Stocking Flat Pilot Restoration Project

The Stocking Flat Pilot Restoration Project is an effort to restore a riparian area along Deer Creek in Nevada City by removing non-native, invasive vegetation, replacing it with fast-growing, native species, and providing hands-on education to local high school students in ecological restoration. Friends of Deer Creek has implemented the pilot restoration with funding from Patagonia, working with high school and junior high student at a site that is concurrently undergoing a separately funded floodplain restoration. The two projects in tandem will result in multiple benefits to the creek environment and to the state of knowledge and stewardship of our local youth.

Introduction

The introduction of invasive species can have severe and lasting ecological impacts. These species can potentially alter the characteristic of an ecosystem, such as the composition of species and their abundance, as well as the function ecosystem function such as erosion control or nutrient cycling.

Riparian areas are at an especially high risk of invasion for a number of reasons. First, the rivers and streams act as a dispersal mechanism of plant seed and provide a pathway for the introduction of an invasive species. Riparian areas are also highly dynamic in nature and are subject to high levels of both natural and human caused disturbances. High disturbance levels can potentially encourage the establishment of invasive species because many of these species are “pioneer” species, which thrive in low competition environments.

The high risk of invasion of riparian areas is of particular concern because of the important ecosystem functions and services these areas provide. Riparian areas are particularly valuable habitat, and because of their unique hydrology they often have different species assemblages relative to the surrounding landscape. In addition, riparian areas provide many functions in terms of water quality. They stabilize the banks of the stream and prevent erosion, they regulate water temperature, and they buffer streams from the runoff of nutrients and other contaminants. The introduction of invasive species can drastically alter the provision of these services, and therefore presents a significant risk in these ecosystems.

One of these invasive species that is particularly prevalent in the Deer Creek watershed is Himalayan blackberry (*Rubus discolor*). This species is native to Western Europe and was introduced to the United States in 1885 as a horticultural crop. The species is highly prolific and spreads via its massive seed production and vegetatively, by rooting at the tips of its canes. It is a vigorous competitor and outcompetes native vegetation. Growing in dense thickets it creates shaded conditions, limiting the growth of other plant species.

Control and removal of Himalayan blackberry is extremely difficult as well as time and labor intensive. Manual removal, though slow, is likely the most effective

control method. Care must be used to remove the entire rootstock from the ground, or the plant will grow back using resources stored in root reserves. Grazing by goats or cattle has been used with some success, as have chemical control methods (herbicides). However, these methods can be problematic for use in riparian areas due to issues of erosion and leaching of the herbicides into the waterway.

After the removal of Himalayan blackberry the risk of reinfestation remains relatively high due to the species' presence in the seed bank and re-sprouting from rootstock left in the ground. It has been suggested that planting fast growing native plants will prevent reestablishment of Himalayan blackberry, because the species is shade intolerant. There are anecdotal accounts by local botanists that suggest that California wild grape and Arroyo willow (*Salix lasiolepis*), may be able to outcompete Himalayan blackberry.

The goal of our project is to evaluate the theory that once established, California wild grape and Arroyo willow are able to outcompete and prevent the reinvasion of Himalayan blackberry. Working with students from Forest Charter School, a local high school, we removed Himalayan blackberry from experimental plots in the riparian corridor bordering Deer Creek in Nevada City, CA. In its stead we planted Arroyo willow and California wild grape and monitored the resulting changes in the vegetative communities. The results of this project have the potential to be extremely useful to land managers and may alter the control methods used on Himalayan blackberry in riparian ecosystems.

Goals and objectives

At the outset of this project FoDC established a number of goals and objectives. This helped keep our project on track and is enabling us to evaluate its overall success. Our goals were to:

- Run a successful pilot restoration study providing useful data and recommendations for future restoration projects
- Encourage student participation and give them ownership of this project
- Foster a sense of stewardship for the environment among the students
- Reduce the cover and dominance of Himalayan blackberry by 50% within the study area
- Increase native plant species cover by 50% within the study area
- Have no negative impacts on water quality in Deer Creek

In addition to the goals of FoDC, the students from Forest Charter School, who helped with much of this project, recorded their goals and objectives for the project. For the most part they were very similar to ours, but with some differences:

- Restore the ecosystem at Stocking Flat
- Ensure that no native species are lost in the process of invasive species removal
- Protect Deer Creek from increases in turbidity

Methods

Study site

We conducted our study at an area known as Stocking Flat (Figure 2), downstream of Nevada City on Deer Creek. The property is owned and managed by the Bureau of Land Management, our partners on a concurrent project at the same site.

