Therriault Creek Riparian Revegetation 2011 Monitoring and Maintenance Report

Contract #120001

Prepared for:

Montana Fish, Wildlife and Parks
385 Fish Hatchery Road
Libby, MT 59923

Prepared by:

Geum Environmental Consulting, Inc.
307 State Street
Hamilton, MT 59840

GEUM
ENVIRONMENTAL
CONSULTING, INC

Table of Contents

Introduction

This report describes work completed in 2011 at the Therriault Creek restoration project site under Fish, Wildlife and Parks Contract #120001. A total of four tasks were included in contract #120001:

- Task 1. Monitoring
- Task 2. Maintenance
- Task 3. Revegetation Treatments
- Task 4. Reporting

Work completed in 2011 represents the continued commitment of project stakeholders to the long-term success of the Therriault Creek Riparian Revegetation Project. As described in previous reports, successfully converting the riparian vegetation along Therriault Creek at the site to a mosaic of native riparian shrubs and trees requires a multi-year, phased approach that includes maintenance and monitoring during the establishment period while vegetation becomes adapted to site conditions. The intention of the initial phase, completed in fall 2007, was to implement a range of treatments based on a detailed evaluation of existing site conditions and ecological processes driving vegetation succession at the site. Effectiveness monitoring of the treatments installed in 2007 was completed in 2008 and 2009. The results were used to determine maintenance needs for 2007 treatments and identify additional revegetation treatments based on how effective the 2007 treatments were at achieving project goals and objectives. A small number of additional revegetation treatments were implemented in September and October 2009 (Phase II). Monitoring continued in 2010 and the results of this and previous monitoring were used to determine treatments for the downstream portion of the project (Phase III). Phase III treatments were implemented during October 2010 and are reported in *Therriault Creek Riparian Revegetation 2010 Implementation and Monitoring Report* (Geum Environmental Consulting, Inc. 2010).

The purpose of this report is to describe the results of 2011 effectiveness monitoring, describe maintenance activities completed in 2011 based on the results of 2011 monitoring, and provide recommendations for continued monitoring and maintenance at the site. Table 1 describes the tasks completed under Contract #120001.

Table 1. Tasks completed at Therriault Creek restoration site under Contract #120001 in 2011.

Monitoring	
Task	**Description and Quantity**
Phase I and II	
Photo documentation	Photos were taken of all treatments. Treatments include: 16 containerized planting units, 2 long term planted solarization units, 3 temporary solarization units, 2 vegetated soil lifts, 800 feet of willow fascine, 400 feet of coir log fascines, and 5 woody debris structures.
Plant survival	Survival monitoring was completed for 3 containerized planting units and 1 planted solarization unit.

Monitoring	
Task	**Description and Quantity**
Record qualitative observations	Observations were recorded for all revegetation treatments, plant community development, channel conditions, and other ecological processes influencing plant community succession and site conditions.
Document maintenance needs	Maintenance needs were recorded for all treatments.
Phase III	
Survival monitoring	Survival monitoring was completed for approximately 400 containerized plants (40 percent of total installed) in nine planting units.
Photo documentation	Photos were taken of all treatments. Treatments include: 21 planting units and 1 planted solarization unit.
Documentation of maintenance needs	Maintenance needs were recorded for all treatments.
Maintenance	
Task	**Description and Quantity**
Watering	Watering was completed at 6 planting units (approximately 300 plants) once in August.
Browse protectors	Expansion of approximately 70 browse protectors and removal of approximately 160 browse protectors due to plant size or mortality was completed in Phase I. Thirteen small exclosures were installed around groups of shrubs in Phase I. Browse protectors in Phase III were straightened and re-secured.
Solarization fabric	Edges of fabric were re-secured and weeds hand-pulled at the base of plants at one long term planted solarization plot in Phase III.
Revegetation Treatments	
Task	**Description and Quantity**
Fabric removal and seeding of temporary solarization plots	Fabric was removed from one temporary solarization plot and partially removed from a second temporary solarization plot in Phase I. Both plots were seeded with a native forb and grass mix and one plot was planted with dormant willow cuttings.
Fabric removal, seeding and expansion of planted solarization plots	Fabric was removed from two planted solarization plots in Phase I. Bare soil was seeded with native forb and grass mix.
Herbicide application	Herbicide was applied in late July and targeted four species and approximately 28 acres.
Reporting	
Task	**Description and Quantity**
Reporting	This report was prepared to summarize the results of monitoring, maintenance and revegetation activities, and provide adaptive management recommendations for future years.

2011 Effectiveness Monitoring

This section describes the results of effectiveness monitoring completed in July 2011. Effectiveness monitoring was completed for treatments installed in Phase I (2007), Phase II (2009), and Phase III (2010) of the project. Details on the Therriault Creek riparian revegetation project including: previously implemented revegetation strategies and treatments; effectiveness monitoring methods; results of 2008, 2009 and 2010 effectiveness monitoring; and the adaptive management framework for the project can be found in five separate documents:

- *Therriault Creek Riparian Revegetation Plan* (Revegetation Plan) prepared for Kootenai River Network (Geum Environmental Consulting, Inc. 2007a);
- *Therriault Creek Riparian Revegetation Plan Implementation Report* (2007 Implementation Report) prepared for Montana Fish, Wildlife and Parks (Geum Environmental Consulting Inc. 2007b);
- *Therriault Creek Riparian Revegetation 2008 Monitoring Report* prepared for Kootenai River Network (2008 Monitoring Report) (Geum Environmental Consulting, Inc. 2008); and
- *Therriault Creek Riparian Revegetation Maintenance and Monitoring 2009 Report* (2009 Monitoring Report) prepared for the Kootenai River Network (Geum Environmental Consulting, Inc. 2009); and
- *Therriault Creek Riparian Revegetation 2010 Implementation and Monitoring Report* (2010 Monitoring Report) prepared for Montana Fish, Wildlife and Parks (Geum Environmental Consulting, Inc. 2010).

As described in the monitoring reports, three types of monitoring are necessary components of the integrated monitoring and adaptive management program. These include: baseline, as-built, and effectiveness monitoring. ***Baseline monitoring*** documents the pre-restoration condition and is described in the Revegetation Plan prepared for the project (Geum 2007a). ***As-built monitoring*** documents completed treatments and for the treatments implemented in fall 2007, is provided in the 2007 Implementation Report (Geum 2007b). ***Effectiveness monitoring*** addresses whether project objectives are being met, determines maintenance needs, and provides inputs into decision pathways for adaptive management. The results of 2008 effectiveness monitoring are provided in the 2008 Monitoring Report (Geum 2008). The 2009 report provides the results of 2009 effectiveness monitoring for treatments implemented in 2007, compares those results with 2008 effectiveness monitoring results, and describes results of as-built monitoring for revegetation treatments implemented in September and October 2009 (Geum2009). The results of 2010 effectiveness monitoring, compared with the results of previous year's monitoring and the determination of 2010 maintenance needs and Phase III revegetation treatments, are provided in the 2010 Monitoring Report (Geum 2010). This report provides the 2011 monitoring results as well as the maintenance and revegetation treatments implemented as a result of the 2010 monitoring.

The focus of 2011 effectiveness monitoring was to verify trends in treatment effectiveness observed in 2008, 2009, and 2010; determine maintenance needs; and determine effectiveness of Phase III treatments. Figure 1 shows an overview of revegetation treatments installed at the project site. Figure 2 shows the locations of monitored treatments in Phase I and Phase III.

Phase II treatments included removal of solarization fabric, protection of residual shrubs, and installation of dormant willow cuttings within the Phase I area. Effectiveness monitoring completed in 2011 included:

- General observations of all revegetation treatments in Phase I, II and III;
- Photographs of all revegetation treatments;
- Repeat survival monitoring of three containerized planting units in Phase I;
- Repeat survival monitoring of one planted solarization plots in Phase I;
- Survival monitoring of 400 plants in nine planting units representing 40 percent of plants installed in Phase III; and
- Documentation of maintenance needs for all revegetation treatments.

Table 2 provides a summary of the results of 2011 effectiveness monitoring, the decision making pathway for making adaptive management recommendations based on results of monitoring, and a summary of the recommendations, such as maintenance needs or continued monitoring, based on monitoring results. The following sections discuss the results of 2011 monitoring and compare those results with 2008, 2009, and 2010 effectiveness monitoring results where possible.

