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Changes in Knowledge and Attitude from a Short-Term Aquatic Education Program

Tiffany Kinder,* Nancy O. Mesner, Mark Larese-Casanova, Kimberly H. Lott, Adrienne Cachelin, and Katherine LaLonde

ABSTRACT Short-term field days are a common outreach tool for watershed programs, yet little is known about their effectiveness. To address this question, we conducted pre- and post-tests on 4th grade students who participated in a field day at a U.S. Forest Service campground. In addition to assessing the value of the single field day, we also tested the value of additional activities on knowledge gain and retention over time. Classes that only participated in the field days demonstrated a significant increase in knowledge after 2 weeks and after 8 months, although the 8-month scores decreased significantly compared with the 2-week scores. We found a similar pattern for classes that received pre- and post-classroom lessons on water. A third group of classes participated in a second field day toward the end of the school year. As with the other groups, this group demonstrated a significant increase in post-test scores, but no significant decrease in post-test scores over time. We also evaluated the single field day for evidence of changed attitudes about protecting streams. We found a heightened sense of stewardship in this group on the 2-week post-test. We conclude that short-term environmental education programs can be effective at increasing knowledge and promoting feelings of stewardship. We also conclude that enhancing these programs with high-quality lessons or additional field experiences may result in greater retention over time.

Environmental education aims to increase awareness and knowledge about the environment, resulting in positive changes in attitude and increased personal involvement in environmental issues (Bogner, 1998; UNESCO and UNEP, 1977). Integrating environmental education into an elementary school curriculum can be an effective way of meeting these goals because children are excited about learning and are still developing attitudes about the world around them (Iozzi, 1989; Jaus, 1982). Furthermore, elementary school children are capable of forming opinions about the environment and understanding environmental stewardship (Bryant and Hungerford, 1977; Barratt Hacking et al., 2007). Involving youth in environmental education programs has the potential to create a positive feedback loop in which learners are more likely to involve themselves in positive environmental action in the future (Schusler et al., 2009). Successful environmental education programs for youth have found that combined classroom and field-based instruction is more

effective at increasing knowledge and changing attitudes than either one alone (Ballantyne and Packer, 2002; Lewis, 1981).

Much of the existing research in environmental education has focused on the effectiveness of programs lasting from 1 week to a full year (Dillon et al., 2006) rather than shorter programs lasting an hour to a day. The research that has addressed short-term programs has considered only immediate rather than long-term impacts (Farmer et al., 2007; Nadelson and Jordan, 2012). It appears, however, that many environmental education programs receive minimal or no formal evaluation (T. Kinder, unpublished data, 2011). This suggests that funding and resources are frequently invested in developing and delivering short-term programs without fully understanding their impacts.

This study asked whether, and to what degree, short-term environmental education programs are effective at increasing knowledge and promoting a more positive attitude toward the environment. Specifically, we evaluated a water education component of a one-day field activity that is offered during the regular school year to all schools in two school districts. We also evaluated two approaches of enhancing this short-program to increase its effectiveness. Finally, we compared responses between the two school districts, which have different socio-demographics, to evaluate potential correlations with student knowledge.

MATERIALS AND METHODS

All 4th grade students in Cache County, Utah, participated in the Natural Resource Field Days program (NR Days) from 8 Sept. 2010 through 17 Sept. 2010. Students and their

T. Kinder, N.O. Mesner, and M. Larese-Casanova, Dep. of Watershed Science, Utah State Univ., 5210 Old Main Hill, Logan, UT 84322-5210; K.H. Lott, School of Teacher Education and Leadership, 2805 Old Main Hill, Logan, UT 84322-2805; A. Cachelin, Univ. of Utah, 260 S. Central Campus Dr. Rm. 252, Salt Lake City, UT 84112; K. LaLonde, Utah Afterschool Network, 254 South 600 East, Ste. 200, Salt Lake City, UT 84102. Received 19 Oct. 2014. Accepted 2 Dec. 2014. *Corresponding author (tiffany.kinder@usu.edu).

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Abbreviations: AYP, Adequate Yearly Progress; BRMBR, Bear River Migratory Bird Refuge; GEE, Generalized Estimating Equation; NR Days, Natural Resource Field Days; UDWR, Utah's Division of Wildlife Resources; WQE, Water Quality Extension.

teachers spent one day at a U.S. Forest Service campground along the Logan River, where they participated in four different experiential science stations for 45 minutes each. Several state and local agencies partnered to provide educational activities related to wildlife, soils, plants, and water quality. All activities were aligned to the 4th grade science core standards for Utah (Utah Education Network, 2002). This study focused on the water quality activities, developed and led by trained volunteers and staff from USU's Water Quality Extension (WQE) program.