In the otherwise bedrock constrained and high gradient Deer Creek, Stocking Flat is the one of the few areas where the creek is flat and shallow enough to allow for the formation of a wetland. As such it is a critical habitat and can be considered a biological hotspot within this type of riverine system. However, due to recent and historic mining activity the creek has become deeply incised, altered course, and is unable to access its floodplain. Moreover, the area has become heavily infested with a number of invasive plant species, namely Himalayan blackberry, Scotch broom (*Cytisus scoparius*), Black locust (*Robinia pseudoacacia*), and Big leaf periwinkle (*Vinca major*) (See Figure 1). Due to the severity of the degradation, this site has been selected for a major floodplain restoration project, making the present project a particularly valuable effort.

Figure 1. Himalayan blackberry stand at Stocking Flat

Experimental Design

After consultation and a site visit with a local botanist, we decided to conduct the study within a large stand of Himalayan blackberry that parallels Deer Creek. The stand is approximately 70 meters long and of varying widths ranging from 3 meters to 10 meters. The stand was divided into seven, 10 meter long plots, providing four control plots (where no removal efforts were taken) and three treatment plots (where Himalayan blackberry was removed completely).

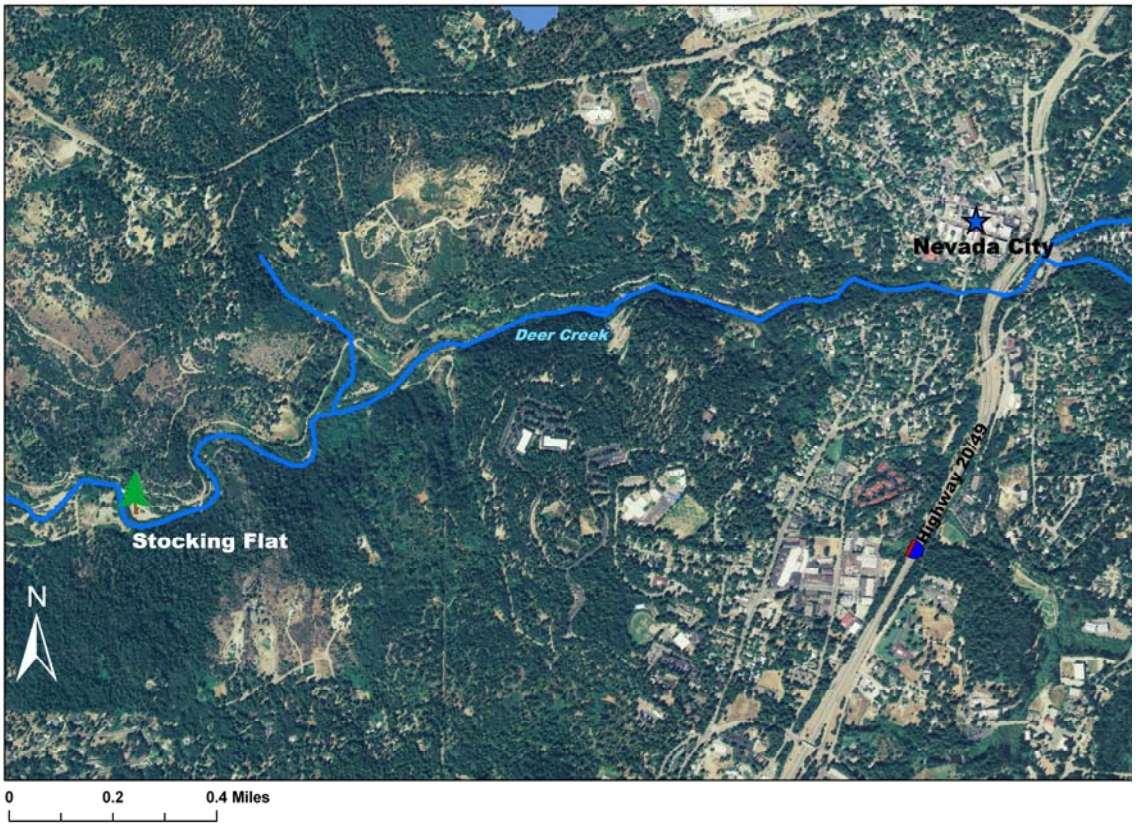

Figure 2. Map of Nevada City and surrounding areas including Stocking Flat along Deer Creek

