Integrating freshwater science and local management through volunteer monitoring partnerships: the Michigan Clean Water Corps

Authors: Latimore, Jo A., and Steen, Paul J.

Source: Freshwater Science, 33(2) : 686-692

Published By: Society for Freshwater Science

URL: https://doi.org/10.1086/676118

Integrating freshwater science and local management through volunteer monitoring partnerships: the Michigan Clean Water Corps

Jo A. Latimore[1,3] and Paul J. Steen[2,4]

[1]Department of Fisheries and Wildlife, Michigan State University, 480 Wilson Road, East Lansing, Michigan 48824 USA
[2]Huron River Watershed Council, 1100 North Main Street, Ann Arbor, Michigan 48104 USA

Abstract: Thousands of local watershed organizations and lake associations are actively involved in protection and management of freshwater systems throughout the USA. These nonprofit organizations may or may not have paid staff and rarely employ trained scientists or natural resource managers. Thus, they face challenges, including lack of access to technical assistance to support their lake and river assessment and management initiatives, and may struggle to convince decision makers of the validity of their efforts. Meanwhile, researchers and managers within academia and agencies are challenged by lack of access to long-term data sets, field sites, funding, and personnel, and sometimes struggle to demonstrate real-world application of research results and to build support for freshwater research and management programs. The Michigan Clean Water Corps (MiCorps) volunteer monitoring program is a partnership-based program involving state and regional organizations and local volunteers that has met the above challenges, resulted in expanded monitoring of lakes and streams in Michigan (USA), and led to synergistic outcomes, such as advancing freshwater science, building public support for research and management, and implementing science-based management and protection projects at the local level.

Key words: volunteer monitoring, Michigan, partnership, collaboration, management, research, lakes, rivers, streams

Thousands of local nonprofit organizations, such as watershed councils and lake associations, are actively involved in monitoring, protection, and management of freshwater systems throughout the USA (Volunteer Water Quality Monitoring National Water Resource Project 2013). These nonprofit organizations may or may not have paid staff. Many are entirely volunteer based, and relatively few employ trained scientists or natural-resource managers. Nevertheless, these organizations regularly monitor lake and stream conditions, including water quality, habitat conditions, stream flow, and lake levels. They initiate education programs to increase awareness and appreciation of local lakes and streams for a variety of audiences, frequently implement on-the-ground restoration and management projects, and are active in local landuse-planning and zoning-decision processes (Addy et al. 2010).

Volunteer monitoring organizations face significant challenges to the success of their stewardship initiatives. First, lack of access to technical assistance can hinder their efforts to collect defensible data about the health of local lakes and streams and to interpret those data. They typically must look beyond their own staff and volunteers to find the technical expertise they need in the field or laboratory, and for data management and interpretation. Technical assistance can be found in natural resource agencies, academic institutions, or private consultants, but the help may not be accessible because of location, cost, or time constraints.

When volunteer monitoring organizations are able to collect or acquire sound data about their local lake or stream, their next challenge is to move from monitoring to actions that result in protection or restoration. Technical assistance is critical for interpreting monitoring data,

E-mail addresses: [3]latimor1@msu.edu; [4]psteen@hrwc.org

**BRIDGES is a recurring feature of FWS intended to provide a forum for the interchange of ideas and information relevant to FWS readers, but beyond the usual scope of a scientific paper. Articles in this series will bridge from aquatic ecology to other disciplines, e.g., political science, economics, education, chemistry, or other biological sciences. Papers may be complementary or take alternative viewpoints. Authors with ideas for topics should contact BRIDGES Co-Editors, Ashley Moerke* (amoerke@lssu.edu) *and Allison Roy* (aroy@eco.umass.edu).

DOI: 10.1086/676118. Received 04 April 2013; Accepted 19 November 2013; Published online 28 March 2014.
Freshwater Science. 2014. 33(2):686–692.

identifying management options, and deciding on a course of action. Local organizations may struggle to convince decision makers of the validity of their data and of their environmental concerns without expert corroboration (Engel and Voshell 2002). Furthermore, implementation and evaluation of many protection and management actions require skilled expertise.

