Restoration of a Degraded Riparian Area in an Urban Watershed:

Fish Renewal One Stream at a Time

ENVS 410: Senior Practicum

Fall Semester 2011

Desiree Davenport, Tucker Hoog, Rocco Saracina

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1. PROBLEM BACKGROUND

1.1 Problem Statement:

The 300-meter section of Widow White Creek that is adjacent to the RV Park and Highway 101 in McKinleyville, CA has been invaded by exotic species that alter the native riparian ecosystem, which native salmonids historically depended on.

1.2 Problem Background:

Invasive species and effects on riparian systems

Riparian areas are very important as a buffer zone for streams, slows the velocity of water, provide energy for smaller streams, and provide habitat for species. These areas protect water quality by acting as a buffer between the nutrients and contaminants associated with urban land use and the stream. Riparian areas are some of the most biologically diverse and productive ecosystems in the world (Odum, 1978). The amount of vegetation between impervious surface and the stream is directly related to fine sediment being input into the stream and overland flow velocity. Energy for aquatic insects is supplied to the stream by organic matter, such as leaves (Vonnote, 1980).

Invasive species present ecological problems wherever they are introduced, since they "displace native species, hybridize with native species, alter biological communities, or alter ecosystem processes" (www.cal-ipc.org). In the case of riparian ecosystems, this loss of ecological function due to invasive species has a significant impact on salmonids and other native fish species that depend on these important functions. Riparian areas regulate the microclimate of the stream and subsequent temperatures regulate the biological metabolism of aquatic organisms (Beschta, 1997). A change in energy input into the stream can change the macro invertebrate community food web. For these reasons invasive plant species displacing native plant species results in a change in ecosystem function.

Native riparian vegetation performs many ecosystem functions. Native large woody debris creates spawning habitat for fish and for insects. Insects become food for aquatic invertebrates, which then become food for fish. Native vegetation also provides organic matter that provides nutrients to the stream, keeps water temperatures cool, and protects stream banks from erosion and pollutants from adjacent runoff into the stream (Platts, 1981). Since invasive species out-compete native riparian plants, they become dominant and alter ecosystem functions given to the stream by the native plants. Therefore invasive species in riparian habitats destabilize stream banks, alter the amount and type of woody debris in the stream, change the canopy cover of the stream, alter stream biochemical processes, change stream nutrient levels and types of nutrients in the stream, shift stream biota, and disrupt the food web. The loss of native plant and fish species is critical problem as it is not only ecologically dangerous, but also has cultural and economical impacts as well.

Coho salmon (*Oncorhynchus kisutch*) have historically been present in Widow White Creek. They are no longer present due to stream degradation and overfishing. South of British Columbia their population has been declining since 1983 (Coronado, 1998). Their habitat preference includes pools, bank cover, cool water, and high dissolved oxygen (Bustard, 1975). Native plant species provide proper habitat for Coho by keeping the stream shaded, cool, creating pools, providing habitat and nutrients for prey, and stabilize stream banks.

Due to intentional plantings and natural proliferation, non-native exotic plant species are present at Widow White Creek. Many of these species are capable of drastically changing the structure and function of the native ecosystem, in which salmonids and other fish depend. The two primary invasive species of concern are blue gum eucalyptus and English ivy. *Eucalyptus* grows much faster and taller than any native plant species present. This allows eucalyptus to dominate the canopy level of the system and quickly replace native tree species, reducing diversity, altering stem placement, and changing canopy structure. The *Eucalyptus* also inhibits the germination of surrounding seeds, preventing the establishment of competing plants by exuding allellopathic chemicals into the soil through leaf, stem and bark litter. *Eucalyptus* is also a very flammable tree, raising the threat of a potentially catastrophic fire (www.cal-ipc.org).

The Widow White Creek watershed

The Widow White Creek watershed is approximately 5 square miles. (Klein and Anderson, 2001) It starts in the mountains east of McKinleyville CA and flows west through the town, towards the coast. The watershed spans from 620 ft elevation at the headwaters to sea level at the confluence. The upper half of the watershed is comprised of steep forested slopes dominated by coastal upland vegetation, where as the coastal bottom half is much more flat being dominated by coastal spruce forest. Two tributaries feed Widow White Creek: North Fork and Norton Creek. The creek occasionally connects to the Mad River and ultimately drains into the northern portion of its estuary. (RCAA, 2007)

2. GOALS AND OBJECTIVES

2.1 Class Goals and Objectives

Our primary goal is to continue ongoing restoration efforts

1. Reduction of Invasive Species within the riparian zone of Widow White Creek
   - Reduction of English ivy (*Hedera helix)* by 50%
   - Reduction of Holly by 100%
   - Reduction of Eucalyptus by 20%
2. No trash within the riparian zone of Widow White Creek
3. Native species filling in the niche
   - Native vegetation present along banks for bank stabilization
   - Native plants presence in spaces created by removal of invasive plants
   - Increase in plant diversity
4. Canopy cover similar to reference sites.
   - Percent canopy cover at Widow White Creek within 20% of percent canopy cover at reference site.

2.2 Humboldt Fish Action Council Objectives

Humboldt Fish Action Council would like GIS mapping that fallows the progress of restoration efforts. A map(s) would help direct restoration efforts, denote invasive removal progress, and potentially acquire funding. As such our group created a map showing the progress made this semester as well as the area of the greatest ivy infestation. In the future HFAC would like a Eucalyptus stem map to guide the felling process.

2.3 Land Manager objectives

Charley Peak, the land manager of the RV Park, agrees with the mission of this project and supports the removal of all Eucalyptus in the riparian zone. We will also help Charley install a bridge and nature trail on the property during the first planned volunteer workday. Volunteers will help compact dirt to anchor the bridge and spread weed free straw to manage erosion along the trail. The bridge and nature trail help increase access to the site and expedite invasive removal. Charley goals can be summarized as the fallowing:

1. Reduction in Eucalyptus and English Ivy by 100%
2. Open up more access to the creek area for park residents (Creation of a bridge and trail system).
3. Aesthetic improvements to the site such as removal of trash and erosion control in muddy areas.

