RETURN OF THE NATIVES – CYCLE OF RESTORATION CURRICULUM

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By

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Return of the Natives – Cycle of Restoration Curriculum

Abstract

The goal of this capstone project was to develop the Cycle of Restoration curriculum and implement its contents as part of an action research based investigation that evaluates its effectiveness and usability. The design and implementation of the RON – Cycle of Restoration curriculum was completed as part of a cooperative internship with the Return of the Natives Restoration Education Project and the Bureau of Land Management. The goal of this internship was to explore the environmental science issues associated with invasive plant species, native plant communities, restoration ethics, and to develop an educator resource that would be useful to traditional and non-traditional educators. Determining the effectiveness of the curriculum was focused on collecting quantitative data that answers the following question: "Does the use of the RON curriculum increase knowledge among students and educators regarding noxious weeds and native plant communities?" Results of qualitative data collected from an educator workshop and a classroom field trial evaluates the curriculum's strategy, usability and effectiveness. Analysis of this qualitative data answers the following question: "Is the RON curriculum conveying the importance of preventing and eradicating invasive plant species, while restoring native plant communities as part of a continuing cycle of restoration?" Quantitative and qualitative results support the initial prediction that the RON Cycle of Restoration curriculum would increase knowledge and awareness regarding the negative impacts associated with noxious weeds and the importance of preserving native plant communities.

Introduction

The Return of the Natives (RON) – A Cycle of Restoration curriculum is a cooperative effort between the Bureau of Land Management - Ft. Ord Project Office, Return of the Natives – Restoration Education Project at the Watershed Institute CSUMB, and the National Fish and Wildlife Foundation. The goal of my work with these organizations was to produce a curriculum focusing on restoration of native plants and eradication of invasive weeds that educators, both traditional and non-traditional, can implement as part of their existing programs and restoration efforts. This curriculum is designed with a diverse group of leaders and educators in mind. Schools, 4-H, Scouts, volunteer organizations, and groups of all shapes and sizes are able to access and implement this program. RON – Cycle of Restoration is designed with the flexibility to be integrated into existing ecology-based curricula to increase awareness about the imposing spread of invasive non-native weeds and the importance of maintaining healthy native plant communities in California.

The RON Cycle of Restoration curriculum goals are:

- To instill in educators and students the concept that the restoration and protection of ecosystems is dependent on the responsible actions of people to help preserve native plant habitats and help stop the spread of invasive non-native weeds.

- Create a self-sustainable community-based restoration curriculum. The curriculum focuses on native plant restoration and invasive non-native weed eradication that various groups can initiate independently or supplement established programs such as "Adopt-A-Watershed".

To achieve the stated program goals it was paramount that the curriculum employs a format that was familiar to educators and easy to understand. To assist educators the RON curriculum provides:

- Pre/Post Student Questionnaires & Scoring Guide
- Standardized Activity Structure with measurable learning objectives.
- Scoring Guides & Suggestions for final student evaluation.
- Educator Evaluation & Suggestion resources

The curriculum is committed to increasing the sustainability of the Return of the Natives Education Project by providing educators with training, lesson plans, and support that elevates the educator's experience and comfort levels with science-based project curricula. The RON Cycle of Restoration curriculum attempts to present relevant issues as objectively as possible. This is always a complicated task, as the majority of individuals close to the problems associated with native plant restoration and invasive plant species eradication have very strong opinions and biases. This is especially true with regards to the use or non-use of chemicals as an eradication method. This curriculum is designed with the intent of familiarizing educators and future decision-makers with the topic of native plant restoration and weed eradication that will give them a basis for making informed choices.

Invasive non-native weeds are defined as plants that interfere with preferred plant species either in a garden or in a natural area. Weedy invasive species compete with desirable native species for water, light, nutrients, and space. The California Exotic Plant Pest Council uses the term 'invasive' to describe the 79 exotic and most dangerous invaders to California. Humans have either intentionally or incidentally introduced these 'exotic' plants to North America within approximately the last 150 years. These 79 invaders constitute a small fraction of the non-native vegetation introduced to this continent for the agricultural or horticulture industries. A non-native plant can be defined as originating from another continent and not found to be historically indigenous to the landscape of a continent. (CALEPPC, 1999)

For land managers, farmers, gardeners, outdoor enthusiasts, and homeowners' weeds can become a catastrophic problem. Invasive non-native weeds are plants that society has declared a legal responsibility to manage because of their negative ecological impacts. Many invasive non-native weeds evolved in other countries where the pressures from the environment keep them in dynamic equilibrium with other plant species. However, once away from their native lands these plants become invasive non-native weeds. Invasive non-native weeds are currently spreading like biological pollution out of control in California and most of the western United States. The state of Montana's Department of Agriculture has reported that 8.7 million acres in the state had been infested with invasive plants by 1987. What is even more staggering is that by 1989 only 2% of the infested acreage has implemented control strategies. Montana Department of Agriculture has also reported an estimated cost associated with invasive plant species of $2.5 million each year to lost crops, lost forage, and eradication programs. (REAP, 1989)

Negative impacts associated with invasive weeds may be both ecological and economic. Invasive non-native weeds displace native plants, reduce biodiversity, eliminate threatened and endangered plant species, alter normal ecological processes (e.g. nutrient cycling, water cycling), decrease wildlife habitat, reduce recreational value, and increase soil erosion and stream sedimentation. Currently, research has not documented the extinction of a native species by an invasive weed, and yet 30 of California's 53 endangered plants are currently threatened by one or more invasive species. (Walston, USFWS, 1998) Losses to agriculture are equally devastating by rendering grazing lands unusable and increasing the cost of removing problem weeds from their lands. In 1997 the California Department of Food & Agriculture released the results of a statewide survey of lands infested with Yellow Starthistle (*Centaurea solstitialis)*, a particularly invasive weed that is responsible for causing 'chewing disease' in livestock. The term 'chewing disease' is given to the livestock that ingest the spiny thistle heads of this plant, suffer brainstem dysfunction, and

subsequently die. The CDFA concluded that 14 million acres of California were infested to a point where grazing or recreation was significantly decreased. (CDFA, 1997) The Bureau of Land Management, which makes up only a fraction of California's native habitat, is losing an estimated 2,300 acres per day to the spread of invasive plant species. (BLM, Partners Against Weeds. 1996) Between 1906 and 1991 seventy-six different non-native plant species caused an estimated $97 billion in agricultural, industrial, and personal losses nationally. Future losses associated with the spread of the top fifteen invasive plant species have been projected as high as $134 billion. (Walston, USFWS, 1998)

Anyone who has ever tried to maintain a healthy garden has observed the effects of unwanted pest plants as they upset the balance of nutrients and space. Weeds in neighborhoods and gardens can create aesthetic eyesores. In contrast, some of the very same species that threaten natural areas are non-native ornamentals that are installed into landscapes for their showy flowers and hearty growth rates. A fraction of these introduced species become plant invaders and can contribute to the degradation of wildlands that border our homes. The removal of these invaders inevitably costs homeowners, neighborhoods, and land managers time and money if they are not quickly and effectively removed.

