CIVIC RESEARCH SERVICES, INC.

FINAL REPORT: EVALUATION OF THE MICHIGAN NATURAL FEATURES INVENTORY'S *2015 GREAT LAKES FISHERY TRUST GRANT*

SUBMITTED NOVEMBER 2017

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INTRODUCTION

The Michigan Natural Features Inventory's Grant and Goals

In 2015, Michigan Natural Features Inventory (MNFI) received a grant from the Great Lakes Fishery Trust (the Trust) for a youth education effort entitled *Vernal Pools Patrol.* In that grant, carried out over the course of the 2015-16 and 2016-17 school years, the MNFI delivered teacher professional development and hands-on support for classroom- and field-based learning efforts organized around local vernal pools.

More specifically, during the school year, MNFI staff came to most classrooms to deliver an in-person, PowerPoint introduction to the ecology of vernal pools, and to the documentation protocol that students would use when visiting a local vernal pool. MNFI staff also accompanied teachers and students to a local vernal pool on an initial visit, and helped them identify species and record observations about the site. Most teachers and students made a second visit to the vernal pool to observe and document the seasonal changes, often with MNFI staff support; and some teachers made a third visit.

In the second year of the program, for returning teachers, MNFI staff shared the PowerPoint but did not deliver it, and did not accompany teachers to the vernal pool sites. This was an intended phase-out of support, and one of the most important evaluation questions for this pilot program was whether the teachers would successfully carry out the program with more limited, remote support from the MNFI. One new teacher did receive the full complement of support in the 2016-17 school year.

The Vernal Pools Patrol (VPP) program that was piloted in this grant is an adaptation of an existing citizen science program for adults.

Evaluation Methods

The evaluation was designed to explore teachers' perspectives on the value of the program and to test whether the amount and sequence of support activities were adequate to meet teachers' needs. The student portion examined learning and attitudinal changes attributable to the program. The sections below provide further detail on the methods employed.

1. TEACHER FEEDBACK

In each year of the program, the evaluator interviewed teachers by telephone near or immediately after the end of the school year. The interviews lasted 15-30 minutes on average, and explored teachers' experiences with the program, perceived capacity to carry it out independently in the future, and recommendations for change and improvement. Because the MNFI intended to support teachers more intensively in year one, and then transition them to a more independent implementation of the program and protocol in year two, the interview guide was modestly updated between years one and two. Both years' instruments are appended to this report.

2. STUDENT MEASURES

The student measures in the evaluation included a pre/post test of knowledge and a pre/post survey. The test of knowledge included seven multiple-choice questions and three short-answer/essay questions focused on students' understanding of the ecology of vernal pools, ability to differentiate between vernal

pools and other wetlands, understanding of the ecological value of vernal pools, and familiarity with citizen science. The survey focused on students' stewardship attributes, including items focused on environmental sensitivity, environmental behaviors, capacity for community-based environmental work, and commitment to future environmental conservation. The survey also included a few questions focused on the activities students engaged in related to vernal pools, and a few questions seeking student feedback on the value of the experience.

In the 2015-16 school year, students took the pretest before the vernal pools unit, and after the unit, took a posttest and a retrospective pre/post survey. The "retrospective pre/post" survey asks for ratings or responses at two different points in time: after the learning experience, and before the learning experience. In this way, the students compared and reflected on what they believed and felt before and after the experience. In the 2016-17 school year, the survey instrument was attached to the pretest and posttest, resulting in a pure pre/post survey. A case can be made for either method, and in trying both, the evaluator's intent was to explore the strengths and weaknesses of each—and the differences in findings.

All instruments are appended to this report.

3. Scope of Participation in the Program and Evaluation

Table 1 shows student participation in the evaluation. As is not unusual in data-collection in K-12, there was substantial attrition between the pretest and posttest. In the first year, one teacher failed to complete posttests after having completed pretests; one teacher reduced student participation in the evaluation from all her classes (98 students) to only one class that participated in fieldwork (26 students), and most teachers had attrition of approximately 10%, which may reflect absences or students who left the building during the school year. In year two, two teachers that collected pretests failed to collect posttests, while one collected partial data only.

Pre- and posttests were matched on the basis of students' names and teachers. Only students with a matched pretest and posttest were considered in the reporting of pre/post statistics, while all post-program surveys were considered for post-only items. In year one, several students who completed a posttest did not complete the separate post-only survey, while in year two, these instruments were integrated together.

Table 1: Student Participation in the Evaluation

	Pretest	Posttest	Matched Pre/Post	Survey
Total count of students	456	264	235	181
Year 1, 2015-16	310	198	180	126
Year 2, 2016-17	146	66	55	55

Participation in the program is estimated in Table 2. Student counts and participation in field visits, where given, are based on teacher interviews (where available) or MNFI-supplied data (where available). In several cases, particularly in year two, no data were available.

Table 2: Program Participation

Teacher	School	Grades	# Students 2015-16	# Students 2016-17	Fall '15 Visit	Spring '16 Visit #1	Spring '16 Visit #2	Fall '16 Visit	Spring '17 Visit #1	Spring '17 Visit #2
Tracy Stoldt	Au Gres MS	6 - 8	78	30	Alone	With MNFI	Alone	Alone	Alone	N
Scott Steensma & Kelly Moran	Onaway Area Schools/HS	9 - 12	20	?	With MNFI	With MNFI (different students)	No	?	?	?
Holly Wirgau & Matt Barsen	Rogers City MS	7	44	39	N	With MNFI	Alone	With partner	With partner	N
Kelli Polleys	Harbor Springs MS	7 - 8	70	50	With MNFI	With MNFI (different students)	With partner (different students)	With partner	With partner	With partner
Karin Church	Montessori Children's House - Traverse City	4 - 6	34-36	42	With MNFI	With MNFI	With partner	With partner	With partner	With partner
Kristen Grote	Grand Traverse Academy	7	30 field, 98 in class	0	With MNFI	With MNFI	With partner	N	N	N
Jenna Scheub	Interlochen Arts Academy	9 - 12	About 15	?	With MNFI	With MNFI	Alone	?	?	?
Jeff Kalember	Gaylord HS	9 - 12	?	?	Alone	?	?	?	?	?
Jean Evans / Julie Crick	Roscommon MS	6	20	22	With partner	With partner/ MNFI Staff	With partner	With partner	With partner	With partner
Melissa Smith	Alpena High School	9 - 12	28	?	N	With MNFI	?	?	?	?

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Table 2: Program Participation

Teacher	School	Grades	# Students 2015-16	# Students 2016-17	Fall '15 Visit	Spring '16 Visit #1	Spring '16 Visit #2	Fall '16 Visit	Spring '17 Visit #1	Spring '17 Visit #2
Christie Thomas & Erin Klinger	Alcona Middle School	7-8	50	54	N	With MNFI	N	With partner	N	N
Rebecca Heckman	Inland Lakes	6	16	0	N	With MNFI	Alone	N	N	N
Wilma Littleton & Amie Byelich	Vanderbilt Area School	7 - 12	0	11	N	N	N	With MNFI	Alone	Alone
Totals	13 schools	4 – 12	480 estimated (including 60 in the classroom only)	260 estimated	8 (2 alone, 5 with MNFI, 1 with partner)	10 (all with MNFI)	8 (3 alone, 1 with MNFI, 4 with partner)	7 (1 alone, 1 with MNFI, 5 with partner)	6 (2 alone, 4 with partner)	4 (1 alone, 3 with partner)

Two of the teachers who participated in year one were no longer employed by their schools in year two of the program. Partners supporting the teachers included:

- The Grand Traverse Regional Land Conservancy (Montessori Children's House, Traverse City)
- The Northeast Michigan Great Lakes Stewardship Initiative (Rogers City Middle School, Alcona Middle School)
- The Little Traverse Conservancy (Harbor Springs Middle School)
- MSU Extension (Roscommon Middle School)

Eleven teachers representing ten schools were interviewed in year one, while six teachers at six schools were interviewed in year two. Of the six 2016-17 interviewees, four had been interviewed in year one, one was new to the program in year two, and one was part of a teacher team and the partner teacher was interviewed in year one. All interviews were conducted by telephone and most were recorded and transcribed.

Findings from Student Data Collection

Pre/Post Test—Multiple Choice Section

Error! Reference source not found. shows the overall percentage correct among the 235 students in the evaluation with a completed pretest and posttest. As shown in the graphic, student scores increased sharply, from 30% correct to 53%. Researchers sometimes use "effect size" to standardize measures of impact and characterize an impact as small, moderate, or large. Although there are a few methods for calculating an effect size, most of the measures divide the estimated impact by the standard deviation of the underlying measures, such that the "effect" is expressed as, for example, half a standard deviation, or .15 of a standard deviation. Cohen's D is one such measure of effect size, and was calculated as 1.29, a very large effect.

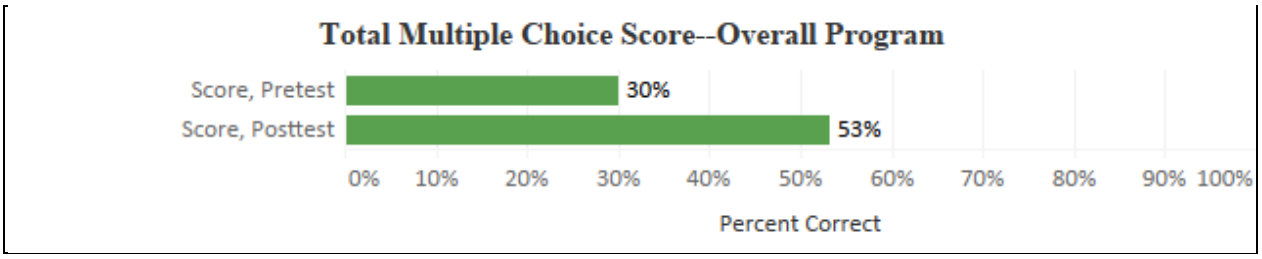

Figure 1

Figure 2 breaks the data into the two school years. Findings were substantially the same in year one (180 students) and year two (55 students). The effect size in year one was 1.20, and the effect size in year two was 1.81.

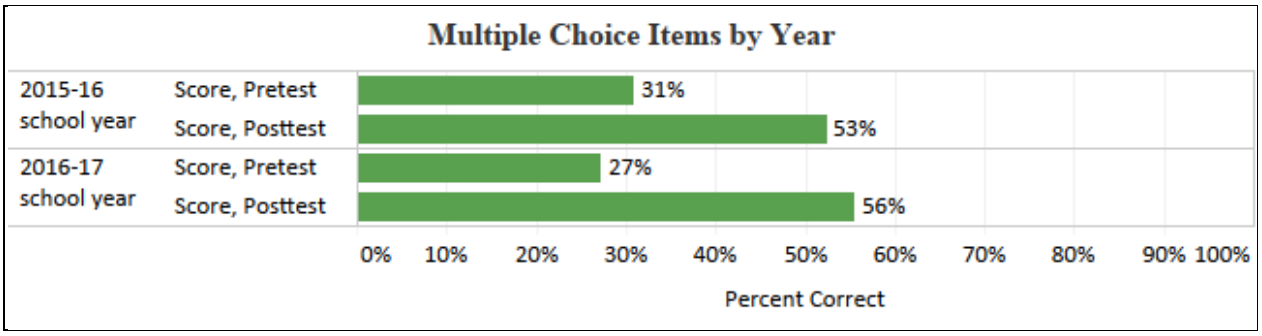

Figure 2

Figure 3 compares pre/post results by teacher, and shows that the improvements are visible in every classroom. The percentage points gained between pre- and posttests ranged from +18% to +28%, and effect sizes ranged from just over 1 to 1.78.

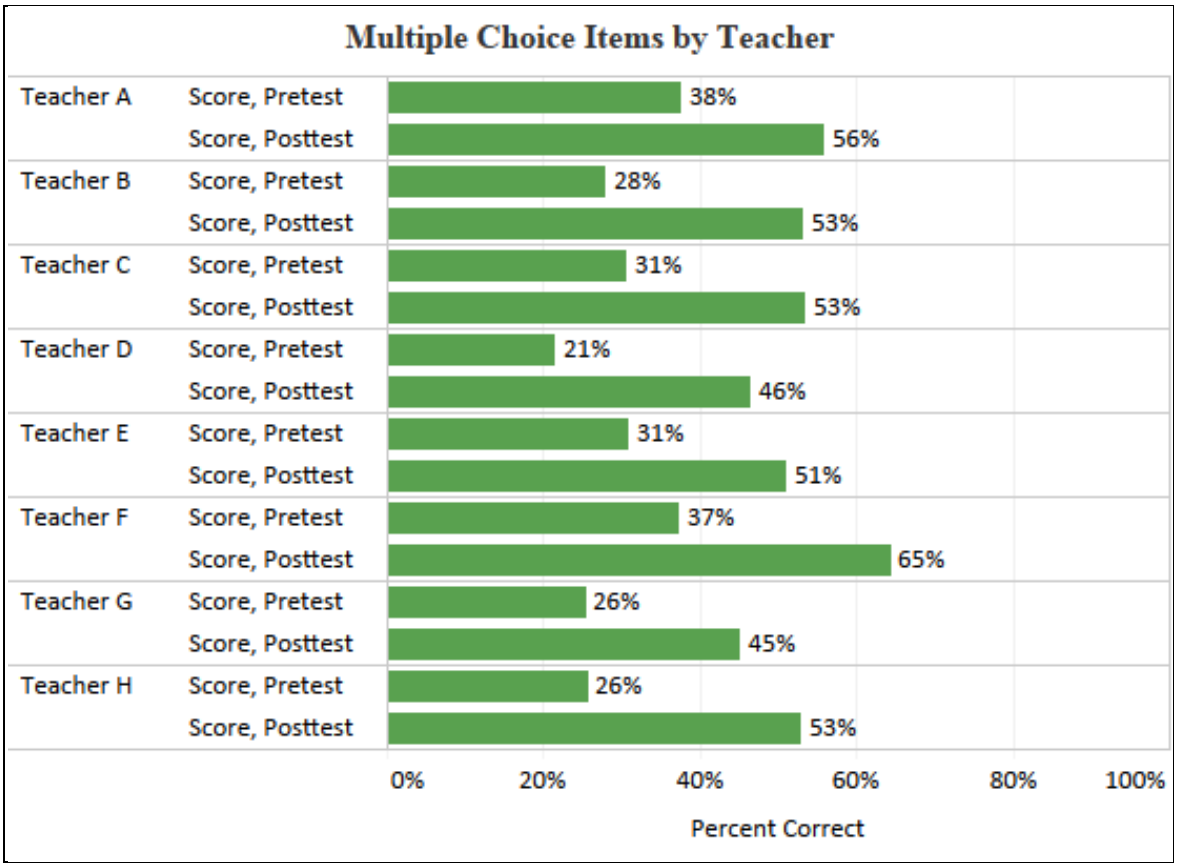

Figure 3

Figure 4 shows pre/post results for each of the seven multiple-choice questions. Gains pre-to-post ranged from +2% to +48%. The greatest gains were seen in student understanding of what a vernal pool is (+48%), student ability to identify vernal pool indicator species (+38%), and student understanding of the nature of citizen science (+34%). Students achieved very little improvement on one question (and in some classrooms, scores worsened), indicating that the item may be a poor measure of intended student learning.

