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Using Social Indicators to Evaluate the Effectiveness of Outreach in Two Indiana Watersheds

*Rebecca Busse[1], Jessica D. Ulrich-Schad[2], Lyn Crighton[3], Sara Peel[4], Ken Genskow[5], Linda Stalker Prokopy[1]

*[1]Purdue University, West Lafayette, IN, [2]South Dakota State University, Brookings, SD, [3]Tippecanoe Watershed Foundation, North Webster, IN, [4]Wabash River Enhancement Corporation, Lafayette, IN, [5]University of Wisconsin-Madison, Madison, WI, *Corresponding Author*

Abstract: Nonpoint source pollution is recognized as one of the greatest threats to water quality in the United States. Outreach is one tool that can be used to help increase public awareness and motivate action towards addressing water issues. In order to create effective outreach, we must understand public perceptions of water quality, perceived barriers to implementing environmental solutions, and what types of outreach best connect with target audiences. In 2010, social indicator surveys were distributed in two watersheds in Indiana to gather baseline data on urban and agricultural residents' attitudes towards and usage of water quality conservation practices. Local watershed organizations then used various outreach methods to encourage residents to implement specific practices. In 2014, post-project surveys were conducted in both watersheds to assess whether the outreach efforts had been effective. Even with outreach efforts, many residents still were unaware that specific water pollutants were problems in their watershed. There were, however, positive changes in overall water quality attitudes. Changes in awareness and adoption of conservation practices varied by watershed and resident type, yet generally moved in a positive direction or were unchanged. The primary barrier to practice adoption for all respondents was cost. Outreach events were generally not well attended and did little to change attendee behavior. Some outreach activities seem to be more useful than others in terms of self-reported effectiveness while others are clearly visible to the community and may be a helpful way to raise awareness.

Keywords: *nonpoint source pollution, water quality, conservation behaviors, limiting factors, education, pre/post surveys*

Nonpoint source (NPS) pollution is recognized as one of the greatest threats to water quality in the U.S. (USEPA n.d.; USEPA 2013). Excess nutrients in lakes and rivers lead to an abundance of aquatic plants and algae which can produce toxic cyanobacteria and also deplete water of oxygen during decay, creating hypoxic zones in both freshwater and marine systems (e.g., USEPA 2013). There are many sources of NPS pollution, including agricultural practices, urban runoff, septic systems, and recreational activities. While some headway has been made in addressing NPS pollution, more outreach could be done to increase urban and rural residents' awareness of water quality issues and encourage increased adoption of conservation best management practices (BMPs). Common agricultural BMPs include planting cover crops, providing riparian buffers, and installing grassed waterways. Common BMPs in lakeshore and riparian areas emphasize maintaining natural shoreline, and reducing potential for direct nutrient runoff to water. Common urban BMPs include rain gardens, rain barrels, and pervious pavement.

Resource managers and educators design and present outreach based on their understanding of the audience's perceptions of water quality, their perceived barriers to implementing environmental solutions, and what type of outreach best reaches that target audience (Floress et al. 2015; McKenzie-Mohr and Smith 1999). Resource managers seeking to reduce NPS pollution provide

technical support to landowners (e.g., help with conservation planning or training in agricultural nutrient management), financial assistance for adopting and maintaining BMPs, and a variety of outreach activities including informational materials, demonstrations, on-site visits, and other educational events. Social indicator surveys focused on understanding underlying attitudes, perceptions, and awareness for specific areas can help determine important barriers and opportunities, and identify means to address them (Prokopy et al. 2009; Genskow and Prokopy 2011; Prokopy and Genskow 2015). This paper examines conservation behaviors and perceptions of water quality among residents of the Upper Tippecanoe and Region of the Great Bend of the Wabash River watersheds in Indiana. Using social indicator surveys conducted in 2010 and 2014 with residents and agricultural producers in both watersheds, we examine how perceptions of water quality have changed over time, if usage of conservation practices has increased, and what barriers exist for adoption of conservation practices. Comparing pre and post project responses helps determine if outreach has been effective in changing attitudes and practices related to water quality. These findings can be used to help conservation practitioners understand and design more effective outreach programs, a task which plays a key role in the conservation of aquatic resources (Bjorkland and Pringle 2001; Dietz and Stern 2002).

Literature Review

Outreach and extension activities seeking to change environmental behaviors are predicated on foundational theories and conceptual models about behavior, values, and individual perceptions. Notably the Theory of Planned Behavior (Ajzen 1991, 2002), the Value-Belief-Norms Theory (Stern 2000), the Diffusion of Innovations Theory, and the Stages of Change (Prochaska et al. 1992; Rogers 1995) suggest that decisions about whether or not to adopt a BMP depend on the interplay of factors such as skills, knowledge, values, beliefs, and behaviors of individuals considering the change.

Numerous studies have identified and reinforced the importance of understanding these factors, or social indicators. Common barriers to adoption of practices include differences in demographics and levels of awareness among audiences (Bjorkland and Pringle 2001), attitudes towards local environmental issues (Stough-Hunter et al. 2014), social norms/approval of one's neighbors (Ajzen 1991; Fishbein and Ajzen 2010), cost of implementing (Lorenzoni et al. 2007; McKenzie-Mohr and Smith 1999), and perceived ability to implement a practice (Ajzen 1991; Ajzen 2002; Fishbein and Ajzen 2010). Other barriers include not wanting to change one's regular practices, fear of sacrificing one's standard of living, belief that one's actions cannot affect the environment, and fear that the government will not take responsibility for environmental issues or that other people will become free riders (Lorenzoni et al. 2007).

While research has documented demographic characteristics associated with pro-environmental behavior, common barriers to adopting conservation practices, and generally effective outreach strategies, there is a shortage of published research focused on the effectiveness of different outreach approaches in influencing attitudes and behaviors towards specific water quality BMPs among targeted populations. Understanding social indicators can help educators plan, evaluate, and improve outreach programs (Behn 2003; Moynihan 2005). In their review for voluntary NPS programs, Genskow and Wood (2009) noted that while metrics can be misleading, intermediate indicators that follow a theory of change can be particularly useful for evaluating efforts to bring about voluntary adoption of conservation behaviors.

