A REVIEW OF SELECT WATER EDUCATION INITIATIVES

OF THE LAST 40 YEARS

by

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This professional paper has been read by each member of the committee and has been found to be satisfactory regarding content, English usage, format, citation, bibliographic style, and consistency and is ready for submission to The Graduate School.

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STATEMENT OF PERMISSION TO USE

DEDICATION

To Will
Who loved water when it was moving, frozen, and everywhere in between…

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ABSTRACT

The Clean Water Act of 1972 brought public attention to the issues surrounding water quality and availability in the U.S. Although the Clean Water Act was not an educational initiative per se, it did provide the foundation and interest for education on water related issues. Much has been learned about sustainable water use and human effect on water quality, but not all efforts to disseminate this knowledge to the general public were successful. This author reviewed and categorized select water education initiatives implemented in the last 40 years and examined their long-term efficacy. Within the first generation, the author looked at the Chesapeake Bay cleanup and the Lake Erie cleanup along with associated education efforts. Chesapeake Bay was relatively successful as an educational effort, while Lake Erie has not had the same kind of long-term public involvement or success mitigating nutrient loading to the lake. The second generation was identified by emphasis on nonpoint source pollution and respective education efforts. Voluntary nonpoint source education was not received nor effective at the rates originally anticipated, largely because of the economic uncertainty associated with implementing best management practices. The third, and current, generation has focused on technological advances and their impacts on water rights, use and mitigation. Agricultural and environmental educators must strive to provide fast, fact-based information and to increase individual self-efficacy by modifying cultural and perceptual norms regarding historic water use. Additional research is needed on impacts from and to specific demographic water users as well as the most effective content and contexts for water resource and educational programming.

CHAPTER 1

INTRODUCTION

Background

Water has always been one of our most precious and most contentious natural resources, all the more so in the populous regions of the United States. High quality and relatively inexpensive water supplies provided the foundation for cities, industrial growth, agricultural production, and recreational activities, but few areas have reported the long-term ability to support current water use trends (Hundley, 2009; Loucks, van Beek, Stedinger, Dijkman & Villars, 2005). These issues have not been confined to the arid West; aging infrastructure and concentrated populations exacerbated water quality and pollution issues for some of the wettest areas in the country. During times of increased public interest in decisions regarding water use and quality standards (Loucks et. al., 2005), educators must prioritize educational initiatives that help users make informed, conservation-based decisions (Chawla & Cushing, 2007).

The tumultuous relationship between a quality water supply and the public has been well documented. In the preface to his book, *Water and the West: the Colorado River Compact and the Politics of Water in the American West* (2009), Norris Hundley poignantly described the connection between water and human development:

> From the time of the first settlers to the present, few westerners have failed to comprehend that control of the West's water means control of the West itself – its industry, agriculture, population distribution, and, withal, the direction of the future. Because the West has always had a water problem, its experiences provide valuable insights into the crisis faced by other

> water-shy areas; they also offer a preview of the even more serious problems that must involve the entire nation and the rest of the world as population grows. (p. ix)

Hundley painted a foreboding picture of past and future water issues, and it was not unfounded. Albuquerque and El Paso both draw from the Rio Grande, a river that has consistently failed to meet human health standards in levels of arsenic, copper, zinc, cadmium, lead, and nickel (Rios-Arana, Walsh, & Gardea-Torresdey, 2003). Experts estimated 25% of the reserves in the Ogallala aquifer, a primary water source to more than two million people in South Dakota, Nebraska, Wyoming, Kansas, Colorado, Oklahoma, New Mexico, and Texas, will be used or contaminated by the year 2020 (Cox, Lawver, Baker & Doerfert, 2004). The East Coast has faced more severe infrastructure challenges. Reports on the water quality of the Hudson River from 2012 indicated the river was still contaminated despite decades of cleanup efforts. Raw sewage from failing sewers and inadequate runoff standards were cited as primary sources of the historic and current pollution to the river. After a major rain event, as many as half of the sample sites on the Hudson Estuary demonstrated unsafe sewage levels (Riverkeeper, 2012).

Climate change forecasters have predicted that climate shifts will intensify these problems. High volume rain events tend to be particularly detrimental for cities and watersheds with low infiltration rates; the east and west coasts of the U.S. have historically reported the highest population densities and some of the most dramatic shifts in rainfall patterns in the country. Coastal California implemented an elaborate system of dams and reservoirs to supply water and control flooding, but climate change upsets the delicate balance of these systems (EPA, 2012a). Vigran (2008) stated, “When snow and rain patterns shift even more, it becomes increasingly difficult to know when to keep the reservoirs full to maintain ecosystems, recreational areas, hydropower and water supply — and when to allow them to empty and make space for flood control" (p. 1). Drought conditions in the mountainous West became more pronounced as spring runoff events happened earlier and faster; in turn this created new ecological and supply problems for the thirsty Southwest (Environmental Protection Agency (EPA), 2012a). An in depth understanding of how to protect water supplies should be prioritized not just an environmental issue, but as a matter of public safety and health.

Education on water issues has been recognized as an important avenue for protecting future users and resources (Educating Young People About Water, 2004). Numerous curricula have been developed to educate users in various formal and informal settings, but the outcomes of environmental education have been difficult to assess. Much of the literature on environmental education suggested science-based education alone was not the driving factor behind acting environmentally (Hungerford & Volk, 1990; Kollmuss & Agyeman, 2002). Moreover, the educational goals for users were not always uniform across state lines. Allocating water for economic benefit was a primary tenant of water policy, and an integral part of many local economies (Tarlock, 2001a). At the same time, much can be learned from states struggling to maintain economic and environmental control over water resources (Huntley, 2009). The tension between users with rights to beneficial use and environmental activists tended to shroud water management decisions in political and ideological debates, posing a challenge for educators trying to present holistic, non-biased information (Welch & Braunworth, 2010).

The disparities between environmental education and conservation-based action were well documented. In the case of global warming, for example, Malka, Krosnick, and Langer (2009) observed that disseminating information about climate change only altered levels of concern in participants with specific predispositions regarding trust in science and political affiliation (p. 645). Other researchers noted an inverse relationship between education about global warming and perceived personal responsibility for climate trends (Kellstedt, Zahran & Vedlitz, 2008). Biotechnology researchers have drawn similar conclusions:

> Engagement with [biotechnology] is a combination of a number of personal and contextual characteristics. To be knowledgeable about science is partly the outcome of an education and culture that is interested in science. As such people have more confident opinions and more resources upon which to arrive at a view (Gaskell, Allum & Stares, 2002, p. 27).

In the case of water use, the gap between information and action appeared in some of the most affluent and *greenest* parts of the country. Cynthia Barnett, author of *Blue Revolution: Unmaking America's Water Crisis* (2011), pointed to central and southern California as the poster child for areas where "America's green craze has missed the blue" (Barnett, 2011, p. 3). Sacramento city leaders adopted the name *Sustainable Sacramento*, and have worked to become a national leader in sustainable energy technologies and policies. Sacramento's citizens supported green construction projects, paid higher rates for alternative energy sources, used strictly organic food in public schools, provided free trees for residents who want to shade their homes, and yet wasted more water per-capita than almost anywhere else on the planet. The average person in Sacramento used 300 gallons of water per day in 2010, in contrast to the water-conscious Dutch who averaged about 33 gallons per day (Barnett, 2011, p. 3).

Sacramento might have been the extreme, but many cities' water use trends were not far behind, particularly in the water-poor Southwest. This was ironic considering that westerners tended to score higher on environmental knowledge tests and spent more time in the outdoors than other Americans (NEETF, 2005). Environmental education had thus fallen short of its goal. This was apparent in the disconnect between education and meaningful change in how Americans use water resources (Barnett, 2011).

The Clean Water Act

Organized environmental education specific to water resources was traced back to the Clean Water Act (CWA) of 1972. Although the legislative act was not purposed to act as an educational platform, the CWA was enacted thanks to growing public concern for surface water conditions and related public health threats (EPA, 2012a). In 1970, the Environmental Protection Agency (EPA) was established in an effort to consolidate environmental research, monitoring, standard-setting, and enforcement activities; the formation of the EPA and passage of the CWA marked an unprecedented public willingness to assume personal responsibility for environmental issues. This unique political climate was due in large part to publications like Rachel Carson's *Silent Spring*, one of the first non-technical writings to critically evaluate the use of pesticides and jump-start the environmental movement (Graham, 1978).

The CWA established robust enforcement guidelines and gave citizens meaningful roles in watershed protection and pollution mitigation measures. Specifically, the law stated that all waters should be “fishable and swimmable,” and have “zero pollution” by 1985 (as cited by Greenberg, 2012, para. 4). It provided increased funding for infrastructure and to help states meet the new pollution requirements, and required industries to take responsibility for infringing on what had been deemed an American right to clean water (Greenberg, 2012). The 1987 revisions to the CWA encouraged states to ensure groundwater protection, required stricter storm water and toxic pollutant regulation, and requested renewed citizen interest through voluntary non-point source management programs (EPA, 2012). Although the CWA never met its original goals, an overwhelming number of public waters were still not fishable or swimmable 40 years after the initial legislation was published, it was a milestone for the environmental movement and the federal government’s involvement in protecting water as a public resource (Greenberg, 2012).

The CWA spurred nationwide water education efforts for a few reasons. Many citizen activists had genuine interest in protecting local ecology, but the EPA eventually realized it could never meet the goals of the CWA without ramping up public involvement (EPA, 1992). By 1987, over half of the remaining surface water pollution was labeled as “nonpoint source” in origin (EPA, 2012). Nonpoint source pollution typically had generic, difficult to pinpoint origins like failing septic systems, over-application of pesticides on lawns and gardens, runoff from agricultural operations, etc. Historically viewed as a state issue, it quickly became obvious that regulating individuals would never be a financial or logistical reality. In part, formal water education was born out of necessity to enforce the goals of the CWA (Greenberg, 2012).

Problem Statement

The Clean Water Act of 1972 brought public attention to the issues surrounding water quality and availability in the U.S. Although the Clean Water Act was not an educational initiative per se, it did provide the foundation and interest for education on water related issues. Much has been learned about sustainable water use and human effect on water quality, but not all efforts to disseminate this knowledge to the general public were successful. This study sought to answer the question: To what extent have water related education initiatives complemented major water related issues of the last 40 years?

Purpose

The purpose of this review was to chronologically examine major water resource issues in the U.S., education on those issues, and the outcomes of educational efforts.

Objectives

1. Identify major themes and events in water availability, quality, and/or management challenges from 1972 to present.
2. Review educational efforts in response to those challenges.

3. Review the outcomes of educational efforts in terms of water quality and availability, public interest, public knowledge, and overall water use patterns.

Definition of Terms

1. Agricultural water issues: legal, environmental, and social issues associated with allocating and withdrawing water for irrigation, livestock, aquaculture, or some other agricultural purposes.
2. Environmental education: education aimed at producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution (Stapp et al., 1969, p. 31).
3. Environmental literacy: environmental knowledge that is distinct from simple awareness or personal conduct; it involves an intimate understanding of environmental issues, a willingness to address those issues, and technical competence.
4. Nonpoint source pollution: pollution generally resulting from land runoff, precipitation, atmospheric deposition, drainage, seepage, or hydrologic modification (EPA, 1994, n. p.).
5. Pro-environmental behaviors: this study utilized definitions from Stern (2000); the four categories of environmental behaviors were defined as: *activism behaviors* such as participating in a rally, *non-activist public-sphere behaviors* such as voting environmentally or supporting environmental policy, *private-*

sphere behaviors related to consumer choices and personal energy/resource consumption, and *behaviors in organizations* such as businesses adopting ecologically friendly technologies.

Acronyms Used

BMP: Best Management Practice
CBF: Chesapeake Bay Foundation
CBP: Chesapeake Bay Program
CWA: Clean Water Act
EE: Environmental Education
EPA: Environmental Protection Agency
MWEE: Meaningful Watershed Education Experience
NAAEE: The North American Association for Environmental Education
NAM: Norm Activation Model
NEETF: National Environmental Education and Training Foundation
NEP: New Environmental Paradigm
NPS: Nonpoint source
TPB: Theory of Planned Behavior
VBN: Value-belief-norm theory
USDA: United States Department of Agriculture
USGS: United States Geological Service

Significance of Study

Although water management practices have improved overall, growing populations and climate change continue to make water resource education an important priority. While curriculums and instructional materials have been developed and implemented, few comprehensive studies have examined water resource educational formats of the last 40 years. This exhaustive literature review examined water education initiatives in response to major events, the historical context of those events, the corresponding educational theories, and the relative successes of those educational initiatives.

