Upper Rock Creek near Ovando, June 2008. Greenwing Restoration photo

Blackfoot Watershed Revegetation Assessment

October 2010

Prepared for the Blackfoot Challenge and
The USDA Natural Resource Conservation Service

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Blackfoot Watershed
Revegetation Assessment

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TABLE OF CONTENTS

MAPS

APPENDICIES

1. Abstract

The Blackfoot River Watershed has benefited from a long history of cooperative partnerships involving landowners, local and national conservation organizations, federal, state, and county agencies, and other stakeholders committed to solving problems and reaching common goals. The successful restoration of native fish-bearing waterways, their associated riparian areas, and water quality and quantity within the watershed are some of these goals.

In order to improve water quality and enhance bull and westslope cutthroat trout fisheries in Blackfoot tributaries, the Big Blackfoot Chapter of Trout Unlimited has partnered with area landowners, the Natural Resources Conservation Service, the Blackfoot Challenge, Montana Department of Fish Wildlife and Parks, and the U.S. Fish and Wildlife Service, among others, to fund and implement numerous area stream restoration projects.

This document summarizes the assessment of the revegetation components of eight restoration projects implemented in the Blackfoot River Watershed between 2005 and 2008. Background information including species planted, seed sources, container sizes, plant material suppliers, and soil and hydrological site conditions was gathered for each project. Revegetation methods and techniques used on each project, and ongoing project maintenance programs were summarized. During the 2009 field season, field crews tabulated revegetation seedling survival, established photopoints, evaluated the various revegetation techniques used on each project, and surveyed general site conditions and responses following project implementation.

This comprehensive document takes an in depth look at these restoration efforts, specifically focusing on success rates of the planted woody seedling revegetation component of each project. This evaluation results in effective recommendations that will help guide partners involved in future restoration efforts within the Blackfoot River Watershed and beyond.

2. Purpose

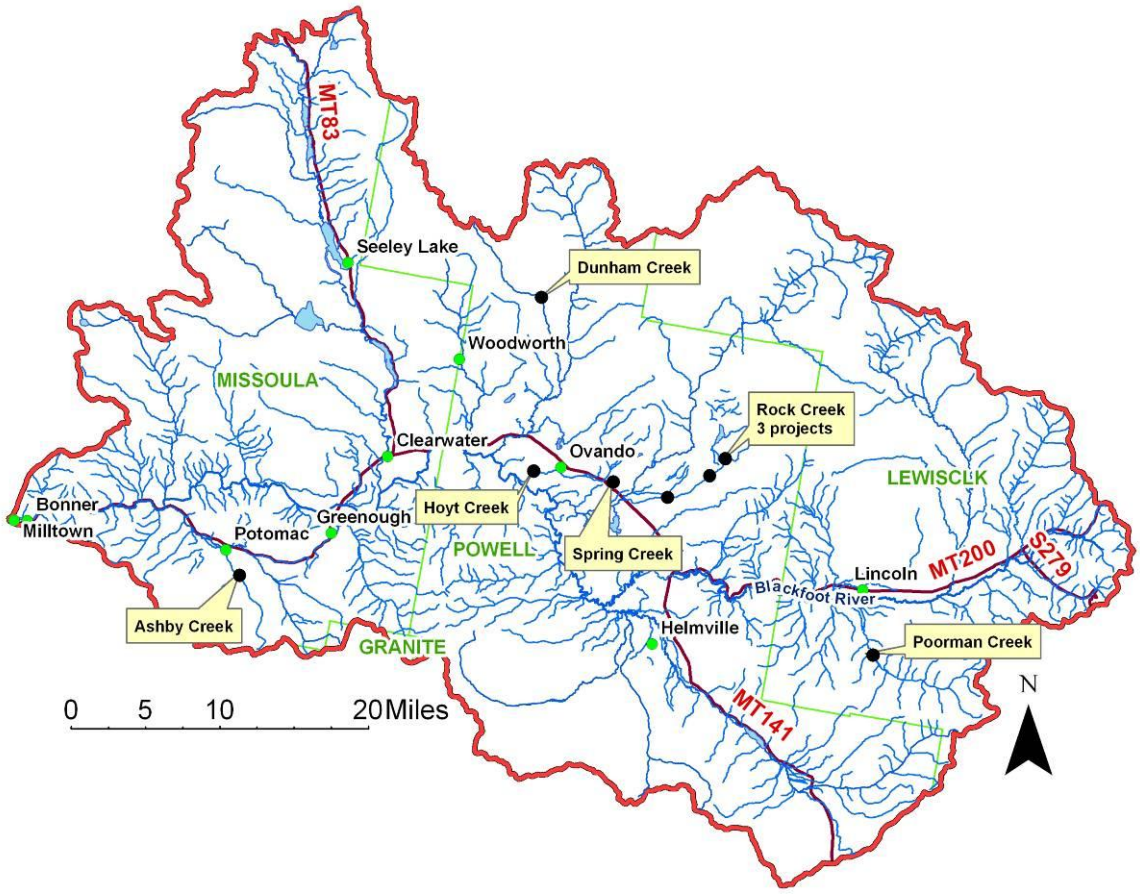
Restoration efforts within the Blackfoot Watershed have largely been led by landowners, as well as by agencies and non-profits such as BBCTU, FWP, FWS, and BC (see Appendix A for glossary of acronyms and abbreviations). Additional assistance has been provided from NRCS, NPCD, TNC, and FVLT. All have played key roles in enhancing and restoring aquatic and riparian habitats within the watershed; some emphasizing monitoring and prioritization, some in project design and management, some in providing funding, and some in land conservation.

In 1989 the Partners for Fish and Wildlife, a FWS program, entered a cooperative agreement with local partners to begin restoration of the Blackfoot Watershed's fisheries. A two year inventory and status of the fisheries within the watershed was conducted. From 1990-2001, additional inventories were completed, largely by FWP, for a total of 88 tributaries to the Blackfoot River. These inventories identified serious habitat degradation impacts in 83 of the 88 Blackfoot River tributaries.

Using these inventories and the prioritization that resulted from them, the partners began to pursue efforts to restore, revegetate and quantify TMDL water quality levels for tributaries important to the survival and enhancement of BT and WSCT populations within the Blackfoot River Watershed. Over the past 20+ years, many landowners partnered with the many stakeholders detailed above, to accomplish numerous stream channel restoration and streambank revegetation projects for the purposes of fisheries recovery and enhancement.

A large push was made within the last five years, under the NRCS "Expedited EQIP" funding program, to accomplish a large number of high priority riparian restoration projects. During this time, increased focus and effort was made towards improving reestablishment of native riparian woody vegetation, largely through the planting of various sized seedlings. Other techniques utilized were native grass seeding, installation of large willow cuttings, streambank bioengineering, and enhanced seedling survival tools such as mulch rings and large plant protectors. It is felt that an assessment of the revegetation components of several of these restoration projects will inform the design and installation of future revegetation efforts in the watershed and beyond.

This document takes a comprehensive look at some of these restoration efforts, and specifically focuses on success rates of the revegetation component of each project. Under this assessment, eight projects completed from 2005 to 2008 were selected for evaluation (Map 1).



Map 1: Blackfoot Watershed Revegetation Assessment Location Map

3. Monitoring and Evaluation Methods

GR conducted monitoring surveys on each of the highlighted projects during the 2009 field season. We collected specific data on percent survival by species as well as gathered general data on site conditions per project. GR visited each project site during a four week period between 7/8/2009 and 8/5/2009. Readers will find the following elements described in detail within each project description and summary:

1. **Percent Survival by Species:** The most significant data we collected was percent survival by seedling species for each project. On most projects we were able to achieve a 100% sample size. This is no small task, as many of these projects are spread out, sizeable, and had been installed in years past. Our ability to achieve complete inventories was enhanced by our involvement in nearly all project installations assessed here. There were only a few situations where a complete sample was not practical, and these are clearly noted in the survival tables. In addition to percent survival data, we also recorded observations on plant vigor and growth. Because there are so many variables within the scope of this monitoring effort, we cannot analyze our survival findings with statistical analysis. Each site had many varying factors; we believe that comparing them with statistical parameters would be unsound.
2. **Soil texture:** We described general soil textures at planting depth.

3. **Depth to seasonal low water table:** We recorded incidental information on when streams experience high and low flows. We also recorded general soil water observations within planting zones. Much of this was based upon observations taken during the initial planting operations.
4. **Competition Rating:** We tabulated the current competition of weeds or non-planted species within the planting area. Weed invasion within mulched areas or weed mats was observed and recorded using a scale of 1 to 6; with 6 representing extreme competition, and 1 representing negligible competition.
5. **Weed Conditions:** We observed weed densities and list weed species; making general recommendations for weed suppression needs.
6. **Photopoints with GPS coordinates:** Photopoints were established at upstream and downstream ends of each project. Additional photopoints and general site photos were included as needed.
7. **Seeded Species and Average plants per Square Foot:** For a few projects where seeding was conducted, we surveyed sample plots to determine the average plants per square foot within seeded (not planted) areas of each project.
8. **Browse Conditions:** We observed and recorded evidence of browse and severity. Observations were made regarding effectiveness of browse treatments.
9. **Fencing:** We observed and recorded any riparian exclosure fences and their effectiveness.
10. **General Stream Condition:** We observed and described current stream conditions related to reconstruction efforts. Incised channels, flooding, eroding banks, and channel widening were noted.
11. **General Revegetation Techniques:** We made observations on the following aspects of each project:
    a. ***Cutting Installation:*** We discuss the type, species, and installation methods used for cuttings, where applicable.
    b. ***Plant Spacing:*** We discuss the actual spacing conditions between plants and plant groups.
    c. ***Planting:*** We discuss the method used to install plants, based upon their container size.
    d. ***Mulching:*** If mulch materials were used we discussed efficacy and current conditions.
    e. ***Plant Browse Protection:*** Where plant protectors were installed, we observed their condition and effectiveness.
12. **Maintenance Plan and Log:** We report on the existence or lack of seedling and site maintenance plans, and record how often maintenance has occurred.
13. **Project Discussion:** The results of each project are summarized and discussed based upon the findings from the data collection, site monitoring, and evaluation of results.
14. **Project Recommendations:** Recommendations are made for each project based upon the findings from the data collection, site monitoring, evaluation of results, and discussion.

4. Project Information and Monitoring Results

The projects evaluated in this report are arranged alphabetically in this section by stream name as follows:

4.1 Ashby Creek
4.2 Dunham Creek
4.3 Hoyt Creek
4.4.1 Upper Jacobsen Spring Creek
4.4.2 Lower Jacobsen Spring Creek (reviewed, but not monitored)
4.5 Poorman Creek
4.6 Lower Rock Creek
4.7 Middle Rock Creek
4.8.1 Upper Rock Creek, Reaches 1 and 2
4.8.2 Upper Rock Creek, Reaches 3 and 4

For each project, the project leader and partners are listed, as well as contractors involved in the design, installation, and maintenance tasks. The project's general location, start date, revegetation date, and a brief project description are detailed. Planting conditions at the time of revegetation are given, as conveyed by people involved in the installation, as well as the various revegetation techniques utilized, such as the use of browse protection or fertilizer.

Following this, the project's revegetation maintenance plan is detailed, as well as a log of how (or how well) the maintenance plan has been followed.

4.1 Ashby Creek

Project Lead: BBCTU
Partners: FVLT, NPCD, BC, FWS, FWP, CF, NRCS
Contractors: RDG, GEC, TNT, WRG, VWCS, GR, Volunteers
Location: Private ranch in the Potomac Valley, South of Highway 200. Ashby Creek is a tributary to Union Creek, which flows into the Blackfoot River near FWP's Johnsrud Fishing Access Site.

Project Start: Summer 2006
Revegetation Date: October 2006

Project Description: In order to optimize farmable ground, Ashby Creek at the project site had been historically moved and channelized into a ditch along the southeastern edge of its floodplain. The project goal was to improve aquatic and riparian conditions for pure strain WSCT fisheries enhancement. RDG developed the channel design, and GEC designed the revegetation. Reconstruction began in 2006 to return the stream to its original location; approximately 15,600 feet of stream channel were reconstructed. Bioengineering elements were incorporated into the channel design, and a fish-friendly headgate was installed. Revegetation efforts were conducted in the fall following channel work.

Planting Conditions: Site conditions were favorable at planting time as the soil was easily workable by crews. Some water-logged soils occurred towards the end of the project.
Revegetation Techniques: Plant materials utilized for the project were either locally-collected, or custom-grown by VWCS. Plant materials are detailed in Table 1. Cuttings were installed in vegetated soil lifts and bank wraps by WRG and GEC in August 2006. BBCTU enlisted a crew of volunteer high school students to do the initial seedling planting, mulch mat installation, and browse protector installation of the first 550 of 1,965 seedlings. BBCTU then hired VWCS and GR to finish the revegetation installation.

- ***Spacing:*** Containerized plants were installed into augured holes at 6' spacing in two rows along four stream reaches.
- ***Planting*:** Planting holes were augered using a standard auger; no planting scalp was created. Planted by professional and volunteer crews. All plants were watered in after planting.
- ***Mulching:*** Crews installed plastic weed barrier squares (RTI 2'x2' "Arbortec" squares) after planting, using 9 landscape staples per plant.
- ***Browse Protection:*** Crews protected plants with 2' wide by 4' tall pieces of black polyethylene mesh rounded into an 8 inch diameter cylinder. Each plant was staked with 2 pieces of rebar, and browse protectors were attached to the rebar using 3 zipties. Note that the rebar stakes were cut too short for the mesh and in the very soft, deep soil, the stakes were neither tall enough nor stable enough to securely hold the plant protectors upright. As a result, elk and deer were able to easily push the cages over and browse or trample the plants during fall and winter of 2006.

Table 1: Ashby Creek Revegetation Species List

Common Name	Latin	Size	Supplier	Source	Totals (1,965)
aspen	*Populus tremuloides*	T1	VWCS	unknown	50
Bebb willow	*Salix bebbiana*	T1	VWCS	unknown	150
bog birch	*Betula glandulosa*	T1	VWCS	Swan Valley, MT	50
Booth willow	*Salix boothii*	T1	VWCS	Warm Springs, 6000'	75
chokecherry	*Prunus virginiana*	T1	VWCS	Clark Fork River, 3800'	165
Drummond willow	*Salix drummondiana*	T1	DNRC	Blackfoot	250
Geyer willow	*Salix geyeriana*	T1	VWCS	unknown	150
gray alder	*Alnus incana*	T1	VWCS	Clark Fork River, Missoula	75
hawthorn	*Crataegus douglasii*	T1	VWCS	W MT	100
redosier dogwood	*Cornus sericeus*	T1	DNRC	Blackfoot	500
sandbar willow	*Salix exigua*	T1	VWCS	Clark Fork River, 3500'	200
water birch	*Betula occidentalis*	T1	VWCS	Swan Valley, MT	50
willow mix	*Salix spp*	30" cuttings	GR	Blackfoot	2,000
willow mix	*Salix spp*	whips	GR	Blackfoot	6,000
wood rose	*Rosa woodsii*	T1	VWCS	Clark Fork River, 3800'	75
yellow willow	*Salix lutea*	T1	VWCS	unknown	75

- ***Seeding:*** In October 2006, a seed mix was broadcast by hand to disturbed areas and soil lifts (Table 2). Planting zones were not seeded, as to avoid competition with the targeted revegetation seedlings. The seeding rate is unknown.

Table 2: Ashby Creek Seed Mix. Seeding rate, supplier and seed lot unknown.

Common name	Latin Name
bluejoint reed grass	*Calamagrostis canadensis*
common yarrow	*Achillea millefolium*
fireweed	*Epilobium angustifolium*
slender wheatgrass	*Elymus trachycaulus*
streambank wheatgrass	*Agropyron riparium*

Maintenance Plan: In their initial revegetation design, GEC recommended spot spraying and weed management, regular maintenance of browse protectors and mulch mats, and bi-monthly watering during July, August and September.

Maintenance Log: On behalf of the landowner, FVLT and BBCTU assumed joint responsibility for maintenance for the first two growing seasons (2007-2008). The following maintenance has been conducted, largely through volunteer maintenance events:

- ***Spring 2007:*** Plant protectors were repaired or replaced, and short rebar stakes were replaced with 4' wooden stakes. These stakes were tall enough to support the nets. Mulch mats were adjusted and re-stapled as needed.
- ***Summer 2007:*** Volunteers hand watered plants in July and August. The crew was unable to provide enough water to plants in the lowest ¼ mile of the project because of stream dewatering

for irrigation purposes. No weeding was conducted. No maintenance was conducted on the upper reach, above the upper culvert.

- ***Summer 2008:*** Plant protectors were repaired downstream of upper culvert; mulch mats were maintained, and plants were hand watered once.
- ***Summer 2009:*** In July, plant protectors were repaired and/or enlarged downstream of upper culvert by volunteers. Plants were hand watered.

Monitoring Results: Results of the site data survey and seedling survival monitoring are displayed below. Photopoint pictures, which are georeferenced in the general site data table, are also included.