The social indicators framework used in this paper (Genskow and Prokopy 2011) reflects substantial literature on factors influencing the adoption of conservation practices in agricultural settings (e.g., Nowak 1992; Lambert et al. 2007; Prokopy et al. 2008), riparian/lakeshore settings (e.g., Amato et al. 2015; Shaw et al. 2011), and urban areas (Brehm et al. 2013). The context in which NPS outreach activities are conducted is critical for interpreting and acting upon evaluative information (Stough-Hunter et al. 2014; Thurston et al. 2012). For any study reviewing pre and post data, it is important to acknowledge the role of other influences on attitude or behavior changes

beyond program interventions and the uncertainties involved in any data collection efforts.

In this paper we use social indicator surveys to 1) examine whether general conservation attitudes and behaviors change at the watershed level and among specific types of residents (e.g., agricultural producers and urban/lake residents) with the introduction of various outreach strategies, 2) provide a better understanding of the barriers that different populations perceive to implementing water quality BMPs in order to advise local watershed groups on how to create more effective outreach in the future, and 3) determine which outreach methods are the most effective at reaching targeted audiences.

Methods

Study Watersheds and Outreach

The Upper Tippecanoe River Watershed in northeastern Indiana covers 114 square miles including portions of Whitley, Noble, and Kosciusko counties (see Figure 1) (TWF 2013). A 2010 census documented the population of this watershed as 11,860 residents (obtained from the TWF director). Although seventy-five percent of the land use is agricultural, the watershed contains over 50 lakes and is the headwaters of the Tippecanoe River. It connects with the Ohio and Mississippi rivers, and eventually drains into the Gulf of Mexico. The Tippecanoe Watershed Foundation (TWF) is a nonprofit organization operating in the watershed that was founded in 1997 with the mission of protecting and improving water quality in local lakes and streams. Many of the waterbodies in the watershed are impaired by phosphorus and *Escherichia coli* and the Tippecanoe River is impaired by *E. coli*, dissolved oxygen, and nutrients. Pollution sources of concern include manure management, lawn care, streambank and shoreline practices, and failing septic systems (Crighton 2015).

Outreach efforts conducted by the TWF from 2010 to 2014 included distributing materials and organizing events. The primary outreach method TWF used to target urban/lake residents included the Clear Choices Clean Water Campaign, which involved distribution of postcards, posters,

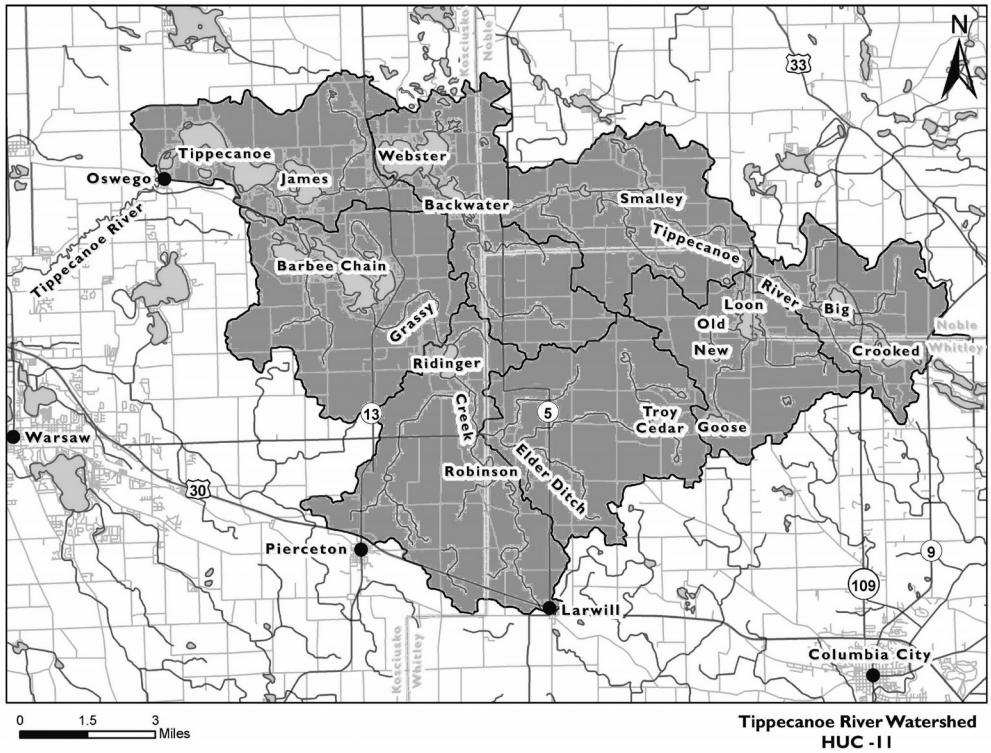

Figure 1. Map of the Upper Tippecanoe River Watershed, IN (shaded area).

newsletter ads, and Facebook posts that encouraged residents to take a pledge online to commit to target conservation practices. The campaign was also promoted at community meetings and events. Additionally, TWF developed the Healthy Shorelines Initiative, which included workshops co-hosted by local lake associations. During the workshops, an expert explained the benefits of natural lake shores, as well as their cost and the process of implementation. Lake residents who installed healthier shorelines with native plants and/or glacial stones received signs to place along their shorelines during the boating season. TWF also mailed a newsletter 2-3 times per year which informed lake residents of water quality issues, as well as events happening in the watershed. Representatives from TWF attended monthly local lake association meetings to distribute flyers for events. Finally, TWF helped start the Northern Indiana Lakes Festival, which educates people about water resources and showcases lake-related events in Kosciusko County with booths, vendors, and a business expo.