2.4 Potential Constraints

- Communication with H-FAC and other partners
- Licensed Arborist for felling Eucalyptus
- Tools required for invasive removal
- Having enough volunteers to accomplish invasive removal
- Safety (i.e. cannot remove invasive or monitor on high slopes and near 101)
- Native plant sources: seed or transplant

3. ALTERNATIVES

3.1 Previously Identified Alternatives

The following alternatives are taken from the Spring 2011, ENVS: Senior practicum group, Widow White Creek Restoration Plan. (Aten et. al. 2011)

1. Leaving *Eucalyptus* and only removing ground cover
This alternative is especially useful if resources are limited. It would provide more time to remove invasives, leading to a better percentage taken out. Removing Eucalyptus or other large trees requires equipment that should only be used by trained individuals which often would not be available for projects. It is a time intensive process but we fortunately have the personnel and

equipment at our disposal, as well as a fairly good amount of time. We are considering the removal of the Eucalyptus to be very important to our needs so we will keep their removal in our current project.

2. Controlled spot treatments using herbicide

The use of herbicide in a spot-treated controlled environment allows for the woody plant species to become isolated from the surrounding vegetation. Spot-treatments permit direct plant contact with the herbicide and highly decreases the chances of the herbicide entering nearby water sources where both plant and animal species may receive negative repercussions if the herbicide is not controlled. The benefit of this alternative is decreasing the likelihood of woody species such as the English Holly and Eucalyptus from resprouting. We will have access to a certified herbicide applicator, who is also the botanist and Nursery Manager for the Humboldt Fish Action Council (HFAC). Using RoundUp near water has the potential to moderately affect inverterbrates health, so it is important for the application to be controlled. Holes will be drilled in the cambium of the trees and the herbicide will be injected directly to avoid any contamination with surrounding soil and vegetation.

3. Replanting native species after removal

The feasibility of replanting trees would allow for a more diverse riparian environment after treating the affected area near the creek. The use of seedlings and cuttings to establish a native canopy, is a very labor intensive approach to active restoration. This will help suppress invasive species from re-establishing post treatment. By replanting native species we would be increasing the ability for natives to thrive and give them a step up in the game of competition before invasives can once again choke out the land and take all of the growing space. The implementation would encompass volunteer work days to remove invasive species and to plant. Crews would go pull invasive plants (ivy crews, holly crews etc.) while another would plant in cleared area.

As previously stated this is a labor intensive treatment, requiring the use of heavy machinery and/or volunteers to plant. These can be hard to come by. Moreover the propogules themselves can be rather costly unless they are collected by us (i.e. willow stakes). Further, seeds would have to be collected in fall for better viability and to increase survival rate. The ideal planting time for this area is in the middle of the winter in January or February. The mortality of the planted species would increase greatly if vegetation was planted in April versus mid-winter. We recommend this option for next spring, but not for this semester's project.

4. Invasive removal volunteer day

Manually removing invasive species is normally the most effective technique to prevent future re-sprout, but can be labor intensive and physically straining. Keeping these factors in mind using volunteers is an effective way to spread out the labor and remove large amounts of invasives in a short period of time.

We are partnering with HFAC, and AmeriCorps Watershed Stewards Project (WSP) both of whom have recruited volunteers for work days on a variety of projects. HFAC workdays are well

known and widely attended for both the fun and the free breakfast and lunch. The Natural Resources Club on campus partners with many local non profits, including HFAC, on a weekly basis to help in restoration projects. Soliciting participation from both HFAC, WSP and the Natural Resources Club will guarantee attendance on a volunteer work day.

5. Removal concentration on English ivy and Scotchbroom

English Ivy is the most prevalent invasive present in this stretch of the creek. It has climbed several Red Alder and Sitka Spruce trees in the riparian areas. There are a few localized spots of Scotch Broom on this stretch of the creek as well, but the infestation is not severe. This alternative would focus the removal efforts on English Ivy and Scotch Broom leaving the other invasive species untreated. This option would allow us to focus on the largest amount of invasives present that are the easiest to take out, thereby increasing the total amount of invasives removed. This would be one of our most feasible options if the tools and volunteer work to remove the larger invasive species (Eucalyptus trees, large Holly plants) is not possible. Since we have the person-power to take on the larger project, our efforts will be focused in that direction.

6. Aggressive treatment of herbicide on specific locations of the creek where invasive species are present

This alternative would eliminate many of the big stretches of English Ivy that are too prevalent for us to remove all of, and would likely destroy whatever rhizomes and roots that may still be left in the ground. Heavy use of pesticide in riparian zones would do more damage to the water quality of the creek than it would aid the creek rebounding. Such use would hinder the aquatic habitat for species' residing in and around the creek. Invertebrates and anadromous fish populations are sensitive to pesticide contaminated waters. Depending on the pesticide, the lingering effects of the pesticide could potentially effect generations of spawning salmonids.

7. The placement of black plastic covering large patches of ivy to solarize all ground cover before replanting with native species

This option is beneficial because it is more likely to kill off the seed bank and root structures that may be left in the ground from just pulling. This alternative is not feasible because the extent of this group's involvement in the project only extends until the end of the semester. Black plastic requires a lot of maintenance so that is does not negatively impair the creek. It is also a hazard to wildlife mistaking the plastic as food in the riparian area and in the creek. The creek's proximity to the coast (less than one mile) and shaded locality means a cooler climate, with very few sunny days. Black plastic covering the ground cover ivy is most effective in places where there is a lot of sunlight, to effectively solarize the plants.

3.2 New Alternatives

In addition to these alternatives, we added the following:

1. Prescribed Fires

The use of fire can be an effective way to reduce and eliminate unwanted species. However, fires would have to be used repeatedly before the plant is at reproductive age in order to eliminate the recurring generations from seed, since the seed bank would still survive. Repetition of prescribed fires that would be effective would likely be more than what may have naturally occurred, and would kill desired species. Prescribed fires for the use of eliminating invasive species is more appropriate on sites that are comprised of monocultures of invasive plants, such as grasslands covered in cheatgrass. Other reasons we will not choose this alternative is that the site is not suitable for prescribed fire since it is within an urban area surrounded by homes and businesses.

Figure 5. Removing a certain percentage of invasive species

Removal of all invasive species is an unrealistic goal. Even removing one species is a daunting challenge. During manual removal of invasive plants areas are missed. After removing invasive plants soil is left bare after vegetational removal and provides suitable habitat for invasive plants to recolonize. Eucalyptus removal is time and labor intensive. Removing it will require trained professionals and heavy equipment. Removing Eucalyptus will damage other vegetation in the area, including natives. Removing any invasive species requires multiple efforts over prolonged periods of time. It is beyond the scope of this class to totally remove all invasive species.