Although much of the blame has been placed on the non-native plant species themselves, they should not entirely be judged as the cause of the economic or ecological degradation mentioned. Humans have cultivated and nurtured these invasive species and ultimately provided the opportunity for these plants to spread through disturbance. We have been radically altering and impacting areas that were previously inhabited by California's native vegetation. Agriculture, urban growth, and recreation all place a strain on native plant communities. We have not afforded the same luxuries to the native plants of this State as we have to the non-native invasive plants. This is not the mechanism by which 'native' plant species have adapted over millions of years. Native plants have developed a dynamic and complex equilibrium with the geology, hydrology, and native wildlife of an area. Return of the Natives defines native plants as those that are indigenous to the landscape, living here before European settlers arrived on the North American continent, and growing within their natural range and dispersal potential. These native species inhabit and spread through an area without the influence of humans. Return of the Natives is also equally concerned about the preservation and restoration of native plant populations that have evolved over many years. When humans directly or indirectly introduce a non-native invasive plant species to an area this plant has not endured the same competitors, diseases, and insects that keep native plant populations in equilibrium. This environmental problem is only magnified when coupled with a lack of awareness in the general public with regards to topics like biodiversity, invasive non-native plants, and human impacts.

Currently, in California there are no conventional restoration education curricula or classroom appropriate materials available for an educator that address the topic of invasive weeds as a threat to the health and productivity of watersheds. Existing curricula of this type do extensively address many of the issues associated with the health of a watershed such as erosion, water quality, waste reduction, and habitat preservation. Montana, a leader in noxious weed education, has reported the successful implementation of an exclusively 'weed' oriented curriculum.

On October 15th, 1999 in Sacramento, California a statewide workshop investigated the topic of noxious and invasive weed education and awareness programs in California. The workshop program included eleven different presenters who presented overviews of their organization's efforts to integrate education materials to the public, landowners, and students K-12 grades. Barbra Mullin from the Montana Department of Agriculture spotlighted the education efforts in Montana, now extensively interconnected with other state agencies, as a model for long-term education projects. Mrs. Mullin pointed out that, since 1989, The Resource Education Awareness Project (REAP) has circulated videos, brochures, posters, and some suggested lesson plan ideas to educators statewide.

This outreach program was targeted at 5th through 12th grade educators and classrooms with a focus on Montana's natural heritage, weeds, and land ethics. Mrs. Mullin also pointed out that the funding for this outreach and education effort came from a $1.5 million fund that was created by placing an extra $1 charge on vehicle registrations. Mrs. Mullin noted that right-of-way traffic is one of the largest contributors to the spread of invasive plant species and education materials should also be targeted towards all audiences involved. (Mullin, 1999) This effort was continued and adapted into a national effort by the Department of the Interior, Bureau of Land Management (BLM) in 1996 as part of the Partners Against Weeds (PAW) – Action Plan. (Reiben, 1996) Currently the BLM is taking steps to integrate the RON – Cycle of Restoration Curriculum into the blm.gov web based network to serve as a model for other organizations and educators who are looking for restoration based curricula that integrate invasive plant issues.

On February 3rd, 2000 education specialists from a variety of organizations met in Sacramento, California at the USDA State Office to discuss the possibility of integrating a K-12 Invasive Species/Weed Education curriculum into existing conventional restoration education curricula. (See *Meeting Agenda K-12 USDA*) The participants agreed that the topic of invasive plant species should be a component of curricula that address agricultural and environmental issues. The participants also agreed that an invasive plant facet could be integrated into existing programs instead of creating an entirely separate agenda. Several participants also emphasized the need for curriculum correlation with the recently adopted California Science Content Standards. Subsequently it was decided by Return of the Natives staff that the RON – Cycle of Restoration Curriculum should be field-tested and integrated into the existing RON Greenhouse/Native Plant restoration education project. The foundation of this integration is rooted in the concept of a native plant restoration cycle that includes the preparation and repair of an area; propagation and planting of native plants, and eradication of invasive plant species.

This capstone project utilizes an integrated understanding of science and policy to produce and investigate the effectiveness of a restoration curriculum concerned with both invasive weed eradication and native plant restoration. Raising awareness and implementing an educational agenda in the local community about the environmental issues associated with invasive plant species requires considerable interaction, understanding, and strategic planning within the constructs of public agency policy and community beliefs and concerns. For example, community members may place aesthetic value above a seemingly trivial environmental concern. Some communities may object to the treatment methods implemented by community agencies to control an invasive plant. Others may object to investing time, energy, and resources into removing a plant species that was introduced by a community agency to control resource degradation from erosion or fire. Local retailers may be economically reliant, unaware, or have no alternatives but to sell and propagate potentially invasive non-native plants. Conversely, agriculture may suffer economic losses as a result of the introduction and spread of these same invasive plant species. An environmental education project of this type must be aware of these groups and their concerns. The challenge therefore resides in both the ability to present the environmental science issues in terms that the general public can comprehend and present this same information objectively with empathy for the opinions, concerns, and regulations that exist in the community. This capstone project will accept the challenges outlined and strive to encourage stewardship in those same communities by emphasizing a science-based, watershed systems approach to sustaining the health of local ecosystems. This outreach project will directly target community educators and provide them with the tools necessary for increasing their experience with science-based restoration curricula as well as provide them with a real-world application of science concepts.

Conducting an effective action research based investigation that evaluates the effectiveness and usability of curricula is a complex task. This type of work first involved the formation of working partnerships with educators and land mangers. Forming these partnerships increased the distribution of knowledge about the importance of preventing the spread of invasive weeds and preserving native plant communities.