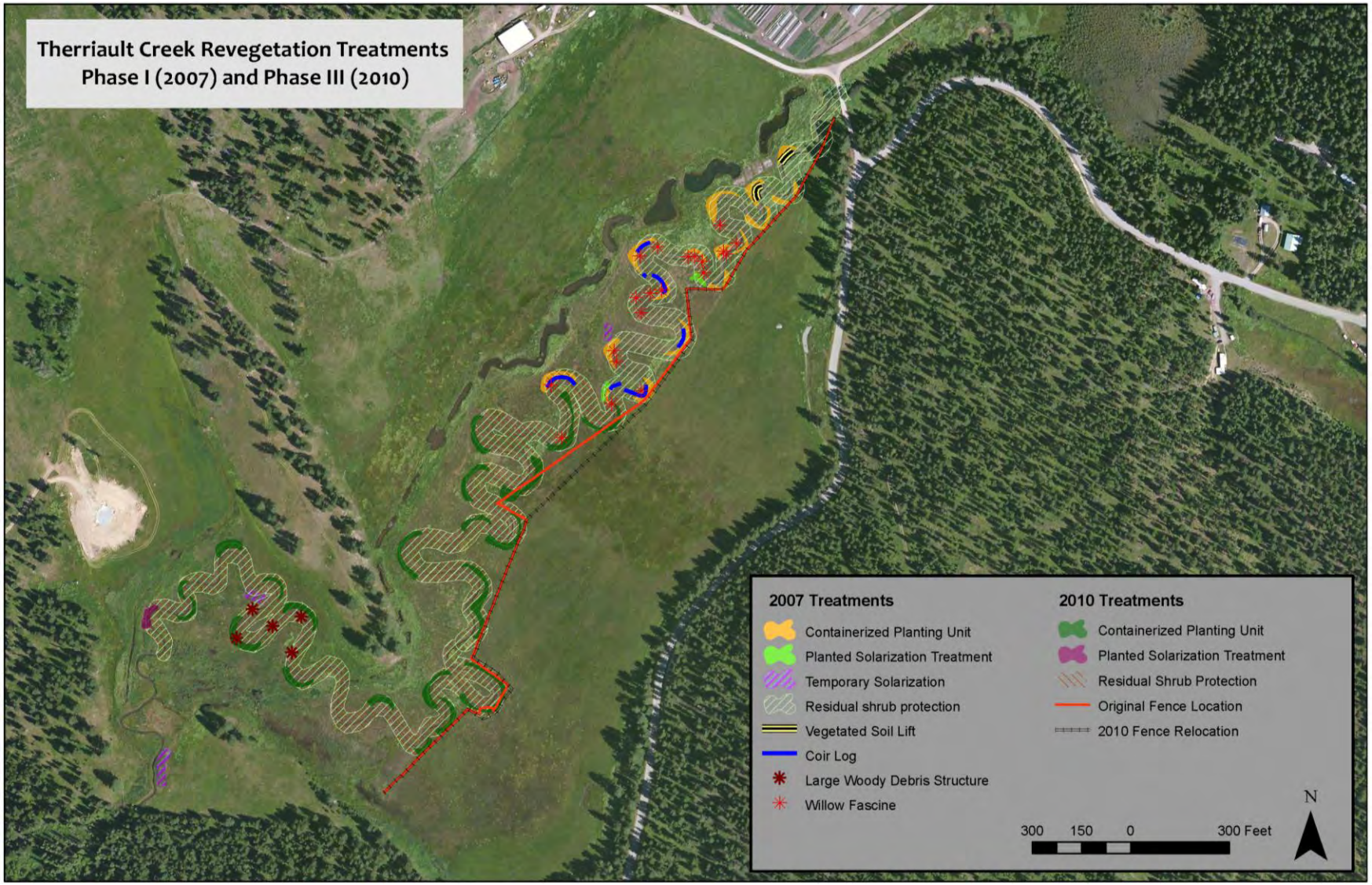


Figure 1. Overview figure showing riparian revegetation treatments installed in 2007 and 2010 at the Therriault Creek Riparian Revegetation project site.

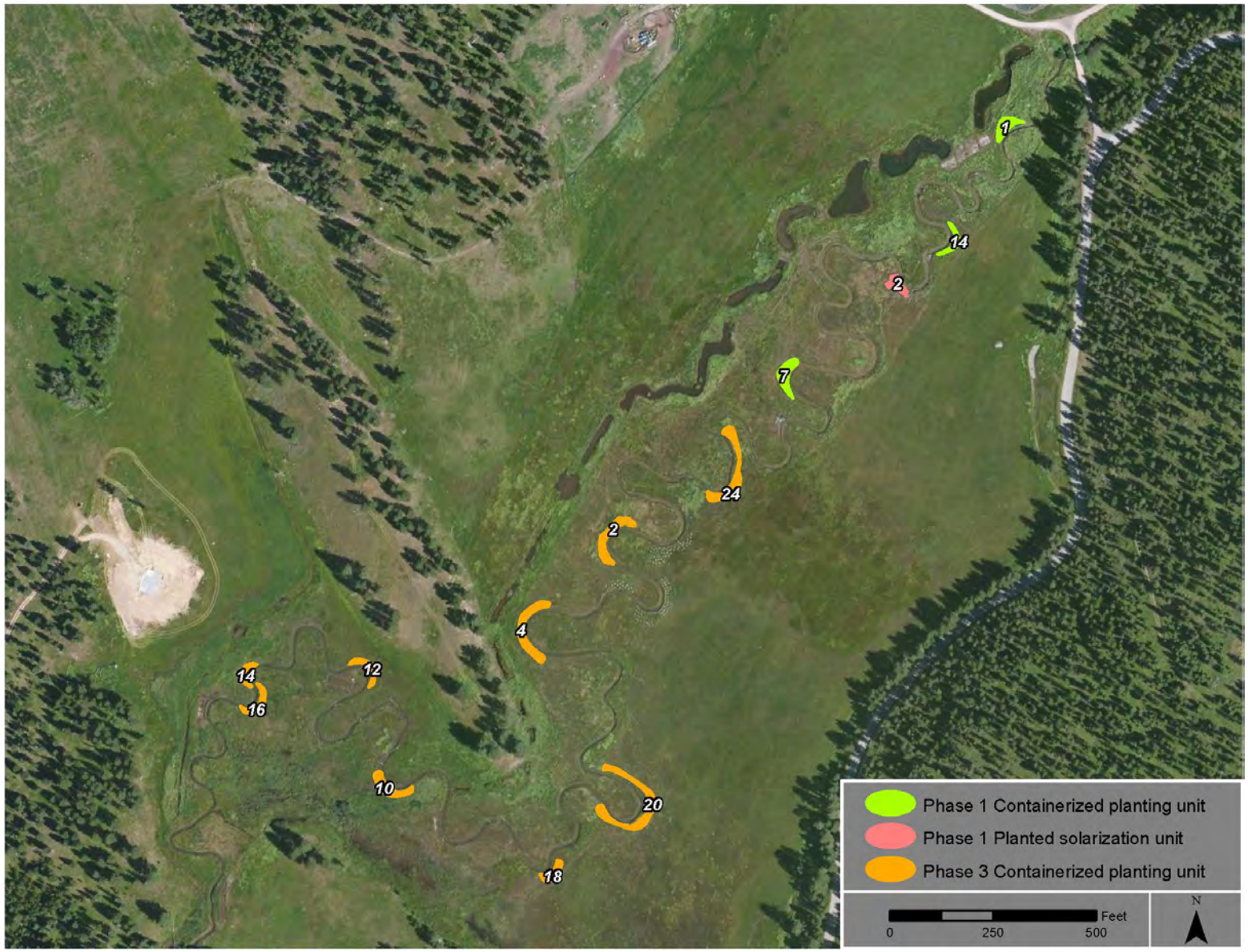


Figure 2. Effectiveness monitoring overview figure showing the locations of planting units monitored in 2011 at the Therriault Creek Riparian Revegetation project site.

Table 2. Summary of results of 2011 effectiveness monitoring, decision pathway for making adaptive management decisions based on the results of monitoring, and recommendations made for 2011 and 2012 for riparian revegetation treatments installed at the Therriault Creek Riparian Revegetation project site.

