Universities Council on Water Resources
Journal of Contemporary Water Research & Education
Issue 156, Pages 21-36, December 2015

Developing Great Lakes Literacy and Stewardship through a Nonformal Science Education Camp

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Abstract: Informal science education has received great attention nationally in recent years, however little has been included in the research or policy literature regarding camps as contexts for informal learning. This article first describes how a Great Lakes water resource education camp is based upon professional definitions of informal, nonformal and formal education. Next, we describe specific details of our long-running Michigan 4-H Great Lakes and Natural Resources Camp designed to foster teen leadership and watershed stewardship. The Camp utilizes research-based best practices in nonformal science education, Place Based Education, Great Lakes Literacy education, and environmental education, as we demonstrate through detailed literature review. We also provide details of quantitative impact evaluation conducted between 1999 and 2012 and involving over 700 youth participants. Youth received pre-Camp and immediate post-Camp surveys. The Camp had a positive impact on teens' Great Lakes literacy, place attachment, and stewardship intentions. We conclude with recommendations for designing nonformal water literacy education, based on guidelines from the National Research Council and from our experiences, to enhance whole-person development and deep learning through nonformal camp-based programs.

Keywords: *Great Lakes literacy, aquatic resource stewardship, nonformal environmental education, aquatic resource education, camping programs, place attachment, youth education*

Nonformal science education is increasingly important to prepare today's youth for active civic engagement in preventing and resolving resource issues of local, regional and global importance. Various types of nonformal environmental education (NFEE) have been used to foster lifelong stewardship; one of the most ubiquitous of these NFEE experiences for youth is attending summer camp. And, what summer camp does not offer direct learning contact with water resources? Camps of all sorts, not just NFEE-oriented camps, foster learning through activities such as: water-based recreation (canoeing, swimming), "nature study," crafts, and campfires by a scenic lake or other natural setting. As numerous researchers have noted, diverse childhood experiences (such as NFEE within natural areas, with peers and mentors in youth organization-sponsored learning environments) can have positive influence on a person's later actions in regard to sustaining environmental quality (Wells and Lekies 2006; Chawla 1999; Tanner 1980).

In spite of the commonality of youth camps, this form of programming receives little mention within the recent literature regarding nonformal or informal science education. Informal science education is defined according to the nature of the venue where learning primarily occurs; these include informal, everyday settings (at home, through media, playing educational games, hobby-related learning, or volunteering), designed environments (zoos and aquaria, nature centers, museums or science centers), and programs (through clubs, after-school activities, and citizen science) (Fenichel and Schweingruber 2010; National Research Council 2009). Missing in this categorization is the youth camp, which would certainly be a common form of informal program environment.

Informal science education is noted for its importance by the National Research Council

for many reasons; most notably, learners spend only a small proportion of their time in formal learning environments (pre-K, K-12 and post-secondary institutions). Furthermore, formal schooling continues to be fraught with challenges and uncertainties tied to standardized curricula and high stakes testing; these foci cause stress and are time-consuming for school-based educators (Edwards and Springs 2014). Gruenewald and Manteaw note that "one consequence of the 'high-stakes' environment…is that the pressure to prepare for tests inhibits the development of outdoor, experiential, project-based learning, or community-based learning….there are fewer opportunities to participate in collaborative inquiry projects, to contribute to community problem-solving, or to be initiated into the political process" (2007: 181).

Informal science camps present tremendous opportunities for water resource education. The purpose of this article is threefold:

1. We explore the definitions of nonformal, informal and formal science education in the EE and science education literature, and apply these definitions to camp programming focused on Great Lakes resources.
2. We describe the program model for and the quantitatively-documented impacts of a particular Great Lakes and Natural Resources youth camp, co-sponsored by 4-H Youth Programs, Sea Grant, Michigan State University and agency and community-based partners.
3. We conclude with recommendations for nonformal science learning through camps designed to foster whole-child youth development and lifelong commitments to water stewardship in the Great Lakes region.

Background: Nonformal, Informal and Formal Science Learning and Youth Camps for Water Resource Understanding and Stewardship

Many studies have identified the learning impacts of conservation education camps. These programs provide intense contact with mentors and result in development of youths' favorable attitudes toward the environment and management of natural resources, internal locus of control, knowledge of ecology, and environmental stewardship (Kruse and Card 2004; Mittelstaedt et al. 1999; Dettman-Easler and Pease 1999; Hanna 1995; Dresner and Gill 1994; Carlson and Baumgartner 1974). The impacts of camp programs on youth learning and personal development are well documented by the American Camp Association (2015).

Some camp programs could be considered mostly formal education – associated with K-12 education systems. The practice of "school camping" emerged in the 1950s as an effort to expose youth to outdoor living and skill development. Such camps are organized by school personnel and attended by youth during the school year and during the week. School camping still exists today, offered by K-12 districts/systems that maintain their own camp properties or that rent camp facilities from other organizations.

