GRAVE CREEK INTEGRATED WEED MANAGEMENT PLAN

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PREPARED FOR:

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Section 1 Introduction

This document describes an integrated weed management plan for a mile-long reach of Grave Creek, located in Lincoln County, near Eureka, Montana (Township 35 North, Range 26 West, Section 12; Latitude 48.81331 Longitude -114.89867). Grave Creek is a tributary to the Tobacco River, which flows into the Kootenai River (at Lake Koocanusa) west of Eureka. This reach of Grave Creek has been the focus of channel, floodplain and riparian revegetation restoration efforts led by the Kootenai River Network (KRN) since 2001. Figure 1 shows the location of the restoration project area within the Grave Creek watershed, and the project area relative to major towns and other watercourses. Figure 2 shows the Grave Creek project reach.

The goal of the Grave Creek restoration project is to restore proper form and function to the river channel and restore the riparian and floodplain area along Grave Creek. Channel restoration included re-alignment of 8,200 feet of channel to restore proper form and pattern by reconstructing a large gravel to small cobble, meandering, riffle-pool stream type. Channel restoration was completed in three phases (Figure 3): Demonstration Phase (1,000 feet), Phase One (4,200) feet and Phase Two (3,000 feet).

The project area includes the restored Grave Creek channel and adjacent floodplain and terrace features (Figures 2 and 3). The project area is approximately 60 acres and is located entirely on land owned by one private land owner. Figure 2 shows the project area and parcels owned by this one landowner. This integrated weed management plan focuses on the project area, but weed management activities are on-going through the rest of the property. These on-going weed management activities are briefly discussed in Section 4 below.

The intent of this integrated weed management plan is to evaluate the potential use of a wide range of weed management strategies for use in the project area. The goal of weed management is to reduce or eliminate existing weed populations and promote establishment and survival of native species that will be more resistant to future weed invasions. Effective management of weeds in the project area will require a multiple year commitment by the landowner and project partners. Recommended management strategies in this plan were developed based on knowledge of the biology of weed species present in the project area, infestation characteristics and revegetation objectives for the restoration project.

Section 2 Purpose and Need

In early 2008, a riparian revegetation and monitoring plan was developed for the project area (*Grave Creek Riparian Revegetation and Monitoring Plan;* Geum Environmental Consulting, Inc. 2008—Revegetation Plan). The purpose of the Revegetation Plan is to guide implementation of revegetation and restoration strategies that will create conditions to support the establishment of riparian and floodplain plant communities capable of sustaining floodplain ecological processes and that will address factors that are limiting revegetation objectives (described in detail in the Revegetation Plan). To achieve revegetation objectives and reach the desired future condition for the project area, the following revegetation-related activities have been implemented throughout various phases of the project:

- Reduce deer and elk browse to allow naturally recruited and planted shrubs and trees to establish along the reach.
- Implement long-term grazing management, including cattle exclusion and off-channel water sources, until plant communities are established.
- Stabilize stream banks where accelerated erosion is occurring using bioengineering treatments that will provide short-term stability while vegetation establishes.
- Promote floodplain point bar stability and revegetation through point bar grading and use of bioengineering treatments that incorporate moisture retaining coir materials with live plant materials, seeding and planting.
- Implement an integrated floodplain and riparian monitoring program to provide the necessary data to determine how vegetation communities are developing in order to make appropriate adaptive management and restoration decisions for the project area.

Weed species have the potential to limit achieving revegetation objectives by directly competing with desired native species and occupying spaces that would normally be occupied by the desired species. The Revegetation Plan identified weed competition from invasive species as a minor but potential factor limiting revegetation in the project area. As part of implementing the Revegetation Plan, effectiveness monitoring data were collected in 2007, 2008 and 2009. Monitoring weed species present, densities and potential threats of weeds to establishment of desired vegetation is a key component of project effectiveness monitoring. Results of this monitoring indicate that weed infestations are expanding, densities are increasing, and new invasive species are present in the project area. Because of this, weed competition is now considered a more significant limiting factor relative to achieving revegetation objectives. The purpose of this integrated weed management plan is to address the limiting factor of weed competition with native species in the project area.

This weed management plan is organized as follows:

- Inventory of weed species in the project area including:
  - Weed inventory methods, and
  - Weed inventory findings.
- Weed management strategies, including;
  - Weed species management priorities and objectives,
  - Previous weed management actions,
  - Weed prevention actions, and
  - Recommended weed management actions.
- Adaptive management framework for monitoring and managing weed species.

2.1 Weed Management Plan Goals and Objectives

The goal of this integrated weed management plan is to reduce the risk of weed competition as a potential limiting factor to achieving revegetation objectives for the project area. The most effective way to reduce the risk of weed competition in the project area is to achieve Revegetation Plan objectives. These objectives are focused on achieving a desired future condition for the project area consisting of a diverse mosaic of native riparian and floodplain plant communities driven by natural channel processes. A structurally diverse riparian area would naturally limit weed infestations because native plant communities would occupy most available niches within the floodplain environment. A range of weed species will probably

always be present in the project area, but by achieving revegetation objectives, these species would be limited in distribution and cover. Integrating this weed management plan as part of project maintenance and adaptive management will help project partners protect their significant investment in channel and floodplain restoration. In addition, integrated weed management will contribute to protecting and conserving threatened and sensitive fish species, wildlife, and water quality in the Grave Creek watershed, because these depend in part on a healthy riparian area.

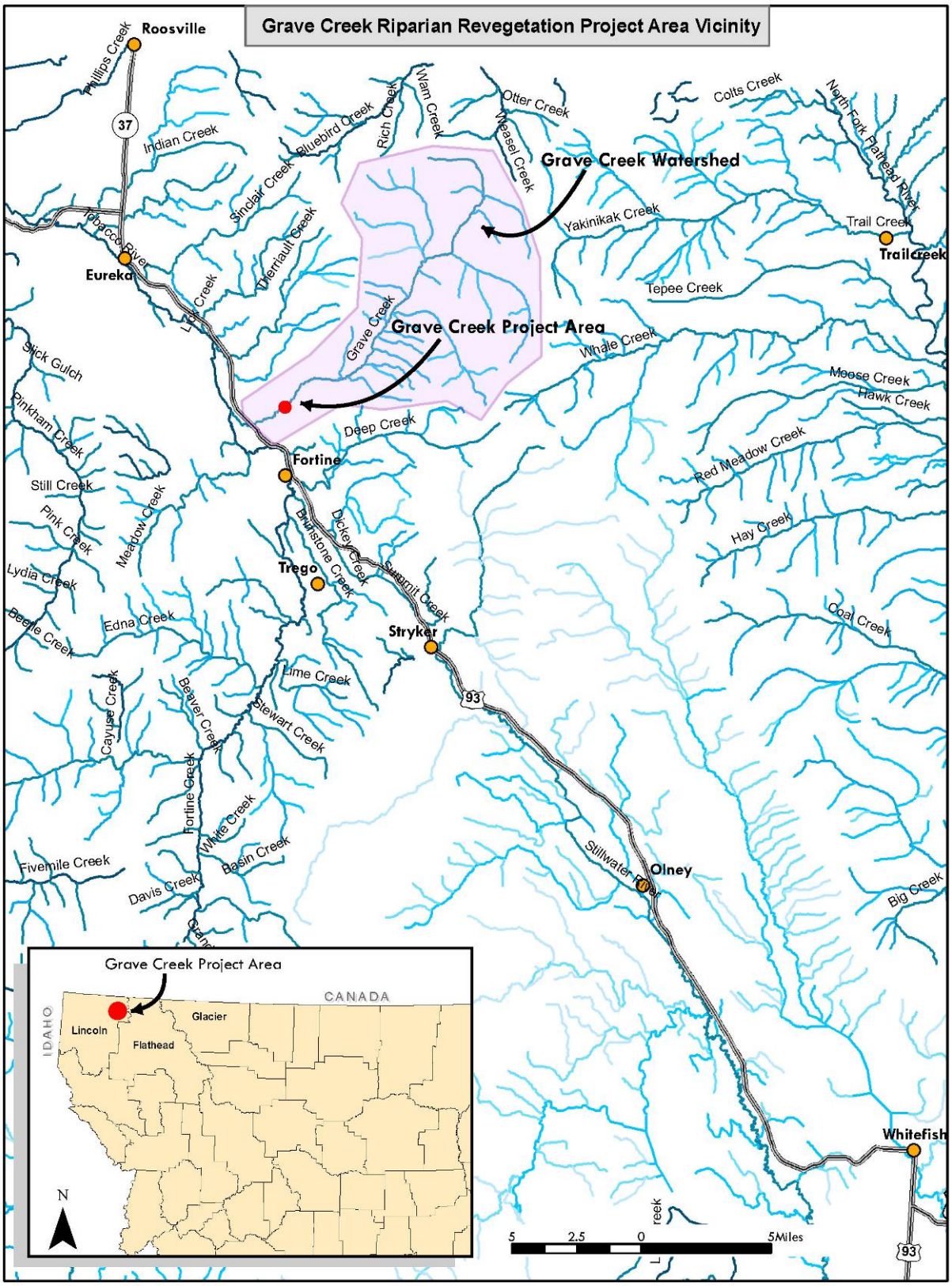


Figure 1. Location of the project area in relation to the Grave Creek watershed, the larger Kootenai River Basin watershed and western Montana (inset).

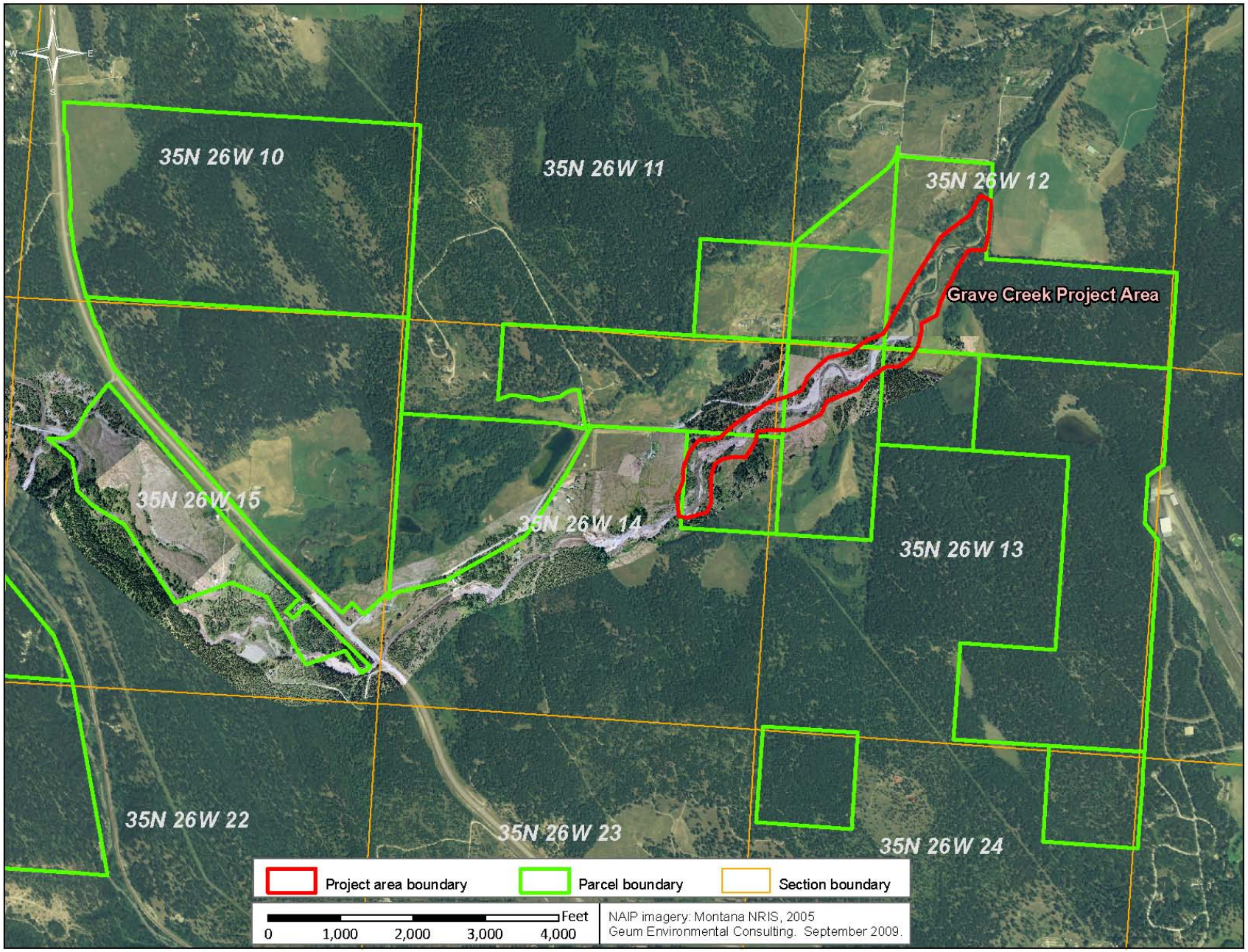


Figure 2. Overview of the Grave Creek project area. Green boundaries indicate parcels owned by the same landowner including the restoration project area.