Table 3: Ashby Creek General Site Data

Ashby Creek	**Monitoring Date: 7/9/09**
Soil texture	Loamy with clay pockets, few cobble lenses. High organics content, with possible anaerobic conditions.
Depth to seasonal low water table	Deep; seedlings are having difficulty accessing ground water.
Competition rating (scale 1-6; 6= extreme)	5: Very high competition even in cultivated areas right along streambanks where herbicide is being used.
Weed conditions	Thistle, pasture grasses above upper culvert. Below upper culvert: annuals such as fanweed, thistle, cheatgrass. Some reed canarygrass.
GPS coordinates	
Photopoint 1: upstream end	46°50'36.6" N 113°35'34.3" W
Photopoints 2 & 3: at middle culvert	46°51'01.1" N 113°35'07.2" W
Photopoint 4: downstream end	46°51'36.4" N 113°34'26.5" W
Seeded areas, avg seedlings/sq foot	21.5
Browsing	Heavy browse on plants growing beyond nets. Many nets damaged by wildlife (elk).
Mulch	2'x2' Plastic mats. Somewhat effective, yet many not properly installed.
Plant protection	8"x4' rigid plastic nets. Effective when installed correctly; however narrow diameter is confining growth of many plants.
Grazing/fence	Area not grazed by stock. Landowner farming right up to riparian edge.
Stream condition	New construction, still establishing banks, channel incised in places.

Table 4: Ashby Creek Percent Survival by Species (after 2 ½ growing seasons)

Ashby Creek				
Common name	**Latin Name**	**Live**	**Planted**	**Survival**
aspen	*Populus tremuloides*	9	50	18.0%
Bebb willow	*Salix bebbiana*	24	150	16.0%
birch (bog or river)	*Betula spp*	39	100	39.0%
Booth willow	*Salix boothii*	51	75	68.0%
chokecherry	*Prunus virginiana*	25	165	15.2%
Drummond willow	*Salix drummondiana*	130	250	52.0%
Geyer willow	*Salix geyeriana*	51	150	34.0%
gray alder	*Alnus incana*	8	75	10.7%
hawthorn	*Crataegus douglasii*	71	100	71.0%
redosier dogwood	*Cornus sericeus*	67	500	13.4%
sandbar willow	*Salix exigua*	79	200	39.5%
wood rose	*Rosa woodsii*	44	75	58.7%
yellow willow	*Salix lutea*	34	75	45.3%
total		**632**	**1965**	**32.2%**

Photo 1: Ashby Creek Photopoint 1 at the upstream end of Reach 1, looking downstream towards the Potomac Valley. Note 4 foot tall plant protectors, and vigorous growth of a number of seedlings.

Photo 2: Ashby Creek Photopoint 2 at the downstream end of Reach 1, looking upstream from the upper culvert crossing on Ashby Creek. No planted seedlings are visible in this photo.

Photo 3: Ashby Photopoint 3 at the upstream end of Reach 2, looking downstream from the upper culvert crossing on Ashby Creek. Note the herbaceous cover of annual weeds and tame pasture grasses in the riparian area, and the adjacent farmed area. Seedling planting groups are in the distance.

Photo 4: Ashby Photopoint 4 at the downstream end of Reach 2, looking upstream from the end of the project. The lower end of the project is subirrigated, as evidenced by the tall stand of Garrison creeping foxtail that appears to be crowding out the seedlings in their black protectors.

Ashby Creek Discussion:

The overall seedling survival for this project is 32.2%. Douglas hawthorn, Booth willow and wood rose are the top three survivors in the planting mix. Gray alder, redosier dogwood and chokecherry plants had the highest mortality rates.

Several project shortcomings became apparent during installation and maintenance (the authors were involved in both of these efforts), as well as during monitoring and evaluation. Many plants were installed with rootballs protruding from plant holes, causing root desiccation, damage and eventual mortality. Some planting locations that were staked during the layout phase, and therefore installed, ended up too far away from streambanks; here plants had difficulty accessing groundwater. The post-project herbaceous plant community in some sections indicates soil and stream water levels are lower than anticipated, in particular at locations where the newly-constructed channel has incised (Photo 5).

Photo 5: Incised section on newly-constructed channel. The planting group at this location has all died, and the protectors and mulch mats were removed by maintenance crews. Note vegetation community dominated by upland pasture grasses and annual weeds.

The use of the T1 containers, with their 14 inch deep roots, certainly gave the seedlings a head start towards accessing this deeper ground water. Had the project design specified shallower-rooted containerized plants, mortality rates would most likely be higher. Use of more site-adapted seedlings, i.e. plants grown from seed collected locally, would likely have increased survival rates.

Soil fertility probably helped aid survival and promote plant growth. However, the landowner's agricultural practices appear to foster highly competitive annual and perennial weeds. Herbicide overspray may be affecting seedling growth and survival.

The lack of scalping prior to planting and mulch mat installation led to increased failure of the mats, as well as increased water being shed away from the seedlings due to "mounding". The plastic-type RTI "Arbortec" mulch mats utilized are designed to be installed over scalped planting sites, i.e. all competing vegetation and sod removed. If they are not, perennial grasses tend to grow up through the mats, compromising their efficacy. It is also preferable to install mats in a basin or slight depression, allowing water to run towards the seedlings. Furthermore, mats improperly installed (not fully stretched out or staked securely) led to increased mortality rates on some plants. Improperly installed mats were ineffective at blocking weed competition: mats buckled up and allowed weeds and rhizomatous grasses to grow under the mulch, thus choking out the installed shrub. Grass rhizomes growing directly next to shrub stems appeared to increased vole use and subsequent vole damage to seedling stems by girdling. Scarce water may have been used up by the competing weeds and grass as well.

Improperly installed plant protectors caused increased browse impacts, trampling, stem collapse, and eventual mortality for many plants. The rebar stakes initially installed were ordered too short, and when installed into the soft, deep topsoil at this site, were neither tall enough nor stable enough to securely hold the protectors upright. This problem should have been corrected prior to installation of all of the protectors. As a result of the short stakes, elk and deer were able to easily push the cages over and browse or trample the plants during fall and winter 2006. In addition to the short stakes, many poorly installed protectors came undone and allowed browsing of the entire top growth on some plants. This problem was corrected the spring following installation, and since then at volunteer maintenance events led by FVLT and BBCTU.

Two land management practices are impacting the success of this revegetation project. Herbicide application on adjacent cropland is overspraying onto stream bank seedlings. This overspray damage appears to be affecting the establishment of a desirable herbaceous community in the riparian area, as evidenced by leaf damage during monitoring. This has been discussed with the landowner by FVLT staff. In some locations along the new channel agricultural cropping is occurring within 10 feet of the stream banks; this is an insufficient buffer for filtering agricultural contaminants from the stream and causes disruptions to the soil web and soil hydrology of the restoration project.

Despite the relatively low survival rates, it is important to recognize that many of the surviving plants are over 4 feet tall and very vigorous (Photo 1). Many plants, particularly those in the upper and lower ends of the project, put on incredible growth after just three growing seasons. These plants are well on their way towards becoming large enough to survive wildlife browsing pressure, to begin to shade the creek, and to provide habitat for insects and other species important to a functioning riparian zone. Most importantly, these plants are developing large root systems which will aid bank stabilization and erosion protection.

Ashby Creek Recommendations:
Many of the difficulties experienced on the Ashby Creek revegetation effort, such as improperly planted seedlings and installed products, could have been averted through the use of experienced restoration or tree planting crews. Some tasks are better performed by experienced crews, in particular when larger and more expensive and difficult to install plants and products are used. Project maintenance is a key component of any revegetation effort; survivability would likely have benefitted from more frequent watering and protector maintenance.

Scarce water and browsing pressure appear to be the largest challenges to woody plant establishment at the Ashby Creek site. However, after numerous visits to the site since project installation, it is clear that some sections of the channel are revegetating with woody natives on their own accord (Photo 6). Had the revegetation effort been delayed several years until the site hydrology became clearer, as evidenced through herbaceous vegetation patterns, fewer plants would have been lost to xeric conditions. Perhaps fewer seedlings would have been needed once it was clear that some streambanks were capable of revegetating themselves passively. Lastly, if a lower "bank-full bench" had been more widely incorporated into the channel design, natural revegetation might have occurred more consistently.

Photo 6: Passive regeneration of woody plants along Ashby Creek. Volunteer aspen, willow species, and alder seedlings were observed in large numbers on some banks. As there is ample seed source upstream, it appears Ashby Creek is capable of natural revegetation given time and ideal conditions.

We recommend an additional 2 years of seedling maintenance on Ashby Creek, ending in September 2011. Watering should continue at a minimum twice per late summer (July 15 through September 1). Perhaps this can be achieved by the landowner, through the extension of the existing wheel-line irrigation system on site already. Plant protectors need to be maintained so they do not damage the seedlings. Browse repellents should be applied to the tops to seedlings where they protrude from the protectors. The thin plastic mulch mats will likely be degraded by this time, but weeding around the seedlings will be beneficial. All remaining plant protectors and mulch mats should be removed by September 2011.

4.2 Dunham Creek

Project Lead: BBCTU
Partners: USFS, FWS, FWP, CF
Contractors: RDG, GEC, TNT, GR
Location: Lolo National Forest land north of Ovando. Dunham Creek is tributary to Monture Creek in the middle Blackfoot. Monture Creek is a major tributary to the Blackfoot River, which enters the river at mile 44.2.

Project Start: Fall 2008
Revegetation Date: October 2008

Project Description: Historical impacts to Dunham Creek's fishery were the result of improper timber harvest practices in the riparian area and stream channelization. Initial instream habitat work and streambank reconstruction was done in 2000, when 1.3 miles of stream channel reconstruction was completed. Partners determined that the creek was no longer able to access its floodplain in most years, and initial revegetation efforts were not performing as expected. As a result, new streambank and channel structures were designed and added in 2008; this effort included passive and active revegetation design features.

Planting Conditions: Site conditions were favorable, with adequate soil moisture during installation. Soils were mostly heavy cobble but workable, especially with mechanized assistance.
Bioengineering Structures: The following bioengineering structures used on the Dunham project are described in detail below.

- ***Soil lifts:*** Benches are excavated, dormant willow cuttings are placed on top of the bench. Soil is wrapped within two layers of biodegradable coconut fiber coir fabric to hold the soil in pace while vegetation becomes established in the relatively high stress land/water interface. Soil lifts will result in near bank areas where native woody vegetation can become established. The face of each soil lift is reinforced with a low density coir log to help maintain the lift shape, keep fine soil particles from filtering out through the lift face, and to maintain surface tension and retain moisture later into the growing season. A second layer of dormant willow cuttings is placed on top of the soil lift before a final layer of soil is placed on top. Finally, the soil lift is seeded.
- ***Coir fascines***: Dormant willow cuttings are laid horizontally onto excavated benches. Next, durable coir logs are set on top of cuttings and staked into place using earth anchors and cables. The coir log fascine is backfilled, and a row of larger dormant cuttings is installed vertically behind the log. A second coir log is installed just behind the first. Finally, the entire structure is backfilled and compacted. The structure is then seeded with the appropriate seed mix.
- ***Brush trenches:*** This floodplain feature is simply a trench dug so that the bottom of the trench is at or below the bankfull elevation. A coir log placed in the bottom of the trench, and willow cuttings or containerized plants are placed upright into the trench before it is backfilled.
- ***Swales:*** Floodplain swales are multileveled depressions excavated into the floodplain perpendicular to the stream channel. The swales are generally ten to twenty five feet long, and three to four feet deep. Containerized plants are installed into the various levels of the swale. Swales were not seeded.

- ***Debris:*** Woody forest debris from nearby sources is scattered across the site on top of soil lifts and swales, and around all other features. This provides soil nutrients, captured wind-blown and water-borne seeds, soil, and debris, and creates physical barriers to browsing wildlife.

Additional Revegetation Techniques:

- ***Willow cuttings:*** 4,000 willow cuttings (stakes and whips) were collected by Big Sky High School Volunteers, BBCTU and GR in October 2008. Willows were collected at the Blackfoot-Clearwater Game Range along Cottonwood Creek. These cuttings were stored on site in water or in deep shade until installation.
- ***Willow cuttings*** were installed in 3 different applications:
  1. Crews layered dormant willow cuttings horizontally in streambank coconut-fiber soil lifts.
  2. Willow cuttings were installed upright in brush trenches built on floodplain benches.
  3. Willow stakes were installed vertically behind double coir (coconut fiber) log fascines.
- ***Containerized plants*** (Table 5) were installed in several "planting pods" throughout the project. Plants were grouped in (a) floodplain trenches with buried coir logs, (b) in machine excavated swales and (c) along the streambank soil lifts. 300 containerized plants and soil lifts were installed by GEC with assistance from GR as well as TNT's heavy equipment.

Table 5: Dunham Creek Revegetation Species list

Common Name	Latin Name	Size	Supplier	Source	Total: 300
black cottonwood	*Populus trichocarpa*	T1	BNP	Blackfoot	90
chokecherry	*Prunus virginiana*	T1	VWCS	Clark Fork River 3800' elevation	20
Drummond willow	*Salix drummondiana*	T1	VWCS	unknown	75
golden current	*Ribes aureum*	1 gallon pot	BNP	Blackfoot	15
gray alder	*Alnus incana*	T1	VWCS	Missoula Valley	20
redosier dogwood	*Cornus sericea*	T1	VWCS	unknown	50
serviceberry	*Amelanchier alnifolia*	1 gallon pot	BNP	Blackfoot	15
wood rose	*Rosa woodsii*	1 gallon pot	BNP	Blackfoot	15

- ***Mulch:*** No mulch was applied, but a large amount of locally collected woody debris and forest litter was hand scattered on the site after planting. Micro sites were created with woody material around many of the planting areas.
- ***Browse protection:*** No nets were used on this project. "Treeguard" brand browse repellent was applied to foliage of seedlings and cuttings in spring and fall of 2009 by GR.
- ***Seeding:*** A native seed (Table 6) mix was broadcast on disturbed ground throughout the site. Areas where containerized plants and cuttings were installed were avoided. Seed was applied as the final step following planting.

Table 6: Dunham Creek Seed mix. Seeding rate, supplier and seed lot unknown.

Common name	Latin Name
Annual ryegrass 'Gulf'	*Lolium perenne spp. multiflorum*
Baltic rush	*Juncus balticus*
Common yarrow	*Achillea millefolium*
Dagger leaf rush	*Juncus ensifolius*
fireweed	*Epilobium angustifolium*
Mountain brome 'Garnet'	*Bromus marginatus*
Sawbeak sedge	*Carex stipata*
Slender wheatgrass	*Elymus trachycaulus*
Tufted hairgrass 'Nortran'	*Deschampsia caespitosa*

Maintenance Plan: The USFS is responsible for maintenance of this project. BBCTU contracted with GR to perform routine maintenance in 2009.
Maintenance Log: "Treeguard" brand browse repellent was applied to all containerized seedlings and willow cuttings in August and again in November 2009. All plants and willow cuttings were hand watered twice, in August and September 2009.

Monitoring Results: Results of the site data survey and seedling survival monitoring are displayed below. Photopoint pictures, which are georeferenced in the general site data table, are also included.

Table 7: Dunham Creek General Site Data

Dunham Creek	**Monitoring Date: 7/24/09**
Soil texture	Cobble, heavy cobble, gravel.
Depth to seasonal low water table	Unknown and variable as stream is intermittent. Likely below rooting depth.
Competition rating (scale 1-6)	1: Very low. Cobble with little or no soil, seeding may come in with time.
Weed conditions	Some weeds: spotted knapweed, tansy, oxeye daisy, some tame Pasture grasses.
GPS coordinates	
Photopoint 1: upstream end	47°09'22.2" N 113°11'19.1" W
Photopoint 2: downstream end	47°09'00.6" N 113°11'04.2" W
Seeded areas, avg seedlings/sq foot	18.8
Browsing	None observed
Mulch	None except some slash
Plant protection	None
Grazing/fence	None
Stream condition	Intermittent, stream maintained water until early September.

Table 8: Dunham Creek Percent Survival by Species (after ½ growing seasons)

Dunham Creek				
Common Name	**Latin Name**	**Live**	**Planted**	**Survival**
black cottonwood	*Populus trichocarpa*	75	90	83.3%
chokecherry	*Prunus virginiana*	17	20	85.0%
Drummond willow	*Salix drummondiana*	75	75	100.0%
golden currant	*Ribes aureum*	11	15	73.3%
gray alder	*Alnus incana*	20	20	100.0%
redosier dogwood	*Cornus sericeus*	50	50	100.0%
serviceberry	*Amelanchier alnifolia*	11	15	73.3%
wood rose	*Rosa woodsii*	15	15	100.0%
total		274	300	**91.3%**

Photo 7: Dunham Creek Photopoint 1 at the upstream end of the project, looking downstream. The bank treatment here is a coconut-fiber soil lift, layered with willow whips above and below the wrap. A planting pod is installed in the floodplain to the left.

Photo 8: Dunham Creek Photopoint 2 at the downstream end of the project, looking upstream. The stream is to the left. A planting basin is installed in the floodplain to the right; behind this is a willow cutting trench. Both features had woody debris scattered over them after planting.

Dunham Creek Discussion:

The overall survival percentage on this project is currently at 91.3%. However, recognize that this is the most recently installed project evaluated for this report, with less than one full growing season under its belt. Typically, seedling mortality levels off after the second or third growing seasons.