The water activities began with a short introduction to aquatic macroinvertebrates and how they may indicate water quality (Utah State University Water Quality Extension, 2010). Students collected aquatic invertebrates in a shallow reach of the river, using a simple kick net sampler. Organisms found in the kick nets were transferred to large shallow containers with fresh water. Students also explored microhabitats in the river, such as shallow backwater areas, riffles, and shallow pools. Leaders then solicited suggestions from the students on necessary adaptations for living underwater, and dressed up one of the children with various costume items representing the different adaptations (feather boa for gills, an extra set of legs with claws, etc). Finally, students were given time to observe the aquatic invertebrates they had previously collected, gently transferring individual organisms into water filled, plastic petri dishes to more closely observe adaptations and see individual behaviors.

We evaluated three groups of students who received different levels of water education and activities. Group 1 classes only participated in NR Days, as described above. Group 2 classes participated in NR Days but also were taught an "enhanced curriculum," designed to provide a pedagogical arch and to complement the NR Days experience. The enhanced curriculum was comprised of three additional 1-hour lessons taught by WQE staff to classes in this group. The first two lessons, taught 1 to 4 days before NR Days, aimed to deepen the students' understanding of the available water resources within a watershed. Lesson one covered the water cycle, water conservation, and water distribution on the Earth. Lesson two introduced watersheds and specifics about the local (Bear River) watershed. Lesson three, taught within 3 days after NR Days, demonstrated how pollution from different land uses may affect aquatic macroinvertebrates. Group 3 classes participated in NR Days and also utilized an existing "spring curriculum," which was developed and sponsored by Utah's Division of Wildlife Resources (UDWR) as a pilot watershed education program. Lessons were designed around a spring field trip to the Bear River Migratory Bird Refuge (BRMBR), located just above the confluence of the Bear River with Great Salt Lake. Students engaged in activities similar to NR Days, exploring wetland habitats and observing aquatic invertebrates. Educators at the BRMBR emphasized that both field experiences were in quite different habitats but within the same watershed.

Teachers participating in the pilot spring curriculum also received a copy of the enhanced curriculum lesson plans, attended in-service training with UDWR on watershed concepts and water quality, and had access to classroom activity trunks. There was, however, no requirement that teachers in the pilot study utilize these additional materials. The pilot program was offered to a small number of 4th grade classes in our study area.

A total of 58 4th grade classes ($n = 1405$ students) participated in our study (Table 1). Group 3 was limited to 7 classes by constraints on the UDWR's pilot project (M. Lee, personal communication, 2010). The remaining 4th grade classes in our study were randomly assigned to Groups 1 or 2. The size of Group 2 was constrained by the logistics of presenting the pre- and post-activities with limited time and WQE staff. Although this resulted in uneven sample sizes, at the student level we exceeded the minimum number of participants required (62) to achieve a statistical power of 0.80 (Warner, 2008).

Assessment Tool

We used a pre/post-test approach to assess change in both knowledge and attitude. Our test included eight "knowledge questions," consisting of a mix of true-false, short answer, and multiple-choice questions to measure student understanding of aquatic invertebrates, their life cycles and adaptations, and the effects of water quality on stream ecosystems (Appendix A). Student attitudes about streams and their ecosystems were assessed using four short answer (open ended) questions. Three of the attitude questions were originally used by Cachelin et al. (2009), and were modified slightly for this assessment. The assessment also asked students to indicate from a list of outdoor activities what they like to do while outside. Assessment specialists at Utah State University and the Utah State Office of Education reviewed the test. In preliminary trials with elementary age students, the tests were completed in less than 10 minutes.

Teachers administered all student testing in the classroom. Students took the pre-test within 1 week of attending NR Days and before any of Group 2's enhanced curriculum classroom activities. Students took the first post-test exactly 2 weeks after attending NR Days and after the enhanced classroom lesson for Group 2. The second post-test was administered 35 weeks (8 months) after NR Days and after Group 3's spring curriculum activities.