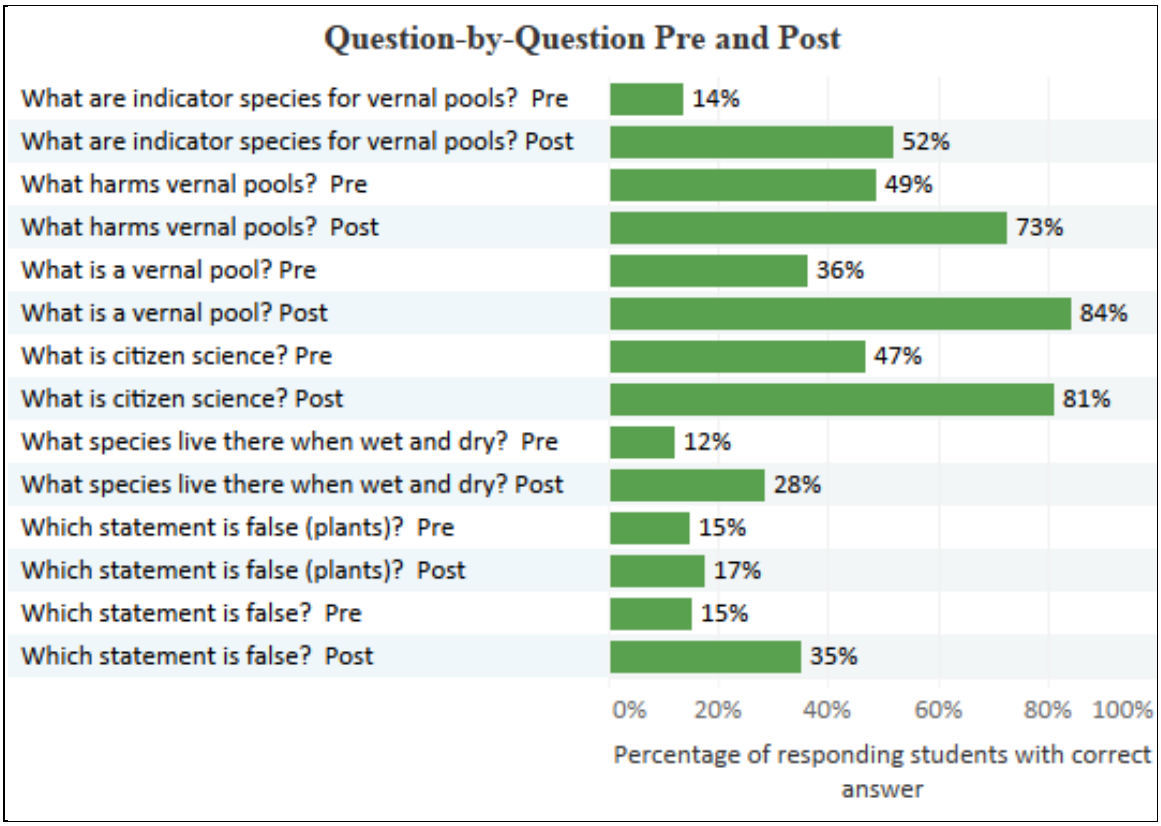

Figure 4

Pre-Post Test: Short Answer Section

Vernal pool distinctions. In the first short-answer question on the test, students identified, in their own words, up to three differences between vernal pools and other wetlands or ponds. Each response was given a score between 0 (wholly wrong) and 3 (substantially correct). The total possible for the full question was thus nine points.

Table 3 shows changes in the overall score on this question. Students increased their average score a great deal, progressing from less than one ideal response (score of 2.63) to more than two ideal responses (score of 6.15). The effect size associated with this change was 1.34, a very strong effect. Part of the change was due to fewer incomplete, blank lines at the time of the posttest: the average student supplied 2.6 answers on the three blank lines, compared to 1.76 responses on the pretest.

Table 3: Pre-to-Post Changes—What are some differences between vernal pools and other ponds or wetlands? List three. If you can't list three, list as many as you can.

	Pretest	Posttest
Average total score (9 points possible)	2.63	6.15
Average number of scorable responses (3 possible)	1.76	2.60

Key themes in the responses offered in the pretest included the following:

- Vernal pools are dry part of the year and wet part of the year
- They have ecosystems that can tolerate seasonal flooding and drying
- They have different animal species than ponds or wetlands, including fairy shrimp but no fish
- They have different plant species than ponds or wetlands
- Vernal pools are typically smaller than ponds or wetlands
- Vernal pools are more swampy, cleaner, less murky, and don't freeze
- Vernal pools are found in different kinds of locations than wetlands (e.g., in forests)
- Vernal pools are natural, while ponds are often manmade
- Some students wrote that pools have chemicals and are for swimming, while wetlands are natural
- Vernal pools are unique, rare, protected, and easily disturbed

Key changes, pre-to-post, in student responses included:

- Students were more likely to articulate core learning goals of the program, e.g., vernal pools are seasonally wet, vernal pools provide habitat for certain species requiring wet and dry phases
- Students were more able, at posttest, to articulate the importance of vernal pools for particular species and for breeding
- Students were less likely, at posttest, to focus on lay descriptions of vernal pools, e.g., "muddy," "like a swamp"
- Students were less likely, at posttest, to focus on recreational uses of ponds for swimming

Some important misconceptions expressed by students included the following:

- Vernal pools are easily disturbed by walking in them, but wetlands and ponds are not disturbed by walking in them
- The only species living in vernal pools are indicator species
- Vernal pools have microscopic life, but ponds don't, or have less microscopic life
- Vernal pools are home to endangered species while wetlands are not
- Leaf debris is significant in vernal pools but not in wetlands
- Vernal pools are legally protected while wetlands are not
- Vernal pools are typically studied while wetlands are not

As the reader may have noticed, several of these statements offer a true observation about vernal pools but that observation does not distinguish vernal pools from other types of ponds or wetlands.

Benefits of vernal pools. In the second short-answer question, students identified up to three benefits offered by vernal pools. Table 4 shows pre-to-post changes in total score and the count of student responses. Student scores also improved on this question, although less notably than on the question

related to the distinctions between vernal pools and other ponds and wetlands. The effect size was 0.58, moderate to large.

Table 4: Pre-to-Post Changes—What are some ways in which wetlands like vernal pools are important to forests, animals living in forests, or people?
List three. If you can't list three, list as many as you can.

	Pretest	Posttest
Average total score (9 points possible)	3.33	4.97
Average number of scorable responses (3 possible)	1.60	2.19

Some of the key resources or benefits provided by vernal pools that students frequently identified included the following:

- Habitat, shelter, or breeding grounds for animals
- Water for animals to drink
- Food for animals
- Water for plants
- Learning and study opportunities for humans

Key changes, pre-to-post, in student responses included:

- At posttest, substantially more students (108 versus 63) wrote about vernal pools offering habitat for wildlife, and more students used the term "habitat" (as opposed to "homes" or such expressions as, "animals live there")
- Students were more inclined at posttest to focus on the relationship between vernal pools and specific species, which they sometimes names and sometimes referred to as "unique species" or "special species" or "specific species"
- Students were slightly more likely at the posttest to write about benefits for plants associated with vernal pools (although equally likely to focus on food and water for animals)

Some important misconceptions or limitations in student learning included:

- Students rarely discussed benefits for humans beyond learning, such as flood management or water quality improvements
- Students frequently said animals in general, or "some" animals, "need" the vernal pool "to survive" but did not provide detail beyond this statement

Adaptations for survival in vernal pools. The final question was an open-ended question focused on adaptations that would help an animal survive in a vernal pool. Specifically, the question read: "In the space below, describe one plant or animal adaptation that is useful for surviving in a vernal pool. Describe the adaptation, and tell how it helps the plant or animal survive in a vernal pool." Students' responses were scored on a scale of 0 to 4; the rubric used in this scoring is appended to this report.

Students were ill prepared to answer this question at pretest, scoring only 0.86 out of 4 on average. With 235 students completing both a pretest and a posttest, 40% left this question blank, said "I don't know," or offered an unintelligible response, and another 15% provided a response scored as wholly wrong. By the posttest, scores improved to 1.72, with blank and unintelligible responses down to 14%, and wholly wrong answers provided by only 2% of students. The effect size was 0.72, large.

Figure 5 shows a pre-to-post comparison of the types of responses offered by students. As shown in the chart, students were much more likely in the posttest to name any animal (27% versus 11%), and more likely to try to describe an adaptation (31% versus 20%). Several students spoke generally about animals needing to adapt to live in both wet and dry environments without describing any particular animal or adaptation (4% pretest, 8% posttest).

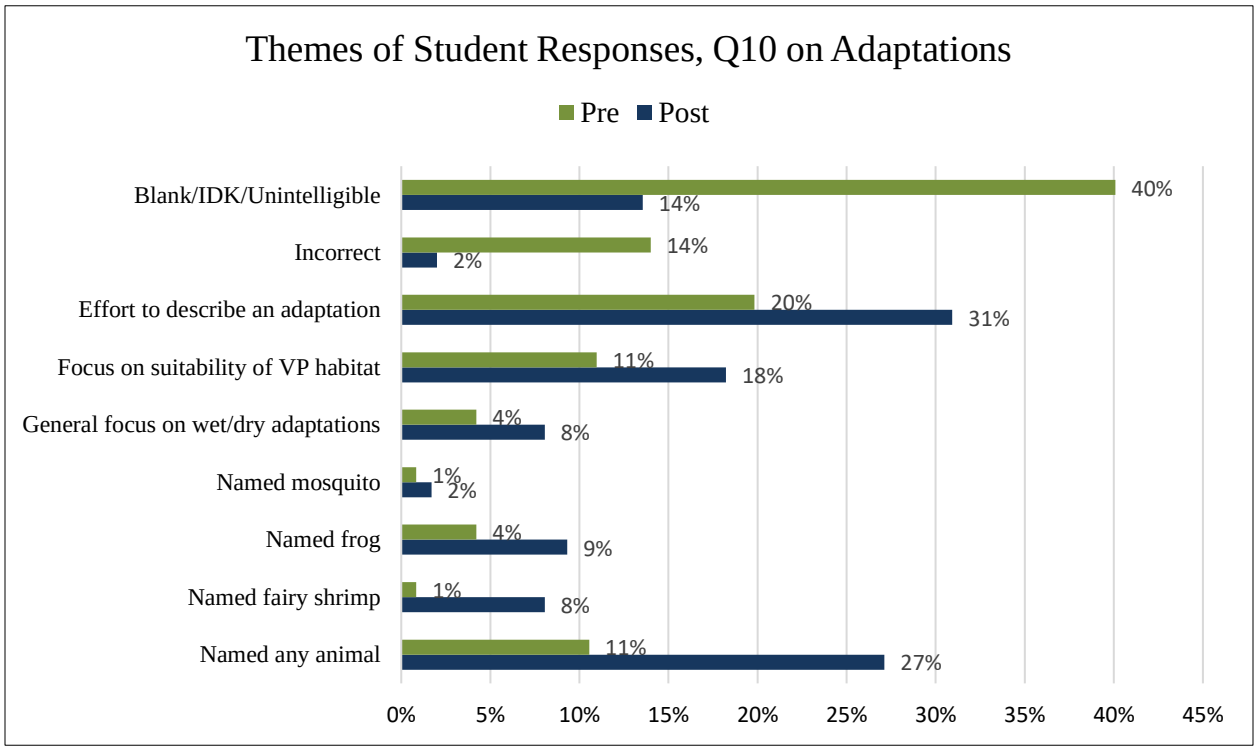

Figure 5

In the posttest, not only did more students focus on adaptations (31% versus 20%), but when they did, they earned higher scores (3.02 versus 2.48 on average).

Often, students focused on scientific concepts other than physical adaptations. For example, many students' responses were focused on the suitability of vernal pools as a habitat for a variety of species and not on the animals' adaptations to the habitat. Some examples of these types of responses, and the associated score given, are shown in Table 5.

Table 5: Responses Emphasizing Habitat Suitability		
Student response	**Score (0-4)**	**Rationale for score**
"The blue spotted salamander has an adaptation to the vernal pool. When they have their larva it is a save place to put it. There aren't a lot of predators to hurt the salamander larva."	3	This is an adaptive behavior, but the student's description emphasizes habitat over physical adaptation (*Note:* 4-point responses describe an adaptation specific to vernal pools)
"less things that can eat animals and a shelter for animals."	1	This response is focused entirely on the safety of the vernal pool habitat
"The water and some of the things that grow in the pool might be food for other animals"	1	This response is focused on the vernal pool as a source of food and water
"Duck Weed because it gives food, and shade for the animals living."	1	This response confuses "adaptation" with the idea of duck weed being a helpful species to other species living in the vernal pool
"salamander because they need water to keep their skin moist"	1	This response is focused on the suitability of the habitat for a salamander

Students also frequently described animals that would "leave when the pool dried up" as their adaptation. All the verbatim responses to this question are provided as an appendix.

Student Survey

Activities. The survey asked students to identify the activities they participated in as part of the program.

Table 6: Participation in Various Activities of the VPP		
Activity	**2015-16**	**2016-17**
Reported visiting a WET vernal pool	78.57%	80.00%
Reported visiting a DRY vernal pool	47.62%	56.36%
Made a presentation	29.37%	27.27%
Analyzed data from YOUR class	73.02%	78.18%
Analyzed data from OTHER classes	12.70%	16.36%
Visited a pool both when wet and when dry	38.10%	52.73%
Number of surveys	126	55

As shown in the table, many of the participating students were not able to visit a vernal pool both when wet and when dry. One of the participating teachers involved a class that runs each trimester, which limited her ability to bring students on multiple visits. A second was not able to bring all students on a return visit, and a third joined the program during the spring, "wet" season. About three-quarters of students analyzed data collected by their own class, but less than 15% overall analyzed data collected in other classes. The reader should interpret these statistics cautiously, as several classes participating in the

pre/post test in year one did not complete the survey, and overall findings on this item may not be representative of the broader group of participants.

Pre-post items. The survey included a number of agree-disagree questions used in either a pure pre/post format or in a retrospective pre/post format (see page 2 for a description of this method). Each item was presented on a scale of 1 (disagree strongly) to 5 (agree strongly). The mean response for each item is shown in Table 7.

Table 7: Pre-to-Post Changes in Stewardship Items

Survey Items	Pre	Post	Change
I know how to gather information about an environmental problem in my community	2.949	3.441	+0.492
By working with others in the community I can help make things better	3.461	3.815	+0.354
Humans have the right to modify the natural environment to suit their needs (reverse coded)	3.289	3.629	+0.340
The balance of nature is very delicate and easily upset	3.551	3.864	+0.313
We must take stronger measures to conserve our nation's resources	3.659	3.959	+0.300
In the future, I would be willing to work with others to solve an environmental problem in the community where I live	2.933	3.215	+0.282
I know how to talk to other people about environmental issues in our community and the things we should do to solve those problems.	2.943	3.216	+0.273
I like to watch what birds, wildlife, and insects do outside	3.583	3.780	+0.197
I would enjoy a career that focuses on environmental issues	2.618	2.642	+0.024
In the future, I would be willing to volunteer for citizen science projects	2.921	2.943	+0.022
I really enjoy nature	4.152	4.149	-0.003

The stewardship index is the composite, average response across all eleven pre/post stewardship items. The overall composite score was 3.28 at the pre-program point, and 3.52 at the post-program point, for a total gain of 0.24. The effect size for this change was 0.34, a small to moderate effect.

Figure 6 shows this statistic by school year. The reader should recall that in 2015-16, the method employed for gathering pre/post responses was a retrospective approach, while a pure pre-program and post-program data collection method was employed in the 2016-17 school year. It is not possible to know how much explanatory weight to place on the difference in methods versus the difference in teachers and students across the years. However, it has been the evaluator's experience that the retrospective pre/post method generally shows stronger positive gains in attitudinal measures than does a pure pre/post approach. Neither approach is free of bias: social desirability bias may nudge retrospective pre/post responses toward a positive result, while pure pre/post responses without a control group tend to nudge findings toward a negative or null result, as they fail to account for demonstrated patterns of decline in environmental sensitivity and attitudes as students grow older. The effect size of the change (+0.36) in 2015-16, using the retrospective pre/post approach, was 0.48, a moderate effect. No overall change was exhibited in the 2016-17 school year using the traditional pre/post approach.

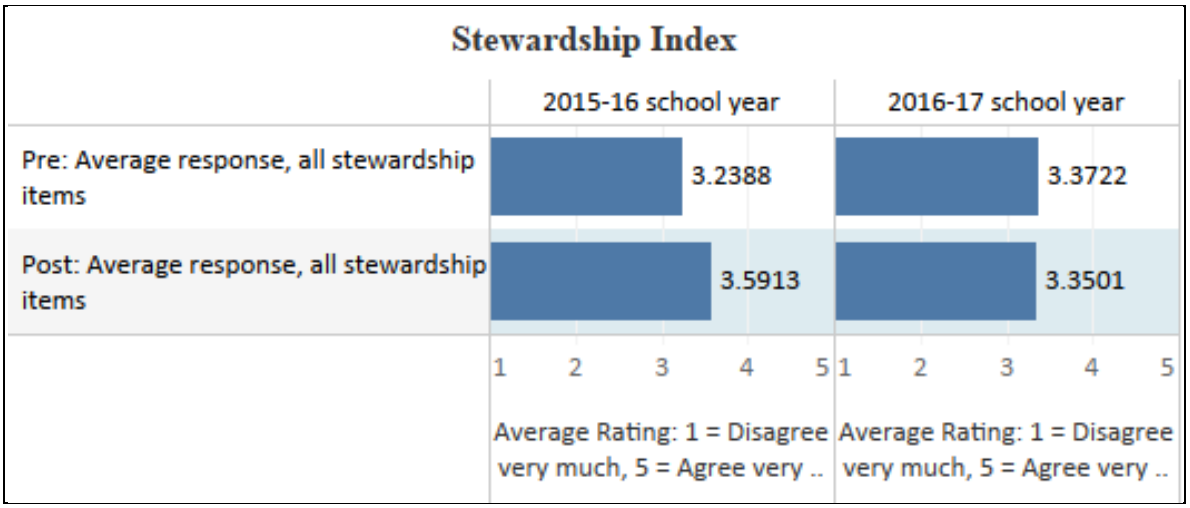

Figure 6

Figure 7 shows the pre-to-post change, in each school year, for the items focused on *environmental sensitivity*, which can be defined as a sense of connection to nature and feeling of care and concern for the environment. The index for these items was calculated as 3.89 (pre) and 3.97 (post), for a change of +0.08 and an effect size of 0.07. Effect sizes below 0.20 are generally considered too small for any substantive significance.

