IMPLEMENTATION OF MEANINGFUL WATERSHED EDUCATION EXPERIENCES (MWEE'S) BY MIDDLE SCHOOL LIFE SCIENCE TEACHERS

By

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A Thesis
Submitted to the
Graduate Faculty
of
George Mason University
in Partial Fulfillment of
The Requirements for the Degree
of
Master of Science
Environmental Science and Policy

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Date: 11/19/13

Fall Semester 2013
George Mason University
Fairfax, VA

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DEDICATION

This is dedicated to my wonderful husband, Eric, my beautiful daughter Elizabeth, and my family for supporting me throughout this endeavor.

ACKNOWLEDGEMENTS

I would like to thank the many friends, relatives, and supporters who have made this happen. I would especially like to thank Dr. Dann Sklarew, my committee chair, who has supported me over many years as I have slowly meandered through this project. In addition, I would like to thank my other committee members Dr. James Witte and Dr. Erin Peters Burton for their invaluable assistance throughout this process. Finally, a thank you to the school district and the middle school science specialist and teachers for engaging and reflecting with me as part of the programmatic evaluation process.

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LIST OF ABBREVIATIONS

Chesapeake Bay Foundation ..... CBF
English Speakers of Other Languages ..... ESOL
Environmentally Responsible Behavior ..... ERB
Environmental Protection Agency ..... EPA
Geospatial Information Systems ..... GIS
Meaningful Watershed Educational Experiences ..... MWEE
National Environmental Education Advisory Council ..... NEEAC
National Oceanic and Atmospheric Administration ..... NOAA
New Ecological Paradigm ..... NEP
Northern American Association for Environmental Education ..... NAAEE
Special Education ..... SPED
United Nations Environmental Programme ..... UNEP
United Nations Educational, Scientific, and Cultural Organization ..... UNESCO
Chesapeake Bay Watershed Education and Training Program ..... B-WET

ABSTRACT

IMPLEMENTATION OF MEANINGFUL WATERSHED EDUCATION EXPERIENCES (MWEE'S) BY MIDDLE SCHOOL LIFE SCIENCE TEACHERS

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As anthropogenic stressors impact local ecosystems, fostering environmentally responsible behaviors in our students continues to be relevant and important. This study examined the impact of teachers' education, training and environmental attitudes, as well as school-specific factors, on their implementation of meaningful watershed educational experiences (MWEE's). In this study, implementation of the MWEE was used as a proxy for environmentally responsible behavior. This study also garnered teacher feedback to inform recommended improvements to the current MWEE curriculum and training opportunities with the goal of increasing MWEE implementation. These improvements focused on ways to increase implementation of each of the three components of the MWEE: the preparation, action and reflection phases. The target population included all seventh grade life science teachers in a large, affluent suburban school district on the East Coast of the United States of America. After the teachers had implemented the MWEE, 51 out of approximately 150 teachers responded to an online questionnaire for this study.

Data were analyzed using chi-square analysis and a logistic regression model to determine relationships between teacher and school specific factors and implementation of each of the three components of the MWEE. Overall, teacher-specific variables did not have significant relationships with completion of the MWEE components. One teacher characteristic did show a relationship with MWEE completion. Surprisingly, being the MWEE coordinator was negatively correlated with completion of the reflection phase of the MWEE. School-site specific variables, including perceived administrative support, concurrent stewardship projects at the school and perceived funding support were the only variables to show significant positive relationships to MWEE completion. Administrative and funding support, coupled with current stewardship projects, increased likelihood of completion of the stewardship project and MWEE field study. Clustering of significance related to school-specific variables, and specifically, the importance of administrative support suggests that school-site factors dramatically impact MWEE completion regardless of teacher characteristics. These school-specific variables should be the focus of any county-wide initiative focused on increased MWEE implementation. Additional recommendations to increase MWEE completion include facilitating MWEE training for administrators and further county-based support to help schools begin stewardship projects. These improvements to the MWEE curriculum and training would increase implementation of the final phase of the MWEE, the environmental stewardship project, to provide a culminating experience for this school-mediated ERB.

INTRODUCTION

As anthropogenic degradations continue to impact our biosphere, it remains important that we invest in educational experiences that help to shape a new generation of environmental stewards. The goal of environmental education is to create ecologically literate and responsible individuals dedicated to making environmentally conscious decisions (Farmer, Knapp, & Benton, 2007; Knapp, 2000). This goal becomes more challenging to realize as children spend less and less time outside interacting with nature (Kellert, 2005; Zaradic & Pergams, 2007). This nature-deprivation can lead to profound psychological and emotional issues and a lack of connection to nature (Louv, 2005). This highlights the intrinsic value of environmental education; its ability to impact an individual's future decision making about environmental issues is critically important to preserving local ecosystems.

This study will evaluate implementation of a specific type of environmental education called a meaningful watershed educational experience (MWEE). The study itself is two-fold; it will examine which factors impact teacher implementation of this environmental curriculum and it will utilize teacher feedback to generate suggestions for improving the curriculum. Specifically, this study will determine how teacher education, experience, training and environmental attitudes and beliefs interact with specific school-based environmental factors to influence the implementation of meaningful watershed

educational experiences. The explicit goal of this study is to determine which factors impact teacher-implementation of this environmental programming, and how this curriculum can be improved. The ultimate hope is that by improving the MWEE curriculum and providing better teacher-training opportunities, more teachers will provide opportunities for students to take part in an environmental social-action project, which should enhance student's ecological knowledge of their local watershed and pro-environmental belief systems, paving the way for future generations of environmental stewards.

Environmental Education and Development of Environmental Stewards

Environmental education is a process that increases individuals' ecological knowledge and awareness while developing the skills and attitudes necessary to make informed decisions and take ecologically responsible actions (UNESCO & UNEP, 1978). One of the purposes of environmental education is to create environmentally responsible citizens (Knapp, 2000). A seminal study by Chawla (1998) found that significant life experiences in nature, especially in childhood, are important for developing environmental sensitivity.

Numerous studies have shown that environmental field trips and outreach programs can impact students' pro-environmental attitudes and behaviors (Andrews Tressler & Mintzes, 2008; Bamberg & Moser, 2007; Chawla, 1999; Chawla, 1998; Dimopoulos, Paraskevopoulos & Pantis, 2008; Farmer, et al., 2007; Kraemer, Zint & Kirwan, 2007; Sivek, 2002; Wells & Lekies, 2006). For example, one study found that

one year after an environmental field trip to Great Smokey Mountains National Park, the majority of the students retained ecological knowledge and many of the students made statements alluding to pro-environmental attitudes (Farmer et al., 2007). Another study surveyed environmentalists from a variety of fields including wilderness protection, pollution control, transportation and environmental education and found that experience in nature, family values, negative experiences (a sense of injustice) and education had a major impact on their career paths and decisions to focus on environmental stewardship (Chawla, 1999). These studies provide evidence that environmental education, specifically focused on experiential learning in nature, can have both short-term and long-term impacts on pro-environmental attitudes and behaviors.

In addition, another study found that to effect change in environmental attitudes, it is important to focus on environmental knowledge as well as decision-making about environmental issues (Arvai, Campbell, Baird & Rivers, 2004). Designing curriculum to target specific environmental knowledge is relatively straight forward; however, designing curriculum to impact decision-making about environmental issues can be difficult due to the number of factors that impact decision making. Decision making is another important component of environmental education as it can impact economic, political and social environmental decisions.

The importance of environmental education has been evident for a long time, and the National American Association for Environmental Education (NAAEE) has worked to support the development of effective environmental education in the United States has for over forty years (NAAEE, 2013). Promoting environmental curricula is important;

however, these curricula can sometimes be ineffective. In fact, one study found that curricula created to teach environmentalism that relies on short, activity-based, teacher-driven units do not seem to result in long-lasting changes in students' attitudes and perceptions (Knapp, 2000). Over the past twenty years, the focus of NAAEE has shifted from promoting environmental education to working to ensure that environmental curricula and teacher training is effective (NAAEE, 2013). Many studies have found that hands-on, sustained, meaningful outdoor activities with civic components are more likely to impact pro-environmental attitudes, and to some extent, pro-environmental behaviors (Stern, Powell & Ardoin, 2011; Kraemer et al., 2007; Morgan, Hamilton, Bentley, & Myrie, 2009; Payne, 2005). The NAAEE has written several books including *Environmental Education Materials: Guidelines for Excellence* (2009) and *Excellence in Environmental Education: Guidelines for Learning* (2010) that can be used to create and evaluate environmental curricula to ensure its effectiveness based on the tenets of sustained, meaningful, inquiry-based, hands-on outdoor activities.

In addition, other organizations have formed partnerships to create more effective environmental curricula (Ballard & Belsky, 2010). In fact, the Chesapeake Bay Foundation (CBF) and NOAA have formed a partnership to promote Chesapeake Bay watershed education and training (B-WET) programming in schools, mostly through implementation of MWEE's. In an important step towards improving effectiveness, in 2007, CBF and NOAA had an outside organization evaluate their B-WET programming by surveying teachers and students (Kraemer et al., 2007). Recently, the importance of evaluation with the aim of increasing effectiveness has been recognized leading to several

studies that have evaluated outdoor environmental education programs by examining their impact on students (Stern et al., 2011; Kraemer et al., 2007; Morgan et al., 2009).

Designing effective curriculum and examining its impact on students is important; however, for curriculum to be effective, it must be successfully implemented by teachers. Implementation is influenced by a teachers training, education and beliefs as well as school-site specific factors. A few studies have evaluated the effectiveness of MWEE training on teacher implementation of curriculum (Kraemer et al., 2007; Shepardson, Harbor, Cooper, & McDonald, 2002; Penuel, Fishman, Yamaguchi, & Gallagher, 2007). More studies are needed to look at the impact of teacher characteristics and school-based situational factors on the successful implementation of curriculum.

MWEE and Environmental Stewardship

A "meaningful watershed educational experience" (MWEE) is characterized by students in K-12 education engaging in investigative learning activities in regions that drain into larger waterways to allow students to think critically about local ecosystems (Chesapeake Bay Program, 2001). A MWEE must include a preparation phase, an action phase and a reflection phase (Chesapeake Bay Program, 2001). The preparation phase must include in-class teacher instruction about the local watershed. The action phase includes an outdoor field investigation, and the reflection phase must include some sort of wrap-up with a service component. In addition, MWEE programming promotes inquiry in the field, students as scientists, and authentic, community-based exploration – all of which are important for environmental and science education (Donahue, Lewis, Price and Schmidt, 1998). A recent evaluation of the Chesapeake Bay's Watershed Educational

programming found that students who had participated in meaningful watershed educational experiences had a significant increase in knowledge of watershed issues; however the results on pro-environmental beliefs and attitudes were inconclusive (Kraemer et al., 2007).

More research must be done to determine what can make the MWEE experience more effective, as this program is one of the primary vehicles for getting students outside and interacting with nature in this school district. In addition, allowing students to interact with nature during the MWEE experience, and to brainstorm and possibly implement environmental stewardship projects during the reflection phase is important because studies have shown that allowing students sustained, meaningful interactions with nature enhance long-term pro-environmental beliefs (Stern et al., 2011; Kraemer et al., 2007; Morgan et al., 2009). Finally, there is a weak link between pro-environmental beliefs and pro-environmental behavior. For example, one study of adolescents found that if students developed pro-environmental beliefs during adolescence, they could be more likely to develop pro-environmental behavioral habits (Carrus, Passafaro, & Bonnes, 2008). This study also found that past behaviors, specifically habits, are a good indication of future behaviors. So forming ecologically responsible habits during adolescence could lead to ecologically responsible behavior and decision-making throughout a person's lifetime.

Factors that Impact Environmentally Responsible Behaviors (ERB)

Environmentally responsible behavior (ERB) was operationalized by Hungerford and Volk (1990) as active involvement in working towards resolution of an environmental problem based on: awareness and knowledge of environmental issues, environmental concern and motivation to help, and finally skill sets necessary to identify and take action on environmental issues. There are many factors that impact ERB's including demographic factors, education, environmental world-view, environmental literacy and situational factors. When specifically looking at implementation of MWEE curriculum as a type of ERB, teacher experience and training and school-site specific factors must also be taken into account.

Demographic indicators and education (formal and informal)

Demographic indicators and education influence attitudes and behaviors, so it is important to examine these with regard to ERB. A meta-analysis by Hines, Hungerford and Tomera (1986/1987) found no link between gender and pro-environmental behavior. However, Olli, Grendstad and Wollebaek (2001) found that women are significantly more likely to exhibit private environmental behavior. The relationship between age and ERB is equally complex. Younger people are more likely to express concern for the environment as they are less likely to be conflicted by economic considerations when compared to older people; however, there is no clear correlation between age and ERB (Jones & Dunlap, 1992; Hines et al., 1986/1987; Schultz, Oskamp, & Mainieri, 1995; Van Liere & Dunlap, 1980).

Many studies have shown that individuals with higher levels of formal education are more likely to espouse pro-environmental concerns and, in some cases, ERB (Hines et al., 1986/1987; Schultz et al., 1995; Van Liere & Dunlap, 1980; Olli et al., 2001). Another study found that environmental literacy, measured by the consumption of environmental literature, is a strong predictor of ERB (Mobley, Vagias & Deward, 2010). In addition, Ernst (2009) found that environmental literacy was associated with implementation of environment-based curriculum, a type of ERB.

Mobley et al. (2010) also found that political orientation is a good predictor of ERB, but that this influence is moderated by environmental literacy and pro-environmental attitudes. Other studies have also shown that being liberal is correlated with engagement in ERB (Olli et al., 2001). Some studies have found that the rural-urban divide is not a strong predictor of ERB (Van Liere & Dunlap, 1980) while other studies have found living in an urban area decreases ERB (Olli et al., 2001).

Teacher experience and training

Teachers, just like all other individuals, are influenced by their experiences, their education, and their belief systems. Volk (2003) had a conversation with four educators that were deeply committed to environmental education in their communities, and at the national level were part of the National Environmental Education Advisory Council (NEEAC) for the United States Environmental Protection Agency (EPA). These teachers cited pro-environmental family values, and childhoods spent interacting with nature as well as catalytic events such as the Exxon-Valdez oil spill as some of the reasons they were committed to environmental education. What was interesting about Volk's (2003)

conversation with these educators is they also cited a workshop they attended as a reason for their growth as environmental educators, and a key reason they deliver strong environmental curriculum. These educators were already committed to environmental education based on their life experiences and yet this professional development still increased their implementation of environmental curricula.

Several studies have looked at the relationships between teacher training, implementation and student engagement. A study by Stern, Powell and Ardoin (2008), found that teacher engagement in a residential environmental program in addition to pre-trip in-class learning and preparation significantly increased pro-environmental attitudes in students. In addition, a survey by Wee, Fast, Shepardson, and Harbor (2004) found that teachers who attended professional development focused on inquiry-based environmental curriculum were more likely to ask students to analyze lab data and utilize problem solving strategies, and less likely to spend their time lecturing or using a textbook. Another study by Ernst (2009) found that the biggest barrier to implementation of environment-based education is teacher training. Finally, a survey of Turkish teacher candidates found that these candidates had less pro-environmental knowledge due to a poor understanding of the ecological concepts related to environmental issues (Oztas & Kalipci, 2009). The Turkish study advised that pre-service programs should include environmental education for teachers. Clearly teacher training, experience and engagement can impact implementation and success of environmental activities. Based on these studies, attending MWEE training is important for implementation of the inquiry-based, environment-based MWEE curriculum. In fact, a NOAA Chesapeake Bay

Watershed Education Training (BWET) program evaluation found that teachers who attended training reported more confidence and greater intentions to implement MWEEs, and were more likely to implement MWEEs (Kraemer et al., 2007).

The composition of a professional development opportunity also impacts implementation making some professional learning experiences more effective than others. An empirical study of teachers that attended a professional development training for an earth science computer-based curriculum found attending this training not only increased comfort with the curriculum, it also increased implementation of curriculum, especially when the attendees were allowed planning time for implementation during the training, and received technical support when using the technology (Penuel et al., 2007). Another study of a watershed education professional development found that when teachers were able to design and implement their own scientific research investigation, they greatly increased their own knowledge of the watershed as well as skills and techniques associated with investigating environmental issues which could be parlayed into classroom use (Shepardson et al., 2002).

Years of teaching experience, and experience with MWEE's are also important factors to consider when thinking about implementation of MWEE curriculum. The stage a teacher is in within their teaching career can impact how receptive they are to professional development opportunities, and trying new things such as MWEE's (Fessler, 1985; Woods & Lynn, 2001). Research has shown that teachers go through a career cycle that includes eight stages which are influenced by the length of time an individual has been teaching in addition to a teacher's attitudes and mindsets and their environment

(Fessler, 1985). The first stage, pre-service, is when teachers enter into a preparation program before teaching begins. The second stage is induction which occurs at the beginning of a teacher's career, typically years 2-4; in this stage, teachers focus on day to day problems and acceptance by peers and students (Fessler, 1985). A teacher in the induction phase might not be as able to fully implement a MWEE as they would be focused more on the day-to-day problems of classroom management and lesson planning. In stage three, competency building, typically beginning by year 5, teachers are learning and improving their skills and are receptive to professional development opportunities and trying new things. In stage four, enthusiastic and growing, competence and job satisfaction is high; teachers take on leadership roles and seek to further their teaching practice (Fessler, 1985). During the competency building and enthusiastic and growing stages, a teacher might be more likely to engage fully in the MWEE training and implementation process. In stage five, career frustration, and stage six, career stability, a teacher is experiencing burn out and while doing an acceptable job, lacks motivation towards growth (Fessler, 1985). During these stages, a teacher might not fully commit to implementation of the MWEE curriculum due to a lack of motivation. During stage seven, career wind-down, and stage eight, career exit, a teacher is focused on reflection which can be positive or negative (Fessler, 1985). During these last stages, it is more difficult to predict how a person would implement MWEE curriculum as it would likely be based on whether their reflection period was positive or negative.

Finally, not all teachers attend MWEE training; some teachers are trained by their peers. A study by Wee, et al. (2004), utilized "turn-around training," which is when

some teachers are directly trained in environmental techniques and then return to their school sites to train other teachers. The same strategy was used in MWEE training in the school district being studied and it will be important to note how different types of training impact MWEE implementation.