Because of IRB confidentiality concerns, we did not track changes by individual students, but rather looked at patterns of change in the grouped responses. Kinder graded each test, assigning a numeric score based on the number of correct responses to the knowledge questions. We originally planned to quantify responses to attitude questions by assigning a numeric value to positive, negative, and neutral responses. After reviewing student responses, however, this method was discarded in favor of a qualitative enumeration

Table 1. NR Days participation by group.

Group	No. of classes (students)	Treatment	Selection	Expected outcomes
1	32(769)	NR Days	random	Modest quantifiable knowledge gain and increase in positive attitude
2	19 (482)	NR Days and enhanced curriculum	random	Intermediate quantifiable knowledge gain and increase in positive attitude, significantly higher than Group 1
3	7 (154)	NR Days and spring curriculum	self	Highest knowledge gain and increase in positive attitude, significantly higher than Group 1 and Group 2

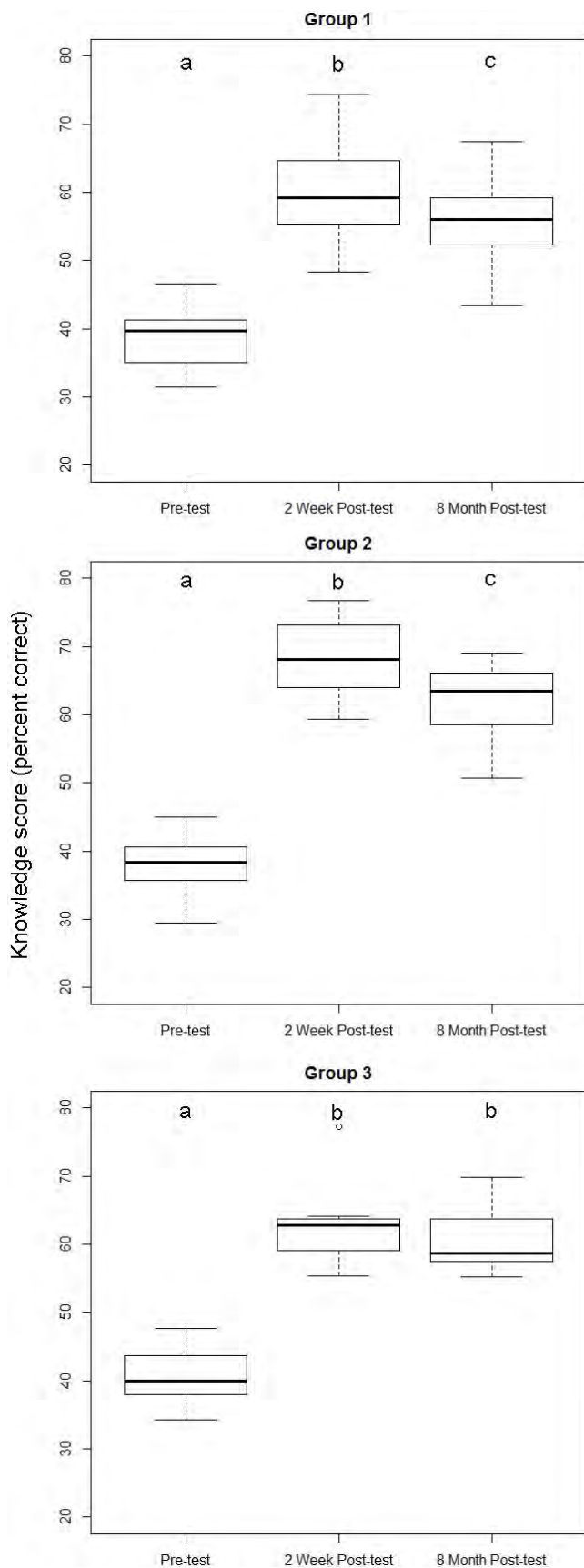


Fig. 1. Boxplot of median classroom knowledge scores by test for Groups 1, 2, and 3. Tests with identical letters within each group are not significantly different (simple paired t test). The line in each box represents the median, the box encompasses the 25 to 75% range of data, and the whiskers show the non-outlier range. (Group 1, pre-test/2-week post-test: $df = 27$, $t = -18.12$; Group 1, pre-test/8-month post-test: $df = 27$, $t = -16.01$; Group 1, 2-week post-test/8-month post-test: $df = 29$, $t = 5.31$; Group 2, pre-test/2-week post-test: $df = 17$, $t = -29.43$; Group 2, pre-test/8-month post-test: $df = 16$, $t = -18.34$; Group 2, 2-week post-test/8-month post-test: $df = 15$, $t = 6.66$; Group 3, pre-test/2-week post-test: $df = 6$, $t = -9.49$; Group 3, pre-test/8-month post-test: $df = 6$, $t = -10.88$; Group 3, 2-week post-test/8-month post-test: $df = 6$, $t = 0.9$).