Treatment[1]	Decision Pathway for Maintenance and Adaptive Management[2]	2011 Effectiveness Monitoring Results	Adaptive Management Recommendations Based on Monitoring
Residual Shrub Protection	(1) If protected shrubs are greater than 3 feet above the height of the browse protector, browse protectors should be removed. If plants are less than 3 feet above the height of the browse protector, leave the protector in place. (2) If protected shrubs have filled greater than 80% of the capacity of the browse protectors, expand protector to accommodate growth. (3) If hedging of protected shrubs is occurring at the height of the browse protector, evaluate the effects on the health of the plant. If the plant appears healthy, no action is needed. If the plant appears stunted or otherwise unhealthy, additional measures for protection may need to be evaluated.	Residual shrubs protected in 2007, 2009, and 2010 continue to thrive compared to unprotected residual shrubs which remain stunted and browsed. In general, sandbar willows have grown greater than 3 feet above browse protectors. Red-osier dogwood, birch and other willow species vary in the height they have grown above browse protectors, but most plants are robust and have filled more than 80% of the browse protector capacity. Hedging at height of the protector is common on red-osier dogwood but plants appear healthy.	In 2011, repaired and re-secured any damaged protectors that are still needed to protect shrubs. Removed browse protectors from individual plants that had outgrown protectors by greater than 3 feet in height or more than 80% of the capacity of the protector. Where plants occur in clumps, used recycled browse protectors to create a small fence around the clump of plants to allow plant expansion but continue to protect the plants from browse and damage. In 2012, evaluate browse or damage to released shrubs, the need for additional expansion or removal, and the effectiveness of the small exclosures.
Containerized Planting	(1) If survival of containerized shrubs in Phase III is greater than 80%, reduce the frequency of monitoring at the site. Continue to conduct annual maintenance site visits and implement necessary maintenance. (2) If survival is less than 80%, determine if additional irrigation or weed suppression measures are needed or if other site conditions are precluding growth (e.g. soils). If limitations to survival are identified, consider re-planting poor survival areas.	Survival of containerized plants in Phase I remained high (90%) at one monitored unit and dropped to 66% and 65% at the other two monitored units. Although survival dropped at two units, it is unclear if this trend is consistent for all of Phase I plants. Surviving plants are generally very robust and beginning to provide riparian function such as shade for the stream and habitat for songbirds. Browse and ungulate damage remain a limiting factor but many plants have grown to a height and diameter that can withstand some browse pressure. In Phase III, survival ranges from 80%	In 2011, expanded or removed browse protectors on shrubs that have filled the capacity of the protectors. Recycled browse protectors to create small fences around planting units or clumps of plants where browse protectors are limiting expansion of shrubs. Very little supplemental watering was necessary given the prolonged duration of high flows and very wet floodplain conditions throughout Phase I and III planting units. Six units in Phase III were watered. In 2012, re-monitor Phase III plants to ensure the trend of high survival continues. Monitor additional planting units in Phase I to determine if the drop in survival is occurring

Treatment[1]	Decision Pathway for Maintenance and Adaptive Management[2]	2011 Effectiveness Monitoring Results	Adaptive Management Recommendations Based on Monitoring
		to 100%. Plants are small and standing water was present within a number of Phase III planting units until the middle of August.	in other Phase I units. Re-evaluate Phase I and III plants for maintenance needs.
Solarization: Planted	(1) If survival remains above 80%, reduce the frequency of monitoring at the site. Continue to conduct annual maintenance site visits and implement necessary maintenance. (2) If survival remains above 80% begin fabric removal around select shrubs in Phase I sites. Leave fabric installed in Phase III in place. (3) If survival drops below 80%, try to determine causes. Consider removing fabric and re-planting once causes are determined.	Survival within planted solarization units is 80%. Most plants have out-grown the browse protectors. Grasses and grass root systems under fabric have been effectively killed. Surviving plants continue to grow vigorously. These plots are ready for fabric removal and seeding. Removing the fabric in planted plots will allow plants to sucker and expand their cover. Planted solarization unit in Phase III was not monitored for survival. Grasses and grass roots are still viable under fabric.	In 2011, removed all fabric from planted solarization units in Phase I leaving a 2-foot by 2-foot square of fabric around the base of each survival plant. Seeded plots with a mix of native shrubs, forbs and grasses. Included a sterile cover crop to take up niches that could be occupied by pasture grasses. Removed browse protectors from surviving plants. In 2012, evaluate natural recruitment and germination of seeded species in two plots where fabric was removed. Evaluate browse or other damage to released plants. Evaluate the potential to remove fabric from planted solarization plot in Phase III.

Treatment[1]	Decision Pathway for Maintenance and Adaptive Management[2]	2011 Effectiveness Monitoring Results	Adaptive Management Recommendations Based on Monitoring
Solarization: Temporary	(1) If percent cover of seeded or other desirable species is greater than 70%, expand plots to treat additional area and continue to evaluate sites each year for maintenance needs. (2) If percent cover of seeded or other desirable species is less than 70% and undesirable species are not present or less than 10% total cover, re-seed with native species. Consider adding soil amendments such as compost or mulch if appropriate. (3) If percent cover of seeded or other desirable species is less than 70% and undesirable species are present and greater than 10% total cover, try to determine causes and consider re-treatment with solarization fabric or chemical control once causes have been identified.	All fabric remaining in temporary solarization plots was ready for removal and seeding based on having effectively killed the grasses under the fabric. A mix of both undesirable and seeded species are present in temporary solarization plots 1 and 3. Cover of undesirable species, primarily including reed canarygrass and quackgrass, is greater than 10% in plot 3. Desirable species are present. Percent cover of seeded species was difficult to determine in Plot 1 due to the small size of new plants. Grasses under solarization fabric in plot 2 has been effectively killed. The plot is surrounded by infestations of reed canarygrass and Canada thistle.	In 2011, removed remaining fabric from temporary solarization plot 3 and seeded exposed soil. Removed half of the solarization fabric from temporary solarization plot 2 and seeded exposed soil and installed willow cuttings. Canada thistle in plot 1 was treated with herbicide. In 2012, evaluate germination and colonization of desirable species in temporary solarization plots 1, 2, and 3. Remove remaining fabric from temporary solarization plot 2 if seeding and willow cutting installation is effective. Re-seed, add additional cuttings, or hand weed as needed in all plots.
Vegetated Soil Lift	(1) If willow shoot height remains below 3 feet and overall percent cover is not increasing, apply chemical barriers to browse. (2) If willow shoot height is greater than 3 feet or density appears the same or increasing take no further action.	Willow cover is near 100 percent on both soil lifts. Approximately one foot of new growth was present at both sites. Browse was less severe than in years past at the time of monitoring. Willows are providing bank stability and in-stream shade and cover.	Continue to evaluate structures but no additional monitoring or maintenance is anticipated.

Treatment[1]	Decision Pathway for Maintenance and Adaptive Management[2]	2011 Effectiveness Monitoring Results	Adaptive Management Recommendations Based on Monitoring
Willow Fascines	Take no further action.	Intact willow fascines have trapped sediment and debris and are functioning to build depositional features within the channel margins and provide substrate for colonizing vegetation. Most fascines are buried with gravels and fine sediment. Some fascines have grown into small willow clumps within the channel margins.	Continue to evaluate structures but no additional monitoring or maintenance is anticipated. Treatments that use dormant willow cuttings using a mix of species should be considered for any supplemental revegetation at the site.
Large Woody Debris Structures	(1) If species composition adjacent to structures appears to have shifted, repeat transect monitoring to evaluate trend. (2) If species composition adjacent to structures appears to have not changed, continue to make annual visual observations of treatment effectiveness. Repeat transect monitoring in 2012.	Wood structures are promoting prolonged floodplain inundation during high flow events and elevating the water surface during base flows. Species composition adjacent to structures appears to have shifted to an overall wetter species composition. Due to high flows at the time of monitoring other intended functions of these structures such as trapping debris and sediment and providing fish habitat could not be observed.	In 2012, re-monitor transects to document shift in vegetation species composition. No additional maintenance is anticipated for these structures.
Coir Logs	(1) If willow shoot height remains below 3 feet and overall percent cover is not increasing, apply chemical barriers to browse to allow willows to grow and become more resistant to browse. (2) If willow shoot height is greater than 3 feet or density appears the same or increasing take no further action.	Willow cover continues to be variable overall, but has increased at most sites. New growth of approximately 1 foot was observed at most sites. Some sites have formed continuous dense bands of willows along the channel margin. Coir logs remain structurally intact and the channel is deepening below the logs at many sites.	Continue to evaluate structures but no additional monitoring or maintenance is anticipated.

