I think has to do with how well preserved the specimens are, and how beat up they get or not. As well as in the keys, if you have drawings to compare to you, but a lot of people don't have access to voucher collections or don't really use them in the way that they should be. A lot of the time you don't have stuff to check yourself with, to keep you going and know that you're on the right path."*

Similarly, another trainer thought that the website was *"more friendly than a dichotomous key":*

> *"People know how to navigate websites and they can click on images. It's not full of scientific words or a lexicon they might not be familiar in order to delve into this world…The site is an intuitive thing. It's not a barrier to things you have to learn already. You can dive into it. You can explore without having to know much about it, whereas a key, there's a lot of preparation to successfully using it."*

Trainers though that volunteers could use the website in tandem with a key: *"To be able to really zoom in and understand the feature and to differentiate features from one another and to be able to see an example of a specific Family, if you feel unsure about where you're getting to in a key."* One trainer thought that volunteers could go home and use a known specimen on the website to help them practice using a dichotomous key to arrive at the same conclusion: *"I can retrace my steps because I know that it's supposed to be a black fly, and I think it's a confidence-building tool."*

One trainer summarized her thoughts on the post-survey about the website overall:

> *"For citizen scientists of all levels, the website acts as an excellent digital platform to equalize understanding of morphological and diagnostic features of macroinvertebrates. It helps build a common thread of comprehension as users zoom into defining characteristics even a loop lens can't always detect, thus helping macro educators and trainers experience the most important pre-requisite for consistently accurate IDs - knowing what they are looking for in the first place. Macroivertebrates.org lets you sharpen your confidence with macro ID either in the field with a specimen in your hands, or curled up in bed sifting through digital galleries."*

Opinions on the Aquatic Macroinvertebrates Training

What Volunteers Liked About the Aquatic Macroinvertebrates Training

When asked what they liked best about the training, volunteers in the focus group overwhelmingly replied that they enjoyed the website: *"It was streamlined for me. It really helped me identify. I was more comfortable with that."* One volunteer felt that the website's appeal and *"breadth of biodiversity"* was a useful tool for hooking people into caring about macroinvertebrates.

Volunteers also appreciated the knowledge and enthusiasm of the trainers themselves. They liked when information was presented with common names alongside scientific names. A few volunteers liked the Caddisfly video that was shown. In particular, they liked finding out how different Orders and Families *"relate to morphology, and some of them [were] sensitive in the water, and even some of the same Order [looked different] and why."*

What Volunteers Wanted to Improve About the Aquatic Macroinvertebrates Training

Time Allotted for Training

Volunteers who participated in the focus group after the pilot training indicated that they wanted more time for the training overall and *"felt rushed the entire day."*

In particular, volunteers wanted more time to play with the website: *"It's phenomenal. There's no doubt about that, but just having time to navigate through that better because someone like me, I'm so used to having to having that book or the paper."* Many volunteers suggested incorporating a deeper website walkthrough at the beginning of the session, where a trainer takes volunteers through the identification of a few specimens before they attempt to do an ID on their own: *"Okay, let's try and identify this organism based on the website, so let's click on this."* One volunteer wanted to take a guided discovery approach, in which a trainer asked volunteers to click on a particular website feature to see what happens, for example, with the "teardrop"-leveled characteristics.

In addition, volunteers wanted time to interact with live critters: *"I think the only thing that was missing was the collection. I would have like to get out and collect in the stream."* One participant wondered whether streamside collection should come before seeing the website to help connect volunteers to what they would be seeing or finding on the website. One volunteer shared that she needed a short, practical reminder on how to collect macroinvertebrate samples in the field.

Volunteers requested more time to devote to practicing IDing to Order and Family, in general. Several volunteers in the focus group also noted that they needed *"a refresher on the dichotomous key."* One participant indicated that he wasn't familiar with some of the terms in the key and needed to spend more time unpacking their meaning before moving on to other activities: *"Some of the terms that we didn't know, it might have been helpful to have that picture with that, 'This is the mezzo and whatever.'"* This same volunteer recommended flagging the Orders with tabs in the dichotomous key, so that volunteers didn't have to flip from section to section, which could lead to readers losing their place. Volunteers also

stated that having to flip between the paper dichotomous key and the website was difficult, so they ended up choosing one or the other. They felt that having a key integrated on the website would be extremely useful.

Differing Comfort Levels With Technology

One volunteer suggested splitting up the group into those who felt comfortable exploring or navigating on their own and those who might want a longer website walkthrough. Another volunteer acknowledged that his navigation of the website was more difficult because he was borrowing a tablet computer and was unfamiliar with the new device's functionality. Yet another volunteer suggested having volunteers view a tutorial video before the training as preparation for the experience.

Volunteers' Experiences with the Research & Evaluation Activities

Some focus group volunteers noted that the research component of the training (i.e., the pre- and post-quizzes) were slightly stressful, while others said that they just completed them to the best of their ability with the time allotted.

What Trainers Liked About the Aquatic Macroinvertebrates Training

Trainers felt that they had provided a nice variety of resources for volunteers: *"One key that I think is brilliant is going to be a big headache for somebody else, so I thought we really did good synthesizing all the opportunities out there and help move them through identification."*

One trainer liked the research and evaluation activities and thought similar interactions might be beneficial at future trainings. For example, having a focus group after the training was viewed as bringing "positive closure." In addition, the trainers liked the post-quiz, where volunteers rotated through a set of ID stations to apply what they had learned at the training session: *"I found that was a great way for people to go through and see where they're running into questions and really test yourself."* Trainers thought that having a portion of the training where volunteers wrote down their answers individually and then came back to discuss the IDs as a group would be

helpful. One trainer also appreciated the “think aloud” portion of the post-quiz because it provided her with instructional insights as to how volunteers move through resources like dichotomous keys. This same trainer also thought that highlighting various project partners and sponsors in the introductory PowerPoint presentation should be part of every workshop.

