

FIELD RESEARCH AND MOTIVATION:
EXPERIENTIAL LEARNING IN THE PARKER RIVER ESTUARY

by

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DEDICATION

To Dr. Franco Marcantonio for his years of continued support.

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ABSTRACT

This action research project examined the initial effects of an experiential learning intervention on students by instituting a long-term salt marsh research project at a New England private school. The field element of the research project included identification of salt marsh vegetation and measurement of soil salinity along three transects. Two first year high school biology classes were tested for student motivation towards learning biology, achievement in the relevant ecology unit and overall perception of the environment through pre- and post-intervention attitudinal surveys, summative evaluations, short answer essays, and teacher notes. The treatment group ($N=9$) studied the salt marsh ecology curriculum over a one month period and participated in two field days in the marsh while the non-treatment group ($N=15$) was exposed to the curriculum in the classroom only.

It was discovered that treatment students had increased motivation toward learning biology. Achievement and perspective on environmental preservation remained fairly unchanged regardless of participation in the experiential research intervention. These factors together show that while experiential field work does not have significantly better results than standard ecology curriculum, it certainly was shown to be just as good as traditional classroom practices. When the geographic proximity and local significance of salt marsh preservation was considered, there was a strong argument that outdoor classroom activities in the marsh were worth pursuing. At the very least they were just as worthy as typical classroom based lessons and therefore should be considered as a worthwhile endeavor.

INTRODUCTION AND BACKGROUND

At more than 20,000 acres, the Great Marsh of Massachusetts comprises the largest contiguous wetland in New England, spanning the coast from Cape Anne to the New Hampshire border. Within this marsh the largest estuary empties into Plum Island Sound and is comprised of the Ipswich and Parker River drainages (Plum Island Ecosystems LTER, 2015). Along the banks of the Parker River in Byfield, the oldest boarding school in the nation, The Governor's Academy, has sat since the year 1763. I graduated from the Governor's Academy in 2001, a full 238 years after its inception as an agricultural school under a decree from then Lieutenant Governor William Dummer.

It is only appropriate that two and a half centuries later the school looks to the land again for guidance, development, and growth. The Governor's Academy owns vast expanses (more than 200 acres) of salt marsh in the Parker River estuary of northeast Massachusetts. Through discussions with administrators at the Governor's Academy, we have recognized that there is a lack of biology and physical science curriculum related to the adjacent estuary. The Governor's Academy strategic plan seeks to develop the marsh into an outdoor classroom but to date lessons have been sporadic and disconnected. At my suggestion, the school agreed to examine the possible benefits of a long-term ecological research site in the marsh.

The objective of my study was to determine whether student participation in such research would elevate student motivation, academic achievement, and environmental awareness in first year biology students. It also was assumed that exposure to scientific research techniques would motivate students towards scientific pursuits in post-secondary education as well as careers. This assumption was outside the scope of this particular

classroom research project but presented an interesting future. The primary research questions asked by this paper can be seen below:

Primary Research Questions

1. What role does participation in a long-term ecological study play on student motivation in school science?
2. What role does the same participation play on science achievement in salt marsh biology?
3. Does participation in a long-term ecological study affect student awareness of ecological issues?

With those questions in mind and the fact that there are at least 18 entities devoted to the conservation of the Great Marsh (The Great Marsh Coalition, 2015), the Governor's Academy realized the potential value in studying salt marsh ecology. Through personal experience I have found that public organizations and private entities are willing to donate resources and personnel to develop science curricula because they share the view that the students of today are the stewards of tomorrow. One such group, Mass Audubon, agreed to help work with the students at the Governor's Academy.

Liz Duff, the education coordinator at Mass Audubon, provided significant time and equipment to help students study salt marsh vegetation in the fall of 2015. Since it is likely that plant species will change over time as sea level rise causes soil salinity to increase, the students collected data that will be compared over a number of years. If any changes do occur, the introductory biology students will play a vital role in the discovery process through the experience of learning in the outdoors.

CONCEPTUAL FRAMEWORK

Any discourse on the theories and practices of experiential learning in modern high schools stands firmly on a foundation built by a myriad of scholars. Rather than vertical in nature, it has grown in a linear fashion much the way that time presses on. These pioneering few whom I will discuss in the ensuing paragraphs have worn a well-trodden path through the woods, which when ventured, leaves the passerby to posit on its long ago creation. At the same time this path allows for a fresh experience through the forest at each individual journey and in the eyes of each journeyer.

The issues discussed in this paper are inherently intertwined with the psychology and philosophy of all humans and especially students. As Dewey (1929) states, “the social participation affected by communication, through language and other tools, is the naturalistic link which does away with the often alleged necessity of dividing the objects of experience into two worlds, one physical and one ideal” (p. 6). In essence, experiencing events and learning from them is as natural a human trait as we possess and can thus be studied in such a fundamental manner. Let me say then that the subsequent pages are my muddy footprint on the trail left by others.

Experiential Learning

There has been much research on the “constructivist” theory of learning and its roots can be traced to philosophers, developmental psychologists, education researchers and teachers. I will touch on the work of a few of these individuals in an attempt to work towards the modern definition of experiential learning and the effects that this has on students. This journey begins with constructivism as its model, the idea that by using

what students already know about the world around them, educators can help students educate themselves further about the world (Doran, Chan, Pinchas, & Lenhardt, 2002).

It is doubtful that anyone would argue that the role of a teacher is to bestow knowledge upon students. In this regard, knowledge must now be defined in order to later understand the means by which it is transferred. “It signifies events understood, events so discriminately penetrated by thought that mind is literally at home in them. It means comprehension, or inclusive reasonable agreement” (Dewey, 1929, p. 161). The term *events*, in this case, is vague but one could argue that a teacher must present such events in a manner that allows for students to understand them. To inclusively agree means that the learner must internalize the event and therefore make sense of it in his or her own head. Piaget (1964) goes further:

Knowledge is not a copy of reality. To know an object, to know an event, is not simply to look at it and make a mental copy or image of it. To know an object is to act on it (p. 176).

Certainly in this sense of the definition it is apparent that, in terms of science, knowledge is not something that is simply facts from a book but rather must be acquired through experience. As the inventor Charles Kettering famously said, “There is a great difference between knowing a thing and understanding it. You can know a lot and not really understand anything” (Boyd, 1957, p. 21).

Indeed knowledge then is so much more than the act of knowing. So the question arises as to how best transfer science knowledge to students. In his work *Experience and Education*, John Dewey (1986) touches on his main theme of continuity. He argues in favor of constructivism in that our present actions are based on the previous influence of our own and others’ actions, or that we gain knowledge by building on the experiences of

our past. This certainly means since no two individuals can share the same experiences, that students acquire information differently. This presents a dilemma, as he states, “Now we have the problem of discovering the connection which actually exists *within* experience between the achievements of the past and the issues of the present” (p. 246). He does not refer specifically to the differences in individual student learning here but rather the holistic approach to education that might allow for all students to maximize their learning potential. This paper is an attempt to test one aspect of the, still relevant, progressivism to which he refers.

Dewey certainly recognized the difficulty he presented because there is a vast difference between unhindered self-learning with no teacher oversight and the traditional, strict classroom setting of rote memorization. As he states, “Everything depends upon the *quality* of the experience which is had” (Dewey, 1986, p. 248). Vygotsky (1978) contends that “properly organized learning results in mental development and sets in motion a variety of developmental processes that would be impossible apart from learning” (p. 90). Dewey does not tell us where on the experiential spectrum learning should fall just as Vygotsky fails to speculate as to what type of organized learning is proper. But Piaget (1964) recognized it “is not what you say, but the discussion which follows” (p. 176) and so they leave us with a few key elements.

To gain knowledge of something is to experience it and to understand how to manipulate it, internally or externally. In order to gain knowledge, learning must take place and must be appropriately coordinated with the previous experiences of the learner. Science education presents itself as specifically unique in these two cases. Not only is the study of science based on empiricism, or the observation of experience, but it builds upon

its own past experiences paralleling the development of an individual learner. And so we arrive at a broad definition of experiential learning as the acquisition of knowledge through an active and repeated manner rather than the absorption of information passively and infrequently.

Nature as Experience

There are two major themes of scientific inquiry currently being studied in the Great Marsh. The first is the abundance of invasive species, specifically *Phragmites australis* (Common Reed), in sections of the marsh previously containing diverse populations of salt marsh hay (Hazelton, Mozdzer, Burdick, Kettenring, & Whigham, 2014). This topic provides ample opportunity for students to learn to identify marsh vegetation species and make inferences about the diversity under different environmental scenarios, including changing weather, salinity, elevation, etc.

The second is the impending rise of sea level due to climate change that is sure to impact low lying areas such as the Parker River Estuary (Massachusetts Office of Coastal Zone Management, 2013). This trend can be measured in the marsh during various tide levels and used in collaboration with other efforts in the area, i.e. The Marine Biological Laboratory and Mass Audubon. Both of these issues are of major local and regional concern as they relate directly to land use trends and future planning needs. School curricula have been in place for some time to address these trends in education (Ochoa, Demetri, & Duff, 2003).

Of particular interest to educators are the opportunities for the broad application of experiential learning outside the classroom. Experiential learning linked to the environment has profound results on students. Landmark studies have shown that field

based ecology instruction produces both significant retention of content and increased environmental stewardship in students (Bogner, 1998; Lisowski & Disinger, 1991). Ecology students at one university involved in a service learning project also expressed expanded world views and increased content knowledge. Most importantly the authors found that the experience made “the course material more meaningful in a way that didactic study cannot” (Bee, Montante, Langian, Andrzejak, & Grabowski, 2011, p. 21). Though questions have been raised on the difficulty of evaluating students during such interactions (Jeronen, Jeronen, & Raustia, 2009), there is evidence that this type of learning has a high impact on students (Caulfield & Woods, 2013)

Bogner and Kossack (2012) found, albeit in a general way, that students involved in a one-day study of a forest showed more connectedness with nature. Connectedness, while vague, brings to mind environmental stewardship. Over a 10 year study of 150 schools in 16 states it was found that “environment-based education produce[d] student gains in social studies, science, language arts, and math; improve[d] standardized test scores and grade-point averages, and develop[ed] skills in problem-solving, critical thinking, and decision-making” (Louv, 2008, p. 206).

Bogner (1998) showed that environmental education could change student perception of the environment. In order to measure this, he developed an instrument, The Model of Ecological Values (MEV) to assess whether student feelings tend towards *preservation* or *utilization* of the environment. Johnson and Manoli (2008) validated a modified version of the instrument and renamed it The Environment Questionnaire (TEQ). They found that environmental education tended to promote thoughts of environmental preservation in students over environmental utilization however Gough et

al. (2001) reminds us that, “Education cannot be expected to ‘save the planet’ through, or mostly through, its own direct or indirect effects” (p. 179).

In summary, there are many advantages to the use of the outdoors as an experiential learning tool. These include connecting students to nature and impacting present experiences so as to draw on the past. With low costs and many chances to train teachers in constructivist methods, there is little argument against using school campuses to explore natural science through experience. Behrendt and Franklin (2014) explain that, “Campus field trips provide a cost-free alternative, while retaining the benefits of traditional field trips” (p. 242) and so campus is the most likely place to first attempt an experiential nature program. That being said, the incorporation of a long-term ecological study of the Parker River Estuary exists in this case as an intervention to be used in the assessment of science learning, rather than as a tool to elicit certain ideals.

Motivation and Science

Self-efficacy has been found to be a major controlling factor to changes in human behavior. Simply put, the level of confidence an individual has in the performance of a task, the more readily they will put forth effort towards its accomplishment. This creates a feedback loop in which completion of the goal will create further motivation and the past experience will promote further growth (Bandura, 1977). As Bandura (1993) reminds us, “a person with the same knowledge and skills may perform poorly, adequately, or extraordinarily depending on fluctuations in self- efficacy thinking” (p. 119).

In terms of education this is significant because student attitude towards “science, scientists, and learning science, which has always been a component of science

education, is increasingly a matter of concern” (Osborne, Simon, & Collins, 2003). It must be mentioned here that *school science* is the topic of the aforementioned quote and not necessarily science in general and the concern the authors speak of is in reference to the United Kingdom’s plummeting college enrollment rates in the sciences. Within science education, numerous studies (Ebenezer & Zoller, 1993; Morag et al., 2013; Ornstein, 2006) have shown that students prefer more active, goal-oriented, hands on learning. This was described in the previous section as *experiential learning*, rather than the more traditional, passive type of learning currently in place in most schools.

Since the attitude of an individual is a very subjective and complex topic, it is difficult to effectively assess and differentiate between the attitudes of individuals (Osborne et al., 2003). It is much more efficient and substantiated to survey student motivation towards ambition and achievement. It is a valid task to focus on the confidence that students possess in relation to science content and skills and the goals that they set and meet as a result (Glynn, Brickman, Armstrong, & Taasobshirazi, 2011).