Treatment[1]	Decision Pathway for Maintenance and Adaptive Management[2]	2011 Effectiveness Monitoring Results	Adaptive Management Recommendations Based on Monitoring
Herbicide Application	(1) If noxious weed infestations are documented, continue to treat infestations. (2) Continue to monitor for new infestations of Canada thistle, reed canarygrass, yellow toadflax, houndstongue, sulfur cinquefoil and any new weed species.	Herbicide applications have been effective at controlling most target species. Yellow toadflax and houndstongue are still present but are not spreading. Isolated patches of reed canarygrass have also decreased in the upper end of the project site. Canada thistle cover has been reduced in the upper end of the project site but young plants are present throughout the site. Dense infestations of Canada thistle are still present in the downstream end of the site, upstream of revegetation treatments, in the hayfield adjacent to the project site.	In 2011, treated yellow toadflax, houndstongue, isolated patches of reed canarygrass and all occurrences of Canada thistle at the site. In 2012, repeat weed mapping to evaluate effectiveness of treatments and set criteria for assessing the need for continued herbicide application. Based on 2012 weed mapping use herbicide to treat priority infestations of Canada thistle in summer 2012.

[1] See Figure 1 for treatment locations and previous reports for descriptions of treatments.
[2] From 2010 Report Adaptive Management Recommendations section.

Residual Shrub Protection

General observations of shrubs that were planted in 2003 during channel restoration and fitted with browse protectors in subsequent years were made in July 2011. Protected residual shrubs continue to grow vigorously. Many protected shrubs are over eight feet tall and are beginning to provide shade and instream cover as well as habitat for songbirds. Bird nests are present in some of the shrubs. Given the effectiveness of this treatment and rapid growth of protected shrubs, browse protectors were enlarged to accommodate growth and added to additional shrubs during maintenance activities in 2009 and 2010. Although these shrubs have grown vigorously since being protected, many are still subject to browse or damage from deer and elk. In general, the sandbar willow have grown large enough to resist browse and have smaller diameter, more flexible stems so they are less susceptible to damage such as antler rub. Red-osier dogwood grows more slowly and is highly palatable and will therefore remain susceptible to browse and damage longer. Protected alders and birch have grown rapidly, but due to the larger diameter stems, which are sturdier and more appealing for deer and elk to rub against will continue to be susceptible to damage.

Based on these observations, previous year's monitoring results, and the pathway for maintenance and adaptive management, the following recommendations were made and implemented for residual shrub protection:

- Individual browse protectors were removed from sandbar willow shrubs growing more than three feet above the protector.
- Individual browse protectors were generally left in place on red-osier dogwood, alder, and birch shrubs that are not located near other protected shrubs.
- For residual shrubs that are found in clumps of multiple plants, individual browse protectors were removed and small exclosures were constructed around the group of shrubs. The purpose of the small exclosures is to continue to protect shrubs from browse and damage while reducing the need for continued annual expansion and removal of browse protectors and to allow multi-stemmed shrubs more growth freedom.

Figures 3 through 5 provide examples of the various growth stages of shrubs and the browse protection that was implemented during 2011 maintenance.

Figure 3. Photograph of previously planted (residual) shrubs protected with individual browse protectors located on an inside meander that have grown to a height where they are beginning to provide shade to the creek.

Figure 4. Photograph of a previously planted (residual) sandbar willow that has grown tall enough to be less vulnerable to browse. This observation of growth is typical of residual shrubs that have been protected for three growing seasons.

Figure 5. Photograph of a group of residual shrubs where individual protectors were removed and used to construct a small exclosure around the group.

Containerized Planting

In 2011, survival monitoring of containerized plants was conducted in three planting units in Phase I and nine planting units in Phase III. The Phase I planting units 1, 7, and 14 were all monitored in 2008, but only planting units 1 and 7 were monitored in 2010. Survival was monitored in planting unit 14 in 2011 because it had the lowest survival in 2008 (90 percent). Survival remained high at planting unit 7, but decreased in planting units 1 and 14 (Table 3). Survival in unit 1 decreased from 91 percent in 2010 to 66 percent in 2011. Survival in unit 7 decreased from 93 percent in 2010 to 90 percent in 2011. Survival in unit 14 decreased from 90 percent in 2008 to 65 percent in 2011. Appendix A provides a photo series of Phase I planting units for 2008 through 2011.

Table 3. Survival within monitored Phase I planting units.

Planting Unit	2008 Survival	2010 Survival	2011 Survival
1	100%	91%	66%
7	96%	93%	90%
14	90%	N/A	65%

Survival declined substantially at planting units 1 and 14 between 2008 and 2011. The exact reasons for this decline are not clear. Planting unit 1 is located at the very upstream end of the project site where the floodplain is generally drier. The species that were lost in this planting unit between 2008 and 2011 included wetter species such as alder, birch, cottonwood and willow. Planting unit 14 is located approximately 500 feet further downstream, where conditions are slightly wetter. The species that were lost in this planting unit between 2008 and 2011 included drier species such as chokecherry and spirea. Survival dropped in these plots between 2010 and 2011 (Table 3). Winter and spring of 2011 were wetter than average and it is possible that the prolonged inundation resulted in the loss of some plants. Prolonged inundation combined with areas of poorly drained clay soils could definitely have resulted in the loss of some plants this year. The prolonged cool, wet spring conditions also resulted in larger than normal populations of some pest species such as aphids throughout western Montana. Insects likely emerged later and were able to take advantage of rapid plant growth. Every year, evidence of bacteria, fungus

or insects has been observed on planted shrubs in the Phase I area. Evidence includes leaf spots, rust, cankers, or direct observations of insects (Figure 6). Leaf damage has also been observed each year, and can be caused by browse, herbicide drift, winter stress or leaf scorch, which occurs when the roots do not supply enough water to replace what is used by the leaves. This typically occurs during periods of drought. There has been adequate moisture in most years since and supplemental watering of the planted shrubs has occurred in years when moisture had not been adequate. The site is open with very little wind or sun protection which may also contribute to some leaf damage.

The upstream portion of the project site had the densest infestations of Canada thistle prior to planting. Many of these infestations occurred in or immediately adjacent to planting units and herbicide has been used to treat these infestations since 2008. It is possible that some plants were affected by herbicide drift or through uptake of herbicide residual in the soil. Milestone® is an herbicide that is very effective at treating Canada thistle and approved for use up to the water's edge. This is the chemical that was used in 2008, 2009 and 2010 to treat thistle infestations at the site. Although it is not supposed to affect native shrubs, this chemical does remain in the soil to control later emerging plants. In 2011, Transline® was used instead of Milestone® for this reason. Stress from competition with weeds and other pasture grasses is likely a factor contributing to the loss of some of the smaller shrubs and slower growing shrub species. Damage from ungulates has also resulted in the loss of some plants or at least the slower growth of some plants. With the exception of spruce and spirea, which had poor survival after the first year of planting, there is no obvious trend in decline of specific species. Therefore, it is most likely that a combination of the factors described above that has affected survival of plants. Although survival has decreased since 2008 in planting units 1 and 14, it is not clear if this trend is consistent throughout Phase I. Overall, the surviving shrubs in all planting units are growing vigorously, both in height and diameter (Figure 7). Significant new growth on surviving spruce, a species that has consistently done poorly at the site, was observed in 2011 (Figure 7).

Figure 6. Photographs showing various factors that may be affecting plant survival in Phase I. Top left photo shows aphids on the stems of a planted aspen. Top right photograph shows rust fungus on a planted sandbar willow. The bottom photograph shows leaf spots and leaf damage from unknown causes on a planted hawthorne.

Figure 7. Typical growth of surviving shrubs in the Phase I area in 2011 which represents the fourth growing season for these plants. Photograph on the right shows new growth of more than one foot on a spruce planted in 2007.

Table 4 shows the results of Phase III planting unit survival by planting unit. Within the nine plots monitored, total survival ranged from a high of 100 percent to a low of 81 percent. Table 5 shows survival data by species. Serviceberry had the lowest survival at 75 percent. Red-osier dogwood, Booth's willow, sandbar willow and snowberry all had 100 percent survival. Site conditions in Phase III are wetter than Phase I as the valley gradient decreases. For this reason, only a small number of plant species that typically occupy drier niches within riparian environments, such as serviceberry, snowberry and aspen, were planted in Phase III. The wet site conditions may explain the lower survival of serviceberry and quaking aspen in the Phase III planting area. Appendix D provides photo comparisons of the Phase III planting units between 2010 and 2011.