TWF sponsored several other outreach efforts with the needs of agricultural producers in mind. The primary agricultural outreach method was the hiring of two local watershed conservationists to talk directly with farmers about conservation practices and to assist them in implementation of BMPs. They also shared details about cost-share programs available through TWF and partner agencies, including Natural Resources Conservation Service (NRCS), Soil and Water Conservation Districts (SWCD), Indiana Department of Environmental Management (IDEM), and Indiana Department of Natural Resources Lake and River Enhancement Program (IDNR LARE). Other outreach methods included sponsoring indoor pasture walks and a cover crop field day, where TWF enlisted a local farmer and SWCD board member to speak about his experience with cover crops and give a tour of his farm. TWF also partnered with a local farm sales company to hold a Soil Health Workshop at the company's customer appreciation event. Finally, Healthy Soils Clean Water signs were installed in agricultural producers' fields along roadways to highlight those who participated in no-till planting, cover crops, and nutrient management.

The second study area is the Region of the Great Bend of the Wabash (referred to as Wabash Watershed for the remainder of this paper). This watershed covers 478 square miles including portions of Benton, White, Fountain, Montgomery, Tippecanoe, and Warren counties and is primarily agricultural although the majority of the cities of Lafayette and West Lafayette are located within its boundaries (see Figure 2). The Watershed Management Plan for the Wabash documented 107,448 residents in 2011 (WREC 2011). There was an average of 3,270 people/mile^2 at the time the plan was created (WREC 2011). The organization working in this watershed is the Wabash River Enhancement Corporation (WREC), established in 2004. Their mission is to improve environmental and economic conditions in the Greater Lafayette Region and the Wabash River Corridor in a sustainable manner. *E. coli*, sediment, nutrients, and poor quality (low density/low diversity) biotic communities (fish and macroinvertebrate populations) are known impairments in the Wabash (Peel 2011). Historical water sampling data indicate that nitrogen, phosphorous, *E. coli*, and suspended solids are an issue throughout the watershed (Peel 2011). There are fish consumption advisories on the Wabash and fish populations are declining (Pyron et al. 2006). There are also problems with erosion, livestock having access to streams, and a lack of adequate buffering between streams and agricultural and urban land (Peel 2011).

Many of WREC's events targeted both urban and rural agricultural residents to educate landowners about BMPs and implementation opportunities, connect the community to the Wabash River, and provide conservation education for youth and adults. Education efforts included two Paint the Rain events to raise awareness about protecting the Wabash through using rain barrels to collect and retain stormwater. Additionally, WREC partnered with other local organizations each year to host an educational booth at the Tippecanoe County Fair. The Wabash Riverfest, organized annually by WREC, aims to teach community members about the importance of the Wabash with games, activities, and educational booths and connect the community with the Wabash. The Wabash Sampling Blitz, organized semi-annually, engages community members with sampling water quality.

WREC also organized a number of rain garden seminars and workshops focused on providing participants with the necessary skills to design and install rain gardens and opportunities to view how they fit within the landscaping efforts of other gardeners. Annual green tours highlighting residents' homes incorporating green practices were also part of their efforts. Finally, WREC continues to promote Detrash the Wabash each year, an event that encourages community members to clean up the Wabash River to promote water quality.

Outreach events that specifically targeted urban residents included: pervious concrete demonstration installation; workshops for gardeners and local residents which highlighted rain barrel installation; native plant workshop series that focused on plant selection, site selection, and maintenance of native plants; a green tour where community members were taken to local residences to speak with homeowners about the water quality practices that they have adopted; and educational presentations as part of the local master naturalist training. WREC also created and distributed Eco Champion signs to local residents who installed a rain barrel, rain garden, native plants, or pervious pavement. If they had implemented multiple water quality practices, they could add a sticker to their sign for each practice.

The outreach that WREC developed specifically for agricultural producers included a variety of field days. These field days were typically sponsored and promoted with Tippecanoe County SWCD and gave producers a chance to learn more about practices by seeing them on site. WREC also promoted the Cover Crop Breakfast at which producers learned about cover crops and soil health, and a Soil Health Workshop that enabled landowners to listen to national level speakers talk about soil health. Finally, they also co-sponsored the Indiana Cover Crop Forum where landowners listened to national level speakers explain the benefits and management of cover crops.