Environmental attitudes

Within the literature, there has been some dispute about whether ERB can be reasonably predicted from attitudes. One meta-analysis of 88 attitude-behavior studies found that attitudes have a significant and substantive impact on future behaviors (Kraus, 1995). Another study of environmental concern amongst boaters found that environmental knowledge significantly impacted ERB, while environmental concern did not significantly increase the explanatory power of the model used to predict ERB. This same study found that the link between overall attitudes and behavior is tenuous at best(Cottrell, 2003). Another study in Norway determined that the link between attitudes and behaviors is present, but the connection is weak and reliant on social context (Olli et al., 2001). Finally, a survey of factors that impact recycling behaviors showed that past behavior and knowledge correlated with recycling (a type of ERB), but that attitudes did not (Gamba & Oskamp, 1994).

A recent study by Mobley et al. (2010) used data collected from the *National Geographic Society Survey 2001* to build a regression model to determine the predictive value of demographic characteristics, environmental concern, environmental world view (using the New Ecological Paradigm, or NEP scale) and environmental literacy on ERB. The New Ecological Paradigm (NEP) is a scale that has been used and revised for many

years to measure environmental world-view, which is a person's general outlook on the environment (Dunlap, Van Liere, Mertig & Jones, 2000). In contrast to the studies above, this study found that specific environmental concerns are better predictors of behavior than general attitudes, and that environmental world view and environmental literacy do have significant impacts on ERB.

School-specific environment

Hines, Hungerford and Tomera (1986/1987) built situational factors into their model of environmentally responsible behavior. They felt that situational factors including economic considerations, social pressures and opportunities to act can modify a person's ability to act on their pro-environmental intentions. In addition, a study by Ernst (2009) found that teachers that worked at schools with supportive administration were more likely to engage in environment-based curriculum. These findings make sense; if a school is already actively engaged in an environmental stewardship project, or the leadership at the school encourages these types of projects, this enhances opportunities for classroom teachers to engage in these types of projects as part of the MWEE reflection phase.

Theories associated with ERB

Within the past 25 years, several theories that seek to predict ERB's have arisen that take into account social cognitive theory – as well as Ajzen's theory of planned behavior (1991), and Schwartz's (1977) norm activation model – in an attempt to create a theory specific to factors that impact environmentally responsible behaviors. Social

cognitive theory recognizes the complex interplay between cognitive, behavioral and environmental factors (Bandura, 2001). Bandura (2001) places great importance on the cognitive aspects of this theory, specifically an individual's ability to self-regulate, reflect and purposefully make decisions. Self-efficacy beliefs are powerful moderators of cognition that can often play an important role in teachers' academic interests and subsequent educational attainment and training, motivation, personal agency and self-regulation. Personal agency is a person's ability to direct their own actions to specific purposes like pro-social environmental behaviors (Zimmerman & Cleary, 2006), such as by implementing all components of the MWEE.

A model to predict ERB by Hines, Hungerford and Tomera (1986/1987) posited that environmentally responsible behavior was a result of two main components: intention to act and situational factors. Intention to act is based on personality factors (attitudes, locus of control, personal responsibility), in addition to knowledge of issues, action skills and knowledge of action strategies. Environmental education seeks to moderate variables that make up the intention to act portion of this model, specifically knowledge of issues and action strategies, action skills and sense of personal responsibility towards the environment. Situational factors include environmental components that can modify intention to act including economic, political and social factors, and in this case, school-site environment.

Hungerford and Volk (1990) modified the model by Hines et al. (1986/1987) by organizing the variables in a sequential fashion to show how they impacted civic behavior, in this case, ERB. First, the entry level variables (environmental sensitivity,

knowledge of ecology and attitudes towards environmental issues) impact an individual; then ownership variables become important (in-depth knowledge of issues, personal investment in the environment and knowledge of consequences of actions towards the environment). Finally, this model takes into account empowerment variables (knowledge and skills related to action strategies, locus of control and intention to act). These three variables act in a linear fashion to impact citizenship behavior (Hungerford & Volk, 1990). A follow-up study by Bamberg and Moser (2007) found that intention to act was the most important indicator of pro-environmental behavior, and the variables that influence intentionality include attitude and behavioral control, personal moral norm and problem awareness.

An alternative model of environmentally responsible behavior by Stern and Dietz (1994) is based on a value-beliefs-norm structure. Their model theorizes that values (biospheric, altruistic, egoistic) impact beliefs (ecological world view, consequences of behavior on the environment and perceived ability to make changes) which impact norms (sense of obligation to take pro-environmental action). Changes in personal norms lead to changes in behavior, specifically related to activism, other public-sphere behaviors, private-sphere behaviors and behaviors in organizations (Stern & Dietz, 1994; Stern, 2000). Other studies have also shown the importance of knowledge, personal responsibility and behavioral intentions when predicting ERB (Forsyth, Garcia, Zyniewski, Story, & Kerr, 2004; Kaiser & Shimoda, 1999). All of these models address ecological knowledge and world view, concern about consequences of actions on the environment and knowledge and skills related to action strategies. When creating a

model to better understand implementation of MWEE activities, these variables, in addition to variables associated with MWEE training, should be included to determine what factors impact implementation of the environmental curriculum, and which components can be improved to facilitate better implementation of this programming.

Learning in nature is a key component of MWEE field-work and training. Brody (2005) has come up with a learning in nature theory matrix that includes acting in nature (the initial setting, the personal and group experience), thinking (the impact of direct experience with nature on creating a knowledge framework, integrating that information with prior knowledge, and sharing that experience with others) and finally feeling (the impact of the direct experience with nature on attitudes and beliefs, integrating the feelings that the experience engenders on prior value systems, and sharing those attitudes and beliefs with others over time). This theory highlights the interaction between prior knowledge and beliefs with the experience in nature, and the importance of social dialogue in framing that event. This theory shows that when designing learning in nature experiences, it is important to frame the experience through goal-specific dialogue, and to recognize that individuals enter these situations with their own preconceived notions of nature and environmental education. It is also important that individuals have a direct experience with nature; environmental education must include an outdoor component, further highlighting the importance of MWEE field work and other outdoor educational experiences for students and teachers.

Research Questions

Environmentally responsible behavior, as defined by Hungerford and Volk (1990), is an active involvement in working towards resolution of an environmental problem. In this study, teacher implementation of each component of the MWEE will be used as a proxy for ERB as MWEE implementation is actively working towards getting kids outside in nature which has been previously discussed as an environmental problem (Louv, 2005). Therefore, the purpose of this study is to investigate implementation of MWEE activities through the following questions:

- What teacher-specific and school-specific factors impact implementation of the three MWEE components?
- How can the MWEE be improved to better facilitate implementation by teachers without sacrificing student learning objectives?

This study has two main aims; first, it seeks to determine which teacher and school-specific characteristics are correlated with implementation of MWEE curriculum. Implementation of MWEE curriculum, particularly implementation of the environmental stewardship project will be considered ERB. Implementing the environmental stewardship project is optional for these teachers. Thus, implementation implies ERB as they are opting to have students participate in an environmental social action project.

The second aim of this study is to evaluate the current curriculum and garner teacher suggestions for improvement of this curriculum with respect to implementation of the three components of the MWEE. Specifically, teachers will be asked how each of the three components of the MWEE could be modified to enhance implementation. Also,

teachers will be asked what other resources would be helpful with the aim of increasing implementation of the MWEE components.

Variables

In order to explore the teacher and school-specific factors that impact MWEE implementation, the following variables were assessed.

Independent Variables

Teacher-specific variables included:

- Demographic information (age, gender, politics, geographic region)
- Informal and formal environmental education
- Teaching experience (number of years taught, MWEE experience)
- Environmental beliefs (environmental world view and literacy)

School-specific variables included:

- Administrative support
- Funding support
- Knowledge of action strategies related to completing a stewardship project
- Concurrent stewardship project at school

Dependent Variables

Completion of MWEE components:

- Preparation phase: Web-based activities
- Action Phase: MWEE field study
- Reflection Phase: Environmental stewardship project

Hypotheses

The four hypotheses below are equally split between factors that impact MWEE implementation and suggestions for improvement. Hypothesis 1 is about teacher-specific variables that impact MWEE implementation while hypothesis 2 is about school-specific variables that impact MWEE implementation. Hypotheses 3 and 4 are linked to teacher-generated suggestions for improvement to the MWEE curriculum with the aim of increasing implementation of all three MWEE components. Each hypothesis is followed by a rationale that provides evidence to support each claim.

Hypothesis 1: Based on prior research, a generalized profile of a teacher that is most likely to implement the MWEE curriculum would be a highly educated, politically liberal female teacher who spends a lot of time in nature and has high levels of environmental literacy and a pro-environmental world view. Additionally, this teacher would be a veteran teacher perhaps 5-15 years through her teaching career. This teacher would have prior experience with MWEEs and watershed curriculum, and would have attended MWEE training in the past.

Rationale 1: Higher levels of formal education, consumption of environmental literature and being politically liberal are strong predictors of environmentally responsible behaviors (Hines et al., 1986/1987; Schultz et al., 1995; Van Liere & Dunlap, 1980; Olli et al., 2001; Ernst, 2009; Mobley et al., 2010). In addition, women are significantly more likely to exhibit private environmental behavior (Olli et al., 2001). Time spent in nature has been shown to increase connectivity to nature (Louv, 2005; Chawla, 1998; Chawla, 1999). Also, having a pro-environmental world view and

increased levels of environmental literacy would seem to increase ERB, however, the correlation between these factors and ERB is tenuous at best (Kraus, 1995; Cottrell, 2003; Olli et al., 2001; Gamba & Oskamp, 1994). Teaching experience that would produce the most ERB is estimated to be between 5 and 15 years as younger people are more likely to express environmental concern, however they are no more likely to engage in environmental behavior (Jones & Dunlap, 1992; Hines et al., 1986/1987; Schultz et al., 1995; Van Liere & Dunlap, 1980). Also, at this point in the career cycle, teachers are most likely to be open to new types of curriculum and professional development opportunities (Fessler, 1985). Finally, studies have shown that increased teacher experience, training and engagement increase success of environmental activities (Stern et al., 2008; Wee et al., 2004; Ernst, 2009; Kraemer et al., 2007).

Hypothesis 2: School-site factors will also influence implementation of MWEE curriculum. Educators at schools with administers that are perceived as being supportive of environmental stewardship projects will be more likely to implement the entire MWEE, and in particular, will be more likely to engage in an environmental stewardship project with their students. In addition, schools that have concurrent stewardship projects running will be more likely to have teachers that implement the stewardship project portion of the MWEE.

Rationale 2: Studies have shown that teachers that work at schools with supportive administration are more likely to engage in environment-based curriculum (Ernst, 2009). In addition, other school-specific situational factors such as concurrent stewardship projects will show higher levels of implementation due to ease of access to

these projects. Previous research has shown that situational factors, including opportunities to act, can modify a person's ability to act on their pro-environmental intentions (Hines et al., 1986/1987).

Hypothesis 3: Educators will seek modifications to the curriculum to increase flexibility. For example, the preparation-phase involves the use of computers and GIS software that teachers may not have access to. In addition, teachers may feel that the preparation phase is too difficult and lengthy for their students to complete within perceived time constraints due to other standards that need to be taught before the state standardized tests.

Rationale 3: A previous evaluation of MWEE implementation found that curriculum flexibility was one of the four limits on use of MWEE's in the classroom. Teacher's felt time constraints due to their pacing guidelines put into place to ensure that all standards were covered before the state standardized assessments (Kraemer et al., 2007).

Hypothesis 4: Educators will ask for additional professional development to support implementation of the curriculum, in addition to help gathering resources to implement an environmental stewardship project.

Rationale 4: A study on watershed education showed that professional development on the curriculum increased teacher knowledge and implementation of student inquiry and research practices (Shepardson et al., 2002). In addition, the evaluation on MWEE implementation discussed previously also found that teachers asked for more professional development as well as funding support. Teachers also

stated that administrative support was important for implementing the MWEE field experience and stewardship project (Kraemer et al., 2007).

METHODS

The methods section has been broken up into four specific sub-sections; study site and sample, intervention and measurement, data collection and data analysis. Study site and sample describes the school district being studied and the composition of the population of teachers that was sampled. Intervention and measurement describes the MWEE intervention that was implemented by the teachers. Also, this section describes the variables assessed in the survey and provides a table that cross references the variables with the specific questions that address that variable. Data collection describes the way that the data was collected. Data analysis goes into detail about how each variable was recoded in addition to the statistical tests run to analyze the data.

Study Site and Sample

This study was conducted in a large, affluent, suburban school district with over one million residents. Enrollment in recent years has been between 170,000 and 200,000 making it the largest school district in its state (Moy, 2013a). There are roughly 25,000 staff positions in this school district, nearly all school-based employees.

Across the 27 middle schools in this school district (Moy, 2013b), the target population included all seventh grade life science teachers (approximately 150). The

sample comprised 51 individuals out of the 150 total possible participants (all individuals that responded were included in the sample).

The respondents varied in all teacher specific characteristics. They showed large variation in demographic characteristics although most were well-educated. In addition, these teachers had varying levels of experience in education; some were first year teachers, some had over thirty years of educational experience. Many different political preferences were indicated, and the participants were raised and educated in many different regions of the world. Finally, the participants showed large variations in their experiences in nature. The target populations was contacted via an e-mail from the middle school science coordinator for the school district, and participants were asked to take a web-based survey to assess the school district's MWEE curriculum and make suggestions for improvement.

Intervention and Measurement

Teachers were asked to implement all three components of the MWEE and this implementation was used as a proxy for ERB. The MWEE was operationalized as an experience that integrates a preparation phase including classroom activities and instruction, an action phase, including MWEE ecological fieldwork, and a reflection phase that includes brainstorming and possibly implementing an environmental stewardship project. This definition is congruent with NOAA and the Chesapeake Bay's Bay Watershed Education Training definition of a MWEE (Chesapeake Bay Program, 2001). Descriptions of all three MWEE components are below.

Preparation phase (web activities): Teachers prepared their students for the MWEE field experience by engaging in an in-class unit on the Chesapeake Bay watershed. In addition, they completed an online assignment using the Chesapeake Bay Foundation (CBF) website and geospatial information systems (GIS) data to enhance knowledge of the watershed and anthropogenic concerns related to the watershed.

Action phase (MWEE field study): The participants in this study, the teachers, engaged in an outdoor educational experience with their students at a local waterway that involved making observations, collecting data, analyzing data and drawing conclusions about the watershed. A sample activity from this experience includes collecting water quality data by utilizing chemical water-quality tests and macro invertebrate studies at a regional park. In addition, teachers and field interpreters engaged in discussions with their students that focused on protection, monitoring and restoration of the ecosystem.

Reflection Phase (Environmental stewardship project): The students and teachers brainstormed an environmental stewardship activity; some teachers implemented the stewardship project with their students. For example, teachers and students could have organized or participated in a trash clean-up day around a local waterway or raised shad in their classroom (Chesapeake Bay Program, 2001).

The survey instrument used was the Testing the Watershed (MWEE) Investigation Teacher Survey (Appendix A). This questionnaire was developed by the investigator and included questions to address how teacher and school-specific factors impacted implementation of the three MWEE components. Independent variables that addressed teacher-specific factors included demographic information, teacher education

and training, environmental world-view and environmental literacy (Appendix A and Table 1). Demographic variables were measured including age, gender, political orientation and geographic location where the respondent grew up. Formal and informal education was measured using questions about type and level of degree received as well as time spent outside as a child and an adult. Teaching experience was measured using questions about number of years as a classroom teacher, experience with MWEE's and being the MWEE coordinator. Also, type of MWEE training received and confidence levels related to implementation post-training were assessed as well. Environmental worldview was measured utilizing the NEP scale (Dunlap et al., 2000). Environmental literacy was measured using a scale modified from the *National Geographic Society Survey 2001* (Witte et al., 2001; Mobley et al., 2010). See Table 1 for more detail on which questions assessed which variable. Independent variables that addressed school-specific factors included perceived administrative support, funding support, knowledge of school-based action strategies for completing a stewardship project and whether or not a concurrent stewardship project was running at the school site. These questions were measured using Likert-style questions (Table 1).

Dependent variables included completion of each component of the MWEE. The questions about MWEE implementation included questions assessing completion of the preparation, action and reflection phases to ascertain the extent to which each activity was completed. Finally, teacher-generated suggestions for improvement of MWEE curriculum and training were collected to determine what improvements could be made to ensure implementation of each MWEE component during subsequent school years.

See Table 1 for cross-referencing information about dependent variables and types of questions used to assess these variables. Some of the questions used to assess MWEE completion were modified from a NOAA survey completed to assess the effectiveness of MWEE programming (Kraemer et al., 2007).

Table 1: Variables and Corresponding Questions

Variables	**Measures (questions)**	**Type of Question(s)**
-Demographic impact: -Age -Gender -Political orientation -Geographic location	30-33	Multiple choice (MC)
-Education (formal/informal): -Type of degree -Level of education -Time spent in nature (child & adult)	Formal: 25-27 Informal: 28-29	MC, fill in the blank, mark all that apply
-Teaching experience: -# of years taught -experience with MWEE's -MWEE training and confidence -MWEE coordinator	11-14 23-24	MC
-Environmentalism: -Environmental world-view -Environmental literacy	21, 22	Likert scale, composite score
-School-specific environment: -administrative support -funding support -knowledge of action strategies -concurrent stewardship project	18	Likert scale
Suggestions for Improvement	3-5, 9, 16-17, 19	MC, short answer
Implementation of MWEE components -preparation phase (web activities) -action phase (field study) -reflection phase (stewardship)	2, 6, 15	MC

Data Collection

This study utilized a mixed-methods approach by collecting and analyzing both qualitative and quantitative data. The data collection method was a survey that was administered post-MWEE field study. The survey was called the "Testing the Watershed Investigation Teacher Survey" as this was the name of the curriculum and thus would be familiar to the respondents (Appendix A). The target population was e-mailed an online questionnaire by the school district's middle school science coordinator that utilized Google survey online. One week after the survey was emailed, a reminder email was sent to prompt responses. A final reminder e-mail was sent after two weeks to garner additional responses and to inform participants that the online window for taking the survey would be closed at the end of the three week data collection period.

In addition, the researcher e-mailed each school and offered to drive to each school site to meet with teachers to encourage participation and to answer any questions they might have. Two school sites requested these additional follow up meetings. These meetings were facilitated with the help of the middle school science coordinator and took place within the three week survey window.