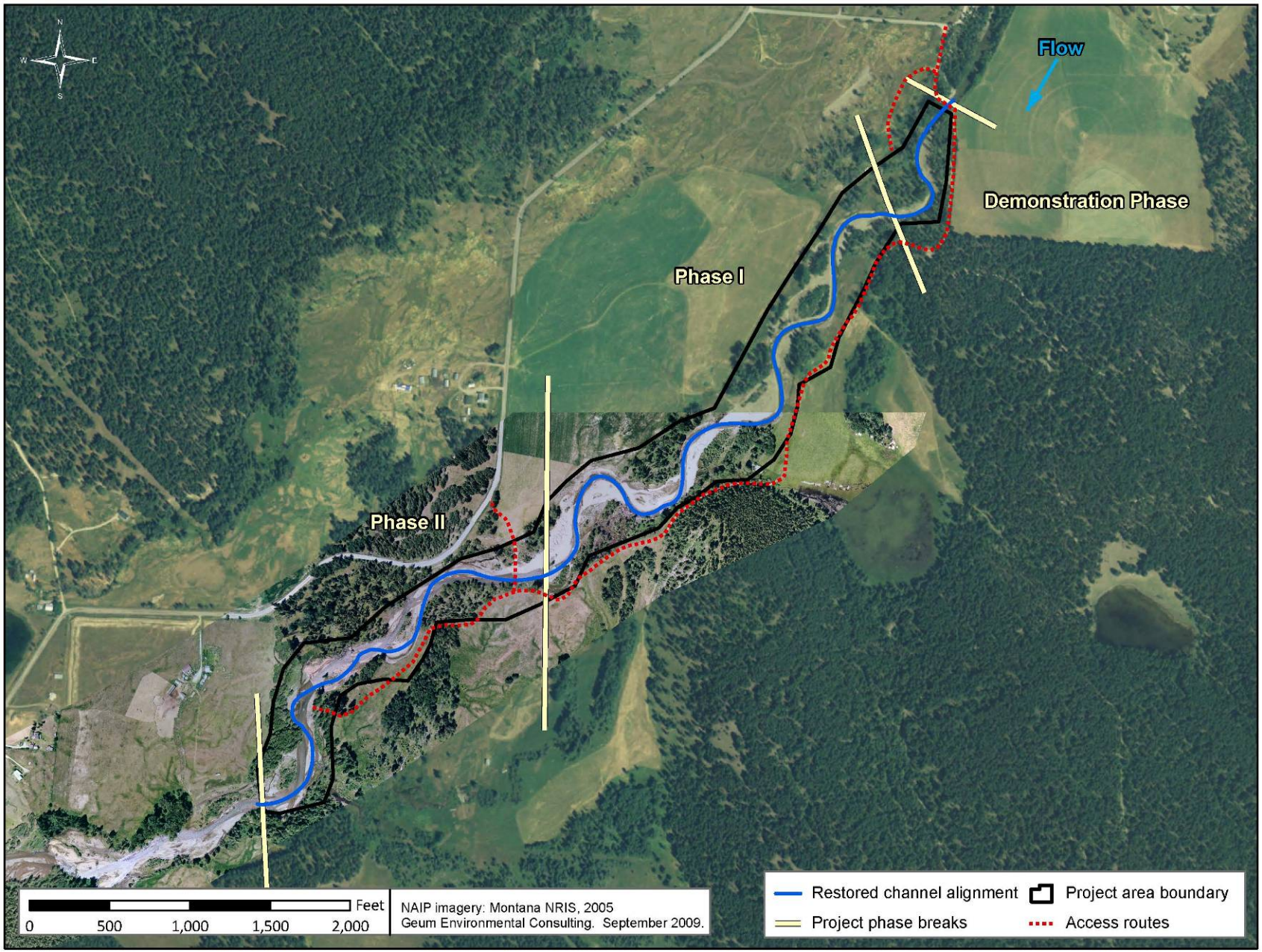


Figure 3. Overview of the Grave Creek project area showing channel restoration project phases and primary access routes.

Section 3 Inventory of Weed Species

3.1 Methods

A weed inventory was completed during July 2009 to determine the distribution and densities of weeds within the project area. The location and density of all high priority weed species throughout the entire project area were recorded. High priority weed species included Category 1 noxious weeds listed by the State of Montana or other weed species determined to pose a significant risk to achieving revegetation objectives for the project described in the Revegetation Plan.

The entire project area was walked and visual observations of weed infestations were made. The location of each weed infestation was recorded using a resource-grade global positioning system (GPS). There was no minimum size for recording infestations and all infestations or occurrences of priority weed species were attempted to be recorded. For infestations less than 100 square feet a point location was recorded. For infestations larger than 100 square feet the boundary of the infestation was recorded. For each infestation, the percent canopy cover for each priority species present, rounded to nearest ten percent, was recorded.

3.2 Results

The following high priority weed species were identified in the project area:

- Spotted knapweed (*Centaurea maculosa*)
- Oxeye daisy (*Chrysanthemum leucanthemum*)
- Canada thistle (*Cirsium arvense*)
- Houndstongue (*Cynoglossum officinale*)
- Yellow toadflax (*Linaria vulgaris*)
- Sulfur cinquefoil (*Potentilla recta*)

These species are all Category 1 noxious weeds listed in the state of Montana according to the Montana County Noxious Weed List effective March 27, 2008 (Montana Department of Agriculture 2009). Maps of weed locations and tables detailing acreages and densities of each weed infestation are included in Appendix A. Weed species presence is summarized below by three different surface features in the project area: floodplain surfaces; point bar surfaces; and bioengineering treatments. Weed species are summarized by these features for purposes of assigning management priorities and management actions. Additional information on high priority weed species and specific infestations can be found in Appendix A.

For purposes of this plan, floodplain surfaces are defined as those locations within the project area that are higher than the bankfull floodplain elevation. These areas generally do not have surface water present throughout the year, but may receive some overbank flow during runoff or flood events. Vegetation communities include forested, shrub, and grass-dominated communities. Spotted knapweed is the most prevalent weed species found on the floodplain surface feature and it is also the most prevalent species within the entire project area. All high priority weed species occur on floodplain surfaces with varying densities.

For purposes of this plan, point bar surfaces refer to locations within the project area that are on the inside of meander bends and include areas approximately at or below the bankfull floodplain elevation. These surfaces include the portions of point bars that are exposed during base flow and the adjacent floodplain surface on the inside of meander bends. These sites typically have coarse alluvial substrate. Channel restoration activities resulted in a restored, single-thread channel through the project reach, resulting in many newly constructed point bar surfaces. These bare cobble, gravel and sand sites were susceptible to colonization by weed species and therefore most high priority weed species are present on point bar surfaces. All of the weed species noted above, except sulfur cinquefoil, were recorded on point bar surfaces. Spotted knapweed is the most common species occurring on these surfaces. Cottonwoods and willows are colonizing these surfaces to varying degrees, and weed competition is a significant threat to seedling survival and establishment. Prior to channel restoration, ungulate browse, livestock grazing and the unbalanced channel form and pattern limited the establishment and survival of naturally recruited willows and cottonwoods. The channel form and pattern have largely been restored throughout the project area. Diverse topography and microsites in the form of floodplain swales and woody debris have been incorporated into point bar surfaces to further encourage establishment of desired vegetation. Livestock grazing is being managed throughout the project area, and ungulate browse is being managed through portions of the project area as discussed in Section 4 below. Weed competition remains a limiting factor to cottonwood and willow establishment on these surfaces.

Two types of bioengineering structures, vegetated soil lifts and coir logs, were installed in the project area to form streambanks capable of supporting woody trees and shrubs. Vegetated soil lifts consist of two lifts constructed using soil wrapped with coir fabric. Dormant willow cuttings are installed between and on top of the lifts. Coir logs consist of high density bales of coir fiber formed into a cylinder bound with coir netting. Dormant willow cuttings are installed between and above the logs. High priority weed species are colonizing some of these bioengineering structures and pose a risk to dormant willow cutting growth and establishment of other desirable species that naturally recruit onto the coir surfaces during the recession of high flows. All of the weed species noted above, except yellow toadflax, were recorded on bioengineering structures.

Section 4 Weed Management Strategies

This section further prioritizes management of the weed species identified in Section 3, evaluates a suite of management actions as they apply to the project area and provides a suite of initial weed management recommendations. Effective management of weeds in the project area will likely require several years. The recommended management strategies described in this section were developed based on knowledge of the species and infestation characteristics in the project area and with revegetation objectives in mind. These recommended strategies should be considered the first phase of weed management for the project. Other strategies described in this section should be considered as tools that can be applied in later phases based on the results of effectiveness monitoring. Section 5 provides recommendations for integrating weed management into the adaptive management framework currently being used for the project.

4.1 Weed Species Management Priorities and Objectives

All of the weed species identified in the project area have the potential to limit the effectiveness of revegetation treatments implemented as part of the Grave Creek restoration project. All of the priority weed species identified in Section 3 will be targeted for control throughout the project area; however, priorities for eliminating and reducing coverage have been further identified by species and are described below:

- **Spotted knapweed** is a high priority for active management in the project area. Spotted knapweed is the most widely distributed species in the project area and high densities are present in sensitive areas such as point bar surfaces. Management of spotted knapweed is also a priority for the landowner. The management objective for spotted knapweed is to reduce coverage of the species so it is not a limiting factor to achieving revegetation goals and objectives. Eliminating this species from the project area is not likely an achievable goal based on the extent of the infestation in the project area and surrounding areas; however, reducing coverage of the species so it no longer impedes establishment and growth of native plant communities is a realistic management objective within the project area.
- **Oxeye daisy** is a low priority for active management because existing infestations do not appear to be spreading and densities are low. Therefore, this species will be managed indirectly through management actions targeting other species. The management objective for oxeye daisy is to not increase or spread existing infestations.
- **Canada thistle** is a high priority for active management because only a few infestations are present and early management to reduce the risk of spread could limit future management action needs. The management objective for Canada thistle is to prevent spread of the species and possibly eliminate the species from the project area.
- **Houndstongue** is a high priority for active management because densities of infestations are currently low. Early management will reduce the risk of spread and could limit future management action needs. The management objective for houndstongue is to prevent spread of the species and possibly eliminate the species from the project area.
- **Yellow toadflax** is a low priority for active management because existing infestations do not appear to be spreading and overall densities are low. Therefore, this species will be managed indirectly through management actions targeting other species. The management objective for yellow toadflax is to not increase or spread existing infestations.
- **Sulfur cinquefoil** is a high priority for active management because only a few infestations are present and early management to reduce the risk of spread could limit future management action needs. Management of sulfur cinquefoil is also a priority for the landowner. The management objective for sulfur cinquefoil is to prevent spread of the species and possibly eliminate the species from the project area.

4.2 Previous Weed Management Actions

Some weed management actions have been implemented in the project area to date. In addition to project related weed management actions, the landowner has applied herbicide to weeds (primarily spotted knapweed) approximately every five years as infestations increase. These

herbicide applications have occurred in areas adjacent to and outside the project area and may limit spread of weed species into the project area.

High densities of cottonwood seedlings and moderate densities of willows were naturally recruited on alluvial point bar surfaces in spring 2008. During 2008 effectiveness monitoring, high density spotted knapweed infestations were noted in areas of cottonwood and willow seedling recruitment. The near total cover of knapweed in some natural recruitment areas was presumed to be limiting establishment and survival of cottonwood and willow seedlings. To address this factor, weeds were hand pulled from four point bars and one floodplain surface in August 2008 and 2009 (shown in Figure A-1 in Appendix A and listed below) to reduce coverage and spread of spotted knapweed without damaging young, establishing cottonwoods and willows.

- Point bar surfaces where hand pulling of spotted knapweed occurred:
  - PB01 demo –2009
  - PB07a – 2008
  - PB10 – 2008 and 2009
  - PB12 – 2008 and 2009
- Floodplain surfaces where hand pulling spotted knapweed occurred:
  - FP19 – 2008 and 2009

Monitoring of hand pulling seems to indicate that while a significant reduction in spotted knapweed canopy cover has occurred in these areas the extents of the infestations remain unchanged.

In addition to hand pulling, a number of the revegetation treatments implemented in the project area also contribute to weed management. Establishing structurally diverse vegetation communities naturally reduces weed infestations by occupying available niches. As woody vegetation grows, it will reduce light availability in the herbaceous layer further eliminating spaces for weeds to establish. All revegetation treatments aim to restore native, structurally diverse riparian plant communities to the project area.

Wildlife browse on desired native species is relatively heavy at times during the year in the project area and was also determined to be a limiting factor to establishment and survival of native vegetation. Indirectly, by limiting establishment of native woody species, ungulate browse may also be promoting establishment and survival of weed species. Ungulates may also be acting as vectors; transporting weed seed or other propagules to and within the project area. A wildlife exclosure fence was constructed in summer 2008 to prevent browse of establishing woody riparian vegetation in a portion of the project area. Effectiveness monitoring of the fencing in 2009 provided some initial qualitative results that suggest the fence has reduced browse pressure, thereby enabling cottonwood and willow seedlings to establish and allowing existing plants to put on new shoot growth.

4.3 Weed Prevention Actions

Weed prevention is one of the most important actions to include in any weed management plan. To prevent further spread of weed species or the introduction of new weed species, the following preventative measures should be implemented:

- Minimize use of vehicles in the project area and use existing access routes and points as much as possible for future restoration project work and access to the project area in general (Figure 3);
- For future restoration project work, wash equipment and vehicles prior to accessing the site and before moving between sites if equipment is used in a weed infestation area;
- Continue to re-establish structurally diverse native vegetation where weed infestations are currently present; and
- Continue to monitor existing and new infestations.

Figure 3 shows the primary existing access routes for the project area. For most activities related to the restoration project and project maintenance, access will be along these routes. Construction of new access routes should be minimized. If new routes are needed, they should be located away from weed infestations to limit the spread of weed species. If this is not possible, weed species present near a new access route should be mechanically removed and disposed of, or treated in place to limit the spread of weed seed or plant parts that may be able to reproduce.

Re-establishing native vegetation is the most effective long-term action for preventing weed infestations. Containerized trees and shrubs have been planted in portions of the project area and dormant willow cuttings have been installed in bioengineering structures to promote bank vegetation. Portions of the project area have also been seeded to promote establishment of desirable vegetation. As described above, cottonwood and willow seedlings that are establishing on point bars are being encouraged by addition of wood and microtopography, and protected by an electric fence.

Another aspect of weed prevention is early detection of new infestations. Section 5 provides recommendations for monitoring existing and new weed infestations.

4.4 Weed Management Actions

Integrated weed management involves using many different methods and approaches to manage weed species (Sheley and Petroff 1999). A wide range of weed management actions are available for use in integrated weed management including: the use of biological agents, chemical, mechanical, and cultural control methods, and competitive exclusion. Appendix A provides additional details on weed management actions specific to the priority species identified in Section 3.

Chemical Management

Chemical weed management includes the use of selective or non-selective herbicides to kill or inhibit the normal growth of target weeds. Herbicides can be applied using either broadcast spraying, spot spraying or wick application depending on site conditions, targeted species and infestation characteristics. In the Grave Creek project area, chemical control is recommended for the treatment of spotted knapweed infestations located on floodplain surfaces (i.e. outside of the active channel and bankfull floodplain). Targeted spraying of concentrated patches of yellow toadflax, houndstongue and sulfur cinquefoil is also recommended.

Mechanical Management

Mechanical weed management includes hand pulling or digging of individual plants. In the Grave Creek project area, hand pulling is recommended for sensitive areas where use of herbicides or cultural control could result in damage to desirable vegetation as it is establishing. Hand pulling can be an effective means of control for spotted knapweed in areas of low to moderate densities. Several areas of spotted knapweed were hand pulled in the project area in late summer 2008 and 2009. This has reduced the density of knapweed at these sites but not the size of the infestations. These sites and any other sites where hand pulling is used should be closely observed for both management effectiveness and cost effectiveness.

Cultural Management

Cultural management of weeds includes activities such as burning, mowing, smothering, and other non-herbicide techniques. Once chemical and mechanical methods recommended in this plan have been implemented as part of initial weed management, cultural management could be considered as a component of broader, long term land management. Cultural techniques such as burning and mowing could kill young native plants in addition to weeds, so these techniques should be used cautiously or not at all until native plants have become well established in the project area.

Competitive Exclusion

Competitive exclusion consists of planting or seeding desired species to reduce available niches for weeds to occupy. Competitive exclusion is probably the most effective long-term weed management action for the project area. All of the revegetation strategies and treatments implemented to date in the project area would fit into this category of weed management.