Conclusion

A clear path was traced in the literature that leads to the cognitive and academic benefits of experiential learning on the student. More indefinite were the outcomes of authentic field research as a means of learning high school science. Using the methods developed by experts in the field of behavioral assessment, this paper attempted to blaze a trail that linked motivation and ecology understanding to the introduction of a long-term biological research experience.

METHODOLOGY

Project Intervention

An action research project was conducted during the fall semester of 2015 to evaluate whether outdoor education affected student motivation and understanding of biology material. The study of salt marsh vegetation and salinity allowed freshmen in introductory biology ($N=24$) at the Governor's Academy to participate in authentic research in the form of experiential learning. The treatment group performed the field research while the non-treatment group did not and was not made aware of the intervention. Activities of the treatment group included the formal collecting and identifying of biological and physical samples, cataloging data for future use, summarizing and synthesizing interpretations, and presenting results. It also included the informal interactions of students with nature by walking through the woods, minimizing marsh destruction, and getting wet shoes. The main questions for the students that this fieldwork addressed were;

1. How does vegetation differ from the upper to lower marsh?
2. What is the salinity of ground water at different depths?
3. How does salinity affect vegetation?
4. What effect will rising sea level have on the marsh?

Intervention Schedule

In the spring of 2015, with the help of Liz Duff of Mass Audubon and Jamie Brandt of the Governor's Academy, three 60 meter transects were placed in the Parker River estuary on campus property. Transects ran from the upland tree line through the salt marsh and terminated on the banks of the Parker River (Appendix A). On each

transect, at 15 m, 30 m, and 45 m from the tree line, three wells made of one-quarter inch diameter PVC were placed in the ground. These wells were 20 cm, 50 cm, and 80 cm deep and thus labeled as shallow, medium, and deep, respectively.

On September 8, 2015, prior to the start of the semester, a teacher-training day was held in the classroom and the marsh study site. It has been suggested as essential that teachers play the role of student prior to instituting nature as experience (Riordan & Klein, 2010). Again with the help of Elizabeth Duff of Mass Audubon, teachers were introduced to the study materials and procedures so they could first experience the intervention that students would be exposed to during the next month. Teachers used the classroom and field forms that introduce students to the material as well as the survey instruments that were used in the design of this study. At the end of the training it was determined that one teacher, Mike Lefebvre, would participate in the project. He had two nearly identical introductory biology classes that provided an ideal situation for a treatment and non-treatment class. Using one teacher with both classes was intended to minimize any bias that might be encountered from differing teacher styles.

In late September 2015, students in both the non-treatment ($N=15$) and treatment ($N=9$) classrooms were asked to complete attitudinal surveys related to biology motivation and environmental perspective. The students also took a marsh ecology vocabulary quiz to determine any prior knowledge of the topics. Throughout the ensuing month of introductory biology the students were taught the standard academy-prescribed ecology curriculum that overlapped with the intervention period. The data collection methods are described in greater detail in the next section.

On October 6, 2015, the treatment group went into the field and recorded data on the vegetation growing along one transect. Using a dichotomous key, they identified plant species in one-meter increments for a total of 60 vegetation data points. Students were assigned to groups so that each group was responsible for a 20 meter section of that transect. In this way, the groups had to compile data with other groups to formulate a vegetation profile of the marsh. On October 20, 2015 the treatment group returned to the field and measured soil salinity, using a refractometer, in each well for a total of nine salinity data points. Field methods for this work can be seen in Appendix B.

Non-treatment students participated in the normal semester curriculum and did not perform the fieldwork. They completed approximately the same amount of class work as the treatment class and all grades were recorded. On October 28, 2015 both groups of students took attitudinal surveys again along with another marsh vocabulary quiz. The pre- and post-tests were therefore spaced approximately two weeks before and after the start of the intervention.

This study site was developed so that each subsequent freshmen class will add to the data compiled by the previous years' students, thus building a long-term picture of marsh vegetation and sea level on campus, and handing down valuable advice, e.g. how to stay dry. The data was archived on the Mass Audubon website for public dissemination and to allow future classes to refer back to the previous class data.

Data Collection

Recent history has expanded on much of the earlier works mentioned in the Conceptual Framework, and the study of human development has been applied to the learning of students in the classroom, laboratory, and afield (Ebenezer & Zoller, 1993;

Doran, Chan, Pinchas, & Lenhardt, 2002; Lisowski & Disinger, 1991). Various techniques, including assessment instruments, have been devised and tested in an attempt to quantify and qualify the variables that promote effective learning of science content and literacy. These variables can include field (outdoor) experience as opposed to traditional (indoor) classroom science. This project specifically addressed fieldwork as it pertained to student motivation, achievement, and environmental perception in high school introductory biology. As stated previously in this paper, an intervention was used to answer three research questions, which can be seen below in Table 1, with the instruments used to address them. Use of instruments, which are discussed below, was not exclusive to individual questions and data sets were used for multiple questions.

Table 1
Data Triangulation Matrix

Research Question	Data Collection Method		
	1	2	3
Does participation in field research affect the motivation of freshmen students in the study of biology?	BMQ-II	Student Short Answer Questions	Teacher Feedback
Does participation in field research affect student achievement in biology?	Vocabulary Quiz Scores	Quarter Grades	Secondary School Achievement Test Scores
Does participation in field research affect student environmental perception?	TEQ	Student Short Answer Questions	Teacher Feedback

Formative instruments are often ungraded and used throughout a unit to assess the effectiveness of teaching and learning while summative assessment usually occurs at the end of a unit or course being taught (Angelo & Cross, 1993). The first and last research questions were formative in nature and were explored with attitudinal surveys and teacher

and student notes while the other question was summative, using graded assessments as evidence. Collecting both types of data made analysis more complex but allowed the research questions to be analyzed from varied perspectives.

Instruments

Building on the work of Bandura (1977; 2006), others have developed what they consider a valid formative assessment tool to measure the efficacy and motivation of college and high school science students. The Science Motivation Questionnaire II was written to assess five student areas of motivation: intrinsic motivation, grade and career motivation, self-determination, and self-efficacy, which, when combined allow for a multifaceted view of student motivation.

Intrinsic or internal motivation is the desire of students to learn science for its own sake. Extrinsic or external motivation is the degree to which students think learning science will affect a grade or career path. Self-determination describes the amount of control students believe they have over their own learning. Self-efficacy is student belief in personal ability to achieve in science (Glynn, Brickman, Armstrong, & Taasoobshirazi, 2011). When studying biology students specifically, the authors of the instrument suggest replacing the word “science” with “biology” so as to be more specific to the nature of the class work. The title was thus adapted to Biology Motivational Questionnaire II (BMQ-II) and can be seen in Appendix C. By citing the authors of the instrument they have granted its free use in this study.

The Environment Questionnaire (TEQ) continued the vast work of Bogner, Wilhelm, and Wiseman (Bogner, 1998; Bogner & Wilhelm, 1996; Bogner & Wiseman, 2006) to assess whether student perception of the environment changes as a result of an

educational intervention (Johnson & Manoli, 2011). Through a process of refinement, the authors were able to create a valid indicator and model to describe the environmental attitude of students. The instrument they developed is explained below. Use of TEQ (Appendix D) was granted via electronic communication with the primary author Bruce Johnson on September 1, 2015.

Two factors were measured with TEQ: *preservation*, related to the desire to conserve the environment and *utilization*, described as human entitlement to manipulate the environment freely. The model holds that preservation and utilization are “uncorrelated” (Johnson & Manoli, 2008, p. 116) rather than binary on either end of a spectrum. For example, a high preservation score and low utilization score would describe an “environmentalist” while opposite scores might describe an individual who believes that the environment is made of natural resources to be exploited. This two dimensional model was used to see whether student scores moved on either the preservation or utilization axes as a result of the intervention.

The BMQ-II and TEQ were administered to the two freshmen classes, treatment and non-treatment, as a pre-test and post-test. The instruments were Likert type surveys and responses were scored based on an ordinal rank. BMQ-II statements were designed to observe the frequency with which students felt a certain way. Increasing frequency was given an increasing number score. The five response choices on were scored as: never (0), rarely (1), sometimes (2), often (3), and always (4). The TEQ statements were designed to signify attitudes along a spectrum of agreement. Responses received higher scores when student beliefs aligned with statement agreement. These scoring options were: strongly disagree (1), disagree (2), not sure (3), agree (4), and strongly agree (5).

In addition to the surveys, vocabulary quiz, quarter grades, and standardized test scores were used to gain achievement information on the students. When applying to a private secondary school most students are required to take the Secondary School Achievement Test (SSAT). This test, along with other factors, allows schools to identify desirable students and to make admissions decisions accordingly. The SSAT scores for the students in both groups were examined and compared to establish an academic baseline. This allowed for any differences in student academic ability to be assessed prior to interaction with the Governor's Academy, Mr. Lefebvre, or the intervention. Quarter grades included classroom assessments over the course of the study period. Each class, treatment and non-treatment, had at least one test, one laboratory, and two homework assignments graded both before and after the intervention. The vocabulary quizzes (Appendix E) were used to assess student acquisition of relevant knowledge as a result of the intervention.

Students in the treatment group were asked to answer two questions in the form of a Minute Paper (Angelo & Cross, 1993) after the intervention. These were:

1. What was the best part of learning out in the marsh?
2. What was the worst part of learning out in the marsh?

These responses were used to find major themes that supported or refuted any significant findings from the surveys and grades. The non-treatment class was not administered the Minute Paper because they had no awareness of the intervention; knowledge of which may have negatively impacted survey and grade results. Once preliminary information was gathered, the general findings were presented to the teacher for analysis. Teacher

feedback was vital to qualitatively explain differences between the two classes, especially during pre- and post-test periods.

These methods painted a picture of how students reacted cognitively when exposed to an authentic scientific endeavor. Subsequently, comparison of student motivation and understanding was assessed both before and after the variable (intervention) was introduced. With this in mind it was the intent of this paper to make clear the differences, if any, which occurred as a result of this process.

As a side note, it was shown that student results in web-based surveys are not significantly different from those that are paper based (Carini, Hayek, Kuh, Kennedy, & Ouimet, 2003). Due to the author's inability to attend class sessions, this study used a web based survey method. The website Survey Monkey (www.surveymonkey.com) offered custom questionnaire formats that collected results online and allowed for statistical analysis of those results. With the aid of this site, students reported instrument answers online to be compiled and analyzed at a later time. The nature of this collection method also allowed for the results to be submitted anonymously. This was in line with the project status as educational research according to the Montana State University Institutional Review Board (Appendix H).

Analysis

Formative evaluations, those used for learning assessment, differ from the summative types that are meant to determine grades. The formative data in this study, when quantitative, were ordinal and responses were not considered equidistant in scoring. Therefore it was appropriate to analyze data by rank. While some argue that validated Likert scales can be examined as interval data with parametric tests (Lovelace &

Brickman, 2013), there were many arguments against this technique. Most importantly, the sample size for this study was very small ($N \leq 15$ for each group), which suggested the use of exact rank tests modified to handle ties (Mundry & Fischer, 1998; Siegel & Castellan, 1988).

Asymptotic probability values were calculated rather than exact ones due to the capabilities of the statistical software used, which may have produced minor hypothesis errors when associated with the small sample sizes. Significance for all statistical tests was set at a $p \leq 0.05$ calculated probability value. Effect size was estimated using nonparametric methods (Hedges & Olkin, 1983; Kraemer & Andrews, 1982) for tests with significant findings to validate that statistical significance correlated to an actual effect on one group versus another. Since N values were so small the 95% confidence interval (Coe, 2002) was calculated for effect size to assess the validity of significance claims.

Osborne et al. (2003), referring to the pitfalls of measuring student attitudes quantitatively, subsequently concluded, "In the case of school science, this points to the need to move away from general quantitative measures of attitude constructs" (p. 1055). The major issue here is that student attitude is a matter of individual perception and so is self-fulfilling, however the questionnaires involved are assuming this subjective information is objective. "That is, a student with positive attitudes towards science may have believed that independent inquiry occurred more frequently while a student with negative attitudes may have believed that they occurred less frequently" (Ornstein, 2006, p. 294).

To correct for these potential biases and corroborate quantitative methods, qualitative data were examined from the students and teacher for major themes and arguments supporting or refuting the results. It was therefore deemed erroneous to calculate interval statistical analysis on this type of data since it was not interval in nature and because of the inherent subjectivity involved. The ordinal, or nonparametric, tests discussed below were used to determine differences between the pre- and post-test groups when analyzing the responses. This longitudinal pairwise comparison reduced the aforementioned bias by measuring the degree of change in student attitudes for both a treatment and non-treatment group.

In this paper, BMQ-II and TEQ responses from before and after incorporation of the field research (intervention) were treated as matched sets and analyzed using a statistical analysis program (Statview). One student transferred from the treatment group to the non-treatment group prior to the intervention. Since this changed the N value for the pre- and post-test groups, the analysis had to be performed on the average survey question scores rather than the average student scores for each class. Each survey had the same number of questions during pre- and post-test, therefore the modified Wilcoxon signed rank test (Wilcoxon, 1945) was used to determine whether the pre-test and post-test survey scores were equal in terms of central tendency for each class. Nonparametric approximations of effect size (Hedges & Olkin, 1983) were calculated for tests with significant results to determine the degree of change observed between the two groups as a result of the intervention.

