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The Effectiveness of Experiential Environmental Education: O'Neill Sea Odyssey Program Case Study

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THE EFFECTIVENESS OF EXPERIENTIAL ENVIRONMENTAL EDUCATION:
O'NEILL SEA ODYSSEY PROGRAM CASE STUDY

A Thesis

Presented to

The Faculty of the Department of Environmental Studies

San Jose State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Lauren E. Hanneman

May 2013

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The Designated Thesis Committee Approves the Thesis Titled

THE EFFECTIVENESS OF EXPERIENTIAL ENVIRONMENTAL EDUCATION:
O'NEILL SEA ODYSSEY PROGRAM CASE STUDY

by

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ABSTRACT

THE EFFECTIVENESS OF EXPERIENTIAL ENVIRONMENTAL EDUCATION: O'NEILL SEA ODYSSEY PROGRAM CASE STUDY

By Lauren E. Hanneman

Environmental education programs aim to develop participant awareness, sensitivity, and understanding of their affective relationship to the natural environment through conceptual knowledge and personal experiences. Previous findings have suggested that participation in environmental education programs leads to short-term positive increases in environmental knowledge, pro-environmental attitudes, and intentions to act in environmentally responsible behaviors; however, few studies have included long-term, follow-up assessment. This research provided an analysis of the effectiveness of the O'Neill Sea Odyssey (OSO) education program in fostering a long-term awareness of personal responsibility about ocean pollution among student participants.

A survey administered to 261 students from the greater San Francisco Bay Area in California was used to explore 7th through 10th grade students' conceptions about the connection between ocean pollution and stewardship behaviors. The study revealed that 75% of 86 former OSO participants retained a high level of awareness of the connection between non-point source pollution and personal behaviors two to five years after the program, regardless of differences in sex, language, grade level, and community setting. These results indicate that OSO participants retained a long-term conceptual awareness about environmental stewardship behaviors taught during the OSO program.

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Finally, I want to thank all of the teachers and students who participated in this project. It is my sincere hope that the results of this study will serve to further validate the continued existence of programs such as the O'Neill Sea Odyssey.

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Introduction

Importance

In April 2012, the White House Fiscal Year 2013 budget request to Congress called for substantial cuts in federal aid that promotes environmental literacy among young people (Greenberg, 2012). The President's Budget for fiscal year 2013 passed in March 2013 ("The White House Office of Management and Budget," 2013). The budget plan cut legislative support for the National Environmental Education Foundation and effectively eliminated the grant programs under the National Environmental Education Act at the Environmental Protection Agency (EPA), including its teacher training and environmental education programs. In addition, the budget plan cut the National Oceanic Atmospheric Administration (NOAA) environmental literacy grant programs for oceans and coastal areas and eliminated NOAA's Bay-Watershed Education and Training program, which is described by NOAA as promoting place-based, experiential learning (as cited in Greenberg, 2012).

The budget cuts funding for environmental literacy, especially ocean literacy, are crippling to a nation that is becoming increasingly science illiterate. In 2004, a report conducted by the U.S. Commission on Ocean Policy found that only 15% of adults described themselves as well informed about science and environmental issues (U.S. Commission on Ocean Policy, 2004). Children have a natural curiosity and desire to engage in the natural environment, but by ninth grade, this innate interest has often faded or been transformed into apprehension or fear (Louv, 2005). Continuity of funding for environmental education programs that engage students in the natural environment is

critical; however, long-term outcome assessments of such programs is necessary to provide documentation of the cognitive and affective benefits of such programs (U.S. Commission on Ocean Policy, 2004). Very few studies have focused specifically on the long-term effectiveness of hands-on, experiential environmental education programs three months or longer after completion of the program. To the best of this investigator's knowledge, this is the only study that has attempted to evaluate the long-term effectiveness of an ocean-based, experiential, environmental education program several years after students completed the program.

Background

The ultimate aim of environmental education (EE) is to promote environmentally responsible behavior (ERB). Traditional evaluations of environmental education have focused on knowledge gains and attitude changes with the assumption that a linear relationship exists between increased environmental knowledge and positive environmental behavior (Darner, 2009; Hungerford & Volk, 1990). Recent studies have shown that increased knowledge alone does not help to change behavior (Ajzen, 2002; Ballentyne, Fien, & Packer, 2000). In an analysis of the variables related to the development of environmentally responsible behavior, Hines, Hungerford, and Tomera (1987) found that cognitive knowledge of the issue, positive attitudes towards the environment, locus of control and desire, or intention to act, were causally related to responsible environmental behavior. Although changes in knowledge, attitude, and intentions to act can be assessed in the short term, they are significantly more difficult to measure years after the program or event. Long-term evaluations of students' developing

conceptions concerning the environment are important for understanding the relationship between student conceptions and their environmental behaviors and decision-making. Such longitudinal research is particularly important for young participants, as intervention effectiveness has been found to be greater among participants who were 18 years old or younger (Eagles & Demare, 1999; Shepardson, 2005; Zelenzy, 1999). This study sought to evaluate the effectiveness of the O'Neill Sea Odyssey program in fostering a long-term awareness of the connection between ocean stewardship and personal behaviors and to determine the importance of incorporating such programs into the public school curriculum. These findings will be useful to educators and policy makers who are responsible for the development of effective programs that aim to advance environmental improvement.

Literature Review

Environmental education background. The seeds of the modern environment movement had been sown by the time Rachel Carson released *Silent Spring* in 1962 (Carson, 1962). Oil spills in the 1960s and early effects of air pollution seen in the United States and Europe, coupled with worries about nuclear war and the effects of fallout radiation, helped to push the modern environmental movement forward (Venkataraman, 2008). At the United Nations Conference on the Human Environment in Stockholm in 1972, world governments issued a declaration that called for the education in environmental matters, for both younger generation and adults, as essential for responsible conduct by individuals, enterprises, and communities in protecting and improving the environment (United Nations, 1972). Following the Stockholm

Conference, an international conference was held by the United Nations in Belgrade in 1975. The resulting document, the Belgrade Charter, proposed a global framework for environmental education, claiming that it is an active process that can ultimately lead to a society that is able to work individually and collectively toward solutions of existing problems and prevention of new ones (UNESCO, 1975). The Tbilisi Declaration was adopted two years later at the world's first intergovernmental conference on environmental education in Tbilisi, Georgia (USSR). This document, written by numerous educators and environmental scientists, presented a very real focus for environment education that emphasized problem solving and issue resolution. The following objectives are found in the Tbilisi Intergovernmental Conference on Environmental Education (1978):

- Awareness—to help social groups and individuals acquire an awareness and sensitivity to the total environment and its associated issues.
- Sensitivity—to help social groups and individuals gain a variety of experiences in, and acquire a basic understanding of, the environment and its associated issues.
- Attitudes—to help social groups and individuals acquire a set of values and feelings of concern for the environment and motivation for actively participating in environmental improvement and protection.
- Skills—to help social groups and individuals acquire skills for identifying and solving environmental problems.

- Participation—to provide social groups and individuals with an opportunity to be actively involved at all levels in working toward resolution of environmental issues.

Environmental education in schools. Even though environmental education developed slowly and hesitantly in the first 20 years after the 1972 Stockholm Conference, the last 20 years have seen a significant growth in environmental education programs. As a result, many primary, secondary, and higher education schools across this nation have been increasing efforts to integrate environmental topics across the curriculum (Venkataraman, 2008).

According to the University of Maryland Research Center, a growing body of evidence supports the significance of environmental education to formal education in providing positive student outcomes in the areas of math, reading, and science achievement (Ernst, 2007). Strong evidence suggests that well-designed environmental education programs in primary and secondary schools, not only improve students' knowledge and attitudes toward the environment, but also improve students' performance in school. A 10-year study by the National Environmental Education Foundation and Roper Public Affairs showed that primary and secondary education with an environmental focus that uses a critical thinking approach to environmental issues improved students' reading, writing, and problem-solving skills (Venkataraman, 2008). Additional studies by Bartosh (2004), and Athman and Monroe (2004) suggest that environmental education can improve critical thinking, math, life science skills, and standardized test performance. At an elementary school in Ashland, North Carolina with

an environmental focus, fourth grade students achieved a 31% point increase in math achievement in one year (White, 2008).

Despite the potential for improving student learning, researchers have found that a lack of teacher training in environmental education is a major barrier to incorporating it fully in the school curriculum (Ernst, 2007; Lane & Wilke, 1994). According to the University of Maryland Survey Research Center (2002), only about 10% of teachers have taken courses in environmental education as part of their preservice preparation program (Ernst). As most preservice teacher preparation programs treat core subject areas in isolation, environmental topics generally piggyback on established discipline-based subjects courses, notably science courses. Therefore, teachers rarely have the breadth of background and desired depth to adequately cover environmental topics (Disinger, 2001; Powers, 2004). In response to these concerns, agencies such as the Environmental Protection Agency's Office of Environmental Education and organizations that include the North American Association for Environmental Education (NAAEE) and the National Environmental Education Foundation have accelerated creation of curricula and professional development for teachers (Venkataraman, 2008).

There is widespread public support for environmental education, with 95% of adults and 96% of parents supporting environmental education in public schools (Coyle, 2005). However, many schools have reduced their environmental education budgets to meet the testing and curriculum requirements of current federal education legislation known as the "No Child Left Behind Act" (Coyle).

The periodic re-authorization of the Elementary and Secondary Act has substantially increased federal involvement and influence over public education in the United States since its original passage in 1965. Much of this influence and funding has been used to push the standards-based reform currently known as the No Child Left Behind Act (NCLB), which was signed into law on January 8, 2002 (No Child Left Behind [NCLB], 2002). NCLB enacts the theories of standards-based education reform, also known as outcome-based education. Research and Development Corporations (RAND) describes standards-based reform as the establishment of objective and measurable metrics that is used to assess students' performance through standardized instructional materials and testing (2012). Through NCLB, states only receive federal funding if they establish academic standards in reading, mathematics, and science (Cronin, Kingsbury, McCall, & Bowe, 2005). The progress of schools is tracked relative to the standards set by the state and enforced by penalizing schools that do not meet yearly goals (Cronin et al., 2005).

This has had a major influence on the pedagogical teaching of environmental education in public schools. Because of the emphasis on achievement in a few of the traditional academic subjects, schools across the country divert time and resources away from cross-disciplinary programs and disciplines (Feinstein, 2009). Schools have also been forced to devote a large amount of time and attention to administering the tests. In order to meet these demands, resources are typically taken away from instruction and innovations that are not directly related to achieving high-test scores are discouraged (Feinstein, 2009).

To combat the growing need for environmental literacy in schools, then-California Assemblywoman Fran Pavley authored legislation in 2003 that mandated California to develop an environment-based curriculum to be available to all California public schools. The legislature was signed into law by then-governor Gray Davis in 2003. The program it sent in motion, known as the Education and Environment Initiative (EEI), resulted in the development of a K-12 model curriculum aligned with statewide Environment Principles and Concepts (EP&C) and California's academic content standards ("California Environmental Protection Agency Education and the Environment Initiative," 2012). The State Board of Education approved the EEI curriculum in 2010. It is the goal of EEI to help prepare students to become responsible environmental stewards and future leaders of science, economists, and green technology. Currently, school districts are being recruited to participate in EEI, and professional development workshops are being offered to district-level education leaders to disseminate EEI curriculum. Although EEI curriculum will be available to teachers both online and through textbooks, schools will not be required to implement EEI curriculum. Therefore, it will be necessary to provide outreach to school districts and ongoing professional development for K-12 teachers. Additionally, evaluation and assessment of EEI curriculum are necessary to develop the efficacy of the EEI curriculum ("California Environmental Protection Agency Education and the Environment Initiative Phases and Timeline," 2012).

Developing environmentally responsible behaviors. Environmental education programs aim, through personal experiential learning, to develop students' environmental

sensitivity and affective relationships to the natural environment (Palmberg & Kuru, 2000). Well-designed environmental education programs can lead to the desired outcomes conveyed in The Belgrade Charter and Tbilisi Declaration (Venkataraman, 2008). However, in order for environmental education programs to fulfill the goals set out by the Tbilisi Declaration, they must focus on motivating learners to engage in environmentally responsible behaviors.

ERBs occur when an individual aims to do what is right in order to help protect the environment in general daily practice and behavior (Cottrell, 2003). There is much debate over the best predictors of environmentally responsible behavior. Most of the current investigation on ERBs comes from social-psychological theories of human behavior and draws upon theories such as the norm activation model (Schwartz, 1977), the theory of reasoned action (Ajzen & Fishbein, 1980), and the theory of planned behavior (Ajzen, 1991). Ajzen and Fishbein's (1980) model of reasoned action indicates that the individual's intention to act has a direct effect on behavior. Models that examine the interactions between sociodemographic, cognitive, psychological, situation, emotional, and social situational predictors of ERB have been developed by several researchers to better understand the best predictors of ERBs and intentions to act (Cottrell, 2003; Hines et al., 1987; Stern, 2000). A carefully crafted meta-analysis of 128 studies (Hines et al., 1987) identified a small set of variables that have been shown to correlate repeatedly with pro-environmental behavior. The most powerful of these factors include knowledge, verbal commitment to intentions to act, locus of control, attitude, and personal responsibility.