3. Biological Control

Ophelimus maskelli is native to New South Wales, Australia. As an invasive insect in the Mediterranean region of Israel it has dessicated large parts of crowns of Eucalyptus. A study would need to be conducted before it is brought to Humboldt County. In Israel *O. maskelli* is now considered an invasive pest that causes too many problems. *Gonipterus scutellatus* is a species of weevil endemic to Australia. It feeds and breeds on Eucalyptus. It is currently considered an invasive pest in many countries that it has spread to. A study would need to be performed to determine its effectiveness against Eucalyptus and to consider if it would become a pest here once it is used.

4. METHODS AND IMPLEMENATION STRATEGIES

4.1 Implementing Site Restoration: Baseline Data Collection Methods

Initial Data Collection

In the spring of 2011, the previous group established permanent transects perpendicular to the stream at a bearing of 252 degrees, at the 40, 140, 240 and 340-meter marks along an initial transect parallel to the stream. The transects were marked with PVC pipes that were hammered into the soil at the bankfull mark, denoting each transect. The first transect begins on the right bank (facing down stream) at bank full, and extends 26 meters at a bearing of 72°. The second transect begins on the left bank (facing down stream and extends 26 meters a bearing of 252°. On each of the transects, percent cover of ground vegetation was estimated. 1 meter2 quadrats were placed every 5 meters along the transect. The quadrat was bisected down the

middle by the transect, and was placed at 0-1 meters, 5-6meters, 10-11 meters, 15-16 meters, 20-21 meters, and 25-26 meters. On the 140-meter right bank transect there was a very narrow riparian area and a steep cliff dropping about 10 meters into the creek. Only two quadrants of percent cover were collected to ensure the safety of the students. This semester, these exact methods were repeated, with additional data collected, such as strata, including herb, shrub and tree for comparison to our reference site.

Reference Site Conditions

A reference site was chosen based on accessibility, the dominant species of tree being Sitka Spruce and Alder, as well as presence of fish in the stream and absence of invasive species in the riparian corridor. The reference site we chose was at Mill Creek, in Trinidad, CA. We collected species occurrence and percent cover of three different strata in the riparian zone of Mill Creek, in order to have objectives to be able to meet for the restoration of riparian vegetation at Widow White Creek. Three transects ran approximately every 20 meters along an initial transect running parallel to the stream, with a random start. These three transects ran perpendicular to the stream and across, as far as was safe and feasible for the students to reach. The first transect was 21 meters long, and the other two were 16 meters long. A quadrat was placed on the right side of the tape at zero, and then alternated sides at every 5 meters along the tape.

4.1 Implementing Site Restoration: Work Days

Workday Preparation November 3rd and 4th

Two days before the first workday, top priority invasive woody plants, such as holly and scotch broom were located for removal by chainsaw operators, and top priority areas were located as well as trails to get to those areas, in order to minimize sedimentation and trampling of native plants by the volunteers. Photo points were also established in order to document the largest infestations, and target areas in order to compare to post work-day conditions.

Approximately ten *Eucalyptus globulus* was felled on this day, since the best course of action was to cut these the day before out of safety and feasibility reasons. HFAC provided a certified arborist; however some local residences (this included the landowner) volunteered to help fell eucalyptus. A climber secured a steal cable in larger trees; the cable was then hooked up to a backhoe to safely bring the tree down. The HSU Logging Sports team and some community member helped buck and remove woody material (for forestry competitions and firewood). They picked up their desired wood in their personal vehicles and hauled it away.

First Workday: November 5th, 2011

Approximately 25 people participated in the first Humboldt Fish Action Council workday. Volunteers were divided into three English ivy teams, each with one leader from our group who knew where the target areas had been located. One team was at the southern-most end of the stream at Murray Road, one team targeted an area near the 240 meter transect, and the third team targeted a large infestation of English ivy on the north end of the stream. Teams consisted of approximately 7, 8, and 10 people, respectively. Removal occurred over five hours.

Meanwhile, a team of HFAC employees and volunteers targeted large holly trees and scotch broom. A chipper was used to process eucalyptus branches and stems so that they could be sent to Scotia where they would be used to generate electricity in a biomass facility. For the safety of the volunteers, only HFAC employees were allowed to operate the chipper, or even go near it. Trash that was found was also removed from the stream and riparian corridor.

English ivy was removed using the same methods as last semester. Ivy infested trees were prioritized, since ivy that is climbing up the trees will berry and reproduce. Ivy was removed 6 feet up infested trees, and a six foot radius around infested trees were removed, using a variety of tools provided by HFAC. Certified weed free straw was used for erosion control and suppression of invasive plants that may regrow. Straw was lain down along steep slopes where English ivy had been removed and the ground was bare. The straw lessens the impacts of precipitation hitting the ground and decreases the velocity of runoff. We hypothesized that English ivy will not regrow as much where the straw covered the ground due to lack of sunlight and being smothered.

Second Workday: December 3rd, 2011

A second HFAC volunteer workday occurred on December 3rd. Approximately 22 people participated in the second workday. The second volunteer workday targeted English ivy left of the stream. People were divided into two groups and one worked on the north most end of the English ivy infestation and everyone else started approximately 100 meters south of them. Removal occurred over five hours. The same methods as the first workday were used for this workday.

Restoration map

A project site map was generated as part of the effort to coordinate a more efficient and effective restoration plan. The map was generated in GIS and all data points were gathered using a Gamin GPS unit. The map gives an areal view of the site and displays: project photo points, vegetation transects, ivy released trees, and the ivy desert infestation area. The photo points and vegetation transect start points are shown for reference and future monitoring purposes. The Ivy released trees are shown to document progress during the two workdays this semester. The location of these released trees also provides a plan for retreatment efforts. Since in most areas the ivy ground mat has not been eradicated it is expected over time these trees will become infested again. The map gives a guide so that trees can be monitored and retreated on future workdays. Similarly the ivy desert infestation has been denoted because: it is the northern extent of Ivy on the site and is also the worst infestation located thus far. It is thought that this area should be treated before moving south to prevent further spread north on the site. As is shown on the map many trees have already been treated in this area, but a viable ivy ground map still exists. (Note: The map was generated in GIS and all data points were gathered using a Gamin GPS unit. Not all of the released trees within the ivy desert infestation area are shown since many trees on the second workday were closely spaced and/or have a small diameter.)

The map was in part made to help HFAC survey restoration progress and provide a reference for future planning. This map can also be used to show potential funding sources the word that has been conducted at Widow White Creek. In the future HFAC would like to have a stem map of the Eucalyptus to help guide the felling and removal process.

