AN ABSTRACT OF THE THESIS OF

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Title: Using Cattle as a Tool: Restoring the Sumpter Valley Dredge Tailings

Abstract approved:

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John Buckhouse

A period of over forty years (1913-1954) of gold dredging dramatically changed the landscape of Sumpter Valley, Oregon into a rocky, uninhabitable terrain. The Defrees Ranch LLC used cattle feeding to increase top soil, vegetation, and habitat on the dredge tailings. This thesis investigated the use of feeding cattle as a restorative measure to increase land value on the Sumpter Valley dredge waste sites. A belt line transect method was used to complete a usable forage test and a species diversity test for three separate plots: a twenty-year site, ten-year site, and control site. A marked increase in vegetation was shown between the control, ten, and twenty year plots, with a transition toward perennial plants and a more evenly dispersed species diversity. Soil samples from each plot showed: an increase in potassium, phosphorous, sulfur, ammonia, and nitrate between the control plot and the plots subject to restoration livestock treatments. The results show that this restoration method has been successful and the continuation of it will persist in increasing the value of the land and provide needed vegetation for a highly distressed land.

Using Cattle as a Tool: Restoring the Sumpter Valley Dredge Tailings

by

Dallas K. Defrees

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Dean, University Honors College

I understand that my project will become part of the permanent colllection of Oregon State University, University Honors College. My signature below authorizes release of my project to any reader upon request.

Dallas K. Defrees, Author

ACKNOWLEDGEMENTS

Many hours have been invested in this project from a diverse collaboration of contributors. I would like to acknowledge OWEB for providing funds that have allowed the progress of this project. I would also like to acknowledge Defrees Ranch LLC and Baker County for having the initiative of forming a lease agreement and compiling a realistic and effective management plan that transformed an area of environmental distress.

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that have occurred due to this project are incredible and I am honored to showcase what they have been able to do and hope to inspire others to follow their lead. My mother and father have both aided me in many ways with this project; changing a sentence, going out in the field with me, showing pride in what I was accomplishing, and finally pushing me through when I was unsure of what my next steps should be.

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INTRODUCTION

Gold is a commodity that has shaped our history, lifestyle, and landscape for many years. It played a pertinent role in the construction of cities, relocation of families, and the wealth of our country; it is a resource that has maintained its intrigue and value throughout history. Although the value of gold has fluctuated through the years, it has always had value, worth, and beauty. However, there are few times when we stop to think what the real cost of gold has been and what other types of legacies it has left in it's wake. In rural Baker County, the gold industry left it's mark on the Sumpter Valley landscape and in many respects has caused other industries and ways of life to be more difficult than they would have been had gold not been mined in the valley.

History of Sumpter Valley and the Gold Dredge

The process of mining gold can be accomplished by several different methods, some environmentally benign and others that can leave scars on the land that last for generations. In 1913 the first gold dredge started turning Sumpter Valley, Oregon upside down, over the next forty years three separate gold dredges would snake their way through Sumpter Valley in the hunt for gold. The dredges were large boat-like structures, built on pontoons or a small hull that would travel along "dredge ponds" through the Valley. The dredge made its own ponds as it devoured the land in front of it, digging between 18-20 feet below the ground surface,

Figure 1: The Sumpter Valley Dredge (National Park Service)

churning up the rocks and gold, flushing all the top soil downstream. While the dredge was in operation the Powder River became so muddy that fish could no longer survive. Top soil of Sumpter Valley can now be found in Baker Valley and Thief Valley Reservoir (Hawley 1977). The third Sumpter Valley gold dredge had seventy-two, one ton buckets that collected the material from the earth. The buckets would carry the rock and soil to the interior of the dredge where it would then be separated according to size by steel cylinders. Smaller material continued further into the dredge while the larger material was spewed out the back. Finally, by using water sluices, the gold would be separated from the remaining debris (Oregon State Parks 2012). The oversized debris that was conveyed out of the back of the dredge is now what covers Sumpter Valley. The dredge functioned everyday of the year except for Christmas and the Fourth of July or when under repair. If a breakdown occurred, two groups would work in twelve hour shifts until the dredge was back in working order. Twenty-three men were employed by the dredge but only three were needed for a shift of digging. The dredge could excavate about sixty acres per year (Hawley 1977).

Sumpter Valley sits below the Blue Mountains south of Baker City. In the years prior to gold dredging it was filled with grassy meadows that ranchers utilized to graze cattle and build homesteads. It was a land almost too beautiful to give up, but in the years affected by the Great Depression many families had no choice but to yield to the high prices of gold and sold their precious land to the dredging companies. During the time of the first dredge, 1913-1924, gold was priced at nearly twenty dollars an ounce. The land situated in Sumpter Valley was rich with gold and the dredge companies saw the potential

wealth. For this reason they were willing to buy farm land for $50-$75 per acre, just above farm prices. Many ranches sold out to the dredge and little by little the land of Sumpter Valley was being transformed into a rocky, upside-down wasteland. From 1935-1954 the price of gold increased to $35 per ounce and with it land prices also increased. By 1954 land was being sold for $300 per acre. In total 2,500 acres of land was destroyed by the three dredges in Sumpter Valley and $10,000,000 worth of gold was recovered.

In 1954 the dredge company lost over $100,000 and decided to stop operations (Hawley 1977). The company pulled out of Sumpter Valley as quickly as possible, with little to no clean-up. The dredge company had cut it's losses and moved out of town before they lost any more money. Old cables and parts of the dredge can still be found in the dredge tailings and the surrounding land. These cables can be harmful to animals, farming equipment, and humans, not to mention their lack of aesthetic value. The dredge company milked what money it could find from the once beautiful Sumpter Valley and moved out, leaving a herringbone pattern pile of rocks that was to become a “no man's land”, devoid of nearly all vegetation and for the most part inaccessible. The land that once sustained families and animals no longer added to the rich heritage of the valley. Along with the gold, the dredge took a part of Sumpter Valley that could never be replaced, ranches were sold and destroyed, ecosystems were lost, and the land was scarred forever.