As weed competition on this site is very slight and surface soil water availability is low, the need for weed suppression measures on this project is minimal. The USFS is conducting weed suppression efforts in the project area. Browse pressure appears to be minimal as well. These site conditions help seedlings survive without additional protective measures, such as browse protectors and weed suppressing mulches.

Photo 9: Typical "cutting trench", installed with an excavator and hand crews. A coir log is buried at the toe of the cuttings to aid in water retention at the rooting zone. Note woody debris placed on floodplain; the addition of more debris would further speed vegetation establishment.

The regular maintenance efforts may well be paying off on this project. Hand watering the seedlings, brush trenches and soil lifts helps plants recover from transplant shock and gives seedlings and cuttings sufficient moisture to grow rapidly during the short growing season at this cold mountain site.

At this early juncture, the relatively passive, low-cost revegetation methods employed on this project appear to be effective. Scattering large and small woody debris on the floodplain helps shade seedlings, reducing soil moisture loss. The debris also aids decomposition and nutrient cycling, soil formation, provides physical browse barriers for the seedlings, and helps create microsites to trap wind and water-borne propagules for enhanced vegetation establishment.

Photo 10: Typical double coir fascine bank treatment, installed with an excavator and hand crews. Willow cuttings are buried under and between the fascines; seedlings and cuttings are also buried behind the fascines.

Dunham Creek Recommendations:
Additional woody debris could have been utilized on this site. Plenty of woody debris was available; the crew just ran out of time. Volunteers could be used to apply more debris, or routine maintenance could include additional debris application. We recommend hand watering and applying browse control spray to seedlings through summer 2011. The "low-tech, low-cost" techniques used at Dunham Creek should be more widely applied to revegetation efforts, likely resulting in reduced expenses and increased revegetation success. A second survival monitoring in 2010 or 2011 will help inform these future efforts.

4.3 Hoyt Creek

Project Lead: BBCTU
Partners: NRCS, NPCD, BC, FWS, CF, DEQ
Contractors: RDG, TNT, GR, VWCS, Volunteers
Location: Private ranch in the middle Blackfoot, south of Highway 200 and immediately west of Ovando. Hoyt Creek is a tributary to Dick Creek, which flows into Monture Creek.

Project Start: Fall 2006
Revegetation: June 2008

Project Description: Hoyt Creek had been historically ditched, and adjacent wetlands drained. In the fall of 2006, approximately 12,400 feet of stream channel was reconstructed to represent an E-type sinuous channel and to restore the creek to its historic flood plain. Off site stock water and seasonal riparian fencing exclosures were installed to reduce grazing impacts.

Planting Conditions: Planting was difficult due to heavy clay soils, some waterlogged planting holes, and heavy wetland graminoid sod. It was difficult to seat the plants correctly and remove all air pockets, especially for inexperienced volunteers.
Revegetation Techniques:

- ***Planting:*** A total of 411 native shrubs were installed (Table 10). All plants were supplied by VWCS in the T1 container size. Seed sources were all from western MT, and are the same as those on the Ashby and Jacobsen projects. The seedlings were installed by a volunteer crew led by professional planters. Plants were watered in immediately after planting. Note that these plants were leftover from the Ashby and Jacobsen projects and were over-wintered in the landowner's barn. Plants were trimmed, stacked upright and covered with a tarp, and banked with sawdust for insulation. Container soil moisture was monitored throughout the winter. When plants were uncovered in spring, there was significant rodent and over-wintering mortality. Plants were inspected and culls were discarded before planting.
- ***Spacing:*** Plants were placed in 10 groups of about 50 plants each, on outside bends and logical sites along the riparian zone. Plants within groups were spaced approximately 6 feet apart.
- ***Planting Holes:*** Holes were augured with a tracked skidsteer and custom two-stage scalping auger (creating a 9"X18" hole with a 36" scalp).
- ***Mulch:*** Plants were mulched using pole yard wood mulch. Mulch was placed in the machine-augered scalps to 4" deep by 36".
- ***Browse Protection:*** Plants were sprayed with "Treeguard" brand browse repellent after installation. No plant protectors were installed on this site.

Maintenance Plan: Landowner and partners are responsible for project maintenance. No specific maintenance was planned.
Maintenance Log: Treeguard was applied fall 2008 and spring 2009. Due to saturated soils during the growing season, watering has not been necessary.

Monitoring Results: Results of the site data survey and seedling survival monitoring are displayed below. Photopoint pictures, which are georeferenced in the general site data table, are also included.

Table 9: Hoyt Creek General Site Data

Hoyt Creek	**Monitoring Date: 7/8/09**
Soil texture	Very heavy wetland soil with clay lenses
Depth to seasonal low water table	At time of monitoring, water is at soil surface or above (standing water) in all but a few planting sites.
Competition rating (scale 1-6)	5 to 6: Extreme competition from 5-6' tall grasses and wetland vegetation.
Weed conditions	Tame pasture graminoids and yellow flag. Some Canada thistle, Garrison creeping foxtail, reed canarygrass
GPS coordinates	
Photopoint 1: upstream end	47°01'55.9" N 113°09'34.5" W
Photopoint 2: downstream end	47°02'12.3" N 113°10'09.2" W
Browsing	Minimal.
Mulch	Pole yard waste. Mostly very effective except where grass is too tall.
Plant protection	None
Grazing/fence	Riparian area is fenced off seasonally from livestock.
Stream condition	Stream has filled in with vegetation. Overbank flows in some areas.

Table 10: Hoyt Creek Planting Mix and Percent Survival by Species (after 1 ½ growing seasons)

Hoyt Creek				
Common Name	**Latin Name**	**Live**	**Planted**	**Survival**
chokecherry	*Prunus virginiana*	14	42	33.3%
golden currant	*Ribes aureum*	6	17	35.3%
gray alder	*Alnus incana*	1	47	2.1%
hawthorn	*Crataegus douglasii*	20	47	42.6%
river birch	*Betula occidentalis*	7	45	15.6%
willow species	*Salix spp*	71	166	42.8%
wolfberry	*Eleagnus commutata*	4	47	8.5%
total		**123**	**411**	**29.9%**

Photo 11: Hoyt Creek Photopoint 1, at the downstream end of the project looking upstream. Note dense, tall graminoid cover.

Photo 12: Hoyt Creek Photopoint 2, at the upstream end of the project looking downstream. Note dense, tall graminoid cover; there is a shrub planting group on the immediate right.

Hoyt Creek Discussion:

The overall seedling survival on this project was 29.9%. Willows, hawthorn and golden currant were the three species with the highest survival rates. Wolfberry and gray alder had very high mortality rates. Many of these plants may have had weakened vigor due to over wintering damage to top and roots, and the resultant stress, before installation. Prolonged inundation, heavy soils and extreme graminoid competition all impacted survival as well.

Project designers and partners did not anticipate such high and prolonged stream flows after reconstruction. Many planting pods were still underwater (Photo 13) at the time of monitoring in July 2009. If the site hydrology had been studied more thoroughly prior to planting, some flooding losses could have been avoided.

The pole yard wood mulch is effective at suppressing competition (Photo 14), however, a wider scalp and mulch ring would have provided decreased competition, in particular when tall grasses fall over the cover the seedlings, blocking out almost all available sunlight (Photo 15).

Hoyt Creek Recommendations:
Given the extreme competition at this site, and the difficulties with inundation, we feel is it important to first monitor fisheries and water quality responses to the rechannelization. If these goals are met, and water temperatures are sufficiently cool, it would seem unnecessary to embark on additional difficult and likely expensive efforts to add more woody vegetation to Hoyt Creek's riparian area. The tame wet-site pasture grasses are here to stay, and are perhaps providing adequate bank stability and channel shading.

To enhance growth and survival of surviving seedlings, sod scalping and additional mulching could be conducted around the shrubs. The landowner has an active weed management program; continuation of this and control of the yellow-flag iris encountered in the stream should be a priority. Broadcast herbicide applications will impair shrub survival and recruitment.

Photo 13: Flooded planting group in mid-summer. Flag is at middle of the group. A few seedlings are still surviving, but certainly not thriving under these conditions.

Photo 14: Successful pole yard wood mulch ring around Geyer willow seedling, growing in a patch of Kentucky bluegrass. Barring heavy browsing, this shrub will likely become established.

Photo 15: Unsuccessful pole yard wood mulch ring around Drummond willow seedling, growing in a patch of Garrison creeping foxtail. Due to the competition, this shrub's chances of survival are questionable.

4.4.1 Upper Jacobsen Spring Creek (north of Highway 200)

Project Lead: BBCTU
Partners: NRCS, NPCD, FWP, CF, WTF, CBF
Contractors: WW, VWCS, DNRC, TNT, GR, Volunteers
Location: Private ranch in the middle Blackfoot, east of Ovando and north of Highway 200. Jacobsen Spring Creek is a tributary to the North Fork of the Blackfoot.

Project Start: Summer 2007
Revegetation Date: September 2007

Project Description: Several large springs coalesce on this ranch to form Jacobsen Spring Creek; these unique features affect the entire stream ecology. Historic grazing practices lead to a wide, shallow creek which did not support BT and WSCT. Approximately 13,700 feet of stream channel has been reconstructed over the whole of Jacobsen Spring Creek (upper and lower), which is essentially the entire stream. Approximately 11,500 feet were revegetated in some manner. Additional improvements include riparian exclosure fences and off site stock water development. Note that under this assessment, only the revegetation portions north of Highway 200 were evaluated (see discussion below), but some general data is also included below for the portions south (downstream) of Highway 200.

Planting Conditions: Planting conditions on this project were favorable. Soils were workable for planting, only a few holes were water logged, and heavy sod was not an issue.
Revegetation Techniques:

- ***Plants:*** A total of 500 native shrubs were installed (Table 11). VWCS and the DNRC grew the plants, all in the T1 container size. Plants were installed by volunteers led by professional planters.
- ***Spacing:*** Below the culvert crossing near the middle of the project, 303 plants were planted in 2 rows, with 6 foot spacing, in a continuous planting zone in along the northwest bank of the creek. Upstream of the culvert crossing, 197 plants were installed in 8 clusters of about 25 plants each, with 6 foot spacing between individual plants. All plants were watered in immediately after planting.
- ***Planting Holes:*** Holes were augured using a custom scalping auger (forming a 9”X18” planting hole and a 36” sod scalp/water basin).
- ***Mulch:*** Pole yard wood mulch was applied to the circular scalps at a depth of 4” by 36” wide.
- ***Browse Protection:*** Browse repellent was applied immediately after planting. No plant protectors were used.

Maintenance Plan: The landowner and BBCTU are responsible for maintenance duties.
Maintenance Log: Treeguard browse repellent was applied each spring and fall in 2008 and 2009. No watering has been performed; it appears the site stays fairly moist during the growing season.

Table 11: Upper Jacobsen Spring Creek Revegetation Species List

Common Name	Latin Name	Supplier	Seed Source	Total: 500
alder	*Alnus incana*	VWCS	Clark Fork River near Missoula	25
aspen	*Populus tremuloides*	DNRC	Blackfoot	5
Bebb & Geyer willow	*Salix bebbiana, geyeriana*	VWCS	Unknown	65
bog birch	*Betula glandulosa*	VWCS	Swan Valley	50
Booth & Drummond willow	*Salix boothii, drummondiana*	VWCS	Warm Springs elevation 6000’	115
chokecherry	*Prunus virginiana*	VWCS	Clark Fork River elevation 3800’	50
hawthorn	*Crataegus douglasii*	VWCS	western MT	20
golden currant	*Ribes aureum*	VWCS	western MT	10
redosier dogwood	*Cornus sericeus*	DNRC	Blackfoot	30
sandbar willow	*Salix exigua*	VWCS	Clark Fork River elevation 3500’	20
river birch	*Betula occidentalis*	VWCS	Swan Valley	20
wolfberry	*Eleagnus commutata*	VWCS	Blackfoot	20
wood rose	*Rosa woodsii*	VWCS	Clark Fork River elevation 3800’	20
yellow willow	*Salix lutea*	VWCS	unknown	50

Monitoring Results: Results of the site data survey and seedling survival monitoring are displayed below. Photopoint pictures, which are georeferenced in the general site data table, are also included.

Table 12: Upper Jacobsen Spring Creek General Site Data

Upper Jacobsen Spring Creek	**Monitoring Date: 7/7/09**
Soil texture	Gravelly loam.
Depth to seasonal low water table	Saturated soils at surface in all near bank zones. Upwelling groundwater common. Most plants are accessing groundwater.
Competition rating (scale 1-6)	4 to 6: Heavy weed and grass competition. Mulch is not reducing the competition; it appears to be applied too thinly.
Weed conditions	Very weedy: reed canarygrass, Canada thistle, fanweed, knapweed, houndstongue, mullein, oxeye daisy.
GPS coordinates	
Photopoint 1: upstream end	47°00'28.00" N 113°02'32.67" W
Photopoint 2: downstream end	47°00'21.44" N 113°02'46.63" W
Browsing	Heavy browse by livestock (horses) and wildlife (deer).
Mulch	Pole yard waste: not effective due to high competition and poor installation.
Plant protection	None
Grazing/fence	Horses are fenced above culvert, i.e. within riparian area at springheads.
Stream condition	Springs and banks affected by livestock, some siltation. New channel construction is still establishing and stabilizing in upper reach.

Table 13: Upper Jacobsen Spring Creek Survival by Species (after 1 ½ growing seasons)

Jacobsen Spring Creek				
Common Name	**Latin Name**	**Live**	**Planted**	**Survival**
aspen	*Populus tremuloides*	2	5	40.0%
bog birch	*Betula occidentalis*	29	50	58.0%
chokecherry	*Prunus virginiana*	14	50	28.0%
golden currant	*Ribes aureum*	7	10	70.0%
gray alder	*Alnus incana*	15	25	60.0%
hawthorn	*Crataegus douglasii*	11	20	55.0%
redosier dogwood	*Cornus sericeus*	21	30	70.0%
river birch	*Betula occidentalis*	10	20	50.0%
willow species	*Salix spp*	203	250	81.2%
wolfberry	*Eleagnus commutata*	9	20	45.0%
wood rose	*Rosa woodsii*	18	20	90.0%
total		**339**	**500**	**67.8%**

Photo 16: Upper Jacobsen Spring Creek Photopoint 1, upstream end looking downstream. Note fresh disturbance from livestock grazing, browsing and trampling on the banks and springhead, and oxeye daisy weed patches. Numerous seedlings are planted in the photo, but are not apparent due to the livestock impacts. Horses were grazing here during monitoring.

Photo 17: Upper Jacobsen Spring Creek Photopoint 2, downstream end adjacent to Highway 200, looking north and upstream. Note oxeye daisy weeds, and ungrazed, stable banks.

Upper Jacobsen Spring Creek Discussion:
The survival on this project is 67.8%. This is very acceptable, given the fact that (a) an inexperienced volunteer crew planted it, (b) minimal maintenance has occurred, (c) little browse protection has occurred, and (d) livestock are damaging the upstream portions of the project (Photo 17). Willow species, wood rose and redosier dogwood demonstrated the greatest survival rates, while chokecherry, aspen and wolfberry species had the highest mortality.

Monitoring efforts in 2009 identified livestock grazing impacts within the revegetation corridor. Further investigation revealed a miscommunication between the landowner and the land manager as to what was allowable under this management plan. The issue was eventually resolved, the livestock was removed from the riparian zone and the land manager understands the grazing exclosure boundaries. This issue highlights the need for clear understanding between landowners and the partners involved when developing revegetation projects and subsequent maintenance plans.

Continued livestock grazing will result in increased mortality rates of the seedlings and damage to the establishing streambanks (Photos 16 and 18). Moderate to heavy browsing by wildlife, mostly whitetail deer, is also a plant survival issue. In retrospect, browse nets would have been an excellent investment on this project, considering the high browse potential in this location.

Photo 18: Livestock damage near Photopoint 1. Several seedlings (with what is left of their wood chip mulch rings) are barely visible in this picture.

Weed competition is also limiting survival and vigor of the seedlings. The pole yard mulch was not able to effectively block out the aggressive weeds on site; the mulch was not applied as deeply as necessary to stop weed and grass growth. This is a function of using volunteer crews, who generally resist hauling large quantities of mulch. 4-6" of mulch was the target depth specified to preclude plant competition for 2 to 3 years; mulch rings here averaged only 2".

Upper Jacobsen Spring Creek Recommendations:
To improve establishment chances for the surviving seedlings, stabilize the streambanks, improve water quality, and generally achieve project goals, the following actions should be taken in 2010 and beyond:

- Enforce the livestock exclusion requirements placed upon the landowner;
- Add additional wood chips around surviving seedlings to reduce competition, minimum 4"x36";
- Add woody debris to the floodplain, to help naturalize the site and encourage vegetation establishment while discouraging browsing.
- Add 12" x48" rigid plastic browse protectors. These may be reused from other area projects.
- Begin a noxious weed control program, with particular care given to minimizing non-target overspray.

Based upon conditions observed at the site, we feel maintenance watering is unnecessary at this time. This project should be excluded from all livestock grazing for a minimum of 10 more years.

4.4.2 Lower Jacobsen Spring Creek (south of Highway 200)

Project Lead: BBCTU
Partners: NRCS, FWS, NPCD
Contractors: WW, GEC, VWCS, TNT, GR, Volunteers

Project Start: Summer/Fall 2005
Revegetation: Spring 2006

Project Location and Description: See Upper Jacobsen Spring Creek above; same except south of Highway 200.

