Invasive Plant Science and Management 2013 6:444–448

Teaching/Education

Environmental Stewardship Outcomes from Year-Long Invasive Species Restoration Projects in Middle School

Marion Dresner and Kelly A. Fischer*

To investigate the impacts of long-term targeted invasive plant stewardship projects on students' subsequent stewardship attitudes, an experiment using pre and post-tests to understand program effects and using post-test only comparisons to understand school effects was conducted. The resulting scores from two science classes that participated in year-long invasive plant and restoration activities were compared with those from three comparable classes at a linked school that did not participate in any of these activities. Students in the experimental classes showed overall significantly higher scores compared with the control classes. These attitude scores were then divided into two indexes: sense of personal effectiveness and attitudes of caring for particular places. Students in the experimental group showed increases in both, as compared with the controls. Parent and student focus groups were conducted at the end of the academic year. The resulting comments provide evidence for actual behavior change outside of the school environment. Analysis showed that any student, especially those in the control classes in the traditional middle school, indicating they had prior exposure to nature stewardship projects showed significantly higher scores than students who did not. The results underscore the value of having students involved in real-world stewardship projects, especially those of a long-term nature.

Key words: Invasive species, natural resources, restoration, stewardship attitudes, student field projects.

Many agencies use environmental stewardship to help them accomplish restoration, intending that these efforts contribute toward recovery of degraded urban ecosystems. In Portland, OR, there are several organizations that engage public groups in removal of invasive species from public parks and greenspaces in structured events. However, we do not understand the effectiveness of these events on changing attitudes or behaviors toward invasive plants, nor do we know the efficacy of particular events (sometimes called "weed pulls") on public attitude change. This project was a study of a relatively ideal set of controlled circumstances whereby groups of students who were engaged in invasive species removal over the course of a school year were studied for changes in attitudes and behavior. A graduate student from a nearby university measured their attitudes and self-reported behaviors, comparing the two participating middle school classes with three comparable middle school classes who did not participate.

Invasive species are one of the most serious threats to biodiversity, especially threatening remaining habitats in urban areas. Invasive species also indirectly impact biodiversity by altering fundamental ecosystem processes. Portland Parks & Recreation, which manages public parks in the city of Portland, holds many volunteer student and adult work parties to remove invasive plants. During the 2011 to 2012 year, they logged 63,277 volunteer work hours in parks. SOLVE (a nonprofit organization) also provides students with opportunities to remove invasive species in public greenspaces. The middle school students in the experimental group described in this project worked with both organizations.

Environmental stewardship is the "duty to look after our world prudently and conscientiously," to defend and protect ecosystems in order to be viable for future generations (Manzanal et al. 1999). Student stewardship

DOI: 10.1614/IPSM-D-12-00079.1

*Associate Professor and Graduate Student, Environmental Science and Management, Portland State University, 1719 SW 10th Ave., Portland, OR 97201. Corresponding author's E-mail: dresnerm@pdx.edu

Management Implications

English ivy (*Hedera helix*) is a pervasive invasive plant growing in parks and greenspaces in many urban areas. This plant is frequently the target of public and school invasive plant removal events. If the management goal is removal, chemical treatment may be more effective. However, if the management goal is greater public awareness about invasive plants, a targeted community-based education and stewardship approach may be effective. By involving an interested teacher, students can be involved in long-term experiences that both inform and involve them directly in work that has credible, beneficial real-world outcomes. Students in the experimental group of this study were highly motivated and continued to both inform and inspire their families to help remove invasive species outside of school in their own communities. In addition, they informed their families and friends about the work they had done removing invasive species in local parks and took them there to show off their results. Agencies can work with schools using long-term stewardship projects in effective strategies that increase awareness and motivation in students and lead to community-wide effects.

attitudes are most influenced by positive experiences with nature; supportive family role models, teachers and educational programs; the work of environmental conservation groups; and witnessing the destruction of a favorite place (Chawla 1998). In the Great Smoky Mountains National Park, middle and high school students participated in a program emphasizing environmental stewardship and biodiversity (Stern et al. 2008). Follow-up surveys measuring stewardship, interest in learning, connection with nature, and awareness of biodiversity showed statistically significant gains in each of the components, especially stewardship. Barnett et al. (2006) followed field-based ecology programs in Boston, MA, that used sites within the city over a 2-yr period. Results were compared with a control group that did not take part in the fieldwork. The experimental group showed a statistically significant increase in their stewardship attitudes based on survey and interview data. These attitudes may remain with them throughout their lives and lead to better environmental protection, conservation, and appreciation of nature as adults.