Most youth camps, however, would typically be classified as nonformal learning contexts. Scholars have long found it useful to define nonformal and informal learning differently. Maarschalk (1988) offered these definitions:

- "Informal education applies to situations in life that come about spontaneously…These are reflected in what a person is reading, viewing, and listening to and also in his or her hobbies.
- Nonformal education proceeds in a planned but highly adaptable way in institutions, organizations, and situations outside the sphere of formal schooling" (p. 139).

Researchers working in the 1990s noted that informal and formal education systems are characterized by different features, including these:

- The learning atmosphere (e.g., non-school institution for nonformal settings, and no special institution for informal learning).
- The party responsible for managing the learning (informal science is learner-managed, whereas nonformal learning is educator-mediated) (Tamir 1990-91).

Both nonformal and informal education experiences are associated with learners developing a strong commitment to science and science learning (Tamir 1990-91).

By the mid-2000s, researchers and practitioners alike distinguished between nonformal and informal learning with a research-based classification of educational terminology called The Definitions Project (2007). This work was funded by the U.S. Environmental Protection Agency, and facilitated by the National Association for Interpretation to provide a collaboratively-generated, common vocabulary for those working within education and interpretation in a variety of settings. The Definitions Project (2007) involved dozens of diverse federal agencies, professional associations, and conservation non-profit organizations. The resultant definitions of formal, nonformal and informal education are similar to the original 1980s classifications, but offer more refined detail in order to provide research-based guidance to those designing educational initiatives. Most recently, the National Research Council lumps both nonformal and informal settings into what it terms "informal science education," then distinguishes among types of learning by classifying these as "everyday learning," "designed environments," or "programs" (NRC 2009). For specific, contemporary definitions, see Table 1.

Although early scholars considered education systems as arrayed along a continuum ranging from formal, to nonformal to informal, Figure 1 depicts a perspective showing interfaces among these systems. This representation is useful in that it shows that programs such as a water science camp are not easy to classify in only one realm. Rather, we see work in water resources education as situated mainly in the interface between nonformal and informal learning, with significant links and ties to formal learning contexts (Figure 1).

As an example of water science education programs that intersect informal, nonformal and even formal education approaches, this article presents the Michigan 4-H Great Lakes and Natural Resources Camp (for teens ages 13-15, and offered since 1985). This Camp is mostly presented as a nonformal science education program; it has clear organization and planning for nonformal learning that is mentored by staff and counselors during a one-week residential experience. The program exhibits best practices in informal science learning in association with parks, maritime museums, and other local community partners. Informal learning at Camp is also accomplished through

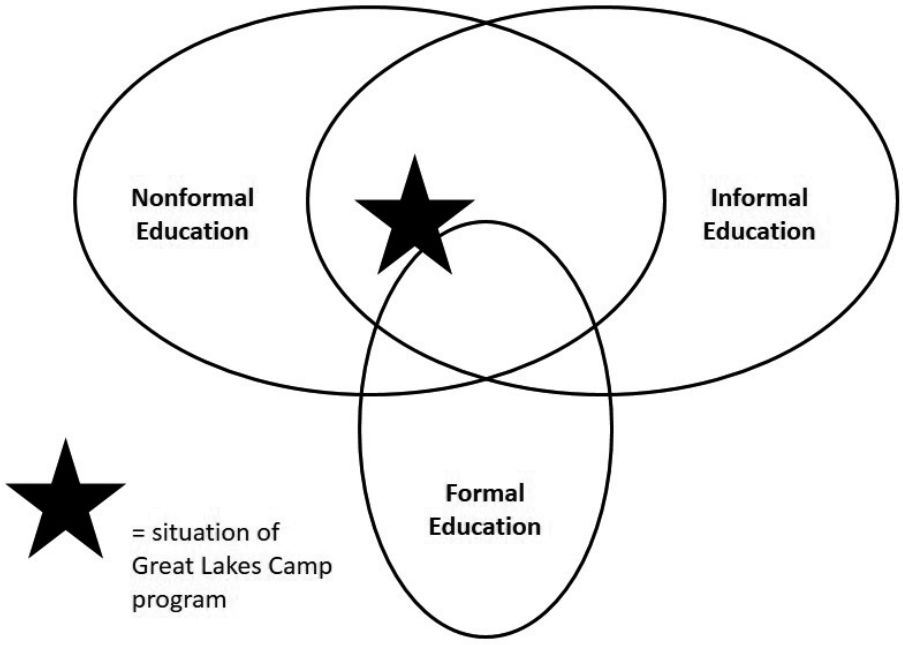

Figure 1. Situating the Michigan 4-H Great Lakes and Natural Resources Camp program within the realms of nonformal, informal and formal science learning.

Table 1. Definitions of informal, nonformal and formal science education.