Data Analysis

IBM SPSS Statistics Data Editor 21 was used to analyze the quantitative data from the survey. Before data were imported into SPSS, verbal descriptions were re-coded into numerical representations of the data using look-up tables in Microsoft Excel. Once the data were in SPSS, further recoding occurred to create categories of responses. Demographic information including gender, age, political orientation and geographic location was recoded into categories (see Table 2 for detailed SPSS recoding information).

Formal education items were recoded into categories and two variables were created; type of education and level of education. Type of education was recoded in Microsoft Excel into categories based on the self-reported major or degree type received. These categories combined degrees received in undergraduate and graduate programs. The categories created included five classifications: non-natural science and non-education, education, natural science, education with natural science and education with a secondary science concentration. Informal education was measured by asking about the number of outdoor activities a participant engaged in as a child and as an adult and then adding up all the activities to create a composite score. The numerical scores were then grouped into categories that included small, moderate and plentiful time spent outside in nature (Table 2).

Items related to number of years of experience with teaching and MWEE's was recoded to create categories which included first year teachers, teachers developing proficiency (2-6 years of experience) and veteran teachers (teachers with 7 or more years

of experience). MWEE training was recoded based on type of training received; no training, turn-around training or external training. Confidence about MWEE implementation was also recoded into not confident, unsure and confident (Table 2).

The items on environmental literacy were converted to a numerical scale based on individual experiences that respondents had to each piece of environmental literature (whether they had read and recommended, read, heard of or never heard of the book). Then the answers were summed to create a numerical literacy scale based on the seven items (0-21) with a higher score indicating recognition and perusal of environmental books, which in this study will be used as an indicator of environmental literacy. These scores were then recoded into two groups; not environmentally literate and environmentally literate (Table 2).

This survey utilized questions from the revised New Ecological Paradigm scale (Dunlap et al., 2000) to measure environmental worldview (question 21). The revised NEP scale includes five categories: limitations to human growth (1,6,11), antianthropocentrism (2,7,12), fragility of nature's balance (3,8,11), rejection of exemptionalism (4,9,14) and the possibility of an ecocrisis (5,10,15) (Dunlap et al., 2000). The eight odd-numbered questions are worded in a pro-ecological fashion and the seven even-numbered questions are worded in an anti-ecological manner. This scale has alpha coefficient of .83 which means that the composite score can be used to measure a single construct, in this case, environmental world-view (Dunlap et al., 2000). An ecological world-view score was calculated by assigning numerical values to the Likert-style answer choices. The answer choices were reverse-numbered for the negatively

worded questions, and a mean score was calculated by averaging together all answers. A pro-environmental world-view score is closer to five while an anti-environmental world-view score is closer to one. In SPSS, this was recoded to create two categories; negative or neutral environmental world view and positive environmental world view (Table 2).

Items related to school site environment were recoded into new categories as well. These variables included administrative support, funding support, knowledge of action strategies and current environmental stewardship projects at the schools. The responses were recoded into two categories; disagree or undecided and agree (Table 2).

Categories were also created for implementation of components of the MWEE (Table 2). For instance, the preparation phase (the web-based pre-lab), was categorized into: did not complete, partially completed and completed. The action phase (field-study) was categorized into: did not complete or partially completed and completed. The reflection phase (environmental stewardship project), was categorized into: did not complete and brainstormed or completed the stewardship project. In addition, the reflection phase was also analyzed in its uncategorized groups which included did not complete, brainstormed and completed stewardship project.

The teacher-specific and school-site specific variables were compared to variables related to implementation of the three MWEE components using chi-squared analysis to ascertain whether there were statistically significant relationships between the independent and dependent variables. The variables that showed a statistically significant relationship to implementation of the reflection component of the MWEE (the

stewardship project) were then used to create a logistic regression model with implementation of the reflection phase (stewardship project) as the dependent variable.

Table 2: SPSS Recoding Information by Variable

Variables	SPSS Recoding Information	Questions
Age	21-30 = 0, 31-40 = 1, 41-50 = 2 and 51 or older = 3	30
Gender	male = 0, female = 1	31
Politics	0 = conservative, 1 = moderate, 2 = liberal	32
Geographic region	0 = urban, 1 = rural, 2 = suburban	33
Type of degree	Non-natural science, non-education degree = 0, education = 1, natural science = 2, education with natural science = 3, education with a secondary science concentration = 4	31-33
Level of education	Bachelor's degree = 0, Bachelor's degree with some master's work = 1, Master's degree = 2, PhD or other professional degree = 3	31-33
Time spent outside (as a child and as an adult)	Small amount of time outside (1-4) = 0, Moderate amount of time outside (5-7) = 1 and Plentiful time spent outside (8- 11) = 2	28-29
Teaching and MWEE experience	first year = 0, 2-6 years = 1, 7 or more years = 2	14, 23, 24
MWEE training	no training = 0, turn-around training = 1, attended external training = 2	11
MWEE confidence	not confident = 0, unsure = 1, confident = 2	12
MWEE coordinator	no = 0, yes = 1	13
Environmental literacy	Read and recommended = 3, read = 2, heard of = 1, never heard of =0 (Summed to create composite score; composite score recoded into: 0-7 was "not environmentally literate" = 0 and 8-16 "was environmentally literate" = 1)	22

Variables	SPSS Recoding Information	Questions
Environmental world-view (NEP)	Answers summed based on NEP guidelines to create world-view score-scores were recoded into: 0-3 "Negative or neutral environmental worldview" = 0 and 3.01-5 "Positive environmental worldview" = 1	21
School-specific factors (Likert)	disagree = 0, undecided = 1, agree = 2	1, 18
Suggestions for improvement	Qualitative; grouped into categories based on response information	3-5, 9, 16-17, 19
Implementation of MWEE component 1 (preparation phase)	did not complete = 0, partially completed = 1, completed = 2	2
Implementation of MWEE component 2 (action phase)	did not complete or partially completed = 0, completed = 1	6
Implementation of MWEE component 3 (reflection phase)	did not complete = 0, brainstormed or completed stewardship project = 1	15

Finally, short answer questions that generated participant suggestions for improvement to the MWEE curriculum with regards to increasing implementation were analyzed in Excel to look for patterns in the responses. Responses were broken down by component of the MWEE that they addressed and then categorized based on theme of the response. Recommendations for improvements to the MWEE curriculum were generated based on the majority of thematic responses in the qualitative data while also considering the trends in the quantitative data.

RESULTS

Data were collected to measure teacher-specific and school-specific variables that could impact MWEE implementation. Teacher specific characteristics included demographic factors, education (both formal and informal), environmental world-view, environmental literacy, teaching experience and experience with MWEE's. The sample was made up of 51 teachers, which is approximately 33% of the roughly 150 middle school life science teachers in the county (number estimated by the middle school science specialist). Ages ranged from 22 upward with the majority of the population (58%) over the age of 41 (Table 5). There were a disproportionate number of females (72%) compared to males (28%). Political orientation varied as well with more participants identifying as liberal (42.1%) or moderate (34.2%) when compared to conservative (23.7%). The majority of the participants grew up in a suburban setting (70%) followed by an urban (20%) or rural setting (6%) (Table 5, Figure 1).

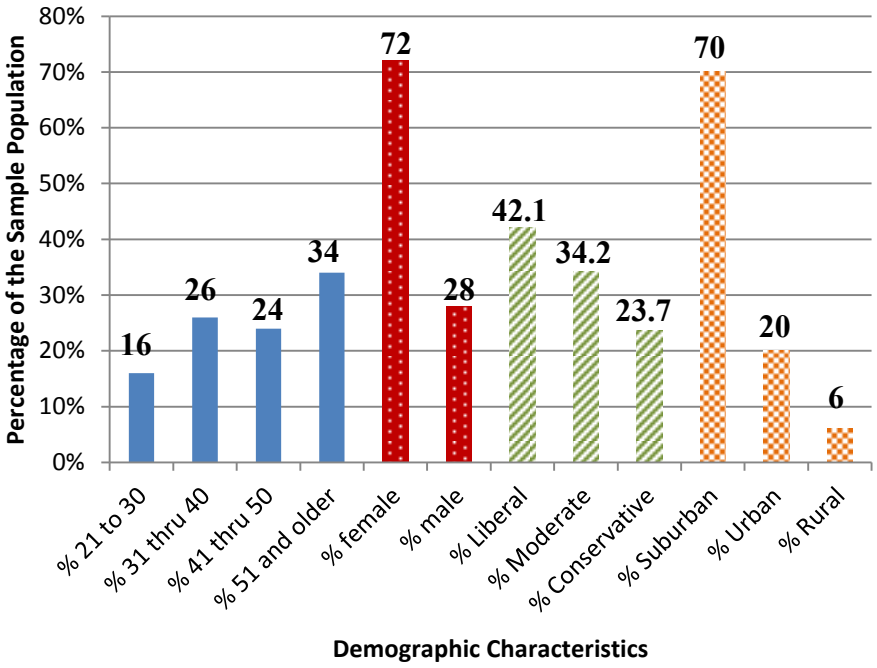

Figure 1: Frequency information for demographic variables (teacher-specific characteristics)
***numbers on the figure represent percentages**

The sample was very well educated; the majority of participants had a master's degree (76%) or a PhD (2%) There was also a fairly even break down based on type of degree received split between education (22%), natural science (22%), education and natural science (28%) and education with a concentration in secondary science (20%) (Table 6, Figure 2).

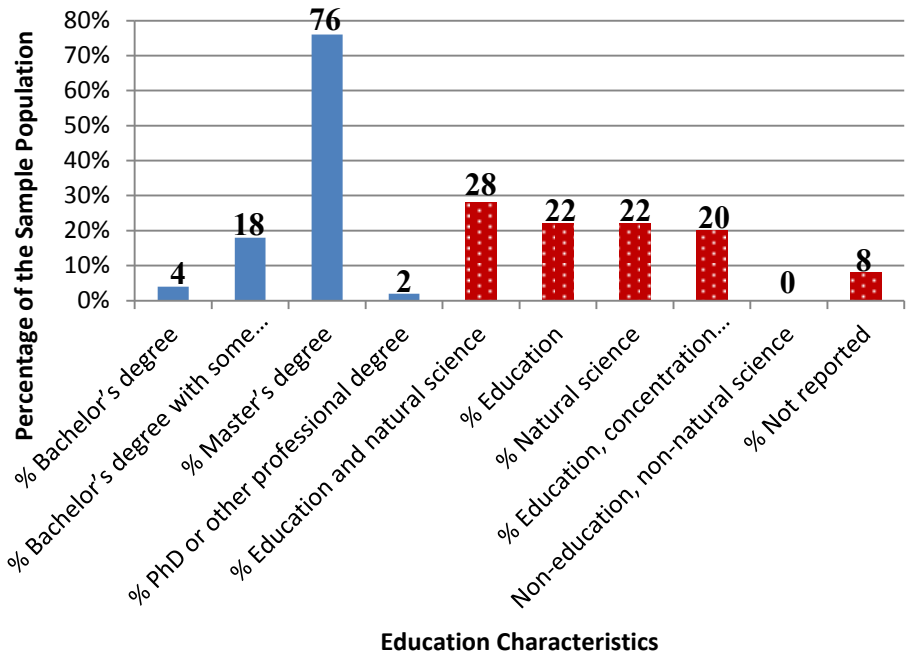

Figure 2: Frequency information for educational variables
***numbers on the figure represent percentages**

Participants received an environmental literacy score based upon their familiarity with different environmental literature (Appendix A, question 21). These composite scores were then split into not environmentally literate (participants who had not read or heard of most of the environmental literature queried) or environmentally literate (participants who had read or heard of most of the environmental literature queried). Participants were evenly split between the two categories: not environmentally literate at 51% and environmentally literate at 49% (Table 7, Figure 3). Participants also received an environmental world view score using the NEP scale classified into two categories; neutral or negative ecological world view (15.7%) and pro-ecological world view (80.4%) (Table 7, Figure 3). Finally, participants were queried about time spent outside

as a child and as an adult. Two "time spent outside" scores were calculated based on the number of outdoor activities in which they participated as children and as adults. These scores were then divided into three categories; small, moderate and large amount of time spent outside. Time spent outside as a child was fairly evenly dispersed between the three categories with moderate amount of time outside as the largest category 43.1%, then small amount of time at 29.4% and large amount of time at 27.5%. The same pattern was observed when time spent outside as an adult was measured: moderate (45.1%), small (33.3%) and large (21.6%) (Table 7, Figure 3).

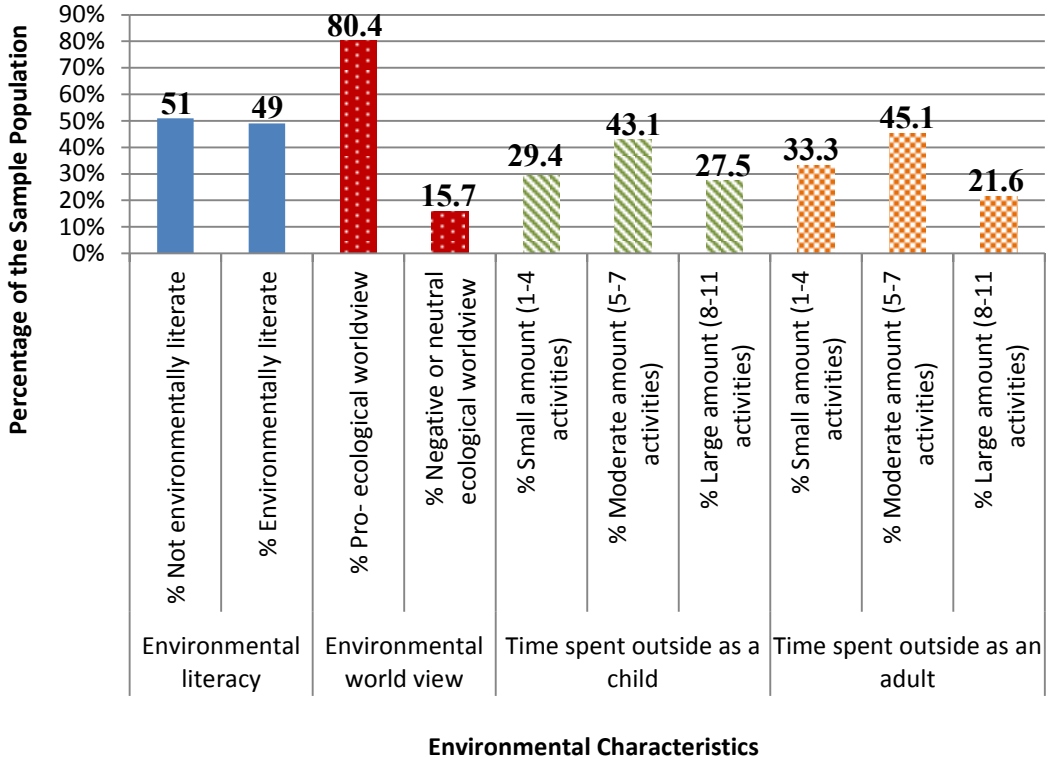

Figure 3: Frequency information for environmental variables
***numbers on the figure represent percentages**

The majority of participants had taught for 7 or more years (76%) followed by two to six years (20%) (Table 8, Figure 4). Participants had slightly less experience with MWEE's then they did with teaching; the majority of participants had two to six years of MWEE experience (74%), followed by seven or more years (14%) with the smallest percentage indicating that it was their first year with the MWEE (12%) (Table 8, Figure 4). Finally, most teachers attended MWEE training outside of the school (62.7%) or were trained by other teachers at their own school (turn-around training) (21.6%), while a smaller group of teachers had not attended training (15.7%). Also, most of the participants were not the MWEE coordinator at their school sites (76.5%) (Table 8, Figure 4). However, the percentage of MWEE coordinators that responded (23.5%) was disproportionately larger than the percentage of MWEE coordinators found in the total population (18%).

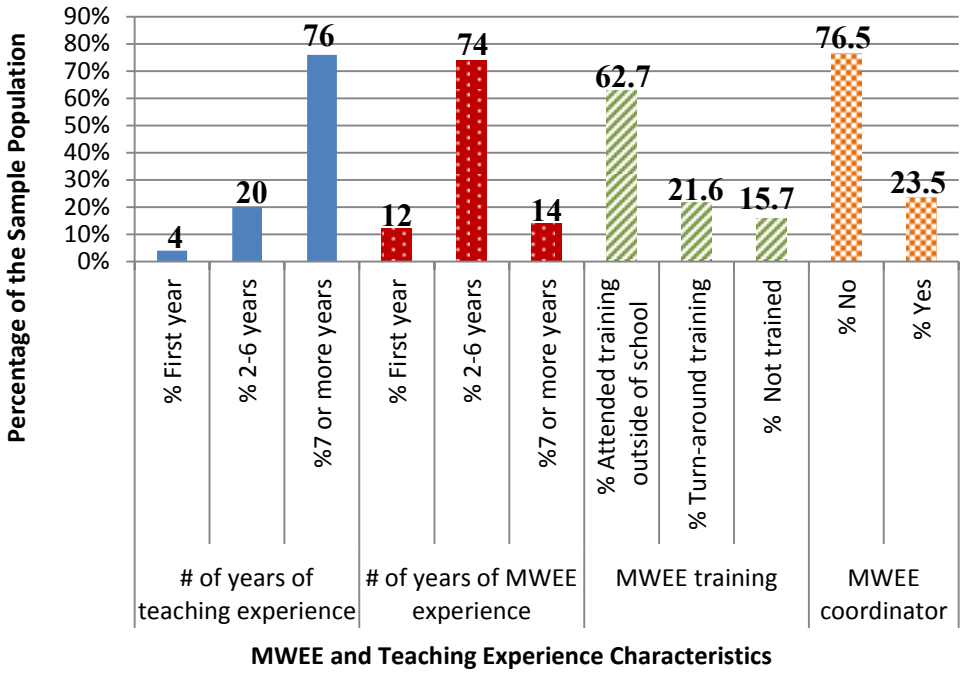

Figure 4: Frequency information for teaching experience
***numbers on the figure represent percentages**

Data were also collected for school-site specific variables including administrative support, funding support, knowledge of action strategies related to implementing a stewardship project and concurrent stewardship projects on the school site. The majority of respondents felt that their administration was supportive of stewardship projects (74.5%) followed by respondents who were undecided (25.5%). A small number of respondents felt that their administration was not supportive of stewardship projects (Table 9, Figure 5).

Respondents were then asked whether they felt like they had access to funding necessary to complete stewardship projects on their school site. The majority of respondents felt that funding was not readily available (60.8%) (Table 10, Figure 6).