Biological Agents

Biological control is the use of living organisms such as insects, spores or nematodes that target a particular weed species in a way that suppresses its growth and survival. Biological controls have been released and continue to be released throughout Lincoln County (Dan Williams, personal communication 2009). Spotted knapweed is the most likely candidate for biological control methods because it is the most widespread throughout the project area. Biological control agents may already be present in the project area and the site should be evaluated to determine which agents, if any, are present. Other priority species observed in the project area such as yellow toadflax also have specific biological control agents. The site could be evaluated to determine if any biological agents for these species are present, but additional releases of biological controls targeting these species may not be a realistic management strategy because of the small size of these infestations which may not support the organisms.

Recommended Weed Management Actions

Recommended weed management actions for priority weed species in the project area are based on the location of the infestation (floodplain, point bar or bioengineering), but also on the biology of the weed species present, infestation characteristics and overall project revegetation objectives. These recommended weed management actions should be considered the first phase of weed management and should be evaluated for effectiveness similar to other revegetation treatments (see Section 5). The following are the initial weed management actions recommended for the project reach:

- Floodplain surfaces
    - Selective herbicide application of spotted knapweed and houndstongue infestations including other priority species that occur in knapweed and houndstongue infestation areas
- Point bar surfaces
    - Hand pull spotted knapweed, houndstongue and yellow toadflax
- Bioengineering surfaces
    - Hand pull spotted knapweed, Canada thistle, houndstongue and sulfur cinquefoil

Table 1 provides more details on the recommended weed management actions and specific locations for actions.

Table 1. Summary of weed management actions for the Grave Creek project area by species and location.

Priority Weed Species	Surface Feature	Initial Management Action	Initial Management Action Location
Spotted knapweed (*Centaurea maculosa*)	Floodplain	Apply herbicide using broadcast, hand line or backpack application methods. Broadcast treatment may be appropriate for larger, higher density infestations. Hand line or backpack application may be appropriate for smaller, lower density infestations to limit damage to non-target species. Backpack application may be necessary for areas where access is difficult.	Treat all floodplain polygons and points: FP03 through FP17, FP19 through FP23, FP25 and FP26; CM1, CM2 and CM3
	Point bar	Hand pull all plants from point bar locations in early summer (June or July) and again in the fall if possible while soils are moist to facilitate removal of the root. Early summer pulling will target newly emerging rosettes. Fall pulling will target any mature plants that have bolted and flowered to remove additional seed sources from the project area and any new rosettes from seed produced the same year.	Treat polygons with moderate to high density infestations: PB01, PB02 demo, PB03, PB04a, PB05, PB06, PB07a, PB08, PB09a, PB09b, PB10, PB11, PB13, PB14a
	Bioengineering	Hand pull all plants from bioengineering structures in early summer and again in the fall if possible while soils are moist to facilitate removal of the root. Fall pulling will target any mature plants that have bolted and flowered to remove additional seed sources from the project area and any new rosettes from seed produced the same year.	All bioengineering structures where knapweed is present: SL-2 and SL-8
Oxeye daisy (*Chrysanthemum leucanthemum*)	Floodplain	Apply herbicide using broadcast or hand line application methods. Broadcast treatment may be appropriate for larger, higher density infestations. Hand line application may be appropriate for smaller, lower density infestations.	Treat polygons that overlap with spotted knapweed or occur along access routes: FP04, FP05, FP06, FP08, FP09, FP10, FP13, FP14, FP18, FP19, FP26
	Point bar	Monitor infestations to detect any increases in population size or density so additional treatment methods such as hand pulling or spot herbicide treatment can be considered.	Monitor all – see Section 5 below
	Bioengineering	Monitor infestations to detect any increases in population size or density so additional treatment methods such as hand pulling can be considered.	Monitor all – see Section 5 below
Canada thistle (*Cirsium arvense*)	Floodplain	Apply herbicide using broadcast, hand line or backpack application methods. Broadcast treatment may be appropriate for larger, higher density infestations. Hand line or backpack application may be appropriate for smaller, lower density infestations to limit damage to non-target species. Backpack application may be necessary for areas where access is difficult.	Treat polygons that overlap with spotted knapweed or occur along access routes: FP05, FP08, FP13, FP20
	Point bar	Monitor infestations to detect any increases in population size or density so additional treatment methods such as hand pulling or spot herbicide treatment can be considered.	Monitor all – see Section 5 below

Priority Weed Species	Surface Feature	Initial Management Action	Initial Management Action Location
	Bioengineering	Hand pull all plants from bioengineering structures in early summer and again in the fall if possible while soils are moist to facilitate removal of the root. For this species removal of as much of the root material as possible will be essential because the plant can re-grow from root material. Early summer pulling will target newly emerging rosettes. Fall pulling will target any mature plants that have bolted and flowered to remove additional seed source from the project area.	All bioengineering structures where Canada thistle is present: SL-2, SL-6, SL-12, Demo SL-2
Houndstongue (*Cynoglossum officinale*)	Floodplain	Apply herbicide using hand line or backpack application methods to limit damage to non-target species. Many of the infestations are relatively small and sparse, except two small, dense infestations. Spot infestations or smaller polygon infestations may also be pulled by hand if soil conditions allow removal of the crown portion of the root.	Treat all polygons: FP01, FP02, FP05, FP06, FP07, FP09, FP17, FP19, FP24, FP26
	Point bar	Hand pull all plants from point bar locations in early summer and again in the fall if possible while soils are moist to facilitate removal of the root. Early summer pulling will target newly emerged rosettes. Fall pulling will target any mature plants that have bolted and flowered to remove additional seed source from the project area.	Treat areas where spotted knapweed is being pulled or where density is moderate or high: PB01, PB02 demo, PB02b, PB03, PB05, PB06, PB08, PB09a, PB09b, PB10, PB11, PB13, PB14a
	Bioengineering	Hand pull all plants from bioengineering structures in early summer and again in the fall if possible while soils are moist to facilitate removal of the root. Fall pulling will target any mature plants that have bolted and flowered to remove additional seed source from the project area.	All bioengineering structures where houndstongue is present: SL-2
Yellow toadflax (*Linaria vulgaris*)	Floodplain	Apply herbicide using hand line or backpack application methods to limit damage to non-target species. Many of the infestations are relatively small and sparse, except one small, high density infestation. Spot infestations or smaller polygon infestations may also be pulled by hand if soil conditions allow removal of the crown portion of the root.	Treat areas that overlap with spotted knapweed or where density is moderate or high: FP04, FP05, FP07, FP09, FP10, FP17, FP18, FP22
	Point bar	Hand pull all plants from point bar locations in early summer and again in the fall if possible while soils are moist to facilitate removal of the root. Early summer pulling will target newly emerged rosettes. Fall pulling will target any mature plants that have flowered to remove additional seed source from the project area.	Treat areas where spotted knapweed is being pulled: PB02 demo, PB02b, PB04a, PB05, PB06, PB08, PB09b, PB10, PB11
	Bioengineering	Not present; continue monitoring to detect any new populations.	Monitor for new infestations – see Section 5 below)

Priority Weed Species	Surface Feature	Initial Management Action	Initial Management Action Location
Sulfur cinquefoil (*Potentilla recta)*	Floodplain	Apply herbicide using broadcast, hand line or backpack application methods. Broadcast treatment may be appropriate for larger, higher density infestations. Hand line or backpack application may be appropriate for smaller, lower density infestations to limit damage to non-target species. Backpack application may be necessary for areas where access is difficult.	Treat all polygons with this species: FP05, FP06, and FP08
	Point bar	Not present, continue monitoring to detect any new populations.	Monitor for new infestations (see Section 5 below)
	Bioengineering	Hand pull all plants from bioengineering structures in early summer and again in the fall if possible while soils are moist to facilitate removal of the root. This species is able to re-grow from root material. Monitoring is essential to determine whether hand pulling is effective so alternative treatment methods can implemented as possible if needed. Fall pulling will target any mature plants that have flowered to remove additional seed source from the project area.	All bioengineering structures where sulfur cinquefoil is present: Demo SL-2

4.5 Weed Management Plan Implementation

This section provides details on implementing this weed management plan. This section provides information on implementing the initial treatments described in Section 4.4 and also provides recommendations for future treatments based on evaluation of how infestations and other plant communities respond to initial treatments. Weed control and management should be based on how the project area continues to respond to treatments and natural processes, including disturbances such as floods and browse. The plant community response to weed management actions and on-going revegetation treatments should be monitored frequently, and later weed management actions should be adjusted based on monitoring results. A long-term commitment by the land owner and project partners to maintain the project and monitor progress within the reach will be necessary to achieve weed management and revegetation objectives.

The following tasks are necessary to implement this integrated weed management plan:

- Develop detailed cost estimates for implementing initial weed management treatments. Table 2 provides a summary of treatment quantities to support development of initial treatment costs. Detailed costs are not provided because commercial applicators will need to evaluate the site and site conditions to provide per acre costs.
- Retain commercial applicators and other contractors as necessary to implement initial weed management actions. Project partners should work together on this task because several options exist for implementing initial treatments. For example, landowners are allowed to spray non-restricted herbicides on their lands and the landowner may be interested in completing initial applications. Also, a Montana Conservation Crew (MCC) crew was retained through the U.S. Fish and Wildlife Service to hand pull target areas in the project area in late summer 2009. It may be possible for these crews to complete some or all of the hand pulling recommended for 2010
- Implement initial weed management actions (see Table 3 for schedule and timing).
- Monitor effectiveness of initial management actions and incorporate observations and data into refining additional phases of treatments (see Table 3 for schedule and Section 5 for monitoring and adaptive management recommendations).
- Obtain funding for initial treatment implementation, effectiveness monitoring and continued weed management for a five-year period.

Management Action Quantities and Locations

Table 2 provides a summary of initial weed management actions recommended for the Grave Creek restoration project area.

Table 2. Summary of initial weed management action quantities for priority weed species.

Treatment Method	Area (acres) or Length (feet)	Target Priority Species
Herbicide treatment of floodplain polygons	2.97 acres	Spotted knapweed, oxeye daisy, Canada thistle, houndstongue, yellow toadflax, sulfur cinquefoil
Hand pulling of point bar polygons	6.36 acres	Spotted knapweed, houndstongue, and yellow toadflax
Hand pulling of bioengineering structures	235 linear feet	Spotted knapweed, Canada thistle, houndstongue, and sulfur cinquefoil

Management Action Schedule and Timing

This section provides additional details on schedule and timing to implement this weed management plan. Table 3 provides a schedule for implementation of this weed management plan.

Chemical Control

Spraying of priority weed species on floodplain surfaces should begin in late spring or early summer 2010 after run-off recedes. A late fall re-treatment may be necessary to target any areas that may have been missed during the earlier treatment. Additional herbicide treatments should continue as needed into the future based on effectiveness monitoring results. Table 2 lists priority weed species on floodplain surfaces that will be targeted for herbicide treatments and the total acreage for initial treatment.

For any restricted use herbicides, a licensed herbicide applicator must apply the herbicides. All application of herbicide will need to follow the manufacturer's label and instructions for use including application rates and the use of surfactants.

Mechanical Control

Hand pulling and or digging weeds from point bar surfaces and bioengineering structures should occur in early summer 2010 and again in fall 2010. Table 2 lists weed species that will be targeted for hand pulling on point bar surfaces and bioengineering structures and initial treatment quantities.

Competitive Exclusion

Some areas should be inter-seeded after chemical or mechanical control management actions are complete. These areas are still to be determined, but would include areas where: (1) there may be few seeds or propagules of desired species remaining in the treatment area or (2) re-growth of native vegetation is slower than desired and may not prohibit future re-infestation of the treatment area. Fall 2010 is the earliest seeding would occur. Monitoring results will determine whether or not weed cover has decreased to a level where additional weed control will be minimal and therefore not threaten survival of seeded species. Seed mixes from the Revegetation Plan will be used as a basis for determining appropriate inter-seeding seed mixes. The actual seed mix will be based on seed species available and current site conditions.

Biological Control

While Lincoln County is using biological controls for some of the priority weed species identified in the project area (Dan Williams, personal communication 2009), the project area has not been evaluated to determine if any biological control populations are present. Spotted knapweed is the dominant weed species in the project area, and many biological control agents are available that target this species. The project area should be evaluated to determine which, if any, biological control agents are present and assess the feasibility of releasing additional or new biological control agents. Biological control agents are available for other weed species identified in the project area; however, the size and density of these infestations may not be large enough to support biological control organism populations and therefore would not be effective as management action.

Table 3. Proposed Grave Creek integrated weed management plan implementation schedule.

Grave Creek Integrated Weed Management Plan Implementation Schedule										
	2010				**2011**			**2012 -2014**		
Task	W	Sp	Su	F	Sp	Su	F	Sp	Su	F
Develop detailed cost estimates and secure funding for initial treatments										
Spot check management locations and lay-out treatment locations as needed										
Herbicide application targeting priority weed species*										
Hand pull priority weed species*										
Develop budgets and secure funding to continue implementation of the Weed Management Plan through 2014										
Monitor initial weed treatment effectiveness and adjust 2011 treatments based on observing treatment effectiveness										
Implement 2011 Treatments (Expected treatment: Spot herbicide treatments for priority species)										
Implement 2011 Treatments (Expected treatment: Hand pulling priority species on point bars and bioengineering)										
Monitor 2011 weed treatment effectiveness including updating weed inventory maps and adjusting future treatment needs based on observing treatment effectiveness										
Implement additional weed treatments as necessary										

*****See Table 1, Table 2 and Figures A-1 through A-6 for initial treatment quantities and locations. Treatments may occur as often as twice each year depending on observed treatment effectiveness.

Section 5 Monitoring and Adaptive Management

This section describes monitoring and adaptive management recommendations for weed management actions described in this plan. The purpose of monitoring and adaptive management is to determine effectiveness of implemented weed management actions and determine if revegetation objectives are being met. The intent of this plan is to integrate weed monitoring and management actions into overall project monitoring and adaptive

management. Table 4 describes the adaptive management strategy for weed management related to achieving the restoration project goals and objectives. Once native vegetation communities are established enough to resist weed invasion, monitoring can occur less frequently. Some degree of monitoring should occur in perpetuity to detect new or expanding weed invasion that could reverse the condition of self-sustaining native plant communities.

5.1 Monitoring

Monitoring will determine the effectiveness of implemented weed management actions and help guide future actions based on the observed results. The weed inventory included in this plan serves as baseline data for weed species locations and densities in the project area. For future monitoring, weeds in the project area should be mapped following methods described in Section 3 and including mapping of priority weeds along project access routes shown in Figure 3.

This monitoring data should be used to determine:

- Changes in weed infestation locations;
- Changes in weed densities;
- Identification of new infestations or new priority species; and
- Effectiveness of implemented management actions.

This information should be combined with other on-going project effectiveness monitoring to determine if revegetation objectives for the project area are being met.