What Trainers Wanted to Improve About the Aquatic Macroinvertebrates Training

Number of Participants & Space Requirements

Trainers indicated that the number of people in the room was larger than they typically would have, especially given the need for space to accommodate computers: *“It made it too crowded for people to move freely, to have a good working environment.”* Trainers shared that this made it difficult for them to cycle around the room to answer volunteers’ questions. It also made it challenging for participants to share or look at specimens.

A trainer observed that one table had 5-6 people, and she thought that two per table would be sufficient in the future (i.e., 10 volunteers total with 5 tables). With a smaller number of participants, this trainer thought that each volunteer could have a microscope as well. She also would encourage participants to bring tablets, rather than laptops to preserve counter space.

Time Allotted for Training & Preparation

Trainers also revealed that they did not have time to practice their presentation beforehand as a team or discuss ways to make sure that the website was integrated throughout the session. This led to the website not being incorporated as fully in the PowerPoint presentations as the lead trainer had hoped.

Like the volunteers, trainers acknowledged that they would have liked more time to cover the various components of the training, and felt that they needed to pause more after each activity to allow volunteers time to process the new information: *"There were too many things sequentially, [volunteers] needed more space in-between."* They also wanted time to more thoroughly answer volunteers' questions. One trainer suggested a six hour duration, one said a full-day, and the other mentioned a two-day training. This last trainer acknowledged that even a 10-week course for interns with pristine specimens does not yield perfect accuracy.

Regardless of the amount of time being spent, all three trainers noted that future family level workshops should allot plenty of time for volunteers to engage with live macroinvertebrates:

> *"I think that it's a miss to have someone come somewhere like the Stroud Water Research Center…and not get their feet a little bit wet or their hands wet."*

> *"I think the original plan was to go out into the field and collect, but we were short on time and then the weather wasn't great. So that kind of transitioning from really nice specimens and photos to what you actually will probably be seeing in the field, and getting a little bit of experience with not so perfect specimens."*

One trainer also felt that time needed to be built in to teach or refresh volunteers regarding how to work with ethanol and a specimen. She noted that she might select a specimen, like Hydropsychidae, that could be kept in its vial for the first ID activity to save time. She also thought that more time could have been spent walking volunteers through how to use Maryland's dichotomous key, and that the first ID could have been done as a group to make sure everyone was on the same page and to free up time for individual exploration and identification attempts later in the session.

Trainers also sought more time to examine key Caddisfly features, and saw the website as a place to zoom in on specific traits: *"If I had more time, I would have really liked to incorporate it into the basic Trichoptera taxonomy, and overall the characteristics, and really engage with the website. I definitely felt pretty rushed even just going through our slides and quickly pointing with my fingers. Like, 'This is a trait. Okay, going on to the next thing.'*

One trainer suggested that some of volunteers' familiarization with the website, dichotomous key, and content being covered could happen before the training. She suggested emailing volunteers a Caddisfly quiz, a PDF of the dichotomous key, and a link to the website and how to use it a few weeks ahead of time: *"Each week they get homework and experience with the site, and they come in on game day and I don't even have to show the video and hopefully we can dive right in."* First, she would send them a video tutorial of how to use the website and a copy of the dichotomous key: *"Any of the tools that I'm going to have them use, I'd try to get them attached to them ahead of time."* Next, she would send volunteers information on different Orders. Then, she thought that it might be nice to send volunteers a 'Family of the Week' *"to have them really get to know, look as this critter, become familiar with this critter and become familiar with how to pronounce its name."*

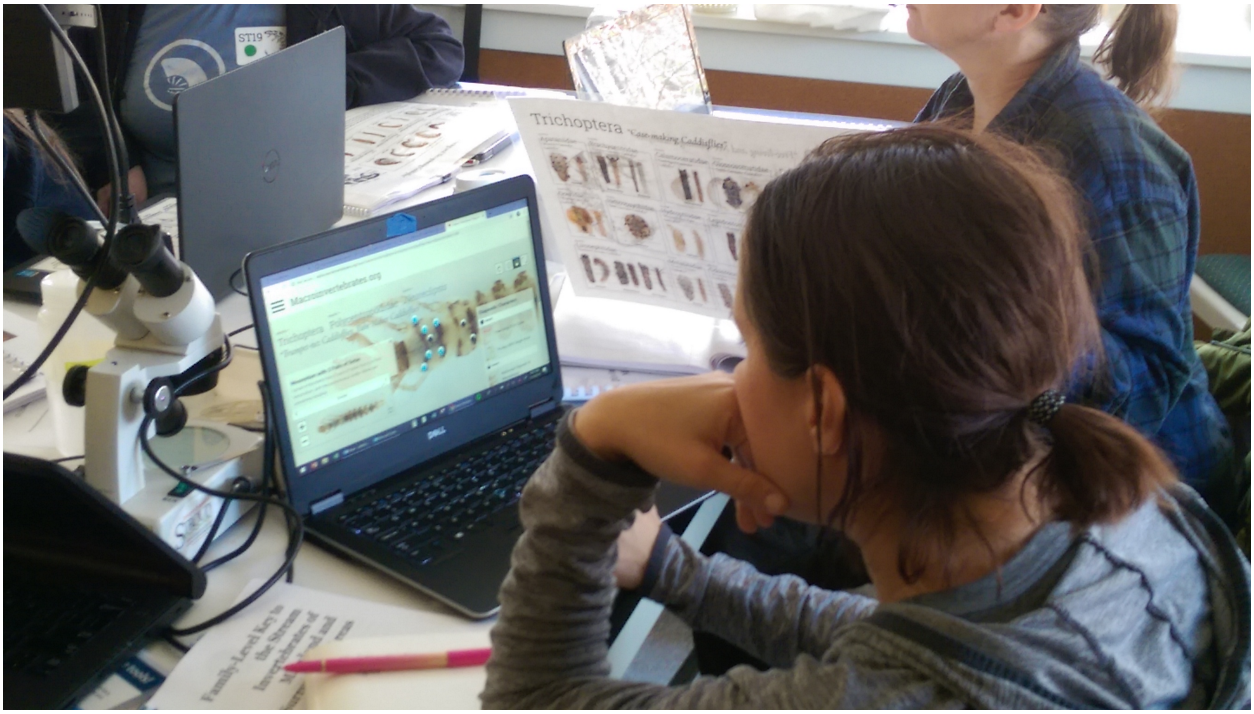
This trainer also felt that sending a follow-up email after the training might be helpful, *"I might send it out in a couple weeks and say, 'Hey, how is everyone doing with the Caddisflies? Here are some tips just to keep yourself familiar.'"* To encourage further use of the website, she said that she might send out a challenge to session participants with an image from the website, asking everyone to try to ID the family: *"I would have a way to gather a quiz for flies. Everyone could enter their data somewhere with, 'This is my family guess,' and then I could do a reveal of the ID."*

