Tall Whitetop Eradication and Native Plant Community Restoration

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Abstract

Tall whitetop (Lepidium latifolium) is a member of the mustard or Brassicaceae family. It is a native of southeastern Europe and southwestern Asia and probably came to the United States in sugar beet seed in about 1900 (Newlands Project, Fallon, NV). It is an invasive species that has spread to thousands of acres in Nevada, including about 25,000 acres in the Truckee River Watershed. Ranchers and farmers are losing thousands of acres and millions of dollars annually to this pestiferous weed. Eradication efforts to date have focused on use of herbicides and controlled grazing. However, eradication of TWT and restoration of native floodplain plant communities has not been accomplished to date. Previous attempts to eradicate TWT have overlooked the simultaneous restoration of beneficial soil microbes that support native vegetation. TWT, like other members of the mustard family does not form a symbiosis with soil fungi called mycorrhiza, as do most native plants. One hypothesis is that soils dominated by TWT have lost these essential symbionts and are no longer available to colonize native plants. The hypothesis being tested is to revegetate infested areas, after the TWT is eradicated by mowing and herbicide applications, with native seed treated with mycorrhiza (hyphae and spores), and activated charcoal (neutralizes the herbicide). In this effort, a one-acre demonstration plot has been established at the 102 Ranch along the Truckee River near Tracy, Nevada, in cooperation with Truckee River Investors, Reforestation Technologies Inc., BASF, Western Botanical Services, Great Basin Earthwork, and Juniper Rose. The project is anticipated to last for three years, and funding sources are being explored.

The demonstration plots will consist of the following treatments:

- 2 Irrigation Levels - No Irrigation and Supplemental Irrigation
- 2 Seed Treatments - Control (untreated seed) and Treated (mycorrhiza + activated charcoal)
- 2 Herbicide treatments – Treated with Plateau and untreated.

To date the plots has been mowed and treated with 8 oz/acre Plateau

Introduction

By Nevada law (NRS 555.005), a “noxious weed” is “any species of plant which is, or is likely to be, detrimental or destructive and difficult to control or eradicate.” Tall whitetop (Lepidium latifolium), (TWT), aka Perennial pepperweed, is a member of the mustard or Cruciferae family and is listed by the State of Nevada at the top of their noxious weed list. It is a native of southeastern Europe and southwestern Asia and probably came to the United States in sugar beet seeds in about
1900 (www.newlands.org/whitetop). According to the University of Nevada Agricultural Experiment Station Bulletin No. 170, dated June 1944, the tall whitetop problem has been around since at least 1938. “Experiments in the control or extermination of Whitetop have been conducted since 1938 in the Fallon, [Nevada] area.” The methods discussed include cultivating, smothering with other crops, use of chemicals, burning or searing, and flooding.

It is one of a number of noxious weeds that have infested 17 million acres of public rangelands in the Western United States. Dealing with these noxious weeds is estimated to cost more than $123 billion a year. Tall whitetop is an invasive species that has besieged thousands of acres of Nevada’s lands, including about 25,000 acres in the Truckee River Watershed. Ranchers and farmers are losing thousands of acres and millions of dollars annually to this pestiferous weed.

Tall whitetop is particularly productive when it can overrun water areas such as streams, rivers, ponds, and wetlands where its negative influence on water quality is devastating. It invades sensitive stream areas and chokes out native plants that help prevent stream bank erosion. It is also quite capable of withstanding adverse water and weather conditions, and is frequently found in salty soils, meadows, abandoned agricultural lands, pastures, hayfields, residential areas, and along roadsides. Tall whitetop out-competes native riparian vegetation, leaving unstable riverbanks subject to erosion and thereby diminishing water quality. There is some evidence that the plant can actually alter soil chemistry, additionally altering native soils and communities that stabilize soils. Large dense stands of tall whitetop limit recreational access to the Truckee River. It replaces willows and other woody species that provide cover for wildlife and fisheries.

Because it appears to some as a pretty plant with clusters of fluffy, delicate white flowers, many people do not recognize it for the villain it is. It spreads by underground roots (rhizomes) which may grow to a length of 3 to 10 feet or longer, and which send out shoots to form new plants. Tiny, reddish seeds -- as many as 10,000 seeds per plant or 6 billion seeds per acre -- also propagate it. In ideal conditions, such as wetlands, it may flower twice in a season.