Baseline data collection

Prior to starting work on this project, we collected baseline data on the vegetation community at the site and chemical water quality data from Deer Creek. Permanent transects were set up within the Himalayan blackberry stand, and using a meter tape, data was collected on the vegetative species present at each meter through the whole stand. This data was collected with the assistance of a qualified botanist, using a protocol developed by the California Native Plant Society. Using this data, percent cover within the herb layer (0–3'), shrub layer (0–12'), and tree layer (>12') was calculated for each species.

FoDC has been monitoring the water quality in Deer Creek at Stocking Flat since June 2008, which provided strong baseline water quality data. A number of parameters were measured both above and below the study site including temperature, pH, dissolved oxygen, conductivity, and turbidity.

These baseline data allowed us to track changes in the vegetation community at the study site, ensuring that native species were unharmed and allowing us to effectively judge the success of our project. In addition, the strong water quality dataset has enabled us to make sure that our project does not adversely impact water quality in Deer Creek.

Himalayan blackberry removal and disposal

Himalayan blackberry was removed entirely from the three experimental plots. Due to the restrictions of working in a riparian area, the removal was done almost entirely by hand, with shovels and loppers, or with a weed wrench. FoDC staff, along with the high school students and regular FoDC volunteers did all of the removal, clearing over 200 m^2 of Himalayan blackberry and piling it on site (Figure 3). The piles have been left to dry out and will be removed to an off-site location for burning at a later date.

Native Planting

FoDC purchased 20 California wild grape plants from High Ranch Nursery, which propagated the plants from cuttings taken in the American River drainage near Auburn, CA. Arroyo willow, like all willow species, is capable of reproducing vegetatively, and will set root from a cutting taken from an established tree. Cuttings of Arroyo willow were taken from trees on site at Stocking Flat, and care was taken to ensure that a wide range of genetic diversity was included. Some of the longer cuttings (up to 8') were tied together using hemp twine to create "wattles", which are planted flat in the ground and effectively reduce erosion.

Two weeks after removal of Himalayan blackberry, students from Forest Charter School and Yuba River Charter School (a local junior high school) returned to Stocking Flat to plant Arroyo willow and California wild grape. The students planted the plants, cuttings, and wattles, in holes dug specifically for the different plants and then watered them with buckets filled with creek water.

Figure 3. Forest Charter School students removing Himalayan blackberry by hand at Stocking Flat

Irrigation

After the students watered the plants on the day they were planted, the plants were given approximately 5 gallons a week through a drip irrigation system designed by FoDC for this project. Lacking a pump to take water out of the creek, FoDC purchased five gallon buckets and drilled small holes into the bottom. These buckets were then manually filled from the creek and drained over the course of about 6 hours. In order to water the willow wattles over their entire length, drip irrigation hose was fitted to the buckets and drained in a similar time period. Only one plot was watered at a time, and the buckets were filled every other day, providing each plant approximately 5 gallons of water a week.

Monitoring

Monitoring of the vegetation communities at the study site occurs once a month, and the same protocol is followed as in the baseline data collection. To date there have been two monitoring events, in addition to the baseline data collection, both of which were done by the high school students. They were given instruction regarding the protocol and the plant species present at the site, and when they were comfortable with the process, they actually taught the junior high students and worked together to collect the data (Figure 4).

Figure 4. Students from Forest Charter School and Yuba River Charter School working together on a monitoring transect through one of the experimental plots

In addition to monitoring the permanent transects, a quick assessment sheet was developed for the experimental plots. Permanent transects, while effective, can miss changes in vegetation as they only run through the middles of the plots. The quick assessment sheet is comprised primarily of “yes” or “no” questions about vegetation, soil conditions, and erosion, and gives valuable data that might otherwise be missed.