Restoration Attempts After the Dredge Ceased Operations

The ground was left in shambles and many did not know what was to be done with it. For twenty years after the dredge ceased operation the land was left to grow

weeds that infested the rest of the valley. Amongst the rock piles are the remnant dredge ponds that were used for the dredge to travel on. There are about 60 acres of dredge ponds; ~25% are able to support a trout fishery with no improvements, ~50% could be made into productive game fish habitat by changes that are monetarily feasible. The remaining ponds are marginal and so shallow that they do not allow for much life other than mosquitoes (Kostol 1997).

In 1975 the Oregon Department of Fish and Wildlife (ODFW) took over management of the tailings in order to improve fish and wildlife conservation. It is not apparent that ODFW has a formal record of what was performed during this time and there is little evidence of any change other than the installment of 77 goose nest boxes. A few dredge ponds were stocked with trout but this soon stopped and the trout died. Overall not much was done and weed populations: houndstongue, mullein, and knapweed increased. In 1979 this agreement with ODFW was expired and Baker County gained ownership (Hawley 1977). The "Sumpter Valley Dredge Tailing Management Plan" was created and was adopted by the the Baker County court in 1979, however nothing was done for 16 years. In 1995 Shapiro et al. were commissioned to provide a Sumpter Valley Park Management Plan which turned out to be almost identical to the 1979 plan already proposed and would be completed at a cost around $23,000. This plan mostly was composed of the implementation of trailer parks with the only restoration to the tailings being done with landscaping around the parks. However, the plan did not come to fruition as it was thought that any money that was going to be spent attracting tourists should go to the State Park where millions had already been spent (Kostol 1997).

History of Defrees Ranch LLC

Defrees Ranch LLC was founded in 1904 by Alexander Izatt. The third, fourth and fifth generations of Defrees Ranch LLC all play an active role on the ranch today. It has provided the livelihood for the Defrees family for over a century. As the dredge was making its way through Sumpter Valley, many ranchers including the Defrees family were worried about the future of their land and the land surrounding them. Unlike so many unfortunate others, the Defrees Ranch LLC did not have land changed by the dredge, however it still greatly affected them and they anguished at the destruction to the valley. The family was invested in the land, both financially and emotionally and looked for a way to increase it's agricultural and aesthetic values.

Baker County and Defrees Ranch LLC desired to improve the Sumpter Valley Dredge tailings. Besides being an eyesore for the Defrees Ranch LLC, the tailings were becoming overrun with weed species that were crossing over to their land and through all of Sumpter Valley. Large numbers of weeds were covering the rocks, little other vegetation could grow in those conditions. The Defrees Ranch LLC saw an opportunity to work with Baker County to gain land for winter feeding and summer grazing as well as to take an active role in controlling the weed populations. Baker County was also looking for something to do with the dredge tailings since any previous attempts had failed to make much of a difference. Thus, a mutualistic partnership seemed to be the next logical step. Shared goals and objectives were clarified, a management plan, and a lease agreement of a Baker County 10.6 acre plot to Defrees Ranch LLC was written. The goals and objectives were outlined in an action plan and the project was initiated.

Continued Restoration

The experimental ten acre plot provided substantial evidence of improvement over the three year period of wintering cattle on the dredge tailings. There was an increase in organic matter and vegetation. These results were sufficient to induce Defrees Ranch LLC and Baker County to extend the lease agreement to another forty acre plot to the northwest of the existing ten acre plot. A few improvements were made to the lease agreement and changes were made to adapt to the increased size of the plot. Defrees Ranch LLC applied for and received a grant from the Oregon Watershed Enhancement Board (OWEB) to aid in the restoration of the forty acre plot. The stated project goal was to return forty acres of the Sumpter Valley Dredge tailings to a more natural state by establishing and maintaining vegetative ground cover. Reclamation was to be accomplished by contouring the site followed by feeding and grazing cattle over a period of three years. On the OWEB grant application, three goals were identified for the management of the plot: (1) the area will be made more aesthetically pleasing, (2) noxious weeds will be controlled, and (3) seeding and fertilization will aid the soil toward its full potential in the production of grasses and legumes (OWEB Grant Application).

Record of Labor and Materials for the Restoration of the 40 acre Plot

A detailed record of labor and materials were kept so that The Defrees Ranch LLC, Baker County, and OWEB could keep an accurate account of cost in order to deduce the effectiveness of the restoration compared to the time and money spent. It also helped to establish what steps would need to be taken in order to be successful in these restorations. Total material and labor expenses came to be $4,580.59 (APPENDIX II).

RESEARCH

After twenty years of restoration evaluating the success of the project was a plausible step in order to examine if this technique should continue to be employed as well as if it could be used in other areas with similar history and destruction. This thesis will serve the dual purpose of recording the cause and effects germane to these decades of effort as well as being an integral part of my education and training. Several tests and observations were conducted to demonstrate what had changed in twenty years of treatment. The ten year old project plot was also useful in order to document the process along the way and how quickly these changes were taking place.

Soil Composition

Soil composition is a vital element in the ability for plants to grow. One goal of the rehabilitation was to increase the amount of organic matter and topsoil on the mining waste which would then provide suitable conditions for plant growth. Soil samples were randomly taken in each of the plots to examine if the goal of adding organic matter to the rocky dredge tailings was achieved.

Usable Forage and Species Diversity

An important aspect of restoration was to increase the amount of usable forage in each of the plots. This forage will improve the value of the land by providing a food source for wildlife and cattle. Not only are these plants more palatable to the livestock but they also add very important elements to the soil. The perennial plants that are being introduced as new forage into these plots are providing organic matter and nutrients for future soil and help with the further growth of vegetation, therefore increasing much needed

biodiversity. The perennial plants also compete with and reduce resources available to the weeds. In order to measure the amount of usable forage in each of the three plots, dry matter samples were randomly taken using a belt line transect. The mass of the dry matter was then used to calculate the amount of usable forage per acre of land. A species identification test was also done. Using the same belt line transect as in the dry matter sampling, species were identified within the eight foot circumference circle and the percentage of each species was recorded. This data was used to asses if the restoration project was increasing plant biodiversity within each plot.

Livestock

Developing a manageable and efficient way in which to utilize cattle was critical in this process. Baker County and Defrees Ranch LLC outlined the best ways in which they thought feeding and grazing of cattle should managed on the land in order for it to be a positive and easily executed plan. Feeding hay to cattle provided: hoof action, defecation, urination, and vegetation consumption, which could all be applied to transforming the land in a positive way. Cattle are often accused of destroying land through over grazing, trampling of vegetation, etc. In this case all of these actions were desired and and resulted in positive outcomes.