Concept/ Term	Defining Entity/Organization		
	Journal of Environmental Education (Tamir 1990-91)*	Definitions Project (U.S. EPA and National Association of Interpretation) (2000s)**	National Academy of Sciences and National Research Council (2010)****
Informal Learning	*Place*: no special institution, home *Learning environment*: not arranged *Attendance*: voluntary *Subject matter*: not structured *Motivation of learners*: mainly intrinsic *Managers of learning*: learners *Assessment*: none	"The truly lifelong process whereby every individual acquires attitudes, values, skills, and knowledge from daily experience and the educative influences and resources in his or her environment – from family and neighbors, from work and play, from the market place, the library, and the mass media."*** Informal learning environments [include'] the places, venues, and settings where informal learning opportunities are intentionally made available to visitors, such as in parks or museums.	Only defines "informal science learning" Everyday Learning: Experiences occur over a lifetime, include family activities, walks, hobbies, media, helping with outdoor tasks (farming, gardening) Designed Environments: Museums, zoos, aquaria, visitor centers, nature centers, historic settings, libraries, botanical gardens, science centers Programs: Afterschool programs, clubs, volunteer groups, citizen science projects, educational vacations, summer programs
Nonformal Learning	*Place*: non-school institution *Learning environment*: pre-arranged *Attendance*: voluntary *Subject matter*: structured *Motivation of learners*: typically intrinsic *Managers of learning*: both mentors and learners *Assessment*: not expected	"Any organized educational activity outside the established formal system – whether operating separately or as an important feature of some broader activity – that is intended to serve identifiable learning clienteles and learning objectives."***	
Formal Learning	*Place*: school-based, classroom, pre-K, K-12, postsecondary *Learning environment*: pre-arranged *Attendance*: compulsory *Motivation of learners*: typically extrinsic *Management of learning*: teacher *Assessment*: expected	"The hierarchically structured, chronologically graded 'education system, running from primary school through the university and including, in addition to general academic studies, a variety of specialized programs and institutions for full-time technical and professional training."**	Science learning that takes place in schools

*Adapted from Tamir (1990-91).

**The Definitions Project (2007), http://www.definitionsproject.com/definitions/media/definitions_list_0107.pdf.

***Adapted by The Definitions Project from The Encyclopedia of Informal Education, 2006 http://www.infed.org/encyclopaedia.htm.

**** Fenichel and Schweingruber 2010; National Research Council 2009.

free choice learning options offered to youth to explore recreational and avocational interests related to water resource recreation. Finally, the Camp clearly links its learning outcomes to formal, K-12 state science curriculum expectations, and communicates these to parents and to teachers who recruit campers; this is done by aligning the camp's lessons to the Michigan K-12 Grade Level Content Standards in Science (revised according to Michigan's adaptation of the Next Generation Science Standards). In addition, the Camp is a formal component of Michigan State University's network of "pre-college" programs, thus providing college preparation and career/major exploration for its participants. In summary, then, there are possibilities and benefits to considering the overlap and linkages among nonformal, informal and formal science learning contexts, as opposed to viewing each as mutually exclusive learning platforms, for enhancing youth water resource science understanding and stewardship.

Nonformal Water Resources Education Model: The Michigan 4-H Great Lakes and Natural Resources Camp for Teen Leadership

The Michigan 4-H Great Lakes and Natural Resources Camp is a one-week environmental leadership program that provides opportunity for youth ages 13-15 to become involved in Great Lakes-related learning regarding water science resource issues, career opportunities, and lifelong recreational interests. Attendees consist of campers from throughout Michigan, most of whom enter eighth through tenth grade the following school year.

The Camp utilizes research and best practice in nonformal science education by providing highly experiential and site-specific learning. The program goals are to:

- Increase youth knowledge about local and Great Lakes regional aquatic and natural resources ecology and management issues.
- Provide diverse role models for youth from among local and Great Lakes regional volunteer, agency and Extension staff.
- Engage youth in field trips to unique local Great Lakes ecological sites where they can meet diverse community experts and volunteers.
- Foster advanced leadership opportunities (for campers to progress to counselor, and ultimately to instructional staff) and through which campers can share their Great Lakes experiences and expertise with others.

The program is situated along Lake Huron in northeast Michigan. Ecosystem features at the site include: rare coastal wetlands, shoreline, inland lakes and rivers, cultural resources such as lighthouses and shallow-water shipwrecks, a marina, swimming and fishing access, animal and plant biodiversity, the world's largest open limestone quarries and unique fossils such as Petoskey stones. Local natural areas, research and management facilities operated by Michigan Department of Natural Resources, U.S. Fish and Wildlife Service, the National Oceanic and Atmospheric Administration and local organizations provide place-centered field learning opportunities. The specified objectives of the program are that youth will:

- Increase their appreciation and enjoyment of the outdoors, natural resources, and science.
- Increase their understanding of natural resource ecology and management.
- Learn to teach about and provide leadership in natural resources, especially the aquatic environment and the Great Lakes.
- Become stewards in local natural resources projects.
- Develop career and personal interests in natural resources, ecology and management.

These outcomes are purposefully aligned with the Great Lakes Literacy Principles (Fortner and Manzo 2011; http://greatlakesliteracy.net/). This research-based, extensively peer-reviewed framework defines a Great Lakes literate person as one who:

- Understands the essential principles and fundamental concepts about the characteristics, function and value of the Great Lakes.
- Can communicate accurately about the Great Lakes' influence on systems and people in and beyond their watershed.