Engaging students in stewardship work can enhance students' environmental efficacy or sense of effectiveness. Students with higher efficacy may view a difficult task as a challenge, and attribute their success to their own effort as opposed to being due to luck or chance (Pajares 1997). Engaging students in invasive species removal work may also enhance their sense of caring for a particular place. Place-based attachment is a well-documented aspect of environmental stewardship (Clayton and Myers 2009; Ryan 2005). Place-based attachment, a bond a person may feel about a place, may be exhibited through wanting to or choosing to spend time in nature, and is seen as an important aspect of stewardship because it has been found to be linked with proenvironmental behaviors in middle school students (Kudryavtsev et al. 2012).

Direct experience is important for changing attitudes (Regan and Fazio 1977). The theory of planned change (Ajzen and Fishbein 1977) points to the possibility that students' attitudes and behaviors can become more environmentally sustainable through engagement in invasive species removal and restoration projects. We studied whether first-hand ecological experiences in invasive species removal, restoration, and monitoring projects can lead to changes in environmental stewardship attitudes and behaviors.

Materials and Methods

The Rachel Carson Middle School in Beaverton, OR, presented an ideal setting for a controlled experiment. This environmental middle school is embedded in a traditional middle school. The two environmental middle school science teachers participated in the weekly stewardship-themed field trips with their students. The science classes are cross-graded and include sixth, seventh, and eighth grade students. The other three science teachers in the traditional middle school classes did not take their students on any of the stewardship-themed field trips. Their students lived in the same neighborhoods as the environmental middle school students and were of similar ethnicities and socioeconomic status.

The science teachers from the experimental group had students work at several particular sites over the year. One of the two science teachers had received training with the authors during a summer course focusing on field ecology techniques and native and invasive plant species research taught at Portland State University; he subsequently shared what he had learned with his teaching colleague. The first extended project involved students in removing invasive species, especially English ivy (*Hedera helix* L.) and replanting native species to help restore animal habitat in a public greenspace. In another project, students labeled the plants in a natural area behind the school, worked to remove the invasive species present and replanted with native species. The third major project involved a science inquiry approach to invasive species removal in a local park; students measured percentage of cover of all plants in two nearby 10 by 10–m (32.8 by 32.8–ft) plots and subsequently removed the English ivy from one of them. They returned in the spring to remeasure and compare the changes in the plot that had been hand-treated. Repeated visits were made over the year to all three of these sites. The three control classes did not participate in any form of invasive species removal.

We measured the pre– and post–school year stewardship attitudes and science interest of students in the experimental classes to understand how student attitudes change through engagement in a series of stewardship and field

https://doi.org/10.1614/IPSM-D-12-00079.1 Published online by Cambridge University Press

ecology projects. We measured the stewardship attitudes of students in the traditional classes at the end of the same school year to understand if differences were due to the school science experience or other external causes.

The survey was 30-question form using a five-point Likert-type scale with responses and point values ranging from 1 (definitely not true for me), to 5 (definitely true for me).

Student and Parent Focus Groups. Group interviews were conducted at the start and end of the academic year to further illustrate the range of environmental behavioral and attitudinal impacts resulting from experimental students' projects. The focus groups, facilitated by a graduate student, were asked about their favorite natural areas, specific activities they engaged in that they felt helped the environment, and which things they learned in science class changed how they felt towards the environment.

We interviewed a group of 15 parents of students from the experimental classes at the end of the year to get additional information about ecological behaviors and students' overall environmental efficacy that might be attributed either to their work in school or to the influence from the family. All participating teachers were asked about the specific activities students had engaged in, whether students spoke of these places after the field trips, and if students spoke of specific behaviors they engaged in outside of school related to their school activities.

Survey Analysis. The surveys were coded (for example, "Definitely true for me" was given a score of 5). The changes in experimental student scores were analyzed. Since the survey was anonymous, the changes were calculated class-wide, not individually. A factor analysis was conducted on posttest results of the stewardship questionnaire to reduce the responses to two composite variables. A multivariate ANOVA test was conducted to compare pre- and posttest results from the experimental groups with the results from the control groups. Science interest questionnaires were analyzed using Welch two-sample *t*-tests. Friedman two-sample tests or Welch two-sample tests were used to compare groups where pre- and posttest data were available. ANOVA was used to compare groups when only posttest data were available. Correlations were performed between stewardship scores and treatment.