Hungerford and Volk (1990) built on the Ajzen and Fishbein analysis, proposing a new model of changing learner behavior through environmental education. Their multilevel model of environmental behavior incorporates three levels of variables that have been identified as having the ultimate impact of ERBs in a sequential fashion. First, entry-level variables that include environmental knowledge and sensitivity to ecology function as prerequisite variables that enhance a person's decision-making once an action is undertaken. Second, ownership variables that make environmental issues tangible and relatable to the learner, allow the person to feel a personal sense of ownership of environmental issues and create a sense of accountability and a locus of control that are enhanced through knowledge and personal investment in an environmental issue. Third, empowerment variables that include knowledge and perceived skill in using environmental action strategies and locus of control provide an individual with a sense of enablement that the person can make a difference as it relates to a particular issue. In addition, intention to act is considered an empowerment variable as it is closely related to both perceived skill in taking action and locus of control. According to Hungerford and Volk (1990), these empowerment variables are likely the cornerstone of training in environmental education.

Hands-on, experiential environmental education. Many studies have found that participation in hands-on, experiential education programs produces short-term positive results across a range of cognitive and affective outcomes (Jordan, Hungerford, & Tomera, 1986; Knapp & Benton, 2006; Smith, Sebesto, & Semrau, 2004). A study of the effectiveness of experiential teaching approaches and outdoor learning programs on

student science learning suggested that hands-on, experience-based programs that directly engage students in the learning process promotes student knowledge (Powell & Wells, 2002). Hands-on activities are not as limited by language barriers that can impede learning from classroom teaching as they are less dependent on formal mastery of the language of instruction. This can be especially effective for English language learners (ELLs) and visual learners as learning is presented in an experience-based, visual form.

Multiple studies have cited significant increases in environmental knowledge, pro-environmental attitudes, and intention to act among students shortly after participation in place-based, outdoor environmental education programs (Palmberg & Kuru, 2000; Powell & Wells, 2002). An attachment to a local natural resource can influence environmentally responsible behavior in an individual's everyday life by enacting a sense of ownership and empowerment (Vaske & Kobrin, 2001). According to Vaske and Kobrin, place attachment arises when settings are instilled with meanings that create or augment one's emotional tie to a natural resource. Their findings indicate that specific ERBs in a natural resource setting encourage ERBs in everyday life. A study conducted in Sweden highlighting the complexity of the learning experience within environmental education showed that engagement with the environment was extremely important for developing an emotional reaction to an aspect of the topic being studied (Rickinson & Lundholm, 2008). This research was further supported by an investigation completed by Mayer, McPherson, Bruehlman-Senecal, and Dolliver (2009), which revealed that a personal connection to nature is an important predictor of ecological behavior.

Importance of outdoor experiences in middle childhood. In a meta-analysis by Zeleny (1999) on the effectiveness of educational interventions in classrooms and nontraditional settings, environmental experiences were found to most effectively improve short-term environmental knowledge and intentions to act when the curricula was hands-on and based on experiences in the outdoor environment. In particular, Zelezny found that active and hands-on educational interventions involving upper elementary student participants (3rd – 5th grades) were most effective in improving environmental behavior and intervention effectiveness. This research was supported by studies done by Wells and Lekies (2006) and Thompson, Aspinall, and Montarzino (2008), which found that children who engage in outdoor activities before age 11 are much more likely to grow up to be environmentally committed as adults.

Adult environmentalists almost universally cite the outdoor experiences of middle childhood (approximately ages 6 through 12) as one of the most significant settings of their childhood (Chawla, 2006). According to sociologist Kellert (2005), middle childhood is a time when children form a sense of wonder and emotional attachment to their natural surroundings and is cited by most adults looking back as an emotionally critical aspect of their youth. These instances of intimate immersion in nature often become seared in memory, are recalled throughout a person's life, and have been shown to positively motivate environmental ethics in adults (Chawla, 2006). Environmental scientist Carson wrote, "For the child . . . it is not half so important to *know* as to *feel*. If facts are the seeds that later produce knowledge and wisdom, then the emotions and the

impression of the senses are the fertile soil in which the seeds must grow” (Carson, *Wonder*, 1998, p. 56).

Unfortunately, there has been a substantial decrease in outdoor, experiential learning in recent decades. Research shows that children are spending 50% less time outside than they did 20 years ago. Today, the average child spends more than six hours a day watching television, operating a computer, or playing video games (White, 2008). In his 2005 book, “Last Child in the Woods,” Louv describes this American trend as “nature deficit disorder.” He cites many contributors to this problem, including parents’ fear of strangers, worry about bug bites and bee stings, lack of time, and the lack of safe outside areas (Louv, 2005, p. 99). The potential mental and health impacts caused by nature deficits are cited in a policy action plan developed by White, director of education advocacy for the National Wildlife Federation. Doctors warn that life expectancy may actually decrease for the first time in American history from the health impacts of childhood obesity, which has been linked to lack of playtime outdoors. Further research has shown that time in nature can improve a child’s academic performance, concentration, coordination, and self esteem as well as possibly reducing the severity of symptoms of Attention Deficit Hyperactivity Disorder (ADHD) which affects millions of American children (White, 2008).

In response to the growing acknowledgement of the importance of experiential environmental education, the U.S. House of Representatives passed the No Child Left Inside Act (NCLI) in 2008. This bill authorized federal money for states to create plans explaining how their students will learn about environmental issues and to prepare

teachers to teach about such issues. Throughout the legislation, “hands-on field experience” for students and teachers was cited as a critical component to accomplishing the legislative intent of the bill (as cited in Hoff, 2008). Unfortunately, logistical barriers, such as lack of planning time, administrative support, transportation, and funding, have made it increasingly difficult for schools to incorporate this aspect of the NCLI legislation. In addition, due to debilitating cuts in the public education sector, environmental education programs are increasingly being requested by schools and donors to provide evidence of their long-term effectiveness.

Long-term experiential environmental program assessment. Although researchers have found that participation in EE programs commonly produces short-term positive results across a range of cognitive and affective outcomes (Jordan et al., 1986; Knapp & Benton, 2006; Smith-Sebasto & Semrau, 2004), there is very little in the literature on the inclusion of long-term follow-up measures (Stern, Powell, & Ardoin, 2008). A meta-analysis of EE evaluations conducted by Schneider and Cheslock in 2003 revealed that only five peer-reviewed evaluations between 1991 and 2000 investigated and reported student-based outcomes three months or more after completion of the programs of interest (Stern et al., 2008). Some of the findings of these studies revealed positive retention of knowledge and attitudes (Dettmen-Easler & Pease, 1999; Knapp & Benton, 2006), while others showed inconclusive evidence (Bogner, 1998). Stern et al. (2008) examined the influences of three and five-day residential environmental education programs in the Great Smokey Mountains Institute at Tremont, North Carolina, on participants connection with nature, environmental stewardship, attitudes, and awareness

of the Great Smokey Mountains National Park (GSMNP) and its biodiversity. Using a pre- and post-survey instrument with a series of five point Likert-type scale statements, the authors found significant short-term effects in all the measured outcomes, and significant retention in students' knowledge, awareness, and commitment to environmental stewardship three months after the program. However, they found that students' connection with nature substantially decreased in the long-term assessment.

There is also a lack of conclusive evidence regarding the influence of EE program duration. EE researchers have assumed that increased program duration leads to an increase in students' environmental knowledge and attitudes, but little empirical research exists to support this assumption (Stern, Powell, & Ardoin, 2008). Bogner (1998) found significant changes in student-related outcomes after five-day, but not after one-day programs. Stern et al. (2008) also found that longer EE program duration contributed to greater influences on desired outcomes, especially regarding short-term changes. However, a study that assessed the impact of one-day school fieldtrips on third and fifth grade children's attitudes, behavior, and learning found that field experiences resulted in significant immediate learning and 30-day knowledge retention for both student groups after the program (Falk & Balling, 1982). A more recent study by Powers (2004) compared the effects of student participation in a one-day EE program versus a two-day EE program on students' knowledge and found that location and economic status of the school were more influential than the duration of the program.

Changes in environmental attitudes and/or behavior are very difficult to measure years after a program or event. Some researchers suggest that evaluating students' long-

term retention of concepts (knowledge) taught during specific EE programs can offer insight as to the effectiveness of an EE program in fostering a long-term awareness of environmentally responsible behaviors (Kaiser & Fuhrer, 2003; Palmberg & Kuru, 2000). Responsible environmental behavior is a learned response or action (Palmberg & Kuru, 2000). Models that focus on environmental behavior development specifically acknowledge knowledge and awareness as a precursor of positive environmental attitudes and a prerequisite for the development of moral norms that influence ERB (Bamberg & Moser, 2007; Hines et. al., 1987; Hungerford & Volk, 1990). According to Kaiser and Fuhrer, knowledge represents a necessary condition for ecological behavior, as appropriate behavior will not occur without appropriate knowledge. In their research investigating the affect of different forms of knowledge on ecological behavior, Kaiser and Fuhrer found that when declarative knowledge (answers to the question of how environmental systems work), procedural knowledge (how to achieve a particular conservational goal), and effectiveness knowledge (knowledge about differential ecological consequences), converge towards a common ecological goal, they are likely to foster ecological behavior.

Knowledge retention from specific lessons taught during the program can be assessed and analyzed through student memories of the program (Knapp & Benton, 2006). Tulving's (1972) theory on long-term memory states that there are two primary memory systems – remembering (episodic memory) and knowing (semantic memory). According to Tulving, episodic memory is “involved in the recording and subsequent retrieval of memories of personal happenings and doings,” while semantic memory is

“knowledge of the world that is independent of a person’s identity and past” (Tulving, 1983, p. 9).

The relationship between episodic and semantic memories was confirmed, to some degree, by studies conducted by Conway, Prefect, Anderson, Gardiner, and Cohen (1997) and Herbert and Burt (2004) that examined how information from specific lectures and programs is processed from episodic to semantic memories. Both studies indicated that early learning knowledge from a lecture or program is first retained in episodic form, but as the learning progresses, memory representations shift from episodic to more conceptual knowledge (Conway et al., 1997; Herbert & Burt, 2004).

In a phenomenological study that assessed the recollections of participants that attended a residential environmental education program, Knapp and Benton (2006) found that students’ retained vivid memories of the residential EE program experience one year after their visits. In particular, Knapp and Benton found that the influence of active, hands-on experiences was related to successful recall of program content and the potential development of actual knowledge gained (semantic memories). In another study, Farmer, Knapp, and Benton (2007) explored the use of memory and knowledge retention to evaluate the long-term effects on 4th grade students who participated in a one-day experiential environmental education program in the Great Smokey Mountains National Park. Informal, in-depth interviews using open-ended questions were conducted with 15 students one year after the trip to explore the students’ long-term recollections of the field trip experience. The results of this study suggested that 14 of the 15 student

participants' retained long-term environmental and ecological content and suggested an increase in pro-environmental attitudes.

Student art. Although many studies have adapted models that incorporate predetermined Likert-items to measure students' environmental knowledge, attitudes, and behaviors (Dunlap & Van Liere, 1978; Dunlap, Van Liere, Mertig, & Jones, 2000; Kellert, 2005; Stern et al., 2008), other researchers argue that constructivist studies based on understanding the meanings constructed by students participating in context-specific activities are more relevant to understanding student knowledge and conceptions about the environment (Bowker, 2007; Shepardson, 2005). A majority of constructivist studies use written or oral accounts to analyze student learning; however, research by Allison (1980) and Brown (1994) has also shown a strong connection between children's art and their ideology.

Because previous experiences and sociodemographic factors influence the way students interpret the world, researchers can use student artwork to compare awareness and visual recall of specific concepts taught during the program (Brown, 1994). In their investigation of students' understanding of a watershed, Shepardson, Wee, Priddy, Schellenberger, and Harbor (2007) used student artwork to explore students' internal constructions, or conceptions, about watersheds. According to Glynn and Duit (1995) and Shepardson, Choi, Niyogi, and Charusombat (2011), these conceptual mental models are based on different cultural, educational, and personal experiences. Interpreting drawings and writings made by students allows researchers to assess student

understanding of phenomena or events (Bowker, 2007; Shepardson, 2005; Shepardson et al., 2007; Shepardson et al., 2011).

Problem Statement

Research has shown that there is a great need for hands-on, experiential environmental education programs, especially for primary school-aged children (Kellert, 2005; Zelezny, 1999). Empirical studies and multiple theories suggest that children's contact with the natural world is crucial to their social and cognitive development (Louv, 2005; White, 2008; Zelezny, 1999), and is highly significant in developing an environmental ethic (Chawla, 2006; Kellert, 2005; Louv, 2005). In the state of California, funding for such programs is rarely provided through school budgets. Increasingly, funding for informal environmental education programs is coming from private foundation grants and private donors. Competition for funding is escalating and donors are requiring long-term outcome assessment.