Freshwater scientists and managers face a rather different set of challenges in their lake and stream work, including access to field sites, availability of long-term and large regional data sets, and access to resources, such as funding and personnel (Bonney et al. 2009, Gommerman and Monroe 2012). Academic scientists, in particular, also are challenged to demonstrate real-world application of research results and to connect their work to society's needs (Lok 2010). Last, professionals are often faced with a lack of public support for the research and management that they do.

Partnerships between local practitioners and experts can be a viable solution to these challenges, and can lead to synergistic advances in local resource management and freshwater science (Courtemanch 1994, Mullen and Allison 1999, Cohn 2008, Isely et al. 2014, Kashian et al. 2014). van Kerkhoff and Lebel (2006) identified a continuum of engagement and power sharing between practitioners and experts in the context of sustainable development. The continuum begins with the conventional *trickle-down model* where expert researchers publish in the academic literature, which practitioners may consult on their own while tackling real local problems. Partnerships emerge further along the continuum when experts and practitioners are in direct communication (the *participation model*). Our goals are to demonstrate that partnerships between local practitioners and experts can be a viable solution to the challenges described above and that these partnerships can result in defensible data that support improved resource management. To make our case, we describe the Michigan Clean Water Corps (MiCorps) volunteer stream and lake monitoring program, an example of a participation partnership (sensu van Kerkhoff and Lebel 2006) of scientists, managers, and volunteers.

MiCorps

MiCorps is a network of volunteer lake and stream monitoring organizations in Michigan (USA). It was established in 2003 by former Governor Jennifer M. Granholm to build a partnership between the Michigan Department of Environmental Quality (MDEQ) and local organizations to collect and share water-quality data for use in water resources protection and management programs (Granholm 2003). Volunteer stream-monitoring organizations conduct macroinvertebrate and habitat monitoring, and volunteer lake monitors choose from a suite of monitoring variables that match their experience level and interest (Table 1).

The MDEQ retains oversight of MiCorps and contracts the day-to-day implementation of the program to several state and regional partners through a competitive-bid process (Table 2). Each partner organization brings unique and valuable strengths to the MiCorps program. The MDEQ represents the connection between local water-quality monitoring and statewide water-quality management. Three nonprofit organizations and Michigan State University, a land grant university, provide technical and administrative expertise and strong connections with various sectors of the public. Here, we refer to involved individuals from all of these organizations collectively as MiCorps staff.

MiCorps program goals include: 1) establishment and expansion of a volunteer monitoring network for Michigan's lakes and streams, 2) public education, 3) collection and exchange of reliable and meaningful water-quality data, and 4) establishment of an internet-based program that includes a database of volunteer-collected water-quality data, a directory of involved organizations, and training and data-interpretation resources (MiCorps 2005).

MEETING THE CHALLENGES

MiCorps provides resources to organizations and individuals interested in volunteer monitoring of their local lakes and streams that help them meet the challenges common to local organizations (Table 3). MiCorps staff provide training to volunteers and volunteer team leaders in the execution of standardized data-collection protocols at annual training events. This training ensures that volunteers can correctly follow protocols for equipment maintenance, sample collection, sample handling, and data reporting. Furthermore, the standardized protocols ensure that volunteers across the state follow the same procedures to monitor their local lakes and streams so that data in a statewide data set are comparable. MiCorps provides laboratory analysis of water-quality samples (total P [TP] and chlorophyll *a*) at a single state-run environmental laboratory, guaranteeing that all samples are handled following the same laboratory protocols.

The founding focus of MiCorps is on quality data collection, and not specifically on interpretation of those data, but MiCorps staff make themselves available to help local organizations understand the meaning of their data, and continue to develop tools and training to assist in data interpretation in response to volunteers' requests and needs. MiCorps staff also help local organizations understand the management options available through their broad and varied experience in lake and stream management and their knowledge of rules and regulations regarding the permitting and implementation of various management actions. The existence of MiCorps has established points of contact and relationships between volunteer-based organizations and a network of freshwater-science professionals across Michigan's natural resource agencies, leading environmental or-

Table 1. Variables monitored by Michigan Clean Water Corps (MiCorps) volunteers.