Erosion

One of the project goals was the increase in native vegetation cover and erosion control. Many areas with steep slopes had all vegetation removed from the area and many people climbing up and down the slope. Native vegetation will be unable to take hold in an unstable soil and erosion will increase, causing a positive feedback loop. To assess our effects on erosion processes an experiment was conducted.

Three sites were selected and then three identical plastic bottles were buried at each site so that the tops of them were even with the top of the ground. The first site was located at a site that had invasive *H. helix* removed during the previous years project. The second and third site had *H. helix* removed this during this project. Site 2 had straw laid down and site 3 had only ground cover was leaf litter. The tops (bottleneck) of the plastic bottles were cut off so that they were wider. At sites 1 and 2 holes were dug at the shoulder slope, back slope, and toe slope. Site 3 did not have much of a slope so all three holes were dug at the base of the slope. All three sites were under a tree. After a day of rain, with approximately .35 inches of precipitation, all plastic bottles were removed from the ground. Their contents were placed in an oven and baked until all water had evaporated. The remaining soil was weighed. The weight of the container was subtracted from the weight of the soil and container. Slope of each site and percent ground cover were measured.

5. RESULTS

A list of plants that we found at Widow White Creek before the workday are as follows:

Herb

Sedge – *Scirpus* spp.
Creeping Buttercup – *Ranunculus repens*
English Ivy – *Hedera helix*
Sword Fern – *Polystichum munitum*
Bracken Fern – *Pteridium aquilinum*
Lady Fern – *Athyrium felix-femina*
Hedge nettle – *Stachys chamissonis*

Shrub

Evergreen Huckleberry – *Vaccinium ovatum*
Button Bush – *Cephalanthus occidentalis*
California Blackberry – *Rubus ursinus*
Himilayan Blackberry – *Rubus bicolor*
Salmonberry – *Rubus spectabilis*
Thimbleberry – *Rubus parviflorus*
Red Elderberry – *Sambucus racemosa*
Red Huckleberry – *Vaccinium parvifolium*

Salal – *Gaultheria shallon*

Tree

Red Alder – *Alnus rubra*
Sitka Spruce – *Picea sitchensis*
Blue Gum Eucalyptus – *Eucalyptus globulus*
Cascara – *Rhamnus purshiana*
Englsh Ivy (In Canopy) – *Hedera helix*
Willow – *Salix* sp.

Invasive plants we had within our transects include Blue Gum Eucalyptus and English Ivy, which were two targeted species for removal. Average percent cover of species at Widow White Creek are shown in Figure 1, followed by species evenness in Figure 2. Evenness was determined by the number of plots in which a species occurred.

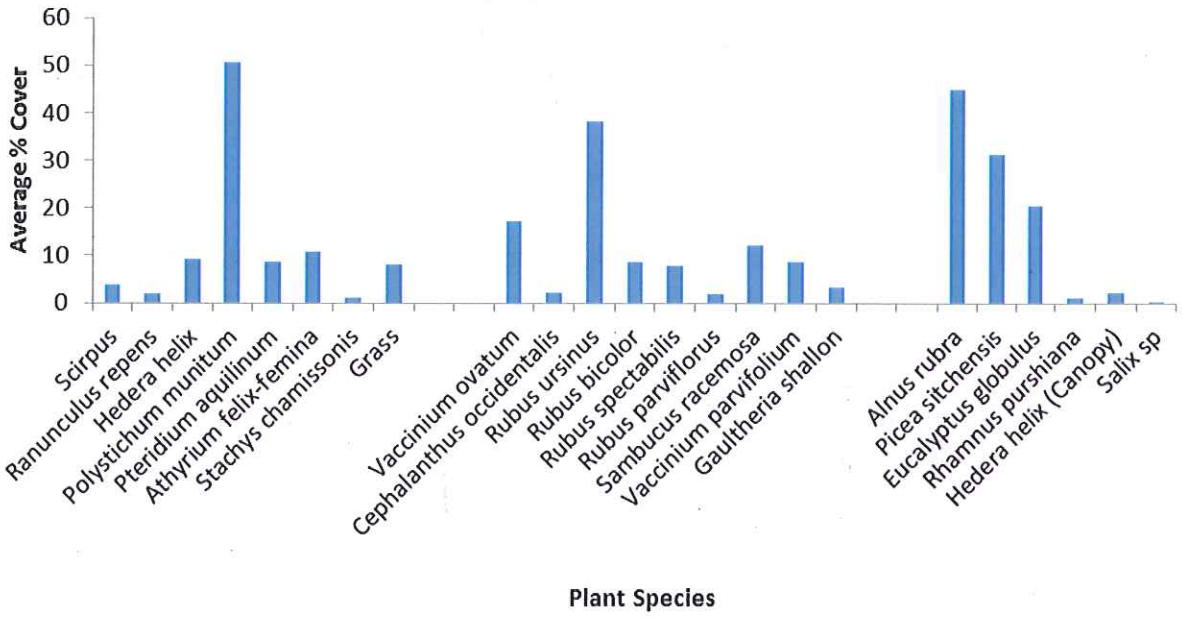
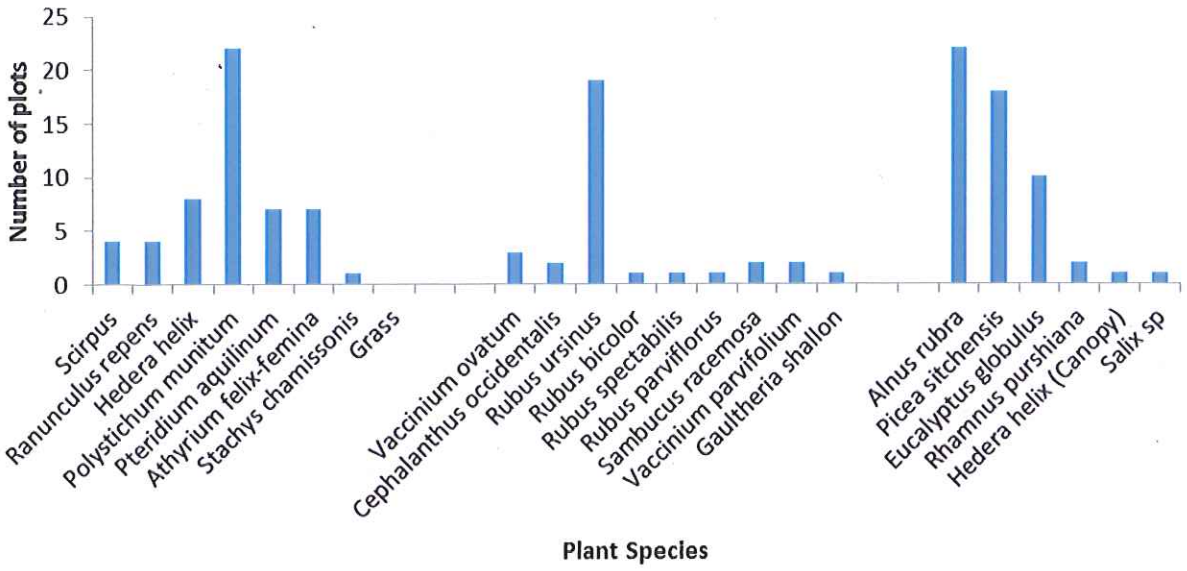


Figure 1. Average percent cover of plants at Widow White Creek, in McKinleyville, California. English Ivy (*Hedera helix*) is represented as a ground cover and as canopy cover.