Water quality monitoring at Stocking Flat occurs once a month and is carried out by FoDC staff and trained volunteers. The majority of the data is collected in the field, but samples are also brought back to our laboratory. This data is all subject to our Quality Assurance Project Plan that is regulated by the California State Water Resources Control Board.

Adaptive Management

FoDC staff and the high school students analyzed the vegetation and water quality data, and recommendations for maintenance of the site made based on emerging trends or short-term changes noticed in the data. The recommendations were generally limited to removal of reestablishing invasive species, but this offered a hands-on introduction to the concept of adaptive management to the high school students.

Education

The majority of the work in this project has been done with the help of students from the Global Studies Academy at Forest Charter School. Their involvement in this project stems from another FoDC project, the development and teaching of an environmental education curriculum funded by a grant from the National Federation of Fish and Wildlife. For the past semester staff from FoDC have been teaching the students about a variety of topics generally centered on local environmental issues. The goal of the curriculum is to not only to inform the students of the problems, but more importantly, of the solutions. The Patagonia and NFWF projects build on each other to provide an impact that is far greater than the sum of their parts, with far-reaching educational and ecological benefits.

Results

Vegetation Community Changes

Though the results of the experiment are still too preliminary to be conclusive, the data highlight some interesting changes within the vegetation communities. Figure 5 shows the percent cover of the five dominant species in the herb layer of the control plots. Within the control plots, where Himalayan blackberry was not removed, its percent cover remained relatively high over all three sampling dates. In contrast percent cover of native Arroyo willow decreased after the initial baseline data collection in February.

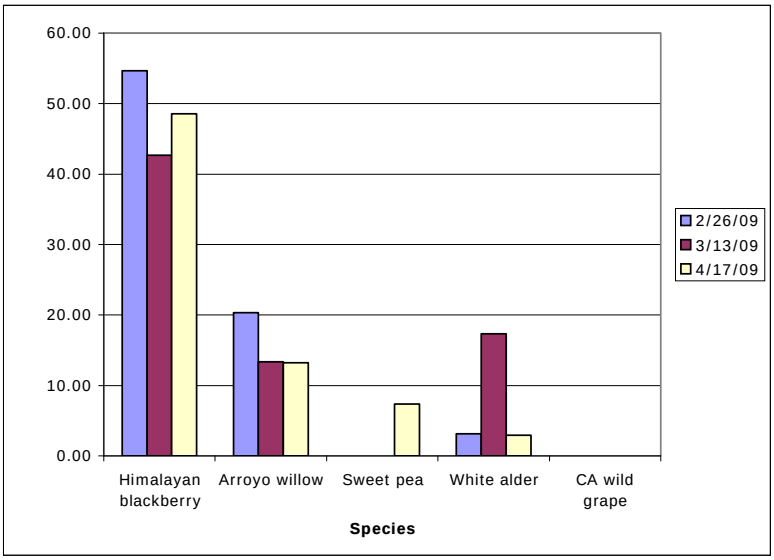

Figure 5. Percent cover of the five most dominant plant species in the herb layer of the control plots (no removal) at Stocking Flat, Himalayan blackberry, Arroyo willow, Sweet pea, White alder, and California wild grape

Within the treatment plots the shifts in vegetation were quite the opposite, the dominance of Himalayan blackberry was severely reduced by our removal efforts, dropping from nearly 70 % cover to just over 10% after the April sampling date (Figure 6). After the removal of blackberry, native species cover increased, as did percent cover of Sweet pea (*Lathyrus latifolius*), a non-native, but non-invasive perennial weed.

