Environmental Literacy Interim Report: Findings from a survey of freshman field trip participants from North Monterey County High School

Report Submitted to the Elkhorn Slough Foundation and North Monterey County High School

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The mission of the Environmental Studies Program at California State University Monterey Bay is to develop students and communities with the knowledge, skills, and compassion to promote social and environmental justice and sustainable communities.

The *mission* of the *Elkhorn Slough Foundation* is to conserve and restore Elkhorn Slough and its watershed.

The *Mission* of the *Elkhorn Slough National Estuarine Research Reserve* is to ensure the perpetual health of ecosystems in *Elkhorn Slough* and the surrounding watershed through preservation, restoration, research, information exchange and education with particular emphasis on the Research Reserve.

ELKHORN SLOUGH RESERVE

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Environmental Literacy Interim Report
Report of findings from a survey of freshman field trip participants

Overview

This research project included partners from the Elkhorn Slough Foundation, North Monterey County High School (NMCHS), and California State University Monterey Bay. This report summarizes findings from an interim survey issued to 140 freshman from NMCHS who participated in a field trip to Elkhorn Slough from January to April 2018. This interim survey was designed solely to evaluate impacts of the field trip and will be considered in conjunction with a more comprehensive survey issued to all students at North Monterey County High School in the fall and spring of the 2017-2018 school year. A summary of the fall 2017 survey results was reported in November 2017. This report includes results only from the survey of freshman field trip participants.

Background

As the second largest tidal salt marsh in California, the Elkhorn Slough is home to a diversity of resident and migratory birds, marine mammals, and fish. The Slough provides habitat for threatened and endangered species, including the endangered Santa Cruz long-toed salamander (*Ambystoma macrodactylum croceum*) and approximately 125 Southern sea otters (*Enhydra lutris nereis*). The wetland provides important ecological services to the region, filtering pollutants and serving as a carbon sequestration source (About Elkhorn Slough, n.d.).

The Elkhorn Slough Foundation is dedicated to conserving and protecting the Elkhorn Slough and surrounding watershed. In hopes of educating the next generation about its rich ecosystem and ecological importance, the Elkhorn Slough Foundation offers educational opportunities for local youth to learn about the environment of which they are a part. One of these opportunities is the Slough Crew run out of North Monterey County High School which began in 2014. The Elkhorn Slough Foundation's educational goal at NMCHS is to "increase environmental literacy in the Elkhorn Slough watershed" (Pofahl 2017). The Slough Crew engages in activities such as regular club meetings, field trips, creating school gardens, and hosting Earth week.

Environmental Literacy is defined as a combination of competencies, knowledge, and dispositions to support the enviornment and to ultimately demonstrate pro-environmental behaviors (NAAEE 2011). Environmental literacy is the capacity of an individual to act successfully in daily life from a broad understanding of how people and societies relate to each other and to natural systems, and how they might do so sustainably (Pofahl 2017). A person who is environmentally literate has the power to act individually or with others to support ecologically sound, economically prosperous, and equitable communities for present and future generations (CA DOE 2015).

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Methods

After the development and issuance of an environmental literacy survey of more than 800 students in the fall of 2017 (see November 2017 report), Katie Pofahl, the Community Outreach Manager of Elkhorn Slough Foundation, Victoria Derr, a professor at CSU Monterey Bay, and science teachers and curriculum coordinators reviewed results together. As a result of these discussions, partners decided to issue a short interim survey of all freshman who attend the winter and spring field trips to Elkhorn Slough. This shorter survey was designed to assess students field trip enjoyment, their connection to nature, and their interest in learning about the environment. The bilingual English/Spanish survey included 3 questions on a 1-5 point Likert Scale:

- How did you feel about the field trip to Elkhorn Slough today?, with responses from "I did not enjoy it at all" (1) to "I loved it" (5)
- Me and Nature: Choose the Venn diagram that best describes how you see yourself and nature, with responses from "not at all connected" (1) to "completely connected" (5)
- What is your level of interest in learning about the environment?, with responses from "Not at all interested" (1) to "Very interested" (5).