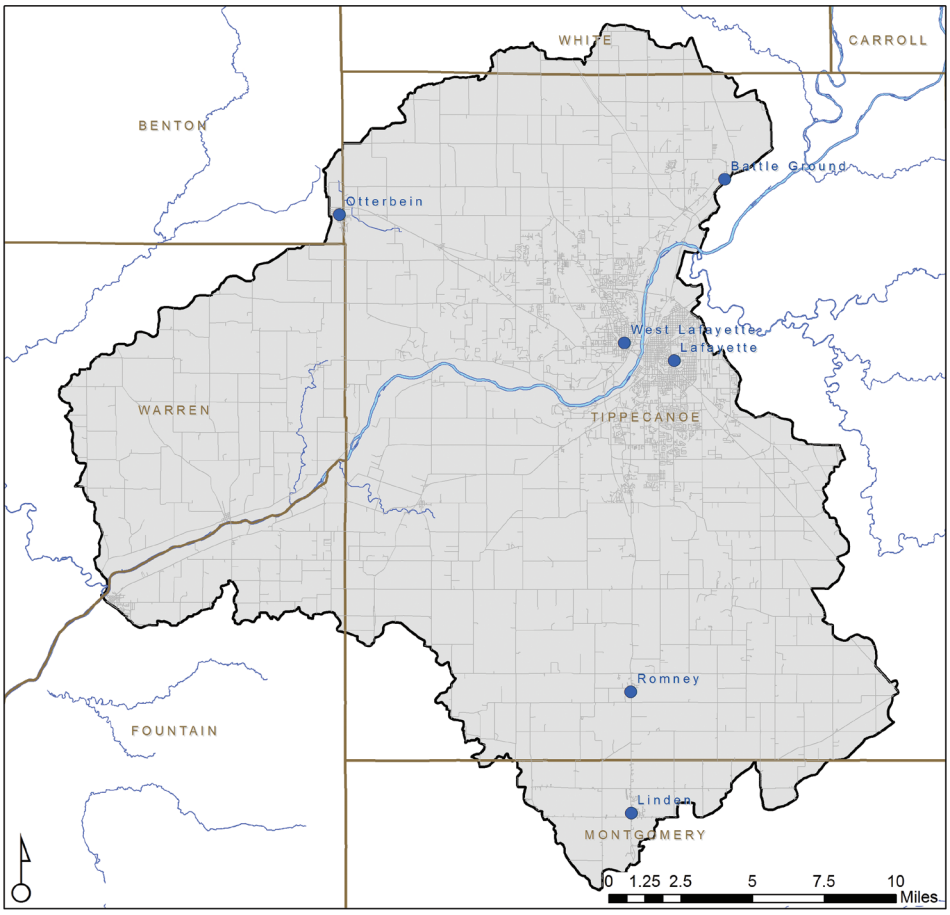

Figure 2. Map of the Great Bend of the Wabash River Watershed, IN (shaded area).

Pre and Post Social Indicator Surveys

The data used in this paper are from four pre/post social indicator surveys, consistent with Genskow and Prokopy (2011), conducted in the study watersheds in both 2010 and 2014 (see Table 1). In the Upper Tippecanoe Watershed, pre/post surveys were conducted with agricultural producers and urban/lake (in some places we refer to this as an "urban" survey for easier comparisons with the Wabash Watershed) residents. In the Wabash Watershed, agricultural producers and urban residents were surveyed. Each survey included questions about perceptions of water quality, background of the respondents and their property, and their usage of and attitudes toward conservation practices. There were also questions specific to each resident type. For instance, agricultural producers were asked conservation questions related to their farming practices, while urban/lake residents were asked about their lake or city property. The local partner watershed organizations were interested in different conservation practices, so the specific practices inquired about for each resident type differed in each watershed. In order to evaluate the outreach conducted between 2010 and 2014, the post surveys (2014) included questions about outreach effectiveness relevant to each watershed and resident group.

The sampling frames were generated differently for each survey. For the surveys of agricultural producers, a Freedom of Information Act (FOIA) request was made to the Farm Service Agency requesting the names and addresses of all owners or renters of farmland in the study counties who had received Farm Service Agency (FSA) payments in 2009. All farmers on these lists were sent surveys. The same address lists were used in 2010 and 2014, meaning that some farmers took the survey both years. The urban/lake resident survey in the Upper Tippecanoe Watershed was sent to residents on TWF's mailing list of all lake residents, which was updated in 2014. A computer-generated simple random sample was taken from the sampling frame in both 2010 (n=879) and 2014 (n=901). The survey of urban residents in the Wabash Watershed was mailed to a computer-generated simple random sample (n=1097 in 2010; n=1100 in 2014) of those on address lists purchased from Survey Sampling International. A different list, the Census tracts that contain the cities of Lafayette and West Lafayette, was purchased for the pre and post surveys using the same parameters.

For each survey, our sample was contacted up to five times which achieved an overall response rate of 41%, with variation from 27% to 54% by survey (see Table 1; response rates were calculated by taking out incorrect addresses or duplicates). Using a modified version of the Dillman (2000) Tailored Design Method, potential respondents were first sent an advance letter, which informed them that the survey would be mailed to them shortly and included the option to take the survey

Table 1. Social indicator surveys in two Indiana watersheds.

Survey watershed	Type of resident	Year	N	Response rate (%)	Sampling frame
Upper Tippecanoe	Agricultural producer	2010	125	54	Freedom of Information Act (FOIA) request
		2014	107	50	FOIA request (same list as 2010)
	Urban/lake	2010	376	48	Tippecanoe Watershed Foundation (TWF) list of residents
		2014	351	42	TWF list of residents (updated)
Wabash	Agricultural producer	2010	341	51	FOIA request
		2014	235	39	FOIA request (same list as 2010)
	Urban	2010	373	38	Sample purchased from Survey Sampling International (SSI)
		2014	278	27	Sample purchased from SSI (new)
Total			2,186	41	

online. We then mailed those who had not yet taken the survey online a paper copy of the survey along with a stamped and addressed return envelope. At about two week intervals, non-respondents were then sent a reminder postcard, then a second copy of the survey, and finally, if no response, a third copy of the survey with a reminder postcard.

Social Indicators

We used social indicators from the surveys to examine five areas of interest: views on water quality impairments, attitudes toward water quality, perceptions of barriers to the adoption of water quality BMPs, awareness and usage of conservation practices, and the effectiveness of watershed level outreach. Survey respondents were asked in both 2010 and 2014 whether they thought five water quality impairments (nitrogen, phosphorus, sedimentation, bacteria, and algae) were a problem in their area. The answer options were: not a problem, slight problem, moderate problem, severe problem, or don't know. The variables were recoded to indicate whether the respondents saw each impairment as a problem (1=slight, moderate or severe) or not (0=not a problem or didn't know). Ten questions asking the degree to which respondents agreed with statements about water quality were included on the surveys in 2010 and 2014 (e.g., "I would be willing to pay more to improve water quality."). The variables were recoded to indicate agreement (1=strongly agree and agree) or disagreement/neutrality (0=strongly disagree, disagree, neither disagree nor agree). In each of the pre/post surveys, respondents were asked whether a number of factors limited their ability to use conservation practices in general, with response choices being a lot, some, a little, not at all, or do not know. We compared those who said a factor limited them a lot (1=a lot) to all other responses (0=some, a little, not at all, don't know).