Summative figures, those that are used to define a grade for each student compared to peers in the same class or a larger group, were analyzed to look for major

differences between the treatment and non-treatment group. These scores are interval rather than ordinal and need not be evaluated based on rank. However, to say that a student with a test score of 80 knows twice as much as another with a score of 40 is not necessarily true so the data were treated as ordinal. Thus, the statistical analyses used for the survey data were also used with achievement results. The analysis for each summative data set is described below.

Achievement data were analyzed in two different ways to see if any change had occurred; first, for score movement and second, the significance related to this. The SSAT scores for each class were first compared graphically as boxplots then compared using the Mann-Whitney U test (Wilcoxon, 1945). The difference of the quarter grades was calculated for both classes and the independent comparison was done with the Mann-Whitney U . Since some of the concepts that students saw during this unit were new, it was assumed that many of them would guess at the quiz answers; thus normalized gain was calculated, a measure which has been shown to be unaffected by random answers (Hake, 1998). The Mann-Whitney U test was also calculated based on the difference in vocabulary quiz scores from pre-test to post-test.

Student responses were sorted by common words or themes and used to further validate the quantitative methods. The nature and frequency of these themes allowed for comparison with attitudinal results and grades to identify if statistical trends were supported by self-reported ones. The student data results were summarized at the end of the intervention and given to the teacher for consideration. This was done in order to verify accurate reflection of student beliefs, assess the validity of the pairwise

comparison results, and check the interpretation of academic skills between the treatment and non-treatment classes.

Each of the three research questions listed previously in Table 1 had three data sets collected in order to gain a robust understanding of the intervention results. The data and analysis of the themes for these three questions; motivation, achievement, and environmental perspective will be discussed further below. The summary statistics for all survey instruments and grades are included in Appendix F. Student responses and teacher feedback are quoted in the analysis and are used to support or refute the statistical findings.

DATA AND ANALYSIS

Motivation

Student motivation was measured by subset using the BMQ-II (Glynn, Brickman, Armstrong, & Taasoobshirazi, 2011). Table 2 shows the results of the score analyses. While the two groups, when measured independently, showed no significant difference in scores, there were two subsets that did have a significant change in the treatment group. The treatment group had large gains in career motivation ($p=0.0431$) and intrinsic motivation ($p=0.0431$). Career motivation is extrinsic or related to receiving a reward for accomplishment. Intrinsic motivation is the joy received simply by taking part in a task; science for science's sake. Validation tests have shown that the two motivations are uniquely related (Glynn, Brickman, Armstrong, & Taasoobshirazi, 2011).

Table 2.
Statistical Results of the Biology Motivation Questionnaire (BMQ-II)

Category	Wilcoxon Signed-Rank Test		Effect Size	Confidence Interval	Confidence Interval*
	Non-Treatment	Treatment			
	<i>p</i> -value	<i>p</i> -value	--	--	--
Career motivation	0.0796	0.0431	0.32	-0.93 to 1.56	-0.10 to 0.73
Grade motivation	0.1441	0.5002	--	--	--
Intrinsic motivation	0.8539	0.0431	0.65	-0.66 to 1.95	0.21 to 1.08
Self-determination	0.3452	0.5002	--	--	--
Self-efficacy	0.0679	0.2249	--	--	--

Note. * Calculated with *N* values from student data rather than question data; **bold**, indicates significant result

Students who view science as fun and interesting may also enjoy the reward of its pursuit later in life. These two motivations exhibit mutual reinforcement and can be seen in Figure 1. The non-treatment group perhaps understood the value of a scientific career, however without the intrinsic desire to pursue biology on its own ($p=0.8539$) the strength of the relationship seemed to break down. Non-treatment career motivation gains were similar to the treatment group, however non-treatment gains were not significant ($p=0.0796$). The non-treatment group also exhibited decreases in grade motivation, self-determination, and self-efficacy but none significant. Figure 1 shows the change in subsets for each group.

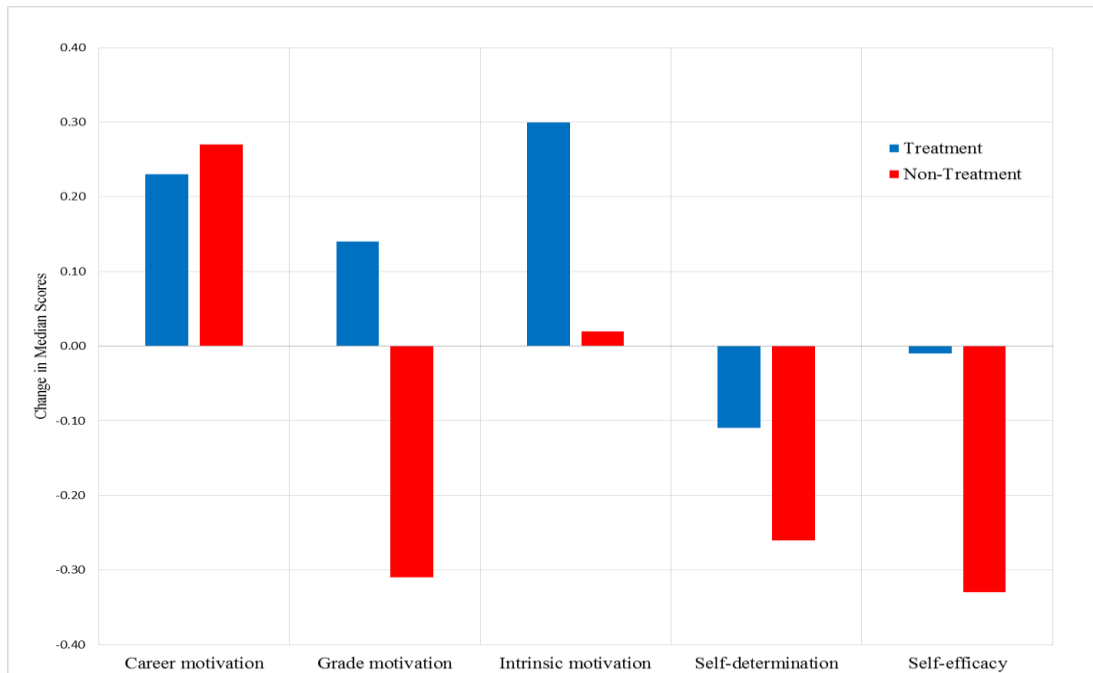


Figure 1. Difference in BMQ-II Scores.

Based on the effect sizes, the treatment score increases were 0.32 and 0.65 standard deviations (career and intrinsic motivation, respectively) above those of the non-treatment group. When the change from pre- to post-test is looked at in a different way, 62% of non-treatment students fell below the average treatment student in career motivation and 76% in intrinsic motivation. This would suggest that the significance seen as a result of the intervention had an actual positive effect on the treatment group.

However, the 95% confidence interval for both categories includes values below zero. This means, with such a small sample size, that the results are inconclusive and the p -value is erroneous. Since confidence increases as sample size increases it is possible to calculate the confidence intervals based on the average student, the initial intent of the analyses, rather than the average question response. Recalculating in this way yields a

positive confidence interval for intrinsic motivation and suggests that the significant increase in these scores is real.

The gains by the treatment group were corroborated by the teacher, “[The treatment class] is one of the stronger freshman classes I have ever had – motivated, upbeat, and very inquisitive.” He goes further and contrasts, “[The non-treatment class] is just the opposite – rather apathetic, disengaged, and quiet” (M. Lefebvre, personal communication, March 3, 2016). Mann-Whitney *U* test results showed no statistically significant difference between the two classes before or after the intervention. Wilcoxon signed rank test results showed a significant increase in career and intrinsic motivation for the treatment class. Both of these significant results showed positive effect sizes and, although the confidence interval rendered the results inconclusive, the teacher agreed that the treatment group was more motivated than the non-treatment group.

Student responses showed a major theme related to what students thought was the best part of the intervention. The most common (frequency) descriptive words stated by the treatment group when asked what they enjoyed most about field work were “hands on” (3), “plants” (3), and “outside” (2). Three less common words in the responses can be combined into a composite sentence that shows this greater theme: “The ‘experience’ of field work allowed the students to ‘apply’ what they learned in class while ‘interacting’ with the campus environment. This points to an experience that treatment students found as both enjoyable and useful and may account for increased biology motivation.

When the quantitative and qualitative data sets are combined it suggests that the treatment class may have become more motivated to learn biology as a result of experiencing field work in the salt water marsh adjacent to the academy. This is

supported by attitudinal survey analysis, teacher input, and the general theme of student responses. The students certainly exhibited positive gains, and made positive comments that refer to the intervention as beneficial. The negative responses will be discussed further with environmental perception.

Achievement

The vocabulary quizzes administered to students of both groups were analyzed using normalized gain. Normalized gain is the post-test quiz scores calculated as a ratio of the possible points to be gained after taking the pre-test (Hake, 1998). Average vocabulary quiz scores are shown in Figure 2. The treatment group had a normalized gain of 0.5 and the non-treatment group had a gain of 0.4, which is very similar. Since this calculation is used to minimize the effect of guessing at answers, the treatment group showed only minimal gains when compared to the non-treatment group. The treatment group had higher vocabulary gains on average, though these differences were not significantly different ($p=0.4523$).

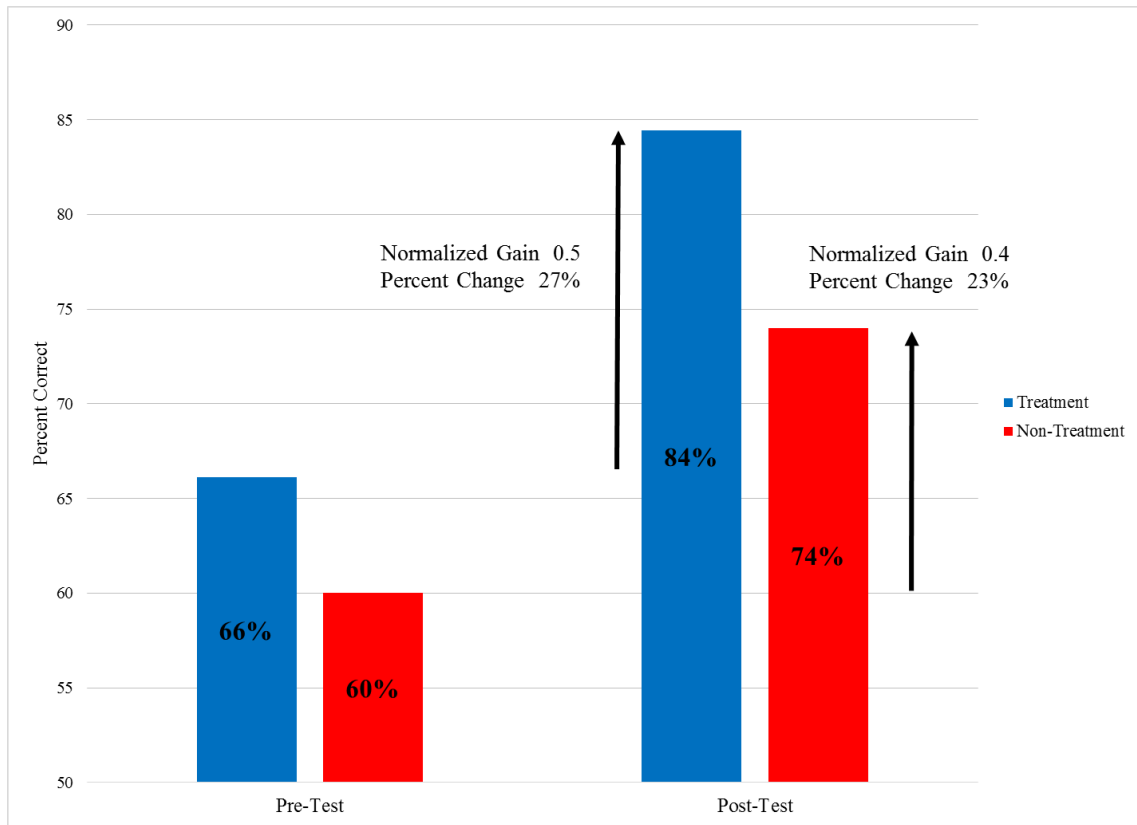


Figure 2. Vocabulary Quiz Score by Class, (N=24).

Quarter grades were analyzed to look for a difference in overall achievement during the four months that the intervention took place. Figure 3 shows the results of the pre-test and post-test grades. By using the weighted grades administered by the teacher to remove bias by the author, the percent change of the average class grades was calculated. Both classes had modest changes in grades after the intervention; the non-treatment group had a slight increase and the treatment group a slight decrease. The difference in quarter scores were not significant ($p=0.4592$).