The survey also asked students to respond to three fill-in-the-blank questions:

- List one thing you learned about the Elkhorn Slough today
- Write the names of 3 animals that depend on the Elkhorn Slough for their habitat
- List 3 words to describe the Elkhorn Slough.

Of these questions, the "me and nature" question, 3 animals, and 3 descriptive words questions replicate questions in the fall/spring survey so that they will be comparable across the year. Between January and April, surveys were administered via a Google Form in the computer lab at school approximately one day after the field trip. After all field trips were complete, the data were extracted from the Google Form, with a total of 140 respondents. The three Likert Scale questions were analyzed using the R Project for Statistical Computing software. Mean scores and standard deviation were calculated for these 3 questions (Figures 1-3). In addition, the correlations between these variables were calculated (Figure 4-6).

In addition to calculating descriptive statistics for Likert-scale questions and word frequencies for open-ended questions, we used a Latent Classification Analysis to classify students into groups of similar experiential profiles. We suspected that it might be possible to have three classification groups: i) a group of very interested, very connected learners with strong positive associations with the environment and the field trip; ii) a group of moderately interested, moderately connected learners; and iii) a group of mildly disinterested, disconnected learners. This analysis could thus help determine different populations of students who might benefit from different types of educational programming, or more focused attention to the lowest interest group to bring them toward the middle or high areas of interest if desired. The Latent Classification Analysis can be used to test whether these groupings are supported by the data. This analysis was performed using the 140 responses to the three Likert-Scale questions that were part of the survey (Figures 7-8).

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Methods (continued)

Two open-ended questions (list 3 animals and list 3 words to describe the slough) were analyzed as qualitative data in NVivo qualitative data software by QSR International. For each question, word frequencies were calculated for all students combined. In addition, for the "list 3 animals" question, word frequencies were analyzed by comparing students who responded that they did not feel very connected to nature (1 or 2 on the 5-point Likert Scale) to those students who responded that they felt very connected to nature (5 on the 5-point Likert Scale). Similarly, for the "list 3 words to describe Elkhorn Slough" question, word frequencies were calculated for students who did not enjoy the field trip very much (1 or 2 on the 5-point Likert Scale) and for those students who "loved" the field trip (5 on the 5-point Likert Scale). Word frequencies for the top 5 responses are provided in Tables 1 and 2. All word frequency analyses are presented in word clouds as well (Figures 9-10).

For the question which asked students to "list one thing" they learned on the field trip, responses were coded in Excel. For this question, responses were scored a 1 for short, basic responses that listed a name of an animal or one other generic responses that showed little scientific knowledge; a 2 for answers that show specific science knowledge or vocabulary; and a 3 for answers that demonstrate an understanding of ecological relationships within the slough. Sample codes include:

> 1— "I learned about the nature" -or- "woodpeckers"
> 2— "It is a mix of fresh and salt water" -or- "Elkhorn Slough is 'home' to many invasive species"
> 3— "Woodpeckers eat termites, and they eat at the dead trees." -or- "I learned that the chemicals for farms run off into the slough."