This study attempted to provide a long-term assessment of the O'Neill Sea Odyssey (OSO) program by analyzing the retention of critical stewardship concepts taught during the Ecology Lesson of the OSO program to determine the effectiveness of the OSO program in fostering a sustained awareness of the relationship between a specific environmental issue, ocean pollution, and personal behaviors among students who participated in the program. In the Ecology Lesson, students experiment with a hands-on watershed model to observe how pollutants enter the ocean by traveling through the environment via watersheds, storm drains, and wind (O'Neill Sea Odyssey [OSO], 2008). The goal of this study was to examine a cohort of 7th – 10th grade students and

examine whether former OSO participants retained a connection between ocean health and their everyday activities several years after completion of the program.

Thank you letters and artwork sent from students who previously participated in the OSO program have indicated increased environmental awareness and expressed strong intentions to act in environmentally responsible behaviors. Building on the content observed in OSO participant artwork and the constructivist methodology by Shepardson et al. (Shepardson, 2005; Shepardson et al., 2007; Shepardson, et al, 2011), this research analyzed students' drawn and written responses to a prompt question that asked students to describe how trash entered the ocean. Responses to Likert-item response statements and students' written responses to an open-ended question regarding their recall of the OSO program were used to supplement question and drawing content and to gain a clearer understanding of the long-term effect of the OSO program on students' knowledge and attitudes about lessons taught during the OSO program.

A limitation of this study that must be addressed is the difficulty in establishing a causal relationship between pro-environmental awareness and attitudes and the students who participate in the OSO program. In response to this limitation, this research explored the influences of sociodemographic factors and previous fieldtrip experiences to determine their effect on student responses.

Research Questions

- 1) Does the OSO program foster long-term awareness of the connection between ocean stewardship and personal responsibility among student participants?

- a. What are 7th – 10th grade students' conceptions of how pollution enters the ocean?
- b. Is there a difference in 7th – 10th grade students' conceptions of how pollution enters the ocean based on sex, primary language, grade level, community setting, and participation in experiential environmental education programs?
- c. Is there a difference in students' conceptions of how pollution enters the ocean based on participation in the OSO program?
- d. Do OSO participants' conceptions of how pollution enters the ocean vary by sex, primary language, grade level, community setting, and participation in other experiential environmental education programs?
- e. Is there a difference in students' responses to the long-term survey ocean-knowledge questions based on participation in the OSO program?

Method

Study Areas

This research focused on the effectiveness of the O'Neill Sea Odyssey (OSO) program in fostering long-term awareness of the connection between ocean stewardship and personal responsibility among student participants. The OSO program is a non-profit organization incorporated in 1996 by wetsuit innovator and surfer Jack O'Neill to promote environmental awareness and personal responsibility among program participants. The program's mission is to provide a "hands-on educational experience to encourage the protection and preservation of our living sea and communities" (Applied Survey Research [ASR], 2011, p. 3). The program engages 4th – 6th grade school groups in lessons about navigation, conservation, and marine science integrated into an education program and takes place aboard a 65-foot catamaran in the Monterey Bay National Marine Sanctuary with follow-up lessons in the Education Center in the Santa Cruz Harbor. The duration of the program is 3 hours, and it serves an average of two classes per day throughout the majority of the school year. The curriculum is aligned with the National Science Content standards for grades four through six in science and mathematics and the National Ocean and Atmospheric Administration's Ocean Literacy Essential Principles and Fundamental Concepts (OLEP & FC). It is free of charge, but students earn their way into the program by designing and performing projects to benefit their communities.

Over 60,000 youth from various ethnic and socioeconomic backgrounds in the greater San Francisco Bay area have participated in the program as of spring, 2011

(Applied Survey Research [ASR], 2011). The hands-on, inquiry-based model executed by the OSO program, in addition to the number and sociodemographic breadth of students served since 1996, are the primary factors that allow the program to serve as a case study to evaluate the long-term effects of experiential environmental education on participating students.

The O'Neill Sea Odyssey organization is located in Santa Cruz County in Santa Cruz, California. The city of Santa Cruz is located on the northern edge of the Monterey Bay, approximately 72 miles south of San Francisco and is the largest city of Santa Cruz County with a population of 59,946 (U.S. Census Bureau, 2010). Santa Cruz County is located on the California central coast, along the Pacific coastline. Agriculture dominates the coastal lowlands of both the county's northern and southern ends. Freshwater marshes are concentrated on the southern end of Santa Cruz County, in the city of Watsonville. The county forms the northern coast of the Monterey Bay and is located along the Monterey Bay National Marine Sanctuary, the largest marine sanctuary in the United States. Santa Cruz County is approximately 10 miles wide between the coast and the crest of the Santa Cruz Mountains and is bordered by Santa Clara County to the north and Monterey County to the south ("County of Santa Cruz," 2012). Most of the student population attending the OSO program originates from schools located within these three counties (ASR, 2011).

Santa Clara County, also known as Silicon Valley, is located at the southern end of the San Francisco Bay between the Santa Cruz Mountains and the Diablo/Mt. Hamilton Range. Santa Clara County is a major urban metropolis and is home to the

world's largest technology corporations. It is the most populated county in the San Francisco Bay Area and includes the city of San Jose, the third-largest city in California and tenth largest city in the United States ("Santa Clara County," 2012).

Monterey County is located on the southern half of Monterey Bay, opposite from Santa Cruz County and along the southern end of the Monterey Bay National Marine Sanctuary. The most populated portion of the county is on the northern coast and in the Salinas Valley. The southern coast and inland mountain regions are nearly devoid of human habitation. The economy is based largely on tourism and the agriculture of the Salinas Valley, which is also known as "America's Salad Bowl" for its production of lettuce, broccoli, tomatoes, and spinach. The Salinas Valley is located between the Gabilan and Santa Lucia mountain ranges, which border the Salinas Valley to the east and west respectively ("Monterey County," 2012).

Population and Sample

Previous OSO participants were not tracked after completion of the program due to legalities concerning minor aged children and confidentiality; therefore, the population for the long-term study was selected based upon the elementary and secondary schools that attended the OSO program yearly since 2006 and the likelihood that students from those schools later filtered into the surrounding middle and high schools. Selected schools were in the three counties from which the most frequent OSO participants hailed since 2006: Santa Cruz County, Santa Clara County, and Monterey County (ASR, 2011). The researcher opted to select both middle and high schools in varying geographic locations to better document the similarity, diversity, and/or variation in students'

conceptions.

Recruitment letters seeking permission to survey classrooms were sent to the acting principals of six public middle schools and six public high schools from the three counties in the study area, totaling twelve schools. Eight schools (four middle schools and four high schools) responded, a 66% response rate. One of the schools in the Santa Cruz County study area was unresponsive after initial agreement to participate in the survey and did not participate in the long-term study. Therefore, seven schools total participated in the long-term study.

School characteristics. Characteristics of each school that participated in the long-term impact study are presented in Table 1. The ethnic designation of students from each sampled school is shown in Table 2. Student ethnicity, level of English fluency, and enrollment in free or reduced price meal programs were estimated using percentages obtained from the Data Quest database of the California Basic Educational Data System (ASR, 2011). The state rank of each school was determined by California School Rankings and based on each school's individual Academic Performance Index (API) Score and how it compared to other schools in California that were within a similar grade-range in 2010 – 2011 (one being the lowest rank, ten being the highest).

Schools located within five miles of the ocean (Pajaro Valley High, North Monterey County Middle, and North Monterey County High) were situated in agricultural settings adjacent to wetland systems and defined “agricultural.” Schools located between 9 miles and 15 miles to the ocean (SLVHS and Lagunita) were situated in mountainous settings and defined “mountainous.” Schools located approximately 30

miles from the ocean (Monroe Middle and Fremont HS) were situated in urban settings and defined “urban.”

Table 1. Characteristics of Schools in the Long-Term Study

School	County	State Rank 1	Free/Reduced Lunch Scale	ELLs	Community Setting	Miles to Ocean
SLVHS	Santa Cruz	9	14.8%	0.4%	mountainous	9.0
PVHS	Santa Cruz	2	82.0%	37.1%	agricultural	2.5
Monroe	Santa Clara	6	52.2%	29.3%	urban	30.0
Fremont	Santa Clara	5	38.3%	20.0%	urban	35.0
NMCMS	Monterey	3	76.7%	36.6%	agricultural	3.5
Lagunita	Monterey	10	11.0%	0.0%	mountainous	15.6
NMCHS	Monterey	4	62.8%	16.9%	agricultural	3.9

Note California School Ratings: <http://school-ratings.com/faq.php>

Source: Data collected from The State of California Department of Education, California Basic Educational Data System, Data Quest database (2010-11).

Table 2. Ethnicity of School Student Population

School	White	Hispanic	Black	Asian	American Indian	Filipino	Two or more races
SLVHS	86.9	6.6	2.1	2.0	—	—	3.5
PVHS	2.6	89.4	0.5	0.3	0.3	1.8	—
Monroe	22.2	55.6	6.1	5.7	0.7	3.1	—
Fremont	23.4	44.4	3.0	16.0	0.3	11.2	0.8
NMCMS	16.1	79.9	1.0	0.7	0.7	0.7	0.8
Lagunita	62.4	29.0	—	1.5	—	—	7.5
NMCHS	25.0	69.7	0.9	0.8	0.6	1.8	0.7

Note. The numbers expressed are the percentage of the entire school population.

Source: Data collected from State of California Department of Education, California Basic Educational Data System, Data Quest database (2010-11).

These defined community settings also reflected sociodemographic differences in student populations among the seven schools. Low-ranked schools, Pajaro Valley High (PVHS), North Monterey County Middle (NMCMS), and North Monterey County High (NMCHS), were in agricultural settings and had the highest percentages of ethnic

minorities and the highest percentages of students enrolled in the free and reduced lunch program. High-ranked schools, Lagunita Elementary and SLVHS, were located in mountainous settings and had the lowest percentages of ethnic minorities and the lowest percentages of students enrolled in the free and reduced lunch program. Mid-ranked schools, Monroe Middle and Fremont High, were located in urban settings and fell between the extremes of the other schools concerning the percentages of ethnic minorities and the percentages of students enrolled in the free and reduced lunch program.

Classroom characteristics. Science classrooms from each of the schools were selected based on teachers' time, availability, and willingness to participate in the study. Two classrooms from each school participated in the long-term study with the exception of Lagunita Elementary and NMCHS, both of which had only one classroom participate in the study. The number of students surveyed from each school was dependent on classroom size and the number of classrooms surveyed from each school. Students were permitted to participate in the study if they wanted to contribute to this research and if their parents had signed a consent form. A copy of both the consent form and the Human Subject Review Board approval letter are included in Appendix E.

Study Design

A survey instrument, Student Survey for Long-Term Study (Appendix A), was developed by the investigator for the long-term study and included four sections: a sociodemographic and fieldtrip experience section, a question and drawing section (Student Art Task), five Likert-scale response questions, and two open-ended questions. The survey instrument was designed to serve multiple purposes; primarily, the student

survey was used to explore 7th – 10th grade student conceptions and knowledge about a specific environmental concept (the relationship between ocean pollution and human behavior) and investigate how sociodemographic factors and outdoor environmental education fieldtrip experiences influenced student conceptions. A list of previous environmental education fieldtrip experiences gathered from students in the survey was used to identify previous OSO participants and to assess OSO participant level of retention of key concepts taught at the program based on watershed knowledge and non-point source pollution.

Demographic section. Demographic data gathered from students included school, age, sex, and first spoken language. These independent variables were treated as control variables when conducting analysis on student responses. No student names were recorded.

Environmental education fieldtrip experiences section. Students were asked to indicate the environmental fieldtrips they attended from a list of regional outdoor environmental education programs (including OSO) available to schools within the three study areas. The fieldtrips listed on the survey included

- O'Neill Sea Odyssey (OSO)
- Watsonville Wetlands Watch (WWW)
- Monterey Bay Aquarium (MBA)
- Science Camp
- Multicultural Education for Resource Issues Threatening Oceans (MERITO)
- Return of the Natives (RET)

- Coastal Watershed Project (CWP)
- Coyote Hills
- Elkhorn Slough (ES)

Students were given the option to add fieldtrips that were not listed on the survey.

Student art section. Written language or symbols (drawings) used by students to communicate their mental representations of ocean pollution were central to this study. The Student Art Task asked that students draw or write how they thought the ocean became polluted and to label the parts of their drawings. Drawings elicit students' conceptions without limiting the student to predetermined responses and allowed students to express themselves in a nontraditional, open-ended way. The meanings in students' conceptions are contextualized because they characterize cognitive constructions at a particular point in time (Shepardson et. al, 2011), and they reflect the distinctive social, educational, and cultural experiences of the students. Additionally, the art task allowed students who have difficulty expressing their ideas verbally or in writing a means to reveal their ideas and understandings. This was especially important to language learners whom may have had difficulty comprehending the meaning of the written questions.

Likert-item response section. The Likert-item response statements were based on curricula taught at the OSO program and used to assess the knowledge retention of specific lessons taught during the program. When responding to a Likert questionnaire item, respondents specified their level of agreement or disagreement for a series of statements. Thus, the range captured the intensity of their feelings for a given item. Likert-item statements included three statements regarding knowledge of ocean

conservation issues and concepts, one environmental attitude-based statement, and one environmental behavior-based statement. Although additional Likert-item statements or questions might have led to a more comprehensive picture of the students' environmental knowledge and attitudes, a longer survey was not viable because of classroom time constraints.