Planting Conditions: Planting conditions on this project were favorable. Soils were workable for planting, only a few holes were water logged, and heavy sod was not an issue.
Revegetation Techniques: Significant bank structure and stabilization work was done by WW and TNT. There was excellent natural vegetation already existing along much of the project length. In addition, coarse woody debris, brush, transplants, and salvaged sod was placed throughout the revegetated area to create microsites for plants and to help stabilize and shade the stream.

- ***Plants:*** 975 T1 native shrubs, grown by VWCS, as well as numerous willow cuttings, were installed by VWCS, GR, BBCTU, and volunteers.
- ***Mulching/Browse Protection:*** No mulch or browse protection was installed.
- ***Maintenance:*** The only maintenance conducted has been two applications of browse repellent by GR in summer and fall 2008. Due to the difficulty in finding seedlings, this effort was abandoned.

Lower Jacobsen Discussion and Recommendations:
We determined that monitoring the revegetation aspects of lower Jacobsen Spring Creek, in the same manner that the other 8 projects were monitored, would be difficult if not impossible. The planted seedlings are almost impossible to locate and identify, since there was no mulching or browse protectors installed to "highlight" the seedlings. In visiting the site, we observed many seedlings browsed to the soil surface, and because there is already extensive natural vegetation in place, differentiating between natural and installed seedlings would be very difficult. A different monitoring protocol could be developed to evaluate riparian vegetation recovery, similar to a "greenline transect".

Overall, this project is extremely successful in terms of stream reconstruction and project goals: BT redds have been documented, as well as reduced siltation and water temperatures. Due to the extensive natural and passive revegetation treatments incorporated into the channel design, it is our opinion that the site didn't need a containerized planting component. Significant native vegetation was already in place, and reconstruction efforts were able to work around the pre-existing native riparian vegetation. In addition, the reconstruction effort incorporated woody debris, logs and brush into the floodplain design. Although browse spray was applied to planted seedlings during the first growing season following installation (summer and fall 2008), it was not effective enough to protect them from high wildlife browse pressure. We recommend allowing this site to continue its naturalization process, and given maintenance of the livestock exclosure, anticipate in time the recovery of at least some of the missing woody plant species. There are ample native seed sources for this to occur.

4.5 Poorman Creek

Project Lead: NRCS
Partners: BBCTU, BC
Contractors: unknown
Project Location: Private ranch southeast of Lincoln. Poorman Creek is a tributary to the upper Blackfoot River, meeting the river at mile 108.

Project Start: 2004
Revegetation: October 2004

Project Description: Poorman Creek has suffered numerous degradations, including placer mining in its headwaters, irrigation withdrawals, and riparian grazing management problems, yet it maintains WSCT and BT populations. This project was a traditional EQIP contract, administered and designed by the NRCS.

Revegetation Techniques:

- ***Plants:*** A total of 1,475 bare root and containerized plants were installed by volunteers, using a mechanical tree planter. All seedlings were purchased from the DNRC (Table 14). The species the NRCS specified are not all native to the site (American plum and pacific willow) or site adapted to the Blackfoot.
- ***Mulch:*** Woven black plastic weed mats were installed on all seedlings following planting.
- ***Browse protectors:*** Rigid plastic mesh seedling protectors (approximately 3"X 18") were installed with bamboo support stakes.

Table 14: Poorman Creek Revegetation Species List

Common Name	Latin Name	Seedling Type/ Size	DNRC Seed Source	Total 1,475
American plum	*Prunus americana*	Bareroot	Mitosis	500
aspen	*Populus tremuloides*	10 CI	Saskatchewan	125
black cottonwood	*Populus trichocarpa*	Bareroot	Rock Ck, MT 4,000'	200
Booth willow	*Salix boothii*	Bareroot	Warm Springs, MT 6,000'	50
chokecherry	*Prunus virginiana*	Bareroot	MT	200
Douglas fir	*Pseudotsuga menziesii*	7 CI	Lolo N.F. 4,000'	200
Pacific willow	*Salix lasiandra*	Bareroot	Clark Fork River, MT	50
redosier dogwood	*Cornus sericeus*	Bareroot	N. Idaho	150

Maintenance Plan/Log: None

Monitoring Results: Results of the site data survey and seedling survival monitoring are displayed below. Photopoint pictures, which are georeferenced in the general site data table, are also included.

Table 15: Poorman Creek General Site Data

Poorman Creek	**Monitoring Date: 7/30/09**
Soil texture	Gravel and loam
Depth to seasonal low water table	2'
Competition rating (scale 1-6)	5 to 6. Very tall sub-irrigated pasture grasses; timothy, brome.
Weed conditions	Canada thistle, tame pasture grasses, yellow toadflax.
GPS coordinates	
Photopoint 1: upstream end	46°56'11.1" N 112°40'46.2" W
Photopoint 2: downstream end	46°56'14.0" N 112°40'55.8" W
Browsing	Heavy
Mulch	2'x2' Plastic mulch mats. Effective, but disappearing. If mulch mats were not installed, there would likely be no live plants.
Plant protection	3" x 18" rigid plastic mesh w/ bamboo stakes. Mostly gone.
Fence/grazing	Riparian area is fenced off from livestock.
Stream condition	Thick willows and cottonwoods; plenty of natural shrubs in narrow riparian band along streambanks.

Table 16: Poorman Creek Survival by Species (after 4 ½ growing seasons)

Poorman Creek				
Common Name	**Latin Name**	**Live**	**Planted**	**Survival**
American plum	*Prunus americana*	52	500	10.4%
aspen	*Populus tremuloides*	0	125	0.0%
black cottonwood	*Populus trichocarpa*	1	200	0.5%
chokecherry	*Prunus virginiana*	10	200	5.0%
Douglas fir	*Pseudotsuga menziesii*	4	200	2.0%
redosier dogwood	*Cornus sericeus*	5	150	3.3%
willow species	*Salix spp*	3	100	3.0%
TOTAL		**75**	**1475**	**5.1%**

Photo 19: Poorman Creek Photopoint 1: Downstream end of project looking upstream. Note riparian area dominated by smooth brome, as well as large established willow on streambank.

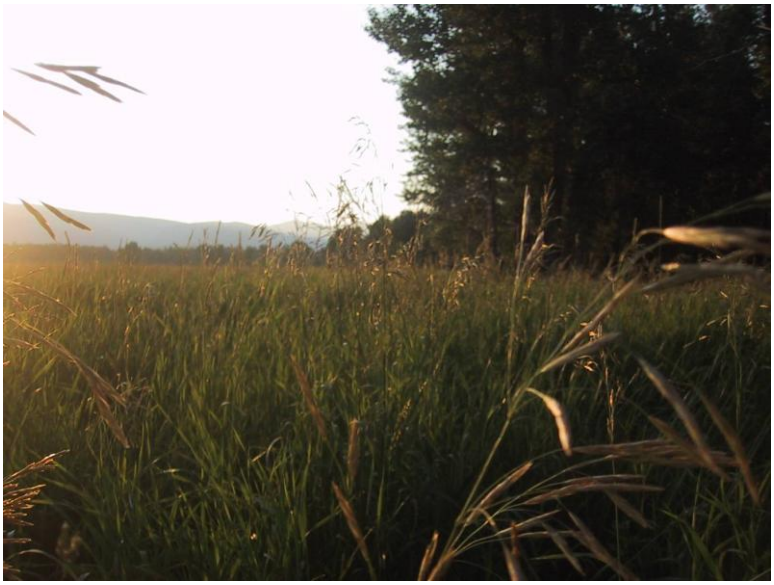


Photo 20: Poorman Photopoint 2: Upstream end of project looking downstream. Note height-challenged photographer buried in smooth brome.

Poorman Creek Discussion:

The native revegetation effort at Poorman Creek is only 5.1% survival of planted seedlings. Ironically, American plum, which is not native to the Blackfoot but is native to a few locations in MT, had the best survival at 10.4%. All other species had very high mortality. The few surviving shrubs (75 out of 1,475) averaged 5 inches tall (Photo 21) after almost 5 growing seasons.

Photo 21: Surviving American plum seedling at Poorman Creek. Note tame pasture grass growing through the woven plastic mat. These mats are very difficult to remove from restoration projects due to grass growth. This seedling will almost certainly die from tame pasture grass competition.

Tame pasture grass competition on this project is extremely high (Photos 19, 20, 21). Four foot tall grasses cover the planting unit, with patches of yellow toadflax and weedy thistles rounding out the mix. Grass has out-competed the seedlings for sunlight, and the rhizomatous roots of the grasses have likely starved the seedlings for moisture and nutrients. The plastic mulch mats are actually quite effective, at least in marking spots where plants had been originally installed. We suspect that little would have survived to this point without the mulch mats.

Browse pressure is extremely high. The remaining nets have deteriorated and are no longer protecting plants. Once again, had nets not been utilized on this site, browse pressure would likely have killed more seedlings sooner.

It should be noted that the streambanks of Poorman Creek support mature, diverse stands of native willows and cottonwoods. It seems unnecessary to have planted non-native species such as American plum and pacific willow where sufficient native streambank vegetation already exists. In addition, the planting unit was spaced quite far back from the stream bank itself (at least 25 feet away from streambanks.) Even if these plantings had been successful, their root systems would have minimal positive impact on bank stability. Nor would the shrub's foliage be close enough to the streambank to help shade and cool the water for optimal fisheries habitat, or provide insect habitat essential for a functioning riparian zone.

This project was designed using a relatively out-of-date revegetation toolbox, specifying large numbers of small, non-adapted (and even non-native) seedlings machine or hand planted through black plastics. This method may work for irrigated shelterbelts around farmsteads, but no so well for riparian restoration projects. The NRCS has since revised its "Riparian Forest Buffer" design components to include techniques and projects utilized on the other 7 projects evaluated here.

Poorman Creek Recommendations:
Successfully enhancing the woody plant community on Poorman Creek through active revegetation would require an effort similar to those undertaken on the Upper Rock Creek project. Passive techniques are unlikely to succeed on this site due to the aggressive grasses. If it is determined that this stream section needs such an effort to meet water quality or fisheries goals, large site-adapted native seedlings should be auger-planted close to stream banks and mulch and browse protection installed. Exclusion of livestock and long-term maintenance would also be necessary.

Barring this degree of effort, the site should be left as is, with riparian grazing protections maintained. The woven plastic mulch mats should be removed; with no maintenance of the surviving seedlings they are merely trash at this point (they are not biodegradable), and will only become more difficult to remove.

4.6 Lower Rock Creek

Project Lead: BBCTU/FWS
Partners: BBCTU, TNC, FWP, CF
Contractors: WW, TNT, NWRER, WRG, GR
Location: Private ranch on Kleinschmidt Flat, east of Ovando and north of Highway 200. Rock Creek is a major tributary to the North Fork of the Blackfoot, entering at river mile 6.2.

Project Start: Spring 2004
Revegetation: May 2005

Project Description: Historic grazing practices created a shallow, over-widened stream, with excessive sedimentation and high temperatures. Much of the length of Rock Creek has been reconstructed over the past 15 years. In order to minimize streambed disturbance, the Lower Rock Creek channel was reconstructed by strategically placing sod mats and wood structures to create a narrow channel. This design minimized streambed disturbance and subsequent streamflow loss to groundwater. Shrubs were planted mechanically following channel reconstruction.

Planting Conditions: Plants and cuttings were installed directly through sod or into scalped areas. Very large rock and cobble was present, as were saturated soils.
Revegetation Techniques: The contractor used an excavator-mounted expandable stinger to mechanically install cuttings and seedlings in the rocky floodplain. Cuttings were installed two per hole. Dogwood and cottonwood cuttings were installed alongside a willow cutting in an attempt to provide some rooting hormone (willows have naturally-occurring rooting hormone in stem tissues, whereas dogwood and cottonwood have little to none). Plants were tamped in and watered after planting.

- ***Spacing:*** Plants were installed in two rows at 3' spacing along outside meander bends.
- ***Mulch:*** No mulch or weed barrier treatments were used on this project.
- ***Plants:*** A total of 3,978 - 100 CI native shrubs. NWRER grew the containerized shrubs in 3"X18" PVC tubes to enable installation with the expandable stinger. Plants were not dormant or hardened off at planting, and had to be aggressively pruned prior to planting to reduce transplant shock. Seed sources are believed to be from the Bitterroot Valley. Plants were installed as follows:
  Upstream reach: 6500 bank feet, 3300 plants
  Downstream reach: 1500 bank feet, 678 plants
- ***Cuttings:*** 2,780 – 36" to 48" cuttings were installed. WRG collected the dormant willow, dogwood and cottonwood cuttings at the Russell Gates Fishing Access Site on the Blackfoot River, and stored them in the stream on-site until planting time.
- ***Browse repellent:*** No browse repellent measures were employed on this project.

Photo 22: Planting the Lower Rock Creek site in May 2005 using PVC-containerized plants and the excavator-mounted expandable stinger.

Table 17: Lower Rock Creek Revegetation Species List

Common Name	Latin Name	Type/Size	Total
black cottonwood	*Populus trichocarpa*	100 CI PVC	540
Drummond willow	*Salix drummondiana*	100 CI PVC	140
Geyer willow	*Salix geyeriana*	100 CI PVC	175
gray alder	*Alnus incana*	100 CI PVC	270
mixed willow	*Salix exigua, geyeriana, bebbiana*	3' and 4' Cuttings (installed 2 per hole)	2,780
redosier dogwood	*Cornus sericeus*	100 CI PVC	1505
sandbar willow	*Salix exigua*	100 CI PVC	500
serviceberry	*Amelanchier alnifolia*	100 CI PVC	770

Maintenance Plan and Log: None

Monitoring Results: Results of the site data survey and seedling survival monitoring are displayed below. Photopoint pictures, which are georeferenced in the general site data table, are also included.

Table 18: Lower Rock Creek General Site Data

Lower Rock Creek	**Monitoring Date: 7/24/09**
Soil texture	Gravel and cobble interspersed with peaty wetland soil.
Depth to seasonal low water table	Water table at soil surface or above.
Competition rating (scale 1-6)	5: Very high, due to wetland graminoid vegetation along banks.
Weed conditions	Minor: Canada thistle, reed canarygrass, mullein. Sulfur cinquefoil, knapweed in adjacent upland areas.
GPS coordinates	
Photopoint 1: upstream end S. Fork	46°59'56.9" N 113°00'25.2" W (at Kleinschmidt Flat Rd)
Photopoints 2, 3 & 4: at S Fk confluence	47°00'02.0" N 113°00'55.5" W (views up S Fork, up mainstem, down mainstem)
Photopoint 5: downstream end of mainstem	46°59'58.5 N 113°01'02.6" W (on Krutar fence line, looking up)
Photopoint 6: upstream end of mainstem	47°00'14.2" N 113°00'25.6" W (at Kleinschmidt Flat Rd)
Browsing	Little to none, most plants have died back from (likely) non-adaptation and are only 4" average height after 4 growing seasons.
Mulch	None
Plant protection	None
Grazing/fence	Riparian area is fenced off seasonally from livestock grazing.
Stream condition	Widening of the channel on downstream property. Some plants are being flooded by stream during growing season.

Table 19: Lower Rock Creek Survival by Species (after 4 ½ growing seasons)

Lower Rock Creek				
Common Name	**Latin Name**	**Live**	**Planted**	**Survival**
black cottonwood	*Populus trichocarpa*	50	540	9.3%
gray alder	*Alnus incana*	37	270	13.7%
redosier dogwood	*Cornus sericeus*	412	1505	27.4%
serviceberry	*Amelanchier alnifolia*	154	770	20.0%
willow species	*Salix spp*	163	815	20.0%
total		**816**	**3900**	**20.9%**
salix cuttings*		306	2780	11.0%

*we attempted a 100% sample size on the cuttings. However, due to time since installation, it was difficult to find all cuttings.

Photo 23: Lower Rock Creek Photopoint 1, looking down the South Fork from the county road. Note that the stream is usually dry at this location from winter through spring, with peak flows July through September.

Photo 24: Lower Rock Creek Photopoint 4, looking down the mainstem from the county road. This fork also goes dry for much of the winter and spring. Additional photopoints not included here show the same riparian condition: dense wetland herbaceous vegetation with scattered low shrubs, which are mostly shrubby cinquefoil (*Potentilla fruticosa*).

Lower Rock Creek Discussion:

The overall percent seedling survival on this project was 20.9%. Redosier dogwood had the highest survival rate at 27.4%. Cottonwood had the highest mortality rate, with only 9.3% surviving. Our confidence in these figures is somewhat compromised by the difficulty of finding all of the live and dead unmarked seedlings and cuttings after 4 ½ growing seasons. Without protectors or mulch to guide us,

we relied upon our experience in providing input to the initial revegetation design and having participated in the planting project, as well as observing the original plant spacing and the dead tops sticking above the wetland herbaceous cover.

Monitoring revealed many problems and setbacks. Firstly, no surviving plants were taller than 12 inches, and most were 4 inches tall or less after 4 ½ growing seasons. Many plants have a prostrate or horizontal growth habit that appears to be from winter die-back. Many plants are heavily browsed by wildlife as well.