Each of the four pre/post surveys also inquired about residents' awareness and usage of different conservation practices. For each practice, survey respondents indicated one of the following: never heard of the practice; somewhat familiar with the practice; knew how to do the practice, but weren't using it; or currently using it. We recoded this question to examine changes in use (1=currently using; 0=not aware of or using) and awareness (1=somewhat familiar, familiar, using; 0=never heard of) in each of the four pre/post surveys. Lastly, both urban and agricultural survey respondents in 2014 were asked a series of questions pertaining to outreach conducted in their watershed and targeting their specific community. Respondents were asked about their familiarity with their local watershed organizations (1=familiar; 0=not familiar), attendance at outreach events (1=attended at least one event; 0=did not attend any events), perceptions of event effectiveness from attendees (1=saw at least one event they attended as very or somewhat effective; 0=did not see any event they attended as effective), and changes in reported behavior as a result of attendance at an outreach event (1=adopted conservation practice; 0=did not adopt).

Data Analysis

We pooled the data from the four pre surveys conducted in 2010 and the four post surveys conducted in 2014 to examine whether views of local water quality impairments, attitudes towards water quality, and perceived limitations had changed over time. To test whether there were significant changes in all respondents' attitudes from 2010 to 2014, we used two-sample t-tests, which test if two population means are equal (Hamilton 2009). We used the same statistical test to determine whether there were significant changes from 2010 to 2014 in each of the four individual pre-post surveys and between agricultural producers and urban/lake residents in 2014. Because local efforts focused on different conservation practices in each survey, we used two-sample t-tests to examine whether there were significant changes in awareness and usage of specific conservation practices in each of the four pre-post surveys only (e.g., we did not pool the data by year). Finally, to examine the impact of outreach, we looked for significant differences between each pairing of the four post surveys by using a one-way analysis of variance (ANOVA) and a Scheffe multiple-comparison test.

Results

Demographic Profile of Survey Respondents

The majority of survey respondents in 2010 and 2014 were male (see Table 2). Agricultural producer survey respondents were more likely to be male,

which is reflective of the farming population in general. The average age of survey respondents was 63.7 years in 2010 and 64.1 years in 2014. Nearly one-half of survey respondents had earned a four year college degree or higher in both 2010 and 2014 (44.5% and 47.7%, respectively). The urban/lake residents were more likely to have a college education than the agricultural producers (Table 2). Agricultural producers in the Upper Tippecanoe Watershed had on average 339.2 acres, while those in the Wabash watershed were slightly larger on average with 461.5 acres.

Views of Water Quality Impairments

When examining the pooled responses from all surveys, no significant changes in views of water quality impairments were found from 2010 to 2014 (see Table 3). In both survey years, residents were most concerned about sedimentation and least concerned about nitrogen. There were also few significant changes in perceptions of water quality impairments from 2010 to 2014 when examining the four pre-post surveys individually. Only the survey of agricultural producers in the Wabash Watershed indicated any significant change in beliefs over time; respondents were significantly less likely to see bacteria and sedimentation as problems in their area in 2014 than in 2010. In combined watersheds in 2014, agricultural producers were significantly more likely than urban/lake residents to see nitrogen, phosphorus, and bacteria as problems, while urban/lake residents were more likely than agricultural producers to see algae as a problem.

Attitudes toward Water Quality

In the pooled dataset, there were a number of significant changes in attitudes towards water quality from 2010 to 2014, all in the direction one would expect with increased watershed-level outreach (see Table 4). In both 2010 and 2014, respondents were the most likely to agree with the statement that it is their own personal responsibility to help protect water quality, but the least likely to agree with the statement that they are willing to pay more to improve water quality, though there was a significant increase in willingness to pay between 2010 and 2014. There were no significant changes in water quality attitudes in both Upper Tippecanoe Watershed surveys, while changes in attitudes towards water quality among Wabash survey respondents were much more pronounced. Wabash agricultural producers were significantly more likely to say that the economic stability of their community depends on good water quality, that their actions have an impact on water quality, and that the quality of life in their community depends on good water quality. Wabash urban residents were significantly more likely to agree with six out of ten statements, all of which moved in the direction of more positive views towards

Table 2. Demographic profile of survey respondents.

	Sex (% female)	Age (mean years)	Education (% with 4 year college degree or higher)	Acres owned (mean)
All (2010)	25.4	63.7	44.5	N/A*
All (2014)	28.3	64.1	47.7	N/A
Upper Tippecanoe, ag. (2014)	11.4	N/A	30.1	339.2
Upper Tippecanoe, urban/lake (2014)	32.1	65.6	49.6	N/A
Wabash, ag. (2014)	16.9	65.9	39.1	461.5
Wabash, urban (2014)	34.6	60.2	53.4	N/A

*N/A indicates that a similar question was not asked on the survey.

Table 3. Percentage of survey respondents who saw impairments as problems. Circles indicate significant differences over time (non-shaded rows) or between resident type (shaded rows) at *p<0.05, **p<0.01, or ***p<0.001.

Survey Respondents	Nitrogen	Phosphorus	Sedimentation	Bacteria	Algae
All (2010)	41.9	43.0	69.5	51.2	65.9
All (2014)	44.9	45.4	68.6	47.9	66.4
Upper Tippecanoe, ag. (2010)	57.0	54.6	56.4	55.6	57.3
Upper Tippecanoe, ag. (2014)	43.0	45.4	43.6	44.4	42.6
Upper Tippecanoe, urban/lake (2010)	47.9	49.8	50.6	51.3	52.0
Upper Tippecanoe, urban/lake (2014)	52.1	50.2	49.4	48.7	48.0
Wabash, ag. (2010)	57.9	59.4	**62.7**	**63.3**	60.4
Wabash, ag. (2014)	42.1	40.6	**37.3***	**36.7***	39.6
Wabash, urban (2010)	56.0	55.9	58.5	59.8	58.1
Wabash, urban (2014)	44.0	44.1	41.5	40.2	41.9
All ag. (2014)	**54.7**	**52.3**	68.5	**53.9**	**59.2**
All urban/lake (2014)	**39.8*****	**41.7****	68.6	**44.8***	**70.1****

Notes: Significance calculated using two sample t-tests. "ag." indicates agricultural producers.

water quality. In combined watersheds in 2014, urban/lake residents indicated significantly more agreement with many statements that exhibit more positive attitudes towards water quality than agricultural producers; of note, urban/lake residents were much more likely than agricultural producers to be willing to pay more to improve water quality (51% versus 25%, respectively).