that would better capture the richness of student responses (Henderson and Bialeschki, 2010). Because of the time and training required to conduct this analysis, however, it was limited to pre-tests and 2-week post-tests by Group 1. We tracked responses to one question, "If you could tell a good friend one or two things about rivers or streams, what would you tell them?" We coded a random sample of 50% of the responses before ($n = 361$) and 50% of the answers after ($n = 381$) and were able to use an enumeration procedure to assess differences.

Each teacher also completed a questionnaire that included a combination of short answer questions about their teaching experiences (number of years teaching, numbers of years participating in NR Days, and number of in-service classes related to watershed science) and Likert scale statements to determine teacher interest in environmental education, their comfort level in teaching about watershed science, and their attitudes about protecting rivers and streams. They also completed the same pre-test given to their students. We gave each teacher a knowledge score based on correct answers similar to the knowledge score given the students.

We were not able to collect personal demographic information from students, so used school district as a possible indicator of demographic influences. The Logan City School District encompasses the entirety of Logan City, which has a population of 48,174 (U.S. Census Bureau, 2010). Housing density averages 935 housing units for every square mile with 44% of those units being in multi-unit structures. Cache County School District includes the rural areas and small towns in the county outside of Logan City, with a housing density of 33 units for every square mile and only 23% in multi-unit structures. We also asked each school to report the percentage of students who qualify for free or reduced lunches as a possible indicator of economic status. Of the 48 4th grade classrooms, 15 classrooms were in Logan City School District and 41 were in Cache County School District. Two classrooms belonged to a charter school and brought in students from both districts and therefore were not included in any district comparisons.

Statistical Methods

The change in knowledge was evaluated by comparing class means within each group using simple paired t tests. In all cases, the data were normally distributed. For each group, we compared the 2-week and 8-months post-test scores with the pre-test scores and also compared the 2-week post-test scores with the 8-month post-test scores.

To compare responses between groups, we used a Generalized Estimating Equation (GEE) instead of an ANOVA as the GEE controlled for potential teacher effects resulting in within-class similarities (Liang and Zeger, 1986). We compared student level data within each group with pre-test classroom averages, as a surrogate for student pre-test scores.

To analyze student attitude before and then 2 weeks after NR Days for Group 1 we used enumeration procedures by finding emergent categories among responses to the question, "If you could tell a good friend one or two things about

Table 2. Knowledge scores and comparison by group.

Group	Group 1		Group 2		Group 3	
	<i>n</i>	Mean (SD)	<i>n</i>	Mean (SD)	<i>n</i>	Mean (SD)
Pre-test	30	39.04 (3.96)	19	38.18 (3.82)	7	40.74 (4.85)
2-week post-test 2	32	59.97 (5.89)	18	68.15 (4.77)	7	63.01 (7.07)
8-month post-test	32	55.27 (5.11)	17	62.45 (4.99)	7	60.93 (12.66)

GEE Model comparing increase in knowledge over pre-test scores among groups. †				
	2-week post-test		8-month post-test	
	<i>P</i>	Difference of least square means	<i>P</i>	Difference of least square means
Group 1 vs Group 2	<0.0001‡	-8.72	<0.0001†	-7.45
Group 1 vs Group 3	0.2458	-2.87	0.0012***	-5.27
Group 2 vs Group 3	0.0112**	5.85	0.2577	2.17

** Significant at the 0.01 level.

*** Significant at the 0.001 level.

† A negative difference of least square means indicates the first group listed in the comparison has a smaller increase in knowledge.

‡ Significant at the 0.0001 level.

rivers or streams what would you tell them?" This procedure allowed us to compare the relative magnitude of each category on the pre- and 2-week post-test.

We used the GEE model to determine the influence teachers had on knowledge gain of their students by comparing student level data on the 2-week and 8-month post-tests to pre-test classroom averages. We also used the GEE model to examine how well school district, percentage free/reduced lunches, and outdoor activity preferences predicted knowledge scores. Rather than look at each outdoor activity separately, we grouped student selections (from the list provided) into three categories: nature-based, machine-based, and urban. Finally, we used a Mann-Whitney U test to compare outdoor activity preferences between the two school districts. This test was chosen because the data were not normally distributed.