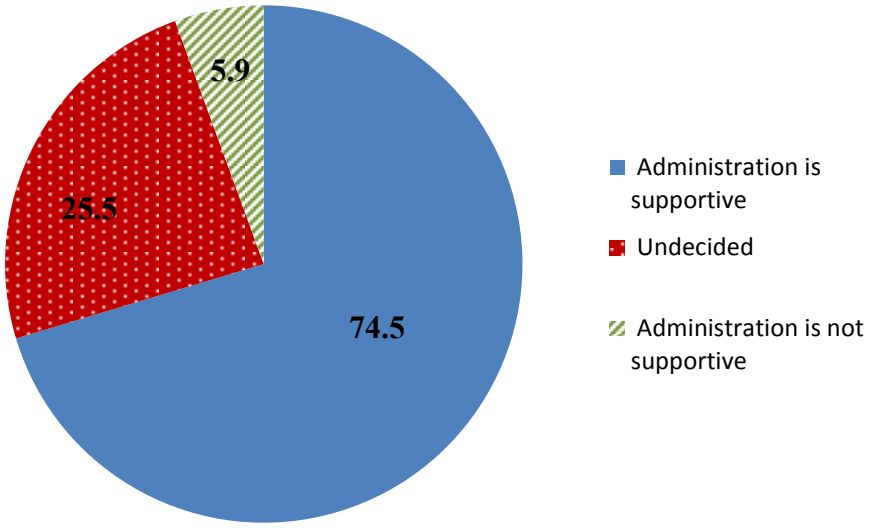

Figure 5: Frequency information for administrative support
***numbers on the figure represent percentages**

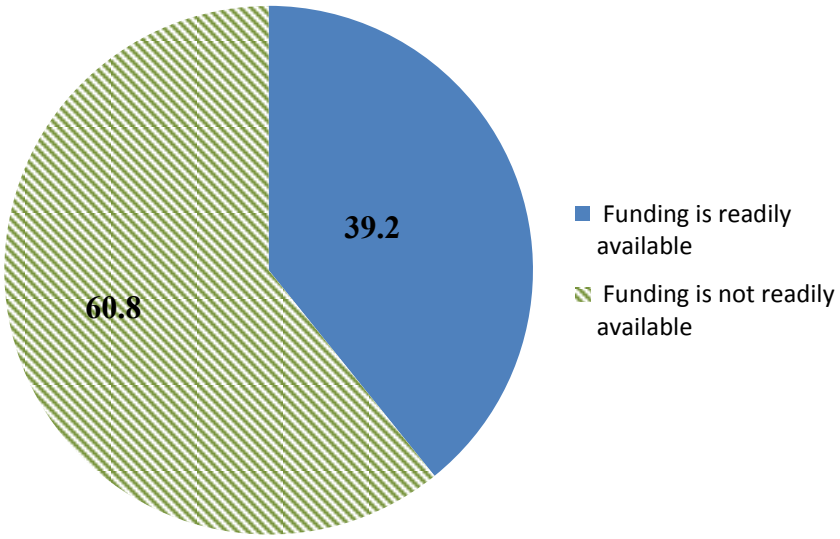

Figure 6: Frequency information for funding support
***numbers on the figure represent percentages**

Next, respondents were asked whether they had the knowledge of action strategies necessary to complete stewardship projects on their school site. Most respondents felt that they did now know the appropriate action strategies necessary to complete the stewardship projects (72.5%). Only slightly over a quarter or respondents felt that they knew action strategies necessary for completing stewardship projects (27.5%) (Table 11, Figure 7).

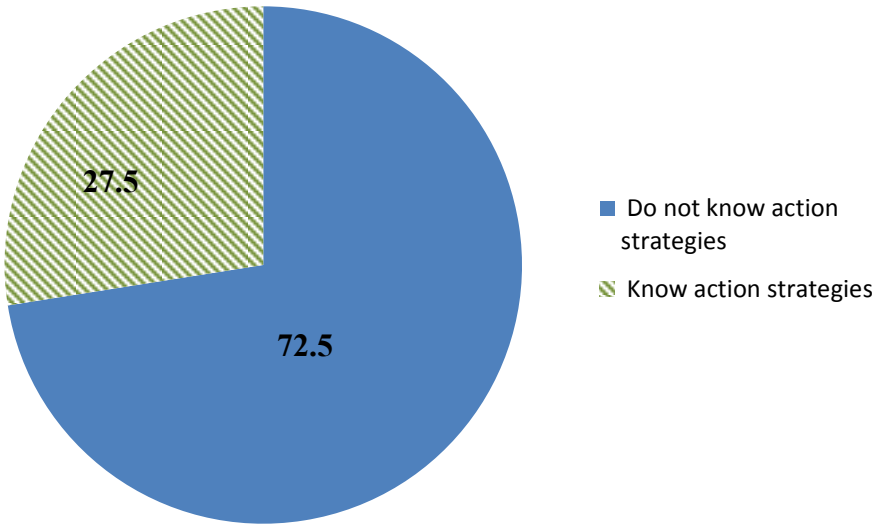

Figure 7: Frequency information for knowledge of action strategies
***numbers on the figure represent percentages**

Finally, respondents were asked whether there was a concurrent stewardship project on their school site. Less than a third of respondents indicated that there was a current stewardship project on their school site (29.4%). Most respondents were indicated that there was not a concurrent stewardship project on their school site or that

they were unsure about whether their school site had a stewardship project (70.6%) (Table 12, Figure 8).

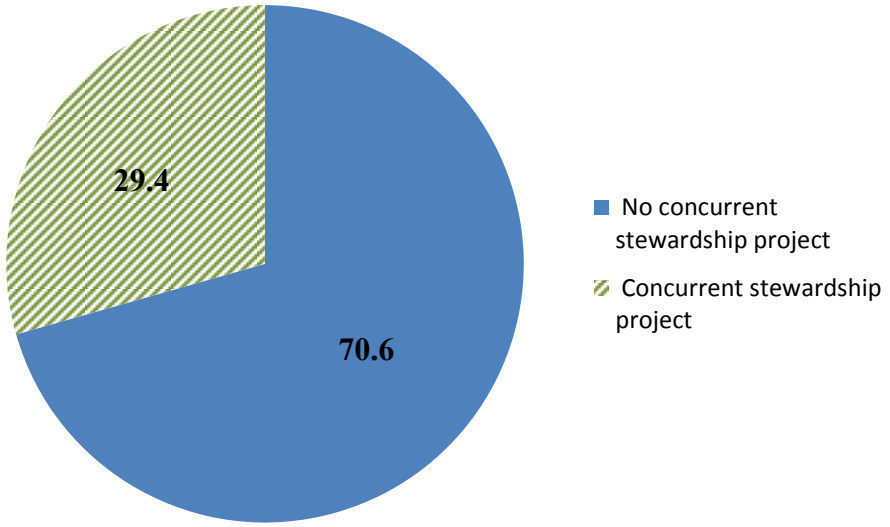

Figure 8: Frequency information for concurrent stewardship project
***numbers on the figure represent percentages**

Frequencies were also ascertained for completion of the three components of the MWEE; the preparation, action and reflection phases. For the preparation phase (web activities), individuals that completed this component of the MWEE made up the largest response category (40%). The majority of respondents (60%), however, only partially completed (30%) or did not complete (30%) this component of the MWEE (Table 13, Figure 9).

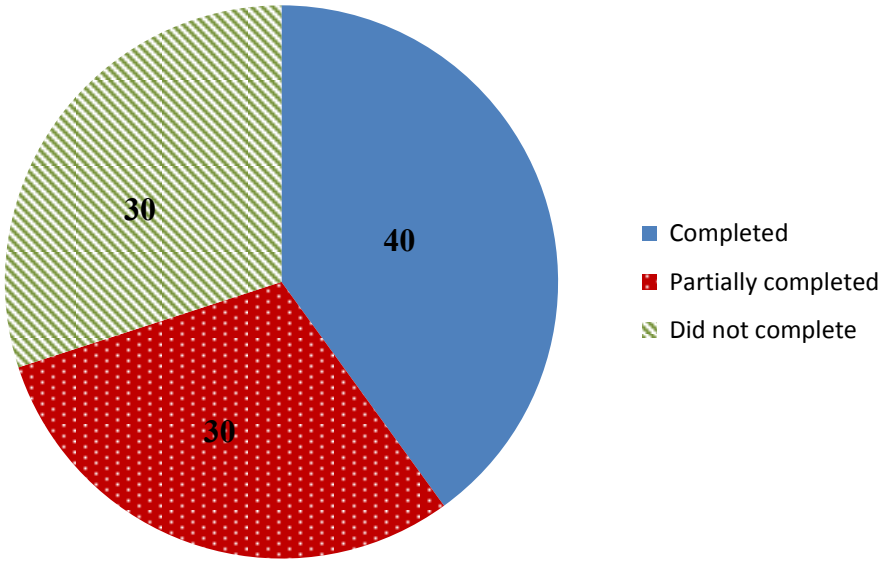

Figure 9: Frequency information for completion of the preparation phase of the MWEE (web activities)
***numbers on the figure represent percentages**

The majority of respondents completed the action phase which was the MWEE field study. 82.4% of respondents completed this part of the MWEE with their students, while 17.6% of respondents did not complete or only partially completed this component of the MWEE (Table 14, Figure 10).

Finally, respondents were asked whether they completed the reflection phase of the MWEE where they were asked to brainstorm and possibly implement an environmental stewardship project with their students. There was a relatively even split with more respondents not completing the project with their students (58.3%) and slightly fewer respondents brainstorming or completing the stewardship project with their students (Table 15, Figure 11).

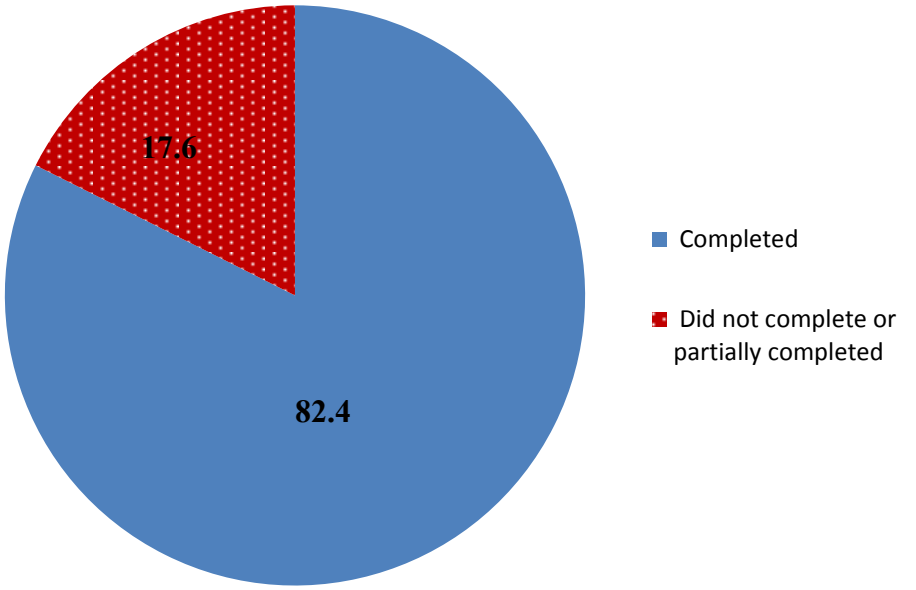

Figure 10: Frequency information for completion of action phase
***numbers on the figure represent percentages**

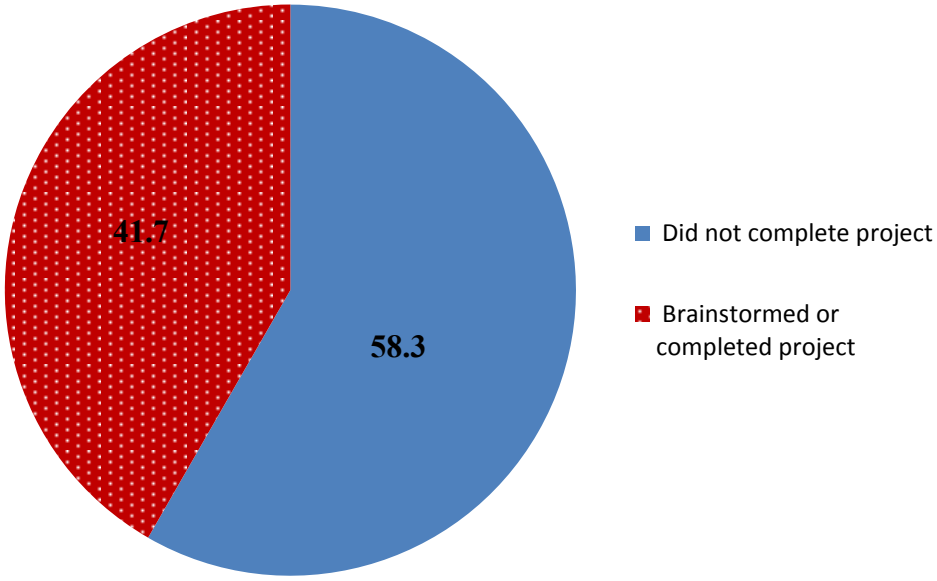

Figure 11: Frequency information for completion of reflection phase
***numbers on the figure represent percentages**

Chi squared analyses were completed to determine whether there were statistically significant relationships between variables related to teacher characteristics and school-site environment when compared to completion of MWEE components. The MWEE components were each analyzed separately based on the categories created by the Chesapeake Bay Program's definition of a MWEE as a three part cycle (Chesapeake Bay Program, 2001). The three components of the MWEE were the preparation phase (web-based activities) the action phase (MWEE field study) and the reflection phase (environmental stewardship project).

These components were categorized as previously discussed in the data analysis section. A brief summary of these categorizations follows. The preparation phase responses were placed into three categories; did not complete, partially completed and completed the web-activities. This is indicated in Table 3 below as "cat". The action phase was categorized into did not fully complete versus completed field study which is also indicated in Table 3 below as "cat". The reflection phase was categorized into did not complete a stewardship project versus brainstormed or completed a stewardship project which is also indicated in Table 3 below as "cat". Finally, the variables for the reflection phase were also analyzed using uncategorized data which included three categories: did not complete, brainstormed project and completed project indicated by the word "uncategorized" in Table 3 below. This was done because teachers were only required to brainstorm a stewardship project. The categorized data creates two categories, teachers that completed what was expected and teachers that did not do what

was expected. The uncategorized data parses this information out to isolate teachers that went beyond what was expected by implementing the stewardship project.

The first teacher-specific characteristics measured were demographic variables. The chi squared analyses showed that there were no statistically significant relationships between demographic variables including age, gender, political orientation and geographic location during youth and completion of each specific MWEE component (see Table 3). In addition, there were no statistically significant relationships between the education variables including type and level of education and time spent outside as a child and adult and specific MWEE component completion (Table 3). Also, there were no significant relationships between environmental literacy, environmental worldview, experience with MWEE's, teaching experience, MWEE training and confidence and completion of any of the MWEE components (Table 3).

The chi square analyses between teacher-specific characteristics and completion of each distinct component of the MWEE showed only one significant relationship. The significant relationship was between being the MWEE coordinator and completion of the reflection phase (stewardship project) (Table 3, Table 16 and Figure 12).

Table 3: p-values for teacher and school specific variables and completion of MWEE components

	Preparation phase (cat) (web activities)	Action phase (cat) (MWEE field study)	Reflection phase (cat) (stewardship project)	Reflection phase (not categorized) (stewardship project)
Demographic Variables				
Age	.243	.659	.967	.997
Gender	.634	.225	.825	.496
Political Orientation	.811	.650	.721	.741
Geographic location	.464	.811	.609	.676
Education				
Level of Education	.217	.375	.948	.685
Type of Education	.077	.509	.065	.192
Time spent outside as child	.858	.352	.127	.220
Time spent outside as adult	.976	.183	.909	.990
Environmentalism				
Environmental literacy	.982	.108	.369	.656
Environmental world view	.438	.468	.583	.350
Teaching Experience				
Experience with MWEE's	.693	.357	.319	.426
MWEE training	.203	.645	.347	.679
MWEE coordinator	.599	.333	**.043***	.117
Confidence after training	.621	.359	.243	.082
School Specific Environment				
Administrative support	.538	**.028***	.146	.359
Funding support	.196	.723	**.029***	**.041***
Action strategies for stewardship project	.967	.663	**.018***	**.009***
Current project	.418	.602	**.007***	**.024***
Sample Size	48			

***=p≤.05, relationship is statistically significant**

Based on the results above, most teacher characteristics did not impact MWEE completion in a statistically significant way with one exception. There was a statistically significant negative relationship between being the MWEE coordinator and completion of the reflection phase (Table 3, Table 16 and Figure 12). MWEE coordinators were less likely than non- coordinators to take action with their students during the reflection phase and implement a stewardship project ($p<.043$, $n=48$). However, MWEE coordinators were more likely to answer the survey when compared to the general population.

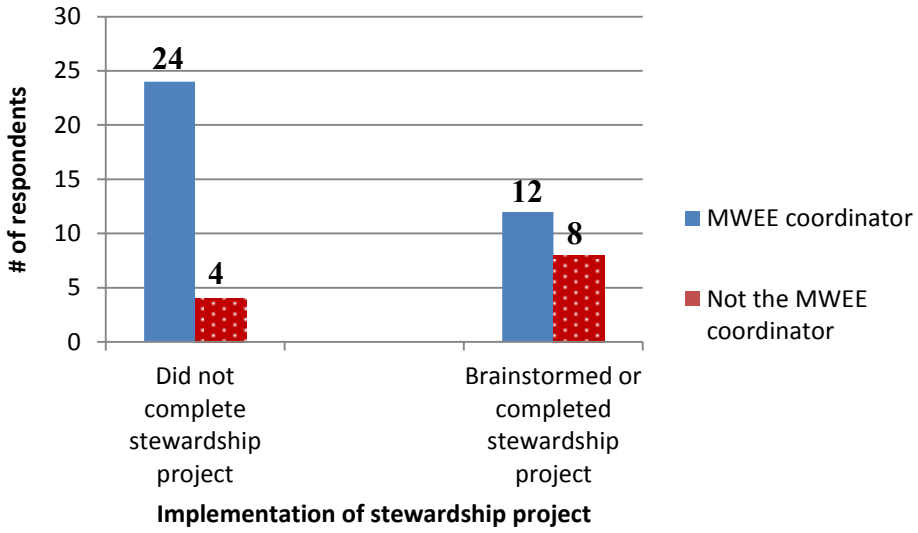

Figure 12: MWEE coordinator compared to completion of stewardship project
***numbers on the figure represent number of respondents**
p<.043, n=48

MWEE training did show a statistically significant relationship with completion of the MWEE components; however, training did show a statistically significant relationship with overall confidence in MWEE implementation (p<.005, n=51), (Figure 13, Table 17). The majority of teachers, 23 of 32, that went to MWEE training outside of the school felt confident about their ability to implement the MWEE while there were no teachers that felt confident about MWEE implementation if they did not attend training (8 teachers). Teachers that were trained by other teachers were divided between not being confident (3), being unsure (3) and being confident (5) (Figure 13, Table 17). Though teachers that attended training felt more confident about MWEE implementation, there was no statistically significant relationship between confidence and MWEE implementation, showing that confidence is not sufficient to ensure implementation (Table 3).