Perceptions of Barriers

There were no significant changes in perceptions of each limiting factor from 2010 to 2014 in the pooled survey responses or the four pre/post surveys (see Table 5). In 2014, survey respondents were most concerned about the personal costs associated with adopting conservation practices. Nearly one out of every three (31.4%) respondents saw expenses as a barrier that limited their usage of conservation practices a lot. Many also saw a lack of access to equipment as a significant barrier to implementing a practice. On the other hand, not knowing anyone else using the practice and approval of neighbors were the least limiting factors. Urban residents were significantly more likely to say that the lack of information about a practice, not knowing anyone implementing the practice, and not being able to see a demonstration limited their ability to adopt a conservation practice a lot than were agricultural residents.

Awareness and Usage of Conservation Practices

Between 2010 and 2014, agricultural producers in the Upper Tippecanoe Watershed became significantly more aware of approved grazing management plans and more likely to have adopted the practice (see Table 6). Awareness and usage of comprehensive nutrient management plans also increased, but not significantly. There was little change in residents' awareness and usage of the other practices. There were no significant changes between 2010 and 2014 in the awareness or usage of the three conservation practices inquired about among agricultural producers in the Wabash Watershed. Awareness and usage of conservation practices was generally lower, although not by a significant amount. Urban/lake residents of the Upper Tippecanoe Watershed were significantly more likely to have heard of and use vegetation

Table 4. Percentage of survey respondents who agreed with statements about water quality. Circles indicate significant differences over time (non-shaded rows) or between resident type (shaded rows) at *p<0.05, **p<0.01, or ***p<0.001.

Survey Respondents	I would be willing to pay more to improve water quality.	Taking action to improve water quality is not too expensive for me.	It is important to protect water quality even if it costs me more.	What I do on my land makes a difference in overall water quality.	It is important to protect water quality even if it slows economic development.	The quality of life in my community depends on good water quality.	My actions have an impact on water quality.	It is not okay to reduce water quality to promote economic development.	The economic stability of my community depends on good water quality.	It is my personal responsibility to help protect water quality.
All (2010)	**35.9**	42.6	**54.4**	72.4	74.9	**75.8**	82.1	**80.4**	**75.0**	90.7
All (2014)	**41.9****	45.2	**60.1***	75.4	76.8	**81.3****	83.5	**84.0***	**84.7*****	90.5
Upper Tippecanoe, ag. (2010)	20.2	36.4	47.2	75.0	71.3	72.4	87.0	73.0	76.2	92.7
Upper Tippecanoe, ag. (2014)	22.7	34.0	45.4	70.5	67.4	71.4	82.5	76.3	81.4	88.8
Upper Tippecanoe, urban/lake (2010)	44.4	48.2	58.5	78.0	79.8	86.2	87.7	86.2	83.4	94.1
Upper Tippecanoe, urban/lake (2014)	47.0	55.3	63.1	81.1	77.5	85.1	86.8	88.3	82.0	93.1
Wabash, ag. (2010)	20.7	36.6	51.8	69.2	73.5	**63.8**	**77.0**	81.4	**71.0**	89.6
Wabash, ag. (2014)	26.6	43.4	54.5	72.3	72.5	**75.4****	**84.0***	80.3	**88.3*****	89.3
Wabash, urban (2010)	**45.9**	44.2	**55.0**	68.7	**72.4**	**76.9**	79.1	**76.3**	**69.8**	87.5
Wabash, urban (2014)	**55.3***	37.9	**66.7****	72.3	**83.1****	**85.0***	79.0	**84.2***	**86.3*****	88.9
All ag. (2014)	**25.4**	**40.5**	**51.6**	71.8	**70.9**	**74.1**	83.6	**79.0**	86.2	89.1
All urban/lake (2014)	**50.6*****	**47.8***	**64.6*****	77.3	**79.9****	**85.1*****	83.5	**86.5****	83.9	91.3

Notes: Significance calculated using two sample t-tests. "ag." indicates agricultural producers.

and/or glacial stones to protect their streambanks and/or shorelines and native plants to control waterfowl in 2014. They were also more likely to use phosphorus free fertilizers and clean their boats after use to reduce the spread of invasive species in 2014 than in 2010; however, the increases were not significant. Awareness of both rain gardens and rain barrels increased significantly over the four year period for Wabash urban residents. They were also significantly more likely to have installed a rain barrel and pervious pavement.

Effectiveness of Watershed Level Outreach

Residents (both agricultural producers and urban) of the Upper Tippecanoe Watershed were significantly more familiar with their local watershed organization than residents of the Wabash Watershed (see Table 7). Urban residents of the Upper Tippecanoe Watershed were significantly less likely (13.7%) to have gone to an event than farmers of the Wabash Watershed (28.6%). Urban residents of the Upper Tippecanoe Watershed were significantly more likely than urban residents of the Wabash Watershed to think an event they attended was effective. Lastly, agricultural producers in the Upper Tippecanoe Watershed were significantly more likely to self-report a change in their behavior as the result of attending an outreach event than agricultural producers in the Wabash Watershed.

There were notable differences in how well the outreach impacted targeted residents as well as whether it made any difference in their behavior. Some of the differences, such as the big gap in awareness of the TWF in comparison with the WREC, are likely a result of how samples were obtained. The outreach material that was the most effective at reaching the most respondents overall were TWF News Splash Newsletters. Over half

Table 5. Percentage of survey respondents who saw each factor as limiting them a lot. No significant differences were found over time (non-shaded rows). Circles indicate significant differences between resident types in 2014 (shaded rows) at **p<0.01 or ***p<0.001.