Secondly, the channel has widened and subsequently inundated many plants and cuttings in the near bank row of seedlings. Inaccurate willow monitoring is likely, as containerized willows were also grown from cuttings, making actual cuttings versus container-grown willows very difficult to differentiate. Some of the containerized seedlings still had their biodegradable mesh liner intact, allowing for positive identification in these instances. But some did not, and many seedlings and cuttings were lost to channel expansion.

After 4 ½ growing seasons, we would expect to see native plant seedlings with vigorous top and root growth, well on their way towards creating an established woody riparian plant community. This poor vigor and survival likely has several causes:

- Containerized plants were not grown from site-adapted stock. Kleinschmidt Flat is a very harsh and cold environment. Early frosts and late winters are the norm here, as are extreme temperatures. Plants adapted to Bitterroot Valley growing conditions are not going to thrive in this locale; in fact, they are wired to bud earlier and actively grow longer into the fall than locally adapted plants, resulting in winterkill and dieback.
- Plants were installed using a mechanized 'stinger', a relatively new restoration tool. Plants may not have had the planting slot backfilled and sealed correctly. Perhaps air pockets occurred in the rooting zones, thus causing root die-off.
- Containerized plants were not dormant, and were actively growing at the time of planting. It is standard restoration planting protocol to plant hardened-off, dormant plant stock, to minimize transplant stock and maximize root-to-shoot ratios.
- A reference plant community was not used to develop the planting mix; the project merely took what the nursery had in stock. Bebb willow, dogwood, and alder are the only species in the mix that are seen growing within a mile of this portion of this intermittent stream.
- Reconstructed stream hydrology was still unknown at the time of design and planting. Flooded near bank zones and increased water flows most likely impacted plant survival (Photo 25).
- Wildlife browsing impacts to containerized plantings were not addressed. Browsing severely limited the vigor of plants, and most likely contributed to mortality.
- Competition from wetland graminoids was relatively high. Because no mulch or weed mats were installed, plants had a hard time competing.
- Neither seedling maintenance nor monitoring was prescribed on this project.

Photo 25: Serviceberry growing in water where channel has expanded into bank sods. Note dead plant top, showing original planted size 4 ½ years ago. Note also that this is not serviceberry habitat; serviceberry is an upland plant, and prefers dry slopes, not wetland sites.

Photo 26: Typical stream and riparian community conditions along lower Rock Creek. The protruding sticks are the planted cuttings and seedlings, now principally dead. The living shrubs visible along the banks are naturally-occurring shrubby cinquefoil. Wetland graminoids and forbs dominate the banks and floodplain.

Lower Rock Creek Recommendations:

Rock Creek at this location is healthy and stable, as is the riparian plant community. Some volunteer willows are establishing in optimal locations. No further revegetation is necessary at this time. The riparian area should continue to be protected from livestock grazing impacts, as the saturated and peaty soils in the floodplain are extremely prone to trampling and hoof shear.

We do not recommend the revegetation approach used here in 2005 for similar sites in the future. The expandable-stinger planting approach is a viable technique for very rocky sites and rip-rapped banks, and has been used to good effect. Project managers should note that the expandable-stinger method of planting is rather costly (about $10/planted plant), therefore extra effort should be made to ensure the survival and success of seedlings installed using this technology. When the stinger approach is applied, plants should be custom grown for specific projects using local seed sources. Reference plant communities should be used to determine appropriate species composition.

4.7 Middle Rock Creek

Project Lead: BBCTU
Partners: NRCS, TNC, FWS, FWP, CF
Contractors: VWCS, TNT, GR, Volunteers
Project Location: Private land on Kleinschmidt Flat, east of Ovando and north of Highway 200. Rock Creek is a major tributary to the North Fork of the Blackfoot, entering at river mile 6.2.

Project Start: Channel reconstruction in 1998
Revegetation: October 2007

Project Description: Historic grazing degradations to Rock Creek led to a wide, shallow stream with high sediment and temperatures. Reconstruction of 3,050 feet of channel has included habitat restoration, off stream stock water facilities development, grazing management changes and streambank revegetation.

Planting Conditions: Plants were easy to install in the pre-augered holes. Soils were loamy and loose enough to seat plants well. Water-logged holes during installation and heavy sod were not issues on this project. In spring 2008, the creek remained at high water until early July. Many plants were underwater or waterlogged for several months.

Revegetation Techniques:

- ***Plants:*** 722 total native shrubs were installed (384 on north bank, 338 on south bank). VWCS grew the plants during summer 2007, with the exception of the dogwood, which was grown by DNRC and left over from the Upper Rock Creek project. All plants were of the T1 size (Table 20).
- ***Spacing:*** Plants were placed in groups of approximately 50, with 2 rows along the banks at 8 feet spacing between plants. Groups were approximately 100-150 feet apart. Wherever possible, riparian species were installed closest to the streambank, while upland species were installed in a second row. Seedlings were spaced away from existing woody vegetation.
- ***Planting Technique:*** Holes were augered with a tracked skidsteer mounted with a two-stage scalping auger (resulting in a 9"X18" hole and a 36" scalp). Plants were installed by volunteers led by professional planters. All plants were watered in immediately after planting.

Table 20: Middle Rock Creek Revegetation Species List

Common name	Latin name	Supplier	Source	Total: 722
gray alder	*Alnus incana*	VWCS	Clark Fork River, Missoula	86
Bebb willow	*Salix bebbiana*	VWCS	Rooted cutting, source unknown	34
Booth/Drummond willow	*Salix boothii, drummondiana*	VWCS	Warm Springs, 6000' elevation	184
chokecherry	*Prunus virginiana*	VWCS	Clark Fork River, 3800' elevation	84
golden currant	*Ribes aureum*	VWCS	W MT	41
hawthorn	*Crataegus douglasii*	VWCS	W MT	14
redosier dogwood	*Cornus sericeus*	DNRC	Middle Blackfoot, from cuttings	19
sandbar willow	*Salix exigua*	VWCS	Clark Fork River, 3500' elevation	16
water birch	*Betula occidentalis*	VWCS	Swan Valley	101
wolfberry	*Eleagnus commutata*	VWCS	Blackfoot	112
wood rose	*Rosa woodsii*	VWCS	Clark Fork River, 3800' elevation	31

- ***Mulch:*** Pole yard wood mulch was applied to each plant, in a circle 4" deep and 36" wide.
- ***Browse Protection:*** Plants were sprayed with "Treeguard" browse repellent after installation.

Maintenance Plan: Landowner and partners are responsible for plant maintenance.
Maintenance Log: Spring and fall applications of "Treeguard" in 2008 and 2009 by GR. No watering has been necessary on this site, stream flows and soil water has been sufficient for plant needs through the growing season.

Monitoring Results: Results of the site data survey and seedling survival monitoring are displayed below. Photopoint pictures, which are georeferenced in the general site data table, are also included.

Table 21: Middle Rock Creek General Site Data

Middle Rock Creek	**Monitoring Date: 7/17/09**
Soil texture	Very rocky and cobbly soils. Large boulders and some bedrock present.
Depth to seasonal low water table	Water table is approximately 1' below surface at time of monitoring.
Competition rating (scale 1-6)	2. Nearbank zone has healthy native herbaceous community.
Weed conditions	Moderate: Knapweed, Canada thistle, rhizomatous grasses, sulfur cinquefoil, cheatgrass. Landowner uses an active weed control program.
GPS coordinates	
Photopoint 1: upstream end	47°00'44.21" N 112°57'52.31" W (at county road)
Photopoint 2: downstream end	47°00'36.58" N 112°58'30.32" W (at west property line/fence)
Browsing	Moderate: Browse repellent applications are helping. Appears to be light browse pressure. Elk, deer, bear scat.
Mulch	Pole yard waste: Some washed away in high stream flows of 2008. Silt has deposited on some mulch rings. Mulch rings are holding up well and are effective.
Plant protection	None
Fence	None
Grazing	No livestock grazing in past 5+ years. Landowner says he will fence.
Stream	Widened beyond constructed bank. Shallow flooding in grassy areas. Very narrow riparian corridor within prairie ecosystem.

Table 22: Middle Rock Creek Survival by Species

Middle Rock Creek				
Common Name	**Latin Name**	**Live**	**Planted**	**Survival**
Bebb willow	*Salix bebbiana*	19	34	55.9%
birch (bog or river)	*Betula spp*	87	101	86.1%
willow (booth and drummondiana)	*Salix boothii and*	175	184	95.1%
chokecherry	*Prunus virginiana*	29	84	34.5%
golden currant	*Ribes aureum*	35	41	85.4%
gray alder	*Alnus incana*	74	86	86.0%
hawthorn	*Crataegus douglasii*	16	14	114.3%
redosier dogwood	*Cornus sericeus*	26	26	100.0%
sandbar willow	*Salix exigua*	15	16	93.8%
wolfberry	*eleagnus commutata*	67	112	59.8%
wood rose	*Rosa woodsii*	27	31	87.1%
total		**570**	**729**	**78.2%**

Photo 27: Middle Rock Creek Photopoint 1, upstream end looking downstream. Several seedlings are in the picture to the left, but are difficult to see.

Photo 28: Middle Rock Creek Photopoint 2, downstream end looking upstream. Note the redosier dogwood seedling in foreground. Several seedlings are visible behind the dogwood, including a wolfberry.

Middle Rock Creek Discussion:
Overall seedling survival on this project was 78.2%. Redosier dogwood, hawthorn and Booth/Drummond/Sandbar willow species show the best survival rates, at 94-100%. Chokecherry, wolfberry and Bebb willow species show the highest mortality, at 35-60%. Many seedlings are over 2 feet tall, with multiple branching and vigorous growth (Photo 29). The site is not prone to severe browse pressure, or rather, browse pressure occurs sporadically, when deer and elk herds move through the area seasonally. The regular browse control applications are quite effective at limiting browse impacts on this site. Livestock have not been grazed on the property in a number of years, although the landowner plans to do so in the near future, after installation of a riparian exclosure fence.

The pole yard mulch is effective. Some material washed away during spring 2008 runoff. Silt was deposited on top of some mulched areas during this runoff period, but the mulch continues to hold up well and is still able to suppress weeds.

The stream has widened in several places beyond its originally-constructed bank width, and there is shallow flooding in grassy areas throughout the summer months. It appears that perennial water flows are currently maintained throughout the growing season. The water table was zero to one foot below the surface at the time of monitoring.

The riparian corridor on this project is very narrow (see Photos 27, 28), with an upland shrub/bunchgrass plant community occurring just ten feet or so from the stream's edge. The near bank zone has a healthy and diverse native herbaceous community with minimal weed problems.

There is an active weed suppression program on this property. The weed contractor focuses weed suppression efforts in the fall when prairie forbs are dormant, thus minimizing non-target kill. The native bunchgrass prairie is very diverse and supports many native forbs and shrubs as well as grasses.

Photo 29: Typical seedlings at Middle Rock Creek site. A wolfberry seedling is visible, along with river birch, willow and dogwood behind it. Note grazing impacts on adjacent downstream property; this reach was reconstructed also, but heavy grazing is returning it to an undesirable, over-widened condition.

This is a good example of a relative simple, yet successful and comprehensive project. There was sufficient time elapsed between stream reconstruction and woody plant revegetation, such that project managers were better able to observe hydrologic conditions and place seedlings accordingly. This time lapse also afforded the opportunity to observe if natural recolonization by woody plants was taking place (which it largely was not). The current woody plant stocking rate appears to be sufficient to, in time, return this portion of Rock Creek to a more naturally-functioning riparian condition.

Volunteers and professionals worked well together to install and maintain the plantings, which results in higher quality control on installation tasks. An effective weed management program is in place, and a regular maintenance regime is being implemented. Despite the fact that no browse control nets were installed on this phase of the project, routine browse spray applications appear effective (note that this site indeed has lower browse pressure than other projects evaluated in this report). The landowner is committed to keeping potential livestock grazing off the riparian corridor, using portable electric fence along the north bank, and a permanent grazing exclosure fence on the south bank.

Middle Rock Creek Recommendations:

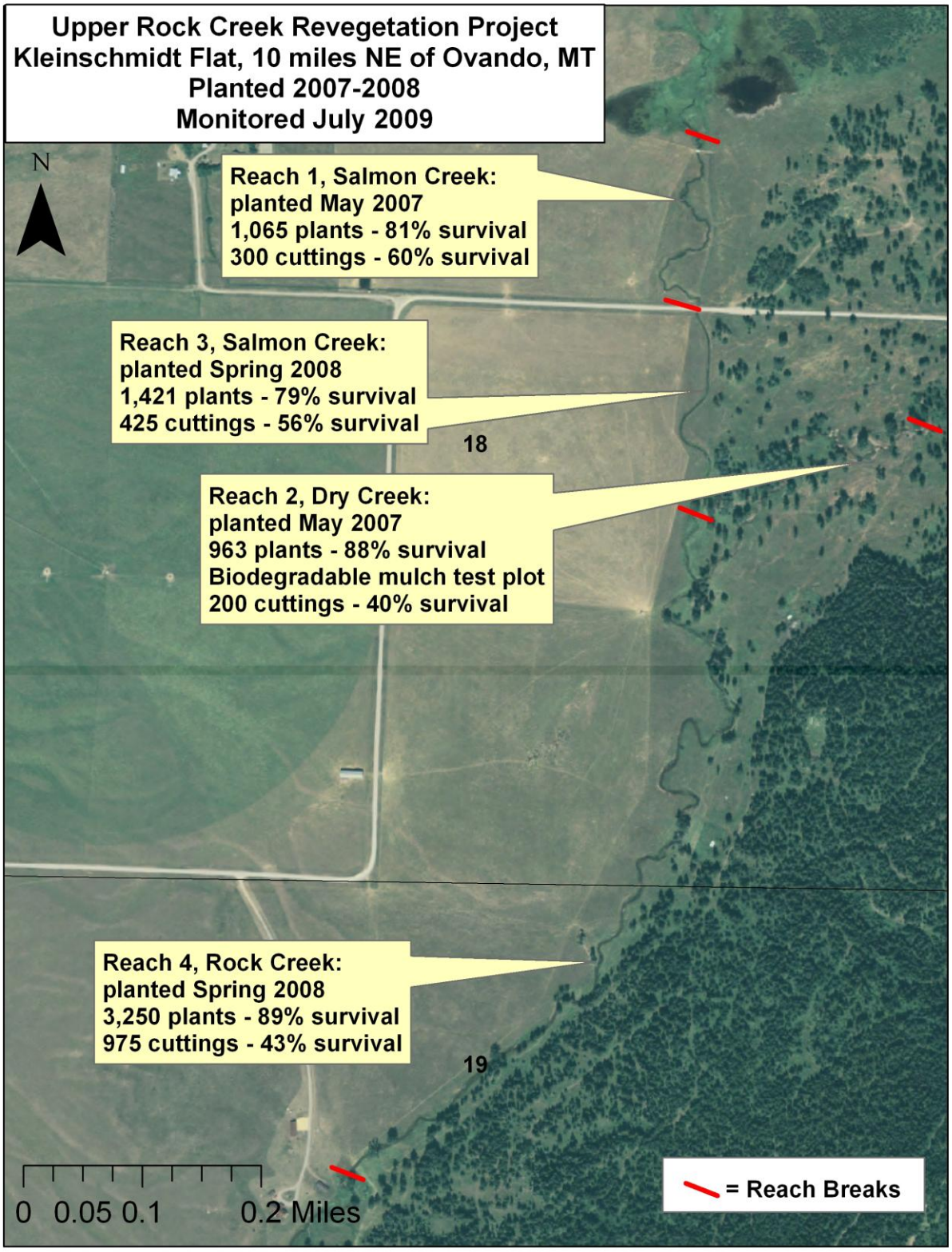
To keep seedlings growing well, browse repellent applications should continue through 2011. By this time plants should be large enough to handle the current level of browse. If livestock are pastured on the site, we recommend that the landowner exclude the still-recovering riparian area from the grazing pasture for at least another 10 years.

The riparian area on the property immediately downstream is receiving excessive livestock grazing pressure, and is in danger of returning to its pre-reconstruction and over-widened condition (Photo 30). The channel is already approximately 50% wider than the evaluated area. Left uncorrected, this use will compromise the fisheries recovery on this and upstream reaches, and may become a thermal barrier to WSCT and BT movement. Water quality is currently being compromised for downstream reaches. There is no riparian woody vegetation on the downstream reach, whereas virtually all of the other reaches of Rock Creek have been revegetated with woody plants or already had functioning riparian areas.

Photo 30: View of property downstream of the Middle Rock Creek project. No riparian exclosure exists on that portion of the stream, and the stream channel is markedly wider than on the project area.

4.8 Upper Rock Creek

From a revegetation standpoint, the Upper Rock Creek project is the largest project assessed here. An NRCS "Expedited" EQIP project, it took three years to complete, including revegetation design, local seed and cutting collection, custom plant propagation, and implementation. The main planting efforts took place during spring 2007 and 2008. Due to the complexities of the project, and the fact that it was installed in 4 reaches over two years, we have divided the reporting of this project into the two years it was installed.



Map 2: Overview of the entire Upper Rock Creek Project and survival statistics.