RESULTS

Knowledge

Average class knowledge scores increased significantly in all three groups as a result of participating in NR Days (Fig. 1). Two weeks after NR Days, mean class knowledge scores in Group 1 showed a significant increase of 21 percentage points over pre-test scores (Table 2) and Group 2 scores increased by 30 percentage points. Scores for both Groups 1 and 2 dropped significantly between the 2-week

and 8-month post-tests, but in both cases were still significantly higher than the pre-test scores (by 16 and 24 percentage points, respectively.) Mean knowledge scores for Group 3 also increased significantly from the pre-test to the 2-week post-test (by 22 percentage points). However, in contrast to Groups 1 and 2, on the 8-month post-test, mean knowledge scores were not significantly different from scores on the 2-week post-test (Fig. 1).

We compared the increase in post-test scores with pre-test class scores to look for changes between the three treatment groups (Table 2). Students in Group 2 had a significantly higher increase in knowledge compared with students in Group 1 on both the 2-week and the 8-month post-test. There was no significant difference in knowledge increase on the 2-week post-test between Group 1 and Group 3, although the difference was significant at 8 months. In contrast, Group 2 scores were significantly higher than Group 3 after 2 weeks, but were statistically identical after 8 months.

Attitude

The categories of responses to the single attitude question: "If you could tell a good friend one or two things about rivers or streams, what would you tell them?" are defined with exemplars in Table 3. The distribution of responses before and after NR Days is shown in Fig. 2. Before NR days, 20% of the responses demonstrated common knowledge and 6% of the responses demonstrated specific knowledge. After

Table 3. Definitions and representative quotations of themes for the question, "If you could tell a good friend one or two things about rivers or streams, what would you tell them?"

Theme	Definition; with a quotation†
Common knowledge	Statements about common knowledge; "fish live in a stream"
Specific knowledge	Statements about specific knowledge of species or habitat; "there's fish and insects, birds make their nest by them"
Stewardship	Exhibiting a concern or care for the place; "that the rivers are pretty and they hold animals so please keep them clean"
Danger/fear	Elements of danger or fear, warns of caution; "that rivers could be danus"
Positive description	A positive statement or description; "streams are pretty"
Do there	Activities that can be done near a river; "you can swim there"
Intrigue	Demonstrates a desire to learn more; "There are a lot of animals in the rivers and streams that arent discovered yet"
Personal experience/expression	Sharing something from a prior experience; "I tell them I go to the forest some time"
Friendship	Focus is on talking to another person; "do you like rivers or streams?"
No response	Blank
Miscellaneous	Any statement that doesn't make sense; "all of it"

† All quotations are verbatim, including spelling and grammar.