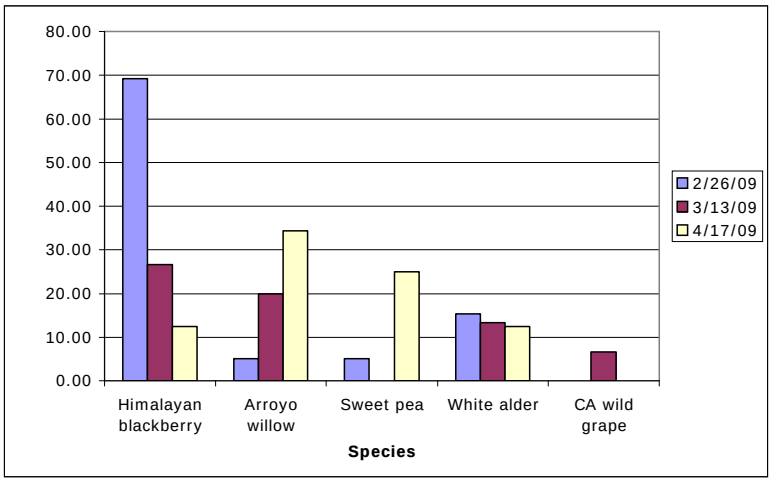

Figure 6. Percent cover of the five most dominant plant species in the herb layer of the treatment (removal) plots at Stocking Flat

Changes similar to those observed in the herb layer occurred in the shrub layer. Within the control plots, the percent cover of Himalayan blackberry remained relatively

high, actually increasing as spring progressed (Figure 7). Some changes were noted in the cover of Arroyo willow and native White alder, but these were minor changes and did not seem to persist into later sampling dates.

Within the shrub layer of the treatment plots the percent cover of Himalayan blackberry was not particularly high to begin with, but after our removal efforts it was reduced to none. Small changes were observed in the cover of White alder (Figure 8), but were largely insignificant, and Arroyo willow had increases of nearly 15% cover in the later sampling dates.

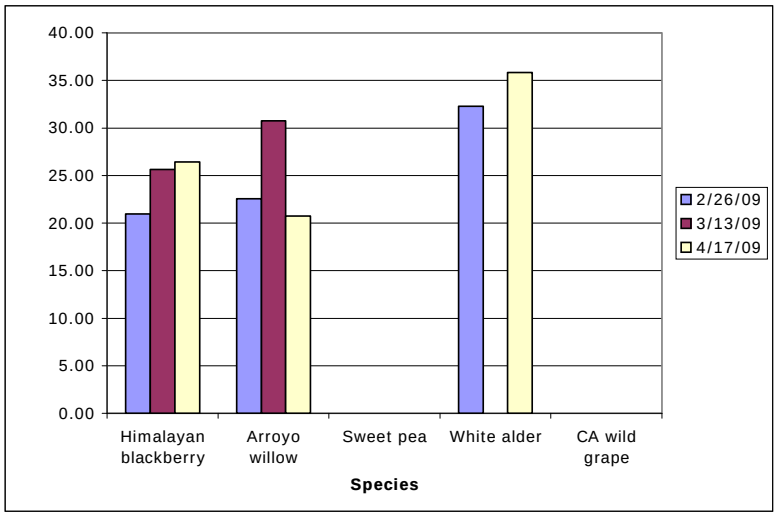

Figure 7. Percent cover of the five most dominant plant species in the shrub layer of the control (no removal) plots at Stocking Flat

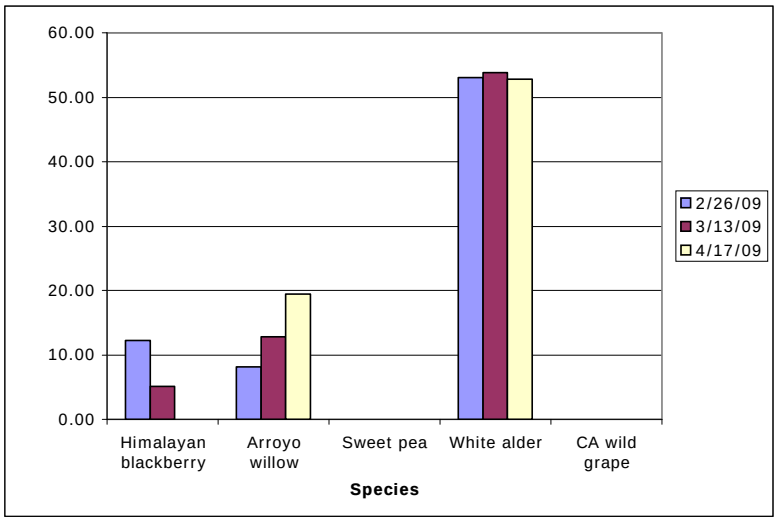

Figure 8. Percent cover of the five most dominant plant species in the shrub layer of the treatment (removal) plots at Stocking Flat

Water quality monitoring

Though there were certainly trends and fluctuations within the water quality data, there was no significant difference in the data collected upstream and downstream of the restoration site (Figures 9–11), indicating that our project had no negative impact on water quality in the creek.