CHAPTER 2

LITERATURE REVIEW

> As man became progressively urbanized, his intimate association and interaction with natural resources diminished and, with it his awareness of his dependency on them. Yet, it is imperative that man, wherever he lives, comprehends that his welfare is dependent upon the proper management and use of these resources. (Stapp, 1969, p. 30)

Environmental Education as a Discipline

Environmental education (EE) as a formal discipline was, in many ways, the predictable result of an increasingly urbanized America. Both the people and the jobs have moved away from rural areas; in 2010 over 80% of the population lived in an urban area (U.S. Census Bureau, 2012), and only 0.6% of American workers were directly employed in a farming, forest and conservation, fishing, or logging profession (Lockard & Wolf, 2012). This migration ultimately led to a distressing discrepancy between the general public's self-reported knowledge about environmental topics and their actual knowledge. According to a 2005 survey from the National Environmental Education and Training Foundation (NEETF), 45 million Americans believed the ocean was a source of fresh water, and 130 million people thought hydropower was a leading energy source when it accounted for less than 10% of the annual energy produced (National Environmental Education and Training Foundation, 2005).

The NEETF emphasized that a lack of education did not necessarily mean Americans were unaware of environmental issues. Generally speaking, Americans were fairly aware of basic environmental problems, an achievement that was not discounted (NEETF, 2005). Hungerford and Volk (1990) articulated the importance of environmental awareness; they emphasized that people could not be expected care about or act upon an issue if they were unaware an issue existed. The researchers indicated that exposure to environmental issues was a well-supported indicator of students' receptiveness to formal EE, and more recent studies demonstrated a generally positive public view of EE principles and formal efforts in public schools (Chawla & Cushing, 2007). Despite these encouraging trends, low levels of comprehension did not indicate public readiness for increased decision-making or input. Moreover, little difference existed between the environmental literacy of the general public and that of elected officials (NEETF, 2005).

Educated public decision making, whether in the form of elections, votes, or physical action, has been a cornerstone objective of EE since its inception. In his benchmark article *The Concept of Environmental Education* (1969), William Stapp discussed the public role in environmental policy and the increased responsibility of citizens to make informed decisions that affected their environment. Stapp did not approach this subject lightly; he placed the onus of responsibility on the general public, saying, "While these problems are legitimate concerns of community government officials and planners, the responsibility for their solution rests, to a large extent, with citizens" (Stapp, 1969, p. 30). This sentiment was consistent with historic working definitions of environmental education established at the Belgrade Working Conference on Environmental Education (1975) and the Tbilisi Intergovernmental Conference on Environmental Education (1977).

The same message was echoed 25 years later. In January 2003, the National Science Foundation released a report from its Advisory Committee for Environmental Research and Education, stating, "In the coming decades, the public will more frequently be called upon to understand complex environmental issues, assess risk, evaluate proposed environmental plan and understand how individual decision affect the environment at local and global scales" (as cited by NEETF, 2005, p. II). The authors went on to describe the current state of American environmental literacy as "sobering and hopeful", stating that although Americans generally supported EE efforts, "our citizenry is by and large both uniformed and misinformed" (NEETF, 2005, p. II).

Behavior Change Theory in Environmental Education

In order to understand the evolution of EE, it was necessary to examine the dominant behavior change theories and models employed in EE research. Researchers have reached the overwhelming consensus that ecological knowledge does not necessarily impact environmental behavior (Hungerford & Volk, 1990; Kellstedt, Zaharan & Vedlitz, 2008; Kollmus &Agyeman, 2010), but limited progress had been made in identifying the traits that most accurately predicted observed environmental action. The oldest environmental education models drew a linear relationship between knowledge and behavior modification (Figure 2.1); however, little scientific or empirical evidence existed to support this train of thought.

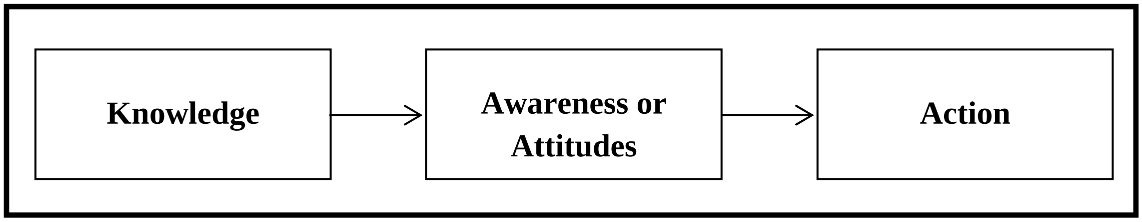

Figure 2.1. Linear Behavior Change Model

Despite such limited utility, the linear behavior change model was consistently applied by non-government organizations (NGOs), in government-funded initiatives, and in various adult education settings (Kollmus & Agyeman, 2002). Although the linear model did not make much intuitive sense based on the generally problematic topic of behavior change, it was the easiest model to interpret and thus survived past its useful life in environmental education research (Hungerford and Volk, 1990).

Subsequent models developed by Hines, Hungerford, and Tomera (1987) attempted to incorporate affective and psychomotor variables. The model proposed by Hines et al. was based loosely on Ajzen and Fishbein's highly popular Theory of Planned Behavior (TPB). The resulting model (Figure 2.2) was derived from an analysis of papers and incorporated the following variables: attitudes, locus of control, personal responsibility, action skills, knowledge of issues, knowledge of action strategies, personality factors, intention to act, and situational factors (Hines et al., 1987, p. 7).

The model ultimately fell short of adequately describing why people act environmentally, primarily because it grouped external factors, i.e. economic constraints and social pressures, into the broad category of situational factors (Hines et al., 1987). Subsequent research demonstrated that these situational factors were not an

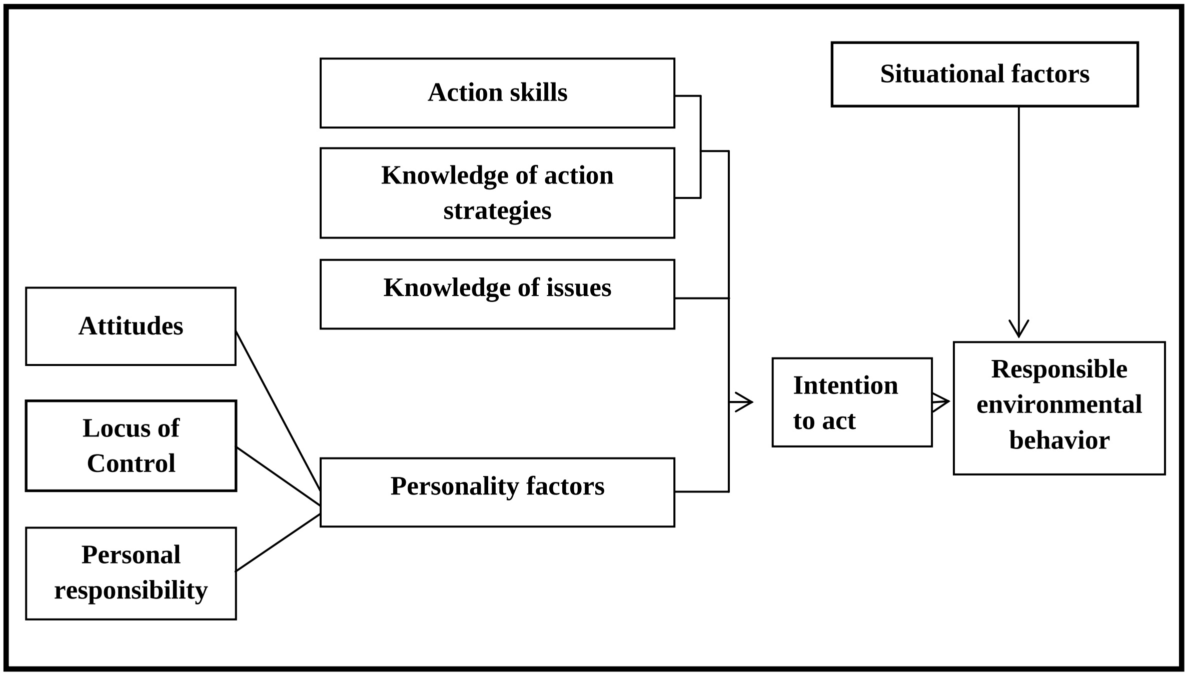

Figure 2.2. Model of Responsible Environmental Behavior - Hines et al. (1987)

afterthought but often the primary motivation for pro-environmental behavior, thus should have be given more emphasis (Hungerford & Volk, 1990). Regardless, the Hines et al. research spurred further discussion on the development of more complex behavior change models and their ability to predict pro-environmental behavior.

Hungerford and Volk (1990) attempted to categorize which variables had the most specific impact on environmental behavior. They synthesized different environmental behavior models and organized variables into three categories: "entry-level variables, ownership variables, and empowerment variables" (p. 11). These categories were examined because of the impact this research had on subsequent work.

Entry-level variables were defined as variables that were good predictors of behavior or appeared to be related to responsible stewardship; they were often referenced as prerequisite variables. The single most important variable identified was environmental sensitivity, defined in the literature as an "empathetic perspective toward the environment" (Hungerford & Volk, p. 12). Hungerford and Volk referred to this variable as the "most significant predictor of future environmental behavior" (p. 12). Environmental sensitivity was followed by androgyny: in this case used in reference to people who did not reflect traditional sex-role characteristics. Hungerford and Volk gave the examples of very sensitive men or very assertive women. Knowledge of ecology was not considered a variable per se, but instead as a prerequisite to sound decision-making. The authors noted this discrepancy, stating, "the research would indicate that knowledge of ecology does not, in itself, produce environmental behavior" (Hungerford & Volk, p. 12).

Ownership variables referred to the concept of personalizing environmental issues; the most significant variables were in-depth knowledge and personal investment. The authors emphasized the personal investment issue, noting that a proprietary interest did not necessarily correlate to a physical gain if the person had a strong ethic and understanding of the human impact on the environment. *Empowerment variables* described those factors that gave people a feeling of importance and the sense that they could ultimately be part of an environmental solution. The three identified variables were: environmental strategies knowledge, a strong internal locus of control, and intentionalism. Hungerford and Volk described empowerment variables as "the cornerstone of training in environmental education," (p. 13) but went emphasized empowerment variables were "a step that is often neglected in educational practice" (p. 13).

One of the most notable contributions from Hungerford and Volk's paper was their commentary on developing environmental sensitivity and the designation of environmental sensitivity as a key prerequisite. Hines et al. recognized the importance of environmental sensitivity, but discussed it as a supplement to formal education and skillset training rather than as a primary driver of eventual behavior. When examining the relationship between knowledge, desire, and action, Hungerford and Volk concluded that the desire to act environmentally and a fundamental concern for the natural world must exist before an individual would spontaneously utilize any real knowledge or skills. These authors' nod to the importance of environmental sensitivity addressed the disconnect between the institutionalization of environmental education and the fundamental prerequisites to an environmentally conscious public.

Environmental sensitivity was considered a troublesome component for educators, largely because it was not historically associated with formal education. The idea was first qualitatively explored by Tanner (1980), who conducted a study with 45 leaders of conservation groups in the United States to identify significant childhood experiences and their relationship to becoming environmentally sensitive as adults. Most of Tanner's participants reported enjoying hunting, fishing, and other outdoor activities over long periods of time; very few reported the importance of educational courses or books. Similar qualitative studies on significant life experiences (Palmer & Suggate, 1996; Palmer, Suggate, Robbotom, & Hart, 1999) supported Tanner's premise. Over 350 environmental educators in the United Kingdom, Canada, and Australia were asked about influential life experiences. Participants overwhelmingly identified time spent in nature (either during childhood or as adults) as the most important driver for acting environmentally and/or choosing an environmental career path. The data provided strong support for Tanner's hypothesis that children must love and understand the environment before they become concerned with its care or be truly receptive to formal EE (as cited by Palmer & Suggate, 1996).

Wells and Lekies (2006) examined the types of outdoor experiences that had the greatest impact on adult pro-environmental behavior. Childhood experiences characterized as *wild nature* (e.g. hiking, camping or hunting) were more influential and ultimately more valuable than those characterized as *domesticated nature* such as planting trees or tending a garden. EE programs were not recognized as a "significant predictor of environmental attitudes or behaviors" (p. 14). This was attributed to the relatively narrow way EE had been approached. When the authors considered the reasons early experiences in *wild nature* caused people to act environmentally, they implied early participation affected the development of individual values and social influences (Wells & Lekies, 2006).

The impact of individual and social norms was examined at length by Bamberg and Moser (2007) in their secondary meta-analysis of EE research; the methodology for the study was almost identical to the one used by Hines et al. (1987) and contrasted the 20 years of data between the two analyses. Bamberg and Moser described pro-environmental behavior as a mixture of self-interests such as impacting one's health and well-being, and pro-social motives like as concerns for the earth, future generations, the ecosystem, etc. Two mainstream theoretical frameworks emerged: the norm-activation model (NAM), and rational choice models like the theory of planned behavior (TPB). NAM tended to describe pro-environmental behavior as a function of moral and social norms (pro-social motives), while TPB assumed people acted to avoid punishment and were heavily influenced by feelings of self-efficacy and perceived control of one's actions (Bamberg & Moser, 2007).