Differing Comfort Levels With Technology

Trainers noted that there was *"a bit of a digital divide in the room."* with some volunteers who were able to explore the website easily, and others who needed more technical assistance: *"Getting familiar with the site, being able to login, there was a lot of technological frustrations. There was a weird pause in momentum…As a trainer, you're always trying to figure out*

how to keep the flow going, how to keep people happy also while they're engaging with this." The trainers acknowledged that internet connectivity issues in the building and getting volunteers all logged onto the system and relevant websites also led to frustration.

One trainer observed that those who felt more comfortable were exploring the website during the PowerPoint presentations and missed key information. Trainers felt like providing more time for volunteers to familiarize themselves with the website's features before going into other content would both help bridge the gap in user aptitude and allow those who wanted to do so time to more closely examine the website. One trainer suggested, *"People having maybe 15-20 minutes to do nothing but click around the website with some direction maybe, like a scavenger hunt."* Another noted that simply reiterating the benefits of the website via a summary slide would help volunteers see additional possibilities for its use.



Understanding the Affordances of the Website and Dichotomous Key

Some trainers felt that volunteers used the website to confirm a quick visual ID, rather than understanding the diagnostic characteristics that defined a

particular macroinvertebrate: *"They were kind of using the website just as, 'Okay, you look like this, so I think you fit,' and they lost the intentionality of moving through all the characters. So I think we need to find a way to teach that a little bit better…You can zoom in and look at the characters more, but they would just look and think, 'Oh, it kind of looks like that,' and call it a day."*

Trainers also thought that volunteers needed more time to familiarize themselves with the specific dichotomous key being used. One trainer realized that the Maryland key that was utilized during the training pointed out different macroinvertebrate features for particular families than the website did, which made it difficult for volunteers to go back-and-forth between the dichotomous key and the website. This trainer was uncertain how to use both in combination, when they contained different information.

Volunteers' Experiences with the Research & Evaluation Activities

Trainers acknowledged that some volunteers felt stressed by the post-quiz timeframe, were unsure which stations to rotate to next, and did not like having to carry their materials from station to station: *"I think they just wanted more time at each station because some people got to my station right when the bell was ringing. People were getting there late, or arriving too early, so some of that frustration was just part of the pilot process of us figuring out how to flow."* One trainer felt that the timed post-quiz led people to adopt bad practices of doing a quick visual ID with the website, rather than systematically searching for features that would tell them what macroinvertebrate they were examining.

Trainers' Vision for Future Training Sessions

At the end of the post-interviews, trainers were asked what they might want future trainings at the family level to look like. One trainer indicated that she would want volunteers to come in with *"a command of Order level,"* although she acknowledged that volunteers often overestimate their IDing abilities. This trainer thought that future family level trainings might spend one day on becoming familiar and comfortable with using the website and a second day on morphology, ideally still focusing on one Order. Trainers

seemed in agreement that repetition and practice were important both in using the website and in doing ID work.

Another trainer outlined what she saw as a framework for future trainings that incorporated the website:

> *"I would say morning lab time, an introduction to macro.org and introduction to the resources that we're using, a quick overview of whatever species or Order that we're really getting close up and personal with. And then kind of in the morning go through the specimen, like we did and practice your ID skills. But then in the afternoon, I really think we need get people out of their seats, get them outside, go to the water and interacting up close, and in doing so they might take laptops out to the field with them. They might take something like the water quality app with them. Or we might just let it be total immersion. Get in the water. Find critters, and kind of compare now that this morning you've seen them on the screen, how does it compare to having them in your hand. It's more exciting in some ways, but how close and intimate you get with all these diagnostic characters, and that's where macro.org really helps you. So definitely got to have the field piece. And then we could come back and have a refresher and closure at the end of the day with macro.org reviewing what critters did we see, maybe pull up a few on the big screen for everybody. That would be great."*

Conclusions & Next Steps

The pilot family level training at the Stroud Water Research Center that incorporated the macroinvertebrates.org website was successful on a number of metrics. After the training, volunteers felt significantly more confident in conducting family level IDs than they had beforehand. Most volunteers thought that the website was easy to use and had increased their confidence, accuracy, and the quality of the data they produced.

For the most part, participating trainers also felt more confident in IDing and in training volunteers to ID after the training. Trainers also felt that the website was easy to use and felt comfortable incorporating the website into trainings.

Both trainers and volunteers thought that future family level trainings that utilize the website should include time to explore the website, to become familiar with dichotomous keys and the IDing process, and to interact with live specimens. Both groups also seemed excited by the possibility of engaging with the website before, during, and after a training takes place. Future trainings sessions could be planned to ensure that both trainers and volunteers have plenty of opportunities to leverage the website and its features to practice doing macroinvertebrate identification.

Appendix A: Training Specifics

Training Participants

The target audiences for the November 2018 family level training were volunteers with at least some ID experience, often educators or trainers themselves (see Table 7): *"These folks that came all had Order level experience, so they were already there, and knew main Orders presented, and 'It's not a barrier for me to dive into Caddisflies today because I know what a Caddisfly is.'"*

Table 7: Target Audiences for the Aquatic Macroinvertebrates Training

Audience	
Beginners/First Time Volunteers	
Volunteers with some ID experience	X
Volunteers with a lot of ID experience	X
K-12 Students/Youth	
Science Professionals	
Other trainers or volunteers	X
Teachers/Educators	X

Training Resources

Trainers acknowledged that their typical trainings at the Order level do not require microscopes, ethanol, or detailed dichotomous keys, but that these things were necessary upgrades for a Family level ID workshop (see Table 8).