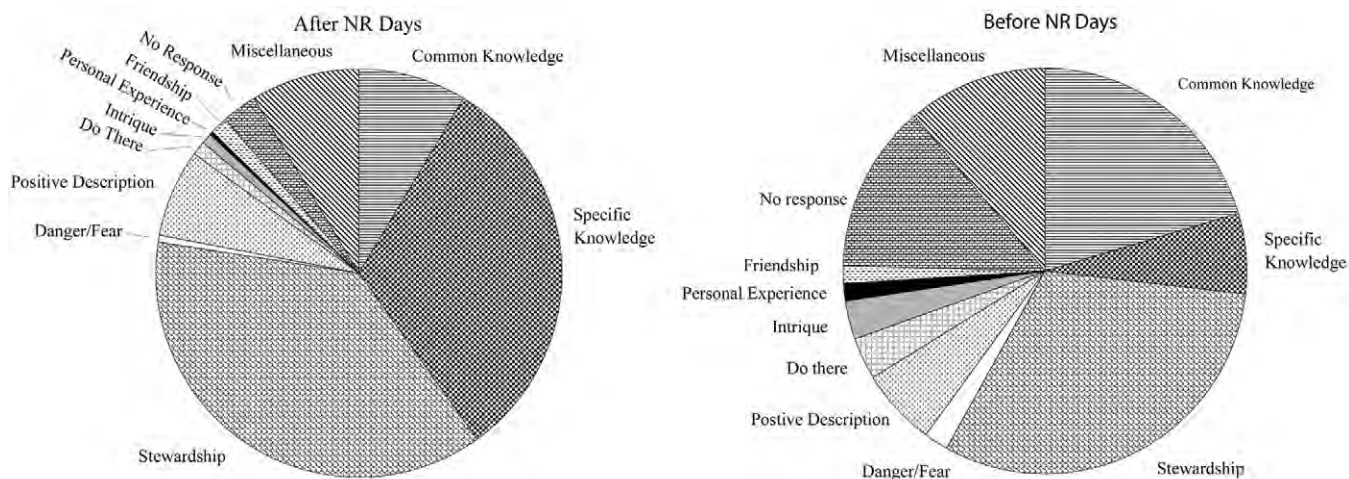


Fig. 2. Comparison of relative magnitude of themes for the prompt, "If you could tell a good friend one or two things about rivers or streams, what would you tell them?" from the pre-test and 2-week post-test for Group 1 only. These differences were not evaluated for statistical significance.

NR days, a higher percentage of responses demonstrated specific knowledge. Stewardship responses also increased after NR days. Although this is not a statistical, quantitative analysis, enumeration procedures are an effective way to demonstrate differences in attitude and environmental sensitivity following an environmental education program (Cachelin et al., 2009).

Teacher Influences

We anticipated that teachers with more teaching experience, a more positive attitude toward protecting rivers and streams, and a higher level of comfort teaching environmental science would have students with a greater increase in knowledge. Mesner and Walker (2007) found that teacher education, experience, and general interest in water all significantly impacted student knowledge gain. However, we did not find a relationship between teachers and gain in student knowledge in any of the three groups. This could be due to the fact that classroom teachers were not teaching during NR Days. All teaching was done by WQE staff and trained volunteers. Because of this non-significant finding we also looked at demographics and outdoor activity preferences as possible predictors of knowledge scores.

Demographics

We compared school district membership rather than gathering personal data from the students, because of the demographic differences between the two school districts. School district membership was a significant predictor of

student knowledge. Students from Cache County School District not only had higher mean pre-test scores ($P = 0.01$), but also had a significantly higher increase in knowledge on the 2-week post-test ($P = 0.01$) and the 8-month post-test ($P = 0.01$) compared with students from Logan City School District (Table 4). We did not find a relationship between percent/free and reduced lunches and knowledge gain.

Outdoor Activity

We categorized the outdoor activities into three broad categories, nature-based (hiking, wildlife-watching, fishing, camping, swimming in a lake), machine-based (riding my bicycle, 4-wheelers/ATVs, jet skis/water skiing), and urban (swimming in a pool, playing in my yard, playground). Participation in nature-based activities and urban activities were both significant predictors of knowledge scores on the pre-test. In contrast, machine-based activities were not a significant predictor of knowledge scores (Table 5). In an attempt to explain the difference we saw between the two school districts, we also looked at outdoor activity preferences by school district. Students in Cache County School District were more likely to indicate any nature-based or machine-based activity than were Logan City School District students (Table 6).

DISCUSSION

The short-term (1 hour) program evaluated in our study resulted in increased knowledge about aquatic ecology that was retained for at least 8 months after actual field

Table 4. Knowledge scores and comparisons by district.

Group	Logan City School District		Cache County School District	
	<i>n</i>	Mean (SD)	<i>n</i>	Mean (SD)
Pre-test	282	36 (15)	999	40 (16)
2-Week post-test	357	58 (21)	934	65 (18)
8-Month post-test	316	53 (18)	858	60 (17)
GEE Model comparing increase in knowledge over pre-test scores between districts. †				
Logan vs. Cache	2-week post-test		8-month post-test	
	<i>P</i>	Difference of least square means	<i>P</i>	Difference of least square means
	0.0096**	-5.5842	0.0091**	-5.5528

** Significant at the 0.01 level.

† A negative difference of least square means indicates the first group listed in the comparison has a smaller increase in knowledge.

Table 5. Bivariate regression (from the GEE model) showing how well outdoor activities predict knowledge scores.

Activities	<i>P</i>	<i>b</i> †
Nature-based	0.0013***	0.9394
Machine-based	0.4211	0.7165
Urban activities	0.0079**	0.9044

** Significant at the 0.01 level.

*** Significant at the 0.001 level.

† *b* values indicate the slope of the regression.

experience. Furthermore, students participating in this event appeared to have a more nuanced understanding of stream systems. The NR Days activities we evaluated, with simple instruction in basic ecology and experiences with nature, can be described as an entry-level phase (Hungerford and Volk, 1990). Our findings indicate that the entry-level phase may be sufficient for a successful environmental education program. Our study also confirms that the quality of the short-term program is an important contributor to its success. Education programs that take place in an outdoor setting, as opposed to a classroom setting, lead to more knowledge gain, positive attitude development, and environmental sensitivity (Cronin-Jones, 2000; Crompton and Sellar, 1981; Iozzi, 1989). Educational programs that use hands-on learning techniques, such as those employed in our study are more effective at increasing awareness and knowledge (Ballantyne and Packer, 2009, 2002; Ballantyne et al., 2001; Paris et al., 1998). Natural Resource Field Days was successful at increasing student knowledge and long-term retention by providing basic ecological knowledge, but more importantly, by engaging students in hands-on activities in a natural setting.