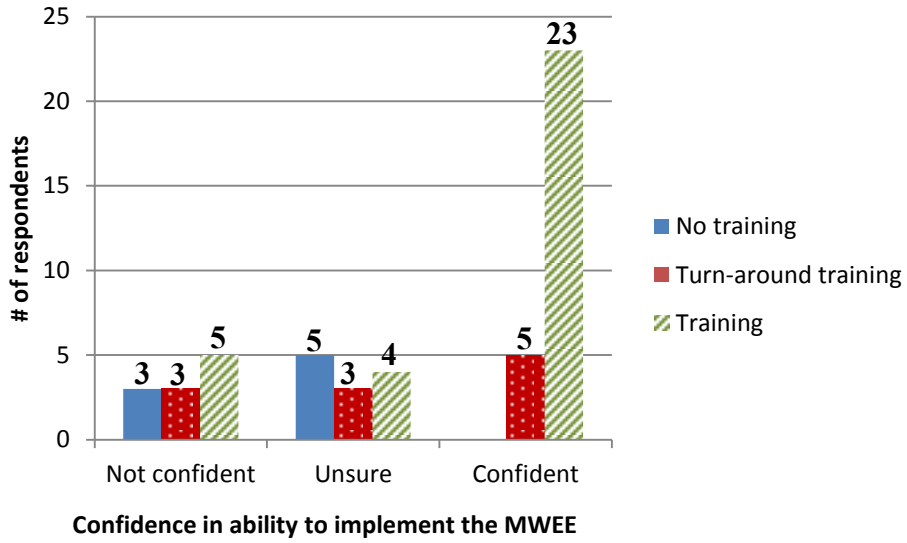

Figure 13: MWEE training compared to confidence in MWEE implementation
***numbers on the figure represent number of respondents**
p<.005, n=51

The school-site specific variables showed a clustering of significance with implementation of different components of the MWEE. These variables included perceived administrative support, funding support, knowledge of action strategies related to implementation of stewardship projects and concurrent environmental stewardship project at a school site. Perceived administrative support showed a statistically significant relationship to completion of the action phase (MWEE field study) ($p<.028$, $n=51$). The majority of the teachers who indicated administration was supportive completed the field study, while two thirds of those surveyed that felt administration was not supportive did not complete the MWEE field study (Table 18, Figure 14).

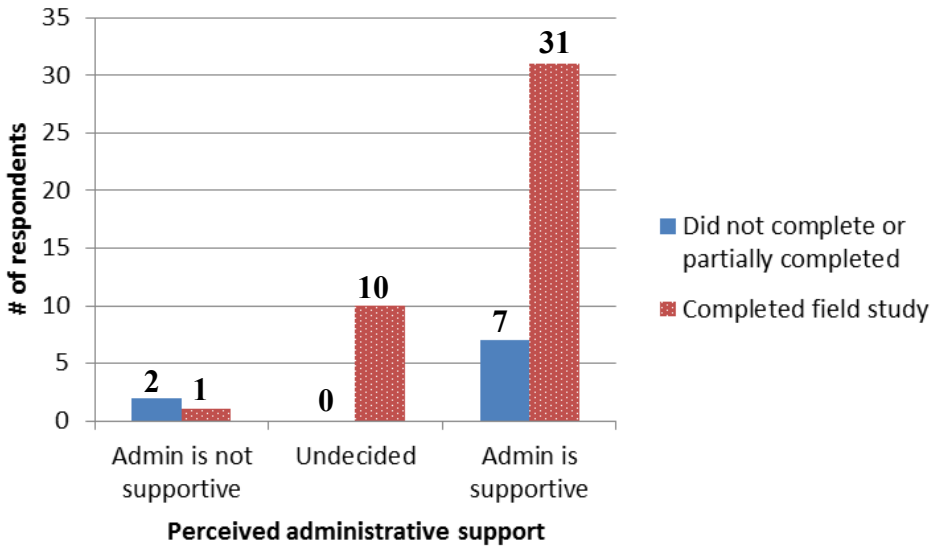

Figure 14: Relationship between administrative support and completion of action phase (categorized)
***numbers on the figure represent number of respondents**
p<.028, n=51

Funding for environmental stewardship projects showed statistically significant positive relationships to completion of the reflection phase when this variable was categorized (p<.029, n=48) and when it was not categorized (p<.041, n=48). Figure 15 and Table 19 show that respondents that did not think funding was available or were unsure of its availability were much less likely to take action on the stewardship project (20 out of 28 took no action) when compared to teachers that felt that funding was available (only 8 out of 20 took no action). Figure 16and Table 20 show the same data with an uncategorized dependent variable (the reflection phase). Figure 16 illustrates that funding availability seems to have the biggest impact on whether teachers attempted to complete any portion of the reflection phase. Also, teachers that felt that funding was

available were more likely to complete a stewardship project (8 out of 20 or 40%) than teachers that did not feel that funding was available (3 out of 28 or 10.7%).

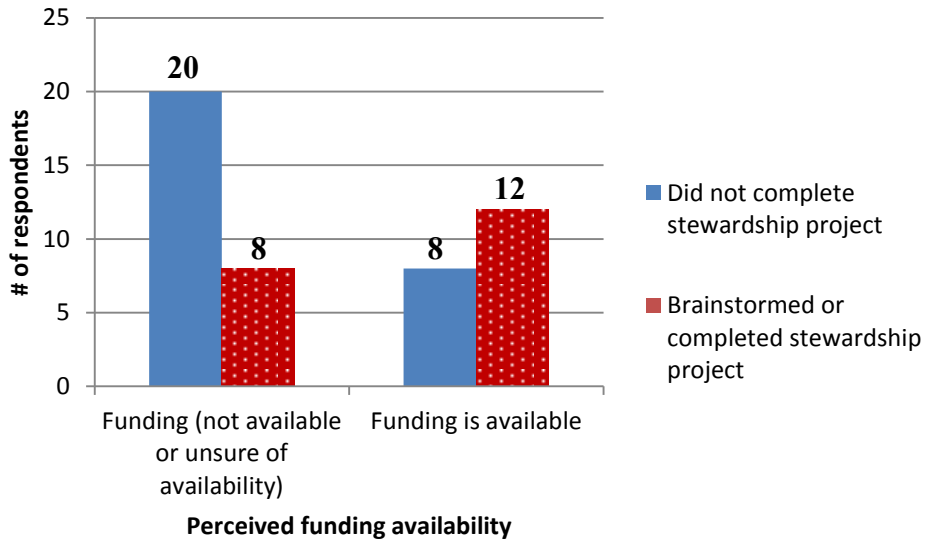

Figure 15: Funding for projects compared to completion of the reflection phase (categorized)
***numbers on the figure represent number of respondents**
p<.029, n=48

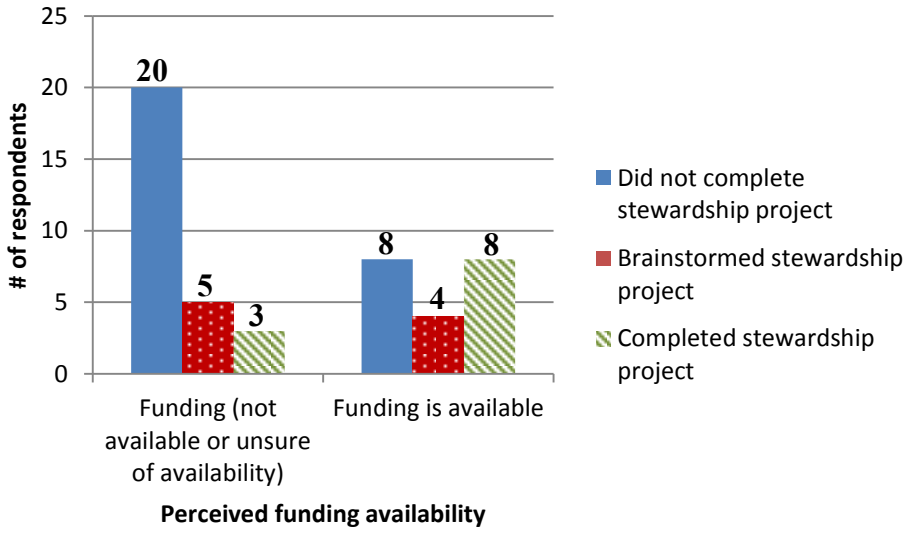

Figure 16: Funding for projects compared to completion of the reflection phase (uncategorized)
***numbers on the figure represent number of respondents**
p<.041, n=48

Knowledge of how to take action to complete an environmental stewardship project showed statistically significant positive relationships to completion of the reflection phase when it was categorized ($p<.018$, $n=48$) and when it was uncategorized ($p<.009$, $n=48$). Again, these findings show that knowledge of action strategies has the biggest impact on whether or not teachers attempted to complete any portion of the reflection phase. When unsure of action strategies, 24 out of 35 took no action compared to those that knew action strategies (4 of 13 took no action) (Table 21, Figure 17). Unlike funding availability, knowledge of action strategies does not seem to increase completion of a stewardship project which is illustrated by Figure 18 and Table 22. 8 of 35 (22.9%) of respondents who did not know action strategies completed stewardship projects compared to 3 of 13 (23.1%) of respondents who did know action strategies.

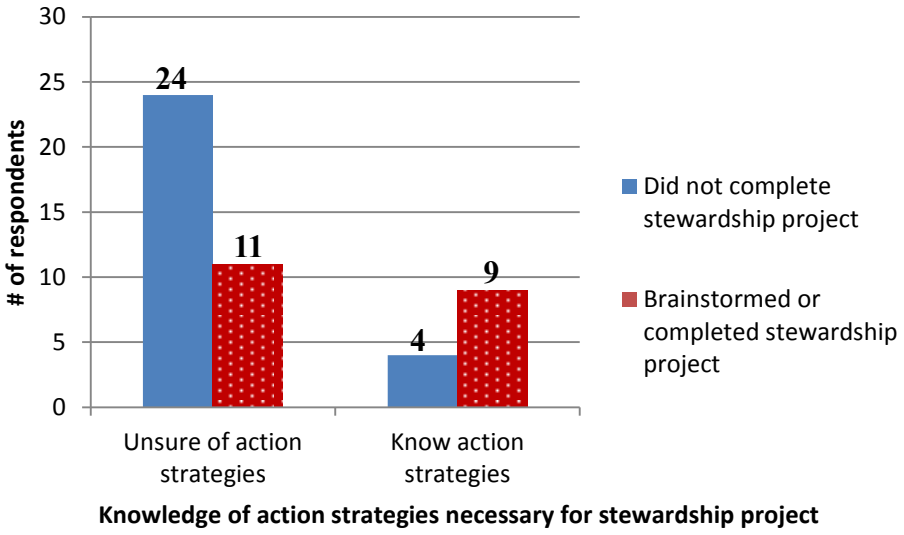

Figure 17: Knowledge of action strategies compared to completion of the reflection phase (categorized)
***numbers on the figure represent number of respondents**
$p<.018$, $n=48$

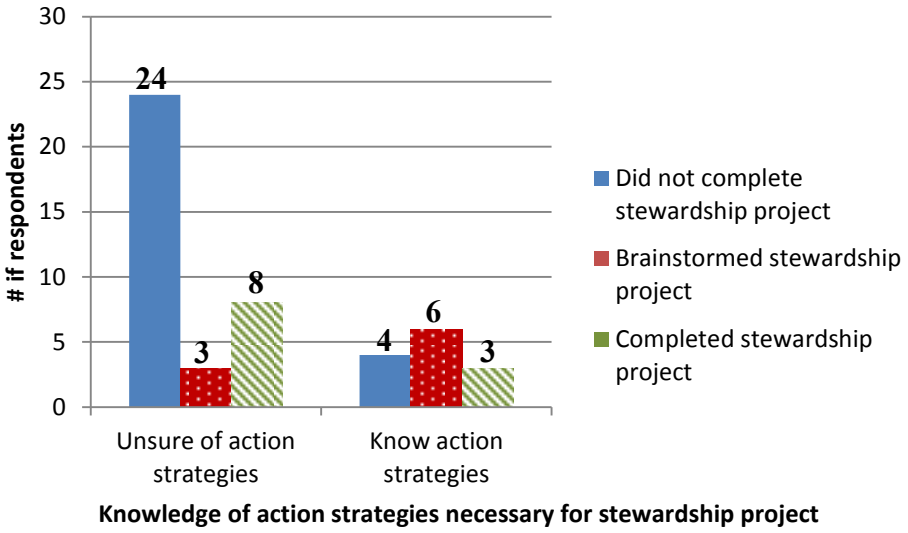

Figure 18: Knowledge of action strategies compared to completion of the reflection phase (uncategorized)
***numbers on the figure represent number of respondents**
p<.009, n=48

Finally, there were statistically significant positive relationships between schools with concurrent stewardship projects and completion of the reflection phase when it was categorized (p<.007, n=48) and when it was uncategorized (p<.024, n=48). The majority of teachers at school sites with current stewardship projects brainstormed or completed stewardship projects with their students (10 out of 14 or 71.4%) while those that were had no current stewardship project or were unsure about whether they had a current project were much less likely to complete a stewardship project (10 out of 34 or 29.4%) (Figure 19, Table 23). Figure 20 and Table 24 illustrate that when brainstorming and completing the stewardship project are split into two separate categories, concurrent stewardship project has an impact on going beyond brainstorming and actually completing the stewardship project. Teachers at schools with concurrent stewardship projects are much

more likely to implement their own stewardship projects (5 out of 14 or 35.7%) when compared to schools without stewardship projects (6 out of 34 or 17.6%).

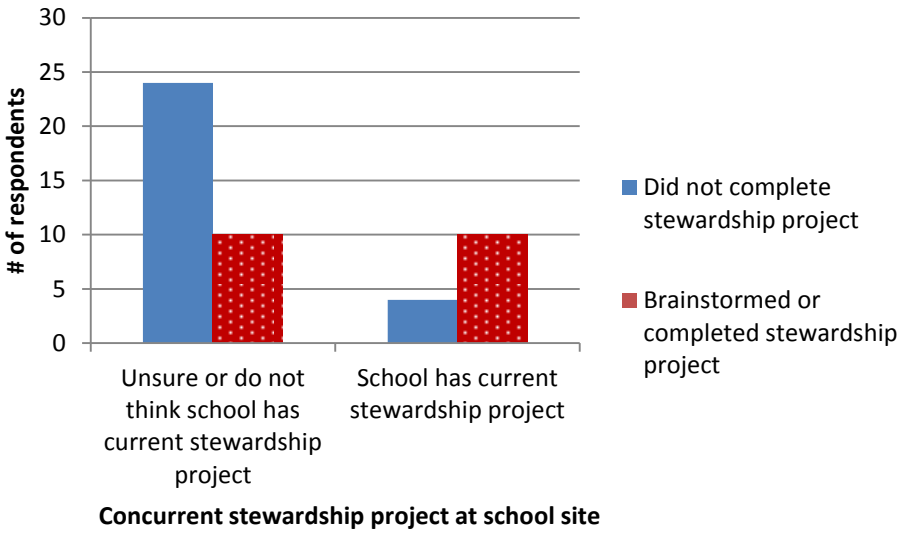

Figure 19: Current stewardship project compared to completion of the reflection phase (categorized)
***numbers on the figure represent number of respondents**
p<.007, n=48

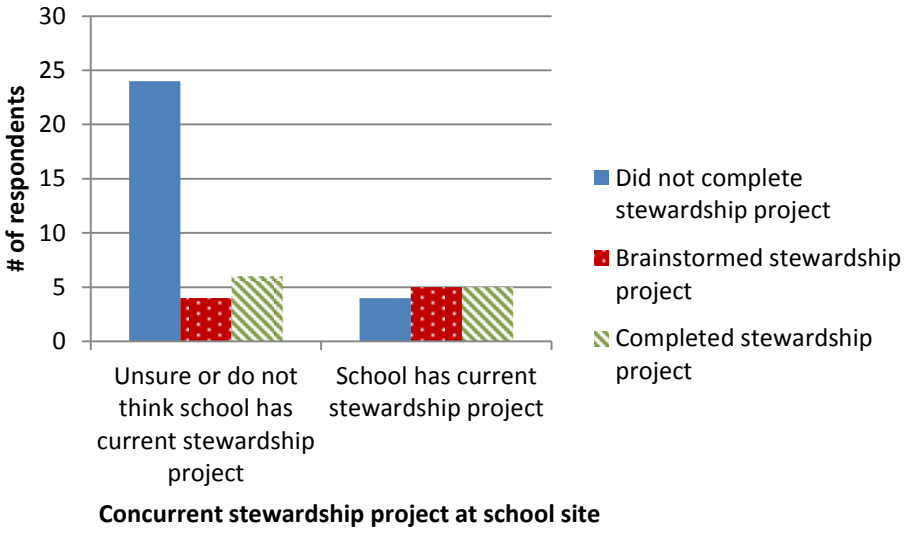

Figure 20: Current stewardship project compared to completion of the reflection phase (uncategorized)
***numbers on the figure represent number of respondents**
p<.024, n=48

A logistic regression model was created using school-site specific variables to predict whether teachers would brainstorm or complete a stewardship project (compared to not completing the stewardship project at all). A binary logistic regression model was used because this model can be used to predict an outcome for a dichotomous dependent variable when the independent variables display a mixture of types including continuous, discrete and dichotomous data. A logistic regression model is appropriate for this data set because it does not make assumptions about the distributions of the predictor variables (Garson, 2012). The three independent variables included were perceived administrative support, availability of funding and current environmental stewardship project. The responses to these variables were grouped into two categories: "disagree or undecided" and "agree". The dependent variable was completion of the reflection phase of the MWEE through brainstorming or completing a stewardship project (Table 4).