Table 8: Training Resources Provided in the Aquatic Macroinvertebrates Training

Resources		Specifics
Collection protocols		
Printed materials	X	
Identification flash cards		
Identification posters	X	Tricoptera 11 x 17 poster
Dichotomous keys	X	Stroud Water Research Center, Maryland DNR
Videos/DVDs	X	
Websites	X	macroinvertebrates.org
Mobile apps	X	
Textbooks/Field guides	X	
PowerPoint presentations	X	
Voucher collections/Preserved specimens	X	
Hand lenses	X	
Camera (for vouchers)		
Video cameras		
Laboratory microscope (compound or dissecting)	X	
Field microscope		
Other	X	Forceps, ethanol, flashlight

Training Activities & Content

During the training, the lead trainer first introduced the purpose of the session, the project partners, and the purpose of the research and evaluation components. Volunteers then took a pre-quiz using the four lucite specimens. Next, the lead trainer played a video tutorial that outlined a few of the macroinertebrates.org website's functionalities: *"The video tutorial, I was hoping would give them a first foundation, so they could launch and start exploring with less inhibitions and kind of know where to go."*

The group then discussed what is difficult about doing ID work. Volunteers responded that the specimens are not always fully intact and are often missing tails or legs, that their features are very small, and that there's a lot of diversity within the Orders. The lead trainer reiterated that the bigger ones are easier to spot during biomonitoring, and that macroinvertebrates within the same Order can be *"morphologically so different."*
The lead trainer then reviewed some tips for doing identification. These tips included understanding the diagnostic characters that make up an Order or Family, knowing the habitat in which they will be found and their sensitivity, taking time to practice and study, using multiple resources and finding those that work for volunteers as individuals, and using ones own language to describe the specimens and their features.

Next, the lead trainer reviewed various Orders and their defining characteristics (see Table 9). She also mentioned a few print and online resources that are good for determining an Order level ID. She quickly reviewed insect morphology and important body parts via a presentation on insect anatomy, and led the group through the dichotomous key they would be using that day from Maryland Department of Natural Resources.

Table 9: Orders Covered in the Aquatic Macroinvertebrates Training

Order	
Coleoptera (Adult Beetles)	X
Coleoptera (Larval Beetles)	X
Diptera (True Flies)	X
Ephemoptera (Mayflies)	X
Hemiptera (True Bugs)	X
Lepidoptera (Aquatic Caterpillars, Snot Moths)	
Megaloptera (Alderflies, Dobsonflies, & Fishflies)	X
Odonata (Dragonflies & Damselflies)	X
Plecoptera (Stoneflies)	X
Tricoptera (Caddisflies)*	X

** Training intended to go through six families, but entire group went through Hydropsychidae, while individual tables explored one other family (Hydroptilida, Philopotamidae, Glossomatidae, Psychomyiidae, or Limnephilidae)*

After a break, another trainer took the group through a PowerPoint presentation on Caddisfly families. The macroinvertebrates.org website was not used during this portion of the training. Instead, the trainer used the dichotomous key to show the group how to get to the Caddisfly family, Hydropsychidae.

Trainers then walked the group of volunteers through doing an ID with a preserved specimen, using *"the images from macroinvertabrates.org to point out key features that need to be looked at as part of going through the [dichotomous] key."* One trainer noted that the goal of this activity was *"was to get people comfortable with the concept of IDing out to the family level, as well as having the image where they could go through, and to stimulate like you were looking at a specimen, and then doing it in a group setting so it's not as intimidating for when you go to do it on your own."*

The trainers then had volunteers break into smaller groups at the tables they were sitting at, and asked them to try to do an ID together around one of the other five Caddisfly families. After this activity concluded, the groups participated in research and evaluation activities in the form of a post-quiz and focus group.

Appendix B: Training Approaches

Table 10: Trainers' Typical Quality Assurance/Quality Control Measures

Quality Assurance/Quality Control Measure Used During Trainings	Number of Trainers Who Mentioned (N=2)
Required training before monitoring/data submission	2
Use of a reference collection for ID	2
Use of a local field guide for taxa known to exist in that stream/watershed	2
Requirement to collect voucher specimen	1
Side by side testing with a trained staff person	2
Flagging questionable taxa in database	1
Collection/assessment of some percent of paper data sheets for comparison with online	2
Follow up monitoring by a professional to reassess conditions if questionable	1