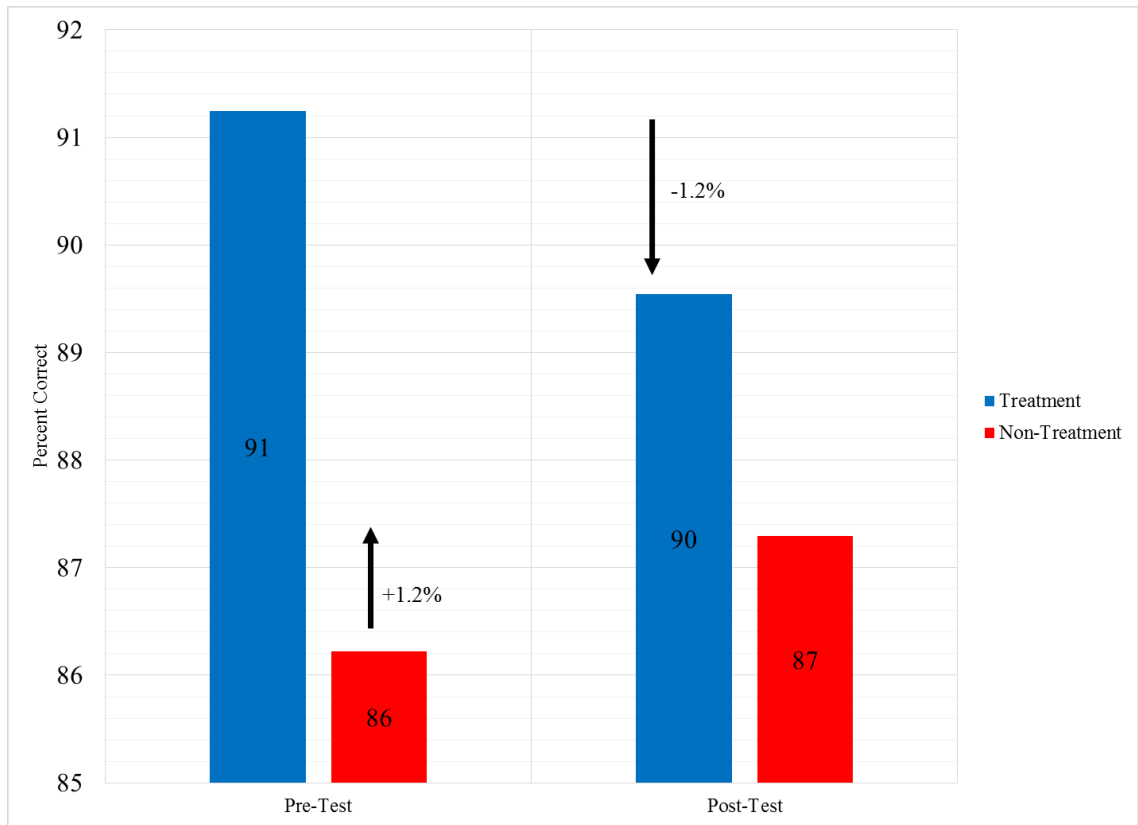


Figure 3. Average quarter grades by class.

The teacher explained that the treatment group seemed stronger to begin with, as exhibited by the higher pre-test grades. He stated, “I’ve been able to pull more out of [the non-treatment class] as the months go by, but the early months proved challenging. Hence, grades for [the treatment class] would be higher than the ones for [the non-treatment class] regardless of setting” (M. Lefebvre, personal communication, March 3, 2016).

The summative data sets suggest slightly higher grades for the treatment group over the non-treatment group and this is perhaps a result of, as the teacher suggests, the treatment group having stronger academic skills. The SSAT was taken only once by each group of students and so they were compared as independent groups using the Mann-

Whitney U . Figure 4 shows the quartiles for each group as a box plot. The intent of this analysis was to validate whether the treatment group was indeed stronger academically prior to not just the intervention but any interaction with high school science in general.

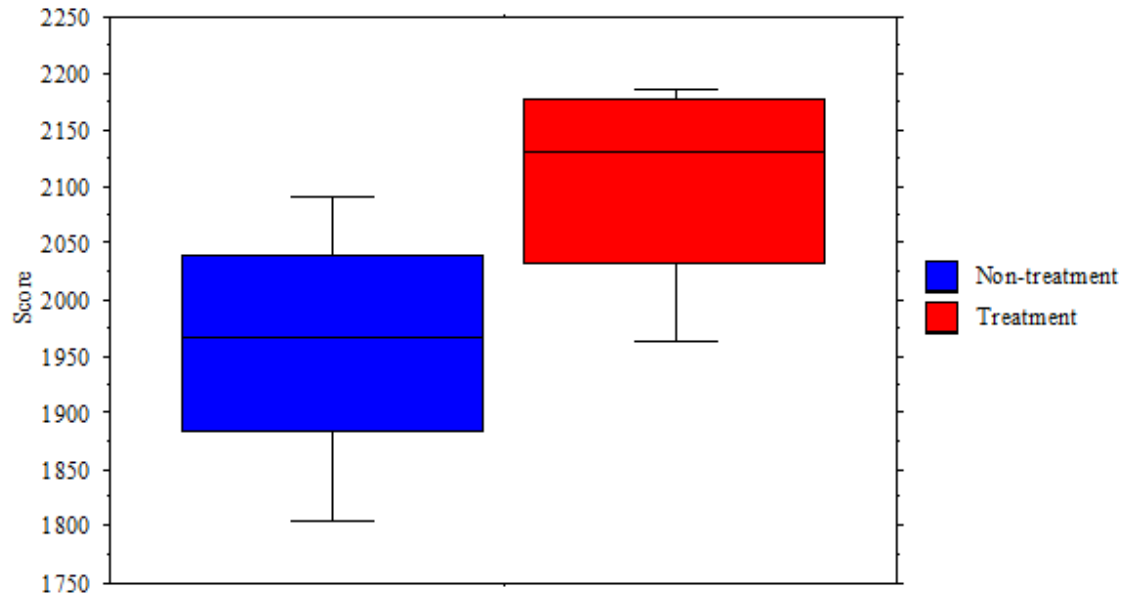


Figure 4. Boxplot of SSAT Scores by Class.

The treatment group was found to have much higher ($p = 0.0184$) SSAT scores when compared to the non-treatment group, as the graph suggests. The effect size of the difference was 0.48 and the 95% confidence interval is above zero so this difference was considered significant. The SSAT trend existed prior to entry into high school and seems to be consistent across both the quarter and vocabulary grades. The treatment group showed a higher level of achievement in general but, other than SSAT scores, none of the grades were significantly different. It cannot be stated whether the intervention affected achievement.

Environmental Perspective

Preservation and utilization scores were tabulated and the results were plotted across two axes to observe the movement of the groups across the four quadrants described by Johnson & Manoli (2008). Figure 5 shows the pre-and post-test scores for each group with the medians denoted by larger markers. The median score of the treatment group moved further in the direction of the quadrant expected of an “environmentalist” sentiment. The non-treatment group median moved from an almost “apathetic” attitude towards a more “mixed” or centralist one.

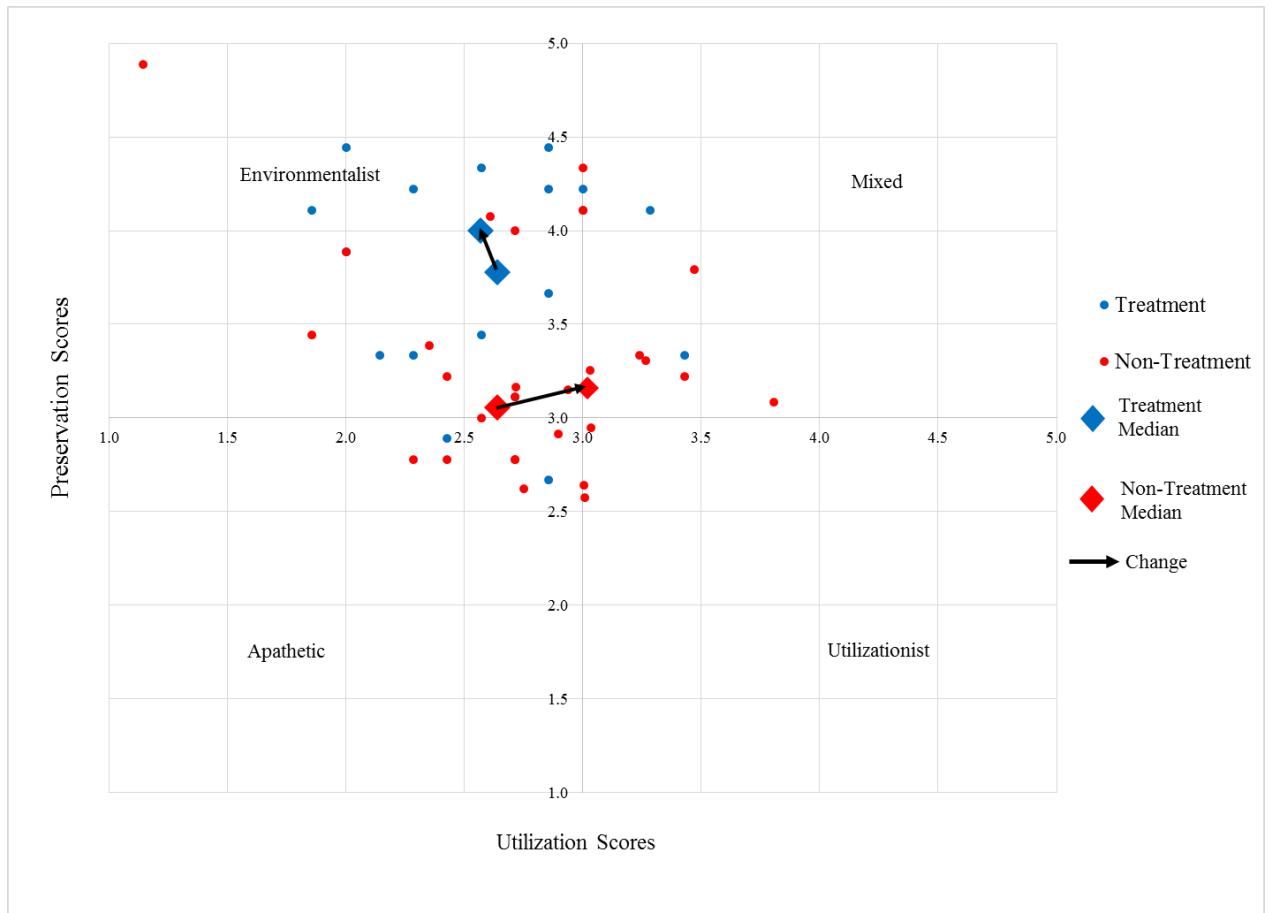


Figure 5. Results of The Environment Questionnaire (TEQ).

Note. Larger diamonds denote median value for each group. Arrows represent the direction of median score changes due to intervention

These shifts in environmental perspective were not shown to be significant from the use of nonparametric tests (Table 3). The groups showed no difference when tested independently against one another or pairwise within each group as a result of the intervention. If the goal of the intervention was to foster a more environmental perspective then this was achieved for the treatment group, since the two groups were not significantly different in preservation or utilization ($p=0.1311$ and 0.4808 , respectively) prior to the intervention. However, it cannot be stated that either group showed a significant change in environmental perspective according to the pairwise comparisons.

Table 3.

Statistical Results of the Environment Questionnaire (TEQ)

	Wilcoxon Rank Sum Test (Treatment vs. Non-Treatment)		Wilcoxon Signed-Rank Test (Pre-Test vs. Post-Test)	
	Pre-Test	Post-Test	Treatment	Non-Treatment
Category	<i>p</i> -value	<i>p</i> -value	<i>p</i> -value	<i>p</i> -value
Preservation	0.1311	0.3081	0.5745	0.3963
Utilization	0.4808	0.6540	0.1724	0.1441

The teacher again supported these findings, “There seems to be very little difference in the environmental attitudes of the two classes.” He goes on to attribute, “This lack of awareness or appreciation stems from their limited exposure to the environmental sciences to date” (M. Lefebvre, personal communication, March 3, 2016). His explanation of this phenomenon is that “students relate field work simply as something different than class time, rather than having any environmental importance.” Student responses from the motivational analysis refute some of this argument as one student stated that they felt “like what I was doing was important.” The teacher did

mention however that “there are a few students in both [groups] who strike me as a bit more environmentally conscious.”

Student responses on the whole followed one major theme that goes to the heart of experiential learning. The most common phrases (frequency) when describing the worst part about learning in the field was “muddy” (3). This was followed by “wet” (2) with minor phrases such as “dirty”(1), “squishy” (1), “gross” (1) and of course the “smell” (1). While this theme seemed to have a negative connotation, it may have been far outweighed by the motivational gains. The teacher again summed it up aptly with, “Yes, they saw the marsh as an inhospitable environment (and it was raining most days), but they didn’t seem to care.” The movement of the non-treatment group scores from apathetic towards the center suggests that perhaps field work is what they need in order to bring ideas about the environment from the abstract into the tangible realm.