Table 4: Logistic regression (ability of school-site specific variables to predict completion of reflection phase)

	B	S.E.	Wald	df	p value	Exp(B)
Admin support at school	-.079	.849	.009	1	.926	.924
Funding support at school	1.036	.675	2.361	1	.124	2.819
Current project at school	1.580	.767	4.240	1	.039	4.857
Sample Size	48					

The logistic regression coefficient B for administrative support was slightly negative, and Exponentiated B for this variable was slightly below one (B=-.079, Exp(B)=.924) indicating that administrative support had a small negative impact on completion of the MWEE, however, this result was not statistically significant (p<.926, n=48) and this result is likely not meaningful (Table 4). The logistic regression coefficient B for funding was slightly above one (1.036) and the Exponentiated B for this

variable was above one (2.819) indicating that funding support has a positive impact on MWEE completion (Table 4). This result was also not statistically significant ($p<.124$, $n=48$), however, this is close to significant and the results overall do seem meaningful as funding support should increase completion of the stewardship project. The results for having a current project at the school were statistically significant ($p<.039$, $n=48$). The logistic regression coefficient B was positive ($B=1.580$, $n=48$) indicating that this variable increases the probability of completion of the stewardship project. The Exponentiated B for this variable was well above 1 (4.857) indicating that implementation of the stewardship project is 400% more likely when teachers work at schools with current environmental stewardship projects (Table 4).

The omnibus test of model coefficients for goodness of fit was significant ($p<.022$, $n=48$) indicating that this model is a good predictor of completion of the stewardship project based on school-site specific variables. Also, the classification table indicated that this model predicted 70.8% of the answers as compared to 58.3% explanatory power when using the base model (the mode). This shows that the expanded model using the school site specific variables increases predictive power by 12.5% with a cut value of .500.

Quantitative data were collected to examine what teacher and school site characteristics impacted completion of all three of the MWEE components. In addition, qualitative data were collected regarding challenges teachers faced while completing each section of the MWEE and what they did to improve the curriculum. Teachers were asked what types of modifications to the curriculum and what types of resources would improve

implementation of each component of the MWEE. The preparation phase required students to go online to the CBF's website and utilize GIS mapping data to increase knowledge about the Chesapeake Bay. Teachers were asked to identify challenges they faced when implementing this part of the MWEE experience and were allowed to choose more than one answer. Most teachers cited lack of time (25 responses), difficulty of reading level (20), no access to computers (16) and lack of student motivation (14). A few teachers chose student's inability to use computers (5). Other reasons included old computers that couldn't support the programming, lack of student lab experience and lack of understanding by the teacher (Table 25, Figure 21).

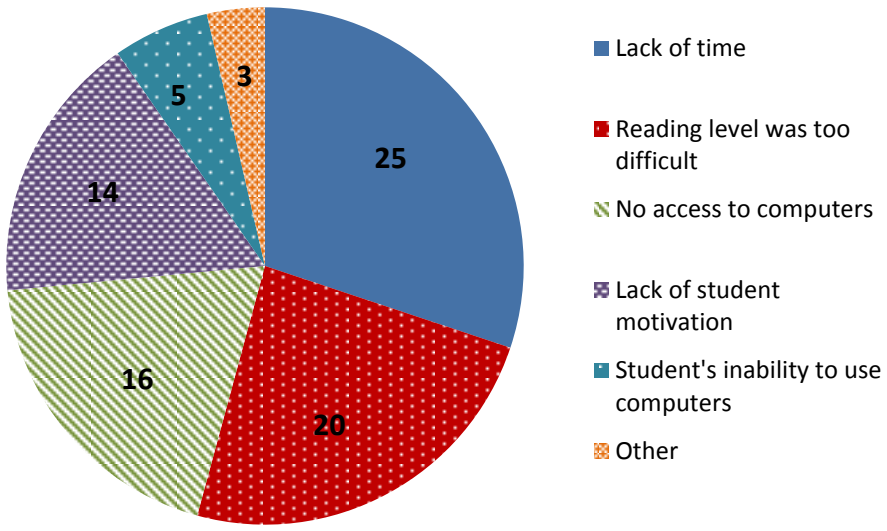

Figure 21: Challenges teachers faced when implementing the preparation phase (web activities)
***numbers on the figure represent number of responses (more than one answer could be selected)**
n=49

Teachers were allowed to write-in suggestions for improvement to the preparation phase. Suggestions made by several teachers included shortening the activity (8

responses), scaffolding reading levels for English Speakers of Other Languages (ESOL) and Special Education (SPED) students (6), providing an alternative assignment if computers aren't available (5) and focusing on main ideas (5). Other suggestions include providing clearer directions (3), making it more interactive (3), increasing computer access (2), increasing connections to students (2) and flipping the lesson (1) (Figure 22, Table 26). Many teachers stated that they liked the use of GIS data but that the online pre-lab took too much time and needed to be condensed and refined so that a few topics were covered in depth (such as water quality and watershed address).

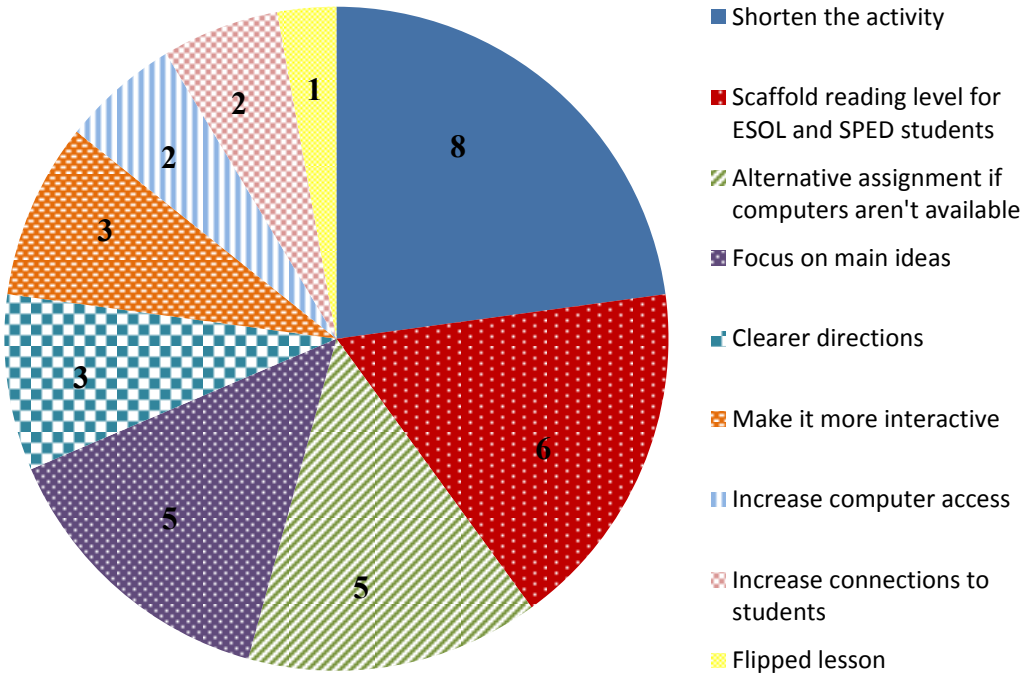

Figure 22: Suggestions for improvement for the preparation phase (web activities)
***numbers on the figure represent number of responses**
n=35

Teachers were also asked about any modifications they made to facilitate successful completion of preparation phase (this was a write-in question as well). The majority of teachers that made modifications completed the pre-lab as a class or in groups (5 responses) or did a teacher-led demo for each part of the website (4). Other teachers created charts to help students organize information (3), added more graphics (2), made the language more student friendly (2), assigned the pre-lab for homework (2) or added additional application questions (1) (Table 27, Figure 23).

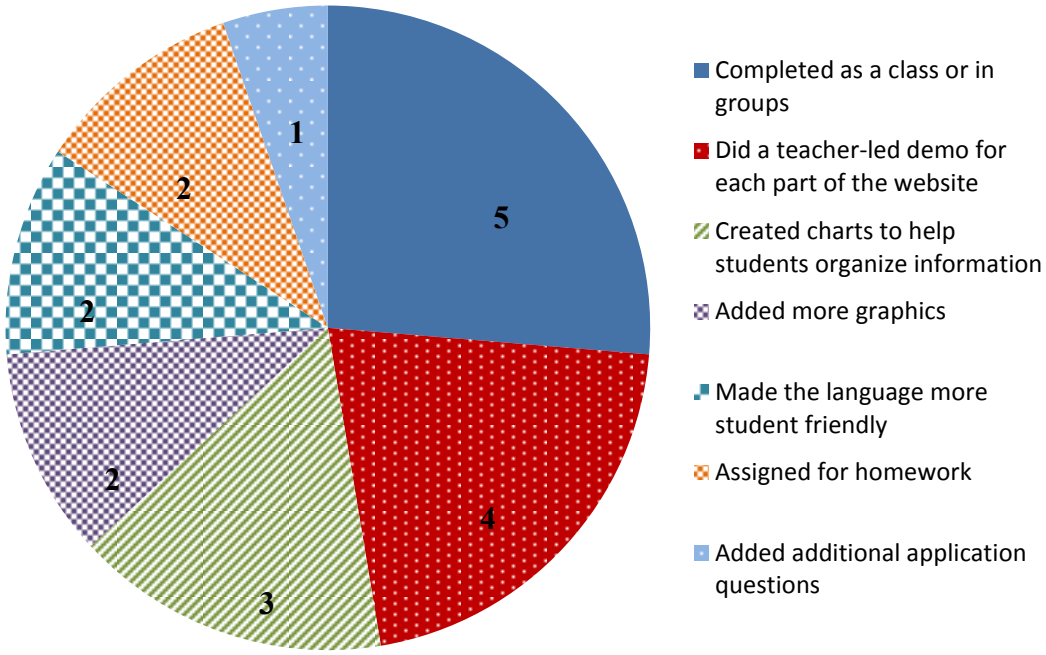

Figure 23: Modifications made by teachers to the preparation phase (web activities)
***numbers on the figure represent number of responses**
n=19

Many teachers stated that overall the action phase (MWEE field study was very well done. Their students loved working with the macro invertebrates and the interpretors did an excellent job, however, they still had suggestions for improvement.

Teachers wanted more support from the county for planning and implementing the trip (3 responses), more time with the macroinvertebrates (2) and modifications to the GPS and journaling stations to make them more student-friendly (2). Other teachers suggested reducing the number of stations to provide more time for data analysis (1) and more time for a wrap-up activity at the end of the field study (1). Finally, teachers suggested improving lab equipment (1), support for school-specific stations (1) and having schools go on their field study during their ecosystem unit (1) (Figure 24, Table 28).

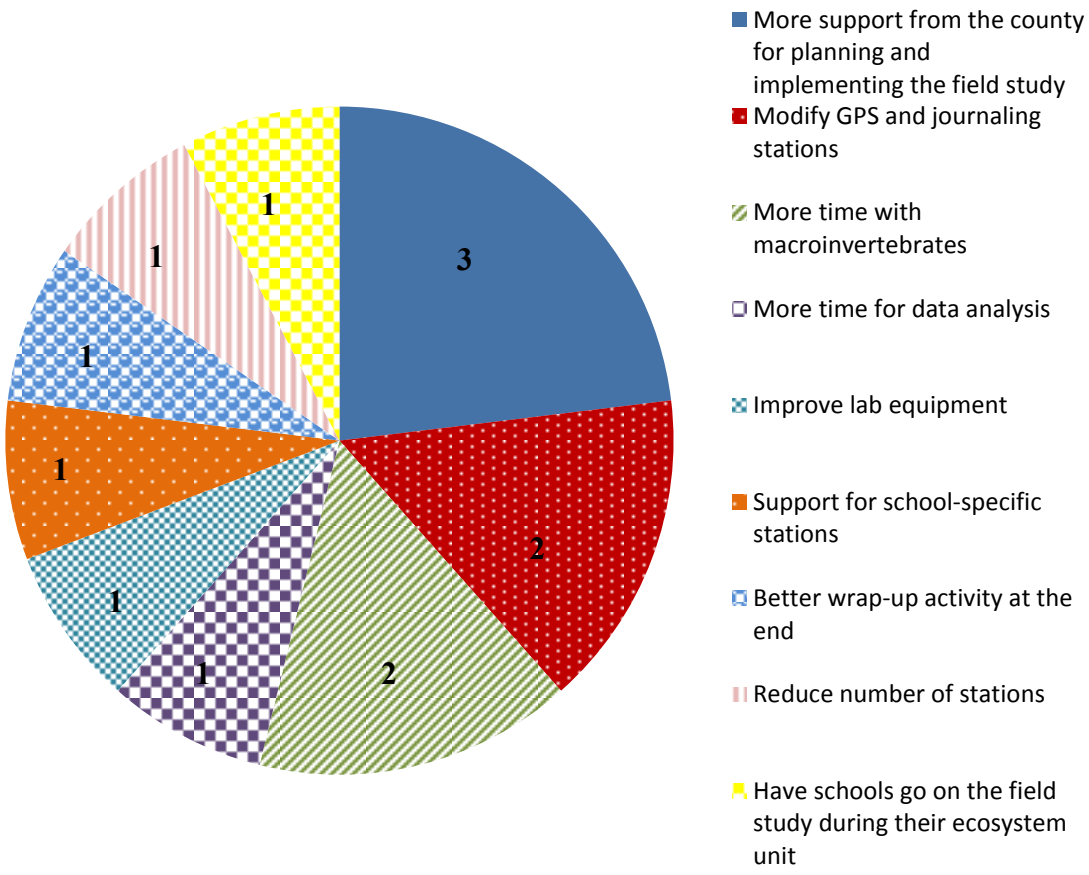

Figure 24: Suggestions for improvement to the action phase (MWEE field study)
***numbers on the figure represent number of responses**
n=13

Teachers that completed the reflection phase of the environmental stewardship component of the MWEE did a variety of projects including hatching shad eggs to be released into the Potomac River (2 responses), working at nature centers (1), cleaning parks and streams, recycling and making green life style choices such as conserving water and electricity (5). Several teachers reported that they had their students make educational posters and brochures related to the connection between surface run-off and storm drains (2). One teacher reported being scheduled to complete a service learning project labeling storm drains as part of their stewardship project (1).

Teachers did have suggestions for improvement to the stewardship project. Specifically, teachers said that there was not enough time to complete this activity as they were already overwhelmed by other things that they had to do at school (2 responses). One teacher suggested reducing the amount of time spent on other components of the lab to have more time to focus on the stewardship project. Many teachers said that they needed more guidance on how to complete this project so that it could be easily accomplished, was accessible to all students and was sustainable over the long-term (5).

Teachers were asked what resources would help them complete a stewardship project. Many teachers responded that it would be helpful to have professional development on environmental stewardship projects (13), have lists of example projects either on Blackboard (8) or on a PowerPoint (12) or have publicized opportunities to volunteer at stewardship projects (10). A few teachers listed knowledge of grant opportunities as helpful (4), and one teacher stated that teachers needed to be given everything they needed to complete a project (Table 29, Figure 25).

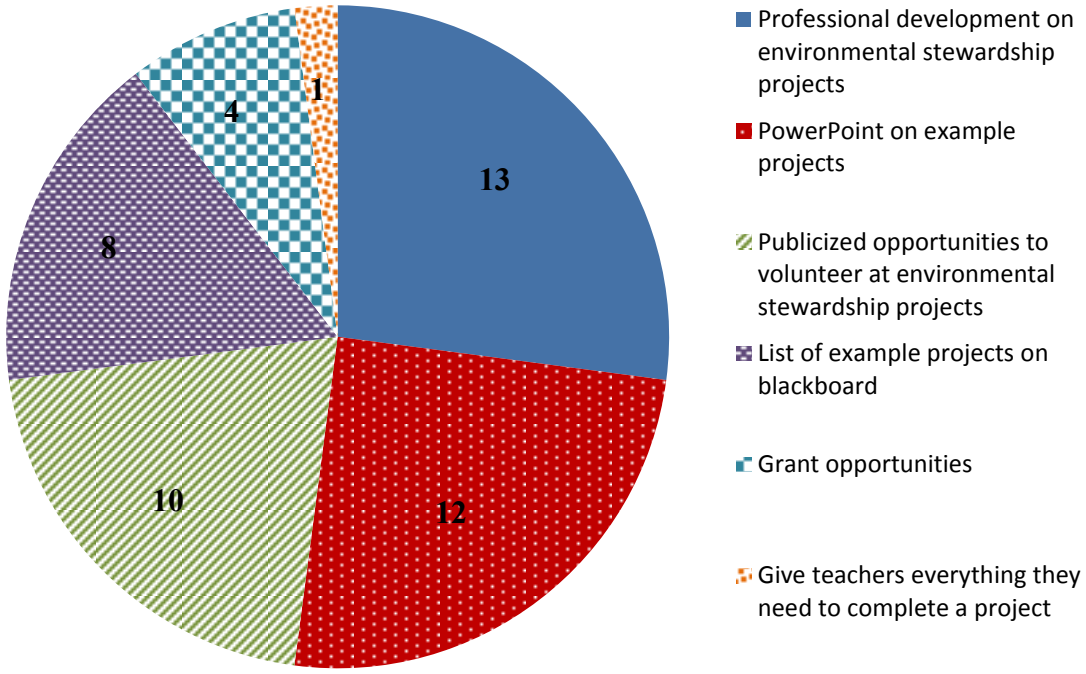

Figure 25: Resources that would be helpful to complete an environmental stewardship project
***numbers on the figure represent number of responses**
n=48

Finally, when asked what types of stewardship projects they would undertake in the future, most teachers wanted to complete stewardship projects on their school site (38 of 48). Some projects suggested included reducing water, electricity and paper usage, creating a school-wide recycling program, creating a schoolyard habitat or rain garden, planting native trees and shrubs, creating an ecology trail through the woods, creating an artificial wetland or any project that could be completed during school hours. Other teachers wanted to look beyond their own schools and work on projects such as raising fish to be released in a local stream, participating in a stream clean-up, participating in community environmental education or starting an ecology club and forming partnerships with the community (Figure 26, Table 30).