Curriculum Information

The following information explains how to access the RON – Cycle of Restoration curriculum via the web or CD (accompanying this report). This section is best explained if access to the curriculum materials is viewed in conjunction with reading this report. The accompanying CD contains all of the lesson plans in a web (.html) and (.pdf) printable format. The same curriculum formats are also available on the web @ www.monterey.edu/students/dh/detkajon/world/ron

To view the curriculum materials, insert the CD and open the file named: enter.htm
*Note: To properly view this CD it is best to use the following:

- PC with Windows 95/98/NT or Mac with OS 8 or higher
- Microsoft Internet Explorer version 4 or higher
- Set screen resolution to 800X600 or higher
- Adobe Acrobat Reader 4.0 and QuickTime Movie Plug-in

After opening the file enter.htm click on the enter button to access the curriculum. The figure below describes the main page features.

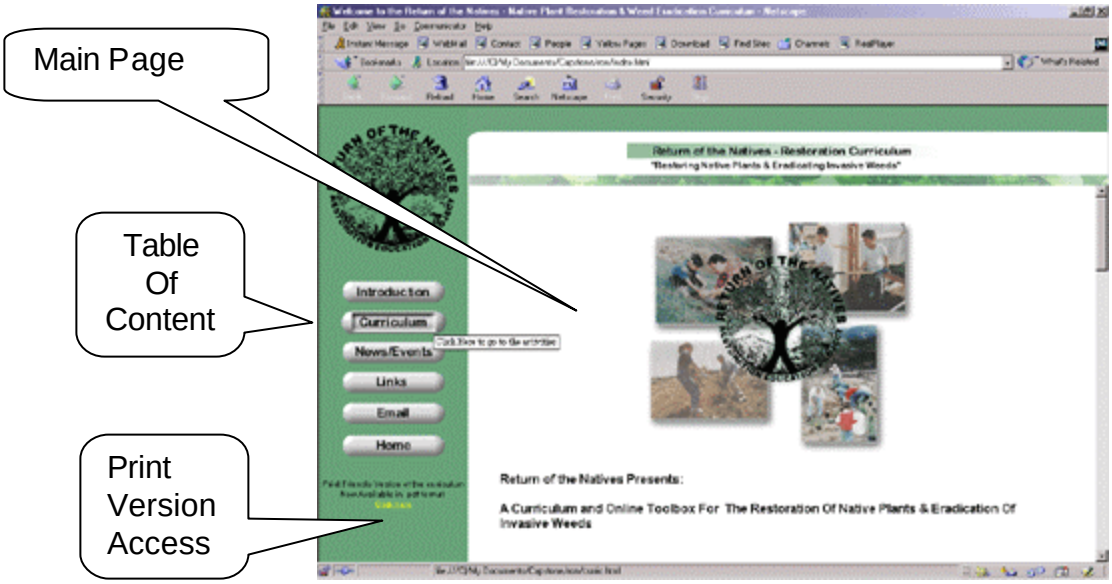


Figure 1 Cycle of Restoration – Main Page

Please take the opportunity to browse the page contents before continuing further. For specific information on the curriculum timeline, lesson structure, or to browse specific lessons click on the Curriculum button. There is also a button in the table of contents linked directly to the print version of the curriculum. Follow this link for access to the curriculum if printing is desired. (Note: This requires Adobe Acrobat Reader 4.0) This print section (.pdf) can be browsed similarly to the .html version from the linked .pdf Table of Contents. The Cycle of Restoration page also contains a News & Events section that highlights some of the project outreach and education efforts. Lastly, there are some valuable links to other web resources via the Links button as well as a link to contact me via email with suggestions, questions, or comments. Note: To go to web-linked pages and email correspondence requires an Internet connection.

Curriculum Development

The development of this curriculum began over a year ago as interns from Return of the Natives at CSUMB (Thor Anderson, Eric Cronk, Leslie Matlack, and myself) teamed up with Student Conservation Association (SCA) interns Chase Jones and Emily Briscoe, Botanist Bruce Delgado, and the team of biological technicians at the Bureau of Land Management Fort Ord Project Office to pilot an outreach effort termed, the "War On Weeds". Over the course of three months each intern accepted the task of acquiring a 'been there done that attitude' with regard to hands-on eradication of invasive weeds in the backcountry of Ft. Ord. Shortly after this, each intern accepted a facet of the outreach effort in the local Monterey region. My task was to design weed related activities as part of the SCA intern outreach efforts. Jones and Briscoe utilized the activities and information that I had assembled in their extensive outreach endeavor to over a dozen outdoor field trips and classroom visits in the Monterey region.

Ultimately, the draft version of the curriculum, called WeedEd, was created and was the product of feedback from the SCA intern educators as well as my work with CSUMB students and grade 7-8th students participating in the Recruitment in Science Education (RISE) Service Learning program at CSUMB, and the students from the summer Youth in Environmental Service to Salinas (YESS) high school intern program. As a result of working with these groups while actively involved in the Return of the Natives Greenhouse Project and Restoration Days a need to illustrate the cyclic nature of restoration work quickly established itself as a curriculum strategy. The WeedEd curriculum contained several elements and references to the importance of native plant communities but it did not emphasize the role of continued stewardship in the greater cycle of restoration. WeedEd did not effectively link weed eradication to a greater cycle of removing the degrading elements in a natural area (I.E. trash, erosion, weeds) and returning the native plant communities through hands-on restoration work. This philosophy of community outreach and education through the cyclical nature of restoration work in local communities was at the center of the RON Education Project and this further validated the need to adopt this strategy. Engaging with these individuals and organizations dramatically altered WeedEd. Initially, the curriculum was focused entirely on weeds to exclusively accommodate the Bureau of Land Management's Partners Against Weeds (PAW) –action plan. The educators that were using the lessons and activities pointed out that it was also necessary to build value in native plants and animals before exploring the problems associated with invasive species. After engaging with educators I realized that I had made the assumption that educators and students would be able to see the parallel between invasive species management and the restoration of native plant communities. Addressing this need to integrate native plant restoration information led to the movement away from the curriculums previous strategy and title, WeedEd, and towards a strategy and title that emphasized the prevention and eradication of weeds and restoration of native plant communities as a 'Cycle of Restoration'.

Four sections currently form the Cycle of Restoration curriculum beginning with 'recognizing' the 'weedy' issues and role of native plant communities. This journey continues through a cycle of action, reflection and outreach, which ultimately radiates outward into the community. By initiating this cycle of actions guided by reflection students move towards a better understanding of the value and importance of restoring and preserving native plant communities, while simultaneously playing an active role in the prevention and eradication of invasive plant species. This cycle is further perpetuated outward into the community as students outreach and inform their friends, families, and neighbors about what they have learned.