- Makes informed and responsible decisions regarding the Great Lakes and the resources of their watershed (http://greatlakesliteracy.net/).

At the Michigan 4-H Great Lakes Camp, youth take part in five ecology sessions during the week that foster Great Lakes literacy. Using best practice in nonformal education (National Research Council [NRC] 2009), generalized lesson plans with specific learning outcomes and teaching options are used during the morning ecology sessions. There is not a formal "curriculum," so instructors (university, agency or conservation partner personnel) have the flexibility to highlight site-specific "teachable moments" given the ecological features and management dilemmas presented at the Lake Huron areas used in instruction. In addition, morning sessions emphasize career opportunities related to various sciences. Examples of these Great Lakes literacy morning sessions include: Great Lakes Fisheries and Charter Fishing, Great Lakes Coasts/Wetlands, Great Lakes Watersheds (Limnology), Great Lakes Region Forests and Wildlife, Great Lakes Geography (using GPS), and Great Lakes History and Maritime Heritage.

Youth do more than simply learn about Great Lakes aquatic resource sciences. They also participate actively in citizen science initiatives with real-world community partners. For example, youth have collected data regarding the threatened Pitcher's thistle, and contributed their findings to the Michigan Natural Features Inventory and the U.S. Fish & Wildlife Service (USFWS). Campers have worked with the USFWS to collect data on distribution of the invasive, non-native *Phragmites*. Another partnership between Camp and the U.S. Geological Survey's Great Lakes Science Center provides youth-collected data relevant to its Lake Huron Predator Diet Study. Additional stewardship service projects for campers offer models for efforts they can undertake as real-world application of their science learning when they return to their own home communities, working with conservation partners and civic organizations locally.

These camp program elements are designed to espouse and follow best practices in Place Based Education (PBE). Smith (2002) notes that PBE aims to "ground learning in local phenomena and students' lived experiences." The Great Lakes Stewardship Initiative notes that PBE uses the local community and environment as a starting place for teaching and learning; PBE also fosters learning that is hands on, inquiry-based, real-world, experiential, and in direct collaboration with community partners (www.glstewardship.org). Many other scholars and practitioners have defined PBE, including Sobel (1996, 2004), Gruenewald (2003), Gruenewald and Smith (2008), Great Lakes Water Studies Institute (2005), The Rural School and Community Trust (2014), and Woodhouse and Knapp (2000). In its report, the NRC validates the "place-centered lens" as one way to understand and situate learning within informal environments (2009).

Each afternoon, youth choose from a variety of place-specific, natural resource-based recreation or field trip options. This is the portion of the Camp program that could be most considered the informal science learning component. Participants have free choice in signing up for their learning interests, and have a great deal of time to explore and learn on their own. Water-based recreation includes: sailing, canoeing, kayaking, snorkeling, wading, and swimming. Field trips take participants to local museums, a National Marine Sanctuary and visitors' center, natural areas, and other trail or exploration sites. Afternoon Camp sessions thus utilize best practices in offering participants Free Choice Learning – "the type of learning guided by a person's needs and interests… learning that people engage in throughout their lives to find out more about what is useful, compelling, or interesting to them" (The Definitions Project 2007, p. 5, adapted from the Institute for Learning Innovation).

Evening programs at Camp develop ownership and empowerment for specific stewardship actions, such as teaching others about the Great Lakes or participating in local or state environmental policy making. Each evening, a campfire program offers a close to the learning for the day. Campfire programs, like all elements of this nonformal science experience, are carefully planned to serve the purposes of reflecting on science learning, developing a sense of belonging to camp community life, and fostering sense of place and attachment to the Great Lakes region. Songs and stories focus on the day's happenings, Great Lakes tales, themes of stewardship and responsibility to one another, and community spirit.

The design for this nonformal science program is based on research by Hungerford and Volk (1990), and on Marcinkowski's logic model for environmental education (2004). This camp strives to develop a strong attitudinal attachment to the significant bioregional features surrounding Michigan (four of the five Great Lakes), and the state's unique natural resources in the form of fisheries, coastal regions, watersheds, wetlands, wildlife, and forests.

Impact Evaluation of the Nonformal Great Lakes Camp

Great Lakes Camp program staff members administered pre- and post-camp surveys from 1999-2012; each survey took participants approximately 40 minutes to complete. The pre-survey was administered at camper check-in, and the post-survey was given during the last evening of camp. Survey questions were adapted from existing studies (Table 2).