Monitoring of weed species composition, density, and response to management actions should be completed at least once annually in 2011 and 2012. Spot check monitoring should be completed in 2010 prior to implementing initial weed management actions to ensure that infestation characteristics have not changed to the extent that alternative actions are warranted. An additional spot check should occur in summer 2010 to determine if any areas were missed with the initial treatment and require a fall re-treatment. The following frequency of monitoring is recommended:

- **2010:** Spot check 2009 weed inventory in June 2010 prior to implementing initial weed management actions and again in late summer 2010 to determine if a fall re-treatment is necessary.
- **2011:** Repeat weed inventory mapping in summer 2011 to evaluate effectiveness of 2010 weed management actions.
- **2012:** Repeat weed inventory mapping in summer 2012 to evaluate effectiveness of 2011 weed management actions.
- **2013-2014:** Spot checks of weed locations and densities should be repeated as needed to ensure that management actions are appropriate.

5.2 Adaptive Management Decision Making Framework

Table 4 below summarizes adaptive management strategies by priority weed species and surface feature in the project area. The table includes the management objectives for each species, the initial management actions, and potential future treatment needs based on possible monitoring results that may be observed in the future. This table should be used to help project partners make decisions about future weed management needs based on monitoring results.

Table 4. Adaptive management strategy for weed management actions related to achieving restoration project goals.

Priority Weed Species	Surface Feature	Weed Management Objective	Initial Management Action	Future Treatments and Decision Criteria
Spotted knapweed (*Centaurea maculosa*)	**Floodplain**	Reduce cover of spotted knapweed so native plant communities are able to establish.	Apply herbicide using broadcast or hand line application methods. Broadcast treatment may be appropriate for larger, higher density infestations. Hand line application may be appropriate for smaller, lower density infestations.	As size and density of the infestations decrease, evaluate the need for supplemental seeding native forbs and/or grasses into treated areas. Continue herbicide application or supplemental seeding as needed until native species predominate and establishment of native riparian plant communities is not hindered by spotted knapweed.
	Point bar	Reduce cover of spotted knapweed so cottonwoods and willows are able to establish on point bar surfaces.	Hand pull all plants from point bar locations in early summer (June or July) and again in the fall if possible while soils are moist to facilitate removal of the root. Fall pulling will target any mature plants that have bolted and flowered to remove additional seed source from the project area and rosettes from seed produced the same year.	Continue to hand pull until cottonwoods and willows have exceeded the height of spotted knapweed plants. If densities of the infestations remain moderate or high and are greater than the cover of cottonwoods and willows, continue management actions. If size or density of the infestations do not decrease as a result of hand pulling then targeted herbicide application may be necessary. If herbicide treatments become necessary, treatment should attempt to avoid damage to colonizing cottonwoods and willows.
	Bioengineering	Reduce spotted knapweed cover so it is not suppressing establishment of woody species along outer meander streambanks.	Hand pull all plants from bioengineering structures in early summer and again in the fall if possible while soils are moist to facilitate removal of the root. Fall pulling will target any mature plants that have bolted and flowered to remove additional seed source from the project area and rosettes from seed produced the same year.	Continue to hand pull until woody species have exceeded the height of spotted knapweed plants. If densities of the infestations remain moderate or high or are greater than the cover of woody species, continue treatments. If size or density of the infestations do not decrease as a result of hand pulling then targeted herbicide application may be necessary. If herbicide treatments become necessary, treatment should attempt to avoid damage to establishing woody species.

Priority Weed Species	Surface Feature	Weed Management Objective	Initial Management Action	Future Treatments and Decision Criteria
Oxeye daisy (*Chrysanthemum leucanthemum*)	**Floodplain**	Limit and monitor the spread of oxeye daisy infestations so native plant communities are able to establish.	Apply herbicide using broadcast or hand line application methods. Broadcast treatment may be appropriate for larger, higher density infestations. Hand line application may be appropriate for smaller, lower density infestations.	If infestations increase in size or spread, then the species may be considered a higher priority for management and herbicide treatments should be used in areas where it the species is spreading or increasing in density.
	Point bar	Monitor infestations of oxeye daisy to ensure that they do not interfere with cottonwood and willow establishment on point bar surfaces.	Monitor infestations to detect any increases in population size or density so additional treatment methods such as hand pulling or spot herbicide treatment can be considered.	If infestations increase in size or spread, then the species may be considered a higher priority for management and hand pulling may need to target this species on point bar surfaces. If hand pulling does not effectively manage the species, then herbicide treatments may be necessary. If herbicide treatments become necessary, treatment should attempt avoid damage to colonizing cottonwoods and willows.
	Bioengineering	Monitor infestations of oxeye daisy to ensure they do not suppress establishment of woody species along outer meander streambanks.	Monitor infestations to detect any increases in population size or density so additional treatment methods such as hand pulling can be considered.	If infestations increase in size or spread, then the species may be considered a higher priority for management and hand pulling may need to target this species on bioengineering structures. If hand pulling does not effectively manage the species, then herbicide treatments may be necessary. If herbicide treatments become necessary, treatment should attempt avoid damage to establishing woody species.

Priority Weed Species	Surface Feature	Weed Management Objective	Initial Management Action	Future Treatments and Decision Criteria
Canada thistle (*Cirsium arvense*)	**Floodplain**	Reduce Canada thistle cover so native plant communities are able to establish.	Apply herbicide using broadcast or hand line application methods. Broadcast treatment may be appropriate for larger, dense infestations. Hand line application may be appropriate for smaller, sparser infestations.	Continue active management until Canada thistle no longer interferes with establishment and survival of native plant communities. Because there are very few infestations, eradication of Canada thistle within the project area may be possible.
	Point bar	Reduce Canada thistle cover so cottonwoods and willows are able to establish on point bar surfaces.	Monitor infestations to detect any increases in population size or density so additional treatment methods such as hand pulling or spot herbicide treatment can be considered.	If infestations increase in size or spread, then the species may be considered a higher priority for management and hand pulling may need to target this species on point bar surfaces. If hand pulling does not effectively manage the species, then herbicide treatments may be necessary. If herbicide treatments become necessary, treatment should avoid damage to colonizing cottonwoods and willows.
	Bioengineering	Reduce Canada thistle cover so it is not suppressing establishment of woody species along outer meander streambanks.	Hand pull all plants from bioengineering structures in early summer and again in the fall if possible while soils are moist to facilitate removal of the root. For this species removal of as much of the root material as possible will be essential because the plant can re-grow from root material. Fall pulling will target any mature plants that have bolted and flowered to remove additional seed source from the project area.	Continue active management until woody species become established and Canada thistle no longer interferes with colonization and establishment of woody species on outer meander streambanks. If hand pulling does not effectively manage the species, then herbicide treatments may be necessary. If herbicide treatments become necessary, treatment should attempt to avoid damage to establishing woody species.

Priority Weed Species	Surface Feature	Weed Management Objective	Initial Management Action	Future Treatments and Decision Criteria
Houndstongue (*Cynoglossum officinale*)	**Floodplain**	Control houndstongue to prevent spread that could negatively influence establishment of native riparian vegetation communities.	Apply herbicide using hand line application methods. Many of the infestations are relatively small and sparse, except two small, dense infestations. Spot infestations or smaller polygon infestations may also be pulled by hand if soil conditions allow removal of the crown portion of the root.	Continue active management until native riparian vegetation communities are established and houndstongue cover is low or absent.
	Point bar	Control houndstongue to prevent spread that could negatively influence establishment of cottonwoods and willows on point bar surfaces.	Hand pull all plants from point bar locations in early summer and again in the fall if possible while soils are moist to facilitate removal of the root. Fall pulling will target any mature plants that have bolted and flowered to remove additional seed source from the project area.	Continue active management until cottonwoods and willows are well established and houndstongue no longer interferes with colonization and establishment of cottonwoods and willows on point bars. If hand pulling does not effectively manage the species, then herbicide treatments may be necessary. If herbicide treatments become necessary, they should avoid damage to establishing cottonwoods and willows.
	Bioengineering	Control houndstongue to prevent spread that could negatively influence establishment of woody species on outer meander streambanks.	Hand pull all plants from bioengineering structures in early summer and again in the fall if possible while soils are moist to facilitate removal of the root. Fall pulling will target any mature plants that have bolted and flowered to remove additional seed source from the project area.	Continue active management until woody species become established and houndstongue no longer interferes with colonization and establishment of woody species on outer meander streambanks. If hand pulling does not effectively manage the species, then herbicide treatments may be necessary. If herbicide treatments become necessary, treatment should avoid damage to establishing woody species.

Priority Weed Species	Surface Feature	Weed Management Objective	Initial Management Action	Future Treatments and Decision Criteria
Yellow toadflax (*Linaria vulgaris*)	**Floodplain**	Control yellow toadflax to prevent spread that could negatively influence establishment of native riparian vegetation communities.	Apply herbicide using hand line application methods. Many of the infestations are relatively small and low density, except one small, moderate density infestation. Spot infestations or smaller polygon infestations may also be pulled by hand if soil conditions allow removal of the crown portion of the root. .	Continue active management until native riparian vegetation communities are established and yellow toadflax cover is low or absent.
	Point bar	Control yellow toadflax to prevent spread that could negatively influence establishment of cottonwoods and willows on point bar surfaces.	Hand pull all plants from point bar locations in early summer and again in the fall if possible while soils are moist to facilitate removal of the root. Fall pulling will target any mature plants that have flowered to remove additional seed source from the project area.	Continue active management until cottonwoods and willows are well established and yellow toadflax no longer interferes with colonization and establishment of cottonwoods and willows on point bars. If hand pulling does not effectively manage the species, then herbicide treatments may be necessary. If herbicide treatments become necessary, treatment should avoid damage to establishing cottonwoods and willows.
	Bioengineering	Prevent spread of yellow toadflax to bioengineering structures.	Not present, continue monitoring to detect any new populations.	Continue revegetation efforts along outer meander streambanks to establish woody vegetation. If yellow toadflax spreads to bioengineering structures, active management measures should be implemented such as hand pulling or herbicide treatments depending on the size and density of any new infestations and the status of the surrounding native plant communities.

Priority Weed Species	Surface Feature	Weed Management Objective	Initial Management Action	Future Treatments and Decision Criteria
Sulfur cinquefoil (*Potentilla recta)*	**Floodplain**	Control the sulfur cinquefoil to prevent spread that could negatively influence establishment of native riparian vegetation communities.	Apply herbicide using broadcast or hand line application methods. Broadcast treatment may be appropriate for larger, dense infestations. Hand line application may be appropriate for smaller, sparser infestations.	Continue active management until native riparian vegetation communities are established and sulfur cinquefoil cover is low or absent.
	Point bar	Prevent spread of sulfur cinquefoil to point bar surfaces.	Not present, continue monitoring to detect any new populations.	Continue revegetation efforts on point bar surfaces so cottonwoods and willows establish. If sulfur cinquefoil spreads to point bar surfaces, active management measures should be implemented such as hand pulling or herbicide treatments depending on the size and density of any new infestations and the status of the surrounding native plant communities.
	Bioengineering	Control sulfur cinquefoil to prevent spread that could negatively influence establishment of woody species on outer meander streambanks.	Hand pull all plants from bioengineering structures in early summer and again in the fall if possible while soils are moist to facilitate removal of the root. This species is able to re-grow from root material. Monitoring is essential to determine whether hand pulling is effective so alternative treatment methods can be implemented as needed. Fall pulling will target any mature plants that have flowered to remove additional seed source from the project area.	Continue active management until woody species are well established and sulfur cinquefoil no longer interferes with establishment of woody species on outer meander streambanks. If hand pulling does not effectively manage the species, then herbicide treatments may be necessary. If herbicide treatments become necessary, treatment should avoid damage to establishing woody species.

5.3 Outreach Recommendations

Although this weed management plan focuses on the Grave Creek restoration project area, it is important to note that weed management is a natural resource management challenge that extends beyond property and project boundaries. For that reason, Kootenai River Network and partners should consider conducting outreach to landowners adjacent to the project area. Developing partnerships with adjacent landowners, county, state and federal entities will provide a wider range of opportunities for funding management actions and overall success of weed management in the project area and watershed.

For example, Lincoln County recognizes 'Special Weed Management Project Areas' as *project areas formed by cooperatives of adjacent landowners to facilitate noxious weed management. These project areas will be given priority for noxious weed control efforts by the Lincoln County Vegetation Management Board* (Lincoln County 2008). Further, the funding opportunity described in Appendix D is only available for cooperatives consisting of at least three landowners.

Section 6 References

Lincoln County Vegetation Management Board. 2008. Lincoln County, Montana Integrated Noxious Weed Management Plan. Lincoln County Weed Management Office Libby, Montana.

Geum Environmental Consulting. 2008. Grave Creek Riparian Revegetation and Monitoring Plan. Prepared for Kootenai River Network, Whitefish, Montana.

Montana Department of Agriculture. 2009. Montana County Noxious Weed List, effective March 27, 2008. Accessed at http://agr.mt.gov/weedpest/pdf/weedlist3-08.pdf.

Sheley, Roger L, and Janet K. Petroff. 1999. Biology and Management of Noxious Rangeland Weeds. Oregon State University Press, Corvallis, Oregon.

Williams, Dan. 2009. Personal communication from Dan Williams, Department Head, Lincoln County Weed Department Libby, Montana to Sarah Flynn, project biologist, Geum Environmental Consulting, Inc., Hamilton, Montana. Phone conversation, November 19, 2009.

List of Appendices

Appendix A: Priority Species Distribution and Integrated Management Plans

Table A-1. Weed species presence and density in floodplain (FP) and point bar (PB) surfaces in the Grave Creek project area. Low density is 0 to 10% aerial cover. Moderate density is greater than 10% to 60% aerial cover. High density is greater than 60% aerial cover. Polygon locations are shown on Figures A-1 through A-6.