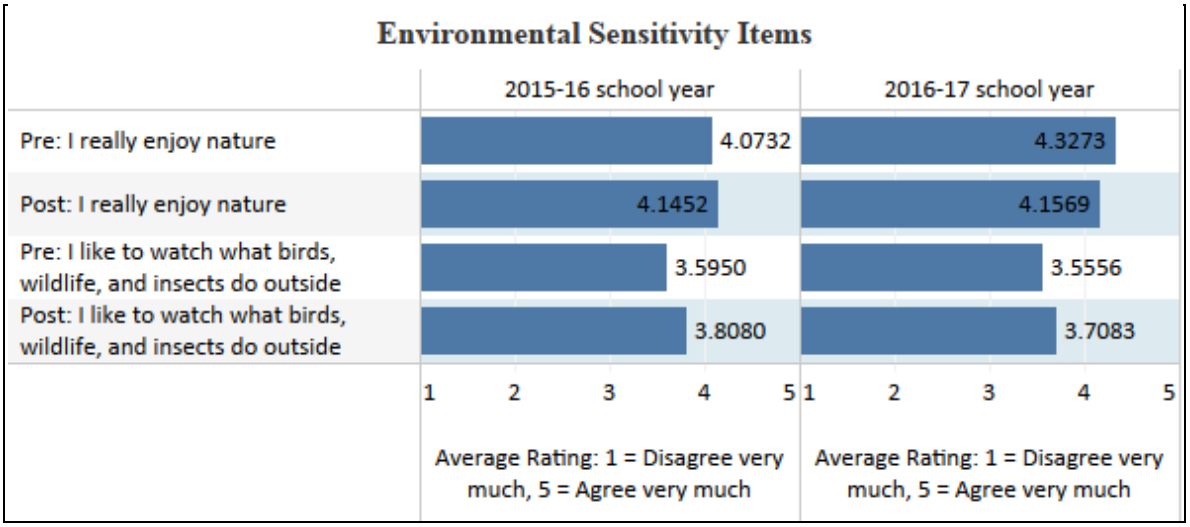

Figure 7

Figure 8 shows the pre-to-post change, in each school year, for the items focused on *environmental attitudes*, which can be defined as beliefs about the importance of environmental conservation and about the inherent rights of humans vis-à-vis the balance of nature. The overall index for these items was calculated at 3.51 (pre) and 3.83 (post), for a change of +0.32 and an effect size of 0.42, a moderate effect.

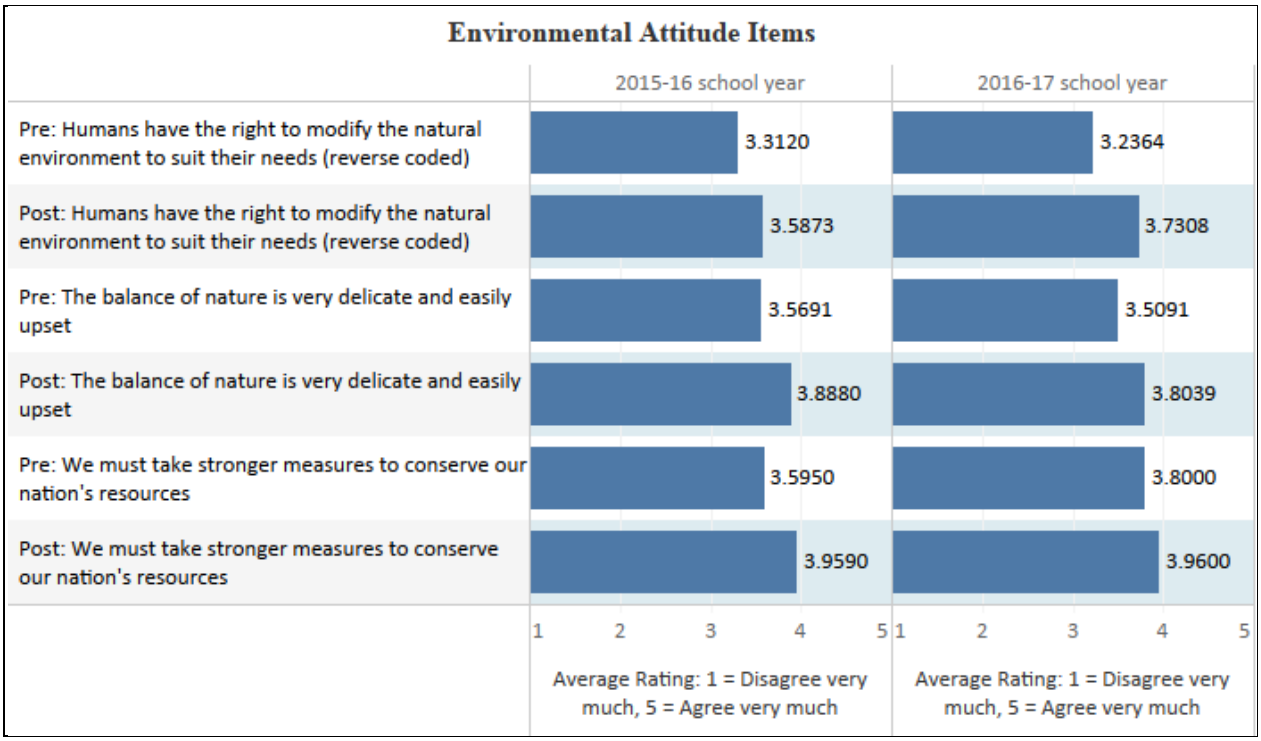

Figure 8

Figure 9 shows the pre-to-post change, in each school year, for the items focused on *civic capacity*, which measure students' self-reported ability to engage in selected civic actions, including speaking to others about environmental problems and solutions, and gathering information about environmental challenges in the community. The index for these items was calculated at 2.91 (pre) and 3.31 (post), for a change of +0.40 and an effect size of 0.43, a moderate effect.

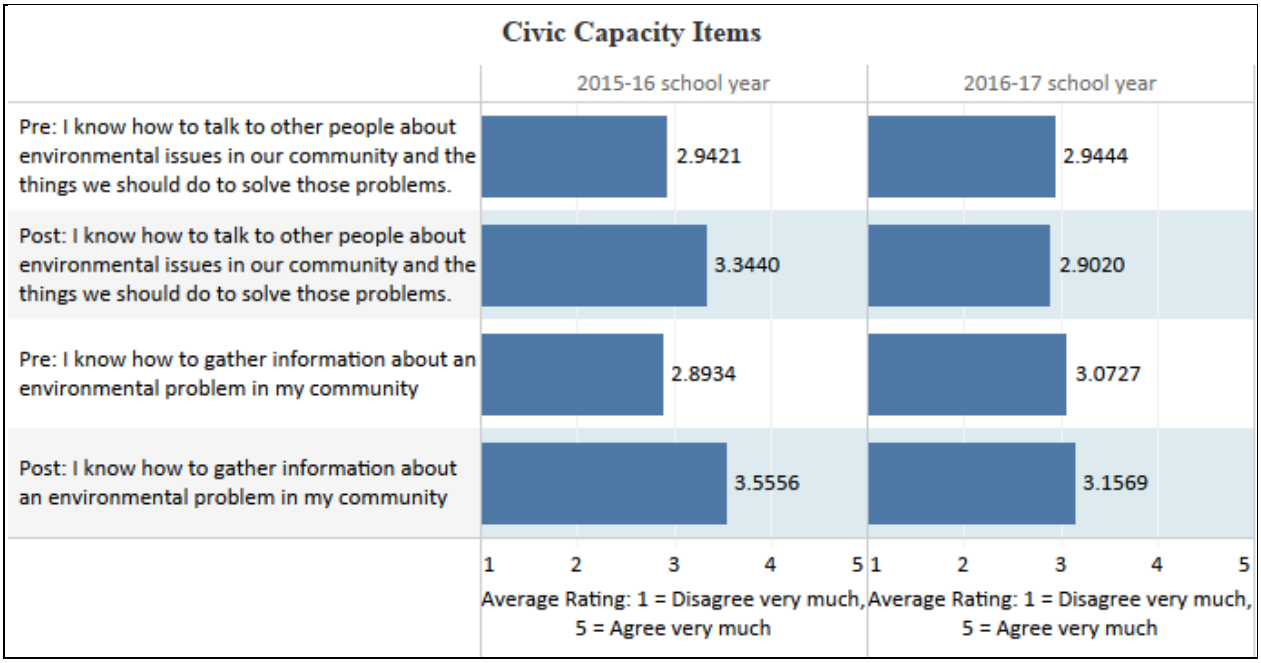

Figure 9

Finally, Figure 10 shows pre/post findings for the remaining survey items. An index was calculated for these items and calculated at 3.00 (pre) and 3.15 (post), a change of +0.15 and an effect size of 0.17, near but not quite reaching the generally accepted threshold of 0.20 as a small effect.

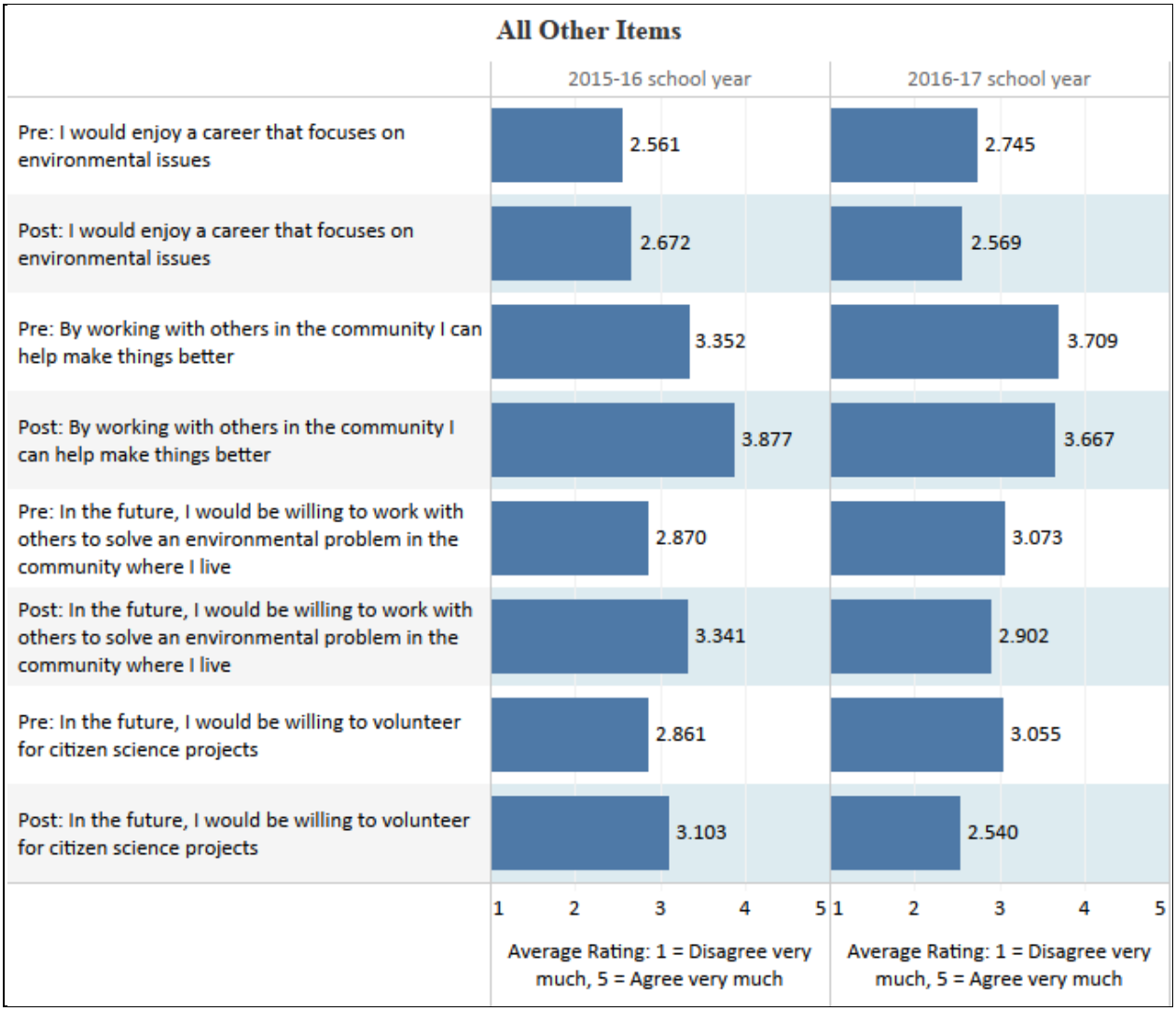

Figure 10

Post-only items. Several survey items were asked at the post-program point only. These captured feedback on the students' experiences in the program and on students' reactions to the program. All items were scaled from 1 (disagree strongly) to 5 (agree strongly). The mean response to each item is shown in Figure 11.

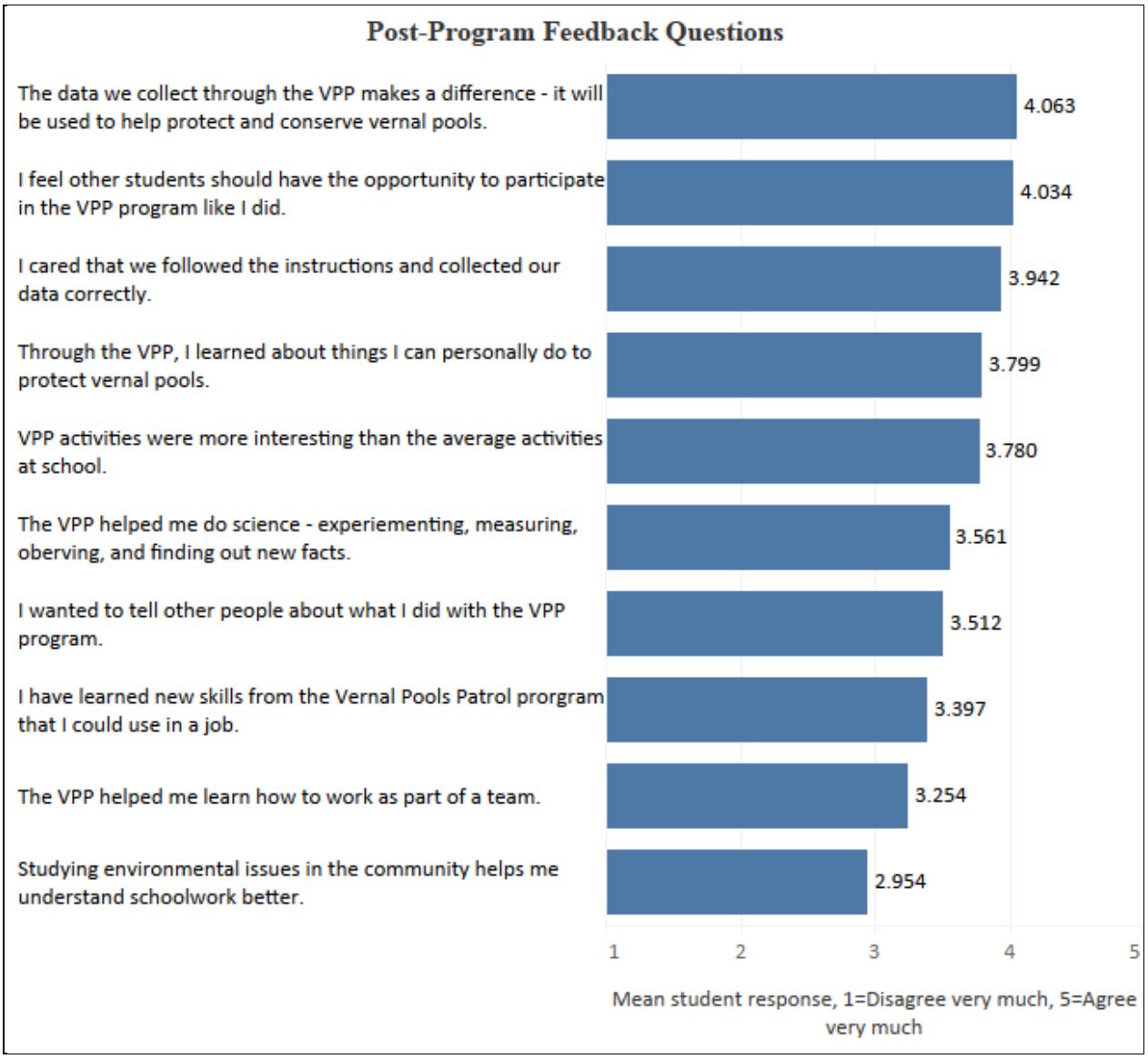

Figure 11

Students expressed modestly more positive attitudes about the program when they experienced both a wet and dry vernal pool visit. Figure 12 explores post-program feedback, separating students into two groups: those who experienced both a wet and dry vernal pool, and those who did not experience the pool in both its wet and dry phases.