The reference site is located just east of Trinidad State Beach at Mill Creek in Trinidad, California. The reference site is located just east of Trinidad State Beach at Mill Creek in Trinidad, California. Species Composition separated by 3 strata: Herb, Shrub and Tree at the Reference site are as follows:

Herbs
Redwood Sorrel – *Oxalis oregana*
Sword Fern – *Polystichum munitum*
Coastal Miterwort – *Mitella ovalis*
Licorice Fern – *Polypodium glycorrhiza*
Creeping Buttercup – *Ranunculus repens*
Lady Fern – *Athyrium felix-femina*
Wild Ginger – *Asarum caudatum*

Shrubs
Salmonberry – *Rubus spectabilis*
Wild Cucumber – *Marah oreganus*
California Blackberry – *Rubus ursinus*
Button Bush – *Cephalanthus occidentalis*
Red-flowering Currant – *Ribes sanguineum*
Red Elderberry – *Sambucus racemosa*
Thimbleberry – *Rubus parviflorus*

Trees -
Big Leaf Maple – *Acer macrophyllum*
Cascara – *Rhamnus purshiana*
Grand Fir – *Abies grandis*
Red alder – *Alnus rubra*
Sitka Spruce – *Picea sitchensis*

Figure 3 shows the average percent cover of plant species, while figure 4 shows species evenness

by the number of plots each species occurs.

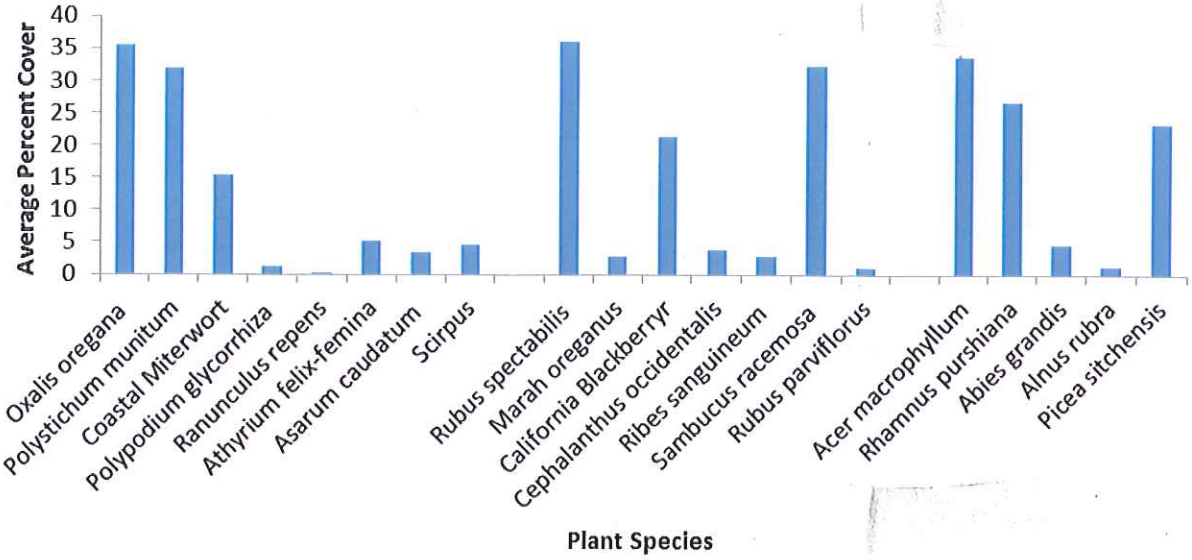


Figure 3. Average percent cover of plant species at Mill Creek, Trinidad, California.

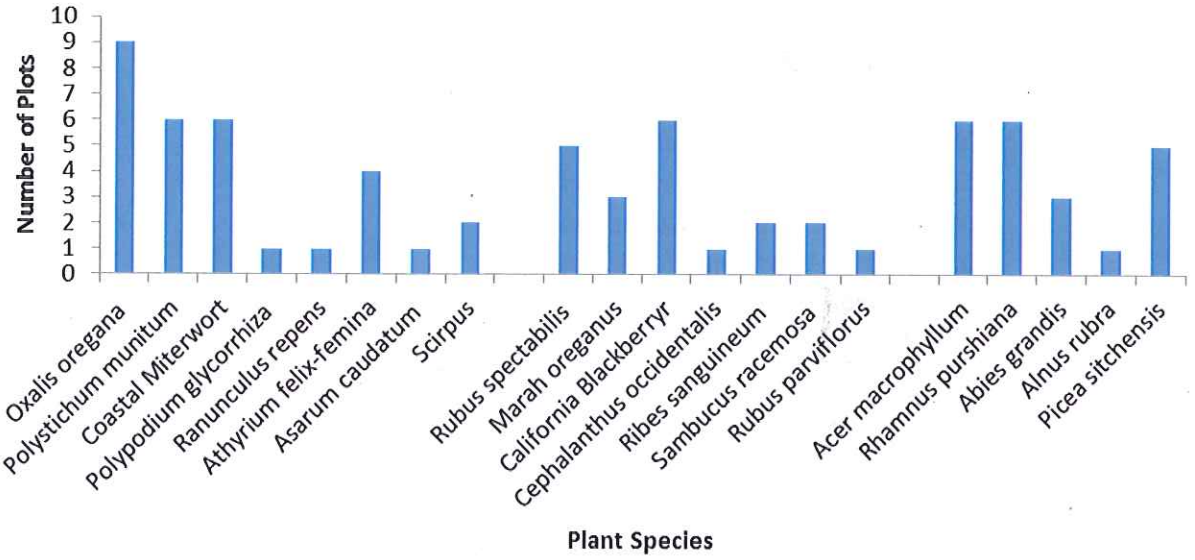


Figure 4. Species Evenness. This shows the number of plots in which each species occurred at Mill Creek, Trinidad, California.