Results

Mean scores for all students showed positive enjoyment of the field trip (Figure 1), middle to high connection to nature (Figure 2), and moderate interest in learning about the environment (Figure 3). Students ranked their enjoyment of the field trip higher than either their connection to nature or their interest in learning about the environment (Figures 1-3). When variables were correlated with each other, all relationships were statistically highly significant at a p value < 0.001. The strongest correlations were found between students connection to nature and their interest in learning about the environment (with a correlation of 0.485, Figure 4), as well as connection to nature and field trip enjoyment (correlation 0.413, Figure 5). In both these cases, students with a high connection to nature were both more interested in learning about the environment and enjoyed the field trip (Figures 4 and 5). Students' interest in learning about the environment was also correlated with students' enjoyment of the field trip, although with a lower correlation (correlation 0.398, Figure 6).
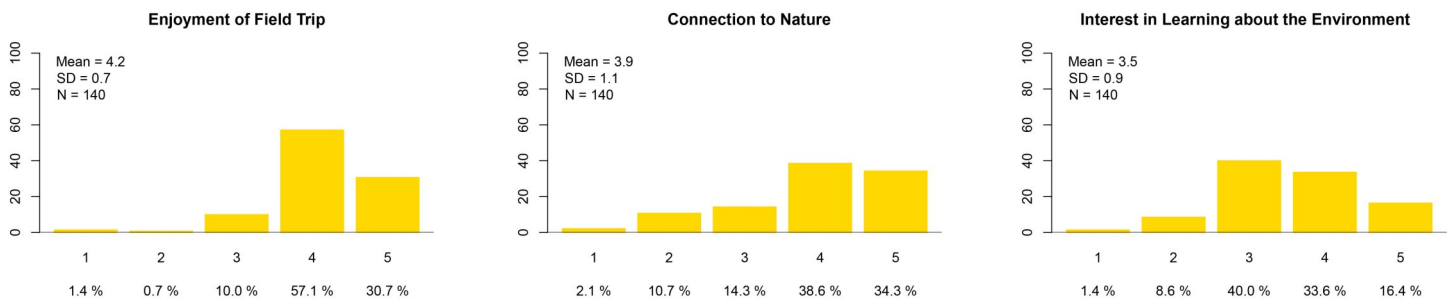
Figures 1-3. Mean scores of students enjoyment of field trip (Figure 1, left), connection to nature (Figure 2, middle), and interest in learning about the environment (Figure 3, right).
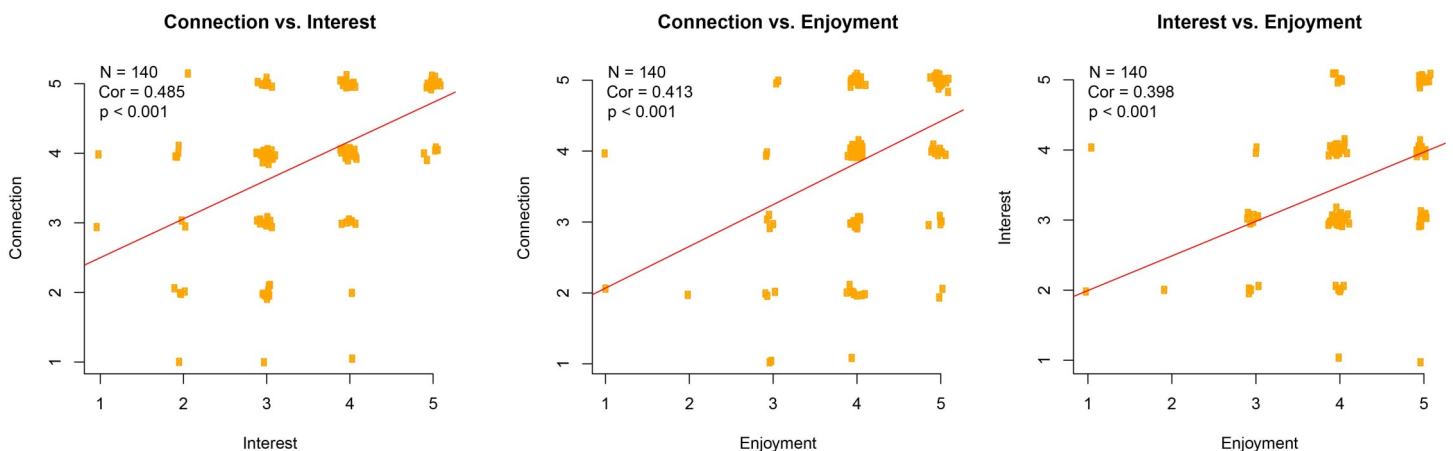
Figures 4-6. Correlations between "connection to nature" and "interest in learning about the environment" (Figure 4, left), "connection to nature" and "enjoyment of field trip" (Figure 5, middle), and "interest in learning about the environment" and "enjoyment of field trip" (Figure 6, right).