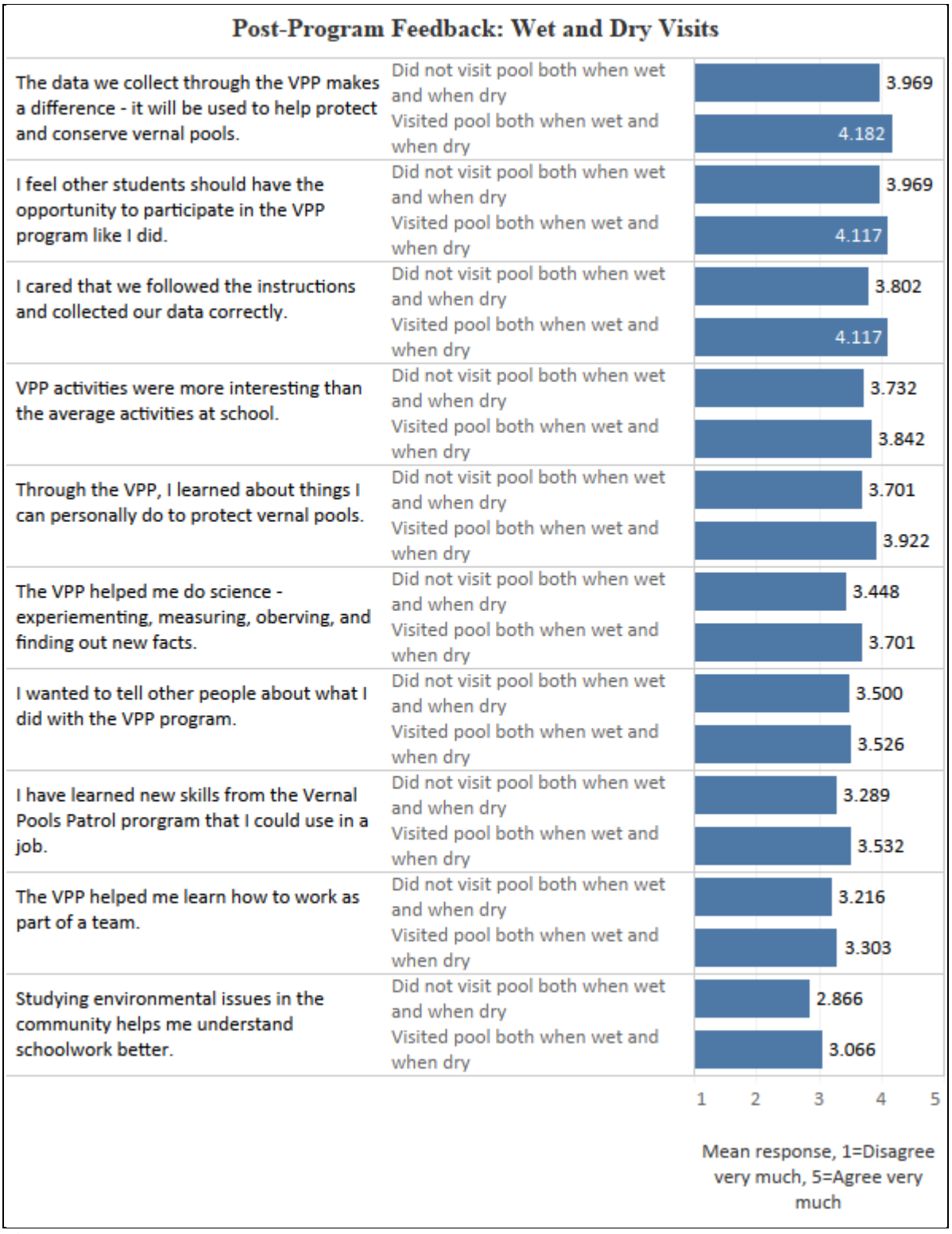
Post-Program Feedback: Wet and Dry Visits
The data we collect through the VPP makes a difference - it will be used to help protect and conserve vernal pools.
Did not visit pool both when wet and when dry
3.969
Visited pool both when wet and when dry
4.182
I feel other students should have the opportunity to participate in the VPP program like I did.
Did not visit pool both when wet and when dry
3.969
Visited pool both when wet and when dry
4.117
I cared that we followed the instructions and collected our data correctly.
Did not visit pool both when wet and when dry
3.802
Visited pool both when wet and when dry
4.117
VPP activities were more interesting than the average activities at school.
Did not visit pool both when wet and when dry
3.732
Visited pool both when wet and when dry
3.842
Through the VPP, I learned about things I can personally do to protect vernal pools.
Did not visit pool both when wet and when dry
3.701
Visited pool both when wet and when dry
3.922
The VPP helped me do science - experiementing, measuring, oberving, and finding out new facts.
Did not visit pool both when wet and when dry
3.448
Visited pool both when wet and when dry
3.701
I wanted to tell other people about what I did with the VPP program.
Did not visit pool both when wet and when dry
3.500
Visited pool both when wet and when dry
3.526
I have learned new skills from the Vernal Pools Patrol prorgram that I could use in a job.
Did not visit pool both when wet and when dry
3.289
Visited pool both when wet and when dry
3.532
The VPP helped me learn how to work as part of a team.
Did not visit pool both when wet and when dry
3.216
Visited pool both when wet and when dry
3.303
Studying environmental issues in the community helps me understand schoolwork better.
Did not visit pool both when wet and when dry
2.866
Visited pool both when wet and when dry
3.066
1
2
3
4
5
Mean response, 1=Disagree very much, 5=Agree very much

Figure 12

Open-ended/free-write items. Students were asked two open-ended questions at the end of the survey. The first varied modestly between years. The 2015-16 version was, "What is the most important thing you learned about yourself or your community from your work with the Vernal Pools Patrol program?" One hundred seventeen students wrote a response, and these were clustered into like categories. The categories and example responses are shown in Table 8.

Table 8: Student Learning about Self or Community—Key Themes

Comment theme	Frequency	Example responses
A fact about vernal pools	26%	◆ Vernal pools exist. ◆ What lives in vernal pools ◆ How to protect vernal pools ◆ That vernal pools are important to echo systems ◆ The most important thing is that I learned how to keep the environment clean and how much nature is important to us the environment and of course animals and insects. ◆ The most important thing I learned was some different little species I didn't know about, like caddisfly larvae. ◆ That it is a major impact on animal species. It helps them survive, and grow, and also reproduce so there species can live on. ◆ That we have a vernal pool in our community. ◆ To be carefull of were u r walking. ◆ You have to look very carefuly to find things
The importance of protecting vernal pools and/or the broader environment	26%	◆ It is important to protect the vernal pools. ◆ Do not disturb the delicate balance of nature. ◆ that there are amazing creatures in the vernal pools that we should watch out for and be careful. ◆ Dont be playing around with vernal pools. ◆ that we have somthing uniqe in negwon ◆ That if you take care of your enviroment then it makes our world a better place to live in. ◆ We as humans need to look at a more natural side at the damage we are doing, and we need to fix it. ◆ We have a special feature and we really care for it. ◆ That we need to keep doing our part to keep vernal pools health for animals.
Something learned about the community	14%	◆ That people are draining vernal pools for themselves, not knowing how special these pools are. ◆ Most people don't know about vernal pools ◆ They really care about nature and so do I. ◆ People do take certain measures to protect nature. ◆ Alot of people care about our community. ◆ That there people who love the out door like me.

Table 8: Student Learning about Self or Community—Key Themes		
Comment theme	**Frequency**	**Example responses**
		◆ That my community doesn't work super well togehter ◆ I learn that humans are doing a terrible job taking care of our planet. ◆ That nature is just as important as citizens in our community ◆ That people care less about the forest than they do each other. ◆ Our community does litter, but not tons.
We can make a difference	11%	◆ It is easy to help take action in helping the forest. ◆ Little changes make big differences ◆ We can all work as a team to find new things that give us a better understanding. ◆ I learned that even the littlest things we do to nature can have a major effect, so we should watch what we do and ask yourself if this will effect anything. ◆ If all of us work together we can make sure vernal pools stay around for a while. ◆ That I can keep vernal pools safe and that there amazing things. ◆ That together we can analized work and objects and help save pools ◆ You Need To Work Togather
I did not learn anything	10%	◆ Was not there. ◆ I didn't attempt ◆ I don't know. ◆ ? ◆ nothing! ◆ Nothing I learned these things in 6th grade.
This was fun	9%	◆ I learned that learning can be fun. ◆ That it is cool!!! ◆ That I injoy doing school related activitys out side of school in nature ◆ I learned that I enjoy watching wildlife. ◆ That nature and science is fun ◆ I learned its hard for me to work in groups, but finding the little organisms were fun ◆ That sometimes the smallest things are the most interesting in nature and I liked to seatch for them. ◆ I learned that there is a lot of nature in my community and that it is fun to do that stuff.

Table 8: Student Learning about Self or Community—Key Themes		
Comment theme	**Frequency**	**Example responses**
Other comments	7%	◆ I like firiey shrimp ◆ I don't like bugs. ◆ I don't like worms ◆ That you have to keep the patroled or else the species inside will go extict ◆ Its not my type of work ◆ That working as a team is easier to do that I thought. ◆ I really dont like miskitos
Totals	103%	

The 2016-17 version was, "How have your feelings about being a steward of the environment in your community changed, if at all, because of your work with the Vernal Pools Patrol program?" Forty-six students wrote a response, and these were clustered into like categories. The categories and example responses are shown in Table 8.

Table 9: Changes in Feelings about Stewardship—Key Themes		
Comment theme	**Frequency**	**Example responses**
Nothing has changed	46%	◆ Nothing has changed i am the same. ◆ I don't no what steward means. ◆ I don't really think my feelings about that have changed because I've always cared for nature. ◆ no i dont care about vernal pools nor will i ever
The importance of protecting vernal pools and/or the broader environment	13%	◆ I will protect more wetlands now that I know how important they are. ◆ i think we shouldn't cut trees down next to a vernal pool because it can harm it ◆ Its a tiny bit more important to keep nature the same ◆ It helped me realize that a vernal pool is a place that we need to protect because there are animals and plants that need them. ◆ I think we should help the environment no matter what. It is up to us to help it because we are the ones who probably did bad things to it. The VPP helped me know what I can do by myself as an individual. ◆ i feel we should do more to fix it

Table 9: Changes in Feelings about Stewardship—Key Themes		
Comment theme	**Frequency**	**Example responses**
A fact learned about vernal pools or the environment	9%	◆ It has helped me learn more about the environment and ecosystems ◆ it is something different from the before things I knew about the world. ◆ Not much change, just one more thing I would see in the woods, and know what it is ◆ I feel happy that I was able to experience and observe a vernal pool(s), because before this program, I had never even heard of a vernal pool.
We accomplished something	9%	◆ Yes, We picked up trash for the environment. Their were over 300 cigarette butts. ◆ yes it felt good going out and picking up everyone's trash at the parking lot and around there ◆ Yes, they have gotten slightly stronger because when I really went out and helped the environment, it felt good.
This was fun	7%	◆ I like looking at the creatures ◆ I think it was a fun and eventful experience. ◆ it seems more interesting after you actually went and did it. When we were talking about it in class its didn't sound to fun but when you actually go out and get involved its very fun and entertaining
I like vernal pools/all other comments	15%	◆ i feel good ◆ vernal pools are pretty interesting ◆ i care about vernal pools ◆ the vernal pool was nice ◆ I feel its a new begging. ◆ i think it was amazing ◆ Vernal pools are cool!
Totals	99%	

The second open-ended question asked for recommendations of how the program could made "more interesting or useful for students like you." Across both years, 163 students wrote a response, and these were clustered into like categories. The categories and example responses are shown in Table 10.

Table 10: Recommendations for Improvement		
Comment theme	**Frequency**	**Example responses**
No recommendations – good as is	79	◆ No nothing it was great ◆ No ◆ No, I think it is fine the way it is. ◆ Not really you guys are doing great.

Table 10: Recommendations for Improvement

Comment theme	Frequency	Example responses
More time in the field/different time of year/multiple times of year	21	◆ I think that we could go on field trips to vernal pools more than one time in the school year. ◆ I feel like we could spend more time out there so we have more time to observe. ◆ have a class that work with just vernal pools ◆ Maybe go to a vernal pool that acctually has water in it, and maybe like touch/hold important things. ◆ If I were a teacher I would make sure the pool was wet before we go to visit the pool because you will get a better understanding of what's in the pool. ◆ That the kids that went when the pool was drie coudl see it when I was wet and vice versa ◆ I I wish we couldn’ve stayed at the program longer so we wouldn't have so little time at each station. ◆ Do another program when the vernal pools are dried up. ◆ Have them come out twice when the pool is dry. ◆ More time to look at the habitat
Other quality suggestions	16	◆ make a few maps of where the vernal pools are located and when it is wet see if the citizen scientists can find it themselves. ◆ I say do more expirements. ◆ No, but we could bring the insects in the school study them more ◆ Use more technology that actual scientists use. ◆ Well we could start collecting data on indagerd species. ◆ Learn more about the species in vernal pools so we can identify them easily. ◆ Compare & contrast vernal pools & regular pool ◆ Bring classes out to help the vernal pools ◆ Have kids to more things, like help with everything. ◆ I think their should be more stations. ◆ You could have stronger microscopes to make it even better, but the ones there were good enough. ◆ You can make it so we look at all the plant around the pool or explain them better. ◆ A suggestion is to keep doing the things like letting us hold the caddisfly larvae and seeing what's in vernal pools. ◆ What I would recommend was to be able to do more things and get more information about the vernal pools. But nothing really. I overall thought the program was amazing and fun!! ◆ Yes, actually change what you are doing each time you visit. ◆ Go to more than 1 pool.

Table 10: Recommendations for Improvement

Comment theme	Frequency	Example responses
More time in the pool and other unlikely suggestions	12	◆ we should be able to bring a phone ◆ I would let students pick there groups. ◆ Food and Underwater robots. ◆ have more donuts ◆ Bring snacks ◆ I think let student bring extra cloths if they want to go in the water. And if the accidently fall in the water. ◆ We should go swimming. ◆ to be more to under water ◆ Not splitting the kids into groups because some kids might want to be with their friends instead of with peopel they don't know if they are with their friends they get more done. ◆ Looking for animals and going in the pool more. ◆ Catching salamanders, insects, and eggs more easy to see and not put right back into the water.
More fun, less talk	8	◆ make it fun some how any way ◆ make it shorter on talking and more doing stuff ◆ Don't be so boring. ◆ Maybe make some cool games or something? ◆ Make the presentation kids have to watch shorter. It was boring. ◆ You can play a game like name that larvae or spot the frog
Expand the program	6	◆ Get more people aware and involved. ◆ They can get more people to do vernal pool stuff. ◆ Start doing it more often and introducing it to other community just like our school district. ◆ I think if you guys did a summer program.
Provide/wear boots	5	◆ let the kids use your boots that u had in the car so they can do something i got to do nothing cause i don't have boot like that and i hated that i got to do nothing because its not fair that every one else got to do something and i did nothing! 😠 ◆ wear boots ◆ Provide wading boots/waders to kids so they can so they can really get into the vernal pools.

Table 10: Recommendations for Improvement		
Comment theme	**Frequency**	**Example responses**
All other comments	19	◆ just look for the animals ◆ instead of having groups and going to different stations we should just explore the vernal pool and walk around and learn for ourselves and if we have questions about what we see we can ask someone that is with us. also when we walk in the vernal poll mor ◆ Just to see the creatures that live inside it ◆ Let them explore more. ◆ Being able to look at some of the celis some of the insects look like ◆ i don't think i want to make it my career ◆ I don't know. Some people don't like the outdoors. ◆ keep going. ◆ YES! ◆ It will help you with alot of thing like science etc.
Totals	166	*Some comments were given multiple codes*

FINDINGS FROM TEACHER INTERVIEWS

In spring 2016, at the end of the first full school year, teacher interviews explored how the program was implemented in the varied sites; teachers' perceptions of the support they received, and how dependent they were on it; student enjoyment of the experience; what learning goals or standards teachers sought to address through the program, and how well those goals were met; teachers' willingness to recommend the program to others and to continue participating; and teachers' recommendations for improvement. In spring 2017, several of these questions were repeated, and where appropriate, teachers were also asked to compare their experience implementing the program alone, or (as was common) with a local partner, to their experience implementing with MNFI staff on site.

Eleven teachers were interviewed in late spring or early summer 2016 regarding the 2015-16 school year. Six participated in spring 2017 regarding the 2016-17 school year. Of the six 2017 interviewees, four had been interviewed the previous year and one's teaching partner was interviewed; the sixth was new to the program in 2016-17.