Table 11: Trainers' Typical Accuracy Assessments**

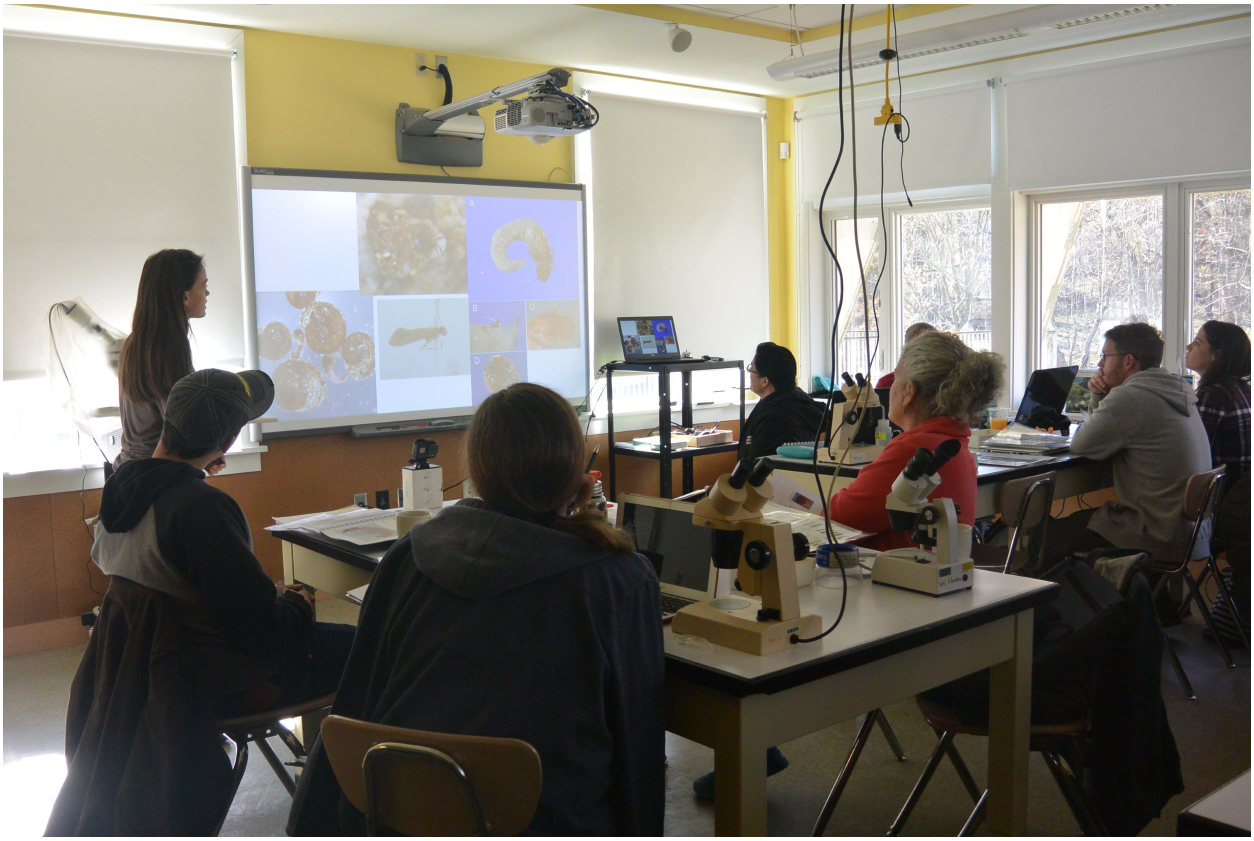
Accuracy Assessments Used During Trainings	Number of Trainers Who Mentioned (N=2)
Paper identification test at end of training	1
Pre-post tests	0
Surveys of participants	0
Unknown Real Specimen ID Test	2
Unknown Images (e.g. PowerPoint or Color Photos) Test	1
Other*	1

** Check all samples as they are learning.*

***Note: Both trainers indicated that assessments are graded or used to determine whether volunteers are qualified to sample or identify macro invertebrates for a specific program or purpose.*

Table 12: How Trainers Use Data That Volunteers Collect

How Volunteers Data Is Used By Trainers	Number of Trainers Who Mentioned (N=2)
Baseline monitoring	2
Educational purposes	1
Looking for impacts on a water source	2
Advocacy/To inform policy	0



Appendix C: Accuracy Task Specifics

Before Training

Table 13: Volunteers' Accuracy & Confidence Before Training

Specimen	Percentage of Volunteers Who Correctly Identified to Order	Percentage of Volunteers Who Correctly Identified to Family	Level of Confidence in ID (5-point scale)
Specimen #1: Trichoptera Rhyacophilidae	73% (n=11)	17% (n=6)	3.46
Specimen #2: Plecoptera Peltoperlidae	64% (n=11)	63% (n=8)	3.50
Specimen #3: Coleoptera Psephenidae	83% (n=12)	83% (n=12)	4.33
Specimen #4: Ephemeroptera Baetiscidae	71% (n=7)	57% (n=6)	3.71
Specimen #5: Hemiptera Gerridae	100% (n=7)	71% (n=7)	3.57

Table 14: Volunteers' Resource Use Before Training (n=11)

Specimen	Field Guide	Dichotomous Key	Project Website	Prior Knowledge	Other**	Did Not Specify	Average # of Resources Used During ID*
Specimen #1: Trichoptera Rhyacophilidae	18%	27%	45%	73%	0%	0%	1.53
Specimen #2: Plecoptera Peltoperlidae	9%	36%	64%	46%	9%	0%	1.64
Specimen #3: Coleoptera Psephenidae	8%	25%	25%	83%	0%	0%	1.42
Specimen #4: Ephemeroptera Baetiscidae	14%	14%	71%	43%	0%	0%	1.43
Specimen #5: Hemiptera Gerridae	0%	29%	14%	57%	0%	0%	1.00

** Note: Most volunteers utilized more than one resource during the ID process.*
*** "Other" resources volunteers used included Encyclopedia of Life, and Nature.MDC Isopod webpage.*

Trichoptera Rhyacophilidae: "Free-Living or Green Caddisflies"

Before training, 73% of volunteers provided a common name ID only, 27% provided a scientific name ID only, and 0% provided both (n=11). All volunteers who had time (n=11) attempted to ID the specimen to Order, while over half (55%) tried to ID the mystery macroinvertebrate to Family. Most volunteers who attempted to ID this macroinvertebrate used prior knowledge.

Many volunteers (73%) were able to correctly ID the specimen to Order. Of those who attempted a Family level ID (n=6), only 17% were correct.

Regardless of whether they correctly IDed the specimen, volunteers were fairly confident in their IDs (M=3.46 on a 5-point scale). Volunteers who correctly IDed the specimen to Order were more confident in their overall ID (M=3.75 on a 5-point scale, N=8) than those who incorrectly IDed the specimen at the Order level (M=2.67, n=3).

Plecoptera Peltoperlidae: "Roach-like Stoneflies"

Before the training, 46% of volunteers provided a common name ID only, 36% provided a scientific name ID only, and 18% provided both (n=11). All volunteers attempted to ID the specimen to Order, and 73% tried to ID the mystery macroinvertebrate to Family. Most volunteers that attempted to ID this macroinvertebrate used the macroinvertebrates.org website.