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Results

Student Profiles

With the sample size of 140 students, it was possible to classify individual students into three groups (Figure 7), but a two-group classification was suggested by the data in the Latent Classification Analysis (Figure 8). For this analysis, there was insufficient data (sample size) to determine if a three-group classification is appropriate. Figure 8 shows that in Group 1, students had moderate to low connection to nature and interest in learning about the environment, but variable enjoyment of the field trip. In Group 2, students had strong enjoyment of the field trip and connection to nature, with moderate to high interest in learning about the environment.
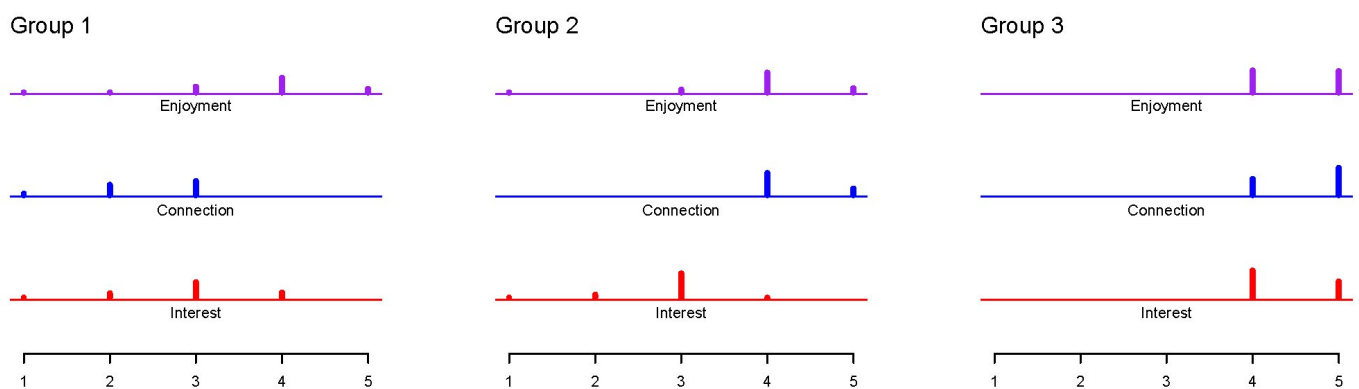
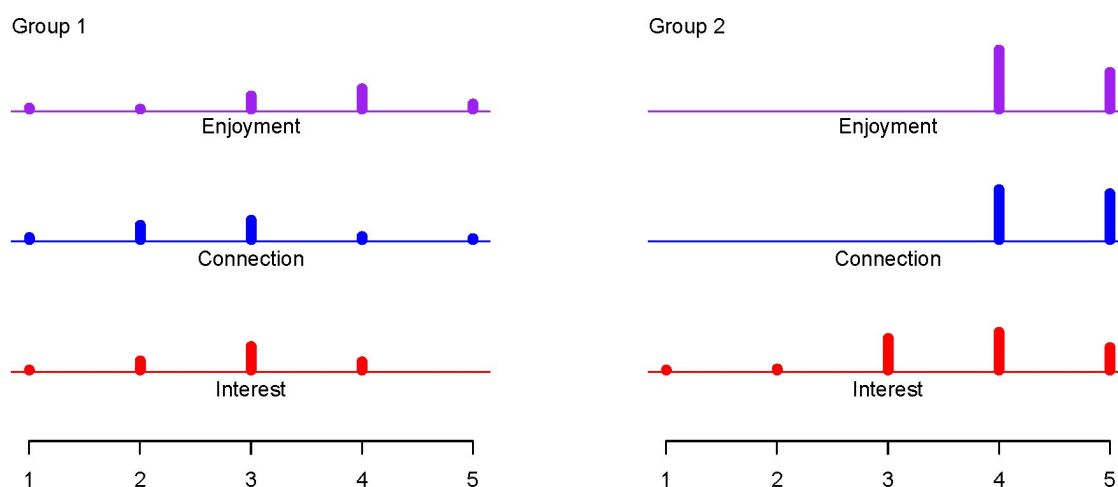Figure 7. Three-group classification using Latent Classification Analysis