Camper assent and parental consent for completion of the surveys has been consistently 100%. Each year, however, some pre-surveys cannot be matched with camper post-surveys, and some respondents do not complete all parts of the surveys. The proportion of unusable cases is less than 5% every year. A total of 736 usable pre- and post-camp cases were compiled from 1999 through 2012, and allow for analysis of Great Lakes literacy (Table 2). Great Lakes place attachment questions added in 2005 resulted in 494 usable cases for analysis. Post-camp questions regarding Great Lakes stewardship intentions were used from 1999-2012 with all respondents; beginning in 2004, the evaluation process used additional questions, both pre- and post-camp. One set of added questions concerned career and other intentions. Another set pertained to what Marcinkowski and Rehrig (1995) term locus of control; these questions assess the respondents' beliefs regarding their capacity for particular stewardship intentions (Table 2). Decades of previous research have noted that

Table 2. Sources from which impact evaluation questions were adapted, years items used, and number of usable survey cases.

Content of questions	Survey items adapted from:	Camp years during which survey items were used	Number of usable survey cases
Great Lakes literacy (see Table 3)	Williamson and Dann 1999; Fortner and Teates 1980; Fortner 1993	1999-2012	736
Great Lakes regional place attachment (see Table 4)	Vaske and Kobrin 2001; Williams and Vaske 2003	2005-2012	494
Great Lakes stewardship attitudes and behavioral intentions (see Table 5)	Williamson and Dann 1999; Zint and Hanson 2002;	Two items used 2004-2012 One item used 2006-2012	543 439
Stewardship capacities for environmental or water-related actions (see Table 6)	Marcinkowski and Rehrig 1995	2004-2012	543
Self-perceived Great Lakes Stewardship attitudes and behavioral intentions (post-Camp only items; see Table 7)	Williamson and Dann 1999;	1999-2012	736

intention to act is a strong precursor to stewardship behavior, thus intentions represent important, immediate post-camp variables (Hungerford and Volk 1990). Given our focus on natural resource teen leadership, for this assessment, stewardship intentions were operationalized as campers' interest in and plans to communicate with others about the Great Lakes, to participate in service projects, and to consider Great Lakes or related careers.

Each camper's pre- and post-camp tests were matched, using the camper's name. The data were then stripped of identifiers to maintain respondent confidentiality. Data were analyzed using SPSS (version 22). The authors used Cronbach's Alpha to ascertain place attachment scale reliability. Analysis included chi-square to investigate differences between pre- and post-test frequencies, and paired t-tests to identify statistically significant changes in mean scores for pre- and post-camp Great Lakes literacy, sense of place, and stewardship.

Fifty-six percent of camp participants are male and 44% are female. About two-thirds of respondents (69.2%) were new campers; 30.8% of cases were campers returning for their second or third year.

Great Lakes literacy increased significantly among the campers as a result of this nonformal water science education program. The mean pre-camp total score was 11.2 (standard deviation 2.9), out of a possible 16 points; the post-camp mean was 12.6, and the standard deviation decreased to 2.5 (Table 3). Only 62.0% of campers scored 11 or higher on the pre-test, but 81.2% gained this score on the post-test.

Although there are many ways to conceptualize and operationalize "sense of place," various scholars have observed the importance of developing learners' sense of place and other attitudinal attributes, in addition to scientific literacy, as precursors to stewardship (Farnum et al. 2005; Vaske and Kobrin 2001). Vaske has worked with various colleagues to operationalize sense of place as "place attachment," which consists of two factors: a) place dependence – a functional connection to place that reflects the importance of a resource in providing amenities for desired activities; and b) place identity – an emotional connection to place that represents a psychological investment with a setting developed over time leading to a component of one's self-identity (Vaske and Kobrin 2001; Williams and Vaske 2003).

Items from Vaske's research were modified to relate specifically to Great Lakes place attachment, and when used with this set of respondents, scale reliabilities (Cronbach's Alpha) ranged from 0.872 to 0.897 (Table 4). Among Great Lakes Campers, both place dependence and place identity scores increased significantly, showing that youth gained a strong sense of place in their Great Lakes bioregion as a result of this nonformal education program (Table 4). Campers' mean total place dependence scores increased from 16.09 to 17.29 (out of a possible score of 20). Likewise, total place identity scores increased from 11.61 to 12.65 (out of a possible score of 15) (Table 4).

Camp affected youths' Great Lakes stewardship intentions, an important outcome desired for this program. The percentage of campers agreeing that they would like to communicate with others about camp increased from 71% pre-camp to 87% post-camp. Similarly, 70% of pre-camp respondents indicated they would use information from camp in projects or teaching others, whereas this proportion increased to 87% post-camp. Fewer campers indicated they would consider careers related to the Great Lakes, (55% pre-camp vs. 64% post-camp). Regardless, all of these pre- vs. post-camp changes in intentions were highly statistically significant (paired t-test, $p<0.001$) (Table 5).

Pre- vs. post-camp self-assessments of capacity for influencing solutions for environmental issues, and for giving a Great Lakes lesson or presentation to others increased significantly. The proportion of campers believing they can influence solutions of environmental issues either on their own or acting with others increased a small amount (7.6% – alone and 13.3% – with others, respectively), however, 86% of campers reported strong post-camp capacity to influence issues by acting with others (Table 6). There was a much greater self-perceived change in capacity (knowledge and confidence) to give a presentation or lesson to others about the Great Lakes; about 44% reported strong capacity for these intentions pre-camp, whereas 78% reported this capacity at the end of camp (Table 6).