Open-ended questions. Two open-ended questions were also included in the long-term survey to enhance information on the attitudes about experiential environmental education experiences and attitudes toward the OSO program experience in particular. Students' responses allowed further insight regarding their attitudes about the relationship between ocean pollution knowledge and personal behaviors.

Data Collection

All data for this study were collected between January and March 2011 from science classrooms during normal school hours with teachers present. Students were permitted to complete the survey if they wanted to participate in this research and if their parents had signed a consent form. The time it took to complete the student survey ranged from ten to twenty minutes, with an average time of fifteen minutes. Teachers who agreed to allow their students to participate in the survey were given a \$25 gift card to Staples to use for classroom supplies. In addition, the OSO program donated a book entitled "Reflections of the Santa Cruz Harbor," by Clark and Gregory, to each teacher and principals of the schools. As compensation for their participation in the survey, students were offered O'Neill logo stickers, Seafood Watch cards, and information brochures from the Monterey Bay Sanctuary Foundation.

Data Analysis

The data from the Long-Term Student Survey were analyzed to explore 7th – 10th grade students' knowledge and conceptions about the relationship between watersheds and ocean pollution and to determine what influence sociodemographic variables and outdoor environmental fieldtrips had on these conceptions. The unit of analysis for this study was the student group. Quantitative statistical analysis was then applied to the data. Statistical procedures included descriptive statistics and the chi-square test of independence. The statistical significance level for this study was established at 0.05 ($\alpha=0.05$). Answers from completed surveys were coded nominally onto an Excel spreadsheet and compiled in an SPSS file.

Demographic data. The first section of the survey involved sociodemographic questions that included school name, sex, grade level, primary language, and community setting. The frequency rates for each of these factors were calculated.

Fieldtrip experiences. The frequency rate of each outdoor environmental education fieldtrip experience was recorded. This allowed the investigator to determine which students had participated in the OSO program and control for other fieldtrip experiences that may have had an influence on OSO participants' responses. Fieldtrips with similar curricula models were combined and the frequency rate of students who had participated in these groups were calculated. Because the intention of the survey instrument was to measure the effects of outdoor environmental education programs on students' awareness about the relationship between the ocean and environment, fieldtrips that included coastal watershed concepts in their curricula (Watershed Group) were

differentiated from the other programs. These fieldtrips included OSO, WWW, MERITO, and CWS. Students who indicated that they had participated in the OSO program were analyzed both as part of the Watershed Group and separately as part of the OSO group

Student art task. The second section of the survey was the Student Art Task. The first phase of analysis for the Student Art Task was inductive in nature and involved a content analysis of students' responses resulting in the identification of students' conceptions. Each drawn or written item recorded by the students in the question and drawing section was entered as a numerical variable, or code, and recorded as either "present" or "absent" from individual student's drawings. These constructed codes were revised during a second reading by the researcher to ensure reliability of the coded variables. After a third reading, the codes were separated and/or combined into final categories. Descriptive themes based on the core ideas that emerged from the students were the basis of the different student mental models. This data analysis process followed the procedures described by Rubin and Rubin (1995) and Shepardson (2005).

The second phase of the Student Art Task involved the statistical testing of the identified conceptions across sociodemographic factors and outdoor environmental education experiences. The chi-square test was used to statistically determine the independence and goodness-of-fit of students' conceptions across demographic variables that included school, grade level, sex, primary language, schools' community setting, and outdoor environmental education fieldtrip experiences (including OSO).

Likert item response section. The third section of the survey was the Likert item response questions. The 5-point Likert item responses (“yes definitely,” “yes I think so,” “I don’t know,” “no I don’t think so,” “no definitely not”) were recorded. In order to perform the chi-square test of independence, the five responses were collapsed into three response categories: yes / no / I don’t know. The chi-square test was used to compare responses from OSO participants and non-OSO participants for each statement to determine if there was relationship between student responses and OSO participation. The chi-square test was also used to statistically determine the independence and goodness-of-fit of OSO participants’ conceptions across demographic variables that included school, grade level, sex, primary language, schools’ community setting, and outdoor environmental education fieldtrip experiences.

Open-ended questions. Students were asked two open-ended questions to enhance information on respondents’ attitudes about their experiences on EE fieldtrips. One of the questions was specific to the population of students who had previously participated in the OSO program. The OSO question asked students what they felt was the most important thing that they learned while on the OSO fieldtrip. Students’ attitudinal values were converged with their conceptions about the sources of ocean pollution in order to gain further insight about whether or not the OSO program fosters ocean stewardship behaviors. The second question asked all students what they felt was the best experience they had on an outdoor fieldtrip to gain information about students’ attitudes regarding environmental fieldtrip experiences.

Results

Response Rate

Seven schools participated in the long-term survey, resulting in 261 returned surveys. Four surveys were discarded because the student art task and the survey questions were unanswered; therefore, 257 student surveys were analyzed. Two classrooms from each school were surveyed except in Lagunita Elementary and North Monterey County High School (NMCHS.) Lagunita Elementary had a very small student population ($n = 93$), and only one science classroom was offered for a combination class of 7th and 8th grades. Only 12 students were sampled at NMCHS. The small student sampling size at NMCHS was due to mass evacuation of the city of origin (Castroville) after a tsunami warning was issued following the 2011 Tōhoku earthquake in Japan. The tsunami warning occurred on the date of the survey administration (3/11/11), so very few students were available in the classrooms to participate in the long-term survey.

Demographic Results

The classroom populations included some mixed-level classes at the middle school level. For this reason, data from 7th and 8th grade classes were presented as combined data. Concerning primary language percentage rates, it should be noted that over half of the students sampled at PVHS (57.9%) and half of the students sampled at NMCMS (50%) recorded Spanish as their primary language. Percentages of students surveyed by school, sex, grade levels, primary language, and outdoor fieldtrip attendance are presented in Table 3. Fieldtrip attendance was gathered from a list of fieldtrip options on the student survey. Students were asked to add fieldtrips that were not listed; those

fieldtrips or programs that were not based on environmental education were not included in the student demographic analysis. Although not an outdoor fieldtrip, the Monterey Bay Aquarium (MBA) was included in the demographic results because of its hands-on, standards- based ocean curricula content, and because of the high percentage of students who indicated the MBA as a selected fieldtrip experience (77.4%).

Table 3. Student Demographic Data and Fieldtrip Experiences

Variables	Number	Percentage
Sex		
Female	123	47.9
Male	134	52.1
Schools		
SLVHS	50	19.2
PVHS	39	14.9
Monroe Middle	57	21.8
Fremont HS	47	18.0
NMCMS	33	12.6
Lagunita Elementary	19	7.3
NMCHS	12	4.6
Grade level		
7th/8th	109	42.4
9 th	96	37.4
10 th	52	20.2
Language		
English	185	72.0
Spanish	70	27.2
Other	2	0.8
Fieldtrips		
None	15	5.8
OSO	87	33.9
WWW	42	16.3
MERITO	9	3.1
CWP	3	1.2
Elkhorn Slough	31	12.1
Science Camp	181	70.0
Coyote Hills	8	3.1
Return of Natives	19	7.4
MBA	200	77.4

Note: N = 257

Student Art Task—Content analysis

The Student Art Task measured students' knowledge about the ocean through their art. Students were asked to either draw and label or verbally state how they believed pollution entered the ocean in the Student Art Task. The artwork presented from two students was illegible; therefore, 255 student drawings were analyzed in the Student Art Task. One hundred sixty-three students (63.9%) chose to answer the question with a labeled drawing, and 92 students (36.1%) chose to answer the question verbally.

Using an inductive analysis, the investigator identified 23 codes (elements) that reflected the students' responses to the Student Art Task; the codes are categorized in Appendix B. The codes with redundant or overlapping themes were combined to form 17 elements. These seventeen elements were grouped based on themes and resulted in four mental models of student conceptions about how they thought pollution entered the ocean; the four models are detailed in Table 4, which records the percent of student responses for each model. The numbering of the mental models is presented only as a means of distinguishing the different ways the students interpreted and made sense of ocean pollution and do not imply a successive sequence. Most of the student respondents (91.7%) included land-based sources in their descriptions of how pollution entered the ocean, while less than ten percent of students believed that pollution in the ocean came solely from ocean-based sources.

Table 4. Ocean Pollution Mental Models

Ocean Pollution Mental Models	Totals (<i>N</i> = 255)
Model 1: The ocean is polluted from trash, no indication of the exact source of the trash. No land is depicted or visible in the drawings and no specific human activities are indicated.	3.5%
Model 2: Ocean pollution comes from offshore human activity.	4.7%
Model 3: Ocean pollution comes from factories and land-based direct discharge (may or may not include off-shore discharge)	47.8%
Model 4: Ocean pollution comes from land-based runoff and wind-blown litter (may or may not include off-shore activity/land-based direct discharge)	43.9%

Several elements crossed students' conceptions and were included in more than one of the mental models. For example, 56.9% of respondents in Models 3 and 4 indicated litter as a major source of ocean pollution, but only students whose responses identified runoff or wind as the means by which litter enters into the ocean were categorized in Model 4. By comparison, Model 3 responses indicated that litter was left on the beach or thrown into the ocean by ocean visitors. Some student responses in Models 3 and 4 also had elements of Model 2 in the drawings, while some responses in Model 4 showed both point source and non-point source pollution. In addition, several students' responses in Models 1, 3, and 4 described the effects of pollution on marine life in the ocean. The elements of each model and the percentages of each models' elements in the responses is shown in Table 5.

Table 5. Percentage of Core Elements/Codes in Each Mental Model

Code/element	Model 1 (n=9)	Model 2 (n=12)	Model 3 (n=122)	Model 4 (n=112)	Total (n=255)
Trash in ocean	100%	—	—	—	3.5%
No indication of source					
Oil from boats		50.0%	9.8%	7.1%	10.2%
Throw trash from boats		58.3%	4.1%	7.1%	7.8%
Offshore drilling			3.3%	1.8%	2.4%
Industrial disposal	—	—	26.2%	9.8%	16.9%
discharge from factories		—	10.7%	1.8%	5.9%
factory smokestacks	—	—	7.4%	2.7%	4.7%
sewage discharge	—	—	8.2%	5.5%	6.3%
Unlabeled discharge pipe	—	—	8.2%	—	3.9%
Shoreline disposal					
dump/throw trash in ocean	—	—	48.8%	7.2%	26.7%
Litter (from land)	—	—	44.3%	81.3%	56.9%
Runoff	—	—	—	89.2%	38.8%
Street storm drains	—	—	—	59.8%	26.3%
River runoff	—	—	—	11.8%	7.5%
Runoff discharge pipe	—	—	—	29.5%	12.9%
Wind-blown litter	—	—	—	9.0%	3.9%
Runoff Pollutants					
Car oil	—	—	—	18.0%	7.8%
Pet poop	—	—	—	0.9%	0.4%
Septic tank	—	—	—	0.9%	2.4%
Marine Life Effectuated	11.1%	—	12.2%	15.3%	12.9%

Note: N = 255. Total is a percentage of all responses.

Because of the low frequency of responses categorized in Model 1 (3.5%) and Model 2 (4.7%), these models were collapsed to form one model based on the concept that pollution is ocean-based. To avoid confusion and keep continuity of the other numbered model sequences, the collapsed model was re-labeled “Model 2.” Models 3 and 4 were unchanged. Descriptions of the mental model conceptions are as follows:

- *Model 2. Ocean pollution comes from offshore human activities.* Student responses in this model emphasized types of pollutants in the ocean and/or offshore polluting activities as the primary source of ocean pollution. Responses included visible trash floating on the ocean surface, boat pollution, oil leaks from boats, and offshore garbage dumping.
- *Model 3. Ocean pollution comes from land-based direct discharge and factories.* Student responses in this model emphasized point sources of pollution that included factory effluents and/or direct “point source” disposal of pollutants into the ocean. Factory effluents included industrial disposal into a bay or ocean, sewage disposal, and air pollution from factory smokestacks. Land-sourced direct discharge included garbage-dumping, trash thrown directly into the ocean, litter left on the beach by ocean visitors, and discharge pipes with unlabeled sources that deposited effluent directly into the ocean. A few students included offshore oil drilling and other ocean-based sources of pollution in their drawings. In addition, some students showed the effects of pollution on marine life.
- *Model 4. Ocean pollution comes from land-based runoff and wind-blown litter.* Student responses in this model emphasized non-point sources of pollution that

included land-based runoff and/or windblown debris. Students described runoff by representing street storm drains, discharge pipes labeled by students as runoff, and rivers that carried pollution and drained into the ocean. Some students also showed the types of pollutants that runoff into the ocean and the effects of pollution on marine life.

Frequency of Students' Mental Models

Model 3 was the dominant model elicited. This model accounted for 47.8% ($n = 123$) of the student responses. This model reflected the belief that pollution in the ocean comes from point sources found on land. Student responses in this model incorporated the understanding that most ocean pollution comes from land-based sources; however, responses in this model implied that pollutants entered the ocean through direct discharge or disposal. For example, many student responses in Model 3 indicated littering behavior as a major cause of ocean pollution, but the source of the litter was isolated to beach visitors and intentional disposal of litter into the ocean. Some responses in this model also included ocean-based pollution sources in their conceptions.