Photograph Points

Photographs were taken throughout the years at several consistent points in order to document the progression of plant growth. These photos help capture the changes that have occurred without going to the actual sites.

METHODS

Soil Composition

A belt line transect was used to collect five random samples from each of the ten-acre, forty-acre, and control sites. A one-hundred foot line was used for the transect, a soil sample was taken every twenty feet for a total of five samples. 200cc (about one pint) of soil was taken for each sample. The larger rocks and plants were removed from the samples, however some roots and debris still remained in the soil samples. The five pints of soil were then combined. The three samples, aggregated from each site, were then tested for pH, Nitrate, Ammonium, Phosphorous, Potassium, and Sulfur.

Usable Forage and Species Diversity

Dry matter samples were taken from each of the plots in order to measure the effectiveness of the restoration efforts by Defrees Ranch LLC. A belt line transect was performed to gather the dry matter samples. A one hundred foot section of tape was placed in a random area in the control, the ten-acre, and forty-acre plots. An eight foot circumference wire circle (APPENDIX III) was placed at 0', 20', 40', 60', 80', and 100'. All surface dry matter was cut at ground level and placed in a plastic baggie (APPENDIX III). The baggie was weighed before and after the dry matter was added in order to calculate total dry matter mass. The species of dry matter were categorized with the help of the Baker County Extension agent, Cory Parsons.

Livestock

Prior to bringing cattle onto the ground preliminary steps needed to be taken. The land required contouring in order for a tractor to be able to safely traverse the rocks and seeds

were dispersed via broadcast seeding. Cattle were used to both provide and work organic matter into the ground. The Defrees Ranch LLC fed cattle on these plots during winter time. In the first years the ranch fed square bails off of a wagon, changing the sites where they drove every few days in order to cover more ground with the hay and disperse where the cattle provided their treatments. In subsequent years they have shifted to feeders. Round and square bails were placed in these feeders every day and the feeders were also moved to a different area every day, once again to disperse feed and organic matter. The organic matter provided by the cow defecation and the not eaten hay as well as grass seeds from the hay began the process of creating an environment for vegetation to grow.

Figure 2: Contouring of the Dredge Tailing for Tractor Passage

Figure 3: Feeders Used in Recent Years for Feeding on Dredge Tailings

Figure 4: Feeding from Wagon

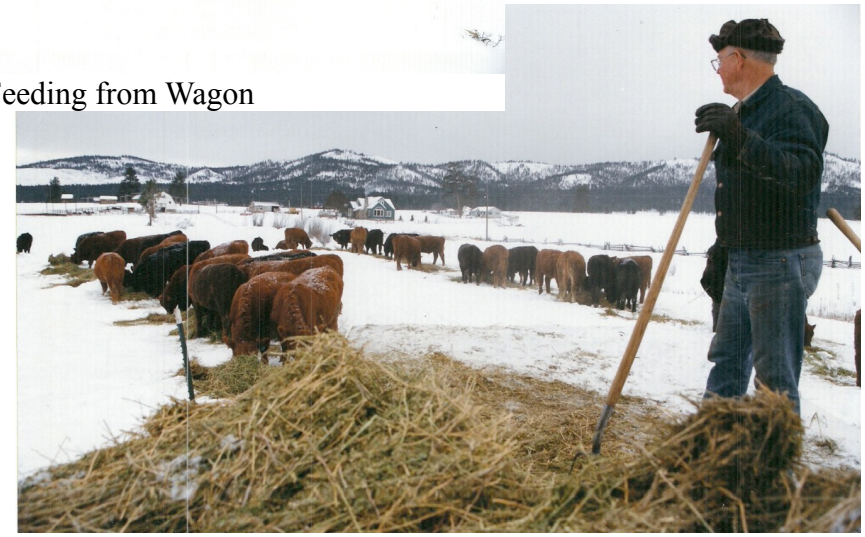


Figure 5 : Winter Feeding off of the Wagon, Cattle Trailing

The exact plan of action was laid out in the original 10.6 acre plot and later the 40 acre plot:

Lease Agreement 10.6 Acre Plot

Sumpter Valley Dredge Tailing Rehabilitation Action Plan Defrees/Warnock Alliance and Baker County:

Goal: To provide a demonstration/experimental project for low cost dredge tailing revegetation.

Objective: To determine if the current trend of plant succession toward noxious weeds on the Sumpter dredge tailing can be redirected toward desirable plant establishment using low impact disturbance pattern.

Low Impact Disturbance Design:

Winter Feeding Area- A site has been selected that would serve as a controlled winter feeding location for livestock. The disturbance objectives are to: 1) Introduce organic material to the site through the deposition of manure as mulch, 2) Introduce the dry site seed mix via a broadcast seeding, and 3) Utilize the hoof action of the livestock to prepare a seedbed and incorporate

the seed into the seed bed.

Fall Seeding Area- A site will be selected for fall disturbance and seeding. The disturbance objectives will be to: 1) Introduce livestock onto the site in numbers that allow a seedbed to be prepared, 2) Introduce the seed mix via broadcast seeing, and 3) Utilize the hoof action of the animals to incorporate the seed into the seed bed.

Grazing- Areas will be selected on which grazing will occur of the prescribed periods of time and prescribed levels of utilization. The purpose will be to design strategies that will maintain or enhance plant vigor, encourage tillering and other forms of reproduction, and introduce the level of disturbance needed to encourage the spread of existing desirable plant communities and/or establish new colonies through seed mix application. Strategies in other areas would be designed to reduce weed vigor ad reproductive potential.