INTERPRETATION AND CONCLUSION

Students in the treatment group showed a marked increase in both intrinsic and career biology motivation. Intrinsic motivation, especially, showed significant gains and a large effect size over the non-treatment group (Table 2). Had the confidence intervals been calculated with the student sample sizes and, most importantly, had the motivation patterns stayed consistent, then the effect sizes would accurately reflect that intrinsic motivation showed actual significant gains.

Reduced drops in self-determination and efficacy suggest that the treatment group, buoyed by outdoor, experiential field work, was able to relate to the study of biology in a much more enjoyable way than the non-treatment group. The non-treatment students shared the career motivation sentiment to a lesser degree but had almost no

increase in intrinsic motivation. It appears that the non-treatment group did not enjoy biology class, which is also corroborated by the large drops in grade motivation, self-determination, and efficacy. The non-treatment group was faced with the sense of having little control over the learning of biology and little belief that they could achieve well.

Achievement results were inconclusive. The treatment class did not show a greater increase in grades than the non-treatment class. This is attributed to the limited scope of the field work and the small sample size of the two classes. Two days of experiential learning, without a broader connection to the quarter wide curriculum, is not reason to expect a significant increase in academic achievement. The trends in vocabulary and quarter grades correlate with the higher SSAT scores for treatment students. Perhaps achievement would have increased for the lower level non-treatment class if they had also taken part in the intervention. This is of course speculation but presents opportunity for action research related to this intervention.

The environmental results were statistically inconclusive, however this shed light on one major implication. The treatment group enjoyed themselves and had minor environmental gains but it is believed that they had actual intrinsic motivation gains. There was no difference between teaching methods when comparing the effects on grades and environmental perspective, suggesting that staying in the classroom is no different than going outside. If looking at these two factors alone, the argument could be spun either way; staying in the classroom is the same as going outside.

However, in terms of motivation it appears that, with a larger sample size, field work has a significant effect on student enjoyment of science. Since this intrinsic increase has been correlated to career motivation it provides a strong argument to make use of the

immense natural classroom that the Governor's Academy campus affords. And as Behrendt & Franklin remind us, "Campus field trips provide a cost-free alternative, while retaining the benefits of traditional field trips" (2014, p. 242). When the geographic proximity and local significance of salt marsh preservation is considered, there is a strong argument that outdoor classroom activities in the marsh are worth pursuing.

In the best case scenario, students showed statistically strong growth in specific types of biology motivation. As cited in previous literature this motivational growth can have reinforcing effects and produce stronger students. Denying early high school biology students the ability to foster an enjoyment of science through realistic fieldwork may cause irreparable motivational harm. If the best we can do is improve student motivation in the sciences and the worst we can do is no harm at all, then this paper makes a very strong case for the incorporation of further field work in freshmen biology classes at the Governor's Academy.

VALUE

This intervention got to the heart of experiential learning, particularly in the outdoors, and created a powerful area of focus with dual measureable outcomes. Not only did the intervention catalog research data for future students but it also allowed for the collection of action research information for teachers and administrators. Part of the Governor's Academy Strategic Plan is to incorporate the Parker River estuary into curriculum and recreation activities. This paper addresses the feasibility of using the marsh surrounding campus within the context of introductory biology. By assessing student interaction, motivation, and achievement during experiential learning in the

estuary, this report gives the administration a tool to shape future strategy related to outdoor education.

There is a strong contingency of faculty and administrators who believe that a marine science program on campus is long overdue. One administrator referred to my study as “a foot in the door” and goes on to write that, “[w]e have been talking about developing outdoor classrooms...as a signature part of a program for [GA]...for 10 years. Enough already. Fish or cut bait.” These are strong words that speak volumes to the significance of my findings.

Another administrator wrote that this project supports the 7 Essential Skills of the academy, “To prepare students to be lifelong learners, responsible citizens, successful college students, and productive adults. To encourage students to embrace the joys, challenges, and rewards of a life of the mind and of a life guided by ethical considerations” (The Governor's Academy, 2015). By learning in and about the environment surrounding them, students surely have the opportunity to become successful pupils, citizens and adults. One value of my paper is that it informs the academy of the positive results that may abound for students if a curriculum is instituted along the Parker River on campus. These opportunities show concrete benefits related to student motivation and no losses in terms of grade retention or environmental perspective.

The infrastructure that the Academy envisions for the program (a boardwalk and outdoor classroom to prevent marsh damage) would surely benefit other programs. For example, the Art and English departments could study the use of landscapes and sense of place associated with the outdoor environment. The vision even goes so far as to

incorporate a summer marine science camp on the site using the same or similar curriculum. It is valuable to know that once the classroom door is opened, opportunities to motivate students spread out in all directions. Biology is the beginning, this paper allows for the Academy to decide the endpoint. Starting as a small farming school and growing for 250 years into a staple of the New England private school tradition, the Governor's Academy should certainly understand the value that the land on its campus holds for its students. This study has shown that its motivation to grow may continue yet.

The takeaway for other educators is that a sound field curriculum and support from administrators can lead to student motivational gains. This may foster a unique learning environment in which students and teachers perform long term, legitimate research together. The motivation of students can present a feedback loop in which teachers become motivated as well and both parties succeed at becoming avid learners together.

The year 2016 marks my 15th reunion from the Governor's Academy. This action research project is a direct result of the knowledge of and love for science instilled in me at the Academy. Collaborating with teachers who taught me and sharing new experiences with the students who have replaced me was truly rewarding. The results of this paper promote further salt marsh research on campus and to see this fulfilled would not only validate the practice of action research but also impart me with a sense of appreciation. Coming full circle as student, teacher, researcher, and back to student has shown me the benefits of this process and I hope that it continues to benefit future students of the Governor's Academy.

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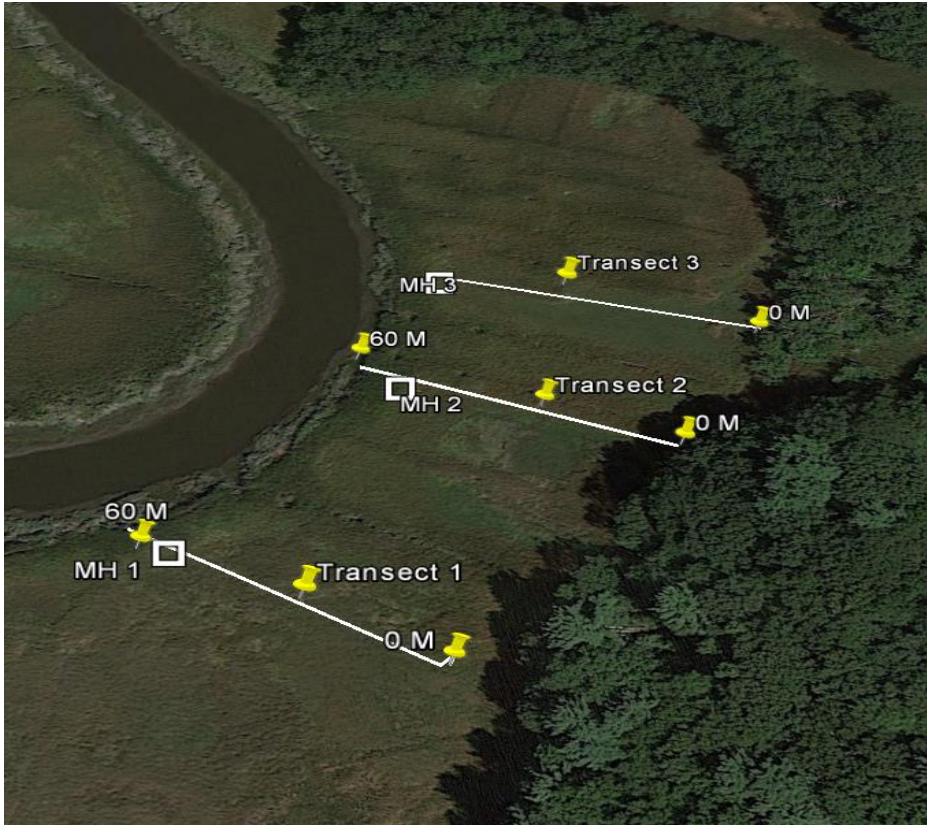
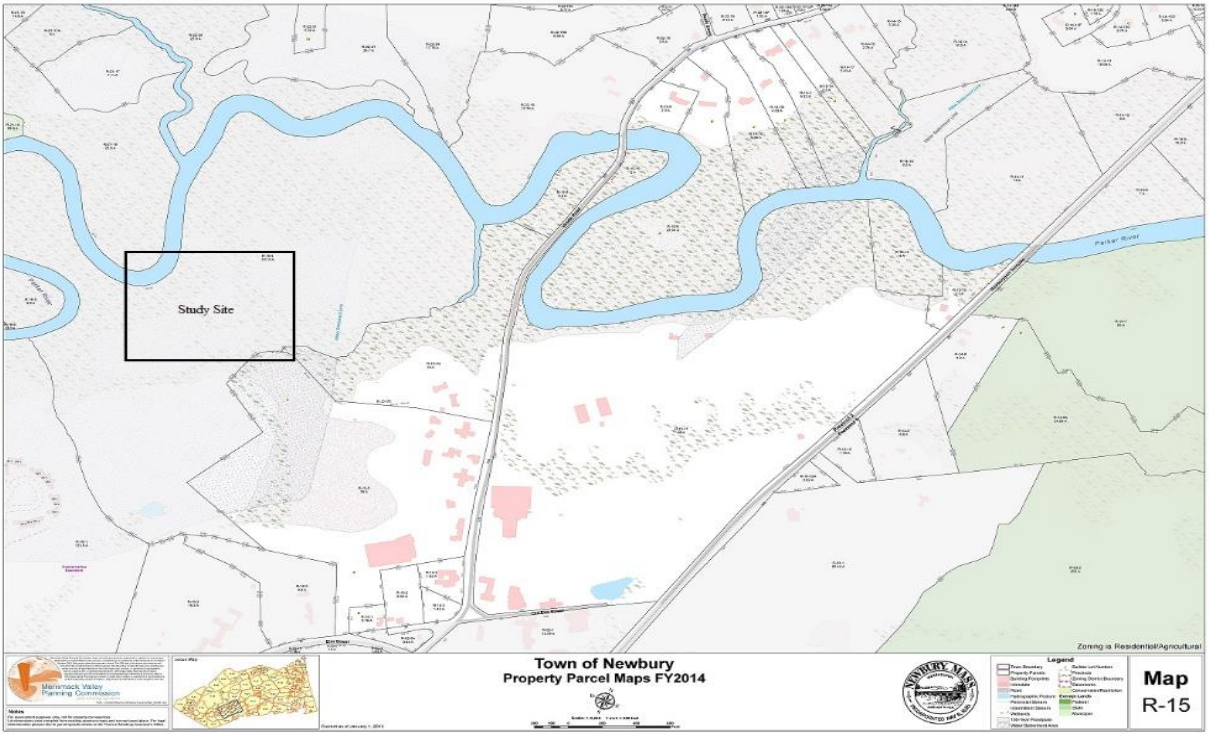
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APPENDICES

APPENDIX A

MAP OF STUDY SITE AND TRANSECTS



APPENDIX B

LONG TERM SALT MARSH STUDY FIELD METHODS

Long Term Salt Marsh Study Field Methods

(Adapted from *Salt Marsh Science: An inquiry based seasonal science study* by Elizabeth Duff, Mass Audubon, 1998)

Goals

Students will learn the methods they will use in the field:

1. Use of the refractometer: What is salinity?
2. What is a transect and how do you do them accurately?
3. What plants grow on a salt marsh? How does one use an identification key to identify plants?

Hypotheses

1. Rising sea level will increase the low marsh area, and decrease the high marsh area. Prediction: We expect this will mean more salt marsh cordgrass, and less salt marsh hay over time.
2. Salt marsh cordgrass (*Spartina alterniflora*) will grow taller, over time, in response to rising sea levels.
3. Rising sea level will lead to salt marsh migrating into areas that were previously upland. Prediction: Salt marsh vegetation will begin growing in areas currently forested, and trees and shrubs will die.

Timeframe

1. Seasonal
 - a. Vegetation data collected in September and October is most valuable. During this time, plants are at the end of their growing season. They are most easy to identify, as many have seed heads at that time.
 - b. The winter and spring are useful for data analysis, entry, and communication as well as planning additional projects. Equipment or transect issues can be addressed, such as fixing wells and markers.
2. Tidal
 - a. **Please check the tides when planning field trips.** Salinity data that is collected at a spring tide and at a neap tide is most valuable. A spring tide occurs around the time of the full moon and the new moon. Look to see where the tide heights are highest and plan the trip for that time. If not possible look for the neap tide, when tides are lowest and plan the trip then.
 - b. If possible, spring tides are a great time to mark the high water line with flags and take GPS coordinates. This data can be used later to measure sea level rise.

Field Research

1. Catalog vegetation types in the marsh from the upland tree line to the bank of the Parker River.
 - a. Install three 60 meter transects in the salt marsh perpendicular to the Parker River.
 - b. Record plant species in 1 meter intervals along each transect at least once per year.
 - c. Enter data in a master file for future use.
 - d. Upload data to Mass Audubon website.