According to the Washoe-Storey Conservation District, tall whitetop:

- Drives out and replaces the beneficial vegetation along creeks, rivers and irrigation ditches.
- Causes riverbanks to slough off during flood events.
- Creates a monoculture of itself and restricts and destroys diverse wildlife habitat.
- Pulls salts out of deeper soils and deposits them on the surface of the ground.
- Limits the germination of seeds of beneficial plants.
- Provides an excellent breeding ground for mosquitoes.

The Nevada State Legislature considered it such a threat to Nevada’s agricultural and recreational lands that in 1999 the University of Nevada Cooperative Extension Agency was asked to head up a two-year tall whitetop program. “Now is the time to tackle the alien weed problem before it becomes outrageously expensive and harmful to the environment and our water quality,” (www.unce.unr.edu/tallwhitetop/).

To date, a number of studies have been done regarding the control of tall whitetop. Eradication efforts so far have focused on use of herbicides in combination with mowing, and controlled grazing. However, control of TWT and restoration of a native floodplain plant community has not been attempted. Seeding of test plots at the 102 Ranch in 2002 with tall wheatgrass (*Elytrigia elongata*) following mowing and herbicide application in various combinations has not yet resulted in any seedlings. It resists the reestablishment of desirable vegetation after treatment and returns with a
vengeance. Previous attempts to revegetate areas where TWT has been partially controlled have overlooked the simultaneous restoration of beneficial soil microbes that support native vegetation.

TWT, like other members of the mustard family (*Brassicaceae*), does not form a symbiosis with soil fungi called mycorrhiza, as do most native plants. One hypothesis is that soils dominated by TWT have lost these essential symbionts that are no longer available to colonize native plants. It appears that the one possible way of controlling this noxious weed is to revegetate the infested area after the TWT is eradicated, with seed treated with mycorrhiza propagules and activated charcoal. Activated charcoal attaches to substances by chemical attraction. When certain chemicals pass next to the carbon surface, they attach to the surface and are trapped.

**Goals and Objectives**

- To develop the best possible management practices and most innovative and successful techniques necessary to locate, control and revegetate acreage in the Truckee River Watershed infested with tall whitetop (TWT), aka perennial pepperweed, (*Lepidium latifolium*), and to do so in a fiscally responsible manner. This can be considered a Best Management Practice demonstration project.

- To evaluate the effectiveness of several possible management techniques for the control and revegetation of water resource areas infested by tall whitetop.

- To determine performance of native species under diverse treatments.

**Site Description**

The 102 Ranch lies along the north shore of the Truckee River in Washoe County, adjacent to Interstate 80 (T 20N, R 22E) at the Patrick exit. It consists of approximately 180 acres including upland sage and saltbrush scrub. Much of the site is unvegetated and disturbed due to previous land uses. Approximately 60 acres in the floodplain consists of an almost solid stand of tall whitetop. The previous owner, Hoss Equipment of Nevada, had planned to develop the property into Golf Course. Toward this end, they drilled a well and planted numerous trees along the northern property line by I-80. Approximately 10 years ago, one of the fields (alfalfa), including a small stand of TWT was leveled and plowed, resulting in the current dense stand of the plant. Peter Morgan, one of the property owners and a personal friend of Julie Etra, was approached in 2002 with the project proposal.

**Project Design**

A series of demonstration plots were established in the spring and summer of 2003 to evaluate the effectiveness of several management techniques for tall whitetop at the 102 Ranch along the Truckee River in Storey County. Plots were mowed on June 16, 2003 during peak flowering, and then sprayed when flowers were in full bloom.

The plots will be divided into six treatment types and revegetated in the winter of 2004. Follow-up monitoring will continue for a period of three years. The treatment types are as follows:

- Two Irrigation Levels - No Irrigation and Supplemental Irrigation
- Two Seed Treatments- Control (untreated seed) and Treated (mycorrhiza + activated charcoal)
Two Herbicide treatments – Treated with Plateau and untreated.

**Project Materials**

1. **Herbicide**

   PLATEAU® herbicide for weed control, native grass establishment and turf growth suppression on pastures, rangeland, and noncrop areas. (See appendix ___ for complete information.)

   Active ingredients consist of Ammonium salt of imazapic \((\pm)-2-[4,5\text{-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl}]\)-5-methyl-3-pyridinecarboxylic acid\(^*\)23.6%.