4.8.1 Upper Rock Creek 2007 (Reach 1, Salmon Creek and Reach 2, Dry Creek)

Project Lead: TNC/GR
Partners: NRCS, BBCTU, FWS, FWP, FVLT
Contractors: WRG, Volunteers (maintenance)
Project Location: Private ranch in the northeast corner of Kleinschmidt Flat, east of Ovando and North of Highway 200. Rock Creek flows across Kleinschmidt Flat and joins the North Fork of the Blackfoot River at mile 6.1.

Project Start: Channel reconstruction was conducted on Salmon Creek in 1998.
Revegetation: Primarily May & June 2007. Some interplanting of upland species occurred in May 2008; these were seedlings that nurseries were not able to have ready in 2007.

Project Description: Historic grazing and irrigation pressure led to a wide, shallow stream with high sediment and temperatures. In the 1990's, restoration of URC included instream habitat restoration, off stream stock water facilities installation, grazing management changes and revegetation. Rock Creek, and its two forks here, Salmon and Dry Creeks, are all spawning habitat for BT and WSCT.

Unfortunately, past planting efforts were not successful or adequate to achieve shading and bank stability goals. In 2005, efforts were restarted to continue the URC restoration through a major woody plant revegetation effort. Between 2007 and 2008, almost 8,000 custom-grown, site adapted seedlings and 2,000 locally collected cuttings were installed over 14,500 feet of streambank.

Planting Conditions: Conditions and soil were mostly favorable during this project in 2007. Soil is coarse and well drained; however, flooding was an issue. Approximately 6 inches of snow fell on the project midway through installation. After installation, water levels rose and some plants remained underwater for over one month.
Revegetation Techniques: Plant materials for this project were all custom grown from locally-collected propagules, with the exception of a few species as noted. Seed was collected during 2006 to allow sufficient time for seed stratification and propagation. The DNRC grew all seedlings, whereas cuttings were locally collected by GR. Plant materials are detailed in Table 23.

- ***Plant spacing and placement:*** The near-bank zone, referred to as "Zone 1" and extending approximately 10 feet from the bank, had an average of average of 2 rows at 6 foot spacing between plants. The mesic zone, referred to as "Zone 2" and extending from 10 to 35 feet from the streambank, had an average of 2 rows at 12 foot spacing. Willow cuttings were spaced along water edge on outside bends only, at 5 foot spacing.
- ***Cuttings:*** Willow cuttings were collected locally, a month before the project. Sizes were 30" length by 3/8" to 1" diameter. They were installed with an electric hammer and custom bit used to pilot holes (Photo 31). Holes were approximately 24", leaving about 12" of cutting exposed. Cuttings were generally angled over the stream to minimize browsing, and were seated into their holes with a rubber mallet. Cuttings were installed by TNC and GR.

Photo 31: Installation of 30" willow cuttings using an electric hammer.

Table 22: Upper Rock Creek Plant Materials Detail, Reaches 1 & 2 combined. Bolded species were interplanted in 2008, all others were planted in 2007.

Common Name	Latin Name	Size	Supplier	Seed Source	Totals plants: 2,403 cuttings: 500
aspen	*Populus tremuloides*	T1	DNRC	Blackfoot	276
black cottonwood	*Populus trichocarpa*	T1	DNRC	Blackfoot	484
chokecherry	***Prunus virginiana***	**30 CI**	**DNRC**	**Blackfoot**	**110**
Douglas hawthorn	*Crataegus douglasii*	30 CI	DNRC	Lolo Creek 3700' elev	160
Engelmann spruce	***Picea engelmanii***	**30 CI**	**DNRC**	**Jocko River**	**208**
gray alder	*Alnus incana*	T1	DNRC	Clearwater River	96
ponderosa pine	*Pinus ponderosa*	30 CI	DNRC	Ravalli County 5700' elev	128
redosier dogwood	*Cornus sericea*	T1	DNRC	Blackfoot	552
serviceberry	***Amelanchier alnifolia***	**30 CI**	**DNRC**	**Blackfoot**	**57**
snowberry	*Symphoricarpos albus*	30 CI &BR	DNRC	Ravalli County, Sula State Forest	130
river birch	*Betula occidentalis*	100 CI	DNRC	Rock Creek 4400' elev	63
wood rose	*Rosa woodsii*	100 CI	DNRC	Anaconda	139
willow cuttings	*Salix boothii, drummondiana, exigua, geyeriana*	1" max by 30"	GR	Middle Blackfoot	500

- ***Planting:*** Seedling planting holes were augered using a tracked skidsteer mounted with a two-stage scalping auger (resulting in a 9"X18"hole with 36" sod scalp) (Photo 32). Plants were installed by GR, TNC, and WRG. Each plant was watered in after planting.
- ***Mycorrhizal inoculant:*** Each aspen seedling had RTI "Myco-Pak" endo-ectomycorrhizal inoculant applied in a "tea-bag" form to the root zone at planting.
- ***Systemic Browse Repellent/Fertilizer:*** Planters applied RTI "Buckmaster Continuem", a 12-4-6 systemic browse repellent/fertilizer blend. This was sprinkled in the planting hole directly in the

root zone upon planting. Aspens, which received mycorrhizal inoculant, did not receive Buckmaster.

Photo 32: Augering holes for T1 size plants using a tracked skidsteer mounted with a two-stage scalping auger, resulting in a 9" wide by 18" deep hole plus a 36" sod scalp.

- ***Mulch:*** Ground wood mulch was applied to each plant scalp at a depth of 4"x 36" width, with mulch being pulled away from each stem. The NRCS dictates this 'cone of depression' in their specifications. Note: In 2007, the supplier shipped a batch of forestry wood mulch that had some building waste (such as ground painted boards and nails) incorporated into it. This may or may not have affected seedling growth or weed suppression, but we feel it should be noted.
- ***Browse protection:*** 12" X 48" rigid plastic mesh browse protectors (custom-made by Norplex of Tacoma, WA) were installed using two 1"x2"x48" Douglas fir stakes and 4 zipties per plant (Photo 33).

Photo 33: Installation of 12" x 48" rigid plastic mesh tree protectors on a planted reach of Upper Rock Creek.

- ***Weed barrier test plot:*** In an effort to compare biodegradable matting products with wood mulch treatments, a mulch test plot was set up on Reach 2 (see discussion and photos below, and Table 26 for results)

Maintenance Plan: FVLT (which holds a conservation easement on the property) and BBCTU work in agreement with the landowners to perform regular maintenance duties on the project.

Maintenance Log: The landowners performed bimonthly watering of each plant during the summer of 2007. The landowners also hired a weed management contractor to spot-spray knapweed, yellow toadflax and Canada thistle infestations within the restoration area. In 2007, FVLT volunteer crews performed hand watering, weed pulling and browse protector maintenance tasks on Reaches 1 and 2 of the project. In 2008, Treeguard browse repellent was applied to vegetation growing beyond the nets, and plants were watered twice by volunteer crews during the summer. In 2009, spring and fall Treeguard applications were made. In summer 2009, Reach 2 was watered once by a FVLT volunteer crew. Maintenance on this project has been more extensive than any other project discussed here.

Monitoring Results: Results of the site data survey and seedling survival monitoring are displayed below. Photopoint pictures, which are georeferenced in the general site data table, are also included.

Table 23: Upper Rock Creek, Reaches 1 & 2, General Site Data

Upper Rock Creek R 1&2	**Monitoring Date: 7/7/09**
Soil texture	R1: Gravelly loam: cobbly and gravelly with low organic matter. R2: Loamy; 12-18" A horizon; some cobble and small gravels.
Depth to seasonal low water table	R1: Near bank- at surface or above. Mesic zone- mostly greater than 1.5' R2: Near bank zone: 1-2' Far bank zone: 2-3'
Competition rating (scale 1-6)	R1: 2: Some efforts at hand weeding with volunteers over the past 2 years. R2: 5: aggressive, non-native graminoids; some Canada thistle.
Weed conditions	R1: Weedy and many non-native graminoids: Canada thistle, yellow toadflax, knapweed, reed canarygrass, timothy, smooth brome. R2: Moderately weedy: Musk and Canada thistle, knapweed, tame pasture grasses, oxeye daisy, yellow toadflax. Active annual spray program.
GPS coordinates	
Photopoint 1: Reach 1 upstream end	47°03'30.6" N 112°54'26.2" W (Salmon Ck at wooden bridge)
Photopoint 2: Reach 1 downstream end	47°03'23.8" N 112°54'25.7" W (Salmon Ck at county road)
Photopoint 3: Reach 2 upstream end	47°03'18.7" N 112°54'11.8" W (Dry Ck)
Photopoint 4: Reach 2 downstream end	47°0311.2" N 112°54'25.3" W (Dry Ck, at confluence with Salmon Ck)
Browsing	Only on plants growing beyond 4' nets, those mostly browsed.
Mulch	Wood waste, including some building waste. Effective, holding up well.
Plant protection	12"x48" rigid plastic mesh with wooden stakes. Effective. Nets are being maintained annually by volunteers.
Grazing/fence	Riparian area is fenced off from livestock.
Stream condition	R1: Native and non-native herbaceous vegetation is heavy on banks; many small trout and frogs observed in stream; banks stable. R2: Somewhat incised in lower end of reach and raw eroding banks there, otherwise much woody vegetation; Dry Ck channel not reconstructed in '98.

Table 24: Upper Rock Creek 2007, Reaches 1 & 2, Survival by Species (after 2 ½ growing seasons)

[does not include small amount of plantings (108) on Reach 4 in 2007]

Common Name	Latin Name	Live	Planted	Survival
aspen	*Populus tremuloides*	242	276	**87.7%**
black cottonwood	*Populus trichocarpa*	346	484	**71.5%**
gray alder	*Alnus incana*	80	96	**83.3%**
hawthorn	*Crataegus douglasii*	161	160	**100.6%**
ponderosa pine	*Pinus ponderosa*	109	128	**85.2%**
redosier dogwood	*Cornus sericeus*	485	552	**87.9%**
snowberry	*Symphoricarpus albus*	75	84	**89.3%**
river birch	*Betula occidentalis*	80	109	**73.4%**
wood rose	*Rosa woodsii*	130	139	**93.5%**
total		**1708**	**2028**	**84.2%**
willow cuttings*	*Salix spp*	219	500	**43.8%**

*100% sample on R1 (59.7%), sample of 100 on R2 (40.0%)

Table 25: Upper Rock Creek, 2008 interplanting, Reaches 1 & 2, Survival by Species (after 1 ½ growing seasons)

Common Name	Latin Name	Live	Planted	Survival
chokecherry	*Prunus virginiana*	76	110	69.1%
Engelmann spruce	*Picea engelmanii*	132	208	63.5%
serviceberry	*Amelanchier alnifolia*	44	57	77.2%
total		**252**	**375**	**67.2%**

Photo 34: Upper Rock Creek Photopoint 1: top of Reach 1 (Salmon Creek) looking downstream. Note old log structure from 1998 rechannelization work by FWS.

Photo 35: Upper Rock Creek Photopoint 2: bottom of Reach 1 looking upstream, from the culvert at the county road. Note heavy grass competition, which is a combination of tame pasture grasses and native wetland graminoids. Also note some plants growing beyond their 4 foot protectors.

Photo 36: Upper Rock Creek Photopoint 3: upstream end of Reach 2 (Dry Creek) looking downstream. This stream typically goes dry by late summer.

Photo 37: Upper Rock Creek Photopoint 4: downstream end of Reach 2 looking upstream. Note eroding bank at furthest upstream point: this extends for hundreds of feet upstream. The banks along this stretch of Dry Creek are higher that the upstream end (Photopoint 3), and are dominated by upland pasture grasses unable to stabilize the banks.

Upper Rock Creek Discussion, Reaches 1 and 2: Combined survival of the 2007 plantings is at 84.2% after 2 ½ growing seasons. At this point, significant losses due to seedling establishment problems (such as plant and planting quality) are not anticipated. Cuttings installed in 2007 didn't fare so well, at only 43.8%. However, cuttings installed under previous volunteer projects, and the few volunteer plants that are establishing do add to the willow community. The interplanted species installed in 2008 also had reduced survival of 67.2%. Wood rose, snowberry and hawthorn all showed the greatest survival. Spruce, chokecherry and cottonwood seedlings had the highest mortality. After just 2 years, many of the 2007 plants are over 4 feet tall, exceeding their cages and branching vigorously. Rhizomatous speices, such as snowberry and rose, are beginning to spread laterally. The planting density and width was extensive on this project, more so than any other evaluated here, so in our opinion the losses do not affect overall project goals. This site is well on its way to establishing a woody plant community along these two important tributaries forming URC.

Many factors point towards success on this project:

1. Planting site-adapted stock has reduced death loss from weather extremes and reduced branch die-back, resulting in improved growth rates.
2. Heavy sod was thoroughly removed from planting holes with the scalping auger, reducing competition.
3. Wood mulch was installed at sufficient depth and width to effectively reduce weed and grass competition around seedlings.
4. Protectors and routine browse spray applications greatly reduced browse pressure.
5. The streambank is fenced off year-round from livestock grazing impacts.
6. An active maintenance program is in place. Routine hand-watering, limited hand-weeding and plant protector maintenance efforts have kept plants growing vigorously without pressure from weeds or browsing.

7. An aggressive weed control program is ongoing. Although there are sizeable populations of noxious weeds, they are being monitored and controlled.

Numerous trout, frogs, snakes, crayfish, and aquatic insects were observed in the creek, indicating use by a variety of species and life forms. It appears this stream is recovering its ecological functions.

Project managers installed a small trial in 2007 along Dry Creek to test rooting success of dogwood and cottonwood cuttings when paired with sandbar willow cuttings. Sandbar willows are believed to have significant amounts of naturally-occurring rooting hormone in their cambium; it was theorized that some of this hormone may increase establishment by these other two species which are poor rooters when directly installed as unrooted cuttings. However, this trial failed due to high water levels during one-half of the 2007 growing season. Further study is warranted, as often the direct-sticking of locally-collected cuttings is an inexpensive and quick way to plant a site with site-adapted woody plants. Survival of cuttings is typically low (11% to 60% under this assessment), but this is offset by the reduced cost, allowing for larger quantities to be installed.

Some other techniques and trials utilized on URC are discussed below.

Mycorrhizal Inoculation: The 2007 phase of the URC revegetation was the only project in this monitoring analysis where a mycorrhizal inoculum was used as a planting amendment. RTI endo-ectomycorrhizal seedling packets (also known as "Myco-paks" or "tea-bags") were installed with all aspen in an effort to help this often fickle species establish. It is difficult to quantify whether this amendment increased survival or not. Because soils on this site are not heavily disturbed, drought was not an issue, and native aspens occurred nearby, mycorrhizal amendments probably had limited impact on seedling survival. Aspen planted on Reaches 3 and 4 in 2008 without inoculants survived better than aspen planted in 2007 (96.7% in 2008 versus 87.7% in 2007). This difference in % survival could have several reasons, including differences in site conditions, mulch materials and fertilizer/amendments. Plants installed in 2008 have had only one full growing season before survival monitoring. In summary, it is difficult to determine the relative efficacy of mycorrhizal amendments in aspen. Note that overall, aspen did dramatically better on the URC project than any other projects evaluated (0% to 40% on 3 other projects versus 81% to 99% on the 4 reaches here).

Systemic Browse Repellent: As stated above, RTI "Buckmaster Continuem", a 12-4-6 systemic browse repellent/fertilizer blend was planted with all seedlings in 2007, excluding aspen. This repellent was sprinkled in the planting hole directly in the root zone upon planting. A browse-repellent chemical in the fertilizer granules is absorbed by the plants as their roots grow, making them unpalatable. This new product had been tested on conifer seedlings before, with very good results, but not tested on the deciduous species that were installed at URC. It was utilized at URC in an effort to reduce anticipated heavy vole girdling damage, despite the risk of adverse side effects to the seedlings from this relatively untested product.

As no test plots or controls were installed, it is impossible to tell for sure what, if any, benefits or impacts the Buckmaster had. From repeated visits to URC by the authors during maintenance events, it was observed than many plants had significant die-back and leaf blackening after planting and throughout the first growing season, in particular cottonwoods and dogwoods. This could be attributed to the Buckmaster; most of these seedlings appear to recover in the second growing season. It was

observed that significant vole damage did not occur as anticipated. However, vole damage did not appear to affect survival at URC Reaches 3 and 4 either; the authors feel that this is more a function of the wood chip mulch repelling rodents than the effects of a systemic browse repellent. Further study is warranted here as well.

Biodegradable Mulch Mat Test Plot: Project managers installed a mulch mat test plot to determine effectiveness of a variety of commercially available biodegradable mulch products. After two and a half growing seasons, we rated the competition from weeds and grasses within the mulch mat on a scale of 1-6, with 6 being high competition. Twenty-five seedlings of each mulch type were evaluated. Results are shown in Table 26. Photos of the mulch types tested are shown in Photos 38 and 39.

Table 26: Biodegradable mulch comparison, 26 months after installation

Mulch Type and Application	Average Competition Rating (6=high, 1=low) n=25 per type	Product Cost (each)	Installation Cost (estimated)
Local hogfuel or chips, ground forestry waste, 36" circle, 4" deep	2.40	$1.09	$1.00
RoLanka coir fiber "BioD Weed Mat", 30" square	2.84	$5.10	$1.00
Ecocover recycled paper "Mulch Mat", 25" square	3.60	$3.85	$1.00
RTI aspen fiber "Mulchmats", 30" square	3.36	$2.33	$1.25

The mulch mats were only 25 or 30 inches square, as compared to 36" circular wood mulch applications. Because of the smaller size, and the dense, tall pasture grasses tended to cover the seedlings more, which resulted in a lower rating for the manufactured mats. The mats would likely have performed better had they been larger. However, the woodchip mulch type proved most effective at minimizing weed competition on this site, and also had the added advantages of being (1) locally available, (2) significantly cheaper, (3) easier to weed around the seedling, and (4) suspected vole-deterrent capabilities. Based upon these observations (and confirmed during the monitoring), all of the other projects evaluated here that used wood chips did so because of the URC findings.