2. Monitor groundwater salinity spatially and temporally in the marsh.
 - a. Install nine wells on each of three transects at various depths and distances from the Parker River.
 - b. Record salinity data for the water in those wells at least once per year.
 - c. Enter data in a master file for future use.
 - d. Upload data to Mass Audubon website.

Materials

1. Vegetation Survey
 - a. 100 meter tape measure
 - b. Meter stick – measure plant height
 - c. Vegetation Key
 - d. Data sheet
 - e. Pencil
 - f. Clipboard
 - g. (Ziplock bags - if bringing samples back for identification)
 - h. (Sharpie for labeling bags)

2. Groundwater Wells
 - a. 1-2 Refractometers
 - b. Distilled water – to calibrate zero salinity
 - c. 1-2 suction tubes
 - d. Data sheet
 - e. Clipboard
 - f. Pencil
 - g. Paper towels
 - h. Film canister or beaker

Classroom Preparation

1. Vegetation Survey (1-2 Class Periods)

- a. Explain that we are recording the vegetation growing along a transect, and students will be studying this over time to notice patterns of vegetation growth.
 - b. Explain how to do transects and practice in the classroom using books, pencils, paper, desks, and students, instead of vegetation. Using “Field Data Sheet for In-School Practice Transect” have students identify items along a transect.
 - c. Discuss the importance of minimizing impact on the salt marsh, particularly along the vegetation transect line. Ask: What would happen to the plants if we walk on them? What should we do to help minimize impact on the salt marsh.
 - d. Plan a study method that will maximize accuracy and minimize impact: Do not have more than 10 students standing in one area at one time. Have different students double check each meter on transect, to reassure accuracy.
 - e. Bring in samples of salt marsh plants to the classroom, and have students practice identifying them using the identification key, “Common Plants of the Salt Marsh Identification Key”.
2. Groundwater Wells (1 Class Period)
- a. Explain: What is salinity? (How salty the water is. Compare the word salt to salinity.)
 - b. Using the “How to use a Refractometer” sheet, explain how a refractometer works and how one is read. Show students that the scale reads from 0 at the bottom to 100 at the top. Using distilled water make sure that the refractometer is calibrated correctly. (Distilled water should read 0 ‰, otherwise adjust the knob.)
 - c. Salinity is measured in parts per thousand. Optional: Demonstrate this by using a mixture of salt and distilled water. Using 1 L (1000 mL) of distilled water ask the students how many grams of salt will be needed to make a 20 ‰ mixture. Show them a diagram of the inside of the refractometer and teach them to read from the right side of the refractometer.
 - d. Explain why we are measuring salinity: We think that it determines which plants can grow in different parts of the marsh. We think that *phragmites*

has trouble growing in highly salty water and prefers brackish water (fresh mixed with salt water.) We are measuring the salinity at different depths to see if salinity makes a difference to the plant species in the marsh.

Field Methods

1. Vegetation Survey (2 Class Periods)
 - a. Remind students of the importance of not trampling the vegetation along the transect line.
 - b. Remind students that the plant must be immediately below the measuring tape. If it is off to the side, it is not on the transect. This helps us collect **unbiased** data.
 - i. Roll out the measuring tape from the upland end of the transect to the other.
 - ii. Along each meter of the transect, students should identify and record what plants are present.
 - iii. Measure the tallest salt marsh cordgrass, *Phragmites*, cattail, and purple loosestrife in centimeters on each meter.
 - iv. Repeat this process on all transects.
2. Groundwater Wells (1 Class Period)
 - a. Ask students to think and make a prediction: Using “Salinity Field Data Sheet” ask, do you think the highest salinity will be in the shallow, medium, or deep well? Explain why. Measure salinity. Was the prediction correct? What might explain this?
 - b. Measure the salinity with the refractometer.
 - i. Record the site on the data sheet.
 - ii. Remove the cover from the well.
 - iii. Insert the tubing to the bottom of the well pipe.
 - iv. Place thumb over the end of tubing and remove water from well.
 - v. Put end of tubing into a film canister or beaker and release thumb.
 - vi. Insert a clean dropper into container and take a sample of water.
 - vii. Open the flap at the end of the refractometer and put on a drop of water.
 - viii. Close the flap tightly and, facing the light, look through the eyepiece.
 - ix. Look for faint line and take reading where the line intersects the right side measurement.

- x. Double check with someone else in your group and record the measurement on the data sheet if your numbers agree. (If they do not agree, take a new reading.)
- xi. Wipe off the refractometer with a towel after each use.

Class and Field Forms

1. Vegetation Survey
 - a. Field Data Sheet for In-School Practice Transect
 - b. Common Plants of the Salt Marsh Identification Key
 - c. Field Data Sheet for Vegetation Transect (0-30 meters)
 - d. Field Data Sheet for Vegetation Transect (30-60 meters)

2. Groundwater Wells
 - a. How to Use a Refractometer
 - b. Salinity Field Data Sheet

FIELD DATA SHEET For IN-SCHOOL PRACTICE TRANSECT

LOCATION _____ Date _____ Class _____

Weather _____

Names _____ Teacher(s) _____

Directions: In the section highlighted on your paper, identify the item immediately below the measuring tape. If the item is to the left or the right of the tape measure, it is not on the transect. If you have a question, ask! Record on the sheet P for present, when an item is present. If an "other" item is present, record the name of the item, and mark P for present.

Distance along line	Desk	Rug	Paper	Pencil	other	other	other	other
0 to 1 meters								
1 to 2								
2 to 3								
3 to 4								
4 to 5								
5 to 6								
6 to 7								
7 to 8								
8 to 9								
9 to 10								
10 to 11								
11 to 12								

Measure the tallest items along your transect area. What are they?

Name of item _____ Height _____

Name of item _____ Height _____

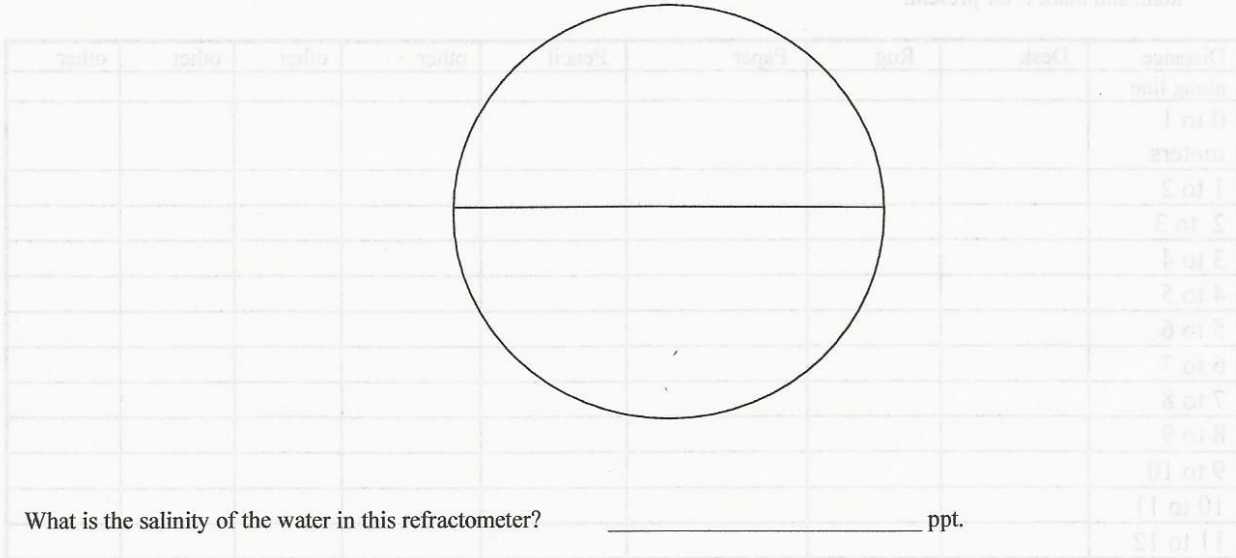
Individual Area surveyed: _____ meters .

How to use a Refractometer

salinity refractometer: An instrument for measuring how salty water is.

How refractometers work: “Refractometers are used to measure substances dissolved in water. The refractometer works using the principle of light refraction through liquids. As light passes from air into water it slows down, creating the phenomenon which gives a “bent” look to objects partially submerged in water. Simply put, the more dissolved solids in water, the slower light travels through it, and the more pronounced the “bending” effect on light. Refractometers use this principle to determine the amount of dissolved solids in water by passing light through a sample and showing the refracted angle on a scale displayed within the refractometer’s eyepiece.” (p. 268 Forestry Suppliers, Inc. Catalog 1997.)

Salinity scale: displaying gravity on the left scale, and Parts Per Thousand (ppt) ($^{\circ}/_{00}$) on the right scale.



Operating procedures:

1. Aim the front end of the refractometer toward a light source and rotate the eyepiece to obtain clearest focus.
2. Adjustment of the null (To calibrate your refractometer, so you know it is accurate, use distilled water, and adjust so it reads 0 ppt. Do this before you measure the salinity of other samples.
 - A. Open the cover plate, and clean the prism with a soft cloth to avoid scratching the surface.
 - B. Apply a few drops of pure distilled water on the prism platform.
 - C. Close cover plate.
 - D. Remove the rubber cap on the calibration screw and rotate the calibration screw so that the dark and light boundary line coincides exactly with the ‘0’ line on the ppt scale.
- 3.
3. Carefully dry the prism platform and cover and replace the rubber cap over the calibration screw.
4. Place a few drops of the test solution on the prism and close the cover plate so solution spreads evenly.
5. Aim the front end of the refractometer toward the light source and adjust the eyepiece for clearest focus of the boundary line between the light and dark hemispheres.

Precautions:

1. After use do not dip or run unit under water. Avoid letting water seep into internal section of refractometer.
2. Carefully clean the refractometer after each use with a soft cloth. Do not scratch prism surfaces.
3. Store unit in a dry, clean, and non-corrosive environment.
4. Avoid strong shocks.



Common Plants of the Salt Marsh Identification Key

By Elizabeth Duff

1997

Please note: not all salt marsh plants are included in this key.

You may want to adapt this key, as you find additional species on your site

1a Plant has long grasslike leaves. (Leaves grow straight to a point.)8

1b Leaves are not straight and grasslike, or plant does not have a recognizable leaf.....2

2a Plant is fleshy. (If you squeeze a leaf or segment, your fingers get wet from the stuff inside)3

2b Plant is not fleshy.4



Glasswort →

3a Plant does not have an obvious leaf.....Common Glasswort (*Salicornia europaea*)

3b Plant has numerous small leaves.....Sea blite (*Suaeda*)

4a Plant has a twig-like brown stem, and is a small shrub.....Marsh Elder (*Iva frutescens*)

4b Plant does not have a woody stem.....5



5a Leaves are triangular..... Orach (*Atriplex*)

5b Leaves are not triangular.....6

6a Plant grows straight with leaves growing along stem.....7



Lavender →

6b Leaves grow at the base of the plant. The top branches and grows many tiny lavender flowers.....Sea Lavender (*Limonium carolinianum*)

7a Plant grows single stem. Leaf is narrow, then widens, then narrows again to a rounded point. Plant grows golden yellow flowers in the fall.Seaside goldenrod
.....(*Solidago sempervirens*)

7b Stems are single or forked. Leaf is straight and narrow, tapering to a point. Plant grows purple daisy-shaped flowers in the fall Aster (*Aster*)



→

8a Plant stem is triangular. The plant grows flowers that resemble miniature pine cones.
.....Saltmarsh Bulrush (*Scirpus*)

8b Stem is not triangular.....9

9a Leaves grow only from the base of the plant.10

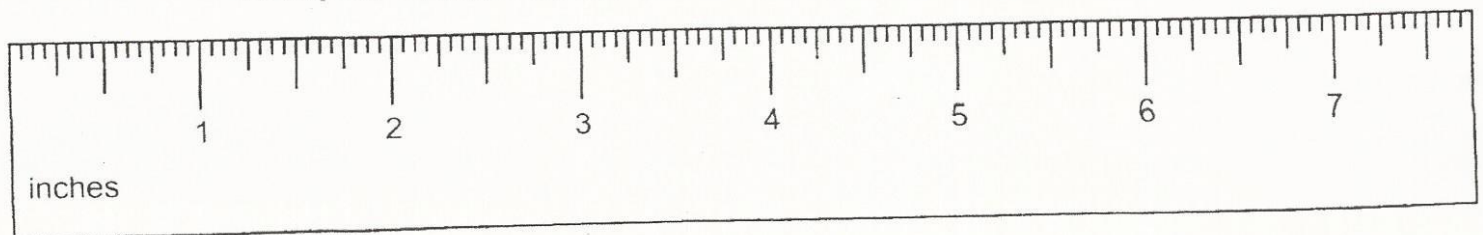
9b Leaves grow along the stem.....11



→

10a Leaf grows ¼ to ½ inch wide, and up to 6 feet high. Plant grows brown spikes at the top.....Narrow leaved cattail (*Typha angustifolia*)

10b Plant leaf is less than ¼ inch wide, and grows numerous small greenish flowers on a spike. Plant grows from 8-32 inches tall. Seaside Arrow Grass (*Triglochin maritimum*)



11a Plant has numerous leaves growing all the way up the stem.....12

* 11b Plant has few leaves (4 or less) and/or leaves grow only part way up the stem.....13

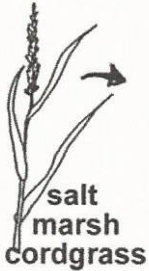
*Please note: Salt marsh hay may have more than 4 leaves, but the leaves are widely spaced.