Variable	Frequency	Experience required
Stream monitoring		
Macroinvertebrates	Spring and autumn	None
Habitat	No more than annually	None
Lake monitoring		
Secchi disk transparency	Every 2 wk, mid-May to mid-September	None
Total P	Spring or autumn	None
Exotic aquatic plant watch (invasive plants)	One survey per year	None
Chlorophyll *a*	Once in May, June, July, August, and September	1 y in program
Dissolved O_2 and temperature profiles	Every 2 wk, mid-May to mid-September	1 y in program
Aquatic plant identification and mapping (all species)	One survey per year	1 y in program

ganizations, and academic institutions, and has established a strong network among the volunteer-based organizations through annual conferences and training events.

By connecting volunteer monitoring efforts across Michigan with MDEQ and supporting engagement of more local organizations in lake and stream monitoring since its inception, MiCorps has enhanced the spatial and temporal frequency of monitoring across the state (Fig. 1). MDEQ conducts biological and habitat assessments in every watershed in the state once every 5 y (15–20 watersheds, 500–600 sites/y) (MDEQ 2005). Nearly 40 partner organizations conduct volunteer stream monitoring statewide using the MiCorps protocol and visit ~500 stream sites twice each year for biological (macroinvertebrate) and physical-habitat assessments (Great Lakes Commission and Huron River Watershed Council 2013). The efforts of the MDEQ's Lake Water Quality Assessment Program result in assessments of the quality of ~70 lakes/y (Fuller and Taricska 2012), whereas MiCorps volunteers monitor ~225 lakes annually.

The data collected by volunteers in the MiCorps program are reliable and defensible. Steps to ensure the quality of volunteer monitoring data include standardized data forms and protocols that incorporate quality-control steps, and standardized volunteer training delivered by program staff (Herron et al. 2012). All volunteer monitoring data are reviewed automatically for reasonableness, and are reviewed by MiCorps staff before incorporation in the MiCorps online database (Latimore and Lawson 2007). Each organization conducting volunteer stream monitoring with MiCorps must submit a Quality Assurance Project Plan (QAPP) for approval by MiCorps staff, whereas all MiCorps lake monitoring is conducted under a single program-wide QAPP. Comparison of professionally collected and volunteer-collected data in the MiCorps program demonstrates remarkable comparability, attesting to the effectiveness of standardized training and volunteer-appropriate quality-assurance techniques. For example, each year, MiCorps staff randomly visit ~10% of the lakes

Table 2. Roles of organizations providing leadership for the Michigan Clean Water Corps (MiCorps).

Organization	Description	Contributions
Michigan Department of Environmental Quality	State agency	Program oversight
Great Lakes Commission	Interstate compact agency	Day-to-day contract management, database and website management
Huron River Watershed Council	Nonprofit regional council of governments	Stream ecology and management expertise, volunteer training
Michigan Lake and Stream Associations, Inc.	Nonprofit umbrella organization of local lake associations, individuals, corporations	Coordination of volunteer lake monitoring program
Michigan State University	Land grant university	Lake ecology and management expertise, volunteer training, public outreach and engagement

Table 3. How the Michigan Clean Water Corps (MiCorps) volunteer monitoring program alleviates challenges faced by local practitioners and experts in freshwater ecosystem assessment, research, and management.

Challenge	How met
For local practitioners	
Knowledge of field and laboratory methods	Standardized protocols and training
Capacity for data management	Internet-based database with strict quality controls
Proving validity of volunteer monitoring data	Side-by-side field sampling with staff, single laboratory for all sample analysis, quality assurance procedures implemented throughout program
Data interpretation capability	Annual training and conference, individualized guidance
Awareness of management options	Annual training and conference, individualized guidance
For experts	
Access to field sites	Volunteers with access to private and remote sites
Availability of long-term monitoring data	Emphasis on long-term monitoring
Availability of spatially broad data	Statewide scope
Access to funding and personnel to conduct large-scale monitoring	Hundreds of volunteers submit data
Connecting work to societal needs	Program is responsive to volunteer concerns by developing monitoring programs, tools, and training
Building public support for research and management	Engagement of public through data collection and regular communication builds support