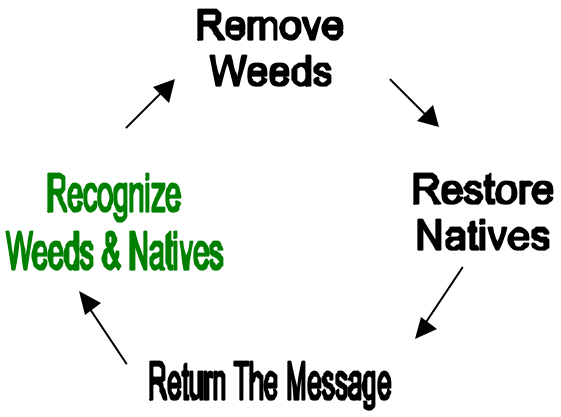


Figure 2. The Cycle of Restoration

Section 1 'Recognizing Native Plants & Weeds in the Local Community', is dedicated to becoming familiar with not only the enemy (weeds), but also our ecosystem allies (native plants). Throughout all of the activities in this section students make observations that increase their understanding of the value native plants provide for the local ecosystems in their community.

Section 2 'Removing Weeds & Studying Native Plants', explores the methods land managers and concerned citizens' use in preventing and controlling the spread of invasive weeds. In this section students devise and maintain a long-term weed/native plant related field study in their community. Field studies focus on the removal, maintenance, and monitoring of weedy areas in their community. Go to the Cycle of Restoration News & Events section to see how the eradication of Iceplant was incorporated into the CSUMB Earth Day 'Iceplant Olympics' to make a fun game and outreach piece out of removing this weedy invader.

Section 3: Restoring the Balance, focuses on the importance restoring the health of an ecosystem by reestablishing native plants back into the ecosystem after invasive weeds have been removed. The 'Cycle of Restoration' activity in this section explores the cycles associated with the restoration of previously weedy areas. Students play an active role in preserving the ecology of their local community by implementing an actual weed eradication project and monitoring its changes over time.

Section 4: Returning the RON Message to the community, completes the awareness cycle as students inform their community about the importance of native plant restoration and preventing the spread of invasive weeds. At this point the lessons and reflections from the three previous sections

are developed into student poster/project presentations that can be used for community education. Students create new 'cycles of restoration' in their community through their own outreach efforts and the restoration education cycle is continually perpetuated outward.

This four-step process of increasing knowledge and developing service learning mirrors the five elements of Environmental Service Learning adopted by the Adopt-A-Watershed Program and the Return of the Natives Restoration Education Project. At the center of these programs is the belief that environmental education is most effective when the local environment is explored and problems are acted on through community partnerships and local action. These programs also utilize reflection and communicating the learned messages outward as a means for facilitating sustainable environmental action in the community. When designing the Cycle of Restoration curriculum it became essential to mirror this strategy as a means of creating a self-sustainable community-based restoration curriculum that Return of the Natives could utilize as part of their education efforts. (Adopt-A-Watershed 2000)

After writing and editing several of the activities in response to qualitative educator feedback it was time to implement and present the RON Cycle of Restoration curriculum and strategy. The curriculum was presented as a model for informing communities about the threats invasive plant species pose to the health and productivity of native plant communities. Implementation began with presentations that focused on the curriculum strategy at the, USDA California State Weed Education Meeting in Sacramento, California Exotic Plant Pest Council (CALEPPC) Symposium in Pleasanton, and the Watershed Institute – War on Weeds Symposium hosted at Moss Landing Marine Labs. Each of these presentations provided a forum for explaining and discussing the Cycle of Restoration strategy with those organizations and individuals that were also concerned with designing and implementing invasive weed related educational resources. As a result of these presentations many of the organization leaders in attendance began integrating invasive species information into their own environmental and natural history educational resources.

Originally I had envisioned the Cycle of Restoration curriculum and its contents providing a resource for local educators that were working directly with the Return of the Natives greenhouse and restoration projects. A need to make the curriculum resource available outside of the Monterey region became increasingly evident as a result of networking with organizations that extended outside of the Monterey region such as the USDA, California Native Plant Society (CNPS), and Bureau of Land Management. Internet posting and linking of resource as well as distribution via CD increased the curriculum's availability and significantly decreased the cost of circulation by Return of the Natives and the Bureau of Land Management.

Coinciding with these events I also coordinated an educator workshop sponsored by the Return of the Natives Restoration Education Project based out of the Watershed Institute at CSUMB. This workshop brought together several traditional and non-traditional educators for around the Monterey region to explore the content and goals of the Cycle of Restoration curriculum.

Shortly after conducting the workshop, I was introduced to Lynda Kamrath from Laurel Wood Elementary School located in Salinas via Penny Immel also from Laurel Wood Elementary and attendee at the workshop. Mrs. Immel and her 3rd grade class maintain a 'buddy classroom' partnership with Mrs. Kamrath's 6th grade class. Mrs. Kamrath did not attend the workshop but had a wealth of experience regarding the topic of restoration and had attended previous RON training sessions. Mrs. Kamrath was interested in involving her 6th grade classroom in the entire curriculum and assessments as part of the field-testing component of this capstone project. The 6th grade students played a vital role as peer educators to the 3rd grade students and informed their 'buddies' about the importance of native plants and the need to stop the spread of invasive weeds.

Methods

During the course of the RON – Cycle of Restoration educator workshop held on October 14th, 2000 at the Watershed Institute, CSUMB qualitative feedback and quantitative data was acquired from participants through survey style workshop evaluations and pre/post questionnaires. This information was used to assess the usability of the curriculum materials and strategy. Educator feedback over the course of this workshop directly guided future editing and improvements in the curriculum resource.