12a Plant leaf is wide, greater than 1/2 inch. Stem is round and hollow. Plant grows a large silky plume at the top. Plant can be 6 1/2- 14 feet high... Phragmites (*Phragmites australis*)

12b Plant leaf is narrow. (Less than 1/8 inch.) Plant has many leaves growing in two directions, like a lot of V's on the stem. Leaves are light green, and can be flattened out.

..... Spikegrass (*Distichlis spicata*)

12c Plant leaf is about 1/4- 1/2 inch wide. Plant grows 1-8 feet high. Plant grows tall close to water. Leaves are dark green or yellowish green Leaves feel rough. Plant flower and seeds grow hugging the center of the plant. Saltmarsh cordgrass (*Spartina alterniflora*)



13a Plant stem is, solid, and round. Flower/seed pods are round, and form from the side of the stem, rather than at the very end.Black Grass (*Juncus gerardi*)



13b Live plant stem is generally green and jointed, Plant flower and seeds grow on the very end of the stem..... 14

14a Plant leaf is about 1/4- 1/2 inch wide. Plant grows 1-8 feet high. Plant grows tall close to water. Leaves are dark green or yellowish green Leaves feel rough. Plant flower and seeds grow hugging the center of the plant. Saltmarsh cordgrass (*Spartina alterniflora*)

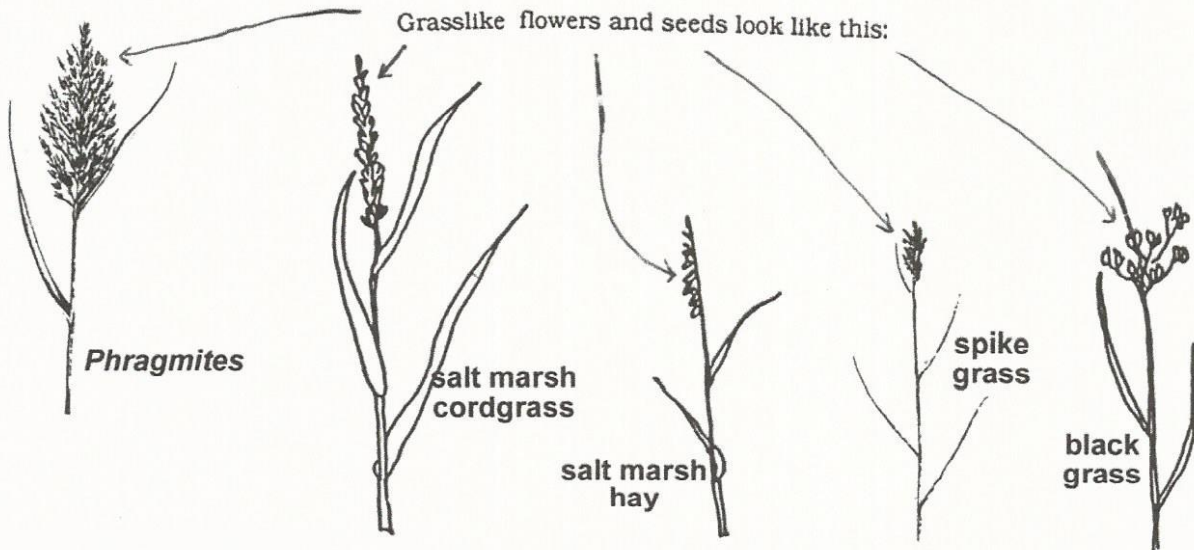
12b Leaf is extremely skinny (It looks like it might fit through a needle eye.) Its sides curve inward. Plant flower and seeds grow on one side of a stalk, (like the teeth on a comb.)

.....Saltmeadow cordgrass (*Spartina patens*)



Additional saltmarsh/brackish water plants not included in this key are: Purple loosestrife, marsh fern, silverweed, amaranth, and numerous upland grasses, and upland species.

Grasslike flowers and seeds look like this:





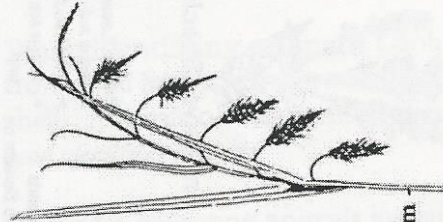
-Triangular Stem

Saltmarsh Sedge
Carex paleacea

- plant grows 1 - 3 feet tall
- grasslike leaves 1/10 - 1/3 inch wide
- seed heads look evenly spaced apart
- seed heads droop to one side

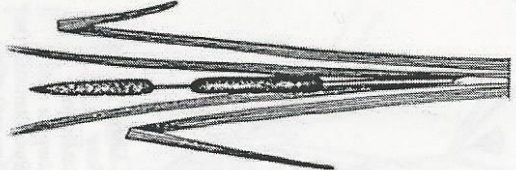
Saltmarsh Buirush
Scirpus robustus

- triangular stem
- leaves 1/2" wide



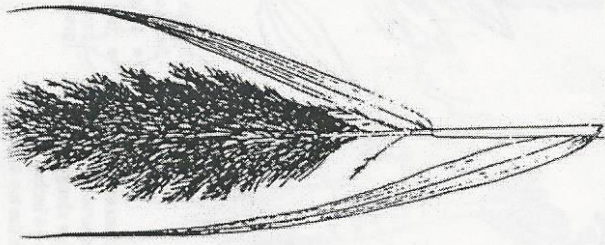
Freshwater Cordgrass
Spartina pectinata

- long leaves tapered to threadlike ends
- leaves 1/5" to 2/5" wide
- seed heads on short stalks and have bristles



Cattail
Typha angustifolia

- leaves grow from the base
- seed heads cigar like on the stem



Common Reed
Phragmites australis

- stems round and hollow
- silky, feathery seed heads at top of stem



Saltmeadow Cordgrass
Spartina patens

- very narrow leaves
- low spreading grass



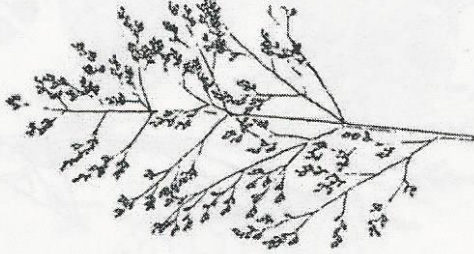
Spike Grass
Distichlis spicata

- leaf is narrow, less than 1/8 in.
- many leaves grow in two directions, looks like V's on stem



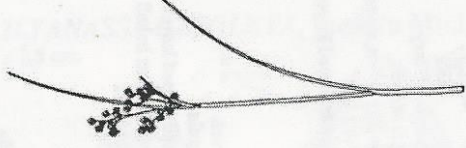
Creeping Bent Grass
Agrostis stolonifera

- low growing, creeping
- leaves 2 - 4" long



Switchgrass
Panicum virgatum

- grows in clumps
- seed heads grow on many branches near the top



Black Grass
Juncus gerardi

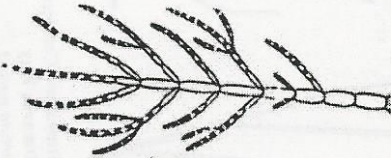
- grasslike, 8 - 24 inches tall
- one to two long leaves
- plant stem is solid and round
- flower/ seed pods are round, similar to peppercorns



Saltmarsh Arrowgrass
Triglochin maritimum

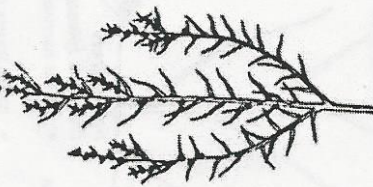
- leaves grow from the base
- leaves up to 20" long
- seeds grow on a spike

Brackish Marsh Plants (Not grasses)



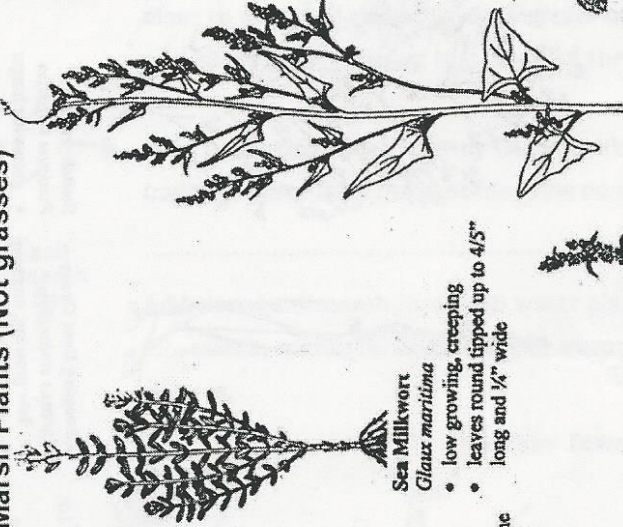
Glasswort
Salicornia europaea

- stems jointed
- fleshy
- fleshy leaves, flat on one side, rounded on other



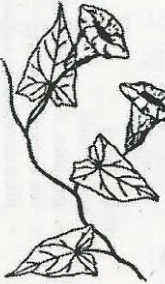
Sea Blite
Suaeda linearis

- fleshy
- fleshy leaves, flat on one side, rounded on other



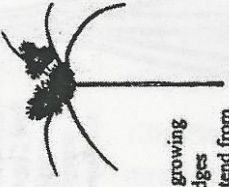
Sea Milkwort
Glaux maritima

- low growing, creeping
- leaves round tipped up to 4/5" long and 1/4" wide



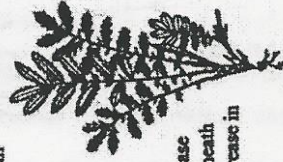
Wild Morning Glory
Calystegia sepium

- grows like a vine, up to 10 feet long
- triangular shaped leaves



Umbrella Sedge
Cyperus filicinus

- grass-like and low growing
- stems have three edges
- long thin leaves extend from bottom of flower



Silverweed
Potentilla egedii

- leaves grow from the base
- leaves silvery hairy beneath
- leaves toothed and increase in size toward the tip



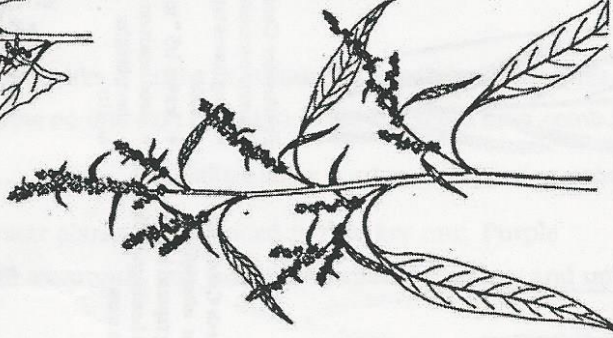
Marsh Elder
Iva frutescens

- is a small shrub
- leaves are opposite (grow in pairs)



Saltmarsh Aster
Aster subulatus

- daisy-like flowers
- leaves clasp the stem
- leaves grow alternately (not across from each other)



Water Hemp
Amaranthus cannabinus

- stem smooth
- tiny seeds grow along the stem on spikes



Purple Loosestrife
Lythrum salicaria

- candlestick flowers, purple
- leaves are heart shaped at one end



Smartweed
Polygonum punctatum

- stem jointed
- leaves taper at both ends
- small green or white flowers on spikes

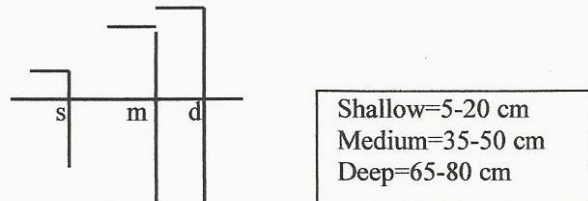
(Invasive Species)

Scaside Goldenrod
Solidago sempervirens

- leaves grow along the stem
- leaves 4 - 16 inches long
- flowers at the top of stem, yellow

SALINITY FIELD DATA SHEET

Date _____
 Location: _____
 Excel file name: _____ well.xls

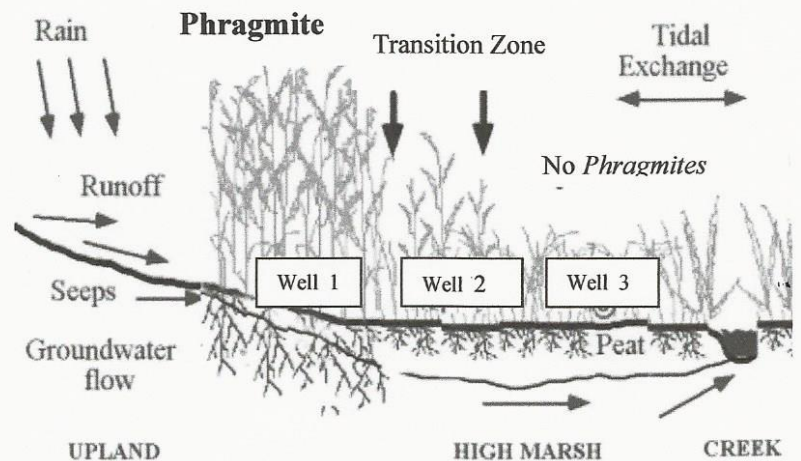


We do not know if shallow, medium, or deep water has the most impact on *Phragmites*. We are measuring salinities at different depths, and locations to see what impact it is having on the plant life.