at which TP and chlorophyll *a* are monitored. Samples collected by volunteers show ≥90% agreement with staff samples, on average, every year (Great Lakes Commission and Huron River Watershed Council 2013). This comparability reflects the conclusions of several studies that confirm the reliability of volunteer-collected data when quality-assurance steps are followed for lakes (Obrecht et al. 1998, Canfield et al. 2002) and streams (Fore et al. 2001, Engle and Voshell 2002, Nerbonne and Vondracek 2003).

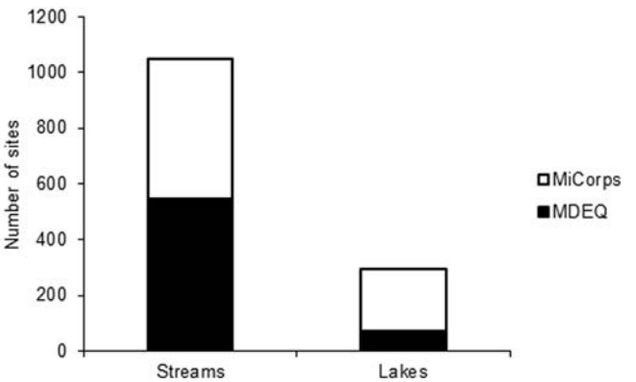

Figure 1. Approximate number of Michigan stream and inland lake sites monitored annually by volunteers in the Michigan Clean Water Corps (MiCorps) and by professional biologists with the Michigan Department of Environmental Quality (MDEQ) as of 2013. Volunteers visit each stream site twice annually, whereas MDEQ biologists visit stream sites once every 5 y.

USE OF MiCorps DATA

MiCorps is intended to lead to more than data collection. Volunteers should come away with an understanding of what the data tell them about the health of their local lakes and streams. The data are used for protection and management activities and to broaden understanding of aquatic ecosystem functions (Bonney et al. 2009, Gommerman and Monroe 2012).

MiCorps staff regularly hear from local lake associations and river organizations that use MiCorps data to assess the current status of their local lakes and streams and trends over time. This information is used to make management decisions from landuse planning to aquatic-weed control. The data also are used to detect the impacts of past changes, such as invasions of nonnative species or the installation of sewer systems to replace old and malfunctioning septic systems. Volunteer monitoring data also are used by lake associations to confirm results reported by commercial contractors, which frequently are hired by lake associations for aquatic-weed control and other lake-management activities. A survey of volunteers involved in the MiCorps program regarding their use of

the data has not yet been conducted, but several notable cases have been documented in MiCorps reports.

For example, in 2012 the Indian Lake Association (Kalamazoo County), involved with MiCorps since 2003, used its transparency, TP, chlorophyll *a*, and dissolved O_2 monitoring data to justify the need for a $230,000 grant to develop a watershed-management plan, which outlined a strategy for reducing lake nutrient loading and establishing a total maximum daily load for *Escherichia coli* (Latimore et al. 2013). The Eagle Lake Improvement Association (Cass County), which has been actively monitoring since the 1970s, used its monitoring data to inform the development of a Special Assessment District encompassing riparian properties around the lake to fund aquatic-plant control and to influence the local zoning board to enact limits on residential and commercial development along the lakeshore (Latimore et al. 2012). The Stony Lake Property Owner Association (Oceana County) began monitoring invasive plant populations in 2009 and is using the data to teach riparian property owners about plants in the lake and to develop an invasive plant control plan (Bednarz et al. 2010). The Friends of the St Clair River (southeastern Michigan) launched a MiCorps volunteer stream monitoring program in 2008. They used macroinvertebrate and habitat data to prioritize streams for restoration, support the delisting of threatened fish species, and correct habitat impairment in the watershed. The City of Marysville was awarded a $1.3 million grant to carry out the restoration efforts (MiCorps 2008).