The transect that showed a change before and after the workdays was the transect at 40 meters. Figure 5 shows the difference between the cover of English Ivy at the 40 meter transect.

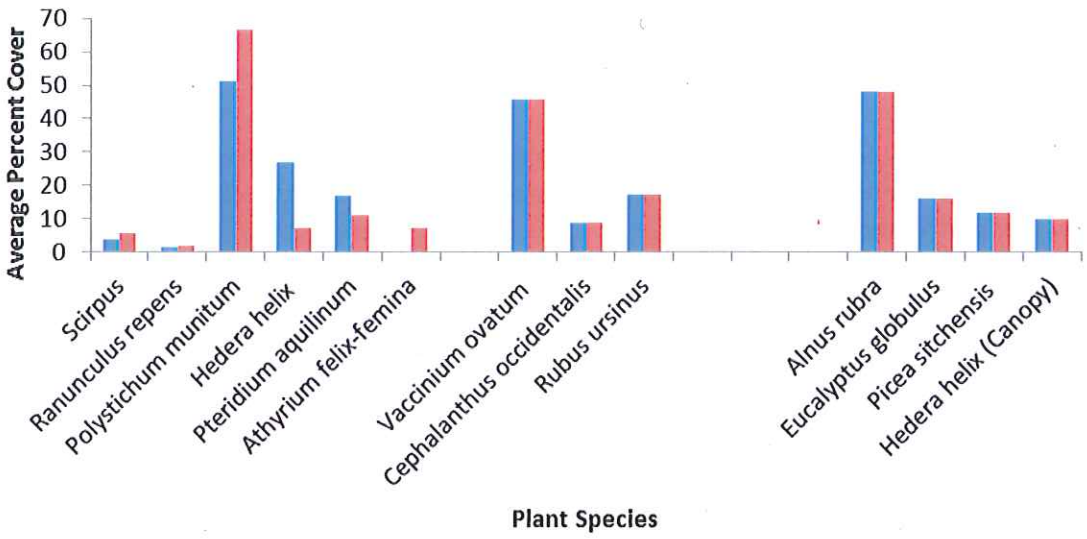
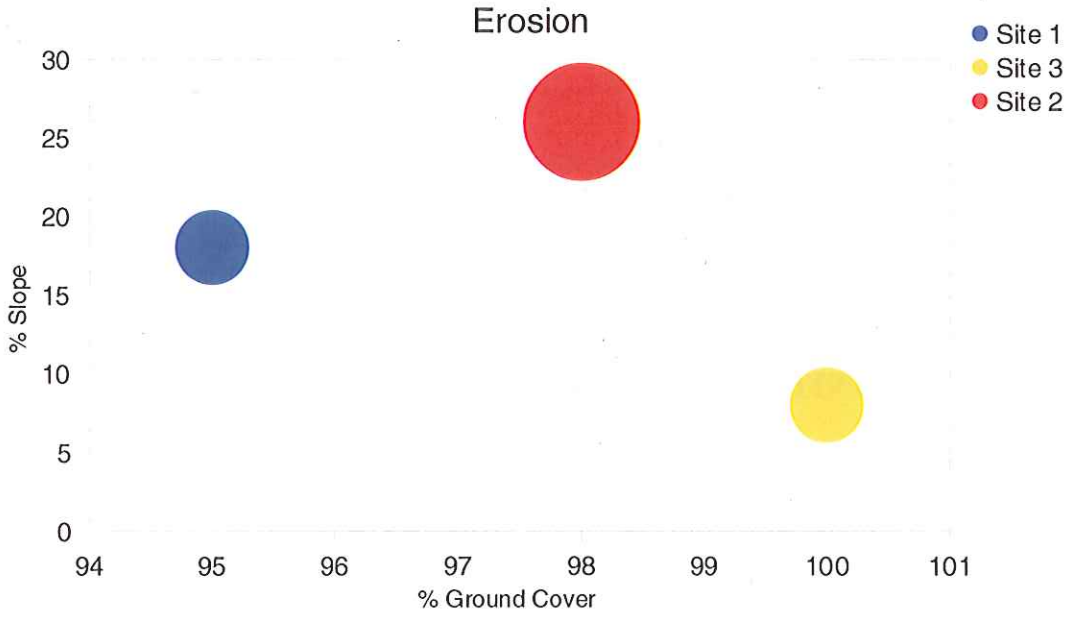


Figure 5. Average percent cover before the work days (in blue) and after the work days (in red) show a reduction in cover of *Hedera helix*.

Note: The restoration map has been appended to the report as well.



6. DISCUSSION

Vegetation transects

Upon post project sampling the transect at 40m showed a reduction in *H. helix* by 35%. Other transects were not repeated because those areas were not treated because no change is expected. Furthermore *H. helix* along the other transects is minimal and so only a small change would have occurred if work was conducted. In the future a new sampling method may be required to represent invasive change over time. Possibly random fixed area plots would show *H. helix* within the site more accurately. Also a greater reduction in H. helix may be seen over time as canopy ivy wilts and dies.

Restoration map

The Restoration map created for the site displays the accomplishments of the project better than the results from the vegetation transects. On the map the trees released from *H. helix* constriction are shown. During the two volunteer work days over 50 native trees were released, which we considered to be a huge success. (Some trees are not mapped due to small diameter and/or proximity to each other) Releasing the trees is crucial because the canopy level *H. helix* is able to effectively produce seeds that then spread throughout the site. Trees being constricted by the *H. helix* may also experience mortality if not released in a reasonable amount of time.

Erosion

Slope appears to be more important than percent ground cover for the amount of sediment being transported. As ground cover increased in Site 2 erosion increased by 250%, presumably due to the 8% difference in slope. There was almost no ground cover consisting of live vegetation at any site. Sites 2 and 3 had only a 2% difference in ground cover but had an 18% difference in slope. Site 2 also had 250% more erosion than site 3.

The workday causes an increase in erosion. Site 1 had less ground cover and a higher slope than site 3. Consequently site 1 should have more erosion than site 3. This was not the case since the same amount of erosion appears to have occurred at site 1 and 3. Site 3 has the erosion rate of a site with steeper slopes and less ground cover, indicating that it has been significantly disturbed.