Photo 38: Biodegradable mulch products tested on Reach 2, Dry Creek. Photos were taken June 21, 2007, approximately one month after planting and installation.

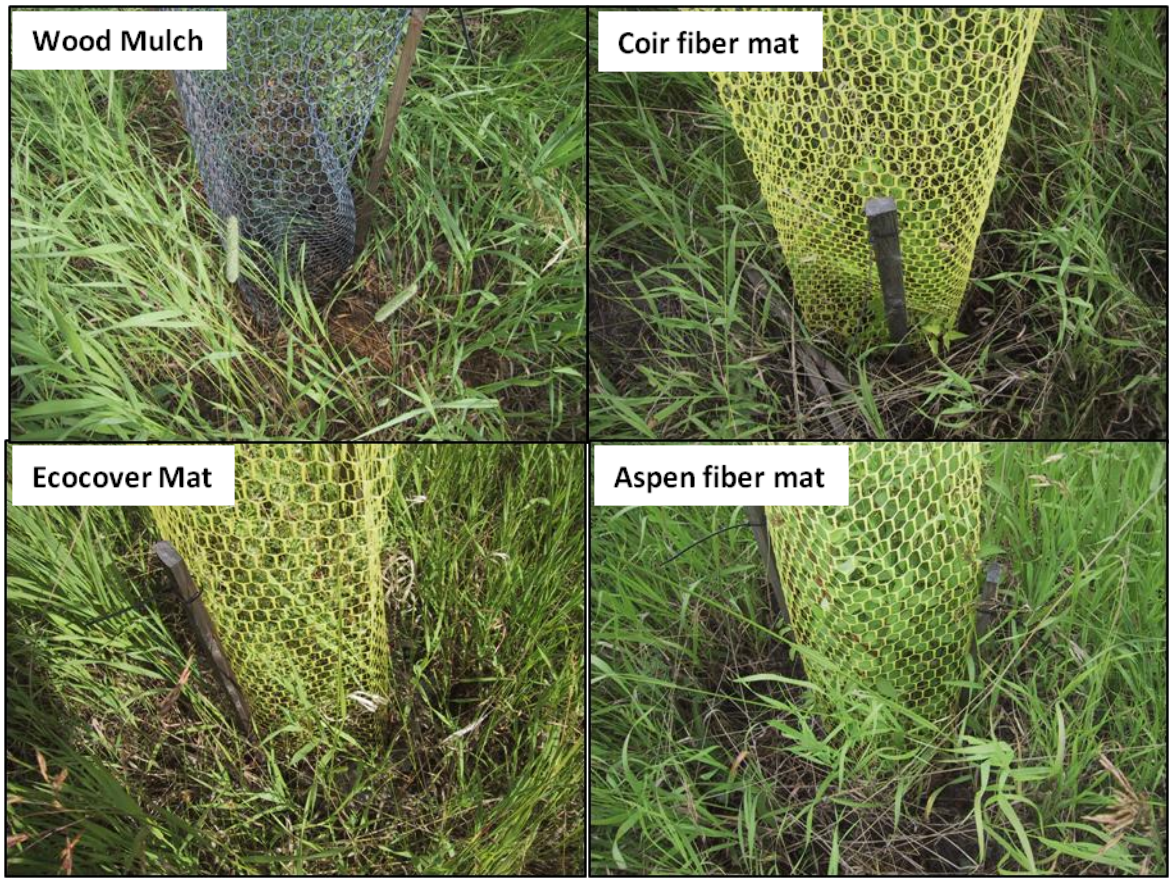


Photo 39: Biodegradable mulches, 26 months after installation.

Upper Rock Creek Recommendations, Reaches 1 and 2: Plant protector maintenance and browse repellent applications (where the seedlings protrude from the protectors) should continue through 2011, at least twice per growing season. By this time woody plants should be large enough to handle the current level of browse. We recommend that the landowners exclude the still-recovering riparian area from grazing for at least another 10 years.

Maintenance watering could continue on this project for another year or two, in order to keep the seedlings growing well. However, if summer drought conditions occur watering should definitely be conducted in order to protect in significant time and effort invested in this restoration. Seedlings would also benefit from weeding for another year or two.

4.8.2 Upper Rock Creek 2008 (Reach 3, Salmon Creek and Reach 4, Rock Creek)

Project Lead: GR
Partners: NRCS, BBCTU, FWS, FWP, FVLT, TNC
Contractors: WRG, Volunteers (maintenance)
Project Location: same as 4.8.1, URC 2007

Project Start: same as 4.8.1, URC 2007
Revegetation: May & June 2008

Project Description: same as 4.8.1, URC 2007

Planting Conditions: Conditions and soil were mostly favorable during this project in 2008. Soil is well drained with less rock and cobble than Reaches 1 & 2. Flooding was an issue, as many holes filled with water between augering and planting operations. After planting, some plants in the near-bank zone remained underwater for over one month.
Revegetation Techniques: Plant materials for this project were all custom grown from locally-collected propagules, with the exception of a few species as noted. Seed was collected in 2006 and 2007 to allow sufficient time for seed stratification and propagation. The DNRC grew all seedlings; cuttings were locally collected by GR. Plant materials are detailed in Table 27.

- ***Plant spacing and placement:*** The near-bank zone, referred to as "Zone 1" and extending approximately 10 feet from the bank, had an average of average of 2 rows at 6 foot spacing between plants. The mesic zone, referred to as "Zone 2" and extending from 10 to 35 feet from the streambank, had an average of 2 rows at 12 foot spacing. Willow cuttings were spaced along water edge, principally on outside bends, at 5 foot spacing.
- ***Cuttings:*** same as 4.8.1, URC 2007
- ***Planting:*** same as 4.8.1, URC 2007
- ***Mulch:*** Wood mulch was applied to each plant scalp at a depth of 4"x 36" width, with mulch being pulled away from each stem. The mulch used in 2008 came from a local post & pole yard, and was principally lodgepole pine bark and shavings. The consistency of this product was much better than the 2007 "hogfuel" mulch, was easier to handle and install, and is suppressing rhizomatous grasses better.
- ***Browse protection:*** same as 4.8.1, URC 2007

Maintenance Plan: FVLT (which holds a conservation easement on the property) and BBCTU work in agreement with the landowners to perform regular maintenance duties on the project.
Maintenance Log: The landowners performed bimonthly watering of each plant during the summer of 2008. The landowners also hired a weed management contractor to spot-spray knapweed, yellow toadflax and Canada thistle infestations within the restoration area. Also in summer 2008 FVLT volunteer crews performed hand watering, weed pulling and browse protector maintenance duties on Reaches 2, 3 and 4 of the project. In 2008, Treeguard browse repellent was applied to vegetation growing beyond the nets, and plants were watered twice by volunteer crews during the summer. In 2009, spring and fall Treeguard applications were made. In summer 2009, Reach 3 and 4 were watered once by a FVLT volunteer crew. Maintenance on this project has been more extensive than any other project discussed here.

Table 27: Upper Rock Creek 2008 Plant Materials Detail, Reaches 3 & 4 combined

Common Name	Latin Name	Size	Supplier	Seed Source	Total seedlings: 4,665 Cuttings: 1,400
aspen	*Populus tremuloides*	T1	DNRC	Blackfoot	490
black cottonwood	*Populus trichocarpa*	T1	DNRC	Blackfoot	1182
chokecherry	*Prunus virginiana*	30 CI	DNRC	Blackfoot	240
Douglas hawthorn	*Crataegus douglasii*	½ - 30 CI ½ - T1	DNRC	Blackfoot	117
Engelmann spruce	*Picea engelmannii*	30 CI	DNRC	South Fork Jocko River	442
gray alder	*Alnus incana*	T1	DNRC	Blackfoot	217
ponderosa pine	*Pinus ponderosa*	30 CI	DNRC	Ravalli County 5700' elev	250
redosier dogwood	*Cornus sericeus*	T1	DNRC	Blackfoot	1112
serviceberry	*Amelanchier alnifolia*	30 CI	DNRC	Blackfoot	123
snowberry	*Symphoricarpos albus*	30 CI	DNRC	Anaconda	33
river birch	*Betula occidentalis*	T1	DNRC	Blackfoot	209
wood rose	*Rosa woodsii*	30 CI	DNRC	Blackfoot	250
willow cuttings	*Salix boothii, drummondiana, exigua, geyeriana*	1" max by 30"	GR	Blackfoot	1400

Monitoring Results: Results of the site data survey and seedling survival monitoring are displayed below. Photopoint pictures, which are georeferenced in the general site data table, are also included.

Table 28: Upper Rock Creek 2008, Reaches 3 & 4, General Site Data

Upper Rock Creek 2008 R3&4	**Monitoring Date: 8/5/09**
Soil texture	Loamy gravel with occasional cobbles.
Depth to seasonal low water table	Varies from 1-6', 1.5 mile long site & variable
Competition rating (scale 1-6)	4 (2 within mulch rings); very tall pasture grasses.
Weed conditions	Low: Tame pasture grasses, Canada thistle, yellow toadflax.
GPS coordinates	
Photopoint 5: Reach 3 upstream end	47°03'23.5" N 112°54'25.8" W (Salmon Ck at county road)
Photopoints 6 & 7: Reach 3 & 4 break	47°03'11.2" N 112°54'25.3" W (confluence of Dry and Salmon Creeks)
Photopoint 8: Reach 4 downstream end	47°02'45.4" N 112°54'45.5" W (Rock Ck at fence above ranch buildings)
Browsing	Only on plants growing beyond 4' nets, those mostly browsed.
Mulch	Pole yard waste, holding up well. Few weeds in mulch.
Plant protection	12"x48" rigid plastic mesh with wooden stakes. Effective. Nets are being maintained annually by volunteers.
Grazing/fence	Riparian area is fenced off from grazing.
Stream condition	Reach 3: channel partially diked on upper end, limited overbank flooding. Reach 4: 1998 channel reconstruct, limited overbank flooding.

Table 29: Upper Rock Creek 2008, Reaches 3 & 4, Survival by Species (after 1 ½ growing seasons)

Common Name	Latin Name	Live	Planted	Survival
aspen	*Populus tremuloides*	474	490	96.7%
black cottonwood	*Populus trichocarpa*	880	1182	74.5%
chokecherry	*Prunus virginiana*	214	240	89.2%
Engelmann spruce	*Picea engelmannii*	329	442	74.4%
gray alder	*Alnus incana*	204	217	94.0%
hawthorn	*Crataegus douglasii*	116	117	99.1%
ponderosa pine	*Pinus ponderosa*	228	250	91.2%
redosier dogwood	*Cornus sericeus*	981	1112	88.2%
river birch	*Betula occidentalis*	196	209	93.8%
serviceberry	*Amelanchier alnifolia*	124	123	100.8%
snowberry	*Symphoricarpos albus*	23	33	69.7%
wood rose	*Rosa woodsii*	237	250	94.8%
total		**4006**	**4665**	**85.9%**
willow cuttings*	*Salix spp*	142 live	158 dead	**47.3%**

*sample size of 100 on R3 and 200 on R4; a total of 1,400 were planted.

Photo 41: Upper Rock Creek Photopoint 5: upstream end of Reach 3 (Salmon Creek from below the county road to the confluence) looking downstream. During channel reconstruction in 1998, this channelized reach was left largely untouched, and therefore is somewhat incised. The remains of the old dike are visible on the left bank; this posed problems for planting close to the stream.

Photo 42: Upper Rock Creek Photopoint 6: downstream end of Reach 3, looking up Salmon Creek. Note dense and tall graminoid cover, resulting in a very high competition rating.

Photo 43: Upper Rock Creek Photopoint 7: upstream end of Reach 4, looking down Rock Creek from the confluence of Salmon and Dry Creeks.

Photo 44: Upper Rock Creek Photopoint 8: downstream end of Reach 4, looking up Rock Creek.

Photo 45: Herbicide damage to a dogwood seedling; surprisingly, herbicide was applied inside the protector and on the surrounding mulch. Unfortunately this didn't even kill the target Canada thistle. At monitoring, this seedling (and many like it) were alive and counted as such. However, it remains to be seen if the desired vegetation pulled through.

Upper Rock Creek 2008 Reach 3 and 4 Discussion: Results from the monitoring for Reaches 3 and 4 is similar to that in Reaches 1 and 2. Overall survival was better, at 85.9%, but this project has only endured almost 1 ½ growing seasons. Seven species had greater than 90% survival, with several of those at or very near 100%. Cottonwood, spruce and snowberry had the lowest survival, in the 69 to74% range. Numerous seedlings on Reach 3 exhibited herbicide overspray damage, in particular redosier dogwood (Photo 45). The spray contractor used a new combination of chemicals, including volatile 2,4-D herbicide, to combat yellow toadflax and thistles in 2009. This spray did damage to

nearby seedlings, in particular when herbicide was applied to weeds growing in the wood mulch and inside the browse protectors.

The spruce seedlings were very small when planted, with tops only 6 inches tall. The combination of short 30 CI roots and short tops may have contributed to losses during flooding to this species. In addition, their shorter roots may have limited their ability to access groundwater in the heat of summer.

Willow cuttings survival throughout the URC project is lower than anticipated, particularly given the extra care given to cuttings selection, collection, storage, and installation. It is likely the cuttings were installed too low on the banks, and experienced two seasons of inundation during the majority of the growing season. This situation likely resulted in lowered vigor and possible mortality. Some browsing to cuttings was noted. Future cuttings installations on this site should specify taller (4 foot) cuttings, or specify installation further up the bank. Tops should be left longer, although the "1/3 out and 2/3 in" planting rule should still be followed. This will allow the above-ground portion of the cutting to reach above high water levels in order to produce branches and photosynthesize during flooding.

Photo 45: Typical surviving willow cutting on Reach 3. At this point, it is unclear whether the plant will establish; the combination of browsing and inundation is a tough hurdle.

The competition rating on these reaches is rather high (4), but mulch is holding up very well and is still effective at reducing competition.

Upper Rock Creek Recommendations, Reaches 3 and 4: Plant protector maintenance and browse repellent applications (where the seedlings protrude from the protectors) should continue through 2012, at least twice per growing season. By this time woody plants should be large enough to handle the current level of browse. We recommend that the landowners exclude the still-recovering riparian area from grazing for at least another 10 years.

Maintenance watering could continue on this project for another year or two, in order to keep the seedlings growing well. However, if summer drought conditions occur watering should definitely be conducted in order to protect in significant time and effort invested in this restoration. Seedlings would

also benefit from weeding for another year or two, if possible. However, this is an expensive and time-consuming undertaking. Herbicide should not be applied at all to mulch rings, or inside plant protectors. Extreme care should be taken when spraying near woody plants, as drift and volatilization can occur.

5. General Discussion and Recommendations

The restoration and revegetation projects assessed herein highlight the wide range of site conditions, project goals and funding sources that can be encountered in the Blackfoot Watershed. The most successful projects utilized a comprehensive approach, beginning with design and planning (such as seed collection and custom plant growing), reconstruction, installation, and follow-up with well-planned maintenance and monitoring programs. While this may seem a luxury given the climate of limited restoration funding, we feel this type of approach should be the goal project designers and managers strive for in order to best achieve recovery goals.

Refer to Appendices B and C for in-depth comparisons of the eight projects. Appendix B looks at the range of methods used coupled with some environmental conditions and survival figures.

Appendix C reviews survival by all species across the board, to better gauge which species and container sizes performed better. Survival percentages are averaged for all projects by species. We also looked at species survival with two of the most problematic (i.e. insurmountable design problems) projects, Poorman and Lower Rock Creek, removed from the analysis. We feel these projects had the effect of creating too much "noise" to the averaged survival percentages, making it difficult to tell with species performed better across the board.

Revegetation projects will be most successful when methods are customized to individual project site conditions and ultimate project goals. For instance, aggressive browse control measures should be included in project design where browse pressure is known to be high. Investing money and effort into revegetation projects that get browsed to the ground one year after planting does not help establish support for publicly funded revegetation. Similarly, planting when natural revegetation is occurring, or may soon occur, can also give "Restoration" a bad name. We recommend land managers and project designers utilize the following steps when developing a revegetation or restoration plan.