			Density Class					
Polygon ID	**Surface Feature**	**Area (acres)**	**Spotted knapweed (*Centaurea maculosa*)**	**Oxeye daisy (*Chrysanthemum leucanthemum*)**	**Canada thistle (*Cirsium arvense*)**	**Houndstongue (*Cynoglossum officinale*)**	**Yellow toadflax (*Linaria vulgaris*)**	**Sulfur cinquefoil (*Potentilla recta*)**
FP01	**Floodplain**	**0.01**	--	**Moderate**	--	**Moderate**	--	--
FP02	**Floodplain**	**0.02**	--	--	--	**High**	--	--
FP03	**Floodplain**	**0.14**	**Moderate**	--	--	--	--	--
FP04	**Floodplain**	**0.03**	**Moderate**	**Low**	--	--	**Low**	--
FP05	**Floodplain**	**0.91**	**Moderate**	**Moderate**	**Low**	**Low**	**Low**	**Low**
FP06	**Floodplain**	**0.20**	**Low**	**Low**	--	**Low**	--	**Low**
FP07	**Floodplain**	**0.14**	**Moderate**	--	--	**Low**	**Low**	--
FP08	**Floodplain**	**0.10**	**Moderate**	**Low**	**Low**	--	--	**Low**
FP09	**Floodplain**	**0.04**	**Low**	**Low**	--	**Low**	**Low**	--
FP10	**Floodplain**	**0.15**	**Moderate**	**Low**	--	--	**Low**	--
FP11	**Floodplain**	**0.02**	**High**	--	--	--	--	--
FP12	**Floodplain**	**0.12**	**High**	--	--	--	--	--
FP13	**Floodplain**	**0.15**	**Moderate**	**Low**	**Low**	--	--	--
FP14	**Floodplain**	**0.06**	**High**	**Low**	--	--	--	--
FP15	**Floodplain**	**0.04**	**High**	--	--	--	--	--
FP16	**Floodplain**	**0.10**	**High**	--	--	--	--	--
FP17	**Floodplain**	**0.04**	**Low**	--	--	**Low**	**Moderate**	--
FP18	**Floodplain**	**0.02**	--	**Low**	--	--	**High**	--
FP19	**Floodplain**	**0.08**	**Low**	**Low**	--	**Low**	--	--
FP20	**Floodplain**	**0.22**	**High**	--	**Low**	--	--	--
FP21	**Floodplain**	**0.04**	**Moderate**	--	--	--	--	--
FP22	**Floodplain**	**0.04**	**High**	--	--	--	**Low**	--
FP23	**Floodplain**	**0.04**	**Moderate**	--	--	--	--	--
FP24	**Floodplain**	**0.12**	--	--	**Low**	**Moderate**	--	--
FP25	**Floodplain**	**0.03**	**Moderate**	--	--	--	--	--
FP26	**Floodplain**	**0.11**	**Moderate**	**Low**	--	**Low**	--	--
PB01	**Point Bar**	**0.35**	**Moderate**	**Low**	--	**Moderate**	--	--

Polygon ID	Surface Feature	Area (acres)	Density Class					
			Spotted knapweed (*Centaurea maculosa*)	Oxeye daisy (*Chrysanthemum leucanthemum*)	Canada thistle (*Cirsium arvense*)	Houndstongue (*Cynoglossum officinale*)	Yellow toadflax (*Linaria vulgaris*)	Sulfur cinquefoil (*Potentilla recta*)
PB01 demo	Point Bar	0.42	Low	Moderate	--	Low	Low	--
PB02 demo	Point Bar	0.05	Moderate	Moderate	--	Low	Low	--
PB02a	Point Bar	0.26	Low	Low	--	--	--	--
PB02b	Point Bar	0.30	Low	Low	--	Moderate	Low	--
PB03	Point Bar	0.18	Moderate	Low	--	Low	--	--
PB04a	Point Bar	0.70	Moderate	Low	--	--	Low	--
PB04b	Point Bar	0.09	Low	Low	--	--	--	--
PB05	Point Bar	0.44	Moderate	Moderate	--	Low	Low	--
PB06	Point Bar	0.77	Moderate	--	--	Low	Low	--
PB07a	Point Bar	0.59	Moderate	--	--	--	--	--
PB07b	Point Bar	0.42	Low	Moderate	--	Low	Low	--
PB08	Point Bar	0.98	High	Low	--	Low	Low	--
PB09a	Point Bar	0.41	High	Low	--	Low	--	--
PB09b	Point Bar	0.25	Moderate	Low	--	Low	Low	--
PB10	Point Bar	0.66	Moderate	--	--	Low	Low	--
PB11	Point Bar	0.05	Moderate	Low	--	Low	Low	--
PB12	Point Bar	0.95	Low	Low	Low	Low	Low	--
PB13	Point Bar	0.51	Moderate	Low	Low	Low	--	--
PB14a	Point Bar	0.12	Moderate	Low	--	Low	--	--
PB14b	Point Bar	0.06	Low	Low	--	Low	--	--

Table A-2. Weed species presence on bioengineering structures in the Grave Creek project area. SL codes represent vegetated soil lift structures. CL codes represent coir log structures. Low density is 0 to 10% aerial cover. Moderate density is greater than 10 to 60% aerial cover. High density is greater than 60% aerial cover. Structure locations are shown on Figures A-1 through A-6.

Bioengineering Structure ID	SL-2	SL-4	SL-6	SL-8	SL-12	Demo SL-2	CL-7
Structure Length (feet)	**40**	**80**	**40**	**35**	**70**	**50**	**110**
Weed Density Class[1]	**Low**	**Low**	**Moderate**	**High**	**Low**	**Low**	**Low**
Spotted knapweed (*Centaurea maculosa*)	**X**	**--**	**--**	**X**	**--**	**--**	**--**
Oxeye daisy (*Chrysanthemum leucanthemum*)	**--**	**X**	**X**	**X**	**X**	**--**	**X**
Canada thistle (*Cirsium arvense*)	**X**	**--**	**X**	**--**	**X**	**X**	**--**
Houndstongue (*Cynoglossum officinale*)	**X**	**--**	**--**	**--**	**--**	**--**	**--**
Yellow toadflax (*Linaria vulgaris*)	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Sulfur cinquefoil (*Potentilla recta*)	**--**	**--**	**--**	**--**	**--**	**X**	**--**

[1]Percent cover of weeds is recorded by five-foot increment on bioengineering structures. The weed density class indicated in this table represents the highest density recorded at each structure.

Centaurea maculosa (spotted knapweed)

Description

Spotted knapweed is in the Asteraceae family. It is a tap-rooted biennial or short-lived perennial weed. It is a Category 1 noxious weed in Montana. It has a multi-branched stalk that grows one to three feet tall. Flowers are pink to purple and are enclosed in an involucre with black-tipped bracts (Photos A-1 and A-2). Spotted knapweed reproduces solely by seed (Sheley and Petroff 1999). Plants average about 1,000 seeds per plant. Seeds are viable for seven years, and germinate throughout the growing season. Seedlings emerging in fall develop into a rosette of leaves that resume growth in spring. Infestation generally leads to a decline in biodiversity, because the invasive plant chokes out native vegetation. Leaves of spotted knapweed contain toxins; in addition, the roots exude chemicals that inhibit the growth of other plants.

Location and Abundance

Spotted knapweed occurs throughout the Grave Creek project area with varying densities (Figure A-1). Spotted knapweed is the most common and widely distributed priority species in the project area. It is most common on point bar features and densities tend to be moderate to high with a few point bars having low density infestations. Point bars with the highest densities in the project area were targeted for hand pulling in 2008 and 2009. These surfaces now have low or moderate density infestations (PB 7a, PB 10, PB 12 and PB01demo). Many of the spotted knapweed infestations on floodplain surfaces are relatively small and densities range from low to high cover.

Methods of Control

Several biological controls have been identified for spotted knapweed including: seedhead feeding flies (*Urophora affinis* and *U. quadifasciata*), a moth larvae (*Metzneria paucipunctella*), root mining species – root moths (*Agapeta zoegana*, *Pelochrista medullana*, and *Pterolonche inspersa*) and a root weevil (*Cyphocleonus achates*). These insects reduce either seed production or damage roots therefore reducing the competitive edge knapweed typically has over other species (Sheley and Petroff 1999). The Lincoln County Weed Board indicated that some of the biological control insects that target spotted knapweed are established in portions of Lincoln County (Dan Williams personal communication 2009).

Hand pulling can be very effective with small patches and in sites of new invasions or sites with low to moderate densities. Cutting or mowing and grazing will reduce seed production, but is only moderately effective for control. Cultivation is an effective method of control particularly in areas of high densities or monoculture. Supplemental seeding is effective as a follow-up treatment, but is not effective by itself (USDA NRCS 2004). Herbicides can be an effective method to control spotted knapweed (Dan Williams personal communication 2009).

Recommended Methods of Control

Point Bars and Bioengineering Structures

Spotted knapweed should be pulled by hand on point bars with moderate to high density infestations and on all vegetated soil lifts. Spotted knapweed should also continue to be hand pulled on sites that were treated in 2008 and 2009. The objective of hand pulling on point bar surfaces is to reduce spotted knapweed competition with naturally recruited cottonwoods and

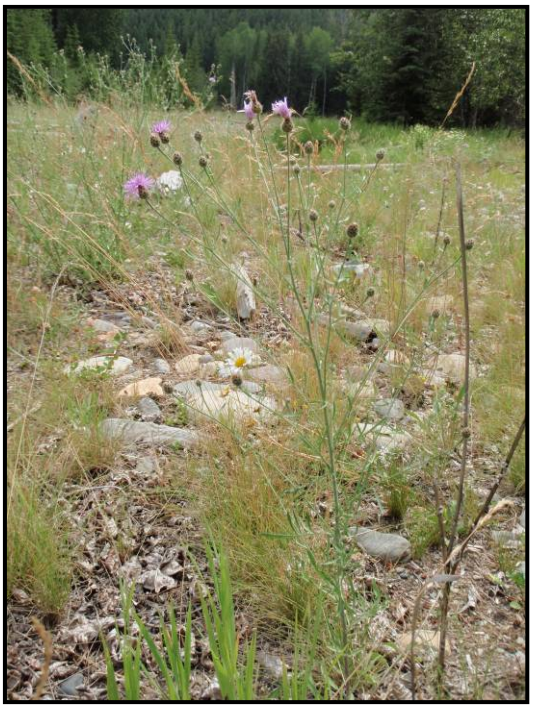
willows and using this method will reduce potential for damage to non-target species. Hand pulling of spotted knapweed on bioengineering surfaces is also recommended to limit damage to non-target species and because these areas are relatively small. Hand pulling should be done in early to mid summer while soils are still moist from snow melt and spring rains. If hand pulling is not feasible at this time of year, timing of pulling should follow rain events when soils are moist to facilitate removal of the root system from the ground. Hand pulling in the early summer will target newly emerging rosettes and removal of older plants that may still have viable seed in the seed heads. Hand pulling should be repeated in the fall as needed to target plants that were missed or that established after the early summer pulling. Hand pulling should continue until establishing cottonwoods and willows have grown above the height of knapweed plants, approximately three feet.

If hand pulling is not effectively suppressing the knapweed infestations to allow cottonwoods and willows to establish, herbicide application may be necessary to. If herbicide application is determined to be necessary, then treatments should be completed using backpack or hand line application methods that will limit damage to others species and continue to allow cottonwoods and willows to establish in these areas. Ideally, herbicide treatments would not be implemented until cottonwoods and willows are taller than spotted knapweed plants, to decrease the likelihood of these species being damaged by any treatments.

Floodplain Surfaces

Floodplain infestations of spotted knapweed in the project area are relatively small and concentrated. For this reason, all of these infestations should be treated with herbicide using either a broadcast method or targeted treatment methods such as backpack or hand line application to minimize damage to non-target species. Broadcast application may be appropriate for larger floodplain infestations such as FP04, FP05, FP06, FP10, FP12 and FP13. Smaller areas could be treated using hand line or backpack application methods to minimize damage to non-target species. These methods may also be appropriate as the size and density of the infestation decreases. Backpack application may be necessary in areas where access is difficult such as FP19, FP22, FP23 and FP26. Over time, if densities of spotted knapweed become low enough in floodplain areas, individual plants could be pulled by hand during the same time frame as points bars and vegetated soil lifts. Supplemental seeding of native forbs or grasses may need to occur as spotted knapweed density decreases if desired native forbs do not appear to be colonizing the area naturally.

The project area should be evaluated to determine if biological agents that target spotted knapweed are present. If they are not found on the site, and the current spotted knapweed infestation size and density is sufficient to support a biological control population, then releases should be considered.




Photos A-1 and A-2. Photos showing flowering spotted knapweed plants in the project area.


Photos A-3 and A-4. Photos showing examples of dense (left) and sparse (right) spotted knapweed infestations on point bar surfaces. Cottonwoods are beginning to establish on the point bar with the sparse infestation of spotted knapweed (right photo).


Photos A-5 and A-6. The left photo shows spotted knapweed growing around a planted shrub with a browse protector net on a point bar surface. The right photo shows spotted knapweed growing on and behind a vegetated soil lift.


Photos A-7 and A-8. Photos showing example spotted knapweed infestations on the floodplain surface in the project area.

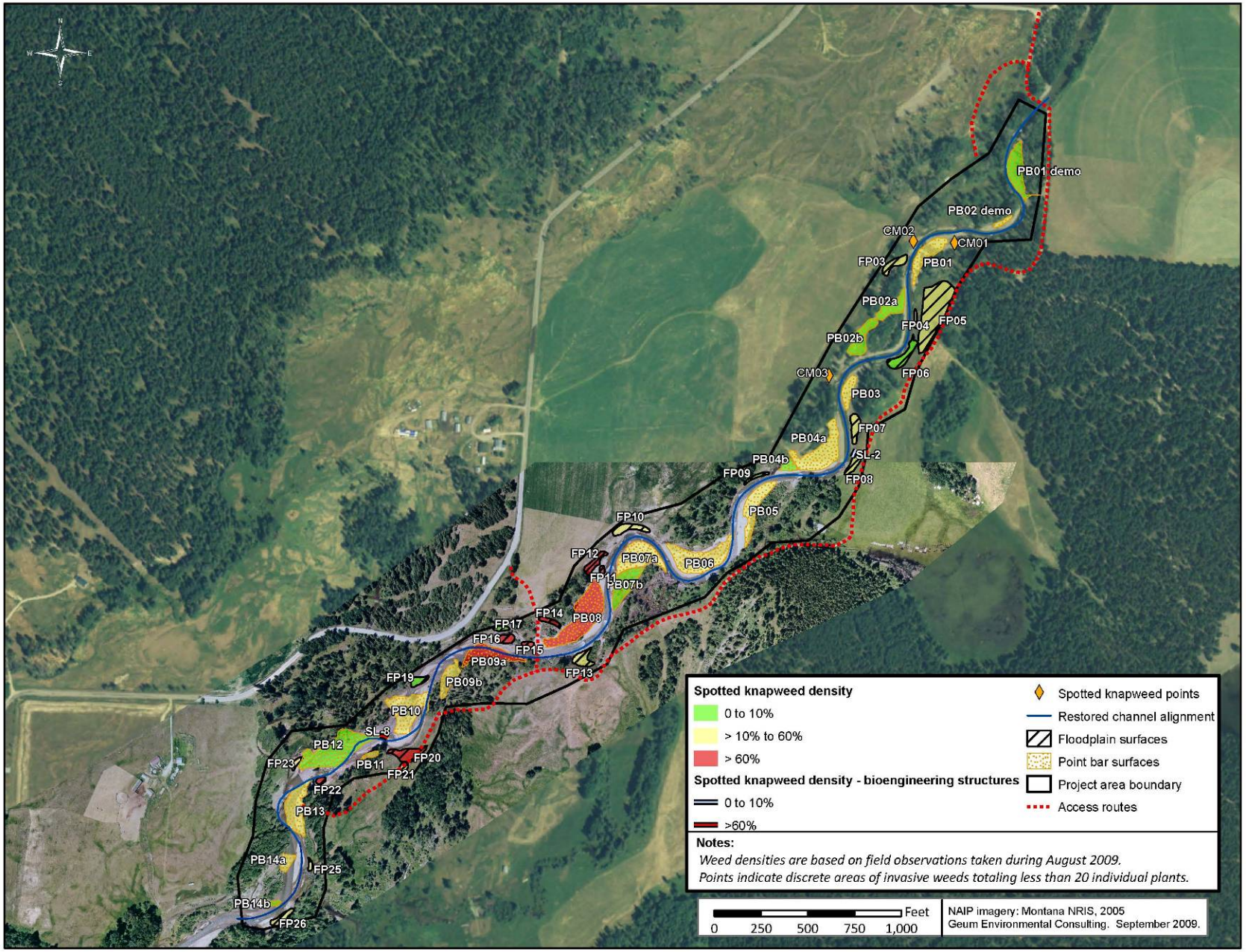


Figure A-1. Spotted knapweed distribution and abundance in the Grave Creek project area.