7. MONITERING AND PROJECT EVALUATION

7.1 Long term Site monitoring

The effectiveness of Restoration along Widow White Creek will be monitored through the vegetation transects that where established previously in spring 2011. We measured vegetation cover along the transects prior to the workdays and will return to measure the change after the second work-day. Since these transects are marked with permanent piping they are ideal as long-term vegetation monitoring sites. In addition to transects photo points have been established at worksites to visually document invasive removal and any other subsequent

changes. These photo points can be used in the future to document continued change in vegetation cover. Both the photo points and transects will be marked on a restoration map. We also recommend that changes in water quality and stream macroinvertebrate populations should also be monitored. This is because it is expected that over time restoration efforts will decrease sedimentation and increase invertebrate diversity increasing habitat and food sources for salmonids. We have established a long-term relationship in which the ENVS 450 class continues this monitoring annually for the duration of restoration efforts.

A restoration map will be added by the end of this semester that will show the invasive ivy infestations before and after the two volunteer workdays as well as focal points for future eradication efforts. From the map and the weights that were given to us by H-FAC on the amount of biomass that was removed over the two workdays, we can estimate the amount of person-hours it will take to remove the rest of the ivy after this semester. Further stem mapping may also be helpful to direct H-FAC in their removal of the remaining Eucalyptus trees. Continued mapping of the invasive plant change is our recommendation for quantifying the progress over the next years.

We also feel that a planting of native plants listed above will be beneficial, and a monitoring plan to go along with it is highly recommended. The vegetation data collected at the Trinidad riparian reference site can be utilized as a restoration model and provides goals for a long-term monitoring plan. We chose this site as a reference because it had little to no cover of invasive species and it had fish present in the stream. Vegetation cover is broken into three categories: herbs, shrubs, and trees. We think that at least within the riparian corridor of Widow White Creek, a similar species composition and cover of natives will be necessary for the return of native fish in the stream.

Species Composition separated by 3 strata: Herb, Shrub and Tree at the Reference site are as follows:

Herbs
Redwood Sorrel - *Oxalis oregana*
Sword Fern - *Polystichum munitum*
Coastal Miterwort - *Mitella ovalis*
Licorice Fern - *Polypodium glycorrhiza*
Creeping Buttercup - *Ranunculus repens*
Lady Fern - *Athyrium felix-femina*
Wild Ginger - *Asarum caudatum*

Shrubs
Salmonberry - *Rubus spectabilis*
Wild Cucumber - *Marah oreganus*
California Blackberry - *Rubus ursinus*
Button Bush - *Cephalanthus occidentalis*
Red-flowering Currant - *Ribes sanguineum*
Red Elderberry - *Sambucus racemosa*
Thimbleberry - *Rubus parviflorus*

Trees - Big Leaf Maple - *Acer macrophyllum*
Cascara - *Rhamnus purshiana*
Grand Fir - *Abies grandis*
Red alder - *Alnus rubra*
Sitka Spruce - *Picea sitchensis*

7.2 Assessment of Success

Post project monitoring will have to show an increase in native species cover and a decrease in invasive species cover for success. Sites pulled should have close to 0% cover of English ivy and holly. Most of the Eucalyptus was beyond the scope of this project. Sites not pulled will still have a high percentage of English ivy and Holly cover. Only the sites that were specifically targeted for invasive eradication will be used to judge success since many areas remained entirely untouched during the workdays. The proportion of the project area targeted for eradication was based upon the number of volunteers we had available to us. The first day had 25 volunteers despite inclement weather. The second workday had 22 volunteers. The removal of invasive species should have done minimal damage to the surrounding land. Factors to consider are erosion and mortality of native species. Both of these factors should be minimal for the project to be successful.

We believe for restoration efforts to continue in creating viable fish habitat additional workdays will be required to eradicate invasive plants from the riparian corridor at Widow White Creek. This work must also be followed by native plant plantings to increase native cover for the stream. In some cases erosion control measures may also be necessary. Unfortunately due to time constraints, we were not able to plant native plants this semester, but we removed a substantial amount of invasive ivy, holly, cotoneaster, broom and Eucalyptus. We also created a map of cleared areas and invasive infestation to direct future eradication efforts.

8. LESSONS LEARNED AND FUTURE RECOMMENDATIONS

8.1 Future Recommendations

- Continuation of Invasive plant removal volunteer workdays until complete eradication of English Ivy.
- Continued Felling of eucalyptus, Holly (if resprouting occurs), and other woody invasives until complete eradication. Removing such materials during volunteer workdays.
- Erosion control measures, such as certified weed free straw, in areas damaged during workdays.
- Continued monitoring of changes in stream metrics (BMI index, pebble counts, Vegetation surveys)

- Anchoring of large woody debris in the steam to create fish habitat.
- Native plant restoration utilizing provided reference site data.
- Reconstruction of the Murray road culvert to made it fish friendly.

ENVS 410 Future involvement

The ENVS 410 should continue this project and partnership with HFAC. There is a culvert that runs under Murray Road that might be a fish barrier too high or water velocity being too fast. A study should be performed to determine how much of a barrier it is. *H. helix* has been significantly reduced and a study of how many more work hours to remove it all and keep it removed would be beneficial. Further research concerning what direction the watershed should be going in, such as describing a described restored condition, structure, and function, would give the project focus.

ENVS 450 Future Involvement

Alison Purcell O'Dowd has agreed to have the Applied Ecological Restoration class (ENVS 450) continue monitoring Widow White Creek until restoration efforts are completed. (Until at least 2015) Future students will be given past ENVS 410 and ENVS 450 WWC reports that describe the sampling methods used and the data collected. From this students will sample stream macroinvertebrates (BMI index), conduct pebble counts, and monitor the permanent vegetation transects. If time permits students will also help in the invasive plant removal. Students will also be asked to contact Doug Kelly of HFAC to coordinate such efforts.

8.2 Lessons Learned

- Collaboration can be difficult when views clash
- Have more quantitative study ideas ready ahead of time
- Outreach and volunteers can make a big difference!
- Think about how to access vegetation cover
- Plant natives at the right time
- Culverts can present a impassible problem!
- English ivy on the west side of the stream
- Eucalyptus trees (and European invasives in general) are everywhere!
- Role of invasives in the greater scheme of ecological restoration.