Figure 8. Two-group classification using Latent Classification Analysis

Animals that Rely on Elkhorn Slough

Results

Qualitative responses to "list 3 animals that rely on Elkhorn Slough for habitat" show a range of responses that reflect some of the most common animals found in the Slough. Many students listed the salamander, with a few students providing the full name of this species (Table 1, Figure 9a). For the 18 students who felt least connected to nature (scoring 1 and 2 on the 5 point Likert Scale), the animals they listed included common species, such as otters, birds, and fish; however, 6 students also listed salamanders, and small numbers of students listing a range of species such as jellyfish, bobcats, hawks, eagles, and owls (Figure 9b). Of the 48 students who felt very connected to nature (scoring 5 on the 5 point Likert Scale), responses were more varied (Figure 9c) but consistent with the overall class of freshmen who participated in the field trip (Figure 9a).

Animal	Frequency	Similar words counted together
Otter	73	Otter, otters
Birds	63	Bird, birds
Salamander	46	Salamander, salamanders, long-toed salamander, Santa Cruz long-toed salamander
Fish	21	Fish, fishes

Table 1. Most frequent responses to "List 3 animals that rely on Elkhorn Slough for their habitat" across all field trip participants.
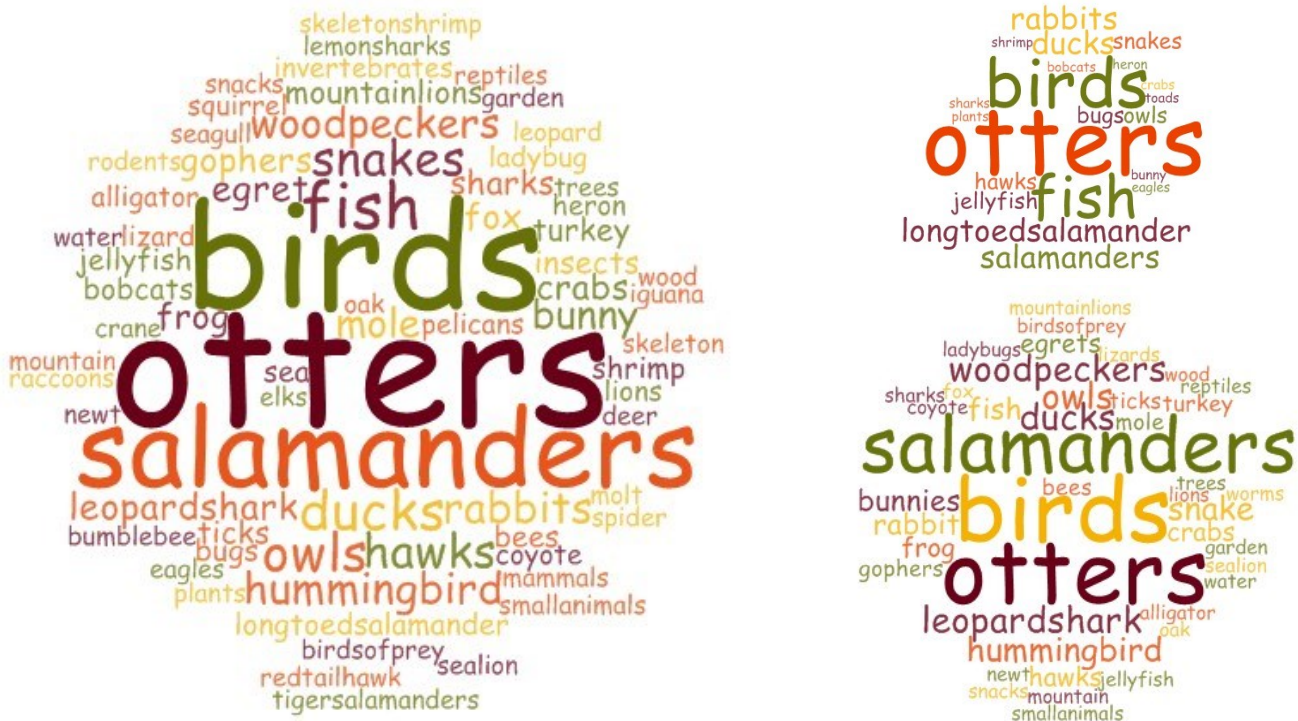