Both state natural resource agencies (MDEQ and the Michigan Department of Natural Resources [MDNR]) use MiCorps volunteer monitoring data to meet their planning and reporting responsibilities. For example, MDEQ biologists, who have responsibility for assessing and reporting on the quality of the state's waters, screen MiCorps volunteer monitoring data for both high-performing and under-performing sites that merit agency assessment. Consideration of volunteer monitoring data is specifically indicated in the state assessment methods (MDEQ 2012). MDNR fisheries managers regularly take MiCorps data into consideration for development of fisheries management plans and harvest regulations (J. Breck, Institute of Fisheries Research, personal communication).

Freshwater scientists have begun to recognize the value of the statewide network of MiCorps volunteer monitors and the data set they continue to build. Standardized protocols allow the efforts of individual volunteers across the state to result in a statewide data set ideal for landscape-level assessments. US Geological Survey (USGS) researchers used MiCorps data to create a model that predicts the trophic state of unsampled lakes across Michigan by relating Secchi disk transparency measurements to Landsat-satellite imagery (Fuller et al. 2011). The researchers needed a large set of lake transparency data to build a strong model, and the extensive Cooperative Lakes Monitoring Program (CLMP) database available through MiCorps was crucial to this innovative project. USGS staff collected some transparency data for the project from the Upper Peninsula and northern Lower Peninsula of Michigan, but most data for those regions and all data from southern Michigan were collected by MiCorps volunteers. The researchers cooperated with the MiCorps implementation team when designing the project and engaged volunteers to measure lake transparency data during the time period that the Landsat satellite was overhead so that their data could be incorporated into the project. The response from volunteers was very positive. Volunteers were enthused to be contributing to a research project with clear implications for managing Michigan's inland lakes, and the researchers kept volunteers updated on progress of the project as it developed (Latimore et al. 2012).

Truly cooperative research projects also have developed through the MiCorps program. Researchers from Michigan State University cooperated with volunteers to investigate the influences of eutrophication and zebra-mussel invasion on concentrations of microcystin, a cyanobacterial toxin, in Michigan lakes (Sarnelle et al. 2010). Volunteers on 77 lakes collected additional water samples during their regular monitoring for TP and chlorophyll *a* to contribute to the study. Using only volunteer-generated data, the researchers were able to identify relationships between zebra-mussel invasion status in lakes and TP concentrations and to conclude that invasion status should be included in forecasting models for microcystin and that shoreline sampling (as opposed to euphotic-zone water-column sampling) should be conducted in monitoring programs for microcystin. The authors confirmed the validity of volunteer monitoring data by conducting side-by-side quality-control sampling with volunteers on 10 of the study lakes. At the conclusion of the study, the researchers discussed the results at a meeting with volunteers, so that the volunteers could incorporate the results of the study into their own local lake management programs if desired (Bednarz et al. 2009).

CONCLUSION

The MiCorps experience illustrates that partnerships between agencies, researchers, and local organizations can yield synergistic benefits for lake and stream science and management, reaching far beyond what could be achieved independently (van Kerkhoff and Lebel 2006). Partnerships between freshwater scientists and local organizations in Michigan have provided local organizations with technical training in the collection of important ecological data, capacity for data management, and scientific guidance in the interpretation of those data. These partnerships have provided experts with free access to long-term monitoring data from lakes and streams across the Michigan, opportunities for their research to influence local management

programs, and a chance to build substantial public support for freshwater research and lake and stream protection and management activities by engaging and educating the public through volunteer monitoring. MiCorps' statewide coordination of field and laboratory protocols, data-assurance standards, and data management has resulted in a growing set of defensible data that has facilitated local improvements in understanding, protection, and management of individual lakes and stream systems, and large-scale assessments of current conditions and trends in Michigan's aquatic ecosystems.

FINAL THOUGHTS

Many models exist for volunteer monitoring and citizen science programs. MiCorps is bolstered by leadership from a state environmental agency mandated to build partnerships with regional and local organizations to collect and share volunteer monitoring data. MiCorps also benefits from the involvement of a land grant university with a strong history of natural resources extension, outreach, and engagement statewide. As a whole, the MiCorps partner organizations strengthen the program with their complementary capabilities in public engagement, freshwater science, education, and program management.