Results and Discussion

Stewardship Survey. Overall, there was a significant effect due to whether students had participated in the experimental classes or the control classes. Students in the experimental group had statistically significant overall higher scores than the students in the control group ($F_{104,1291} = 7.419$, $P < 0.0005$; Wilk's $\lambda = 0.156$, partial $\varepsilon^2 = 0.371$). Aggregate scores between classes from the environmental middle school classes were not significantly different; aggregate scores between control traditional middle school classes were not significantly different.

Pre and posttest results between the two environmental middle school classes were compared using the related-sample Friedman two-way test. The distributions of pre- and posttest scores overall for both classes were similar ($P = 0.715$). A factor analysis was conducted, (using varimax rotation with 12 iterations), which resulted in two factors, "personal effectiveness" and "caring about a place," as shown in Table 1.

These factors were used to create composite scores; one for "personal effectiveness" and one for "caring about place." The composite scores for students in the experimental classes and the control classes were compared using Welch two-sample *t*-tests. Results showed significant differences between the experimental group and the control groups for the "caring about places" factor ($t = 10.73$, $P = .00$), and for personal effectiveness ($t = 16.22$, $P = .00$).

Although students in the control classes may have not participated in environmentally themed field trips, individual students' prior restoration experiences appeared to affect their stewardship scores. We compared composite personal effectiveness scores between students in the control groups who indicated they had participated in stewardship on prior occasions with those who had not using ANOVA. The scores were significantly different ($F = 5.48$, $P = 0.02$). An ANOVA performed on the composite caring about a place scores was not significantly different ($F = 5.482$, $P = 0.21$). In general, there was a strong relationship between participation in restoration activities and scores on the stewardship questionnaire.

Focus Group Data. Student statements were grouped by a team of three outside collaborators for indications of personal effectiveness, including those statements indicating students felt their work made a difference. For example, "I feel like we can all make a difference" was coded as personal effectiveness. Statements were coded for indication of caring about a place related to their work at restoration sites, for example, "Forest Park (is my favorite place) because it is so peaceful and quiet." These statements were seen as examples of specific behaviors students were involved in during the school year that supports their strong showing on the stewardship attitude surveys.

Over the course of the year, there were significant changes in student stewardship attitudes because of their participation in long-term stewardship projects. The impact from engagement in restoration work with these middle school students is notable. Students appeared to be eager to be given a chance to do something that had meaning in the larger world. These students understood their work as authentic because it took place outside the confines of the school and in parks and public places of their community, and had an organizational context. Braund (2006) also found that out-of-school science

https://doi.org/10.1614/IPSM-D-12-00079.1 Published online by Cambridge University Press

Table 1. Results of a factor analysis conducted on stewardship responses.

	Factor loading
Factor 1. Caring about place	
I like the chance to be outdoors.	0.823
I feel at home when I am in natural areas.	0.746
I feel a strong attachment to particular natural places.	0.721
I go outdoors to natural environments in my free time whenever I can.	0.535
I enjoy observing things in nature.	0.507
Factor 2. Personal effectiveness	
I think my work in natural areas is doing something useful.	0.787
I think my work in natural areas will result in improvements in environmental conditions.	0.627
I think that I am going to help the environment through our project in science class.	0.578
I actively advocate for conservation by talking to others.	0.562
I am more aware of my impacts to the natural environment (than before).	0.506

experiences utilizing actual world situations and off school grounds sites improve student motivation.

The most important changes reported in this study were between students in the environmental middle school and students in a traditional neighboring school without a field ecology or stewardship projects emphasis. The differences in these scores can be attributed to their exposure to structured invasive species removal and restoration activities. Students' sense of personal effectiveness was built though participation in the various long-term projects over the course of the year. These students did not feel helpless when they learned about these problems, but rather they were encouraged, excited, and proactively came up with solutions. Particular statements made by students during the focus groups illustrated how they brought their work back home with them into their own neighborhoods:

> "I pull ivy everywhere I see it."
>
> "I learned how to remove [invasive] blackberry and it has opened my eyes to what is really a problem out there."
>
> "I feel like we can all make a difference to this problem."
>
> "After working at SOLV and in Forest Park, I'm happy to see places [without invasives] like that now and I want to change my own to be like that."

Actual behaviors that were engaged in at home, according to parents, specifically involved invasive plant removal. All of the parents noted that their child had created opportunities to help remove invasive species in their own neighborhood and at the homes of members of their extended families. Parents had the following comments:

> "They are often spotting [invasive] blackberry and ivy and saying how they could fix that."
>
> "My child is often asking, 'Don't you want to pull this ivy with me?'"
>
> "He identified reed canarygrass and suggests sites that should be a restoration site next year."