Implementation. Although it is ideal to visit the vernal pool both when wet and when dry, the nature of implementation was more varied (as is also shown in Table 2 on page 3 and Table 6 on page 12). Some teachers made multiple visits to the local vernal pool, but their participating classes were semester or trimester based, so students were not the same from visit to visit. Four teachers in year one did visits only in the spring. One teacher conducted the program after school, working with students who volunteered due to personal interest. Five teachers made fall and spring visits with the same students. In 2016-17, fewer teachers were interviewed, but five again made fall and spring visits with the same students, while one teacher visited the vernal pool in the fall only and one made multiple visits but with different students. Several teachers' implementation profile in the 2016-17 school year is not known.

Those implementing independently in 2016-17, after having been supported more extensively by MNFI in 2015-16, were asked if they used the PowerPoint presentation prepared and delivered by MNFI staff in year one, and if they made any changes to the program implementation when working on their own. Four of the five interviewees eligible for this question said they did use the PowerPoint; the fifth used "brochures and pamphlets" from MNFI but did not use the PowerPoint. When asked if they had made any changes to the program, several said they had, but those changes were typically minor. One added the MEECS[1] curriculum, and another said, "we did a little pre-reading about biodiversity." A third teacher, who has worked with an MSU Extension educator to implement the Vernal Pools Patrol Program over the last three years said, "It ran the smoothest ever" because she and the partner continue to work on systems to stage groups of students in the field and to avoid stirring the vernal pool.

One teacher collected substantially less data in 2016-17 than the previous year because the weather aligned poorly with his other scheduling priorities and pressures. Additionally, the teacher said he is trying to combine the VPP with student use of a BioBlitz app developed by National Geographic. The teacher said the immediate area of the vernal pool is changing, with a growing phragmites problem and recent flooding.

Student engagement. Almost without exception or reservation, teachers said the students enjoyed and were highly engaged by the program. Typical comments included the following:

[1] MEECS stands for Michigan Environmental Education Curriculum Support. The program is offered by the Michigan Department of Environmental Quality. See http://www.michigan.gov/deq/0,4561,7-135-3307_3580_29678---,00.html for more information.

"They loved it."

"They were super into it."

"High. Very high engagement."

"The highest you can give it."

"I have kids on all different academic levels. Some are never engaged—but they were there."

Teachers themselves enjoyed the Vernal Pools Patrol program as well.

Support. Teachers felt confident and well supported in the program. In year one, they were asked if having MNFI staff present in person in the classroom and for at least one field visit was "necessary for success," "helpful but not necessary for success," or "not necessary for success." Eight of eleven interviewees said it was "necessary for success." Two teachers said it was "helpful but not necessary for success," and the last interviewee has worked continuously with a partner from MSU Extension and the question was not relevant to her situation.

Teachers were also asked, after initial vernal pool visits with MNFI staff, how well prepared they were to carry out visits without staff present, on a scale of "very prepared," "prepared," "somewhat unprepared," or "very unprepared." This question prompted more of a range of responses:

- Three teachers said they felt "very prepared," although two of these had carried out a first field visit with a local partner and therefore did not actually carry out a field visit in a fully independent way. An additional teacher felt "well prepared."
- Seven teachers said they felt "prepared." Two had local partners and did not actually need to carry out a field visit independently. Others offered some caveats:

"Prepared—but not to take 30 students. It's a hard environment with 30."

"I still feel like I need to get a better grasp on all the different types of plant life that's out there. Then, it was nice to have the AmeriCorps volunteers there because we did have somebody who had experience with aquatic invertebrates. She was able to talk about the macro invertebrates and give the names. If it didn't match the paperwork—I had materials that had been provided, but not all of the larva we were seeing matched the pictures of the larva and it was nice to have her there because she would say, 'Oh, that's a predatory water beetle,' or something like that."

- Three teachers were less confident. One said, "I could do it myself with the same group, but otherwise I would need help." The last two teachers rated their preparedness as "right down the middle" and "somewhat unprepared." They offered the following explanations:

"I would need about three more visits with them to feel I was doing quality work. If I was going out on my own, I definitely would have more adults with me. We did have some volunteers with us, so, that was nice to have. It would not have been done to quality had I not had those ladies with me. And, the things that I would need to take with me are not readily available to me here in the school. They had that. Made it a quality experience for my students I cannot provide for those students at this point. I would need a few years to build up some supplies to take out there with me."

> "I knew what my group did, but I didn't know what all the other groups did. Even though it was written in the thing, I didn't really know how they went about it. The kids knew, cuz they were in the same groups as the time before. I had supplies, but they had better supplies. They had a better microscope—they had a better magnifier microscope. They gave us materials to take too. We used those, which was very helpful. She even brought us equipment to use. Things get so hectic. It's like I'm trying to get permission slips in. I was more thinking about that than what I was gonna do. … [But] Maybe the adult doesn't have to know everything. I mean, [the students] really—they took charge of it."

Teachers also said the initial field visit and related preparation was "very well organized." Nine gave this rating, while one said the program was "pretty" organized, and the last, "well organized." Year-one teachers felt the staff was receptive to their scheduling needs and very responsive to their questions, and the program was carried out as they expected and as advertised. One teacher offered an additional comment to this effect:

> "I think the visit with Yu Man and the other specialist was wonderful and going outdoors with them was great and I felt very supported because I hadn't done a bigger outing like that with the class. It gave me the encouragement. I'm a relatively new teacher and so it gave me that confidence that, oh, I can do this, and we can go out and we can be outdoors and have an outdoor classroom without it turning into PE … It was nice to have that experience with that support, and then she's continued to follow up consistently and just sort of be there in case we needed her. That was nice too. It didn't feel like she just disappeared."

Educational value. Teachers were asked to rate the program's educational value for their students on a scale of "excellent," "good," "fair," or "poor." Fourteen teachers rated the program an "excellent" educational experience for students, and one rated it as "good," "because I teach English language arts and not science."

Teachers were asked about learning benefits they hoped to realize through the program. The most common focus, expressed by ten teachers, was habitat, ecosystems, ecology, and interconnectedness. Teachers focused on this area spoke of "learning the importance of varied habitats," "ecology and interconnectedness, and this special ecosystem," "what a vernal pool is and how it is a habitat," "specialized ecosystems," and the like.

Five teachers spoke about data collection. A few spoke of analysis, but a few also said that they recognized they didn't cover analysis with the program. Five teachers (mostly different teachers) also spoke of working with "an actual scientist," learning about "citizen science," learning about science careers, and learning what "ecological field data collection looks like," and how it's "not always glamorous."

Other science topics listed by at least one teacher included "change and life cycles," "biodiversity," "biotic and abiotic factors," "food chain and food web" (which was noted to align to sixth grade science standards particularly well), and "ability to identify specific species" or "learning what's out there, like fairy shrimp and larvae." One teacher's overarching goal was for the students to see the dramatic change between fall and spring. Another noted that the program has potential ties to topics in the earth sciences and to hydrology.

Several teachers also spoke of learning goals not explicitly tied to science learning. Three wanted their students to learn about the local environment "around them," "their surroundings and where they can

recreate. Similarly, three focused on better environmental stewardship or "participating in their community" and "helping beyond themselves." A final teacher emphasized the development of critical thinking skills through real-world work.

Teachers were asked if they realized the benefits they sought, and all said they did. When asked if there were additional, non-academic benefits realized for themselves or their students, several teachers offered observations:

> "It's always a good relationship builder, too, because they get to see—you're just sharing that experience and that interest together. I always feel closer to my kids after we do a field trip."
>
> "A personal benefit for me is I'm excited about this and being involved in this. It's kinda helped me refuel my, just rejuvenation for teaching and just that whole aspect of not getting bogged down. It's been helpful for me to be excited about something that I've kind of initiated to be involved in versus the administration says you need to do such and such. It's kind of been driven from myself and it's been really rewarding."
>
> "I really think it was just such a great benefit to learn about this special type of a wetland, because… Often times, I would be walking on hikes and then think—I would wanna avoid those areas and not be aware that they have those indicator species living there and only there. I think it just really opened up the world for me. I think for many other students too to discover that, oh wow, there's more than just mosquitoes. … I do think that the children have grown to care about more areas—they'll look more closely at wherever they go because of learning about the special thing that we otherwise wouldn't have run across most likely."
>
> "Students got a chance to meet specialists in scientific fields of study. That's important too."
>
> "A lot of our students are—they do spend time outdoors, but a few other ones are cooped up. For them to acclimate, to be able to be comfortable outside, as opposed to inside all the time, I think that that has a wellness impact on them. I'm hoping that they learn from that."

Other observations focused on learning to use microscopes, "being able to work independently with a stranger," students "pushing their boundaries," becoming aware of citizen science, having a "new way to look at the landscape," working in groups, and "for both myself as a teacher and for my students, a deeper connection to the local community."

Teachers participating in year two were asked if the absence of MNFI staff diminished the experience. Three teachers were able to respond. In terms of learning benefits, the teachers felt the experience was still very positive, but noted that MNFI staff have special expertise, and that some questions staff likely could have answered went unanswered, and that the exposure to "real scientists" was a lost benefit. In terms of student engagement, teachers similarly noted that engagement was still very high, yet having fewer people and lacking some specialized equipment may have diminished enjoyment slightly.

A final item related to educational value was assessments. Many teachers did not do assessments beyond the pre/post test used in this evaluation. A few did modest formative assessments; one teacher did a project where students selected from options including a PowerPoint, a podcast, a poster, or a song or rap; one teacher made the material "fair game" on her quizzes and midterm exam; and a last gave a short quiz.

Recommendations. In the first year, the most common recommendations to modify or strengthen the program (offered by four teachers) included providing additional, thematically related resources to allow teachers to extend or build on the experience. Three generally suggested that MNFI could provide access to related information such as videos, magazines, periodicals, or assessments; these teachers all felt that teachers themselves could supply information about extensions they had used to help the MNFI build a library (although none could supply that information during the interview and it appeared this had not in fact occurred in this recent school year). Also suggested by this group was access to information about related environmental issues such as phragmites, which may be located near many vernal pools. A fourth teacher suggested that MNFI should find ways to extend the VPP experience to involve students more directly in data submission, or make the cross-site/time-series data available so that students could do data analysis or interpretation.

Several additional recommendations were offered by one or two teachers each and year one. Two teachers expressed some concern about the size of student groups during field work. One could not see how she could involve all her students due to concerns about environmental impacts; a second felt the group sizes during the first year had been too large. One teacher wondered if there could be an option to "take a pass" on the initial lecture, or ways to make it more interactive; however, many other teachers commended the lecture and found it useful preparation. One teacher hoped for more flexibility on the timing of late spring visits because of the need to "do what nature asks," i.e., due to the reality of when the pools are exhibiting the features of interest. A last suggested that, if the MNFI could crosswalk the program to the Next Generation Science Standards, it would help teachers document what standards were addressed.

In year two, teachers offered a few new recommendations. One teacher said, "I would like specific guidance on this topic: how many should be in the pool? I don't know how many would be too much." Another said the group had "some questions about the forms and how to go about filling them out," and suggested that MNFI "give a sample form to show what parts need to be filled out. It would be really nice if it was separated for different groups to do—one group measuring, one group photographing, and so on."

Willingness to recommend and repeat. Every teacher interviewed said he or she would recommend it to a colleague. All but two teachers would "definitely" do the program again. One of these faced significant challenges related to transporting students and this was the reason for hesitation. The other teacher would do it again if there were sufficient adults to support it and if transportation costs could be met.

The teachers were asked how they would present the program to a colleague to whom they were recommending it. Their "pitches" would emphasize:

> "It's a way to actively engage students to reinforce the content knowledge."
>
> "Great exposure to scientific research."
>
> "There's support - they will help you get started, and there can be community partners to continue the support."
>
> "It's a manageable, interesting way to get your students outside learning the ecosystem, a hands-on way to gather data and put it to use."
>
> "Kids are really fired up and interested. It's cool to see [a vernal pool] at different times."

"When trying to do place-based education, it may seem too broad, and this is a focused type of wetland, it seems a bit more defined. Yu Man and the other specialists are great; I felt supported, and it gave me the confidence to be outdoors."

"It is a fun, very rewarding activity that teaches about our local area and the science in it. It gives them buy-in into the natural areas. Fun!"

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. **Teachers are enthusiastic about the program**. They say it delivers science learning benefits in the areas of ecosystem and habitat science, data collection, and exposure to real-world science and scientists. They also say that students are highly engaged, and that both students and teachers benefit from the opportunity to spend time outdoors exploring community resources.
2. **Every teacher interviewed said he or she would recommend the program to a friend**. Their "pitches" emphasized student engagement and the "fun" factor, the quality of support, that the program is manageable due to the support and its defined nature, and that the work is authentic and "real."
3. **With rare exceptions, teachers depend on either MNFI staff or a knowledgeable local partner to carry the program out, particularly the field work**. In year one, most of the teachers interviewed said having MNFI staff present was "necessary for success." In year two, those teachers able to be interviewed had generally transitioned from MNFI support to the support of a local partner. Teachers frequently depend on MNFI or the local partner for help overseeing student groups working on varied tasks and for identifying species. In some instances, teachers also felt that MNFI-supplied equipment was helpful, if not essential.
4. **Students were also generally enthusiastic about the program.** When asked to improve it, nearly half offered no recommendations, and many of these indicated the program was "great as it is" and "fun." The next most common response was to suggest that the program be expanded—with more time in the field, or more related activities in the classroom—indicating that the students wanted more and appreciated what they had experienced. On the post-program survey, students were likely to agree that the data collected through the program will make a difference, and that other students should have the opportunity to participate: both of these items earned an agreement score of more than 4 on a 5-point scale.
5. **Student science learning related to vernal pools was evident.** Scores on the multiple choice section of the pre/post test and on a short-answer question about the distinguishing features of vernal pools both showed sharp increases, with very large effect sizes of more than 1.0—indicating improvements of more than a full standard deviation. Scores on another short-answer question related to the benefits of vernal pools, and on a short answer/essay question about adaptations for survival in vernal pools also showed large positive effects of 0.58 and 0.72, respectively. Student performance was not extraordinary on the posttest, but learning gains were impressive, indicating that the test is not too easy.
6. **Student stewardship gains were less notable than learning gains but some change was evident**, particularly in the areas of attitudes about the environment (where an effect size of 0.42 was exhibited) and civic capacity (where an effect size of 0.43 was documented). These effect sizes are moderate, and based on a limited number of items, but suggest that the program is contributing to enhanced stewardship attributes.
7. **Wet and dry visits were associated with slightly more positive results**. Students who were able to visit a vernal pool both when wet and when dry exhibited slightly stronger pre-to-post impacts than students who did not experience the vernal pool in both the wet and dry condition.

Further, students who did not have the opportunity to see the pool both when wet and dry frequently recommended the program be changed to allow this in the future.

8. **Many students were unable to visit the vernal pool both when wet and when dry.** Barriers reported by teachers included teaching on a semester or trimester basis, difficulty when the weather didn't align with the intended travel schedule, and challenges with transportation. One teacher conducted the program after school due to a school policy that requires every student in the grade be offered the chance to participate in any field trip. Some teachers joined the program later in the year and only made spring visits.
9. **Teacher-recommended enhancements include add-ons and "extenders" and some clarifications about field protocols.** Teachers are interested in doing more with the program although the observed pattern indicates few have time to build out their own additional lessons or assessments.

Recommendations

1. **MNFI should strive to maintain the core of the program in as-is form.** Often, in an evaluation like this, suggestions are made by students or teachers for options to improve the program. While these suggestions are important and should be considered, it is important to remember that the core program is well reviewed as it is, and changes should enhance rather than radically alter the experience, as big changes are likely to produce their own unforeseen consequences.

2. **MNFI should seek out sites for implementation where there is an able and willing partner to assume the MNFI role in times when MNFI is not funded to visit schools, deliver PowerPoints, and participate in site visits.** With rare exceptions, teachers do not express confidence in their ability to do it alone: they need the people power of a partner as well as technical expertise in species identification and other aspects of ecology. MSU Extension, land trusts, watershed councils, and institutions of higher education may all be potential partners, and the AmeriCorps program may be a way to supplement the staffing capabilities of local partners. GLSI hubs may also be potential partners, although MNFI should note that several have more expertise in teaching than in natural resources.