Many volunteers (64%) were able to correctly ID the specimen to Order. Of those who attempted a Family level ID (n=8), 63% were correct.

Regardless of whether they correctly IDed the specimen, volunteers were moderately confident in their IDs (M=3.50 on a 5-point scale, N=18). Volunteers who correctly IDed the specimen to Order had similar confidence in their overall ID (M=3.63 on a 5-point scale, N=8) compared to those who incorrectly IDed the specimen at the Order level (M=3.00, n=2).

Coleoptera Psephenidae: "Water Pennies"

Before the training, 67% of volunteers provided a common name ID only, 25% provided a scientific name ID only, and 8% provided both (n=12). All volunteers attempted to ID the specimen to Order and to Family. Most volunteers that attempted to ID this macroinvertebrate used their prior knowledge.

Most volunteers (83%) were able to correctly ID the specimen to Order. Of those who attempted a Family level ID (n=12), 83% were correct.

Regardless of whether they correctly IDed the specimen, volunteers were very confident in their IDs (M=4.33 on a 5-point scale, N=12). Volunteers who correctly IDed the specimen to Order had higher confidence in their overall ID (M=4.60 on a 5-point scale, N=10) compared to those who incorrectly IDed the specimen at the Order level (M=3.00, n=2).

Ephemeroptera Baetiscidae: "Armored Mayflies"

Before the training, 72% of volunteers provided a common name ID only, 14% provided a scientific name ID only, and 14% provided both (n=7). All volunteers attempted to ID the specimen to Order, and 86% tried to ID the mystery macroinvertebrate to Family. Most volunteers that attempted to ID this macroinvertebrate used the macroinvertebrates.org website.

Most volunteers (71%) were able to correctly ID the specimen to Order. Of those who attempted a Family level ID (n=6), 57% were correct.

Regardless of whether they correctly IDed the specimen, volunteers were confident in their IDs (M=3.71 on a 5-point scale, N=7). Volunteers who correctly IDed the specimen to Order had similar confidence in their overall ID (M=4.40 on a 5-point scale, N=5) compared to those who incorrectly IDed the specimen at the Order level (M=2.00, n=2).

Hemiptera Gerridae: "Water Striders"

Before the training, 43% of volunteers provided a common name ID only, 43% provided a scientific name ID only, and 14% provided both (n=7). All volunteers attempted to ID the specimen to Order and Family. Most volunteers that attempted to ID this macroinvertebrate used their prior knowledge.

All volunteers (100%) were able to correctly ID the specimen to Order. Of those who attempted a Family level ID (n=7), 71% were correct. Volunteers were confident in their IDs (M=3.57 on a 5-point scale, N=7).

After Training

Table 15: Volunteers' Accuracy & Confidence After Training

Specimen	Percentage of Volunteers Who Correctly Identified to Order	Percentage of Volunteers Who Correctly Identified to Family	Level of Confidence in ID (5-point scale)
Specimen #1: Trichoptera Rhyacophilidae	67% (n=18)	25% (n=4)	2.80
Specimen #2: Plecoptera Peltoperlidae	89% (n=19)	100% (n=14)	3.78
Specimen #3: Ephemoptera Ephemerelidae	89% (n=19)	71% (n=7)	3.94
Specimen #4: Trichoptera Limnephilidae	100% (n=19)	66% (n=9)	3.47
Specimen #5: Coleoptera Gyrinidae	100% (n=19)	50% (n=14)	3.63
Specimen #6: Plecoptera Perlidae	84% (n=19)	70% (n=10)	3.42
Specimen #7: Plecoptera Pteronarcyidae	84% (n=19)	45% (n=11)	3.69
Specimen #8: Diptera Tipulidae	89% (n=19)	75% (n=16)	3.42

Table 16: Volunteers' Resource Use After Training (n=19)

Specimen	Field Guide	Dichotomous Key	Project Website	Prior Knowledge	Other**	Did Not Specify	Average # of Resources Used During ID*
Specimen #1: Trichoptera Rhyacophilidae	11%	47%	37%	26%	0%	26%	1.53
Specimen #2: Plecoptera Peltoperlidae	16%	53%	63%	26%	5%	0%	1.63
Specimen #3: Ephemoptera Ephemerelidae	11%	58%	68%	26%	0%	5%	1.72
Specimen #4: Trichoptera Limnephilidae	11%	58%	58%	32%	16%	5%	1.83
Specimen #5: Coleoptera Gyrinidae	11%	47%	58%	37%	5%	0%	1.58
Specimen #6: Plecoptera Perlidae	16%	47%	68%	32%	5%	11%	1.88
Specimen #7: Plecoptera Pteronarcyidae	16%	58%	53%	32%	0	11%	1.77
Specimen #8: Diptera Tipulidae	16%	32%	58%	26%	0	11%	1.47

** Note: Most volunteers utilized more than one resource during the ID process.*
*** "Other" resources volunteers used included Google images, notes from the training, and the Caddisfly placemat.*

Trichoptera Rhyacophilidae: "Free-Living or Green Caddisflies"

After the training, 61% of volunteers provided a common name ID only, 17% provided a scientific name ID only, and 22% provided both (n=18). All volunteers who had time (n=18) attempted to ID the specimen to Order, while only 22% tried to ID the mystery macroinvertebrate to Family. Most volunteers that attempted to ID this macroinvertebrate used a dichotomous key.

Many volunteers (67%) were able to correctly ID the specimen to Order. Of those who attempted a Family level ID (n=4), only 25% were correct.

Regardless of whether they correctly IDed the specimen, volunteers were not very confident in their IDs (M=2.80 on a 5-point scale). Volunteers who correctly IDed the specimen to Order were more confident in their overall ID (M=3.20 on a 5-point scale, N=10) than those who incorrectly IDed the specimen at the Order level (M=2.00, n=5).