Dry Site Seed Mix:

- Covar Sheep Fescue
- Hycrest crested wheatgrass
- Dryland alfalfa
- Small burnett
- Yellow blossom sweetclover

Moist to Sub-irrigated mix:

- Smooth brome
- Greenar Intermediate wheatgrass
- Redtop
- Meadow Foxtail

Management Plan 10.6 Acre Plot

Sumpter Valley Dredge Tailing Experimental Contouring and Forage Re-establishment Management Plan 10 Acre Plot as part of the Lease Agreement:

Land History- This land was originally homesteaded by William H. Fisher on January 14, 1892 following owners were Sidney W. Tibbs (October 29, 1909-April 30, 1930), and Lloyd Izatt (April 30, 1930-January 6, 1939), then sold to Sumpter Valley Dredge Company. Prior to the dredge the area was covered with grass and small deciduous trees and the soil was Hershal silt loam with a gravely subsoil pahose of bottom and and alluvial fans. The parent material was stratified gravelly, cobbly or sandy, alluvium, mostly of granitic and basaltic origin.

Currently- the area is gravelly with stones intermingled with loam silt, sand and clay.

Vegetation-

A. Slough and pond areas have willows, cattails, and other water loving plants.

B. Leveled areas have alsike clover, sweet clover, some grasses, teasel, mullein, and houndstongue.

C. Upper levels have brush, mullien, houndstongue, twenty-five ponderosa pines, 5 black pine trees, 5 juniper trees, and 1 Douglas fir tree.

Management Recommendations-

1. Smooth the corrugations and shape topography surface so area can be traversed safely with farm tractor.
2. Fence Perimeter
3. Eliminate the weed houndstongue and continue to monitor for all noxious weeds.
4. Remove, prune, or fence pine trees
5. Install Culvert (optional)
6. Annually feeding cattle for a three year commitment
    1. Winter of 98-99, feed 100 pregnant cows, 110 days
    2. Density of cattle : 13.46 animals/acre
    3. Manure and Urine contribution for fertilizer
        1) 43 pounds manure/head/day for a total of 236.5 tone for area per winter
        2) Ten pounds of nitrogen/ton of manure = 2365 pounds of nitrogen for area or 318 pounds of nitrogen per acre.
7. Seeding of grasses and/or legumes if needed.

Management Plan 40 Acre Plot

Sumpter Valley Dredge Tailing Experimental Contouring and Forage Re-establishment Management Plan 40 Acre Plot as part of the Lease Agreement:

Management Objective- Return the project area in the Sumpter Valley dredge tailings to a more natural state by establishing and maintaining ground cover by contouring, reseeding, feeding and grazing cattle using Defrees Ranch LLC Resources and the Oregon Watershed Enhancement Board Small Grant monies in the amount of $3,619.00 per agreement between the OWEB board as Grantor, Baker County as landowner, and Defrees Ranch LLC, L.L.C. And Grantee. Three goals will be emphasized:

A. Soil to reach its full potential in production of grasses and legumes.
B. Area be made more aesthetically pleasing
C. Elimination of noxious weeds.

Management constraints which will hamper reaching the objective include:

A. Biological. Disturbance of topography will set back succession of the plant community and create an environment for noxious weeds.
B. Soil. Soil is intermingled with gravel and is limited in the production capability.
C. Limited resources. Labor, time, and capital is limited.

Background- In 1998 the Defrees Ranch LLC used an adjacent Baker County owned Dredge Tailing plot to experiment with the rehabilitation of the mining aftermath as a result of Gold Dredging.

Land History- The area was mined for gold with a gold dredge starting in the late 1930's. The south edge of the area was re-dredged in the 1950's. Originally the area was covered with forage and sparse deciduous trees and shrubs. Before dredging the soil "same as other plot"

Now- the area is gravelly with stones intermingled with loam silt, sand and clay.

Vegetation-

A. Slough and pond areas have willows, cattails, and other water loving plants.
B. Leveled areas have alsike clover, sweet clover, some grasses, teasel, bullein, and houndstongue.
C.Upper levels have brush, mullien, some grasses and sedges, houndstongue, ponderosa pines, lodgepole pine, and juniper trees.

Management-

1. Set up photo points and photograph areas of interest.
2.Establishment approximate quarter section corners to SW ¼ , of SW ¼ section 13, T. 10 S. R. 37 E.
3.Fence Perimeter. Establish fence pad and construct fence.
4.Eliminate invasive noxious weeds.
5. Shape the topography surface so area can be traversed safely with farm tractor.
6. Seeding of grasses/legumes.
7. Annual feeding of cattle until forage is established.
    1.Winter of 04-05 feed 200 or more beef weaners for 110 days.

2.Density of Cattle: 20 per acre
3.Tons of hay for one winter: 250
4. Manure and Urine contribution for fertilizer:
1) 30 pounds of manure/head/day for a total of 330 tons for area per winter.
2) Ten pounds of nitrogen/ton manure = 3,300 pounds of nitrogen for area or 95 pounds of nitrogen per acre per year.
8.Sign area, provide a sign on the project site and notice on any technical, educational, or informational material produced.
9. Complete Oregon Plan Watershed Restoration Project Reporting for and submit verifiable receipts of expenditures. Continue rehabilitation in year 2, 3, 4, etc.

Photograph Points

Stakes were set up in the 10 and 40 acre plots so that photographs could be taken at the same points throughout the years. The photos were then filed and documented. A sample of photos were chosen to show in this study that are a good representation of the changes that have occurred.

RESULTS

Data was collected from all of the tests that were conducted and compiled into tables and figures that represent the data. Trends can be seen in the graphs of the change in the rehabilitated environment in each of the plots.

Soil Composition

Table 1: Soil Chemical Composition Comparison

	Control	10 yr (40 acre plot)	20 yr (10 acre plot)
PH (ppm)	6.6	6.9	6.5
Phosphorous (ppm)	9	78	93
Potassium (ppm)	106	484	1158
Nitrate (ppm)	9	147	250

Ammonium (ppm)	16	144	136
Sulfur (ppm)	4.4	23.2	47

Figure 6: Soil Composition (Arithmetic Scale)