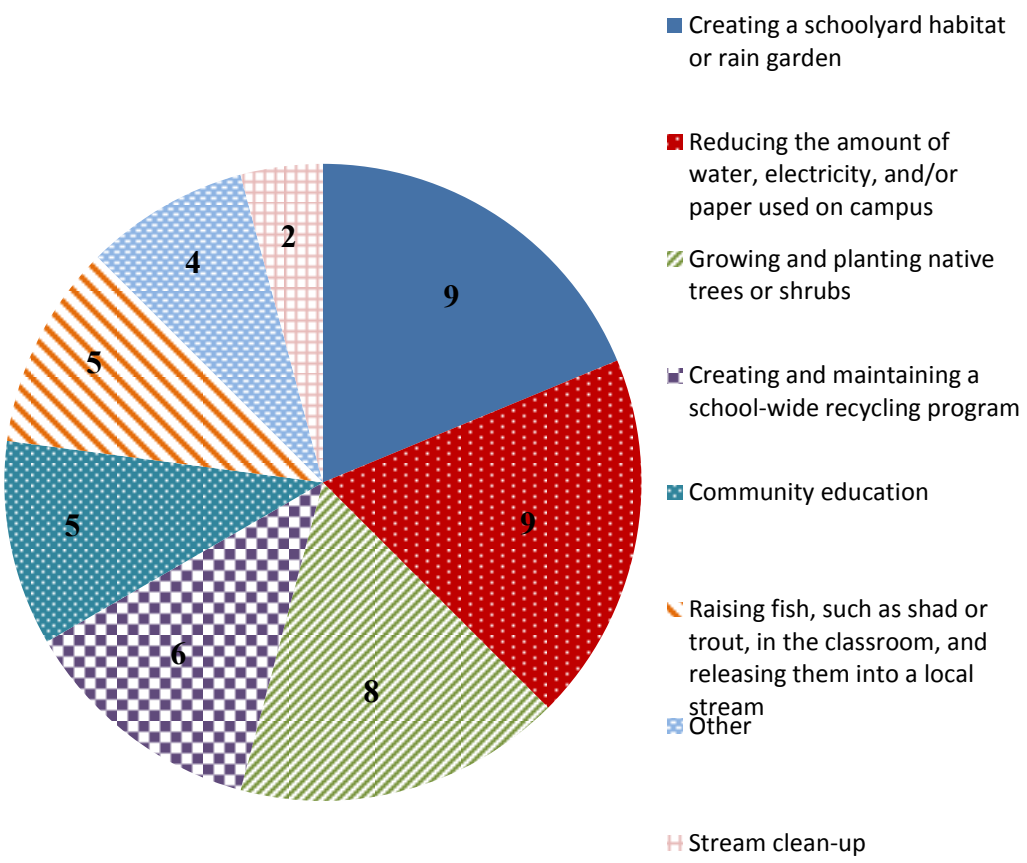

Figure 26: Potential stewardship projects
***numbers on the figure represent number of responses**
n=48

Teachers provided thoughtful feedback for each component of the MWEE curriculum. The majority of the teachers wanted to shorten the preparation phase and simplify it so that it was appropriate for students in ESOL, SPED and general education classrooms, and so that it focused on specific learning objectives instead of covering such a broad range of material. For the most part, teachers were familiar with the computer software, but not all teachers had access to computers so one improvement to the

curriculum would be providing an alternative assignment at school sites where computer access is limited.

For the action phase, teachers wanted to decrease the number of stations so that students had more time to delve deeply into the material at each station, and so that there was more time for hands-on learning opportunities and a chance to reflect at the end of the field study. Teachers also wanted help with planning and implementation of the field study at the county level. This reflects the findings in the quantitative data; administrative support (possibly related to planning and implementation) led to better implementation of the field study.

For the reflection phase, teachers did ask for additional professional development opportunities, example projects, and publicized stewardship events that students could attend. Teachers seemed hesitant to implement projects due to time constraints, but seemed more willing to implement these projects when they had easy access to environmental stewardship opportunities for their students.

DISCUSSION

Based on the literature review, a highly educated, politically liberal female teacher who spends a lot of time in nature and has high levels of environmental literacy, 5-15 years of teaching experience and prior experience with MWEE's should have been most likely to complete the MWEE curriculum (Olli et al., 2001; Jones & Dunlap, 1992; Hines et al., 1986/1987; Van Liere & Dunlap, 1980; Stern et al., 2008; Wee et al., 2004; Ernst, 2009; Kraemer et al., 2007; Schultz et al., 1995; Mobley et al., 2010; Kraus, 1995; Cottrell, 2003; Gamba & Oskamp, 1994) (see Hypothesis 1). This study found that there were no significant relationships between these teacher-specific characteristics and implementation of MWEE curriculum.

The lack of a link between gender and MWEE implementation, while counter to hypothesis one, could be explained by the findings of a study by Olli et al. (2001) which found that women are more likely to engage in private environmental behavior and implementation of MWEE curriculum is more of a public behavior (Olli et al., 2001). The literature can also help explain the lack of a relationship between age and pro-environmental world-view as most studies found only tenuous relationships between these variables and environmentally responsible behavior (Jones & Dunlap, 1992; Hines et al., 1986/1987; Schultz et al., 1995; Van Liere & Dunlap, 1980; Kraus, 1995; Cottrell, 2003; Olli et al., 2001; Gamba & Oskamp, 1994). More surprising was the lack of

significant correlations between teacher experience and training, levels of education, political leanings and consumption of environmental literature when compared to completion of the MWEE components as other studies have shown that these variables should be good predictors of ERB (Stern et al., 2008; Wee et al., 2004; Ernst, 2009; Kraemer et al., 2007; Hines et al., 1986/1987; Schultz et al., 1995; Van Liere & Dunlap, 1980; Olli et al., 2001; Mobley et al., 2010). It is possible that the small sample size contributed to fewer significant relationships due to non-response bias and fewer individuals in the different categories. Also, the clustering of significance in the school-site specific variables could indicate that environmental factors such as administrative support and concurrent stewardship project on school site overshadow the impact of individual characteristics.

There was a statistically significant relationship between being the MWEE coordinator and implementation of the MWEE stewardship project ($p<.043$, $n=51$). Individuals who are MWEE coordinators are less likely to implement the stewardship project. Upon first consideration, this does not make sense as it would seem that the MWEE coordinators would likely be more invested in the process. One possible explanation for this result is that the MWEE coordinators felt that they were already doing extra work coordinating the travel arrangements for the MWEE field study and as a result, other teachers should be the ones to implement the stewardship project. Also, the sample had a higher percentage of MWEE coordinators (23.5%) than present in the total population (18%). This could indicate that MWEE coordinators felt responsible for completing the survey to represent their school sites even if they did not work on the

stewardship project. Other respondents might have responded because they were proud that they implemented a stewardship project, creating this interesting data point which is contrary to the literature and hypotheses.

Also, there was a statistically significant, meaningful relationship between MWEE training and confidence in MWEE implementation ($p<.005$, $n=51$), however training received did not significantly impact MWEE implementation. This fits with previous studies that show that environmental attitudes do not necessarily translate into environmental behaviors (Kraus, 1995; Cottrell, 2003; Olli et al., 2001; Gamba & Oskamp, 1994). Future research might look at interaction effects between confidence and school site factors to determine how much situational factors influence implementation.

In contrast to the teacher-specific variables, the majority of the statistically significant, meaningful relationships were clustered in the school-site factors indicating that they are key contributors to MWEE implementation. For instance, administrative support significantly impacts implementation of the action phase while a concurrent stewardship project significantly impacts implementation of the reflection phase. Both of these findings reflect the suppositions in Hypothesis 2. These findings are also consistent with Hines, Hungerford and Tomera's model of ERB (1986/1987) that states that situational factors, in this case, school-site factors, can modify a person's ability to act on their pro-environmental intentions. This is also consistent with a study by Ernst (2009) which found that teachers who work at schools with supportive administration are more likely to engage in environment-based curriculum. Specifically, perceived administrative

support showed a statistically significant relationship to completion of the MWEE field study ($p<.028$, $n=51$). Knowledge of action strategies ($p<.018$, $n=48$; $p<.009$), perceived funding support ($p<.029$, $n=48$; $p<.041$, $n=48$) and current stewardship project ($p<.007$, $n=48$; $p<.024$, $n=48$) alao showed statistically significant relationships with completion of the stewardship project when this variable was categorized and when it was uncategorized. This shows the importance of situational factors in influencing individuals' behavior. Specifically, this study shows how school environment can have a profound impact on MWEE implementation (a type of ERB).

Finally, a logistic regression model with administrative support, funding support and current stewardship project as the independent variables was a good predictor of completion of the stewardship project ($p<.022$, $n=48$). Having a concurrent stewardship project at the school had the biggest positive impact on completion ($B=1.580$, $p<.039$). This makes sense as the qualitative data found that teachers are overwhelmed with all their current commitments and do not have time to work on creating a new stewardship project at their school. However, schools with current stewardship projects provide easy access and less preparation for teachers who want to participate in stewardship projects and this likely increases implementation of the reflection phase.

The qualitative data echoed the findings in the quantitative data as well as the arguments put forth in Hypotheses 3 and 4. Many of the teacher's suggestions for improvement for the MWEE field study and the stewardship project asked for more county-wide support for planning and implementation of the field study, more flexibility within the curriculum, further professional development focused on stewardship projects

along with example projects. While these findings are interesting, it is also important to note that while teachers might want professional development, they actually need support throughout the entire stewardship project process. In fact, a chapter from a book on learning in science argues that for learning and effective implementation to occur, individuals must receive support during the goal setting and planning stages, through the performance stage and into the reflection period to increase effectiveness and spur improvements based on reflection (Peters-Burton, 2013). For example, teachers might want to raise trout and release them, but they would likely need financial support to purchase the fish tank supplies, and mentoring support to learn how to raise the trout and where they can be released. There are studies that have been done by teachers on ways to determine whether a stream could support trout (Smith & Sklarew, 2012); however, teachers would need training on these methodologies as well as support throughout the implementation process.

The responses teachers provided for the qualitative questions were illuminating because of the answers provided, but also because of the number of respondents that answered those questions. For the preparation phase, many respondents discussed challenges they faced (n=49) and suggested improvements to the curriculum (n=35) demonstrating that they felt that this section needed a lot of modification. For the action phase, only 13 respondents suggested improvements, demonstrating that most teachers felt that this stage was effective and enjoyable. Finally, only 8 respondents suggested improvements to the reflection phase, probably because most teachers did not complete this component of the MWEE. The enthusiasm for completing a stewardship project in

the future, and the perceived need for resources and professional development related to the stewardship project were clear as many teachers requested additional resources (n=48) and brainstormed the projects they would complete in the future (n=48).

Based on the data collected, recommendations for increasing implementation of the three components of the MWEE follow. The preparation phase could be improved by not relying as heavily on computers. Also, more flexibility within the preparation phase curriculum would increase implementation as it could be differentiated to meet different learners' needs. Additional professional development for administrators would likely increase implementation of the action phase as administrative support showed a positive relationship to completion of the MWEE field study. Also, providing additional professional development for teachers on stewardship projects would be beneficial as the data shows that knowledge of action strategies and funding availability were positively correlated to completion of the stewardship project. In addition to professional development, support throughout the stewardship project process might also help increase implementation of the reflection phase.

CONCLUSIONS

Environmental education should create responsible citizens who think critically about political, social, economic and ecological problems. This study focused on one specific component of environmental education: delivery of meaningful watershed educational experiences (MWEE's). Ideally, these experiences should increase ecological knowledge, pro-environmental attitudes and environmentally responsible behavior in students and teachers. Significant relationships identified here between some school-site specific environmental factors and completion of MWEE components have profound implications for improving MWEE implementation at the campus level, school district level and across the country. Providing a school environment that has a supportive administration, easy access to funding for stewardship projects, and mentors to help teachers with action strategies for implementing stewardship projects could greatly increase implementation of the action and reflection phases of the MWEE. In addition, training administrators as well as teachers is crucial for creating supportive administration that can facilitate MWEE implementation through an understanding of the MWEE process, school-wide professional development and structures that facilitate easier access to resources and strategies for success. These findings were echoed by a recent MWEE evaluation which found that supportive administration and thorough training can increase MWEE implementation (Kraemer et al., 2007). Also, teachers at

schools with ongoing stewardship projects were much more likely to implement stewardship projects, so targeting specific schools each year to foster stewardship projects should help to increase the number of current projects. This would slowly increase the number of schools with ongoing stewardship projects which would increase implementation of stewardship projects at those schools and across the school district over time.

Potential weaknesses in the research design include differences in interpretation of survey questions between teachers and different implementation concerns and considerations across schools, classrooms and field-work opportunities. In addition, because many items in the survey were not field-tested, some of the items may have been unreliable or lacking in internal consistency. Also, due to social desirability, the data collected could be skewed because teachers might feel social pressure to report a more pro-environmental world-view, higher levels of environmental literacy or higher levels of completion of MWEE components. For example, studies on self-reports of recycling compared to observations of recycling in families have shown that self-reports are often quite different than observed behaviors due to social desirability issues (Corral-Verdugo, 1997; Schultz et al., 1995).

Also, perceptions of risk associated with length of time necessary to complete the survey might have led to unwillingness to take the survey (Dillman, Smyth & Christian, 2009). In addition, using an online survey may have precluded some older teachers from taking the survey as they may have been less comfortable with the survey medium as compared to younger respondents (Witte, 2009). These factors could have led to non-

response error; the people who responded to the survey were different from people who did not respond (Dillman et al., 2009). Also, there was likely a lower response rate from individuals disengaged from the entire MWEE experience and a higher response rate from individuals who felt more invested in the MWEE process. For example, 23.5% of the respondents were MWEE coordinators when MWEE coordinators only comprised 18% percent of the total population. Finally, the target population was small, approximately 150 teachers, and the sample size was also small, 51 respondents, which could have impacted the statistical analyses as some of the response categories only had a few individuals in each cell.

Based on the limitations discussed above, future research should include other school districts to increase sample size and variability within the data. The importance of school-site specific factors was clear in this study, so in the future these structures should be examined in more detail to both validate this finding with a larger sample and determine what school district-wide changes in administrator training and school-site structures could be implemented to increase implementation of MWEE programming. Also, interaction effects between teacher characteristics and school-site factors should be examined to investigate how school-site factors moderate an individual's willingness to implement the MWEE. Finally, a longitudinal study could be put into place to continue to examine how changes to the MWEE programming and training are impacting implementation procedures. This would establish a long-term process of implementation, evaluation, reflection and revision that could continue to improve the MWEE experience.

This study adds to the body of literature on the importance of school leadership in implementation of hands-on learning curriculum. Specifically, it highlights the influence that administration and school environment can have on implementation of outdoor environmental education. These findings are exciting because it is often easier to make changes to school sites than to individual teacher characteristics. More programs need to be implemented that include administrators in this training process as their support and guidance is crucial to successful implementation of environmental stewardship programs.

Many programs across the world work to train teachers in outdoor environmental education curriculum; there should be more large-scale programmatic evaluations to provide additional data on which factors impact implementation of this programming. This data could be used to inform how large organizations focused on environmental education allocate their funding. For example, when NOAA receives more funding for its Chesapeake Bay Watershed Education and Training program (B-WET program), it could use the recommendations from these larger scale studies to inform improvements to its own programming and the programs it supports. Based on this study, the B-WET program could focus on supporting school-site stewardship projects and training that works with teachers and administrators at the same time. Finally, evaluations of outdoor environmental education could be used to inform state and federal standards of learning to help influence curriculum across the country. The importance of environmental education is clear; it is our job to make sure that the curriculum and training used to support this type of education is able to effectively produce future generations of environmental stewards.

APPENDIX A: QUESTIONNAIRE AND FORMS

Participants were sent an e-mail asking them to participate in the survey. The language for the e-mail is below. Two follow-up e-mails were sent to remind participants to complete the survey before the survey window closed. The follow up emails were the same as the initial email, with the addition of two sentences at the beginning; "This is a follow-up email regarding the Testing the Waters Investigation (MWEE) teacher survey. The survey window closes in one week and I would greatly appreciate your participation." The same script was used when going to schools to visit teachers.

Email: "Dear Educator,

My name is Lauren Kinne, and I am a _____ County Biology teacher pursing my master's degree at George Mason University. I am writing to ask you to complete an online survey that aims to improve the Testing the Waters investigation (MWEE), that you engage in with your students. I will collect data from _____ County middle school teachers using a Google online survey tool. The data collected in this study will be used in my master's thesis which is on factors that impact meaningful watershed environmental education (MWEE) implementation. Additionally, the results will be provided in aggregate to the county to provide them with feedback that they can use to improve the MWEE for teachers and students. Your results will be confidential, and the data will only be analyzed in aggregate. The survey will not ask for identifying

information such as name or school-site placement. This survey is voluntary; you may stop taking the survey at any time, and skip any questions you do not want to answer. There are no risks and no benefits to participants for taking part in this study. The survey will take approximately 15-20 minutes to complete.

As a teacher myself, I understand that sometimes small changes in curriculum and logistics can have a huge impact on ease of implementation, and student success. Your expertise and opinion are valued and appreciated, as teachers are in the best position to evaluate the MWEE curriculum because they are the educators in charge of implementing the curriculum. The long-term goal is to provide the county with teacher-generated suggestions for improvement. If you have questions or concerns regarding this questionnaire, please feel free to contact Lauren Kinne (lwalsh2@gmu.edu) or Dr. Dann Sklarew (dsklarew@gmu.edu), the faculty advisor for this study. You may contact the George Mason University Office for Research Integrity & Assurance at 703-993-4121 if you have questions or comments regarding your rights as a participant in this research. After this study is completed, the results will be available on the following website: http://digilib.gmu.edu:8080/xmlui/handle/1920/2811.

Please click on the link below if you consent to taking the survey: (Link inserted here)

Thank you for your time and consideration,

Best,

Lauren Kinne

Testing the Waters Investigation (MWEE)---Teacher Survey

Section A: Experience with Testing the Waters Investigation (the MWEE)

1. For each of the statements below, decide whether you Strongly Agree (1), Moderately Agree (2), are Undecided (3), Moderately Disagree (4) or Strongly Disagree (5).