Plecoptera Peltoperlidae: "Roach-like Stoneflies"

After the training, 26% of volunteers provided a common name ID only, 47% provided a scientific name ID only, and 26% provided both (n=19). All volunteers attempted to ID the specimen to Order, and 74% tried to ID the mystery macroinvertebrate to Family. Most volunteers that attempted to ID this macroinvertebrate either used the macroinvertebrates.org website or a dichotomous key.

Most volunteers (89%) were able to correctly ID the specimen to Order. Of those who attempted a Family level ID (n=14), 100% were correct.

Regardless of whether they correctly IDed the specimen, volunteers were moderately confident in their IDs (M=3.78 on a 5-point scale, N=18). Volunteers who correctly IDed the specimen to Order had similar confidence in their overall ID (M=3.82 on a 5-point scale, N=17) compared to those who incorrectly IDed the specimen at the Order level (M=3.00, n=1).

Ephemoptera Ephemerellidae: "Spiny Crawler Mayflies"

After the training, 42% of volunteers provided a common name ID only, 42% provided a scientific name ID only, and 14% provided both (n=19). All volunteers attempted to ID the specimen to Order, while only 37% tried to ID the mystery macroinvertebrate to Family.

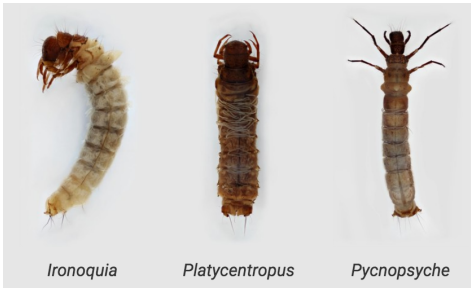
Most volunteers (89%) were able to correctly ID the specimen to Order. Of those who attempted a Family level ID (n=7), 71% were correct.

Regardless of whether they correctly IDed the specimen, volunteers were moderately confident in their IDs (M=3.94 on a 5-point scale). Volunteers who correctly IDed the specimen to Order were more confident in their overall ID (M=4.13 on a 5-point scale, N=17) than those who incorrectly IDed the specimen at the Order level (M=2.50, n=2).

Trichoptera Limnephilidae: "Northern Caddisflies or Northern Casemakers"

After the training, 21% of volunteers provided a common name ID only, 42% provided a scientific name ID only, and 37% provided both (n=19). All volunteers attempted to ID the specimen to Order, while only 47% tried to ID the mystery macroinvertebrate to Family. Most volunteers that attempted to ID this macroinvertebrate used the macroinvertebrates.org website and a dichotomous key.

All volunteers (100%) were able to correctly ID the specimen to Order. Of those who attempted a Family level ID (n=9), 66% were correct. Volunteers were fairly confident in their IDs (M=3.47 on a 5-point scale).



Coleoptera Gyrinidae: "Whirligig Beetles"

After the training, 21% of volunteers provided a common name ID only, 53% provided a scientific name ID only, and 26% provided both (n=19). All volunteers attempted to ID the specimen to Order, and 74% tried to ID the mystery macroinvertebrate to Family. Most volunteers that attempted to ID this macroinvertebrate either used the macroinvertebrates.org website or a dichotomous key.

All volunteers (100%) were able to correctly ID the specimen to Order. Of those who attempted a Family level ID (n=14), 50% were correct. The specimen was most often mistaken for a diving beetle. Volunteers were fairly confident in their IDs (M=3.63 on a 5-point scale).

Plecoptera Perlidae: "Common Stoneflies"

After the training, 42% of volunteers provided a common name ID only, 37% provided a scientific name ID only, and 21% provided both (n=19). All volunteers attempted to ID the specimen to Order, and just over half (53%) tried to ID the mystery macroinvertebrate to Family. Most volunteers that attempted to ID this macroinvertebrate either used the macroinvertebrates.org website or a dichotomous key.

Most volunteers (84%) were able to correctly ID the specimen to Order. Of those who attempted a Family level ID (n=10), 70% were correct.

Regardless of whether they correctly IDed the specimen, volunteers were moderately confident in their IDs (M=3.42 on a 5-point scale). Volunteers who correctly IDed the specimen to Order were more confident in their overall ID (M=3.47 on a 5-point scale, N=16) than those who incorrectly IDed the specimen at the Order level (M=2.67, n=3).

Plecoptera Pteronarcyidae: "Giant Stoneflies"

After the training, 42% of volunteers provided a common name ID only, 37% provided a scientific name ID only, and 21% provided both (n=19). All

volunteers attempted to ID the specimen to Order, and over half (58%) tried to ID the mystery macroinvertebrate to Family. Most volunteers that attempted to ID this macroinvertebrate either used the macroinvertebrates.org website or a dichotomous key.

Most volunteers (84%) were able to correctly ID the specimen to Order. Of those who attempted a Family level ID (n=11), 45% were correct.

Regardless of whether they correctly IDed the specimen, volunteers were moderately confident in their IDs (M=3.69 on a 5-point scale). Volunteers who correctly IDed the specimen to Order were more confident in their overall ID (M=3.86 on a 5-point scale, N=16) than those who incorrectly IDed the specimen at the Order level (M=2.50, n=2).

Diptera Tipulidae: "Large Craneflies"