Finally, a battery of post-camp only questions about stewardship intentions show meaningful impacts of camp programming on water science

Table 3. Great Lakes literacy, pre- vs. post-camp. Items used 1999-2012, with 736 usable cases.

Question (T=True, F=False)	Pre-Camp		Post-Camp	
	% Correct	% Undecided	% Correct	% Undecided
An important difference between oceans and most lakes is that oceans are salty. (T)	84.9	5.5	86.5**	4.5
The reason you can find fossil clam shells on the top of some mountains is that area was once under water. (T)	76.7	17.7	87.2**	8.5
On a hot summer day, air over the beach is the same temperature as air over Lake Huron. (F)	67.2	26.4	72.3**	17.0
The Edmund Fitzgerald was an ore boat that sank in Lake Superior. (T)	58.4	29.3	76.1**	9.1
Marshes are disappearing because people are filling in the marshes for homes, farms and businesses. (T)	78.0	17.6	88.4**	8.1
The sucker is a parasitic fish found in the Great Lakes. (F)	21.9	33.7	33.9**	23.6
Sea lampreys have been a problem in the Great Lakes because they suck blood from lake trout and other fish. (T)	72.7	21.7	93.0**	4.2
Plankton are non-living substances in the sea or the Great Lakes. (F)	68.5	18.6	76.3**	9.7
Beaches are safe and beautiful places to build houses. (F)	71.0	20.4	78.6**	12.4
Algae are plants that live in water. (T)	87.5	6.6	90.7**	4.9
Fish have lungs. (F)	61.2	10.7	70.3**	7.2
People are necessary for the water cycle to work. (F)	62.9	19.9	65.1**	12.7
Less than 25% of the water on Earth is fresh water. (T)	76.2	14.5	90.5**	4.6
This is a food chain in the correct order: water...insects…fish…water plants…people. (F)	80.6	12.3	84.9**	8.1
People should eat Great Lakes fish only once in awhile because very few fish live in the Great Lakes. (F)	59.2	29.2	64.7**	22.8
Forests and wetlands help keep the water in the Great Lakes clean and clear. (T)	63.5	27.7	79.7**	15.1
MEAN (standard deviation) total score (max 16)	11.2 (2.9)		12.6 (2.5)**	
Mean total score converted to % correct	69.8%		78.6%	
Campers receiving a "passing score" of 11/16 or greater	62.0%		81.2%	

**=Statistically significantly different, Chi-square test comparison of frequencies (1 d.f.) or paired t-test comparison of means, $p<0.001$.

Table 4. Great Lakes regional place attachment, pre- vs. post-camp. Items used 2005-2012, with 494 usable cases. Rows referring to Great Lakes Place Dependence are shaded. Rows referring to Great Lakes Place Identity are non-shaded.

Question	Pre-Camp Mean* (sd)	Post-Camp Mean* (sd)
Great Lakes Place Dependence		
The Great Lakes are the best place for what I like to do.	3.79 (1.03)	4.11 (1.00)**
I get a lot of satisfaction out of visiting the Great Lakes.	4.21 (0.86)	4.48 (0.79)**
I would not trade the Great Lakes for any other region.	4.09 (1.11)	4.36 (0.97)**
No other place can compare to the Great Lakes region.	3.97 (1.18)	4.31 (0.99)**
MEAN total score (max=20)	16.09 (3.57)	17.29 (3.19)**
Reliability (alpha)	0.872	0.897
Great Lakes Place Identity		
I think often about coming to the Great Lakes.	3.79 (1.14)	4.13 (1.07)**
I am very attached to the Great Lakes region.	3.92 (1.10)	4.30 (0.96)**
I identify with the Great Lakes.	3.86 (1.14)	4.18 (1.01)**
MEAN total score (max=15)	11.61 (3.07)	12.65 (2.75) **
Reliability (alpha)	0.872	0.896

*Where 1=strongly disagree, 5=strongly agree.
**=Statistically significantly different, paired t-test, $p<0.001$.

Table 5. General changes in Great Lakes stewardship attitudes and behavioral intentions.

Question	% of Campers agreeing		Mean* (sd)	
	Pre-Camp	Post-Camp	Pre-Camp	Post-Camp
I would like to share this camp with others.[a]	71.5	87.1	4.15 (1.01)	4.50 (0.91)**
I am interested in a career that is outdoors, working with the Great Lakes, marine biology, or connected to any type of environmental science.[a]	55.5	63.7	3.65 (1.31)	3.86 (1.26)**
I will use the information I learn at Camp in school, in other types of projects, or by teaching others.[b]	70.5	87.4	4.11 (1.02)	4.44 (0.90)**

*Where 1=strongly disagree, 5=strongly agree.
[a]Item added in 2004, with 543 usable cases.
[b]Item added in 2006, with 439 usable cases.
**=Statistically significantly different, paired t-test, $p<0.001$.