This research involved the collecting and analyzing of a combination of quantitative and qualitative data from students and educators in order to gain a better understanding of what knowledge was being conveyed and the breadth and depth of that knowledge. (Bioland 1992) Qualitative data in this report can be defined as "the nonnumeric examination and interpretation of observation for the purpose of discovering underlying meaning and patterns of relationships". (Bioland 1992) According to Luquet (1913) student drawings can be used to evaluate their perception of the environment around them. Luquet's classified these stages of development into five categories separated by age group. According to Luquet's classification student's ages 5 to 7 years old and up are able to render intellectual realism that reflects the impact of knowledge on drawing. Piaget (1969) went on to show that drawing has a significant influence in on a student's ability to reason cognitively. In the past student's renderings have been used as emotional indicators that assess how students prioritize environmental problems. (King 1995) "In King (1995) 47% of students rendered images that depict themselves taking personal action for positive social/environmental change."(Barraza 1999)

The use of quantitative pre/post test method in this project is commonly used to demonstrate statistical changes in knowledge among a test group. (Bioland 1992) The use of Wilcoxon's Rank Sum T-test allows for statistical comparison of results when the variable of interest, increase in knowledge, is measured on an ordinal scale. (Ott 1990) A blending of quantitative and qualitative methods is common practice as part of action research. Action research can be defined herein as, "a blending of theory and practice in such a way that those who will be most affected by any proposed changes derived from the research are also the ones who help determine what theories and experiences are the most meaningful and relevant." (Wals, Oct 1997)

Qualitative and quantitative data were also collected during the course of curriculum implementation with Mrs. Lynda Kamrath's 6th grade students at Laurel Wood Elementary in Salinas as a method of analyzing the effectiveness of the curriculum. Field-testing with Mrs. Kamrath's class consisted of five classroom visit activity days and three off-campus field trips spanning from January 10, 2001 to March 21, 2001. During the course of these visits and field trips students engaged in the Cycle of Restoration activities beginning and ending with the pre/post questionnaire. In total, three out of the twenty-three students were absent for the administering of either the pre or post questionnaire making a sample size of twenty students.

Student artwork and journal entries were considered in a qualitative analysis of student performance. Qualitative data featured an analysis of selected poster projects and journal entries produced by students over the course of the curriculum implementation. The selection criterion of these drawings was based on student's completion of the requested activity. Students were asked to design a sign that could be used to tell others about invasive weeds, native plants, and what people can do to help. They were asked to render an image and design a slogan for the poster. Students rendered all the selected works over the course of a 1-1.5 hour session. To further understand student's works it was also necessary to gather additional verbal descriptions from students. Notes were transcribed and used in the interpretation of qualitative works. This form of data analysis was

used to provide insight into thoughts that students may be unable or uncomfortable expressing in words on pre/post assessments. (Barraza 1999)

The quantitative data acquired from educator and student pre/post questionnaires was assessed using a complement scoring guide and provided a measure of effectiveness for the RON curriculum. The pre/post questionnaires and scoring guide used in the educator workshop was the same pre/post questionnaire and scoring guide used in the classroom field-testing visits but here it was used as a qualitative measure of educator knowledge and more importantly to gain feedback from teachers about the questionnaire design. Both educators and students were allowed to use observations and reflections from their notes and reflection journals during the administering of the post questionnaire. The pre/post questionnaire consisted of four open-ended questions that were designed to assess four areas of knowledge. The four areas of knowledge are as follows:

1. Knowledge regarding the role/importance of plants to people and the environment.
2. Student's define the term restoration and provide examples.
3. Student's define the term weed and provide examples.
4. Student's define the term native plant and provide examples.

(See also; CD print version of curriculum, Evaluation section, Pre/Post Questionnaire).

The goal of conducting an educator workshop was to create a forum where professional educators, non-traditional and traditional, could convene to explore and provide feedback regarding the contents of the Cycle of Restoration curriculum. Educators engaged hands-on in the curriculum activities and provided constructive verbal criticism throughout the training workshop regarding the usability of the curriculum. Results of educator workshop feedback and pre/post questionnaires were analyzed through a direct comparison of average scores pre/post and changes in depth and breadth of answers. This comparison method was used for the purpose of discovering underlying patterns and connections that educators were lacking in prior to and after the workshop.

Results of student pre/post data were scored and evaluated using the Wilcoxon's Rank Sum T-test. Scores were evaluated to confirm or reject the null hypothesis that knowledge would stay the same. The predicted hypothesis was that knowledge would increase. Results of student's artwork were evaluated qualitatively for their depth in conveying the concept that the restoration and protection of ecosystems is dependent on the responsible actions of people to help preserve native plant habitats and help stop the spread of invasive non-native weeds.

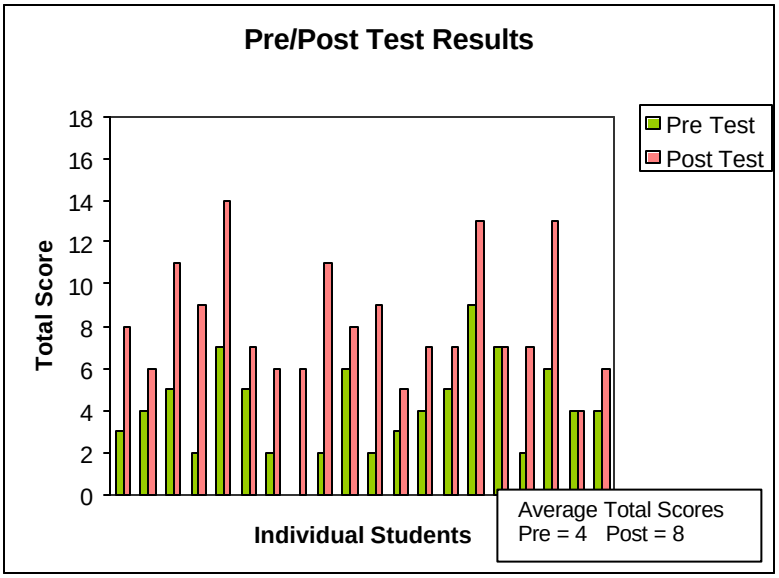
Results

Workshop Results

Results from pre-questionnaires completed by educators in attendance indicated a high level of previous knowledge regarding the role of plants in the environment, defining restoration, and the differences between native plants and weeds. The average score on the pre-questionnaire from the fourteen educators in attendance was 16 points out of 18 total possible points. Although scores were high, two main areas of knowledge were not evident in the pre-questionnaire. First, many of the educators did not include the names of specific weeds or native plants in questions #3 and #4. Secondly, educators did not describe restoration as a cyclical process that requires monitoring or the eradication of non-native invasive species. Results from post-questionnaires completed by educators reinforced the previous results from the pre-questionnaire that educators in attendance had a high level of previous knowledge. The average post-questionnaire score was 17 points out of 18 total points possible.