Bamberg and Moser did not completely subscribe to either framework-model instead emphasizing a combination of pro-social and self-interest ideals to determine the factors that most directly influenced pro-environmental behavior. Notably, they identified moral norms as applicable to both NAM and TPB models. They described moral norms as an influence of social norms; norms ultimately determined the feelings of guilt associated with not acting in an environmentally conscious manner. Social norms tended to be a "more indirect determinant of intention to act environmentally" (p. 22); they played into the perceived degree of control over one's actions and how easy an action was to implement (Bamberg & Moser, 2007). The researchers concluded that present models did not adequately predict or explain pro-environmental behavior, but that moral and social norm development did explain a portion of the variance observed. Influencing moral and social norms ultimately did bring about behavior change (Bamberg & Moser, 2007).

The most enduring theory in the EE literature to demonstrate the relationship between values, norms, and ultimate environmental behaviors was the value-belief-norm

(VBN) theory proposed by Stern (2000). VBN theory "links value theory, norm-activation theory, and the New Environmental Paradigm (NEP) perspective through a casual chain of five variables leading to behavior" (Stern, 2000, p. 412). The inter-related VBN variables were: values (with a focus on altruistic values), ecological worldview, adverse consequences for not acting pro-environmentally, the person's self-efficacy and their personal norms in regard to environmentalism (Figure 2.3).

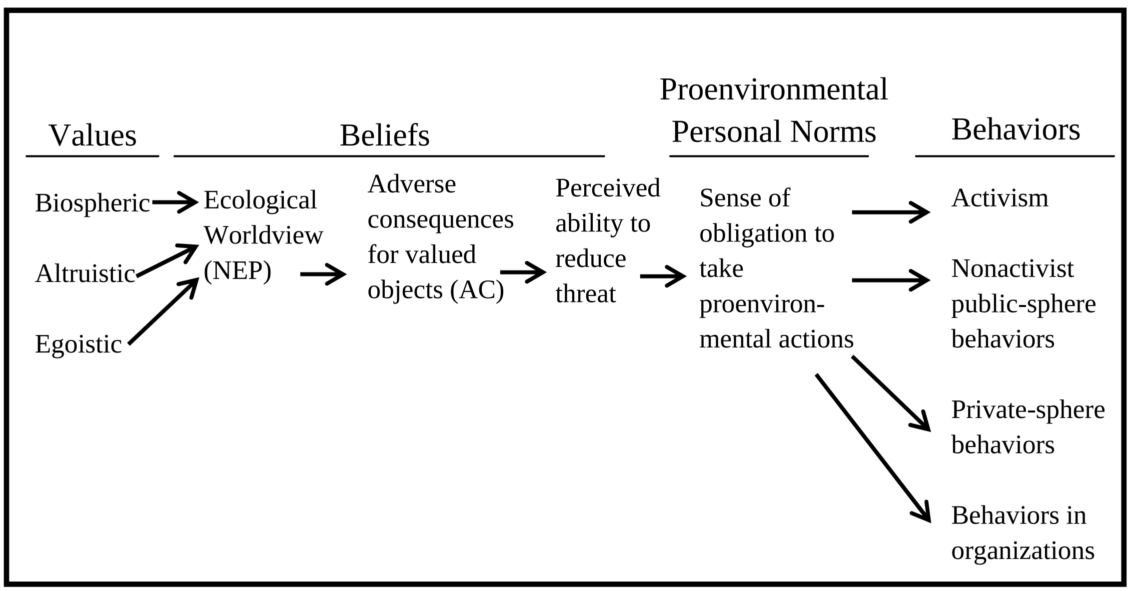

Figure 2.3. Value-Belief-Norm Model (Stern, 2000)

The critical assumption for the VBN theory was that a person's values determined their ultimate propensity to act environmentally. The assumption was well supported in subsequent research (Poortinga, Steg, & Vlek, 2004; Slimak & Dietz, 2006; Steg, Dreijerink, & Abrahmase, 2005) and provided a concise, relatively non-technical theory for educators and researchers. Stern noted that "self-enhancement/egoistic and traditional values such as obedience, self-discipline, and family security…" (2000, p. 414) were demonstrated to have a negative correlation with pro-environmental norms. Though the relationship between traditional values and moral norms was still relatively inconclusive, Stern's model provided some basis of understanding for educators trying to overcome principled opposition to environmental initiatives.

Stern's classification of environmental behaviors created a useful rubric for describing outcomes and behavior goals. Examining the categories was worthwhile, particularly from the perspective of environmental program design and evaluation. They were summarized as follows:

- Activism related to participation in a movement such as direct involvement in an environmental organization or demonstration. Stern described this as a *recruitment* process.
- Nonactivist public-sphere behaviors included support and acceptance of public policies that required the public to act environmentally. These were separate from more active public-sphere behaviors such as petitioning for increased regulation or donating to an environmental group; they were often described a willingness to pay higher taxes or vote for a more environmentally conscious candidate.
- Private-sphere environmentalism included individual actions such as purchasing eco-friendly goods, recycling, saving energy in the home, etc. The majority of the research on environmental behavior change has been in this category.
- Behaviors in organizations referred to the ways individuals impact and influence the actions of organizations they belong to. Stern cited the example of engineers

designing manufactured products in more environmentally conscious ways. These types of behaviors were an important consideration because organizations and businesses were such a large source of environmental problems (Stern, 2000, pp. 409-410).

Previous researchers (Stern, Dietz, Abel, Guagnano, & Kalof, 1999) established that personal norms were the only reliable indicator for predicting public-sphere environmentalism, private-sphere environmentalism, and behaviors in organizations. They noted that true activism, such as participation in a rally, was likely to have additional variables. In their study, the researchers contrasted VBN with three other behavior theories; of the 14 variables examined, personal norms was the only variable relevant to all three non-activist environmentalism types (Stern et al., 1999).

VBN theory earned an important place in environmental education research and water education initiatives because of the emphasis it placed on impacting personal norms, or the desire and sense of obligation to act as a steward of the environment. Much of the behavior change literature focused on private-sphere environmentalism such as consumer behavior, but neglected other private-sphere behaviors such as willingness to pay for environmental protection or voting environmentally. Consumer behavior was considered an important yardstick for educational programming, but in reality green products and consumerism have been only a small portion of the solution. Effective environmental initiatives also encouraged citizens to influence government decision-making and continue to dialogue about EE within family groups, work groups, and other organizations.

Environmental Literacy

Following one of the largest longitudinal studies ever conducted on environmental literacy in the U.S., the National Environmental Education and Training Foundation (NEETF) published a report in 2005 compiling nearly a decade of data on the prevalence and statistical achievements of environmental education efforts. The report looked at the nationwide environmental education agenda and contrasted it with independent surveys conducted through the NEETF in collaboration with Roper Reports to provide an objective measure of public environmental knowledge. The report described the fundamental flaw of the current system, saying, “What passes for environmental education in America is usually environmental information” (NEETF, 2005, p. xv). This was an important distinction, particularly considering the resources and funding devoted to providing the public with more information about the environment. The NEETF noted that generic data in the form of pamphlets, press releases, billboards, etc. was not bad in premise, but had historically failed to produce a population with the desire and skillset to act environmentally.

For the purposes of defining EE goals, the NEETF identified three stages of learning: environmental awareness; environmental knowledge that involved a combination of awareness and personal action; and environmental literacy (NEETF, 2005). Environmental awareness implied generic baseline recognition, often that a person had heard of an environmental crisis. This designation was appropriate for about 50-70% of the population. The environmental knowledge distinction referred to those people willing to make individual efforts such as saving electricity or recycling. This group typically did not participate in activities where much in-depth knowledge was required, but was willing to make small lifestyle changes and understood the benefits of consuming eco-friendly products. Adjusting for social factors, somewhere between 5% and 50% of the population fell into this category. Environmental literacy referred to a working knowledge base and advanced skillset; the NEETF estimated only 1-2% of Americans were truly environmentally literate in 2005. Most environmentally literate individuals had a personal or professional background in laboratories or conducting field work in areas of ecology, earth science, medicine, etc., and expressed a lifetime of interest and involvement in environmental issues.

Nationwide environmental literacy was the goal of the NEETF, but progress towards this goal has been slow Formal environmental education had not significantly improved knowledge levels; there was “no appreciable difference between people who finished high school prior to 1970 and those who graduated after 1990 when formal environmental education was more commonplace in schools. If anything, the former are more knowledgeable about the environment” (NEETF, 2005, p.3). This discrepancy was examined at length by both environmental educators and development specialists. Though there was little hard data, it was generally accepted that a correlation existed between the amount of time spent outdoors as children and being receptive to environmental education as adults. In his frequently cited book *Last Child in the Woods*, Richard Louv (2005) defined this phenomenon as the “nature-deficit disorder” (Louv, 2005, p. 2). Louv’s book was more of a sentimental account than an empirical analysis (Audubon, 2008), but it was consistent with ongoing research on the relationship between significant life experiences and pro-environmental behavior in adulthood. Despite its non-technical nature, the book received the 2008 Audubon Medal for raising awareness of the "health and societal costs of children's isolation from the natural world" (Audubon, 2008, p. 1).

Perhaps the most illustrative data from the NEETF/Roper public surveys was the gender gap; it characterized differences between men's and women's views of environmental issues (NEETF, 2005). Women tended to score poorly on environmental knowledge tests; they were particularly weak in the areas of wetlands, nuclear waste disposal, ozone function, and U.S. electrical generation means. While 43% of men received a passing grade on the knowledge quiz, only 21% of women passed. The participants had the same levels of formal education, so the incongruity was most likely a function of professional differences; in the U.S. men were twice as likely as women to have a career and/or higher education in science-related fields (NEETF, 2005).

The paradox of the gender gap was that in terms of environmental sensitivity, women consistently reported higher environmental concern and were more likely to demonstrate environmentally conscious behavior (Davidson & Freudenburg, 1996; McCright, 2010; Stern, Dietz, & Kalof, 1993). Women (including those surveyed by NEETF/Roper) often rated the environment as a more pressing issue than the economy, and were more likely than men to vote pro-environmentally. The reasons for this difference were not clearly understood, but served to concretely illustrate the non-linear relationship between knowledge and environmental action. The gender-gap was an interesting marker for the environmental literacy debate because it changed the paradigm for what should be emphasized in environmental education curricula and how environmental literacy was defined in practice.

Environmental Education and Classic Education Theory

The review of EE partially served to make a case for more educational emphasis on environmental sensitivity and impacting personal and moral norms. This was a common theme in environmental education literature (Chawla, 1998; Kollmuss & Agyeman, 2002; Metzger and Mcewen, 1999; Stern et al., 1999), but it was not often contrasted with traditional education theory on teaching students to modify their attitudes or emotions. Bloom, Engelhart, Furst, Hill, and Krathwohl (1956) articulated the idea of teaching value systems and developing a system of objectives for emotional learning; they were among the first group of researchers to formally organize educational objectives into a taxonomy based on the natural relationships between the domains of learning. They defined this goal as the “ways in which individuals are to act, think, or feel as the result of participating in some unit of instruction” (Bloom et al., 1956, p. 12). The resulting taxonomy created three overlapping domains: “the cognitive domain, the affective domain, and the psychomotor domain” (p. 12).

The cognitive domain was by far the best fit for a taxonomic system, as it dealt primarily with students’ knowledge of a specific topic and their ability to memorize and repeat information. This domain also lent itself to the hierarchal nature of the taxonomy; it was the domain where teachers received the majority of their training and were most comfortable evaluating students’ readiness to move up in the hierarchy (Bloom et al., 1956). When the cognitive domain was examined in the context of environmental education, it was obvious why the linear environmental action model (Figure 2.1) was so prevalent despite the empirical evidence that it did not lead to increased environmental consciousness. Additionally, the majority of educational impact statements and standardized tests focused on the cognitive domain, which explained why funders and educators were still most comfortable with programming (including environmental education programming) that focused on the cognitive domain (NEETF, 2005).

The affective domain included educational objectives that sought to change or modify the student's interest, attitude, or values. In the literature, objectives for affective education were typically expressed as "interests, attitudes, appreciations, values, and emotional sets or biases" (Krathwohl, Bloom, & Masia, 1964. p. 12). Krathwohl et al. reported difficulty summarizing these results because of the covert and overt nature of feelings and emotions. The affective domain was discussed at length in *Handbook II* (Krathwohl et al., 1964), where it was divided into five categories arranged in increasing complexity: receiving (attending), responding, valuing, organization, and characterization by a value or value complex.