5.1 Recommendations for Revegetation Project Design and Installation:

1. *Identify project goals*. Clearly defined project goals help to direct successful restoration efforts and simplify monitoring and maintenance requirements in the future.
2. *Determine if adequate natural vegetation exists on site*. Natural regeneration can occur relatively quickly when conditions are favorable.
3. *Before planting, consider waiting at least two growing seasons after stream channel reconstruction* to avoid miscalculations in stream hydrology and groundwater interactions. Excessive flooding, channel incisement, and/or channel widening will all adversely affect seedling survival. This delay will also help refine follow-up revegetation needs, methods, and plant placement.
4. *Incorporate passive revegetation techniques*. Low-tech techniques, such as bank-full benches, cutting trenches, bioengineered bank treatments, and woody floodplain debris. These "low-tech" techniques can be very effective and less costly than installing large numbers of rooted plants.
5. *Always choose locally-occurring native plant species for revegetation projects*. Just because something is native to Montana, or even western Montana, doesn't mean it will succeed locally. The middle Blackfoot is a tough place for a Bitterroot Valley plant in mid-winter or even summer. Keep in mind that some species, such as dogwood and certain willow species, may not appear in reference reaches because of domestic and wildlife browse pressure. Also keep in mind that pioneer species

which you may want to include may also not occur in reference reaches, having been crowded out by "climax" species.

6. *Select site-adapted native plants whenever possible*. This requires substantial lead time for adequate plant production. Most nurseries require a minimum of 2 years to get woody species up to a large container size. Nurseries will require that seed be collected for contract orders well in advance of propagation. (See specific species recommendations below.)
7. *Control weed infestations before project installation*. Whenever possible, invasive weed populations should be controlled before groundwork begins. This minimizes impacts to restoration seedlings from herbicide applications..
8. *Assess weed populations and aggressive rhizomatous grasses on site to determine mulch/weed barrier needs*. Invest in up front weed barriers or mulch to protect high value plantings. Remove competing vegetation before planting and mulch installation. Ensure that the "scalp" is of sufficient size to reduce the competition problem.
9. *Beware of reed canarygrass* (*Phalaris arundinacea*). Small infestations of this aggressive and massive riparian grass can strangle any revegetation efforts within a matter of years. It can grow to heights of 6 feet in the Blackfoot, and cause channel avulsion and braiding as it displaces and confines the channel. Do not transplant sod mats containing this aggressive weed, in particular from one restoration project to another.
10. *When planting seedlings, "field fit" the design to the site*. For example, if the planting plan prescribes installing plants in an area flooded for much of the growing season, move the planting group to higher ground. Field fitting helps project managers put plants where they will do best according to actual, on-the-ground conditions. Visit the site as often as possible before planting to determine appropriate planting zones based upon actual site hydrology.
11. *Always build a comprehensive maintenance plan during the design phase of the revegetation project*. Maintenance should include weed control, watering, browse protector maintenance and/or browse repellent application, survival monitoring, and project cleanup (such as eventual removal and disposal of protectors). In addition to accomplishing obvious maintenance tasks, a regular maintenance program can help managers identify problems as they arise, and allow time for solving problems before they become too large to tackle. Watering, weeding and plant protector maintenance all pay off in improved seedling survival and growth.
12. *Schedule follow-up inspection visits* to evaluate successes and failure, and to catch problems before they arise or before they get too big to handle. This can be done simultaneously with maintenance.
13. *Grazing management plans must be built into revegetation projects***.** Grazing management is a key component to successful revegetation projects. Landowners and land managers need a clear understanding of what livestock grazing practices are acceptable and what is not acceptable on their project sites. Grazing exclosures need to be budgeted during project design and installed immediately following revegetation. Poor grazing management can lead to project failure in a matter of a few short days.

5.2 Recommendations for Revegetation Tools and Techniques:

1. *Use larger container sizes* (such as "Tall One" 1 gallons), which appear to perform better than smaller sizes (such as bareroot stock or 7 or 10 CI tublings) (refer to Appendices B and C). Larger seedlings also have deeper roots, requiring less time to establish and likely less maintenance watering. Larger plants, however, require mechanized installation, so managers need to carefully consider mechanical impacts and the expenses associated with them.

2. *Use mulch.* Mulch improves seedling survival and reduces weeds and competition. Locally-available wood chip mulch appears to outperform manufactured mulch matting, and is less expensive (refer to Table 26 and Appendix B). Applying mulch, whether wood chips or pre-made mats, can effectively increase survival and vigor of seedlings. Wood mulch may, however, require mechanical equipment to efficiently transport it around the site, and to assist in the
3. *Invest up front in aggressive browse control structures to protect high value plantings*. If browsing is a problem, use adequate browse protection. Cages or plant protectors work better than browse sprays, but require significant maintenance inputs, and eventual removal/disposal. Use adequate staking and tying material to keep browse structures upright and secure for at least 3 growing seasons. Cluster-fencing is a good option on some sites instead of installing individual seedling protectors. Installation of an herbivore-proof fence around a grouping of seedlings can be less costly than individual protectors, and also may require less maintenance.
4. *Apply woody debris*. Woody debris, when applied heavily to a planting area, can also be an effective browse deterrent. (This is sometimes referred to as a brush fence, but it need not be installed in a linear fashion.) Scattered debris can also help build and trap soils and native seeds, speeding site recovery.
5. *Incorporate mycorrhizal inoculants.* Mycorrhizal fungi are naturally occurring beneficial organisms which can enhance a plant's ability to gather available soil nutrients and withstand drought stress. Project managers should consider adding mycorrhizal inoculum at the time of planting on a case by case basis. Mycorrhizal inoculum is an additional cost for managers to consider, as is the extra labor necessary to incorporate it. On revegetation sites where nutrients are limited or soil is heavily disturbed, naturally occurring mycorrhizal fungi may not be present. In such cases, managers or project designers may wish to use a mycorrhizal inoculum treatment to increase plant survival. Alternatively, managers can specify that plant suppliers provide containerized plants with established mycorrhizae populations already in place. Research indicates that containerized seedlings with established mycorrhizae populations at the time of planting are better able to withstand transplant shock and become established on site than plants that are installed with mycorrhizal inoculants upon outplanting. Significant increases in plant survivability attributed to mycorrhizal amendments may only be achievable on heavily disturbed sites.

5.3 Blackfoot Watershed Species Recommendations:

1. *Use site adapted plant material* (rather than simply regional) whenever possible. Growing conditions in the Blackfoot Watershed can be quite challenging, and site-adapted material is more capable of thriving under such conditions than non site-adapted planting stock. Take, for example, results from restoration projects on Kleinschmidt Flat's Rock Creek (see projects 4.6, 4.7 and 4.8). We saw better seedling survival on the two projects that utilized site-adapted stock, and the poorest seedling survival on the project which used only regional stock.
2. *Significant lead time is necessary* to employ site-adapted stock. Managers need to identify seed or cuttings crops, contract with local or regional growers, and allow ample time for adequate seedling production and hardening off prior to planting (generally two weeks minimum).
3. *Use the most effective species possible*. Some species perform better in revegetation situations than others (Appendices B and C). In this study, birch species, chokecherry, and wolfberry had the lowest survival. Snowberry, cottonwood, and aspen were problematic as well. We found that willow success varied widely, but in general rooted plants performed significantly better than unrooted cuttings. Douglas hawthorn, wood rose, ponderosa pine and serviceberry appeared to

perform very well (above 80%) on a range of sites; it should be noted that these species are all "generalists", and require less water to survive.

4. *Select a diverse mix of species* to revegetate future restoration projects. Crop failures can occur if a limited range of species is installed. Designing complicated species mixes can be challenging, however. Managers need to consider plant stock availability (think ahead) and seed sources as the ultimate factors in designing a revegetation mix.

5.4 Labor and Contracting Considerations:

1. *Utilize volunteer labor for appropriate revegetation tasks*. Tailor volunteer efforts to less crucial restoration tasks, such as maintenance watering, weeding, and plant protector maintenance and removal. Cuttings collection and processing, and debris scattering are also excellent tasks for volunteers.
2. *Use trained and professional crews to ensure better seedling survival* through improved planting quality and material installation. Long grueling hours of hard physical labor may not be optimal for volunteers. Professional crews should be experienced in adherence to specifications, quality control, implementation efficiency, and a wide range of restoration techniques.
3. *When using volunteer labor, minimize project failures by employing professionals to assist in the volunteer effort*

Appendix A. Glossary of Acronyms and Abbreviations

BBCTU	Big Blackfoot Chapter of Trout Unlimited, based in Ovando, MT
BC	Blackfoot Challenge, watershed conservation organization based in Ovando, MT
BNP	Blackfoot Native Plants of Potomac, MT, a native plant nursery
BT	Bull trout, a native fish species listed for protection under the Endangered Species Act
CBF	The Cinnabar Foundation
CF	The Chutney Foundation
CI	Cubic inches of measure, a measure of plant container pot/root ball size
DEQ	Montana Department of Environmental Quality
DNRC	Montana State Department of Natural Resources and Conservation, here referring to the Montana Conservation Seedling Nursery of Missoula, MT
EQIP	Environmental Quality Incentives Program, an NRCS program funded by periodic USDA Farm Bills
FVLT	Five Valleys Land Trust, based in Missoula, MT
FWP	Montana Department of Fish, Wildlife and Parks
FWS	U.S. Fish and Wildlife Service
GEC	Geum Environmental Consulting, Inc. of Hamilton, MT, a restoration consulting and design firm
GPS	Global Positioning System, referring here to the use of a hand-held GPS unit
GR	Greenwing Restoration, LLC of Ovando, MT, restoration design and installation contractor
MT	State of Montana
NPCD	North Powell County Conservation District
NRCS	USDA Natural Resource Conservation Service, a branch of the USDA providing restoration design assistance and funding thru Farm Bill programs.
RDG	River Design Group, Inc. of Whitefish, MT, a stream channel design and engineering firm
RTI	Reforestation Technologies International of Salina, CA, a revegetation products supplier
T1	“Tall One”, A restoration plant container size of 1 gallon, measuring 4”x4”x14”, or 175 cubic inches, designed and manufactured by Stuewe and Sons, Inc. of Corvallis, OR
TMDL	Total Maximum Daily Load, a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards. Regulated by the USEPA and MT DEQ
TNC	The Nature Conservancy of Montana
TNT	TNT Excavating, Inc. of Ovando, MT, heavy equipment operators specializing in stream channel restoration
TU	Trout Unlimited, or Montana Trout Unlimited
URC	The Upper Rock Creek project, evaluated here, and consisting of portions of Dry, Salmon, and Rock Creeks.
USDA	United States Department of Agriculture
USFS	USDA Forest Service
VWCS	Vander Meer’s Wildland Conservation Services of Missoula, MT, revegetation installation contractor and native plant nursery
WRG	Watershed Restoration Group, Inc. of Hamilton MT, revegetation installation contractor and native plant nursery
WSCT	Westslope cutthroat trout, a native fish species listed by the State of Montana as a species of “Special Concern”, and the USFS and BLM as “Sensitive”
WTF	The Wild Trout Foundation
WW	West Water Consultants, Inc. of Corvallis, MT, a stream channel design firm.

Appendix B. Assessment Summary I: Seedling Survival and Treatment Comparison

Project/ Creek	Planting Date	Seedling Source	Number of Plants/ Cuttings	Container Size(s)	Mulch	Seedling Protectors	Overbank Flooding During Growing Season	Volunteer or Professional Planting Crew	Seedling Survival	Maintenance/Comments
Ashby	Fall 2006	W MT?	1,965 8,000	Tall One 1 gallon	36" Plastic mats	8"x48" rigid plastic mesh cages	None, or Limited	Both	**32%**	Once or twice per summer since planting: cage maintenance and some watering. Cages collapsing,
Dunham	Fall 2008	Blackfoot, W MT	300 4,000	Tall One 1 gallon & 1 gallon pots	None, but some debris	None	Limited	Professional	**91%**	Twice since planting: Treeguard browse repellant application and watering of plants and cuttings.
Hoyt	Spring 2008	Blackfoot, W MT?	411	Tall One 1 gallon	36" ring of pole yard peelings	None	Extensive	Volunteer	**30%**	No watering. Once per year since planting: Treeguard browse repellant application. Very aggressive
Jacobsen Spring	Fall 2007	Blackfoot, W MT?	500	Tall One 1 gallon	36" ring of pole yard peelings	None	Limited	Volunteer	**68%**	No watering. Twice per year since planting: Treeguard browse repellant application. Lower Jacobsen not
Poorman	Fall 2004	Mostly regional	1,475	7 & 10in^3, bareroot	Woven geotextile	3"x18" rigid plastic mesh cages	No	Volunteer	**5%**	No maintenance. Followed standard NRCS riparian reveg protocols. Dry riparian site with plantings well
Lower Rock	Spring 2005	W MT?	3,978 2,780	3"x18" PVC	None	None	Extensive	Professional	**21%**	No maintenance. Planted with Stinger mounted excavator. Some upland species planted in
Middle Rock	Fall 2007	Blackfoot, W MT?	722	Tall One 1 gallon	36" ring of pole yard peelings	None	Moderate	Volunteer	**78%**	No watering. Twice per year since planting: Treeguard browse repellant application.
Upper Rock 2007	Spring 2007	Blackfoot	2,136 500	Tall One 1 gallon, few bareroot and 30in^3	36" ring of hog fuel	12"x48" rigid plastic mesh cages	Moderate	Professional	**84%**	Twice per summer since planting: cage maintenance and watering, some weeding. Weed spraying in riparian. Treeguard on tops.
Upper Rock 2008	Spring 2008	Blackfoot	5,123 1,450	Tall One 1 gallon, some 30in^3	36" ring of pole yard peelings	12"x48" rigid plastic mesh cages	Moderate	Professional	**86%**	Same as above.

Appendix C. Assessment Summary II: Seedling Survival by Project and Species. Species that had greater than 100% survival (i.e. more of that species were actually planted than were reported by the project manager) have been changed to 100% here. Thus, the survival by species reported here may be slightly different than that shown in the document tables.

		Ashby	Dunham	Jacobsen	Hoyt	Poorman	Lower Rock	Middle Rock	U Rock Reach 1	U Rock Reach 2	U Rock Reach 3	U Rock Reach 4	Average by Species	Average w/o Poorman	Average w/o Po & L Rk	Species
	Survival by Project	32.2%	91.3%	67.8%	29.9%	5.1%	20.9%	78.2%	81.0%	87.6%	78.9%	88.9%	60.2%	65.7%	70.6%	<- (live/number planted)
1	American plum					10.4%							10.4%			American plum
2	aspen	18.0%		40.0%		0.0%			81.0%	96.6%	90.7%	99.1%	60.8%	70.9%	70.9%	aspen
3	birch, bog			58.0%									58.0%	58.0%	58.0%	birch, bog
4	birch, river			50.0%	15.6%				83.7%	100.0%	100.0%	90.9%	73.4%	73.4%	73.4%	birch, river
5	birch, river & bog	39.0%						86.1%					62.6%	62.6%	62.6%	birch, river & bog
6	black cottonwood		83.3%			0.5%	9.3%		69.2%	73.9%	68.4%	76.9%	54.5%	63.5%	74.3%	black cottonwood
7	chokecherry	15.2%	85.0%	28.0%	33.3%	5.0%		34.5%	50.0%	85.0%	100.0%	85.1%	52.1%	57.3%	57.3%	chokecherry
8	Douglas fir					2.0%							2.0%			Douglas fir
9	Engelmann spruce								48.9%	74.6%	68.9%	76.6%	67.3%	67.3%	67.3%	Engelmann spruce
10	golden currant		73.3%	70.0%	35.3%			85.4%					66.0%	66.0%	66.0%	golden currant
11	gray alder	10.7%	100.0%	60.0%	2.1%		13.7%	86.0%	81.4%	84.9%	100.0%	90.4%	62.9%	62.9%	68.4%	gray alder
12	hawthorn	71.0%		55.0%	42.6%			100.0%	87.1%	100.0%	98.2%	100.0%	81.7%	81.7%	81.7%	hawthorne
13	ponderosa pine								89.1%	81.3%	97.1%	88.9%	89.1%	89.1%	89.1%	ponderosa pine
14	redosier dogwood	13.4%	100.0%	70.0%		3.3%	27.4%	100.0%	82.4%	92.0%	68.3%	98.5%	65.5%	72.4%	78.1%	redosier dogwood
15	serviceberry		73.3%				20.0%		80.0%	75.0%	85.3%	100.0%	72.3%	72.7%	82.7%	serviceberry
16	snowberry								85.9%	66.7%	69.7%		74.1%	74.1%	74.1%	snowberry
17	wolfberry			45.0%	8.5%			59.8%					37.8%	37.8%	37.8%	wolfberry
18	wood rose	58.7%	100.0%	90.0%				87.1%	93.8%	93.3%	90.0%	96.7%	88.7%	88.7%	88.7%	wood rose
19	willow, bebb	16.0%						55.9%					36.0%	36.0%	36.0%	willow, bebb
20	willow, booth & drum							95.1%					95.1%	95.1%	95.1%	willow, booth & drum
21	willow, booth	68.0%											68.0%	68.0%	68.0%	willow, booth
22	willow, cuttings						11.0%		59.7%	40.0%	56.0%	43.0%	41.9%	41.9%	49.7%	willow, cuttings
23	willow, drummond	52.0%	100.0%										76.0%	76.0%	76.0%	willow, drummond
24	willow, pacific					3.0%							3.0%			willow, pacific
25	willow, sandbar	39.5%						93.8%					66.7%	66.7%	66.7%	willow, sandbar
26	willow, yellow	45.3%											45.3%	45.3%	45.3%	willow, yellow
27	willow, unknown species			81.2%	42.8%		20.0%						48.0%	48.0%	62.0%	willow, unknown species
													57.7%	65.6%	67.9%	= arithmetic mean