Classroom Field-Trial Results - Quantitative Evidence

Results from pre-questionnaires completed by students in attendance indicated an average total score of 4 points out of a possible 18 points. Total individual scores ranged from a low of 0 points to a high of 9 points. Results from post-questionnaires indicated an average score of 8 out of a possible 18 points. Total individual scores ranged from a low of 4 points to a high of 14 points. (See Graph 1; Pre/Post Test Results)



Graph 1 Pre/Post Test Results

Results from Wilcoxon's Rank Sum T-test for individual question results indicate rejection of the hypothesis that pre/post test scores would stay the same for questions #2-4. Question #1 T+ was >5 indicating the acceptance of the null hypothesis that pre/post test scores on question #1 remained unchanged. (See Table I T+ values from pre/post testing)

Question	n value	Reject Null Value (? = .05)	T+ value
1	8	T+<5	6
2	16	T+<35	3
3	19	T+<53	1
4	19	T+<53	3

Table I T+ values from pre/post testing

Classroom Field-Trial Results - Qualitative Evidence

Qualitative evidence for an increased connection and sense of responsibility to the environment was observed when evaluating student's restoration journal entries and outreach poster projects.

In a student journal entry from the February 7th hike through the backcountry of Fort Backcountry a student expressed a desire to engage in future educational outings. (Refer to Fig. 3) The student has described the positive experiences and has rendered an image of the native bunchgrasses and shrubs stabilizing the soil with their roots. This written portion provides evidence of a personal connection to nature and the rendering describes an observation about the role of native plants in the functioning of natural systems.

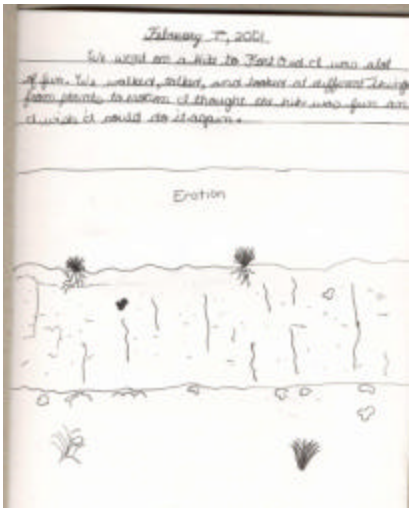


Figure 3 Student Journal Entries

Further evidence of a connection to native plants and restoration stewardship can be interpreted from journal entries made by students during the February 14th restoration project outing at Toro Creek on the Ft. Ord Public Lands. On this outing students engaged hands-on in the eradication of invasive French Broom (*Genista monspessulana)* from an area along the banks of Toro Creek and then reintroduction of native plant species endemic to this area. Students designed and attached Valentines for the Earth onto plants of their choosing as part of a class-monitoring project. The following student journal entries illustrate some of the concern and connection towards their restoration efforts and native plants. (Refer to Fig. 4)

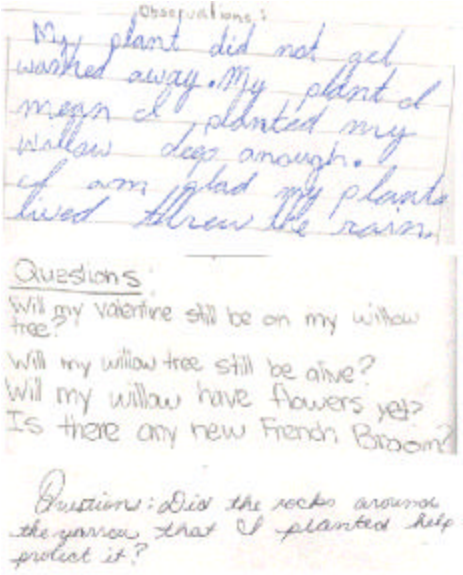


Figure 4 Student Journal Entries

Additional qualitative interpretations of effectiveness were drawn from analysis of student poster projects. Students designed their own outreach messages that addressed the topics of restoration, invasive weeds, and native plants. Several qualitative observations were made from these works that were not as distinguishable in the quantitative pre/post assessment.

In the following illustration (Figure 5) the student has chosen to describe the role of native plants in providing a diverse habitat and shelter. The student has rendered 'holes' in the trees to indicate habitat for wildlife and has drawn a diverse array of vegetation. Although weeds are not emphasized in the image the text explains what the human role is in preserving the health of these habitats.

Figure 5 Student Poster Project

In Figure 6 (at right), the student has decided to illustrate how humans can assist in the restoration of natural environments. The student has illustrated activities that the class has participated in as part of the Cycle of Restoration curriculum.
I have interpreted the line dividing the scene as a clarifying line that separates the two actions into steps towards helping the environment.

Figure 6 Student Poster Project

In Figure 7, the student has rendered a cartoon depicting the "War on Weeds". This student depicts the diverse, beautiful, and unarmed native plants under siege from a larger number of weeds equipped with 'seed bombs' that are being dispersed into the native soil space. This illustration goes on to depict the role of the weed warrior in the bottom right. The weed warrior is rendered as a smaller figure that is outnumbered but armed with a shovel and ready to do battle on the restoration battlefield.

Figure 7 Student Poster Project

The following figures feature a collection of posters that inform the community about how to stop the spread of invasive weeds and help preserve native plant communities. (See Figure 8 & 9) Each student chooses a distinctly different layout and strategy for explaining what people can do to preserve the health of native plant communities. Each student has either listed or prioritized the steps they have taken towards helping native plant communities and stopping the spread of invasive weeds.

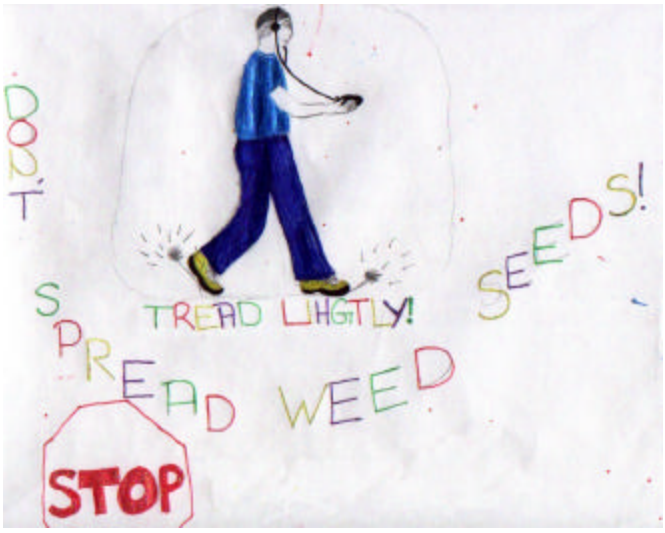


Figure 8 Student Poster Projects

Figure 9 Student Poster Projects

Discussion

Workshop Analysis

Although the scores were equally as high in educator's pre/post questionnaires it was more evident from post-questionnaires and verbal feedback that educators were able to give specific examples of native plants and invasive weed species. This supports the initial prediction that the RON Cycle of Restoration curriculum is effective in its ability to increase student and educator knowledge about invasive weeds and native plants.