Krathwohl et al. further noted the objectives for the affective domain lacked clarity, they could not be ordered as simply as the cognitive domain, and that teachers were hesitant to grade students' interests, attitudes, or character development. Moreover, teachers were not even sure they could assess affective education. Even Krathwohl et al. questioned the book's success at creating meaningful hierarchy for the affective domain.

Louis Iozzi underscored the institutional problems associated with teaching to the affective domain in the spring 1989 edition of the *Journal of Environmental Education:*

> Even though there is significant evidence that the affective domain is the ‘key’ entry point to the teaching-learning process, dealing with the affective domain in the classroom can present formidable problems for the educator… Despite a new and growing national initiative to include values education – moral values in particular – in the school curriculum, there are school districts across the country that still frown upon the inclusion of affective-related information. Some school boards even forbid the ‘teaching of values’ in their schools. (Iozzi, 1989, p. 5)

In relatively current research on teachers’ ability to teach to the affective domain, Griffith and Nguyen (2006) surveyed 70 education students before and after their semester of student teaching. In the pre-test, 68% of respondents reported they had the skills and knowledge to teach affective skills; this number dropped to 39% of respondents in the post-test. Participants reported the problem as twofold: they felt ill-equipped to teach in the affective domain, and they also did not feel like adequate class time was devoted to character development. Pierre and Oughton (2007) echoed the latter sentiment; they argued the affective domain was the most-overlooked of the three domains in classroom settings. Pierre and Oughton stressed the inherent importance of the affective domain by encouraging the reader to reflect on their own learning to “confirm that there is seldom cognition or psychomotor activity not accompanied by some emotion or affect” (p. 2).

Non-formal educators and program developers have also discussed the challenges of teaching to the affective domain (Culbertson, 1968; Johnston, 1982; Shaw, Hazel, Bardon, & Jayaratne, 2012; Ryden & Whaples, 1975). Due to the emphasis placed on cognitive and psychomotor skills, non-formal educators have been trained to consider programming in the context of attitudes or emotions (Ryden & Whaples, 1975).

In one programmatic example through the Cooperative Extension Service (CES), Lawrence, Schuknecht, and Lally (2006) designed two workshops purposed to improve livestock management practices in regard to water quality. The ultimate goal of both programs was providing livestock producers with low-cost ways to lessen the environmental impact of their operations. One program provided producers with a prescribed management plan and little supplementary information, while the other program focused on educating participants about their options and the standards defined by the Natural Resource Conservation Service (NRCS). Both programs indicated some success; attendees reported they would continue to implement best management practices and that they had a better understanding of how to minimize impacts to water and the environment. The telling part of the article was in the implications for future programming. The researchers did not find meaningful differences between the behaviors of the two groups; the group with the prescribed plan subscribed to the management changes at about the same rate as those who attended the holistic education workshop. The researchers made recommendations for combining the two programs and continuing the workshops, but concluded:

> Perhaps the role for Extension is in teaching and coaching the farmers to use proven management models and to train the professionals in technical skills that they in turn provide to the farmer. Stewardship principles and pride of ownership cannot be outsourced. They are inherent and engrained in the farmer. However, they are expressed through effective planning and implementation of practices that protect natural resources. (Lawrence et al., 2006, n.p.)

This type of hesitation was common, and it may have ultimately served to undermine the effectiveness of EE efforts that were grounded in the affective learning domain. The affective domain was overlooked both in training and practice (Iozzi, 1989).

Water Education

The nature of water often made its management and protection seem outside of individual or public control. According to the U.S. Geological Survey (USGS), water allocated for public supply and domestic use accounted for about 14% of nationwide water withdrawals in 2005. The USGS calculated withdrawals as water removed from a source for any length of time, regardless of how quickly it was returned to the system. For reference, agriculture (including irrigation, livestock, and aquaculture) accounted for 34% of withdrawals; industrial sources and mining operations accounted for 5%; and thermoelectric power plants represented 49% of all fresh and saline water withdrawn in the U.S. (totals may not equal 100 due to independent rounding) (USGS, 2009). At first glance, municipal water withdrawals appeared relatively inconsequential in the spectrum of how water was allocated nationally.

The truth was more complicated. Water use was divided into two categories: consumptive and non-consumptive (Gleick, 2003, p. 278). Consumptive use referred to water allocations that altered the amount of water available in the stream or groundwater system, whereas non-consumptive use was described as water that returned back to the original system. Hydroelectric power plants and some types of thermoelectric power plants were considered to have low overall consumption rates (Gleick, 2003). Although consumption rates did not clearly address ecological consequences in either direction, consumption rates had some meaning when evaluating existing infrastructure, how water reached municipalities, and how much water was allocated and transferred for human needs (Hoekstra & Chapagain, 2008).

Much of the municipal and agricultural water in the U.S. was allocated through engineered inter-basin and trans-basin transfers. These types of transfers required both infrastructure and energy resources, and they were often inefficient in the sense that return flow had no opportunity to return to its original system (Gleick, 2003). Treating, storing and redistributing municipal water was expensive; sustainability was dependent on the vitality of the system. A major failure, such as a dam or pipeline break, had the ability to leave large numbers of water consumers without access to fresh water. Large-scale water transfers have historically been a western problem, but growing populations in eastern cities have called for larger quantities than ever before (Klein, 2008). Reducing municipal water use was not viewed as overbearing environmentalism; it represented ethical practice fiscally while securing public access to fresh water. Moreover, it set the stage for industrial and agricultural reform driven by a public water ethic, not arbitrary mandates (Hoekstra & Chapagain, 2008).

According to Barnett (2011), America had the biggest water footprint in the world over the last century. Based on population, the United States used more water than any other developed country in the last decade. Water use was generally correlated to gross national income, however consumption rates in the U.S. were almost double those of drought-ridden Australia despite having similar agricultural exports and quality of life standards (Gleick, 2003; Hoekstra & Chapagain, 2008). Aldo Leopold may have articulated the answer when he called for America to establish a *guiding belief* on water use, noting that water cannot be everything to everyone (as cited by Barnett, 2011). When discussing America's water ethic, Cynthia Barnett (2011) contrasted America's future with the drought-conscious Australians and the flood-prone Dutch:

> Hurricane Katrina made clear that we are too large, diverse, and regionalized for even the worst water calamity to bring us together in a national "Never again" pledge like the Dutch. And unlike in Australia, where the entire continent can be battered by drought or by flood, our water problems are intensely local: the Southeast can be swamped with hurricane waters at the same the Southwest is scorched in drought.
> But if the Netherlands, Singapore, and Australia have one thing in common, it is the ongoing conversation among citizens, government, and industry about water and its value. In Perth, the daily newspaper runs charts showing water levels in the dams right alongside the weather forecast. (p. 226)

While U.S. water education efforts have been laudable, the nationwide agenda focused more on pollution and water quality issues than modifying use patterns. These education efforts were partially successful; point-source pollution, rivers on fire, and public complacency in the face of national water disasters were dismissed as issues of the past (Hundley, 2009). Glieck (2003) noted a need for water planners and users to move beyond the belief that water use equated with prosperity.

Generational Perspectives of Water Events and Education Efforts

This paper aimed to examine select water-related events of the last 40 years, the educational initiatives in response to those events, and ultimately to assess the impact those initiatives had on water quality and availability, public interest, public knowledge, and overall water use patterns. Topics were examined chronologically, and organized into three generations of environmental learners and educators. The generations were defined as follows:

- *The first generation* was deemed the "Silent Spring Era"; it started just before the passage of the Clean Water Act (1972) and ended during the major agricultural and irrigation reform of the late 70s and early 80s. The period was characterized by little to no formal environmental education; even so, individuals were relatively optimistic and/or ignorant about the future of the environment and ecological health of U.S waterways.
- *The second generation* was defined by the adoption of nonpoint source pollution mitigation (Section 319 of the CWA) and by the population booms in the southwest that resulted in irrigation reform and brought public awareness to the ecological impact of reclamation projects. This generation was the first group required to make large-scale modifications to water use patterns, a necessity that killed the romanticized environmental ideals of the "Silent Spring Era". This group received some amount of formal environmental education, and was the first generation to recognize environmental education as a legitimate academic pursuit (Palmer, 1998).
- *The third generation* started in the late 90s and early 00s; it was defined by the technological advancements that affected water use patterns and the way educational material was disseminated. This generation tended to view technology as the answer to major environmental dilemmas, but had less personal

contact with the environment and did not understand the intrinsic relationships between natural resource use and human wellbeing.

First Generation – The Silent Spring Era

The '60s and early '70s represented a time of new beginnings for environmentalism and water education efforts in America. Rachel Carson had published *Silent Spring* (1962), one of the first efforts to outline the environmental crises in language that was easily understood by the reading public. Carson understood the importance of appealing to the typical reader, a fact obvious both in the book's sentimental nature and panache. *Silent Spring* contrasted aerial synthetic pesticide applications with widespread fears of nuclear fallout and radiation, a move that made her work both explosive and controversial (Griswold, 2012). *Silent Spring* appeared in a three-part series in *The New Yorker*, was selected for the Book-of-the-Month-Club, and ultimately garnered Carson major television appearances (Koehn, 2012).

Carson was often credited with starting the environmental movement; whether or not this distinction was appropriate remained a topic of contention among both her critics and admirers. Regardless, most would agree Carson entered the world of environmental journalism at a time when few people understood the breadth of the human impact on ecosystems. Carson was a good scientist and talented writer, but her work was not new news to the scientific community (Koehn, 2012). Instead, *Silent Spring* served as a wake-up call to the American people and as a model for environmental educators. She inspired people to care about nature, and to protect their resources and their own health.

Carson's work was notable because it did not simply present the facts; it pointed a finger at chemical companies, pesticide users, and pesticide application techniques that posed threats to environmental and public health (Griswold, 2012).

Not surprisingly, Carson's book created a massive backlash among the industries it attacked. Houghton Mifflin (*Silent Spring's* publisher) and *The New Yorker* both faced legal threats from pesticide manufacturers. Carson was accused of being a communist sympathizer and agricultural propagandist who sought to reduce the capacity of U.S. food production (Griswold, 2012). Through the intervening years, Carson's book has continued to be attacked by private organizations and individuals who maintained that limiting pesticide use resulted in catastrophic consequences related to mosquito-born diseases and food production efficiency (Rachelwaswrong.org, 2013; Rosenberg, 2004).

The criticisms *Silent Spring* received provided a glimpse into how the first generation shaped the environmental education paradigm. In a 2012 *New York Times* article, Eliza Griswold articulated the industry response:

> The well-financed counter reaction to Carson's book was a prototype for the brand of attack now regularly made by super-PACs in everything from debates about carbon emissions to new energy sources. 'As soon as *Silent Spring* is serialized, the chemical companies circle the wagons and build up a war chest,' Souder says. 'This is how the environment became such a bitter partisan battle.' (p. MM 36)

The perspectives and initiatives of the first generation were something of an enigma; they came from a nation that had previously not had much environmental persuasion in any given direction. Environmentalism as a cause had not yet been limited by either lobbyists or politicians; this point was underscored by the movement's transition from social ideals to enforceable laws. John F. Kennedy was president when

Silent Spring was published; he was a supporter of Carson's work and established a committee to study pesticide use (Koehn, 2012). Yet it was almost 10 years later that Richard Nixon signed legislation forming the Environmental Protection Agency (EPA) after witnessing the nation's excitement about the first Earth Day celebration in 1970. Nixon passed the Clean Air Act but vetoed the Clean Water Act (CWA) on the basis that the associated costs were exorbitant. Congress overrode the veto, and the CWA was passed in 1972 (Aitken, 1996).

The passage of the CWA marked a new era for water improvement projects. The CWA had lofty goals, among them that all waters should be fishable and swimmable and have zero pollution by 1985 (as cited by Greenberg, 2012). The very language of the CWA was a reminder of the naiveté and optimism of the first generation; no policy writer in modern times with any sort of self-preservation would have proposed a goal of zero pollutants nationwide, much less in a 13 year time span (Babcock, 1990). The first generation didn't understand the scope of the human impact on the environmental movement, but ignorance, in many ways, was bliss. Americans genuinely believed in the feasibility of fixing the environment. The conditions created an educational and political climate that will likely never exist again in the context of environmental education.

The New Environmental Paradigm

In 1978, Dunlap and Van Liere identified and measured the burgeoning support for environmental protection efforts in their article "The 'New Environmental Paradigm'" (1978). The New Environmental Paradigm (NEP) was loosely classified during the mid '70s; it described the societal shift toward a more environmentally conscious public.

Dunlap and Van Liere proposed the NEP in the wake of research that pointed to traditional attitudes and values (i.e., Americans' devotion industrial growth, commitment to science and technology, and limited government regulation) as primary contributors to environmental degradation. NEP was well received academically because it provided a way to measure societal acceptance of environmental ideals (Dunlap & Van Liere, 1978, p. 10).