3. Opportunities to strengthen the program may include the following:

    a. **Crosswalking the program to the Next Generation Science Standards, with a particular emphasis on the eight science and engineering practices**.[2] Tying the

[2]The practices are:

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

program to the Next Generation Science Standards could help teachers understand its potential, and could also be a process that helps the MNFI identify "extenders"—activities that could be added onto the core experience to deepen learning. In particular, the eight NGSS Science and Engineering Practices identify skills that students should be developing, and several of these have obvious and currently untapped application to the program.

b. **Developing model, authentic assessments**[3] could also help teachers take the program to the next level in terms of learning benefits. MNFI could contract for this service, or could write grants that offer a stipend to teachers willing to develop and share such assessments.

c. **Collaborating with stewardship experts to offer optional add-ons that involve students in a service activity related to vernal pools.** While ecological knowledge is part of environmental stewardship, other aspects of stewardship are affect-based and skill-based: communicating with others about the environment, feeling a connection to nature, being disposed to protect the environment and support conservation measures, and joining with others to take action on the environment. Research on stewardship suggests that a few features of environmental education programs are important: those particularly relevant to the VPP model may include student voice (allowing students to make choices about what they want to study and what they choose to do to enhance the community or protect the environment); seeing the outcome of their choices (i.e., seeing tangible improvements associated with their own efforts); and having reflection opportunities.

d. **Building a learning community.** The MNFI has already developed a Google Drive folder with resources, and a broader learning community effort is underway. Delivering this resource could help teachers develop a peer community around the VPP.

e. **Responding to selected student suggestions.** Students offered several valid suggestions listed on page 23 under the header "other quality suggestions."

f. **Share common misconceptions and limits to learning with program facilitators.** This evaluation has revealed several misconceptions among students, or limits to achieved learning. For example, students often perceived vernal pools as "more special" than other wetlands; had little to say about human benefits from vernal pools; and their understanding of physical adaptations related to vernal pools improved sharply but was still relatively limited. Sharing the findings can help all program facilitators fine-tune their presentations while working with students and teachers.

4. **MNFI should be continuously cautious about the logistical challenges that teachers face in participating in the program.** Getting students to distant vernal pools, adapting the schedule to

[3] "Authentic" assessments result in products relevant in the real world, such as presentations, data analysis summaries and research reports, brochures, signage, podcasts, or other means of outreach and reporting.

permit field visits when the vernal pool is both wet and dry, recruiting adults to help chaperone and guide students—all of these have the potential to prevent a teacher's initiation or successful conclusion of the program in any given year. The current educational climate imposes many limitations on teachers' schedules and flexibility. These factors reinforce the importance of supportive partners and careful selection of appropriate sites for the program.

5. **MNFI should modify the program evaluation in several ways.** The recommended changes include some for any future evaluation, and some for future evaluation with limited funding. In *any* future evaluation, the MNFI should modify question #3 on the 2015 pre/posttest, as students exhibited no pre-to-post gains. The MNFI should also evaluate whether question 8, as framed (with its emphasis on the distinctions between vernal pools and other wetlands) is aligned with learning goals, as discussion of the scoring suggested that there was some uncertainty on this issue among staff. Finally, MNFI should also reevaluate question #10, focused on physical adaptations, as it may be too difficult as written. In future evaluations *with limited funding*, the MNFI should consider reducing or eliminating open-ended test and survey questions, as these are time-intensive to score, and should consider a shorter, retrospective pre/post survey in lieu of the survey used in this evaluation, which included numerous items. In general, the MNFI should understand that both a pure pre/post survey, and a retrospective pre/post survey, have methodological limitations vis-à-vis a pure pre/post survey with a control group—a standard difficult to achieve in most settings. MNFI should be prepared to explain the choices it makes and to acknowledge the methodological limitations inherent in that choice.

APPENDIX A: TEACHER INTERVIEW PROTOCOLS

2015-16 School Year

1. I understand that you teach/taught grade(s) _____describe_____ and (subjects) _____describe_____ this year, and that involved [all of your students/this group of your students (describe)] in the program. Do I have that right? *Confirm grades, subjects, portion of students engaged in the VPP.*

2. Please tell me briefly about the timeline of your work with the Vernal Pools Patrol program this year. Did you do a fall and spring visit? *Establish timeline and any unusual characteristics in the way the teacher and students engaged with the program.*

3. Sometimes, students and teachers who get involved in the VPP program are engaging in *other,* complementary hands-on activities having to do with the environment or with stewardship. Is that the case for you and your students? *If yes:* What other types of things did you do this year?

4. I would like to understand how well the VPP worked for you from an organization and logistics standpoint. As you know, in this program you initially visit the vernal pool with staff, then you as the teacher manage the visit or visits to the vernal pool.
    a. Thinking about the time when you went through the field visit and preparation *with a Vernal Pools Patrol staff person to guide you*, would you say the process was very well organized, organized, somewhat disorganized, or very disorganized?
    b. *If less than very well organized*, in what ways was the experience less than very well organized?
    c. Now thinking about the time when you went through the visit and preparation on your own, do you feel you were very well prepared, prepared, somewhat unprepared, or very unprepared to guide the students?
    d. What problems or challenges did you encounter working on your own? How could the process be revised to address this for other teachers in the future?
    e. Thinking about the importance of having staff from the Natural Features Inventory with you on your initial visits to the vernal pool, would you say that having them along was necessary for success, helpful but not necessary for success, or not necessary for success?

5. I am curious to know how engaging the experience was for students. How would you characterize their level of interest and enjoyment?

6. Now, I want to ask you about the fit of this program with your responsibilities as a teacher. What content knowledge or process skills did you hope students would gain from participating in this program?

7. Keeping in mind what <u>you</u> wanted students to learn and be able to do, was the program an excellent, good, fair, or poor educational experience for students?

8. What would you say were the chief learning benefits? Did you assess their learning in any way beyond the pre/post test that MNFI provided?

9. Are there learning benefits you thought would occur that did not?

10. And are there other types of benefits you think you got, either for yourself as a teacher or for the students?

11. Are there certain types of students for whom this program worked particularly well? Particularly poorly?

12. Are there ways this program should be modified so that it will fit better in your curriculum?

13. Would you recommend this to a colleague? What would you tell them about it?

14. And for yourself in the future, which of these statements best reflect your thinking? Why do you feel that way?

    a. I would definitely do this again.
    b. I would do this again *if*....and fill in the blank _____
    c. I would probably not do this again

2016-17 School Year

1. First, I was hoping to get an update on your teaching responsibilities and students this year. What subject or subjects are you teaching? _____

   And what grade levels? _____

   About how many students did you work with this year? _____

   And of these, how many did you involve in the Vernal Pools Patrol work? _____

2. Sometimes, students and teachers who get involved in the VPP program are engaging in *other,* complementary hands-on activities having to do with the environment or with stewardship. Is that the case for you and your students? *If yes:* What other types of things did you do this year?

3. The next questions have to do with how you used the vernal Pools Patrol program this year?

    a. How many pool visits did you do, and on what timeline?

    b. Did any other teachers work with you this year?

    c. Did you use the slideshow with students that MNFI staff delivered last year?

    d. Did you modify or add to the program in any way, for example by tying in additional content, or adding or subtracting specific data collection tasks, or creating your own assessments? *If yes,* What did you do and how well did it work out?

4. I would like to understand how well the VPP worked for you from an organization and logistics standpoint.

    a. Do you feel you were *very well prepared, prepared, somewhat unprepared,* or *very unprepared* to guide and manage the students in the field?

    b. Do you feel you were *very well prepared, prepared, somewhat unprepared, or very unprepared* to introduce the material to students in the classroom and help them close out the process?

    c. Compared to times when you worked with MNFI staff to bring students to the vernal pool, would you say that this year was *even more successful, about equally as successful, somewhat less successful, or substantially less successful*?

    d. What problems or challenges did you encounter working on your own? How could the process be revised to address this for other teachers in the future?

5. Overall, how would you characterize the students' level of interest and enjoyment?

6. Do you feel student interest and enjoyment this year was affected either positively or negatively by the fact that MNFI staff were not present?

7. Keeping in mind what <u>you</u> wanted students to learn and be able to do, was the program an excellent, good, fair, or poor educational experience for students?

8. What would you say were the chief learning benefits?

9. Are there ways in which learning benefits were affected by not having MNFI present?

10. And are there other types of benefits you think you got, either for yourself as a teacher or for the students?

11. Would you recommend this to a colleague, assuming they would have the same onboarding experience that you did? What would you tell them about it?

    Rec Y N Maybe Other

12. And for yourself in the future, which of these statements best reflect your thinking?

    a. I would definitely do this again.

    b. I would do this again *if*....and fill in the blank

    _____

    c. I would probably not do this again

    Why do you feel that way?

13. What additional support would help make the program more doable for teachers like you who are trying to do it independently?

14. Is there anything else I should know about the Vernal Pools Patrol Program?

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Appendix B: Vernal Pool Patrol Program
Pre- and Posttest, 2015-16 School Year

Your name: _____Your grade: _____

Your school: _____

Your teacher's name: _____

What is the name of the class/period/hour you are in? _____

Today's date: _____

Are you male ❒ or female ❒ ?

Read each multiple-choice question carefully, and circle the letter of the one best answer.

1. **What is a vernal pool?**
   a. A small pond that provides breeding habitat for fish
   b. A special type of wetland that holds water or is wet for only part of the year and provides habitat for unique animals and plants
   c. A special type of wetland found only in Michigan
   d. All of the above

2. **Which of the following are "indicator species" for vernal pools?**
   a. Spotted salamanders, bullfrogs, wood frogs, and painted turtles
   b. Fairy shrimp, wood frogs, spotted salamanders, and blue-spotted salamanders
   c. Both A and B
   d. Neither A nor B

3. **Which of the following statements is FALSE?**
   a. All vernal pools have many different types of plants growing in them.
   b. Vernal pools can contain plants that normally grow in *wet* places, and plants that normally grow in *dry* places.
   c. Plants and decomposed matter are the largest source of nutrients in most vernal pools, and form the bottom of the food web.
   d. By studying the plants in an area, you can learn if that area might be a vernal pool, and how long it might be wet.

4. **Which of the following species can be found in vernal pools when they are wet AND when they are dry?**
   a. Fingernail clams and snails
   b. Millipedes
   c. Mosquito larvae
   d. All of the above

5. **Which of the following can be harmful to vernal pools and the plants and animals that live in them?**
   a. Disturbing the pool by walking in the pool
   b. Climate change affecting the amount and timing of rain, snow, and dry and hot periods
   c. Removing all the plants, shrubs or trees in or around the pool
   d. All of the above

6. **Which of the following statements is NOT TRUE?**
   a. Vernal pools are unique and can be very different within an area and even within a year.
   b. There are no laws against disturbing or damaging vernal pools in Michigan.
   c. Vernal pools can be hard to find because they are small, and they dry up.
   d. We have good information on how many vernal pools are in Michigan, where they are located, and what condition they are in.

7. **What is citizen science?**
   a. Studies or research in which non-scientist volunteers collect specific information about nature (or other topics of study), and share it with professional scientists
   b. Studies or research about vernal pools
   c. Studies or research about citizen behaviors like voting, signing a petition, or running for election
   d. None of these

8. **What are some differences between vernal pools and other ponds or wetlands?**
   List three. If you can't list three, list as many as you can.

   1. _____

   2. _____

   3. _____

9. **What are some ways in which wetlands like vernal pools are important to forests, animals living in forests, or people?** List three. If you can't list three, list as many as you can.

   1. _____

   2. _____

   3. _____

10. **In the space below, describe one plant or animal adaptation that is useful for surviving in a vernal pool.** Describe the adaptation, and tell how it helps the plant or animal survive in a vernal pool.

Appendix C: Vernal Pool Patrol Program
Program Survey
2015-16 School Year

Your grade: _____ Your school: _____

Today's date: _____Your teacher's name: _____

What is the name of the class you are in? _____

Are you male ❒ or female ❒ ?

How much do you agree or disagree? For each sentence, circle only the **one** answer that best matches your answer. Please do not leave any blanks.

	Disagree very much	Disagree	Not certain	Agree	Agree very much
I have learned new skills from the Vernal Pools Patrol program that I could use in a job.	1	2	3	4	5
I feel other students should have the opportunity to participate in the Vernal Pools Patrol program like I did.	1	2	3	4	5
Studying environmental issues in the community helps me understand schoolwork better.	1	2	3	4	5
I cared that our Vernal Pools Patrol work was done correctly.	1	2	3	4	5
I wanted to tell other people about what I did with the Vernal Pools Patrol program.	1	2	3	4	5
The data we collected through the VPP makes a difference - it will be used to help protect and conserve vernal pools.	1	2	3	4	5
Through the Vernal Pools Patrol Program, I learned about things I can personally do to protect vernal pools.	1	2	3	4	5
The Vernal Pools Patrol program helped me learn how to do science - experimenting, measuring, observing, and finding out new facts.	1	2	3	4	5
The Vernal Pools Patrol program helped me learn how to work as part of a team.	1	2	3	4	5
The Vernal Pools Patrol program activities were more interesting than the average activities at school.	1	2	3	4	5

What do you think now? Please answer the questions that follow focusing on how you feel **NOW**.

	Disagree very much	Disagree	Not certain	Agree	Agree very much
Humans have the right to modify the natural environmental to suit their needs.	1	2	3	4	5
I would enjoy a career that focuses on environmental issues.	1	2	3	4	5
The balance of nature is very delicate and easily upset.	1	2	3	4	5
We must take stronger measures to conserve our nation's resources.	1	2	3	4	5
By working with others in the community I can help make things better.	1	2	3	4	5
In the future, I would be willing to work with others to solve an environmental problem in the community where I live.	1	2	3	4	5
I know how to talk to other people about environmental issues in our community and the things we should do to solve those problems.	1	2	3	4	5
I know how to gather information about an environmental problem in my community.	1	2	3	4	5
I really enjoy nature.	1	2	3	4	5
I like to watch what birds, wildlife, and insects do outside.	1	2	3	4	5
In the future, I would be willing to volunteer for citizen science projects.	1	2	3	4	5

What did you think then? Think back to **BEFORE** you began your work with the Vernal Pools Patrol Program. How would you have answered these questions then? Please circle the answer that best reflects your thinking **THEN**.

	Disagree very much	Disagree	Not certain	Agree	Agree very much
Humans have the right to modify the natural environmental to suit their needs.	1	2	3	4	5
I would enjoy a career that focuses on environmental issues.	1	2	3	4	5
The balance of nature is very delicate and easily upset.	1	2	3	4	5
We must take stronger measures to conserve our nation's resources.	1	2	3	4	5
By working with others in the community I can help make things better.	1	2	3	4	5
In the future, I would be willing to work with others to solve an environmental problem in the community where I live.	1	2	3	4	5

	Disagree very much	Disagree	Not certain	Agree	Agree very much
I know how to talk to other people about environmental issues in our community and the things we should do to solve those problems.	1	2	3	4	5
I know how to gather information about an environmental problem in my community.	1	2	3	4	5
I really enjoy nature.	1	2	3	4	5
I like to watch what birds, wildlife, and insects do outside.	1	2	3	4	5
In the future, I would be willing to volunteer for citizen science projects.	1	2	3	4	5

What did you do with the Vernal Pools Program? Please put an "X" in the box next to ALL of the activities that you personally participated in as part of the Vernal Pools Patrol Program.

- ❒ Collecting data on WET vernal pools
- ❒ Collecting data on DRY vernal pools
- ❒ Presenting your findings to people who are not students at your school, such as parents, the school board, or a community organization
- ❒ Analyzing vernal pool data collected by YOUR class
- ❒ Analyzing vernal pool data collected by OTHER classes

What is the most important thing you learned about yourself or your community from your work with the Vernal Pools Patrol program?

Do you have suggestions to make the Vernal Pools Program more interesting or useful for students like you?

You have reached the end! Please fold your survey in half with the plain side out, and return to your teacher.

Appendix D: Vernal Pool Patrol Program
Pretest 2016-17 School Year

Your name: _____Your grade: _____

Your school: _____

Your teacher's name: _____

What is the name of the class/period/hour you are in? _____

Today's date: _____

Are you male ❒ or female ❒ ?

Read each multiple-choice question carefully, and circle the letter of the one best answer.

1. **What is a vernal pool?**
   a. A small pond that provides breeding habitat for fish
   b. A special type of wetland that holds water or is wet for only part of the year and provides habitat for unique animals and plants
   c. A special type of wetland found only in Michigan
   d. All of the above

2. **Which of the following are "indicator species" for vernal pools?**
   a. Spotted salamanders, bullfrogs, wood frogs, and painted turtles
   b. Fairy shrimp, wood frogs, spotted salamanders, and blue-spotted salamanders
   c. Both A and B
   d. Neither A nor B

3. **Which of the following statements is FALSE?**
   a. Almost all vernal pools have many different types of plants growing in them.
   b. Vernal pools can contain plants that normally grow in *wet* places, and plants that normally grow in *dry* places.
   c. Plants and decomposed matter are the largest source of nutrients in most vernal pools, and form the bottom of the food web.
   d. By studying the plants in an area, you can learn if that area might be a vernal pool, and how long it might be wet.

4. **Which of the following species can be found in vernal pools when they are wet AND when they are dry?**
   a. Fingernail clams and snails
   b. Millipedes
   c. Mosquito larvae
   d. All of the above

5. **Which of the following can be harmful to vernal pools and the plants and animals that live in them?**
   a. Disturbing the pool by walking in the pool
   b. Climate change affecting the amount and timing of rain, snow, and dry and hot periods
   c. Removing all the plants, shrubs or trees in or around the pool
   d. All of the above

6. **Which of the following statements is NOT TRUE?**
   a. Vernal pools are unique and can be very different within an area and even within a year.
   b. There are no laws against disturbing or damaging vernal pools in Michigan.
   c. Vernal pools can be hard to find because they are small, and they dry up.
   d. We have good information on how many vernal pools are in Michigan, where they are located, and what condition they are in.