It is also important to point out that some educators modified their definition of restoration to a cyclical process. Educators suggested a strategy that included the removal of weeds, restoration of natives, monitoring, and service learning through community outreach. This supports the prediction that the RON Cycle of Restoration curriculum is able to convey the importance of preventing and eradicating invasive plant species, while restoring native plant communities as part of a continuing cycle of restoration.

Qualitative feedback from workshop evaluation forms provided additional information regarding my effectiveness in delivering the curriculum materials as well as feedback regarding the general usability of the curriculum. In all of the participants' evaluations an overall increase in comfort level with the topic of native plant restoration and invasive weeds was evident. Many of the participants selected a moderate or higher level of experience with the topic and agreed that they would be able to use some or all of the activities in their classrooms. Although many of the participants found the curriculum materials and strategy to be delivered clearly and in a helpful format, others emphasized their need to modify the materials and pre/post test to accommodate their specific grade levels. Areas of recommended improvement included modifying vocabulary and activities to accommodate lower grade levels and English learners, more images and diagrams of processes, and additional workshops to discuss how these activities could be modified to accommodate specific age groups.

Accommodating the educator's request for correlating the curriculum to multiple grade levels became an enormous undertaking. It was necessary to modify several of the activities into several versions based on the scientific thinking processes that students are capable of using at a particular age. (California Alliance of Math & Science 2000) Rather than build several versions of each activity the addition of age modification suggestions was added to the 'Going Further' sections of some activities. Additional images were also added to describe processes and cycles specifically in the 'Population Explosion - Weed Relay'. In addition to these modifications each educator received a CD containing the entire curriculum materials in electronic formats. This allowed educators to access and modify the materials according to their specific needs.

The workshop was successful in encouraging participation from experienced traditional and non-traditional educators that have worked with the Return of the Natives Restoration Education Project in the past. Future workshops need to encourage educators with little experience and low comfort to attend as an introduction to the topic of restoration education and the cyclical nature of the RON Restoration Education Program.

Future workshop implementation could include the integration of the activity sections into seasonal workshops held by the Return of the Natives Restoration Education Project. These workshops could address the particular section activities that educators could implement during a season in conjunction with propagation and planting in the RON greenhouses. This form of implementation would space out activities and allow for more integration into educator's existing curriculum.

Partnering with educators and utilizing an action research agenda during workshop implementation can accommodate the needs of multiple age groups and inexperienced restoration educators when designing the curriculum content. Future projects could focus on investigating and making the necessary modifications for successful implementation at specific age groups and with varied educator experience levels. This future research would include the implementation of activities and pre/post testing with several age groups and educators in both traditional and non-traditional scenarios. This future research could also lead to the correlation of activities based on science content standards and the accepted scientific thinking processes for each particular age group.

Classroom Field-Test Analysis

Results of the Wilcoxon's Sum Rank T-test indicate that the curriculum increased knowledge among students regarding noxious weeds and native plant communities. The results of this test also indicated no change in student's knowledge regarding the role/importance of plants to people and the environment (See Question #1 Pre/Post Test). This may be for several reasons that were not considered prior to testing. First, students may have simply assumed that people are part of the environment and subsequently only addressed a portion of the question. Secondly students may have interpreted the question properly but assumed that the textbook replies, "plants give us oxygen" and "we eat plants", were the most 'correct' answers. Lastly, students at a 6th grade level are only starting to draw cause and effect relationships and inferences about their place in the environment. (California Alliance of Math & Science)

A direct qualitative comparison of pre and post questionnaires also noted areas of improvement for individual students and these improvement trends were summarized. With regard to Question #1 and the role/importance of plants to people and the environment 6 students expanded their descriptions to included plants as soil stabilizers and necessary for maintaining the natural food web. Thirteen out of 20 students expanded their definition of restoration to include

elements from their own restoration experiences over the course of the curriculum implementation. Seventeen out of 20 students emphasized that invasive weeds are not native and can take over in wilderness areas by crowding out native plant species. Eighteen out of 20 students also provided examples of invasive weed species that they worked to eradicate in outdoor experiences during the course of the curriculum. Seventeen out of 20 students provided examples of native plants to their region and expanded their definition of a native plant to include residency in an area over a long period of time and the role of native plants as preferred food and shelter for native wildlife. Two students described elements of community outreach and monitoring as part of a continuing cycle of restoration. These trends and observations tend to indicate that students have acquired a wealth of knowledge particularly about native plants and invasive weeds as a result of engaging in the in-class and outdoor curriculum activities. Results from the Wilcoxon's Rank Sum T-test suggest a similar trend. Students knowledge about native plants and weeds increased but knowledge about the role/importance of plants for the environment and people did not increase.

Qualitative evidence from student's artwork does convey the importance of preventing and eradicating invasive plant species, while restoring native plant communities as part of a continuing cycle of restoration. The combination of quantitative pre/post assessments and qualitative evaluation of artwork supported the effectiveness of the curriculum as a tool for increasing student's knowledge about the restoration of native plants and eradication of invasive weeds. To accurately assess students understanding and application of larger concepts, such as stewardship and the restoration cycle, required a qualitative scoring guide approach that is flexible and allows for interpretation of drawings in conjunction with reflective writings produced by students. Quantitatively there was an overall increase in student performance and yet it was difficult to ascertain from the pre/post examination whether students had acquired a greater sense of stewardship as a result of participating in a cycle of restoration. The wording of question #1 from the pre/post questionnaire may have resulted in confusion among students. Students may have simplified their replies to only addressing the environmental or the human aspects. Future questionnaires may separate the question into two separate parts. For example, Question #1 could ask: "Why are plants important to the environment?" and Question #2 could ask: "Why are plants important to people?"