Table 6. Self-perceived changes in stewardship capacities for environmental or water-related actions. Items added in 2004, with 543 usable cases.

Question	% Campers Agreeing (answering 4 or 5*)		Mean Score* (sd)	
	Pre-Camp	Post-Camp	Pre-Camp	Post-Camp
To what extent do you believe that you can influence the solution of an environmental issue by acting on your own?	47.9	55.5	3.43 (0.99)	3.64 (1.04)**
To what extent do you believe that you can influence the solution of an environmental issue by acting with others?	73.0	86.3	4.09 (0.92)	4.44 (0.80)**
To what extent do you feel knowledgeable about how to give a lesson or a presentation about nature, the environment, or Great Lakes Camp to others?	44.1	78.8	3.34 (1.06)	4.17 (0.84)**
To what extent do you feel confident that you are able to give a lesson or a presentation about nature, the environment, or Great Lakes Camp to others?	43.6	78.1	3.24 (1.19)	4.16 (0.89)**

*Where 1=no extent, 3=moderate extent, 5=a great extent.
**=Statistically significantly different, paired t-test, $p<0.001$.

Table 7. Post-camp stewardship intentions. Items used 1999-2012, with 736 usable cases.

Question	% Campers Agreeing
Leadership and Communications (Persuasion)–Personal Responsibility	
I will apply to be a Great Lakes Camp counselor in the future.	75.7
I plan to teach others some of the activities and information I learned here at Camp.	80.3
I'll share my Camp experience with local groups by making a presentation.	49.8
I will tell other teens about Camp, and encourage them to be Campers next year.	81.1
I will contact some of the adult camp instructors to learn more in the future.	48.1
Knowledge Application	
I think I'll use some of the information I learned at camp in my 4-H projects or in my school projects.	81.8
I plan to work with others to do a community service project next year to improve the environment.	67.5
I plan to use the information I learned at Camp over the next 6 months.	79.8
Career Choice	
I plan to choose a career related to the Great Lakes.	41.6
I plan to choose a career in natural resources or environmental science.	49.2
I plan to choose a career in science.	56.4
Outdoor Recreation	
I plan to take part in more outdoor activities (sailing, etc.) in the future.	86.2

actions and career choice (Table 7). High proportions (70-80%) of campers indicate they will communicate about and use the information from camp in future actions. Although smaller proportions (42-56%) indicate career choice interests related to the Great Lakes, natural resources/environmental sciences or science in general, this is to be expected since campers are only 13-15 years old (Table 7).

Overall, nonformal water science education programs, when carefully and intentionally planned and executed, can have significant impacts on learners' water literacy, place attachment to water resources, and intentions for further stewardship actions. The challenge, then, is making sure that camp programming is informed from sound research and best practices in science education for informal and nonformal audiences.

Discussion and Recommendations for Nonformal Water Education Programming

This in-depth analysis of impacts of a Great Lakes nonformal science education program provides insights into research-based, evidence-based programming. Yet, this evaluation also has its limitations. Funding constraints have prevented 3-6 month follow-up studies, which other scholars have used to investigate long-term influences on youth learning (e.g., Bogner 1998). Some evaluators have used parents' perceptions of lasting program impacts as a proxy for direct measures of long-term learning of youth (e.g., Ballentyne et al. 2001); this method has been used once with our Michigan Great Lakes camp, but response rates for these methods are typically low. Instead, as co-authors we have chosen to establish a dataset large enough to allow for causal modeling of program-related learning factors that have strong influence on Great Lakes stewardship intentions; this analysis is planned for the near future.

One goal of informal and nonformal science education concerning water resources is to create strong, scientifically-grounded environmental stewards familiar with the unique characteristics of their locale and their bioregion. We make the following recommendations regarding nonformal camp programming designed to foster water science literacy and stewardship.

- *Develop a unique, research-based niche for your water resources education camp, and evaluate impacts on water science learning.* Today's youth camp programs have essential learning niches to fill. The American Camp Association (ACA 2015) stresses the importance of intentional education planning and risk management, based in sound social science.
- *Communicate with staff and sponsors that "nonformal" does not mean "unplanned," "spontaneous" or "laissez faire" learning contexts!* Rather, nonformal and informal science learning programs such as camps have detailed lessons and desired outcomes linked to school learning standards in science, while at the same time offering flexibility for learners to explore dramatically new interests in a non-school setting. Furthermore, programs like our camp, linked with a university, offer unique opportunities to try pre-college learning situations, with stimulating learning provided by university faculty/staff as well as water research, agency and organization partners.
- *Have an explicit purpose for every component of a nonformal water resource education program*, including what are typically considered "down times" (recreation sessions, campfire). In the case of our camp program, we align the purposes of each scheduled component with explicit program desired outcomes, and with the evaluation items used to assess near-term impacts. For example, morning sessions focus on Great Lakes literacy, afternoon and campfire programs focus on place attachment, and evening sessions focused on leadership prepare learners for stewardship actions such as communication about Great Lakes water resource topics. Our evaluations document that we achieve these explicit objectives with our nonformal water science education.
- *Tie the purposes of program components to the essential six strands for informal science learning identified by the National Research Council* (2009, p. 4). This action will ensure rigor and relevance given the broader findings of science education research.