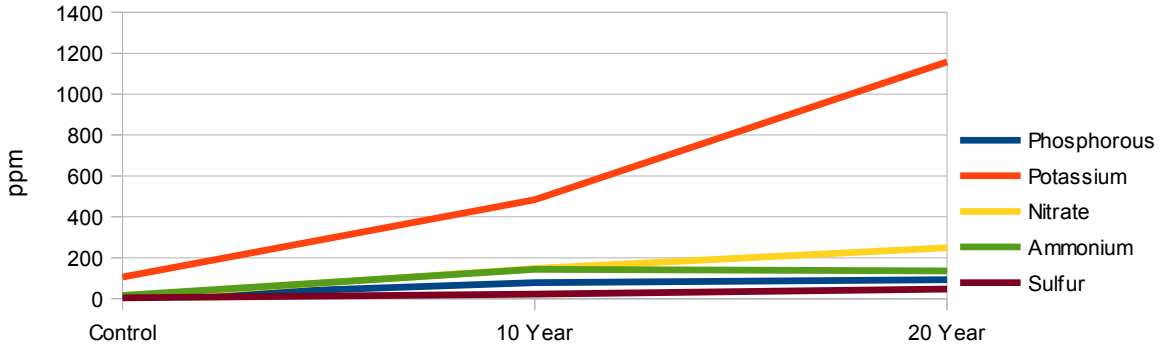
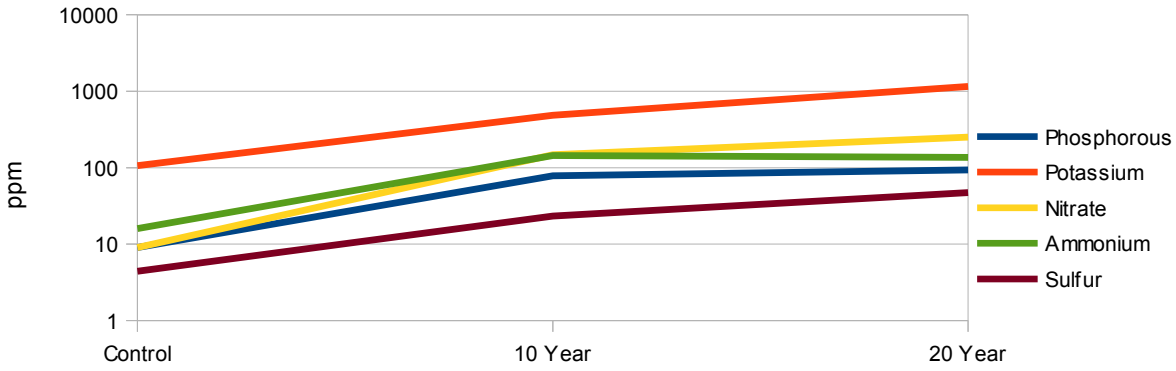


Figure 7: Soil Composition (Logarithmic Scale)