The second most dominant model elicited was Model 4. This model accounted for 43.9% ($n = 110$) of the student responses. This model differed from Model 3 in that students indicated pollution in the ocean came from litter and land-based non-point sources in the form of runoff and wind-blown debris. Runoff sources included storm drain runoff (59.8%), river runoff (11.8%), and drainage pipe runoff (29.5%). Nine percent of students indicated wind-blown debris as a source of ocean pollution. Some responses in this model included point sources and ocean-based sources of pollution in

their conceptions. Model 4 is aligned most closely with curriculum taught in the Ecology Lesson at the OSO program and implies that students understand that pollutants can be carried to the ocean from unspecified distances.

The least elicited model was Model 2. Only 7.8% ($n = 20$) of students believed ocean pollution was caused solely by ocean-related activities. Some students (3.5%) depicted different types of pollutants in the ocean, such as oil or six-pack rings, but did not specify the exact source of ocean activity, while 4.3% of students indicated that boat activity was the source of ocean pollution (i.e., littering and oil leaks from the boats). The frequency of the mental model conception is illustrated in Figure 1.

Figure 1. Frequency of Student Mental Model Conceptions

Effect of Demographic Factors on Students' Mental Models

A chi-square test was used to statistically determine the independence of student mental model conceptions across school, grade level, sex, and primary language. The frequencies of the conceptions by grade level, sex, and primary language were consistent across all mental models and showed no significant differences.

As shown in Table 6, students sampled from schools in urban communities (Monroe Middle and Fremont High) were more likely to have responses found in Model 3 than in Model 4. The relationship between these variables was significant, $\chi^2(6, N = 255) = 22.83, p = .001$. The effect size for this finding, Cramer's V, was moderate, .30 (Cohen, 1988).

Table 6. Students' Mental Models by Schools and Community Setting

Community Setting	Model 2	Model 3	Model 4	Total ¹
<u>Agricultural/wetlands setting</u>				
Pajaro Valley HS	2.7%	27.0%	70.3%	14.5%
NMCMS	12.1%	39.4%	48.5%	12.9%
NMCHS	8.3%	58.3%	33.3%	4.7%
<u>Mountainous setting</u>				
SLVHS	6.0%	40.0%	54.0%	19.6%
Lagunita	10.5%	31.6%	57.9%	7.5%
<u>Urban setting</u>				
Monroe Middle	5.3%	66.7%	28.1%	22.4%
Fremont High	14.9%	61.7%	23.4%	18.4%
Total	8.2%	48.2%	43.5%	100.0%

Note: Total counts and percentages are based on the total student population. $N = 255$

Students who attended schools in urban communities had the lowest percentage of responses categorized in Model 4 compared to schools located in other community settings. However, students who attended North Monterey County Middle (NMCMS)

also had a low percentage rate of responses categorized in Model 4 (33.3%). In comparison, Pajaro Valley HS had the highest percentage of schools with responses found in Model 4 (70.3%). Figure 2 demonstrates the differences in students' mental model conceptions by community setting.

Figure 2. Students' Mental Model Frequency Rate by Community Setting

Effect of Fieldtrip Experiences on Students' Mental Models

Outdoor environmental fieldtrip experiences were extremely variable among students, and participation rates in individual programs ranged from 1.2% (CWP) to 77.4% (MBA). To run statistical analysis to determine what effects participation in the fieldtrips had on students' mental models, programs with similar curricula were

combined and analyzed as a group. OSO, Watsonville Wetlands Watch (WWW), MERITO, and Coastal Watershed Project (CWP) curricula contained watershed and stewardship-based curricula and were combined under the group name, “Watershed group.” Of the total student sample ($N = 255$), 43.1% of students attended at least one fieldtrip in the “Watershed group” ($n = 110$). Of the students who participated in a fieldtrip in the “Watershed group,” 71.8% of students had responses that were found in Model 4 ($n = 79$). In comparison, only 12.5% of students that did not attend a fieldtrip in the “Watershed group” had responses found in Model 4 ($n = 32$). The chi-square test of independence determined the relationship between the “Watershed group” and Model 4 to be significant, $\chi^2(3, N = 255) = 64.81, p = .00$. The effect size for this finding, Cramer’s V , was strong, .50 (Cohen, 1988). Because of the relatively high sample of students who participated in the WWW program ($n = 41$), additional analyses were run to determine the relationship between participation in WWW and the Model 4 conception. Fisher’s Exact Test revealed the relation to be significant, $\chi^2(1, N = 255) = 15.17, p = .00$. The effect size for this finding, Cramer’s V , was moderate, .24 (Cohen, 1988). Incidentally, 89.5% of students from Pajaro Valley HS participated in either the OSO fieldtrip or WWW from the “Watershed group.” A closer examination of the fieldtrip experiences of students sampled at Pajaro Valley HS revealed that of the 86.6% of students who participated in the WWW program, 70% of those students’ responses were found in the Model 4 conception. Students’ mental model conceptions based on participated in Watershed Programs is shown in Figure 3.

Coyote Hills Regional Park and Elkhorn Slough Reserve fieldtrips emphasized marsh and grassland ecology and were combined under the group name, “Marshland group.” Of the total student sample ($N = 255$), 14.9% of students attended at least one fieldtrip in the Marshland group ($n = 38$). The relationship between the Marshland group and students’ mental model conceptions was not significant. The remaining fieldtrips, Science Camp and Return of the Natives, were recorded as individual fieldtrips because of differences in their curricula content. The MBA was included in this analysis because of its relevance to the subject matter and the high percentage of students who had visited the aquarium (77.4%). Fisher’s Exact test was performed to examine the relationship between each of these fieldtrips and students’ mental model conceptions. The frequency of students’ mental model conceptions by each of these fieldtrip groups was consistent and showed no significant differences.

Figure 3. Students' Conceptions Based on Participation in Watershed Programs
Effect of Participation in the OSO Program on Students' Mental Models

Eighty-seven students (33.9% of the total population of surveyed students) had previously participated in the OSO program. One survey was discarded because the art task and the survey questions were unanswered; therefore, 86 student surveys were analyzed in the OSO group ($n = 86$). As shown in Table 7, the majority of student responses (75.6%) categorized in Model 4 had previously participated in the OSO program.

Table 7. Frequency of Mental Model Conceptions Based on OSO Participation

OSO Participation	Model 2	Model 3	Model 4	Total
Attended OSO	3.5%	20.9%	75.6%	33.7%
Did not attend OSO	5.9%	61.5%	27.8%	66.3%
Total	4.7%	47.8%	43.9%	100.0%

Note: N = 255

A comparison of the frequency of students' mental model conceptions based on participation in the OSO program showed that 75.9% of OSO participants responses were categorized in Model 4. The comparison is illustrated in Table 7. This difference was statistically significant, $\chi^2 (1 N = 86) = 54.23, p = .00$. The effect size for this finding was strong, .46 (Cohen, 1988). In addition, students who listed the OSO program as their only outdoor fieldtrip experience were all found in Model 4 ($n = 4$). Littering behavior was identified by 87.7% of OSO participants in Model 4. A comparison of students' mental model frequency based on participation in the OSO program is shown in Figure 4.

Figure 4. OSO Participants' Mental Model Conceptions

Demographic effects on OSO participants' mental model conceptions. OSO participants' demographic data were recorded on a separate spreadsheet and analyzed using the same methods presented in the demographic analysis of the whole student sample. The demographic data gathered from the OSO group are presented in Table 8. There were no students sampled from North Monterey County High (NMCHS) who participated in the OSO program, therefore, NMCHS was not included in the school demographic analysis.

Table 8. OSO Participants' Demographic Data

Variables	Number of OSO students	Percent of OSO students
Schools		
SLVHS	28	32.6
PVHS	13	15.1
Monroe Middle	20	23.3
Fremont HS	1	1.2
NMCMS	9	10.5
Lagunita	15	17.4
NMCHS	—	—
Grade level		
7 th /8 th	44	51.2
9 th	28	32.6
10 th	14	16.3
Sex		
Male	48	55.8
Female	38	44.2
Language		
English	64	74.4
Spanish	20	23.3
Other	2	2.3
Fieldtrips		
None (other than OSO)	4	4.7
WWW	18	20.9
MERITO	5	5.8
CWP	2	2.3
Elkhorn Slough	16	18.6
Coyote Hills	1	1.2
Science Camp	60	69.8
Return of the Natives	15	17.4
MBA	72	18.3

Note: N = 86

Chi-square analysis and Fisher's Exact Test were used to test the null hypothesis of expected frequencies of the mental models of OSO participants' responses across participants' OSO participation and demographic factors (school, grade level, sex, and primary language). The frequency of OSO participants' mental model conceptions by school, grade level, sex, primary language, and community setting was consistent and

showed no significant differences; however, OSO participants from Monroe Middle had a higher frequency of students with responses found in Model 3 than the other schools. Comparatively, OSO participants from Pajaro Valley HS (PVHS) had the highest frequency (relative to the population sampled from Pajaro Valley HS) of student responses found in the Model 4 conception; these frequencies are shown in Figure 5.

Figure 5. Frequency of OSO Participants' Mental Model Conceptions by School

Effect of fieldtrip experiences on OSO participants' mental models. There was no direct relationship found between an individual fieldtrip experience (other than OSO and OSO participants' mental model conceptions) and students' mental models. This supports the likelihood that the relationship between OSO participation and Model 4

conceptions is not the result of another individual fieldtrip experience. However, the results do indicate that students who attended multiple programs in the Watershed Group were more likely to have responses found in the Model 4 conception. Twenty OSO participants ($n = 20$) attended at least one of the other fieldtrips in the Watershed Group besides the OSO program; 85% of those students had responses found in Model 4. Approximately 37% of sampled students from PVHS participated in the OSO program; 92.9% of these students had conceptions in Model 4. For students who participated in both the OSO and WWW programs, 93.3% had conceptions found in Model 4. Figure 6 illustrates the relationship between watershed-based fieldtrip experiences and students' mental model conceptions.

Figure 6. Influence of Watershed Programs on OSO Participants' Mental Models

Likert-Item Response Evaluation

The Long-Term Student Survey included five statements that students were asked to answer using a 5-point Likert-item response scale. Four students left the Likert-item questions left unanswered; therefore, 253 student surveys were analyzed for the Likert-item response section. The correct answer to statement 1 was “no.” The second and third statements regarding bioaccumulation and runoff, respectively, were accurate statements, and correct responses to these statements were “yes.” Statement 4 was an attitude-based statement, and a “yes” response indicated that the respondent believed that his or her daily decisions had an impact on ocean health. Statement 5 was a behaviorally based statement, and a “yes” response indicated that the respondent had shared his or her knowledge about ocean pollution with family and/or friends. Students’ response percentages for each question were separated into two groups: OSO participants and non-OSO participants, which is shown in Table 9.

Table 9. Likert-Item Response Percentages Based on OSO Participation

Scale item	Program Participant	Students' Response Percentages		
		Yes	I don't know	No
1: The color of the ocean water off the coast of California is green only because it is dirty and polluted.	Yes	36.5	27.1	36.5
	No	58.3	20.8	20.8
2: Animals in the ocean at the top of the food chain absorb toxic substances from the animals and plants they eat.	Yes	69.3	18.7	12.0
	No	70.4	20.4	9.2
3: The majority of pollution in the ocean comes from polluted runoff from land.	Yes	80.0	16.5	3.5
	No	67.3	28.0	4.8
4: Things I do daily have an impact on the health of the ocean.	Yes	57.6	18.8	23.5
	No	50.9	28.1	21.0
5: I have talked with my family and/or friends about pollution in the ocean.	Yes	45.9	14.1	40.0
	No	45.5	11.4	43.1

Note: $N = 255$

Overall, students who participated in the OSO program had a higher correct response rate for Statements 1, 2, and 4. The relationship between the correct percentage response rate to Statement 1 based on OSO participation was significant, $\chi^2 (2, N = 255) = 11.54, p = .002$. The effect size, $V = .21$, was moderate. Students who did not participate in the OSO program were less likely to respond correctly with “no” to Statement 1. However, although OSO participants had a higher correct percentage response rate to Statement 1 when compared with students who did not participate in the

OSO program, the percentage of OSO participants who correctly responded “no” to Statement 1 (36.5%) was equal to the percentage of OSO participants who responded “yes,” as shown in Figure 7.

Figure 7. Responses to Statement 1 Based on Participation in the OSO Program

There was no significant relationship between OSO participation and responses to Statement 2 through Statement 5, although the results indicated a marginally significant relationship between OSO participation and Statement 3, $\chi^2 (2, N = 253) = 4.91, p = .086$. The effect size, $V = .14$, was small.

Because of the contextual similarities of the prompt question in the Student Art Task and Statement 3, a chi-square test was performed between students' mental model conceptions and students' responses to Statement 3. The results showed that 79.4 percent of students with responses categorized as Model 4 responded, "yes" to Statement 3. This relationship was significant, $\chi^2 (2, N = 253) = 6.20, p = .045$. The effect size, $V = .157$ was small. Although the relationship between Model 3 and Statement 3 was not significant ($p = .802$), 70.1% of students with responses categorized as Model 3 also responded, "yes" to Statement 3. There were no significant relationships found between the remaining four questions and students' mental model conceptions.