Chrysanthemum leucanthemum (oxeye daisy)

Description

Oxeye daisy is in the Asteraceae family. It is a Category 1 noxious weed in Montana. Oxeye daisy grows between one and 2 ½ feet tall. It has white ray flowers surrounding yellow disk flowers (Photos A-9 and A-10). It is a perennial species with branched rhizomes and adventitious roots. It reproduces by seeds, rhizomes, and prostrate stems are also able to form roots. Seeds are viable in the soil for a long period of time. Oxeye daisy grows well in a wide variety of environmental conditions but it has a low shade tolerance (Sheley and Petroff 1999).

Location and Abundance

In the Grave Creek project area, most oxeye daisy infestations occur on point bar features and density is generally low, but moderate is some locations (Figure A-2). Three point bar features have moderate (10-60% aerial cover) density infestations of oxeye daisy. Oxeye daisy infestations on floodplain surfaces tend to be relatively small and low density. However, the largest infestation in the project area (0.9 acres) has moderate density.

Methods of Control

Cutting or mowing and grazing reduce seed production of oxeye daisy, but these methods are only moderately effective at controlling the plant. Hand pulling is moderately effective only in small patches. Supplemental seeding and cultivation are only moderately effective. Biological controls are not currently available (NRCS 2004). Cultivation easily destroys the shallow root system however, plowing or disking may also result in a flush of new seed germination requiring that cultivation be repeated to deplete the soil seed bank (Sheley and Petroff 1999).

Recommended Methods of Control

Point Bars and Bioengineering Structures

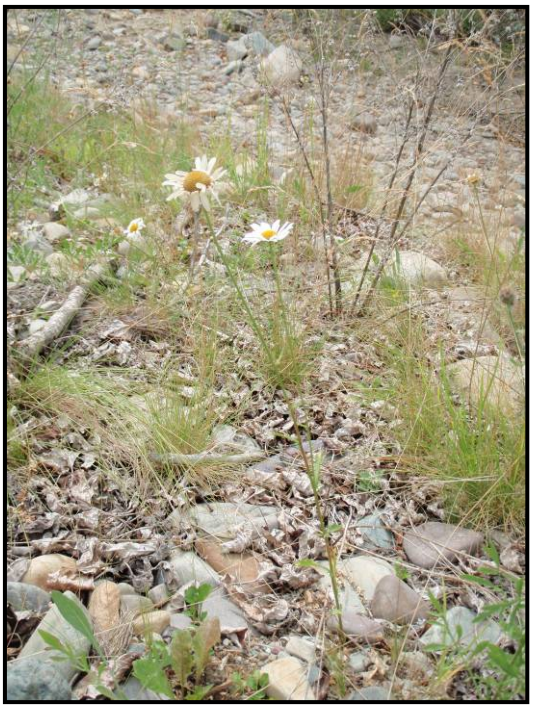
Because infestation densities are low, oxeye daisy on point bars and vegetated soil lifts should be monitored to ensure that existing infestations do not increase in size or density.

If oxeye daisy densities increase and appear to be limiting establishment of cottonwoods and willows, management may become necessary in the future. Management actions could include hand pulling or herbicide applications. If necessary, hand pulling should be done during the same early to mid-summer and fall timeframe as hand pulling for spotted knapweed. Follow-up monitoring will be essential as oxeye daisy can re-grow from root fragments left in the ground. If hand pulling is not effectively reducing cover of oxeye daisy, then targeted application of herbicide may be needed. If herbicide application is determined to be necessary, then treatments should be completed using backpack or hand line application methods that will limit damage to non-target species and continue to allow cottonwoods and willows to establish in these areas.

Floodplain Surfaces

Floodplain infestations of oxeye daisy should be treated with herbicide application where other priority species, such as spotted knapweed, are also being treated. The larger floodplain infestations (FP04, FP05, FP06, FP10 and FP13) may be treated using broadcast application methods, but smaller infestations should be treated using more selective hand line or backpack

treatments. As infestations decrease in size, hand line or broadcast treatment methods that limit damage to non-target species should be implemented. Supplemental seeding of native forbs or grasses may occur as oxeye daisy density decreases if desired native forbs do not appear to be colonizing the area naturally.




Photos A-9 and A-10. Photos showing flowering oxeye daisy plants in the project area.


Photos A-11 and A-12. Photos showing examples of oxeye daisy infestations on point bar surfaces in the project area.

Photo A-13. Example of a sparse infestation of oxeye daisy on the floodplain surface in the project area. Oxeye daisy are the white flowers in the lower half of the photo.

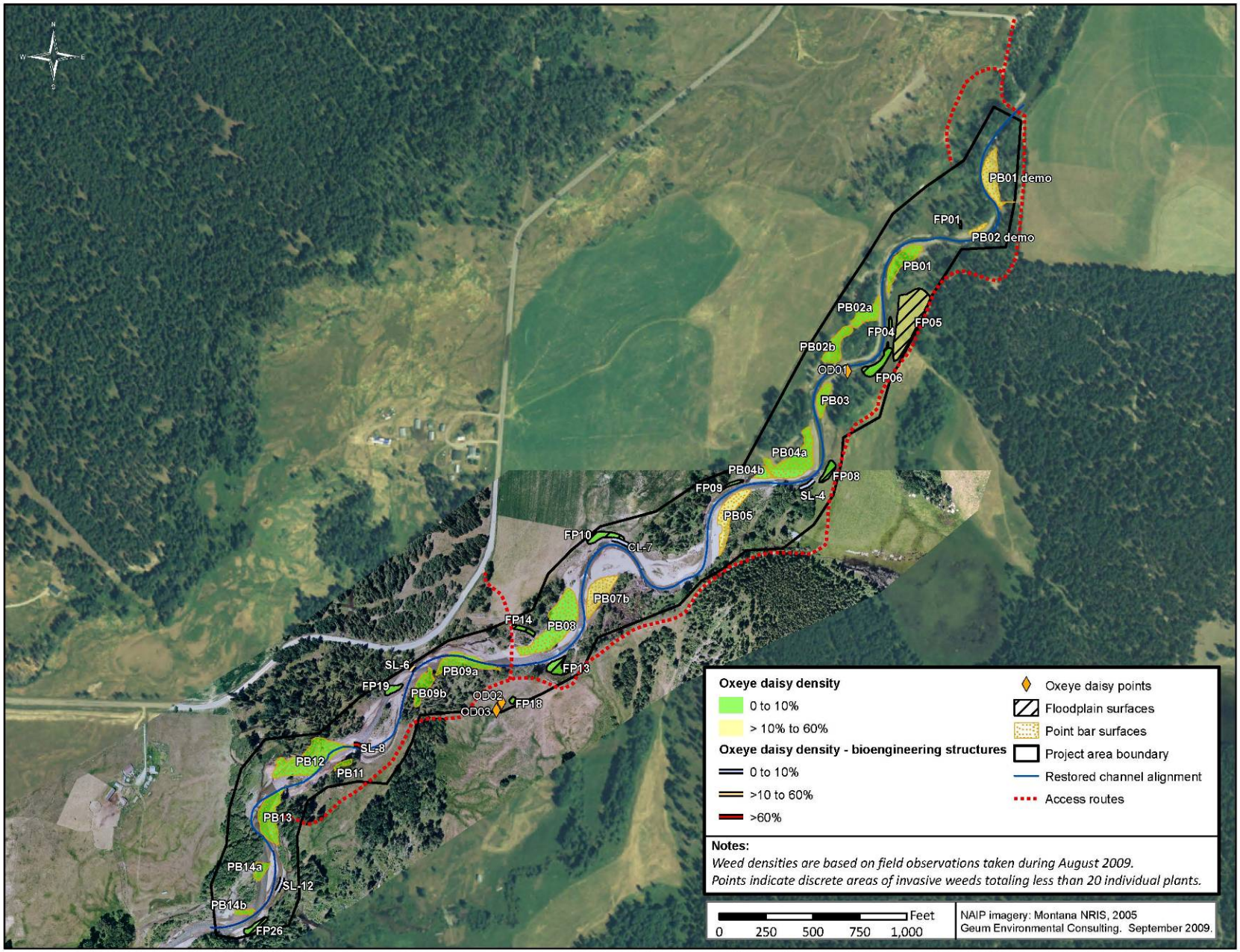


Figure A-2. Oxeye daisy distribution and abundance in the Grave Creek project area.

Cirsium arvense (Canada thistle)

Description

Canada thistle is in the Asteraceae family. It is a Category 1 noxious weed in Montana. Canada thistle grows between one and four feet tall. It has purple flowers enclosed in an involucre. It is a perennial weed with an extensive horizontal root system. Canada thistle reproduces from the buds on the root system, root fragments, and seed. Deeply buried seed can survive for up to 22 years if seed is buried at least eight inches deep. It is adapted to many ecological conditions but thrives in well-aerated, clay soil, dry conditions, and high light intensity (Sheley and Petroff 1999). It is difficult to control because its extensive root system allows it to recover from control attempts.

Location and Abundance

All infestations of Canada thistle in the Grave Creek project are low density (Figure A-3). Infestations occur on both point bar and floodplain surfaces. A few spot infestations are located throughout the project area on floodplain surfaces (Figure A-3).

Methods of Control

Cutting or mowing and hand pulling are not effective means of control for Canada thistle because of the extensive root system of the plant. Grazing can reduce seed production and cultivation is moderately effective in combination with herbicide treatments that will contain infestations. Biological controls include the tortoise beetle (*Cassida rubiginosa*), a stem mining weevil (*Ceutorhynchus litura*) and a stem gall fly (*Urophora cardui*). Biological controls are moderately effective and primarily reduce seed production (NRCS 2004, Sheley and Petroff 1999). Canada thistle does not tolerate shading and re-establishing tree and shrub cover should reduce coverage of the plant (Sheley and Petroff 1999).

Recommended Methods of Control

Point Bars and Bioengineering Structures

Canada thistle on point bars should be monitored to ensure that existing infestations do not increase in size or density. Canada thistle on bioengineering structures should be pulled by hand to reduce possible damage to non-target species. As much of the root as possible should be removed. Hand pulling should be done during the same early to mid-summer and fall timeframe as hand pulling for spotted knapweed. Follow-up monitoring will be essential as Canada thistle can re-grow from root fragments left in the ground. If Canada thistle spreads or densities increase and appear to be limiting revegetation objectives, herbicide application may be necessary. If herbicide application is determined to be necessary, then treatments should be completed using backpack or hand line application methods that will limit damage to non-target species and continue to allow cottonwoods and willows to establish in these areas.

Floodplain Surfaces

Floodplain infestations of Canada thistle should be treated with herbicide application. The larger floodplain infestations (FP05, FP13 and FP20) may be treated using broadcast application methods, but smaller infestations should be treated using more selective hand line or backpack methods. As infestations decrease in size, hand line or backpack treatment methods that limit

damage to non-target species should be used. Supplemental seeding of native forbs or grasses may be necessary if desired native forbs do not appear to be colonizing the area naturally as Canada thistle density decreases.

Photo A-14. Photo showing Canada thistle infestation in flower at site FP24 in the project area.

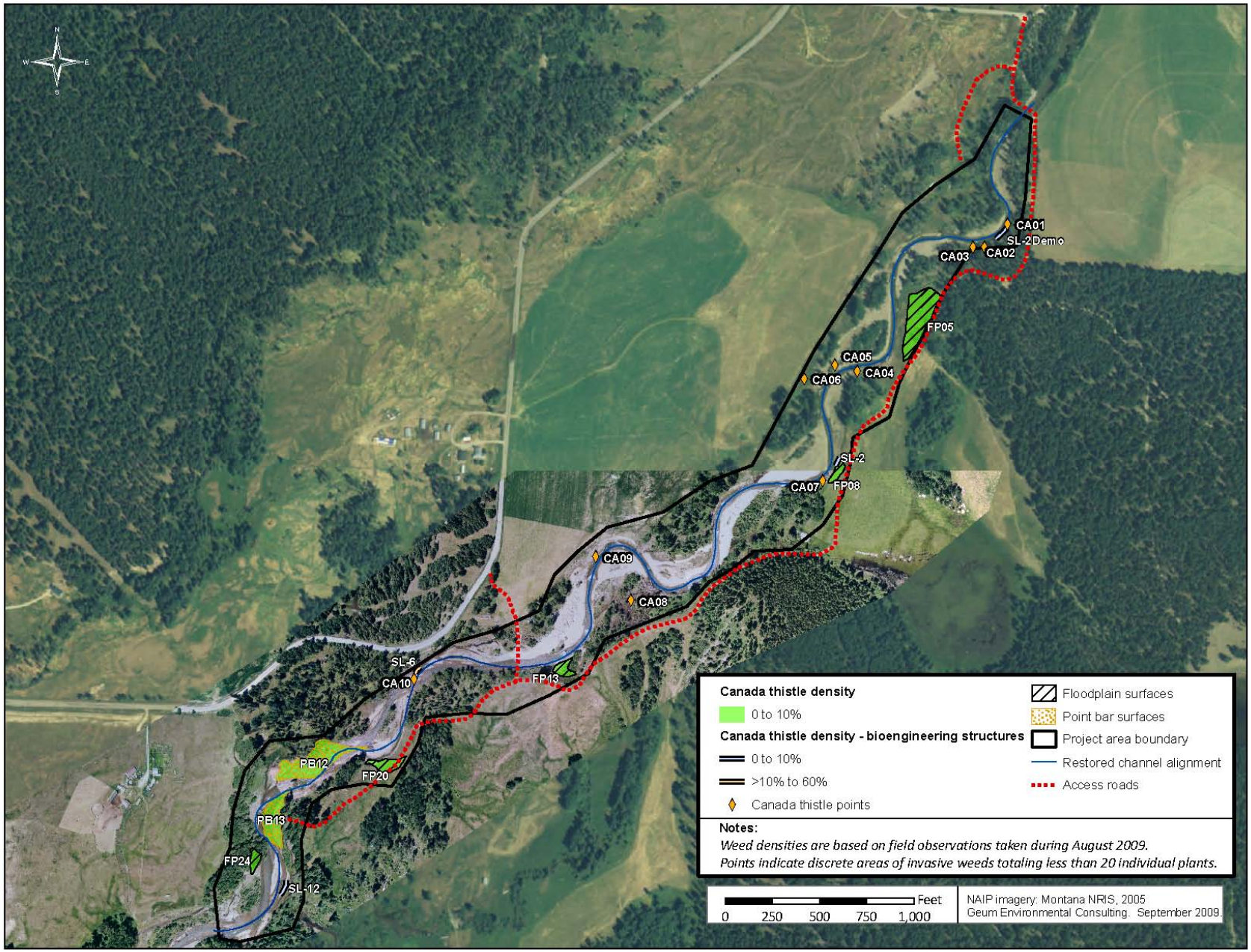


Figure A-3. Canada thistle distribution and abundance in the Grave Creek project area.