Proponents of the NEP argued that Americans would have to abandon their primarily anti-ecological social paradigm if they wanted to enact meaningful environmental change or policy. Dunlap and Van Liere noted that these well-publicized social-environmental principles were contrary to the more traditional American social paradigm (Dunlap, 2008). These principles did not represent an ephemeral shift, but an entirely distinct worldview:

> We increasingly hear of the inevitability of "limits to growth," the necessity of achieving a "steady-state" economy, the importance of preserving the "balance of nature," and the need to reject the anthropocentric notion that nature exists solely for human use. Taken together, such ideas comprise a worldview – perhaps best captured by the "spaceship earth" metaphor – which differs dramatically from that provided by our dominant social paradigm. (Dunlap & Van Liere, 1978, p. 10)

The authors measured alignment with the NEP by distributing paper surveys; twelve items designed to measure the NEP were nested within other questions that addressed a range of environmental issues. The survey utilized a Likert-type scale ranging from strongly disagree to strongly agree. Four of the twelve original NEP questions were listed below for contextual purposes:

1. We are approaching the limit of the number of people the earth can support.

2. The balance of nature is very delicate and easily upset.
3. Humans have the right to modify the natural environment to suit their needs.
4. Mankind was created to rule over the rest of the world. (Dunlap & Van Liere, 1978, p. 13)

Preliminary results of the NEP survey were encouraging. Dunlap and Van Liere noted, "The general public tends to accept the content of the emerging environmental paradigm much more than we had expected, and that environmentalists strongly endorse it" (1978, p. 13). The authors added a word of caution, however, warning readers that the NEP was too new to be completely understood or internalized by the public. They summarized with guarded optimism, saying, "It is quite likely possible that many of those who endorse the NEP do not yet fully understand the personal and societal implications of 'limits to growth,' 'living in harmony with nature,' etc." (Dunlap & Van Liere, 1978, p. 14). Regardless, the authors were impressed with the quick adoption of NEP ideals, particularly considering how contrary they were to traditional American values (Dunlap & Van Liere, 1978).

The discussion of the NEP was included in the review of the first generation because it summarized the often-paradoxical environmental perspectives of the 1970s and early 1980s. The NEP also had enduring significance as a measurement tool; modified forms of the NEP scale were the most widely used measures of environmental concern worldwide in 2008 (Dunlap, 2008). The NEP was often integrated into behavior change prediction models like the value-belief-norm (VBN) model proposed by Stern (2000), and was utilized by academics to describe both environmental education and sociological phenomena (Buttel, 1987; Dunlap, 2008).

Early Water Resource Education

Two hallmark projects and their respective educational initiatives were selected for review: Lake Erie and Chesapeake Bay. These projects were selected primarily because of their national publicity and dynamic educational efforts; they were also sufficiently similar in size and scope to be compared with relative ease. These projects obviously did not create a comprehensive snapshot of this generation, but they were interesting in the context of this paper and provided compelling evidence in support of large-scale water quality education efforts.

Lake Erie and the Cuyahoga River

Lake Erie and the Cuyahoga River were some of the first high-publicity catastrophes mitigated after the CWA was enacted. It didn’t take much convincing to implement major public reform; the Cuyahoga River (a tributary to Lake Erie) caught on fire several times in the 20th century because it was so thick with oil, and in 1970 the Ohio Department of Health reported that Lake Erie was dead (Babcock, 1990). The link between environmental initiatives and the public good was a clear one: Lake Erie’s fishing industry had crashed, the lake could not support tourism because the beaches were littered with dead fish and masses of algae, and human or animal contact with many of the rivers flowing into the lake was discouraged because the water was too toxic. The pollution in Lake Erie was primarily industrial, but the larger issue was the algal bloom as a result of phosphorus loading. When the algae died, the decomposition process sapped the lake of available oxygen and killed almost everything living in it (Babcock, 1990; Ohio Sea Grant College Program, 1989).

Lake Erie was an almost perfect backdrop for a high-publicity water quality disaster because so much of the pollution was point source and could be directly attributed to local industry and agriculture. The public wasn't really blamed for the problem or encouraged to participate in the process; they were simply informed about increased legislation and taxpayer-funded cleanup efforts. These conditions made awareness on the topic relatively easy and dramatic, as people were already emotionally charged about the problem and were economically motivated to restore the fishing and tourism industries (Ohio Sea Grant College Program, 1989). Overwhelming public concern gave rise to the Great Lakes Water Quality Agreement, a bi-national agreement signed in 1972 by Canadian Prime Minister Pierre Trudeau and President Nixon. It was America's first international treaty drafted in the name of water quality protection, and represented an important shift in federal water protection efforts (Ohio Department of Natural Resources, n.d.).

The amended Great Lakes Water Quality Agreement (1978) indicated an almost nonexistent public involvement in mitigation efforts. The purpose and objectives of the document did not address education in any context, nor were these types of initiatives mentioned anywhere in the document. Article IV, "Programs and Other Measures", called for abatement and control of pollution from municipal sources, but the sources were almost entirely related to infrastructure and sewer system failures and did not concretely link the efforts to the residents of those municipalities. Other pollution sources cited were agriculture and other land use activities, dredging activities, industrial sources, onshore and offshore facilities, shipping activities, etc. The only well-documented consumer change was the ban on phosphate laundry detergents, which helped lower the phosphate levels in sewage (Yeoman, 2011).

Lake Erie and its tributaries were a short-term success story for the EPA, largely because of the conformation of the lake and the amount of pollution to which it was subjected. It was the shallowest of the Great Lakes, and cycled water and pollutants through in about 2.6 years, 70 times faster than Lakes Superior and Michigan (Babcock, 1990). The geological setting and clear-cut pollution sources meant the initial wave of reform seemed relatively successful; the EPA was motivated to enact fast, sweeping restoration measures. From a surface perspective, Lake Erie was a relative environmental cleanup success by the late 1970s (Burns, 1985).

Lake Erie and the Cuyahoga River were compelling subjects in the media, but there was never much formal, science-based public education on why the lake had reached such a dismal turning point. The public was emotionally invested, but lost interest once the lake seemed to improve. In a 1990 interview for the *Christian Science Monitor,* the director of the Northeast Ohio Regional Sewer District described the problem with an uneducated public, saying, “People no longer see the mattes of algae. It’s no longer the oozing, stinking mess it once was. They’re catching fish they didn’t before. Now it’s difficult to convince the public that problem still exists” (Babcock, 1990, p. 1).

The problem turned out to be a sleeping giant that returned in full force. In 1985, The Ohio Sea Grant College Program published a fact sheet detailing the carcinogens present in the lake and the continued threat of non-point source pollution, but the issue was largely ignored (Babcock, 1990). Lake Erie did not receive much national recognition again until the mid-1990s, when agriculture runoff due to heavier than normal rainfall patterns caused a salient jump in algae blooms; the bloom was exacerbated by invasive species and global climate change patterns. In 2011, the algal bloom contaminated drinking water for more than 2.8 million people and re-established Lake Erie's status as an endangered body of water (Wines, 2013).

The cycle of Lake Erie's ecological health was consistent with the NEETF's push for an environmentally literate population. As a case study, Lake Erie was a strong indicator that sensationalized awareness and blind compassion were inadequate; the public must also grasp the scope of environmental cleanup projects and begin to consider those projects in terms of generations and centuries, not decades or presidential terms. Cuts to federal programs and a complacent public contributed to an increasingly vulnerable ecosystem that may not bounce back as neatly as it did 40 years ago. Lake Erie did not die overnight, and in turn the measures of the CWA did not provide a panacea for the problem.

For the first generation, water-resource education was more about emotionalism and awareness, with little research-based science. The first wave of crises promoted before the passage of the CWA was so offensive to the basic human desire for clean, natural water sources, that most residents felt like they had a grasp on why environmental restoration water source was an important goal. This generation may have been sufficiently sensitive to the crisis on Lake Erie, but it was uncharted territory; the majority of users could not conceptualize permanent harm to a body of water as large as the Great Lakes (Carson, 1962; Yeoman, 2011). Even those who could comprehend it were perhaps overly optimistic about society's ability or willingness to turn the trend around.

Chesapeake Bay

The Chesapeake Bay cleanup was an intriguing contrast to Lake Erie because the two projects were strikingly similar in timing, scale, and affliction. As the nation's largest and most fertile estuary, Chesapeake Bay waters in the mid-1970s were so hypoxic that they were unable to support life. Though there were multiple causes, one of the most drastic was almost identical to the one that plagued Lake Erie; nutrient runoff from local farmlands fed algal blooms that sapped the water of available oxygen and created dead zones near the bottom of the shallow bay. The bay suffered from massive fish kills, a sobering sight for a waterway famous for its pristine beauty, diverse oyster populations, and seemingly limitless sources of blue crab and rockfish (Fahrenthold, 2009).

In 1967, area residents formed the Chesapeake Bay Foundation (CBF), a private-sector group purposed to advocate for the bay's ecological health. The CBF was founded on education-centered principles partially inspired by the former congressman Rogers Morton, who called for an organization that could "represent the best interests of the Chesapeake Bay. [The group] should build public concern, then encourage government and private citizens to deal with these problems together" (Chesapeake Bay Foundation, 2012, p. 1). Early members of the CBF responded with a forward-thinking public awareness campaign; they recruited a diverse group of stakeholders for the first board of trustees and printed their now-infamous SAVE THE BAY™ motto on bumper stickers that would become a trademark of the area (Chesapeake Bay Foundation, 2012b).

In 1970, Arthur Sherwood was appointed executive director of the CBF. Sherwood was a strong advocate for public education and something of a visionary as a program developer; he was famously quoted as saying "The place to teach people about the bay is in it and on it" (Chesapeake Bay Foundation, 2012, p. 1). Sherwood bought a workboat and few dozen canoes to lead school trips and educational tours into protected waters, and hired staff biologists to campaign for stricter enforcements and more extensive land conservation easements (Chesapeake Bay Foundation, 2012). His successors remembered him as a liberated thinker who spoke about environmental protection long before it was in vogue. Sherman was a lawyer with no formal training in education, but understood that saving the Chesapeake would mean more than waiting for the EPA to follow up on mandated promises. Sherwood laid the foundation for future educators and ensured that policies designed to protect Chesapeake Bay would present the problem as a holistic, community-based issue (Greene, 1996).

Chesapeake Bay was the first estuary targeted for protection by the EPA, and the foundation took full advantage of its media spotlight. The CBF had appointed former Senator Charles Mathias to its board of trustees; Senator Mathias was able to gather resources and support for a seven-year study on the ecological health of the bay. The report eventually culminated in a primary draft of the *Chesapeake Bay Agreement* in 1983, and the formation of the Chesapeake Bay Program (CBP) (Chesapeake Bay Program, 2012a). The *1987 Chesapeake Bay Agreement* (a follow-up to the initial draft) solidified the objectives of the document, which placed a heavy emphasis on continued research, citizen monitoring, and citizen decision-making. The educational and public participation goals of the 1987 agreement included:

- Promote greater understanding among citizens about the Chesapeake Bay System, the problems facing it and policies and programs designed to help it.
- Provide increased opportunities for citizen participation in programs and decisions affecting the bay.
- Promote increased opportunities for public appreciation and enjoyment of the bay. (Chesapeake Bay Agreement, 1987, p. 5).

These goals might have seemed almost prosaic 25 years after the fact, but in truth the *1987 Chesapeake Bay Agreement* was completely novel in the spectrum of water-resource contracts. Non-formal water quality education was happening on a small scale, but the Chesapeake Bay watershed covered over 64,000 square miles in portions of New York, Delaware, Pennsylvania, Maryland, Virginia, and West Virginia, and was home to 13.5 million people in 1985 (Chesapeake Bay Program, 2012c). Discussing water quality education was a monumental undertaking, consistent with the optimism seen in the first generation.

The encouraging conclusion for Chesapeake Bay was that this optimism not only survived, it was fostered. Though it was impossible to definitively link current trends to past initiatives, both the CBF and the CBP boasted one of the most aggressive outreach and educational campaigns in the country. In the 2008-2009 school year, 2.17 million of the 2.72 million students in the watershed participated in some form of environmental education programming through the CBP. Collaborations between watershed groups and across state lines yielded an interdisciplinary curriculum called the Meaningful Watershed Education Experience (MWEE); the program was designed in the spirit of Arthur Sherwood's ideals to get students out of the classroom and "in or on" Chesapeake Bay. In 2000, the governors of all the Chesapeake states signed a commitment to provide an MWEE experience for every student in the Chesapeake Watershed before high-school graduation (Chesapeake Bay Program, 2012b).

Despite these efforts, the bay remained classified as a highly degraded system in 2012. The Chesapeake Bay Foundation annually evaluated the bay's ecological health on a scale of 1-100; in 2012 the bay scored 32 out of the possible 100 points. Of particular concern were nutrient levels, dissolved oxygen, and toxins. These problems were consistent with historic pollutants and stressors to the bay's ecosystem (Chesapeake Bay Foundation, 2012a). In many ways the Chesapeake Bay story aligned with the Lake Erie story.