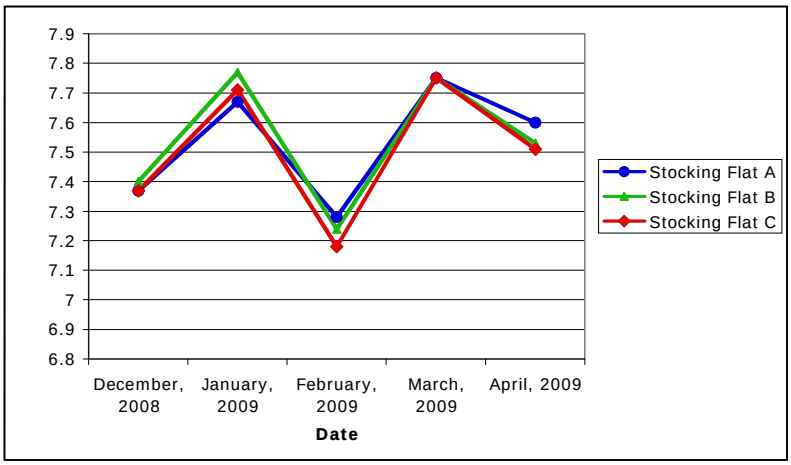

Figure 9. Mean pH of Deer Creek at three sites, Stocking Flat A (upstream of the project site), B (upstream), and C (downstream), from December 2008 to April 2009

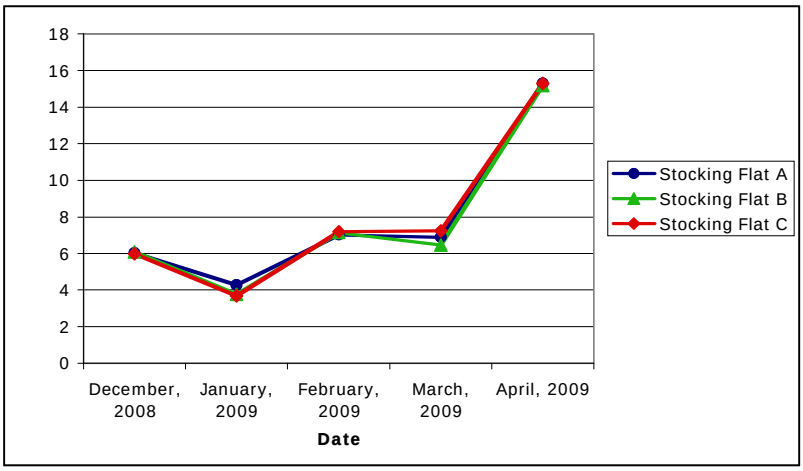

Figure 10. Mean water temperature (ºC) in Deer Creek at three sites, Stocking Flat A (upstream of the project site), B (upstream), and C (downstream), from December 2008 to April 2009

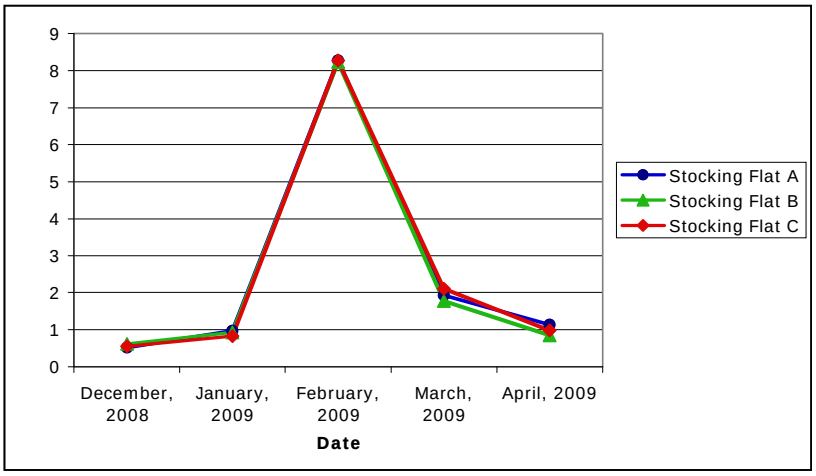

Figure 11. Mean turbidity (NTU) in Deer Creek at three sites, Stocking Flat A (upstream of the project site), B (upstream), and C (downstream), from December 2008 to April 2009