   Inert ingredients 76.4%, for a total of 100.0%

   \(^*\)Equivalent to 22.2% \((\pm)-2-[4,5\text{-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl}]\)-5-methyl-3-pyridinecarboxylic acid. (1 gallon contains 2.0 pounds of active ingredient as the free acid)

2. **Mycorrhiza Inoculants: Background, Specifications**

   Mycorrhiza are fungi that dwell in the soil and form symbiotic associations between the roots of most plant species and the fungi. Mycorrhiza is localized in a root or root-like structure in which energy moves in a two-way manner, primarily from plant to fungus, while the inorganic resources and water move from fungus to plant. The main responsibility of mycorrhiza is to increase the efficiency of mineral uptake and water in soil. Once the soil becomes disturbed from its native state, the mycorrhiza do not persist without the symbiont and the soil has difficulty supporting native species since the root system is reduced. Mycorrhizal inoculation can improve plant establishment, nutrient and water uptake, plant vigor, yield and growth, and disease resistance. It will also reduce transplant shock and drought stress. Mycorrhizal plants are often more competitive and better able to tolerate environmental stresses than are non-mycorrhizal plants. About 95% of the world’s land plants form the mycorrhizal relationship in their native habitats. TWT is one of the 5% that does not form this relationship.

   Thus, when attempting to revegetate disturbed soils, it is advisable to use a mycorrhizal inoculant as will be shown in this study.

The benefits of mycorrhizal inoculation are:

- A Natural functioning ecosystem with a strong mycorrhiza presence may force out non-mycorrhizal species such as “Whitetop”.
- Greater resistance to invasion by noxious weeds.
- Improved soil structure.
- Improved plant growth rate.
- Protection from pathogens.
- Increased seedling survival.
- Higher species diversity.
- Increased drought resistance.
The three species of mycorrhizal inoculants used in this study are *Glomus intraradices*, *G. mosseae*, and *G. aggregatum*. All three species were originally collected in the western United States and isolated and identified at the International Culture Collection of Vesicular Arbuscular Mycorrhizal Fungi (INVAM) located at the University of West Virginia. These three species were chosen because of their widespread occurrence in arid environments and ability to colonize and affect plant growth under a wide range of environmental conditions.

Methods for the production of mycorrhizal fungi inoculum have been widely known in the academic world since the early 1970s. Soon following the establishment of these methods, the academic community documented the plant establishment and growth benefits of using mycorrhizal inoculum in agriculture and land restoration. However, the commercial production of mycorrhiza inocula was limited, at first, to a few isolated commercial forestry nurseries. The limited market for commercial production of mycorrhiza inocula silenced innovation and large-scale production of high quality inocula until the 1990s. The market and need for large-scale commercial production of high quality mycorrhizal inocula quickly expanded with the increased use of native plants in erosion control and restoration of disturbed lands. Now there are over ten companies in North America who commercially produce mycorrhiza inocula. Innovations in inocula production, quality assurance and control, and application methods are driven by consumer education and testing under “real world” field conditions. The academic world has proven that mycorrhizal fungi are extremely important to plant growth but it will take a unique partnership between producer and consumer to find the most cost effective and beneficial use of mycorrhiza inocula in large-scale field projects.

3. **Seed Mix**

The following species were selected based on their presence in remaining floodplain communities and similar soil types, their ability to establish rapidly and competitively, and their known association with mycorrhiza. With the exception of ryegrain, Baltic rush and four-wing saltbrush, all species are mycorrhizal, with varying degrees of dependence on the symbiosis. The cereal crop was added as a nurse crop to provide shade for species slower to germinate and establish. Tall wheatgrass, the other non-native, was included since it is a competitive, rapidly establishing species adapted to fluctuating water tables and soils that occur on the project site. Big sagebrush and rabbitbrush, both in the family Asteraceae, produce an abundance of short-lived seed and are excellent colonizers. Inland saltgrass, however, has a known record of poor establishment from seed due to dormancy mechanisms. It has been included since it is a major component of the Truckee River floodplain community. It will be interesting to examine if better germination and establishment is accomplished with the inoculant. Creeping wildrye is also a dominant species in these communities.