Effect of demographic factors and fieldtrip experiences on OSO participants'

Likert-item responses. The chi-square test was used to statistically determine the independence of OSO participants' Likert-item responses to each statement across school, grade level, sex, primary language, and previous fieldtrip experiences. The frequency of students' responses to Statements 2 through 5 by school, grade level, sex, primary language, and previous fieldtrip experiences was consistent and showed no significant differences; however, the relationship between Statement 1 and the schools' community setting was significant $\chi^2 (4, N = 85) = 10.54, p = .032$. The effect size, $V = .354$, was moderate. Figure 8 shows OSO participants' from mountainous communities had the highest percentage of "no" responses to Statement 1.

No significant relationships were found between Statements 1 through 5 and participation in individual fieldtrip experiences and the watershed-based programs.

Figure 8. OSO Participants' Responses to Statement 1 based on Community Setting

Qualitative Findings

The long-term student survey also included two open-ended questions. The first question directed only to the OSO group asked, “What do you feel was the most important thing you learned while on the O’Neill Sea Odyssey fieldtrip?” Ten OSO participants chose not to respond (11.4%), while some students wrote multiple responses to this question. Over half of the students (68%) wrote that learning how to help the ocean and/or the effects of ocean pollution was the most important lesson that they learned ($n = 59$.) Thirty-three percent of the students wrote that learning about ocean life

was the most important lesson that they learned in the program ($n = 26$), while 9% of students wrote that the lessons taught in the navigation lesson (such as about compass use, GPS, radar,) were the most important lessons they learned. Finally, 17.4% of students responded that experiences they had while on the OSO program (eating seaweed, raising the main sail, and so forth) were the most important lessons.

The second open-ended question was addressed to all the students who completed the long-term survey and asked, “What was your best experience on an outdoor fieldtrip?” Sample responses included:

- Have fun
- Enjoy nature
- Monterey Bay Aquarium
- Boats
- Being at the ocean
- Being away from the city
- Seeing new things
- Learning
- New People

Discussion

The primary purpose of this study was to evaluate the effectiveness of the experiential environmental education model developed by the O'Neill Sea Odyssey (OSO) program in fostering a long-term awareness of ocean stewardship and personal responsibility among its student participants. An analysis of 7th–10th grade students' conceptions about the causes of ocean pollution revealed that 75% of sampled OSO participants retained a high level of awareness of the connection between non-point source pollution and personal behaviors several years after attending the program. These results were independent of differences in students' sociodemographic characteristics. Additional findings indicated similar effects on long-term awareness among students who participated in other hands-on environmental education programs that focused on watershed-based or ocean stewardship concepts and behavior.

To evaluate the effectiveness of the OSO program in fostering long-term awareness of the connection between ocean stewardship and personal responsibility, a student survey was designed by the researcher to evaluate the retention of ocean stewardship concepts taught in the Ecology Lesson about the relationship between non-point source pollution and the ocean. This hands-on visual lesson was the basis of the Student Art Task in the long-term study. Previous studies (Allison, 1980; Bowker, 2007; Brown, 1994) have used student art to evaluate environmental knowledge and visual recall among students. The Student Art Task was used to evaluate the retention of ocean stewardship concepts taught during the Ecology Lesson of the OSO program. Because students are not tracked after completion of the OSO program, it was not possible to

anticipate the sample size of OSO participants from the total population of students who participated in the long-term study. It was also not possible to anticipate the other environmental education fieldtrip experiences students had outside of the OSO program; therefore, the long-term survey was designed to gather data that included previous outdoor, environmental education experiences as well as sociodemographic factors that may have influenced students' responses.

It is important to stress that the constructed student conceptions about the sources of ocean pollution reflect the sample as a whole and not individual students. It is possible that an individual student would convey a different conception within a different context. The mental models are an attempt to characterize the different conceptualizations students hold about the relationship between pollution and the ocean and to summarize these to evaluate the effectiveness of the OSO program in creating a long-term awareness about ocean stewardship behaviors among student participants. Furthermore, the mental models are meant to distinguish the multiple ways in which students conceptualize their understanding of the sources of ocean pollution.

A vast majority of students (91.7%) from the overall sample population believed that ocean pollution is largely caused by land-based sources. In comparison, less than ten percent of students believed ocean pollution is caused by ocean-based sources. These results were not unexpected. Students sampled in the long-term study live in coastal communities and are likely to have a basic understanding of the sources of ocean pollution. Although some students drew or wrote about multiple sources of ocean pollution, many students focused on what they believed was the biggest single cause of

ocean pollution. For this reason, several distinctions about the characterizations of the sources were made based on the content of students' responses. For instance, some students described shoreline disposal as the major cause of ocean pollution, while other students depicted littering as the greatest source. The activity of purposely dumping garbage in the ocean (shoreline disposal) was separated from the behavior of littering based on the intent of the behaviors. Shoreline disposal implied an outside source (e.g., garbage trucks), was purposely dumping trash into the ocean, whereas students depicted littering as a behavior caused by carelessness or laziness. Distinguishing students' characterization of sources of ocean pollution based on content was the basis for evaluating students' conceptual awareness of the connection between ocean pollution and personal, daily behaviors. This distinction is most relevant in students' conceptions about the relationship between litter and the ocean. Student responses that displayed beach litter as a leading source of ocean pollution were characterized separately (Model 3) from responses that portrayed litter in relation of storm drains or river runoff (Model 4) as the leading cause of ocean pollution. To keep continuity when distinguishing students' mental model conceptions, non-point source transport systems (e.g., storm drains) had to be present or verbally stated in the students' response for the students' conception to be categorized in Model 4.

A very small sample of students (8.2%) depicted ocean pollution as being caused only by ocean-based sources. Students whose responses fall into this Model 2 conception largely describe littering activity and garbage dumping from boats as the primary source of pollution in the ocean. Surprisingly, no students in Model 2 included oil spills in their

conceptions. Some responses in Model 2 displayed types of littered pollutants in the ocean, with no clear source of the pollutants. It is possible that the respondents did not understand the meaning of the question or did not have a clear conception of the sources of ocean pollution.

Approximately half of the students sampled (47.8%) believed land-based point sources to be the major causes of ocean pollution (Model 3). Students whose responses fit the Model 3 conception believed that ocean pollution was caused by polluting activity that occurs on or next to the ocean. Students with this conception also indicated they believed the biggest sources of point-source pollution to be shoreline disposal and beach litter, although some students identified factory discharge and industrial waste as leading causes of ocean pollution. Some students also included ocean-based sources, such as boat activity or oil spills, in addition to land-based, point-sources. In all cases, responses in the Model 3 conception demonstrated ocean pollution sources to be caused by direct disposal of pollutants into the ocean.

Students whose responses fit the Model 4 category (43.9%) identified non-point source pollution as a result of runoff (89.2%) or wind (9.0%) as the leading cause of ocean pollution. Storm drains (labeled), runoff discharge pipes, and rivers were the most commonly described transport systems of pollutants into the ocean, although 9% of students also described wind-blown litter as a source of ocean pollution. Over 80% of student responses in this model identified litter as the primary non-point source pollutant. The other most commonly identified pollutant was oil runoff from cars (18%). One student identified pet waste as a runoff pollutant, and six students identified septic tank

discharge into rivers as a runoff pollutant. Although septic tank discharge can also be identified as a point-source pollutant, it was included in the Model 4 conception because of the nature of its transport into the ocean through rivers. The knowledge that behaviors (e.g., littering) can and will be transported from land to the ocean, regardless of where the littering activity occurred, was interpreted as an awareness of the connection between personal behaviors (e.g., littering and driving cars) and ocean pollution.

Approximately 13% of the total students sampled included the effects of ocean pollution on marine life in their responses. Marine birds, mammals, and fish were shown impacted by plastic, oil, cigarettes, and in some cases, the effects of bioaccumulation. There was no clear pattern as to which mental model conceptions included the effects of pollution on marine life; however, responses in Model 4 had a slightly higher percentage of students who included marine life in their conceptions when compared to the other mental model conceptions.

When students' mental model conceptions were controlled for sociodemographic variables, no relationship was found between sex, primary language, and grade level and mental model conceptions. This indicated that students' mental model conceptions were not a reflection of these particular sociodemographic factors. However, there was a relation between students' community setting and their respective mental model conceptions. Fewer than 30% of student respondents from urban communities identified non-point source pollution as a major cause of ocean pollution, indicating that community setting may be a factor in students' conceptions about the sources of ocean pollution. Interestingly, students from NMCMS, which is located in an agricultural

setting within 5 miles of the ocean, also had a low percentage (33%) of students whose responses were found in the Model 4 conception. However, students from Pajaro Valley HS, located in the same community setting as NMCMS, had the highest percentage of student responses found in Model 4. This implies that, although community setting may play a factor in the ways students connect their behavior to ocean pollution, there are likely additional factors that influence students' conceptions.

An examination of the students' fieldtrip experiences revealed that 71.8% of students who participated in fieldtrip programs with watershed or stewardship-based curricula (including the OSO program) gave responses categorized in Model 4, thus demonstrating an understanding of the effect of personal behaviors on the ocean environment. In comparison, only 22.1% of students who did not participate in one or more of these fieldtrips gave responses that were found in Model 4. These results suggest that fieldtrips in the "Watershed group" were notably effective in creating a long-term awareness about the connection between personal behaviors and ocean pollution; however, this does not imply that the other fieldtrips were not effective in their own purposes. Because the intention of the survey instrument was to assess students' knowledge retention about the relationship between the ocean and environment, it was not inclusive of the variations in different environmental programs' curricula.

When the effects of specific fieldtrips were analyzed, there was a correlation found between students who attended the OSO program or the Watsonville Wetlands Watch program (WWW) and Model 4 responses. Watsonville Wetlands Watch Educational Center is situated on the Pajaro Valley HS campus adjacent to extensive

fresh-water wetlands. Similar to the OSO program, the education programs at WWW implement standards-based curriculum in both the natural environment and in classroom discussions, giving students the opportunity to directly experience the wetland systems they are being taught to protect. The responses from students who participated in this study showed that 70% of students who participated in the WWW program gave responses that fit the Model 4 conception.

When the effects of the OSO program were analyzed separately, 75.9% of OSO participants gave responses categorized in the Model 4 conception. Littering behavior was identified by 87.7% of OSO participant responses in Model 4. When specific demographic data was analyzed, the attended school, grade level, sex, and primary language did not have a significant effect on OSO participants' mental model conceptions. To better test for a causal relationship between the OSO program and students' long-term awareness about non-point source pollution, other fieldtrip experiences were also evaluated for their potential influence on students' conceptions. Although no direct relationship was found between other individual fieldtrips and OSO participants' mental model conceptions, a strong pattern emerged from students who participated in other fieldtrips from the "Watershed group." Approximately 24% of OSO participants also attended at least one of the other fieldtrips in the "Watershed group." Within that student subgroup, 85% gave responses fitting Model 4. Specifically, when OSO participants' fieldtrip experiences were compared by school, it was found that approximately 37% of students from Pajaro Valley attended both the WWW and the OSO programs, and 93% of these students gave responses fitting the Model 4 conception.

Comparatively, only 5.2% of students from Pajaro Valley who did not attend either program gave responses fitting the Model 4 conception. It should be noted that PVHS had the highest percentage of primary Spanish speakers (57.9%) and the lowest state rank (2) in terms of API scores, yet had the highest frequency of responses in the Model 4 conception.

These results are not surprising, but very far-reaching in their implications about the long-term effectiveness of the OSO program. According to Kaiser and Fuhrer (2003), when declarative knowledge, procedural knowledge, and effectiveness knowledge converge towards a common ecological goal, they are more likely to foster ecological behavior. Through hands-on activities, on the ocean and shoreside, OSO participants engage in lessons about marine food chains and ecological systems before engaging in group activities and discussions about how they can affect the ocean environment. Students are given the knowledge and tools, as well as a sense of ownership and locus of control over their surroundings (Hungerford & Volk, 1990), to understand how their personal behaviors can affect the ocean environment. In identifying non-point source runoff and littering behavior as the leading cause of ocean pollution, OSO participants demonstrate a long-term retention of key empowerment lessons taught during the program.

Studies have shown that environmental education programs are more likely to be effective in promoting environmentally responsible behaviors when students participate in multiple programs that focus on similar issues over extended periods of time (Knapp & Benton, 2006; Zint, Kraemer, Northway, & Lim, 2002). Multiple outdoor fieldtrip

experiences have also been shown to lead to a greater sense of attachment and ownership to local natural resources, as well as to reinforce action strategies that can empower students and engage them in ways to help those resources. (Vaske & Kobrin, 2001; Hungerford & Volk, 1990). As regional environmental education agencies such as the OSO program, MERITO, Save Our Shores, and WWW continue to collaborate with one another, students are provided with multiple experiences and lessons in environmental stewardship. Programs such as OSO and WWW that engage in hands-on activities (i.e., plankton tows, monitoring water quality in a wetlands, and observing the effects of litter on wildlife) are not only interesting and fun, but also have a powerful influence on students' interest in and awareness of environmental problems (Ballantyne, Fien, & Packer, 2000).