7. **What is citizen science?**
   a. Studies or research in which non-scientist volunteers collect specific information about nature, and share it with professional scientists
   b. Studies or research about vernal pools
   c. Studies or research about citizen behaviors like voting, signing a petition, or running for election
   d. None of these

8. **What are some differences between vernal pools and regular ponds or wetlands?** List three. If you can't list three, list as many as you can.

   1. _____

   2. _____

   3. _____

9. **What are some ways in which vernal pools are important to forests, animals living in forests, or people?** List three. If you can't list three, list as many as you can.

   1. _____

   2. _____

   3. _____

10. **In the space below, describe one plant or animal adaptation that is useful for surviving in a vernal pool.** Describe the adaptation, and tell how it helps the plant or animal survive in a vernal pool.

How much do you agree or disagree? Please circle one number on each row. There are no right or wrong answers to these questions; they are about your beliefs, likes, and dislikes.

	Disagree very much	Disagree	Not certain	Agree	Agree very much
Humans have the right to modify the natural environmental to suit their needs.	1	2	3	4	5
I would enjoy a career that focuses on environmental issues.	1	2	3	4	5
The balance of nature is very delicate and easily upset.	1	2	3	4	5
We must take stronger measures to conserve our nation's resources.	1	2	3	4	5
By working with others in the community I can help make things better.	1	2	3	4	5
In the future, I would be willing to work with others to solve an environmental problem in the community where I live.	1	2	3	4	5
I know how to talk to other people about environmental issues in our community and the things we should do to solve those problems.	1	2	3	4	5
I know how to gather information about an environmental problem in my community.	1	2	3	4	5
I really enjoy nature.	1	2	3	4	5
I like to watch what birds, wildlife, and insects do outside.	1	2	3	4	5
In the future, I would be willing to volunteer for citizen science projects.	1	2	3	4	5

You have reached the end! Please fold your test in half with the name inside the fold, and return to your teacher.

Appendix E: Vernal Pool Patrol Program
Posttest 2016-17 School Year

Your name: _____Your grade: _____

Your school: _____

Your teacher's name: _____

What is the name of the class/period/hour you are in? _____

Today's date: _____

Are you male ❒ or female ❒ ?

Read each multiple-choice question carefully, and circle the letter of the one best answer.

1. **What is citizen science?**
   a. Studies or research in which non-scientist volunteers collect specific information about nature (or other topics of study), and share it with professional scientists
   b. Studies or research about vernal pools
   c. Studies or research about citizen behaviors like voting, signing a petition, or running for election
   d. None of these

2. **Which of the following are "indicator species" for vernal pools?**
   a. Spotted salamanders, bullfrogs, wood frogs, and painted turtles
   b. Fairy shrimp, wood frogs, spotted salamanders, and blue-spotted salamanders
   c. Both A and B
   d. Neither A nor B

3. **Which of the following statements is FALSE?**
   a. All vernal pools have many different types of plants growing in them.
   b. Vernal pools can contain plants that normally grow in *wet* places, and plants that normally grow in *dry* places.
   c. Plants and decomposed matter are the largest source of nutrients in most vernal pools, and form the bottom of the food web.
   d. By studying the plants in an area, you can learn if that area might be a vernal pool, and how long it might be wet.

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4. **What is a vernal pool?**
   a. A small pond that provides breeding habitat for fish
   b. A special type of wetland that holds water or is wet for only part of the year and provides habitat for unique animals and plants
   c. A special type of wetland found only in Michigan
   d. All of the above

5. **Which of the following statements is NOT TRUE?**
   a. Vernal pools are unique and can be very different within an area and even within a year.
   b. There are no laws against disturbing or damaging vernal pools in Michigan.
   c. Vernal pools can be hard to find because they are small, and they dry up.
   d. We have good information on how many vernal pools are in Michigan, where they are located, and what condition they are in.

6. **Which of the following species can be found in vernal pools when they are wet AND when they are dry?**
   a. Fingernail clams and snails
   b. Millipedes
   c. Mosquito larvae
   d. All of the above

7. **Which of the following can be harmful to vernal pools and the plants and animals that live in them?**
   a. Disturbing the pool by walking in the pool
   b. Climate change affecting the amount and timing of rain, snow, and dry and hot periods
   c. Removing all the plants, shrubs or trees in or around the pool
   d. All of the above

8. **What are some differences between vernal pools and other ponds or wetlands?** List three. If you can't list three, list as many as you can.

   1. _____

   2. _____

   3. _____

9. **What are some ways in which wetlands like vernal pools are important to forests, animals living in forests, or people?** List three. If you can't list three, list as many as you can.

   1. _____

   2. _____

   3. _____

10. **In the space below, describe one plant or animal adaptation that is useful for surviving in a vernal pool.** Describe the adaptation, and tell how it helps the plant or animal survive in a vernal pool.

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How much do you agree or disagree? Please circle one number on each row. There are no right or wrong answers to these questions; they are about your beliefs, likes, and dislikes.

	Disagree very much	Disagree	Not certain	Agree	Agree very much
Humans have the right to modify the natural environmental to suit their needs.	1	2	3	4	5
I would enjoy a career that focuses on environmental issues.	1	2	3	4	5
The balance of nature is very delicate and easily upset.	1	2	3	4	5
We must take stronger measures to conserve our nation's resources.	1	2	3	4	5
By working with others in the community I can help make things better.	1	2	3	4	5
In the future, I would be willing to work with others to solve an environmental problem in the community where I live.	1	2	3	4	5
I know how to talk to other people about environmental issues in our community and the things we should do to solve those problems.	1	2	3	4	5
I know how to gather information about an environmental problem in my community.	1	2	3	4	5
I really enjoy nature.	1	2	3	4	5
I like to watch what birds, wildlife, and insects do outside.	1	2	3	4	5
In the future, I would be willing to volunteer for citizen science projects.	1	2	3	4	5
People should be able to cut down trees whenever they want to.	1	2	3	4	5

How much do you agree or disagree? For each sentence, circle only the **one** answer that best matches your answer. Please do not leave any blanks.

	Disagree very much	Disagree	Not certain	Agree	Agree very much
I have learned new skills from the Vernal Pools Patrol program that I could use in a job.	1	2	3	4	5
I feel other students should have the opportunity to participate in the Vernal Pools Patrol program like I did.	1	2	3	4	5
Studying environmental issues in the community helps me understand schoolwork better.	1	2	3	4	5
I cared that we followed the instructions and collected our Vernal Pools Patrol data correctly.	1	2	3	4	5
I wanted to tell other people about what I did with the Vernal Pools Patrol program.	1	2	3	4	5
The data we collected through the VPP Program makes a difference - it will be used to help protect and conserve vernal pools.	1	2	3	4	5
Through the Vernal Pools Patrol Program, I learned about things I can personally do to protect vernal pools.	1	2	3	4	5
The Vernal Pools Patrol program helped me learn how to do science - experimenting, measuring, observing, and finding out new facts.	1	2	3	4	5
The Vernal Pools Patrol program helped me learn how to work as part of a team.	1	2	3	4	5
The Vernal Pools Patrol program activities were more interesting than the average activities at school.	1	2	3	4	5

What did you do with the Vernal Pools Patrol Program? Please put an "X" in the box next to ALL of the activities that you personally participated in as part of the Vernal Pools Patrol Program.

- ❒ Collecting data on WET vernal pools
- ❒ Collecting data on DRY vernal pools
- ❒ Presenting your findings to people who are not students at your school, such as parents, the school board, or a community organization
- ❒ Analyzing vernal pool data collected by YOUR class
- ❒ Analyzing vernal pool data collected by OTHER classes

How have your feelings about being a steward of the environment in your community changed, if at all, because of your work with the Vernal Pools Patrol program??

Do you have suggestions to make the Vernal Pools Patrol Program more interesting or useful for students like you?

You have reached the end! Please fold your test and survey in half with the name inside the fold, and return to your teacher.

APPENDIX F: PRE AND POST RESPONSES TO QUESTION 10 ON ADAPTATION

Pretest

Please note: Blanks and simple "I don't know" responses are excluded, and student responses are produced verbatim, as typed or written, excluding pictures, which are described.

- (picture of a fish) that's a white fish
- ?a painted turtle
- A adaptation to live on land and water because the pools my dry up and this helps them with that
- A bullfrog can live in a vernal pool. It gives the bullfrog a place to cool down and live.
- A fern. The adaptaion of a fern is dry and wet. May deep other plants germinate, that are like a fern? (I have no idea).
- A fox can adapt to a vernal pool for its need of food water and sometimes shelter.
- a frog
- A frog adapts so it lives better (picture of egg => tadpole => frog
- A frog being able to live in or out of water would be useful for when the vernal pool is wet or if it is dried up.
- a frog can hide behind trees
- a frog can learn to adapt to vernal pool because it could be safer for them to live in.
- a frog cause it lives under water and comes up for air
- A frog is helpful it eats bugs. It helps an animal survive by giving bugs and plants Plus a habbitat is provided for shelter.
- A frog, there are lilly pads and water for it to survive and fliest to eat. And a good places to have babies.
- A good adaption would be to be able to survive in wet or dry conditions because when the vernal pool dries up, plants and animals need ot be able to survive.
- A millipede can live in a vernal pool whether the area is wet or dry, allowing it to thrive and survive in the pool
- A mushroom because it breaks things down.
- A plant adaption that would help is not getting enough sunlight
- A plant can decompose in the pool and become food
- A plant can survive in alot of water over time and evolution, animals can get used to walking in water
- a plant helps it stay warm?
- a salamander
- A salimander because of wet land and it is the perfect habitat for them.
- A tadpole changing into a frog. It helps it survive in a vernal pool by being able to travel different places for safety or food.
- A toad or frog is an animal that can live live in a vernal pool. The reason it can is because a vernal pool has water for it to lay eggs doing and live in.
- A turtle can adapt from going to dry land and survive in water (changes from dry to wet).
- A vernal pool can provide a home for many mosquito larvas. For them to hatch and grow to become an adult mosquito.
- able to breath under water
- Algi
- An adaptation would be to quickly adapt to when the vernal pool dries or gets wet or being able to live in both ways. It helps them so they don't rely on a wet or dry area.
- An adaption to vernal pools would be to be able to quickly change with the enviornment. This would help because if they could adapt quickly, they would be able to survive.

- An animal adaptation that can be helpful in a vernal pool is being able to breath underwater.
- An animal adaption that is useful is how they find and create a 'living space.' The vernal pool can create that space for living if necessary.
- Any microrganisim that can feed on plant matter
- be able to survive in wet and dry seasons
- bears hibernate and when the come out they are thirsty
- beaver has good habitat.
- Because the plants are provided alot of water and sunlight and animals have lots of food and water for them to live
- Because vernal pools are clean and have plants for animal to eat.
- being able to adapt when the pools dry up
- Being able to live in and out of water, so they can thrive when the vernal pool is wet and when it is dry
- being able to swim
- Bullfrogs
- Camouflage. Camouflage would be important for an animal in a vernal pool because humans study vernal pools and they may disturb the animals that are visible.
- Certain fish that need to be held until they grow to a certain amount and then can be let free into the wild
- Crabs live in the vernal pools so do shrimp bugs and other small animals.
- Deep roots and long stems because they need to survive in dry and wet climates.
- don't know
- drawing of a swimming/legless blob with "teeth for chewing" and "hair for warmth"
- Drawing shows a tadpole becoming a frog.
- Drawing: frog as a tadpool (shows three stages of growth)
- fairy shrimp
- fairy shrimp it basically can only survive in a vernal pool
- fern, water weed.
- ferry shrimp they live for about 2 weeks and the eggs need to freeze before they hatch
- fingernail clam
- fish adapt to different temp. water.
- Fish might live in their and the fish need the water
- fish need water and if they were in a vernal pool they would have to adapt to the environment.
- fish, helps animals surive bedcause its a save place
- fish, water,air,
- Fish. They might ehlp keep the vernal pools clean.
- Fishes that have gills so they can live and breath in the vernal pool
- for/toad
- frog its watery and frogs needs water acosionly
- frog wet
- frogs
- frogs
- frogs
- Frogs can change from baby frogs into big frogs.
- frogs fish
- Frogs have long legs for swimming and long tounges for catching their prey. Vernal pools are a great habitat for frogs because they have water for swimming and lots of bugs around to eat!
- Frogs have webed feet to swim with but can also walk on dry land with them.
- frogs it gives them a place to swim for a short time. Salamanders mud and a wet place to be.
- frogs the adapted to turn into tadpoles and they are helping because the eat bugs flys

- gills and webbed feet because it would help the animals survive in the water and get away from predators faster.
- growing gills. It would help them survive underwater.
- growing on a side of the pool
- I don't know what a vernal pool is
- I don't know what a vernal pool is.
- I don't know. :(
- I don't know???
- I have no idea
- I helps more species grow and helps plants and trees live longer.
- I lizard because its moist and wet for them and they feast on other insect in the pool
- I think a beaver is useful for surviving in a vernal pool. Because it can block any other water source so the water will stay there. It can even live off of the fish and salimanders.
- I think that the bullfrog will survive in the vernal pool because it can go under water.
- I would say a plant because the water is right there and it gives the plant water to survive.
- If there is a plant that needs to adapt to a vernal pool, it will adapt by knowing how much water to take in from the pool.
- It can be useful for plants and animals because of the water there.
- it has food in side of it and water
- It helps them survive because it gives them shelter
- It helps with the food and whater
- It provides water, it may also change the temperature around the vernal pool
- knowing how to breath under water
- less water
- less water
- Lives there for a long time, and the food and water and resources
- Maybe a salamander and it can eat the plants in the pool
- Maybe being able to live in wet and dry areas because the vernal pool does both.
- Maybe there for small animals to live. Or a good water source.
- Mesquito (picture of pond, with egg mass, and mosquito flying away)
- milipeds adopt to enivormnets to surive, it has special abiltes to help the animals.
- Millipedes have adapted to live in vernal pools. They are able to live in the dry vernal pool, and wet vernal pool.
- Miskito lay larva in the pool
- Mosquitos use these pools to lay their larvae into. Larvae must be in water. Then, they hatch. When the water dries up, the larvae have already transformed into mosquitoes.
- No dirty water. No pretors.
- One adaptation that is useful for surviving in a vernal pool is being able to still survive in wet & dry habitats
- One adaptation that is useful is the ability to breathe on land and live/breathe underwater. This adaptation allows it to survive in the vernal pool when it is dry and when it is wet. It helps the animal survive becauuse the animal can still live there w
- one adaptation would be being able to survive wet and dry changes
- one animal is a tree frog. It has adaptationed by the wether and/or the climate
- One animal would be a bullfrog it adapts to the climate change, it can help other animals or plants by passing nutrients when it dies. Another way would be when it breeds it keeps the species alive.
- One plant is moss. It can help animals hide form danger.
- painted turtle: turtles can survive in hot and moist climate
- picture of a fish, text: "I'm going to live here now!"
- Picture of a tree growing out of a pond

- picture of fish and flowers in a pond
- picutre of a turtle, arrow pointing to "shell" and "webbed feet"
- plant sun water animal food water pool water
- plants and animlas. They need water.
- plants because the don't have to wait for rain because the are surounded by water
- Plants or animals would need to be able to live in the water and on dry land. Say you have an animal that lays eggs in the water then they hatch when it dries. It helps the species carry on.
- root if it is a plant that floats on the surface and it needs more nutrients it could get it from the ground
- salamander
- salamander because they need water to keep their skin moist
- salamanders they need to be in a very wet plases
- salimanders help plants grow.
- Seaweed can help a fish live in a verna pool
- Snails or clams?
- some incets are bor in water like pounds and a vernal pool is like a pound.
- some species need water to breathe
- some thing they could drink place to lay eggs
- Spiders, they eat the little bugs and keep the vernal pools sort of clean.
- stick figure picture
- stick figure picture
- stick figure picture
- swamp
- The adaptation is that humans can swim in it also plants and animals love to drink water from the vernal pools. It helps the animals grow and survive in tough times. Also animas who can swim have protection.
- The animal can grow gills, it will help survive in the water
- The animal or plant need to adapt to the envirment.
- The fairy shrimp's way of swimming. It's legs have adapted tso that they are like wings in the water to move around from place to place.
- the plant like a flower. A flower needs water to grow.
- the tempature of the water is very importent
- the vernal pool is moving fast so preteders cant catch them
- the water
- there is sun shining down and there is water to suck up
- There is water sun slight and there is animals to spread seeds
- they can adapt very easy to the forest.
- they drink from the vernal pool to survive
- They survive by taking the water and soaking it up
- They suvive because there's water and they need water to grow
- Trees are surviving because of wetlands because trees need water to survive
- unintelligible picture
- unintelligible picture
- water
- Webbed feet help animals move quicker and eaiser through water