Usable Forage and Species Diversity

Figure 8: Measured Biomass

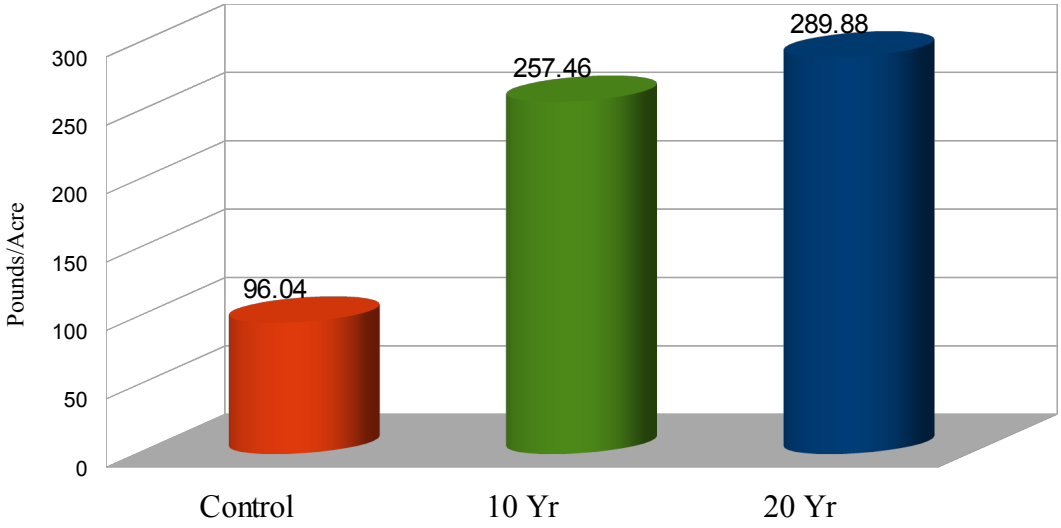


Figure 9: Forage of Differing Plot Points

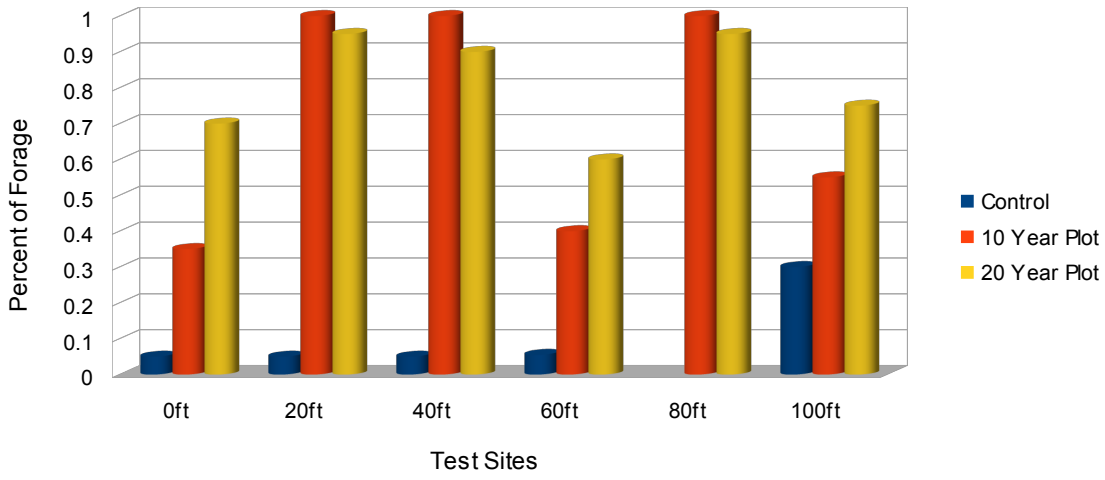


Figure 10: Ground Cover in Control Plot

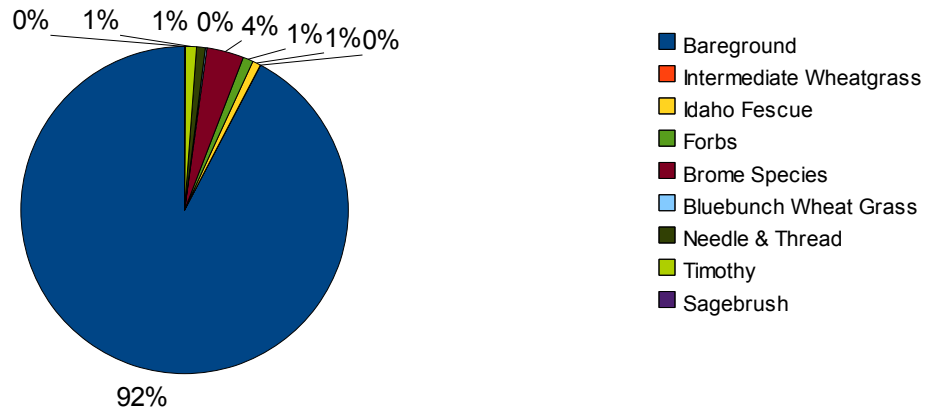


Figure 11: Ground Cover 10 yr. Plot

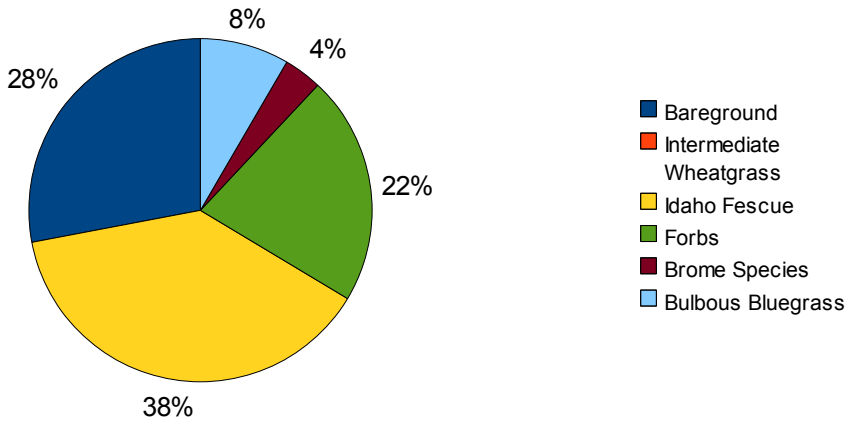
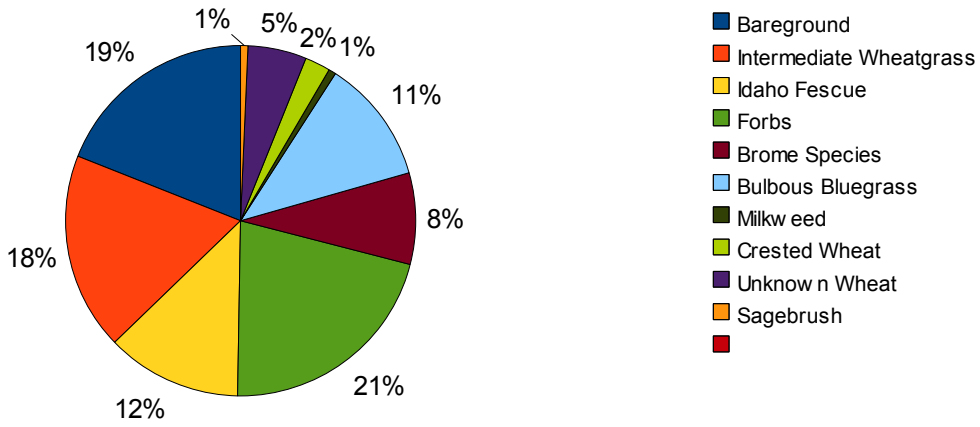


Figure 12: Ground Cover in 20 yr. Plot



Photograph Points

Figure 13: Control July 2012, No Restoration

Figure 14: Control July 2012, No Restoration

Figure 15: Twelve Years of Restoration July 2003

Figure 16: Twelve Years of Restoration July 2003

Figure 17: Twenty Years of Restoration September 2012

Figure 17: Twenty years of Restoration July 2012

DISCUSSION

Soil Composition

The pH value stayed relatively constant through each of the plots, however nutrient composition showed changes in each of the plots. Phosphorous increased dramatically during the first 10 years of restoration and continued to increase over the second 10 years, though at a slower rate. Potassium increased nearly 400% in the first 10 years and approximately another 200% in the second 10 years. Nitrate, ammonium and sulfur showed similar trends. Nitrate in the 20 year plot was 27 times more abundant than in the control, ammonium was 8.5 times more abundant in the 20 year plot than in the control, and sulfur was over 10 times more abundant in the 20 year plot than in the control. An obvious positive correlation exists between nutrient level and the number of years of feeding and grazing.

Usable Forage and Species Diversity

The results of the data collection seem to show an obvious pattern of plant growth associated with years of grazing and feeding on the separate plots. The control plot has the lowest usable forage per acre , the 10 year plot has the second highest usable forage per acre, and the 20 year plot has the most usable forage per acre. From these results it can be deduced that the feeding and grazing of cattle on the dredge tailings has contributed to the level of vegetation and plant growth. This is valuable information for the continuation of the experiment. This demonstrates that introduction of new seeds, leveling, feeding, and grazing of cattle on these plots initially increased the forage on these sites, and that the longer that these steps are taken, more vegetation continues to

grow.

The Control plots showed the largest amount of bare, non-vegetative ground. What little vegetation did exist was comprised mostly of brome species with lower percentages of timothy grass, forbs, needle and thread, Idaho fescue, intermediate wheatgrass, bluebunch wheatgrass, and sagebrush respectively. The Brome species represented nearly 50% of the overall species. In the 10 yr plot, bare ground decreased from 92% to 28%. When compared to the control, many of the species present were the same albeit in much greater amounts. Idaho fescue represented over 50% of sample vegetation with forbs following with 30% and bulbous bluegrass and Brome species making up the remainder. Bareground was further decreased in the 20-year plot to only 19%. It had almost equal amounts of intermediate wheatgrass, Idaho fescue, forbs, and bulbous bluegrass. The remaining vegetation was composed of Brome species, wheat, crested wheat, milkweed and sagebrush. The representation of species composition changed on each of the plots, which indicated that change occurred due to feeding and grazing on each of the plots. Bare ground had decreased from 92% to 19% percent over the twenty years of feeding. The plots showed a positive correlation between feeding and vegetation growth. Species diversity changed through each of the plots evolving from mostly brome species in the control plot, to forbs in the 10 year plot and wheat grasses in the 20-year plot.