The Likert-item response statements were used to supplement data collected from the Student Art Task and compare the differences in students' responses to specific ocean literacy statements based on participation in the OSO program. Overall, students who participated in the OSO program had a higher correct response rate for Statements 1, 2, and 4. The largest differences occurred with Statement 1, "The color of the ocean water off the coast of California is green only because it is dirty and polluted." Although the "no" percentage response rate was significantly higher for OSO participants than non-OSO participants, the percent of OSO participants who correctly responded "no" to Statement 1 was the same percentage as the participants who responded "yes" (36.5%). In comparison, 58.3% of non-OSO participants responded "yes" to Statement 1. It is possible that students who responded "yes" are not familiar with phytoplankton, the

microscopic algae that give coastal California its green waters. It is also possible that students misinterpreted the question. A high percentage of students, both OSO participants and non-OSO participants, responded, “I don’t know” to Statement 1. These response percentage rates may be a reflection of the wording of the question, especially if students were rushed. The sequential order of the survey components (the student art question preceded the Likert-item response questions) may have also influenced students’ interpretation of the question.

Approximately 70% of both OSO participants and non-OSO participants correctly responded “Yes” to Statement 2, “Animals in the ocean at the top of the food chain absorb toxic substances from the animals and plants they eat.” This indicates that most students understand the concept of bioaccumulation in ocean species.

The second largest difference between OSO participant and non-OSO participants’ responses occurred with Statement 3, “The majority of pollution in the ocean comes from polluted runoff from land.” Overall, 71.1% of the total student population responded “Yes” to Statement 3. Specifically, 75% of OSO participants and 67% of non-OSO participants answered “Yes” to Statement 3. Because 75% of OSO participants identified non-point source pollution as the primary cause of ocean pollution in the Student Art Task, it was not surprising that 80% of OSO participants responded, “Yes” to Statement 3. It was interesting to find that, although 67% of non-OSO participants answered “Yes” to Statement 3, only 22.1% of non-OSO participants gave responses that fit the Model 4 conception. It is probable that the wording of the statement was confusing to students, as the wording does not specify the source of polluted runoff

(point source vs. non point-source) and is open to interpretation of individual's conception of the term "runoff." The percentage response rate of "I don't know" from non-OSO participants was almost double the percentage response rate of "I don't know" from OSO participants. This reasoning is supported by the percentage of correct responses of OSO participants to Statement 3 (80%), in relation to the percentage from OSO participant responses' found in the Model 4 conception (75%).

Statement 4, "Things I do daily have an impact on the health of the ocean" was also open to students' interpretation. The intention of the statement was to develop a better understanding of the level of students' awareness about how their daily behaviors can affect the ocean. Although there was a slight increase in the percent response rate of OSO participants (57.6%) who answered "Yes" to Statement 4 compared to the percent response rate of non-OSO participants (50.9%), there was also a high percent rate of students who answered "I don't know" in both groups. Similar to Statement 1 and 3, the wording of the statement may have been confusing to students in both groups. Although students who gave responses categorized as Model 4 conceptually understand that the behavior of littering is a leading source of non-point source pollution, they may not associate themselves as having an impact on the ocean if they do not litter. Similarly, it is possible that students who gave responses categorized as Model 3 responded to the statement based on their behaviors when visiting the beach. Again, the wording is open to interpretation.

Statement 5, "I have talked with my family and/or friends about pollution in the ocean" was a behavioral question. The original intention of this statement was to

determine if students engaged in a specific action behavior, based on their awareness of the effects personal behaviors can have on the ocean. Approximately 45% of both OSO participants and non-OSO participants responded “Yes” to Statement 5. Given the age range of the students in the long-term study, ages 13-16, it is not surprising that less than half of the students reported having talked with their families about ocean pollution. Interestingly, this statement had the lowest “I don’t know” response rate, indicating that students either misunderstood the statement and/or had a more clear response to the statement.

When OSO participant responses were analyzed based on sociodemographic factors and previous fieldtrip experiences, there was a significant relationship found between Statement 1 and schools located in the “mountainous” community setting. These schools, Lagunita Elementary and SLVHS, have the lowest percent of students enrolled in the free and reduced lunch program and are the highest state ranked schools based on API scores in the study sample. It is possible that this increased understanding is due to students’ interpretation of the question, as it is worded very similarly to standard-based test questions. It is also possible that the higher rate of correct responses to Statement 1 is the result of an increased knowledge of science-based concepts.

Although the original intention of the long-term survey was to use the Likert-scale item statements to supplement the Student Art Task in measuring ocean literacy concepts, the findings from both the Student Art Task and the Likert-item responses indicate that the responses were largely not comparable. This was especially indicative in the high response rate of, “I don’t know” for a majority of the questions. The OSO program is

aesthetic and visual; accessing students' memories and knowledge retention through their visual representations decreased the possibility of language misinterpretation.

Finally, when OSO participants were asked what they felt was the most important thing they learned during the OSO program, 68% of students responded that lessons in ocean stewardship were the most important thing they learned, while 33% of students felt that learning about ocean life was the most important lesson. This ecologicistic attitude, which is defined by Kellert (2005) as concern for the environmental system and for interrelationships among wildlife species and the environment, is considered a strong indicator of action behaviors (Auster et al., 2008). As children go through adolescence (ages 13 to 17), they expand their abstract and conceptual reasoning about nature, and develop their ecological and moralistic perspectives of the natural world, which, in turn, helps them, form ethical and moral judgments about their relationship to the natural world (Kellert, 2005). At the same time, psychologists also consider adolescence to be a time out period when concerns about peer relationships and social competence overshadow the exploratory interest seen in middle childhood (Kellert, 2005). This may explain why group – oriented outdoor programs (e.g., Outward Bound) are very popular among late adolescents. The positive environmental attitudes expressed by OSO participants three to five years after participating in the program, combined with the cognitive differences in evaluative development, offer further validation for the importance and lasting effects of early environment education intervention with youths.

Conclusions

Multiple studies have shown that participation in experiential environmental education programs often leads to a short-term increase in environmental knowledge, positive environmental attitudes, and intentions to act after completion of the program; however, the ultimate goal of environmental education is to foster a long-term environmental awareness that will ultimately lead to environmentally responsible behaviors. This research showed that a majority of OSO participants sampled several years after completion of the program retained a high level of awareness and expressed attitudes of concern about a specific environmental issue, non-point source pollution, reiterated during the program. These results were consistent across multiple sociodemographic factors. In comparison, fewer than 30% of students who did not previously attend the OSO program identified non-point source pollution as the primary cause of ocean pollution. Although it cannot be determined whether these results are solely from the influence of the OSO program, these findings, coupled with positive stewardship attitudes gathered from the open-ended question, suggest that the OSO program fosters a long-term awareness about the relationship between ocean stewardship and personal behaviors.

The most important lesson taught at the OSO program to students, the “take home” message, is that students’ everyday decisions and actions have an impact on the ocean environment. The intent of this research was to determine if OSO participants retain these lessons on stewardship behaviors several years after completion of the program. Drawing upon the work of Shepardson et al (2011) and Knapp and Benton

(2006), this study attempted to conceptualize students' internalization and understanding of the connection between their daily actions and the nonpoint source pollution in the environment. By analyzing students' drawings, the researcher was able to identify three general mental model conceptions held by 7th – 10th grade students about the sources of ocean pollution: ocean-based point sources, land-based point sources, and non-point sources. This research found that 75% of previous OSO participants demonstrated retention of teachings from the OSO program about the connection between littering behavior and non-point source pollution three to five years after participating in the program.

The implication that a one day, three-hour program can have a long-term impact on participants' environmental awareness is far reaching. Multiple studies have cited the importance of prolonged and repeated exposure in the natural environment at a young age in developing a positive environmental ethic (e.g., Eagles & Demare, 1999; Thompson, Aspinnall, & Montarzino, 2008). Unfortunately, as modern children continue to spend less free time in the natural environment, there is a question whether or not they still experience enough direct contact with it to foster stewardship behaviors (Kellert, 2005). Constraints on classroom time and inadequate funding have made it increasingly difficult for teachers to take their students outside the classroom. As inadequate funding for extended, multi-day programs (e.g., science camp) limits the availability of such programs to students, the need for low cost, single day environmental education experiences is critical. Results of this study correlate with the findings from Falk and Balling (1982) and Bowker (2007), who found that single-visit fieldtrips can promote

cognitive learning and retention, especially when students are actively engaged in the environment.

Lastly, the age of students who participate in hands-on, experiential environmental education programs can be critical in developing a lasting memory and awareness that will carry into adulthood. Many active ocean scientists and conservationists trace their deep emotional commitment and motivation to preserve and protect the sea to their early experiences with nature. Feelings of attachment to the ocean, a sense of loss for what it once was, and a desire to protect what remains drives many people to act. The challenge for the ocean conservation community is how to explain to the broader public, which often lacks an attachment to the sea, why they should care about the state of the oceans (Kellert, 2008). Through participation in the OSO program, students are given the knowledge, attachment, and empowerment to become future ocean stewards. The lasting effects of such experiences in nature is best summed up by American historian and Pulitzer Prize winner Wallace Stegner, “There is a time somewhere between five and twelve . . . when an impression lasting only a few seconds may be imprinted . . . for life . . . Expose a child to a particular environment at this susceptible time and he will perceive in the shapes of the environment until he [or she] dies” (cited in Kellert, 2005, p. 78).

Applications and Recommendations

The affect that experiential environmental education programs can have on students' long-term cognitive understanding of the concepts and issues of the natural environment cannot be overstated; however, crippling funding cuts in formal and informal education have resulted largely in teaching only standards-based education. Long-term program evaluations are desperately needed to ensure future funding from grants and donors. The process of conducting long-term program evaluations can be extremely challenging. To understand better the conceptions that students have about specific environmental issues, it is recommended that researchers expand beyond measurements that use pre-ordained response categories, as they are open to interpretation by the reader. It is also recommended in the future that multiple researchers evaluate students' responses and triangulate their assessments to reduce individual researcher bias, which was a limitation in this study. Some currently used and respected alternative methods include:

- Question and drawing response
- Concept maps
- Open-ended questions
- Phenomenological analysis (e.g., interviews)

It is also important for evaluators to analyze differences in student sociodemographic variables and related environmental experiences to understand better what other factors may affect students' long-term learning and conceptions. In addition, it is recommended that evaluations focus on measuring student's knowledge and attitudes

about specific issues or components of the environment directly experienced by the respondents, rather than on the environment as a whole, to develop a better understanding of what drives changes in behavior.

The findings of this study indicate that hands-on, experiential environmental education programs can bring all students, regardless of ethnicity and economic backgrounds, to a higher level of knowledge and awareness. Although English language and literacy development is emphasized for English Learners in the context of subject area instruction, studies indicate poor science performance of U.S. students overall and persistent achievement gaps between mainstream and non-mainstream students (Lee, 2005). Hands-on, experiential learning approach has been shown to be the most effective tool for in teaching science concepts and practical problem solving as well as increasing understanding of environmental concepts (Venkataraman, 2008).

The education model designed by the O'Neill Sea Odyssey program is a highly successful example of how one organization uses local natural resources, habitats, and organisms as education tools to assist students in making the connection between the ocean environment and their lives. A published copy of the O'Neill Sea Odyssey curriculum, *Investigations in a National Marine Sanctuary*, is available at www.oneillseaodyssey.org/PDF/Curriculum.pdf.

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Appendix A: Student Survey for Long Term Study

Part I

1. Are you a
GIRL BOY
2. How old are you?
3. What was your first spoken language?
English Spanish Other _____
4. What environmental/outdoor fieldtrips have you attended?

How many times?

a. O'Neill Sea Odyssey (sailboat charter)	_____
b. Watsonville Wetlands Watch	_____
c. Monterey Bay Aquarium	_____
d. Science Camp	_____
i. Elkhorn Slough	_____
e. MERITO Watershed Program	_____
f. Return of the Natives (planting/restoration)	_____
g. Coastal Watershed Project	_____
h. Coyote Hills Fieldtrip	_____
j. Other (please list):	_____

5. O'Neill Sea Odyssey Student Questions

If you attended the Sea Odyssey, please answer the questions below. If you *did not* attend the Sea Odyssey please skip these questions and continue to Part II.

- 5(a). What grade (s) were you in when you attended the O'Neill Sea Odyssey program?
4th 5th 6th Other
- 5(b). What do you feel was the most important thing you learned while on the O'Neill Sea Odyssey fieldtrip?

Part II

In the space below **draw a picture** or **write how you think** pollution gets into the ocean.
Label the parts of your drawing.

A large, empty rectangular box with a thin black border, intended for a student to draw a picture or write an explanation of how pollution enters the ocean. The box is currently blank.