Some willow species may have been misidentified during as-built monitoring in fall 2010. It is difficult to accurately identify young willows when they are dormant and lack green leaves. This may explain the discrepancy in numbers among the willows in 2010 and 2011 (Table 5). For example in planting unit 2 the total number of plants remained the same between 2010 and 2011

but the number of Bebb willow was less by one in 2011 while the number of Drummond's willow increased by one. Therefore it is a reasonable assumption that there was a misidentification in fall 2010. During 2011 monitoring in Phase III, willows were tagged with identification numbers so that identification will be easier and more consistent regardless of the season.

Table 4. Phase III survival by planting unit.

Phase III Planting Unit	2011 Survival
Planting Unit 2	100%
Planting Unit 4	102%*
Planting Unit 10	100%
Planting Unit 12	81%
Planting Unit 14	100%
Planting Unit 16	88%
Planting Unit 18	105%*
Planting Unit 20	90%
Planting Unit 24	95%

*One extra plant counted in each of these units in 2011

Table 5. Phase III containerized planting survival by species in the nine monitored planting units.

Species		2010 Installation Quantity	2011 Alive	Survival
Alnus incana	Mountain alder	11	10	91%
Amelanchier alnifolia	Serviceberry	8	6	75%
Betula occidentalis	River birch	22	21	95%
Cornus sericea	Red-osier dogwood	64	64	100%
Populus tremuloides	Quaking aspen	24	20	83%
Salix bebbiana	Bebb willow	98	95	97%
Salix boothii	Booth's willow	24	26	108%*
Salix drummondiana	Drummond's willow	114	103	90%
Salix exigua	Sandbar willow	31	31	100%
Symphoricarpos occidentalis	Snowberry	15	15	100%
Overall Survival		**411**	**391**	**95%**

*Due to the difficulty of identifying willows during dormancy, it is possible that some willows were misidentified during fall 2010 as-built documentation.

The herbaceous vegetation in both Phases I and III remains a mix of pasture grasses, sedges, rushes, and native grasses. The Phase III planting units support a greater diversity of sedges and rushes as these units tend to be wetter in general than the Phase I planting units. There was standing water throughout the floodplain in July 2011 in Phase III (Figure 8) and some areas of Phase I. In general the cover of native, wetter species appears to be increasing in both Phases I and III (Figure 9).

Figure 8. Photographs showing inundation in Phase III planting units taken during July 2011 monitoring.

Figure 9. Photographs showing the abundance of sedge species in planting units and throughout the floodplain in Phases I and III.

No vole damage was observed during monitoring in the Phase I or Phase III planting units, which is consistent with observation in previous years since installation of vole protectors. No browse or other damage to plants was observed in Phase III planting units. These plants are still very small and therefore completely protected by individual browse protectors.

In Phase I, 2011 is the fourth growing season for planted shrubs and trees. Many of the surviving shrubs are very large and continue to outgrow the browse protectors, but other shrubs are being browsed down to the height of the browse protector (Figure 10). On many of the planted shrubs, the browse protectors are beginning to restrict horizontal growth of the shrubs. Some shrubs are still small and well contained within the existing browse protector.

Figure 10. Photograph of browse on planted red-osier dogwood to the height of the browse protector.

Based on 2011 effectiveness monitoring and observations, previous year's monitoring results, and the pathway for maintenance and adaptive management, the following recommendations were made for containerized planting:

- Due to the prolonged duration of elevated streamflows, water levels in Therriault Creek and adjacent floodplain remained high late into the growing season. For this reason, very little supplemental watering was needed during the summer. Six planting units within the Phase III planting area were watered in late August.
- In Phase I, individual browse protectors were removed from any shrubs exceeding the height of the browse protector by more than three feet (approximately 85 removed).
- In Phase I, individual browse protectors were expanded for shrubs that have filled the capacity of the browse protector but continue to be browsed to the height of the browse protector (approximately 70 expanded).
- In Phase I, for planting units where multiple shrubs were close to out-growing their browse protectors, individual browse protectors were removed and a small exclosure was constructed around the planting unit or a portion of the planting unit. Thirteen small exclosures were constructed. The purpose of the small exclosures is to continue to protect shrubs from browse and damage while reducing the need for continued annual expansion and removal of browse protectors and reducing growth restriction of multi-stemmed shrubs.
- In Phase I, individual browse protectors, vole protectors and weed mats were removed from dead plants (approximately 80).
- No browse protectors were removed in Phase III and only minimal maintenance of browse protectors was needed.

Planted Solarization

In 2011, plant survival was monitored at planted solarization unit 2. Total survival was 80 percent. Table 6 compares survival by species between 2008 and 2011 in this unit. Survival remains at 100 percent for most of the species installed. Survival of spruce dropped from 50 percent to zero. Survival of Drummond's willow dropped from 100 percent to 64 percent. Surviving plants continue to grow vigorously (Figure 11). Overall, survival in this planted solarization plot remains higher than plots where solarization fabric was not placed. This may indicate that the reduced competition with grasses for light and nutrients continues to be a factor for planted shrubs and trees in other planting units. Appendix A provides a photo series of planted solarization plots for 2008 through 2011.

Table 6. Survival by species within planted solarization plot 2.

Planted Solarization Unit 2			
Species		**2008 Survival**	**2011 Survival**
Alnus incana	Mountain alder	100%	100%
Betula occidentalis	Water birch	100%	100%
Cornus sericea	Red-osier dogwood	100%	100%
Picea engelmannii	Engelmann spruce	50%	0%
Populus tremuloides	Quaking aspen	100%	100%
Salix drummondiana	Drummond's willow	100%	64%

Figure 11. Photograph of planted solarization unit 2 in Phase I taken in August 2011. Most of the shrubs have outgrown their browse protectors and are large enough to withstand some browse pressure.

Spring high flows overtopped the banks and fine sediment was deposited on top of the fabric in all solarization units. This is the type of bare substrate that is necessary for natural recruitment of willows and other riparian shrubs species. This type of bare substrate deposition in the floodplain has not been observed at the project site in any previous year of monitoring. The bare soils that are exposed when fabric is removed should mimic sediment deposits and promote natural recruitment.

Based on 2011 effectiveness monitoring observations, previous year's monitoring results, and the pathway for maintenance and adaptive management, the following recommendations were made for planted solarization plots:

- Remove browse protectors on plants greater than three feet above browse protectors or robust enough to resist browse.
- Remove fabric from both planted solarization units and seed with a mix of native grasses, sedges and forbs. Most of the willows in the planted solarization units are mature and release seed each year. These sites should be observed for natural recruitment of willows on the exposed soils in summer 2012.

Temporary Solarization Plots

In 2011, general observations were made of all temporary solarization plots. Solarization fabric was removed from plot 3 in fall 2009. Solarization fabric was removed from plot 1 in fall 2010. No fabric had been removed from plot 2 prior to 2011 due to a dense stand of reed canarygrass and the density of Canada thistle adjacent to the plot.

In plot 1, the bare mineral soil has been colonized by a range of species (Figure 12). Many of the colonizing grasses are too young to identify, but appear to consist of a mix of seeded species (tufted hairgrass, fowl mannagrass, and slender wheatgrass), and pasture grasses present adjacent to the plot (quackgrass, redtop, smooth brome, and timothy). Other seeded species observed in the plot include: red-osier dogwood, chokecherry, and Baltic rush. Sedge species were observed but were too young to identify. Other species observed in plot 1 include both native species (sandbar willow, field mint, violet, common willowherb, cattail and knotweed) and invasive species (reed canarygrass and Canada thistle). This plot had standing water in it until the middle of August 2011.

In plot 3, the bare mineral soil has been colonized by both seeded and non-seeded species. Some seeded species, such as fowl mannagrass, are a dominant species in the plot but the plot is dominated mostly by pasture grass species including reed canarygrass, timothy and quackgrass that dominate adjacent areas (Figure 13). Some other desirable species, such as sedges, rushes and wetland forbs are present in small amounts within the plot. In general, the species diversity of seeded species is lower in this plot compared with plot 1. This may indicate that an increase in pasture grasses will occur in plot 1 during the next growing season or it may indicate that the seed bank and root system of pasture grasses was more effectively killed in plot 3 due to the fabric staying in place for one additional growing season. There is little opportunity for colonization of woody vegetation in the plot similar to plot 1 due to the continuous cover of grasses and forbs.