1. Make predictions: Circle where do you think salinity will be greatest?
 Shallow Medium Deep
 Explain your prediction.

2. Wells are located at 3 different locations. (See Diagram.)
 Where do you think the greatest salinity levels will be found?
 (Circle one)

1. In the *Phragmites* 2. In the transition zone 3. In the salt marsh grasses, with no *Phragmites*
3. Explain your predictions: Why do you think so?



4. Measure salinity. Be sure to double check you are reading it accurately. Have members in your group double-check your answer.

Salinity:

Well	Transect 1		Transect 2
Well 1.1 (in <i>Phragmites</i>)	Shallow ____ Medium ____ Deep ____ Notes:	Well 1.2	Shallow ____ Medium ____ Deep ____ Notes:
Well 2.1 (transition)	Shallow ____ Medium ____ Deep ____ Notes:	2.2	Shallow ____ Medium ____ Deep ____ Notes:
Well 3.1 (No <i>Phragmites</i>)	Shallow ____ Medium ____ Deep ____ Notes:	3.2	Shallow ____ Medium ____ Deep ____ Notes:
Well 5.1 (No <i>Phragmites</i>)	Shallow ____ Medium ____ Deep ____ Notes:		
Well	Transect 3		
1.3	Shallow ____ Medium ____ Deep ____ Notes:		
2.3	Shallow ____ Medium ____ Deep ____ Notes:		
3.3	Shallow ____ Medium ____ Deep ____ Notes:		

Salinity: Background information.
 Salinity is how salty the water is. The saltier the water is, the higher the salinity. Most refractometers measure salinity in parts per thousand. Something that is 20 grams salt out of a total 1000 ml of water is written 20 ‰. We think that *Phragmites* has difficulty growing in high salinities (greater than 20 ‰) (20 ‰ is the same as 2 %.)

APPENDIX C

BIOLOGY MOTIVATION QUESTIONNAIRE – II

Science Motivation Questionnaire II (SMQ-II): Components

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In order to better understand what you think and how you feel about your science courses, please respond to each of the following statements from the perspective of “When I am in a science course...”

Components (Scales) and Statements (Items)	Never 0	Rarely 1	Sometimes 2	Often 3	Always 4
Intrinsic Motivation					
01. The science I learn is relevant to my life.					
03. Learning science is interesting.					
12. Learning science makes my life more meaningful.					
17. I am curious about discoveries in science.					
19. I enjoy learning science.					
Self-Efficacy					
09. I am confident I will do well on science tests.					
14. I am confident I will do well on science labs and projects.					
15. I believe I can master science knowledge and skills.					
18. I believe I can earn a grade of “A” in science.					
21. I am sure I can understand science.					
Self-Determination					
05. I put enough effort into learning science.					
06. I use strategies to learn science well.					
11. I spend a lot of time learning science.					
16. I prepare well for science tests and labs.					
22. I study hard to learn science.					
Grade Motivation					
02. I like to do better than other students on science tests.					
04. Getting a good science grade is important to me.					
08. It is important that I get an "A" in science.					
20. I think about the grade I will get in science.					
24. Scoring high on science tests and labs matters to me.					
Career Motivation					
07. Learning science will help me get a good job.					
10. Knowing science will give me a career advantage.					
13. Understanding science will benefit me in my career.					
23. My career will involve science.					
25. I will use science problem-solving skills in my career.					

Note. The SMQ-II is copyrighted and registered. Go to <http://www.coe.uga.edu/smq/> for permission and directions to use it and its discipline-specific versions such as the Biology Motivation Questionnaire II (BMQ-II), Chemistry Motivation Questionnaire II (CMQ-II), and Physics Motivation Questionnaire II (PMQ-II) in which the words *biology*, *chemistry*, and *physics* are respectively substituted for the word *science*. Versions in other languages are also available.

APPENDIX D
THE ENVIRONMENT QUESTIONNAIRE

Appendix. The Environment Questionnaire – revised ENV items – arranged by Model of Ecological Values factors**Preservation***Intent of support*

If I ever have extra money, I will give some to help protect nature.
I would help raise money to protect nature.
I try to tell others that nature is important.

Care with resources

To save energy in the winter, I make sure the heat in my room is not on too high.
I always turn off the light when I do not need it any more.
I try to save water by taking shorter showers or by turning off the water when I brush my teeth.

Enjoyment of nature

I would really enjoy sitting at the edge of a pond watching dragonflies in flight.
I really like to be able to go on trips into the countryside – for example to forests or fields.
I feel good in the silence of nature.

Utilization*Altering nature*

People have the right to change the environment (nature).
I like a grass lawn more than a place where flowers grow on their own.
To feed people, nature must be cleared to grow food.
Weeds should be killed because they take up space from plants we need.

Human dominance

Building new roads is so important that trees should be cut down.
Because mosquitoes live in marshes and swamps, it would be better to drain these and use them for farming.
People are supposed to rule over the rest of nature.

Note: In the TEQ that is completed by participants, items are mixed and are not identified by factor.

APPENDIX E
VOCABULARY QUIZ

Vocabulary Quiz**Fill in the word next to the definition:**

volume	salinity	population	invasive plant
estuary	detritus	culvert	transect refractometer
erosion	interdependence	deposition	consumers wetland
traits	producers	ecosystem	density conservation
watershed	solution	food chain	food web diversity
decomposers	anaerobic	spring tide	neap tide
decomposition	restoration	transition zone	upland

- _____ The process of laying down sediment or accumulating layers of material carried in suspension.
- _____ An ecological community together with its environment, functioning as a unit.
- _____ The lower course of a river where the current is met by ocean tides.
- _____ Marked line along which scientific sampling or surveying is undertaken.
- _____ The greatest range of high and low tide, occurring near the time of the full moon and new moon.
- _____ Disintegrated material and debris, as from organic decomposition.
- _____ Protection, to minimize the use of something.
- _____ Wearing away, such as land by the action of water
- _____ The tide with the least difference between low and high tide,
- _____ A tool for measuring salinity.
- _____ The degree of saltiness, usually referring to water.
- _____ The entire land area that contributes surface runoff to a given drainage system.
- _____ Living or growing where there is no oxygen
- _____ Organisms that ingests other organisms or organic material in a food chain.
- _____ Any of various organisms (as many bacteria and fungi) that feed on and break down organic substances (such as dead plants and animals.)
- _____ The transfer of food energy in sequence from plants to animals that eat plants to animals that eat other animals.
- _____ Photosynthetic green plants that constitute the first nutritional level in a food chain.
- _____ A mixture that forms when one substance dissolves another.
- _____ A group of organisms of the same species that live in a particular location or region

20. _____ Interrelated food chains in an ecological community whereby food energy passes among organisms as each consumes and in turn is preyed upon by others.

APPENDIX F
SURVEY SUMMARY DATA

Summary of Median Student Survey Scores

The Environment Questionnaire (TEQ)

Category	Treatment		Non-Treatment	
	Pre-Test	Post-Test	Pre-Test	Post-Test
Preservation	3.78	4.00	3.06	3.16
Utilization	2.64	2.57	2.64	3.02

Biology Motivation Questionnaire-II (BMQ-II)

Category	Treatment		Non-Treatment	
	Pre-Test	Post-Test	Pre-Test	Post-Test
Career motivation	2.10	2.33	1.93	2.20
Grade motivation	3.30	3.44	3.71	3.40
Intrinsic motivation	2.70	3.00	2.71	2.73
Self-determination	3.00	2.89	2.86	2.60
Self-efficacy	2.90	2.89	2.86	2.53

Summary of Average Grades

Type	Treatment		Non-Treatment	
	Pre-Test	Post-Test	Pre-Test	Post-Test
SSAT	2100	--	1972	--
Quarter Grades	91	90	86	87
Vocabulary Quiz	66	84	60	74

APPENDIX G
STUDENT AND TEACHER RESPONSES

1. What was the best part of learning out in the marsh?

Having a hands on experience instead of hearing about the marsh and being only told about the plants.

It was really hands on. It was nice learning about what happens.

Getting to go out into the outdoors and apply to the marsh what we learned in class.

I liked the hands on work and feeling like what I was doing was important.

The best part about learning in the marsh was partially learning how to keep human destruction of the marsh and mostly learning about the different types of plants.

I loved being outside and interacting.

Being outside learning by doing versus learning in a classroom.

Identifying plants we learned about in class.

2. What was the worst part of learning out in the marsh?

I didn't enjoy the smell.

Miscommunication between my teacher and I about clothing.

The worst part of learning was the mud and getting dirty. I also wish we could have studied animals.

It was a little wet and rainy one day.

No response.

I was muddy.

It being muddy and wet and squishy and gross.

Having to lean down for prolonged periods of time.

Question 1: It seems that [the treatment group] certainly appreciates the experience of learning in the outdoors however putting one's self in the environment that is muddy, wet and smelly may diminish one's value for it. It is certainly easier to appreciate the environment when it is in the abstract rather than in your wet shoes. This is a stretch but I was wondering if you have any further input on the environmental opinions of those two class groups.

Teacher Response: There seems to be very little difference in the environmental attitudes of the two classes, although there are a few students in both [the treatment group] and [the non-treatment group] who strike me as a bit more environmentally conscious. This lack of awareness or appreciation stems from their limited exposure to the environmental sciences to date, which, to be frank, is a shame. We've been lobbying the middle schools that feed kids to us to take on environmental science as a core science course, but to no avail. I believe our freshman students relate field work simply as something different than class time, rather than having any environmental importance, but that could change by providing them a more elaborate foundation in the environmental/ecological sciences at an earlier age.

Question 2: Since the study is pairwise, meaning before versus after with [the treatment group and the non-treatment group], any insight into the general motivational attitudes of the two classes that may have biased the results would be insightful.

Teacher Response: Unfortunately, I think this may have biased your results. [The treatment group] is one of the stronger freshman classes I have ever had - motivated, upbeat, and very inquisitive. Yes, they saw the marsh as an inhospitable environment (and it was raining most days), but they didn't seem to care. [The non-treatment group] is

just the opposite - rather apathetic, disengaged, and quiet. I've been able to pull more out of [the non-treatment group] block as the months go by, but the early months proved challenging. Hence, grades for [the treatment group] would be higher than ones for [the non-treatment group] regardless of setting.

Question 3: The bottom line that I have found is that, especially with such small sample numbers, there is no significant difference between the classes after the outdoor work. This may seem negative however since there is no difference then it can be stated that outdoor learning may not be better but is certainly statistically just as good as teaching in the classroom. So then the question is, why not take advantage of the resources available on campus and teach outdoors?

Teacher Response: I would agree with that conclusion, but only based on the limited scope of the analysis. I would bet on different results if we designed one field-based and one class-based class that spanned an entire semester or year. There only so much we can get from the kids in terms of educational impact with just three trips out into the marsh. The other part of this conversation focuses on pedagogy, is much more theoretical, and very difficult to assess. Do I think students could get more from a bio class that was strictly field based? Yes. But it depends on the quality of the curriculum design and teaching, as well as the collective of kids you're working with.

APPENDIX H
IRB APPROVAL AND LETTER



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MEMORANDUM

TO: Joseph Levitt and Peggy Taylor

FROM: Mark Quinn *Mark Quinn CQJ*

DATE: September 3, 2015

RE: "Field Research and Motivation: Experiential Learning in the Parker River Estuary" [JL090315-EX]

The above research, described in your submission of **September 3, 2015**, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

- (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
- (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.
- (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.
- (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.
- (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.
- (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

Administrator Approval

I, Elaine White, administrator at the Governor's Academy, verify that I approve of the classroom research conducted by Joseph Levitt.

Elaine White, Academic Dean
(Signed Name, Title of Position)

Elaine White

(Printed Name)

9/2/15

(Date)

Administrator Exemption Regarding Informed Consent

I, Elaine White, administrator at the Governor's Academy, verify that the classroom research conducted by Joseph Levitt is in accordance with established or commonly accepted educational settings involving normal educational practices and that I approve the project. To maintain the established culture of our school and not cause disruption to our school climate, I have granted an exemption to Joseph Levitt regarding informed consent.

Elaine White, Academic Dean
(Signed Name, Title of Position)

Elaine White

(Printed Name)

9/2/15

(Date)