Figure 9. Frequencies of words to describe Elkhorn Slough. 9a (left): word frequency for all field trip participants; 9b (top right): for participants who rated their connection to nature a 1 out of 5; and 9c (bottom right) for those who rated their nature connection a 5 out of 5.

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Experiences of Elkhorn Slough

Qualitative responses to "list 3 words to describe Elkhorn Slough" show a wide range of responses (Figure 10a). The most frequent responses reflect positive or neutral experiences of nature (Table 2). Other responses (9 or more) include big, cool, water, peaceful, animals, adventurous, and educational. Only 7 words total (out of 420 (or 1.67%) were negative words such as ugly, smelly, or polluted. The three students who rated the field trip as a 1 on a 5-point Likert Scale still described the slough in positive terms (Figure 10b). Of the 43 students who rated the field trip as a 5, the majority of words also were positive (Figure 10c). It is within this group that students also described the slough with "negative" words, such as smelly, muddy, or rotten.

Word	Frequency	Similar words counted together
Fun	46	Fun
Nature	40	Natural, nature
Beautiful	34	Beautiful
Interesting	26	Interesting
Amazing	21	Amazing, awesome, surprising

Table 2. Most frequent responses to "List 3 words to describe Elkhorn Slough" across all field trip participants.

Figure 10. Frequencies of words to describe Elkhorn Slough. 10a (left): word frequency for all field trip participants; 10b (top right): for participants who rated the field trip a 1 out of 5; and 10c (bottom right) for those who rated the field trip a 5 out of 5.

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Results

One Thing Learned

Qualitative responses to "list one thing you learned about Elkhorn Slough" show positive experiences and gains in knowledge and/or appreciation for the slough (Table 3). Statements that demonstrate basic knowledge or experience compose 26% of all responses while nearly half (49%) demonstrate some scientific vocabulary or knowledge, and 25% showed an understanding of ecological relationships (Table 3). Students who responded that they were very connected to nature (5 on a 5-point Likert Scale) showed a mean score of 2.04 in their responses. Students who responded with a low connection to nature (1 or 2 on a 5-point Likert Scale) showed a mean score of 1.77. Students who were very interested in learning about the environment (5 on a 5-point Likert Scale) showed a mean score of 2.22 while students with a low interest (1 or 2 on a 5-point Likert Scale) showed a mean score of 2.