Plot 2 is surrounded by Canada thistle and reed canarygrass (Figure 14). This lower portion of the site has consistently been missed by herbicide applicators in past years and was not sprayed this year due to standing water at the time of application. The ground beneath the fabric consists of bare mineral soil.

Figure 12. Photograph of temporary solarization plot 2 in July 2011, the second growing season after fabric removal. Black lines in the figure represent the approximate extents of where the solarization fabric covered the plot.

Figure 13. Photograph of temporary solarization plot 3. The area between the standing water is the original plot location that was exposed and seeded in fall 2009. The areas of standing water have fabric under the water that was placed around the original plot.

Figure 14. Photograph of temporary solarization plot 2 located at the downstream end of the project site prior to fabric removal and seeding.

Based on 2011 and previous year's observations and the pathway for maintenance and adaptive management, the following recommendations were made for temporary solarization plots:

- Continue to observe species composition in plot 1. It may be necessary to protect woody species colonizing the plot from browse or competition.
- Remove all remaining fabric from plot 3 and seed exposed surfaces
- Partially remove fabric from plot 2 and seed exposed surfaces and install dormant willow cuttings. Installation of dormant willow cuttings, which are hardier than young seedlings established from seed may allow woody vegetation establishment in this plot to avoid colonization by reed canarygrass.
- Include a quick germinating cover crop in the seed mix quick to help avoid re-infestation by undesirable pasture grasses or weeds.

Vegetated Soil Lifts

In 2011, general observations were made of both vegetated soil lifts. Percent cover of willows continues to increase resulting in a dense band of cover immediately along the channel at both sites (Figure 15). New growth on willows was greater than observed in previous years but willows at both sites continue to be restricted by browse . Appendix B provides a photo series for each site from 2008 through 2011.

Based on 2011 and previous year's observations and the pathway for maintenance and adaptive management, the following recommendations were made for vegetated soil lifts:

- Continue to observe function of the structures but no future maintenance or monitoring is anticipated because the dense growth and associated deep binding root mass is providing the desired function of bank stability.

Figure 15. Photograph of vegetated soil lift 1 (right bank in the left photo) and vegetated soil lift 2 (right bank in the right photo) showing dense but browsed bands of willows.

Willow Fascines

In 2011, general observations were made of all willow fascines that could be relocated. Willow fascines continue to function for trapping debris and sediment. Most fascines have significant sand or gravel deposition on them but willow clumps continue to grow from the exposed ends along the channel margins (Figure 16). Due to the water level at the time of monitoring, most willow fascines were under water and difficult to observe.

Based on 2011 and previous year's observations and the pathway for maintenance and adaptive management, the following recommendations were made for willow fascines:

- No maintenance of structures is necessary. The fascines are functioning to trap sediment and debris and establish vegetation within the channel margins.
- Continue to observe the function of the willow fascines but no future maintenance or monitoring is anticipated.

Figure 16. Photographs of buried willow fascines growing along inside meanders along the channel margins.

Large Woody Debris Structures

In 2011, general observations were made of all large woody debris structures. It was difficult to observe some of the intended functions of these structures, such as sediment, debris and seed recruitment, due to high flows. However, the large woody debris structures coupled with the high spring flows in 2011 resulted in extensive sustained floodplain inundation in the lower reach of the project area (Figure 17). An increase in native species and wetter species continues to be observed in floodplain areas adjacent to these structures. Large patches of sedges and rushes are now common within the floodplain which was not the case prior to installation of the structures.

Based on 2011 and previous year's observations and the pathway for maintenance and adaptive management, the following recommendations were made for large woody debris structures:

- No maintenance of structures is necessary.
- Because shifts in species composition and percent cover occur slowly, transect monitoring at these sites has not occurred since August 2009. Collecting transect data should be considered for summer 2012 to document the shift in species composition at these sites.

Figure 17. Photographs of large woody debris structure sites and the surrounding floodplain in late July 2011. There was standing water in the floodplain adjacent to all sites.

Coir Logs

In 2011, general observations were made of all coir log structures. Overall survival of willow cuttings appears to be consistent with data collected in previous years. Percent cover of willows and willow height appears to be increasing at most sites. Coir logs are difficult to see at most sites due to the cover of willows. New growth on willows was approximately six to 12 inches in late July 2011. No browse of the current year's growth was observed during 2011 monitoring. Browse has been a limiting factor for the height of willow cuttings in past years. At many sites, willow cuttings are beginning to form a dense band of woody vegetation along the streambank (Figure 18). No lateral migration of the channel was observed at any of the coir log sites; however, deepening of the channel and an increase in undercut banks was observed at a number of the sites.

Based on 2011 and previous year's observations and the pathway for maintenance and adaptive management, the following recommendations were made for coir logs:

- No maintenance of structures is necessary.
- Continue to observe the function of coir logs but no future maintenance or monitoring is anticipated. Willow survival and percent cover is adequate at all sites to expect willows to maintain streambank and floodplain stability once the coir logs degrade.

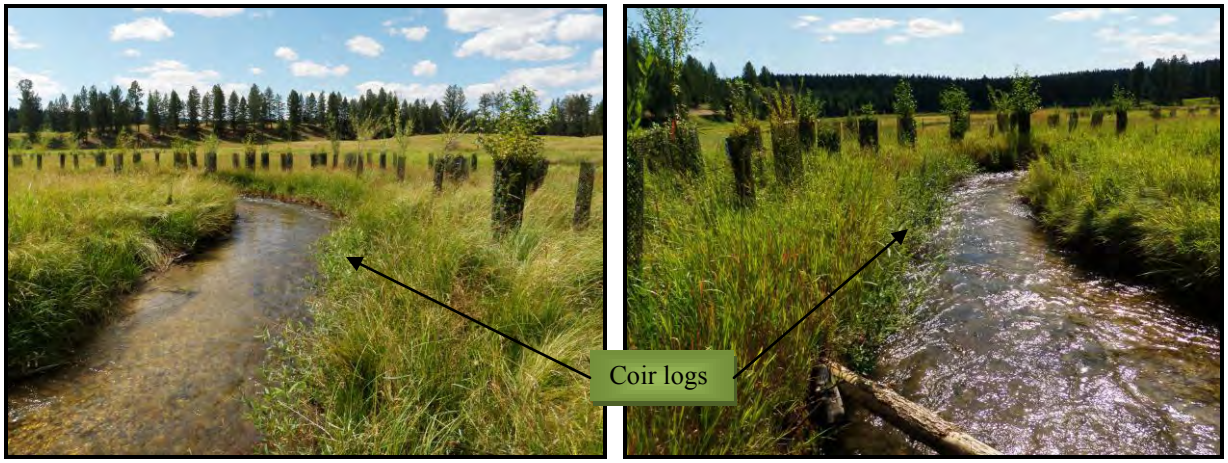


Figure 18. Photographs of coir log sites showing dense patches of willows growing from cuttings installed between the coir logs and pasture grass roots.

Weed Control

In 2011, general observations of remaining weed densities and distributions were made. Observations of the effectiveness of summer 2011 herbicide application were also made. Weed control has been completed annually at the site since 2008. Weed management has consisted of primarily herbicide application due to the extent of infestations and the presence of multiple target species. Efforts have been effective in controlling most of the target species. No sulfur cinquefoil was observed in 2011. Yellow toadflax and houndstongue continue to only be present in small patches near the road at the upstream end of the project area. Canada thistle and reed canarygrass remain widespread in the project site and surrounding area but densities of both have been significantly reduced. Reed canarygrass is only present in small isolated patches in the upper reaches of the project site and the spread has been effectively controlled by continued

herbicide application. Reed canarygrass remains dense and widespread at the very downstream extent of the project site. These populations have not been treated due to their proximity to the channel and the extent of the infestation. Canada thistle remains the primary target species at the site. The large infestations of Canada thistle within project site have been significantly reduced and large, mature plants are now rare. In 2006, Canada thistle infestations consisting of mature, three to four foot tall plants were common throughout the project area. Although the large, mature infestations have been controlled, in 2011 small plants were found throughout the project area indicating that a significant residual seed bank remains at the site (Figure 19).

Figure 19. Typical size of thistle plants at the project site in 2011.