The six strands for informal science learning (NRC 2009) can be used as a lens to examine our Great Lakes Camp as follows:

Strand 1: Learners experience excitement, interest and motivation to learn about phenomena in the natural and physical world (NRC 2009, p.7).

The Great Lakes Camp provides variety in aquatic resource science learning opportunities, such as learning in the field, making use of "teachable moments" that the learning site provides (e.g., invasive species), and integrating technology (GPS, photography), the arts (traditional maritime and Great Lakes songs), and water-based recreation to spark interest in water resources and aquatic sciences.

Strand 2: Learners come to generate, understand, remember, and use concepts, explanations, arguments, models, and facts related to science.

Strand 5: Learners participate in scientific activities and learning practices with others, using scientific language and tools (NRC 2009, p.7).

Campers develop understanding, using scientific content and knowledge for explanations of Great Lakes issues and phenomena through their morning ecology sessions with aquatic scientists. Campers also use the tools and language of science by recording measurements of ecological phenomena and contributing to long-term citizen-science databases used by resource professionals. Learning sessions are rigorous, with science concepts and vocabulary tied to research-based frameworks (e.g., state science content and process standards, Great Lakes Literacy Principles 2010).

Strand 3: Learners manipulate, test, explore, predict, question, observe, and make sense of the natural and physical world (NRC 2009, p.7).

Campers engage in scientific reasoning, learn by doing, and describe their reasoning to peers and mentors through conversations, journaling, photography and other forms of communication. This is done not only in the science-specific sessions (as with the morning sessions we conduct at camp), but also in the recreation-related free choice sessions; for example, campers make observations and inferences about the science (physics) and math concepts involved in tacking while sailing, describe their observations while snorkeling a shipwreck, inquire and wonder about the unique species observed at aquatic features of natural areas, and consider/discuss human impacts on sensitive conservation areas.

Strand 4: Learners reflect on science as a way of knowing; on processes, concepts, and institutions of science; and on their own process of learning about phenomena (NRC 2009, p.7).

The Camp schedule provides time with mentors to reflect, and structures end-of-the-day campfires with a reflective mood and purpose to consider the campers' learning throughout the day.

Strand 6: Learners think about themselves as science learners and develop an identity as someone who knows about, uses, and sometimes contributes to science (NRC 2009, p.7).

Camp allows learners to identify with the Great Lakes bioregion and the scientific enterprise. The pre- and post-surveys prompt campers to think about themselves as science learners. The program invites many types of aquatic resource professionals, persons with avocational interests in water resources, and diverse (gender, racial/ethnic, age) mentors that appeal to diverse campers with varied interests.

Having youth learn that there is a place for them in the "scientific enterprise," whether or not they eventually choose a career in science, is an important program objective, addressed through our diverse, mentoring staff of researchers, counselors, and educators Water science fields need all sorts of professionals and citizen-leaders with familiarity with aquatic resource sciences in all walks of life – as community opinion leaders, as informed consumers, as neighbors, as civic volunteers working in our libraries (and not only our conservation groups), and most of all, as political leaders.

Finally, nonformal water science education programmers should remember to make mindful and intentional decisions about program philosophy and approach. We have chosen to work through the lens of Place-Based Education, and to base our work on the research within environmental

education realms. In this way, our nonformal camp program is positioned to support the wide-ranging initiatives of others working from these lenses, and to foster a large "ripple" in the world of science education.

Acknowledgements

Funding and support for this work was provided by: Michigan State University (MSU) Extension, Michigan Sea Grant College Program and Sea Grant Extension, MSU Land Policy Institute, MSU Outreach and Engagement, Michigan 4-H Foundation, two departments within MSU (Community Sustainability, Fisheries and Wildlife), Michigan Charter Boat Owners' Association, Michigan branches of the Woman's National Farm and Garden Association, Dow Chemical Company Foundation, U.S. Fish and Wildlife Service, Pharmacia/Upjohn Corporation, MSU Department of Fisheries and Wildlife Youth Aquatic Stewardship Endowment Fund, and many individual donors, including camp alumni, parents of campers, and staff. Collaborating partners include Michigan Department of Natural Resources, National Oceanic and Atmospheric Administration, Michigan Natural Features Inventory, and other state and local conservation groups. Special thanks are owed to Kristen Pratt, Judy Ratkos, Jackie Harnick, Jennifer Lentz, Heather Triezenberg, Katy Burns, Jordan Burroughs, and numerous other camp staff and alumni who assisted with camp programming, survey administration and data entry. Thanks to anonymous reviewers for their constructive feedback. For more information about the Michigan 4-H Great Lakes and Natural Resources Camp, please see http://4h.msue.msu.edu/events/glnrc.

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