This study also demonstrated ways to increase the effectiveness of short-term environmental education programs. Our study evaluated several approaches to enhancing the single NR Days experience. Group 1 received no enhancements. Group 2 received extra classroom lessons taught by water quality educators. Group 3 received an additional high quality field experience several months after NR Days. Group 3 teachers were also provided the Group 2 lesson plans and activity trunks. After 2 weeks, we anticipated that Group 2 classes would have higher test scores than Group 1 because Group 2 classes had received the extra lessons. Bowker (2002) demonstrated that linking field visits to classroom experiences not only prepared students for the experience, but also increased opportunities for learning. Ballantyne and Packer (2002) also found that students who participated in pre-field trip activities were more excited about the field trip than students who did not participate in pre-activities. One teacher from Group 2 commented on the differences she observed between her students who were more engaged at the water station, and her colleague's students (from Group 1) who had not had the pre-NR Days classroom experiences and who were less engaged during the actual field experience (R. Mask, personal communication, 2010).

We anticipated that students in Group 3 would have an increase in short-term test scores similar to Group 2, based on our assumption that Group 3 teachers would use the lesson plans we provided in their classes. In fact, Group 2 had significantly higher scores than Group 3 after 2 weeks. Follow-up interviews with Group 3 teachers indicated that the extra lesson plans and materials we provided were not used (D. Lowry, personal communication, 2011). This finding is in agreement with Mesner and Walker (2007), who found that simply producing high quality lesson plans for teachers will not overcome other

Table 6. Comparison of outdoor activity preference between Logan and Cache School District students.

Activities	Logan District Mean (SE)	Cache District Mean (SE)	<i>p</i> value	Mann-Whitney U
Nature-based activities	2.07 (0.10)	2.57 (0.05)	<0.0001	117,567
Machine-based activities	0.056 (0.05)	0.75 (0.03)	0.0002	122,195
Urban-based activities	2.24 (0.09)	2.46 (0.05)	0.055	130,427

barriers to their being used in a classroom, such as lack of teacher knowledge about water science.

Eight months after the NR Days experience, both Groups 2 and 3 had significantly higher knowledge scores than Group 1, but Group 2 and Group 3 were no longer significantly different because Group 2's scores dropped somewhat. The spring field experience for Group 3 appears to have contributed to the retention of knowledge by these students. The apparent similarities between Group 2 and Group 3 on the 8-month post-test suggest that long-term knowledge retention can be achieved in at least two very different ways. Combined classroom and field experiences such as those offered Group 2 have been shown to be more effective than field experiences alone (Ballantyne and Packer, 2002; Lewis, 1981). This study demonstrated that multiple field experiences can result in the same long-term retention as occurred from combining classroom and field experiences. The higher 2-week scores for Group 2 suggests that even greater benefits could be accrued from combining additional classroom and field experiences, although we did not evaluate this option.

This study also reinforced the importance of training teachers on the use of lesson plans and curriculum materials. Lack of training is a well-documented barrier to incorporating environmental education into the classroom (Mesner and Walker, 2007). Teachers who receive either pre-service or in-service training in environmental education spend more time teaching about the environment and are more confident in their abilities to teach about the environment (Ham and Sewing, 1988; Lane et al., 1994; Powers, 2004). Further, teachers who participate in high-quality professional development workshops are more likely to adopt new teaching techniques such as inquiry-based learning (Supovitz and Turner, 2000).