In 2011, weed control targeted all occurrences of Canada thistle, yellow toadflax, houndstongue and isolated patches of reed canarygrass. Figure 20 shows small isolated of reed canarygrass after treatment with herbicide. Figure 21 shows Canada thistle plants after treatment. Figure 22 shows the extents of 2011 herbicide application. A total of 28 acres were treated. Treatment in 2011 was very thorough with very few skips or missed plants observed three weeks after treatment. Transline® was applied at a rate of 0.5 ounces/gallon and 40 gallons per acre to treat thistle, toadflax and houndstongue. Roundup® was used to treat reed canarygrass.

Based on 2011 and previous year's observations and the pathway for maintenance and adaptive management, the following recommendations were made for weed control:

- Weed mapping was completed for the project area in July 2009 and is described in the 2009 monitoring and maintenance report (Geum 2009). Weed mapping should be repeated in 2011 to guide continued weed control efforts at the site. Based on the results of weed mapping, specific goals and objectives for weed management should be developed along with criteria to guide continued weed management the project site. These criteria should consider weed management needs on adjacent properties.
- Continue weed control in 2012. If present, yellow toadflax and houndstongue should be treated with herbicide. Any remaining isolated stands of reed canarygrass in the upper two-thirds of the project should be treated. The primary areas where Canada thistle should be targeted include:
    - Spot treatments within the revegetation treatment area.

- The downstream portion of the project site. This area was consistently missed by applicators between 2008 and 2010. The area was effectively treated in 2011 but will require retreatment for plants that were too small to see at the time of treatment or located in areas that were too wet to treat.
- Upstream of the bridge marking the upstream extent of channel restoration and revegetation treatments.
- The hayfield located to the southwest of the project boundary fence. The thistle infestation in this area is widespread but densities remain relatively low due to continuous mowing.

Figure 20. Photographs of small clumps of reed canarygrass after summer 2011 herbicide treatment.

Figure 21. Areas treated for Canada thistle ranged from treating young plants in the Phase I area (upper left photograph) to denser infestations of older plants in the lower half of the Phase III area (upper right photograph) and upstream of the bridge, above the revegetation treatment area (lower photograph).

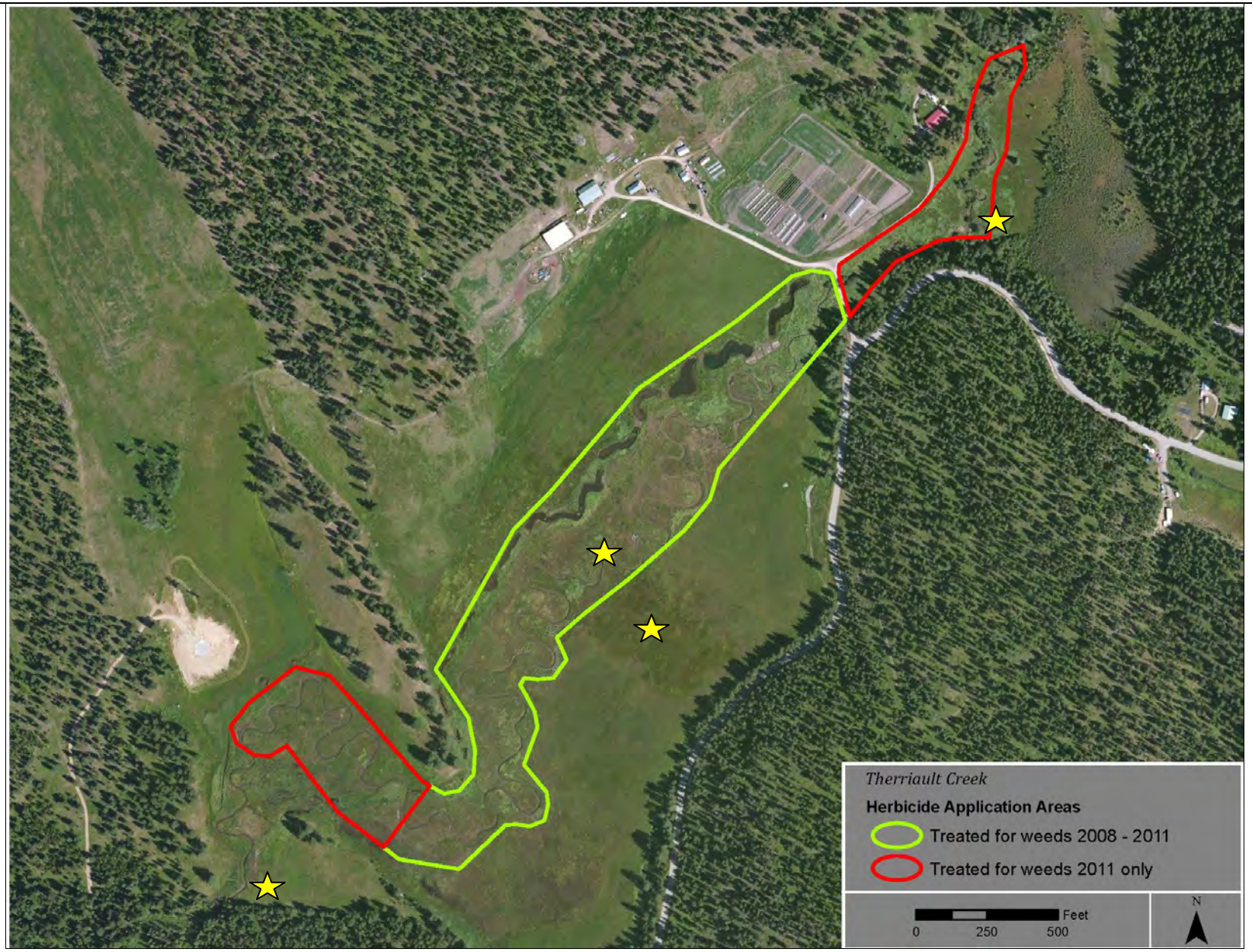


Figure 22. Extent of herbicide applications at the project site. Yellow stars indicate priority area for 2012 weed treatment.

Summary of 2011 Maintenance and Revegetation Treatments

As described in the previous sections, maintenance needs for revegetation treatments were determined during July 2011 effectiveness monitoring. Maintenance tasks completed in August, September and October 2011 included:

- Watering of select planting units in Phase III. Most planting units remained wet throughout the summer due to prolonged high streamflows from spring runoff and therefore did not require watering. Six planting units including approximately 300 plants were watered once in late August.
- Removal and expansion of individual browse protectors that either residual shrubs or planted shrubs had outgrown. Small exclosures using recycled browse protector materials around groups of shrubs were constructed wherever possible to allow shrub expansion while still providing some protection from browse and damage. Approximately 80 protectors were removed from plants large enough to withstand browse, 80 removed from dead plants, 70 expanded and 13 exclosures were constructed.
- Removal of remaining solarization fabric from temporary solarization plot 3 and partial removal of fabric from temporary solarization plot 2. Exposed soils in both plots were seeded with a mix of native grasses, forbs and shrubs. Plot 2 was also planted with dormant willow cuttings. A quick germinating, sterile cover crop was included in the seed mix in an attempt to occupy niches that could be readily taken over by pasture grasses or reed canarygrass.
- Removal of solarization fabric from both planted solarization plots in Phase I. An approximately two-foot by two-foot square of fabric was left around the base of each surviving plant. Exposed soils in both plots were seeded with a mix of native grasses, forbs and shrubs. A quick germinating, sterile cover crop was included in the seed mix in an attempt to occupy niches that could be readily taken over by pasture grasses or reed canarygrass.
- Re-securing of fabric in planted solarization plot in Phase III.
- Herbicide application to target species including; Canada thistle, yellow toadflax, houndstongue and isolated patches of reed canarygrass on approximately 28 acres.

Adaptive Management: Next Steps

This section summarizes recommendations for continued monitoring, maintenance and revegetation activities at the Therriault Creek restoration project site. The revegetation plan for the Therriault Creek restoration project was prepared in 2007. The first phase of implementing the revegetation plan was completed in the fall of 2007. Since that time, monitoring, maintenance and additional phases of revegetation have been implemented using an adaptive management framework. In 2012, vegetation installed in Phase I will be in its fifth growing season. Five years is an appropriate point in revegetation projects to evaluate if, and to what extent, implemented treatments are achieving project goals and objectives.