Cynoglossum officinale (houndstongue)

Description

Houndstongue is in the Boraginaceae family. It is a Category 1 noxious weed in Montana. It is a tap-rooted biennial that forms a rosette of softly hairy leaves the first year and a one to four foot flowering stalk the second year (Photo A-15). It reproduces by seeds that stick to hair and clothing (Whitson and others 1996). Flowers are generally purple. Houndstongue readily displaces desirable species and can establish monocultures. It is also poisonous to livestock.

Location and Abundance

In the Grave Creek project area, houndstongue infestations generally occur at low density on point bar features (Figure A-4). Two point bar areas have moderately dense infestations. One floodplain area has a small (0.02 acres) dense infestation of houndstongue. Other floodplain infestations are low density.

Methods of Control

Hand pulling may be practical and effective in small infestations as long as the root crown is removed (MSU 2009). Cutting or mowing reduces seed production in houndstongue, but will not kill the plant and is not an effective method of control. Cultivation may control houndstongue as long as the root is severed below the surface. Herbicide is an effective control method for houndstongue. Supplemental seeding is only moderately effective. Grazing will reduce seed production but is more likely to contribute to the spread of houndstongue because the species is resistance to defoliation and is poisonous to some livestock. Prescribed burning may destroy seeds but may also stimulate germination and provide optimal conditions for houndstongue establishment by creating disturbed areas (MSU 2009). Five biological controls have been identified for houndstongue but none have been approved for release (NRCS 2004, MSU 2009).

Recommended Methods of Control

Point Bars and Bioengineering Structures

Houndstongue on point bars and vegetated soil lifts should be pulled by hand to limit damage to non-target species in these areas. Hand pulling should be done during the same early to mid-summer and fall timeframe as hand pulling for spotted knapweed. Hand pulling should focus on removing as much of the root as possible, but at least the crown portion of the root needs to be removed for pulling to be effective. If houndstongue spreads or densities increase and appear to be limiting revegetation objectives, herbicide application may be necessary. If herbicide application is necessary, then treatments should be completed using backpack or hand line application methods that will limit damage to non-target species and continue to allow cottonwoods and willows to establish in these areas.

Floodplain Surfaces

Floodplain infestations of houndstongue should be treated with herbicide application. The larger floodplain infestations (FP05, FP06 and FP07) may be treated using broadcast application methods, but smaller infestations should be treated using more selective hand line treatments. Point infestations of houndstongue can be treated using hand line, or backpack methods or by

hand pulling if soil conditions permit removal of the upper portion of the root. As infestations decrease in size, hand line or broadcast treatment methods that limit damage to non-target species should be implemented.


Photos A-15 and A-16. The left photo shows a houndstongue plant with developed seed. The right photo shows scattered houndstongue rosettes on a point bar surface in the project area.

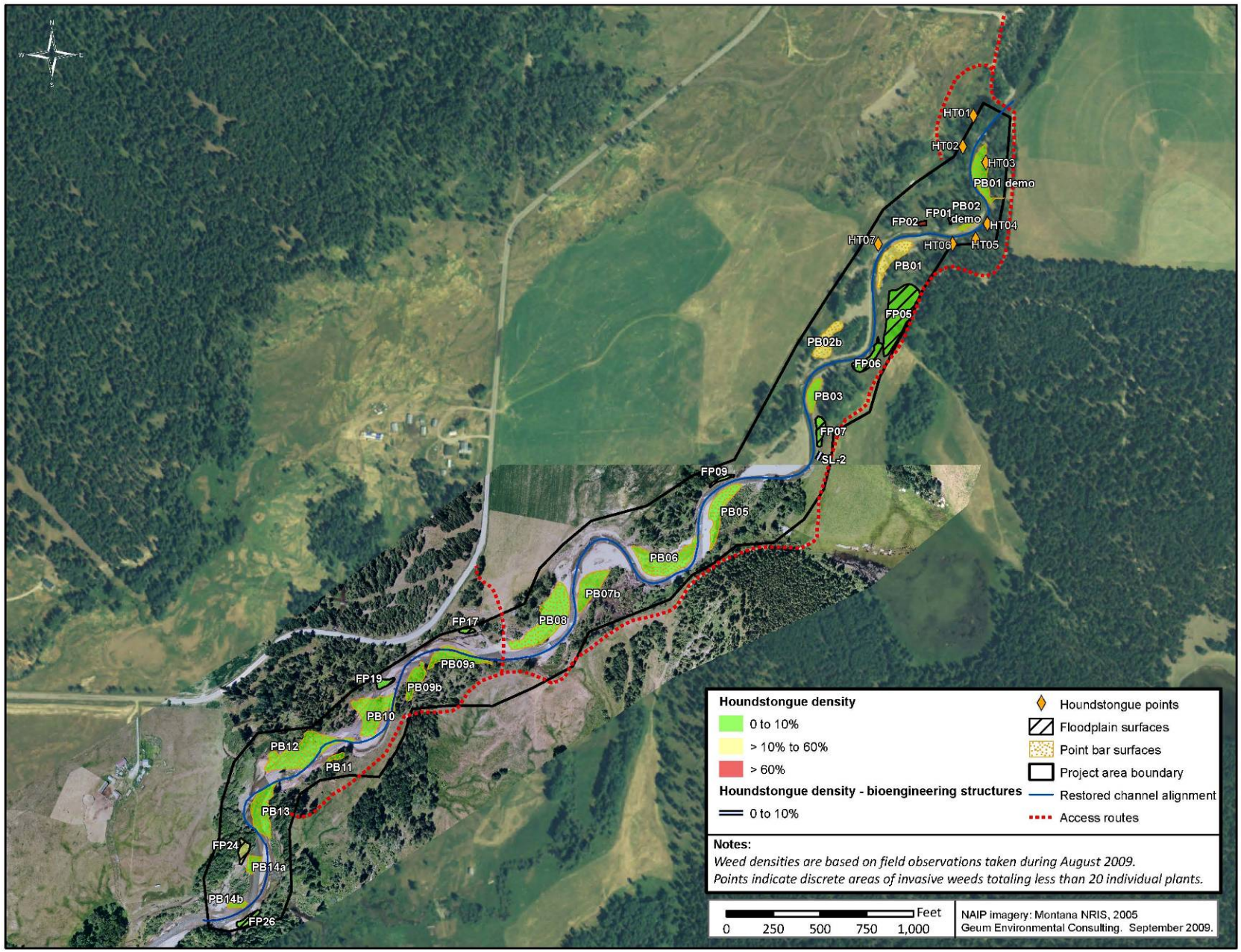


Figure A-4. Houndstongue distribution and abundance in the Grave Creek project area.

Linaria vulgaris (yellow toadflax)

Description

Yellow toadflax is in the Scrophulariaceae family. It is a Category 1 noxious weed in Montana. It is a perennial forb that reproduces and spreads by seed and adventitious root buds (Carpenter and Murray 1998). It grows between one and three feet tall and has narrow, linear leaves. Its yellow flowers resemble those of Dalmatian toadflax, but the leaves are very different (Zouhar 2003). The leaves of yellow toadflax are narrower and more linear that the leaves of Dalmatian toadflax (Figures A-17 and A-18). Yellow toadflax seed can remain viable in the soil for up to ten years (Carpenter and Murray 1998). Yellow toadflax is an intense competitor for available soil resources and can displace native plant communities. It is also moderately toxic to livestock.

Location and Abundance

In the Grave Creek project area, yellow toadflax infestations occur primarily on point bar surfaces with relatively low density of coverage. A few spot infestations occur on floodplain surfaces throughout the project area. One larger floodplain polygon has low density of yellow toadflax (Figure A-5).

Methods of Control

Herbicide treatment can be effective in managing yellow toadflax but applications must be repeated and typically require a high rate of application. Cutting will remove the current year's seed production, but plants can regrow from the base or root and therefore cutting is not an effective method of control. Repeated hand pulling can be effective particularly in young infestations before extensive root systems develop. Biological control agents are available for yellow toadflax but the current population size and density is likely not sufficient to support a release of biological control agents.

Recommended Methods of Control

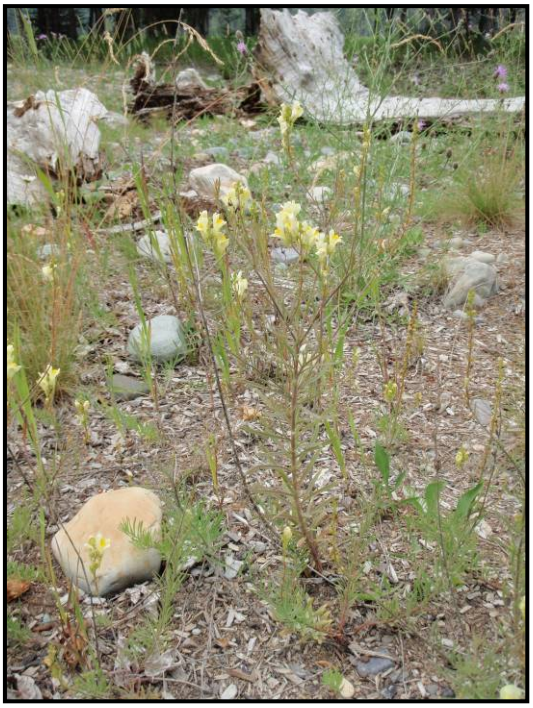
Point Bars and Bioengineering Structures

Yellow toadflax was not observed on bioengineering structures in 2009. Yellow toadflax on point bars should be pulled by hand to reduce possible damage to establishing willows and cottonwoods. Hand pulling should be done prior to seed set to reduce additional seed input to the site. Hand pulling should remove as much of the root as possible. If hand pulling is not effectively reducing cover of yellow toadflax, then targeted application of herbicide may be needed. If herbicide application is determined to be necessary, then treatments should be completed using backpack or hand line application methods that will limit damage to non-target species and continue to allow cottonwoods and willows to establish in these areas.

Floodplain Surfaces

Floodplain infestations of yellow toadflax should be treated with herbicide application. The larger floodplain infestations (FP04, FP05, FP07 and FP10) may be treated using broadcast application methods, but smaller infestations should be treated using more selective hand line treatments. Point infestations of yellow toadflax can be treated using either spot hand line or backpack treatments or by hand pulling if soil conditions permit removal of the root. As infestations decrease in size, hand line or broadcast treatment methods that limit damage to non-

target species should be implemented. Supplemental seeding may be necessary if natural recruitment of desired native species is not occurring to discourage re-invasion of the project area by the species.




Photos A-17 and A-18. Photos of flowering yellow toadflax in the project area.


Photos A-19 and A-20. Photos showing example locations of yellow toadflax on point bar surfaces in the project area.

Photo A-21. Photo showing infestation of yellow toadflax (point TD04) in flower on the floodplain surface in the project area.

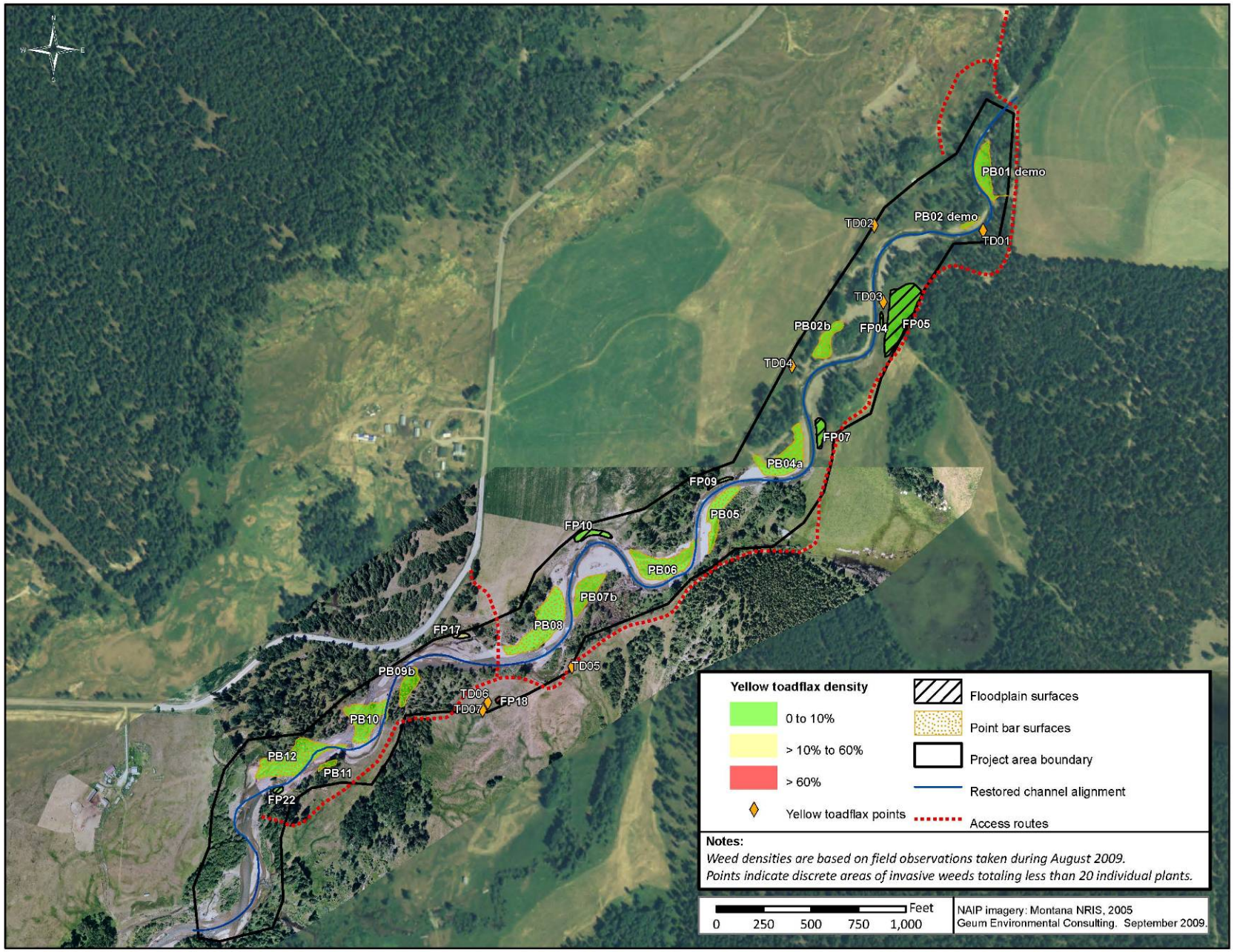


Figure A-5. Yellow toadflax distribution and abundance in the Grave Creek project area.