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Appendix 1

Photo Point 1 Before

Photo Point 1 After

Photo Point 4 Before

Photo Point 4 After

Photo Point 7 Before

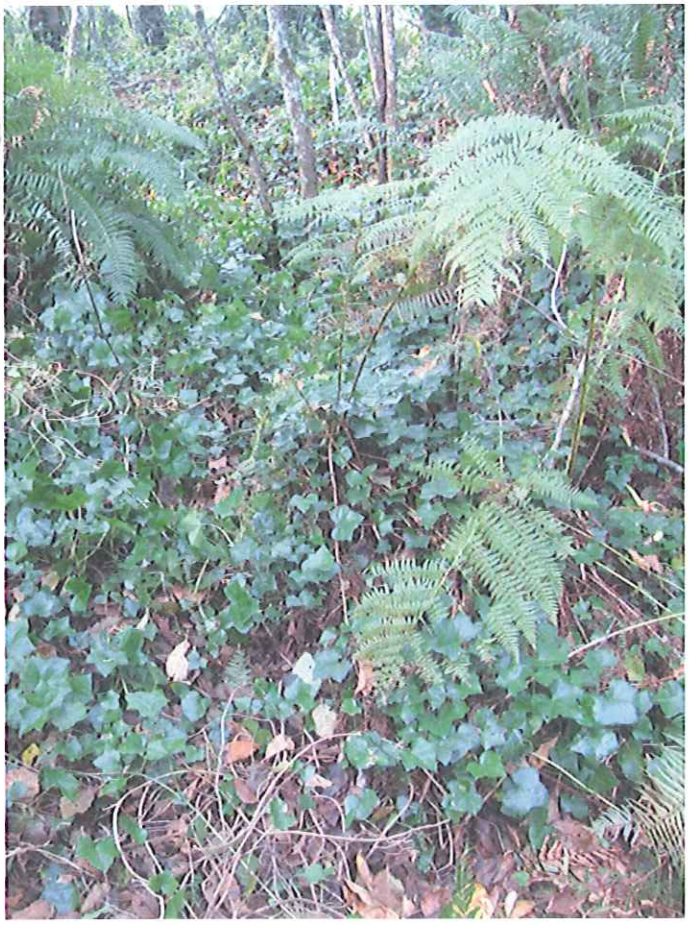


Figure 1Photo Point 7 After

INVASIVE PLANT REMOVAL
Volunteer Work Day.

Humboldt Fish Action Council

and the

California Department of Fish & Game's

"Fisheries Restoration Volunteer Program",

Along

Widow White Creek

Saturday, November 5, 2011

9am-2pm

(Rain or Shine)

Take Hwy 101 North to Murray Road Exit #721, turn right onto Murray Road then turn Left into Widow White Creek RV Park.
LOOK FOR **HFAC VOLUNTEER WORK** SIGN.
Drive straight through the RV Park to the HFAC Trailer.

Continental breakfast & Barbecue Lunch will be provided for volunteers!

For 16 years, this program has provided HSU students and community members with hands-on experience in a variety of watershed restoration projects.

Bring water, gloves, good boots, and rain gear. **Please, no pets**.

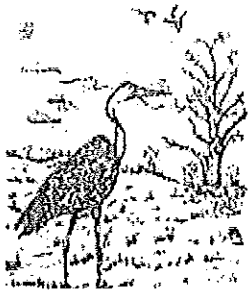
If you have questions, please call:

Doug Kelly, Humboldt Fish Action Council

(707) 822-3834 phone / (707) 499-2301 cell / dougkelly@h-fac.org

Take part in your community by helping to restore your local watersheds!

FISH HABITAT RESTORATION



Humboldt Fish Action Council and the California Department of Fish & Game Present

Watershed Restoration on Widow White Creek

Saturday - December 3, 2011 from 9am-2pm (rain or shine)

At the RV Park on Murray Rd. In Mckinleyville

Take the Murray Rd. exit off of HWY 101

Look for the HFAC VOLUNTEER WORKDAY sign!

A Delicious Barbecue Lunch will be served for volunteers!

If you have any questions please contact Rocco Saracina at ras61@humboldt.edu / (703) 772-0599 or Doug Kelly, Humboldt Fish Action Council (707) 822-3834 phone / (707) 499-2301 cell / dougkelly@h-fac.org

Event Sponsored by:

Humboldt Fish Action Council

Americorp Watershed Stewards program

& Humboldt State University

Come take part in your community through the restoration of the Widow White Creek watershed!

Come join in the watershed restoration at Widow White Creek by removing invasive species! Rain or shine, a delicious barbecue lunch will be served!

Please bring water, gloves, boots, and rain gear.

Saturday November 5th from 9am-2pm

At the RV Park on Murray Rd. in McKinleyville

Take the Murray Rd. exit off of 101N

Event Sponsored by:

ENVS 410 Senior project

Humboldt Fish Action Council

And the Americorps Watershed Stewardship program

For more information please contact: Ras61@humboldt.edu
Or the Humboldt State Natural Resources club

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features
- Gully
- Short Steep Slope
- Other

Political Features
- Cities

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

MAP INFORMATION

Map Scale: 1:1,430 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 10N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Humboldt County, Central Part, California
Survey Area Data: Version 1, Mar 14, 2007

Date(s) aerial images were photographed: 6/15/2005

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Watershed Restoration on Widow White Creek

Saturday - November 5, 2011

from 9am-2pm (rain or shine)

At the RV Park on Murray Rd. In Mckinleyville

Take the Murray Rd. exit off of HWY 101

Look for the HFAC VOLUNTEER WORKDAY sign!

A Delicious Continental Breakfast and Barbecue Lunch will be served for volunteers!

Please bring gloves, rubber boots, rain gear, and water!

If you have any questions please contact:

Doug Kelly of Humboldt Fish Action Council at (707) 822-3834 phone

(707) 499-2301 cell, or dougkelly@h-fac.org

or

Rocco Saracina at ras61@humboldt.edu or (703) 772-0599

Event Sponsored by:

Humboldt Fish Action Council

Americorp Watershed Stewards program

& Humboldt State University

Come take part in your community in the restoration of the Widow White Creek watershed!

Widow White Creek Invasive Species Removal

Humboldt Fish Action Council Volunteer Day
Saturday December3rd from 9am-2pm

- Widow White Creek RV Park
- Murray Road Exit 121 off of Highway 101
- 1085 Murray Rd. McKinleyville

Look for the HFAC Volunteer Workday Sign!

Come join in the watershed restoration at Widow White Creek by removing invasive species!

Rain or shine, a delicious barbecue lunch will be served!

Please bring water, gloves, boots, and raingear. Limited supplies of gloves and boots are available.

Event Sponsored by: ENVS 410 Senior project
Humboldt Fish Action Council
Americorps Watershed Stewardship program