The goal of the revegetation plan was to create a diverse mosaic of native woody riparian plant communities within the project area. The objectives for revegetation of the Therriault Creek restoration project include:

- Protect the stability of the restored channel using native woody vegetation;

- Enhance habitat for native fish populations through the use of native woody vegetation;
- Limit invasion and continued spread of Canada thistle and other noxious weeds;
- Protect surviving containerized plantings from initial revegation efforts; and
- Create conditions that will promote natural revegetation by native species.

Most of these objectives are long term, but monitoring data and observations indicate that the site is trending towards meeting all of them. Observations indicate that the site continues to trend toward the desired conditions with woody riparian vegetation establishing along the streambanks and conversion of the herbaceous vegetation from predominantly pasture grass to a more diverse mix of native sedges, rushes, forbs and grasses. Revegetation treatments implemented in Phases II and III were selected based on monitoring Phase I treatments and evaluating which of those treatments would be most effective at meeting the above goal and objectives. Very few additional active revegetation treatments are anticipated to be necessary at the site to meet project objectives. Continued evaluation of site conditions and maintenance of installed treatments will be necessary for a few more years. The decision making pathway for revegetation treatments in Table 2 will continue to apply to decision making in 2012.

The following monitoring should be completed in 2012:

- Monitor three planting units in Phase I that were not monitored in 2011 to evaluate if the downward trend in survival shown in planting units 1 and 14 has occurred at other units.
- Repeat monitoring of Phase III planting units at the same level of effort as 2011 to ensure that plant survival remains high.
- Evaluate Phase III planted solarization plot for fabric removal.
- Repeat vegetation composition transect monitoring along the large woody debris structures to verify observed shifts in herbaceous species composition.
- Repeat weed mapping of the project site to evaluate effectiveness of herbicide treatments and determine criteria for on-going weed management at the site.
- Repeat broad-scale plant community mapping to compare existing conditions with conditions at the time the revegetation plan was developed.
- Repeat photo monitoring of all treatments.
- Record observations of all treatments.
- Determine maintenance needs for all revegetation treatments.

The following maintenance is anticipated in 2012:

- Watering of Phase III plants as needed.
- Continue maintenance and removal of browse protectors in Phase I if monitoring observations indicate that plants with removed browse protectors are withstanding browse pressure.

The following revegetation activities are anticipated in 2012:

- Continue to treat Canada thistle, yellow toadflax, isolated patches of reed canarygrass and any other noxious weeds found in priority areas.
- Remove remaining fabric in planted solarization plot 3 if seeding and dormant willow cuttings are effectively colonizing the site.

References

Geum Environmental Consulting, Inc. 2007a. Therriault Creek Riparian Revegetation Plan. Internal report prepared for Kootenai River Network, Libby, Montana.

Geum Environmental Consulting, Inc. 2007b. Therriault Creek Revegetation Plan Implementation Report. Internal report prepared for Montana Fish, Wildlife and Parks, Libby, Montana. Contract #080067.

Geum Environmental Consulting, Inc. 2008. Therriault Creek Riparian Revegetation Monitoring Report Contract #0803. Internal Report prepared for Kootenai River Network, Libby, Montana.

Geum Environmental Consulting, Inc. 2009. Therriault Creek Riparian Revegetation Maintenance and Monitoring 2009 Report Contract #0709. Internal Report prepared for Kootenai River Network, Libby, Montana.

Geum Environmental Consulting, Inc. 2010. Therriault Creek Riparian Revegetation Maintenance and Monitoring 2010 Report Contract #110032. Internal Report prepared for Montana Fish, Wildlife and Parks, Libby Montana.

Appendix A: Phase I Planting Units Photograph Documentation 2008 through 2011

Planting Unit 1




2008 **2009** **2010** **2011**

Planting Unit 3

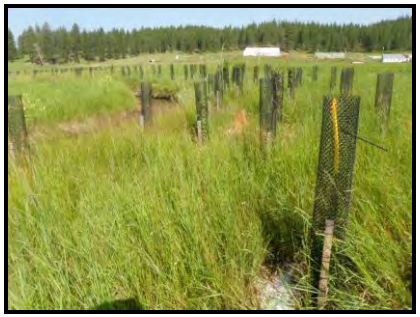



2008 **2009** **2010** **2011***

*2011 photo taken from upstream viewing downstream. All other photos view upstream.

Planting Unit 5


2008


2009


2010


2011

Planting Unit 7


2008


2009


2010


2011

Planting Unit 12


2008


2009


2010


2011

Planting Unit 14


2008


2009


2010

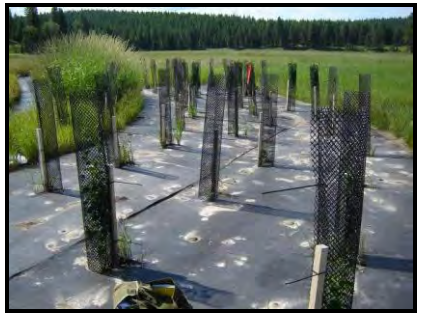

2011

Planting Unit 16




2008 **2009** **2010** **2011**

Planted Solarization Unit 1




2008 **2009** **2010** **2011**

Planted Solarization Unit 2

2008

2009

2010

2011

Appendix B: Phase I Vegetated Soil Lift Photograph Documentation 2008 through 2011

Vegetated Soil Lift 1

2008

2009

2010

2011

Vegetated Soil Lift 2

2008

2009

2010

2011

Appendix C: Phase I Coir Log Photograph Documentation 2008 through 2011

Coir Log 1

2008

2009

2010

2011

Coir Log 2

2009

2010

Coir Log 3

2008

2009

2010

2011

Coir Log 4

2008

2009

2010

2011

Coir Log 5

2008

2009

2010

2011

Coir Log 6

2008

2009

2010

2011

Coir Log 7

2008

2009

2010

2011

Appendix D: Phase III Planting Units Photograph Documentation Fall 2010 through 2011

Planting Unit 1

Planting Unit 2

Planting Unit 3

Planting Unit 4

Planting Unit 6

Planting Unit 7

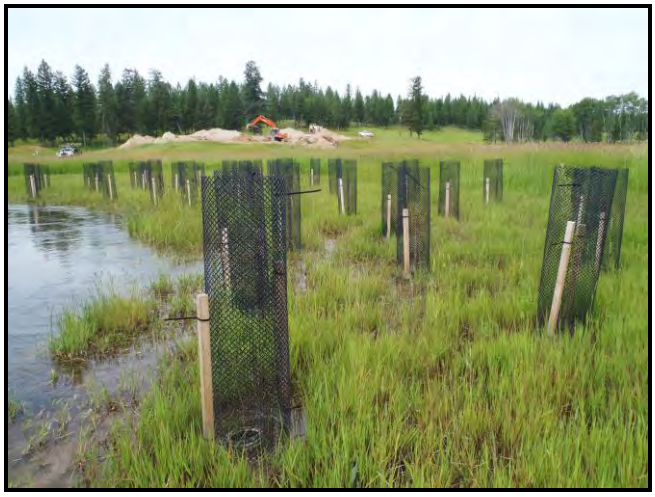
Planting Unit 9

Planting Unit 10

Planting Unit 11

Planting Unit 12

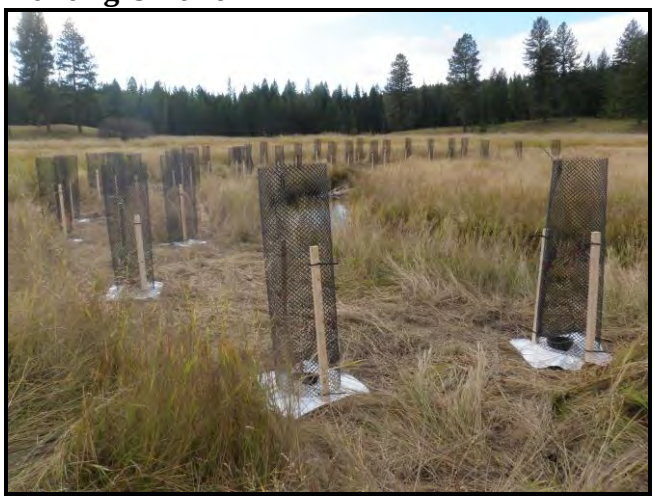
Planting Unit 13



Planting Unit 14

Planting Unit 15

Planting Unit 16



Planting Unit 17

Planting Unit 18


Planting Unit 19


Planting Unit 20


Planting Unit 21


Planting Unit 22


Planting Unit 23


Planting Unit 24