In relative terms, however, Chesapeake Bay was improving. The bay's health index rose three points on the CBF's scale in 2010 and one point in 2012, a 10% improvement in the past five years. Even with increasing urbanization and heavy rains, nutrient levels have held steady; indicators that buffer strips and bolstered shellfish populations did seem to be helping filter pollutants. These natural restoration practices were slower to yield exciting numbers, but ecologists maintained they provided long-term protection against unpredictable rain events and runoff patterns (Chesapeake Bay Foundation, 2012a).

In 2008, the Chesapeake Bay Trust surveyed Maryland residents on perceived importance of environmental issues and the future of the bay. Participants were asked whether they experienced Chesapeake Bay fatigue (i.e. if they were more or less interested in hearing about the health of the Chesapeake Bay than they had been previously) and if they would support increased public funding for bay restoration efforts. They were also asked how much time they spent in or near the bay recreationally. The results were compelling: 90% of respondents indicated they were just as interested or more interested in the Chesapeake Bay than they had been a few years prior, and a large majority said they would support increased public funding for the bay despite the national economic downturn. Interestingly, respondents did not report spending a significant amount of time near the water; only 11% said that they frequently fish or crab, and just 8% frequently went swimming or boating in natural waters (Chesapeake Bay Trust, 2009). Four decades of public support and willingness to pay for continued research indicated preliminary success on the part of educators and programmers, and created a strong case for the education campaign designed by the CBF and CBP.

The benefits of these programs and monitoring efforts were not isolated to Chesapeake Bay or its residents. The data collected over the last 40 years, both biological and sociological, represented some of the most comprehensive and cogent research available on long-term estuary restoration projects. The CBF, CBP, and other partnering organizations conducted quality programming evaluations, employed monitoring techniques that were consistent with industry standards, and compiled information in ways that was packaged and utilized by government organizations, NGOs, and environmental education groups. Chesapeake Bay empirically demonstrated the educational longevity of early public sensitization followed by sound science and consistent public outreach from trusted sources (Chesapeake Bay Foundation, 2012a).

Second Generation – Environmentalism versus Economic Growth

If the first generation was characterized by a sense of revolution regarding improved water resources, it was fair to say that portions of the second generation had become somewhat disenfranchised with the environmental movement and the topic of water use reform. Cleanup on the most severe cases was in full swing; *Time* magazine was no longer publishing stories about lakes on the precipice of doom or pictures of rivers on fire. The goals of the CWA that had once seemed endearingly optimistic were understood to be gross miscalculations; to imply that the nation's waters could be pollution free by 1985 seemed more like a science fair project than a national environmental initiative. This was partially due to a growing body of research on storm water drainage, agricultural runoff, and other forms of nonpoint source pollution, but it was also ingrained in the implied failure of the CWA and the EPA. The CWA and its pilot projects had not come anywhere close to meeting quantitative pollution goals, a fact heavily advertised by industries forced to meet new cleanup and production standards. Gone were the days of unregulated water pollution and corresponding profit margins.

The CWA made things personal, and the political repercussions were consistent with nationwide polarization on environmental topics (Reisner, 1993).

These perceived failures were compounded by Reagan-era tax cuts and administrative changes that ultimately undermined the authority and jurisdiction of the EPA. Reagan was an outspoken skeptic of environmental protection laws and promised to "reduce compliance burdens associated with environmental controls and other federal health and safety regulations" (Kovacic, 1991, p. 673). Though Reagan had been championed as an environmental advocate during his tenure as governor of California, that sentiment did not necessarily transfer to his presidency. He was determined to curb the environmental agenda both from a regulatory and ideological standpoint; he removed the solar panels installed on the White House roof during the Carter administration, and placed industry-oriented leaders at the helm of the EPA and the Department of the Interior. To one *New York Times* columnist, it seemed like Reagan had "selected the nation's environmental policies as a prime target of his social revolution" (Shabecoff, 1989, para. 4).

Portraying Reagan as an environmental villain was both unfair and oversimplified. He was remembered not as being anti-environment, but as a strident advocate of free market solutions to national problems. Political discourse aside, Reagan's regulatory changes did lessen the scope of environmental policy enacted in the previous decade. Between 1981 and 1989, the EPA's funding was cut by 30%, and the Office of Management and Budget was given the authority to require a favorable costs-benefits analysis of any environmental regulation before it could be enacted (Shabecoff, 1989). Reagan changed the environmental paradigm from an ideological motive to fiscal one. He was not opposed to environmental protection as long as it did not compromise industry progress (Kovacic, 1991).

The economic growth versus environmental protection debate might have been the real tragedy, and enduring legacy, of the second generation (Kovacic, 1991). Slow progress made on the benchmark projects of the CWA was disheartening, and those projects had been expensive. Most of the glamorous pollution abatement projects had been implemented, and a decade later it was clear that many of those policies had not been effective on the scale originally anticipated (Hammer, 1992). The economic and social costs to some of the nation's largest industries served as political ammunition for a more critical look at environmental legislation. The result was a polarized climate that painted environmental compliance as a hindrance to national economic wellbeing, and divided groups that might have been better served through more symbiotic solutions (Draper, 2006; Zaring, 1996).

The complex water resource and quality issues raised by the second generation further muddled public emotion. In a retrospective review, one overarching theme emerged during the mid-1980s: nonpoint source (NPS) pollution mitigation nationwide. NPS pollution was not explicitly addressed in the original draft of the CWA, but from the 1980s forward, it became obvious NPS pollution would present a significant logistical challenge to water managers and educators (Zaring, 1996). This was partially due to the relatively esoteric nature of the problem. It was not an intellectual or emotional stretch to understand why discharging raw sewage into a river could create a public health hazard, but the connection was less concrete when discussing mundane activities like washing a car in the driveway or applying garden fertilizers (EPA, 1994).

Nonpoint Source Pollution

In 1987, the CWA was amended to establish the Section 319 Nonpoint Source Management Program. The term nonpoint source (NPS) pollution was often viewed as a catchall for various types of pollution sources not defined in the CWA; the EPA defined NPS pollution as “pollution generally resulting from land runoff, precipitation, atmospheric deposition, drainage, seepage, or hydrologic modification” (EPA, 1994, n. p.). The 319 CWA addendum designated grant monies and federal assistance for state programs addressing nonpoint source pollution projects and abatements. While the majority of point-source pollution had been identified, if not explicitly addressed, ongoing NPS pollution cast a dark shadow on existing restoration projects because it was so extensive and multifarious. Section 319 established guiding principles and goals for grants, as well a framework for individual state programs and assessments. States were required to create an assessment of impaired navigable waters, to identify major sources of nonpoint source pollution, and to propose a nonpoint source best management plan (BMP) within 18 months of Section 319’s enactment (Zaring, 1996, p. 526).

Unfortunately, the EPA did not provide much incentive for states to meet the proposed goals. There were few repercussions for those states failing to establish monitoring programs or BMPs; if states did not submit a report, the process simply defaulted to the EPA. Although this default automatically resulted in a forfeit of control over NPS programs, it was no great loss for some states already struggling to comply with guidelines established 15 years earlier in the first draft of the CWA. Section 319 mandated over-arching and under-funded additions to the already stringent surface water compliance goals. In a conservative estimate, NPS pollution was responsible for 30-50% of the ongoing water quality degradation in the early 1990s (Hammer, 1992).

The NPS pollution standards provided the impetus for formal, national public water quality education because it was economically and logistically impossible to manage NPS pollution through regulation alone. The first *Quality of Our Nation's Water* report underscored this point; the report compiled data from all 50 states and portions of Canada in an attempt to describe geographically the extent of water pollution across the country (EPA, 1992). The authors emphasized public involvement in water quality maintenance, noting, “The EPA encourages each citizen to become a steward of our precious natural resources. Complex environmental threats and diminishing funds for pollution control force us to jointly solve the pollution problems” (EPA, 1992, pp. 1-2).

Karr and Dudley (1981) provided discourse on the motivations for implementing BMPs and the potential efficacy of voluntary BMP education in their much-cited article *Ecological Perspective on Water Quality Goals*. The authors provided insight on the kind of educational programming that might inspire communities of agricultural users to adopt more ecologically conscious and economically sustainable practices. They were optimistic about the future of voluntary and incentive-based BMPs, stating, “We can even envision groups of farmers exerting pressure on neighbors to develop a classified headwater program on their marginal land in the name of soil and water conservation benefit to society and economic benefit to them as individuals" (Karr & Dudley, 1981, p. 66).

The large-scale development of voluntary Best Management Practice (BMP) education was one of the first times federal agencies publicly recognized the need for structured educational programs regarding water quality management. BMP information was published en masse through various government agencies like the Extension service, the USGS, and the EPA; many of these informational fact sheets and their corresponding programmatic curriculums were distributed and taught by county Extension personnel and through other publicly funded programs. The logistical and political implications associated with regulating NPS pollution resulted in a mostly voluntary system that encouraged water users to apply for 319 grants through the EPA to mitigate NPS pollution and install BMP infrastructure such as buffer strips, livestock fencing, etc. These grants subsidized a portion of the associated cost; other cost-sharing incentives such as tax exemptions were integrated throughout the 1990s (Christensen & Norris, 1983; Feather & Amacher, 1994, Prokopy, Floress, Klotthor-Weinkauf, & Baumgart-Getz, 2008).

Educational opportunities like the demonstration projects designed by the U.S. Department of Agriculture (USDA) were an attempt to increase farmer education and subsequently lower the economic cost of BMP implementation. Such projects to increase education were attempts to lower grant and/or cost sharing requirements in the long-term because water users would have a more holistic understanding of why BMPs were important on a social and ecological level (Feather & Amacher, 1994). Feather and

Amacher further suggested economic incentives for BMPs could have been eliminated with sufficient education and engagement; the goal of education was to change farmer perception and create an informational incentive rather than a financial one (Feather & Amacher, 1994).

Despite such a large-scale voluntary public education and outreach effort, and the federal funding devoted to NPS educational programming, BMPs were not adopted by water users at rates originally proposed by educators (Prokopy et al., 2008; Valentin, Bernardo, & Kastens, 2004). Educational programming directed at agricultural users typically centered on the idea that profitability would not be negatively affected by implementing BMPs; some research even suggested implementing BMPs could have an overall positive affect on farm income. Empirical evidence indicated economic effects tended to be highly variable and could not necessarily be generalized across different kinds of users (Park, Mostaghimi, Cooke, & McClellan, 1994). This uncertainty may have contributed to seemingly low adoption rates of BMPs among agricultural and other industry water users (Prokopy et al, 2008; Valentin et al., 2004).

Prokopy et al. (2008) synthesized 25 years of literature on why agricultural users did or did not adopt BMPs in an attempt to make recommendations for increasing farmer adoption of BMPs and to make programmatic recommendations for educators. The researchers concluded:

> The role of education programs needs to be more closely explored. This synthesis shows increased information and increased awareness both have the potential to impact adoption rates. In Rubas' (2004) meta-analysis focusing on adoption of any type of agricultural innovation, she found an insignificant relationship with outreach. We did not find this in our review, which suggests that determinants of adoption may well be

> different than determinants of adoption for the entire set of agricultural innovations. However, even for BMPs, education campaigns are clearly not a panacea as evidenced by Napier and Bridge's (2002) comparative analysis in Ohio. One of the study watersheds (Darby Creek) received many more education inputs but did not have improved results. There is a need for more study on the effect of specific education programs, especially education programs that target behavior change based on knowledge of social factors. (2008, p. 309)

Prokopy et al.'s recommendation to consider the "knowledge of social factors" (p. 309) in BMP educational programming was in-line with the early vision of Karr & Dudley (1981), who suggested that peer pressure between farmers would increase the adoption of BMPs. This was somewhat contrary to the informational incentive suggested by Feather & Amacher (1994). Prokopy et al.'s analysis suggested that in the case of voluntary management practices, additional emphasis was needed on the social aspect of educational programming. Water users did not voluntarily modify their practices in response to traditional education alone, particularly when those practices were perceived as economically or socially risky.

Formalized Water Resource Education

The review of the second generation educational efforts identified localized and national efforts in response to growing concern over or about NPS pollution. These educational programs were more formal than the previous generation and utilized a combination of ongoing monitoring, citizen involvement, and voluntary grant-funded and cost-share projects to engage communities and educate the public about water resource issues. The birth of public school-based youth environmental and water resource education occurred in the second generation. Although environmental education had existed under the blanket of youth development programs like 4-H, Boy and Girl Scouts, etc., it gained status as a legitimate academic topic in public school systems and through the Cooperative Extension Service during the late 1980s and early 1990s.