An original assumption in designing the pre/post test was that students would be able to easily convey their knowledge and experiences in writing and drawings. As a result of working hands-on with students I began to observe behaviors that could be used to support the effectiveness in the curriculum's ability to instill a sense of stewardship. I had only come to this conclusion after significant interaction with the Laurel Wood test group. Students verbally expressed more of a genuine concern for the environment and specifically native plants and an equal dislike for invasive weeds as we continued to work together. Students eagerly informed their 3rd grade 'buddy' classmates about the importance of native plants and need to identify and eradicate invasive weeds during their Return of the Natives restoration-planting day in the backcountry of Ft. Ord. Mrs. Kamrath also observed that student attendance and engagement had increased significantly on the Wednesdays that I was scheduled to work with students. Several students even visited and engaged in work at the restoration site on weekends with their parents. This stewardship action by students was a completely independent action facilitated strictly by students. The following observations, although anecdotal and subjective, do support the need to modify future research methods. These future research methods should include criteria for evaluating the actions of students through verbal interview methods. These interviews could consist of open-ended questions that could be scored according to guidelines and analyzed for specific content.

Community Partnership Notes

One of the most successful facets of this program was the facilitation of lasting partnerships in the community. Community partnerships create a support network that is capable of extending outside of the limits of one's own community. As a result of conducting the educator workshop I was able to share information with other educators about the environmental issue that was outside the scope of conventional environmental education curricula. By engaging in service learning with educators in my community I gained the educator feedback necessary for making the RON environmental education curriculum more usable. Over the course of this workshop I also acquired a working knowledge of how to meet the needs of experienced professional educators. The partnership was successful because I was not the only one to gain from this experience. The participating educators also increased their knowledge and comfort levels as a result of working with each other and with the Return of the Natives Restoration Education Project.

By partnering with government agencies like the Bureau of Land Management at Ft. Ord, I was able to enlist the assistance of experienced land managers and outdoor educators who were equally concerned with the distribution of information and resources regarding the spread of invasive weeds. In turn I served a diplomatic role for the BLM as an environmental educator and scientist to those citizens who utilize public lands or reside in communities that border these natural areas. This partnership increased circulation and awareness about the threats invasive weeds pose to the native plant communities that the BLM is working to preserve through their own legislation. The BLM has maintained a productive partnership with the Return of the Natives Restoration Education Project that has spanned several years. This project has strengthened that cooperative restoration effort in the backcountry of Ft. Ord by providing the BLM with a strategy for education and outreach that is in tandem with the goals of Return of the Natives. I also aimed to develop an educational resource model that could be used by multiple organizations. I also assisted in securing the future integration of invasive weeds into existing educational resources by presenting and sharing my education strategy with other agencies that extended outside this region. In turn these agencies utilized this education strategy to create their own resource materials that contained information specific to their regions.

The partnerships created between Mrs. Kamrath, her 6th grade students, and myself was essential to the successful implementation of this curriculum. This partnership was facilitated through Mrs. Immel, who attended the educator workshop and had built a buddy classroom situation with Mrs. Kamrath. Mrs. Kamrath and I maintained a high level of communication and flexibility for implementation to be achieved. Mrs. Kamrath was very experienced and comfortable with the topic of restoration ecology and outdoor education so this created a 'team' educator situation. This 'team' teaching scenario allowed Mrs. Kamrath and I the opportunity to split the class into two smaller groups when working outdoors with the reassurance that students in both groups were getting the same level of information and guidance.

On several occasions Chase Jones, outreach intern with the BLM at Ft. Ord, was also able to assist with restoration work and this resulted in even smaller more intimate group sizes. Mr. Jones had acquired extensive naturalist experience in the backcountry of Ft. Ord and was a valuable asset to this education effort. After working with Mr. Jones and Mrs. Kamrath in the field I quickly realized that this team teaching approach is a necessary component of the outdoor education experience. Implementing this type of activity requires that a partnership exist between traditional educators and experienced naturalists.

Laurel Wood Elementary School is centered in an urban setting and surrounded by the industrial agriculture complex on all sides. Accessing the Ft. Ord public lands where students were permitted to conduct their restoration-monitoring project was limited due to transportation budget constraints. This constraint on transportation was overcome through cooperation with public

transit. In order to access the public lands for our work students traveled via the public transit system on three separate occasions, not including the Return of the Natives school planting day with 3rd grade students from Laurel Wood. This creative alternative was successful with the 6th grade students because it could be integrated into Mrs. Kamrath's curriculum agenda as a lesson in social development. It was also possible to use this mode of transportation because the maturity level of students was high and the overall class size was small enough to fit on a single bus. These constraints did excluded Mrs. Immel's 3rd grade class from participating in the same outdoor activities. Mrs. Immel, like many other educators, was also not as available to engage in the complete curriculum because of mandatory testing and curricular implementation constraints. The only alternative was for Mrs. Immel to implement and modify particular activities and conduct them when possible on campus. This constraint was overcome as much as possible by facilitating the buddy relationship that existed between Mrs. Kamrath's 6th grade students and Mrs. Immel's 3rd grade students. Students from the 6th grade participated in weed pulls and native garden activities with 3rd grade buddies as a means of informing 3rd grade students about invasive weeds and native plant restoration. It is also important to note that it is the policy of traditional education that any off-campus field trip must have access to restroom facilities at the off-campus site. This policy mandate was met through our partnership with the BLM who was able to accommodate these facilities in the form of a porto-pottie. Without the cooperation of partners, like the BLM and public transit, this project would have been limited to on-campus experiences.

As a result of engaging hands-on with students in the Cycle of Restoration activities I was able to gain a better understanding of what concepts students grasped. For this partnership to be successful I had to continue to remain flexible in my delivery of the curriculum. On several occasions I modified the curriculum to include my personal experiences and enthusiasm as a weed warrior and university student. Sharing my vision with students facilitated a higher level of mutual trust and led to a more productive learning environment. I became an educator, scientist, and mentor over the course of working these students. Through this service learning and mentoring process I was guiding students reflections as a result of my actions as an educator and 'weed warrior'. The service learning partnership that I had maintained with students was responsible for developing much more than that curriculum resource. This experience with students developed my skills as an educator and led to a deeper level of self reflection that will continue to guide my actions as an educator.

In the future I envision the Cycle of Restoration curriculum undergoing continued revision and editing as a result of creative implementation by environmental educators from the Return of the Natives Restoration Education Project. I also intended the design, implementation, and field-testing of this curriculum to be a model for other organizations that have a desire to include the topic of invasive species into their existing cycles of restoration. The topic of invasive species may seem alien to many but it is my hope that this project has demonstrated how information and activities regarding this environmental issue can easily and effectively be integrated into existing ecological restoration curricula.

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