Table 3. Response to the question "List one thing you learned at Elkhorn Slough"

Code	Number of Responses	Sample Responses
1 Basic knowledge or experience expressed	37 (26%)	"hummingbird" "otters" "I learned about a crab" "The slough has a lot of different animals" "It was beautiful" "The history of the place" "The location used to be a dairy farm" "It is made of salt water" "I learned about different types of birds" "I learned what the Elkhorn Slough was" "The [Elkhorn Slough staff] love being visited and hiking with students"
2 Some scientific vocabulary or knowledge demonstrated	68 (49%)	"I learned about binoculars" "I learned how to use a microscope and look at little things bigger, for example, little things that you wouldn't be able to see with your own eye without a microscope" "They measure water levels" "I learned that ticks like high grass" "It is a mix of fresh and salt water" "Elkhorn Slough is 'home' to many invasive species" "Acorn woodpeckers are a thing and they are cool" "Benthic creatures are creatures that live at the bottom of the ocean" "I learned that it is a critical habitat for sea otters" "I learned that animals like sharks come into to the Elkhorn Slough" "It is an estuary, which is a mix of fresh and salt water together" "Pickle weeds taste like pickles because of the salt" "I learned that the water in our area is getting very contaminated" "The female skeleton shrimp has a bump, seeming like it's pregnant" "Elkhorn Slough is part of a watershed"
3 Understanding of ecological relationships demonstrated	35 (25%)	"Different types of birds go to the slough to rest" "Woodpeckers eat termites, and they eat at the dead trees" "What I learned about the Elkhorn Slough today was about how the water flows to the Elkhorn Slough whenever it rains." "That when it rains, the oil and mud go into the pond and that affects the birds" "That when it rains the rain water goes into the fields and washes some of the fertilizer into the slough and ocean, which is bad, so the farms and dairy farms should limit the amount of fertilizer they use for their fields" "I learned that fertilizer runoff from farms goes into the water, which feed the algae. The algae then can grow super thick, so it suffocates the organisms below." "Any little thing can make such a great impact on our wildlife. For example, gopher holes give salamanders homes" "I learned that a certain purple flower can kill other plants to survive" "I learned that nature depends on us as much as we depend on nature. Our actions affect the environment."

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Discussion

The results show that overall, students' experiences and gains in knowledge were positive, with 87.8% of students enjoying their field trip experience (rated as a 4 or 5 on the 5 point Likert Scale) (Figure 1). Students who felt connected to nature or interested in learning about the environment were more likely to have enjoyed the field trip, and these relationships were statistically highly significant at $p < 0.001$ (Figures 4-6). This pattern can also be observed in Figure 8. However, all students, regardless of interest or connection to nature predominately expressed positive descriptions of the slough and some knowledge about the slough's wildlife (Tables 1-2, Figures 9-10). The majority of students (74%) were able to demonstrate scientific vocabulary, site specific scientific facts, or ecological relationships (Table 3). Specificity of concepts learned (codes 2 or 3 in Table 3) about Elkhorn Slough were higher for students who were interested in learning about the environment or felt connected to nature. When we applied the Latent Classification Analysis to the data, we found two groups of students: those who were connected, interested, and enjoy the field trip, and those who were less connected and interested but varied in the extent that they enjoyed the field trip (Figure 8). Continued analysis with a larger sample may help to determine if this is a useful construct for assessing program participants. Qualitative interviews or focus groups might also help determine what aspects of these variables are important—to obtain more information about the *how* and *why* of programming influence (Stern et al., 2014).

These results also reflect student responses immediately following a field trip. We do not know the extent that these responses in attitudes or knowledge might be maintained over time. The end of year assessment will provide a basis for comparison and may help identify the durability of freshmen responses over time.

In the preliminary report from fall 2017 survey data, we discussed that Chawla's (2009) model of factors associated with the environment suggests that knowledge about the environment *as well as* knowledge about *how* to take action are important precursors to providing opportunities to *take action*. Many responses among the 25% of students who wrote about ecological relationships demonstrated learning about these relationships, such as that "farmers can make the slough better or worse" or that "the Elkhorn Slough is a preserved piece of land, and we should protect it" suggest that students began to learn about pro-environmental actions, but not necessarily what they, as individuals can do. Other aspects of Elkhorn Slough's programming may accomplish this, and this will be assessed through the fall/spring survey assessment.

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