<table>
<thead>
<tr>
<th>Botanical Name</th>
<th>Common Name</th>
<th>PLS Lbs/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Artemisia tridentata</em></td>
<td>Big sagebrush</td>
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</tr>
<tr>
<td><em>Atriplex canescens</em></td>
<td>Fourwing saltbush</td>
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<tr>
<td><em>Distichlis stricta</em></td>
<td>Inland saltgrass</td>
<td>3.00</td>
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<tr>
<td><em>Chrysothamnus nauseosus</em></td>
<td>Rubber rabbitbrush</td>
<td>0.50</td>
</tr>
<tr>
<td><em>Elymus cinereus</em></td>
<td>Great Basin Wildrye</td>
<td>3.00</td>
</tr>
<tr>
<td><em>Elytrigia elongata</em></td>
<td>Tall wheatgrass, ‘Jose’</td>
<td>4.00</td>
</tr>
<tr>
<td><em>Juncus balticus</em></td>
<td>Baltic rush</td>
<td>0.25</td>
</tr>
<tr>
<td><em>Leymus triticoides</em></td>
<td>Creeping wildrye</td>
<td>5.00</td>
</tr>
</tbody>
</table>
4. Activated Charcoal- Background and Specifications

The activated charcoal is used in the seed coating to sequester the active ingredients that are present in the soil, which has resulted from the application of the BASF herbicide "Plateau". The herbicide will stop any of the undesirable seeds present in the soil such as "Whitetop" from germinating and the "activated charcoal" present in the seed coating of the desirable seeds that have been treated with charcoal and mycorrhiza in combination should germinate and become established on the site.

Methodology
The demonstration plots will consist of the following combination of treatments:

- Two irrigation Levels - No Irrigation and Supplemental Irrigation
- Two seed treatments- Control (untreated seed) and Treated (mycorrhiza + activated charcoal)
- Two herbicide treatments – Treated with Plateau and untreated.

1. Application Data
   A reference site of a healthy native floodplain community will be selected as an outside control.
   The one-acre demonstration area was mowed using a brush hog mower at the peak flowering stage of tall whitetop. When tall whitetop had re-grown to the full flowering stage, Plateau was applied on August 6, 2003, between 8:00 am and 8:30 am through a boom sprayer on an ATV, utilizing TeeJet flat fan nozzles, 8004, applying 20 gallons of water per acre, at 8 fl ounces per acre with one quart per acre of methylated seed oil. Weather was clear, winds were 1-2mph from the west, temperature were 65°F with a relative humidity of 43%.
   Plots will then be tilled and broadcast seeded in the winter of 2004. The seeds will be applied by a seeder and gently raked in so to create an interface between the soil and the seeds.

2. Monitoring
   Sampling will begin in the spring following winter seeding.

   a. Vegetation Sampling: (Western Botanical Service Inc.)
      - Germination will be measured within a 2 x 2 ft randomly selected area within each plot. This will be accomplished by a 100 percent count of all species germinating within the sampled area.
      - Cover, frequency and diversity will be determined by the point- intercept methodology along permanently located transects.
      - Establishment, vigor, vitality (reproduction) will be determined qualitatively.
      - Permanent photo-points will be established and monitored.
b. Mycorrhiza monitoring: (RTI)

- Root sampling for mycorrhiza colonization will be done for selected plant species using a stratified random sampling method. Root sampling will start at the third leaf stage and continue biannually during the spring and fall of each growing season.


. c. Soil fertility

- Soil sampling for nutrient analysis will be taken in the spring and fall of the first year of growth. Samples will also be taken from an adjacent representative area as well as the control.

d. Soil microbiology: (Soil Food Web)

- Sampling for soil bacteria and fungal presence, diversity, and activity will be taken in the spring and fall of the first year of growth. Samples will also be taken from an adjacent representative area as well as the control.

Management and Contingency

This may include spot or broadcast applications of herbicides, mowing and pruning, seeding, and re-application of inoculants. Additional new technologies will be evaluated for incorporation into existing or additional plots. Every attempt will be made to complete the project as proposed. Changes to the work plan will be reviewed and approved by NDEP prior to implementation.

MEASURE OF SUCCESS

Success will be determined through monitoring of plant establishment in conjunction with evaluating root colonization and soil biology and chemistry. This will be compared to a ‘control’ site with healthy floodplain species. Replacement of TWT with a native plant community is the criteria for success.

The Abundance and Distribution of Non-native Woody Species in Sacramento Valley Riparian Zones

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Abstract.

For a 2003 study of wildlife in riparian zones, we recorded the species composition of riparian vegetation in one hectare plots at 47 locations distributed across 16 streams in the Sacramento Valley and adjacent foothills. Non-native woody species were an important component of the shrub layer at