We think that volunteer-collected monitoring data have tremendous potential for aquatic research and management. Local volunteer efforts can generate high-quality data that are sorely needed and can foster public stewardship and scientific literacy by directly engaging people with aquatic resources (Penrose and Call 1995, Bonney et al. 2009). Therefore, we encourage aquatic scientists to engage with volunteer monitoring and citizen science programs. They represent a largely untapped resource for advancing the field and a substantial opportunity for expanding the impact of our work.

ACKNOWLEDGEMENTS

The authors thank W. Dimond and K. Goodwin of the MDEQ and J. Breck of the Institute for Fisheries Research for sharing examples of research and management efforts in Michigan that use volunteer monitoring data.

LITERATURE CITED

Addy, K., L. Green, E. Herron, and K. Stepenuck. 2010. Why volunteer water quality monitoring makes sense. USDA-NIFA Volunteer Water Quality Monitoring National Facilitation Project, Factsheet II. US Department of Agriculture, Washington, DC. (Available from: http://www.usawaterquality.org/volunteer/pdf/GuideBook/Why_Makes_Sense_II.pdf)

Bednarz, R., J. Latimore, and P. Steen. 2009. Cooperative Lakes Monitoring Program 2008 annual summary report. MI/DEQ/WB-09/005. Michigan Department of Environmental Quality, Lansing, Michigan.

Bednarz, R., J. Latimore, and P. Steen. 2010. Cooperative Lakes Monitoring Program 2009 annual summary report. MI/DEQ/WB-10/003. Michigan Department of Environmental Quality, Lansing, Michigan.

Bonney, R., C. B. Cooper, J. Dickinson, S. Kelling, T. Phillips, K. V. Rosenberg, and J. Shirk. 2009. Citizen science: a developing tool for expanding science knowledge and scientific literacy. BioScience 59:977–984.

Canfield, D. E., C. D. Brown, R. W. Bachmann, and M. V. Hoyer. 2002. Volunteer lake monitoring: testing the reliability of data collected by the Florida LAKEWATCH program. Lake and Reservoir Management 18(1):1–9.

Cohn, J. P. 2008. Citizen science: can volunteers do real research? BioScience 58:192–197.

Courtemanch, D. L. 1994. Bridging the old and new science of biological monitoring. Journal of the North American Benthological Society 13:117–121.

Engel, S. R., and J. R. Voshell. 2002. Volunteer biological monitoring: can it accurately assess the ecological condition of streams? American Entomologist 48:164–177.

Fore, L. S., K. Paulsen, and K. O'Laughlin. 2001. Assessing the performance of volunteers in monitoring streams. Freshwater Biology 46:109–123.

Fuller, L. M., R. S. Jodoin, and R. J. Minnerick. 2011. Predicting lake trophic state by relating Secchi-disk transparency measurements to Landsat-satellite imagery for Michigan inland lakes, 2003–05 and 2007–08. Scientific Investigations Report 2011-5007. US Geological Survey, Reston, Virginia.

Fuller, L. M., and C. K. Taricska. 2012. Water-quality characteristics of Michigan's inland lakes, 2001–10. Scientific Investigations Report 2011-5233. US Geological Survey, Reston, Virginia.

Gommerman, L., and M. C. Monroe. 2012. Lessons learned from evaluations of citizen science programs. EDIS publication FOR291. University of Florida, Gainesville, Florida. (Available from: https://edis.ifas.ufl.edu/fr359)

Granholm, J. 2003. Michigan Clean Water Corps, Department of Environmental Quality. Executive Order No. 2003-15 of September 30, 2003. Executive Office of the Governor, Lansing, Michigan. (Available from: http://michigan.gov/granholm/0,1607,7-168-21975-76645--,00.html)

Great Lakes Commission and Huron River Watershed Council. 2013. Michigan Clean Water Corps annual program report for October 2011–September 2012. Michigan Clean Water Corps, Lansing, Michigan. (Available from: http://www.micorps.net/documents/MiCorpsAnnualReport2012_Final.pdf)

Herron, E., L. Green, K. Stepenuck, and K. Addy. 2012. Building credibility: quality assurance and quality control for volunteer monitoring programs. Volunteer Water Quality Monitoring National Facilitation Project. Factsheet VI. US Department of Agriculture, Washington, DC. (Available from: http://www.uwex.edu/ces/csreesvolmon/pdf/GuideBook/BuildingCredibilityVI.pdf)

Isely, E. S., A. D. Steinman, P. N. Isely, and M. A. Parsell. 2014. Building partnerships to tackle conservation and management of West Michigan's natural resources. Freshwater Science 33:679–685.