As a result of completing this lab on local watersheds, students are better prepared for ecology questions on the Virginia SOL exam.	1 □	2 □	3 □	4 □	5 □
As a result of completing this investigation, students are more engaged in their learning.	1 □	2 □	3 □	4 □	5 □
As a result of completing this investigation, students are more knowledgeable about their local watershed.	1 □	2 □	3 □	4 □	5 □
As a result of completing this investigation, students are more likely to take action to protect their local watershed.	1 □	2 □	3 □	4 □	5 □

2. In Part 1 of the Testing the Waters Investigation, students are asked to complete online web-based activities. What answer choice below best describes how you completed this activity with your students?

Please pick one answer.

- Completed the entire activity exactly as written
- Completed the entire activity with modifications
- Completed part of the activity with modifications
- Did not complete the activity
- Other:_____

3. What challenges did your students face when working on Part 1?

Check all that apply.

- Had no difficulty completing this portion of the lab
- No access to computers
- Student inability to use computers
- Reading level of lab is too difficult for students
- Lack of time
- Lack of student motivation
- Other: _____

4. How could Part 1 be improved?

5. If you modified Part 1, what modifications did you make to ensure that it was more effective for your students?

6. In Part 2, the MWEE field study, students are taken outside to collect data on the health of their local watershed. What answer choice below best describes how you completed Part 2 with your students?

Please pick one answer.

- Went on a field experience (on or off of school grounds), completed all lab activities
- Went on a field experience (on or off of school grounds), completed all lab activities with modifications
- Went on a field experience (on or off of school grounds), completed some of the activities
- Did not go on a field experience
- Other: _____

7. If you delivered the field study, what site(s) did you use?

Please pick one answer.

- Off-campus site (Lake Fairfax, Accotink Creek, Burke Lake)
- Off-campus site (Cub Rub, Scotts Run, South Run)
- On or near campus site (local creek)
- Other:_____

8. How many hours of local watershed or Chesapeake Bay instruction did your students receive before they completed Part 2?

Please pick one answer.

- None
- Less than 1 hour
- 1 to less than 2 hours
- 2 to less than 4 hours
- 4 to less than 6 hours
- 6 to less than 8 hours
- More than 8 hours

9. How could Part 2 be improved?

10. What percentage of your students chose to participate in the outdoor field study?_____

11. Have you attended training on Testing the Waters investigation and MWEE?

Please pick one answer.

- Yes, I attended a professional development session run by the middle school science specialist
- Yes, I was trained by teachers at my school that went to training
- No
- Unsure

12. If so, did attending Testing the Waters and MWEE training make you feel more confident in your ability to implement the investigation?

Please pick one answer.

- Yes
- No
- Unsure

13. Are you the MWEE coordinator at your school?

Please pick one answer.

- Yes
- No
- Unsure

14. How many years have you attended a MWEE field experience?

Please pick one answer.

- First year
- 2-3 years
- 4-6 years
- 7-9 years
- 10 years or more

15. What answer choice below best describes how you pursued Part 3 with students?

Please pick one answer.

- Students brainstormed an environmental stewardship project and completed the project
- Students brainstormed an environmental stewardship project and took action to complete the project
- Students brainstormed an environmental stewardship project and the projects were discussed in class
- Students brainstormed an environmental stewardship project
- Students did not complete this activity
- Other:_____

16. If your students completed a stewardship project, please describe it/them below:

17. How could Part 3, the environmental stewardship project, be improved?

18. For each of the statements below, decide whether you Strongly Agree (1), Moderately Agree (2), are Undecided (3), Moderately Disagree (4) or Strongly Disagree (5).

At my school site, the administration is supportive of environmental stewardship projects.	1 □	2 □	3 □	4 □	5 □
I have the funding necessary to implement an environmental stewardship project at my school, or I know how to get this funding.	1 □	2 □	3 □	4 □	5 □
I am unsure of what action steps I would need to take to implement an environmental stewardship project at my school site.	1 □	2 □	3 □	4 □	5 □
My school has a school-wide environmental stewardship project that my students were able to participate in.	1 □	2 □	3 □	4 □	5 □

19. There are many tools, trainings and resources that could be helpful in assisting teachers as they try to work on an environmental stewardship project with their students. Please choose the answer below that would be <u>most</u> helpful.

Please pick one answer.

- Professional development on environmental stewardship projects
- PowerPoint on example projects
- List of example projects on blackboard
- Grant opportunities
- Publicized opportunities to volunteer at environmental stewardship projects
- Other:_____

20. If you were to complete an environmental stewardship project with your students, which project would you be <u>most</u> likely to choose?

Please pick one answer.

- Growing and planting native trees or shrubs
- Creating a schoolyard habitat or rain garden
- Creating a manmade wetland
- Creating and maintaining a school-wide recycling program
- Reducing the amount of water, electricity, and/or paper used on campus
- Growing and planting underwater grasses
- Raising fish, such as shad or trout, in the classroom, and releasing them into a local stream
- Stream clean-up
- Community education
- Other:_____

Section B: Environmental Attitudes and Environmental Literacy

21. For each of the statements below, decide whether you Strongly Agree (1), Moderately Agree (2), are Undecided (3), Moderately Disagree (4) or Strongly Disagree (5).

We are approaching the limit of the number of people the earth can support.	1	2	3	4	5
Humans have the right to modify the natural environment to suit their needs.	1	2	3	4	5
When humans interfere with nature it often produces disastrous consequences.	1	2	3	4	5
Human ingenuity will insure that we do NOT make the earth unlivable.	1	2	3	4	5
Humans are severely abusing the environment.	1	2	3	4	5
The earth has plenty of natural resources if we just learn how to develop them.	1	2	3	4	5
Plants and animals have as much right as humans to exist.	1	2	3	4	5
The balance of nature is strong enough to cope with the impacts of modern industrial nations.	1	2	3	4	5
Despite our special abilities humans are still subject to the laws of nature.	1	2	3	4	5
The so-called “ecological crisis” facing humankind has been greatly exaggerated.	1	2	3	4	5
The earth is like a spaceship with very limited room and resources.	1	2	3	4	5

Humans were meant to rule over the rest of nature.	1	2	3	4	5
The balance of nature is very delicate and easily upset.	1	2	3	4	5
Humans will eventually learn enough about how nature works to be able to control it.	1	2	3	4	5
If things continue on their present course, we will soon experience a major ecological catastrophe.	1	2	3	4	5

22. For each of the books below, please pick the answer that most closely reflects your experience with the book.

Book Name	**Experience with the Book**			
Silent Spring	I have never heard of this book.	I have heard of this book, but have never read it.	Yes, I have read this book.	Yes, I have read this book and have recommended it to others.
An Inconvenient Truth	I have never heard of this book.	I have heard of this book, but have never read it.	Yes, I have read this book.	Yes, I have read this book and have recommended it to others.
Lorax	I have never heard of this book.	I have heard of this book, but have never read it.	Yes, I have read this book.	Yes, I have read this book and have recommended it to others.
Sand County Almanac	I have never heard of this book.	I have heard of this book, but have never read it.	Yes, I have read this book.	Yes, I have read this book and have recommended it to others.
Walden	I have never heard of this book.	I have heard of this book, but have never read it.	Yes, I have read this book.	Yes, I have read this book and have recommended it to others.
The Omnivore's Dilemma	I have never heard of this book.	I have heard of this book, but have never read it.	Yes, I have read this book.	Yes, I have read this book and have recommended it to others.
Bringing Nature Home	I have never heard of this book.	I have heard of this book, but have never read it.	Yes, I have read this book.	Yes, I have read this book and have recommended it to others.

Section C: Background Information

The background information will only be used in aggregate and will **not** be provided to anyone for use as identifying information.

23. How many years have you taught about the local watershed or Chesapeake Bay (including this year)?

Please pick one answer.

- First year
- 2-3 years
- 4-6 years
- 7-10 years
- More than 10 school years

24. How many years have you been a classroom teacher (including this year)?

Please pick one answer.

- First year
- 2-3 years
- 4-6 years
- 7-10 years
- More than 10 school years

25. What were your college majors/minors?

Please be as specific as possible, even noting concentrations or tracks, if applicable.

Major (s):
Minor (s):

26. Which of the options below best describes your current level of education?

Please pick one answer.

- Bachelor's degree
- Bachelor's degree with some graduate work completed
- Master's degree
- PhD or other professional degree
- Other

27. If applicable, what is/are/were the academic area(s) of focus of your graduate degree(s)?

For example: Masters in Education.

Graduate degree 1:
Graduate degree 2:
Graduate degree 3:

28. Of the outdoor activities listed below, how many did you engage in as a child?

Mark all that apply.

-Girl/boy scouts
-Nature center
-4-H
-Hiking
-Camping
-Nature or Science camp
-Playing outside (unstructured)
-Sports
-Zoo or other environmental museum
-Outdoor-focused vacations
-Other outdoor activity

29. Of the outdoor activities listed below, how many do you engage in as an adult?

Mark all that apply.

-Volunteering for a clean-up event
-Nature center
-Gardening
-Hiking
-Camping
-Environmental professional development
-Walking the dog
-Sports
-Zoo or other outdoor environmental museum
-Outdoor-focused vacations
-Other outdoor activity

30. What is your age range?

- 21-30
- 31-40
- 41-50
- 51-60
- 61-70
- 70+

31. What is your gender?

- Male
- Female

32. What is your political orientation?

- Very liberal
- Liberal
- Moderate
- Conservative
- Very Conservative
- Other, please describe:

33. Which option below best describes the area where you grew up?

- Urban
- Rural
- Suburban
- Other, please describe:

APPENDIX B: TABLES AND FIGURES

Table 5: Frequency information for demographic variables (teacher-specific characteristics)

	Frequency of Variable
Age	
% 21 thru 30	16%
% 31 thru 40	26%
% 41 thru 50	24%
% 51 and older	34%
Gender	
% female	72%
% male	28%
Political Orientation	
% Liberal	42.1%
% Moderate	34.2%
% Conservative	23.7%
Geographic Location during Youth	
% Suburban	70%
% Urban	20%
% Rural	6%
% Unknown or mixed	4%
Sample Size	51

Table 6: Frequency information for educational variables (teacher-specific characteristics)

	Frequency of Variable
Level of Education	
% Bachelor's degree	4%
% Bachelor's degree with some graduate work	18%
% Master's degree	76%
% PhD or other professional degree	2%
Type of Degree	
% Education and natural science	28%
% Education	22%
% Natural science	22%
% Education, concentration secondary science	20%
Non-education, non-natural science	0%
% Not reported	8%
Sample Size	51

Table 7: Frequency information for environmental variables (teacher-specific characteristics)

	Average or Frequency of Variable
Environmental Literacy	
% Not environmentally literate	51%
% Environmentally literate	49%
Environmental World View (NEP scale)	
% Pro- ecological worldview	80.4%
% Negative or neutral ecological worldview	15.7%
Time Spent Outside as a Child	
% Small amount (1-4 activities)	29.4%
% Moderate amount (5-7 activities)	43.1%
% Large amount (8-11 activities)	27.5%
Time Spent Outside as an Adult	
% Small amount (1-4 activities)	33.3%
% Moderate amount (5-7 activities)	45.1%
% Large amount (8-11 activities)	21.6%
Sample Size	51

Table 8: Frequency information for teaching experience (teacher-specific characteristics)

	Average or Frequency of Variable
# of years of teaching experience	
% First year	4%
% 2-6 years	20%
%7 or more years	76%
# of years of MWEE experience	
% First year	12%
% 2-6 years	74%
%7 or more years	14%
MWEE training	
% Attended training outside of school	62.7%
% Turn-around training	21.6%
% Not trained	15.7%
MWEE coordinator	
% No	76.5%
% Yes	23.5%
Sample Size	51

Table 9: Frequency information for administrative support of stewardship projects (school-specific characteristic)

	Frequency of Variable
Administration is supportive	74.5%
Undecided	25.5%
Administration is not supportive	5.9%
Sample Size	51

Table 10: Frequency information for funding support for stewardship projects (school-specific characteristic)

	Frequency of Variable
Funding is not readily available	60.8%
Funding is not readily available	39.2%
Sample Size	51

Table 11: Frequency information for knowledge of action strategies related to implementation of stewardship projects on school site (school-specific characteristic)

	Frequency of Variable
Do not know action strategies	72.5%
Know action strategies	27.5%
Sample Size	51

Table 12: Frequency information for concurrent stewardship projects at school site (school-specific characteristic)

	Frequency of Variable
No concurrent stewardship project	70.6%
Concurrent stewardship project	29.4%
Sample Size	51

Table 13: Frequency information for completion of the preparation phase of the MWEE (web activities)

	Frequency of Variable
Completed	40%
Partially completed	30%
Did not complete	30%
Sample Size	50

Table 14: Frequency information for completion of the action phase of the MWEE (field study)

	Frequency of Variable
Completed	82.4%
Did not complete or partially completed	17.6%
Sample Size	51

Table 15: Frequency information for completion of the reflection phase of the MWEE (stewardship project)

	Frequency of Variable
Did not complete project	58.3%
Brainstormed or completed project	41.7%
Sample Size	48

Table 16: MWEE coordinator compared to completion of the reflection phase (categorized)

	Did not complete stewardship project	Brainstormed or completed stewardship project
MWEE coordinator	24	12
Not the MWEE coordinator	4	8
Sample Size	48	

Pearson chi square, 2 sided, $p<.043$

Table 17: MWEE training compared to confidence in MWEE implementation

	Not confident	Unsure	Confident
No training	3	5	0
Turn-around training	3	3	5
Training	5	4	23
Sample Size	51		

Pearson chi square, 2 sided, p<.005

Table 18: Relationship between administrative support and completion of action phase (field study)

	Did not complete or partially completed the MWEE field study	Completed the MWEE field study
Admin is not supportive	2	1
Undecided	0	10
Admin is supportive	7	31
Sample Size	51	

Pearson chi square, 2 sided, p<.028

Table 19: Funding for projects compared to completion of the reflection phase (categorized)

	Did not complete stewardship project	Brainstormed or completed stewardship project
No funding (not readily available or unsure of availability)	20	8
Funding is readily available	8	12
Sample Size	48	

Pearson chi square, 2 sided, p<.029

Table 20: Funding for projects compared to completion of the reflection phase (uncategorized)

	Did not complete stewardship project	Brainstormed stewardship project	Completed stewardship project
No funding (not readily available or unsure of availability)	20	5	3
Funding is readily available	8	4	8
Sample Size	48		

Pearson chi square, 2 sided, p<.041

Table 21: Knowledge of action strategies compared to completion of the reflection phase (categorized)

	Did not complete stewardship project	Brainstormed or completed stewardship project
Unsure of action strategies	24	11
Know action strategies	4	9
Sample Size	48	

Pearson chi square, 2 sided, p<.018

Table 22: Knowledge of action strategies compared to completion of the reflection phase (uncategorized)

	Did not complete stewardship project	Brainstormed stewardship project	Completed stewardship project
Unsure of action strategies	24	3	8
Know action strategies	4	6	3
Sample Size	48		

Pearson chi square, 2 sided, p<.009

Table 23: Current stewardship project compared to completion of the reflection phase (categorized)

	Did not complete stewardship project	Brainstormed or completed stewardship project
No current stewardship project or unsure if there is a current project	24	10
Current stewardship project	4	10
Sample Size	48	

Pearson chi square, 2 sided, p<.007

Table 24: Current stewardship project compared to completion of the reflection phase (uncategorized)

	Did not complete stewardship project	Brainstormed stewardship project	Completed stewardship project
No current stewardship project or unsure if there is a current project	24	4	6
Current stewardship project	4	5	5
Sample Size	48		

Pearson chi square, 2 sided, p<.024

Table 25: Difficulties related to completing the preparation phase (web-based activities)

	Number of responses	Percentage based on total number of responses
No access to computers	16	19.3%
Lack of time	25	30.1%
Lack of student motivation	14	16.9%
Reading level was too difficult	20	24.1%
Student's inability to use computers	5	6%
Old computers that cannot support online programming	1	1.2%
Lack of student lab experience	1	1.2%
Teacher didn't understand	1	1.2%
Sample Size	51	

Table 26: Suggestions for improvement for the preparation phase (web-based activities)

	Number of responses	Percentage based on total number of responses
Shorten the activity	8	22.9%
Scaffold reading level for ESOL and SPED students	6	17.1%
Increase connections to students	2	5.7%
Focus on main ideas	5	14.3%
Clearer directions	3	8.6%
Alternative assignment if computers aren't available	5	14.3%
Increase computer access	2	5.7%
Make it more interactive	3	8.6%
Flipped lesson	1	2.9%
Sample Size	51	

Table 27: Modifications made by teachers to the preparation phase (web-based activities)

	Number of responses	Percentage based on total number of responses
Added more graphics	2	10.5%
Assigned for homework	2	10.5%
Completed as a class or in groups	5	26.3%
Did a teacher-led demo for each part of the website	4	21.1%
Added additional application questions	1	5.3%
Created charts to help students organize information	3	15.7%
Made the language more student-friendly	2	10.5%
Sample Size	51	

Table 28: Suggestions for improvement to the action phase (MWEE field study)

	Number of responses	Percentage based on total number of responses
Modify GPS and journaling stations	2	15.4%
More time with macro invertebrates	2	15.4%
More support for planning and implementing the trip from the county	3	23.1%
More time for data analysis	1	7.7%
Improve lab equipment	1	7.7%
Support for school-specific stations	1	7.7%
Better wrap-up at the end	1	7.7%
Reduce number of stations	1	7.7%
Have schools go on the field study during their ecosystem unit	1	7.7%
Sample Size	51	

Table 29: Resources that would be helpful for completing the reflection phase (stewardship project)

	Number of responses	Percentage based on total number of responses
Professional development on environmental stewardship projects	13	27.1%
Publicized opportunities to volunteer at environmental stewardship projects	10	20.8%
PowerPoint on example projects	12	25%
List of example projects on blackboard	8	16.7%
Grant opportunities	4	8.3%
Give teachers everything they need to complete a project	1	2.1%
Sample Size	51	

Table 30: Future environmental stewardship projects (reflection phase)

	Number of responses	Percentage based on total number of responses
Stream clean-up	2	4.2%
Raising fish to be released	5	10.4%
Reducing water, electricity & paper usage	9	18.8%
Planting native trees or shrubs	8	16.7%
School wide recycling program	6	12.5%
Schoolyard habitat or rain garden	9	18.8%
Community education	5	10.4%
Ecology trail through the woods	1	2.1%
Creating a manmade wetland	1	2.1%
Ecology club with community partnerships	1	2.1%
Project during school hours only	1	2.1%
Sample Size	51	

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