Environmental Education (EE) and Youth Water Education in Schools

Many educators of the second generation called for a more formal and scientific approach to EE. The primary criticism of EE as a discipline was efforts had become too advocacy oriented; critics cited educational messages that were "laced with despair, emotionalism, hype, and misinformation" (Marcinkowski, 2009, p. 36). Professionals and educators maintained that EE without respect for science and/or economics was damaging to the credibility of the field as whole. In response, the North American Association for Environmental Education (NAAEE) drafted guidelines for general publications, K-12 grade education, and the preparation of environmental educators. These guidelines clearly distinguished between education and advocacy, and were supported and updated through the NAAEE and the EPA (Marcinkowski, 2009).

Specific youth water resource education was not initiated as direct response to NPS pollution, but a significant number of formal youth-specific EE movements were developed and implemented during the second generation (Ballantyne, Connell, & Fien, 1998). The main objective of youth environmental and water resources education was to foster an early-childhood appreciation for nature and environmental stewardship principles; this was consistent with research that linked youth experiences in nature to lifetime stewardship principles (Chawla, 1998; Tanner, 1980). Youth-specific environmental education was not a novel concept; youth development organizations like 4-H and boy/girl scouts had encouraged environmentally oriented projects for decades (Lousley, 1999). The difference in the second generation was the acceptance of EE as a legitimate academic discipline in mainstream public schools (Ballantyne et al., 1998; Palmer, 1998).

Despite early mixed perceptions about formal EE, parents were generally supportive about their children receiving EE in schools. According to surveys summarized by NEETF/Roper reports, 75% of adults surveyed in 2000 indicated they felt like EE was as important as math or English, and 84% of respondents believed that EE positively complimented science curriculums (NEETF, 2005). Parents also believed environmental education would help their children become more sensitive as adults. In a 2001 study, 50% of parents believed EE would encourage their children to be involved in community service projects, and that education would have a “great deal of effect on children’s respect for people and places around them” (NEETF, 2005, p. 66).

Environmental educators also recognized dissemination potential in youth programming. In the article *Students as Catalysts of Environmental Change: A Framework for Researching Intergenerational Influence Through Environmental Education*, Ballantyne et al. discussed the possibility of intergenerational information transfer between youth students and their family members. The authors noted that intergenerational transfer could be viewed as a means of “’multiplying’ the impact of school environmental education programs beyond the boundaries of the classroom” (Ballantyne et al., 1998, 286). This type of information transfer also held less political charge and was viewed as a creative way of overcoming logistical adult education barriers (Ballantyne et al., 1998).

Several notable water-resource youth specific programs started during this generation. The North Dakota State Water Commission formed Project WET™ in 1984; Project WET™ later received funding through the Bureau of Reclamation and expanded its publication and education guides to all 50 states and 19 countries (Project WET, 2013). The Chesapeake Bay Program formally increased public school integration; it also began to plant the seeds for the Meaningful Water Education Experience (MWEE) program in light of research regarding the over-institutionalization of environmental education. The MWEE concept received national recognition as an example of quality theoretical and practical application; it was funded by the NOAA Bay Watershed Education and Training (B-WET) program, and was documented as an effective training and educational format (Chesapeake Bay Program, 2012b).

Third Generation – Education and Technology

The third generation of water users was defined by a monumental shift in the way technology shaped the American existence. The effect technology had on water resource education was twofold: information was disseminated and received in ways never before imagined via the internet, home computers or social media; but there was a corresponding loss of personal self-efficacy in the face of rapidly shifting technologies (Blumstein & Saylan, 2007; NEETF, 2005). The communication advancements of this generation changed both traditional and environmental education techniques, but they had a particularly interesting effect on environmental education because of the political and emotional nature of environmental topics. Environmental educators were concerned about the media's accuracy regarding environmental issues coverage (NEETF, 2005); the Internet and social media outlets added a new dimension because environmental issues were so quickly sensationalized by social media and various types of propaganda.

Cox noted:

> It would be difficult to overstate the impact of news media on the public's understanding of environmental concerns. Media not only reports events but acts as conduits for other voices seeking to influence public attitudes. These voices include scientists, corporate spokespersons, environmentalists, and citizen groups. (2013, p. 31)

On-the-ground technologies were discussed as a potential answer to environmental crises, and Americans of the third generation were gradually subscribing to the idea that technology could be a solution to environmental problems. In a 2001 survey, 66% of respondents reported they believed "technology will find a way of solving environmental problems" (NEETF, 2005, p. 127). The NEETF went on to say, "Many Americans seem to buying into this belief. While this shows some public optimism that solutions to environmental problems can be found, it also shows that the public is turning outward, rather than inward, for these solutions" (p. 127).

Technology, however, proved as burdensome as it was helpful to environmental and water quality goals of the third generation. The third generation review examined the major water quality and use issues, and the to-date education initiatives in response to those issues. Understanding this generation necessitated reviewing western water law and why water use patterns did not significantly change over the course of the third generation.

Hydrologic Fracturing

Congress passed the Energy Policy Act of 2005 to ensure domestic energy, create jobs related to energy and fossil fuel extraction, and incentivize the use of greener technologies. At face value, the bill seemed like a good compromise between industry progression and environmental consciousness (Howarth & Ingraffea, 2011).

The Energy Policy Act also created exemptions for natural gas companies wanting to speed up natural gas extraction efforts through hydrologic fracturing, or fracking (Scientific American, 2011). The fracking process required a great deal of water infused with small amount of chemicals to be forced below the bedrock at high pressure; most of the chemical additives were toxic (Howarth & Ingraffea, 2011). The Energy Policy Act of 2005 exempted natural gas companies from disclosing the names of chemicals used and specifically excluded fracking from Safe Drinking Water and Clean Water regulations.

Fracking received scrutiny from the public health and environmental communities who maintained that the effects of fracking were not sufficiently understood. In a 2011 editorial, the *Scientific American* printed, “A long list of technical questions remains unanswered about the ways the practice could contaminate drinking water, the extent to which it already has, and what the industry could do to reduce the risks” (2011, para. 4). Most regulation on fracking was left up to states; whether or not states sufficiently regulated the practice remained a topic of contention. Suggestions to track the movement of fluids such as injecting tracers into fracking fluid to appease the concerns of well and groundwater users were not implemented (Scientific American, 2011).

These types of technological changes may have lowered the self-efficacy of the average American regarding water pollution mitigation. It was difficult to promote lifestyle patterns like proper disposal of household products and greener consumerism when residents near fracking sites were posting online videos of tap water lighting on fire; videos that were widely spread on social media networks like Facebook™. While technology dramatically improved the availability of information available to the third generation, it also emotionalized the topics and made the public more aware of legislative and industry inconsistencies in regard to environmental protection goals (Howarth & Ingraffea, 2011).

Sustainable Energies Production

Other attempts to increase U.S. energy production in the third generation focused on the production of alternative energies to supplement traditional fossil fuels use. Unfortunately, many green technologies had adverse effects to water resources; natural gas, for example, was promoted as being less damaging ecologically than other types of fuels (Howarth & Ingraffea, 2011). Ethanol production was touted as a partial solution to America's dependence on gasoline; the government promoted large-scale corn production and encouraged farmers to plant corn in heavily irrigated states like Nebraska, Colorado, and Montana. The result was increased irrigation in some of the driest parts of the country (Barnett, 2011). Many of the farmers irrigated from the Ogallala Aquifer, a massive underground water source that received national attention because of depletion and contamination rates (Cox, Lawver, Baker & Doerfert, 2004). The depletion of the Ogallala and other western water sources was not exclusively linked to ethanol production, but the case was an interesting snapshot of the national inclination to prioritize alternative energies and green initiatives that have deleterious impacts on water quality and water availability (Barnett, 2011).

Western Water Background

In the same way industry pollution issues harmed people's perception regarding individual importance, western water law and historic practice hindered educational efforts to encourage users to implement more efficient use patterns. Western water use patterns were examined during the third generation (Barnett, 2011; Hundley, 2009), but few large-scale changes were implemented in the context of ecological health (Barnett, 2011).

In order to discuss water availability issues in the West, it was pertinent to examine historic and current water legislation and priorities in the western U.S. Most water law in the West adhered in some part to the prior appropriation doctrine, a system often termed "first-in-time, first-in-right" (Colorado Division of Water Resources, 2012, para. 2). The doctrine had roots in the mining camps of California and Colorado, and originated from the need for a simple, enforceable system on relatively small streams (Bates, Getches, MacDonnell, & Wilkinson, 1993). Under the doctrine, water rights were considered property independent of land ownership; the first individual to withdraw water and apply it to some beneficial use had the "first right to use that water within a particular stream system" (Tarlock, 2001b, p. 770). This initial user became a senior water right holder, meaning their water right had priority before other users could withdraw from the stream or aquifer. Users were required to allocate the water toward a beneficial use (Colorado Division of Water Resources, 2012); if a user did not apply all of their water toward a beneficial use during a specified period, the right could be considered abandoned and the user would no longer have rights to the water (Tarlock, 2001b).

Historically, beneficial use was linked with economic benefit, and included agricultural, industrial, and municipal use (Colorado Division of Water Resources, 2012). During the Reclamation Era from the late 19th century to the mid-1970s, the federal government constructed dams, aqueducts, and pipelines to provide an adequate water supply during drought periods and to extend the irrigation season. These dramatically changed the scope of water use and the distances water could travel. The basics of the prior appropriation doctrine evolved to fit a much different system than the one initially intended, and quickly became a topic of contention among increasingly diverse users (Tarlock, 2001b). Moreover, Reclamation projects mostly came at a high economic and environmental cost. Construction was largely government subsidized. By the end of the 20th century, environmental concerns regarding in-stream flows had gained significant scientific and public momentum to limit such projects (Landry, 1998).

One of the biggest criticisms of prior appropriations was that it undermined its own attempt at ensuring beneficial use. Because the law was often ambiguous regarding what constituted efficient use, there was little legislative incentive for senior users to allocate their water in the most efficient way (Landry, 1998). Westcoat (1985) noted, "The question of how vested rights can be integrated with the principle of maximum utilization constitutes the most important water policy problem facing the American West" (p. 22). Nearly three decades later, the majority of northwestern and mountain states recognized ecological health as a key priority and altered beneficial use definitions to include in-stream flows, but these changes came after a century of the ingrained *use it or lose it* mentality (Landry, 1998).

Fears about future changes to water appropriations and the increased value of water rights to growing cities strained relationships between stakeholders. The prior appropriation doctrine created a theoretically free market for water right ownership and transfers; this market often meant that buying agricultural rights was the cheapest way for cities to ensure the availability of municipal water. Such conflicts had major economic and sociologic implications (Draper, 2006). The most significant changes to in-stream flow priorities occurred in the last 20-30 years, a time-frame that coincided with huge population increases and long-term drought in many western states (Landry, 1998; Pulwarty, 2003).

Reviewing historic water priorities in the West was crucial to understanding water education related to reducing use patterns. The economy and lifestyle of the American West was tied to extraction industries and the direct use of natural resources (Smith & Krannich, 2000; Malone, 1989). Thus, water users in the West have always subscribed to the belief that using less water (or not having the ability to use water) correlates to a loss of prosperity (Gleick, 2003, p. 296). This was particularly true for traditional agriculture and industry users;

Water Use Education

Some water use educational initiatives were prioritized for municipal users during the third generation, but the overall impact has been uncertain (Barnett, 2011). While a handful of western cities made meaningful strides in reducing municipal use, agricultural water withdrawals still represented an overwhelming portion of the water withdrawn in the 17 conterminous western states and the country (USGS, 2005).

According to United State Geological Service (USGS) statistics for 2005, 37% of all freshwater withdrawals in the U.S. were for irrigation; the 17 conterminous western states accounted for 85% of the country's total irrigation withdrawals and predominately used flood irrigation. In the states of Arizona, Idaho, Kansas, New Mexico, Oregon, Utah and Wyoming, over 75% of state water withdrawals were for agricultural use; Colorado and Montana allocated over 90% of all water withdrawals to agricultural uses. The total amount of water withdrawals for irrigation declined since its peak in the 1970s, but questions about overall efficiency and whether irrigated agriculture was economically justified were still at the forefront of development (Molden et al., 2010).

This section covered western water use and the associated legislation because of the implications it has for future water use education. As discussed in literature review, municipal water use reduction efforts were important in reference to overall water use patterns, but they did not effectuate large-scale ecological health because western water users have not historically been on the same page regarding the future of western water use (Barnett, 2011).

CHAPTER 3

CONCLUSIONS AND IMPLICATIONS

The conclusions summarized each generation by reviewing the main education initiatives and providing discussion regarding the types of water resource education employed, the results of the education, and corresponding behavior change theories.