Survey Respondents	Approval of my neighbors	No one else I know is using the practice	Not being able to see a demonstration of the practice	Lack of available information about a practice	Not having the equipment I need	Personal out-of-pocket expenses
All (2010)	5.4	10.5	13.1	15.7	20.9	34.5
All (2014)	5.2	9.9	11.7	17.3	22.5	31.4
Upper Tippecanoe, ag. (2010)	5.9	6.8	6.0	10.0	23.5	46.7
Upper Tippecanoe, ag. (2014)	5.7	2.3	7.0	12.4	28.1	33.3
Upper Tippecanoe, urban/lake (2010)	4.9	9.0	11.7	12.2	13.9	25.7
Upper Tippecanoe, urban/lake (2014)	6.2	10.2	9.9	14.6	14.8	28.4
Wabash, ag. (2010)	4.8	5.7	6.9	10.1	18.6	29.4
Wabash, ag. (2014)	2.7	6.5	5.9	9.5	23.8	26.2
Wabash, urban (2010)	6.2	17.5	22.5	26.2	29.2	43.7
Wabash, urban (2014)	5.7	15.1	21.0	29.8	30.4	39.0
All ag. (2014)	3.6	**5.2**	**6.3**	**10.4**	25.2	28.5
All urban/lake (2014)	6.0	**12.2****	**14.5****	**20.8*****	21.2	32.8

Notes: Significance calculated using two sample t-tests. "ag." indicates agricultural producers.

Table 6. Changes in awareness and usage of conservation practices from 2010 to 2014. Circles indicate significant differences over time at *p<0.05, **p<0.01, or ***p<0.001.

Watershed, resident type	Conservation practice	% heard of (2010)	% heard of (2014)	% using (2010)	% using (2014)
Upper Tippecanoe, ag.	Comprehensive nutrient management plan	61.2	72.2	18.4	27.8
	Cover crops	98.3	97.9	53.5	51.1
	Approved grazing management plan	**64.4**	**89.3***	**7.8**	**21.4***
	Restored/enhanced wetlands	94.8	93.1	23.5	28.7
Wabash, ag.	Conservation tillage	96.6	98.2	69.0	65.1
	Grassed waterways	97.3	96.9	79.6	72.4
	Conservation buffers	91.1	87.4	46.8	44.0
Upper Tippecanoe, urban/lake	Phosphorus free fertilizer on lawn	83.6	86.4	31.3	37.8
	Protect streambanks and/or shorelines with vegetation and/or glacial stones	**74.8**	**86.0*****	**21.4**	**28.3***
	Native plants to control waterfowl	**36.2**	**50.8*****	**3.0**	**9.0****
	Clean boat and trailer after use to reduce the spread of invasive species	95.0	94.5	60.5	63.9
Wabash, urban	Rain garden	**41.6**	**51.9***	2.3	2.6
	Rain barrel	**88.8**	**94.5***	**2.6**	**8.5***
	Pervious pavement	47.8	47.2	**1.2**	**4.3***
	Maintaining native plant communities	60.9	65.2	10.9	13.3

Notes: Significance calculated using two sample t-tests. "ag." indicates agricultural producers.

Table 7. Percentage of survey respondents who fall into each category by survey, 2014. Different letters within rows indicate significant differences between resident type at *p<0.05, **p<0.01, or ***p<0.001.

	Upper Tippecanoe, ag.	Upper Tippecanoe, urban/lake	Wabash, ag.	Wabash, urban
Heard of local watershed organization***	82.5 [a]	94.0 [a]	47.3 [b]	40.7 [b]
Attended at least one event**	19.0 [ab]	13.7 [b]	28.6 [a]	22.4 [ab]
Attendees who saw at least one event as effective**	63.2 [a]	62.8 [a]	41.3 [ab]	28.6 [b]
Attendees who changed behavior*	29.6 [a]	17.0 [ab]	10.7 [b]	13.2 [ab]

Notes: Significance calculated using ANOVA and Scheffe multiple-comparison test. "ag." indicates agricultural producers.

of the Upper Tippecanoe urban residents who responded to our survey had seen this newsletter. Other outreach materials seen by a high percentage of our respondents were the Healthy Shoreline and Healthy Soils yard signs in the Upper Tippecanoe Watershed. Almost half of all respondents had seen these signs. The outreach events that were perceived as most effective overall were the Two-Stage Ditch Design Field Day in the Wabash, and the Northern Indiana Lakes Festival in the Upper Tippecanoe Watershed, with more than 70% of attendees seeing these events as very effective. Individual farmer meetings with conservation officers were also effective methods for education/outreach. More than 20% of the farmers in the Upper Tippecanoe Watershed had met individually with a watershed conservationist within the past two years prior to responding to our survey. More than half of the farmers who met with a watershed conservationist found the information they gained to be very useful. Of the outreach materials that we asked about in the Wabash urban surveys, more respondents had seen painted rain barrels than any other form of outreach, with more than 37% having seen a painted rain barrel.

Discussion

The results presented in this paper compare pre and post survey data from two different watersheds in Indiana where substantial outreach was conducted, and highlight the difficulties in changing awareness, attitudes, and behaviors related to water quality. Where other studies have examined what motivates individuals to adopt practices at one point in time (e.g., Brehm et al. 2013; Prokopy et al. 2008), we examined what leads to change over time. We found that awareness of different pollutants did not seem to change with the outreach approaches used, some attitudinal measures changed, constraints to change behaviors remained the same, and some specific behaviors changed – primarily among urban residents.

The finding that residents of all watersheds generally exhibited more positive attitudes towards water quality in 2014 than in 2010 indicates that outreach may be having some intended results. Residents may be slow to implement conservation practices because of costs or other limitations, but the finding that their attitudes are becoming more positive may indicate other benefits to creating water quality outreach. For example, while residents may not be willing to adopt a new practice themselves, they may be more likely to volunteer for a clean-up day or discuss water quality issues with friends or family. Our results highlight the importance of examining differences in water quality attitudes between agricultural and urban/lake residents. For instance, there were important differences in what water impairments they were most concerned about and their general attitudes towards addressing water quality. Urban/lake residents generally had much more positive views towards protecting water resources than agricultural residents.