Posttest

- (Picture of plans and vernal pool): This plant is able to survive in water and on dry land when it dries up in the season change.
- ?
- A blue spotted salamander has the ability to swim and go under
- A fairy shrimp, fairy shrimp only come in the spring and not any other time

- a fougy win the water dry up it go deep in the mound.
- A frog & turtle would have to try to stay safe in a vernal pool. They would lay effs either in the water like the frogs or in the sand like the turtles.
- a frog because it can go land and in water5.
- A frog has adapted to a vernal pool because their is water to keep moist in and insects for food that hand around as long as the pool is there.
- A frog li9ve the virnal pool
- A frog starts off as tad pool and hop away. There are other speices in there that do almost the same thing.
- a frog. A grog can grow as a tadpole int the water then has land and food when it turns into a frog.
- a frogs us the vernal pool to make more frogs and then buries himself deep down into the mud.
- a frogs of uses the vernal to make move frogs and then buries himself deep down into the mad
- A frogs uses the vernal pool to make more frogs and then buries himself deep down into the mud
- A good plant adaptation is going without lots of sunlight. A animals adaption is breathing under water.
- A little shrimp
- A plant can float to get water and sunlight and not drown.
- A plant has seed packets at the top so they stay dry.
- A salamander because it can swim and eventually grows legs and then find a place to put their eggs
- A salamander will live there during the fall and leave due to the condition of the vernal pool during the winter, and then will come back and reproduce
- a slimy frog
- A tree A tree adapt so the roots are on top of the ground because they don't have to go down to get the water
- A turtle needs water
- a wood frog has to know when to lay its eggs before it drys up
- A wood frog lays its eggs in there because it is safe for them in the vernal pool. Some animals need to dry and freeze before these can hatch. Wood frogs need to be in vernal pools to survive and therea re no fish to eat its eggs.
- A wood frog produces its eggs there and the it helps the woodfrog grow bigger
- A wood frog survives in a vernal pool because that is where it lays its eggs.
- able to be in a water source for a short time and have eggs before it happens
- an adaptation could be worms being able to go into the dirt fast. It helps them get away from predators quicker.
- An adaptation is the fairy shrimp's way of swimming. It uses it to help swim away quickly and without being noticed.
- An adaptation made by the wood frog is it lays its eggs in the pool at the right time of season. When its legs growing up its big enough to leave the pool when it dries up.
- An adaptation that is helpful to animals that live in vernal pools is leaving before the pool dryss up.
- An adaptation would be being able to adapt to the vernal pool drying up or getting moist. They don't have to rely on a dry place or a wet place.
- Animal has to be able to live in wet and dry climates/habitates because the vernal pool dries up and then refills.
- Animals adapt because the species goes through the process whenever another vernal pool shows
- Animals can lay their eggs in the water, then the eggs can hatch by the time the pool dries up. This adaptation helps carry a species on.
- Animals in the vernal pool may need to be able to survive in wet areas as well as dry, because in some parts of the year the vernal pool is dry and in others it is wet. Some species have adapted to this by only being around for wet parts of it, and others
- Animals such as the painted turtles only live there when the vernal pool is wet, once it dries up, the turtles will relocate.
- Animals that can live in a dried up environment and a wet environment.

- Be able to survive wet and dry enviormnts.
- Being able to live in water or on land is one adapttaion. That way if the vernal pool dries up, the organism can still survive.
- Being able to survive in dry and wet land
- Being able to survive in the water and on land this is important because it would allow the animal to survive once the pool has dried up
- Being able to survive in wet and dry. So this plant/animal does not die during the change.
- Bullfrog egg masses blend into the surunding area providing safety. (Picture of egg masses)
- Camoflauge: blends in. Can't be seen. Catch prey easier.
- Can live in water and land, if they can do this then the vernal pool is good habitat because it is seasonal.
- cattails, because animals can lay eggs on it
- Change in weather.
- Decaying leaves that have fallen from an over-hanging tree. They give other plants nriants to survie.
- Dragonfly larve living underground so they do not freeze.
- Duck Weed because it gives food, and shade for the animals living.
- duck weed has oxegen cells inside it that help it float.
- duck weed, its has adapted to growin roots at the bottom of the pool and they the tops coming up to the top for sunlight
- duckweed, duckweed survives by floating on top of the vernal pool and getting water from it
- Eggs dropped and fertilized then the vernal pool dries and the shrimp die. It comes back and the babies
- eggs only hatch when dry
- fairy ship had to adapt to swimiming or the back the lages
- fairy shrimp
- Fairy shrimp and how the eggs are able to withstand the winter until they hatch in spring when the pool is full/wet.
- Fairy shrimp are small so it makes it hard for predators to see them.
- fairy shrimp bury themselves into the ground, when the pool is drying up.
- Fairy shrimp can hide under the leaves and swim when wet
- Fairy shrimp dig into the mud when it dries up and waits until it fills back up again.
- Fairy shrimp eggs have to go through dry season to hatch
- Fairy shrimp filter the wtaer
- Fairy shrimp have a good home because fish eat them and in a vernal pool there are no fish so that can stay alive and they can come back since there eggs freeze during winter and hatch during spring.
- Fairy shrimp lay their eggs/live their short life before the pool drys/next time the pool is full the eggs hatch
- Fairy shrimp plant their eggs in the mud
- Fairy shrimp, because they add more of their kind.
- fairy shrimp, fairy shrim have adaptated to pools by having a short life spand. They are born from eggs they grow they greed they burrie them eggs they die.
- fairy shrimp.
- Fairy Shrimp. They can survive in the dry season and wet season because they dig down in the mud for survival. They lay eggs when its wet so they survive better.
- Fairy shrip... They ahve to survive here because anywhere else things eat it.
- Fariy shrip it feeds of bactria
- Farry Shrimp eggs need to go a long time with out water.
- fary shrimp
- ferry shrimp
- ferry shrimp and their eggs have to dry and freeze
- Fiary shrimp lay there eggs there for next year
- finger nail clams survive in wet and dry

- Fingernail claims and mosquito larvae. Mosquito larvae reproduce in the water and fingernail clams live in wetland water environments. The vernal pool provides a habitat for these species.
- Fingernail clam when in danger burrows self underground
- fish
- fish and plants
- For moscito larvae, they can stay in the pool when it's wet, so when it's dry, they are most likely already became a moscito. Moscitos don't need water all the time so a vernal pool is a great habitat for them.
- Frog
- Frog it lives around the edge of the vernal pool. It's surrounded by cactails.
- frogs addapt because they grow up in water but then leave water
- frogs because they can live on dry land or water, and they can eat new food like masquitos.
- frogs change from eggs to tadpol to frog and thats how they adapt
- frogs lay their eggs then wait for them to hatch them get out
- gills
- gills. They are helpful because the animal can then breath under water
- I can't think of any
- I think a beaver would be good in a vernal pool because it can adapt well and it has food.
- If a salamander wants to make babies he can do it in the vernal pool so fish don't eat the babies.
- If a turtle lived in a vernal pool it could adapt to living in a dry climate and having it wet. Turtles adapt from dry to wet and can survive either way (unless it is a sea turtle).
- illegible
- It has food
- It is red and swims on its back and is a good food sors
- It's a good temp. for animals and gives food and protects animals.
- krayfish has claws that burrow into the ground to survive when vernal pool drys up
- Leafs, they form the bottom of the vernal pool, and serve as food fro the micro orgnisms, which most micro organisms serve as food for bigger microorganisms
- less things that can eat animals and a shelter for animals.
- lil pad: spot for frogs and salamanders to lay
- Living among other creatures. Plants and animals both will be sharing the pool with multiple other species.
- Many plants have adapted by making seeds that float so they float on top of the water until the water goes down where the seeds plant themselves and grow.
- Masiqeto larva needs the vernal pool to grow and survive, the misiqetos use water then when it drys up they grow bigger and once water drys up.
- Mayflies eggs are at the bottom so they're protected and hatch lay eggs and only live for a few weeks. Salamanders live in it and get their food during the wet times and same in the dry times just live in a different place
- millipedes
- Millipedes can live in a vernal pool when it is wet and dry. It can live there year round.
- Moscettio larve because when it dry up the are small flys.
- Mosquito larvae needs to adapt to the type of water its living in
- Mosquitos are adapted well because they live as larvae in the water and then will fly away. So when the pool dries up they will aloready be adults and be able to leave.
- Moss is helpful because it provides food for other creatures
- mossy back on a snapping turtle like the one we caught mossy back is camo
- Most animals there are predators of fish and there is no fish in vernal pools
- N/A
- one adaptation is being able to survive in the vernal pool when it is wet and dry

- One adaptation that is useful is being able to transform gills to lungs. A salamander has gills in their early stages which later turns to lungs when they are old enough to go on land.
- One animal that lives in a vernal pool is a wood frog. The adaptation is useful for surviving in a vernal pool because it can live under water. The wood frog adaptation is able to breath under water through its skin.
- One big advantage is having no fish - many different species that would be preyed upon in a pond (with fish) can survive in a vernal pool. There are less predators to kill other species so fairy shrimp and salamanders can survive moer successfully and re
- One plant or animal that helps the vernal pools is animals that live in the vernal pools give the other animals and the plants life through water and food
- Picture - labels say frogg eggs (points to mass), or salamander eggs can be kept in them
- Picture - the frogs need the flys to live and the flys need the pool to breed.
- picture drawn of water with a tree growing in the middle
- picture of a bug
- picture of a many legged creature like a water bug
- picture of a multilegged creature with a circle around it
- picture of a salamander with spots
- picture of a tree
- picture of fish swimming in a pond with plants on the side…
- picture of two flowers
- Picture shows plant with long roots
- Picture: "laying eggs" arrow to "pool dries up" arrow to "Hatch when water returns". Helps reproduction
- Plants and trees give nutrients to the species in the venal pools.
- plants because most of the species need something to live on and they help the enviorment
- Plants create air pockets in the stems or under their leves so that they float on top of the water and get more sunlight
- Plants grow out of the water to get sunlight when the vernal pool has water in it.
- Plants have air pockets to breath
- Plants that grow all the time in vernal pools
- Plants will always be able to grow in vernal pools. Caterpillars will leave during winter and stay during fall.
- Salamanders - a place for them to hied. A place for them to find food.
- Salamanders feed on fairy shrimp
- salamanders live in the wet mud so they don't try out and they can eat bugs?
- Salamanders. They have a lot in htme. They will adapt to the area against predators.
- seeds or eggs that can survive water and dry lannd
- Shells on a snail for protection. Snails adapt to the summer weaterh then moves to avoid the winter conditions.
- Shells on the snails for protections Change from wetland to not wetland
- Snails have adapted to having shells to protect themselves with from other organisms
- Some animals have adapted in ways like burrowing themselves into the mud when the pool is dry and spawning there when there is water.
- Some animals may use the vernal pools to adapt to predators. Ex. Wood frogs.
- Some animals that live in the vernal pool have to learn to adapt to living in it when it is wet or dry.
- Some animals/plants need to be able to live in a wet and dry environment. So they have developed ways to do this.
- some of the plants adapt and it helps the animals have a home or hiding spot.
- some plants have floating seeds.
- spooted salimender eat the misquito larve that are in the pool
- spoted salamander it lays its eggs.

- Spotted salamanders because wihtout vernal pools there would be a spot for the salamanders to lay there eggs
- Spotted salamanders near a vernal pool because they need a place to lay their eggs
- spotted salemander: it lives in the water but can get out because its not deep.
- Tadpole to a frog (being able to change into something that can live in both dry or wet areas) because the vernal pools dry up at a certain time
- The ability to live in and out of water
- The animalos addapting and getting used to their soundings, trees and leaves help hide and get food, there's different animals and plants in each phase of the veral pools
- The blue spotted salamander has an adaptation to the vernal pool. When they have their larva it is a save place to put it. There aren't a lot of predators to hurt the salamander larva.
- The blue-spotted salamander breeds in these pools instead of in the rivers because it is safer for the eggs. If they lay their eggs in a river, the eggs could be eaten or tossed around with the currents.
- The certain plant has to adapt to the vernal pool to live (picture shows a flower ina vernal pool)
- the eggs of a frog because they are suppose to live in water
- the eggs of the fairy shrimp has to freeze to live
- The fairy shrimp has legs and can also swim, allowing it to be able to live in the vernal pool area whether the land is wet or dry.
- The fairy shrimp. Because they help it stay alive so that nobody just came and trashed it because when they heard it was endangered they didn't ruin it.
- The fairy shrimp. They've adapted to lie their eggs in the vernal pool for one year and they hatch the next year.
- the finger clam
- the frogs had to learn that it is only there for part of the year
- the leaves give nutrients to the animals to live in for fairy shrimp. Fairy shrimps have a short life time in vernal pools.
- The logs in the vernal pool give frogs a place to live and lay their eggs
- the male salmander it goes there does stuff then leaves and the girl salmander ferlize to reproudce the species.
- the mosquito because it has mosquato larva in the water and when they grow up, they can still live in the wetlands
- The musketo larva are dithrent because they can swim
- The plants adapt to being in water which helps them survive because for a month or two, it will be mostly under water
- The plants are mostly on the top of the water. They cannot get sunlight on the bottom of the pool.
- The salamander, it stays under moist leaves so it doesn't get burnt by the sun.
- The shallow water makes a good home for wood frogs and makes it easy to climb in and out of the water
- The small holes on the sides of trees in the water help them collect the air thay need without exposed root systems. It helpes the tree survive because it can still get air.
- The snails have shells for shelter when there in danger they have a shell thats like there home and the shrimp have a short life time in vernal poos
- The spotted salamander starts its life cycle in the water nd develops shortly after so it can walk on dry land after the pool drys up.
- The tadpole can grow into a frog so when the water drys up, it will survive.
- The vegetation in a vernal pool is important, because different types of spicies are going to need that vegetation to keep on living inside the vernal pool.
- the vernal pool dries up and larvae depend on that
- The water and some of the things that grow in the pool might be food for other animals
- The water will help grow plants which then it helps the animal eat. And then will help the animal grow.
- the wood frog looks like a leaf it has camoflauge

- there are fairy shimp that when they lay their eggs the eggs have to dryp up and then frezze and have water. And that is why they live in vernal pools.
- There is no fish to eat them
- They eat the elg and othe small animals (picture of a water ug)
- They survive by using skills such as hiding inside a piece of tree bark and move around or just plain eat each other
- This shows a chart headed with "salamanders," under which subheads are written: "helps" and "adapatation." Under "helps," it says "Reeds" or "Reeas" them. Under adaptation, it says, "Lays eggs."
- Tree branches help keep the wood frog's eggs in one place
- Tree the roots move to where they don't get to much water
- Trees adapt by spreading their roots out so that they don't need their roots in deep soil for water because water is there already.
- Trees are able to adapt by making sure they can live in both water and on dry land, when the pool dries up
- Weather change and fish and plants.
- Well all plants and animals are important whether its for food living or anything else both kinds are very imporant.
- well there's the water mites who need the vernal pools to survive.
- When there is water in the pool , frogs and salamanders to lay their eggs.
- Wood frog, gives it nutrients
- Wood frogs - camo for hiding
- Wood frogs will only lay eggs in bodies of water, like vernal pools, that don't contain any fish
- wood frogs will only lay eggs in vernal pools
- Woord frogs live in vernal pools, to survive they could look for small animals to eat in the pool. They adapt to the pool, and the area.
- worm
- Worms - because they gives us better soil and feed other animals

APPENDIX G: SCORING RUBRIC FOR QUESTION 10, ADAPTATION

Is this student expressing something like the intended/desired answer(s)?
0 – This answer bears no resemblance to any desired answer
1 – This answer bears a mild resemblance to a desired answer but is mostly wrong
2 – This answer has some content that is right balanced with some content that is not right.
3 – This answer is mostly correct but less than complete or focused on adaptations not uniquely suited to vernal pools
4 – This answer is correct and complete

If stuck between two scores, go up; if answer has substantial inaccuracies not captured in rubric, reduce score appropriately, focusing on score labels for guidance

0 blank, nonsensical, wholly wrong	1 mostly wrong	2 some right/some wrong	3 more right than wrong	4 correct and complete
IDK Picture that can't be decoded Wholly inappropriate	Describes a different scientific concept germane to vernal pools, such as: --suitable habitat --ecosystem interrelationships OR Describes an adaptation not germane to vernal pools but that represents the concept of adaptation OR Provides a one-word animal identification where the animal uses vernal ponds and e.g., frog, fairy shrimp, turtle, mosquito	Describes or names an adaptation germane to vernal pools, OR identifies an animal and an adaptive behavior or use of vernal pools, but does not identify the adaptation Does not describe how the adaptation helps the animal OR Any two from column 1 OR identifies that a helpful adaptation would help a living thing to survive in wet and dry environments	Describes or names an adaptation germane to vernal pools --related to wet or dry --could apply to other environments that don't cycle between wet and dry, e.g., a wetland, a pond, a forest environment AND Makes an effort to tell how it helps the animal	Describes or names an adaptation germane to vernal pools --related to wet and dry AND Effectively tells how it helps the animal survive

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