Photograph Points

The photographs exhibit the changes that have taken place. Growth is seen to have developed from almost complete bare rock in the control plots to obvious growth twelve

years after rehabilitation and then to almost complete coverage in the twenty-year plots. Wheat grass can also be seen to be more prevalent in the twenty year plots.

CONCLUSIONS

Encouraging results have been shown by changes in soil composition resulting in vegetative growth, species change over time, and the overall aesthetic value of the land in the nearly twenty-year period that cattle were used as a restoration tool on mine spoils. Bare ground decreased 73% in the twenty years; biomass increased over 300%; species diversity shifted to more diverse composition with more perennials. Soil analysis demonstrated that phosphorous, potassium, nitrate, ammonium, and sulfur all improved from nearly sterile conditions toward that of a healthier, more productive environment. Further encouragement lies in the fact that, to date, there is no evidence this improvement has stopped. Levels of vegetation and soil nutrition have continued to grow in the twenty years. Dedication to the land is a value that anyone who makes a living from the land learns early on. Unfortunately the yearning for money can cloud this basic insight and cause long lasting damage as was noted when early struggling landowners sold properties to mining companies for short-term gain. However, it is promising to see that the restoration projects have the ability to return land to a more sustainable and valuable state. The Defrees Ranch LLC has provided an example of how persistence and hard work has resulted in the incredible transformation of land.

In the time that the gold dredge sludged it's way through Sumpter Valley, desperate landowners were forced to make desperate decisions that compromised the land that they lived on and cared for. Reflecting on these occurrences of the past those individuals that profess a land ethic understand that a better alternative is to have concerned stewards of the land . This of course means that we as a society should be

dedicated to keeping these stewards financially sound, since both historical and current practices continue to put an emphasis on a quick profit with little reflection on future impacts. If society has the ability to support and stabilize concerned stewards of the land, society can continue on a path of feeding a hungry world while simultaneously sustaining a planet that will continue to supply our needs, both physical and aesthetic.

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Sumpter Valley Dredge Tailing Rehabilitation Action Plan Defrees/Warnock Alliance and Baker County.

APPENDIX I

FURTHER RESEARCH

This thesis has demonstrated that positive changes have occurred due to using cattle to restore damaged and barren land. However, there is still more work that can be done and more questions that can be answered. Through further studies and continued efforts the full effects of this project can be clarified and introduced to broader audiences.

1. Continue the restoration project and sample each plot for current measurements.
    - The Defrees Ranch LLC will continue to maintain restoration practices for as long as possible: feeding the cattle on the sites, grazing during the appropriate summer months, etc.
    - Tests and research similar to the ones used in this study will be repeated in future years in order to further demonstrate the impacts that are a result of the cattle restoration.
    - If Baker County and Defrees Ranch LLC are both in agreement to the addition of another small plot or extension of a plot, then plots with differing intervals of restoration can be measured to show progress through the years.
2. Examine impacts on wildlife: increased habitat and food supply.
    - The large transformation of the land has caused adaptations to occur in the wildlife patterns in Sumpter Valley. Elk, as well as other animals have been observed frequenting the restored areas more often.
    - The patterns of wildlife could have either positive or negative effects to the restored areas and observing these patterns could aid in further research and

restoration attempts.

3. Explore how this management approach might apply to other sites with similar backgrounds and features

    - Dredge waste sites can be found all throughout the United States of America. Exploring and adapting restoration methods such as this one may provide an efficient and low cost way in which to assist others in rehabilitating countless sites around the United States.

APPENDIX II

RECORD OF BIODIVERISTY

The biodiversity was recorded into tables, the means and results were taken from this raw data and presented in a more accessible format.

Table 2: Species Diversity of Control 1

ft	Int. Wheat -grass	Idaho Fescue	Forbs	Bulbous Blue-grass	Milk - weed	Crested Wheat grass	Unknown Wheat grass	Brome Species	Blue-bunch Wheat - grass	Needle & Thread	Timothy	Sage-brush
0		50%						50%				
20		10%									80	
40								100%				
60	50%							50%				
80	X	X	X	X	X	X	X	X	X	X	X	
100			40%					60%				

Table 3: Species Diversity of Control 2

ft	Int. Wheat -grass	Idaho Fescue	Forbs	Bulbous Blue-grass	Milk - weed	Crested Wheat grass	Unknown Wheat grass	Brome Species	Blue-bunch Wheat - grass	Needle & Thread	Timothy	Sage-brush
0			70%					10%		20%		
20		10%	30%					40%		20%		
40								40%		10%	50%	
60								50%		50%		
80								60%		20%	20%	
100		40%						40%	20%			

Table 4: Species Diversity of 10 yr (40 acre) Plot 1

ft	Int. Wheat-grass	Idaho Fescue	Forbs	Bulbous Blue-grass	Milk-weed	Crested Wheat grass	Unknown Wheat grass	Brome Species	Blue-bunch Wheat-grass	Needle & Thread	Timothy	Sage-brush
0		50%	30%					20%				
20		40%	20%	20%				20%				
40		40%	20%	40%								
60		40%	40%	20%								
80		60%	20%	20%								
100		80%	20%									

Table 5: Species Diversity of 10 yr (40 acre) Plot 2

ft	Int. Wheat-grass	Idaho Fescue	Forbs	Bulbous Blue-grass	Milk-weed	Crested Wheat grass	Unknown Wheat grass	Brome Species	Blue-bunch Wheat-grass	Needle & Thread	Timothy	Sage-brush
0			50%	30%					20%			
20			40%	40%	20%							
40			40%	60%								
60			60%	20%	20%							
80			70%	30%								
100			70%	30%								