We also found that some outreach activities seemed to be more successful than others in terms of self-reports of effectiveness. There does not seem to be a pattern about which types of outreach activities were most effective, although field days, festivals, and one-on-one meetings with a conservationist were reported as effective in the Upper Tippecanoe Watershed. Note that field days and festivals in the Wabash Watershed were not reported as effective, however, highlighting the importance of understanding local context. It is possible that working in a lake watershed is quite different than working in a non-lake watershed in terms of what outreach efforts will be effective. Newsletters, signage and painted rain barrels were all reported as being visible by survey respondents and may be a helpful way to start raising awareness.

There was a large difference in familiarity with watershed groups between the watersheds, particularly with urban residents, but this may be a result of how the survey samples were generated. A list of lake residents in the Upper Tippecanoe Watershed was provided by TWF, but in the Wabash Watershed a sample was purchased from an outside organization.

Urban/lake residents were more likely to have significantly increased their usage of target practices than farmers. In both the Upper Tippecanoe and Wabash Watershed there were significant increases in the usage of (and often awareness of) two out of four practices. There were no changes in conservation practice uptake or awareness among agricultural producers in the

Wabash Watershed over this time and change for only for one practice - use of approved grazing management plans - among farmers in the Upper Tippecanoe Watershed. We suspect that this is the result of more intense outreach conducted in both watersheds geared towards urban/lake residents. The outreach to urban/lake residents was also information they had likely not heard before, while agricultural audiences have been receiving similar information for years from other entities. We saw the greatest increase in positive attitudes towards water quality among urban residents in the Wabash Watershed, which might be related to their relatively high increase in uptake of conservation practices.

There are numerous limitations inherent in any type of longitudinal study that need to be considered in interpreting our results. (1) Actual environmental conditions in the areas studied may change during the study period. In these two locations, no substantive changes occurred so we do not believe this to be a threat to our conclusions. (2) Other efforts to change awareness, attitudes and increase practice adoption might have occurred in the study areas. Again, we do not believe this happened in these two study areas. Both WREC and TWF worked closely with other entities in their areas on events that are discussed here. (3) Our pre and post measures are all self-reported. This is potentially problematic for many reasons, including the notion that as education about water quality and conservation practices increases in an area, there may be a tendency for respondents to overinflate practice awareness and adoption as a socially desirable response. (4) Other factors can influence people's attitudes over time. For example, if the economy in a local area is stronger in the second time period, respondents might be more likely to report a willingness to pay for water quality improvements even if their underlying beliefs about the importance of water quality have not changed.

Conclusion

Despite the potential limitations mentioned above, our findings lead to recommendations for future outreach at the watershed level aimed at improving urban and agricultural residents' knowledge about and usage of conservation practices. We recommend surveying the same people over time to learn how their perception of water quality and usage of conservation practices change (Genskow 2012). Watershed groups should conduct interviews or surveys that dig more deeply into why events are not seen as effective directly after or during educational events in order to gauge participants' perceptions of an event while the event is still fresh in their memory. Watershed groups should use event-specific surveys, asking attendees about their knowledge of the target BMP before and after the event in order to gauge the effectiveness of the event. We realize that other factors may account for the changes in attitudes and behaviors we have documented, so further studies would need to be conducted asking different questions about their perceived barriers to implementing a practice, and perhaps some focus groups should be conducted to gain further insight using more qualitative data. We recommend the use of practice-specific outreach to address the most common barriers associated with each individual practice. Stakeholder-specific outreach to address barriers perceived by specific stakeholder groups would be useful. Lastly, with regard to agricultural residents, we would recommend one-on-one farmer contact with conservation officers, as this was one of the most successful means of outreach in the Upper Tippecanoe River watershed.

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Author Bio and Contact Information

Rebecca Busse is an undergraduate student at Purdue University working in the Natural Resource Social Science lab. She will graduate with a B.S. in Wildlife and intends to pursue a masters in environmental studies or a related field. Her research interests lie in human dimensions, community engagement, environmental decision making, environmental outreach and extension. She can be contacted at beccabusse93@gmail.com and her mailing address is 195 Marsteller Street, West Lafayette, IN 47907.

Jessica D. Ulrich-Schad is an Assistant Professor of Sociology and Rural Studies at South Dakota State University. Her interests as a rural sociologist are broad and include topics such as agricultural producers' attitudes towards and usage of conservation practices, amenity migration, and persistent poverty. Her email address is jessica.schad@sdstate.edu and her mailing address is Scobey Hall (SSB) 224, Room 218, Brookings, SD 57007.

Lyn Crighton is the Executive Director for the Tippecanoe Watershed Foundation. She is the co-founder of Clear Choices Clean Water, LLC. She can be contacted at lyn@tippecanoewatershed.org and her mailing address is PO Box 55, North Webster, IN 46555.

Sara Peel is the Director of Watershed Projects for the Wabash River Enhancement Corporation. She currently serves as the President for the Indiana Lakes Management Society, is a board member on the Indiana Water Monitoring Council and the North American Lakes Management Society, is a representative to the Indiana Lakes Management Work Group and is a TogetherGreen Fellow with Audubon's TogetherGreen program in partnership with Toyota. She can be contacted at speel@wabashriver.net and her mailing address is 200 N. 2nd Street, Lafayette, IN 47901.

Ken Genskow is an associate professor at the University of Wisconsin-Madison. His research and applied work have explored the evaluation and assessment of collaborative watershed management, watershed governance, and the effectiveness of educational and technical assistance programs on land management. Ken holds a joint appointment with UW-Extension, where he serves as a specialist on water resource and directs UW-Extension's Regional Natural Resources Program. He can be contacted at kgenskow@wisc.edu and his mailing address is 445 Henry Mall, Room 202, Madison, WI 53706.

Linda Stalker Prokopy is the Director of the Natural Resource Social Science lab and a Professor at Purdue University. She is also on the board of the NICHES Land Trust, an organization that protects critical habitats, and she is active with efforts to clean the Wabash River. She can be contacted at lprokopy@purdue.edu and her mailing address is 195 Marsteller Street, West Lafayette, IN 47907.

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