Potentilla recta (sulfur cinquefoil)

Description

Sulfur cinquefoil is in the Rosaceae family. It is a Category 1 noxious weed in Montana. Sulfur cinquefoil is a perennial forb that grows from one to 1.5 feet tall. It has white to yellow flowers that appear from May to July (Whitson and others 1996) (Photo A-22). Native cinquefoils may also be present in the project area, but sulfur cinquefoil can be distinguished from native cinquefoils by long, erect hairs that extend out from the stem at 90 degree angles. Sulfur cinquefoil is one of the first plants to emerge in the spring, which provides it with a competitive edge that allows it to become established and displace native plants.

Location and Abundance

Three infestations with low density occur on floodplain surfaces in the Grave Creek project area (Figure A-6). One spot infestation also occurs in the floodplain. One vegetated soil lift also has sulfur cinquefoil.

Methods of Control

Hand pulling may be an effective control method for small populations and if repeated persistently can reduce populations. The caudex (woody base of the stem which has regenerative buds) must be removed for pulling to be effective (NRCS 2007). Cutting or mowing can reduce seed production but will not eliminate infestations. Grazing is not effective because most livestock avoid eating the plants. Grazing by goats, which have a high tolerance for tannins, can be effective if concentrated in infestation areas. Cultivation may also not be effective in controlling sulfur cinquefoil and may actually result in spread of the species. Prescribed burning is not an effective control method because the woody caudex which contains regenerative buds may not be killed except by high temperature fires. Supplemental seeding is moderately effective as a follow-up treatment. Herbicide treatments are effective in controlling sulfur cinquefoil (NRCS 2004 and 2007).

Recommended Methods of Control

Point Bars and Bioengineering Structures

Sulfur cinquefoil was not found on point bar surfaces, but these areas should be closely monitored to detect any new invasions early. If any plants are found on point surfaces they should be pulled by hand and their location should be noted so follow-up monitoring can determine if hand pulling is effectively managing the species.

Sulfur cinquefoil was recorded on one vegetated soil lift and these plants should be pulled by hand to reduce possible damage to non-target species at this site. Hand pulling should be done during the same spring and fall timeframe as hand pulling for spotted knapweed. Hand pulling should remove as much of the root as possible and the soil lift should be closely monitored to determine if hand pulling is effectively managing the species. If it appears that hand pulling is not effectively reducing cover of sulfur cinquefoil, then targeted application of herbicide may be needed. If herbicide application is determined to be necessary, then treatments should be completed using backpack or hand line application methods that will limit damage to non-target species.

Floodplain Surfaces

Floodplain infestations of sulfur cinquefoil should be treated with herbicide application. The larger floodplain infestations (FP05, FP06 and FP08) can be treated using broadcast application methods. The point infestation (SC01) of sulfur cinquefoil can be treated using either hand line or backpack methods or by hand pulling if soil conditions permit removal of the root. As infestations decrease in size, hand line or backpack treatment methods that limit damage to non-target species should be implemented.

Photo A-22. Photo of a flowering sulfur cinquefoil plant on the floodplain surface in the project area.

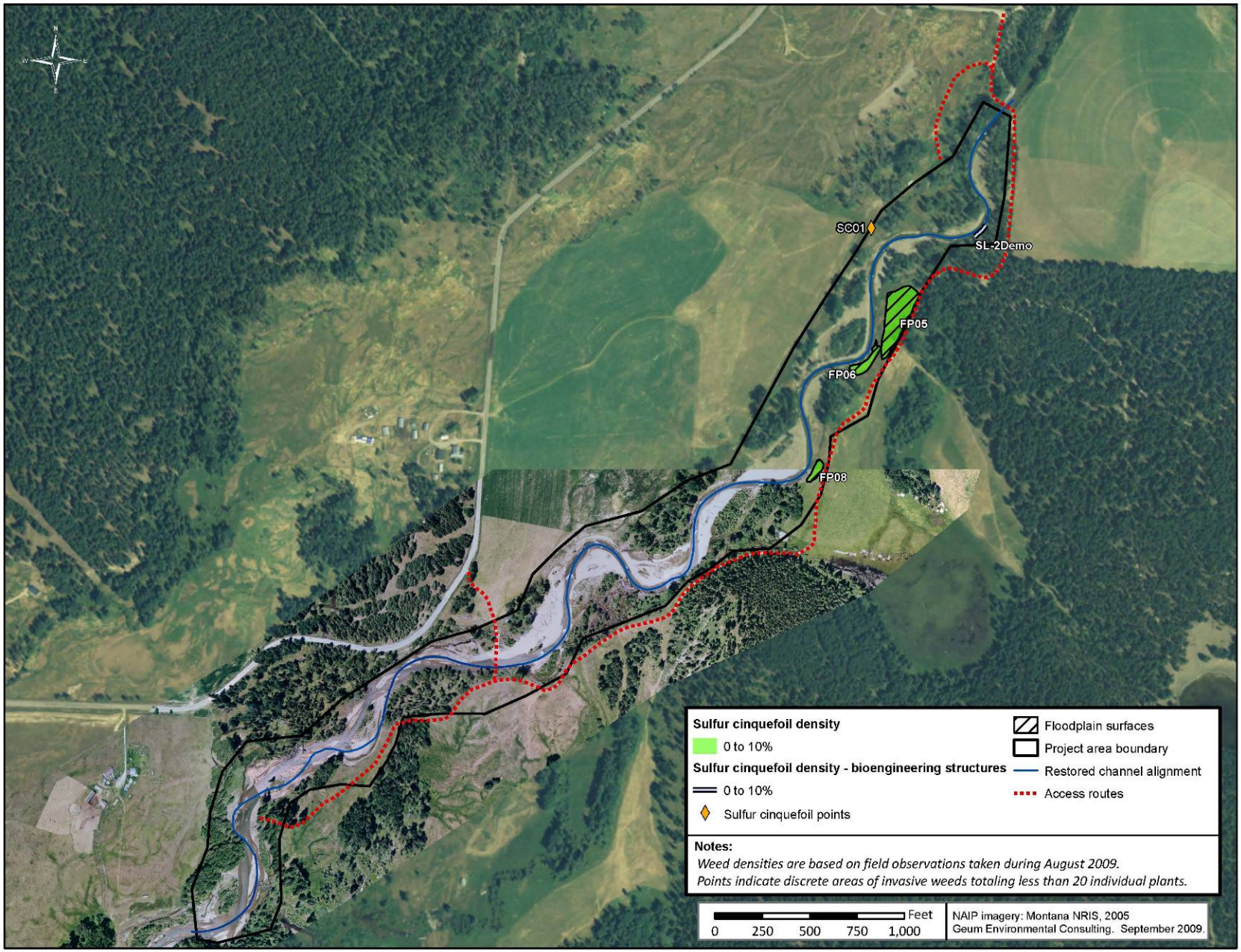


Figure A-6. Sulfur cinquefoil distribution and abundance in the Grave Creek project area.

Notes on Herbicide Use

Herbicide application is recommended for weed infestations on floodplain surfaces. Many of the polygons identified within the project area have multiple weed species present. The choice of herbicides will depend on the species composition within a particular area. Multiple treatments or application methods may be necessary to target each species; however, some herbicides may be able to control multiple species within an area.

All herbicides should be applied according to the manufacturers label and following all laws related to application of herbicides. Any restricted use herbicides should be applied by a licensed applicator. The use of a specific herbicide will depend on the location of the infestation to be treated relative to surface and groundwater, the time of year for application, and the presence of non-target species.

Appendix A References

Carpenter, Alan T. and Thomas A. Murray 1998. Element Stewardship Abstract for *Linaria genistifolia* (L.) P. Miller ssp. *dalmatica* (L.) Maire & Petitmengin (Synonym: *Linaria dalmatica* (L.) P. Miller) and *Linaria vulgaris* P. Miller, Dalmatian toadflax, Broad-leaved toadflax and Yellow toadflax, Butter and eggs, Wild snapdragon, Common toadflax. The Nature Conservancy.

MSU. 2009. Houndstongue: Identification, Biology and Integrated Management. MontGuide MT 199709AG 8/09. Montana State University Extension Bozeman, Montana.

NRCS. 2004. Noxious Weed Treatment Quick Reference, Poster. Natural Resources Conservation Service, poster developed by the 2004 Montana Noxious Weed Calendar Advisory Committee.

NRCS. 2007. Ecology and Management of Sulfur Cinquefoil (*Potentilla recta* L.). United States Department of Agriculture. Natural Resources Conservation Service. Invasive Species Technical Note No. MT-17. December 2007.

Sheley, Roger L, and Janet K. Petroff. 1999. Biology and Management of Noxious Rangeland Weeds. Oregon State University Press, Corvallis, Oregon.

Whitson, Tom D., Larry C. Burrill, Steven A. Dewey, David W. Cudney, B.E. Nelson, Richard D. Lee, and Robert Parker. 1996. Weeds of the West. Published by the University of Wyoming in cooperation with the Western Society of Weed Science, the Western United States Land Grant University Cooperative Extension Service. Printed by Pioneer of Jackson Hole, Jackson, Wyoming.

Williams, Dan. 2009. Personal communication from Dan Williams, Department Head, Lincoln County Weed Department Libby, Montana to Sarah Flynn, project biologist, Geum Environmental Consulting, Inc., Hamilton, MT. Phone conversation, November 19, 2009.

Zouhar, Kris. 2003. Linaria spp. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2007, January 30].

Appendix B: Montana County Noxious Weed List

Category 1:
Category 1 noxious weeds are weeds that are currently established and generally widespread in many counties of the state. Management criteria include awareness and education, containment and suppression of existing infestations and prevention of new infestations. These weeds are capable of rapid spread and render land unfit or greatly limit beneficial uses.

(a) Canada thistle (*Cirsium arvense*)
(b) Field bindweed (*Convolvulus arvensis*)
(c) Whitetop or Hoary cress (*Cardaria draba*)
(d) Leafy spurge (*Euphorbia esula*)
(e) Russian knapweed (*Centaurea repens*)
(f) Spotted knapweed (*Centaurea maculosa*)
(g) Diffuse knapweed (*Centaurea diffusa*)
(h) Dalmatian toadflax (*Linaria dalmatica*)
(i) St. Johnswort (*Hypericum perforatum*)
(j) Sulfur (Erect) cinquefoil (*Potentilla recta*)
(k) Common tansy (*Tanacetum vulgare*)
(l) Oxeye-daisy (*Chrysanthemum leucanthemum* L.)
(m) Houndstongue (*Cynoglossum officinale* L.)
(n) Yellow toadflax (*Linaria vulgaris*)
(o) Hoary alyssum (*Berteroa incana)*

Category 2:
Category 2 noxious weeds have recently been introduced into the state or are rapidly spreading from their current infestation sites. These weeds are capable of rapid spread and invasion of lands, rendering lands unfit for beneficial uses. Management criteria include awareness and education, monitoring and containment of known infestations and eradication where possible.

(a) Purple loosestrife or lythrum (*Lythrum salicaria*, *L. virgatum*, and any hybrid crosses)
(b) Tansy ragwort (*Senecio jacobea* L.)
(c) Meadow hawkweed complex (*Hieracium pratense*, *H. floribundum*, *H. piloselloides*)
(d) Orange hawkweed (*Hieracium aurantiacum* L.)
(e) Tall buttercup (*Ranunculus acris* L.)
(f) Tamarisk [Saltcedar] (*Tamarix* spp.)
(g) Perennial pepperweed (*Lepidium latifolium*)
(h) Rush skeletonweed (*Chondrilla juncea*)
(i) Yellowflag iris (*Iris pseudacorus*)
(j) Blueweed (*Echium vulgare)*

Category 3:
Category 3 noxious weeds have not been detected in the state or may be found only in small, scattered, localized infestations. Management criteria include awareness and education, early detection and immediate action to eradicate infestations. These weeds are known pests in nearby states and are capable of rapid spread and render land unfit for beneficial uses.

(a) Yellow starthistle (*Centaurea solstitialis*)
(b) Common crupina (*Crupina vulgaris*)
(c) Eurasian watermilfoil (*Myriophyllum spicatum*)
(d) Dyer's woad (*Isatis tinctoria*)
(e) Flowering rush (*Butomus umbellatus)*
(f) Japanese knotweed complex (*Polygonum cuspidatum, sachalinense & polystachyum)*

Category 4:
Category 4 noxious weeds are invasive plants and may cause significant economic or environmental impacts if allowed to become established in Montana. Management criteria include prohibition from sale by the nursery trade. Research and monitoring may result in the plant being listed in a different category.

(a) Scotch broom (*Cytisus scoparius)*

Appendix B References

Montana Department of Agriculture. 2009. Montana County Noxious Weed List, effective March 27, 2008. Accessed at [http://agr.mt.gov/weedpest/pdf/weedlist3-08.pdf].

Appendix C: Lincoln County, Montana Noxious Weed List

Lincoln County follows the Montana State Noxious weed list, but it also maintains a list of additional noxious weed species for the county detailed in Table C-1 below. Lincoln County recommends active management of these species in addition to the State Noxious weeds.

Table C-1. Additional species listed as noxious weeds by Lincoln County, Montana as of June 2009 (Montana Department of Agriculture 2009).

Scientific Name	Common Name
Anchusa officinalis	Bugloss
*Arctium lappa (*synonym *A. minus)*	Burdock
Artemisia absinthium	Absinth wormwood
Carduus acanthoides	Plumeless thistle
Carduus nutans	Musk thistle
Centaurea pratensis	Meadow knapweed
Chaenorrhinum minus	Dwarf snapdragon
Cichorium intybus	Chicory
Conium maculatum	Poison hemlock
Hypochaeris radicata	Spotted cat's-ear
Kochia scoparia	Kochia
Matricaria maritima	Scentless chamomile
Onopordum acanthium	Scotch thistle
Veronica chamaedrys	Germander speedwell
Veronica officinalis	Common speedwell

Note: None of these species are known to occur in the project area.

Appendix C References

Montana Department of Agriculture. 2009. County-Listed Noxious Weeds. Montana Noxious Weed Program. Accessed at [http://agr.mt.gov/weedpest/pdf/countyList6-09.pdf].

Appendix D: Licensed Herbicide Applicators in Lincoln County, Montana and Potential Funding Sources for Vegetation Management Activities

Licensed Herbicide Applicators in Lincoln County, Montana

Kootenai Services – (406) 889-3810

Potential Funding Sources for Vegetation Management Activities

Grant funding for completing weed control is available through the Montana Noxious Weed Trust Fund. The program provides cost share funding for local cooperative weed management areas with at least three landowners. Details about the program and application forms can be found through the Montana Department of Agriculture's website at: http://agr.mt.gov/weedpest/trustFund.asp.