Please circle your response below (there are no wrong or right answers)

1. The color of ocean water off the coast of California is green only because it is dirty and polluted.

YES, DEFINITELY YES, I THINK SO I DON'T KNOW NO, I DON'T THINK SO NO, DEFINITELY NOT

2. Animals in the ocean at the top of the food chain absorb toxic substances from the animals and plants they eat.

YES, DEFINITELY YES, I THINK SO I DON'T KNOW NO, I DON'T THINK SO NO, DEFINITELY NOT

3. The majority of pollution in the ocean comes from polluted runoff from land.

YES, DEFINITELY YES, I THINK SO I DON'T KNOW NO, I DON'T THINK SO NO, DEFINITELY NOT

4. Things I do daily have an impact on the health of the ocean.

YES, DEFINITELY YES, I THINK SO I DON'T KNOW NO, I DON'T THINK SO NO, DEFINITELY NOT

5. I have talked with my family and/or friends about pollution in the ocean.

YES, DEFINITELY YES, I THINK SO I DON'T KNOW NO, I DON'T THINK SO NO, DEFINITELY NOT

Please answer question in space below

What was your best experience on an outdoor fieldtrip?

Thank you very much for your participation in this survey!

Appendix B: Student Art Codes

Table C 1. Student art codes and categories

Categories						
Codes	Trash only	Garbage dumping/ beach litter	Boats	Atmospheric pollution	Direct discharge of waste	Surface runoff
Trash in ocean	x					
ocean dirty	x					
no recycling		x				
beach litter		x				
dump/throw trash in ocean		x				
garbage trucks		x				
boats		x	X			
oil spills			X			
ships sink			X			
smoking				x		
acid rain				x		
air pollution				x		
wind-blown debris				x		
discharge pipe						
industrial/factories					x	
superfund site					x	
sewage pipe					x	
poop					x	
toilet						x
rivers						x
storm drain						x
oil (from cars)						x
street litter						x

Appendix C: Samples of Student Art

Mental Model Conception 1

Part II

In the space below **draw a picture** or **write how you think** pollution gets into the ocean.
Label the parts of your drawing.

Mental Model Conception 2

Part II

In the space below draw a picture or write how you think pollution gets into the ocean.
Label the parts of your drawing.

Mental Model Conception 2

Part II

In the space below **draw a picture** or **write how you think** pollution gets into the ocean.
Label the parts of your drawing.

Mental Model Conception 3

Part II

In the space below **draw a picture** or **write how you think** pollution gets into the ocean.
Label the parts of your drawing.

Mental Model Conception 4

Part II

In the space below **draw a picture** or **write how you think** pollution gets into the ocean.
Label the parts of your drawing.

When people throw there garbega in the street and it washes into the storm drains and gets into the rivers then in the oceans.

Mental Model Conception 4

Part II

In the space below **draw a picture** or **write how you think** pollution gets into the ocean.
Label the parts of your drawing.

I think pollution gets into the ocean by us leaving garbage on streets which leads to the sewer that goes down into the ocean.

Appendix D: Fieldtrip Descriptions

Watsonville Wetlands Watch (WWW): WWW is on the Pajaro Valley HS campus, adjacent to surrounding freshwater wetlands and agriculture. WWW implements standards-based curriculum and engages student groups in grades 4th-12th in hands-on laboratory and outdoor activities designed to foster an understanding of the surrounding wetlands systems and nature as a whole.

<http://www.watsonvillewetlandswatch.org/education.htm>

Monterey Bay Aquarium (MBA): The MBA is on Cannery Row in Monterey, CA. The mission of the Monterey Bay Aquarium is to inspire conservation of the oceans.

www.montereybayaquarium.org/

Science Camp: Many regional students in grades 5th and 6th are given the opportunity to participate in a residential, outdoor science camp in various terrestrial ecosystems. The lessons follow the CA State Science Standards and emphasize hands-on learning experiences in the science of ecology. Regional students usually attend Santa Cruz County Resident Outdoor Science School or Walden West Outdoor School.

Santa Cruz County: www.cde.ca.gov/be/st/ss/documents/sciencestnd.pdf

Walden West Outdoor School:

www.sccoe.org/waldenwest/school_programs/outdoor.asp

Multicultural Education for Resource Issues Threatening Oceans (MERITO): A marine conservation outreach effort that provides classroom support, field trips, training, and other resources in ocean and watershed to communities living near the Monterey Bay National Marine Sanctuary. <http://montereybay.noaa.gov/educate/merito/welcome.html>

Return of the Natives (RON): A community and school-based environmental education program at CA State University of Monterey Bay (CSUMB). RON involves students from kindergarten to college level in habitat restoration and service learning projects.

<http://ron.csumb.edu/>

Coastal Watershed Project (CWP): The Watershed Project engages students, teachers, and classroom volunteers in creek beds and on the shoreline and works to protect, restore, and preserve the local watersheds in the San Francisco Bay Area.

<http://www.thewatershedproject.org/WhatWeDo/WhatWeDo.html>

Coyote Hills: Coyote Hills Regional Park is comprised of 978 acres of marshland and rolling grassland hills in east San Francisco Bay. Education programs include clean-up efforts, interpretive walks, and lessons in the local ecology.

http://www.ebparks.org/parks/coyote_hills

Elkhorn Slough: Elkhorn Slough is a 1700-acre reserve found in Moss Landing, CA and is the largest tidal salt marsh in California outside of San Francisco Bay. The education and teacher training programs at the Elkhorn Slough National Estuarine Research Reserve promote conservation and research on the wetland habitat and surrounding marsh and grasslands. <http://www.elkhornslough.org/education/index.htm>

Appendix E: Consent Forms

IRB Approval Form

**SAN JOSÉ STATE
UNIVERSITY**

To: Lauren Hanneman

From: Pamela Stacks, Ph.D.
Associate Vice President
Graduate Studies and Research

Date: January 4, 2011

Division of Academic Affairs

Associate Vice President
Graduate Studies & Research

www.sjsu.edu/gradstudies

One Washington Square
San José, California 95192-0025
Voice: 408-924-2427
Fax: 408-924-2612

www.sjsu.edu

The Human Subjects-Institutional Review Board has approved your request to use human subjects in the study entitled:

“Long-Term Impact of Experiential Environmental Education: A Case Study of the O'Neill Sea Odyssey Program”

This approval is contingent upon the subjects participating in your research project being appropriately protected from risk. This includes the protection of the confidentiality of the subjects' identity when they participate in your research project, and with regard to all data that may be collected from the subjects. The approval includes continued monitoring of your research by the Board to assure that the subjects are being adequately and properly protected from such risks. If at any time a subject becomes injured or complains of injury, you must notify Dr. Pamela Stacks, Ph.D. immediately. Injury includes but is not limited to bodily harm, psychological trauma, and release of potentially damaging personal information. This approval for the human subject's portion of your project is in effect for one year, and data collection beyond January 4, 2012 requires an extension request.

Please also be advised that all subjects need to be fully informed and aware that their participation in your research project is voluntary, and that he or she may withdraw from the project at any time. Further, a subject's participation, refusal to participate, or withdrawal will not affect any services that the subject is receiving or will receive at the institution in which the research is being conducted.

If you have any questions, please contact me at (408) 924-2427.

Protocol #S1004187

cc Will Russell 0115

The California State University:
Chancellor's Office
Bakersfield, Channel Islands, Chico, Dominguez Hills,
East Bay, Fresno, Fullerton, Humboldt, Long Beach,
Los Angeles, Maritime Academy, Monterey Bay,
Northridge, Pomona, Sacramento, San Bernardino,
San Diego, San Francisco, San José, San Luis Obispo,
San Marcos, Sonoma, Stanislaus

School Recruitment Letter

To: Principal

My name is Lauren Hanneman. I have been a Marine Biology and Marine Ecology instructor for the O'Neill Sea Odyssey for the past 6 years. I am also a graduate student in the Environmental Studies Department at San Jose State University. The O'Neill Sea Odyssey, along with most environmental education programs, has struggled with gathering the funds needed to continue serving the 180+ classes that attend the program each year. The aim of my thesis project is to provide a long-term evaluation of the effectiveness of the Sea Odyssey program in fostering long-term environmental stewardship awareness. My long-term goal (and hope) is that other environmental education organizations will conduct their own long-term impact studies whose results will eventually lead to including such experiential environmental education programs in public school curricula. This is a goal shared by Theresa Rouse, Associate Superintendent in Educational Services at the Santa Cruz County Office of Education. I have also met with Superintendent Michael Watkins and been granted approval by the County Department of Education to move forward on this study. In addition, I have fingerprint clearance and am currently approved for emergency substitute teaching in Santa Cruz County.

Many students that attended the Sea Odyssey and other similar programs have filtered into your school and I am hoping to survey two science classrooms at some point during this semester. I will administer the survey to the students in the class at the teacher's convenience. The survey will take approximately 10 minutes to complete. Recruitment letters and parental consent forms will be collected for each subject. I understand how limited classroom time is and hope to have the most minimal impact on the teacher's time. I am offering a \$25 gift card to Office Max for the teachers' time and efforts. I would be happy to discuss this further via phone, email, or a meeting. I am attaching the survey I will be administering for your review. Thank you very much for your time. Very sincerely,

Lauren Hanneman

Graduate Department of Environmental Studies, SJSU
O'Neill Sea Odyssey Instructor

Parental Consent Form

**San José State
UNIVERSITY**

**Department of
Environmental Studies**

One Washington Square
San José, CA 95192-0115
Voice: 408-924-5450
Fax: 408-924-5477

The California State University:
Chancellor's Office
Bakersfield, Channel Islands, Chico,
Dominguez Hills, Fresno, Fullerton,
Hayward, Humboldt, Long Beach,
Los Angeles, Maritime Academy,
Monterey Bay, Northridge, Pomona,
Sacramento, San Bernardino, San Diego,
San Francisco, San José, San Luis Obispo,
San Marcos, Sonoma, Stanislaus

Agreement to Participate in Research

Responsible Investigator: Lauren Hanneman

Title of Protocol: "Short and Long-Term Impact of Experiential Environmental Education: A Case Study of the O'Neill Sea Odyssey Program."

Dear Parent,

My name is Lauren Hanneman and I am instructor for the O'Neill Sea Odyssey program in Santa Cruz, CA and a graduate student in the Department of Environmental Studies at San Jose State University. Your child or ward has been asked to participate in a research study evaluating the effectiveness of outdoor environmental education programs that includes the O'Neill Sea Odyssey.

Your child or ward will be asked to participate in a brief survey that will take place at some point during the 2010-2011 year. The principal of the school and the science teacher are aware of this research and have granted permission for me to conduct the survey while the students are in class.

There are no anticipated risks to your child associated with their participation in this research.

This research will help determine the importance of incorporating hand's-on environmental education programs in public school curriculum. Regardless of whether or not your child participated in the Sea Odyssey program, their answers will help provide information that will enable the Sea Odyssey to continue serving the children in our regional community to the best of its ability.

Although the results of this study may be published, no information that could identify your child or ward, your family, or you will be included. The survey is anonymous and your child's name will not be recorded.

Teachers that allow their classroom to participate in this study will receive a gift card to use for class supplies. Students will receive a small gift for their participation in the study.

Questions about this research may be addressed to [REDACTED] at [REDACTED] or [REDACTED]. Complaints about the research may be presented to Lynne Trulio, Ph.D, Department Chair of Environmental Studies, at (408) 924-5445. Questions about research subjects' rights, or research-related injury may be presented to Pamela Stacks, Ph.D., Associate Vice President, Graduate Studies and Research, at (408) 924-2427.

No service of any kind, to which you and/or your child or ward is otherwise entitled, will be lost or jeopardized if you choose not to participate in the study.

**Department of
Environmental Studies**

One Washington Square
San José, CA 95192-0115
Voice: 408-924-5450
Fax: 408-924-5477

Initial _____

Your consent for your child or ward to participate is being given voluntarily. You may refuse to allow his or her participation in the entire study or in any part of the study. Your child/ward has the right to not answer questions that he/she does not wish to answer. If you allow his or her participation, you are free to withdraw your child or ward from the study at any time, without any negative effect on your relations the O'Neill Sea Odyssey, your child's school, or San Jose State University. Your child also has the right to withdraw from the study at any time.

At the time you sign this consent form, you may keep a copy of it for your records, signed and dated by the investigator.

The signature of a parent or legal guardian on this document indicates approval for the child or ward to participate in the study, that the child is freely willing to participate, and that the child is permitted to decline to participate, in all or part of the study, at any time.

Name of Child or Ward

Parent of Guardian Signature

Date

Relationship to Child or Ward

Full Mailing Address (optional)

Investigator's Signature

Date

The signature of the researcher on this document indicates agreement to include the above named subject in the research and acknowledges that the subject has been fully informed of his or her rights.

Please keep one copy of this letter for your record and send the other back to school with your child. Thank you for your cooperation!

The California State University:
Chancellor's Office
Bakersfield, Channel Islands, Chico,
Dominguez Hills, Fresno, Fullerton,
Hayward, Humboldt, Long Beach,
Los Angeles, Maritime Academy,
Monterey Bay, Northridge, Pomona,
Sacramento, San Bernardino, San Diego,
San Francisco, San Jose, San Luis Obispo,
San Marcos, Sonoma, Stanislaus

Appendix F: List of Acronyms

CPW (Coastal Watershed Project)

MERITO (Multicultural Education for Resource Issues Threatening Oceans)

NMCHS (North Monterey County High School)

NMCMS (North Monterey County Middle School)

OSO (O'Neill Sea Odyssey)

RET (Return of the Natives)

SLVHS (San Lorenzo Valley High School)

WWW (Watsonville Wetlands Watch)