Table 6: Species Diversity of 20 yr (10 acre) Plot 1

ft	Int. Wheat-grass	Idaho Fescue	Forbs	Bulbous Blue-grass	Milk-weed	Crested Wheat grass	Unknown Wheat grass	Brome Species	Blue-Bunch Wheat-grass	Needle & Thread	Timothy	Sagebrush
0	40%	30%	10%	20%								
20		60%	20%	20%								
40			10%	80%	10%							
60	10%	30%	30%	30%								
80	40%		20%			20%		20%				
100		15%	40%			15%		20%				

Table 7: Species Diversity of 20 yr (10 acre) Plot 2

ft	Int. Wheat -grass	Idaho Fescue	Forbs	Bulbous Blue-grass	Milk - weed	Crested Wheat grass	Unknown Wheat grass	Brome Species	Blue-bunch Whea-grass	Needle & Thread	Timothy	Sage-brush
0	60%		40%									
20	40%		50%									10%
40	50%		50%									
60			20%				80%					
80	30%	30%	25%					15%				
100		20%		20%				60%				

APPENDIX III

PHOTOS OF DRY MATTER PROCEDURE

The wire circle used and the storage of dry matter collected are shown below to give an insight into what the procedure of collecting data looked like.

Photo 1: 8' Circumference wire used for the belt line transects

Photo 2: Dry Matter Samples

APPENDIX IV

RECORDS OF LABOR AND SUPPLY COSTS

Maintaining a detailed record of the costs and labor associated with this project was important to Defrees Ranch LLC not only for outside funding options but also in order to know the exact cost to benefit ratio of this project. By knowing exact cost and hours of labor the reality of this project can be realized and measured by different entities to determine if the results of the project compensate for what was put into it.

Table 8: Machine Use Cat D-6 w/operator

Date	Task	Time (Hours)	Expense ($)
11/04/04	Construct fence pad and some shaping	2.5	150.00
11/05/04	Construct fence pad and some shaping	2.75	165.00
11/06/04	Construct fence pad and some shaping	2.5	150.00
11/08/04	Construct fence pad and some shaping	2	120.00
11/09/04	Construct fence pad and some shaping	4	240.00
11/10/04	Construct fence pad and some shaping	2	120.00
11/11/04	Construct fence pad and some shaping	2	120.00
11/13/04	Construct fence pad and some shaping	2	120.00
11/15/04	Construct fence pad and some shaping	2	120.00
11/17/04	Construct fence pad and some shaping	1	60.00
11/20/04	Shaping and contouring	1	60.00
11/27/04	Shaping and contouring	3.5	210.00

Table 8: Machine Use Cat D-6 w/operator Continued

12/08/04	Construct fence pad and some shaping	1.25	75.00
12/11/04	Shaping and contouring	2	120.00
12/15/04	Shaping and contouring	2	120.00
12/17/04	Shaping and contouring	2	120.00
		Total	**2,370.00**

Table 9: Fencing Labor

Date	Task	Time (Hours)	Expense ($)
04/12/04	Photograph	1	10.00
04/31/204	Establish boundary lines and corners	8	80.00
12/04/04	Place corner and gate wood post	5	50.00
12/06/04	Place corner and gate wood post	1.5	15.00
12/09/04	Lay wire, place post, attach wire, etc	3	30.00
12/10/04	Lay wire, place post, attach wire, etc	6	60.00
12/11/04	Lay wire, place post, attach wire, etc	12	120.00
12/13/04	Lay wire, place post, attach wire, etc	1.5	15.00
		Total	**380.00**

Table 10: Machine Use Backhoe Ford 4500 w/operator

Date	Task	Time (Hours)	Expense ($)
12/04/04	Place wood post	5	175.00
12/06/04	Place wood post	1.5	52.50
12/09/04	Place wood post	1	35.00
12/10/04	Place steel post	1	35.00
12/11/04	Place steel post	1	35.00
		Total	**332.50**

Table 11: Machine Use ATV w/operator

Date	Task	Time (Hours)	Expense ($)
12/09/04	Lay wire	1	15.00
12/10/04	Lay wire	4.5	67.50
12/11/04	Lay wire	1	15.00
		Total	**97.50**

Table 12: Material List, Fence

Item	Unit	Amount	Price/Unit ($)	Expense ($)
Energizer, fence, 8 joules	each	1	384.99	384.99
Wire, 12.5 gage	foot	10560	0.02	211.20
Post, wood, corner and gate	each	19	6.00	114.00
Post, steel, 5.5ft, 303	each	64	3.50	224.00
Stay, spacer, wood, 2x4x3	each	25	0.50	12.50
Insulators, plastic	each	75	0.45	33.75
Insulators, plastic	each	23	0.2228	5.12
Insulators, glass	each	13	0.50	6.50
Strainer, in-line	each	9	3.23	29.07
Spring, tension	each	4	6.75	27.00
Spring, tension	each	5	6.29	31.45
Handle, gate, electric	each	2	1.88	3.76
			Total	**1,083.34**

Table 13: Material List, Seed

Item	Unit	Amount	Expense ($)
Seed, grass and legume	pounds	150	317.25
		Total	**317.25**

Table 14: Dry Matter Data

	Bag + Grass (g)	Grass (g)	Mean (g)	Lbs /Acre	% of forage used	Usable Forage/Acre
Control 1	9.62	0.53				
Control 2	44.03	34.94				
Control 3	18.92	9.83				
Control 4	18.68	9.59				
Control 5	28.85	19.76	13.72	274.4	35.00%	**96.04**
10 Year 1	28.23	19.14				
10 Year 2	38.78	29.69				
10 Year 3	40.68	31.59				
10 Year 4	28.5	19.41				
10 Year 5	35.88	26.79				
10 Year 6	26.52	17.43				
10 Year 7	36.27	27.18				
10 Year 8	132.1	123.01				
10 Year 9	65.81	56.72	36.78	735.59	35.00%	**257.46**
20 Year 1	55.23	46.14				
20 Year 2	52.68	43.59				
20 Year 3	74.31	65.22				
20 Year 4	32.92	23.83				
20 Year 5	20.15	11.06				
20 Year 6	67.73	58.64				
			41.41	828.23	35.00%	**289.88**