Summary of the First Generation

The literature review of the first generation showcased two major restoration projects from the era: Lake Erie and Chesapeake Bay. The juxtaposition of these two projects and their respective educational initiatives was intriguing because the ecological damage was similar, but the corresponding public education efforts could not have been more different. Both bodies of water were targeted during the first wave of CWA reform, but in the case of Chesapeake Bay one of the most comprehensive and proactive water education programs of the 20th century complimented those mandates. Forty years later, residents in Chesapeake states still reported moderate to high knowledge of the bay's ecological condition and remained intellectually interested and fiscally supportive of restoration and education efforts (Chesapeake Bay Trust, 2009; Chesapeake Bay Foundation, 2012).

To claim that educational programs were the basis of Chesapeake Bay's success would be an oversimplification. There was, however, evidence to support a positive relationship between the two factors. Many of the technical variables between the

Chesapeake Bay and Lake Erie projects were similar. They both involved large populations: approximately 17 million people lived in the Lake Erie watershed in 1985 (Ohio Sea Grant College Program, 1989), and 13.5 million people lived in the Chesapeake Watershed (Chesapeake Bay Program, 2012c). Lake Erie and Chesapeake Bay were both hallmark projects of the CWA; they were targeted for restoration at the same time and drafted similar inter-state water quality compacts. Both of these complex watersheds contain massive arterial tributaries tapped by diverse industrial and agricultural users. The Chesapeake Bay watershed covers six states, while the Lake Erie Watershed covers five (including Ontario).

It was tempting to postulate that Lake Erie's continued troubles stem from bi-national management conflicts, but there was little empirical or technical data to indicate that Canada's contribution to the problem was larger than that of the U.S. Research conducted in 1990 compared levels of environmental concern between U.S. and Canadian residents of the Lake Erie watershed. Findings indicated that Canadians were generally more concerned and more willing to address pollution in the lake than their American neighbors; this was particularly true for "white collar" Canadians versus the same demographic of American respondents (Steel, Soden, & Warner, 1990). The majority of municipal development around Lake Erie occurred on American shores (Fortner, Mayer, Brothers & Lichtkoppler, 1991), and Canadian agricultural practices did not appear to be more detrimental than those employed by U.S. farmers (Steel et al., 1990).

With respect to the similar physical, political, and land-use patterns of the two projects, ecological health theoretically should have improved at about the same rate. Instead, in 2012 Lake Erie experienced eutrophication rates second only to those measured during the 1970s (Wines, 2013), while Chesapeake Bay continued to demonstrate steady, albeit slow, progress (Chesapeake Bay Foundation, 2012a). It seemed reasonable to conclude that pro-active education efforts did have a tangible effect on the overall restoration plan for the bay. Public education programs for Lake Erie residents have been implemented in the last decade, but they were reactionary in nature and must overcome decades of public apathy and feelings of low self-efficacy regarding the condition of the lake (Konisky & Beierle, 2001).

In an analysis of Chesapeake Bay's programming, it was important to note a few of the main factors that likely contributed to its overall success:

- The Chesapeake Bay Foundation had already planted the seeds for comprehensive public education prior to the establishment of the EPA and the approval of the CWA. Educators had a grasp on the scope of the project and had already established community rapport and exposure through Chesapeake Bay Foundation propaganda, bumper stickers, etc.
- The first generation of educators did not have to overcome principled political or social opposition; they had a clean slate for shaping public attitudes and opinions regarding stewardship practices.
- The programs were not linear in nature. Sherwood's *in it and on it* probably was not purposively aligned with environmental education theory, but the motto was

consistent with subsequent research that demonstrated people were more likely to act environmentally based on time spent in nature. This philosophy was mirrored in the Meaningful Watershed Education Experience (MWEE) curriculum adopted by the Chesapeake Bay states.

- There was a strong social norm to improve ecological health in the bay because it was and is such a large part of the area's economy. Restoration practices were not purposed to reduce water use, tourism, etc.

Summary of the Second Generation

The second generation was an interesting paradox in the history of water-resource education and the CWA. On one hand, the population as a whole was becoming more skeptical of the EPA and its regulations; this sentiment was fueled by the political climate of the generation. Many BMP educational programs demonstrated the general inadequacy of the linear environmental education model, but the programs' focus was slow to shift because of the hands-off approach of voluntary implementation efforts (Zaring, 1996). This might have been a product of Section 319's tenuous beginnings; the section was passed by Congress but vetoed by President Reagan on the premise that it was too expensive and would harm industry and agricultural operations (Kovacic, 1991).

Conversely, environmental education in schools was gaining popularity as a legitimate discipline, partially because of internal reviews and criticisms that precipitated streamlined educational guidelines. In her book *Environmental Education in the 21st Century: Theory, Practice, Progress, and Promise,* Joy Palmer (1998) outlined the trends of environmental education throughout the mid-1980s and 1990s. She described the mid-80s as time of increasing global education, values education, and community-led action research; the 90s outlined trends in empowerment for capacity building, community and watershed level understanding of issues, and sustainability discussions in schools and communities.

The seemingly hypocritical viewpoint of the second generation was examined by the NEETF; surveys conducted in 2000 asked participants whether the government had "gone too far", "not gone far enough", or had achieved "the right balance" on environmental regulation (NEETF, 2005, p. 119-121). About half (46%) of Americans did not believe regulations were adequate, 32% believed the laws had struck an appropriate balance, and 15% of adults believed the laws were too extensive. The NEETF combined these numbers under the assumption that moderate respondents could be persuaded in either direction; the result was either a sizeable majority (78%) who believed current environmental laws were inadequate, or a tie between those who did and did not believe the laws were adequate, depending on how moderate respondents were swayed on an issue. This might explain some of the polarization and heated debate that underlines environmental discussions (NEETF, 2005).

Regarding what did and did not work in BMP implementation and education efforts, it was useful to outline some of the main ideas:

- Voluntary management programs like BMPs were only effective if a strong social norm existed to implement the change. BMPs often had some out of pocket cost for producers and secondary economic benefits were not guaranteed.

- The idea of creating an “information incentive” (Feather & Amacher, 1994, p. 159) was not useful when BMPs required out of pocket costs and were not well supported within a community. Thus, environmental education only achieved the goal of helping reduce financial incentives and cost-share programs when the programs were supported on a community level. This was different from Lake Erie and The Chesapeake Bay; instances where citizens were more economically motivated to improve water quality.
- Prokopy et al.’s (2008) recommendation to consider the “knowledge of social factors” (p. 309) in BMP educational programming was in-line with the early vision of Karr & Dudley (1981), who suggested that peer pressure between farmers would increase the adoption of BMPs; it was also in-line with the large body of research pointing to social norms and other social factors as a driving force behind environmental action, particularly in communities that felt threatened by environmental regulations.

Summary of the Third Generation

The third generation may have been the most telling of all three generations, particularly regarding the self-efficacy component. The literature of the third generation pointed to the idea that individuals did not believe their actions mattered if large-scale water users and policies did not complement the efforts of individuals (Barnett, 2011; Hundley, 2009; NEETF, 2005). This was consistent with Stern’s value-belief-norm model and the types of environmental action it predicted (2000). Stern emphasized that true environmental activism such as participating in rallies and joining environmental clubs was not well explained by models that relied on social norms; those models only predicted private-sphere environmentalism (Stern et al., 1999, Stern 2000). Thus, it was not easy to predict actions that were contrary to popular culture.

The review of the third generation revealed less about the actual education initiatives and more about the barriers to environmental education. This was purposeful; by the beginning of the third generation environmental education was more or less a household term. Though there may have been funding and/or political issues with implementing environmental education in schools or otherwise, the mechanics of designing an educational program had been established (NEETF, 2005).

The third generation had not let go of the economic-growth-versus-environmental-protection debate from the second generation; this was evident in policies that increased extraction industry development without much regard to water use or degradation (Scientific American, 2011). Policies that did not sufficiently protect the environment might have actually harmed the efforts of environmental educators, particularly those educating adults. Americans were concerned with water quality and availability; on a scale of personal importance, water quality and air quality tended to rank above all other environmental topics in surveys conducted during the third generation (NEETF, 2005).

Technology innovations of the third generation shaped water management faster than policy and management practices could be updated. This trend is only accelerating; in the coming decades it will be important to insure that those charged with water resource education, particularly educators of adults and diverse users, are able to respond quickly and with research-based information. Technology is a catalyst for all types of information dissemination, factual and non-factual. Thus, educators must be well prepared to confront the opportunities and challenges associated with society's improved access to information.

Cross Generational Implications

There were a few educational themes that emerged across all three generations:

- **Social norms**: Voluntary programs have not been demonstrated to be effective unless they are supported by social norms. Water educators must internalize the past and current relationships between regulatory agencies and water users and design programming that speaks to community perceptions about water resources and availability. The review of the third generation reiterated the idea that water use and ownership is still correlated to financial well-being. Thus, water educators must understand that changing water use patterns also involves shifting historic paradigms.
- **Self-efficacy**: Educators must emphasize the ability of the water user to impact water quality and future availability. The scope of water related infrastructure and projects has tended to decrease personal self-efficacy; future regulatory decisions will have significant impacts on how water is used in the coming decades. Promoting self-efficacy among water users is done through a

combination of physical skill development such as practicing more efficient use patterns, and an emphasis on regulatory paths to water management change.

- **Interactions between diverse users**: All three generations spoke to the complex and often heated interactions between diverse water users. Inefficiencies associated with the polarization of different groups were highlighted throughout the review; water educators should seek to promote more dialogue between users in an effort to promote management strategies that are economically and ecologically viable.

This paper reviewed several behavior change theories within environmental and traditional education frameworks. Although there is no overarching theory behind why people act environmentally, the research strongly supported the triadic interaction between cognitive learning, affective learning, and psychomotor learning. Educators must remember and emphasize these interactions: providing students with facts about water resource issues is not beneficial if students are not sensitized to the issue via affective learning. Similarly, teaching students to care but not providing them with sufficient scientific background or skill development does not produce an environmentally literate population. Psychomotor skills contribute to feelings of self-efficacy, as evidenced by action-based programming like Meaningful Watershed Education Experiences (MWEE). Water resource educators must focus on all three domains to reach the ultimate goal of education: meaningful behavior change.

There has been much discussion within environmental education arenas about not promoting environmental agendas; this has caused educators to stray away from the affective domain in their teaching. While agendas and propaganda are valid concerns, promoting more sustainable water use practices is an issue of public wellbeing and water resource security. Educators not only can promote a more sustainable water use ethic in the U.S., they need to promote sustainable use in order enact meaningful change. Otherwise, they are simply providing students and the public with environmental *information.* Education without an environmental sensitivity component does not ultimately lead to behavior change.

There are larger implications for agricultural users and educators, mainly because agriculture uses so much water in the western U.S. and its viability is constantly threatened by municipal and industrial growth. The idea of a water use ethic has started to permeate classrooms, but it has not consistently reached large scale and agricultural water users in a way that does not villanize them. Most water use mandates have come from sprawling municipalities and environmental activists; very few agriculturalists have called for serious water use reform in the U.S. Tarlock reviewed these sustainability failures in his 2001 article *The Paradox of Sustainable Development: Ideas without Institutions:*

> Sadly, but not surprisingly, three plus decades of environmental regulation have not changed the fundamental structure of unsustainable resource consumption. We have, of course, curbed some of the worst sources of pollution – although perhaps the most important - and preserved some remnants of biodiversity. But, as many students of environmental regulation have forcefully observed, environmental regulation is a modest overlay on the liberal institutions of private property and consumer sovereignty. Regulation does not challenge the fundamental idea that individuals are allowed to determine the amount of their resource consumption, subject to the caveat that they internalize some portion of the social costs of that consumption (p. 42).

Tarlock's critique on regulation made a strong argument for promoting a water ethic. Agricultural educators must take it upon themselves to promote sustainable water use principles and understand that they are equal parts environmental and agricultural educators. Changing traditional social norms within agricultural users must happen internally; norms cannot be imposed by external agencies or by activists who do not understand the relationship between irrigation and agricultural viability.

Agricultural water users can lead the way in meaningful water use reform that is written with goals of future economic and ecological security, not retroactive regulations imposed by federal agencies. The definitions of beneficial water use have shifted in many states, but many traditional agricultural users do not understand the complex web of future rights to use water, economic incentives to reduce consumptive use, or whether their current systems are managing water in the most efficient way possible. The literature review of the third generation partially explained why water law has undermined beneficial use goals; large scale users need to understand these issues and what they can do to enhance future water security. If use patterns are not changed, the viability of western agriculture altogether may be threatened as water distribution changes and water sources are consumed or contaminated.

Additional research is needed within agricultural and environmental education to understand the content and contextual goals of current and future programming, and how these should best be delivered to the third generation of users. Use type and demographic differences should be explored including: differences between surface water and groundwater users, demographic differences related age, location (basin), type of production operation, etc. Future researchers should also focus on investigating the impact of 3rd generation education efforts and forecasting the next generation.

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