We did not find a correlation between teacher characteristics and knowledge scores; however, we did find a correlation between knowledge scores and school district membership. This correlation may be explained by a difference in exposure to natural settings. It is possible that students in Cache County School District have a higher exposure to nature as a result of residing in a more rural environment than students residing in Logan City. Mesner and Walker (2007) found that rural students who participated in a water quality education program had higher pre-test knowledge than their urban and suburban counterparts. However, rural students exhibited a smaller increase in knowledge as a result of the program. They suggested that rural students had a higher pre-test knowledge of water quality issues because of their proximity to water resources; however, no knowledge differences existed between urban and rural students after participating in the program. In this study, Cache County School District students not only had higher pre-test knowledge scores, but they also had a higher increase in post-test knowledge scores. It is possible that something besides a rural/urban dynamic influenced the

difference between knowledge scores on the pre- and post-tests. We tried to explain this difference by looking at outdoor activity preference. Students in Cache County School District were more likely to indicate any nature-based or machine-based activity. Nature-based activities were a significant predictor of knowledge scores. However, urban-based activities were also a significant predictor of knowledge scores, whereas machine-based activities were not. Although this is an interesting finding, it may not explain the knowledge difference between the two school districts.

Another difference between the school districts during the study period was school achievement. Although both districts as a whole made Adequate Yearly Progress (AYP) as required by the U.S. No Child Left Behind Act (2001), four groups within Logan City School District did not make sufficient progress in language arts and were designated as "not OK" in the Federal AYP. Summary Report (USOE, 2011). The differences we saw in the post-test scores between the two school districts could be due to a combination of exposure to natural settings, outdoor activity preferences, and academic achievement.

CONCLUSIONS

Organizations across the nation depend on short-term programs to reach elementary age students without truly knowing if they are effective at increasing knowledge and long-term retention. This study demonstrated that short-term field experiences that provide students with hands-on activities and opportunities to interact with and explore nature can significantly increase student knowledge and long-term retention and may lead to feelings of stewardship toward the environment. We tested three models that were successful at increasing knowledge and long-term retention of the participants. The short program alone was highly successful at increasing knowledge and long-term retention. When enhanced with classroom lessons or a second field experience participants showed a greater increase in knowledge and long-term retention.

Many organizations and agencies are mandated to offer environmental education programs about water resources, stormwater runoff, and other water-related topics. In a survey by Kinder (T. Kinder, unpublished data, 2011) of 70 non-formal educators from watershed organizations, nature centers, and similar organizations in 30 states, more than half stated that their organization relied primarily on short programs to educate elementary age audiences. However, only three indicated the use of a formal evaluation to measure the success of these programs (T. Kinder, unpublished data, 2011). Our results suggest that these programs can have meaningful impacts on knowledge and attitude. If limited budgets constrain the number of activities possible for each student, our results suggest that the focus should be on single, high-quality, short programs.

APPENDIX A

NR Days Worksheet

- Which of the following animals would you expect to find living in the Logan River? (circle your answers)
 - fish whale
 - beavers worms
 - birds snails
 - insects sharks
 - jelly fish

- Circle the body part that allows this mayfly to breathe.



- For the following two statements, answer true or false and explain your answer.
 - Polluted water does not bother animals that live in the water.
 - Just like humans, many aquatic insects live most of their lives as adults.
- Some aquatic insects in streams have tiny claws. What would they use them for?
- Give one example of something *you* could do to help keep rivers and lakes clean and healthy.
- How does a caddisfly (like the one in the picture) get the "house" that it lives in? (circle your answer)



- It builds it out of materials it finds in the stream
 - If finds one left behind by other animals
 - It leaves the stream and builds it out of materials it finds on land
 - It grows it like a snail grows its shell
- Grass clippings, dumped in a stream, will decompose (rot) in the water. How might this affect the insects that live in the water? (circle your answer)
 - They can't see as well
 - They have more food
 - They can't breathe
 - They are not affected
 - They will have nothing to eat
 - When you spend time outside what do you like to do?
 - Bird/wildlife watching
 - Hiking
 - Fishing
 - Riding jet skis or water skiing
 - Swimming in a lake or pond
 - Swimming in a swimming pool
 - Playing in my yard
 - Riding my bicycle
 - Riding 4-wheelers/other ATVs
 - Camping
 - Going to a playground
 - I don't like to spend time outside
 - List other things you like to do outside.
 - Are you interested in learning more about keeping the water in rivers and lakes clean and healthy? (yes or no)
 - Are you interested in learning more about animals that live in rivers and streams? (yes or no)

12. If you could tell a good friend one or two things about rivers or streams, what would you tell them?
13. Please complete the following statements:
- If I look on the bottom side of a rock in a stream, I might find...
 - Being near a river or stream makes me feel...
 - I would visit a river or stream because...
 - I would not visit a river or stream because...

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