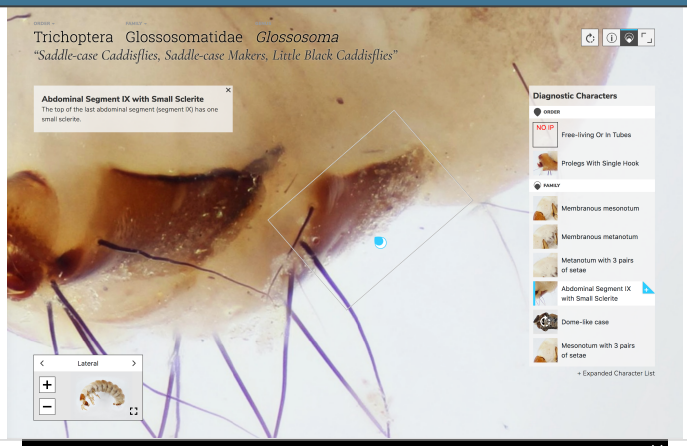
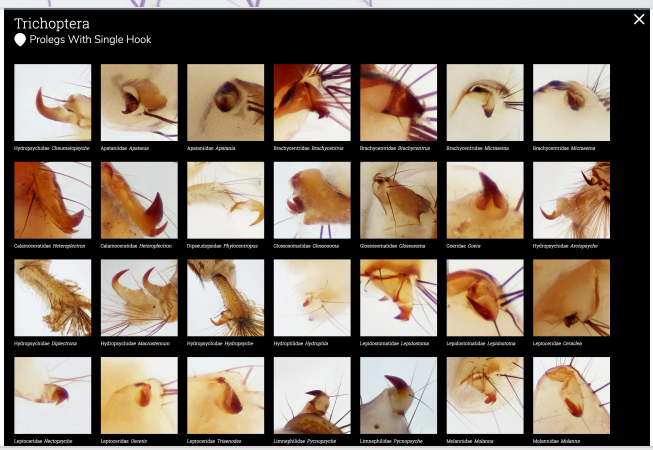
After the training, 26% of volunteers provided a common name ID only, 32% provided a scientific name ID only, and 42% provided both (n=19). All volunteers attempted to ID the specimen to Order, and many (84%) tried to ID the mystery macroinvertebrate to Family. Most volunteers that attempted to ID this macroinvertebrate used the macroinvertebrates.org website.

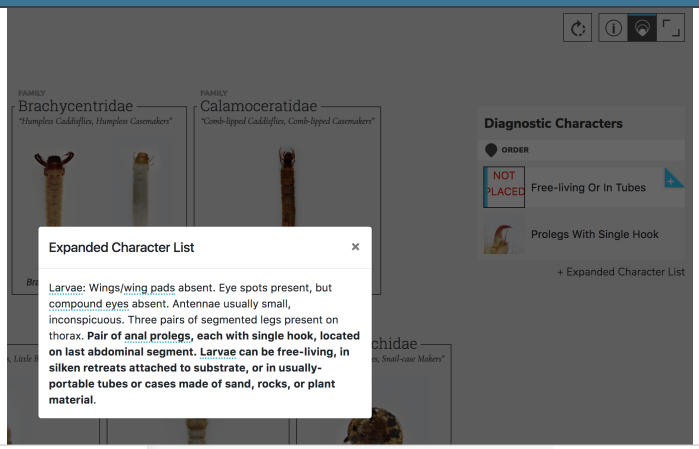
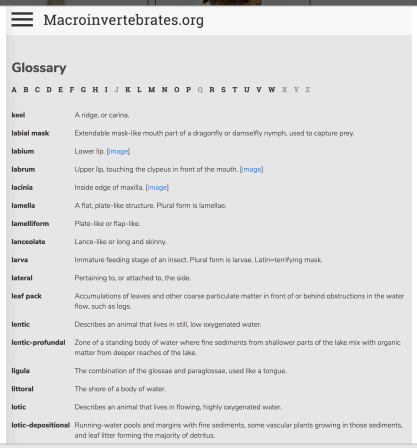
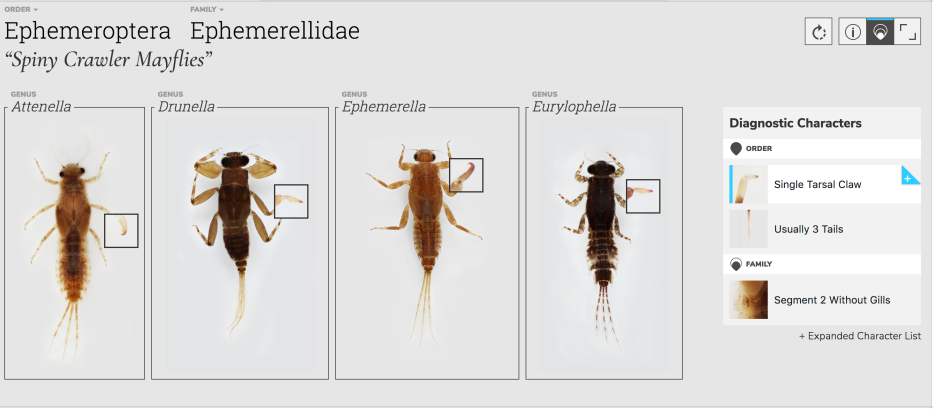
Most volunteers (89%) were able to correctly ID the specimen to Order. Of those who attempted a Family level ID (n=16), the majority (75%) were correct.

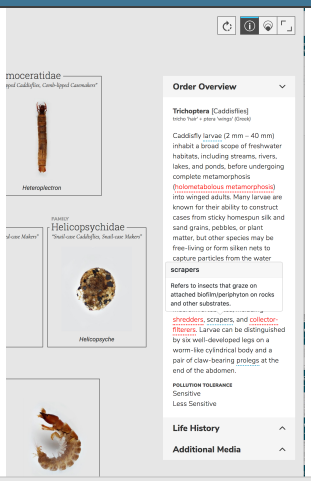
Regardless of whether they correctly IDed the specimen, volunteers were moderately confident in their IDs (M=3.42 on a 5-point scale). Volunteers who correctly IDed the specimen to Order were more confident in their overall ID (M=3.59 on a 5-point scale, N=17) than those who incorrectly IDed the specimen at the Order level (M=2.00, n=2).

Appendix D: Website Features

Table 17: Images of Website Features

Feature	Image from macroinvertebrates.org
Zoomable photographs of whole macroinvertebrates (with diagnostic characteristics feature)	
Snapshot Gallery	
Flip Dorsal/Ventral/ Lateral Views functionality	

Feature	Image from macroinvertebrates.org
Expanded Character List feature	
Glossary feature	
Diagnostic Character Panel feature	

Feature	Image from macroinvertebrates.org
Order/Family Overview Panel text	
Pollution Tolerance Value information