Overall, these students had strong beliefs about their capacity to change environmental problems such as the persistence of invasive species, and they followed through, according to their own statements and those made by parents, with actions consistent with those attitudes.

The experimental group of students showed that they had developed a degree of affiliation with natural places they had worked in over the year. According to the science teacher, several students had talked about returning to places on their own where they had worked to remove invasive species, such as Forest Park. Their sense of caring was manifested in specific sustainable behaviors. These students reported taking their families and friends to the natural areas where they had removed invasive plants to show them the results of their efforts.

The Value of Sustained Work with Students. Student participation in long-term invasive species removal and restoration projects resulted in significant increases in environmental stewardship attitudes. The experimental group, which had made many visits to natural spaces throughout the school year, developed attitudes of attachment and caring about the places where they had worked. Teachers from the traditional middle school did not provide their students with significant exposure to environmental projects; consequently their students had significantly lower scores. Even the control group students that had participated in some prior environmental restoration work had a higher mean stewardship score than those who had not. This demonstrates a general effect that experiences in restoration and conservation activities can have on students.

Limitations. Our findings would be considerably strengthened if we would have involved more classes from different schools in a similar study. Second, the students at the environmental middle school may have been unique; they were a self-selected group of students who had chosen to attend a specialized middle school. Our

https://doi.org/10.1614/IPSM-D-12-00079.1 Published online by Cambridge University Press

results might have been different if we compared two more-traditional middle school classes, one of which was involved in long-term stewardship projects. These students could also be studied in a longitudinal study. To what extent, and under what circumstances, do their environmental stewardship attitudes remain heightened? Do they continue to practice environmentally responsible behaviors?

Focused, long-term field projects involving students in repeated visits to different sites where they can conduct particular stewardship activities and observe the results of their work over time can help build a sense of attachment to particular places. A sense of attachment, combined with attitudes of concern and caring, are the underpinnings for sustained stewardship participation over time. Organizations might also target adult community members to work along with students to ensure a community-wide impact from invasive species removal projects.

Acknowledgments

This study was supported by National Science Foundation grant 00554379 and a grant from the Oregon Community Foundation. We appreciate the work of science teacher Padriac Quinn. We thank Portland Parks & Recreation and SOLVE for their work with these students.

Literature Cited

Ajzen, I. and M. Fishbein. 1977. Attitude-behavior relations: a theoretical analysis and review of empirical research. Psychol. Bull. 84:888–918.

Barnett, M., C. Lord, E. Strauss, C. Rosca, H. Langford, D. Chavez, and L. Deni. 2006. Using the urban environment to engage youths in urban ecology field studies. J. Environ. Educ. 37:3–11.

Braund, M. and M. Reiss. 2006. Towards a more authentic science curriculum: the contribution of out-of-school learning. Int. J. Sci. Educ. 28:1373–1388.

Chawla, L. 1988. significant life experiences revisited: a review of research on sources of environmental sensitivity. J. Environ. Educ. 29:11–21.

Clayton, S. and G. Myers. 2009. Conservation Psychology: Understanding and Promoting Human Care for Nature. West Sussex, UK: Wiley-Blackwell. 253 p.

Kudryavtsev, A., R. C. Stedman, and M. E. Krasny. 2012. Sense of place in environmental education. Environ. Educ. Res. 18:229–250.

Manzanal, R. F., L.M.R. Barreiro, and M. C. Jimenez. 1999. Relationship between ecology fieldwork and student attitudes toward environmental protection. J. Res. Sci. Teaching 36:431–453.

Pajares, F. 1997. Current directions in self-efficacy research. Pages 1–49 *in* M. Maehr and P. Pintrich, eds. Advances in Motivation and Achievement. Volume 10. Greenwich, CT: JAI.

Regan, D. T. and R. Fazio. 1977. Forming attitudes that predict future behavior. Psychol. Bull. 132:778–822.

Ryan, R. L. 2005. Exploring the effects of environmental experience on attachment to urban natural areas. Environ. Behav. 37:3–42.

Stern, M. J., R. B. Powell, and N. M. Ardoin. 2008. What difference does it make? Assessing outcomes from participation in a residential environmental education program. J. Environ. Educ. 39:31–43.

Received October 2, 2012, and approved March 12, 2013.