Education

This project can be considered an absolute success in terms of FoDC's educational goals. The level of student engagement and participation in the project was amazing. The students were constantly asking questions about the project, our motivations, and riparian ecosystems. Students and their teachers also commented to FoDC staff on multiple occasions how much they were enjoying the field- work.

The level of responsibility that the students were given in this project was a critical component. By giving them some of the decision-making power, we hoped to increase their level of ownership in this project, which seems to have been successful. The students took their time while making decisions about the monitoring and maintenance of the site. They asked FoDC staff a lot of questions and for our input, but made their own decisions and came to their own conclusions.

Discussion

Though the preliminary results indicate that the treatment is effective at reducing Himalayan blackberry cover, the data is still too limited to draw that conclusion. With only two post-removal sampling dates, the data does not show any major reinvasions or reductions in native species cover. At this point we are only observing the impacts of our removal efforts, and some increase in native plant cover. To truly gauge whether Arroyo willow and California wild grape are able to outcompete Himalayan blackberry, the plots will have to be monitored for a minimum of two growing seasons.

The changes that we did observe in the vegetation could be due to a number of influences, most likely a combination of the arrival of spring and the increased resources now available to plants in the treatment plots. Himalayan blackberry is capable of completely shading out other plants, but their seed would still be dormant in the soil waiting for the availability of moisture and light. The removal of Himalayan blackberry

would allow light to penetrate to these other plants, and decrease the competition for water. This coupled with the warm temperatures and moisture of spring, would accelerate plant growth, and is a likely reason for the increase in Arroyo willow, Sweet pea, and White alder cover.

Although the data might be too preliminary to draw any conclusions it does allow us to make recommendations for the management of the plots. FoDC staff recently reviewed the data with the students at Forest Charter School, and the students each made their own recommendations as to how we should maintain the plots. They recommended:

- Watering the plots more frequently as the soil is drying out
- Removing the Himalayan blackberry as it grows back within our treatment plots
- Planting more native species to further shade Himalayan blackberry
- Removing the Sweet pea that has firmly established itself in the plots
- Devising a less labor intensive irrigation system, that could operate independently, providing more water to the plants

Based on their own recommendations the students will be having a work- day on May 8th, and will be controlling for reinfestations and irrigating the plants.

Roadblocks and challenges

We have faced relatively few large challenges during this project, though it was not without its speed bumps. The largest challenge was dealing with apathy within the junior high class that worked with us on two occasions. Most of the class was excited, but there were some who simply did not want to participate. To deal with this FoDC staff and their teachers worked closely with their groups, trying to raise morale and encourage their participation, which for the most part worked well.

Another issue faced during this project was devising an inexpensive alternative to pumping water out of the creek to irrigate the plants. The system would have to deliver water over an extended period of time because of the sandy nature of the soil, but would ideally require little labor. After a lot of thought and brainstorming, we were able to come up with a drip system using buckets with small holes that has proved to be quite successful.

Future plans for restoration and education

Friends of Deer Creek has a number of restoration projects planned for the near future, most of which will be in the riparian zones bordering the creek, and all will undoubtedly deal with Himalayan blackberry. The data and conclusions drawn from this study at Stocking Flat will provide guidance and inform the decisions of FoDC and our partners in these upcoming projects, and will help restore these ecosystems to a more natural and functioning state.

Students from Forest Charter School will be involved not only in the continued monitoring of the study site at Stocking Flat, but also in the future restoration projects

resulting from this study. Their involvement in this project has been a great success and has provided the students with amazing hands-on field experience that they wouldn't otherwise get in their schooling. The students now know that there are solutions to the myriad environmental problems we face and are empowered to continue this important work. Friends of Deer Creek is excited to continue our collaboration with these budding ecologists.

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