Kashian, D. R., A. Krause, L. Sano, K. Drouillard, and B. Nowell. 2014. Capacity building in stakeholders around Detroit River fish consumption advisory issues. Freshwater Science 33:674–678.

Latimore, J., P. Steen, and W. Dimond. 2012. Cooperative Lakes Monitoring Program 2011 annual summary report. MI/DEQ/

WRD-12/014. Michigan Department of Environmental Quality, Lansing, Michigan.

Latimore, J., P. Steen, and W. Dimond. 2013. Cooperative Lakes Monitoring Program 2012 annual summary report. MI/DEQ/WRD-13/007. Michigan Department of Environmental Quality, Lansing, Michigan.

Latimore, J. A., and R. Lawson. 2007. Importance of quality assurance planning for long-term monitoring programs: the volunteer monitoring experience. Water Resources Impact 9 (5):25–26.

Lok, C. 2010. Science for the masses. Nature 465:416–418.

MDEQ (Michigan Department of Environmental Quality). 2005. Michigan water quality monitoring strategy update. Michigan Department of Environmental Quality, Lansing, Michigan. (Available from: http://mi.gov/documents/deq/wb-swas-strategyupdate_254121_7.pdf)

MDEQ (Michigan Department of Environmental Quality). 2012. Assessment methodology. Chapter 4 *in* Water quality and pollution control in Michigan. 2012 Sections 303(d), 305(b) and 314 integrated report. MI/DEQ/WRD-12/001. Michigan Department of Environmental Quality, Lansing, Michigan.

MiCorps (Michigan Clean Water Corps). 2005. The Michigan Clean Water Corps. MiCorps Monitor 1(1):1–2. (Available from: http://www.micorps.net/newsletter/)

MiCorps (Michigan Clean Water Corps). 2008. FOSCRW Stream Leaders final project report. Project #3003-VSM2008-01. Michigan Clean Water Corps, Lansing, Michigan. (Available from: http://www.micorps.net/projects/2008/StClair_FinalReport.pdf)

Mullen, M. W., and B. E. Allison. 1999. Stakeholder involvement and social capital: keys to watershed management success in Alabama. Journal of the American Water Resources Association 35:655–662.

Nerbonne, J. F., and B. Vondracek. 2003. Volunteer macroinvertebrate monitoring: assessing training needs through examining error and bias in untrained volunteers. Journal of the North American Benthological Society 22:152–163.

Obrecht, D. V., M. Milanick, B. D. Perkins, D. Ready, and J. R. Jones. 1998. Evaluation of data generated from lake samples collected by volunteers. Lake and Reservoir Management 14:21–27.

Penrose, D., and S. M. Call. 1995. Volunteer monitoring of benthic macroinvertebrates: regulatory biologists' perspectives. Journal of the North American Benthological Society 14:203–209.

Sarnelle, O., J. Morrison, R. Kaul, G. Horst, H. Wandell, and R. Bednarz. 2010. Citizen monitoring: testing hypotheses about the interactive influences of eutrophication and mussel invasion on a cyanobacterial toxin in lakes. Water Research 44: 141–150.

van Kerkhoff, L., and L. Lebel. 2006. Linking knowledge and action for sustainable development. Annual Review of Environment and Resources 31:445–477.

Volunteer Water Quality Monitoring National Water Resource Project. 2013. Volunteer water quality monitoring and Master Naturalist programs in the US. US Department of Agriculture, Washington, DC. (Available from: http://www.usawaterquality.org/volunteer/VolunteerMonPrograms/)